Englobe
Soils Materials Environment

Department of National Defence / Defence Construction Canada

HUMAN HEALTH AND ECOLOGICAL RISK ASSESSMENT FORMER USAF RADAR STATION, CARTWIRGHT, NL

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FINAL REPORT

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Executive Summary

A Risk Assessment in the form of a HHERA has been conducted by Englobe at the Former USAF Radar Station located in Cartwright, Labrador. This report presents a summary of the findings. Work is based on results of the previous Phase III ESA conducted by Englobe and the Phase II ESA conducted by Stantec. The request for this work was made by DCC, on behalf of the DND.

For ease of review, the reader is directed to the acronym list on (page vii).

The site was established in 1953 as a General Surveillance Radar Station, funded by the USAF and operated until 1968. The former operational areas of the site covered approximately 25 hectares. It was used to guide interceptor aircraft towards unidentified intruders as a Ground-Control Intercept and warning station as part of the Pinetree Line. In total, the site contained four Troposcatter Communication Antennas, four Radomes, barracks and recreational facilities, all connected together as one Main Complex on the hillside overlooking the Town of Cartwright. Fuel storage facilities were located near the community docks (known as the lower POL) and connected to the upper POL tank at the radar site. Fuel was pumped from ASTs in the lower POL via an aboveground pipeline to a large steel AST on the hill, which in turn supplied smaller ASTs for the diesel generators used to power the station. Historically, solid waste was disposed of in an unlined landfill to the east of the Main Complex, which was covered and graded in 1988. Solid waste was also reportedly buried or covered in a ravine located between the main complex and the main POL tank.

In 1968 the USAF transferred control of the site to the Canadian Forces and the site was officially decommissioned in 1987 with the razing of the remaining buildings/structures. Only the concrete foundations of the former buildings and former radar towers remain at the site. The property is currently owned by the province of Newfoundland and Labrador.

The site is currently vacant (with the exception of the Bell microwave station and CCG Navtex and MF Rx Communication Towers), and is largely treed and overgrown, with some partially cleared areas remaining. Access to the site from Cartwright is via a dirt and gravel road. Former infrastructure associated with the USAF Radar Stataion has been demolished. Only the concrete foundations of the former buildings and radar towers remain.

The Phase II ESA completed by Stantec in 2017 and the Phase III ESA completed by Englobe in 2018 investigated PHC, PAH, metals, VOC and PCB impacts in soil, sediment, groundwater and surface water within the General Area of the site, as well as three smaller study areas. The three areas of investigation were the Former Contractor Village, the Main Complex, and the Former USAF Dump Area and Former Ammunition Storage Area. Metals and PCB analysis of vegetation and berries was also conducted.

The findings of the HHRA at the Former USAF Radar Station are as follows:

- Commercial workers would only be expected to visit the General Area; there are no communication towers or other anticipated access (i.e. helicopter pad) in the Former Contractor Village, Main Complex or Former USAF Dump Area and Former Ammunition Storage Area. There were no COPCs that exceeded the generic screening levels for human health in the General Area, and the commercial worker would not be expected to visit other study areas at the site as part of their regular duties. Further, the commercial worker would

not be expected to hunt and consume game from the site during their regular duties. Therefore, the commercial worker exposure scenario is considered to have been adequately addressed, and potential for adverse human effects for the commercial worker is negligible.

- For recreational and indigenous receptors at the General Area, there were no COPCs in soil that exceeded the screening levels for human health, although potential existed for indirect exposure to PCBs through the ingestion of country foods (berries and game). The evaluation of ingestion of country foods revealed HQs less than the target values.
- For recreational and indigenous receptors at the Former Contractor Village, there were no COPCs in soil that exceeded the screening levels for human health, although potential existed for indirect exposure to PCBs through the ingestion of country foods (berries and game). The evaluation of ingestion of country foods revealed HQs less than the target values.
- For recreational and indigenous receptors at the Main Complex, the EPC value for BaP TPE in soil exceeded the human health screening level. Also, potential existed for indirect exposure to PCBs through the ingestion of country foods (berries and game). The calculated ILCR for BaP TPE in soil was less than the target risk of $1x10^{-5}$ and the maximum concentration was less than the SSTL. The evaluation of ingestion of country foods revealed HQs less than the target values.
- For recreational and indigenous receptors at the Former Dump Area and Former Ammunition Storage Area, the EPC values for PCBs and BaP TPE exceeded the human health screening levels. The HQ for PCBs in soil was less than 0.2, the calculated ILCR was less than the target risk of $1x10^{-5}$ and the maximum concentration was less than the SSTL. The calculated ILCR for BaP TPE was less than the target risk of $1x10^{-5}$ and the maximum concentration for was less than the SSTL. The evaluation of ingestion of country foods revealed HQs less than the target values.
- Based on the results of the HHRA, the site is considered to pose a low risk to human receptors and therefore does not require additional assessment or risk management at this time.

The findings of the ERA at the Former USAF Radar Station are as follows:

- In the General Area, COPC in soil, sediment, groundwater and surface water were not carried forward for further assessment based on the ecological screening carried out. Vegetation samples from the General Area contained detectable concentrations of PCBs. Therefore, PCBs were carried forward for further assessment.
- In the Former Contractor Village, COPC in soil, sediment, groundwater and surface water were not carried forward for further assessment based on the ecological screening carried out. Vegetation samples from the Former Contractor Village contained detectable concentrations of PCBs. Therefore, PCBs were carried forward for further assessment.
- In the Main Complex, benzo(a)pyrene in soil was carried forward for further assessment based on the ecological screening carried out. COPC in sediment, groundwater and surface water in the Main Complex were not carried forward for further assessment. Vegetation samples from the Main Complex contained detectable concentrations of PCBs. Therefore, PCBs were carried forward for further assessment.
- In the Former USAF Dump Area and Former Ammunition Storage Area, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, chrysene, dibenzo(a,h)anthracene, fluoranthene and total PCB in soil were carried forward for further assessment based on the ecological screening carried out. COPC in sediment, groundwater and surface water in the Former USAF Dump Area and Former Ammunition Storage Area were not carried forward for further assessment. Vegetation samples from the Former USAF

Dump Area and Former Ammunition Storage Area contained detectable concentrations of PCBs. Therefore, PCBs were carried forward for further assessment.

- A quantitative risk assessment that included food web modelling and the calculation of EHQ values for representative species at the site was conducted.
- In the General Area, the EHQ values (LOAEL) for all species were less than 1 for all COPCs indicating that the current conditions in the General Area are unlikely to pose a significant risk. The EHQ (NOAEL) calculated for all ROC evaluated except for PCBs for the American robin were less than 1, indicating that the current conditions in the General Area are unlikely to pose a significant risk for most ROC evaluated.
- In the General Area, in consideration of several LOE, the EHQ (NOAEL) for the American robin do not indicate a likelihood of harmful effects to the American robin or other small birds it represents at this site. As a result of these conservative aspects of the analysis, it is unlikely that population level effects will be observed due to PCB exposure of SAR at the General Area.
- In the Former Contractor Village, the EHQ values (LOAEL) for all species were less than 1 for all COPCs, indicating that the current conditions in the Former Contractor Village are unlikely to pose a significant risk. The EHQ (NOAEL) calculated for all ROC evaluated except for PCBs for the American robin were less than 1, indicating that the current conditions in the Former Contractor Village are unlikely to pose a significant risk for most ROC evaluated.
- In the Former Contractor Village, in consideration of several LOE, the EHQ (NOAEL) for the American robin do not indicate a likelihood of harmful effects to the American robin or other small birds it represents at this site. As a result of these conservative aspects of the analysis, it is unlikely that population level effects will be observed due to PCB exposure of SAR at the Former Contractor Village.
- In the Main Complex, the EHQ values (LOAEL) for all ROC evaluated except for PCBs for the masked shrew were less than 1, indicating that the current conditions in the Main Complex are unlikely to pose a significant risk. Also, the EHQ (NOAEL) calculated for all ROC evaluated except for PCBs for the American robin were less than 1, indicating that the current conditions in the Main Complex are unlikely to pose a significant risk for most ROC evaluated.
- In the Main Complex, in consideration of several LOE, the EHQ (LOAEL) for the Masked shrew and the EHQ (NOAEL) for the American robin do not indicate a likelihood of harmful effects to the Masked shrew, American robin or other small mammals or birds they represent at this site. As a result of these conservative aspects of the analysis, it is unlikely that population level effects will be observed due to PCB exposure of SAR at the Main Complex.
- In the Former USAF Dump Area and Former Ammunition Storage Area, the EHQ values (LOAEL) for all ROC evaluated except for PCBs for the masked shrew and American robin were less than 1, indicating that the current conditions in the Former USAF Dump Area and Former Ammunition Storage Area are unlikely to pose a significant risk to most ROC. Also, the EHQ (NOAEL) calculated for all ROC evaluated except for PCBs for the Red fox and American robin, and fluoranthene for the American robin, were less than 1, indicating that the current conditions in the Former USAF Dump Area and Former Ammunition Storage Area are unlikely to pose a significant risk for most ROC evaluated.
- In the Former USAF Dump Area and Former Ammunition Storage Area, in consideration of several LOE, it is unlikely that population level effects will be observed due to PCB exposure to ROC and potential SAR at the Former USAF Dump Area and Former Ammunition Storage Area, however, to achieve greater certainty in the conclusion, the “hot spot” would need to be removed or managed, or site specific invertebrate tissue be collected.

- In the Former USAF Dump Area and Former Ammunition Storage Area, in consideration of several LOE, it is unlikely that population level effects will be observed due to fluoranthene exposure of SAR at the Former USAF Dump Area and Former Ammunition Storage Area.
- It should be noted that based on the lack of a suitable TRV for HMW PAHs it is uncertain if there is a potential risk to potential avian receptors from these COPC in the Main Complex and Former USAF Dump Area and Former Ammunition Storage Area, although based on the EQH values for LMW PAHs, the risk is expected to be low.
- In the General Area, substantive site-related risks to ecological receptors, including plant and soil invertebrate communities, mammals, birds, and species at risk from COPC were not identified. Risk management for ecological receptors is not recommended.
- In the Former Contractor Village, substantive site-related risks to ecological receptors, including plant and soil invertebrate communities, mammals, birds, and species at risk from COPC were not identified. Risk management for ecological receptors is not recommended.
- In the Main Complex, substantive site-related risks to ecological receptors, including plant and soil invertebrate communities, mammals, birds, and species at risk from COPC were not identified. Risk management for ecological receptors is not recommended.
- In the Former USAF Dump Area and Former Ammunition Storage Area, substantive population-related risks to ecological receptors, including plant and soil invertebrate communities, mammals, birds, and species at risk from COPC were not identified. However, localized site risks may be present to some ROC (Masked shrew) and to potential SAR (Rusty blackbird) related to the one PCB “hot spot”. The “hot spot” should be removed or risk managed, or site-specific invertebrate tissue be collected to provide greater confidence in EPC values used in the food web modelling.

Based on the results of the HHERA, Englobe provides the following recommendations:

- Soil from the “hot spot” identified at sample location CWT-TP3-BS2 (24 mg/kg) in the Former USAF Dump Area and Former Ammunition Storage Area should be excavated and transported to an appropriate disposal facility.

ACRONYM LIST

2378-TCDD	2,3,7,8-tetrachlorodibenzo-p-dioxin
ACCDC	Atlantic Canada Conservation Data Centre
ACM	Asbestos Containing Material
ADD	Average Daily Dose
AF	Absorption Factor
ARBCA	Atlantic Risk Based Corrective Action
AST	Aboveground Storage Tank
BaP TPE	Benzo[a]pyrene Total Potency Equivalent
BEDS	Biological Effects Database for Sediment
BTEX	Benzene, Toluene, Ethylbenzene, Xylenes
BW	Body Weight
CCG	Canadian Coast Guard
CCME	Canadian Council of Ministers of Environment
cm	Centimeter
COPC	Chemical of potential concern
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CSF	Cancer slope factor
CSM	Conceptual Site Model
CWS	Canada Wide Standard
DCC	Defence Construction Canada
DND	Department of National Defence
DOC	Dissolved organic carbon
ECCC	Environment and Climate Change Canada
EHQ	Environmental Hazard Quotient
Englobe	Englobe Corp.
EPC	Exposure Point Concentration
ERA	Ecological Risk Assessment
ESA	Environmental Site Assessment
ESL	Ecological Screening Level
FAL	Freshwater aquatic life
FCSAP	Federal Contaminated Sites Action Plan
F_{OC}	Fraction of Organic Carbon
GHD	GHD Limited
HHERA	Human Health and Ecological Risk Assessment
HHRA	Human Health Risk Assessment
HMW	High Molecular Weight
IF	Intake Factor
ILCR	Incremental lifetime cancer risk
ISQG	Interim Sediment Quality Guidelines
km	Kilometer
LMW	Low Molecular Weight
m^3	Meters cubed
MF Rx	Medium Frequency Radio
mm	Millimeter
MSL	Maximum screening level
NLMAE	Newfoundland Municipal Affairs and Environment.
OMOE	Ontario Ministry of the Environment

PAH	Polycyclic Aromatic Hydrocarbons
PCB	Polychlorinated Biphenyls
PEL	Probable Effects Level
PHC	Petroleum hydrocarbon
POL	Petroleum Oil and Lubricants
PSSL	Pathway specific screening level
RAP	Remedial action Plan
RBCA	Risk Based Corrective Action
RBSL	Risk based screening level
RDL	Routine Detection Limit
RES	Residential
ROC	Receptor of Concern
SARA	Species at Risk Act
SOL	Solubility Limit
SQG	Soil quality guideline
SRA	Species at Risk Act
SSTL	Site Specific Screening Level
Stassinu Stantec Ltd.	Stantec
TC	Tolerable Concentration
TDI	Total Daily Intake
TEF	Toxic equivalency factor
TEQ	Total toxic equivalent
TOC	Total Organic Carbon
TPH	Total Petroleum Hydrocarbons
TRV	Toxicological Reference Value
UCL	Upper confidence level
USEPA	United States Environmental Protection Agency
USFA	United States Air Force
VOC	Volatile Organic Compounds
WHO	World Health Organization

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Property and Confidentiality

"This report was prepared for the exclusive use of DCC/DND and is based on data and information provided to Englobe and obtained during field work by Englobe on the subject sites including soil, groundwater, surface water and sediment sampling and select chemical analyses; and is based solely upon the condition of the property on the date of such work, supplemented by information obtained and described herein. Any use that a third party makes of this report, or any reliance on or decisions made based on it, are the sole responsibility of the third party. Englobe accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

The evaluation and conclusions contained in this report have been prepared in light of the expertise and experience of Englobe.

Environmental conditions are dynamic in nature and changing circumstances in the environment and in the use of the property can alter radically the conclusions and information contained herein."

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1 Introduction

A Risk Assessment in the form of a HHERA has been conducted by Englobe at the Former USAF Radar Station located in Cartwright, Labrador. This report presents a summary of the findings. Work is based on results of the previous Phase III ESA conducted by Englobe and the Phase II ESA conducted by Stantec. The request for this work was made by DCC, on behalf of the DND.

The HHERA was based on accepted risk assessment standards including those published by Health Canada (2010a, 2010b, 2010c), ECCC (2012) and ARBCA (2012, rev. 2015). The assessment involved the following:

- COPC Selection;
- Hazard Identification;
- Receptor Identification;
- Exposure Assessment;
- Risk Characterization;
- Target Level Determination, if relevant;
- Uncertainty Assessment; and
- Recommendations.

For ease of review, the reader is directed to the acronym list on (page vii).

1.1 Objectives of the Assessment

The purpose of this study was to evaluate potential risks associated with COPCs at the site and, if concentrations exceeded screening levels or established SSTLs, to assess requirements for risk management or remediation. The objectives were to:

- Conduct separate human health and ecological risk screenings;
- Conduct a quantitative HHRA with the available data, if required;
- Conduct a quantitative ERA with the available data, if required; and
- Complete a report summarizing all the findings, including risk management recommendations.

2 Background Information

2.1 History of the Site

The site was established in 1953 as a General Surveillance Radar Station, funded by the USAF and operated until 1968. The former operational areas of the site covered approximately 25 hectares. It was used to guide interceptor aircraft towards unidentified intruders as a Ground-Control Intercept and warning station as part of the Pinetree Line. In total, the site contained four Troposcatter Communication Antennas, four Radomes, barracks and recreational facilities, all connected together as one Main Complex on the hillside overlooking the Town of Cartwright. Fuel storage facilities were located near the community docks (known as the lower POL) and connected to the upper POL tank at the radar site. Fuel was pumped from ASTs in the lower POL via an aboveground pipeline to a large steel AST on the hill, which in turn supplied smaller ASTs for the diesel generators used to power the station. Historically, solid waste was disposed of in an unlined landfill to the east of the Main Complex, which was covered and graded in 1988. Solid waste was also reportedly buried or covered in a ravine located between the main complex and the main POL tank.

In 1968 the USAF transferred control of the site to the Canadian Forces and the site was officially decommissioned in 1987 with the razing of the remaining buildings/structures. Only the concrete foundations of the former buildings and former radar towers remain at the site. The property is currently owned by the province of Newfoundland and Labrador.

2.2 Site and Area Descriptions

The subject property is identified as the Cartwright Former USAF Radar Station, located 4 km northeast of Cartwright, Labrador. A site location map and site plan are provided as Figure 1 and Figure 2 in Appendix A.

The site is currently vacant (with the exception of the Bell microwave station and CCG Navtex and MF Rx Communication Towers), and is largely treed and overgrown, with some partially cleared areas remaining. Access to the site from Cartwright is via a dirt and gravel road. Former infrastructure associated with the USAF Radar Stataion has been demolished. Only the concrete foundations of the former buildings and radar towers remain.

The Phase II ESA completed by Stantec in 2017 and the Phase III ESA completed by Englobe in 2018, investigated impacts in three smaller study areas, as shown in Figures 3, 4 and 5, located in Appendix A. The three areas of investigation were the Former Contractor Village, the Main Complex, and the Former USAF Dump Area and Former Ammunition Storage Area.

The General Area (Figure 2) consists of access routes between the three smaller study areas, the communication towers, helicopter pad, as well as other former areas of the site that were used, such as former potable water pump house. A helicopter pad is still present at the site and is still used by CCG, and a gazebo and picnic table are present near the helicopter pad. Potable water was formerly supplied by an un-named pond present in this area.

The Former Contractor Village (Figure 3) is located along the shoreline of Sandwich Bay and contains a poorly maintained gravel road. It formerly contained a drum-storage area, motor pool, barracks, mess hall, medical dispensary and a dock.

The Main Complex (Figure 4) contains a gravel road. It formerly contained an above ground waterline, above ground PHC pipeline, PHC ASTs, troposcatter communication antennas and multiple buildings. A historical PCB spill was discovered within this area in 1979 and subsequently remediated.

The Former USAF Dump Area and Former Ammunition Storage Area (Figure 5) contains a gravel road. It formerly contained a dumping area (subsequently capped) and former ammunition storage area. A historical PCB clean up occurred in this area in 1987.

An existing municipal landfill, two former municipal landfills, two DFO/Coast Guard communication towers and a Bell communication tower are present within the boundary of the site, but are not included in the scope of this HHERA work. The land surrounding the site consists of undeveloped land.

The subject site slopes away from the Main Complex (the high point of the site at approximately 170 m above sea level) on all sides, toward Sandwich Bay to the north and west, toward Goose Cove to the east, and toward Larks Harbour Pond to the south. An unnamed brook drains from Larks Harbour Pond to Sandwich Bay. Regional topography slopes generally downward to Sandwich Bay, the exact direction of which depends on location with respect to Sandwich Bay.

2.2.1 Geology and Hydrogeology

Available surficial geology mapping of the area indicates that the site contains native surficial soils consisting of a mixture of discontinuous, non-stratified, poorly sorted silty to sandy diamicton, gravel, and sandy gravel with exposed bedrock in places (Klassen et al., 1992).

Geological mapping indicates that the site is underlain by late Paleoproterozoic bedrock of the Grenville, Nain and Makkovik provinces. Bedrock consists of granite, quartz, monzonite, granodiorite, syenite and minor quartz diorite (Wardle et al., 1997 and Gower, 2010).

Local shallow groundwater is expected to flow toward Sandwich Bay, the exact direction of which depends on location with respect to Sandwich Bay.

2.2.2 Meteorological Conditions

Meteorological data were extracted from ECCC's Canadian Climate Normals 1981-2010 webpage, using data from the Cartwright, NL station (53°42'30.000"N, 57°02'06.000"W) (ECCC, 2018).

January and August are the coldest (-14.3 °C) and warmest (12.7 °C) months, respectively, with an annual average temperature of 0 °C. Yearly rainfall amounts to 616.8 mm, while yearly snowfall amounts to 462.0 cm. Snow covers the ground (≥ 1 cm) for 190.1 days in a year, generally between the months of October and June. Average windspeed is calculated at 19.8 km/h (5.5 m/s) with southwest (SW) being the most frequent wind direction.

2.2.3 Site Habitat Description

The Cartwright site lies within the Coastal Barrens ecoregion in Newfoundland and Labrador, which is represented by islands, exposed headlands, and protected inlets, from Napaktok Bay south to the Strait of Belle Isle (Government of Newfoundland, 2018a). More precisely, it is situated in the Boreal Shield Ecozone, characterized by vast stretches of trees, lakes and rivers, and exposed bedrock (Government of Newfoundland, 2018b).

The site habitat description has been prepared based on a habitat assessment performed by a biologist during the Phase III ESA field work, as well as review of available site and aerial photographs and previous reports. The site consists primarily of exposed barrens. Vegetation, where present, consists of coniferous trees and patterned peatland composed of bogs and fens.

Summits consisting of exposed bedrock are present throughout the site. Large expanses of the site leading from the summits are barren, with low shrub, sapling and herbaceous cover. Alaskan blueberry (*Vaccinium uligenosum*), bearberry (*Arctostaphylos uva ursus*) and crowberry (*Empetrum nigrum*) were observed in barren areas. Forest habitat at the site is limited to slopes and gullies on the northern areas, and generally is dominated by Black spruce (*Picea sp*.), as well as Alder (*Alnus* sp.), Larix (*Larix Laricina*) and willows species (*Salix* sp.). Inland areas are more vegetated, also dominated with Black spruce, Alder and Larix. Blackberries (*Rubus* sp.) were also observed throughout some areas of the site.

As well, there are forested shallow blanket bogs, perched wetlands and forested wetlands present on some slopes and in inland areas. Most of the wetlands were isolated in nature, with no inlets or outlets. Water collected in these wetlands through precipitation events and overland surface flow. Most water was lost through evapotranspiration and subsurface seepage. A number of small ponds and bog pools were located throughout the peatland and other wetlands at the site. These ponds and pools are ephemeral in nature and most had only very shallow amounts of standing water. Occasionally, floating peat mats were present at the wetlands, with up to 1m of unstable floating vegetation, overlying stagnant water. None of these areas were considered to be fish habitat.

Larks Harbour Pond is located just south of the site and drains to Sandwich Bay via an unnamed brook that extends through the site. This watercourse was bordered by wetlands for some of its extent. The watercourse substrate consisted of mucky bottom and organics. A second drainage corridor was suspected to discharge from Larks Harbour Pond, to the northeast towards Goose Cove; however, this area was outside the scope of the current assessment and was not field verified.

A large pond is present west of the Bell communication tower, and was formerly used to supply potable drinking water to the Main Complex. All potable water infrastructure has been decommissioned and removed from the site. This was the only permanent ponded freshwater at the site, and appeared to discharge from the north side of the pond, towards Sandwich Bay. The total depth of the pond was not verified; however, at the perimeter edges up to 3 m of water was present, and the substrate consisted of rocky bottom with cobble and gravely coarse sand. This pond would be considered fish habitat.

2.2.4 Plants and Soil Invertebrates

Based on observations by an experienced biologist during the habitat assessment, and a review of available land based and aerial photographs taken of the site, the vegetative communities on the site appeared to be generally healthy and similar to surrounding areas; those areas devoid or absent of vegetation were limited to areas of human activity and/or bedrock barrens. Soil invertebrates (earthworms) were noted during soil sampling activities completed at the time of the assessment. No evidence of ecological impairment (i.e. stressed vegetation, bare patches, etc.) was noted. As a result, plant and soil invertebrate communities in the vicinity of the Site appear structurally and functionally intact; no significant adverse effect or impact is anticipated for these taxonomical groups.

2.2.5 Schedule 1 / Provincially Listed Endangered Species Potentially Present On-site

Species that are listed on the federal SARA Schedule 1 benefit from all the legal protection afforded and the mandatory recovery planning required under SARA (SARA, 2002). Provincially, similar protection is afforded to species under Newfoundland and Labrador's *Species at Risk Act*.

There were 38 records of species for Newfoundland and Labrador. A review and evaluation of potential SAR for the Site, including review of the available habitats, was conducted during the recent field program. For most the listed species on Schedule 1 of SARA, the probability of the species being present was low since the northern extent of their distribution does not reach Cartwright. Also, appropriate habitat was not present at the Site for many species.

Potential habitat for Peregrine Falcon (*Falco peregrinus*), Red-necked Phalarope (*Phalaropus lobatus*), Rusty blackbird (*Euphagus carolinus*), Short-eared owl (*Asio flammeus*) and wolverine (*Gulo gulo*) was present at the Site and there was moderate likelihood that these species may be present. During the field survey, no species listed on Schedule 1 of SARA or the provincial endangered species act was observed. A summary of the SAR and evaluation of potential habitat is provided in Appendix B.

2.2.6 Other Species

A request was made to the ACCDC for rare or uncommon species present within 5km of the Site, in addition to the Schedule 1 species identified in Section 2.2.5. Based on the information obtained from ACCDC (ACCDC, 2019), there were 10 rare animal records and 30 rare plant records found. Only one record (Polar Bear (*Ursus maritimus*)) was identified in Section 2.2.5.

For the 10 rare animal records, all of the species were butterflies, with the exception of the Polar Bear, and none were identified at the site; rather they were identified in the nearby Town of Cartwright or on Earl Island. Only four of the listed butterflies have a S2 rank, the remaining five are ranked as S3. Globally and nationally, the butterfly species are listed as secure (N5 and G5 rankings), and their general status in NL is listed as secure or undetermined. The Polar Bear is listed as vulnerable under the NL Endangered Species Act and Special Concern under COSEWIC. One sighting was recorded in 1991 near the site. However, based on the preferred habitat and food source of the polar bear, it is unlikely one would use the site. The remaining rare animal records were for species which are not on the provincial ESA or federal COSEWIC lists, and outside of Newfoundland & Labrador, they are not considered globally rare.

The 30 rare flora records are for vascular and nonvascular plants. Of the 30 plants, only two mosses (*Fontinalis dalecarlica* and *Sphagnum fimbriatum*) have a S1 ranking and one moss (*Racomitrium macrocarpon*) has an uncertain S2 ranking, the remaining flora species are considered provincially secure, none are found on the provincial Endangered Species Act or federal COSEWIC lists. Outside of NL, only *Fontinalis dalecarlica* is considered globally rare. All observations were from 1928, and were from locations approximately 1km from the site.

Further, while there were no observations in the ACCDC database for the following species at the site, expert opinion maps suggest that the presence of Common nighthawk (*Chordeiles minor*), breeding/molting Harlequin duck (*Histrionicus histrionicus*), Ivory gull (*Pagophila eburnean)*, Peregrine Falcon (*Falco peregrinus*), Rusty blackbird (*Euphagus carolinus*), Woodland Caribou (*Rangifer tarandus caribou*) and Short-eared Owl (*Asio flammeus)* are possible. The site is also said to be within the migrating, molting & nesting range of Barrow's Goldeneye (*Bucephala islandica*). Based on review of the site and habitats present, the presence of Common nighthawk, Harlequin duck, Ivory gull, Caribou and Barrow's goldeneye were considered unlikely to be present.

2.2.7 Species Observed During Habitat Assessment

During the field survey, partridge (*Lagopus lagopus*), black bears (*Ursus americanus*) and red fox (*Vulpes vulpes*) were observed on site. Terns, seagulls, black duck, crows and pigeons were noted in the area surrounding the site. Reindeer (*Rangifer tarandus*) were not observed during site visit but strong evidence in the form of bones, skat and trails, suggest the site is used by reindeer. Also, from discussions with residents of Cartwright, Moose (*Alces alces*) and Ptarmigan (*Lagopus* sp.) are reported to be present at the site.

2.2.8 Summary of Relevant Site Characteristics

Table 2-1 summarizes site characteristics applicable to human health and ecological risk screening and risk assessment activities.

Table 2-1 Site Characteristics

Characteristic	Site Condition
Land Use	Former USAF Radar Station, Bell microwave station and CCG Navtex and MF Rx Communication Towers (commercial), recreational (occasional visitor), foraging (occasional visitor).
Freshwater Habitat	One pond, formerly used for potable water, and is likely fish habitat. One watercourse that discharges from Larks Harbour Pond to Sandwich Bay is likely fish habitat. Numerous hydraulically isolated wetlands that are not fish habitat.
Water Use	Non-Potable
Soil Type	Coarse-grained
Nearest Residence	Approximately 4 km away (Town of Cartwright)
Visitor Frequency	Infrequent (recreational/foraging visitor), occasional (commercial)
SAR	Peregrine Falcon, Rusty blackbird, Wolverine and Short-Eared Owl could possibly be present on the site.
Fauna Observed On-site	Black Bear, Red Fox, Partridge observed on-site. Terns, Seagulls, Black Duck, Crows and Pigeons were noted in the surrounding area. Reindeer were not observed during site visit but strong evidence in the form of bones, skat and trails, suggest the site is used by reindeer. Moose and Ptarmigan are reported to be present at the site.
Stressed Vegetation	None Observed
Soil Invertebrates	Soil-dwelling invertebrates (earthworms) were observed on the site during soil sampling.

3 Regulatory Criteria

The site was previously "occupied" by the USAF, but the area is currently owned by the Province of Newfoundland. Therefore, analytical results are compared to provincial criteria, as well as federal criteria (where applicable). As necessary, the analytical results are also compared to applicable guidelines available from other jurisdictions where there are no provincial or federal guidelines. Specific regulatory criteria selected and used to determine COPC to human and ecological health are discussed in detail in the HHRA (Section 6.2) and the ERA (Section 7.2), respectively.

Although the land is zoned as commercial and commercial activities do occur at the site, based on review of site characteristics, actual land use and the actual human and ecological occupancy (and expected future occupancy) is considered to be best represented by residential/parkland land use.

Residential/parkland land use at the initial screening level is more representative of actual exposure conditions than commercial or agricultural land use for both human and ecological health, as discussed further below. A summary of the land use is provided in Table 3-1.

Table 3-1 Summary of Land Use and Receptors.

Land Use	Present	Receptor Group
Agricultural	No	N/A
Residential	No	N/A
Commercial with daycare	No	N/A
Commercial	Yes	Adults: Occasional exposure frequency

Land Use	Present	Receptor Group
Industrial	No	N/A
Urban Recreational	No	N/A
Remote Wild Lands	Yes	All human age groups: Recreational and/or indigenous occasional visitor, foraging and hunting; no camping Ecological Receptors
Construction Worker	No	N/A

For human health, the primary activities of concern are commercial users at the communication towers, and recreational and possible indigenous users visiting the site and collecting country foods (berries and game).

Agricultural land use (as a surrogate for remote wild land use) has been defined by CCME (CCME 2006) as where the primary land use is growing crops or tending livestock. Further, human exposure is 24 hours per day and in addition to other sources, it is assumed that 50% of produce and meat ingested is from on-site sources. From our knowledge of the site, the limited areas with COPC, and site uses, this exposure pathway is more conservative than the actual land use since crops are not exclusively grown at the site, nor is livestock exclusively tended at the site, even though these foods are collected from the site.

Commercial land use does not consider ingestion of country foods; therefore, it was considered less conservative than the actual land use.

Residential/parkland land use is protective of all human life cycle exposures (24 hours per day) and there are exposure pathways protective of country food (produce) consumption. Therefore, residential land use screening criteria were used to identify COPC that required further evaluation in the HHRA. Although this screening pathway is more conservative than required for commercial land users, selection of COPC carried forward (if any) for HHRA for commercial scenarios will be further refined in Section 6.2. Further, although some COPC have more conservative agricultural generic screening guidelines, not all are based on human health effects related to uptake of COPC. Consequently, COPC that may biomagnify or otherwise are best represented by agricultural guidelines, if present, were individually assessed and discussed in Section 6.2.

For ecological health, there are no impediments or deterrents for ecological receptors accessing and using the site, therefore, commercial screening guidelines are not protective of ecological health. CCME (CCME 2006) has not derived guidelines specifically for natural area or wildland land use.

Agricultural land use could apply to the site (as a surrogate for remote wild land); however, considering that tending livestock does not occur at the site, that the actual areas with impacts are limited in size (compared to the entire parcel) and the home ranges of some species are quite large, in our opinion, agricultural land use would be overly conservative to use at the screening level.

Except for a few COPC, soil contact and ingestion pathways for wildlife are derived for residential/parkland land use and are generally equivalent to the agricultural guidelines. Therefore, residential land use screening criteria were used to identify COPC that required further evaluation in the ERA. Further, although some COPC have more conservative agricultural generic screening guidelines, not all are based on ecological receptors present at the site. Consequently, COPC that may biomagnify or otherwise are best represented by agricultural guidelines, if present, were individually assessed and discussed in Section 7.2.

In summary, for the human health and ecological health screening scenarios, the site has been classified as a non-potable, residential site with coarse-grained soil.

3.1 Soil

Analytical results for soil are compared to:

- 1999 (with 2018 Updates) CCME SQG for residential/parkland land use, coarse-grained soil;
- 2008 (with 2012 Updates) CCME CWS for PHC in Soil, Tier 1 Values, residential/parkland land use – coarse-grained soil;
- 2012 (with 2015 Updates) Atlantic RBCA Tier I RBSLs for a residential property with non-potable groundwater and coarse-grained soil; and
- 2011 OMOE Table 3: Full depth, non-potable water scenario, residential/parkland land use.

The CCME CWS ecological screening pathways are equivalent to the Atlantic RBCA ESLs for soil (Table 1A, Atlantic RBCA Ecological Screening Protocol for Petroleum Impacted Sites in Atlantic Canada).

3.2 Sediment

Analytical results for sediment are compared to:

- 1999 (with 2001 Updates) CCME Sediment Quality Guidelines for the protection of aquatic life (freshwater) ISQGs and PELs; and
- 2012 (with 2015 Updates) Atlantic RBCA ESLs for the protection of freshwater and marine aquatic life.

Across Canada, there are no sediment quality guidelines or criteria for the protection of human health that could be used as a screening benchmark to identify COPC. The few human health-based sediment criteria currently available from other jurisdictions would not be directly applicable to most contaminated sites as they generally do not consider all potentially relevant exposure pathways, or they rely on regional data to assist with the development of site-specific screening criteria. For the purposes of screening COPC in sediment, the relevant CCME soil quality guidelines for human health would generally be considered the most appropriate screening values.

CCME publish the ISQGs and PELs based on an evaluation of data from the BEDS to establish associations between sediment concentrations of each parameter and any observed adverse biological effects. The two guidelines are derived as follows:

- ISQGs: geometric mean of the 15th percentile of the effects concentration and the 50th percentile of the no-effects concentration; and
- PELs: geometric mean of the 50th percentile of the effects concentration and the 85th percentile of the no-effects concentration.

The ISQGs are described as the lowest range of concentrations, within which adverse effects are rarely observed whereas the PELs are effects threshold concentrations that represent the concentrations above which adverse effects are more likely to occur. No-effects based data such as the 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 (Environment Canada, 2008).

This document recommends that when the concentration is lower than the PEL there is no need to initiate a remediation process, unless development projects or dredging work is planned at the site. The PELs are considered to be protective of community or population level health of valued environmental components and will provide a healthy functioning ecosystem capable of sustaining the current and likely future uses of the site by ecological receptors.

Sediment sample analytical data for PHCs including BTEX and modified TPH are compared to the Atlantic RBCA ESLs (ARBCA, 2012a). Sediment ESLs for 'Typical' and 'Other' sites are based on an evaluation of data from the PETROTOX model to establish associations between sediment porewater concentrations of petroleum hydrocarbons and any observed adverse biological effect. The two guidelines were derived as follows:

- Typical: sediment concentration in equilibrium with the 5th percentile of the aquatic species sensitivity distribution (chronic HC_5 - concentration considered to have no deleterious effects to 95% of the aquatic species); and
- Other: sediment concentration in equilibrium with the 50th percentile (chronic HC_{50}) of the aquatic species sensitivity distribution.

Analogous to the CCME ISQGs, the 'Typical' ESLs represent the lowest range of concentrations, within which adverse effects are rarely observed, whereas the 'Other' ESLs represent concentrations above which adverse effects are more likely to occur. As defined in the Atlantic RBCA User Guidance Document, "Typical" sediment sites are those where the sediment is used as habitat for sensitive components of freshwater, marine or estuarine aquatic ecosystems. 'Other' sediment sites are those sites where the sediment is not classified as typical such as ditches, industrial-influenced receiving areas such as urban harbours, etc. Based on conditions at the site, the 'Typical' screening level was applied for the current assessment.

ESLs for sediment are based on an assumed F_{OC} in sediment of 0.01 (1%); however, Atlantic RBCA guidance permits adjustment of the ESLs based on site-specific measurements of F_{OC}. Average F_{OC} values were used to adjust the ESLs. There is also an MSL of 500 mg/kg modified TPH (analogous to a management limit) that evaluates the cumulative effect of PHCs. The MSL cannot be adjusted by F_{OC}.

3.3 Groundwater

Analytical results for groundwater are compared to:

- 1999 (with 2018 Updates) CCME Water Quality Guidelines for the protection of Freshwater Aquatic Life. Since all groundwater analyzed is more than 10m from surface water, 10x the guideline has been applied to account for dilution;
- 2012 Atlantic RBCA Tier I ESLs for plant and soil invertebrate direct contact with shallow groundwater;
- 2012 Atlantic RBCA Tier I ESLs for the protection of freshwater and marine aquatic life; and
- 2011 OMOE Table 9: Generic Site Condition Standards for use within 30m of a water body in a non-potable groundwater condition.

Since this is a provincial site, the Federal Interim Groundwater quality guidelines were not considered appropriate for screening purposes as the province of Newfoundland and Labrador does not accept their use. Also, since the site is non-potable and there are no buildings, there are no relevant guidelines for groundwater that are protective of human health.

3.4 Surface Water

Analytical results for surface water are compared to:

- 1999 (with 2018 Updates) CCME Water Quality Guidelines for the protection of freshwater aquatic life; and
- 2012 (revised 2015) Atlantic RBCA Tier I ESLs for the protection of freshwater and marine aquatic life (Table 3a), surface water guidelines.

For PCBs the CCME Water Quality Guidelines for the Protection of Freshwater Aquatic Life is no longer recommended and the value was withdrawn by CCME. A water quality guideline is not recommended. Environmental exposure is predominantly via sediment, soil, and/or tissue, therefore, screening for COPC is carried out through respective guidelines for these media.

From review of the site, most waterbodies are shallow watercourses and shallow ponded water associated with wetlands, although there is deeper water associated with the pond located west of the Bell communication tower that was formerly used to supply potable drinking water to the Main Complex. We understand that this water body is not used for swimming, although boat use may occur. Although the Health Canada drinking water quality guidelines could be used for screening purposes, from our understanding of the site use, these would be overly conservative. Based on CCME guidance and the Guidelines for Canadian Recreational Water Quality (Health Canada, 2012), there are no relevant or recommended guidelines for surface water that are protective of human health (through primary or secondary contact). Primary contact activities (in which the whole body or the face and trunk are frequently immersed or the face is frequently wetted by spray, and where it is likely that some water will be swallowed) are unlikely to occur at the site. Secondary contact (in which only the limbs are regularly wetted and in which greater contact (including swallowing water) is unusual) is possible. Consequently, the incidental ingestion of surface water by human receptors at the site is considered an inconsequential pathway, there are no relevant guidelines available for dermal contact and human exposure to impacted surface water was not further evaluated.

4 Previous Investigations

4.1 Phase I Environmental Site Assessment, Former United States Military Site, Cartwright, NL, GHD, March 2016

The purpose of the Phase I ESA conducted by GHD was to identify the existence of any significant actual or potential areas of environmental concern at the site based on a review of the site history, document review, interviews with individuals with knowledge of the previous site operations and correspondence with regulatory agencies. A site visit was not completed as part of the Phase I ESA. Potential environmental issues identified at the site included the historic handling, use, and storage of petroleum hydrocarbons; solid waste/recyclables; heavy metals; chemical spills/releases; and potentially creosote containing wood used throughout the site.

Significant quantities of fuel were formerly stored at the site in ASTs, as well as in thousands of POL drums. Additionally, the site also formerly contained a garage building with service bays, a helicopter landing pad that contained drum storage and a portable fuel tank used for refueling helicopters, as well as reports of a significant quantity of drum storage and garage/service bay facilities in the former contractor's village (which operated from 1951 to 1953). The main areas of concern identified with regard to historic handling, use, and storage of petroleum hydrocarbons included the main area, former AST areas, former product pipelines, the former contractor's village, former helicopter landing area, as well as in the former landfill area.

It was identified that during the operation of the facility from 1953 to 1968 solid waste was disposed in an unlined landfill located to the east of the site (identified as the Former USAF Dump Area and Former Ammunition Storage Area in subsequent investigations). The landfill was re-graded and covered following site decommissioning and a subsequent remediation program completed in 1988. It was identified that the landfill may contain ACM building materials; wooden building materials containing preservatives (i.e. creosote), material with painted surfaces containing lead and/or mercury based paint, former electrical equipment containing PCBs, mechanical equipment debris, motor repair wastes and/or drums formerly containing POLs as well as other solvents. Solid waste (including metal and other materials) were also reported as being buried and covered in a ravine located between the former main radar station and the main AST (i.e. upper POL) as part of the 1987 site decommissioning program. It was noted that the site decommissioning program was completed under the approval of the Government of Newfoundland & Labrador, Department of Environment and Conservation, and included the razing of all remaining structures and the burning of all materials on site, followed by the burying and covering of the debris and remaining materials.

It was noted that heavy metals may be associated with vehicle repairs at the former garage building and helicopter repairs at the former helicopter pad area. In addition, the age of the former on-site buildings indicated the potential exists that lead/mercury based paint was used on the interior and exterior surfaces which may have potentially impacted the surface soils.

The review of historical documents confirmed at least one large PCB spill at the main radar site (former operations building) and confirmation of PCB impacts in the former landfill. Although the documentation discussed the remediation of these areas, reporting outlining the confirmatory sampling results and/or locations was not part of the historical documents reviewed. It was noted that the 1988 PCB remediation program in the former landfill area was confined to an area of heavily impacted soil and only extended to a depth of 0.2 metres.

The records review conducted during the Phase I ESA identified a large PCB spill in the Main Complex area in the abandoned operations building discovered in October 1979. The spill was approximately 100 gallons of PCB liquid released as a result of damage to 9 abandoned transformers remaining in the former operations building according to estimates by Environment Canada. Approximately 84 m^2 in surface area, the spill leaked through the tile floor and pooled in the soil beneath the former building. PCB liquid was also tracked throughout the building by visitors to the site. The clean-up included sealing the leaking transformers, securing the remaining transformers, placing all PCB contaminated debris in sealed drums, removing the wooden floor and floor tiles heavily contaminated with PCBs, cleaning the remaining floor with solvents, excavating the heavily contaminated soil and water, placing all impacted materials in sealed drums, and cleaning the bedrock with solvents. Sealed drums were later removed from the Site and reportedly transported to Goose Bay for permanent storage. No information pertaining to the PCB concentrations encountered in the soil during the spill and/or clean-up were noted in the Phase I ESA.

In addition, the Phase I ESA noted that during site decommissioning in 1987, soil sampling in the former landfill area identified PCB concentrations in soil exceeding 15,000 ppm. In 1988 the province implemented a limited PCB removal program where 306 m^3 of PCB impacted soil of was excavated and removed. PCB impacted soil was sealed in 228 specially designed containers, stacked and temporally stored on two former concrete foundations at the Site (the locations were secured with a locked chain-link fence). Containers were later shipped to Goose Bay for storage. The excavation extended to a depth of approximately 0.2 metres and was backfilled with 1.5 metres of clean overburden.

Based on historical photographs, wooden cribbing and building supports were noted as being used beneath former structures. These potentially contained preservatives such as creosote which may have impacted the surface soils. This material may have also been disposed of in the former landfill area. The wharf/decking in the area of the former pumphouse was also comprised of wood containing preservatives.

4.2 Phase II Environmental Site Assessment, Former Military Site, Cartwright, NL, Stassinu Stantec Limited Partnership, June 7, 2018

Field work was conducted in October and November, 2017 and included the excavation of test pits, freshwater/marine sediment, surface water and vegetation samples from four main areas. These areas included the General Area, Former Contractors Village, Main Complex and Former USAF Dump Area and Former Ammunition Storage Area. The two former municipal landfills, two DFO Coast Guard communication towers and the Bell communications tower present within the site boundaries were not included in the assessment as they were not considered the responsibility of the provincial government. The site was classified as a commercial site and commercial land use was used in selection of the applicable guidelines.

A total of 113 test pits were dug and select soil samples were collected and submitted for TPH/BTEX, PAH, metals, VOC and PCB analysis. Seven sediment samples were collected and submitted for select TPH/BTEX, PAH, metals and PCB analysis; seven surface water samples were collected and submitted for select TPH/BTEX, general chemistry, PAH, metals and PCB analysis; and 16 vegetation/berry samples were collected and submitted for select metals and PCB analysis.

The Phase II ESA identified commercial guideline exceedances (above CCME and Atlantic RBCA guidelines) for PHCs in soil, sediment and surface water; VOCs in soil (only one VOC exceedance for trichloroethylene was identified during the Phase II ESA); PAHs in soil, sediment and surface water; metals in soil, sediment and surface water; and general chemistry in surface water. Additional delineation was recommended to define the extent of impacts identified at the site. Based on an ecological screening completed by Stantec, further assessment was recommended to address ecological concerns. Specifically, it was recommended that the vertical extent of impacts should be investigated with a borehole/monitor well program and should include a groundwater assessment.

4.3 Phase III Environmental Site Assessment, Former USAF Radar Station, Cartwright, NL, Englobe, March 2019

The Phase III ESA was conducted by Englobe in August of 2018 based on the recommendations of the previous Phase II ESA. The Phase III ESA included the advancement of 16 boreholes with installation of groundwater monitor wells in each, excavation of 80 test pits, collection of groundwater, soil, surface water and sediment samples. Collection of four background vegetation samples and three bulk building material samples (from suspected asbestos containing material identified during field work) were also included. The site was classified as a commercial site and commercial land use was used in selection of the applicable guidelines.

A total of 80 test pits were dug and select soil samples were collected and submitted for TPH/BTEX, PAH, metals and VOC analysis. Eight sediment samples were collected and submitted for select TPH/BTEX, F_{OC}, PAH and PCB analysis; 10 surface water samples were collected and submitted for select TPH/BTEX, general chemistry and metals analysis; 16 groundwater samples were collected for TPH/BTEX, PAH, general chemistry, VOC, metals and PCB analysis; four background vegetation samples were collected for metals and PCB a modified TPH analysis; and three bulk building material samples were collected for asbestos analysis.

PHC impacts (modified TPH) were identified in soil above human health and/or ecological health guidelines (Atlantic RBCA RBSLs and ESLs) for a commercial site with non-potable water. Impacts in soil were identified in the Former Contractor Village, the Main Complex and the Former USAF Dump Area and Ammunition Storage Area.

PHC impacts (modified TPH) above ecological health guidelines (Atlantic RBCA ESLs) were found in sediment samples from the Former Contractors Village, Former USAF Dump Area and Ammunition Storage Area, and from background samples collected. The Phase III ESA noted that PHC in sediment results were within or below the range of PHC concentrations detected in background samples. Based on this and comments received from the laboratory, it was deemed likely that these exceedances were due to biogenic material that may appear as petroleum hydrocarbon products during analytical testing, and are not related to contamination from petroleum hydrocarbon usage at the Former USAF Radar Station.

PAH impacts were identified in soil above human health and/or ecological health guidelines (CCME SQGs). Impacts in soil were identified in the Former Contractor Village, the Main Complex, and the Former USAF Dump Area and Former Ammunition Storage Area.

PAH impacts were identified in groundwater above ecological health guidelines (CCME FAL) at sample locations within the Former Contractor Village and the Former USAF Dump Area and Former Ammunition Storage Area.

Metals impacts were identified in soil above human health and/or ecological health guidelines (CCME SQGs). Impacts in soil were identified in the Former USAF Dump Area and Former Ammunition Storage Area and the Main Complex.

Metals impacts were identified in surface water above ecological health guidelines (CCME FAL) at all sample locations.

Metals impacts were identified in groundwater above ecological health guidelines (CCME FAL) in all monitor wells. The extent of groundwater impacts could not be estimated, further delineation would be required to achieve this.

VOC impacts in soil were identified at one location in the Former USAF Dump Area and Former Ammunition Storage Area above human health and ecological health guidelines (CCME SQGs).

General Chemistry results for a majority of surface water and groundwater samples showed pH values outside of the CCME FAL guidelines.

All three of the bulk building material samples collected from the Former Dump Area and submitted for analysis were found to contain asbestos (chrysotile).

Metals and PCB analysis was conducted on the three background vegetation samples collected. Various metals were detected in all three samples. No PCB concentrations were detected in any of the three samples. There are currently no guidelines for metals or PCBs in vegetation. Various metals were previously detected in the samples collected during the Phase II ESA, at concentrations that were generally similar to those from the background samples. Certain metals, such as aluminum, iron and manganese, were higher than background concentrations at various locations. PCB concentrations were previously detected in 11 of the 16 vegetation samples collected during the Phase II ESA.

Based on the analytical results obtained during the Phase III ESA, it was recommended that further action was required to address the impacts identified. An HHERA was recommended to assess requirements for risk management or remediation at the site. In addition, it was recommended that a RAP be developed and that asbestos-containing material identified at the Former Dump Area and Former Ammunition Storage Area should be removed from site by a certified asbestos abatement contractor and disposed of at a licensed disposal facility.

5 Data Suitability for Risk Assessment

The suitability of all available data for risk assessment was reviewed.

Analytical data collected during previous assessments, compared to current guidelines, is compiled in Tables 1 through 29, Appendix C. Since there are no relevant human health guidelines for exposure to COPC in sediment, the soil guidelines were used as surrogate guidelines.

As historical COPC have been identified at concentrations exceeding various generic criteria, it was determined by previous assessments that human and ecological receptors at the site could be exposed to unacceptable levels of the identified COPC in soil, sediment, groundwater and surface water. Further assessment is discussed further below.

Although some of the soil, sediment and surface water analytical results were collected during different assessments, most data from the Phase II ESA (Stantec, 2018) and Phase III ESA (Englobe, 2019) investigations were considered recent and valid and samples appear to have been collected and analyzed in accordance with current standards and (with a few exceptions which are discussed below) are reasonably expected to represent current environmental conditions at the site. Detection limits were below applicable human health and ecological screening levels for all parameters analyzed.

Data that was determined to be not suitable and therefore excluded from the risk assessment included the following.

PHC analyses in sediment (Stantec, 2018) did not have silica gel clean-up completed, nor was F_{OC} analyzed, both of which limit the usefulness of the Stantec PHC sediment data. Where PHC analysis with no silica gel clean-up generally satisfy the applicable screening levels, the potential overestimate of PHC magnitude is not expected to affect the findings of the HHRA or ERA. However, where PHCs with no silica gel clean-up exceeded the applicable screening levels (CWT-SED-5, CWT-SED-7 and CWT-SED-8), these data were not used in the HHRA or ERA since there were comparable data from the same sample location that had silica gel clean-up. Evaluation of the Englobe data revealed that significant components of the PHC analyses without silica gel clean-up were non-petrogenic.

The PHC analyses in surface water collected during the Phase II ESA (Stantec, 2018) identified trace modified TPH in one sample (CWT-SW-8), at a concentration that marginally exceeded the

Atlantic RBCA ESL. Additional samples were collected from this location during the Phase III ESA (Englobe, 2019) and revealed no detectable PHCs. Review of the other laboratory analyses from this location in the Phase II ESA identified elevated turbidity, TOC and was a highly coloured water. The reporting limit for TOC was also increased due to turbidity for this location. On this basis, PHC analytical results from CWT-SW-8 (Stantec, 2018) were considered irregular and likely related to organic matter in the sample and were not carried forward in the HHRA or ERA.

PHC analyses in sediment collected during the Phase III ESA (Englobe, 2019) identified toluene in one sample (CWT-SED-8-18, collected on August 15, 2018), at a concentration that exceeded the Atlantic RBCA ESL. This sample was noted as being collected from a depth below floating bog. This sample depth was not consistent with the expected location of ecological receptors and subsequently, an additional sample was collected closer to the surface from this same location on August 24, 2018 and revealed no detectable concentrations of toluene. Toluene was not detected in any other sediment samples collected during either the Phase II ESA or Phase III ESA field programs, with the exception of CWT-SED-7 (collected during the Stantec Phase II ESA), which was below Atlantic RBCA ESLS. Further, given the anomalous toluene result, we suspect it may have been cross contaminated. Therefore, the analytical results from CWT-SED-8-18 (dated August 15, 2018) were considered not representative and were not carried forward in the HHRA or ERA.

PAH analysis in sediment completed during the Phase II ESA (Stantec, 2018) identified chrysene in one sample (CWT-SED-8), at a concentration that exceeded the CCME freshwater PEL. Additional samples were collected from this location during the Phase III ESA (Englobe, 2019) and revealed no detectable concentrations of PAHs. Review of the laboratory analyses revealed that no other PAH congeners were identified in the analysis of CWT-SED-8 (Stantec, 2018), and the chrysene concentration detected was over 30 times higher than the next highest concentration detected (0.37 mg/kg, which was detected at sample location CWT-SED-7 during the Stantec Phase II). On this basis, PAH analytical results from CWT-SED-8 (Stantec, 2018) were considered irregular and were not carried forward in the HHRA or ERA.

5.1 Contaminant Distribution

Based on the review of previous reporting and as summarized in Tables 1 through 29 (Appendix C), COPC (for human or ecological health) included PHCs, PAHs, metals, VOCs and PCBs. Note, since there are no human health guidelines for exposure to sediment, the soil guidelines were used as surrogate guidelines. The areas of concern include the General Area, the Former Contractor Village, the Main Complex and the Former USAF Dump Area and Ammunition Storage Area. It should be noted that no groundwater was analyzed in the General Area, since there were no soil guideline exceedances during previous work completed in the area.

For sediment, concentrations that were greater than the freshwater ISQG were not carried forward in the risk assessment. Only those greater than the freshwater PEL were retained for further assessment.

Analytical results are depicted on Figures 6 through 13 (Appendix A) to represent sample locations where a human health or ecological based screening level was exceeded.

Background samples were collected for some COPC in some media for screening purposes. These samples are discussed in Sections 6.2 and 7.2. Produce (berries) and foliage samples were also collected in some areas, to assess potential for uptake of select COPC in plants and to assess for background conditions. These results are also discussed in Sections 6.2 and 7.2.

5.1.1 Petroleum Hydrocarbon Distribution

PHCs were identified in soil at the Former Contractor Village, the Main Complex and the Former USAF Dump Area and Ammunition Storage Area at concentrations that exceed the screening levels for human and/or ecological health. No PHC impacts were identified in soil in the General Area of the site.

PHCs were identified in sediment at the Former Contractor Village and the Former USAF Dump Area and Ammunition Storage Area at concentrations that exceed the screening levels for ecological health. No PHC impacts were identified in sediment in the General Area of the site or the Main Complex.

PHCs were identified in groundwater at the Main Complex at concentrations that exceed the screening levels for ecological health. No PHC impacts were identified in groundwater at the Former Contractor Village or the Former USAF Dump Area and Ammunition Storage Area.

No PHC impacts were identified in surface water at any areas of the site.

Further assessment for PHC impacted soil, sediment and groundwater is recommended and is further discussed below. No further assessment for PHC impacts in surface water is recommended.

5.1.2 Polycyclic Aromatic Hydrocarbon Distribution

PAHs were identified in soil at the Main Complex and the Former USAF Dump Area and Former Ammunition Storage Area, at concentrations that exceed the screening levels for human and ecological health. No PAH impacts were identified in soil in the General Area of the site or in the Former Contractor Village.

PAHs were identified in sediment at the General Area, Former Contractor Village, Main Complex and Former USAF Dump Area and Former Ammunition Storage Area at concentrations that exceed the freshwater ISQGs, but that were below the freshwater PELs for ecological health.

No PAH impacts were identified in groundwater or surface water at any areas of the site.

Further assessment for PAH impacted soil is recommended and is further assessed below. No further assessment for PAH impacts in sediment, groundwater nor surface water is recommended.

5.1.3 Metals (and Elements) Impacts Distribution

Metals were identified in soil at the General Area, Former Contractors Village, the Main Complex and the Former USAF Dump Area and Former Ammunition Storage Area at concentrations that exceed the screening levels for human and/or ecological health.

Metals were identified in sediment at the General Area, Former Contractor Village and Former USAF Dump Area and Former Ammunition Storage Area at concentrations that exceed the freshwater ISQGs, but that were below the freshwater PELs for ecological health. No metals were identified in sediment at the Main Complex at concentrations that exceed the ISQGs. No metals impacts to sediment were identified at any areas of the site.

Metals were identified in groundwater at the Former Contractor Village, the Main Complex and the Former USAF Dump Area and Ammunition Storage Area at concentrations that exceed the screening levels for ecological health. In addition, pH was outside the recommended range at all areas where groundwater was analyzed.

Metals were identified in surface water in the General Area, Former Contractors Village, the Main Complex and the Former USAF Dump Area and Ammunition Storage Area, at concentrations that exceed the screening levels for ecological health. In addition, pH was outside the recommended range in all areas.

Further assessment for metals impacted soil, and metals (and pH) impacted groundwater and surface water is recommended and is further discussed below. No further assessment for metals impacts in sediment is recommended.

5.1.4 Volatile Organic Compound Distribution

Where analyzed, no VOC impacts were identified in soil, sediment, groundwater nor surface water at any areas of the site.

No further assessment for VOC impacted soil, sediment, groundwater nor surface water is recommended.

5.1.5 Polychlorinated Biphenyls Distribution

PCBs were identified in soil at the Main Complex and the Former USAF Dump Area and Former Ammunition Storage Area at concentrations that exceed the screening levels for human and/or ecological health. No PCB impacts were identified in soil in the General Area of the site nor the Former Contractors Village. Note, that the human health guideline is based on protection of the tertiary ecological receptor.

PCBs were identified in sediment at the Main Complex at concentrations that exceed the freshwater ISQG, but that were below the freshwater PEL for ecological health. No PCB impacts were identified in sediment in the General Area of the site, the Former Contractors Village nor the Former USAF Dump Area and Former Ammunition Storage Area.

Groundwater was not analyzed for PCBs since there are no relevant screening levels for PCBs in groundwater.

No PCB impacts were identified in surface water at any areas of the site.

Further assessment for PCB impacted soil is recommended and is further discussed below. No further assessment for PCB impacts in sediment, groundwater nor surface water is recommended.

5.2 Outliers

As part of this process for the HHERA, an outlier test was performed by ProUCL (Version 5.1) for any COPC where an EPC was required for screening purposes (i.e., where the maximum measured concentration exceeded the selected screening level). USEPA (2013) discusses outlier tests and indicates that the presence of outliers distorts all statistics, including the UCLs and may lead to incorrect conclusions with respect to adverse effects on human health and the environment.

Decisions about whether to include or exclude outliers in the data set to be used to compute the EPCs 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.

Based on the results of outlier tests performed using ProUCL, a number of outliers were identified (based on 5% significance level) in soil and groundwater analytical results for PHCs, PAHs, metals, and PCBs. As previously noted, due to the small number of sediment and surface water results, no statistical analysis was conducted. In the case of groundwater, no statistical analysis was conducted for the areas with less than 10 groundwater monitoring wells. The outliers identified by ProUCL are summarized in Table 5-1, as well as the rationale for inclusion or exclusion from the data set.

Table 5-1 Outliers Identified by ProUCL outlier test

Parameter	Media	Sample Concentration	Outlier (Y/N)	Included in HHERA (Y/N)
General Area				
Fraction F3 (>C16-C34)	Soil	550 mg/kg	Yes	Yes - known historical sources
Former Contractor Village				
Fraction F2 (>C10-C16)	Soil	4070 mg/kg	Yes	Yes - known historical sources
Tin	Soil	29 mg/kg	Yes	No – small area and delineated.
Main Complex				
Fraction F1 (C6-C10)	Soil	248 mg/kg	Yes	Yes - known historical sources
Fraction F2 (>C10-C16)	Soil	12500 mg/kg	Yes	Yes - known historical sources
Fraction F3 (>C16-C34)	Soil	27000 mg/kg	Yes	Yes - known historical sources
Total Modified TPH	Soil	27000 mg/kg	Yes	Yes - known historical sources
Fuel Range (>C16-C21)	Groundwater	0.63 mg/L	Yes	Yes - known historical sources
Anthracene	Soil	5.6 mg/kg	Yes	Yes - known historical sources
Benzo(a)anthracene	Soil	9.37 mg/kg	Yes	Yes - known historical sources
Benzo(a)pyrene	Soil	6.9 mg/kg	Yes	Yes - known historical sources
Benzo(b)fluoranthene	Soil	5.7 mg/kg	Yes	Yes - known historical sources
Chrysene	Soil	9.1 mg/kg	Yes	Yes - known historical sources
Dibenzo(a,h)anthracene	Soil	2.22 mg/kg	Yes	Yes - known historical sources
Fluoranthene	Soil	24.7 mg/kg	Yes	Yes - known historical sources

Parameter	Media	Sample Concentration	Outlier (Y/N)	Included in HHERA (Y/N)
Phenanthrene	Soil	22.5 mg/kg	Yes	Yes - known historical sources
Aluminum	Groundwater	21700 µg/L	Yes	No – no known source and surface water assessed.
Cadmium	Soil	49 mg/kg	Yes	No – small area and delineated.
Chromium	Soil	73 mg/kg	Yes	No – small area and delineated.
Iron	Groundwater	9790 µg/L	Yes	No – no known source and surface water assessed.
Lead	Soil	200 mg/kg	Yes	No – small area and delineated.
	Groundwater	15.8 µg/L	Yes	No – no known source and surface water assessed.
Molybdenum	Soil	9.7 mg/kg	Yes	Yes –unable to calculate UCLM95% if outlier removed.
Tin	Soil	6.8 mg/kg	Yes	No – small area and delineated.
Vanadium	Soil	88 mg/kg	Yes	No – small area and delineated.
Zinc	Soil	1400 mg/kg	Yes	No – small area and delineated.
	Groundwater	818 µg/L	Yes	No – no known source and surface water assessed.
Total PCBs	Soil	2 mg/kg	Yes	Yes - known historical sources
Former USAF Dump Area and Former Ammunition Storage Area				
Fraction F3 (>C16-C34)	Soil	6380 mg/kg	Yes	Yes - known historical sources
Anthracene	Soil	15.9 mg/kg	Yes	Yes - known historical sources
Benzo(a)anthracene	Soil	19.7 mg/kg	Yes	Yes - known historical sources
Benzo(a)pyrene	Soil	14.5 mg/kg	Yes	Yes - known historical sources
Benzo(b)fluoranthene	Soil	12.6 mg/kg	Yes	Yes - known historical sources
Chrysene	Soil	16.1 mg/kg	Yes	Yes - known historical sources
Dibenzo(a,h)anthracene	Soil	1.9 mg/kg	Yes	Yes - known historical sources
Fluoranthene	Soil	59.5 mg/kg	Yes	Yes - known historical sources
Phenanthrene	Soil	46.8 mg/kg	Yes	Yes - known historical sources
Cadmium	Soil	2 mg/kg	Yes	No – delineated and no known source
Zinc	Soil	180 mg/kg	Yes	No – delineated and no known source
Molybdenum	Soil	6 mg/kg	Yes	No – small area and delineated.
Tin	Soil	14 mg/kg	Yes	No – small area and delineated.
Zinc	Soil	1800 mg/kg	Yes	No – small area and delineated.
Total PCBs	Soil	24 mg/kg	Yes	Yes - known historical sources

5.3 Exposure Point Concentration Calculation

Risk assessments generally use maximum or exposure point concentrations 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, 2013).

When the number of samples are greater than 10 (n>10), representative statistics can be calculated from the analytical data. In those instances, the UCLM95%was deemed representative of the EPC. This value is an estimate of a reasonable upper limit value for the average chemical concentration in the media, determined for each exposure unit. The UCLM95%s were calculated using ProUCL (Version 5.1). In the case where concentrations were reported at less than laboratory detection limits, the full detection limit amount was included in the calculation (USEPA, 2015). ProUCL determines the most appropriate UCLM95%value for a dataset, given its distribution and characteristics. A number of statistically valid methods to calculate a UCLM95% can be run simultaneously, with ProUCL recommending options for the most appropriate or statistically robust value(s) to select. As the calculated options for a UCLM95% generated by ProUCL can vary considerably (based on the statistical models and the soil data distribution type), some degree of professional judgement is typically necessary in selecting the most appropriate UCLM95% value for use as the EPC in a HHERA. Considerations include the data distribution type, the significance level associated with the UCLM95% calculation methods (i.e., ProUCL-recommended values are not always at the 95% significance level, nor do they always correspond to the underlying distribution type), any warnings generated by the ProUCL and the magnitude of the calculated UCLM95%.

Where the number of samples (per area) were lower than 10 (n<10), representative statistical analysis were not calculated and the maximum value of the concentrations detected for a COPC was used as the EPC. UCLM95%s could not be calculated for sediment or surface water as an insufficient number of samples were collected from each area to allow for statistical analysis. In the case of groundwater, UCLM95%s were not calculated for the areas with less than 10 groundwater monitoring wells.

Laboratory duplicates and field duplicates were not used in the calculation of UCLM95% values.

For the HHERA, the results of the ProUCL statistical analyses are provided in Appendix D.

5.4 Data Summary

Sufficient data are available to conduct the HHRA (Section 6) and ERA (Section 7). All available data from the Phase II ESA and Phase III ESA were carried forward into the initial screening tables included in Appendix C. Data was subsequently reviewed for suitability (Section 5), and data that had been supplemented with more current results, data that had potential to overestimate results, data that was irregular or data that were considered outliers were removed from the HHERA.

Based on the screening review above, PHCs, PAHs, metals, and PCBs in soil were carried forward for human and ecological receptors for additional detailed evaluation, as described in Sections 6.2 and 7.2.

Based on the screening review above, PHCs in sediment were carried forward for ecological receptors for additional detailed evaluation, as described in Section 7.2.

Based on the screening review above, metals and pH in groundwater were carried forward for ecological receptors for additional detailed evaluation, as described in Section 7.2.

Based on the screening review above, metals and pH in surface water were carried forward for ecological receptors for additional detailed evaluation, as described in Section 7.2.

6 Human Health Risk Assessment

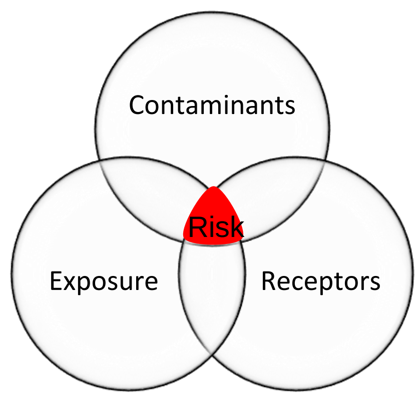
This HHRA has been conducted based on current regulatory guidance documents and in a manner consistent with accepted methodologies and guidance published by regulatory agencies, including Health Canada (Health Canada 2010), CCME, Atlantic RBCA (2012), WHO and USEPA.

6.1 Problem Formulation

The Problem Formulation is an information gathering and interpretation step that focuses the assessment on the primary areas of concern for the site. This initial step of the assessment identifies hazards, receptors, exposure pathways, the COPC to be evaluated by the HHRA and the resulting exposure scenarios.

Human receptors may be in contact with substances present in their environment through several exposure pathways depending on their daily activities and the way in which they interact with this environment. There are three main exposure routes through which COPC can enter the human body: inhalation, ingestion and dermal absorption through the skin. In general, there can only be a health concern or potential health risk when there is a complete link from a substance (i.e. PHC, metal, PAH, etc.) through an environmental medium (i.e. air, water, soil/sediment) to a person (i.e., inhalation of a volatile compound).

In other words, the presence of a contaminant in the environment does not pose a risk by itself. The mobility and bioavailability of the chemical, and thus its possible contact with a living organism is the basis of the risk. In general, the relationship between the exposure and the risk can be expressed by the following diagram; for there to be a potential risk (i.e. represented by the colored polygon), there must be three factors present: (1) a chemical, (2) a receptor, and (3) an operable exposure pathway or route.



In other terms, if there is no exposure pathway to a chemical, regardless of its inherent toxicity, potency or environmental concentration, there would be no potential for the development of an adverse human health effect or no risk.

In this case, the possible exposure pathways for human contact with COPC in soil at the site to be investigated was through ingestion and dermal absorption through the skin. Since there are no buildings at the site, indirect exposure through air inhalation is not a complete pathway, although inhalation of dust was considered. There is also a possible exposure pathway for direct human contact with COPC in sediment which may include incidental ingestion of bedded sediment and dermal absorption from sediments adhering to the skin. There is no drinking water at the site, there are no buildings and groundwater does not discharge to surface water in areas evaluated, therefore, there are no complete direct or indirect exposure pathways for groundwater. Based on the use of the site, there are unlikely to be primary contact activities (i.e. swimming) associated with surface water, although secondary contact activities (i.e. boating) associated with surface water may be possible. Further, there is potential for exposure to COPC through the consumption of country foods such as berries and game. Since there were no COPC impacts in the water bodies (surface water and sediment) that were considered fish habitat, ingestion of fish was not considered a relevant exposure pathway. These exposure pathways are discussed further in Section 6.4

6.2 Hazard Identification

Human health screening was conducted to identify potential chemical hazards to human health at this site that should be carried forward for further evaluation. The human health screening involved comparing COPC concentrations to the following human health screening levels:

- 1999 (with 2018 Updates) CCME Canadian SQG for residential/parkland land use;
- 2008 (with 2012 Updates) CCME CWS for PHC in Soil, Tier 1 Values, residential/parkland land use – coarse-grained soil;
- 2012 (with 2015 Updates) Atlantic RBCA Tier I RBSLs for a residential property with non-potable groundwater and coarse-grained soil; and
- 2011 OMOE Table 3: Full depth, non-potable water scenario, residential/parkland land use.

Although using the residential human health screening levels is overly conservative for commercial receptors if COPC are carried forward for further HHRA, if no COPC concentrations exceed the residential screening levels, then potential for adverse human effects for the commercial worker is negligible.

Across Canada, there are no sediment quality guidelines or criteria for the protection of human health that could be used as a screening benchmark to identify COPC. The few human health-based sediment criteria currently available from other jurisdictions would not be directly applicable to most contaminated sites as they generally do not consider all potentially relevant exposure pathways, or they rely on regional data to assist with the development of site-specific screening criteria. For the purposes of screening COPC in sediment, the relevant CCME soil quality guidelines for human health would generally be considered the most appropriate screening values.

Where CCME human health-based soil quality guidelines are not available, human health soil criteria or guidelines from another jurisdiction may be selected. Generic guidelines have been developed by various jurisdictions (including CCME) as conservative benchmarks for screening purposes. If soil concentrations are below these guidelines, then the potential for adverse human effects is negligible. Since ecological receptors are being addressed independently, specifically human based guidelines and site-specific conditions were considered in the HHRA. Carcinogenic guidelines based on an incremental lifetime cancer risk (ILCR) of 10^{-6} (or 1 in 100,000) were not considered.

The appropriate screening levels were selected based on current and intended land use. The site is not controlled by restricted access and may be visited by recreational users. Commercial users also visit the site infrequently to service communications equipment. As discussed in Section 3, at the initial screening level, residential/parkland land use is most representative of actual human health exposure conditions rather than commercial or agricultural land use. Residential/parkland land use is protective of all human life cycle exposures, the primary activities of concern are recreational and commercial workers, there are no impediments or deterrents to human receptors accessing and using the site and the site is not solely used to grow produce or raise livestock. This land use is likely to remain unchanged for the foreseeable future. As such the CCME, CWS, Atlantic RBCA and OMOE residential screening levels were considered appropriate and conservative. Although there are residential land use guideline pathway checks protective of the consumption of produce and meat (i.e. surrogate for country food), some COPC have more conservative agricultural generic screening guidelines. For COPC that may biomagnify or otherwise are best represented by agricultural guidelines (cadmium, molybdenum, tin and trichloroethylene), if present, were further assessed to ensure human health related to food consumption was adequately addressed. This further assessment is presented in Table 6-1, Table 6-2, Table 6-3 and Table 6-4 for the COPC mentioned above. It should be noted that mercury agricultural and residential soil guidelines are equivalent for the protection of human health. Also, although the PCB agricultural guideline is smaller than the residential guideline, neither are based on the protection of human health. The recommended agricultural guideline is based on the 1991 interim soil quality criteria, and the recommended residential guideline is based protection of the tertiary ecological receptor. Since agricultural foods are not exclusively grown at the site, nor is livestock exclusively tended, the recommended residential PCB guideline is considered protective of human health and has been used as the human health screening guideline.

The groundwater at the site is not used as a potable water source. Based on our assessment, groundwater does not discharge to surface water in the areas where groundwater was assessed, and surface water was evaluated directly and provides more representative data. There are no buildings. Therefore, there are no relevant guidelines for groundwater that are protective of human health. Consequently, exposure to groundwater was not further assessed for COPC.

From review of the site, most waterbodies are shallow watercourses and shallow ponded water associated with wetlands, although there is deeper water associated with the pond located west of the Bell communication tower, which was formerly used to supply potable drinking water to the Main Complex. We understand that this water body is not used for swimming, although boat use may occur. Surface water could be incidentally ingested or dermally contacted at the site, however, considering the size, the nature and location of the surface water locations sampled, it is highly unlikely they would be used for primary contact recreational activities such as swimming. Although secondary contact recreational activities are possible, such as boating, incidental ingestion of surface water from these activities was considered unlikely. As outlined in Section 3.4, based on CCME guidance and the Guidelines for Canadian Recreational Water Quality (Health Canada, 2012), there are no relevant guidelines for inorganic chemical parameters for surface water that are protective of human health (through primary or secondary contact). In addition, the few metals detected in surface water would not exceed more conservative drinking water standards, and no organic COPC were present. Therefore, exposure to surface water was not further assessed for COPC.

Screening for COPC to be included in the HHRA in soil and sediment was conducted by study area (General Area, Former Contractor Village, Main Complex and Former USAF Dump Area and Former Ammunition Storage Area). Given the large size of the overall/entire site, screening and assessment of COPC on a site by site basis was deemed to be more conservative and more representative of the conditions at each study area. In Englobe's opinion, it would be less conservative to assess the entire site based on isolated areas with "hot spots." In addition, assessing based on a site by site basis makes it easier to identify those areas requiring further remediation or assessment, should this be required. Those COPC that had a maximum concentration above human health screening values in a particular media (see Tables 1 through 29 in Appendix C) were qualitatively assessed for data suitability and irregular or otherwise non-representative data were not considered (as described in Section 5). Remaining representative data are summarized in Table 6-1, Table 6-2, Table 6-3 and Table 6-4.

Also, during previous testing some COPC (metals and PCBs) were evaluated in berries and/or foliage from the General Area, Former Contractor Village, Main Complex and Former USAF Dump Area and Former Ammunition Storage Area to assess potential for uptake into plants. Although there were PCBs detected in foliage from all sites, no PCBs were detected in berries where berries were present and therefore analyzed (General Area and Main Complex). There are no relevant guidelines for PCBs in these media, rather, they should be used to support detailed HHRA. If PCBs were detected in vegetation or berries, PCBs in soil was generally carried forward in the HHRA.

Maximum concentrations and UCLM95%s are compared to human health screening levels in Table 6-1, Table 6-2, Table 6-3 and Table 6-4. If the maximum concentration in any area, exceeded the relevant screening level, the parameter is included within the tables below for all areas. Where the maximum concentration did not exceed the relevant screening level, an UCLM95% was not calculated. Where there are no guidelines recommended to be protective of human health, these COPC were not presented. An UCLM95% was not calculated for the BaP TPE, since this value is a calculation. Where the EPC (either maximum or UCLM95%) did not exceed the screening level, the COPC was not carried forward for further assessment.

6.2.1 General Area

COPC identified in soil are summarized in Table 6-1 Table 6-2. In sediment, all maximum concentrations were below the human health screening values. As discussed in the previous section, there are no human health guidelines for groundwater and surface water. Although no guidelines exist, PCBs were detected in vegetation samples from the General Area. PCBs were analyzed in berries from the General Area; however, none were detected.

Table 6-1 Human Health Screening of Soil General Area.

Parameter	Maximum Concentration (mg/kg)	UCLM95% (mg/kg)	Screening Guideline (mg/kg)	Reference	Included
PHC					
Total Modified TPH	550	NC	8600 (Fuel)	Atlantic RBCA Tier II PSSLs, Soil ingestion and dermal contact	No
Fraction F2 (>C10-C16)	<10	NC	6800	CCME CWS Tier 1, Ingestion/direct contact	No
Fraction F3 (>C16-C34)	550	NC	15000	CCME CWS Tier 1, Ingestion/direct contact	No
PAHs					
BaP TPE	0.0126	NC	5.3	CCME Soil Ingestion	No
Metals					
Cadmium	<0.3	NC	14	CCME Soil Ingestion	No
			1.4	CCME Soil Plant Uptake (agricultural)	
Lead	6.8	NC	140	CCME Soil Ingestion	No
Molybdenum	<2	NC	10	CCME interim (residential)	No
			5	CCME interim (agricultural)	
Tin	<2	NC	50	CCME interim (residential)	No
			5	CCME interim (agricultural)	

Parameter	Maximum Concentration (mg/kg)	UCLM95% (mg/kg)	Screening Guideline (mg/kg)	Reference	Included
Vanadium	45	29	39	OMOE Soil Contact S2	No
PCB					
Total PCBs	<0.05	NC	1.3	CCME Soil and Food Ingestion, Tertiary Consumer	No

Notes:

NC – Not Calculated

6.2.2 Former Contractor Village

COPC identified in soil are summarized in Table 6-2. In sediment, all maximum concentrations were below the human health screening values. As discussed in the previous section, there are no human health guidelines for groundwater and surface water. Although no guidelines exist, PCBs were detected in vegetation samples from the Former Contractor Village. There were no berries in this study area.

Table 6-2 Human Health Screening of Soil Former Contractor Village.

Parameter	Maximum Concentration (mg/kg)	UCLM95% (mg/kg)	Screening Guideline (mg/kg)	Reference	Included
PHC					
Total Modified TPH	4800	NC	8600 (Fuel)	Atlantic RBCA Tier II PSSLs, Soil ingestion and dermal contact	No
Fraction F2 (>C10-C16)	4070	NC	6800	CCME CWS Tier 1, Ingestion/direct contact	No
Fraction F3 (>C16-C34)	465	NC	15000	CCME CWS Tier 1, Ingestion/direct contact	No
PAHs					
BaP TPE	0.076	NC	5.3	CCME Soil Ingestion	No
Metals					
Cadmium	<0.3	NC	14	CCME Soil Ingestion	No
			1.4	CCME Soil Plant Uptake (agricultural)	
Lead	23	NC	140	CCME Soil Ingestion	No
Molybdenum	<2	NC	10	CCME interim (residential)	No
			5	CCME interim (agricultural)	
Tin	29	2.127	50	CCME interim (residential)	No
			5	CCME interim (agricultural)	
Vanadium	61	36	39	OMOE Soil Contact S2	No
PCB					
Total PCBs	<0.05	NC	1.3	CCME Soil and Food Ingestion, Tertiary Consumer	No

Notes:

NC – Not Calculated

6.2.3 Main Complex

COPC identified in soil are summarized in Table 6-3. In sediment, the maximum concentrations were below the human health screening values. As discussed in the previous section, there are no human health guidelines for groundwater and surface water. Although no guidelines exist, PCBs were detected in vegetation samples from the Main Complex. PCBs were analyzed in berries from the Main Complex; however, none were detected.

Table 6-3 Human Health Screening of Soil Main Complex.

Parameter	Maximum Concentration (mg/kg)	UCLM95% (mg/kg)	Screening Guideline (mg/kg)	Reference	Included
PHC					
Total Modified TPH	27000	3268	8600 (Fuel)	Atlantic RBCA Tier II PSSLs, Soil ingestion	No
Fraction F2 (>C10-C16)	12500	1533	6800	CCME CWS Tier 1, Ingestion/direct contact	No
Fraction F3 (>C16-C34)	27000	2451	15000	CCME CWS Tier 1, Ingestion/direct contact	No
PAHs					
BaP TPE	**10.41**	**NC**	**5.3**	**CCME Soil Ingestion**	**Yes**
Metals					
Cadmium	49	1.4	14	CCME Soil Ingestion	No
			1.4	CCME Soil Plant Uptake (agricultural)	
Lead	200	35	140	CCME Soil Ingestion	No
Molybdenum	9.7	2.5	10	CCME interim (residential)	No
			5	CCME interim (agricultural)	
Tin	6.8	2.1	50	CCME interim (residential)	No
			5	CCME interim (agricultural)	
Vanadium	88	31	39	OMOE Soil Contact S2	No
PCB					
Total PCBs	2	0.67	1.3	CCME Soil and Food Ingestion, Tertiary Consumer	No

Notes:
NC – Not Calculated

6.2.4 Former USAF Dump Area and Former Ammunition Storage Area

COPC identified in soil are summarized in Table 6-4. In sediment, the maximum concentrations were below the human health screening values. As discussed in the previous section, there are no human health guidelines for groundwater and surface water. Although no guidelines exist, PCBs were detected in vegetation samples from the Former USAF Dump Area and Former Ammunition Storage Area. There were no berries in this study area.

Table 6-4 Human Health Screening of Soil Former USAF Dump Area and Former Ammunition Storage Area.

Parameter	Maximum Concentration (mg/kg)	UCLM95% (mg/kg)	Screening Guideline (mg/kg)	Reference	Included
PHC					
Total Modified TPH	6500	NC	8600 (Fuel)	Atlantic RBCA Tier II PSSLs, Soil ingestion	No
Fraction F2 (>C10-C16)	140	NC	6800	CCME CWS Tier 1, Ingestion/direct contact	No
Fraction F3 (>C16-C34)	6380	NC	15000	CCME CWS Tier 1, Ingestion/direct contact	No
PAHs					
BaP TPE	**21.96**	**NC**	**5.3**	**CCME Soil Ingestion**	**Yes**
Metals					
Cadmium	2	0.3	14	CCME Soil Ingestion	No
			1.4	CCME Soil Plant Uptake (agricultural)	
Lead	180	19.5	140	CCME Soil Ingestion	No
Molybdenum	6	2	10	CCME interim (residential)	No
			5	CCME interim (agricultural)	
Tin	14	2.8	50	CCME interim (residential)	No
			5	CCME interim (agricultural)	
Vanadium	38	NC	39	OMOE Soil Contact S2	No
PCB					
Total PCBs	**24**	**8.6**	**1.3**	**CCME Soil and Food Ingestion, Tertiary Consumer**	**Yes**

Notes:

NC – Not Calculated

6.3 List of COPC retained for HHRA

6.3.1 General Area

In soil at the Former Contractor Village, the maximum value for vanadium exceeded the human health screening levels, while the maximum concentrations of all other COPC in soil and sediment were below the human health screening levels. The ULCM95% for vanadium was below the human health screening level, and consequently vanadium was not carried forward.

No exceedances of the human health screening guidelines were encountered for any other COPC within the General Area for any media.

Although no guidelines exist, PCBs were detected in vegetation samples from the general area. As such, further assessment of PCBs is recommended.

6.3.2 Former Contractor Village

In soil at the Former Contractor Village, the maximum value for tin and vanadium exceeded the human health screening levels, while the maximum concentrations of all other COPC in soil and sediment were below the human health screening levels. The ULCM95% for tin and vanadium were below the human health screening level, and consequently were not carried forward.

No exceedances of the human health screening guidelines were encountered for any other COPC within the Former Contractor Village for any media.

Although no guidelines exist, PCBs were detected in vegetation samples from the General Area. As such, further assessment of PCBs is recommended.

6.3.3 Main Complex

In soil at the Main Complex, the maximum values for total modified TPH (fuel oil), Fraction F2, Fraction F3, BaP TPE, cadmium, lead, molybdenum, tin, vanadium and total PCBs exceeded the human health screening levels, while the maximum concentrations of all other COPC in soil were below the human health screening levels.

The ULCM95% for total modified TPH (fuel oil), Fraction F2, Fraction F3, cadmium, lead, molybdenum, tin, vanadium and total PCBs were below the human health screening levels, and consequently were not carried forward.

The maximum value for BaP TPE exceeded the human health screening level, and as such was carried forward for further assessment.

No exceedances of the human health screening guidelines were encountered for any other COPC within the Main Complex for any media.

Although no guidelines exist, PCBs were detected in vegetation samples from the Main Complex. As such, further assessment of PCBs is recommended.

6.3.4 Former USAF Dump Area and Former Ammunition Storage Area

In soil at the Former USAF Dump Area and Former Ammunition Storage Area, the maximum values for BaP TPE, cadmium, lead, molybdenum, tin and total PCBs exceeded the human health screening levels, while the maximum concentrations of all other COPC in soil were below the human health screening levels.

The ULCM95% for cadmium, lead, molybdenum and tin were below the human health screening levels, and consequently were not carried forward.

The maximum value for BaP TPE and the ULCM95% for PCBs the exceeded the human health screening levels and as such, BaP TPE and PCBs were carried forward for further assessment.

Although no guidelines exist, PCBs were detected in vegetation samples from the Former USAF Dump Area and Former Ammunition Storage Area.

6.4 Exposure Scenarios and Operable Pathway Identification

The identification of exposure scenarios and operable exposure pathway aims to evaluate the likelihood that human receptors may come into contact with COPC in targeted environmental media (hazards). The likelihood of exposure is determined through consideration of the physio-chemical properties of individual COPC that control the environmental fate (i.e., intermedia transfer and transport) and chemical mobility and bioavailability, and the various pathways through which the receptor could be exposed to COPC. Thus, this step considers the possible routes of exposure by which a COPC may reach the 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, surface water, etc.) to a point where it can come in contact with a human receptor. The possible exposure scenarios that have been considered for human receptors at the areas of the site include:

- Ingestion/dermal contact with soil and sediment;
- Inhalation/ingestion/dermal contact with soil dust; and
- Ingestion of country foods (game and berries).

Since no COPCs that were carried forward were not detected in groundwater, uptake of COPCs from groundwater to plants was not considered.

The relevant exposure pathways at each area of the site are summarized in Table 6-5, Table 6-6, Table 6-7and Table 6-8which includes an evaluation of each pathway based on site-specific conditions. Those complete hazard-exposure-receptor combinations considered to have the highest likelihood to contribute to human health risk are carried forward for further quantitative analysis. COPC.

Table 6-5 Potential Exposure Scenarios - Human Receptors in the General Area.

Exposure Pathway Description	Pathway Complete?	Carried Forward?	Justification
Ingestion of soil	Yes	No	Although ingestion or dermal contact with soil is possible, they were not retained as a potential exposure media and pathway. The COPC detected in soil were below all human health guidelines (protective of the recreational as well as commercial user) as described in Section 6.2. Therefore, this pathway was not independently assessed further, although PCBs in soil were included to address additive effects related to PCBs in game (discussed below).
Dermal contact with soil			
Ingestion of dust			
Dermal contact with dust			
Ingestion of sediment	Yes	No	Although sediments could be incidentally ingested or dermally contacted at the site, they were not retained as a potential exposure media and pathway. The COPC detected in the sediments were below all human health guidelines as described in Section 6.2. Therefore, this pathway was not assessed further.
Dermal contact with sediment			
Ingestion of vegetation/ garden produce grown in impacted soil	Yes	Yes	It is unlikely that edible produce would be grown at this site based on its limited use and short growing season. However, the site is used for foraging of berries. There were no metals or PAH COPCs that exceeded screening guidelines that are protective of consumption of produce, nor were any of the metals detected in the berry samples carried forward in soil exposure pathways. As reported by Hale (2004), uptake of inorganic metals or PAHs into fruit is not expected. Berries tested from the areas with known

Exposure Pathway Description	Pathway Complete?	Carried Forward?	Justification
			PCB impacts in soil contained no detectable PCBs, although to be conservative, this pathway was assessed further.
Consumption of Game	Yes	Yes	Based on information reviewed for the site, hunting of game occurs in the area. There were no COPC (including PCBs) that exceeded screening guidelines that are protective of consumption of game, however, vegetation samples from the area contained detectable concentrations of PCBs. Therefore, this pathway was assessed further.
Dermal contact with/Ingestion of surface water	No	No	There is surface water present at the site, although based on the conditions at the site, primary contact activities (such as swimming) would not occur at the site. Secondary contact (such as boating) is possible, but incidental ingestion of surface water is considered unlikely. Further, exposure to inorganic chemical contaminants is not considered a significant health risk for recreational water users (Health Canada 2012) and the few metals present would not exceed more conservative drinking water standards, and no organic COPC were present. Therefore, this pathway was not assessed further.
Ingestion of groundwater	No	No	There is no current or anticipated future use of groundwater on the subject property for drinking water purposes. Groundwater does not discharge to surface water, in the areas assessed, and surface water was evaluated directly and is more representative. Therefore, the pathways for human exposure to groundwater are not considered further in this risk assessment.
Inhalation of vapours (indoors)	No	No	There are no buildings and no anticipated future building construction. Therefore, the human receptor indoor air pathway is incomplete and was not considered further in this risk assessment.
Inhalation of vapours (outdoors)	No	No	Although PHCs are volatile, Atlantic RBCA considers inhalation of PHC vapours in outdoor air to be a negligible pathway and PHC concentrations less than RES or SOL (i.e. free petroleum product) are considered acceptable for exposure to outdoor air vapours. The PHC concentrations were all below the relevant guidelines. PAHs, metals and PCBs have low volatility and are not be expected to pose a risk in terms of inhalation in outdoor environments. Therefore, the human receptor outdoor air pathway is incomplete and was not considered further in this risk assessment.

Table 6-6 Potential Exposure Scenarios - Human Receptors in the Former Contractor Village.

Exposure Pathway Description	Pathway Complete?	Carried Forward?	Justification
Ingestion of soil	Yes	No	Although ingestion or dermal contact with soil is possible, they were not retained as a potential exposure media and pathway. The COPC detected / UCLM95% calculated in soil were below all human health guidelines (protective of the recreational as well as commercial user) as described in Section 6.2. Therefore, this pathway was not independently assessed further, although PCBs in soil were included to address additive effects related to PCBs in game (discussed below).
Dermal contact with soil			
Ingestion of dust			
Dermal contact with dust			
Ingestion of sediment	Yes	No	Although sediments could be incidentally ingested or dermally contacted at the site, they were not retained as a potential exposure media and pathway. The COPC detected in the

Exposure Pathway Description	Pathway Complete?	Carried Forward?	Justification
Dermal contact with sediment			sediments were below all human health guidelines as described in Section 6.2. Therefore, this pathway was not assessed further.
Ingestion of vegetation/ garden produce grown in impacted soil	Yes	No	It is unlikely that edible produce would be grown at this site based on its limited use and short growing season. However, the Former USAF site is used for foraging of berries. There were no metals or PAH COPCs that exceeded screening guidelines that are protective of consumption of produce. As reported by Hale (2004), uptake of inorganic metals or PAHs into fruit is not expected. There were no berries present in this area. Therefore, this pathway was not assessed further.
Consumption of Game	Yes	Yes	Based on information reviewed for the site, hunting of game occurs in the area. There were no COPC (including PCBs) that exceeded screening guidelines that are protective of consumption of game, however, vegetation samples from the area contained detectable concentrations of PCBs. Therefore, this pathway was assessed further.
Dermal contact with/Ingestion of surface water	No	No	There is surface water present at the site, although based on the conditions at the site, primary contact activities (such as swimming) would not occur at the site. Secondary contact (such as boating) is possible, but incidental ingestion of surface water is considered unlikely. Further, exposure to inorganic chemical contaminants is not considered a significant health risk for recreational water users (Health Canada 2012) and the few metals present would not exceed more conservative drinking water standards, and no organic COPC were present. Therefore, this pathway was not assessed further.
Ingestion of groundwater	No	No	There is no current or anticipated future use of groundwater on the subject property for drinking water purposes. Groundwater does not discharge to surface water, in the areas assessed, and surface water was evaluated directly and is more representative. Therefore, the pathways for human exposure to groundwater are not considered further in this risk assessment.
Inhalation of vapours (indoors)	No	No	There are no buildings and no anticipated future building construction. Therefore, the human receptor indoor air pathway is incomplete and was not considered further in this risk assessment.
Inhalation of vapours (outdoors)	No	No	Although PHCs are volatile, Atlantic RBCA considers inhalation of PHC vapours in outdoor air to be a negligible pathway and PHC concentrations less than RES or SOL (i.e. free petroleum product) are considered acceptable for exposure to outdoor air vapours. The PHC concentrations were all below the relevant guidelines. PAHs, metals and PCBs have low volatility and are not be expected to pose a risk in terms of inhalation in outdoor environments. Therefore, the human receptor outdoor air pathway is incomplete and was not considered further in this risk assessment.

Table 6-7 Potential Exposure Scenarios - Human Receptors in the Main Complex.

Exposure Pathway Description	Pathway Complete?	Carried Forward?	Justification
Ingestion of soil Dermal contact with soil Ingestion of dust Dermal contact with dust	Yes	Yes	PAH impacts were identified in the surface soil. Recreational receptors may be exposed to the impacted soil during months without snow cover. Commercial receptors are not expected to be present in this area, since there are no communication towers. Further, PCBs in soil were included to address additive effects related to PCBs in game (discussed below)
Ingestion of sediment Dermal contact with sediment	No	No	Although sediments could be incidentally ingested or dermally contacted at the site, they were not retained as a potential exposure media and pathway. The COPC detected in the sediments were below all human health guidelines as described in Section 6.2. Therefore, this pathway was not assessed further.
Ingestion of vegetation/ garden produce grown in impacted soil	Yes	Yes	It is unlikely that edible produce would be grown at this site based on its limited use and short growing season. However, the site is used for foraging of berries. There were no metals or PAH COPCs that exceeded screening guidelines that are protective of consumption of produce, nor were any of the metals detected in the berry samples carried forward in soil exposure pathways. As reported by Hale (2004), uptake of inorganic metals or PAHs into fruit is not expected. Berries tested from the areas with known PCB impacts in soil contained no detectable PCBs, although to be conservative, this pathway was assessed further.
Consumption of Game	Yes	Yes	Based on information reviewed for the site, hunting of game occurs in the area. PCBs in soil exceeded the screening guideline that is protective of consumption of game. Further, vegetation samples from the area contained detectable concentrations of PCBs. Therefore, this pathway was assessed further.
Dermal contact with/Ingestion of surface water	No	No	There is surface water present at the site, although based on the conditions at the site, primary contact activities (such as swimming) would not occur at the site. Secondary contact (such as boating) is possible, but incidental ingestion of surface water is considered unlikely. Further, exposure to inorganic chemical contaminants is not considered a significant health risk for recreational water users (Health Canada 2012) and the few metals present would not exceed more conservative drinking water standards, and no organic COPC were present. Therefore, this pathway was not assessed further.
Ingestion of groundwater	No	No	There is no current or anticipated future use of groundwater on the subject property for drinking water purposes. Groundwater does not discharge to surface water, in the areas assessed, and surface water was evaluated directly and is more representative. Therefore, the pathways for human exposure to groundwater are not considered further in this risk assessment.
Inhalation of vapours (indoors)	No	No	There are no buildings and no anticipated future building construction. Therefore, the human receptor indoor air pathway is incomplete and was not considered further in this risk assessment.
Inhalation of vapours (outdoors)	No	No	Although PHCs are volatile, Atlantic RBCA considers inhalation of PHC vapours in outdoor air to be a negligible pathway and PHC concentrations less than RES or SOL (i.e. free petroleum product) are considered acceptable for exposure to outdoor air vapours. The PHC concentrations were all below the relevant guidelines.

Exposure Pathway Description	Pathway Complete?	Carried Forward?	Justification
			PAHs, metals and PCBs have low volatility and are not be expected to pose a risk in terms of inhalation in outdoor environments. Therefore, the human receptor outdoor air pathway is incomplete and was not considered further in this risk assessment.

Table 6-8 Potential Exposure Scenarios - Human Receptors in the Former USAF Dump Area and Former Ammunition Storage Area

Exposure Pathway Description	Pathway Complete?	Carried Forward?	Justification
Ingestion of soil	Yes	Yes	PAHs and PCB impacts were identified in the surface soil. Recreational receptors may be exposed to the impacted soil during months without snow cover. Commercial receptors are not expected to be present in this area, since there are no communication towers.
Dermal contact with soil			
Ingestion of dust			
Dermal contact with dust			
Ingestion of sediment	No	No	Although sediments could be incidentally ingested or dermally contacted at the site, they were not retained as a potential exposure media and pathway. The COPC detected in the sediments were below all human health guidelines t as described in Section 6.2. Therefore, this pathway was not assessed further.
Dermal contact with sediment			
Ingestion of vegetation/ garden produce grown in impacted soil	Yes	No	It is unlikely that edible produce would be grown at this site based on its limited use and short growing season. However, the Former USAF site is used for foraging of berries. There were no metals or PAH COPCs that exceeded screening guidelines that are protective of consumption of produce. As reported by Hale (2004), uptake of inorganic metals or PAHs into fruit is not expected. There were no berries present in this area. Therefore, this pathway was not assessed further.
Consumption of Game	Yes	Yes	Based on information reviewed for the site, hunting of game occurs in the area. PCBs in soil exceeded the screening guideline that is protective of consumption of game (i.e. tertiary consumer). Further, PCBs were detected in vegetation at this site. Therefore, this pathway was assessed further.
Dermal contact with/Ingestion of surface water	No	No	There is surface water present at the site, although based on the conditions at the site, primary contact activities (such as swimming) would not occur at the site. Secondary contact (such as boating) is possible, but incidental ingestion of surface water is considered unlikely. Further, exposure to inorganic chemical contaminants is not considered a significant health risk for recreational water users (Health Canada 2012) and the few metals present would not exceed more conservative drinking water standards, and no organic COPC were present. Therefore, this pathway was not assessed further.
Ingestion of groundwater	No	No	There is no current or anticipated future use of groundwater on the subject property for drinking water purposes. Groundwater does not discharge to surface water, in the areas assessed, and surface water was evaluated directly and is more representative. Therefore, the pathways for human exposure to groundwater are not considered further in this risk assessment.

Exposure Pathway Description	Pathway Complete?	Carried Forward?	Justification
Inhalation of vapours (indoors)	No	No	There are no buildings. Therefore, the human receptor indoor air pathway is incomplete and was not considered further in this risk assessment.
Inhalation of vapours (outdoors)	No	No	Although PHCs are volatile, Atlantic RBCA considers inhalation of PHC vapours in outdoor air to be a negligible pathway and PHC concentrations less than RES or SOL (i.e. free petroleum product) are considered acceptable for exposure to outdoor air vapours. The PHC concentrations were all below the relevant guidelines. PAHs, metals and PCBs have low volatility and are not be expected to pose a risk in terms of inhalation in outdoor environments. Therefore, the human receptor outdoor air pathway is incomplete and was not considered further in this risk assessment.

6.5 Receptors

The site was previously "occupied" by the USAF, but the area is currently owned by the Province of Newfoundland.

The site is uninhabited, although there are several communication towers present that are infrequently serviced by commercial workers. Commercial workers would only be expected to visit the General Area; there are no communication towers or other anticipated access (i.e. helicopter pad) in the Former Contractor Village, Main Complex or Former USAF Dump Area and Former Ammunition Storage Area. There were no soil COPCs carried forward from the General Area, and the commercial worker would not be expected to visit other study areas at the site as part of their regular duties (and be exposed to soil). Further, the commercial worker would not be expected to hunt and consume game from the site during their regular duties. Therefore, the commercial worker exposure scenario is considered to have been adequately addressed, and potential for adverse human effects for the commercial worker is negligible.

The site is not controlled by restricted access, and given its proximity to the Town of Cartwright, it is possible that recreational and indigenous users occasionally visit the site for recreational activities and harvesting of country foods.

For threshold substances, assessing risk to a sensitive target group such as toddlers would be protective of other receptor groups that could access the site for both commercial and recreational activities. For carcinogenic substances, the aggregate life cycle of an adult (80 years) would be protective of all receptor groups.

6.6 Human Health Conceptual Site Model

The CSM developed for the General Area, Former Contractor Village, Main Complex and Former USAF Dump Area and Former Ammunition Storage Area are presented on Figure 6-1, Figure 6-2, Figure 6-3 and Figure 6-4. It indicates that the toddler visitor and/or adult receptor (aggregate life cycle of 80 years) may be exposed to select COPC in surface soil, and potentially to select COPCs in game. As mentioned before, assessing risk to potential toddler visitors (for threshold COPC) is protective of other human groups (e.g., adults) on this site.

Figure 6-1 Toxicological Conceptual Site Model – General Area, Former USAF Radar Station, Cartwright, NL

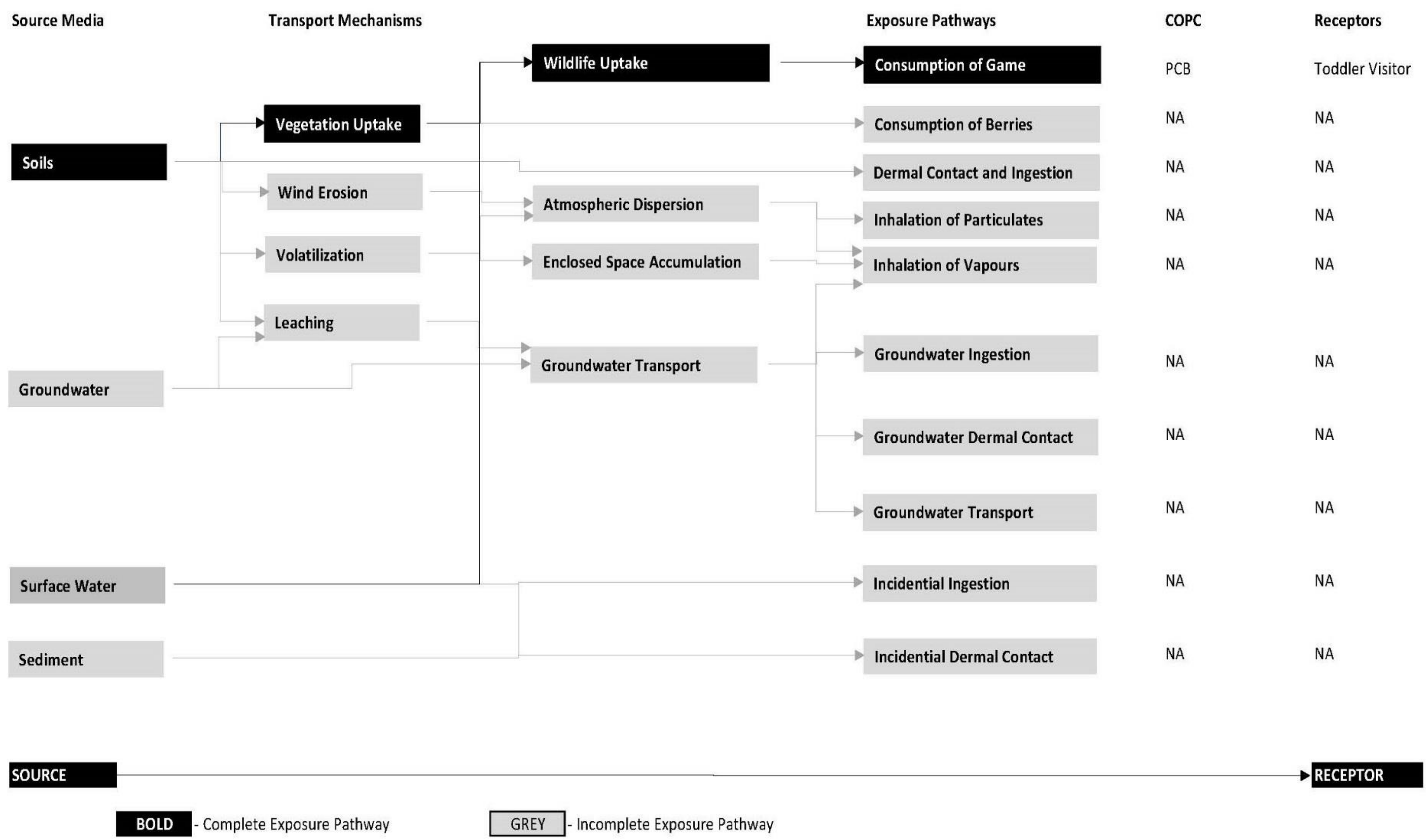


Figure 6-2 Toxicological Conceptual Site Model – Former Contractor Village, Former USAF Radar Station, Cartwright, NL

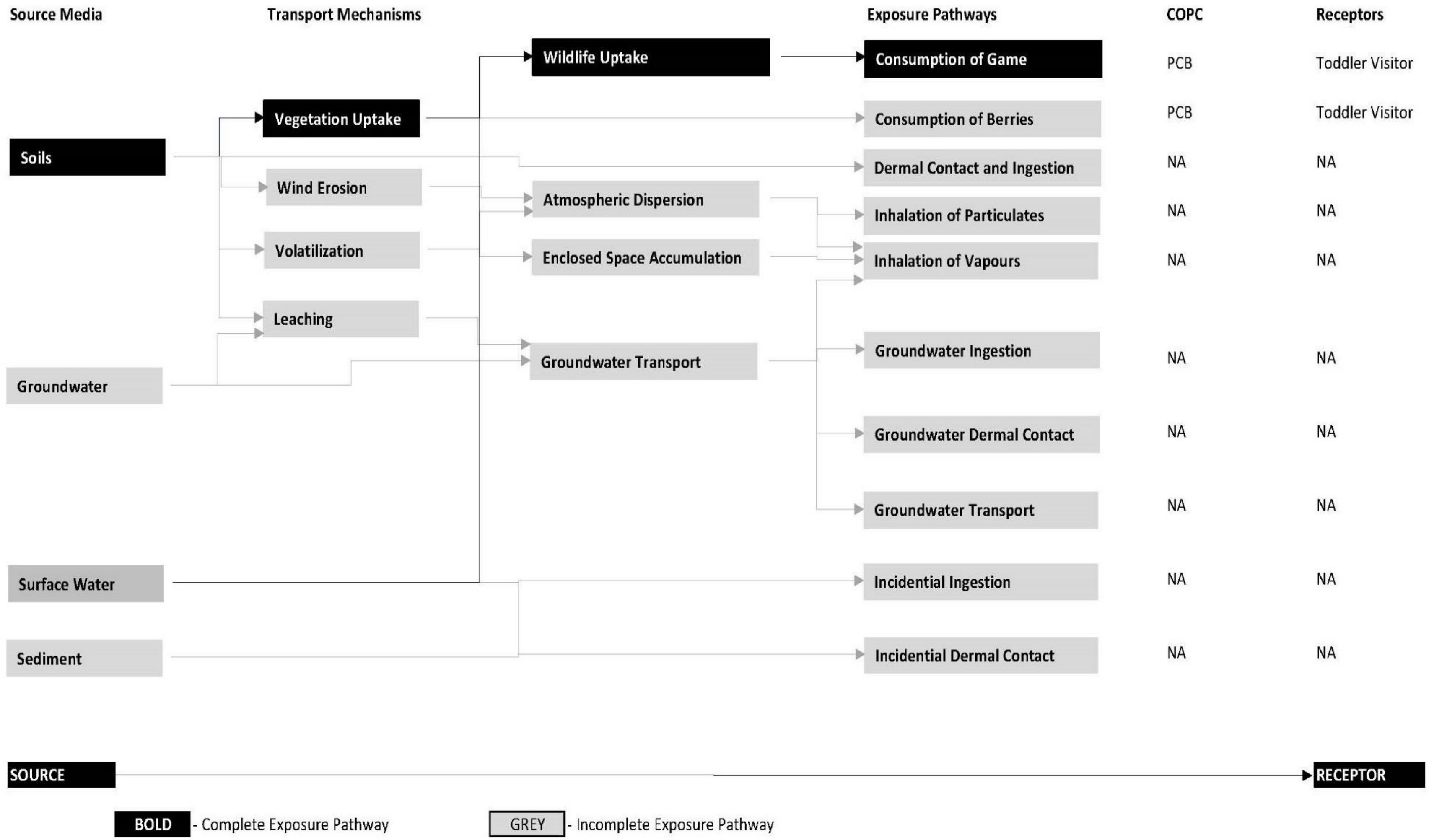


Figure 6-3 Toxicological Conceptual Site Model – Main Complex, Former USAF Radar Station, Cartwright, NL

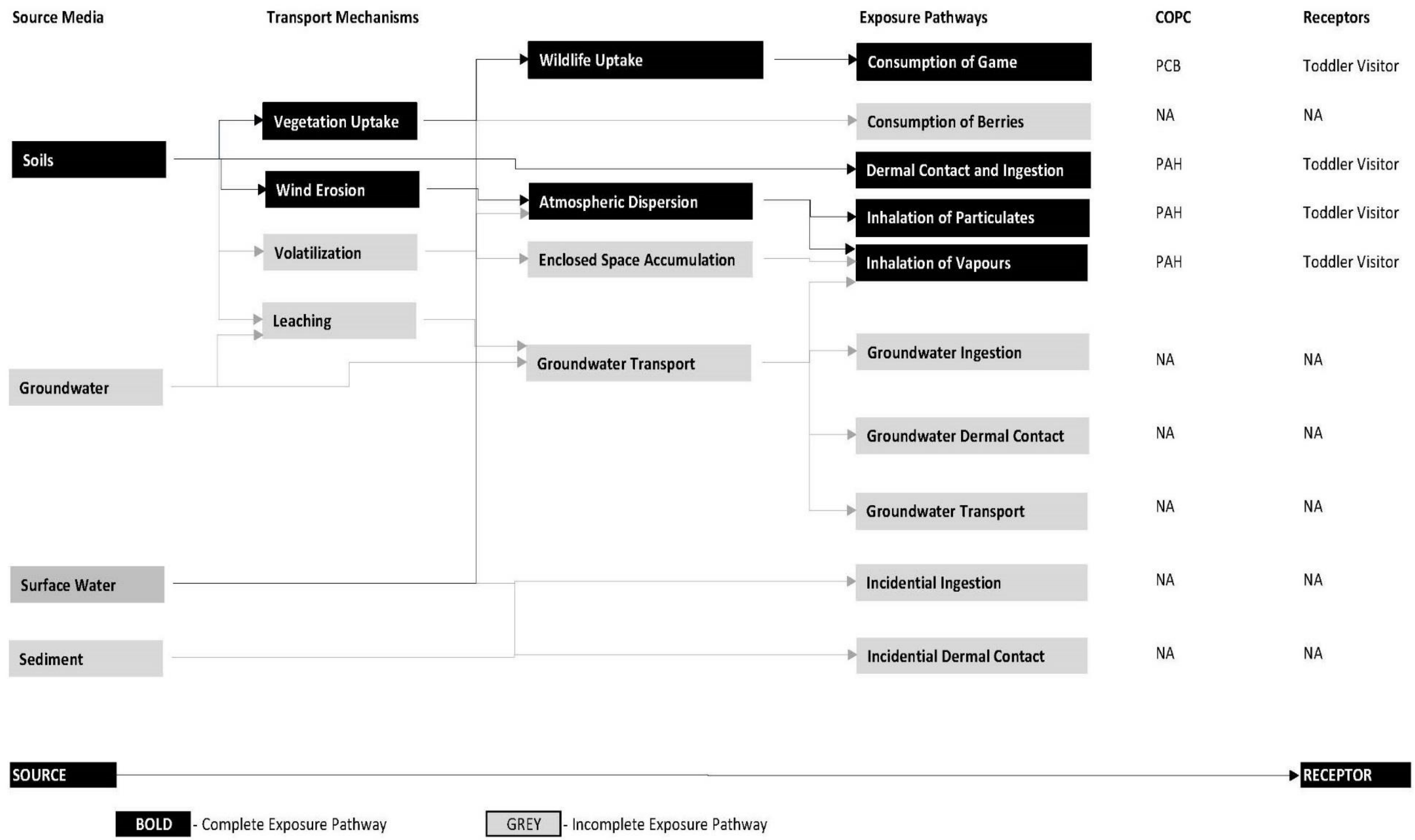
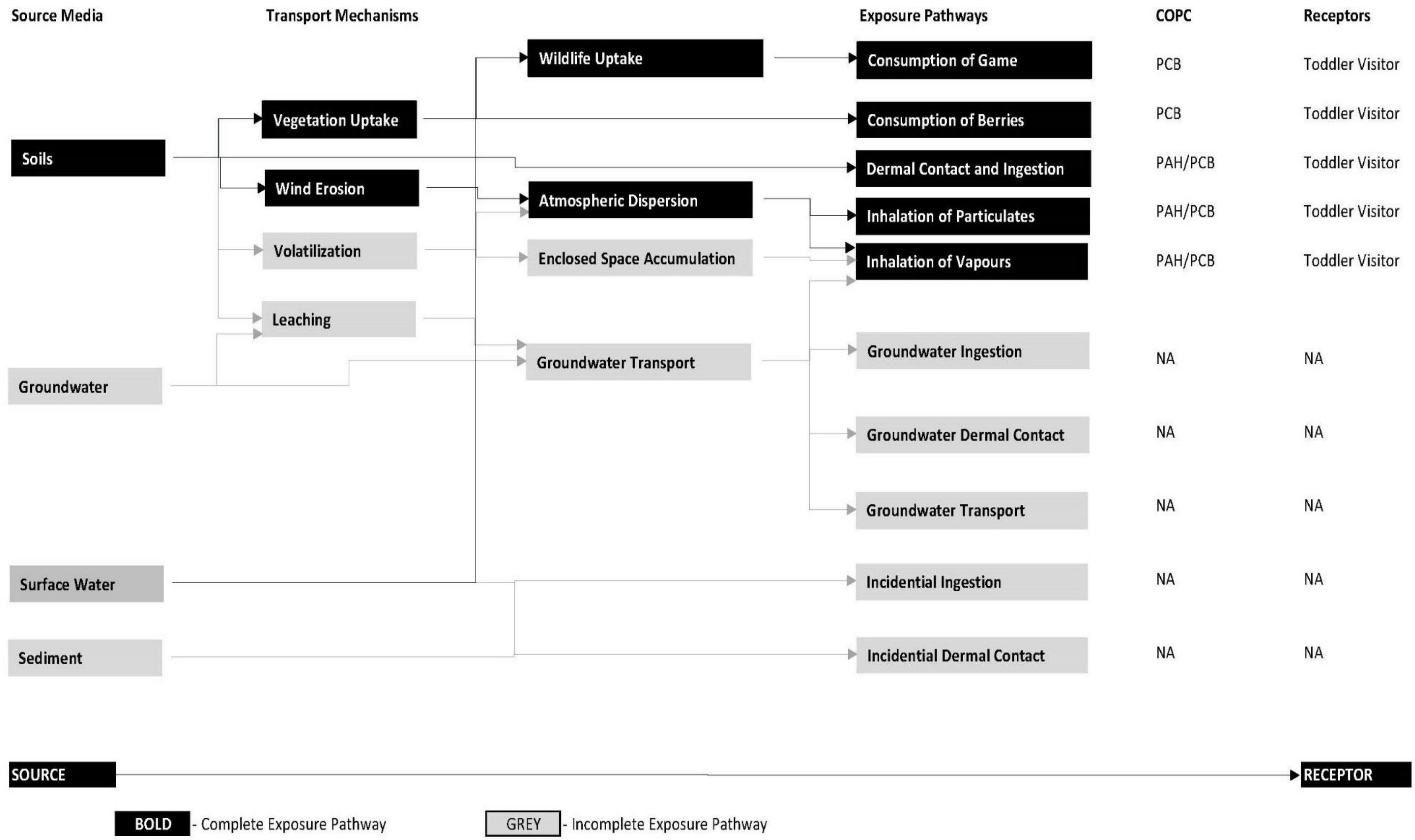


Figure 6-4 Toxicological Conceptual Site Model – Former USAF Dump Area and Former Ammunition Storage Area, Former USAF Radar Station, Cartwright, NL



6.7 Exposure Assessment

6.7.1 Assessment Tools

A risk assessment model was used to calculate the human health risk associated with BaP TPE and PCB impacts in soil identified at the site. SSTLs were only derived only if the target risks were exceeded. These equations are based on the general model from Health Canada (2010c). SSTLs were derived in accordance with the methods presented in "A Protocol for the Derivation of Environmental and Human Health Soil Quality Guidelines" (CCME, 2006).

Where empirical data was not available for a media (i.e. game), uptake calculations were employed to predict concentrations of COPC. In the case of this HHRA, this includes game bird and moose tissues.

The specific methods employed to develop the target risks and SSTLs are consistent with CCME and Health Canada protocols and with standard human health risk assessment methodologies. The equations used in the modelling of metal impacts are shown on the spreadsheet in Appendix E.

6.7.2 Receptor Characteristics

To ensure the conservative nature of the HHRA screening, the exposure scenario assumes that a recreational visitor would be exposed to soil and surface water at the site 25 weeks per year (average number of weeks without snow cover), 3 days per week, 6 hours per day. It is assumed site usage will be limited from approximately October through June, due to weather conditions (as observed at the nearby Environment Canada weather station in Cartwright, i.e. negative temperatures and snow cover). For the dermal contact and ingestion exposure pathway, it is assumed that the receptors will receive their entire daily exposure during the 3 hours that they are outside (i.e., event driven exposure). Overall, this scenario was deemed overly conservative for the current and likely future land use of the site, and its use is therefore considered protective of all potential receptors.

As mentioned previously, the COPCs identified for quantitative risk assessment are BaP TPE and total PCBs. Human health risks from carcinogenic substances are generally evaluated based on a lifetime (80 years) of exposure. Human health risks for threshold substances are usually evaluated based on the most sensitive receptor, although for developmental toxicants, exposure amortization is limited to "days per week", rather than amortized over a year.

Receptor characteristics such as physical and behavioural characteristics, age, body weight, soil ingestion rate or inhalation rate of the receptors were determined in accordance with HC guidance and are presented in Appendix E.

The soil ingestion rate for the toddler receptor was set at 20 mg/day as recommended by Richardson et al. (2013), instead of 80 mg/day as recommended by Health Canada. The validity and reliability of the studies from which soil ingestion rates currently used by Health Canada originate from have been critiqued by the U.S. EPA and others, with recent refinement demonstrating that the mean ingestion rate for children is approximately one-third the intake rate originally interpreted by Health Canada (Richardson et al., 1997). More recent assessments as summarized by Richardson et al. (2013) further support that the ingestion rate for toddlers of 80 mg/day recommended by Health Canada, was likely greater than the 95th percentile soil ingestion rate for this age group. The use of soil ingestion rates that equal or exceed the 95^{th} percentile values coupled with average or typical values for most exposure factors (e.g., body

validation and weight of evidence studies for cancer outcome studies can take several years to validate, it is not uncommon for a jurisdiction to only have a threshold TRV available, even though there is strong evidence to suggest the substance is a human carcinogen.

Given the current carcinogenic status of PCBs in Canada, this HHRA assesses these substances as threshold substances. However, recognizing PCBs are potentially human carcinogens, this HHRA also examines the impact of assuming PCBs are carcinogenic on the human health risk estimates. The currently available and most conservative cancer-based TRVs for PCBs from the USEPA were to be used to evaluate this exposure.

A summary of the CSFs selected for inclusion in the risk assessment are provided in Table 6-10.

Table 6-10 Selected Toxicity Reference Values for Carcinogens.

Chemical	Route of Exposure	Cancer Slope Factor	Source Agency
Benzo(a)pyrene	Ingestion	2.3 mg/kg-day	HC, 2010b
	Inhalation	0.13 mg/kg-day	
PCBs	Ingestion	2 mg/kg-day	IRIS, 2015a
	Inhalation	2 mg/kg-day	

6.7.3.3 Bioavailability

Bioavailability refers to “the fraction of the total amount of material absorbed (internal dose) or in contact with a body portal-of-entry (lung, gut, skin) that enters the blood”. For example, not all COPCs present in soil 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 repre43(y[(m)3(g/)4(k)-2s14 29.1 019(sev)13(eral)4( )

6.7.4.2 Carcinogens

Based on the published CSF and calculation of intake rate from ingestion, inhalation and dermal contact, an ILCR can be calculated such that the lifetime chemical intake multiplied by the CSF does not exceed HC's acceptable cancer risk benchmark of 1 in 100,000 (one additional cancer case per 100,000 individuals, or $1x10^{-5}$).

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

6.7.5 Human Health Risk Assessment

Results of the HHRA are summarized in Tables 6-12 through 6-15.

6.7.5.1 General Area

Table 6-12 Pathway HQs and Target Risks General Area

Chemical	Exposure Pathway	HQ	Target HQ	ILCR	Target ILCR	SSTL (mg/kg)
PCBs	Soil (< 0.05 mg/kg)	NA	NA	NA	NA	NA
	Game Ingestion	0.13	0.2	NA	$1x10^{-5}$	NA
	Berry Ingestion	0.03	0.2	NA	$1x10^{-5}$	NA

The HQ for PCBs for the game ingestion pathway, as well as the berry ingestion pathway, were less than 0.2.

6.7.5.2 Former Contractor Village

Table 6-13 Pathway HQs and Target Risks Former Contractor Village.

Chemical	Exposure Pathway	HQ	Target HQ	ILCR	Target ILCR	SSTL (mg/kg)
PCBs	Soil (< 0.05 mg/kg)	NA	NA	NA	NA	NA
	Game Ingestion	0.12	0.2	NA	$1x10^{-5}$	NA
	Berry Ingestion	0	0.2	NA	$1x10^{-5}$	NA

The HQ for PCBs for the game ingestion pathway, as well as the berry ingestion pathway, were less than 0.2.

6.7.5.3 Main Complex

Table 6-14 Pathway HQs and Target Risks Main Complex.

Chemical	Exposure Pathway	HQ	Target HQ	ILCR	Target ILCR	SSTL (mg/kg)
BaP TPE	Soil (10.41 mg/kg)	NA	NA	$4.3x10^{-6}$	$1x10^{-5}$	24
PCB	Soil (0.67 mg/kg)	NA	NA	NA	NA	NA
	Game Ingestion	0.19	0.2	NA	$1x10^{-5}$	NA
	Berry Ingestion	0.03	0.2	NA	$1x10^{-5}$	NA

The ILCR for BaP TPE in soil was less than $1x10^{-5}$. The maximum concentration for BaP TPE in soil was less than the SSTL.

The HQ for PCBs for the game ingestion pathway, as well as the berry ingestion pathway, were less than 0.2.

6.7.5.4 Former USAF Dump Area and Former Ammunition Storage Area

Table 6-15 Pathway HQs and Target Risks Former USAF Dump Area and Former Ammunition Storage Area

Chemical	Exposure Pathway	HQ	Target HQ	ILCR	Target ILCR	SSTL (mg/kg)
BaP TPE	Soil (21.96 mg/kg)	NA	NA	$9.1x10^{-6}$	$1x10^{-5}$	NA
PCB	Soil (8.6 mg/kg)	0.02	0.2	$8.5x10^{-6}$	$1x10^{-5}$	28
	Game Ingestion	0.12	0.2	NA	$1x10^{-5}$	NA
	Berry Ingestion	0	0.2	NA	$1x10^{-5}$	NA

The ILCR for BaP TPE in soil was less than $1x10^{-5}$. The maximum concentration for BaP TPE in soil was less than the SSTL. The HQ for PCBs in soil was less than 0.2 and the maximum concentration for PCBs in soil was less than the SSTL.

The HQ for PCBs for the game ingestion pathway, as well as the berry ingestion pathway, were less than 0.2.

6.7.6 Uncertainty Analysis

As a result of the scientific investigations, literature reviews, and risk assessment guidance 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. A detailed summary of the uncertainty analysis is provided in Appendix E. If further certainty were required with regard to human health risks from the consumption of country foods from at or near the site, a country foods assessment for the consumption of country foods, including additional low level PCB analysis in consumed game and berries, would be required.

6.8 Summary of Human Health Risk Review

In summary, the findings of the HHRA at the Former USAF Radar Station are as follows:

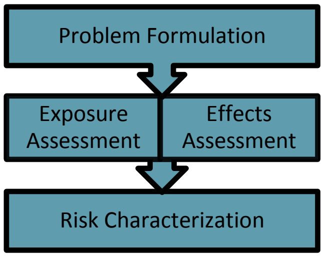
- Commercial workers would only be expected to visit the General Area; there are no communication towers or other anticipated access (i.e. helicopter pad) in the Former Contractor Village, Main Complex or Former USAF Dump Area and Former Ammunition Storage Area. There were no COPCs that exceeded the generic screening levels for human health in the General Area, and the commercial worker would not be expected to visit other study areas at the site as part of their regular duties. Further, the commercial worker would not be expected to hunt and consume game from the site during their regular duties. Therefore, the commercial worker exposure scenario is considered to have been adequately addressed, and potential for adverse human effects for the commercial worker is negligible.
- For recreational and indigenous receptors at the General Area, there were no COPCs in soil that exceeded the screening levels for human health, although potential existed for indirect exposure to PCBs through the ingestion of country foods (berries and game). The evaluation of ingestion of country foods revealed HQs less than the target values.
- For recreational and indigenous receptors at the Former Contractor Village, there were no COPCs in soil that exceeded the screening levels for human health, although potential existed for indirect exposure to PCBs through the ingestion of country foods (berries and game). The evaluation of ingestion of country foods revealed HQs less than the target values.
- For recreational and indigenous receptors at the Main Complex, the EPC value for BaP TPE in soil exceeded the human health screening level. Also, potential existed for indirect exposure to PCBs through the ingestion of country foods (berries and game). The calculated ILCR for BaP TPE in soil was less than the target risk of $1x10^{-5}$ and the maximum concentration was less than the SSTL. The evaluation of ingestion of country foods revealed HQs less than the target values.
- For recreational and indigenous receptors at the Former Dump Area and Former Ammunition Storage Area, the EPC values for PCBs and BaP TPE exceeded the human health screening levels. The HQ for PCBs in soil was less than 0.2, the calculated ILCR was less than the target risk of $1x10^{-5}$ and the maximum concentration was less than the SSTL. The calculated ILCR for BaP TPE was less than the target risk of $1x10^{-5}$ and the maximum concentration for was less than the SSTL. The evaluation of ingestion of country foods revealed HQs less than the target values.

- Based on the results of the HHRA, the site is considered to pose a low risk to human receptors and therefore does not require additional assessment or risk management at this time.

7 Ecological Risk Assessment

ERA is commonly used as a site management tool at contaminated sites. The FCSAP Ecological Risk Assessment Focus Group has developed guidance for ERA supplemental to the existing CCME guidance.

ERA is an iterative process for evaluating the likelihood that adverse effects may occur or are occurring because of exposure to one or more environmental stressors (Suter 1993). The purpose of this ecological risk assessment is to provide an analysis of the likelihood and potential magnitude of adverse effects to receptor ecosystems associated with COPC identified in the study area.



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 effects (toxicity) assessment, and culminates in a quantitative risk characterization. Following this framework, the limitations and uncertainties inherent in 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) and (FCSAP, 2012a).

The framework used for this ERA considered a qualitative evaluation of plant and soil invertebrate communities and effects at the population level for common mammals and birds.

As there is no single set of ecological values or resources to be protected that can be generally applied to every site, the initial CSM constructed for this site, which was based on a desktop review of the site and similar sites, was re-evaluated based on habitat and wildlife observed during site visits, as well as professional judgment.

7.1 Problem Formulation

This first step of the ERA aims to clarify the nature of issues associated with the contamination at a site and how those issues will be addressed. It includes the site management goal, the identification of the COPC, the selection of the ROC, the identification of the exposure pathways and the construction of the CSM. It may include also the identification of the assessment and measurement endpoints.

7.2 Hazard Identification

Any risk assessment is based on a fundamental understanding of the site conditions, the potential exposure pathways and the characteristics of the receptors present at the site. Ecological screening was conducted to identify COPC by comparing environmental media measured concentrations to applicable governmental screening levels or criteria including:

Soil

- 1999 (with 2018 Updates) CCME Soil Quality Guidelines for Environmental Health – Residential land use for coarse-grained soil. Pathway-specific information from the individual fact sheets was reviewed to confirm ecological health guidelines;
- 2012 (with 2015 Updates) Atlantic RBCA Tier I ESLs, plants and soil invertebrates direct soil contact, and wildlife and livestock soil and food ingestion; and
- 2011 OMOE Table 3: Full depth, non-potable water scenario, residential/parkland land use.

Although the residential land use guideline pathway is protective of ecological receptors, some COPC have more conservative agricultural generic screening guidelines. For COPC that may biomagnify or otherwise are best represented by agricultural guidelines (cadmium, lead, molybdenum, tin, trichloroethylene), if present, were further assessed to ensure ecological health was adequately addressed. This further assessment is presented in Table 7-1, Table 7-4, Table 7-8 and Table 7-12 for the COPC mentioned above. Mercury and PCB agricultural and residential soil guidelines are equivalent for the protection of ecological health.

Sediment

- 1999 (with 2001 Updates) CCME Sediment Quality Guidelines for the protection of aquatic life (freshwater) PELs; and
- 2012 (with 2015 Updates) Atlantic RBCA ESLs for the protection of freshwater and marine aquatic life, Typical site.

As described in Section 3.2, the CCME ISQGs are described as the lowest range of concentrations, within which adverse effects are rarely observed, whereas the PELs are effects threshold concentrations that represent the concentrations above which adverse effects are likely to occur. No-effects based data such as the ISQGs are appropriate for site screening but are not appropriate to guide remedial decisions.

Further, analogous to the CCME ISQGs, the 'Typical' ESLs represent the lowest range of concentrations, within which adverse effects are rarely observed, whereas the 'Other' ESLs represent concentrations above which adverse effects are more likely to occur. "Typical" sediment sites are those where the sediment is used as habitat for sensitive components of freshwater, marine or estuarine aquatic ecosystems. 'Other' sediment sites are those sites where the sediment is not classified as typical such as ditches, industrial-influenced receiving areas such as urban harbours, etc. Based on conditions at the site, the 'Typical' screening level was applied for the current assessment.

Groundwater

- 1999 (with 2018 Updates) CCME Water Quality Guidelines for the protection of freshwater aquatic life. Since all groundwater analyzed is more than 10 m from surface water, 10x the guideline has been applied to account for dilution;
- 2012 Atlantic RBCA Tier I ESLs for plant and soil invertebrate direct contact with shallow groundwater;
- 2012 Atlantic RBCA Tier I ESLs for the protection of freshwater and marine aquatic life; and
- 2011 OMOE Table 9: Generic Site Condition Standards for use within 30m of a water body in a non-potable groundwater Condition.

Since this is a provincial site, the Federal Interim Groundwater Quality Guidelines were not considered appropriate for ecological health screening purposes.

Surface Water

- 1999 (with 2018 Updates) CCME Water Quality Guidelines for the protection of freshwater aquatic life; and
- 2012 (revised 2015) Atlantic RBCA Tier I ESLs for the protection of freshwater and marine aquatic life (Table 3a), surface water guidelines.

For PCBs the CCME Water Quality Guidelines for the Protection of Freshwater Aquatic Life is no longer recommended and the value was withdrawn by CCME. A water quality guideline is not recommended. Environmental exposure is predominantly via sediment, soil, and/or tissue, therefore, screening for COPC is carried out through respective guidelines for these media.

In many cases, the screening levels are considered indicative of thresholds that could potentially lead to effects on plants, soil invertebrates, and/or wildlife, although they incorporate conservative assumptions in their derivation. While it is unlikely that there will be adverse effects on ecological receptors where COPC concentrations are below the screening levels, situations where the screening levels are exceeded should not be interpreted as evidence of effects, nor risks.

Based on the results of previous field work and a review of photographs available for the site, it was concluded that significant adverse effects to plant and soil invertebrate communities in any of the areas are not anticipated from their contact with soil. However, soil organisms' direct contact has still been considered in the selection of the ecological screening levels for soil.

Based on the results of the field work and a review of photographs available for the site, it was concluded that only surface water analyzed from the General Area (SW-2 and SW-3) was from connected water bodies that could be considered fish habitat. Surface water locations in the Former Contractor Village (SW-5), Main Complex (SW-6) and Former USAF Dump Area and Former Ammunition Storage Area (SW-7 and SW-8) were from shallow water (20cm deep or less) impounded over floating sphagnum moss mats. Although some of these locations had deeper water present beneath the sphagnum mats, these wetlands were generally hydraulically isolated (i.e. no surface inlets or outlets). Given the surface water samples collected from the wetlands contained organic matter (as evidenced by high TOC, turbidity and colour) and the sampling methodology (unfiltered), the results were likely biased high for total metals. FAL was considered in the selection of the ecological screening levels for surface water, although any retained COPCs were further evaluated on a site by site basis.

Screening for COPC to be included in the ERA was conducted by each study area (General Area, Former Contractor Village, Main Complex and Former USAF Dump Area and Former Ammunition Storage Area). Those COPC that had a maximum concentration above ecological health screening values in a particular media (see Tables 1 through 29 in Appendix C) were qualitatively assessed for data suitability, and irregular or otherwise non-representative data were not considered (as described in Section 5). Remaining representative data are summarized in Table 7-1 through Table 7-15.

Also, during previous testing some COPC (PCBs) were evaluated in berries and/or foliage from the General Area, Former Contractor Village, Main Complex and Former USAF Dump Area and Former Ammunition Storage Area to assess potential for uptake into plants. Although there were PCBs detected in foliage from all sites, no PCBs were detected in berries where they were present and analyzed (General Area and Main Complex). There are no relevant guidelines for PCBs in these media, rather, they should be used to support detailed ERA.

Maximum concentrations and UCLM95%s are compared to ecological health screening levels in Table 7-1 through Table 7-15. If the maximum concentration in any area, exceeded the relevant screening level, the parameter is included within the tables below for all areas. Where the maximum concentration did not exceed the relevant screening level, an UCLM95% was not calculated. Where there are no guidelines recommended to be protective of ecological health, these COPC were not presented. Where the EPC (either maximum or UCLM95%) did not exceed the screening level, the COPC was not carried forward for further assessment.

7.2.1 General Area

7.2.1.1 Soil

COPC identified in soil are summarized in Table 7-1.

Table 7-1 Ecological Screening of Surface Soil General Area.

<table>
<tr><th>Parameter</th><th>Maximum Concentration (mg/kg)</th><th>UCLM95 % (mg/kg)</th><th>Screening Guideline (mg/kg)</th><th>Reference</th><th>Included in ERA</th></tr>
<tr><td colspan="6">PHCs</td></tr>
<tr><td>Fraction F1 (C6-C10)</td><td><5</td><td>NC</td><td>210</td><td>Atlantic RBCA Tier I ESLs Plants and Soil Invertebrates Direct Soil Contact</td><td>No</td></tr>
<tr><td>Fraction F2 (>C10-C16)</td><td><10</td><td>NC</td><td>150</td><td>Atlantic RBCA Tier I ESLs Plants and Soil Invertebrates Direct Soil Contact</td><td>No</td></tr>
<tr><td>Fraction F3 (>C16-C34)</td><td>550</td><td>162</td><td>300</td><td>Atlantic RBCA Tier I ESLs Plants and Soil Invertebrates Direct Soil Contact</td><td>No</td></tr>
<tr><td colspan="6">PAHs</td></tr>
<tr><td>Anthracene</td><td><0.01</td><td>NC</td><td>2.5</td><td>CCME Ecological Contact</td><td>No</td></tr>
<tr><td>Benzo(a)anthracene</td><td><0.01</td><td>NC</td><td>6.2</td><td>CCME Soil and food ingestion</td><td>No</td></tr>
<tr><td>Benzo(a)pyrene</td><td><0.01</td><td>NC</td><td>0.6</td><td>CCME Soil and food ingestion</td><td>No</td></tr>
<tr><td>Benzo(b)fluoranthene</td><td><0.01</td><td>NC</td><td>6.2</td><td>CCME Soil and food ingestion</td><td>No</td></tr>
<tr><td>Chrysene</td><td><0.01</td><td>NC</td><td>6.2</td><td>CCME Soil and food ingestion</td><td>No</td></tr>
<tr><td>Dibenzo(a,h)anthracene</td><td><0.01</td><td>NC</td><td>1</td><td>CCME Interim SQG</td><td>No</td></tr>
<tr><td>Fluoranthene</td><td><0.01</td><td>NC</td><td>15.4</td><td>CCME Soil and food ingestion</td><td>No</td></tr>
<tr><td>Phenanthrene</td><td><0.01</td><td>NC</td><td>43</td><td>CCME Soil and food ingestion</td><td>No</td></tr>
<tr><td colspan="6">Metals</td></tr>
<tr><td>Cadmium</td><td><0.3</td><td>NC</td><td>1.9</td><td>OMOE Mammals and Birds</td><td>No</td></tr>
<tr><td>Chromium</td><td>19</td><td>NC</td><td>64</td><td>CCME Ecological Contact</td><td>No</td></tr>
<tr><td rowspan="2">Lead</td><td rowspan="2">8.1</td><td rowspan="2">NC</td><td>300</td><td>CCME Ecological Contact</td><td rowspan="2">No</td></tr>
<tr><td>70</td><td>CCME Soil and Food Ingestion(Agricultural)</td></tr>
<tr><td rowspan="2">Molybdenum</td><td rowspan="2"><2</td><td rowspan="2">NC</td><td>10</td><td>CCME interim (residential)</td><td rowspan="2">No</td></tr>
<tr><td>5</td><td>CCME interim (agricultural)</td></tr>
<tr><td rowspan="2">Tin</td><td rowspan="2"><2</td><td rowspan="2">NC</td><td>50</td><td>CCME interim (residential)</td><td rowspan="2">No</td></tr>
<tr><td>5</td><td>CCME interim (agricultural)</td></tr>
</table>

Parameter	Maximum Concentration (mg/kg)	UCLM95 % (mg/kg)	Screening Guideline (mg/kg)	Reference	Included in ERA
Zinc	54	NC	250	CCME Ecological Contact	No
PCB					
Total PCBs	<0.05	NC	1.3	CCME Soil and Food Ingestion, Tertiary Consumer	No

Notes:
NC – Not Calculated

7.2.1.2 Sediment

No exceedances of the ecological screening guidelines were encountered within the General Area.

COPC identified in sediment are summarized in Table 7-5.

Table 7-2 Ecological Screening of Sediment General Area.

Parameter	Maximum Concentration (mg/kg)	UCLM95 % (mg/kg)	Screening Guideline (mg/kg)	Reference	Background (mg/kg)	Included in Risk Assessment
PHCs						
Fuel Range (>C10-C16)	<10	NC	527	Atlantic RBCA Adjusted ESLs	<15-163	No
Fuel Range (>C16-C21)	<10	NC			65-229	
Total Modified TPH	39	NC	500	Atlantic RBCA ESLs	480-1120	No

Notes:
NC – Not Calculated

7.2.1.3 Groundwater

Groundwater was not evaluated in the General Area.

7.2.1.4 Surface Water

COPC identified in surface water are summarized in Table 7-3.

Table 7-3 Ecological Screening of Surface Water General Area.

Parameter	Maximum Concentration (mg/L)	UCLM95% (mg/L)	Screening Guideline (mg/L)	Reference	Background Samples (mg/L)	CCME Irrigation/ Livestock	Included in ERA
Metals							
pH	6.09	NC	6.5-9	CCME FAL	4.8 to 5.93	NC	No
Aluminum	520	NC	5-100	CCME FAL	540 to 959	5000	No
Cadmium	<0.09	NC	0.08	CCME FAL	<0.09	5.1	No

Parameter	Maximum Concentration (mg/L)	UCLM95% (mg/L)	Screening Guideline (mg/L)	Reference	Background Samples (mg/L)	CCME Irrigation/ Livestock	Included in ERA
Copper	<2	NC	2	CCME FAL	<1 – 1	500 (sheep)	No
Iron	800	NC	300	CCME FAL	252 to 3060	5000	No
Lead	<0.5	NC	1	CCME FAL	<0.5-1.5	100	No
Zinc	<5	NC	8.1	CCME FAL	<5-14	1000-5000	No

Notes:
NC – Not Calculated
Aluminum Guideline = 5 ug/L at pH < 6.5 or 100 ug/l at pH >= 6.5
Cadmium concentration = 100.86[log10(hardness)]-3.2
Copper concentration dependant on water hardness
Lead concentration dependant on water hardness
Zinc concentration dependant on DOC, hardness and pH

Since all COPCs satisfy the more protective FAL guidelines or are less than background concentrations, additional screening for wildlife water consumption was not recommended.

7.2.2 Former Contractors Village

7.2.2.1 Soil

COPC identified in soil are summarized in Table 7-4.

Table 7-4 Ecological Screening of Surface Soil Former Contractor Village.

Parameter	Maximum Concentration (mg/kg)	UCLM95 % (mg/kg)	Screening Guideline (mg/kg)	Reference	Included in ERA
PHCs					
Fraction F1 (C6-C10)	260	118.1	210	Atlantic RBCA Tier I ESLs Plants and Soil Invertebrates Direct Soil Contact	No
Fraction F2 (>C10-C16)	4070	1059	150/9800	Atlantic RBCA Tier I ESLs Plants and Soil Invertebrates Direct Soil Contact / Atlantic RBCA Tier I ESLs for the Protection of Wildlife (mammals and birds)	No
Fraction F3 (>C16-C34)	465	222.9	300	Atlantic RBCA Tier I ESLs Plants and Soil Invertebrates Direct Soil Contact	No
PAHs					
Anthracene	0.04	NC	2.5	CCME Ecological Contact	No
Benzo(a)anthracene	0.07	NC	6.2	CCME Soil and food ingestion	No
Benzo(a)pyrene	0.04	NC	0.6	CCME Soil and food ingestion	No
Benzo(b)fluoranthene	0.07	NC	6.2	CCME Soil and food ingestion	No
Chrysene	0.08	NC	6.2	CCME Soil and food ingestion	No

Parameter	Maximum Concentration (mg/kg)	UCLM95 % (mg/kg)	Screening Guideline (mg/kg)	Reference	Included in ERA
Dibenzo(a,h)anthracene	0.009	NC	1	CCME Interim SQG	No
Fluoranthene	0.15	NC	15.4	CCME Soil and food ingestion	No
Phenanthrene	0.05	NC	43	CCME Soil and food ingestion	No
Metals					
Cadmium	<0.3	NC	1.9	OMOE Mammals and Birds	No
Chromium	18	NC	64	CCME Ecological Contact	No
Lead	23	NC	300	CCME Ecological Contact	No
			70	CCME Soil and Food Ingestion(Agricultural)	
Molybdenum	<2	NC	10	CCME interim (residential)	No
			5	CCME interim (agricultural)	
Tin	29	2.1	50	CCME interim (residential)	No
			5	CCME interim (agricultural)	
Zinc	34	NC	250	CCME Ecological Contact	No
PCB					
Total PCBs	<0.05	NC	1.3	CCME Soil and Food Ingestion, Tertiary Consumer	No

Notes:
NC – Not Calculated

7.2.2.2 Sediment

COPC identified in sediment are summarized in Table 7-5.

Table 7-5 Ecological Screening of Sediment Former Contractor Village.

Parameter	Maximum Concentration (mg/kg)	UCLM95 % (mg/kg)	Screening Guideline (mg/kg)	Reference	Background (mg/kg)	Included in Risk Assessment
PHCs						
Fuel Range (>C10-C16)	413	NC	527	Atlantic RBCA Adjusted ESLs	<15-163	No
Fuel Range (>C16-C21)	110	NC			65-229	
Total Modified TPH	602	NC	500	Atlantic RBCA ESLs	480-1120	No

Notes:
NC – Not Calculated

7.2.2.3 Groundwater

COPC identified in groundwater are summarized in Table 7-6.

Table 7-6 Ecological Screening of Groundwater Former Contractor Village.

Parameter	Maximum Concentration (mg/L)	UCLM95 % (mg/L)	Screening Guideline (mg/L)	Reference	Included
PHCs					
Fuel Range (>C10-C16)	0.3	NC	0.84	Atlantic RBCA ESLs	No
Fuel Range (>C16-C21)	<0.1	NC		Atlantic RBCA ESLs	No
Metals					
pH	6	NC	6.5-9	CCME FAL	No
Aluminum	860	NC	50	CCME FAL x 10	No
Iron	30000	NC	3000	CCME FAL x 10	No
Lead	0.9	NC	10	CCME FAL x 10	No
Zinc	17	NC	70	CCME FAL x 10	No

Notes:

NC – Not Calculated
Aluminum Guideline = 5 ug/L at pH < 6.5 or 100 ug/l at pH >= 6.5
Lead concentration dependant on water hardness
Zinc concentration dependant on dissolved organic carbon (DOC), hardness and pH

Groundwater guidelines presented above evaluate the potential for groundwater (in locations more than 10m away) to discharge to surface water. At this site, surface water was evaluated directly, and empirical data is available that is more representative than groundwater. Therefore, even though there are COPC that exceed screening levels, groundwater was not carried forward, since direct evaluation of surface water is more protective of ecological receptors.

7.2.2.4 Surface Water

COPC identified in surface water are summarized in Table 7-7.

Table 7-7 Ecological Screening of Surface Water Former Contractor Village.

Parameter	Maximum Concentration (mg/L)	UCLM95% (mg/L)	Screening Guideline (mg/L)	Reference	Background Samples (mg/L)	CCME Irrigation/ Livestock	Included
Metals							
pH	5.32	NC	6.5-9	CCME FAL	4.8 to 5.93	NC	No
Aluminum	1410	NC	5	CCME FAL	540 to 959	5000	No
Cadmium	<0.09	NC	0.08	CCME FAL	<0.09	5.1	No
Copper	2.7	NC	2	CCME FAL	<1 to 1	500 (sheep)	No
Iron	987	NC	300	CCME FAL	252 to 3060	5000	No
Lead	2	NC	1	CCME FAL	<0.5 to 1.5	100	No
Zinc	7	NC	8.1	CCME FAL	<5-14	1000-5000	No

Notes:
NC – Not Calculated
Aluminum Guideline = 5 ug/L at pH < 6.5 or 100 ug/l at pH >= 6.5
Cadmium concentration = 100.86[log10(hardness)]-3.2

Copper concentration dependant on water hardness
Lead concentration dependant on water hardness
Zinc concentration dependant on DOC, hardness and pH

From review of McConnell and Ricketts (2010), a regional study of lake water and sediment was conducted, and although the samples were from large water bodies and sample analysis was for dissolved metals, the result provide context to surface water quality in southeast Labrador. The copper and lead results presented in Table 7-7 are within ranges reported for dissolved copper (0.2 to 20.4 µg/L) and lead (0.3 to 4.0 µg/L). Further, regional stream water quality from NLMAE (2018), reports ranges of total copper (7 to 14 µg/L) and lead (0.6 to 6 µg/L).

Although the concentrations of total aluminum and iron detected at the site are more than the regional distributions of dissolved aluminum (84 to 1031 µg/L) and iron (179 to 955 µg/L), we expect the site values are biased high based on sampling methodology (total rather than dissolved) which includes organic in the total metals digest. Further, regional stream water quality from NLMAE (2018), reports ranges of total aluminum (440 to 4000 µg/L) and iron (1390 to 12900 µg/L). Surface water in these type of wetland habitats with low pH and low dissolved oxygen contents have inherently elevated metals concentrations in surface water. On this basis, surface water was not carried forward related to fresh water aquatic life habitat.

7.2.3 Main Complex

7.2.3.1 Soil

COPC identified in soil are summarized in Table 7-8.

Table 7-8 Ecological Screening of Surface Soil Main Complex.

Parameter	Maximum Concentration (mg/kg)	UCLM95 % (mg/kg)	Screening Guideline (mg/kg)	Reference	Included in ERA
PHCs					
Fraction F1 (C6-C10)	248	35.62	210	Atlantic RBCA Tier I ESLs Plants and Soil Invertebrates Direct Soil Contact	No
Fraction F2 (>C10-C16)	12500	1533	150/9800	Atlantic RBCA Tier I ESLs Plants and Soil Invertebrates Direct Soil Contact / Atlantic RBCA Tier I ESLs for the Protection of Wildlife (mammals and birds)	No
Fraction F3 (>C16-C34)	27000	2451	300/16000	Atlantic RBCA Tier I ESLs Plants and Soil Invertebrates Direct Soil Contact / Atlantic RBCA Tier I ESLs for the Protection of Wildlife (mammals and birds)	No
PAHs					
Anthracene	5.6	0.734	2.5	CCME Ecological Contact	No
Benzo(a)anthracene	9.37	1.473	6.2	CCME Soil and food ingestion	No
Benzo(a)pyrene	**6.9**	**1.001**	**0.6**	**CCME Soil and food ingestion**	**Yes**
Benzo(b)fluoranthene	5.7	0.879	6.2	CCME Soil and food ingestion	No
Chrysene	9.1	1.465	6.2	CCME Soil and food ingestion	No
Dibenzo(a,h)anthracene	2.22	0.336	1	CCME Interim SQG	No

Parameter	Maximum Concentration (mg/kg)	UCLM95 % (mg/kg)	Screening Guideline (mg/kg)	Reference	Included in ERA
Fluoranthene	24.7	3.529	15.4	CCME Soil and food ingestion	No
Phenanthrene	22.5	NC	43	CCME Soil and food ingestion	No
Metals					
Cadmium	49	1.4	1.9	OMOE Mammals and Birds	No
Chromium	73	13	64	CCME Ecological Contact	No
Lead	200	35	300	CCME Ecological Contact	No
			70	CCME Soil and Food Ingestion (Agricultural)	
Molybdenum	9.7	2.5	10	CCME interim (residential)	No
			5	CCME interim (agricultural)	
Tin	6.8	2.1	50	CCME interim (residential)	No
			5	CCME interim (agricultural)	No
Zinc	1400	150	250	CCME Ecological Contact	No
PCB					
Total PCBs	2	0.668	1.3	CCME Soil and Food Ingestion, Tertiary Consumer	No

Notes:
NC – Not Calculated

7.2.3.2 Sediment

COPC identified in sediment are summarized in Table 7-9.

Table 7-9 Ecological Screening of Sediment Main Complex

Parameter	Maximum Concentration (mg/kg)	UCLM95 % (mg/kg)	Screening Guideline (mg/kg)	Reference	Background	Included in ERA
PHCs						
Fuel Range (>C10-C16)	<10	NC	25	Atlantic RBCA Adjusted ESLs	<15-163)	No
Fuel Range (>C16-C21)	25	NC			65-229	
Total Modified TPH	39	NC	500	Atlantic RBCA ESLs	480-1120	No

Notes:
NC – Not Calculated

7.2.3.3 Groundwater

COPC identified in groundwater are summarized in Table 7-10.

Table 7-10 Ecological Screening of Groundwater Main Complex

Parameter	Maximum Concentration (mg/L)	UCLM95 % (mg/L)	Screening Guideline (mg/L)	Reference	Included in ERA
PHCs					
Fuel Range (>C10-C16)	0.63	0.455	0.84	Atlantic RBCA ESLs	No
Fuel Range (>C16-C21)	0.37	0.188		Atlantic RBCA ESLs	No
Metals					
pH	5.44	NC	6.5-9	CCME FAL	No
Aluminum	21700	17726	50-1100	CCME FAL x 10	No
Iron	9790	4130	3000	CCME FAL x 10	No
Lead	15.8	1.712	10-70	CCME FAL x 10	No
Zinc	818	76.93	70	CCME FAL x 10	No

Notes:

NC – Not Calculated
Aluminum Guideline = 5 ug/L at pH < 6.5 or 100 ug/l at pH >= 6.5
Cadmium concentration = 100.86[log10(hardness)]-3.2
Copper concentration dependant on water hardness
Lead concentration dependant on water hardness
Nickel concentration dependant on water hardness
Zinc concentration dependant on dissolved organic carbon (DOC), hardness and pH

Groundwater guidelines presented above evaluate the potential for groundwater (in locations more than 10m away) to discharge to surface water. At this site, surface water was evaluated directly, and empirical data is available that is more representative than groundwater. Therefore, even though there are COPC that exceed screening levels, groundwater was not carried forward, since direct evaluation of surface water is more protective of ecological receptors.

7.2.3.4 Surface Water

COPC identified in surface water are summarized in Table 7-11.

Table 7-11 Ecological Screening of Surface Water Main Complex

Parameter	Maximum Concentration (mg/L)	UCLM95 % (mg/L)	Screening Guideline (mg/L)	Reference	Background Samples (mg/L)	CCME Irrigation/Live stock	Included in ERA
Metals							
pH	6.45	NC	6.5-9	CCME FAL	4.8–5.93	NC	No
Aluminum	3200	NC	100	CCME FAL	540-959	5000	Yes
Cadmium	0.18	NC	0.08	CCME FAL	<0.09	5.1	Yes
Copper	8.2	NC	2	CCME FAL	<1 – 1	500 (sheep)	Yes
Iron	13000	NC	300	CCME FAL	252-3060	5000	Yes
Lead	3	NC	1	CCME FAL	<0.5-1.5	100	Yes
Zinc	33	NC	8.1	CCME FAL	<5-14	1000-5000	Yes

Notes:
NC – Not Calculated
Aluminum Guideline = 5 ug/L at pH < 6.5 or 100 ug/l at pH >= 6.5

Cadmium concentration = 100.86[log10(hardness)]-3.2
Copper concentration dependant on water hardness
Lead concentration dependant on water hardness
Zinc concentration dependant on DOC, hardness and pH

From review of McConnell and Ricketts (2010), the copper and lead results presented in Table 7-11 are within ranges reported for dissolved copper (0.2 to 20.4 µg/L) and lead (0.3 to 4.0 µg/L). Further, regional stream water quality from NLMAE (2018), reports ranges of total copper (7 to 14 µg/L) and lead (0.6 to 6 µg/L).

Although the concentrations of total aluminum and iron detected at the site are more than the regional distributions of dissolved aluminum (84 to 1031 µg/L) and iron (179 to 955 µg/L), we expect the site values are biased high based on sampling methodology (total rather than dissolved) which includes organic in the total metals digest. Further, regional stream water quality from NLMAE (2018), reports ranges of total aluminum (440 to 4000 µg/L) and iron (1390 to 12900 µg/L). Surface water in these type of wetland habitats with low pH and low dissolved oxygen contents have inherently elevated metals concentrations in surface water

The detection limits on the regional sampling (McConnell and Ricketts) were not sufficiently low to evaluate cadmium. The maximum cadmium concentration presented in Table 7-11, is from Stantec (2018). Follow up testing by Englobe (2019) at the same location revealed no detectable cadmium. Further, cadmium was rarely detected, at elevated concentrations, in surface water at any of the sites. Regional stream water quality from NLMAE (2018), reports ranges of total cadmium (0.3 to 4 µg/L).

The zinc screening guideline for FAL was recently revised and is now based on dissolved zinc concentrations and calculated using DOC, hardness and pH. The maximum zinc concentration presented in Table 7-11, is total zinc. Further DOC was not measured. As mentioned above, the total metals analysis will bias the results high, when compared to a dissolved guideline. Further, since DOC was not measured, its positive effect on reducing toxicity cannot be fully quantified. Regional stream water quality from NLMAE (2018), reports ranges of total zinc (3.2 to 58 µg/L).

On this basis, surface water was not carried forward related to fresh water aquatic life habitat.

7.2.4 Former USAF Dump Area and Former Ammunition Storage Area

7.2.4.1 Soil

COPC identified in soil are summarized in Table 7-12.

Table 7-12 Ecological Screening of Surface Soil Former USAF Dump Area and Former Ammunition Storage Area.

Parameter	Maximum Concentration (mg/kg)	UCLM95 % (mg/kg)	Screening Guideline (mg/kg)	Reference	Included in ERA
PHCs					
Fraction F1 (C6-C10)	9.3	NC	210	Atlantic RBCA Tier I ESLs Plants and Soil Invertebrates Direct Soil Contact	No
Fraction F2 (>C10-C16)	140	NC	150	Atlantic RBCA Tier I ESLs Plants and Soil Invertebrates Direct Soil Contact	No

Parameter	Maximum Concentration (mg/kg)	UCLM95 % (mg/kg)	Screening Guideline (mg/kg)	Reference	Included in ERA
Fraction F3 (>C16-C34)	6380	1760	300/16000	Atlantic RBCA Tier I ESLs Plants and Soil Invertebrates Direct Soil Contact / Atlantic RBCA Tier I ESLs for the Protection of Wildlife (mammals and birds)	No
PAHs					
Anthracene	**15.9**	**10.92**	**2.5**	**CCME Ecological Contact**	**Yes**
Benzo(a)anthracene	**19.7**	**13.52**	**6.2**	**CCME Soil and food ingestion**	**Yes**
Benzo(a)pyrene	**14.5**	**10.11**	**0.6**	**CCME Soil and food ingestion**	**Yes**
Benzo(b)fluoranthene	**12.6**	**8.975**	**6.2**	**CCME Soil and food ingestion**	**Yes**
Chrysene	**16.1**	**11.2**	**6.2**	**CCME Soil and food ingestion**	**Yes**
Dibenzo(a,h)anthracene	**1.9**	**1.317**	**1**	**CCME Interim SQG**	**Yes**
Fluoranthene	**59.5**	**40.74**	**15.4**	**CCME Soil and food ingestion**	**Yes**
Phenanthrene	46.8	32.04	43	CCME Soil and food ingestion	No
Metals					
Cadmium	2	0.4	1.9	OMOE Mammals and Birds	No
Chromium	15	NC	64	CCME Ecological Contact	No
Lead	180	20	300	CCME Ecological Contact	No
			70	CCME Soil and Food Ingestion (Agricultural)	
Molybdenum	6	2.1	10	CCME interim (residential)	No
			5	CCME interim (agricultural)	
Tin	14	2.8	50	CCME interim (residential)	No
			5	CCME interim (agricultural)	
Zinc	1800	154	250	CCME Ecological Contact	No
PCB					
Total PCBs	**24**	**8.561**	**1.3**	**CCME Soil and Food Ingestion, Tertiary Consumer**	**Yes**

Notes: NC – Not Calculated

7.2.4.2 Sediment

COPC identified in sediment are summarized in Table 7-13.

Table 7-13 Ecological Screening of Sediment Former USAF Dump Area and Former Ammunition Storage Area

Parameter	Maximum Concentration (mg/kg)	UCLM95 % (mg/kg)	Screening Guideline (mg/kg)	Reference	Background	Included in ERA
PHCs						
Fuel Range (>C10-C16)	94	NC	1350	Atlantic RBCA Adjusted ESLs	<15-163	No
Fuel Range (>C16-C21)	102	NC			65-229	No
Total Modified TPH	580	NC	500	Atlantic RBCA ESLs	480-1120	No

Notes:
NC – Not Calculated

7.2.4.3 Groundwater

COPC identified in groundwater are summarized in Table 7-14.

Table 7-14 Ecological Screening of Groundwater Former USAF Dump Area and Former Ammunition Storage Area

Parameter	Maximum Concentration (mg/L)	UCLM95 % (mg/L)	Screening Guideline (mg/L)	Reference	Included in ERA
PHCs					
Fuel Range (>C10-C16)	0.21	NC	0.84	Atlantic RBCA ESLs	No
Fuel Range (>C16-C21)	<10	NC		Atlantic RBCA ESLs	No
Metals					
pH	6.32	NC	6.5-9	CCME FAL	No
Aluminum	186	NC	50	CCME FAL x 10	No
Iron	16300	NC	3000	CCME FAL x 10	No
Lead	<0.5	NC	10	CCME FAL x 10	No
Zinc	252	NC	70	CCME FAL x 10	No

Notes:
NC – Not Calculated
Aluminum Guideline = 5 ug/L at pH < 6.5 or 100 ug/l at pH >= 6.5
Lead concentration dependant on water hardness
Zinc concentration dependant on dissolved organic carbon (DOC), hardness and pH

Groundwater guidelines presented above evaluate the potential for groundwater (in locations more than 10m away) to discharge to surface water. At this site, surface water was evaluated directly, and empirical data is available that is more representative than groundwater. Therefore, even though there are COPC that exceed screening levels, groundwater was not carried forward, since direct evaluation of surface water is more protective of ecological receptors.

7.2.4.4 Surface Water

COPC identified in surface water are summarized in Table 7-15.

Table 7-15 Ecological Screening of Surface Water Former USAF Dump Area and Former Ammunition Storage Area

Parameter	Maximum Concentration (mg/L)	UCLM95% (mg/L)	Screening Guideline (mg/L)	Reference	Background Samples (mg/L)	CCME Irrigation/ Livestock	Included in ERA
Metals							
pH	5.75	NC	6.5-9	CCME FAL	4.8 to 5.93	NC	No
Aluminum	1600	NC	5-100	CCME FAL	540 to959	5000	No
Cadmium	<0.09	NC	0.08	CCME FAL	<0.09	5.1	No

Parameter	Maximum Concentration (mg/L)	UCLM95% (mg/L)	Screening Guideline (mg/L)	Reference	Background Samples (mg/L)	CCME Irrigation/ Livestock	Included in ERA
Copper	4	NC	2	CCME FAL	<1 to 1	500 (sheep)	No
Iron	1390	NC	300	CCME FAL	252-3060	5000	No
Lead	2.9	NC	1	CCME FAL	<0.5 to1.5	100	No
Zinc	22	NC	7	CCME FAL	<5 to14	1000-5000	No

Notes:

NC – Not Calculated
Aluminum Guideline = 5 ug/L at pH < 6.5 or 100 ug/l at pH >= 6.5
Cadmium concentration = 100.86[log10(hardness)]-3.2
Copper concentration dependant on water hardness
Lead concentration dependant on water hardness
Zinc concentration dependant on dissolved organic carbon (DOC), hardness and pH

From review of McConnell and Ricketts (2010), the copper and lead results presented Table 7-12 are within ranges reported for dissolved copper (0.2 to 20.4 µg/L) and lead (0.3 to 4.0 µg/L). Further, regional stream water quality from NLMAE (2018), reports ranges of total copper (7 to 14 µg/L) and lead (0.6 to 6 µg/L).

Although the concentrations of total aluminum and iron detected at the site are more than the regional distributions of dissolved aluminum (84 to 1031 µg/L) and iron (179 to 955 µg/L), we expect the site values are biased high based on sampling methodology (total rather than dissolved) which includes organic in the total metals digest. Further, regional stream water quality from NLMAE (2018), reports ranges of total aluminum (440 to 4000 µg/L) and iron (1390 to 12900 µg/L). Surface water in these type of wetland habitats with low pH and low dissolved oxygen contents have

The zinc screening guideline for FAL was recently revised and is now based on dissolved zinc concentrations and calculated using DOC, hardness and pH. The maximum zinc concentration presented in Table 7-12, is total zinc. Further DOC was not measured. As mentioned above, the total metals analysis will bias the results high, when compared to a dissolved guideline. Further, since DOC was not measured, its positive effect on reducing toxicity cannot be fully quantified. Regional stream water quality from NLMAE (2018), reports ranges of total zinc (3.2 to 58 µg/L).

On this basis, surface water was not carried forward related to fresh water aquatic life habitat.

7.3 List of COPC retained for ERA

7.3.1 General Area

In the General Area, the maximum value for Fraction F3 (>C16-C34) in soil exceeded the ecological health screening level, while the maximum concentrations of all other COPC in soil were below the ecological health screening levels.

The ULCM95% for Fraction F3 (>C16-C34) was below the ecological health screening level, and was consequently not carried forward.

Vegetation samples from the area contained detectable concentrations of PCBs. As such, further assessment of PCBs is recommended.

7.3.2 Former Contractor Village

At the Former Contractor Village, the maximum values for Fraction F1 (C6-C10), Fraction F2 (>C10-C16), Fraction F3 (>C16-C34) and tin in soil exceeded the ecological health screening levels, while the maximum concentrations of all other COPC in soil were below the ecological health screening levels.

The ULCM95% for Fraction F1 (C6-C10), Fraction F3 (>C16-C34) and tin were below the ecological health screening levels, and were consequently not carried forward.

The ULCM95% for Fraction F2 (>C10-C16) in soil exceeded the Atlantic RBCA Tier I ESL for Plants and Soil Invertebrates Direct Soil Contact; however, it was below the Atlantic RBCA Tier I ESL for the Protection of Wildlife (mammals and birds). As mentioned above, during the field program, plant and soil invertebrate communities appeared functionally intact. As such, the Atlantic RBCA Tier I ESL for the Protection of Wildlife was used for screening, and Fraction F2 (>C10-C16) was not carried forward for further assessment.

At the Former Contractor Village, the maximum value total modified TPH in sediment exceeded the ecological health screening level, while the maximum concentrations of all other COPC in sediment were below the ecological health screening levels.

A ULCM95% value was not calculated since there was insufficient data for statistical analyses. Total modified TPH was found to be within the range of background samples collected, and therefore was not carried forward for further assessment.

At the Former Contractor Village, the values for pH, and maximum values aluminum and iron in groundwater exceeded the ecological health screening levels, while the maximum concentrations of all other COPC in groundwater were below the screening levels.

ULCM95% values were not calculated for groundwater since there was insufficient data for statistical analyses. However, groundwater was not carried forward, since direct evaluation of surface water is more protective of ecological receptors.

At the Former Contractor Village, the maximum values for pH, aluminum, cadmium, copper, iron and lead in surface water exceeded the ecological health screening levels, while the maximum concentrations of all other COPC in surface water were below the ecological health screening levels.

ULCM95% values were not calculated for surface water since there was insufficient data for statistical analyses. The pH, aluminum, cadmium, copper, iron and lead concentrations were found to be within the range of background samples collected and the maximum values were all below ecological health screening levels for wildlife consumption, therefore, they were not carried forward for further assessment.

Vegetation samples from the area contained detectable concentrations of PCBs. As such, further assessment of PCBs is recommended.

7.3.3 Main Complex

At the Main Complex, the maximum values for Fraction F1 (C6-C10), Fraction F2 (>C10-C16), Fraction F3 (>C16-C34), anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, chrysene, dibenzo(a,h)anthracene, fluoranthene, cadmium, chromium, lead, molybdenum, tin, zinc and total PCB in soil exceeded the ecological health screening levels, while the maximum concentrations of all other COPC in soil were below the ecological health screening levels.

ULCM95% values for Fraction F1 (C6-C10), anthracene, benzo(a)anthracene, benzo(b)fluoranthene, chrysene, dibenzo(a,h)anthracene, fluoranthene, cadmium, chromium, lead, molybdenum, tin, zinc and total PCB in soil were below the screening levels, and were not carried forward for assessment.

The ULCM95% for Fraction F2 (>C10-C16) and Fraction F3 (>C16-C34) in soil exceeded the Atlantic RBCA Tier I ESLs for Plants and Soil Invertebrates Direct Soil Contact; however, they were below the Atlantic RBCA Tier I ESLs for the Protection of Wildlife (mammals and birds). As previously noted, during the field program, plant and soil invertebrate communities appeared functionally intact. As such, the Atlantic RBCA Tier I ESLs for the Protection of Wildlife were used for screening, and Fraction F2 (>C10-C16) and Fraction F3 (>C16-C34) were not carried forward for further assessment.

The ULCM95% value for benzo(a)pyrene in soil exceeded the ecological health screening level, and was carried forward for further assessment.

At the Main Complex, the maximum concentrations of all COPC in sediment were below the ecological health screening levels.

At the Main Complex, the maximum values for Fuel Range (>C10-C16), Fuel Range (>C16-C21), pH, aluminum, iron, lead and zinc in groundwater exceeded the ecological health screening levels, while the maximum concentrations of all other COPC in groundwater were below the ecological health screening levels.

ULCM95% values for lead, Fuel Range (>C10-C16) and Fuel Range (>C16-C21) in groundwater were below the ecological health screening levels, and were not carried forward for assessment.

ULCM95% values for aluminum, iron and zinc exceeded the ecological health screening levels. However, groundwater was not carried forward, since direct evaluation of surface water is more protective of ecological receptors.

At the Main Complex, the value for pH and maximum values, aluminum, copper, iron, lead and zinc in surface water exceeded the ecological health screening levels, while the maximum concentrations of all other COPC in surface water were below the ecological health screening levels. ULCM95% values were not calculated for surface water since there was insufficient data for statistical analyses.

pH, aluminum, cadmium, copper, iron, lead and zinc were found to be within the range of background samples collected and the maximum values were all below ecological health screening levels for wildlife consumption, therefore, they and were not carried forward for further assessment.

Vegetation samples from the area contained detectable concentrations of PCBs. As such, further assessment of PCBs is recommended.

7.3.4 Former USAF Dump Area and Former Ammunition Storage Area

At the Former USAF Dump Area and Former Ammunition Storage Area, the maximum values for Fraction F3 (>C16-C34), anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, chrysene, dibenzo(a,h)anthracene, fluoranthene, phenanthrene, cadmium, lead, molybdenum, tin, zinc and total PCB in soil exceeded the ecological health screening levels, while the maximum concentrations of all other COPC in soil were below the ecological health screening levels.

ULCM95% values for phenanthrene, cadmium, lead, molybdenum, tin and zinc in soil were below the ecological health screening levels, and were not carried forward for assessment.

The ULCM95% for Fraction F3 (>C16-C34) in soil exceeded the Atlantic RBCA Tier I ESL for Plants and Soil Invertebrates Direct Soil Contact; however, it was below the Atlantic RBCA Tier I ESL for the Protection of Wildlife (mammals and birds). As previously noted, during the field program, plant and soil invertebrate communities appeared functionally intact. As such, the Atlantic RBCA Tier I ESL for the Protection of Wildlife was used for screening, and Fraction F3 (>C16-C34) was not carried forward for further assessment.

ULCM95% values for anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, chrysene, dibenzo(a,h)anthracene, fluoranthene and total PCB in soil exceeded the ecological health screening levels, and were carried forward for further assessment.

At the Former USAF Dump Area and Former Ammunition Storage Area, the maximum value for Total Modified TPH in sediment exceeded the ecological health screening levels, while the maximum concentrations of all other COPC in sediment were below the ecological health screening levels.

ULCM95% values were not calculated for sediment since there was insufficient data for statistical analyses. Total modified TPH was found to be within the range of background samples collected, and was not carried forward for further assessment.

At the Former USAF Dump Area and Former Ammunition Storage Area the value for pH and maximum values for aluminum, iron and zinc in groundwater exceeded the ecological health screening levels, while the maximum concentrations of all other COPC in groundwater were below the ecological screening levels.

UCLCM95% values were not calculated for groundwater since there was insufficient data for statistical analyses. However, groundwater was not carried forward, since direct evaluation of surface water is more protective of ecological receptors.

At the Former USAF Dump Area and Former Ammunition Storage Area, the value for pH and maximum values for, aluminum, cadmium, copper, iron, lead and zinc in surface water exceeded the ecological health screening levels, while the maximum concentrations of all other COPC in surface water were below the ecological health screening levels.

ULCM95% values were not calculated for surface water since there was insufficient data for statistical analyses. pH, aluminum, cadmium, copper, iron, lead and zinc were found to be within the range of background samples collected and the maximum values were all below ecological health screening levels for wildlife consumption, therefore, they were not carried forward for further assessment.

Vegetation samples from the area contained detectable concentrations of PCBs. As such, further assessment of PCBs is recommended.

7.4 Identification of Receptors of Concern

For the purpose of the ERA, it is not practical or necessary to individually assess each wildlife species that may potentially visit or occupy the Site. Instead, the potential for adverse effects imposed on a selected subset of wildlife receptors exposed to COPCs at the Site was evaluated. The receptors 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 on the site);
- Likely to be highly exposed to COPCs due to their habitat preference, behavioral traits and home range;
- Representative of various feeding guilds or levels in the trophic web (e.g., herbivore, insectivore, carnivore); and/or
- Of cultural, economic or social importance.

As discussed in Section 2, potential mammalian and avian receptor habitats and receptors were identified through a desktop review of ACCDC information and previous reports for the site and similar sites. This information was used to identify appropriate ROC that are likely exposed to COPCs at the site or that would serve as suitable surrogates for other species that are exposed to COPCs at the Site.

7.4.1 Mammals

Potential mammalian receptors of the Former USAF Radar Station located in Cartwright were identified from on-site observation of the habitat, and through desktop review of fauna expected to occupy the site. This region is represented by mammals of various sizes such as the caribou (*Rangifer tarandus tarandus*), lynx (*Lynx canadensis*), red fox (*Vulpes vulpes*), weasel (*Mustela erminea*), marten (*Martes americanus*) and mink (*Mustela vison*). Multiple species of rodents can also be found in this ecosystem, such as beavers (*Castor canadensis*), voles (e.g. Meadow vole (*Microtus pennsylvanicus*)), red squirrel (*Sciurus vulgaris*), ground hog (*Masmota monax*), arctic hare (*Lepus timidus*), masked shrew (*Sorex cinerus*). Local residents also report moose (*Alces alces*).

The following mammalian species were identified as surrogate species and retained as ecological receptor for the present quantitative ERA:

- Red fox (*Vulpes vulpes*) selected for its potential presence, representative for carnivores and a surrogate species for wolverine;
- Masked shrew (*Sorex cinerus*) selected for its potential presence, small home range and representative for insectivores;
- Meadow vole (*Microtus pennsylvanicus*) selected for its potential presence, small home range and representative for omnivores,
- Moose (*Alces alces)* selected for its potential presence, representative for herbivores and as a surrogate species for caribou (although it is unlikely to be present); and
- Black Bear (*Ursus americanus*) selected for its potential presence, representative for omnivores.

Although the polar bear was sighted once near Earl Island, it is very unlikely to use the site, based on its habitat and food source preferences.

7.4.2 Avian Wildlife

The region is also represented by a variety of birds, including waterfowl, pheasants, grebes, pigeons and doves, gulls, sandpipers, owls, falcons, woodpeckers, jays, swallows, chickadees, and many more. Local residents also report grouse and ptarmigan. While there were no observations in the ACCDC database for the following species at the site, expert opinion maps suggest that Common Nighthawk (*Chordeiles minor*), breeding/molting Harlequin Ducks (*Histrionicus histrionicus*), Ivory Gulls (*Pagophila eburnean)*, Peregrine Falcons (*Falco* *peregrinus*), Rusty Blackbirds (*Euphagus carolinus*) and Short-eared Owls (*Asio flammeus)* are possible. The site is also said to be within the migrating, molting & nesting range of Barrow's Goldeneye (*Bucephala islandica*). From review of the habitat preferences and habitat at the site, there is likely little habitat for Ivory Gulls, and only one pond that would likely be used by waterfowl.

The following birds were identified as surrogate species and were retained as ecological receptor for the present quantitative ERA:

- Ruffed grouse (*Bonasa umbellus*) selected for its potential present and as an omnivore and as a surrogate species of the ptarmigan (also present);
- American robin (*Turdus migratorius*) selected for its potential presence, representative for omnivore birds and as a surrogate species for the Rusty blackbird; and
- Peregrine falcon (*Falco peregrinus*) selected for its potential presence (also SAR), to represent carnivore birds, and as a surrogate species for the Short-eared Owl.

7.4.3 Aquatic and Other Terrestrial Receptors

Based on the results of previous field work and a review of photographs available for the site, it was concluded that significant adverse effects to plant and soil invertebrate communities in any of the areas are not anticipated from their contact with soil.

Further, COPCs were all below the ecological screening levels or within background levels for all aquatic habitats.

7.5 Exposure Pathway Identification

In order for chemicals to have deleterious effects, they need to gain access to the organism or receptor. The route by which this occurs 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 COPC 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; and
- 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 7-16, which includes a qualitative evaluation of each pathway and a discussion about whether the pathways are complete. Those complete 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 7-16 Potential Exposure Scenarios - Ecological Receptors

Exposure Pathway Description	Complete Pathway?	Carried Forward For Analysis?	Justification
Ingestion of soil Dermal contact with soil	Yes	Yes	COPCs are present in surface soils at the site. Although terrestrial receptors may come into contact with chemicals identified in surface soil, direct dermal contact is considered unlikely due to the presence of fur or feathers. However, ecological receptors may ingest soil through grooming or other

Exposure Pathway Description	Complete Pathway?	Carried Forward For Analysis?	Justification
			related behaviors. As such, the ingestion of soil containing COPCs was considered further within this ERA.
Ingestion of terrestrial invertebrates, vegetation, or small animal prey living at the site and exposed to contaminated soil	Yes	Yes	Terrestrial receptors on the site may ingest terrestrial invertebrates and terrestrial vegetation that are living at the site and have been exposed to the impacts in surface soil. Some receptors prey on small animals.
Soil that may leach to freshwater habitat	Yes	No	Fresh water habitat exists at the site which could be impacted by soil leaching. However, surface water was assessed directly. As such, soil that may leach to freshwater habitat was not considered further in this ERA.
Groundwater that may affect terrestrial and freshwater habitat.	No	No	It is not anticipated that groundwater at the site will affect terrestrial and freshwater habitat. No COPCs identified in soil were detected in groundwater.
Ingestion of surface water or sediments.	Yes	No	Surface water is present at the site. The potential for ingestion of surface water and dermal contact with surface water or freshwater sediments exists, although all COPCs were below the screening levels or considered background. As such, this pathway was not carried forward for further assessment.
Dermal contact with surface water or freshwater sediments			
Surface water that may affect freshwater habitat.	Yes	No	Surface water and freshwater sediment are present at the site. However, surface water results were all considered representative of background conditions and not considered further in this ERA.

7.6 Conceptual Site Model for Ecological Receptors

Based on the qualitative risk evaluation, the CSM for the ecological receptors developed for the ROC is:

- Plant and soil invertebrate communities may be exposed to COPCs identified in surface soil;
- Terrestrial ecological receptors may ingest COPCs identified in surface soil at the site;
- Terrestrial ecological receptors may ingest terrestrial invertebrates, terrestrial vegetation, and/or small animals that have accumulated COPCs identified at the site.

Subsurface soil (i.e., > 1,5 m depth), sediments and groundwater were not considered to be sources of contaminant exposure in this ERA because there were either no contamination in these media, or there are no direct exposure pathways for ecological receptors to these media.

The conceptual site model developed for this site, presented in Figure 7-1 schematically represents the interactions between the receptors and the COPCs, via the identified exposure pathways. In Figure 7-1, the relevant exposure pathways are designated by arrows leading from the contaminant source media to each receptor.

7.7 Assessment and Measurement Endpoints

Assessment endpoints are explicit expressions of environmental values or characteristics to be protected at a site, and reflect societal and ecological values (Suter, 1993). Societal values address the need to protect species that are endangered, threatened, or of special interest, important as game or commercial species, or that are recognized as having aesthetic value.

Ecological relevance refers to the importance of the species to the function of the ecosystem. Evaluation of potential for adverse effects at the population level is used to infer potential for adverse effects at higher levels of organization, such as communities and ecosystems. For birds and mammals inhabiting the site, assessment endpoints focus on maintenance and protection of their populations, such that contaminants in the soil would not significantly impact either species abundance or diversity. For SAR, assessment endpoints focus on protecting individual organisms, because this level of protection is mandated by Canadian legislation (i.e., the SARA).

Based on the CSM for each ecological habitat, the following assessment endpoint is identified for the ecological risk assessment:

- Communities of plants and soil invertebrates, populations of common mammals and birds, and individuals of species identified as endangered, threatened, or extirpated under the Species at Risk Act, or similar provincial legislation, should not be harmed as a result of increased mortality or decreased growth or reproduction because of the presence of COPCs in soil.

The information needed to deal directly with the assessment endpoints is difficult to generate and rarely available. Therefore, measurement endpoints are used to bridge the gap.

Measurement endpoints are measurable responses to stressors related to assessment endpoints, and are intended to provide a basis for assessing risk potential for the assessment endpoint. They may be defined in terms of an unacceptable level of impact to ecological receptors, such as a certain relative percent decrease in survival, growth or reproduction of ecological populations (Suter, 1993). As part of a weight-of-evidence approach, one or more measurement endpoints may be used for each assessment endpoint. The measurement endpoints for each ecological habitat type in this assessment are as follows:

- Whether there is evidence of stressed vegetation or impacts to plant and soil invertebrate communities; and
- Whether concentrations of COPCs are likely to result in ingested doses to birds or mammals that are greater than those observed to result in increased mortality or decreased growth or reproduction upon chronic exposure.

Figure 7-1 Conceptual Site Model for Ecological Receptors – Former USAF Radar Station, Cartwright, NL

Source Media	Exposure Media	Potential Exposure	Soil invertebrates & plants communities	Freshwater organisms	Red fox	Masked shrew	Meadow vole	Moose	Ruffed Grouse	Black Bear	American robin	Peregrine Falcon
Surface Soil	Surface Soil	Direct Exposure	X									
		Ingestion			X	X	X	X	X	X	X	X
	Plants	Ingestion			X	X	X	X	X	X	X	
	Soil Invertebrates	Ingestion			X	X			X	X	X	
	Small Mammals/Birds	Ingestion			X					X		X
Sediment	Freshwater Organisms	Ingestion		X								
	Sediment	Direct Exposure		X								
		Ingestion		X	X	X	X	X	X	X	X	X
Surface Water	Freshwater Organisms	Ingestion		X								
	Surface Water	Direct Exposure		X								
		Ingestion		X	X	X	X	X	X	X	X	X

SOURCE → RECEPTORS

7.8 Exposure Assessment

7.8.1 Exposure Point Concentration

To evaluate the level of exposure for each ROC to each COPC, it is necessary to first estimate the EPC of each COPC in various media or biological tissues. This includes soil, and representative soil invertebrate, plant, and small mammal/bird tissues.

Surface soil COPC concentrations were characterized using results from available data (excluding outliers) through the use of maximum values or statistically derived EPCs as described in Section 5.3.

Representative concentrations of inorganic COPCs in soil invertebrates were characterized using regression equations or other uptake factor estimates. The regression equations or uptake factors use the soil EPC value to calculate expected earthworm tissue metal concentrations as described in Appendix F.

Concentrations of COPCs in plant and small mammals/birds were calculated using published regression equations from:

- US EPA (2007) Guidance for Developing Ecological Soil Screening Levels (EcoSSLs) – Attachment 4-1 Exposure Factors and Bioaccumulation Models for Derivation of Wildlife Eco-SSLs. April 2007 Revision. OSWER Directive 9285.7-25;
- Sample et al. (1998) to estimate concentrations in small mammals from soil concentrations; and
- Research Triangle Institute (2005) to estimate concentrations in terrestrial prey from soil and terrestrial plant concentrations.

Where regression equations were not available from these references, uptake factors were obtained from scientific literature as discussed in Appendix F and the generalized uptake factor equation was used to calculate the concentration of a COPC in an organism or biological tissue (e.g., terrestrial plants) from the concentration in a surrounding medium (e.g., soil) as follows:

$$EPCj = EPCi \times UPij$$

Where: EPCj = exposure point concentration in biological compartment j (e.g., mg/kg wet weight terrestrial plant tissue);

EPCj = exposure point concentration (Maximum or UCLM) in environmental medium i (e.g., mg/kg dry soil); and

UPij = uptake factor from surrounding medium (in this case soil) to the target biological tissue (e.g., mg/kg wet weight tissue / mg/kg dry soil).

7.8.2 Daily Dose for Representative Avian and Mammalian Receptors

For representative avian and mammalian receptors, exposure to a COPC was calculated as the ADD ingested. The ADD was defined as the amount of a COPC a modeled species might be exposed to on an mg/kg - bw/day basis. 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:

$$ADDj = IFj \times AFj \times EPCj$$

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

IFj = intake factor (kg medium/kg – bw/day); and

AFj = absorption factor (default value of 1; most conservative).

The IF is not specific to each COPC, but is a characteristic of the modeled species and is calculated for each receptor and exposure pathway combination as follows:

$IFj = IRj / BW$

Where: IRj = medium-specific ingestion rate (kg medium/day); 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 ERA the AF is assumed to have a value of 1 for all ingested food items. Average daily dose for each applicable environmental media can be found in Appendix F.

In the case of PCBs in vegetation, predicted terrestrial plant concentrations for PCBs were compared to the maximum concentrations for each area obtained during the Phase II ESA and the greater of the two was used.

7.9 Effect Assessment (Toxicity)

One of the key components of this ERA is the characterization of relationships between the dose (or concentration for contact organism) resulting from the exposure to COPCs present in the media of concern (i.e. surface soil), and a threshold dose for adverse effects expressed as the TRV for the specific pathway of exposure and COPCs.

The toxicological database supporting a TRV includes acute, subchronic chronic or multi-generational exposure studies of relevant and sensitive test species (i.e., the ecological receptor of interest or a phylogenetically similar species) to chemical of interest. Ideally, one or more relevant biological endpoints such as growth, reproductive effects, or survival are considered to derive the TRVs. Databases that meet this requirement are available for some chemicals, but in most cases, available toxicity data is limited to studies conducted with laboratory animals (e.g., mammals: mice, rats, rabbits; birds: quail, chicken, ducks).

TRVs were based on AMEC (2018) for PAHs and PCBs for birds and mammals. Based on AMEC (2018) NOAEL TRVs are protective of potential SAR (, and TRVs for common mammals and birds should be based on LOAELs. TRVs used for this ERA are summarized in Appendix F.

7.10 Risk Characterization

Risk characterization is the final step of an ERA. It includes a quantification of the potential nature and magnitude of adverse effects that may occur to receptor species due to the presence of chemicals in identified ecological habitats at the site. In this step, characterization of exposure and characterization of ecological effects for each COPC are integrated into quantitative EHQ estimates of the potential for adverse effects to ecological receptors.

For this assessment, EHQ values for birds and mammals were calculated by dividing exposure (as the ADD values) derived for each receptor by their appropriate TRV. For ecological receptors with a home range less than the areal extent of the site, the EHQ values were calculated as follows:

$$EHQTOTAL = ADDSITE / TRV$$

Where: ADDSITE = total average daily dose for the site (mg/kg – bw/day)

The exact areal extent of the site is not known. Taking this into account and being conservative, most ROC was given an occupancy factor of 1, which assumes they spend all of their time on the site. However, the home range of the moose can be up to several thousand hectares, depending upon the habitat.

Given the overall tendency to introduce conservatism (through the use of data or assumptions that are likely to overstate, rather than understate risk) into risk assessments, it is likely that no adverse effect will exist below the EHQ target value of less than 1.0. Alternatively, an EHQ value greater than 1.0 does not automatically indicate that there is an unacceptable level of risk. In this case, the conservative approach used in the ERA reduces the certainty of this conclusion and dictates a need for more careful review of both predicted exposure levels and exposure limit derivations. As a result, EHQ values greater than 1.0 should be examined carefully, and furthermore focused investigations may be required to reduce conservatism and provide a more realistic assessment of the actual risk level before selecting a risk management approach.

7.11 Soil Invertebrates and Plants

As discussed in Section 2.2.4, significant adverse effects to plant and soil invertebrate communities in the vicinity of the site are not anticipated and therefore plant and soil invertebrate communities appear functionally intact.

7.12 General Area - Birds and Mammals

Table 7-17 and Table 7-18 present total EHQs for mammalian and avian receptors. The contribution of each exposure pathway to the total EHQ is provided in Appendix F.

Table 7-17 Total EHQ for Mammalian Receptors General Area.

COPC	EQH						
	Red Fox		Masked Shrew	Meadow Vole	Moose		Black Bear
	NOAEL	LOAEL	LOAEL	LOAEL	NOAEL	LOAEL	LOAEL
Target EHQ	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
PCBs	0.099	0.020	0.090	0.170	0.133	0.027	0.104

Note: Bold indicates that the total calculated EHQ exceeds the target EHQ.
NC = Not Calculated (No TRV available).

Table 7-18 Total EHQ for Avian Receptors General Area.

COPC	EQH				
	Ruffed Grouse	American Robin		Peregrine Falcon	
	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
Target EHQ	<1.0	<1.0	<1.0	<1.0	<1.0
PCBs	0.063	**1.441**	0.144	0.157	0.016

Note: Bold indicates that the total calculated EHQ exceeds the target EHQ.
NC = Not Calculated (No TRV available).

The EHQ values (LOAEL) for all ROC evaluated were less than 1, indicating that the current conditions in the Main Complex are unlikely to pose a significant risk. Also, the EHQ (NOAEL) calculated for all ROC evaluated except for PCBs for the American robin were less than 1, indicating that the current conditions in the Main Complex are unlikely to pose a significant risk for most ROC evaluated.

It should be noted that based on the lack of a suitable TRV for HMW PAHs it is uncertain if there is a potential risk to potential avian receptors from these COPC, although based on the EQH values for LMW PAHs, the risk is expected to be low.

For the American robin, the primary intake pathways include terrestrial plant ingestion and terrestrial invertebrate ingestion. Most of the diet of the American robin is derived from terrestrial plants, with a lesser component derived from terrestrial invertebrate ingestion. The American robin is assumed to potentially nest at the site, deriving all of its dietary requirements from the site; however, in this case it is acting as a surrogate species for the Rusty blackbird. It should be noted, that the Rusty Blackbird (SAR ROC represented by the American Robin) is migratory in nature, and would not spend all or its life cycle at this site. For the American robin, approximately 60% of the EHQ value is associated with the PCB concentration in terrestrial plant material. However, the American robin (and the Rusty Blackbird) actually consume fruit, seeds and grain, etc., rather that herbaceous vegetation which is what the plant EPC represented. Therefore, the estimated trace element concentrations in terrestrial plant material are biased high as a consequence of the EPC value (compared to the ROCs actual diet). Further, approximately 40% of the EHQ value is associated with the predicted element concentration in earthworms. While the empirical uptake factors used for these elements are considered to be robust and unbiased, they are also driven by the calculated soil EPC values. The bio-accessibility of trace elements from soil is likely to be less than 100%, and in addition the site assessment process results in positively biased data, from which an intentionally conservative estimator (the 95% UCLM) is calculated as the EPC value. Therefore, the estimated trace element concentrations in earthworm tissues are biased high as a consequence of the soil EPC values. Earthworms represent only a single component of the soil invertebrate community, which also includes a wide variety of other forms including: insects, other arthropods, and mollusks (slugs and snails). And while American robins do consume worms they also consume insects; the Rusty blackbird consumes insects, rather than worms. Importantly, where different components of the soil invertebrate community have been tested, earthworms typically have much higher trace element concentrations than mollusks, which in turn have higher concentrations than insects and other arthropods. Therefore, where wildlife species such as the American robin (or the SAR ROC it represents) are feeding on a mixed diet of soil invertebrates (not exclusively earthworms), their actual dietary exposure would be much less than that predicted assuming a diet of 100% earthworms. In consideration of these factors and the low EHQ (LOAEL) value (0.144), the EHQ (NOAEL) does not indicate a likelihood of harmful effects to the small SAR birds it represents at this site. As a result of these conservative aspects of the analysis, it is unlikely that population level effects will be observed due to PCB exposure of SAR at the site.

7.13 Former Contractor Village – Birds and Mammals

Table 7-17 and Table 7-20 present total EHQs for mammalian and avian receptors. The contribution of each exposure pathway to the total EHQ is provided in Appendix F.

Table 7-19 Total EHQ for Mammalian Former Contractor Village.

COPC	EQH						
	Red Fox		Masked Shrew	Meadow Vole	Moose		Black Bear
	NOAEL	LOAEL	LOAEL	LOAEL	NOAEL	LOAEL	LOAEL
Target EHQ	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
PCBs	0.094	0.019	0.086	0.160	0.130	0.027	0.100

Note: Bold indicates that the total calculated EHQ exceeds the target EHQ.
NC = Not Calculated (No TRV available).

Table 7-20 Total EHQ for Avian Receptors Former Contractor Village.

COPC	EQH				
	Ruffed Grouse	American Robin		Peregrine Falcon	
	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
Target EHQ	<1.0	<1.0	<1.0	<1.0	<1.0
PCBs	0.060	**1.360**	0.136	0.148	0.015

Note: Bold indicates that the total calculated EHQ exceeds the target EHQ.
NC = Not Calculated (No TRV available).

The EHQ values (LOAEL) for all ROC evaluated were less than 1, indicating that the current conditions in the Main Complex are unlikely to pose a significant risk. Also, the EHQ (NOAEL) calculated for all ROC evaluated except for PCBs for the American robin were less than 1, indicating that the current conditions in the Main Complex are unlikely to pose a significant risk for most ROC evaluated.

It should be noted that based on the lack of a suitable TRV for HMW PAHs it is uncertain if there is a potential risk to potential avian receptors from these COPC, although based on the EQH values for LMW PAHs, the risk is expected to be low.

The American robin has been discussed above. In consideration of the factors outlined and the low EHQ (LOAEL) value (0.136), the EHQ (NOAEL) does not indicate a likelihood of harmful effects to the small SAR birds it represents at this site. As a result of these conservative aspects of the analysis, it is unlikely that population level effects will be observed due to PCB exposure of SAR at the site.

7.14 Main Complex – Birds and Mammals

Table 7-21 and Table 7-22 present total EHQs for mammalian and avian receptors. The contribution of each exposure pathway to the total EHQ is provided in Appendix F.

Table 7-21 Total EHQ for Mammalian Receptors Main Complex.

COPC	EQH						
	Red Fox		Masked Shrew	Meadow Vole	Moose		Black Bear
	NOAEL	LOAEL	LOAEL	LOAEL	NOAEL	LOAEL	LOAEL
Target EHQ	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(a)pyrene	$4.4x10^{-4}$	$2.1x10^{-4}$	0.014	$2.0x10^{-4}$	$4.7x10^{-4}$	$2.2x10^{-4}$	$5.2x10^{-4}$
PCBs	0.236	0.049	**1.881**	0.248	0.224	0.046	0.157

Note: Bold indicates that the total calculated EHQ exceeds the target EHQ.
NC = Not Calculated (No TRV available).

Table 7-22 Total EHQ for Avian Receptors Main Complex.

COPC	EQH				
	Ruffed Grouse	American Robin		Peregrine Falcon	
	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
Target EHQ	<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(a)pyrene	NC	NC	NC	NC	NC
PCBs	0.109	**3.952**	0.359	0.231	0.023

Note: Bold indicates that the total calculated EHQ exceeds the target EHQ.
NC = Not Calculated (No TRV available).

The EHQ values (LOAEL) for all ROC evaluated except for PCBs for the masked shrew were less than 1, indicating that the current conditions in the Main Complex are unlikely to pose a significant risk. Also, the EHQ (NOAEL) calculated for all ROC evaluated except for PCBs for the American robin were less than 1, indicating that the current conditions in the Main Complex are unlikely to pose a significant risk for most ROC evaluated.

It should be noted that based on the lack of a suitable TRV for HMW PAHs it is uncertain if there is a potential risk to potential avian receptors from these COPC, although based on the EQH values for LMW PAHs, the risk is expected to be low.

The EHQ (LOAEL) calculated for PCBs for the masked shrew was greater than 1, indicating that PCBs in soil at the Main Complex could potentially present risk. Also, the EHQ (NOAEL) calculated for PCBs for the American robin was greater than 1, indicating that PCBs in soil at the Main Complex could potentially present risk to species at risk; the PCB EHQ (LOAEL) was less than 1.

For the masked shrew, the primary intake pathways include terrestrial plant ingestion and terrestrial invertebrate ingestion. Most of the diet of the masked shrew is derived from terrestrial invertebrates, with a lesser component derived from terrestrial plant ingestion. The masked shrew is assumed to potentially occupy the site, deriving all of its dietary requirements from the site. Approximately 95% of the EHQ value is associated with the predicted PCB concentration in earthworms. While the empirical uptake factors used for these elements are considered to be robust and unbiased, they are also driven by the calculated soil EPC values. The bio-accessibility of trace elements from soil is likely to be less than 100%, and in addition the site assessment process results in positively biased data, from which an intentionally conservative estimator (the 95% UCLM) is calculated as the EPC value. Therefore, the estimated trace element concentrations in earthworm tissues are biased high as a consequence of the soil EPC values. Earthworms represent only a single component of the soil invertebrate community, which also includes a wide variety of other forms including: insects, other arthropods, and mollusks (slugs and snails). Importantly, where different components of the soil invertebrate community have been tested, earthworms typically have much higher trace element concentrations than mollusks, which in turn have higher concentrations than insects and other arthropods. Therefore, where wildlife species such as the masked shrew are feeding on a mixed diet of soil invertebrates (not exclusively earthworms), their actual dietary exposure would be much less than that predicted assuming a diet of 100% earthworms. In consideration of these factors and the relatively low LOAEL EHQ value (1.881), there EHQ does not indicate a likelihood of harmful effects to the masked shrew or other small mammals it represents at this site. As a result of these conservative aspects of the analysis, it is unlikely that population level effects will be observed due to PCB exposure of SAR at the site.

The American robin has been discussed above. In consideration of the factors outlined and the low EHQ (LOAEL) value (0.359), the EHQ (NOAEL) does not indicate a likelihood of harmful effects to the small SAR birds it represents at this site. As a result of these conservative aspects of the analysis, it is unlikely that population level effects will be observed due to PCB exposure of SAR at the site.

7.15 Former USAF Dump Area and Former Ammunition Storage Area – Birds and Mammals

Table 7-21 and Table 7-22 present total EHQs for mammalian and avian receptors. The contribution of each exposure pathway to the total EHQ is provided in Appendix F.

Table 7-23 Total EHQ for Mammalian Receptors Former USAF Dump Area and Former Ammunition Storage Area.

COPC	EQH						
	Red Fox		Masked Shrew	Meadow Vole	Moose		Black Bear
	NOAEL	LOAEL	LOAEL	LOAEL	NOAEL	LOAEL	LOAEL
Target EHQ	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Anthracene	$6.6x10^{-4}$	$3.2x10^{-4}$	$2.5x10^{-2}$	$3.2x10^{-4}$	$8.4x10^{-5}$	$4.1x10^{-5}$	$4.8x10^{-4}$
Benzo(a)anthracene	$5.8x10^{-3}$	$2.7x10^{-3}$	$2.3x10^{-1}$	$4.9x10^{-4}$	$6.7x10^{-4}$	$3.2x10^{-4}$	$4.3x10^{-3}$
Benzo(a)pyrene	$4.2x10^{-3}$	$2.0x10^{-3}$	$1.5x10^{-1}$	$1.9x10^{-3}$	$7.4x10^{-4}$	$3.5x10^{-4}$	$3.9x10^{-3}$
Benzo(b)fluoranthene	$7.5x10^{-3}$	$3.5x10^{-3}$	$2.5x10^{-1}$	$4.3x10^{-3}$	$1.0x10^{-3}$	$4.8x10^{-4}$	$5.3x10^{-3}$
Chrysene	$8.6x10^{-3}$	$4.1x10^{-3}$	$2.8x10^{-1}$	$4.5x10^{-4}$	$5.2x10^{-2}$	$2.4x10^{-2}$	$9.3x10^{-3}$
Dibenz(a,h)anthracene	$8.4x10^{-4}$	$4.0x10^{-4}$	$3.3x10^{-2}$	$2.3x10^{-4}$	$2.3x10^{-4}$	$1.1x10^{-4}$	$6.5x10^{-4}$
Fluoranthene	3.610^{-3}	$1.8x10^{-3}$	$1.2x10^{-1}$	$2.8x10^{-3}$	$4.8x10^{-4}$	$2.4x10^{-4}$	$2.6x10^{-3}$
PCBs	**2.547**	0.524	**48.4**	0.097	0.143	0.029	0.357

Note: Bold indicates that the total calculated EHQ exceeds the target EHQ.
NC = Not Calculated (No TRV available).

Table 7-24 Total EHQ for Avian Receptors Former USAF Dump Area and Former Ammunition Storage Area.

COPC	EQH				
	Ruffed Grouse	American Robin		Peregrine Falcon	
	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
Target EHQ	<1.0	<1.0	<1.0	<1.0	<1.0
Anthracene	0.011	0.301	0.072	0.007	0.002
Benzo(a)anthracene	NC	NC	NC	NC	NC
Benzo(a)pyrene	NC	NC	NC	NC	NC
Benzo(b)fluoranthene	NC	NC	NC	NC	NC
Chrysene	NC	NC	NC	NC	NC
Dibenz(a,h)anthracene	NC	NC	NC	NC	NC
Fluoranthene	0.066	**1.538**	0.370	0.067	0.016
PCBs	0.521	**42.05**	**4.205**	0.125	0.012

Note: Bold indicates that the total calculated EHQ exceeds the target EHQ.
NC = Not Calculated (No TRV available).

The EHQ values (LOAEL) for all ROC evaluated except for PCBs for the masked shrew and American robin were less than 1, indicating that the current conditions in the Former USAF Dump Area and Former Ammunition Storage Area are unlikely to pose a significant risk to most ROC. Also, the EHQ (NOAEL) calculated for all ROC evaluated except for PCBs for the Red fox and American robin, and for Fluoranthene and PCBs for the American robin were less than 1, indicating that the current conditions in the Former USAF Dump Area and Former Ammunition Storage Area are unlikely to pose a significant risk for most ROC evaluated.

It should be noted that based on the lack of a suitable TRV for HMW PAHs it is uncertain if there is a potential risk to potential avian receptors from these COPC, although based on the EQH values for LMW PAHs, the risk is expected to be low.

The Masked shrew and American robin have been discussed above. As previously noted for the Masked shrew, the bulk of its diet is based on invertebrates, and the very conservative assumption of earthworms comprising 100% of the invertebrate diet is likely to bias the PCB EHQ high. This assumption is also the largest component of the elevated American robin PCB EHQ (LOAEL and NOAEL). Also, as noted previously, the Rusty blackbird has a slightly different preferred invertebrate food profile than the American robin and is migratory in nature. In the Former USAF Dump Area and Former Ammunition Storage Area, only one very high PCB concentration (CWT-TP3-BS2), and if this location was removed from the statistical analysis, the 95%ULCM would be 0.43 mg/kg resulting in an EHQ (LOAEL) of 1.04 instead of 48.4. A similar reduction in EHQ (NOAEL) would occur for the American robin (reduction to 1.668) and the American robin EQH (LOAEL) would be less than 1 (reduction to 0.167). The spatial area of PCB impacts around CWT-TP3-BS2 is approximately 707 m^2. As a result of these conservative aspects of the analysis, it is unlikely that population level effects will be observed due to PCB exposure to ROC at the Former USAF Dump Area and Former Ammunition Storage Area, however, to achieve greater certainty in the conclusion, the “hot spot” would need to be removed or managed, or site-specific invertebrate tissue collected.

For the Fluoranthene EHQ (NOAEL) of 1.5 for the American robin (as a surrogate for Rusty blackbird), the conservative nature of earthworm diet is causing the EHQ to be greater than 1. If the true diet of the Rusty blackbird were evaluated, as well as considering its migratory nature, the EHQ (NOAEL) would be less than 1. As a result of these conservative aspects of the analysis, it is unlikely that population level effects will be observed due to fluoranthene exposure of SAR at the Former USAF Dump Area and Former Ammunition Storage Area.

For the Red fox the primary intake pathways include terrestrial plant ingestion, terrestrial invertebrate ingestion and ingestion of mammals/birds. Most of the diet of the red fox is derived from mammals/birds, with a lesser component derived from direct soil, terrestrial plant ingestion and terrestrial invertebrate ingestion. The red fox is assumed to potentially occupy the site, deriving all of its dietary requirements from the site; however, in this case it is acting as a surrogate species for the Wolverine.

For the red fox, although 60% of its diet is from small prey, approximately 95% of the EHQ (NOAEL) value is associated with the predicted PCB concentration in terrestrial invertebrates (i.e. earthworms). While the Red fox actually consumes invertebrates, the Wolverine does not consume terrestrial invertebrates, most specifically worms, which is what the invertebrate EPC represents. While the empirical uptake factors used for these elements are considered to be robust and unbiased, they are also driven by the calculated soil EPC values. The bio-accessibility of trace elements from soil is likely to be less than 100%, and in addition the site assessment process results in positively biased data, from which an intentionally conservative estimator (the 95% UCLM) is calculated as the EPC value. Therefore, the estimated trace element concentrations in earthworm tissues are biased high as a consequence of the soil EPC values. Earthworms represent only a single component of the soil invertebrate community, which also includes a wide variety of other forms including: insects, other arthropods, and mollusks (slugs and snails). Importantly, where different components of the soil invertebrate community have been tested, earthworms typically have much higher trace element concentrations than mollusks, which in turn have higher concentrations than insects and other arthropods. Therefore, where wildlife species such as the Wolverine are feeding on a mixed diet, their actual dietary exposure would be much less than that predicted assuming a diet of 100% earthworms. In consideration of these factors and the low LOAEL EHQ value (0.524), the NOAEL EHQ does not indicate a likelihood of harmful effects to the small carnivorous SAR it represents at this site. As a result of these conservative aspects of the analysis, it is unlikely that population level effects will be observed due to PCB exposure of SAR at the site.

7.16 Summary of Ecological Risk Assessment

In summary, the findings of the ERA at the Former USAF Radar Station are as follows:

- In the General Area, COPC in soil, sediment, groundwater and surface water were not carried forward for further assessment based on the ecological screening carried out. Vegetation samples from the General Area contained detectable concentrations of PCBs. Therefore, PCBs were carried forward for further assessment.
- In the Former Contractor Village, COPC in soil, sediment, groundwater and surface water were not carried forward for further assessment based on the ecological screening carried out. Vegetation samples from the Former Contractor Village contained detectable concentrations of PCBs. Therefore, PCBs were carried forward for further assessment.
- In the Main Complex, benzo(a)pyrene in soil was carried forward for further assessment based on the ecological screening carried out. COPC in sediment, groundwater and surface water in the Main Complex were not carried forward for further assessment. Vegetation samples from the Main Complex contained detectable concentrations of PCBs. Therefore, PCBs were carried forward for further assessment.

- In the Former USAF Dump Area and Former Ammunition Storage Area, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, chrysene, dibenzo(a,h)anthracene, fluoranthene and total PCB in soil were carried forward for further assessment based on the ecological screening carried out. COPC in sediment, groundwater and surface water in the Former USAF Dump Area and Former Ammunition Storage Area were not carried forward for further assessment. Vegetation samples from the Former USAF Dump Area and Former Ammunition Storage Area contained detectable concentrations of PCBs. Therefore, PCBs were carried forward for further assessment.
- A quantitative risk assessment that included food web modelling and the calculation of EHQ values for representative species at the site was conducted.
- In the General Area, the EHQ values (LOAEL) for all species were less than 1 for all COPCs indicating that the current conditions in the General Area are unlikely to pose a significant risk. The EHQ (NOAEL) calculated for all ROC evaluated except for PCBs for the American robin were less than 1, indicating that the current conditions in the General Area are unlikely to pose a significant risk for most ROC evaluated.
- In the General Area, in consideration of several LOE, the EHQ (NOAEL) for the American robin do not indicate a likelihood of harmful effects to the American robin or other small birds it represents at this site. As a result of these conservative aspects of the analysis, it is unlikely that population level effects will be observed due to PCB exposure of SAR at the General Area.
- In the Former Contractor Village, the EHQ values (LOAEL) for all species were less than 1 for all COPCs, indicating that the current conditions in the Former Contractor Village are unlikely to pose a significant risk. The EHQ (NOAEL) calculated for all ROC evaluated except for PCBs for the American robin were less than 1, indicating that the current conditions in the Former Contractor Village are unlikely to pose a significant risk for most ROC evaluated.
- In the Former Contractor Village, in consideration of several LOE, the EHQ (NOAEL) for the American robin do not indicate a likelihood of harmful effects to the American robin or other small birds it represents at this site. As a result of these conservative aspects of the analysis, it is unlikely that population level effects will be observed due to PCB exposure of SAR at the Former Contractor Village.
- In the Main Complex, the EHQ values (LOAEL) for all ROC evaluated except for PCBs for the masked shrew were less than 1, indicating that the current conditions in the Main Complex are unlikely to pose a significant risk. Also, the EHQ (NOAEL) calculated for all ROC evaluated except for PCBs for the American robin were less than 1, indicating that the current conditions in the Main Complex are unlikely to pose a significant risk for most ROC evaluated.
- In the Main Complex, in consideration of several LOE, the EHQ (LOAEL) for the Masked shrew and the EHQ (NOAEL) for the American robin do not indicate a likelihood of harmful effects to the Masked shrew, American robin or other small mammals or birds they represent at this site. As a result of these conservative aspects of the analysis, it is unlikely that population level effects will be observed due to PCB exposure of SAR at the Main Complex.
- In the Former USAF Dump Area and Former Ammunition Storage Area, the EHQ values (LOAEL) for all ROC evaluated except for PCBs for the masked shrew and American robin were less than 1, indicating that the current conditions in the Former USAF Dump Area and Former Ammunition Storage Area are unlikely to pose a significant risk to most ROC. Also, the EHQ (NOAEL) calculated for all ROC evaluated except for PCBs for the Red fox and American robin, and fluoranthene for the American robin, were less than 1, indicating that the

current conditions in the Former USAF Dump Area and Former Ammunition Storage Area are unlikely to pose a significant risk for most ROC evaluated.

- In the Former USAF Dump Area and Former Ammunition Storage Area, in consideration of several LOE, it is unlikely that population level effects will be observed due to PCB exposure to ROC and potential SAR at the Former USAF Dump Area and Former Ammunition Storage Area, however, to achieve greater certainty in the conclusion, the “hot spot” would need to be removed or managed, or site specific invertebrate tissue be collected.
- In the Former USAF Dump Area and Former Ammunition Storage Area, in consideration of several LOE, it is unlikely that population level effects will be observed due to fluoranthene exposure of SAR at the Former USAF Dump Area and Former Ammunition Storage Area.
- It should be noted that based on the lack of a suitable TRV for HMW PAHs it is uncertain if there is a potential risk to potential avian receptors from these COPC in the Main Complex and Former USAF Dump Area and Former Ammunition Storage Area, although based on the EQH values for LMW PAHs, the risk is expected to be low.
- In the General Area, substantive site-related risks to ecological receptors, including plant and soil invertebrate communities, mammals, birds, and species at risk from COPC were not identified. Risk management for ecological receptors is not recommended.
- In the Former Contractor Village, substantive site-related risks to ecological receptors, including plant and soil invertebrate communities, mammals, birds, and species at risk from COPC were not identified. Risk management for ecological receptors is not recommended.
- In the Main Complex, substantive site-related risks to ecological receptors, including plant and soil invertebrate communities, mammals, birds, and species at risk from COPC were not identified. Risk management for ecological receptors is not recommended.
- In the Former USAF Dump Area and Former Ammunition Storage Area, substantive population-related risks to ecological receptors, including plant and soil invertebrate communities, mammals, birds, and species at risk from COPC were not identified. However, localized site risks may be present to some ROC (Masked shrew) and to potential SAR (Rusty blackbird) related to the one PCB “hot spot”. To achieve greater certainty in the conclusion, the “hot spot” would need to be removed or risk managed, or site-specific invertebrate tissue be collected to provide greater confidence in EPC values used in the food web modelling.

7.17 Uncertainty Analysis

As a result of the scientific investigations, literature reviews, and risk assessment guidance followed in the preparation of this ERA, it is believed that the risk assessment results present a reasonable yet conservative 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 yet conservative assumptions were made, or data were selected, in order to ensure that risks were not underestimated. Uncertainties are inherent in every aspect of the ERA process. The most effective way to decrease uncertainty is to collect site-specific data. Application of site-specific information assists in reduction of uncertainty by allowing removal of generic data.

The factors and other relationships established between contaminant concentrations in the environment and those in the tissues of wild game tend to be associated with a high degree of variability and uncertainty. To compensate for this, models are significantly biased towards maximising the estimates of tissue residue levels. This can lead to over estimates of risk. Further, it is also important to note that many uptake models typically provide an estimate of whole- animal residue levels and not the tissue-specific residue levels for muscle or organ meat. The whole body residue may over-estimate or under-estimate the actual contaminant residue levels in the specific tissue of interest. This uncertainty is difficult to quantify and further decreases the ability to strongly rely on whole-organism residue level estimates as a surrogate for tissue-specific levels within the context of the human health exposure assessment.

Despite incorporation of a considerable amount of site-specific data, the ERA incorporates assumptions that lead to uncertainty. Significant aspects of uncertainty inherent in this risk assessment are discussed qualitatively in Appendix F.

8 Conclusions and Recommendations

8.1 Conclusions

Based on the current assessment, the following conclusions can be made with respect to the environmental condition of the Former USAF Radar Station located in Cartwright, Labrador.

8.1.1 Human Health Risk Assessment

In summary, the findings of the HHRA at the Former USAF Radar Station are as follows:

- Commercial workers would only be expected to visit the General Area; there are no communication towers or other anticipated access (i.e. helicopter pad) in the Former Contractor Village, Main Complex or Former USAF Dump Area and Former Ammunition Storage Area. There were no COPCs that exceeded the generic screening levels for human health in the General Area, and the commercial worker would not be expected to visit other study areas at the site as part of their regular duties. Further, the commercial worker would not be expected to hunt and consume game from the site during their regular duties. Therefore, the commercial worker exposure scenario is considered to have been adequately addressed, and potential for adverse human effects for the commercial worker is negligible.
- For recreational and indigenous receptors at the General Area, there were no COPCs in soil that exceeded the screening levels for human health, although potential existed for indirect exposure to PCBs through the ingestion of country foods (berries and game). The evaluation of ingestion of country foods revealed HQs less than the target values.
- For recreational and indigenous receptors at the Former Contractor Village, there were no COPCs in soil that exceeded the screening levels for human health, although potential existed for indirect exposure to PCBs through the ingestion of country foods (berries and game). The evaluation of ingestion of country foods revealed HQs less than the target values.
- For recreational and indigenous receptors at the Main Complex, the EPC value for BaP TPE in soil exceeded the human health screening level. Also, potential existed for indirect exposure to PCBs through the ingestion of country foods (berries and game). The calculated ILCR for BaP TPE in soil was less than the target risk of $1x10^{-5}$ and the maximum concentration was less than the SSTL. The evaluation of ingestion of country foods revealed HQs less than the target values.
- For recreational and indigenous receptors at the Former Dump Area and Former Ammunition Storage Area, the EPC values for PCBs and BaP TPE exceeded the human health screening levels. The HQ for PCBs in soil was less than 0.2, the calculated ILCR was less than the target risk of $1x10^{-5}$ and the maximum concentration was less than the SSTL. The calculated

ILCR for BaP TPE was less than the target risk of $1x10^{-5}$ and the maximum concentration for was less than the SSTL. The evaluation of ingestion of country foods revealed HQs less than the target values.

- Based on the results of the HHRA, the site is considered to pose a low risk to human receptors and therefore does not require additional assessment or risk management at this time.

8.1.2 Ecological Risk Assessment

In summary, the findings of the ERA at the Former USAF Radar Station are as follows:

- In the General Area, COPC in soil, sediment, groundwater and surface water were not carried forward for further assessment based on the ecological screening carried out. Vegetation samples from the General Area contained detectable concentrations of PCBs. Therefore, PCBs were carried forward for further assessment.
- In the Former Contractor Village, COPC in soil, sediment, groundwater and surface water were not carried forward for further assessment based on the ecological screening carried out. Vegetation samples from the Former Contractor Village contained detectable concentrations of PCBs. Therefore, PCBs were carried forward for further assessment.
- In the Main Complex, benzo(a)pyrene in soil was carried forward for further assessment based on the ecological screening carried out. COPC in sediment, groundwater and surface water in the Main Complex were not carried forward for further assessment. Vegetation samples from the Main Complex contained detectable concentrations of PCBs. Therefore, PCBs were carried forward for further assessment.
- In the Former USAF Dump Area and Former Ammunition Storage Area, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, chrysene, dibenzo(a,h)anthracene, fluoranthene and total PCB in soil were carried forward for further assessment based on the ecological screening carried out. COPC in sediment, groundwater and surface water in the Former USAF Dump Area and Former Ammunition Storage Area were not carried forward for further assessment. Vegetation samples from the Former USAF Dump Area and Former Ammunition Storage Area contained detectable concentrations of PCBs. Therefore, PCBs were carried forward for further assessment.
- A quantitative risk assessment that included food web modelling and the calculation of EHQ values for representative species at the site was conducted.
- In the General Area, the EHQ values (LOAEL) for all species were less than 1 for all COPCs indicating that the current conditions in the General Area are unlikely to pose a significant risk. The EHQ (NOAEL) calculated for all ROC evaluated except for PCBs for the American robin were less than 1, indicating that the current conditions in the General Area are unlikely to pose a significant risk for most ROC evaluated.
- In the General Area, in consideration of several LOE, the EHQ (NOAEL) for the American robin do not indicate a likelihood of harmful effects to the American robin or other small birds it represents at this site. As a result of these conservative aspects of the analysis, it is unlikely that population level effects will be observed due to PCB exposure of SAR at the General Area.
- In the Former Contractor Village, the EHQ values (LOAEL) for all species were less than 1 for all COPCs, indicating that the current conditions in the Former Contractor Village are unlikely to pose a significant risk. The EHQ (NOAEL) calculated for all ROC evaluated except

for PCBs for the American robin were less than 1, indicating that the current conditions in the Former Contractor Village are unlikely to pose a significant risk for most ROC evaluated.

- In the Former Contractor Village, in consideration of several LOE, the EHQ (NOAEL) for the American robin do not indicate a likelihood of harmful effects to the American robin or other small birds it represents at this site. As a result of these conservative aspects of the analysis, it is unlikely that population level effects will be observed due to PCB exposure of SAR at the Former Contractor Village.
- In the Main Complex, the EHQ values (LOAEL) for all ROC evaluated except for PCBs for the masked shrew were less than 1, indicating that the current conditions in the Main Complex are unlikely to pose a significant risk. Also, the EHQ (NOAEL) calculated for all ROC evaluated except for PCBs for the American robin were less than 1, indicating that the current conditions in the Main Complex are unlikely to pose a significant risk for most ROC evaluated.
- In the Main Complex, in consideration of several LOE, the EHQ (LOAEL) for the Masked shrew and the EHQ (NOAEL) for the American robin do not indicate a likelihood of harmful effects to the Masked shrew, American robin or other small mammals or birds they represent at this site. As a result of these conservative aspects of the analysis, it is unlikely that population level effects will be observed due to PCB exposure of SAR at the Main Complex.
- In the Former USAF Dump Area and Former Ammunition Storage Area, the EHQ values (LOAEL) for all ROC evaluated except for PCBs for the masked shrew and American robin were less than 1, indicating that the current conditions in the Former USAF Dump Area and Former Ammunition Storage Area are unlikely to pose a significant risk to most ROC. Also, the EHQ (NOAEL) calculated for all ROC evaluated except for PCBs for the Red fox and American robin, and fluoranthene for the American robin, were less than 1, indicating that the current conditions in the Former USAF Dump Area and Former Ammunition Storage Area are unlikely to pose a significant risk for most ROC evaluated.
- In the Former USAF Dump Area and Former Ammunition Storage Area, in consideration of several LOE, it is unlikely that population level effects will be observed due to PCB exposure to ROC and potential SAR at the Former USAF Dump Area and Former Ammunition Storage Area, however, to achieve greater certainty in the conclusion, the “hot spot” would need to be removed or managed, or site specific invertebrate tissue be collected.
- In the Former USAF Dump Area and Former Ammunition Storage Area, in consideration of several LOE, it is unlikely that population level effects will be observed due to fluoranthene exposure of SAR at the Former USAF Dump Area and Former Ammunition Storage Area.
- It should be noted that based on the lack of a suitable TRV for HMW PAHs it is uncertain if there is a potential risk to potential avian receptors from these COPC in the Main Complex and Former USAF Dump Area and Former Ammunition Storage Area, although based on the EQH values for LMW PAHs, the risk is expected to be low.
- In the General Area, substantive site-related risks to ecological receptors, including plant and soil invertebrate communities, mammals, birds, and species at risk from COPC were not identified. Risk management for ecological receptors is not recommended.
- In the Former Contractor Village, substantive site-related risks to ecological receptors, including plant and soil invertebrate communities, mammals, birds, and species at risk from COPC were not identified. Risk management for ecological receptors is not recommended.
- In the Main Complex, substantive site-related risks to ecological receptors, including plant and soil invertebrate communities, mammals, birds, and species at risk from COPC were not identified. Risk management for ecological receptors is not recommended.

- In the Former USAF Dump Area and Former Ammunition Storage Area, substantive population-related risks to ecological receptors, including plant and soil invertebrate communities, mammals, birds, and species at risk from COPC were not identified. However, localized site risks may be present to some ROC (Masked shrew) and to potential SAR (Rusty blackbird) related to the one PCB "hot spot". The "hot spot" should be removed or risk managed, or site-specific invertebrate tissue be collected to provide greater confidence in EPC values used in the food web modelling.

8.2 Recommendations

Based on the results of the HHERA, Englobe provides the following recommendations:

- Soil from the "hot spot" identified at sample location CWT-TP3-BS2 (24 mg/kg) in the Former USAF Dump Area and Former Ammunition Storage Area should be excavated and transported to an appropriate disposal facility.

9 Report Use and Conditions

This report was prepared for the exclusive use of DCC/DND and is based on data and information provided to Englobe and obtained during field work by Englobe on the subject sites including soil, groundwater, surface water and sediment sampling and select chemical analyses; and is based solely upon the condition of the property on the date of such work, supplemented by information obtained and described herein. Any use that a third party makes of this report, or any reliance on or decisions made based on it, are the sole responsibility of the third party. Englobe accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

The evaluation and conclusions contained in this report have been prepared in light of the expertise and experience of Englobe.

Environmental conditions are dynamic in nature and changing circumstances in the environment and in the use of the property can alter radically the conclusions and information contained herein.

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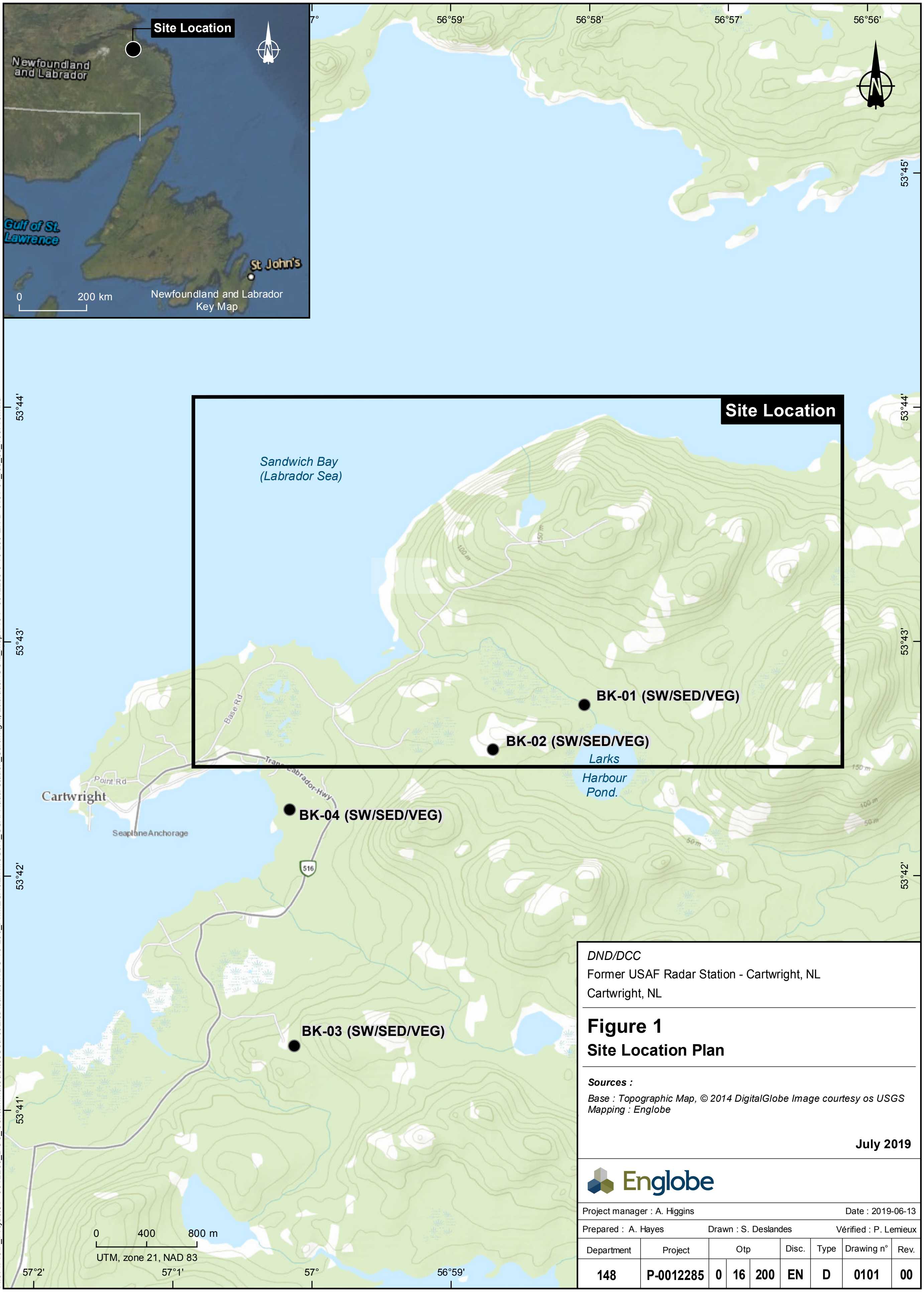
Appendix A Figures



DND/DCC
Former USAF Radar Station - Cartwright, NL
Cartwright, NL

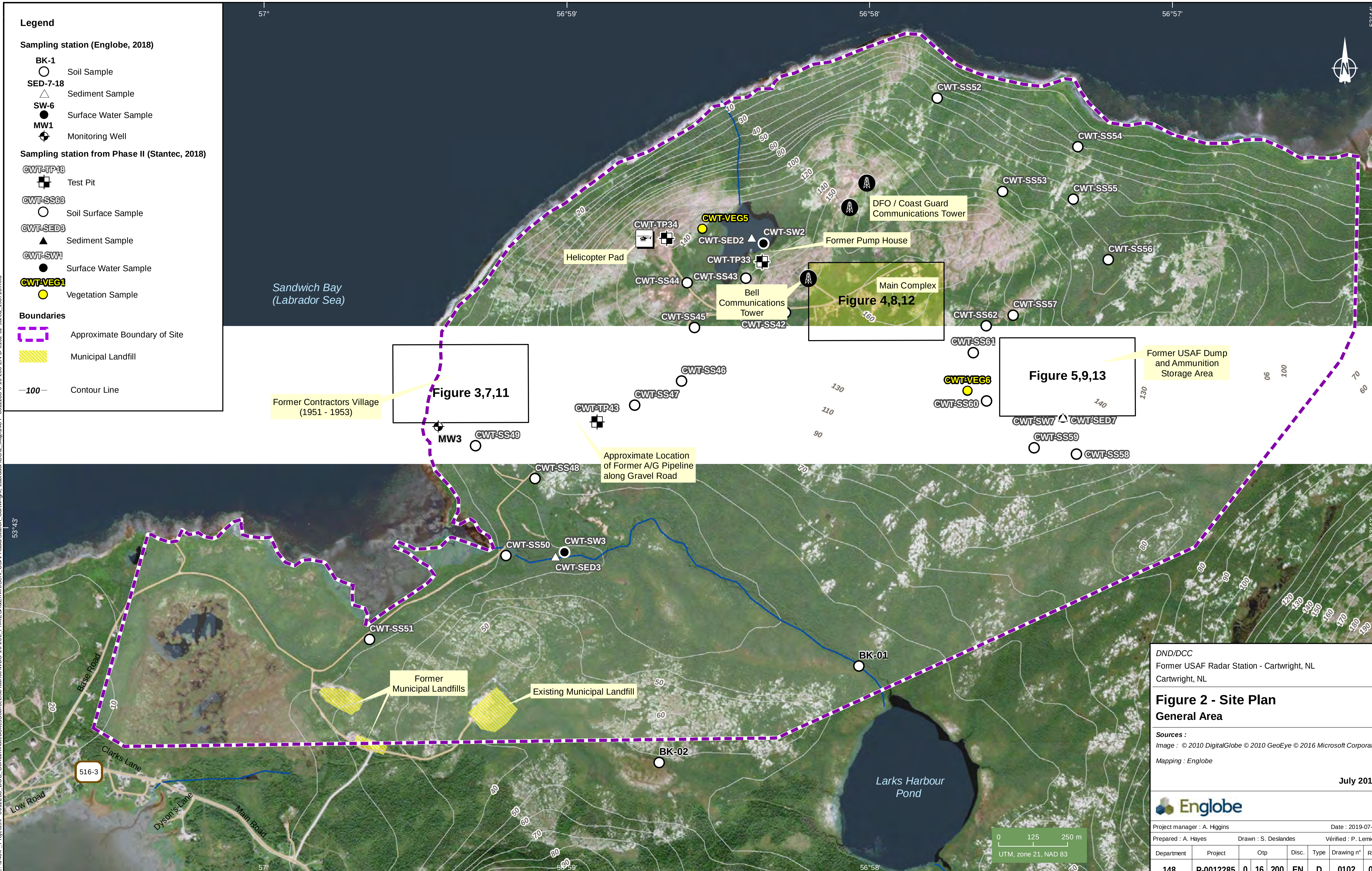
Figure 1
Site Location Plan

Sources :
Base : Topographic Map, © 2014 DigitalGlobe Image courtesy os USGS
Mapping : Englobe

July 2019

Englobe

Project manager : A. Higgins							Date : 2019-06-13	
Prepared : A. Hayes		Drawn : S. Deslandes					Vérified : P. Lemieux	
Department	Project	Otp			Disc.	Type	Drawing n°	Rev.
148	P-0012285	0	16	200	EN	D	0101	00



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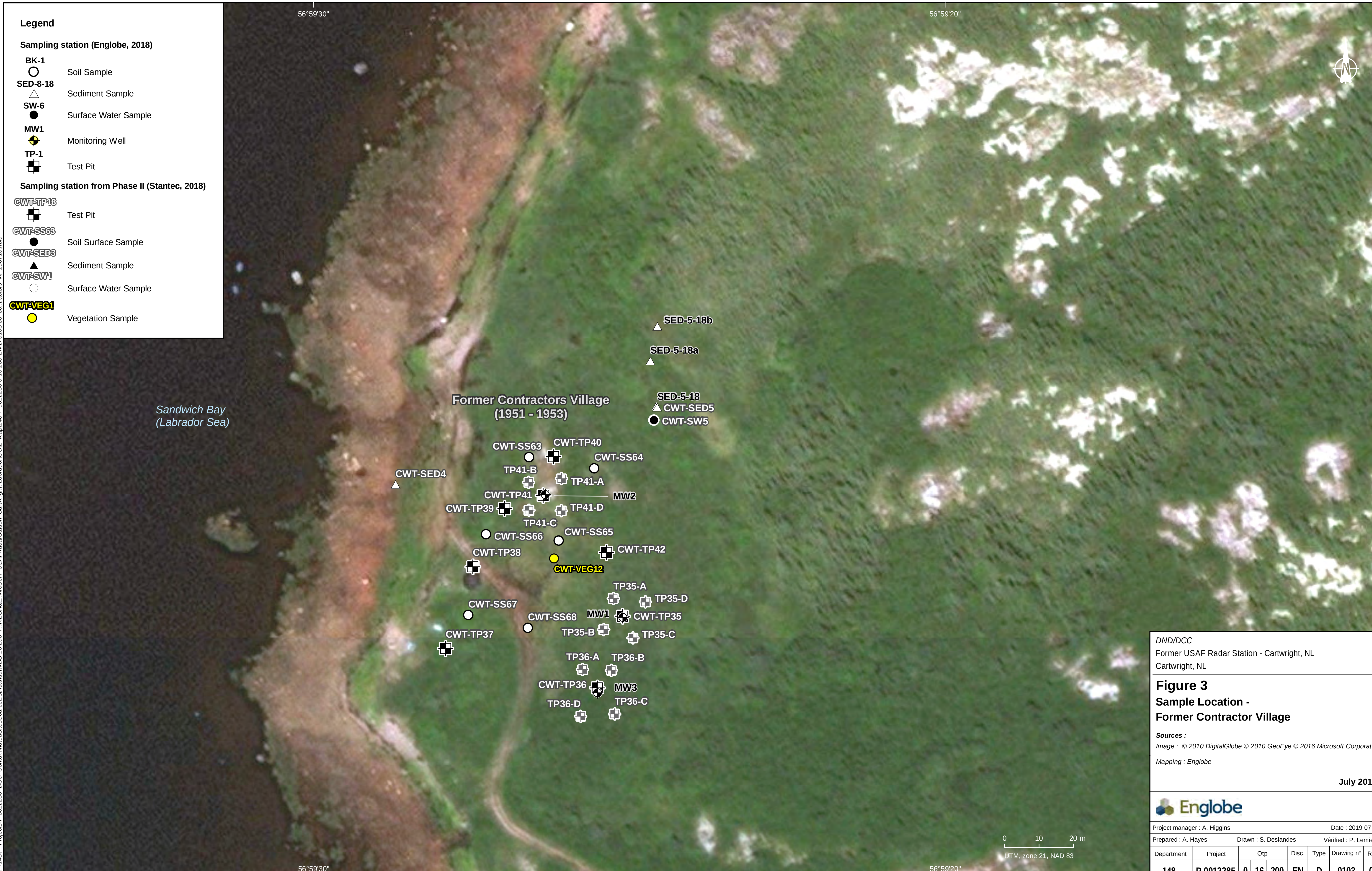

DND/DCC
Former USAF Radar Station - Cartwright, NL
Cartwright, NL

Figure 3
Sample Location -
Former Contractor Village

Sources :
Image : © 2010 DigitalGlobe © 2010 GeoEye © 2016 Microsoft Corporation
Mapping : Englobe

July 2019

Englobe

Project manager : A. Higgins							Date : 2019-07-10	
Prepared : A. Hayes		Drawn : S. Deslandes				Vérified : P. Lemieux		
Department	Project	Otp			Disc.	Type	Drawing n°	Rev.
148	P-0012285	0	16	200	EN	D	0103	00

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DND/DCC

Former USAF Radar Station - Cartwright, NL

Cartwright, NL

Figure 4

Sample Location

Main Complex

Sources :

Image : © 2010 DigitalGlobe © 2010 GeoEye © 2016 Microsoft Corporation

Mapping : Englobe

July 2019

Englobe

Project manager : A. Higgins					Date : 2019-07-10			
Prepared : A. Hayes		Drawn : S. Deslandes			Vérified : P. Lemieux			
Department	Project	Otp			Disc.	Type	Drawing n°	Rev.
148	P-0012285	0	16	200	EN	D	0104	00

File: \148P_Projects\P-0012285_DCC_ContaminatedSitesSourceList\Atlantic\WBS-16-200_PhIIESA\4EnviroServ_USAFRadarStation_Cartwright_Labrador\GOI2_Map\148-P-0012285-0-16-200-EN-D-0104-c4_main_190710.mxd

Legend

Sampling station (Englobe, 2018)

BK-1 — Soil Sample

SED-8-18 — Sediment Sample

SW-6 — Surface Water Sample

MW1 — Monitoring Well

Sampling station from Phase II (Stantec, 2018)

CWT-TP18 — Test Pit

CWT-SS63 — Soil Surface Sample

CWT-SED3 — Sediment Sample

CWT-SW1 — Surface Water Sample

CWT-VEG1 — Vegetation Sample

DND/DCC

Former USAF Radar Station - Cartwright, NL

Cartwright, NL

Figure 5

Sample Location

Former USAF Dump Area and

Former Ammunition Storage Area

Sources :

Image : © 2010 DigitalGlobe © 2010 GeoEye © 2016 Microsoft Corporation

Mapping : Englobe

July 2019

Englobe

Project manager : A. Higgins — Date : 2019-07-10

Prepared : A. Hayes — Drawn : S. Deslandes — Vérified : P. Lemieux

Department	Project	Otp	Disc.	Type	Drawing n°	Rev.
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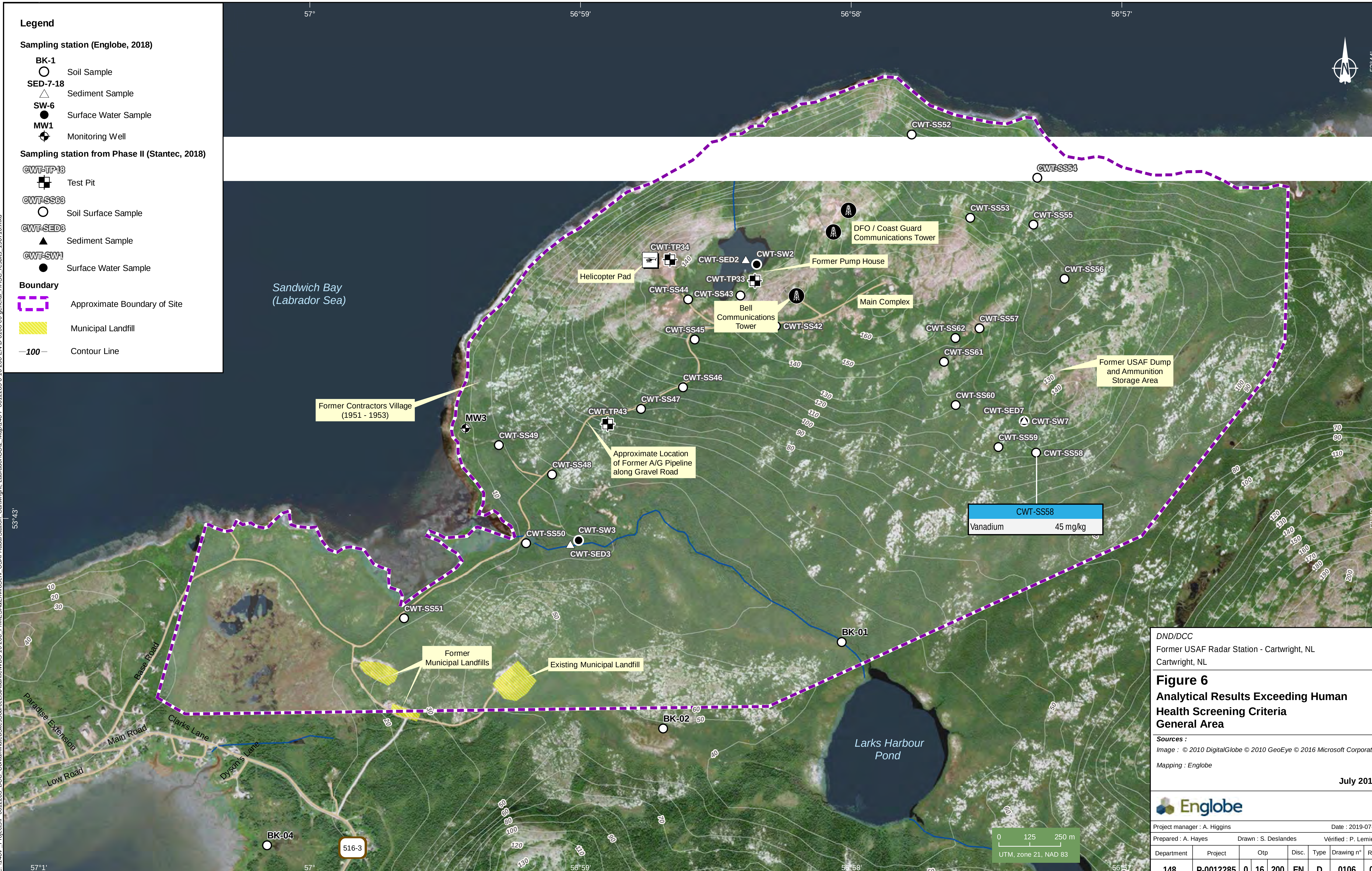

DND/DCC

Former USAF Radar Station - Cartwright, NL

Cartwright, NL

Figure 6

Analytical Results Exceeding Human Health Screening Criteria General Area

Sources :

Image : © 2010 DigitalGlobe © 2010 GeoEye © 2016 Microsoft Corporation

Mapping : Englobe

July 2019

Englobe

Project manager : A. Higgins | Date : 2019-07-10

Prepared : A. Hayes | Drawn : S. Deslandes | Vérified : P. Lemieux

Department	Project	Otp			Disc.	Type	Drawing n°	Rev.
148	P-0012285	0	16	200	EN	D	0106	00

DND/DCC
Former USAF Radar Station - Cartwright, NL
Cartwright, NL

Figure 7
Analytical Results Exceeding Human Health Screening Criteria Former Contractor Village

Sources :
Image : © 2010 DigitalGlobe © 2010 GeoEye © 2016 Microsoft Corporation
Mapping : Englobe

July 2019

Englobe

Project manager : A. Higgins				Date : 2019-07-10			
Prepared : A. Hayes		Drawn : S. Deslandes			Vérified : P. Lemieux		
Department	Project	Otp			Disc.	Type	Drawing n°	Rev.
148	P-0012285	0	16	200	EN	D	0107	00

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LEGEND
A/G WATERLINE (ASSUMED)
FORMER PUMP
FORMER AST
FORMER AST
APPROXIMATE LOCATION OF 1978/80 PCB SPILL AND REMEDIATION
GRAVEL ROAD TO FORMER USAF DUMP
FORMER AST
GRAVEL ROAD
FORMER BUILDINGS
CWT-TP11
FORMER A/G PIPELINE (TO DOCK)
CWT-SS41
FORMER BUILDINGS
FORMER GRAVEL ROAD
FORMER A/G PIPELINE
CWT-TP25
FORMER AST
FORMER DIESEL ASTs
SS32-C
APPROXIMATE AREA OF DEBRIS BURIAL (1987)

File: \\148P_Projects\P-0012285_DCC_ContaminatedSitesSourceList\Atlantic\WBS-16-200_PhIIIESA\EnviroServ_USAFRadarStation_Cartwright_Labrador\GOI2_Map\148-P-0012285-0-16-200-EN-D-0109-c9-amuntion_HHSC_190710.mxd

Legend

Sampling station (Englobe, 2018)

- BK-1 Soil Sample
- SED-8-18 Sediment Sample
- SW-6 Surface Water Sample
- MW1 Monitoring Well

Sampling station from Phase II (Stantec, 2018)

- CWT-TP18 Test Pit
- CWT-SS63 Soil Surface Sample
- CWT-SED3 Sediment Sample
- CWT-SW1 Surface Water Sample

DND/DCC

Former USAF Radar Station - Cartwright, NL

Cartwright, NL

Figure 9

Analytical Results Exceeding Human Health Screening Criteria Former USAF Dump Area and Former Ammunition Storage Area

Sources :

Image : © 2010 DigitalGlobe © 2010 GeoEye © 2016 Microsoft Corporation

Mapping : Englobe

July 2019

Englobe

Project manager : A. Higgins — Date : 2019-07-10

Prepared : A. Hayes — Drawn : S. Deslandes — Vérified : P. Lemieux

Department	Project	Otp			Disc.	Type	Drawing n°	Rev.
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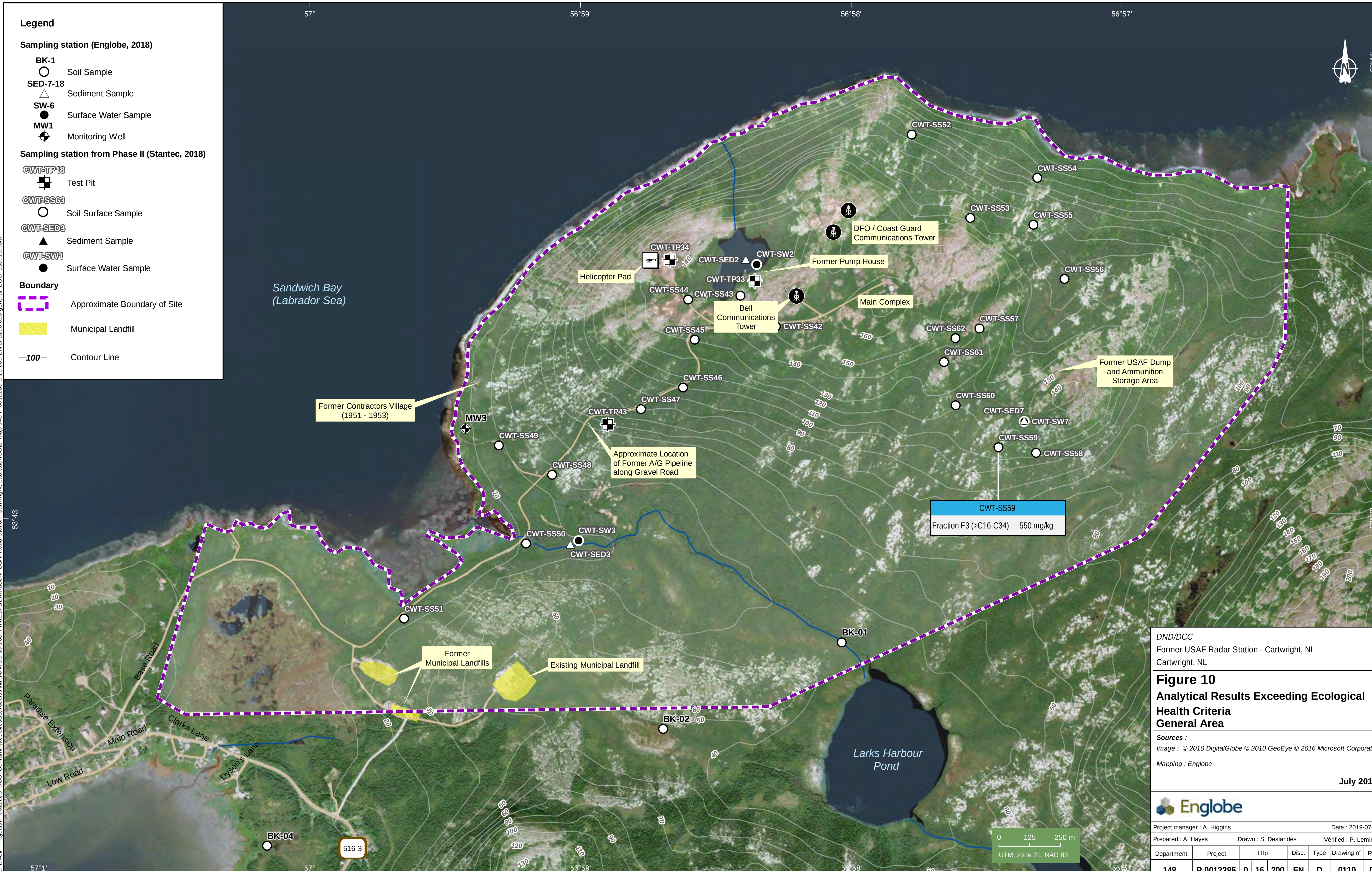

DND/DCC
Former USAF Radar Station - Cartwright, NL
Cartwright, NL

Figure 10
Analytical Results Exceeding Ecological Health Criteria General Area

Sources :
Image : © 2010 DigitalGlobe © 2010 GeoEye © 2016 Microsoft Corporation
Mapping : Englobe

July 2019

Englobe

Project manager : A. Higgins | Date : 2019-07-10
Prepared : A. Hayes | Drawn : S. Deslandes | Vérifié : P. Lemieux

Department	Project	Otp			Disc.	Type	Drawing n°	Rev.
148	P-0012285	0	16	200	EN	D	0110	00

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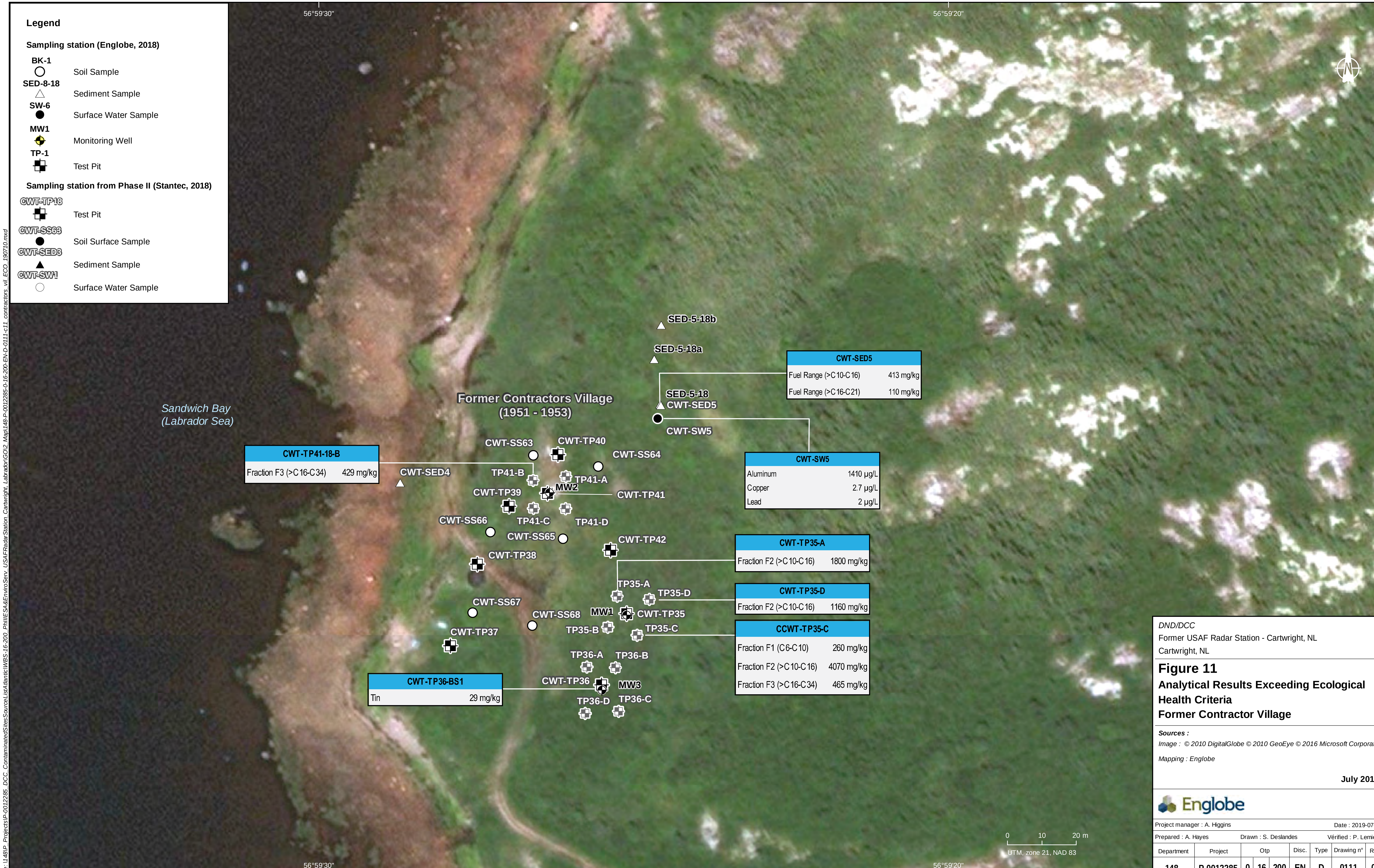

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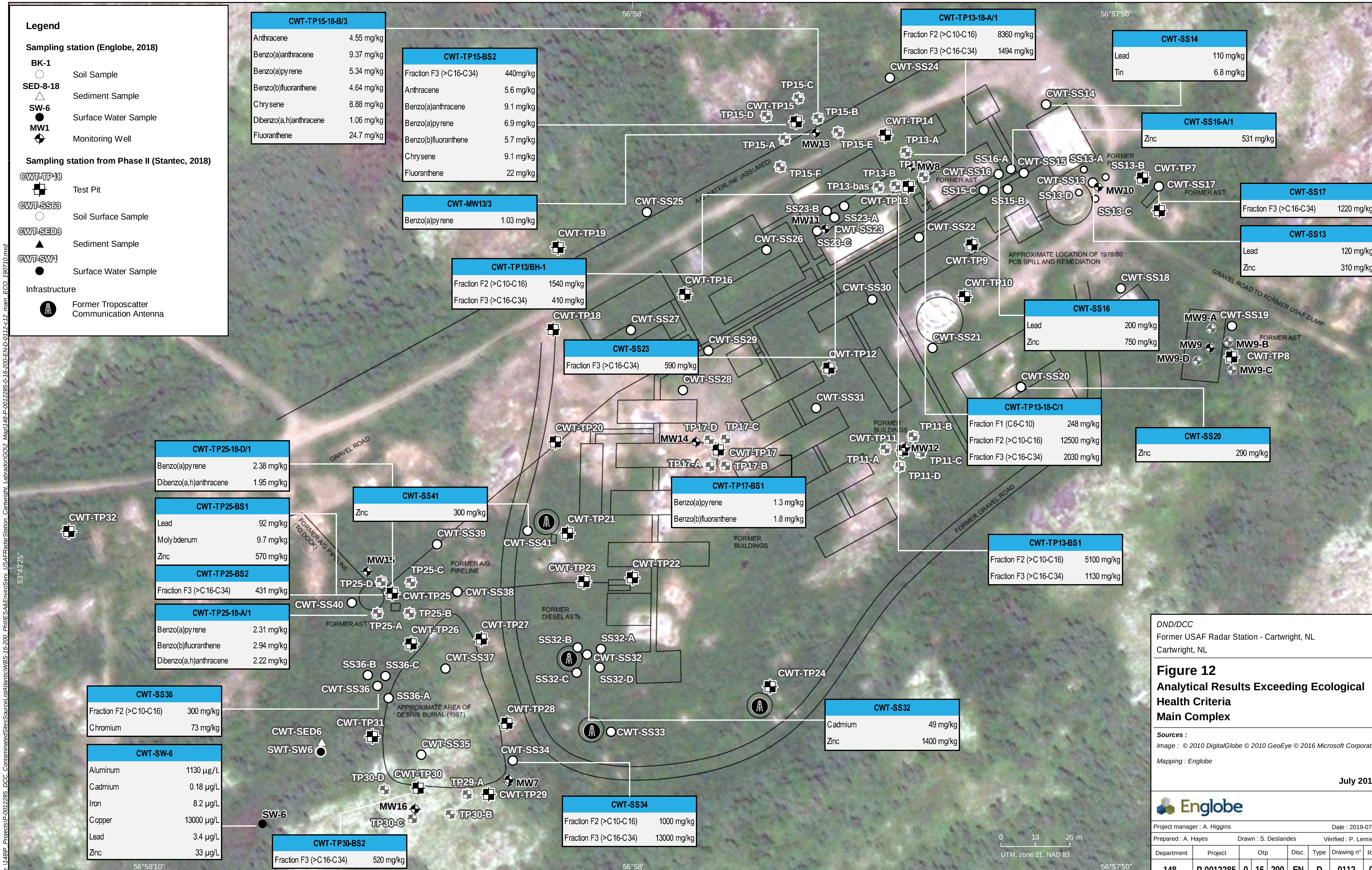
Legend
Sampling station (Englobe, 2018)
BK-1
Soil Sample
SED-8-18
Sediment Sample
SW-6
Surface Water Sample
MW1
Monitoring Well
Sampling station from Phase II (Stantec, 2018)
CWT-TP18
Test Pit
CWT-SS63
Soil Surface Sample
CWT-SED3
Sediment Sample
CWT-SW1
Surface Water Sample
Infrastructure
Former Troposcatter Communication Antenna
CWT-TP15-18-B/3
Anthracene 4.55 mg/kg
Benzo(a)anthracene 9.37 mg/kg
Benzo(a)pyrene 5.34 mg/kg
Benzo(b)fluoranthene 4.64 mg/kg
Chrysene 8.88 mg/kg
Dibenzo(a,h)anthracene 1.06 mg/kg
Fluoranthene 24.7 mg/kg
CWT-TP15-BS2
Fraction F3 (>C16-C34) 440mg/kg
Anthracene 5.6 mg/kg
Benzo(a)anthracene 9.1 mg/kg
Benzo(a)pyrene 6.9 mg/kg
Benzo(b)fluoranthene 5.7 mg/kg
Chrysene 9.1 mg/kg
Fluoranthene 22 mg/kg
CWT-MW13/3
Benzo(a)pyrene 1.03 mg/kg
CWT-TP13-18-A/1
Fraction F2 (>C10-C16) 8360 mg/kg
Fraction F3 (>C16-C34) 1494 mg/kg
CWT-SS14
Lead 110 mg/kg
Tin 6.8 mg/kg
CWT-SS16-A/1
Zinc 531 mg/kg
CWT-SS17
Fraction F3 (>C16-C34) 1220 mg/kg
CWT-SS13
Lead 120 mg/kg
Zinc 310 mg/kg
CWT-TP13/BH-1
Fraction F2 (>C10-C16) 1540 mg/kg
Fraction F3 (>C16-C34) 410 mg/kg
CWT-SS23
Fraction F3 (>C16-C34) 590 mg/kg
CWT-SS16
Lead 200 mg/kg
Zinc 750 mg/kg
CWT-TP13-18-C/1
Fraction F1 (C6-C10) 248 mg/kg
Fraction F2 (>C10-C16) 12500 mg/kg
Fraction F3 (>C16-C34) 2030 mg/kg
CWT-SS20
Zinc 290 mg/kg
CWT-TP17-BS1
Benzo(a)pyrene 1.3 mg/kg
Benzo(b)fluoranthene 1.8 mg/kg
CWT-TP13-BS1
Fraction F2 (>C10-C16) 5100 mg/kg
Fraction F3 (>C16-C34) 1130 mg/kg
CWT-TP25-18-D/1
Benzo(a)pyrene 2.38 mg/kg
Dibenzo(a,h)anthracene 1.95 mg/kg
CWT-TP25-BS1
Lead 92 mg/kg
Molybdenum 9.7 mg/kg
Zinc 570 mg/kg
CWT-TP25-BS2
Fraction F3 (>C16-C34) 431 mg/kg
CWT-TP25-18-A/1
Benzo(a)pyrene 2.31 mg/kg
Benzo(b)fluoranthene 2.94 mg/kg
Dibenzo(a,h)anthracene 2.22 mg/kg
CWT-SS41
Zinc 300 mg/kg
CWT-SS36
Fraction F2 (>C10-C16) 300 mg/kg
Chromium 73 mg/kg
CWT-SW-6
Aluminum 1130 µg/L
Cadmium 0.18 µg/L
Iron 8.2 µg/L
Copper 13000 µg/L
Lead 3.4 µg/L
Zinc 33 µg/L
CWT-TP30-BS2
Fraction F3 (>C16-C34) 520 mg/kg
CWT-SS34
Fraction F2 (>C10-C16) 1000 mg/kg
Fraction F3 (>C16-C34) 13000 mg/kg
CWT-SS32
Cadmium 49 mg/kg
Zinc 1400 mg/kg
CWT-SS24
CWT-SS14
CWT-TP15
TP15-C
TP15-D
TP15-B
TP15-A
MW13
TP15-E
TP15-F
CWT-TP14
TP13-A
TP13-B
TP13-bas
CWT-TP13
MW8
CWT-SS16
SS16-A
CWT-SS15
SS15-C
SS15-B
SS13-A
SS13-B
CWT-SS13
SS13-D
SS13-C
MW10
CWT-TP7
CWT-SS17
FORMER AST
CWT-SS25
CWT-SS26
SS23-B
MW11
SS23-A
CWT-SS23
SS23-C
CWT-SS22
CWT-TP9
APPROXIMATE LOCATION OF 1978/80 PCB SPILL AND REMEDIATION
CWT-TP19
CWT-TP16
CWT-SS30
CWT-TP10
CWT-SS18
GRAVEL ROAD TO FORMER USAF DUMP
CWT-TP18
CWT-SS27
CWT-SS29
CWT-SS21
CWT-TP12
MW9-A
CWT-SS19
MW9
MW9-B
MW9-D
CWT-TP8
MW9-C
CWT-SS28
CWT-SS20
CWT-SS31
CWT-TP20
TP17-D
TP17-C
MW14
CWT-TP17
TP17-A
TP17-B
CWT-TP11
TP11-B
MW12
TP11-A
TP11-C
TP11-D
FORMER BUILDINGS
GRAVEL ROAD
FORMER GRAVEL ROAD
CWT-TP32
CWT-SS39
CWT-TP21
CWT-SS41
FORMER A/G PIPELINE (TO DOCK)
MW15
TP25-C
FORMER A/G PIPELINE
TP25-D
CWT-TP25
CWT-SS38
CWT-TP23
CWT-TP22
CWT-SS40
FORMER AST
TP25-A
TP25-B
FORMER DIESEL ASTs
CWT-TP26
CWT-TP27
SS32-B
SS32-A
CWT-SS32
SS32-C
SS32-D
CWT-SS37
SS36-B
SS36-C
CWT-SS36
SS36-A
APPROXIMATE AREA OF DEBRIS BURIAL (1987)
CWT-TP24
CWT-TP28
CWT-SED6
SWT-SW6
CWT-TP31
CWT-SS35
CWT-SS33
CWT-SS34
TP30-D
CWT-TP30
TP29-A
MW7
CWT-TP29
MW16
TP30-B
TP30-C
SW-6
A/G WATERLINE (ASSUMED)
56°58'
56°57'50"
56°58'10"
53°43'25"
0 13 26 m
UTM, zone 21, NAD 83
DND/DCC
Former USAF Radar Station - Cartwright, NL
Cartwright, NL
Figure 12
Analytical Results Exceeding Ecological Health Criteria
Main Complex
Sources :
Image : © 2010 DigitalGlobe © 2010 GeoEye © 2016 Microsoft Corporation
Mapping : Englobe
July 2019
Englobe
Project manager : A. Higgins
Date : 2019-07-10
Prepared : A. Hayes
Drawn : S. Deslandes
Vérified : P. Lemieux
Department 148
Project P-0012285
Otp 0 16 200
Disc. EN
Type D
Drawing n° 0112
Rev. 00

CWT-SW-8
Lead 2.9 µg/L
Zinc 18 µg/L
CWT-SED8
CWT-SW8
CWT-SS6
Total Calculated PCB 2.6 mg/kg
CWT-SS7
Total Calculated PCB 3 mg/kg
CWT-TP3-BS2
Total Calculated PCB 24 mg/kg
Cadmium 2 mg/kg
Lead 180 mg/kg
Molybdenum 6 mg/kg
Tin 14 mg/kg
Zinc 1800 mg/kg
CWT-TP2-BS2
Total Calculated PCB 2.2 mg/kg
Tin 6.1 mg/kg
CWT-TP2-18C
Anthracene 15.9 mg/kg
Benzo(a)anthracene 19.7 mg/kg
Benzo(a)pyrene 14.5 mg/kg
Benzo(b)fluoranthene 12.6mg/kg
Chrysene 16.1 mg/kg
Dibenzo(a,h)anthracene 1.9 mg/kg
Fluoranthene 59.5 mg/kg
Phenanthrene 46.8 mg/kg
FORMER DUMP AREA
CWT-SS8
Zinc 380 mg/kg
CWT-SS8-18-B/1
Zinc 444 mg/kg
CWT-TP2-18D
Benzo(a)pyrene 2.48 mg/kg
Benzo(b)fluoranthene 3.35 mg/kg
TP5-A
TP5-C
TP5-B
MW6
TP5
SS8-C
CWT-SS7
SS8
SS8-D
SS8-B
TP3-D
TP3
TP3-B
TP3-F
SS8-A
TP3-C
TP3-A
CWT-TP4
CWT-SS9
TP3-E
CWT-SS10
TP2-E
TP2-A
CWT-SS11
TP2-B
CWT-TP2
TP2-D
TP2-C
MW5
Approximate
Area of Regrading
CWT-TP1
CWT-SS12
CWT-SS2-18A
Fraction F3 (>C16-C34) 1422 mg/kg
CWT-SS4
CWT-SS1
CWT-SS-2A
CWT-SS-2
CWT-SS-2D
CWT-SS-2B
CWT-SS3
MW4
CWT-SS-2C
CWT-SS2
Fraction F3 (>C16-C34) 6380 mg/kg
FORMER AMMUNITION
STORAGE AREA
CWT-SS5
CWT-SS5
Total Calculated PCB 1.4 mg/kg
CWT-SW-7-18
Aluminum 1600 µg/L
Lead 3.8 µg/L
Zinc 22 µg/L
Copper 4 µg/L
CWT-SED7
CWT-SW7
56°57'30"
56°57'20"
56°57'10"
53°43'20"
Aerial
Legend
Sampling station (Englobe, 2018)
BK-1
Soil Sample
SED-8-18
Sediment Sample
SW-6
Surface Water Sample
MW1
Monitoring Well
Sampling station from Phase II (Stantec, 2018)
CWT-TP18
Test Pit
CWT-SS63
Soil Surface Sample
CWT-SED3
Sediment Sample
CWT-SW1
Surface Water Sample
0 15 30 m
UTM, zone 21, NAD 83
DND/DCC
Former USAF Radar Station - Cartwright, NL
Cartwright, NL
Figure 13
Analytical Results Exceeding Ecological Health Criteria
Former USAF Dump Area and
Former Ammunition Storage Area
Sources :
Image : © 2010 DigitalGlobe © 2010 GeoEye © 2016 Microsoft Corporation
Mapping : Englobe
July 2019
Englobe
Project manager : A. Higgins
Date : 2019-07-10
Prepared : A. Hayes
Drawn : S. Deslandes
Vérifié : P. Lemieux
Department 148
Project P-0012285
Otp 0 16 200
Disc. EN
Type D
Drawing n° 0113
Rev. 00

Appendix B ACCDC Report

Alex Hayes

From:	Aven Cole
Sent:	7 août 2018 16:41
To:	Christina Caldwell; Lisa Ladouceur
Subject:	Fwd: ACCDC DATA REQUEST: Cartwright, NL
Attachments:	Map.jpg; ATT00001.htm; RareFauna.xls; ATT00002.htm; RareFlora.xls; ATT00003.htm; Caveats.doc; ATT00004.htm; DATA DICTIONARY.doc; ATT00005.htm; herbaria.xls; ATT00006.htm; RANKING.rtf; ATT00007.htm; RQ0686.pdf; ATT00008.htm

Sent from my iPhone

Begin forwarded message:

> **From:** "Durocher, Adam" <AdamDurocher@gov.nl.ca>
> **To:** "Aven Cole" <Aven.Cole@englobecorp.com>
> **Subject: RE: ACCDC DATA REQUEST: Cartwright, NL**
>
> Hi Aven,
> Attached are the data request results for your study area at the old U.S. military property site in Cartwright, Newfoundland & Labrador.
>
> Summary: Within your study area, there were 10 rare animal records and 30 rare plant records found. These 30 rare plant records are for plants which are not found on the provincial ESA or federal COSEWIC lists, and outside of Newfoundland and Labrador, only the moss *Fontinalis dalecarlica* is considered globally rare.
>
> As for the 10 rare animal records, there was 1 Polar Bear record (*Vulnerable* under our Endangered Species Act (ESA) and *Special Concern* under COSEWIC). The remaining rare animal records are for species which are not on the provincial ESA or federal COSEWIC lists, and outside of Newfoundland & Labrador, they are not considered globally rare.
>
> 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, SARA 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 Common Nighthawk, breeding/molting Harlequin Ducks, Ivory Gulls, Peregrine Falcons, Rusty Blackbirds, Woodland Caribou and Short-eared Owls are possible. Your area is also said to be within the migrating, molting & nesting range of Barrow's Goldeneye.
>
> For more information, including a map of the area showing the locations of the rare flora, rare fauna and the area of interest, please refer to the following attached documents:
> Map.jpg - shows the locations of the rare flora, rare fauna and the 5km buffer around your area of interest.
> RareFlora.xls – a list of the plants, including their SRANK, NRANK, GRANK, and habitats.
> RareFauna.xls – a list of rare animal 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.
RQ0686.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 depend upon the season. The ACCDC makes a strong effort to verify the accuracy of all the data it obtains, generates and manages, but it will not be held responsible for inaccuracies in data that it provides.

PLEASE NOTE:
* ACCDC data is restricted for use by the specified data user only; any third party requiring data must make its own request to the ACCDC.
* Specified data users may not publish any information provided by the ACCDC or its partners without prior permission.
* To ensure the currency of the data, the ACCDC requires Data Users to destroy all copies of data 18 months after the date of receipt.
* ACCDC data reports are restricted to that data in our Data System at the time of the request.
* Data accuracy is qualified as to location (Accuracy) and time (Date)
* ACCDC data reports are not to be constructed as exhaustive inventories of taxa in an area.
* The non-occupancy of a taxon cannot be inferred by its absence in an ACCDC data report.
* Museum databases, which are the basis for more accessible public databases, such as those of the ACCDC, are works in progress. Essentially, they are finding aids and dynamic data records, constructed primarily to serve scientists engaged in the continuing, active process of plant systematics and taxonomy. Ongoing additions of new collections, and frequent upgrades to the identifications of all plant specimens housed in museum herbaria, may not always be reflected, in real time, by databases such as those of the ACCDC. Specifically, the conservation status of individual species recorded in the ACCDC database may not be absolutely current. It is therefore the responsibility of the data user to contact the relevant museums directly, in order to check for the most current identifications of specimens of interest, and to ascertain from the scientists concerned, their current understanding of the conservation status of individual species in question. The absolute conservation status of any given species is dynamic, and subject to change over short periods of time.

From: Aven Cole [mailto:Aven.Cole@englobecorp.com]
Sent: Thursday, July 26, 2018 8:29 AM
To: Durocher, Adam
Cc: Christina Caldwell; Lisa Ladouceur
Subject: ACCDC DATA REQUEST: Cartwright, NL

Hi Adam,

Can we get a standard search done. I've attached the site area…it is quite large, and our radius should be 5km outside the project boundaries.

The coordinates are 502114E 5952108N.

Our project number is P-12885-0-16-200 and the PO for the invoice is A20651.

Let me know if there is anything else.

Thanks,
Aven

Aven Cole, M.Sc.E., P.Eng.
Project Manager
Environmental Engineering

Englobe
97 Troop Avenue
Dartmouth (Nova Scotia) B3B 2A7
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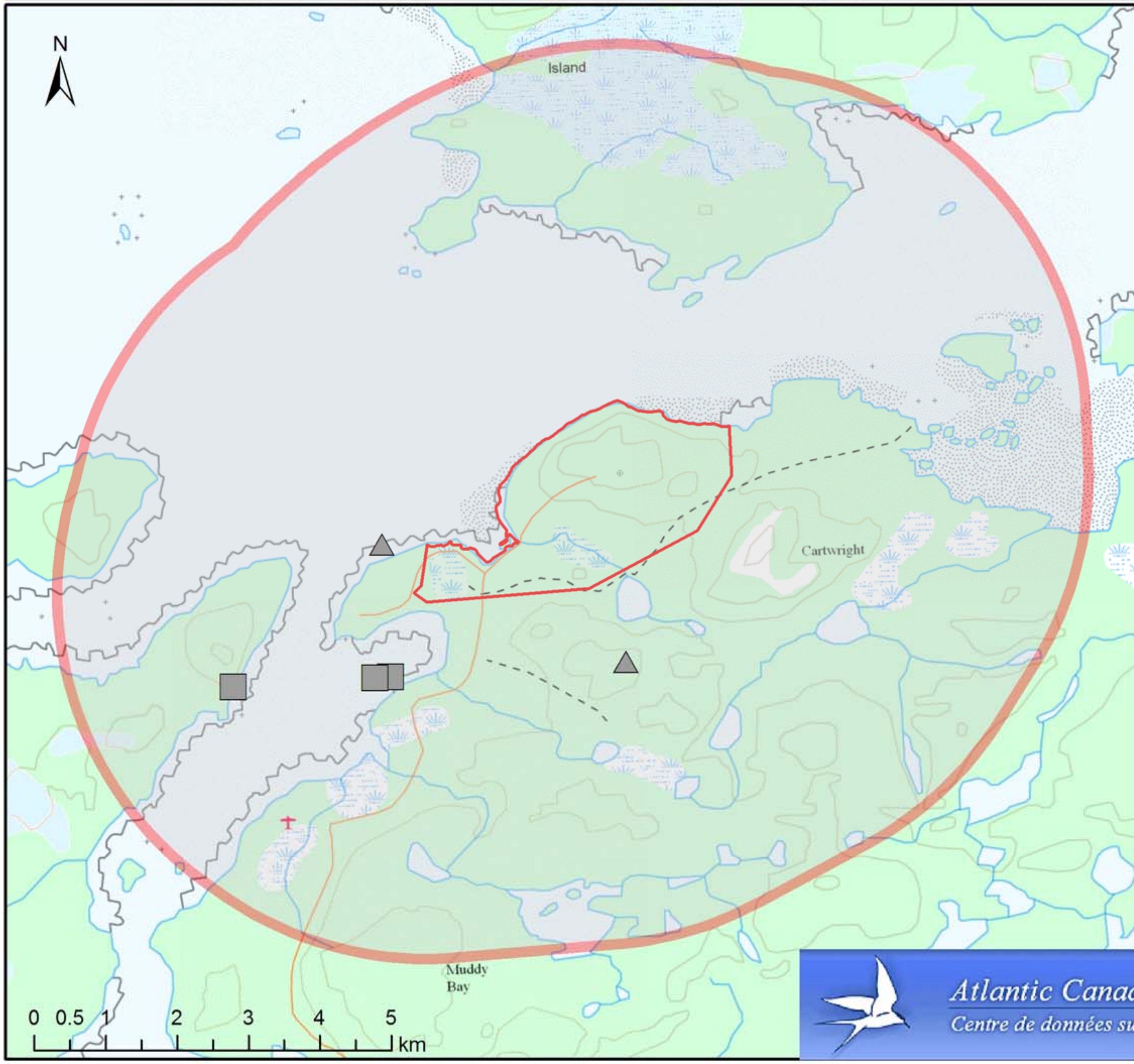
aven.cole@englobecorp.com
www.englobecorp.com

GIS Scan of Rare and Provincially/Federally Listed Species for Former U.S. Military Site in Cartwright, Newfoundland and Labrador



Legend

Area of Interest (AOI)

5 km Buffer Around AOI

Rare Fauna

Unknown Accuracy

Rare Flora

Unknown Accuracy

Atlantic Canada Conservation Data Centre
August 7, 2018
For: Englobe
Project No.: P-12885-0-16-200
Data Request: RQ0686

Datum: Transverse Mercator NAD83
Note: Interpretations of this map should always be conducted in relation with data provided in spreadsheets and any other communications.

Atlantic Canada Conservation Data Centre
Centre de données sur la conservation du Canada Atlantique

Atlantic Canada CDC Canada Atlantique

2012 Edition

Part I. Conservation Data Centre Subnational Rarity Ranks

Biological diversity or biodiversity can be described at a number of levels, from molecules to ecosystems. Biodiversity is a combination of species diversity (the variety of species), genetic diversity (the genetic variability among individuals of that species), and ecological diversity (the variety of ecosystems/habitats in which they live). Conservation Data Centres (CDCs), as part of The NatureServe* international network, track biodiversity at two levels: species and ecological communities. Species and ecological communities are referred to as **elements** of biodiversity. Elements are ranked in each jurisdiction (province or state) and at global and national levels in order to help prioritize conservation efforts.

NatureServe and all CDCs (called Heritage Programs in the US) use a standardized element ranking system that has evolved over some 30 years, with input from hundreds of scientists, managers and conservationists. The following material describes this element ranking system at the subnational (S) or provincial level and explains how ranks are assigned for species elements of biodiversity. (The community ranking process is slightly different.)

* Formerly known as The Nature Conservancy (TNC)

<u>Definitions of Provincial (subnational) ranks - SRANKS</u>

S1 **Critically Imperiled**—Critically imperiled in the jurisdiction because of extreme rarity or because of some factor(s) such as very steep declines making it especially vulnerable to extirpation from the jurisdiction.

S2 **Imperiled**—Imperiled in the jurisdiction because of rarity due to very restricted range, very few populations, steep declines, or other factors making it very vulnerable to extirpation from jurisdiction.

S3 **Vulnerable**—Vulnerable in the jurisdiction due to a restricted range, relatively few populations, recent and widespread declines, or other factors making it vulnerable to extirpation.

S4 **Apparently Secure**—Uncommon but not rare; some cause for long-term concern due to declines or other factors.

S5 **Secure**—Common, widespread, and abundant in the jurisdiction.

SX Pr**esumed Extirpated**—Species or ecosystem is believed to be extirpated from the jurisdiction (i.e., nation or state/province). Not located despite intensive searches of historical sites and other appropriate habitat, and virtually no likelihood that it will be rediscovered.

SH **Possibly Extirpated**— Known from only historical records but still some hope of rediscovery. There is evidence that the species or ecosystem may no longer be present in the jurisdiction, but not enough to state this with certainty. Examples of such evidence include (1) that a species has not been documented in approximately 20-40 years despite some searching or some evidence of significant habitat loss or degradation; (2) that a species or ecosystem has been searched for unsuccessfully, but not thoroughly enough to presume that it is no longer present in the jurisdiction.

S#S# **Range Rank** — A numeric range rank (e.g., S2S3 or S1S3) is used to indicate any range of uncertainty about the status of the species or ecosystem. Ranges cannot skip more than two ranks (e.g., SU is used rather than S1S4).

SU **Unrankable**—Currently unrankable due to lack of information or due to substantially conflicting information about status or trends.

SNR **Unranked**—National or subnational conservation status not yet assessed.

SNA **Not Applicable** —A conservation status rank is not applicable because the species or ecosystem is not a suitable target for conservation activities.

Not applicable cases:
Hybrid – Element represents an interspecific hybrid without conservation value. (Note that hybrids may be assigned a numeric rank if they do have a conservation value.)

Exotic Origin – Element is not native to the nation or subnation.

Accidental/Nonregular – Element is not regularly found in the nation or subnation, in other words, infrequent and outside of normal range.

Not Confidently Present – Element's presence in the nation or subnation has been reported, but the report is unconfirmed or doubtful; Element has been falsely reported, and may or may not potentially occur; Element may potentially occur (e.g., habitat is suitable); Element was never present in the nation or subnation despite presence in surrounding areas.

No Definable Occurrences – Element is native and appears regularly but lacks practical conservation concern in the subnation because it is transient or occurs in a dispersed, unpredictable manner.

Synonym – Element reported as occurring in the nation or subnation, but the national or provincial data center does not recognize this taxon; therefore the Element is not assigned a national or subnational rank.

Rank Qualifier

S#? **Inexact Numeric Rank**—Denotes inexact numeric rank. This designation should not be used with any of the variant national or subnational conservation status ranks or NX, SX, NH, or SH.

<u>Breeding Status Qualifiers</u>[4]

B **Breeding**—Conservation status refers to the breeding population of the species in the nation or state/province.

N **Nonbreeding**—Conservation status refers to the non-breeding population of the species in the nation or state/province.

M **Migrant**—Migrant species occurring regularly on migration at particular staging areas or concentration spots where the species might warrant conservation attention. Conservation status refers to the aggregating transient population of the species in the nation or state/province.

[4] 4A breeding status is only used for species that have distinct breeding and/or non-breeding populations in the nation or state/province. A breeding-status S-rank can be coupled with its complementary non-breeding-status S-rank if the species also winters in the nation or state/province. In addition, a breeding-status S-rank can also be coupled with a migrant-status S-rank if, on migration, the species occurs regularly at particular staging areas or concentration spots where it might warrant conservation attention. Multiple conservation status ranks (typically two, or rarely three) are separated by commas (e.g., S2B,S3N or SHN,S4B,S1M).

Part II. The Ranking Process

To rank species elements, 8-10 different biological criteria are assessed for each species. The ten factors considered in assigning status ranks are described below.

<u>**Ranking Matrix** Eight ranking criteria and value of letter scores for each criterion.</u>

	MATRIX SCORE						
	A	**B**	**C**	**D**	**E**	**F**	**(**
CRITERIA							
Population size	1-50	50-250	250-1000	1000-2500	2500-10000	10000-100000	100 100
Range Extent	<100km²	100-250km²	250-1000km²	1000-5000km²	5000-20000 km²	20000-200000 km²	2000 250 kı
Short-term Trend	Decline >90%	Decline of 80-90%	Decline of 70-80%	Decline of 50-70%	Decline of 30-50%	Decline of 10-30%	Rela Sta (<1 cha
Long-term Trend	Decline >90%	Decline of 80-90%	Decline of 70-80%	Decline of 50-70%	Decline of 30-50%	Decline of 10-30%	Rela Sta (<1 cha
Area of Occupancy	<0.4km²	0.4-4km²	4-20km²	20-100km²	100-500km²	500-2000km²	20 2000

Number of Element Occurrences (EOs)	0-5	6-20	21-100	>100			
Number of EOs with Good Viability	No occurrences with excellent or good viability or ecological integrity	Very few (1-3) occurrences with excellent or good viability or ecological integrity	Few (4-12) occurrences with excellent or good viability or ecological integrity	Some (13-40) occurrences with excellent or good viability or ecological integrity	Many (41-125) occurrences with excellent or good viability or ecological integrity	Very Many (>125) occurrences with excellent or good viability or ecological integrity	
Environmental Specificity	Very Narrow	Narrow	Moderate	Broad			
Threat Scope	Pervasive (71-100%)	Large (31-70%)	Restricted (11-30%)	Small (1-10%)			
Threat Severity	Pervasive (71-100%)	Large (31-70%)	Restricted (11-30%)	Small (1-10%)			

1. Population Size

Population size is the estimated current total population of the species which is naturally occurring and wild within the area of interest (globe, nation, or subnation), and that is of reproductive age or stage (at an appropriate time of the year), including mature but currently non-reproducing individuals, which should be included in counts or estimates. Abundance is measured in different ways depending on the biology of the species. For animal populations it is usually measured by the number of individuals, for plants it may be measured by the area occupied by a distinct population, and for aquatic invertebrates it may be measured by the stream length that the species occupies:

Z = Zero, no individuals believed extant (i.e., species presumed extinct)
A = 1–50 individuals
B = 50–250 individuals
C = 250–1,000 individuals
D = 1,000–2,500 individuals
E = 2,500–10,000 individuals
F = 10,000–100,000 individuals
G = 100,000–1,000,000 individuals
H = >1,000,000 individuals
U = Unknown
Null = Factor not assessed

*A value range (e.g., DE) can also be used to indicate uncertainty.
(DE would indicate between 1000 – 10000 individuals).

2. Range Extent

This denotes the approximate range of the species as a percentage of the province's area. It is defined as the current area contained within the shortest continuous imaginary boundary which can be drawn to encompass all the known, inferred or projected sites of occurrence, but, *excluding* significant areas where the species does not occur due to unsuitable habitat. Thus the estimate of range for a species exhibiting a linear use of coastal forests or riverine habitats would not consider tracts of unsuitable habitat in the interior of the polygon.

Z = Zero (no occurrences believed extant; species presumed extinct or ecosystem believed eliminated throughout its range)
A = <100 km²
(less than about 40 square miles)
B = 100–250 km²
(about 40–100 square miles)
C = 250–1,000 km²
(100–400 square miles)
D = 1,000–5,000 km²
(400–2,000 square miles)
E = 5,000–20,000 km²
(2,000–8,000 square miles)
F = 20,000–200,000 km²
(8,000–80,000 square miles)
G = 200,000–2,500,000 km²
(80,000–1,000,000 square miles)
H = >2,500,000 km²
(greater than 1,000,000 square miles)

3. Short-term Trend

The rating code that best describes the observed, estimated, inferred, or suspected degree of change in population size, extent of occurrence (range extent), area of occupancy, number of occurrences, and/or number of occurrences or percent area with good viability or ecological integrity over the short term, whichever most significantly affects the conservation status assessment in the area of interest (globe, nation, or subnation). Consider short-term historical trend within ten years or three generations (for long-lived taxa), whichever is the longer (up to a maximum of 100 years), or, for communities and systems, typically 30 years, depending on the characteristics of the type.

The trend may be recent or current, and the trend may or may not be known to be continuing. Trends may be smooth, irregular, or sporadic. Fluctuations will not normally count as trends, but an observed change should not be considered as merely a fluctuation rather than a trend unless there is evidence for this. Conservation Status Assessments: Factors for Assessing Extinction Risk 25
In considering trends, do not consider newly discovered but presumably long existing occurrences, nor newly discovered individuals in previously poorly known areas.

Also, consider fragmentation of previously larger occurrences into a greater number of smaller occurrences to represent a decreasing area of occupancy as well as decreasing number of good occurrences or populations.

A = Decline of >90%
B = Decline of 80–90%
C = Decline of 70–80%
D = Decline of 50–70%
E = Decline of 30–50%
F = Decline of 10–30%
G = Relatively Stable (≤10% change)
H = Increase of 10–25%
I = Increase of >25%
U = Short-term trend unknown
Null = Factor not assessed

4. Long-term Trend

The rating code that best describes the observed, estimated, inferred, or suspected degree of change in population size, extent of occurrence (range extent), area of occupancy, number of occurrences, and/or number of occurrences or percent area with good viability or ecological integrity over the long term (ca. 200 years) in the area of interest (globe, nation, or subnation).

A = Decline of >90%
B = Decline of 80–90%
C = Decline of 70–80%
D = Decline of 50–70%
E = Decline of 30–50%
F = Decline of 10–30%
G = Relatively Stable (≤10% change)
H = Increase of 10–25%
I = Increase of >25%
U = Long-term trend unknown
Null = Factor not assessed

5. Area of Occupancy

Area of occupancy for taxa can be defined as (modified from the International Union for the Conservation of Nature 2001):
"...the area within its 'extent of occurrence', which is occupied by a taxon or ecosystem type, excluding cases of vagrancy. The measure reflects the fact that a taxon or type will not usually occur throughout the area of its extent of occurrence, which may contain unsuitable or unoccupied habitats. In some cases, (e.g., irreplaceable colonial nesting sites, crucial feeding sites for migratory taxa) the area of occupancy is the smallest area essential at any stage to the survival of existing populations of a taxon. The size of the area of occupancy will be a function of the scale at which it is measured, and should be

at a scale appropriate to relevant biological or ecological aspects of the taxon or type, the nature of threats and the available data."

A = <0.4km²
B = 0.4-4
C = 4-20 km²
D = 20-100 km²
E = 100-500 km²
F = 500-2000 km²
G = 2000-20000 km²
H = >20000 km²

5b. Linear Distance of Occupancy

Ecosystems that occur as linear strips. They are often ecotonal between terrestrial and aquatic ecosystems. In undisturbed conditions, typical occurrences range in linear distance from 0.5 to 100 km.

A = <4km²
B = 4-40
C = 40-200 km²
D = 200-1000 km²
E = 1000-5000 km²
F = 5000-20000 km²
G = 20000-200000 km²
H = >200000 km²

6. Number of Element Occurrences (EOs)

An "element occurrence" is the mapping unit of CDC methodology. It is generally defined as an area of land or water on which an "element of biodiversity" (plant and animal species or natural community) is or was present. It is a physical location important to the conservation of a species or community, an area worth preserving to insure the survival of a community or species at risk. For a species it is generally the habitat occupied by a local population, for a community it is the area containing a stand or patch. What constitutes an occurrence also varies between species (e.g. hibernacula, den sites, breeding ponds where adults, egg masses and/or larvae have been identified, breeding colonies, etc.). Some species can have more than one type of occurrence, for example breeding and wintering occurrences.

A single letter code (below) represents the number of estimated occurrences believed extant for the species in the province. When a species' distribution is extremely limited and there are very few site occurrences, it is very susceptible to any number of ecological disturbances, both predictable and unpredictable. This criteria is therefore an important factor influencing SRANK when the number of occurrences is few. If the letter code for this field is A or B, the species usually qualifies for a rank of S1 or S2.

A = 0 - 5 occurrences
B = 6 - 20 occurrences

C = 21 - 100 occurrences
D = 101+ occurrences

7. Number of EOs with Good Viability

For species, an occurrence with at least good (i.e., excellent-to-good) viability exhibits favorable characteristics with respect to population size and/or quality and quantity of occupied habitat; and, if current conditions prevail, the occurrence is likely to persist for the foreseeable future (i.e., at least 20–30 years) in its current condition or better. See Hammerson et al. (2008) for more details. For ecosystems, an occurrence has excellent-to-good ecological integrity when it exhibits favorable characteristics with respect to reference conditions for structure, composition, and function, operating within the bounds of natural or historic disturbance regimes, and is of exemplary size (Faber-Langendoen et al. 2008). One would expect only minor to moderate alterations to these characteristics for an occurrence to maintain good ecological integrity.

For many occurrences, viability or ecological integrity assessments or ranks have been applied by biologists and ecologists throughout the NatureServe network. For species, these Element Occurrence (EO) ranks estimate the probability of persistence of the occurrence. For ecosystems, the rank is a succinct assessment of the degree to which, under current conditions, an occurrence of an ecosystem matches reference conditions for that system, without any presumptions made about future status or persistence. Ranks for species and ecosystems are based on a set of “occurrence rank factors,” namely size (including population size and/or occupied area), abiotic and biotic condition, and landscape context. These factors may be further refined to specific indicators or metrics. The overall ranks range from A = Excellent viability/integrity, to D = Poor viability/integrity

A = No occurrences with excellent or good (assessed as A or B) viability or ecological integrity
B = Very few (1–3) occurrences with excellent or good viability or ecological integrity
C = Few (4–12) occurrences with excellent or good viability or ecological Integrity
D = Some (13–40) occurrences with excellent or good viability or ecological integrity
E = Many (41–125) occurrences with excellent or good viability or ecological integrity
F = Very many (>125) occurrences with excellent or good viability or ecological integrity
U = Unknown number of occurrences with excellent or good viability or ecological integrity
Null = Factor not assessed

8. Environmental Specificity

Environmental Specificity is the degree to which a species or ecosystem depends on a relatively scarce set of habitats, substrates, food types, or other abiotic and/

or biotic factors within the overall range. Relatively narrow requirements are thought to increase the vulnerability of a species or ecosystem. This factor is most important when the number of occurrences, and the range extent or area of occupancy, are largely unknown.

A = Very Narrow. Specialist or ecosystem with key requirements scarce. For species, specific habitat(s), substrate(s), food type(s), hosts, breeding/non-breeding microhabitats, or other abiotic and/or biotic factor(s) are used or required by the species or ecosystem in the area of interest, with these habitat(s) and/or other requirements furthermore being scarce within the generalized range of the species or ecosystem within the area of interest, and the population (or the number of breeding attempts) expected to decline significantly if any of these key requirements become unavailable. For ecosystems, environmental requirements are both narrow
and scarce (e.g., calcareous seepage fens).

B = Narrow. Specialist or ecosystem with key requirements common. Specific habitat(s) or other abiotic and/or biotic factors (see above) are used or required by the species or ecosystem, but these key requirements are common and within the generalized range of the species or ecosystem within the area of interest. For ecosystems, environmental requirements are narrow but common (e.g., floodplain forest, alpine tundra).

C = Moderate. Generalist or community with some key requirements scarce. Broad-scale or diverse (general) habitat(s) or other abiotic and/or biotic factors are used or required by the species or ecosystem, but some key requirements are scarce in the generalized range of the species or ecosystem within the area of interest. For ecosystems, environmental requirements are broad but scarce (e.g., talus or cliff forests and woodlands, alvars, many rock outcrop communities dependent more on thin, droughty soils per se than specific substrate factors).

D = Broad. Generalist or community with all key requirements common. Broad-scale or diverse (general) habitat(s) or abiotic and/or biotic factors are used or required by the species or ecosystem, with all key requirements common in the generalized range of the species or ecosystem in the area of interest. For animals, if the preferred food(s) or breeding/non-breeding microhabitat(s) become unavailable, the species switches to an alternative with no resulting decline in numbers of individuals or number of breeding attempts. For ecosystems, environmental requirements are broad and common (e.g., forests or prairies on glacial till, or forests and meadows on montane slopes).

9. Threat Severity

Within the scope (as defined spatially and temporally in assessing the scope of the Threat), severity is the level of damage to the species or ecosystem from the Threat that can reasonably be expected with continuation of current circumstances and trends (including potential new threats) (Table 7). Note that severity of Threats is assessed within a ten-year or three-generation time frame, whichever is longer (up to 100 years).

For species, severity is usually measured as the degree of reduction of the species' population. Surrogates for adult population size (e.g., area) should be used with caution, as occupied areas, for example, will have uneven habitat suitability and uneven population density. For ecosystems, severity is typically measured as the degree of degradation or decline in integrity (of one or more key characteristics).

Extreme	Within the scope, the Threat is likely to destroy or eliminate the occurrences of an ecological community, system or species, or reduce the species population by 71–100%
Serious	Within the scope, the Threat is likely to seriously degrade/reduce the effected occurrences or habitat or, for species, to reduce the species population by 31–70%
Moderate	Within the scope, the Threat is likely to moderately degrade/reduce the effected occurrences or habitat or, for species, to reduce the species population by 11–30%
Slight	Within the scope, the Threat is likely to only slightly degrade/reduce the effected occurrences or habitat or, for species, to reduce the species population by 1–10%

10. Threat Scope

Scope is defined herein as the proportion of the species or ecosystem that can reasonably be expected to be affected (that is, subject to one or more stresses) by the Threat within ten years with continuation of current circumstances and trends (Table 6). Current circumstances and trends include both existing as well as potential new threats. The ten-year time frame can be extended for some longer-term threats, such as global warming, that need to be addressed today. For species, scope is measured as the proportion of the species' population in the area of interest (globe, nation, or subnation) affected by the Threat. For ecosystems, scope is measured as the proportion of the occupied area of interest (globe, nation, or subnation) affected by the Threat. If a species or ecosystem is evenly distributed, then the proportion of the population or area affected is equivalent to the proportion of the range extent affected by the Threat; however, if the population or area is patchily distributed, then the proportion differs from that of range extent.

Pervasive Affects all or most (71–100%) of the total population or occurrences
Large Affects much (31–70%) of the total population or occurrences
Restricted Affects some (11–30%) of the total population or occurrences.
Small Affects a small (1–10%) proportion of the total population or occurrences.

11. Intrinsic Vulnerability

Note that this factor is not used if the Threats status factor has been assessed.

Intrinsic Vulnerability is the observed, inferred, or suspected degree to which characteristics of the species or ecosystem (such as life history or behavior characteristics of species, or likelihood of regeneration or recolonization for ecosystems) make it vulnerable or resilient to natural or anthropogenic stresses or catastrophes. For ecosystems, Intrinsic Vulnerability is most readily assessed using the dominant species and vegetation structure that characterize the ecosystem, but it can also refer to ecological processes that make an ecosystem vulnerable or lack resiliency (e.g., shoreline fens along estuarine and marine coasts subject to rising sea levels).

Since geographically or ecologically disjunct or peripheral occurrences may show additional vulnerabilities not generally characteristic of a species or ecosystem, characteristics of Intrinsic Vulnerability are to be assessed for the species or ecosystem throughout the area of interest, or at least for its better occurrences. Information on population size, number of occurrences, area of occupancy, extent of occurrence, or environmental characteristics that affect resiliency should not be considered when assessing Intrinsic Vulnerability; these are addressed using other status factors.

Note that the Intrinsic Vulnerability characteristics exist independent of human influence, but may make the species or ecosystem more susceptible to disturbance by human activities. The extent and effects of current or projected extrinsic influences themselves should be addressed in the comments field of the Threats status factor.

A = Highly Vulnerable. Species is slow to mature, reproduces infrequently, and/or has low fecundity such that populations are very slow (>20 years or five generations) to recover from decreases in abundance; or species has low dispersal capability such that extirpated populations are unlikely to become reestablished through natural recolonization (unaided by humans). Ecosystem occurrences are highly susceptible to changes in composition and structure that rarely if ever are reversed through natural processes even over substantial time periods (>100 years).

B = Moderately Vulnerable. Species exhibits moderate age of maturity, frequency of reproduction, and/or fecundity such that populations generally tend to recover from decreases in abundance over a period of several years (on the order of 5–20 years or 2–5 generations); or species has moderate dispersal capability such that extirpated populations generally become reestablished through natural recolonization (unaided by humans). Ecosystem occurrences may be susceptible to changes in composition and structure but tend to recover through natural processes given reasonable time (10–100 years).

C = Not Intrinsically Vulnerable. Species matures quickly, reproduces frequently, and/or has high fecundity such that populations recover quickly (<5 years or 2 generations) from decreases in abundance; or species has high dispersal capability such that extirpated populations soon become reestablished through natural recolonization (unaided by humans). Ecosystem occurrences are resilient or resistant to irreversible changes in composition and structure and quickly recover (within 10 years).

U = Unknown

Null = Factor not assessed

12. Other Considerations

Other considerations in determining the rank that are not apparent from the letter codes selected for the above criteria. Generally, these considerations will raise rather than lower the rank, e.g., "Never sexually reproduces" or "All occurrences are in areas under development".

References

Master, L., D. Faber-Langendoen, R. Bittman, G. A. Hammerson, B. Heidel, J. Nichols, L. Ramsay, and A. Tomaino. 2009. NatureServe Conservation Status Assessments: Factors for Assessing Extinction Risk. NatureServe, Arlington, VA.

GNAME	GCOMNAME	FAMILY	Observer	TotalNumber	Month	Day	Year	SRANK	NRANK	GRANK	GeneralSta	COSEWIC_ST	PROVINCIAL	SARA	DESCR_HABI	SITE_NAME	Accuracy	SYNAME	ACRONYM_OF	COLLECTION	CITATION	IDNUM
Colias hecla	Hecla Sulphur	Pieridae	Ross	0	0	0	0	S2	N5	G5	Undetermine	0	0	0	0	Cartwright	0				Ross Newfoundland Data.x	mstr1040900
Somatochlora forcipata	Forcipate Emerald/ Gre	Corduliidae	SternsE.E.	0	8	22	1955	S2	N5	G5	Undetermine	0	0	0	0	Cartwright	0				2DDragonflydata.xls	mstr1034514
Somatochlora forcipata	Forcipate Emerald/ Gre	Corduliidae	SternsE.E.	0	8	10	1955	S2	N5	G5	Undetermine	0	0	0	0	Cartwright	0				2DDragonflydata.xls	mstr1034515
Somatochlora minor	Ocellated Emerald	Corduliidae	unknown	0	0	0	0	S2	N5	G5	Undetermine	0	0	0	0	Cartwright	0				2DDragonflydata.xls	mstr1034522
Ursus maritimus	Polar Bear	Ursidae	Ian Stirling	1	5	9	1991	S2S3	N3N4	G3G4	Sensitive	Special Concern	Vulnerable	Special Concern	0	CARTWRIGH	0				DFO	mstr1033413
Polites peckius	Peck's Skipper	Hesperiidae	Ross	0	0	0	0	S3	N5	G5	Secure	0	0	0	0	Cartwright	0				Ross Newfoundland Data.x	mstr1040706
Pyrgus centaureae	Grizzled Skipper	Hesperiidae	Ross	0	0	0	0	S3	N5	G5	Secure	0	0	0	0	Cartwright	0				Ross Newfoundland Data.x	mstr1040635
Coenagrion resolutum	Taiga Bluet/ Narrow Wi	Coenagrioni	SternsE.E.	0	7	5	1955	S3	N5	G5	Secure	0	0	0	0	Cartwright	0				2DDragonflydata.xls	mstr1034506
Somatochlora albicincta	Ringed Emerald	Corduliidae	CashmanE.F.	0	8	5	1955	S3	N5	G5	Undetermine	0	0	0	0	Cartwright	0				2DDragonflydata.xls	mstr1034513
Aeshna eremita	Lake Darner	Aeshnidae	Cashman E.F.	0	8	10	1955	S3	N5	G5	Secure	0	0	0	0	Cartwright	0				2DDragonflydata.xls	mstr1034521

GNAME	GCOMNAME	OBSERVER	MONTH	DAY	YEAR	SRANK_2015	SRANK_2010	NRANK	GRANK	GENERAL_STA	FAMILY	PROV_END_A	COSEWIC	DESCR_HABIT	ACCURACY_ME	SYNAME	SITE_NAME	SURVEYSITE	ACRONYMS_O	COLLECTION	SOURCES	IDNUM	EST_LB_ID
Festuca rubra	red fescue	Malte, M.O.	7	21	1928	S1S3	S4S5	NNR	G5	Secure	Poaceae	0	0	0	0	Festuca rubra subsp. juncea; F. rubra var. juncea	Cartwright(NF)	0	CAN	0	Herbarium Data Entry, CAN	SP52136	743744
Carex mackenzei	Mackenzie├¿s sedge	Malte, M.O.	7	21	1928	S2S3	S2S3	NNR	G4?	Undetermined	Cyperaceae	0	0	0	0	Carex norvegica;	Cartwright(NF)	0	CAN	0	Herbarium Data Entry, CAN	SP51857	743389
Hordeum jubatum subsp. jubatum	foxtail barley, squirreltail grass	Malte, M.O.	7	21	1928	S2S3	S2S4	N5	G5T5	Undetermined	Poaceae	0	0	0	0	Critesion jubatum; Sitanion jubatum;	Cartwright(NF)	0	CAN	0	Herbarium Data Entry, CAN	SP52056	743771
Hordeum jubatum subsp. jubatum	foxtail barley, squirreltail grass	Malte, M.O.	7	21	1928	S2S3	S2S4	N5	G5T5	Undetermined	Poaceae	0	0	0	0	Critesion jubatum; Sitanion jubatum;	Cartwright(NF)	0	CAN	0	Herbarium Data Entry, CAN	SP52058	743771
Rumex occidentalis	Western dock, windowed dock	Malte, M.O.	7	21	1928	S2S3	S2S3	N5	G5T5	Sensitive	Polygonaceae	0	0	0	0	Rumex aquaticus subsp. fenestratus; R. aquaticus var. fenestratus; R. a	Cartwright(NF)	0	CAN	0	Herbarium Data Entry, CAN	SP52593	742878
Puccinellia pumila	dwarf alkaligrass	Malte, M.O.	7	21	1928	S2S4	SNR	NNA	G4G5	Not Assessed	Poaceae	0	0	Sandy shore	0	Glyceria pumila; Atropis alaskana; Phippsia langeana; Puccinellia alaska	Cartwright(NF)	0	CAN	0	Herbarium Data Entry, CAN	SP52340	0
Puccinellia pumila	dwarf alkaligrass	Malte, M.O.	7	21	1928	S2S4	SNR	NNA	G4G5	Not Assessed	Poaceae	0	0	0	0	Glyceria pumila; Atropis alaskana; Phippsia langeana; Puccinellia alaska	Cartwright(NF)	0	CAN	0	Herbarium Data Entry, CAN	SP52311	0
Puccinellia pumila	dwarf alkaligrass	Malte, M.O.	7	21	1928	S2S4	SNR	NNA	G4G5	Not Assessed	Poaceae	0	0	0	0	Glyceria pumila; Atropis alaskana; Phippsia langeana; Puccinellia alaska	Cartwright(NF)	0	CAN	0	Herbarium Data Entry, CAN	SP52341	0
Puccinellia pumila	dwarf alkaligrass	Malte, M.O.	7	21	1928	S2S4	SNR	NNA	G4G5	Not Assessed	Poaceae	0	0	0	0	Glyceria pumila; Atropis alaskana; Phippsia langeana; Puccinellia alaska	Cartwright(NF)	0	CAN	0	Herbarium Data Entry, CAN	SP52345	0
Juncus bufonius	toad rush	Malte, M.O.	7	21	1928	S2S4	S2S4	NNR	G5	Undetermined	Juncaceae	0	0	0	0	Juncus bufonius var. congestus; J. bufonius var. halophilus; J. bufonius v	Cartwright(NF)	0	CAN	0	Herbarium Data Entry, CAN	SP54132	743575
Ribes triste	swamp red currant	Malte, M.O.	7	21	1928	S3	S3S4	NNR	G5	Secure	Grossulariaceae	0	0	0	0	Ribes albinervium; R. propinquum; R. triste var. albinervium; R. rubrum v	Cartwright(NF)	0	CAN	0	Herbarium Data Entry, CAN	SP52860	742741
Fontinalis dalecarlica	a Moss	Bridgland, J.	8	18	1981	S3	S1	NNR	G3G5	May Be At Risk	Fontinalaceae	0	0	0	0	0	0	Cartwright	UBC Herbarium	81-031	University of British Columb	SP60906	741841
Conioselinum chinense	Hemlock parsley	Malte, M.O.	7	21	1928	S3S4	S3S4	N3N4	G5	Secure	Apiaceae	0	0	0	0	Athamantha chinense; Conioselinum pumilum	Cartwright(NF)	0	CAN	0	Herbarium Data Entry, CAN	SP51948	742065
Poa pratensis subsp. alpigena	alpine meadow bluegrass	Malte, M.O.	7	21	1928	S3S4	SNR	N5	G5T5	Undetermined	Poaceae	0	0	0	0	Poa alpigena; P. pratensis var. alpigena	Cartwright(NF)	0	CAN	0	Herbarium Data Entry, CAN	SP52291	743810
Poa pratensis	Kentucky bluegrass	Malte, M.O.	7	21	1928	S3S4	SNR	N5	G5	Undetermined	Poaceae	0	0	0	0	Poa crocata; P. serotina; P. triflora; P. eyerdamii;	Cartwright(NF)	0	CAN	0	Herbarium Data Entry, CAN	SP52300	743809
Minuartia groenlandica	Greenland sandwort	Malte, M.O.	7	21	1928	S3S4	S3S4	NNR	G5	Secure	Caryophyllaceae	0	0	0	0	Stellaria groenlandica; Alsinopsis groenlandica; Arenaria groenlandica; F	Cartwright(NF)	0	CAN	0	Herbarium Data Entry, CAN	SP52607	742483
Vahlodea atropurpurea	mountian hairgrass	Malte, M.O.	7	21	1928	S3S4	S2S4	NNR	G5	Undetermined	Poaceae	0	0	0	0	Aira atropurpurea; Deschampsia atropurpurea; D. atropurpurea var. latif	Cartwright(NF)	0	CAN	0	Herbarium Data Entry, CAN	SP53767	743846
Eriophorum scheuchzeri	Scheuchezer's cottongrass	Malte, M.O.	7	21	1928	S3S4	S2S4	NNR	G5	Undetermined	Cyperaceae	0	0	0	0	Eriophorum altaicum; E. capitatum; E. scheuchzeri var. tenuifolium;	Cartwright(NF)	0	CAN	0	Herbarium Data Entry, CAN	SP53904	743526
Poa arctica subsp. arctica	Arctic bluegrass	Malte, M.O.	7	0	1928	S3S4	S3S4	NNR	G5T3T5	Secure	Poaceae	0	0	0	0	Poa arctica subsp. longiculmis; P. arctica subsp. williamsii; P. arctica var	0	Cartwright	DAO	0	Agriculture and Agri-Food C	SP62244	743798
Racomitrium microcarpon	a Moss	Bridgland, J.	8	15	1981	S3S4	S2?	NNR	GNRQ	Sensitive	Grimmiaceae	0	0	0	0	0	0	Cartwright, near	UBC Herbarium	81-016	University of British Columb	SP60902	741945
Sphagnum fimbriatum	Fringed Bog Moss	Bridgland, J.	8	17	1981	S3S4	S1	NNR	G5	May Be At Risk	Sphagnaceae	0	0	0	0	0	0	Cartwright	UBC Herbarium	81-22	University of British Columb	SP60905	741959
Carex glareosa	gravel sedge, weak clustered sed	Malte, M.O.	7	21	1928	S3S5	S3S5	NNR	G4G5	Secure	Cyperaceae	0	0	0	0	0	Cartwright(NF)	0	CAN	0	Herbarium Data Entry, CAN	SP51886	743355
Angelica atropurpurea	Purplestem angelica, Alexanders	Malte, M.O.	7	21	1928	S3S5	S3S5	NNR	G5	Secure	Apiaceae	0	0	0	0	Angelica laurentiana; Angelica atropurpurea var. occidentalis	Cartwright(NF)	0	CAN	0	Herbarium Data Entry, CAN	SP51957	742059
Carex brunnescens subsp. brunnesc	brownish sedge	Malte, M.O.	7	21	1928	S3S5	S3S5	N5	G5T5	Secure	Cyperaceae	0	0	0	0	Carex brunnescens subsp. alaskana Kalela; C. brunnescens subsp. pac	Cartwright(NF)	0	CAN	0	Herbarium Data Entry, CAN	SP52209	743320
Carex bigelowii subsp. bigelowii	Bigelow's sedge	Malte, M.O.	7	21	1928	S3S5	S3S5	NNR	G5	Secure	Cyperaceae	0	0	0	0	Carex rigida var. bigelowii	Cartwright(NF)	0	CAN	0	Herbarium Data Entry, CAN	SP52225	743316
Carex bigelowii subsp. bigelowii	Bigelow's sedge	Malte, M.O.	7	21	1928	S3S5	S3S5	NNR	G5	Secure	Cyperaceae	0	0	0	0	Carex rigida var. bigelowii	Cartwright(NF)	0	CAN	0	Herbarium Data Entry, CAN	SP52238	743316
Carex glareosa	gravel sedge, weak clustered sed	Malte, M.O.	7	21	1928	S3S5	S3S5	NNR	G4G5	Secure	Cyperaceae	0	0	0	0	0	Cartwright(NF)	0	CAN	0	Herbarium Data Entry, CAN	SP52248	743355
Puccinellia X phryganodes	creeping alkaligrass	Malte, M.O.	7	21	1928	S3S5	SNA	NNA	GNR	0.000000	Poaceae	0	0	0	0	Poa phryganodes, atropis phryganodes, phippsia phryganodes	Cartwright(NF)	0	CAN	0	Herbarium Data Entry, CAN	SP52283	0
Carex canescens	hoary sedge, silvery sedge	Malte, M.O.	7	21	1928	S3S5	S3S5	NNR	G5	Secure	Cyperaceae	0	0	0	0	Carex cinerea; C. curta; C. richardii	Cartwright(NF)	0	CAN	0	Herbarium Data Entry, CAN	SP53167	743322
Carex canescens	hoary sedge, silvery sedge	Malte, M.O.	7	21	1928	S3S5	S3S5	NNR	G5	Secure	Cyperaceae	0	0	0	0	Carex cinerea; C. curta; C. richardii	Cartwright(NF)	0	CAN	0	Herbarium Data Entry, CAN	SP53967	743322

DATA DICTIONARY

GNAME	Scientific Name of taxon
GCOMNAME	Common name of taxon
FAMILY	Family of taxon
OBSERVER	Person or persons who observed the taxon
TOTAL NUMBER	The number of specimens at a given observation.
MONTH	Month of survey
DAY	Day of survey
YEAR	Year of survey
SRANK_2010	Subnational rank - CDC ranking system
SRANK_2015	Subnational rank - CDC ranking system
NRANK	National Rank - CDC ranking system
GRANK	Global Rank - CDC ranking system
GeneralStatusRanks	General Status text for the province
COSEWIC_STATUS	Denotes the COSEWIC status.
PROVINCIAL_STATUS	Denotes if the species is on the provincial endangered species list.
SARA	Denotes if the species is on the federal SARA list.
HABITAT	Description of the habitat where plant or animal was found
SITE_NAME	The name of the place where the occurrence occurred
ACCURACY	The accuracy in metres of the location.
SYNAME	Synonym for the plant or animal name in cases it is known by more than one scientific name.
ACRONYM OF HERBARIA	Acronym of the herbarium where this specimen is kept, see the complete definitions of the acronyms in the HERBARIA.xls
COLLECTION NUMBER	The collection number assigned to the specimen by the collector, this should be used to refer to the specimen when contacting the herbarium
CITATION	Primary source of the data
IDNUM	Field Office Number: Internal ACCDC record reference (not the EONUM)

DATA SOURCES:
All data housed at Atlantic Canada Conservation Data Centre (ACCDC). Refer to '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 depend upon the season. The ACCDC makes a strong effort to verify the accuracy of all the data it obtains, generates and manages, but it will not be held responsible for inaccuracies in data that it provides.

PLEASE NOTE:
* ACCDC data is restricted for use by the specified data user only; any third party requiring data must make its own request to the ACCDC.
* Specified data users may not publish any information provided by the ACCDC or its partners without prior permission.
* To ensure the currency of the data, the ACCDC requires Data Users to destroy all copies of data 18 months after the date of receipt.
* ACCDC data reports are restricted to that data in our Data System at the time of the request.
* Data accuracy is qualified as to location (Accuracy) and time (Date)
* ACCDC data reports are not to be constructed as exhaustive inventories of taxa in an area.
* The non-occupancy of a taxon cannot be inferred by its absence in an ACCDC data report.
* Museum databases, which are the basis for more accessible public databases, such as those of the ACCDC, are works in progress. Essentially, they are finding aids and dynamic data records, constructed primarily to serve scientists engaged in the continuing, active process of plant systematics and taxonomy. Ongoing additions of new collections, and frequent upgrades to the identifications of all plant specimens housed in museum herbaria, may not always be reflected, in real time, by databases such as those of the ACCDC. Specifically, the conservation status of individual species recorded in the ACCDC database may not be absolutely current. It is therefore the responsibility of the data user to contact the relevant museums directly, in order to check for the most current identifications of specimens of interest, and to ascertain from the scientists concerned, their current understanding of the conservation status of individual species in question. The absolute conservation status of any given species is dynamic, and subject to change over short periods of time.

Government of Canada Gouvernement du Canada

Home → Species at risk public registry → Advanced search

Searching species for :

- Keywords : **""**
- Common name : **""**
- Population : **""**
- Taxonomy : **All**
- Range : **Newfoundland and Labrador**
- COSEWIC Status : **All**
- Schedule : **Schedule 1**
- SARA Status : **All**
- COSEWIC ID : **""**

Total : 38 record(s) found.

Species Index

Common name *	Scientific name	Population	Taxon	Range	COSEWIC status	On Schedule 1 (Yes/No)?	SARA status
			All	Newfou	All	Schedu	All

Filter again

* A common name search will search all common names in English and French as well as aliases and former names which are not displayed below.

Common name	Scientific name	Population	Taxon	Range	COSEWIC status	On Schedule 1 (Yes/No)?	SARA status
American Marten	Martes americana atrata	Newfoundland population	Mammals	Newfoundland and Labrador	Threatened	Yes	Threatened
Atlantic Walrus	Odobenus rosmarus rosmarus	Northwest Atlantic population	Mammals	Quebec, New Brunswick, Prince Edward Island, Nova Scotia, Newfoundland and Labrador, Atlantic Ocean	Non-active	Yes	Extirpated
Banded Killifish	Fundulus diaphanus	Newfoundland populations	Fishes	Newfoundland and Labrador	Special Concern	Yes	Special Concern

Bank Swallow	Riparia riparia		Birds	Yukon, Northwest Territories, British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec, New Brunswick, Prince Edward Island, Nova Scotia, Newfoundland and Labrador	Threatened	Yes	Threatened
Barn Swallow	Hirundo rustica		Birds	Yukon, Northwest Territories, British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec, New Brunswick, Prince Edward Island, Nova Scotia, Newfoundland and Labrador	Threatened	Yes	Threatened
Barrens Willow	Salix jejuna		Vascular Plants	Newfoundland and Labrador	Endangered	Yes	Endangered
Barrow's Goldeneye	Bucephala islandica	Eastern population	Birds	Quebec, New Brunswick, Prince Edward Island, Nova Scotia, Newfoundland and Labrador	Special Concern	Yes	Special Concern
Blue Felt Lichen	Degelia plumbea		Lichens	New Brunswick, Nova Scotia, Newfoundland and Labrador	Special Concern	Yes	Special Concern

Bobolink	Dolichonyx oryzivorus		Birds	British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec, New Brunswick, Prince Edward Island, Nova Scotia, Newfoundland and Labrador	Threatened	Yes	Threatened
Boreal Felt Lichen	Erioderma pedicellatum	Boreal population	Lichens	Newfoundland and Labrador	Special Concern	Yes	Special Concern
Caribou	Rangifer tarandus	Boreal population	Mammals	Yukon, Northwest Territories, British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec, Newfoundland and Labrador	Threatened	Yes	Threatened
Common Nighthawk	Chordeiles minor		Birds	Yukon, Northwest Territories, Nunavut, British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec, New Brunswick, Prince Edward Island, Nova Scotia, Newfoundland and Labrador	Special Concern	Yes	Threatened

Eskimo Curlew	Numenius borealis	Birds	Yukon, Northwest Territories, Nunavut, Alberta, Saskatchewan, Manitoba, Ontario, Quebec, New Brunswick, Prince Edward Island, Nova Scotia, Newfoundland and Labrador	Endangered	Yes	Endangered
Evening Grosbeak	Coccothraustes vespertinus	Birds	Yukon, Northwest Territories, British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec, New Brunswick, Prince Edward Island, Nova Scotia, Newfoundland and Labrador	Special Concern	Yes	Special Concern
Fernald's Braya	Braya fernaldii	Vascular Plants	Newfoundland and Labrador	Endangered	Yes	Endangered
Fernald's Milk-vetch	Astragalus robbinsii var. fernaldii	Vascular Plants	Quebec, Newfoundland and Labrador	Special Concern	Yes	Special Concern
Griscom’s Arnica	Arnica griscomii ssp. griscomii	Vascular Plants	Quebec, Newfoundland and Labrador	Threatened	Yes	Threatened

Gypsy Cuckoo Bumble Bee	Bombus bohemicus		Arthropods	Yukon, Northwest Territories, British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec, New Brunswick, Prince Edward Island, Nova Scotia, Newfoundland and Labrador	Endangered	Yes	Endangered
Harlequin Duck	Histrionicus histrionicus	Eastern population	Birds	Nunavut, Quebec, New Brunswick, Nova Scotia, Newfoundland and Labrador	Special Concern	Yes	Special Concern
Ivory Gull	Pagophila eburnea		Birds	Northwest Territories, Nunavut, Newfoundland and Labrador	Endangered	Yes	Endangered
Little Brown Myotis	Myotis lucifugus		Mammals	Yukon, Northwest Territories, British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec, New Brunswick, Prince Edward Island, Nova Scotia, Newfoundland and Labrador	Endangered	Yes	Endangered
Long's Braya	Braya longii		Vascular Plants	Newfoundland and Labrador	Endangered	Yes	Endangered
Mountain Holly Fern	Polystichum scopulinum		Vascular Plants	British Columbia, Quebec, Newfoundland and Labrador	Threatened	Yes	Threatened

Northern Myotis	Myotis septentrionalis	Mammals	Yukon, Northwest Territories, British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec, New Brunswick, Prince Edward Island, Nova Scotia, Newfoundland and Labrador	Endangered	Yes	Endangered
Olive-sided Flycatcher	Contopus cooperi	Birds	Yukon, Northwest Territories, Nunavut, British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec, New Brunswick, Prince Edward Island, Nova Scotia, Newfoundland and Labrador	Special Concern	Yes	Threatened
Peregrine Falcon anatum/tundrius	Falco peregrinus anatum/tundrius	Birds	Yukon, Northwest Territories, Nunavut, British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec, New Brunswick, Nova Scotia, Newfoundland and Labrador	Not at Risk	Yes	Special Concern

Piping Plover melodus subspecies	Charadrius melodus melodus	Birds	Quebec, New Brunswick, Prince Edward Island, Nova Scotia, Newfoundland and Labrador	Endangered	Yes	Endangered
Polar Bear	Ursus maritimus	Mammals	Yukon, Northwest Territories, Nunavut, Manitoba, Ontario, Quebec, Newfoundland and Labrador, Arctic Ocean	Special Concern	Yes	Special Concern
Porsild's Bryum	Haplodontium macrocarpum	Mosses	Nunavut, British Columbia, Alberta, Newfoundland and Labrador	Threatened	Yes	Threatened
Red Crossbill percna subspecies	Loxia curvirostra percna	Birds	Quebec, Newfoundland and Labrador	Threatened	Yes	Threatened
Red Knot rufa subspecies	Calidris canutus rufa	Birds	Northwest Territories, Nunavut, British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec, New Brunswick, Prince Edward Island, Nova Scotia, Newfoundland and Labrador	Endangered	Yes	Endangered

Red-necked Phalarope	Phalaropus lobatus	Birds	Yukon, Northwest Territories, Nunavut, British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec, New Brunswick, Prince Edward Island, Nova Scotia, Newfoundland and Labrador, Pacific Ocean, Arctic Ocean, Atlantic Ocean	Special Concern	Yes	Special Concern
Rusty Blackbird	Euphagus carolinus	Birds	Yukon, Northwest Territories, Nunavut, British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec, New Brunswick, Prince Edward Island, Nova Scotia, Newfoundland and Labrador	Special Concern	Yes	Special Concern

Short-eared Owl	Asio flammeus	Birds	Yukon, Northwest Territories, Nunavut, British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec, New Brunswick, Prince Edward Island, Nova Scotia, Newfoundland and Labrador	Special Concern	Yes	Special Concern
Vole Ears Lichen	Erioderma mollissimum	Lichens	New Brunswick, Nova Scotia, Newfoundland and Labrador	Endangered	Yes	Endangered
Wolverine	Gulo gulo	Mammals	Yukon, Northwest Territories, Nunavut, British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec, Newfoundland and Labrador	Special Concern	Yes	Special Concern
Wrinkled Shingle Lichen	Pannaria lurida	Lichens	New Brunswick, Prince Edward Island, Nova Scotia, Newfoundland and Labrador	Threatened	Yes	Threatened

Yellow-banded Bumble Bee	Bombus terricola	Arthropods	Yukon, Northwest Territories, British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec, New Brunswick, Prince Edward Island, Nova Scotia, Newfoundland and Labrador	Special Concern	Yes	Special Concern

Date modified: 2011-11-29

Common name *	Scientific name	Population	Taxon	COSEWIC status	SARA status	Likelyhood of occurance	Habitat Requirements	Habitat or Present?	Notes
Gypsy Cuckoo Bumble Bee	Bombus bohemicus		Arthropods	Endangered	Endangered	Moderate	FORESTED WETLAND, HERBACEOUS WETLAND, SCRUB-SHRUB WETLAND, Forest/Woodland, Suburban/orchard, Urban/edificarian	Present in Labrador. Habitat present at site, but not seen	
Yellow-banded Bumble Bee	Bombus terricola		Arthropods	Special Concern	Special Concer	Low	FORESTED WETLAND, Forest/Woodland. It is found close to or within wooded areas and wetlands (Williams et al.	Present in Labrador. Unlikely to be present at the site based on northern climate	
Bank Swallow	Riparia riparia		Birds	Threatened	Threatened	Low	Aerial, Riparian. Habitat includes open and partly open situations, frequently near flowing water (AOU 1983). Nests are in steep sand, dirt, or gravel banks, in burrows dug near the top of the bank, along the edge of inland water, or along the coast, or in gravel pits, road embankments, etc.	Present in Labrador. No habitat present at site.	
Barn Swallow	Hirundo rustica		Birds	Threatened	Threatened	No	Cliff, Cropland/hedgerow, Grassland/herbaceous, Old field, Savanna, Suburban/orchard	Not present in Labrador.	
Barrow's Goldeneye	Bucephala islandica	Eastern population	Birds	Special Concern	Special Concern	No	Winters on lakes, rivers, estuaries, and bays. Usually nests near lake or pond surrounded by dense vegetation. May nest in wooded or open country. Usually nests in a natural tree cavity, abandoned woodpecker hole, rock cavity, stream bank. Often nests in same area in successive years.	Not present in Labrador.	similar food intake to rusty blackwing
Bobolink	Dolichonyx oryzivorus		Birds	Threatened	Threatened	No	Cropland/hedgerow, Grassland/herbaceous	Not present in Labrador.	
Common Nighthawk	Chordeiles minor		Birds	Special Concern	Threatened	Low	Cropland/hedgerow, Grassland/herbaceous, Old field, Savanna, Shrubland/chaparral, Suburban/orchard, Woodland - Conifer Habitat. Habitats include mountains and plains in open and semi-open areas: open coniferous forests, savanna, grasslands, fields, vicinity of cities and towns. Nesting occurs on the ground on a bare site in an open area. In some areas, this species also nests on flat gravel roofs of buildings, perhaps related to prey availability at artificial lights.	Present in Labrador. Habitat present at site, but unlikely to be present this far north. Not observed	
Eskimo Curlew	Numenius borealis		Birds	Endangered	Endangered	No	Cropland/hedgerow, Grassland/herbaceous, Tundra	Not present in Labrador.	
Evening Grosbeak	Coccothraustes vespertinus		Birds	Special Concern	Special Concern	No	Forest - Conifer, Forest - Hardwood, Forest - Mixed, Suburban/orchard, Woodland - Conifer, Woodland - Hardwood, Woodland - Mixed	Not present in Labrador.	
Harlequin Duck	Histrionicus histrionicus	Eastern population	Birds	Special Concern	Special Concern	Low	Winters in rough coastal waters, especially along rocky shores or reefs; summering nonbreeders and immatures also occur in this habitat.	Present in Labrador. Little or no habitat at the site.	
Ivory Gull	Pagophila eburnea		Birds	Endangered	Endangered	Low	Near shore, Pelagic, Cliff, Ice	Not present in Labrador, bu tmay be a migrant.	
Olive-sided Flycatcher	Contopus cooperi		Birds	Special Concern	Threatened	Low	Bog/fen, FORESTED WETLAND, Riparian, Forest - Conifer, Forest - Hardwood, Forest - Mixed, Woodland - Conifer, Woodland - Hardwood, Woodland - Mixed	Present in Labrador. Habitat present at site, but unlikely to be present this far north. Not observed	
Peregrine Falcon anatum/tundrius	Falco peregrinus anatum/tundrius		Birds	Not at Risk	Special Concern	Low to Moderate	Nesting in sheer cliffs along the coast of Labrador, occupies south Labrador treeline	Possible	
Piping Plover melodus subspecies	Charadrius melodus melodus		Birds	Endangered	Endangered	No	Marine shoreline	Not present in Labrador.	
Red Crossbill percna subspecies	Loxia curvirostra percna		Birds	Threatened	Threatened	No	Endemic to Newfoundland	Not present in Labrador.	
Red Knot rufa subspecies	Calidris canutus rufa		Birds	Endangered	Endangered	No	Herbaceous wetland, River mouth/tidal river, Tidal flat/shore, Sand/dune	Not present in Labrador	
Red-necked Phalarope	Phalaropus lobatus		Birds	Special Concern	Special Concern	Moderate	Bay/sound, Herbaceous wetland, Lagoon, Shallow water, HERBACEOUS WETLAND, Riparian, Tundra	Present in Labrador. Habitat present at site (pelagic) and primarily water feeder. Not seen.	
Rusty Blackbird	Euphagus carolinus		Birds	Special Concern	Special Concern	Moderate	Bog/fen, FORESTED WETLAND, Riparian, SCRUB-SHRUB WETLAND, Cropland/hedgerow, Grassland/herbaceous, Shrubland/chaparral, Woodland - Conifer	Present in Labrador. S3:Vulnerable	
Short-eared Owl	Asio flammeus		Birds	Special Concern	Special Concern	Low to Moderate	Herbaceous wetland, Bog/fen, Cropland/hedgerow, Grassland/herbaceous, Old field, Savanna, Tundra	Present in Labrador. S3:Vulnerable	
Banded Killifish	Fundulus diaphanus	Newfoundland populations	Fishes	Special Concern	Special Concern	No	Found in shallow, clear and quiet water, with a sand, gravel or mud substrate	Not present in Labrador.	
Blue Felt Lichen	Degelia plumbea		Lichens	Special Concern	Special Concern	No	It grows as an epiphyte, predominately on hardwoods in woodlands. Found on the trunks ofold broad-leaved trees growing in moist habitats or close to stream and lake margins. In coastal suboceanic areas but also some distance inland in damp valleys	Not present in Labrador.	
Boreal Felt Lichen	Erioderma pedicellatum	Boreal population	Lichens	Special Concern	Special Concern	Moderate	Grows on the bark of coniferous trees. In North America, has also been found on the trunks of trees, mainly of Abies balsamea.	Present in Labrador. Habitat present at the site, but not seen.	
Vole Ears Lichen	Erioderma mollissimum		Lichens	Endangered	Endangered	No	occurs in cool, humid coastal coniferous forests dominated by Balsam Fir. often found close to peatland/coastal forest wetlands	Not present in Labrador.	
Wrinkled Shingle Lichen	Pannaria lurida		Lichens	Threatened	Threatened	No	The ones in Newfoundland are on White Spruce growing in an unusual habitat on cliffs close to the sea.	Not present in Labrador.	
American Marten	Martes americana atrata	Newfoundland population	Mammals	Threatened	Threatened	No	the Newfoundland population of the American Marten appears to live in a wider array of habitats, including coniferous forests of varying ages.	Not present in Labrador.	
Atlantic Walrus	Odobenus rosmarus rosmarus	Northwest Atlantic population	Mammals	Non-active	Extirpated	No		No habitat at Site	
Caribou	Rangifer tarandus	Boreal population	Mammals	Threatened	Threatened	Low	Bog/fen, Riparian, Alpine, Forest - Conifer, Tundra, Woodland - Conifer. caribou habitats include arctic tundra (including tussock tundra and sedge meadow), subarctic taiga, mature coniferous forest, forested peatlands, semi-open and open bogs, rocky ridges with jack pine, and riparian zones.	Present in Labrador. The Boreal population covers southern Labrador. Woodland Caribou also found in Labrador.	
Little Brown Myotis	Myotis lucifugus		Mammals	Endangered	Endangered	Possible, none observed	Aerial, Bog/fen, FORESTED WETLAND, HERBACEOUS WETLAND, Riparian, Aerial, Forest - Hardwood, Forest - Mixed, Grassland/herbaceous, Old field, Shrubland/chaparral, Suburban/orchard, Urban/edificarian, Woodland - Hardwood, Woodland - Mixed. Standing snag/hollow tree.	Present in Labrador.	
Northern Myotis	Myotis septentrionalis		Mammals	Endangered	Endangered	Possible, none observed	Riparian, Aerial, Forest - Conifer, Forest - Hardwood, Forest - Mixed, Urban/edificarian, Woodland - Conifer, Woodland - Hardwood, Woodland - Mixed, Standing snag/hollow tree	Present in Labrador.	
Polar Bear	Ursus maritimus		Mammals	Special Concern	Special Concern	low	Near shore, Tidal flat/shore, Ice, Tundra	Present in Labrador.	
Wolverine	Gulo gulo		Mammals	Special Concern	Special Concern	Moderate	Alpine, Forest - Conifer, Grassland/herbaceous, Shrubland/chaparral, Tundra, Woodland - Conifer. Burrowing in or using soil, Fallen log/debris	Present in Labrador. Habitat present at the site, but not seen.	
Porsild's Bryum	Haplodontium macrocarpum		Mosses	Threatened	Threatened	No	This moss grows in cracks and cliffs of calcareous conglomerate rock, limestone, basalt, sandstone, and shale.	Not present in Labrador.	
Barrens Willow	Salix jejuna		Vascular Plants	Endangered	Endangered	No		No habitat at Site	
Fernald's Braya	Braya fernaldii		Vascular Plants	Endangered	Endangered	No	Bare rock/talus/scree, Barrens, Grassland/herbaceous	Not present in Labrador.	
Fernald's Milk-vetch	Astragalus robbinsii var. fernaldii		Vascular Plants	Special Concern	Special Concern	No	found mainly on the cliff tops and sides of limestone hills, in calcium-rich soils where vegetation is sparse or has been removed by natural disturbance	Present in Labrador. No habitat present at site.	
Griscom's Arnica	Arnica griscomii ssp. griscomii		Vascular Plants	Threatened	Threatened	No	found only on small, isolated calcareous cliffs and limestone barrens	Not present in Labrador.	
Long's Braya	Braya longii		Vascular Plants	Endangered	Endangered	No	Bare rock/talus/scree, Barrens, Grassland/herbaceous	Not present in Labrador.	
Mountain Holly Fern	Polystichum scopulinum		Vascular Plants	Threatened	Threatened	No	shallow soil with a high concentration of heavy metals over a substrate of rocks containing iron and magnesium silicate (ultramafic rocks), mainly olivine and serpentine.	Not present in Labrador.	

Appendix C Analytical Results

TABLE 1: TOTAL PETROLEUM HYDROCARBON COMPOUNDS in Soil - Human Health Guidelines
Client: Department of National Defence
Site Location: Former USAF Radar Station, Cartwright, NL
Englobe Project Number: P-0012285-0-16-200

PARAMETER		UNITS	CCME RESIDENTIAL/PARKLAND [1,2]				RBCA Tier II PSSL [3]	OMOE[4]	Stantec 2018 Phase II ESA – General Area																	
			Ingestion surface soil	Dermal Contact surface soil	Produce, meat and milk check	Management Limits	Soil Ingestion Residential	Soil Contact S1 Risk	CWT-SS42	CWT-SS43	CWT-SS44	CWT-SS46	CWT-SS48	CWT-SS49	CWT-SS50	CWT-SS51	CWT-SS52	CWT-SS53	CWT-SS54	CWT-SS55	CWT-SS56	CWT-SS57	CWT-SS58	CWT-SS59	CWT-SS60	CWT-SS61
									0 - 0.2 m	0 - 0.2 m	0 - 0.2 m	0 - 0.2 m	0 - 0.2 m	0 - 0.2 m	0 - 0.2 m	0 - 0.2 m	0 - 0.2 m	0 - 0.2 m	0 - 0.2 m	0 - 0.2 m	0 - 0.2 m	0 - 0.2 m	0 - 0.2 m	0 - 0.3 m	0 - 0.2 m	0 - 0.2 m
BTEX	Benzene	mg/kg	110	250	NC	-	66	9.3	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
	Toluene	mg/kg	22000	220000	NC	-	20000	1 700	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
	Ethylbenzene	mg/kg	10000	58000	NC	-	9300	2 100	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
	Xylenes (Total)	mg/kg	150000	NA	NC	-	140000	4200	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.10	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Modified TPH	Gas Range (C6-C10) (less BTEX)	mg/kg	-	-	-	-	-	-	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<5.0	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
	Fuel Range (>C10-C16)	mg/kg	-	-	-	-	-	-	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
	Fuel Range (>C16-C21)	mg/kg	-	-	-	-	-	-	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
	Lube Range (>C21-<C32)	mg/kg	-	-	-	-	-	-	<25	28	<25	<25	<25	48	<25	24	<25	18	<25	140	<25	<25	<25	550	21	27
Total Modified TPH		mg/kg	-	-	-	-	15000 as gas 8600 as fuel oil 14000 as lube oil	-	<15	28	<15	<15	<15	48	<15	24	<15	18	<15	140	<15	<15	<15	550	21	27
CWS Fraction F1 (C6-C10)		mg/kg	12000 / NA		NC	700[2]		6900	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<5.0	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
CWS Fraction F2 (>C10-C16)		mg/kg	6800 / NA		NC	1000[2]		3100	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
CWS Fraction F3 (>C16-C34)		mg/kg	15000 / NA		NC	3500[2]	-	5800	<25	28	<25	<25	<25	48	<25	24	<25	18	<25	140	<25	<25	<25	550	21	27
CWS Fraction F4 (>C34)		mg/kg	21000 / NA		NC	10000[2]	-	6100	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Product Resemblance		-	-	-	-	-	-	-	-	ULO	-	-	-	PLO	-	PLO	-	ULO	-	ULO	-	-	-	ULO	ULO	ULO
Return to Baseline at C32		Y/N	-	-	-	-	-	-	-	Y	-	-	-	Y	-	Y	-	Y	-	Y	-	-	-	Y	Y	Y

PARAMETER		UNITS	CCME RESIDENTIAL/PARKLAND [1,2]				RBCA Tier II PSSL [3]	OMOE[4]	Stantec 2018 Phase II ESA – General Area					
			Ingestion surface soil	Dermal Contact surface soil	Produce, meat and milk check	Management Limits	Soil Ingestion Residential	Soil Contact S1 Risk	CWT-SS62	CWT-TP33-BS1	CWT-TP33-BS2	CWT-TP34-BS1	CWT-TP43-BS1	CWT-TP111-BS1
									0 - 0.2 m	0.1 - 0.6 m	1.2 - 1.7 m	0 - 0.4 m	0 - 0.4 m	0 - 0.4 m
BTEX	Benzene	mg/kg	110	250	NC	-	66	9.3	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
	Toluene	mg/kg	22000	220000	NC	-	20000	1 700	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
	Ethylbenzene	mg/kg	10000	58000	NC	-	9300	2 100	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
	Xylenes (Total)	mg/kg	150000	NA	NC	-	140000	4200	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Modified TPH	Gas Range (C6-C10) (less BTEX)	mg/kg	-	-	-	-	-	-	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
	Fuel Range (>C10-C16)	mg/kg	-	-	-	-	-	-	<10	<10	<10	<10	<10	<10
	Fuel Range (>C16-C21)	mg/kg	-	-	-	-	-	-	<10	<10	20	<10	22	<10
	Lube Range (>C21-<C32)	mg/kg	-	-	-	-	-	-	<25	100	120	<25	95	<25
Total Modified TPH		mg/kg	-	-	-	-	15000 as gas 8600 as fuel oil 14000 as lube oil	-	<15	100	140	<15	120	<15
CWS Fraction F1 (C6-C10)		mg/kg	12000 / NA		NC	700[2]		6900	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
CWS Fraction F2 (>C10-C16)		mg/kg	6800 / NA		NC	1000[2]		3100	<10	<10	<10	<10	<10	<10
CWS Fraction F3 (>C16-C34)		mg/kg	15000 / NA		NC	3500[2]	-	5800	<25	100	140	<25	117	<25
CWS Fraction F4 (>C34)		mg/kg	21000 / NA		NC	10000[2]	-	6100	-	-	-	-	-	-
Product Resemblance		-	-	-	-	-	-	-	-	LO	LO	-	FO/LO	-
Return to Baseline at C32		Y/N	-	-	-	-	-	-	-	Y	Y	-	Y	-

Notes:

value	-value exceeds CCME	-	-no guideline or value
[value]	-value exceeds RBCA	NA	-not applicable
value	-value exceeds OMOE		

[1] 1999 (with 2018 update) CCME *Canadian Environmental Quality Guidelines* for residential/parkland land use.

[2] 2008 (with 2012 Updates) CCME Canada Wide Standards (CWS) for Petroleum Hydrocarbons (PHC) in Soil, Tier 1 Values, Residential/Parkland Land Use - Coarse Grained Soil.

[3] 2012 Atlantic RBCA Tier II Pathway Specific Screening Levels (PSSL) for a residential property with non-potable groundwater and coarse-grained soil.

[4] 2011 Ontario Ministry of the Environment (OMOE) Table 3: Full Depth Generic Site Condition Standards in a Non-Potable Ground Water Condition, Residential/Parkland Land Use

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

FO = One product in the fuel oil range / fuel oil fraction
LO = One product in lube oil range / lube oil fraction
UFO = Unidentified compounds in fuel oil range
ULO = Unidentified compounds in lube oil range
PLO = Possible lube oil fraction
FO = One produce in fuel oil range / fuel oil fraction
G = One product in the gas range

UC - Unidentified Compounds
NR - No Resemblance
NA - Not Applicable

TABLE 1: TOTAL PETROLEUM HYDROCARBON COMPOUNDS in Soil - Human Health Guidelines
Client: Department of National Defence
Site Location: Former USAF Radar Station, Cartwright, NL
Englobe Project Number: P-0012285-0-16-200

PARAMETER		UNITS	CCME RESIDENTIAL/PARKLAND [1,2]				RBCA Tier II PSSL [3]	OMOE[4]	Stantec 2018 Phase II ESA														Englobe 2018 Phase III Results		
									Former Contractor Village																
			Ingestion surface soil	Dermal Contact surface soil	Produce, meat and milk check	Management Limits	Soil Ingestion Residential	Soil Contact S1 Risk	CWT-SS63 0 - 0.2 m	CWT-SS64 0 - 0.2 m	CWT-SS66 0 - 0.3 m	CWT-SS67 0 - 0.3 m	CWT-SS68 0 - 0.3 m	CWT-TP35-BS2 1.0 - 1.5 m	CWT-TP37-BS2 0.8 - 1.3 m	CWT-TP38-BS2 0.8 - 1.3 m	CWT-TP39-BS2 0.8 - 1.3 m	CWT-TP40-BS2 0.8 - 1.3 m	CWT-TP41-BS2 0.9 - 1.4 m	CWT-TP42-BS2 0.9 - 1.4 m	CWT-TP106-BS2 1.0 - 1.5 m	CWT-TP109-BS2 0.9 - 1.4 m	CWT-MW1/1 0 - 0.6 m 19-Aug-18	CWT-MW1/2 0.6 - 1.2 m 19-Aug-18	CWT-MW1/3 1.2 m - 1.8 m 19-Aug-18
BTEX	Benzene	mg/kg	110	250	NC	-	66	9.3	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.03	<0.03	<0.03
	Toluene	mg/kg	22000	220000	NC	-	20000	1 700	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.04	<0.04	<0.04
	Ethylbenzene	mg/kg	10000	58000	NC	-	9300	2 100	<0.025	<0.025	<0.025	<0.025	<0.025	0.14	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	0.047	<0.025	0.2	<0.03	<0.03
	Xylenes (Total)	mg/kg	150000	NA	NC	-	140000	4200	<0.05	<0.05	<0.05	<0.05	<0.05	1.5	<0.05	<0.05	<0.05	<0.05	<0.05	0.17	0.4	<0.05	1.56	<0.05	<0.05
Modified TPH	Gas Range (C6-C10) (less BTEX)	mg/kg	-	-	-	-	-	-	<2.5	<2.5	<2.5	<2.5	<2.5	210	<2.5	<2.5	<2.5	<2.5	70	260	120	25	10	6	3.0
	Fuel Range (>C10-C16)	mg/kg	-	-	-	-	-	-	<10	<10	<10	<10	<10	490	<10	15	<10	<10	830	27	330	68	33	81	15
	Fuel Range (>C16-C21)	mg/kg	-	-	-	-	-	-	<10	14	<10	<10	<10	53	<10	<10	<10	<10	<10	<10	21	<10	18	17	<15
	Lube Range (>C21-<C32)	mg/kg	-	-	-	-	-	-	<25	43	<25	<25	34	240	19	28	<25	<25	<25	<25	48	<25	92	270	<15
Total Modified TPH		mg/kg	-	-	-	-	15000 as gas 8600 as fuel oil 14000 as lube oil	-	<15	57	<15	<15	34	990	19	43	<15	<15	900	280	520	93	153	374	<20
CWS Fraction F1 (C6-C10)		mg/kg	12000 / NA		NC	700[2]		6900	<2.5	<2.5	<2.5	<2.5	<2.5	210	<2.5	<2.5	<2.5	<2.5	70	260	120	25	10	6	3
CWS Fraction F2 (>C10-C16)		mg/kg	6800 / NA		NC	1000[2]		3100	<10	<10	<10	<10	<10	490	<10	15	<10	<10	830	27	330	68	33	81	15
CWS Fraction F3 (>C16-C34)		mg/kg	15000 / NA		NC	3500[2]	-	5800	<25	57	<25	<25	34	293	19	28	<25	<25	<25	<25	69	<25	110	287	<15
CWS Fraction F4 (>C34)		mg/kg	21000 / NA		NC	10000[2]	-	6100	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Product Resemblance		-	-	-	-	-	-	-	-	FO/LO - PLO	-	-	PLO	FO - LO - ULO	PLO	FO - PLO	-	-	WFO	G/FO	WFO - PLO	WFO	FOF, LOF	FOF, LOF, UC	NR
Return to Baseline at C32		Y/N	-	-	-	-	-	-	-	Y	-	-	Y	Y	Y	Y	-	-	Y	Y	Y	Y	Y	N	Y

PARAMETER		UNITS	CCME RESIDENTIAL/PARKLAND [1,2]				RBCA Tier II PSSL [3]	OMOE[4]	Englobe 2018 Phase III Results									
									Former Contractor Village									
			Ingestion surface soil	Dermal Contact surface soil	Produce, meat and milk check	Management Limits	Soil Ingestion Residential	Soil Contact S1 Risk	CWT-TP35-18-A 0 - 0.6 m 18-Aug-18	CWT-TP35-18-B 0 - 0.6 m 18-Aug-18	CWT-TP35-18-C 0 - 0.6 m 18-Aug-18	CWT-TP35-18-D 0 - 0.6 m 18-Aug-18	CWT-MW2/1 0 - 0.6 m 19-Aug-18	CWT-MW2/2 0.6 - 1 m 19-Aug-18	CWT-TP41-18-A 0 - 0.6 m 18-Aug-18	CWT-TP41-18-B 0 - 0.6 m 18-Aug-18	CWT-TP41-18-C 0 - 0.6 m 18-Aug-18	CWT-TP41-18-D 0 - 0.6 m 16-Aug-18
BTEX	Benzene	mg/kg	110	250	NC	-	66	9.3	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
	Toluene	mg/kg	22000	220000	NC	-	20000	1 700	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	0.056	<0.04	0.93
	Ethylbenzene	mg/kg	10000	58000	NC	-	9300	2 100	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
	Xylenes (Total)	mg/kg	150000	NA	NC	-	140000	4200	<0.05	0.1	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Modified TPH	Gas Range (C6-C10) (less BTEX)	mg/kg	-	-	-	-	-	-	131	4	260	163	3.0	3.0	3	3	3	3.0
	Fuel Range (>C10-C16)	mg/kg	-	-	-	-	-	-	1800	56	4070	1160	15.0	15	41	17	15	30
	Fuel Range (>C16-C21)	mg/kg	-	-	-	-	-	-	57	60	263	22	19	<15	52	61	34	41
	Lube Range (>C21-<C32)	mg/kg	-	-	-	-	-	-	16	137	202	22	85	<15	96	368	137	250
Total Modified TPH		mg/kg	-	-	-	-	15000 as gas 8600 as fuel oil 14000 as lube oil	-	2000	257	4800	1370	104	<20	189	446	171	321
CWS Fraction F1 (C6-C10)		mg/kg	12000 / NA		NC	700[2]		6900	131	4	260	163	3	3	3	3	3	3
CWS Fraction F2 (>C10-C16)		mg/kg	6800 / NA		NC	1000[2]		3100	**1800**	56	***4070***	**1160**	15	15	41	17	15	30
CWS Fraction F3 (>C16-C34)		mg/kg	15000 / NA		NC	3500[2]	-	5800	73	197	465	44	104	<15	148	429	171	291
CWS Fraction F4 (>C34)		mg/kg	21000 / NA		NC	10000[2]	-	6100	-	-	-	-	-	-	-	-	-	-
Product Resemblance		-	-	-	-	-	-	-	WFOF	WFOF+LOF+UC	WFOF	FOF	WFOF, LOF	NR	WFOF+LOF+UC	LOF	WFOF+LOF	LOF+UC
Return to Baseline at C32		Y/N	-	-	-	-	-	-	Y	Y	Y	Y	Y	Y	Y	N	Y	N

Notes:

value	-value exceeds CCME	-	-no guideline or value
[value]	-value exceeds RBCA	NA	-not applicable
value	-value exceeds OMOE		

[1] 1999 (with 2018 update) CCME *Canadian Environmental Quality Guidelines* for residential/parkland land use.
[2] 2008 (with 2012 Updates) CCME Canada Wide Standards (CWS) for Petroleum Hydrocarbons (PHC) in Soil, Tier 1 Values, Residential/Parkland Land Use - Coarse Grained Soil.
[3] 2012 Atlantic RBCA Tier II Pathway Specific Screening Levels (PSSL) for a residential property with non-potable groundwater and coarse-grained soil.
[4] 2011 Ontario Ministry of the Environment (OMOE) Table 3: Full Depth Generic Site Condition Standards in a Non-Potable Ground Water Condition, Residential/Parkland Land Use

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

FO = One product in the fuel oil range / fuel oil fraction
LO = One product in lube oil range / lube oil fraction
UFO = Unidentified compounds in fuel oil range
ULO = Unidentified compounds in lube oil range
PLO = Possible lube oil fraction
FO = One produce in fuel oil range / fuel oil fraction
G = One product in the gas range

UC - Unidentified Compounds
NR - No Resemblance
NA - Not Applicable

TABLE 1: TOTAL PETROLEUM HYDROCARBON COMPOUNDS in Soil - Human Health Guidelines
Client: Department of National Defence
Site Location: Former USAF Radar Station, Cartwright, NL
Englobe Project Number: P-0012285-0-16-200

PARAMETER		UNITS	CCME RESIDENTIAL/PARKLAND [1,2]				RBCA Tier II PSSL [3]	OMOE[4]	Stantec 2018 Phase II ESA – Main Complex																	
			Ingestion surface soil	Dermal Contact surface soil	Produce, meat and milk check	Management Limits	Soil Ingestion Residential	Soil Contact S1 Risk	CWT-SS14 0 - 0.2 m	CWT-SS15 0 - 0.2 m	CWT-SS16 0 - 0.2 m	CWT-SS17 0 - 0.2 m	CWT-SS18 0 - 0.2 m	CWT-SS19 0 - 0.2 m	CWT-SS20 0 - 0.2 m	CWT-SS21 0 - 0.2 m	CWT-SS22 0 - 0.2 m	CWT-SS23 0 - 0.2 m	CWT-SS24 0 - 0.2 m	CWT-SS25 0 - 0.2 m	CWT-SS26 0 - 0.2 m	CWT-SS27 0 - 0.2 m	CWT-SS29 0 - 0.2 m	CWT-SS30 0 - 0.2 m	CWT-SS31 0 - 0.2 m	CWT-SS32 0 - 0.2 m
BTEX	Benzene	mg/kg	110	250	NC	-	66	9.3	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
	Toluene	mg/kg	22000	220000	NC	-	20000	1 700	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	0.23	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
	Ethylbenzene	mg/kg	10000	58000	NC	-	9300	2 100	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
	Xylenes (Total)	mg/kg	150000	NA	NC	-	140000	4200	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Modified TPH	Gas Range (C6-C10) (less BTEX)	mg/kg	-	-	-	-	-	-	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
	Fuel Range (>C10-C16)	mg/kg	-	-	-	-	-	-	<10	<10	22	23	<10	<10	<10	14	<10	26	<10	20	<10	<10	<10	<10	<10	<10
	Fuel Range (>C16-C21)	mg/kg	-	-	-	-	-	-	43	<10	78	120	<10	<10	<10	52	38	100	20	51	<10	<10	<10	<10	<10	<10
	Lube Range (>C21-<C32)	mg/kg	-	-	-	-	-	-	270	47	220	1100	48	40	54	180	130	490	150	120	32	26	<25	46	37	23
Total Modified TPH		mg/kg	-	-	-	-	15000 as gas 8600 as fuel oil 14000 as lube oil	-	310	47	320	1200	48	40	54	240	170	620	170	190	32	26	<15	46	37	23
CWS Fraction F1 (C6-C10)		mg/kg	12000 / NA		NC	700[2]		6900	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
CWS Fraction F2 (>C10-C16)		mg/kg	6800 / NA		NC	1000[2]		3100	<10	<10	22	23	<10	<10	<10	14	<10	26	<10	20	<10	<10	<10	<10	<10	<10
CWS Fraction F3 (>C16-C34)		mg/kg	15000 / NA		NC	3500[2]	-	5800	313	47	298	1220	48	40	54	232	168	590	170	171	32	26	<25	46	37	23
CWS Fraction F4 (>C34)		mg/kg	21000 / NA		NC	10000[2]	-	6100	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Product Resemblance		-	-	-	-	-	-	-	LO	ULO	UFO/ULO - LO	LO	LO	PLO	PLO	UFO/ULO - LO	FO/LO - PLO	FO/LO	LO	FO/LO	ULO	PLO	-	ULO	PLO	PLO
Return to Baseline at C32		Y/N	-	-	-	-	-	-	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	-	Y	Y	Y

PARAMETER		UNITS	CCME RESIDENTIAL/PARKLAND [1,2]				RBCA Tier II PSSL [3]	OMOE[4]	Stantec 2018 Phase II ESA – Main Complex																	
			Ingestion surface soil	Dermal Contact surface soil	Produce, meat and milk check	Management Limits	Soil Ingestion Residential	Soil Contact S1 Risk	CWT-SS33 0 - 0.2 m	CWT-SS34 0 - 0.2 m	CWT-SS36 0 - 0.2 m	CWT-SS38 0 - 0.2 m	CWT-SS39 0 - 0.2 m	CWT-SS40 0 - 0.2 m	CWT-SS41 0 - 0.2 m	CWT-TP6-BS1 0 - 0.6 m	CWT-TP7-BS1 0 - 0.3 m	CWT-TP8-BS2 0.3 - 0.6 m	CWT-TP9-BS1 0 - 0.3 m	CWT-TP10-BS2 1.0 - 1.5 m	CWT-TP11-BS1 0 - 0.5 m	CWT-TP12-BS1 0 - 0.6 m	CWT-TP13-BS1 0 - 0.5 m	CWT-TP14-BS1 0.1 - 0.5 m	CWT-TP15-BS1 0.1 - 0.6 m	CWT-TP15-BS2 1.2 - 1.8 m
BTEX	Benzene	mg/kg	110	250	NC	-	66	9.3	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
	Toluene	mg/kg	22000	220000	NC	-	20000	1 700	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
	Ethylbenzene	mg/kg	10000	58000	NC	-	9300	2 100	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
	Xylenes (Total)	mg/kg	150000	NA	NC	-	140000	4200	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Modified TPH	Gas Range (C6-C10) (less BTEX)	mg/kg	-	-	-	-	-	-	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	98	<2.5	<2.5	<2.5
	Fuel Range (>C10-C16)	mg/kg	-	-	-	-	-	-	<10	1000	300	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	5100	21	110	170
	Fuel Range (>C16-C21)	mg/kg	-	-	-	-	-	-	<10	13000	72	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	88	1000	49	160	200
	Lube Range (>C21-<C32)	mg/kg	-	-	-	-	-	-	25	14000	27	<25	<25	28	<25	24	<25	21	74	<25	29	170	130	130	140	240
Total Modified TPH		mg/kg	-	-	-	-	15000 as gas 8600 as fuel oil 14000 as lube oil	-	25	**[27000]**	400	<15	<15	28	<15	24	<15	21	74	<15	29	260	6300	200	410	610
CWS Fraction F1 (C6-C10)		mg/kg	12000 / NA		NC	700[2]		6900	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	98	<2.5	<2.5	<2.5
CWS Fraction F2 (>C10-C16)		mg/kg	6800 / NA		NC	1000[2]		3100	<10	1000	300	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	***5100***	21	110	170
CWS Fraction F3 (>C16-C34)		mg/kg	15000 / NA		NC	3500[2]	-	5800	25	***27000***	99	<25	<25	28	<25	24	<25	21	74	<25	29	258	1130	179	300	440
CWS Fraction F4 (>C34)		mg/kg	21000 / NA		NC	10000[2]	-	6100	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Product Resemblance		-	-	-	-	-	-	-	ULO	FO/LO	FO	-	-	PLO	-	ULO	-	PLO	LO	-	ULO	PLO	WFO	FO/LO	FO/LO	FO/LO
Return to Baseline at C32		Y/N	-	-	-	-	-	-	Y	N	Y	-	-	Y	-	Y	-	Y	Y	-	Y	Y	Y	Y	Y	Y

Notes:

value	-value exceeds CCME	-	-no guideline or value
[value]	-value exceeds RBCA	NA	-not applicable
value	-value exceeds OMOE		

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FO = One produce in fuel oil range / fuel oil fraction
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UC - Unidentified Compounds
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Client: Department of National Defence
Site Location: Former USAF Radar Station, Cartwright, NL
Englobe Project Number: P-0012285-0-16-200

									Stantec 2018 Phase II ESA								
			CCME RESIDENTIAL/PARKLAND [1,2]				RBCA Tier II PSSL [3]	OMOE[4]	Main Complex								
PARAMETER		UNITS	Ingestion surface soil	Dermal Contact surface soil	Produce, meat and milk check	Management Limits	Soil Ingestion Residential	Soil Contact S1 Risk	CWT-TP16-BS2 1.1 - 1.6 m	CWT-TP17-BS2 0.9 - 1.3 m	CWT-TP18-BS1 0 - 0.3 m	CWT-TP19-BS2 1.0 - 1.4 m	CWT-TP20-BS1 0.1 - 0.6 m	CWT-TP21-BS1 0 - 0.5 m	CWT-TP22-BS1 0 - 0.3 m	CWT-TP23-BS1 0 - 0.4 m	CWT-TP24-BS1 0.2 - 0.7 m
BTEX	Benzene	mg/kg	110	250	NC	-	66	9.3	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
	Toluene	mg/kg	22000	220000	NC	-	20000	1 700	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
	Ethylbenzene	mg/kg	10000	58000	NC	-	9300	2 100	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
	Xylenes (Total)	mg/kg	150000	NA	NC	-	140000	4200	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Modified TPH	Gas Range (C6-C10) (less BTEX)	mg/kg	-	-	-	-	-	-	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
	Fuel Range (>C10-C16)	mg/kg	-	-	-	-	-	-	17	<10	<10	<10	<10	<10	<10	<10	<10
	Fuel Range (>C16-C21)	mg/kg	-	-	-	-	-	-	23	13	<10	14	<10	<10	<10	<10	21
	Lube Range (>C21-<C32)	mg/kg	-	-	-	-	-	-	87	66	<25	71	<25	<25	<25	52	85
Total Modified TPH		mg/kg	-	-	-	-	15000 as gas 8600 as fuel oil 14000 as lube oil	-	130	79	<15	85	<15	<15	<15	52	110
CWS Fraction F1 (C6-C10)		mg/kg	12000 / NA		NC	700[2]		6900	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
CWS Fraction F2 (>C10-C16)		mg/kg	6800 / NA		NC	1000[2]		3100	17	<10	<10	<10	<10	<10	<10	<10	<10
CWS Fraction F3 (>C16-C34)		mg/kg	15000 / NA		NC	3500[2]	-	5800	110	79	<25	85	<25	<25	<25	52	106
CWS Fraction F4 (>C34)		mg/kg	21000 / NA		NC	10000[2]	-	6100	-	-	-	-	-	-	-	-	-
Product Resemblance		-	-	-	-	-	-	-	FO/LO	PLO - ULO	-	PLO - ULO	-	-	-	LO	LO
Return to Baseline at C32		Y/N	-	-	-	-	-	-	Y	Y	-	Y	-	-	-	Y	Y

		Stantec 2018 Phase II ESA								
		Main Complex								
PARAMETER		CWT-TP25-BS2 1.0 - 1.5 m	CWT-TP26-BS2 1.0 - 1.5 m	CWT-TP27-BS2 1.1 - 1.6 m	CWT-TP28-BS2 1.3 - 1.8 m	CWT-TP29-BS2 1.2 - 1.7 m	CWT-TP30-BS2 1.0 - 1.5 m	CWT-TP31-BS2 1.2 - 1.7 m	CWT-TP32-BS1 0 - 0.5 m	CWT-TP32-BS2 1.0 - 1.5 m
BTEX	Benzene	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
	Toluene	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
	Ethylbenzene	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
	Xylenes (Total)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Modified TPH	Gas Range (C6-C10) (less BTEX)	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
	Fuel Range (>C10-C16)	14	<10	<10	28	14	33	<10	<10	<10
	Fuel Range (>C16-C21)	51	<10	18	38	33	100	<10	<10	<10
	Lube Range (>C21-<C32)	380	22	78	110	63	420	<25	20	31
Total Modified TPH		440	22	96	180	110	560	<15	20	31
CWS Fraction F1 (C6-C10)		<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
CWS Fraction F2 (>C10-C16)		14	<10	<10	28	14	33	<10	<10	<10
CWS Fraction F3 (>C16-C34)		431	22	96	148	96	520	<25	20	31
CWS Fraction F4 (>C34)		-	-	-	-	-	-	-	-	-
Product Resemblance		LO	ULO	PLO - ULO	FO/LO	FO/LO	FO/LO - UFO/ULO	-	LO	PLO
Return to Baseline at C32		N	Y	Y	Y	Y	N	-	Y	Y

									Stantec 2018 Phase II ESA			Englobe 2018 Phase III Results						
			CCME RESIDENTIAL/PARKLAND [1,2]				RBCA Tier II PSSL [3]	OMOE[4]	Main Complex									
PARAMETER		UNITS	Ingestion surface soil	Dermal Contact surface soil	Produce, meat and milk check	Management Limits	Soil Ingestion Residential	Soil Contact S1 Risk	CWT-TP100-BS1 0 - 0.3 m	CWT-TP102-BS1 0.1 - 0.6 m	CWT-TP103-BS2 1.0 - 1.4 m	CWT-MW7/1 0 - 0.7 m 18-Aug-18	CWT-TP13-18-A/1 0.1 - 0.3 m 16-Aug-18	CWT-TP13-18-B/1 0 - 0.4 m 16-Aug-18	CWT-TP13-18-C/1 0.2 - 0.3 m 16-Aug-18	CWT-TP13/BH-1 0.1 - 0.3 m 16-Aug-18	CWT-SS36-18-A/1 0 - 0.2 m 18-Aug-18	CWT-SS36-18-B/1 0 - 0.2 m 15-Aug-18
BTEX	Benzene	mg/kg	110	250	NC	-	66	9.3	<0.025	<0.025	<0.025	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
	Toluene	mg/kg	22000	220000	NC	-	20000	1 700	<0.025	<0.025	<0.025	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
	Ethylbenzene	mg/kg	10000	58000	NC	-	9300	2 100	<0.025	<0.025	<0.025	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
	Xylenes (Total)	mg/kg	150000	NA	NC	-	140000	4200	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Modified TPH	Gas Range (C6-C10) (less BTEX)	mg/kg	-	-	-	-	-	-	<2.5	<2.5	<2.5	3.0	114	3.0	248	195	3	3
	Fuel Range (>C10-C16)	mg/kg	-	-	-	-	-	-	<10	<10	<10	15	8360	24	12500	1540	15	15
	Fuel Range (>C16-C21)	mg/kg	-	-	-	-	-	-	<10	<10	<10	<15	1360	<15	2030	387	<15	<15
	Lube Range (>C21-<C32)	mg/kg	-	-	-	-	-	-	<25	<25	30	21.0	134	9	N/A	23	<15	19
Total Modified TPH		mg/kg	-	-	-	-	15000 as gas 8600 as fuel oil 14000 as lube oil	-	<15	<15	30	21	**[10200]**	88	**[14800]**	2150	<20	<20
CWS Fraction F1 (C6-C10)		mg/kg	12000 / NA		NC	700[2]		6900	<2.5	<2.5	<2.5	3	114	3	248	195	3	3
CWS Fraction F2 (>C10-C16)		mg/kg	6800 / NA		NC	1000[2]		3100	<10	<10	<10	15	***8360***	24	***12500***	**1540**	15	15
CWS Fraction F3 (>C16-C34)		mg/kg	15000 / NA		NC	3500[2]	-	5800	<25	<25	30	21	1494	9	2030	410	<15	19
CWS Fraction F4 (>C34)		mg/kg	21000 / NA		NC	10000[2]	-	6100	-	-	-	-	-	-	-	-	-	-
Product Resemblance		-	-	-	-	-	-	-	-	-	ULO	UC	WFOF	WFOF+LR	WFOF	FOF	NR	UC
Return to Baseline at C32		Y/N	-	-	-	-	-	-	-	-	Y	Y	Y	Y	Y	Y	Y	Y

Notes:

value	-value exceeds CCME	-	-no guideline or value
[value]	-value exceeds RBCA	NA	-not applicable
value	-value exceeds OMOE		

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Englobe

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Site Location: Former USAF Radar Station, Cartwright, NL
Englobe Project Number: P-0012285-0-16-200

PARAMETER		UNITS	CCME RESIDENTIAL/PARKLAND [1,2]				RBCA Tier II PSSL [3]	OMOE[4]	Stantec 2018 Phase II ESA – Former USAF Dump Area and Former Ammunition Storage Area														
			Ingestion surface soil	Dermal Contact surface soil	Produce, meat and milk check	Management Limits	Soil Ingestion Residential	Soil Contact S1 Risk	CWT-SS1 0 - 0.2 m	CWT-SS2 0 - 0.2 m	CWT-SS3 0 - 0.2 m	CWT-SS4 0 - 0.2 m	CWT-SS5 0 - 0.2 m	CWT-SS7 0 - 0.3 m	CWT-SS9 0 - 0.3 m	CWT-SS10 0 - 0.3 m	CWT-SS11 0 - 0.3 m	CWT-SS12 0 - 0.3 m	CWT-SS70 0 - 0.3 m	CWT-TP1-BS1 0 - 0.3 m	CWT-TP3-BS2 0.4 - 0.8 m	CWT-TP4-BS1 0 - 0.5 m	CWT-TP5-BS2 0.3 - 0.6 m
BTEX	Benzene	mg/kg	110	250	NC	-	66	9.3	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
	Toluene	mg/kg	22000	220000	NC	-	20000	1 700	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
	Ethylbenzene	mg/kg	10000	58000	NC	-	9300	2 100	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
	Xylenes (Total)	mg/kg	150000	NA	NC	-	140000	4200	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Modified TPH	Gas Range (C6-C10) (less BTEX)	mg/kg	-	-	-	-	-	-	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	9.3	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
	Fuel Range (>C10-C16)	mg/kg	-	-	-	-	-	-	75	140	<10	<10	<10	<10	<10	15	<10	<10	<10	<10	17	<10	<10
	Fuel Range (>C16-C21)	mg/kg	-	-	-	-	-	-	220	480	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	56	<10	37
	Lube Range (>C21-<C32)	mg/kg	-	-	-	-	-	-	67	5900	20	23	<25	29	<25	<25	<25	<25	29	<25	240	<25	120
Total Modified TPH		mg/kg	-	-	-	-	15000 as gas 8600 as fuel oil 14000 as lube oil	-	360	6500	20	23	<15	29	<15	24	<15	<15	29	<15	310	<15	160
CWS Fraction F1 (C6-C10)		mg/kg	12000 / NA		NC	700[2]		6900	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	9	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
CWS Fraction F2 (>C10-C16)		mg/kg	6800 / NA		NC	1000[2]		3100	75	140	<10	<10	<10	<10	<10	15	<10	<10	<10	<10	17	<10	<10
CWS Fraction F3 (>C16-C34)		mg/kg	15000 / NA		NC	3500[2]	-	5800	287	***6380***	20	23	<25	29	<25	<25	<25	<25	29	<25	296	<25	157
CWS Fraction F4 (>C34)		mg/kg	21000 / NA		NC	10000[2]	-	6100	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Product Resemblance		-	-	-	-	-	-	-	FO/LO	UFO/ULO - LO	PLO	PLO	-	ULO - PLO	-	FO	-	-	ULO	-	LO	-	LO
Return to Baseline at C32		Y/N	-	-	-	-	-	-	Y	Y	Y	Y	NA	Y	-	Y	-	-	Y	-	N	-	Y

PARAMETER		UNITS	CCME RESIDENTIAL/PARKLAND [1,2]				RBCA Tier II PSSL [3]	OMOE[4]	Englobe 2018 Phase III Results – Former USAF Dump Area and Former Ammunition Storage Area					
			Ingestion surface soil	Dermal Contact surface soil	Produce, meat and milk check	Management Limits	Soil Ingestion Residential	Soil Contact S1 Risk	CWT-MW 4/1 0 - 0.35 m 18-Aug-18	CWT-MW 4/2 0.35 - 0.7 m 18-Aug-18	CWT-SS2-18-A 0 - 0.15 m 18-Aug-18	CWT-SS2-18-B 0 - 0.2 m 18-Aug-18	CWT-SS2-18-C 0 - 0.1 m 18-Aug-18	CWT-SS2-18-D 0 - 0.25 m 18-Aug-18
BTEX	Benzene	mg/kg	110	250	NC	-	66	9.3	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
	Toluene	mg/kg	22000	220000	NC	-	20000	1 700	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
	Ethylbenzene	mg/kg	10000	58000	NC	-	9300	2 100	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
	Xylenes (Total)	mg/kg	150000	NA	NC	-	140000	4200	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Modified TPH	Gas Range (C6-C10) (less BTEX)	mg/kg	-	-	-	-	-	-	3	3	3	3	3	3
	Fuel Range (>C10-C16)	mg/kg	-	-	-	-	-	-	15	15	15	15	15	15
	Fuel Range (>C16-C21)	mg/kg	-	-	-	-	-	-	<15	<15	142	<15	<15	<15
	Lube Range (>C21-<C32)	mg/kg	-	-	-	-	-	-	30	23	1280	56	63	74
Total Modified TPH		mg/kg	-	-	-	-	15000 as gas 8600 as fuel oil 14000 as lube oil	-	30	23	1420	56	63	74
CWS Fraction F1 (C6-C10)		mg/kg	12000 / NA		NC	700[2]		6900	3	3	3	3	3	3
CWS Fraction F2 (>C10-C16)		mg/kg	6800 / NA		NC	1000[2]		3100	15	15	15	15	15	15
CWS Fraction F3 (>C16-C34)		mg/kg	15000 / NA		NC	3500[2]	-	5800	30	23	1422	56	63	74
CWS Fraction F4 (>C34)		mg/kg	21000 / NA		NC	10000[2]	-	6100	-	-	-	-	-	-
Product Resemblance		-	-	-	-	-	-	-	LR	LR	UC	LR	UC	UC
Return to Baseline at C32		Y/N	-	-	-	-	-	-	Y	Y	Y	Y	Y	Y

Notes:

value	-value exceeds CCME	-	-no guideline or value
[value]	-value exceeds RBCA	NA	-not applicable
value	-value exceeds OMOE		

[1] 1999 (with 2018 update) CCME *Canadian Environmental Quality Guidelines* for residential/parkland land use.
[2] 2008 (with 2012 Updates) CCME Canada Wide Standards (CWS) for Petroleum Hydrocarbons (PHC) in Soil, Tier 1 Values, Residential/Parkland Land Use - Coarse Grained Soil.
[3] 2012 Atlantic RBCA Tier II Pathway Specific Screening Levels (PSSL) for a residential property with non-potable groundwater and coarse-grained soil.
[4] 2011 Ontario Ministry of the Environment (OMOE) Table 3: Full Depth Generic Site Condition Standards in a Non-Potable Ground Water Condition, Residential/Parkland Land Use

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

FO = One product in the fuel oil range / fuel oil fraction
LO = One product in lube oil range / lube oil fraction
UFO = Unidentified compounds in fuel oil range
ULO = Unidentified compounds in lube oil range
PLO = Possible lube oil fraction
FO = One produce in fuel oil range / fuel oil fraction
G = One product in the gas range

UC - Unidentified Compounds
NR - No Resemblance
NA - Not Applicable

TABLE 2: TOTAL PETROLEUM HYDROCARBON COMPOUNDS in Soil - Ecological Health Guidelines
Client: Department of National Defence
Site Location: Former USAF Radar Station, Cartwright, NL
Englobe Project Number: P-0012285-0-16-200

PARAMETER		UNITS	CCME RESIDENTIAL/PARKLAND[1,2]		RBCA Tier I ESLs[3]		OMOE[4]		Stantec 2018 Phase II ESA																	
									General Area																	
			Management Limits	Ecological Soil Contact Surface Soil	Plants and Soil Invertebrates Direct Soil Contact	Wildlife and Livestock Soil and Food Ingestion	Plants & Soil Organism	Mammals & Birds	CWT-SS42	CWT-SS43	CWT-SS44	CWT-SS46	CWT-SS48	CWT-SS49	CWT-SS50	CWT-SS51	CWT-SS52	CWT-SS53	CWT-SS54	CWT-SS55	CWT-SS56	CWT-SS57	CWT-SS58	CWT-SS59	CWT-SS60	CWT-SS61
									0 - 0.2 m	0 - 0.2 m	0 - 0.2 m	0 - 0.2 m	0 - 0.2 m	0 - 0.2 m	0 - 0.2 m	0 - 0.2 m	0 - 0.2 m	0 - 0.2 m	0 - 0.2 m	0 - 0.2 m	0 - 0.2 m	0 - 0.2 m	0 - 0.2 m	0 - 0.3 m	0 - 0.2 m	0 - 0.2 m
BTEX	Benzene	mg/kg	-	31	31	18	60	370	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
	Toluene	mg/kg	-	75	75	980	220	140	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
	Ethylbenzene	mg/kg	-	55	55	640	120	90	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
	Xylenes (Total)	mg/kg	-	95	95	2600	55	96	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.10	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Modified TPH	Gas Range (C6-C10) (less BTEX)	mg/kg	-	-	-	11000	-	-	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<5.0	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
	Fuel Range (>C10-C16)	mg/kg	-	-	-	9800	-	-	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
	Fuel Range (>C16-C21)	mg/kg	-	-	-	16000	-	-	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
	Lube Range (>C21-<C32)	mg/kg	-	-	-	8400	-	-	<25	28	<25	<25	<25	48	<25	24	<25	18	<25	140	<25	<25	<25	550	21	27
Total Modified TPH - Tier I		mg/kg	-	-	-	-	-	-	<15	28	<15	<15	<15	48	<15	24	<15	18	<15	140	<15	<15	<15	550	21	27
CWS Fraction F1 (C6-C10)		mg/kg	700[2]	210	210	-	210	-	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<5.0	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
CWS Fraction F2 (>C10-C16)		mg/kg	1000[2]	150	150	-	150	-	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
CWS Fraction F3 (>C16-C34)		mg/kg	3500[2]	300	300	-	1300	-	<25	28	<25	<25	<25	48	<25	24	<25	18	<25	140	<25	<25	<25	[550]	21	27
CWS Fraction F4 (>C34)		mg/kg	10000[2]	2800	2800	-	5600	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Product Resemblance		-	-	-	-	-	-	-	-	ULO	-	-	-	PLO	-	PLO	-	ULO	-	ULO	-	-	-	ULO	ULO	ULO
Return to Baseline at C32		Y/N	-	-	-	-	-	-	-	Y	-	-	-	Y	-	Y	-	Y	-	Y	-	-	-	Y	Y	Y

PARAMETER		UNITS	CCME RESIDENTIAL/PARKLAND[1,2]		RBCA Tier I ESLs[3]		OMOE[4]		Stantec 2018 Phase II ESA					
									General Area					
			Management Limits	Ecological Soil Contact Surface Soil	Plants and Soil Invertebrates Direct Soil Contact	Wildlife and Livestock Soil and Food Ingestion	Plants & Soil Organism	Mammals & Birds	CWT-SS62	CWT-TP33-BS1	CWT-TP33-BS2	CWT-TP34-BS1	CWT-TP43-BS1	CWT-TP111-BS1
									0 - 0.2 m	0.1 - 0.6 m	1.2 - 1.7 m	0 - 0.4 m	0 - 0.4 m	0 - 0.4 m
BTEX	Benzene	mg/kg	-	31	31	18	60	370	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
	Toluene	mg/kg	-	75	75	980	220	140	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
	Ethylbenzene	mg/kg	-	55	55	640	120	90	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
	Xylenes (Total)	mg/kg	-	95	95	2600	55	96	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Modified TPH	Gas Range (C6-C10) (less BTEX)	mg/kg	-	-	-	11000	-	-	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
	Fuel Range (>C10-C16)	mg/kg	-	-	-	9800	-	-	<10	<10	<10	<10	<10	<10
	Fuel Range (>C16-C21)	mg/kg	-	-	-	16000	-	-	<10	<10	20	<10	22	<10
	Lube Range (>C21-<C32)	mg/kg	-	-	-	8400	-	-	<25	100	120	<25	95	<25
Total Modified TPH - Tier I		mg/kg	-	-	-	-	-	-	<15	100	140	<15	120	<15
CWS Fraction F1 (C6-C10)		mg/kg	700[2]	210	210	-	210	-	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
CWS Fraction F2 (>C10-C16)		mg/kg	1000[2]	150	150	-	150	-	<10	<10	<10	<10	<10	<10
CWS Fraction F3 (>C16-C34)		mg/kg	3500[2]	300	300	-	1300	-	<25	100	140	<25	117	<25
CWS Fraction F4 (>C34)		mg/kg	10000[2]	2800	2800	-	5600	-	-	-	-	-	-	-
Product Resemblance		-	-	-	-	-	-	-	-	LO	LO	-	FO/LO	-
Return to Baseline at C32		Y/N	-	-	-	-	-	-	-	Y	Y	-	Y	-

Notes:				
	value	-value exceeds CCME	-	-no guideline or value
	[value]	-value exceeds RBCA	NA	-not applicable
	value	-value exceeds OMOE		

[1] 1999 (with 2018 update) CCME *Canadian Environmental Quality Guidelines* for residential/parkland land use.
[2] 2008 (with 2012 Updates) CCME Canada Wide Standards (CWS) for Petroleum Hydrocarbons (PHC) in Soil, Tier 1 Values, Residential/Parkland Land Use - Coarse Grained Soil;
[3] 2012 Atlantic RBCA Tier 1 Soil Ecological Screening Levels for the Protection of Plants and Soil Invertebrates; Direct Soil Contact, Residential Land Use (updated Sept 2015)
[3] 2012 Atlantic RBCA Tier 1 Soil Ecological Screening Levels for the Protection of Wildlife (mammals and birds) and Livestock; Soil and Food Ingestion, Residential Land Use (updated Sept 2015)
[4] 2011 Ontario Ministry of the Environment (OMOE) Table 3: Full Depth, Non-Potable Water Scenario, Residential/Parkland Land Use

Resemblance Comment Key:

GF - Gasoline Fraction	FO = One product in the fuel oil range / fuel oil frac	UC - Unidentified Compounds
WGF - Weathered Gasoline Fraction	LO = One product in lube oil range / lube oil fractio	NR - No Resemblance
GR - Product in Gasoline Range	UFO = Unidentified compounds in fuel oil range	NA - Not Applicable
FOF - Fuel Oil Fraction	ULO = Unidentified compounds in lube oil range	
WFOF - Weathered Fuel Oil Fraction	PLO = Possible lube oil fraction	
FR - Product in Fuel Oil Range	FO = One produce in fuel oil range / fuel oil fraction	
LOF - Lube Oil Fraction	G = One product in the gas range	
LR - Lube Range		

Englobe

TABLE 2: TOTAL PETROLEUM HYDROCARBON COMPOUNDS in Soil - Ecological Health Guidelines
Client: Department of National Defence
Site Location: Former USAF Radar Station, Cartwright, NL
Englobe Project Number: P-0012285-0-16-200

PARAMETER		UNITS	CCME RESIDENTIAL/PARKLAND[1,2]		RBCA Tier I ESLs [3]		OMOE [4]		Stantec 2018 Phase II ESA														Englobe 2018 Phase III Results		
									Former Contractor Village																
			Management Limits	Ecological Soil Contact Surface Soil	Plants and Soil Invertebrates Direct Soil Contact	Wildlife and Livestock Soil and Food Ingestion	Plants & Soil Organism	Mammals & Birds	CWT-SS63 0 - 0.2 m	CWT-SS64 0 - 0.2 m	CWT-SS66 0 - 0.3 m	CWT-SS67 0 - 0.3 m	CWT-SS68 0 - 0.3 m	CWT-TP35-BS2 1.0 - 1.5 m	CWT-TP37-BS2 0.8 - 1.3 m	CWT-TP38-BS2 0.8 - 1.3 m	CWT-TP39-BS2 0.8 - 1.3 m	CWT-TP40-BS2 0.8 - 1.3 m	CWT-TP41-BS2 0.9 - 1.4 m	CWT-TP42-BS2 0.9 - 1.4 m	CWT-TP106-BS2 1.0 - 1.5 m	CWT-TP109-BS2 0.9 - 1.4 m	CWT-MW1/1 0 - 0.6 m 19-Aug-18	CWT-MW1/2 0.6 - 1.2 m 19-Aug-18	CWT-MW1/3 1.2 m - 1.8 m 19-Aug-18
BTEX	Benzene	mg/kg	-	31	31	18	60	370	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.03	<0.03	<0.03
	Toluene	mg/kg	-	75	75	980	220	140	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.04	<0.04	<0.04
	Ethylbenzene	mg/kg	-	55	55	640	120	90	<0.025	<0.025	<0.025	<0.025	<0.025	0.14	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	0.047	<0.025	0.2	<0.03	<0.03
	Xylenes (Total)	mg/kg	-	95	95	2600	55	96	<0.05	<0.05	<0.05	<0.05	<0.05	1.5	<0.05	<0.05	<0.05	<0.05	<0.05	0.17	0.4	<0.05	1.56	<0.05	<0.05
Modified TPH	Gas Range (C6-C10) (less BTEX)	mg/kg	-	-	-	11000	-	-	<2.5	<2.5	<2.5	<2.5	<2.5	210	<2.5	<2.5	<2.5	<2.5	70	260	120	25	10	6	3.0
	Fuel Range (>C10-C16)	mg/kg	-	-	-	9800	-	-	<10	<10	<10	<10	<10	490	<10	15	<10	<10	830	27	330	68	33	81	15
	Fuel Range (>C16-C21)	mg/kg	-	-	-	16000	-	-	<10	14	<10	<10	<10	53	<10	<10	<10	<10	<10	<10	21	<10	18	17	<15
	Lube Range (>C21-<C32)	mg/kg	-	-	-	8400	-	-	<25	43	<25	<25	34	240	19	28	<25	<25	<25	<25	48	<25	92	270	<15
Total Modified TPH - Tier I		mg/kg	-	-	-	-	-	-	<15	57	<15	<15	34	990	19	43	<15	<15	900	280	520	93	153	374	<20
CWS Fraction F1 (C6-C10)		mg/kg	700[2]	210	210	-	210	-	<2.5	<2.5	<2.5	<2.5	<2.5	210	<2.5	<2.5	<2.5	<2.5	70	260	120	25	10	6	3
CWS Fraction F2 (>C10-C16)		mg/kg	1000[2]	150	150	-	150	-	<10	<10	<10	<10	<10	490	<10	15	<10	<10	830	27	330	68	33	81	15
CWS Fraction F3 (>C16-C34)		mg/kg	3500[2]	300	300	-	1300	-	<25	57	<25	<25	34	293	19	28	<25	<25	<25	<25	69	<25	110	287	<15
CWS Fraction F4 (>C34)		mg/kg	10000[2]	2800	2800	-	5600	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Product Resemblance		-	-	-	-	-	-	-	-	FO/LO - PLO	-	-	PLO	FO - LO - ULO	PLO	FO - PLO	-	-	WFO	G/FO	WFO - PLO	WFO	FOF, LOF	FOF, LOF, UC	NR
Return to Baseline at C32		Y/N	-	-	-	-	-	-	-	Y	-	-	Y	Y	Y	Y	-	-	Y	Y	Y	Y	Y	N	Y

PARAMETER		UNITS	CCME RESIDENTIAL/PARKLAND[1,2]		RBCA Tier I ESLs [3]		OMOE[4]		Englobe 2018 Phase III Results									
									Former Contractor Village									
			Management Limits	Ecological Soil Contact Surface Soil	Plants and Soil Invertebrates Direct Soil Contact	Wildlife and Livestock Soil and Food Ingestion	Plants & Soil Organism	Mammals & Birds	CWT-TP35-18-A 0 - 0.6 m 18-Aug-18	CWT-TP35-18-B 0 - 0.6 m 18-Aug-18	CWT-TP35-18-C 0 - 0.6 m 18-Aug-18	CWT-TP35-18-D 0 - 0.6 m 18-Aug-18	CWT-MW2/1 0 - 0.6 m 19-Aug-18	CWT-MW2/2 0.6 - 1 m 19-Aug-18	CWT-TP41-18-A 0 - 0.6 m 18-Aug-18	CWT-TP41-18-B 0 - 0.6 m 18-Aug-18	CWT-TP41-18-C 0 - 0.6 m 18-Aug-18	CWT-TP41-18-D 0 - 0.6 m 16-Aug-18
BTEX	Benzene	mg/kg	-	31	31	18	60	370	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
	Toluene	mg/kg	-	75	75	980	220	140	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	0.056	<0.04	0.93
	Ethylbenzene	mg/kg	-	55	55	640	120	90	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
	Xylenes (Total)	mg/kg	-	95	95	2600	55	96	<0.05	0.1	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Modified TPH	Gas Range (C6-C10) (less BTEX)	mg/kg	-	-	-	11000	-	-	131	4	260	163	3.0	3.0	3	3	3	3.0
	Fuel Range (>C10-C16)	mg/kg	-	-	-	9800	-	-	1800	56	4070	1160	15.0	15	41	17	15	30
	Fuel Range (>C16-C21)	mg/kg	-	-	-	16000	-	-	57	60	263	22	19	<15	52	61	34	41
	Lube Range (>C21-<C32)	mg/kg	-	-	-	8400	-	-	16	137	202	22	85	<15	96	368	137	250
Total Modified TPH - Tier I		mg/kg	-	-	-	-	-	-	2000	257	4800	1370	104	<20	189	446	171	321
CWS Fraction F1 (C6-C10)		mg/kg	700[2]	210	210	-	210	-	131	4	260	163	3	3	3	3	3	3
CWS Fraction F2 (>C10-C16)		mg/kg	1000[2]	150	150	-	150	-	1800	56	4070	1160	15	15	41	17	15	30
CWS Fraction F3 (>C16-C34)		mg/kg	3500[2]	300	300	-	1300	-	73	197	465	44	104	<15	148	429	171	291
CWS Fraction F4 (>C34)		mg/kg	10000[2]	2800	2800	-	5600	-	-	-	-	-	-	-	-	-	-	-
Product Resemblance		-	-	-	-	-	-	-	WFOF	WFOF+LOF+UC	WFOF	FOF	WFOF, LOF	NR	WFOF+LOF+UC	LOF	WFOF+LOF	LOF+UC
Return to Baseline at C32		Y/N	-	-	-	-	-	-	Y	Y	Y	Y	Y	Y	Y	N	Y	N

Notes:

value	-value exceeds CCME	-	-no guideline or value
[value]	-value exceeds RBCA	NA	-not applicable
value	-value exceeds OMOE		

[1] 1999 (with 2018 update) CCME *Canadian Environmental Quality Guidelines* for residential/parkland land use.
[2] 2008 (with 2012 Updates) CCME Canada Wide Standards (CWS) for Petroleum Hydrocarbons (PHC) in Soil, Tier 1 Values, Residential/Parkland Land Use - Coarse Grained Soil.
[3] 2012 Atlantic RBCA Tier II Pathway Specific Screening Levels (PSSL) for a residential property with non-potable groundwater and coarse-grained soil.
[4] 2011 Ontario Ministry of the Environment (OMOE) Table 3: Full Depth Generic Site Condition Standards in a Non-Potable Ground Water Condition, Residential/Parkland Land Use

Resemblance Comment Key:

GF - Gasoline Fraction	FO = One product in the fuel oil range / fuel oil frac	UC - Unidentified Compounds
WGF - Weathered Gasoline Fraction	LO = One product in lube oil range / lube oil fractio	NR - No Resemblance
GR - Product in Gasoline Range	UFO = Unidentified compounds in fuel oil range	NA - Not Applicable
FOF - Fuel Oil Fraction	ULO = Unidentified compounds in lube oil range	
WFOF - Weathered Fuel Oil Fraction	PLO = Possible lube oil fraction	
FR - Product in Fuel Oil Range	FO = One produce in fuel oil range / fuel oil fraction	
LOF - Lube Oil Fraction	G = One product in the gas range	
LR - Lube Range		

Englobe

TABLE 2: TO JNDS in Soil - Ecological Health Guidelines
Client: Depa
Site Locatio
Englobe Proj

	Parameter	Units	CCME RESIDENTIAL/PARKLAND[1,2] Management Limits	CCME RESIDENTIAL/PARKLAND[1,2] Ecological Soil Contact Surface Soil	RBCA Tier I ESLs Plants and Soil Invertebrates Direct Soil Contact[3]	RBCA Tier I ESLs Wildlife and Livestock Soil and Food Ingestion[4]	OMOE[5] Plants & Soil Organism	OMOE[5] Mammals & Birds	16-BS2 .6 m	CWT-TP17-BS2 0.9 - 1.3 m	CWT-TP18-BS1 0 - 0.3 m	CWT-TP19-BS2 1.0 - 1.4 m	CWT-TP20-BS1 0.1 - 0.6 m	CWT-TP21-BS1 0 - 0.5 m
BTEX			-	31	31	18	60	370	25	<0.025	<0.025	<0.025	<0.025	<0.025
			-	75	75	980	220	140	25	<0.025	<0.025	<0.025	<0.025	<0.025
			-	55	55	640	120	90	25	<0.025	<0.025	<0.025	<0.025	<0.025
	Xylenes (Total)	mg/kg	-	95	95	2600	55	96	05	<0.05	<0.05	<0.05	<0.05	<0.05
Modified TPH	Gas Range (C6-C10) (less BTEX)	mg/kg	-	-	-	11000	-	-	5	<2.5	<2.5	<2.5	<2.5	<2.5
	Fuel Range (>C10-C16)	mg/kg	-	-	-	9800	-	-	[illegible]	<10	<10	<10	<10	<10
	Fuel Range (>C16-C21)	mg/kg							[illegible]	13	<10	14	<10	<10
	Lube Range (>C21-<C32)	mg/kg							87	66	<25	71	<25	<25
Total Modified TPH - Tier I		mg/kç						-	130	79	<15	85	<15	<15
CWS Fraction F1 (C6-C10)		mg/						-	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
CWS Fraction F2 (>C10-C16)		m						-	17	<10	<10	<10	<10	<10
CWS Fraction F3 (>C16-C34)		r						-	110	79	<25	85	<25	<25
CWS Fraction F4 (>C34)							,0	-	-	-	-	-	-	-
Product Resemblance							-	-	FO/LO	PLO - ULO	-	PLO - ULO	-	-
Return to Baseline at C32							-	-	Y	Y	-	Y	-	-

Stantec 2018 Phase II ESA — Main Complex

Parameter	CWT-TP22-BS1 0 - 0.3 m	CWT-TP23-BS1 0 - 0.4 m	CWT-TP24-BS1 0.2 - 0.7 m	CWT-TP25-BS2 1.0 - 1.5 m	CWT-TP26-BS2 1.0 - 1.5 m	CWT-TP27-BS2 1.1 - 1.6 m	CWT-TP28-BS2 1.3 - 1.8 m	CWT-TP29-BS2 1.2 - 1.7 m	CWT-TP30-BS2 1.0 - 1.5 m	CWT-TP31-BS2 1.2 - 1.7 m	CWT-TP32-BS1 0 - 0.5 m	CWT-TP32-BS2 1.0 - 1.5 m
BTEX	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
Xylenes (Total)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Gas Range (C6-C10) (less BTEX)	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
Fuel Range (>C10-C16)	<10	<10	<10	14	<10	<10	28	14	33	<10	<10	<10
Fuel Range (>C16-C21)	<10	<10	21	51	<10	18	38	33	100	<10	<10	<10
Lube Range (>C21-<C32)	<25	52	85	380	22	78	110	63	420	<25	20	31
Total Modified TPH - Tier I	<15	52	110	440	22	96	180	110	560	<15	20	31
CWS Fraction F1 (C6-C10)	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
CWS Fraction F2 (>C10-C16)	<10	<10	<10	14	<10	<10	28	14	33	<10	<10	<10
CWS Fraction F3 (>C16-C34)	<25	52	106	431	22	96	148	96	520	<25	20	31
CWS Fraction F4 (>C34)	-	-	-	-	-	-	-	-	-	-	-	-
Product Resemblance	-	LO	LO	LO	ULO	PLO - ULO	FO/LO	FO/LO	FO/LO - UFO/ULO	-	LO	PLO
Return to Baseline at C32	-	Y	Y	N	Y	Y	Y	Y	N	-	Y	Y

	PARAMETER			...and Soil and ...ngestion[4]	OMOE[5] Plants & Soil Organism	OMOE[5] Mammals & Birds	Stantec 2018 Phase II ESA — Main Complex CWT-TP100-BS1 0 - 0.3 m	CWT-TP102-BS1 0.1 - 0.6 m	CWT-TP103-BS2 1.0 - 1.4 m	Englobe 2018 Phase III Results CWT-MW7/1 0 - 0.7 m 18-Aug-18	CWT-TP13-18-A/1 0.1 - 0.3 m 16-Aug-18	CWT-TP13-18-B/1 0 - 0.4 m 16-Aug-18	CWT-TP13-18-C/1 0.2 - 0.3 m 16-Aug-18	CWT-TP13/BH-1 0.1 - 0.3 m 16-Aug-18	CWT-SS36-18-A/1 0 - 0.2 m 18-Aug-18	CWT-SS36-18-B/1 0 - 0.2 m 15-Aug-18
BTEX	Benzene			18	60	370	<0.025	<0.025	<0.025	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
	Toluene			980	220	140	<0.025	<0.025	<0.025	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
	Ethylbenzene			640	120	90	<0.025	<0.025	<0.025	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
	Xylenes (Total)			2600	55	96	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Modified TPH	Gas Range (C6-C10) (less B			11000	-	-	<2.5	<2.5	<2.5	3.0	114	3.0	248	195	3	3
	Fuel Range (>C10-C16)		-	9800	-	-	<10	<10	<10	15	8360	24	[12500]	1540	15	15
	Fuel Range (>C16-C21)		-	16000	-	-	<10	<10	<10	<15	1360	<15	2030	387	<15	<15
	Lube Range (>C21-<C32)		-	8400	-	-	<25	<25	30	21.0	134	64	N/A	23	<15	19
Total Modified TPH - Tier I			-	-	-	-	<15	<15	30	21	10200	88	14800	2150	<20	<20
CWS Fraction F1 (C6-C10)		,10	210	-	210	-	<2.5	<2.5	<2.5	3	114	3	248	195	3	3
CWS Fraction F2 (>C10-C16)		150	150	-	150	-	<10	<10	<10	15	8360	24	12500	1540	15	15
CWS Fraction F3 (>C16-C34)		300	300	-	1300	-	<25	<25	30	21	1494	64	2030	410	<15	19
CWS Fraction F4 (>C34)		2800	2800	-	5600	-	-	-	-	-	-	-	-	-	-	-
Product Resemblance		-	-	-	-	-	-	-	ULO	UC	WFOF	WFOF+LR	WFOF	FOF	NR	UC
Return to Baseline at C32		-	-	-	-	-	-	-	Y	Y	Y	Y	Y	Y	Y	Y

Notes: ...xceeds CCME   - -no guideline or value
...exceeds RBCA   NA -not applicable
...ue exceeds OMOE

[1] 1999 (with 2018 update) CC ...es for residential/parkland land use.
[2] 2008 (with 2012 Updates) ... Petroleum Hydrocarbons (PHC) in Soil, Tier 1 Values, Residential/Parkland Land Use - Coarse Grained Soil.
[3] 2012 Atlantic RBCA Tier I ...L) for a residential property with non-potable groundwater and coarse-grained soil.
[4] 2011 Ontario Ministry of ... epth Generic Site Condition Standards in a Non-Potable Ground Water Condition, Residential/Parkland Land Use

Resemblance Comment
GF - Gasoline Fraction
WGF - Weathered Ga
GR - Product in Gaso
FOF - Fuel Oil Fracti
WFOF - Weathered
FR - Product in Fue
LOF - Lube Oil Fra
LR - Lube Range

FO = One product in the fuel oil range / fuel oil frac UC - Unidentified Compounds
LO = One product in lube oil range / lube oil fractio NR - No Resemblance
UFO = Unidentified compounds in fuel oil range   NA - Not Applicable
ULO = Unidentified compounds in lube oil range
PLO = Possible lube oil fraction
FO = One produce in fuel oil range / fuel oil fraction
G = One product in the gas range

TABLE 2: TOTAL PETROLEUM HYDROCARBON COMPOUNDS in Soil - Ecological Health Guidelines
Client: Department of National Defence
Site Location: Former USAF Radar Station, Cartwright, NL
Englobe Project Number: P-0012285-0-16-200

PARAMETER		UNITS	CCME RESIDENTIAL/PARKLAND[1,2]		RBCA Tier I ESLs		OMOE[5]		Stantec 2018 Phase II ESA – Former USAF Dump Area and Former Ammunition Storage Area														
			Management Limits	Ecological Soil Contact Surface Soil	Plants and Soil Invertebrates Direct Soil Contact[3]	Wildlife and Livestock Soil and Food Ingestion[4]	Plants & Soil Organism	Mammals & Birds	CWT-SS1 0 - 0.2 m	CWT-SS2 0 - 0.2 m	CWT-SS3 0 - 0.2 m	CWT-SS4 0 - 0.2 m	CWT-SS5 0 - 0.2 m	CWT-SS7 0 - 0.3 m	CWT-SS9 0 - 0.3 m	CWT-SS10 0 - 0.3 m	CWT-SS11 0 - 0.3 m	CWT-SS12 0 - 0.3 m	CWT-SS70 0 - 0.3 m	CWT-TP1-BS1 0 - 0.3 m	CWT-TP3-BS2 0.4 - 0.8 m	CWT-TP4-BS1 0 - 0.5 m	CWT-TP5-BS2 0.3 - 0.6 m
BTEX	Benzene	mg/kg	-	31	31	18	60	370	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
	Toluene	mg/kg	-	75	75	980	220	140	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
	Ethylbenzene	mg/kg	-	55	55	640	120	90	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
	Xylenes (Total)	mg/kg	-	95	95	2600	55	96	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Modified TPH	Gas Range (C6-C10) (less BTEX)	mg/kg	-	-	-	11000	-	-	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	9.3	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
	Fuel Range (>C10-C16)	mg/kg	-	-	-	9800	-	-	75	140	<10	<10	<10	<10	<10	15	<10	<10	<10	<10	17	<10	<10
	Fuel Range (>C16-C21)	mg/kg	-	-	-	16000	-	-	220	480	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	56	<10	37
	Lube Range (>C21-<C32)	mg/kg	-	-	-	8400	-	-	67	5900	20	23	<25	29	<25	<25	<25	<25	29	<25	240	<25	120
Total Modified TPH - Tier I		mg/kg	-	-	-	-	-	-	360	6500	20	23	<15	29	<15	24	<15	<15	29	<15	310	<15	160
CWS Fraction F1 (C6-C10)		mg/kg	700[2]	210	210	-	210	-	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	9	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
CWS Fraction F2 (>C10-C16)		mg/kg	1000[2]	150	150	-	150	-	75	140	<10	<10	<10	<10	<10	15	<10	<10	<10	<10	17	<10	<10
CWS Fraction F3 (>C16-C34)		mg/kg	3500[2]	300	300	-	1300	-	287	6380	20	23	<25	29	<25	<25	<25	<25	29	<25	296	<25	157
CWS Fraction F4 (>C34)		mg/kg	10000[2]	2800	2800	-	5600	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Product Resemblance		-	-	-	-	-	-	-	FO/LO	UFO/ULO - LO	PLO	PLO	-	ULO - PLO	-	FO	-	-	ULO	-	LO	-	LO
Return to Baseline at C32		Y/N	-	-	-	-	-	-	Y	Y	Y	Y	NA	Y	-	Y	-	-	Y	-	N	-	Y

PARAMETER		UNITS	CCME RESIDENTIAL/PARKLAND[1,2]		RBCA Tier I ESLs		OMOE[5]		Englobe 2018 Phase III Results – Former USAF Dump Area and Former Ammunition Storage Area					
			Management Limits	Ecological Soil Contact Surface Soil	Plants and Soil Invertebrates Direct Soil Contact[3]	Wildlife and Livestock Soil and Food Ingestion[4]	Plants & Soil Organism	Mammals & Birds	CWT-MW 4/1 0 - 0.35 m 18-Aug-18	CWT-MW 4/2 0.35 - 0.7 m 18-Aug-18	CWT-SS2-18-A 0 - 0.15 m 18-Aug-18	CWT-SS2-18-B 0 - 0.2 m 18-Aug-18	CWT-SS2-18-C 0 - 0.1 m 18-Aug-18	CWT-SS2-18-D 0 - 0.25 m 18-Aug-18
BTEX	Benzene	mg/kg	-	31	31	18	60	370	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
	Toluene	mg/kg	-	75	75	980	220	140	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
	Ethylbenzene	mg/kg	-	55	55	640	120	90	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
	Xylenes (Total)	mg/kg	-	95	95	2600	55	96	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Modified TPH	Gas Range (C6-C10) (less BTEX)	mg/kg	-	-	-	11000	-	-	3	3	3	3	3	3
	Fuel Range (>C10-C16)	mg/kg	-	-	-	9800	-	-	15	15	15	15	15	15
	Fuel Range (>C16-C21)	mg/kg	-	-	-	16000	-	-	<15	<15	142	<15	<15	<15
	Lube Range (>C21-<C32)	mg/kg	-	-	-	8400	-	-	30	23	1280	56	63	74
Total Modified TPH - Tier I		mg/kg	-	-	-	-	-	-	30	23	1420	56	63	74
CWS Fraction F1 (C6-C10)		mg/kg	700[2]	210	210	-	210	-	3	3	3	3	3	3
CWS Fraction F2 (>C10-C16)		mg/kg	1000[2]	150	150	-	150	-	15	15	15	15	15	15
CWS Fraction F3 (>C16-C34)		mg/kg	3500[2]	300	300	-	1300	-	30	23	1422	56	63	74
CWS Fraction F4 (>C34)		mg/kg	10000[2]	2800	2800	-	5600	-	-	-	-	-	-	-
Product Resemblance		-	-	-	-	-	-	-	LR	LR	UC	LR	UC	UC
Return to Baseline at C32		Y/N	-	-	-	-	-	-	Y	Y	Y	Y	Y	Y

Notes:

value	-value exceeds CCME	-	-no guideline or value
[value]	-value exceeds RBCA	NA	-not applicable
value	-value exceeds OMOE		

[1] 1999 (with 2018 update) CCME *Canadian Environmental Quality Guidelines* for residential/parkland land use.

[2] 2008 (with 2012 Updates) CCME Canada Wide Standards (CWS) for Petroleum Hydrocarbons (PHC) in Soil, Tier 1 Values, Residential/Parkland Land Use - Coarse Grained Soil.

[3] 2012 Atlantic RBCA Tier II Pathway Specific Screening Levels (PSSL) for a residential property with non-potable groundwater and coarse-grained soil.

[4] 2011 Ontario Ministry of the Environment (OMOE) Table 3: Full Depth Generic Site Condition Standards in a Non-Potable Ground Water Condition, Residential/Parkland Land Use

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

FO = One product in the fuel oil range / fuel oil frac
LO = One product in lube oil range / lube oil fractio
UFO = Unidentified compounds in fuel oil range
ULO = Unidentified compounds in lube oil range
PLO = Possible lube oil fraction
FO = One produce in fuel oil range / fuel oil fraction
G = One product in the gas range

UC - Unidentified Compounds
NR - No Resemblance
NA - Not Applicable

TABLE 3: POLYCYCLIC AROMATIC HYDROCARBONS in Soil - Human Health Guidelines
Client: Department of National Defence
Site Location: Former USAF Radar Station, Cartwright, NL
Englobe Project Number: P-0012285-0-16-200

PARAMETER	UNITS	CCME RESIDENTIAL/PARKLAND [1]		OMOE [2]	Stantec 2018 Phase II ESA				
					General Area				
		Ingestion and Dermal Contact	Produce, meat and milk	Soil Contact S1 Risk	CWT-SS49 0 - 0.2 m	CWT-SS52 0 - 0.2 m	CWT-SS55 0 - 0.2 m	CWT-SS58 0 - 0.2 m	CWT-SS61 0 - 0.2 m
1-Methylnaphthalene	mg/kg	-	-	72	<0.01	<0.01	<0.01	<0.01	<0.01
2-Methylnaphthalene	mg/kg	-	-	72	<0.01	<0.01	<0.01	<0.01	<0.01
Acenaphthene	mg/kg	-	-	78	<0.01	<0.01	<0.01	<0.01	<0.01
Acenaphthylene	mg/kg	-	-	7.8	<0.01	<0.01	<0.01	<0.01	<0.01
Acridine	mg/kg	-	-	-	-	-	-	-	-
Anthracene	mg/kg	-	-	5400	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo(a)anthracene	mg/kg	-	NC	0.78	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo(a)pyrene	mg/kg	-	NC	0.078	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo(b)fluoranthene	mg/kg	-	NC	0.78	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo(b+j)fluoranthene	mg/kg	-	NC	-	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo(e)pyrene	mg/kg	-	NC	-	-	-	-	-	-
Benzo(g,h,i)perylene	mg/kg	-	NC	7.8	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo(k)fluoranthene	mg/kg	-	NC	0.78	<0.01	<0.01	<0.01	<0.01	<0.01
Chrysene	mg/kg	-	NC	7.8	<0.01	<0.01	<0.01	<0.01	<0.01
Dibenz(a,h)anthracene	mg/kg	-	NC	0.078	<0.01	<0.01	<0.01	<0.01	<0.01
Fluoranthene	mg/kg	-	-	7.8	<0.01	<0.01	<0.01	<0.01	<0.01
Fluorene	mg/kg	-	-	720	<0.01	<0.01	<0.01	<0.01	<0.01
Indeno(1,2,3-cd)pyrene	mg/kg	-	NC	0.78	<0.01	<0.01	<0.01	<0.01	<0.01
Naphthalene	mg/kg	-	-	360	<0.01	<0.01	<0.01	<0.01	<0.01
Perylene	mg/kg	-	-	-	<0.01	<0.01	<0.01	<0.01	<0.01
Phenanthrene	mg/kg	-	-	-	<0.01	<0.01	<0.01	<0.01	<0.01
Pyrene	mg/kg	-	-	78	<0.01	<0.01	<0.01	<0.01	<0.01
Quinoline	mg/kg	-	-	-	-	-	-	-	-
B(a)P TPE [3]	-	5.3	-	-	0.0126	0.0126	0.0126	0.0126	0.0126

PARAMETER	UNITS	CCME RESIDENTIAL/PARKLAND [1]		OMOE [2]	Stantec 2018 Phase II ESA					Englobe 2018 Phase III ESA							
					Former Contractor Village												
		Ingestion and Dermal Contact	Produce, meat and milk	Soil Contact S1 Risk	CWT-SS63 0 - 0.2 m	CWT-SS66 0 - 0.3 m	CWT-TP36-BS2 1.2 - 1.7 m	CWT-TP41-BS1 0.9 - 1.4 m	CWT-TP104-BS2 1.2 - 1.7 m	CWT-MW3/1 0 - 0.3 m 19-Aug-18	CWT-MW3/2 0.3 - 0.6 m 19-Aug-18	CWT-MW3/3 0.6 - 1.2 m 19-Aug-18	CWT-MW3/4 1.2 - 1.8 m 19-Aug-18	CWT-TP36-18-A 0 - 0.6 m 18-Aug-18	CWT-TP36-18-B 0 - 0.6 m 18-Aug-18	CWT-TP36-18-C 0 - 0.6 m 18-Aug-18	CWT-TP36-18-D 0 - 0.6 m 18-Aug-18
1-Methylnaphthalene	mg/kg	-	-	72	<0.01	<0.01	0.083	<0.01	0.25	<0.05	<0.05	<0.05	0.05	<0.05	0.08	<0.05	<0.05
2-Methylnaphthalene	mg/kg	-	-	72	<0.01	<0.01	0.11	<0.01	0.51	<0.01	<0.01	0.05	0.11	<0.01	<0.01	<0.01	<0.01
Acenaphthene	mg/kg	-	-	78	<0.01	<0.01	<0.01	<0.01	0.013	<0.00671	<0.00671	<0.00671	<0.00671	<0.00671	<0.00671	<0.00671	<0.00671
Acenaphthylene	mg/kg	-	-	7.8	<0.01	<0.01	<0.01	<0.01	<0.01	<0.004	<0.004	<0.004	<0.004	0.011	<0.004	<0.004	<0.004
Acridine	mg/kg	-	-	-	-	-	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Anthracene	mg/kg	-	-	5400	<0.01	<0.01	<0.01	<0.01	<0.01	<0.03	<0.03	<0.03	<0.03	<0.03	0.04	<0.03	<0.03
Benzo(a)anthracene	mg/kg	-	NC	0.78	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	0.07	<0.01	<0.01
Benzo(a)pyrene	mg/kg	-	NC	0.078	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.04	<0.01	<0.01
Benzo(b)fluoranthene	mg/kg	-	NC	0.78	<0.01	<0.01	<0.01	<0.01	<0.01	<0.05	<0.05	<0.05	<0.05	<0.05	0.07	<0.05	<0.05
Benzo(b+j)fluoranthene	mg/kg	-	NC	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.1	<0.1	<0.1	<0.1	<0.1	0.11	<0.1	<0.1
Benzo(e)pyrene	mg/kg	-	NC	-	-	-	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Benzo(g,h,i)perylene	mg/kg	-	NC	7.8	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	0.02	<0.01	<0.01
Benzo(k)fluoranthene	mg/kg	-	NC	0.78	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.05	<0.01	<0.01
Chrysene	mg/kg	-	NC	7.8	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.03	0.08	<0.01	<0.01
Dibenz(a,h)anthracene	mg/kg	-	NC	0.078	<0.01	<0.01	<0.01	<0.01	<0.01	<0.006	<0.006	<0.006	<0.006	<0.006	0.009	<0.006	<0.006
Fluoranthene	mg/kg	-	-	7.8	<0.01	<0.01	<0.01	<0.01	<0.01	<0.05	<0.05	<0.05	<0.05	<0.05	0.15	<0.05	<0.05
Fluorene	mg/kg	-	-	720	<0.01	<0.01	<0.01	<0.01	0.021	<0.01	<0.01	<0.01	<0.01	<0.01	0.03	<0.01	<0.01
Indeno(1,2,3-cd)pyrene	mg/kg	-	NC	0.78	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	0.03	<0.01	<0.01
Naphthalene	mg/kg	-	-	360	<0.01	<0.01	<0.026	<0.01	0.21	<0.01	<0.01	<0.01	<0.01	<0.01	0.66	<0.01	<0.01
Perylene	mg/kg	-	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Phenanthrene	mg/kg	-	-	-	<0.01	<0.01	<0.01	<0.01	0.012	<0.03	<0.03	<0.03	<0.03	<0.03	0.05	<0.03	<0.03
Pyrene	mg/kg	-	-	78	<0.01	<0.01	<0.01	<0.01	<0.01	<0.05	<0.05	<0.05	<0.05	<0.05	0.2	<0.05	<0.05
Quinoline	mg/kg	-	-	-	-	-	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
B(a)P TPE [3]	-	5.3	-	-	0.0126	0.0126	0.0126	0.0126	0.0126	0.0146	0.0146	0.0146	0.0146	0.0160	0.0760	0.0146	0.0146

Notes:

value	-value exceeds CCME
[value]	-value exceeds OMOE
0.96	-guidelines based on 10^{-6} ILCR, therefore not used
-	-no guideline or value
NC	-not calculated

[1] 1999 (with 2018 update) CCME *Canadian Environmental Quality Guidelines* for residential/parkland land use.
[2] 2011 Ontario Ministry of the Environment (OMOE) Table 3: Full Depth Generic Site Condition Standards in a Non-Potable Ground Water Condition, Residential/Parkland Land Use
[3] When the concentration was less than the RDL, half of the RDL was used in the benzo(a)pyrene potency equivalence factor (B(a)P TPE) calculations.

TABLE 3: POLYCYCLIC AROMATIC HYDROCARBONS in Soil - Human Health Guidelines
Client: Department of National Defence
Site Location: Former USAF Radar Station, Cartwright, NL
Englobe Project Number: P-0012285-0-16-200

PARAMETER	UNITS	CCME RESIDENTIAL/PARKLAND [1]		OMOE [2]	Stantec 2018 Phase II ESA – Main Complex																		
		Ingestion and Dermal Contact	Produce, meat and milk	Soil Contact S1 Risk	CWT-SS13 0 - 0.3 m	CWT-SS20 0 - 0.2 m	CWT-SS23 0 - 0.2 m	CWT-SS32 0 - 0.2 m	CWT-SS35 0 - 0.2 m	CWT-SS37 0 - 0.2 m	CWT-TP7-BS1 0 - 0.3 m	CWT-TP8-BS2 0.3 - 0.6 m	CWT-TP11-BS1 0 - 0.5 m	CWT-TP15-BS2 1.2 - 1.8 m	CWT-TP17-BS1 0 - 0.5 m	CWT-TP19-BS1 0 - 0.5 m	CWT-TP22-BS1 0 - 0.3 m	CWT-TP25-BS2 1.0 - 1.5 m	CWT-TP26-BS1 0 - 0.5 m	CWT-TP28-BS1 0 - 0.5 m	CWT-TP30-BS1 0.1 - 0.6 m	CWT-TP31-BS1 0.1 -0.6 m	CWT-TP101-BS1 0 - 0.5 m
1-Methylnaphthalene	mg/kg	-	-	72	<0.01	<0.01	<0.01	<0.01	<0.01	<0.053	<0.01	<0.01	<0.01	0.41	0.018	<0.01	<0.01	<0.01	<0.01	<0.01	0.019	<0.01	<0.01
2-Methylnaphthalene	mg/kg	-	-	72	<0.01	<0.01	<0.01	<0.01	0.018	<0.095	<0.01	<0.01	<0.01	0.68	0.039	<0.01	<0.01	0.016	<0.01	<0.01	0.044	<0.01	<0.01
Acenaphthene	mg/kg	-	-	78	0.029	<0.01	0.056	<0.01	<0.01	<0.049	<0.01	<0.01	<0.01	4	0.096	<0.01	<0.01	0.088	<0.01	<0.01	1.8	<0.01	<0.01
Acenaphthylene	mg/kg	-	-	7.8	<0.01	<0.01	<0.01	<0.01	<0.01	<0.088	<0.01	<0.01	0.019	0.043	0.048	<0.01	<0.01	<0.01	<0.01	<0.01	0.08	<0.01	<0.01
Acridine	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Anthracene	mg/kg	-	-	5400	0.069	0.015	0.062	<0.01	<0.01	<0.056	<0.01	<0.01	0.047	5.6	0.49	<0.01	<0.01	0.14	<0.01	<0.01	0.53	<0.01	<0.01
Benzo(a)anthracene	mg/kg	-	NC	0.78	0.13	0.038	0.18	<0.01	<0.01	<0.087	<0.01	<0.01	0.066	9.1	1.7	<0.01	<0.01	0.26	<0.01	<0.01	1.5	<0.01	<0.01
Benzo(a)pyrene	mg/kg	-	NC	0.078	0.1	0.072	0.15	<0.01	<0.01	<0.01	<0.01	<0.01	0.042	6.9	1.3	<0.01	<0.01	0.25	<0.01	<0.01	0.36	<0.01	<0.01
Benzo(b)fluoranthene	mg/kg	-	NC	0.78	0.075	0.18	0.14	0.013	0.033	0.18	<0.01	<0.01	0.096	5.7	1.8	<0.01	<0.01	0.25	<0.01	<0.01	0.48	<0.01	<0.01
Benzo(b+j)fluoranthene	mg/kg	-	NC	-	0.123	0.257	0.226	0.013	0.033	0.18	<0.01	<0.01	0.149	9.2	2.8	<0.01	<0.01	0.39	<0.01	<0.01	0.78	<0.01	<0.01
Benzo(e)pyrene	mg/kg	-	NC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Benzo(g,h,i)perylene	mg/kg	-	NC	7.8	0.069	0.089	0.11	<0.01	<0.01	<0.035	<0.01	<0.01	0.027	3.1	0.57	<0.01	<0.01	0.15	<0.01	<0.01	0.087	<0.01	<0.01
Benzo(k)fluoranthene	mg/kg	-	NC	0.78	0.049	0.075	0.086	<0.01	<0.01	<0.025	<0.01	<0.01	0.052	3.4	1	<0.01	<0.01	0.14	<0.01	<0.01	0.28	<0.01	<0.01
Chrysene	mg/kg	-	NC	7.8	0.14	0.12	0.21	0.023	<0.01	1.1	<0.01	<0.01	0.19	9.1	2.1	<0.01	<0.01	0.32	<0.01	<0.01	1.2	<0.01	<0.01
Dibenz(a,h)anthracene	mg/kg	-	NC	0.078	0.016	0.025	0.024	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.91	0.14	<0.01	<0.01	0.037	<0.01	<0.01	0.024	<0.01	<0.01
Fluoranthene	mg/kg	-	-	7.8	0.36	0.074	0.47	0.025	<0.01	0.05	<0.01	<0.01	0.22	22	4.2	<0.01	<0.01	0.7	<0.01	<0.01	9.8	<0.01	<0.01
Fluorene	mg/kg	-	-	720	0.021	<0.01	0.041	<0.01	<0.01	<0.14	<0.01	<0.01	<0.01	3.4	0.18	<0.01	<0.01	0.072	<0.01	<0.01	1.3	<0.01	<0.01
Indeno(1,2,3-cd)pyrene	mg/kg	-	NC	0.78	0.056	0.085	0.097	<0.01	0.018	<0.01	<0.01	<0.01	0.026	3.1	0.55	<0.01	<0.01	0.12	<0.01	<0.01	0.086	<0.01	<0.01
Naphthalene	mg/kg	-	-	360	<0.01	<0.01	0.017	<0.01	<0.01	<0.12	<0.01	<0.01	<0.01	1.6	0.067	<0.01	<0.01	0.026	<0.01	<0.01	0.014	<0.01	<0.01
Perylene	mg/kg	-	-	-	0.032	0.02	0.038	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	1.8	0.26	<0.01	<0.01	0.073	<0.01	<0.01	0.098	<0.01	<0.01
Phenanthrene	mg/kg	-	-	-	0.22	0.022	0.34	<0.01	<0.01	<0.049	<0.01	<0.01	0.062	20	1.1	<0.01	<0.01	0.57	<0.01	<0.01	4.3	<0.01	<0.01
Pyrene	mg/kg	-	-	78	0.27	0.066	0.33	0.022	0.025	0.24	<0.01	<0.01	0.18	16	4.9	<0.01	<0.01	0.52	<0.01	<0.01	6.1	<0.01	<0.01
Quinoline	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
B(a)P TPE [3]	-	5.3	-	-	0.1539	0.1446	0.2361	0.0136	0.0167	0.0458	0.0126	0.0126	0.0785	**10.41**	2.07	0.0126	0.0126	0.38	0.0126	0.0126	0.6615	0.0126	0.0126

PARAMETER	UNITS	CCME RESIDENTIAL/PARKLAND [1]		OMOE [2]	Englobe 2018 Phase III ESA – Main Complex																		
		Ingestion and Dermal Contact	Produce, meat and milk	Soil Contact S1 Risk	CWT-MW7/1 0 - 0.7 m 18-Aug-18	CWT-MW13/1 0 - 0.6 m 18-Aug-18	CWT-MW13/3 1.8 - 2 m 18-Aug-18	CWT-TP15-18-A/1 0 - 0.6 m 16-Aug-18	CWT-TP15-18-A/3 1.4 - 1.8 m 16-Aug-18	CWT-TP15-18-B/1 0 - 0.6 m 16-Aug-18	CWT-TP15-18-B/3 1.4 - 1.8 m 16-Aug-18	CWT-TP15-18-C/1 0 - 0.6 m 16-Aug-18	CWT-TP15-18-C/2 0.6 - 0.9 m 16-Aug-18	CWT-TP15-18-D/1 0 - 0.6 m 16-Aug-18	CWT-TP15-18-D/3 1.5 - 1.7 m 16-Aug-18	CWT-TP15-18-E/3 1.4 - 1.7 m 16-Aug-18	CWT-TP15-18-F-A/1 0.3 - 0.6 m 16-Aug-18	CWT-TP15-18-F-A/3 1.8 m 16-Aug-18	CWT-MW14/1 0 - 0.2 m 16-Aug-18	CWT-TP17-18-A/1 0 - 0.2 m 16-Aug-18	CWT-TP17-18-B/1 0 - 0.7 m 16-Aug-18	CWT-TP17-18-C/1 0 - 0.3 m 16-Aug-18	CWT-TP17-18-D/1 0 - 0.3 m 16-Aug-18
1-Methylnaphthalene	mg/kg	-	-	72	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.47	0.1	<0.05	<0.05	1.07	<0.05	<0.05	0.12	<0.05	<0.05	<0.05	<0.05	<0.05
2-Methylnaphthalene	mg/kg	-	-	72	<0.01	0.01	0.06	<0.01	0.02	0.04	0.74	0.1	<0.01	<0.01	1.25	<0.01	<0.01	0.22	<0.01	<0.01	<0.01	<0.01	<0.01
Acenaphthene	mg/kg	-	-	78	<0.00671	0.0582	0.295	<0.00671	0.0602	0.117	2.97	0.114	0.0129	0.0308	0.0921	<0.00671	0.0149	0.0392	<0.00671	<0.00671	<0.00671	<0.00671	<0.00671
Acenaphthylene	mg/kg	-	-	7.8	<0.004	<0.004	0.031	<0.004	0.015	0.038	0.15	0.092	<0.004	<0.004	0.078	0.147	<0.004	0.086	<0.004	0.004	<0.004	<0.004	<0.004
Acridine	mg/kg	-	-	-	<0.05	<0.05	0.07	<0.05	<0.05	<0.05	0.79	<0.05	<0.05	<0.05	0.08	0.17	<0.05	0.08	<0.05	<0.05	<0.05	<0.05	<0.05
Anthracene	mg/kg	-	-	5400	<0.03	0.07	0.35	0.05	0.11	0.1	4.55	0.08	<0.03	0.04	0.07	0.05	<0.03	0.07	<0.03	<0.03	<0.03	<0.03	<0.03
Benzo(a)anthracene	mg/kg	-	NC	0.78	<0.01	0.19	0.93	0.15	0.27	0.29	9.37	0.35	0.05	0.1	0.2	0.03	0.05	0.06	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo(a)pyrene	mg/kg	-	NC	0.078	<0.01	0.16	1.03	<0.01	0.23	0.22	5.34	0.27	0.03	0.07	0.22	0.04	0.04	0.04	<0.01	0.02	<0.01	<0.01	<0.01
Benzo(b)fluoranthene	mg/kg	-	NC	0.78	<0.05	0.16	0.88	<0.05	0.3	<0.05	4.64	<0.05	<0.05	<0.05	0.22	<0.05	<0.05	<0.05	<0.05	0.05	<0.05	<0.05	<0.05
Benzo(b+j)fluoranthene	mg/kg	-	NC	-	<0.1	0.24	1.55	<0.1	0.45	<0.1	10.3	<0.1	<0.1	<0.1	0.31	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(e)pyrene	mg/kg	-	NC	-	<0.05	0.13	0.72	<0.05	0.26	0.25	3.08	0.36	<0.05	<0.05	0.17	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Benzo(g,h,i)perylene	mg/kg	-	NC	7.8	<0.01	0.13	0.76	<0.01	0.25	<0.01	3.2	<0.01	0.04	0.03	0.17	0.04	0.03	0.03	0.02	0.03	<0.01	<0.01	<0.01
Benzo(k)fluoranthene	mg/kg	-	NC	0.78	<0.01	0.09	0.37	<0.01	0.11	<0.01	2.2	<0.01	0.02	<0.01	0.09	0.03	<0.01	0.03	<0.01	0.02	<0.01	<0.01	<0.01
Chrysene	mg/kg	-	NC	7.8	<0.01	0.19	0.92	0.17	0.3	0.36	8.88	0.39	0.05	0.1	0.23	0.04	0.06	0.11	<0.01	0.03	<0.01	<0.01	<0.01
Dibenz(a,h)anthracene	mg/kg	-	NC	0.078	<0.006	0.029	0.168	<0.006	0.058	<0.006	1.06	<0.006	0.008	0.011	0.052	0.007	<0.006	0.008	<0.006	0.01	<0.006	<0.006	<0.006
Fluoranthene	mg/kg	-	-	7.8	<0.05	0.35	1.69	0.25	0.59	<0.05	24.7	<0.05	0.11	0.15	0.41	0.06	0.09	0.2	<0.05	<0.05	<0.05	<0.05	<0.05
Fluorene	mg/kg	-	-	720	<0.01	0.04	0.27	<0.01	0.05	<0.01	2.76	<0.01	0.01	0.02	0.1	<0.01	0.01	0.08	<0.01	<0.01	<0.01	<0.01	<0.01
Indeno(1,2,3-cd)pyrene	mg/kg	-	NC	0.78	<0.01	0.14	0.85	<0.01	0.24	<0.01	3.98	<0.01	0.03	0.03	0.18	0.04	0.03	0.03	0.02	0.03	<0.01	<0.01	<0.01
Naphthalene	mg/kg	-	-	360	<0.01	0.01	0.16	<0.01	0.02	<0.01	1.5	<0.01	<0.01	<0.01	0.17	<0.01	<0.01	0.05	<0.01	<0.01	<0.01	<0.01	<0.01
Perylene	mg/kg	-	-	-	<0.05	<0.05	0.28	<0.05	0.06	<0.05	1.3	<0.05	<0.05	<0.05	0.06	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Phenanthrene	mg/kg	-	-	-	<0.03	0.28	1.69	0.29	0.39	0.48	22.5	0.26	0.07	0.18	0.26	0.04	0.1	0.36	<0.03	<0.03	<0.03	<0.03	<0.03
Pyrene	mg/kg	-	-	78	<0.05	0.26	1.21	0.25	0.43	<0.05	16.4	<0.05	0.08	0.15	0.36	0.07	0.09	0.16	<0.05	<0.05	<0.05	<0.05	<0.05
Quinoline	mg/kg	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.11	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
B(a)P TPE [3]	-	5.3	-	-	0.0146	0.2582	1.58	0.0299	0.4005	0.2617	**9.11**	0.3180	0.0489	0.0959	0.3540	0.0563	0.0604	0.0599	0.0163	0.0351	0.0146	0.0146	0.0146

Notes:

value	-value exceeds CCME	-	-no guideline or value
[value]	-value exceeds OMOE	NC	-not calculated
0.96	-guidelines based on 10^{-6} ILCR, therefore not used		

[1] 1999 (with 2018 update) CCME *Canadian Environmental Quality Guidelines* for residential/parkland land use.

[2] 2011 Ontario Ministry of the Environment (OMOE) Table 3: Full Depth Generic Site Condition Standards in a Non-Potable Ground Water Condition, Residential/Parkland Land Use

[3] When the concentration was less than the RDL, half of the RDL was used in the benzo(a)pyrene potency equivalence factor (B(a)P TPE) calculations.

TABLE 3: POLYCYCLIC AROMATIC HYDROCARBONS in Soil - Human Health Guidelines
Client: Department of National Defence
Site Location: Former USAF Radar Station, Cartwright, NL
Englobe Project Number: P-0012285-0-16-200

PARAMETER	UNITS	CCME RESIDENTIAL/PARKLAND [1]		OMOE [2]	Englobe 2018 Phase III ESA																			
					Main Complex																			
		Ingestion and Dermal Contact	Produce, meat and milk	Soil Contact S1 Risk	CWT-MW15/1 0 - 0.6 m 16-Aug-18	CWT-TP25-18-A/1 0 - 0.3 m 17-Aug-18	CWT-TP25-18-A/2 0.3 - 0.9 m 17-Aug-18	CWT-TP25-18-B/2 0.9 - 1.5 m 17-Aug-18	CWT-TP25-18-C/2 0.7 - 1.5 m 17-Aug-18	CWT-TP25-18-D/1 0 - 0.4 m 17-Aug-18	CWT-TP25-18-D/2 0.4 - 1.6 m 17-Aug-18	CWT-SS13-18-A 0 - 0.25 m 16-Aug-18	CWT-SS13-18-B 0 - 0.3 m 16-Aug-18	CWT-SS13-18-C 0 - 0.2 m 16-Aug-18	CWT-SS13-18-D 0 - 0.3 m 16-Aug-18	CWT-SS23-18-A/1 0 - 0.3 m 16-Aug-18	CWT-SS23-18-B/1 0 - 0.3 m 16-Aug-18	CWT-SS23-18-C/1 0 - 0.3 m 16-Aug-18	CWT-TP11-18-A 0.5 m 17-Aug-18	CWT-TP11-18-B 0.4 m 17-Aug-18	CWT-TP11-18-C 0.4 m 17-Aug-18	CWT-TP11-18-D 0.5 m 17-Aug-18	CWT-TP30-18-A/1 0 - 0.6 m 17-Aug-18	CWT-TP30-18-A/2 1 - 1.4 m 17-Aug-18
1-Methylnaphthalene	mg/kg	-	-	72	<0.05	1.22	<0.05	<0.05	<0.05	1.01	<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
2-Methylnaphthalene	mg/kg	-	-	72	0.02	1.26	0.02	<0.01	<0.01	0.89	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
Acenaphthene	mg/kg	-	-	78	0.119	1.14	0.112	<0.00671	<0.00671	1.2	0.0515	0.013	<0.00671	<0.00671	<0.00671	<0.00671	<0.00671	0.0763	<0.00671	0.0397	<0.00671	<0.00671	<0.00671	<0.00671
Acenaphthylene	mg/kg	-	-	7.8	<0.004	<0.004	0.03	<0.004	<0.004	0.962	0.025	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	0.018	0.006	0.014	<0.004	<0.004
Acridine	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	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Anthracene	mg/kg	-	-	5400	0.16	<0.03	0.16	<0.03	<0.03	0.85	0.07	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	0.15	<0.03	0.19	<0.03	<0.03	<0.03	<0.03
Benzo(a)anthracene	mg/kg	-	NC	0.78	0.38	3.31	0.42	<0.01	<0.01	3.13	0.21	0.03	<0.01	0.02	<0.01	<0.01	0.02	0.3	<0.01	0.35	0.04	0.02	<0.01	0.02
Benzo(a)pyrene	mg/kg	-	NC	0.078	0.32	2.31	0.36	<0.01	<0.01	2.28	0.19	0.03	<0.01	<0.01	<0.01	<0.01	0.01	0.24	<0.01	0.28	0.06	0.02	<0.01	<0.01
Benzo(b)fluoranthene	mg/kg	-	NC	0.78	0.29	2.94	0.32	<0.05	<0.05	<0.05	0.18	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.23	<0.05	0.33	0.07	0.05	<0.05	<0.05
Benzo(b+j)fluoranthene	mg/kg	-	NC	-	0.52	4.97	0.54	<0.1	<0.1	<0.1	0.32	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.37	<0.1	0.46	0.1	<0.1	<0.1	<0.1
Benzo(e)pyrene	mg/kg	-	NC	-	0.24	2.65	0.26	<0.05	<0.05	2.58	0.16	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.22	<0.05	0.23	0.06	0.06	<0.05	<0.05
Benzo(g,h,i)perylene	mg/kg	-	NC	7.8	0.23	2.36	0.25	<0.01	<0.01	2.26	0.17	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	0.31	<0.01	0.2	0.05	0.03	<0.01	<0.01
Benzo(k)fluoranthene	mg/kg	-	NC	0.78	0.14	3.51	0.17	<0.01	<0.01	<0.01	0.08	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.14	<0.01	0.14	0.03	0.02	<0.01	<0.01
Chrysene	mg/kg	-	NC	7.8	0.4	3.07	0.41	<0.01	<0.01	3.08	0.23	0.03	<0.01	0.01	<0.01	<0.01	0.02	0.32	<0.01	0.38	0.05	0.06	<0.01	0.02
Dibenz(a,h)anthracene	mg/kg	-	NC	0.078	0.07	2.22	0.061	<0.006	<0.006	1.95	0.035	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	0.06	<0.006	0.051	0.013	0.011	<0.006	<0.006
Fluoranthene	mg/kg	-	-	7.8	0.77	<0.05	0.85	<0.05	<0.05	1.7	0.43	0.07	<0.05	<0.05	<0.05	<0.05	<0.05	0.73	<0.05	0.83	0.05	<0.05	<0.05	0.14
Fluorene	mg/kg	-	-	720	0.12	<0.01	0.09	<0.01	<0.01	1.14	0.05	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.07	<0.01	0.06	<0.01	<0.01	<0.01	<0.01
Indeno(1,2,3-cd)pyrene	mg/kg	-	NC	0.78	0.23	2.38	0.25	<0.01	<0.01	2.23	0.16	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	0.21	<0.01	0.23	0.05	0.03	<0.01	<0.01
Naphthalene	mg/kg	-	-	360	0.03	1.15	0.03	<0.01	<0.01	1.07	0.03	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Perylene	mg/kg	-	-	-	0.1	2.26	0.09	<0.05	<0.05	2.11	0.06	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.07	<0.05	0.06	<0.05	<0.05	<0.05	<0.05
Phenanthrene	mg/kg	-	-	-	0.76	1.73	0.72	<0.03	<0.03	1.83	0.36	0.1	<0.03	<0.03	<0.03	<0.03	<0.03	0.49	<0.03	0.49	<0.03	<0.03	<0.03	0.05
Pyrene	mg/kg	-	-	78	0.54	<0.05	0.61	<0.05	<0.05	<0.05	0.34	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.52	<0.05	0.57	0.05	<0.05	<0.05	0.12
Quinoline	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	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
B(a)P TPE [3]	-	5.3	-	-	0.5233	6.00	0.5656	0.0146	0.0146	4.82	0.3060	0.0440	0.0146	0.0162	0.0146	0.0146	0.0213	0.4083	0.0146	0.4548	0.0960	0.0379	0.0146	0.0163

PARAMETER	UNITS	CCME RESIDENTIAL/PARKLAND [1]		OMOE [2]	Englobe 2018 Phase III ESA				
					Main Complex				
		Ingestion and Dermal Contact	Produce, meat and milk	Soil Contact S1 Risk	CWT-TP30-18-B/1 0 - 0.6 m 17-Aug-18	CWT-TP30-18-B/2 1 - 1.2 m 17-Aug-18	CWT-TP30-18-C/1 0 - 0.6 m 17-Aug-18	CWT-TP30-18-C/2 1 - 1.5 m 17-Aug-18	CWT-TP30-18-D/2 0.8 m 17-Aug-18
1-Methylnaphthalene	mg/kg	-	-	72	<0.05	0.1	<0.05	0.42	<0.05
2-Methylnaphthalene	mg/kg	-	-	72	<0.01	0.1	<0.01	0.39	<0.01
Acenaphthene	mg/kg	-	-	78	<0.00671	0.508	<0.00671	0.283	<0.00671
Acenaphthylene	mg/kg	-	-	7.8	<0.004	<0.004	<0.004	0.063	<0.004
Acridine	mg/kg	-	-	-	<0.05	0.06	<0.05	<0.05	<0.05
Anthracene	mg/kg	-	-	5400	<0.03	0.17	<0.03	<0.03	<0.03
Benzo(a)anthracene	mg/kg	-	NC	0.78	<0.01	0.17	<0.01	0.03	<0.01
Benzo(a)pyrene	mg/kg	-	NC	0.078	<0.01	0.07	<0.01	<0.01	<0.01
Benzo(b)fluoranthene	mg/kg	-	NC	0.78	<0.05	0.06	<0.05	<0.05	<0.05
Benzo(b+j)fluoranthene	mg/kg	-	NC	-	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(e)pyrene	mg/kg	-	NC	-	<0.05	0.07	<0.05	<0.05	<0.05
Benzo(g,h,i)perylene	mg/kg	-	NC	7.8	<0.01	0.04	<0.01	<0.01	<0.01
Benzo(k)fluoranthene	mg/kg	-	NC	0.78	<0.01	0.05	<0.01	<0.01	<0.01
Chrysene	mg/kg	-	NC	7.8	<0.01	0.21	<0.01	0.02	<0.01
Dibenz(a,h)anthracene	mg/kg	-	NC	0.078	<0.006	<0.006	<0.006	<0.006	<0.006
Fluoranthene	mg/kg	-	-	7.8	<0.05	1.18	<0.05	0.07	<0.05
Fluorene	mg/kg	-	-	720	<0.01	0.61	<0.01	0.21	<0.01
Indeno(1,2,3-cd)pyrene	mg/kg	-	NC	0.78	<0.01	0.04	<0.01	<0.01	<0.01
Naphthalene	mg/kg	-	-	360	<0.01	0.14	<0.01	0.14	<0.01
Perylene	mg/kg	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05
Phenanthrene	mg/kg	-	-	-	<0.03	1.21	<0.03	0.11	<0.03
Pyrene	mg/kg	-	-	78	<0.05	0.77	<0.05	0.05	<0.05
Quinoline	mg/kg	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05
B(a)P TPE [3]	-	5.3	-	-	0.0146	0.0990	0.0146	0.0173	0.0146

Notes:

value	-value exceeds CCME	-	-no guideline or value
[value]	-value exceeds OMOE	NC	-not calculated
0.96	-guidelines based on 10^{-6} ILCR, therefore not used		

[1] 1999 (with 2018 update) CCME *Canadian Environmental Quality Guidelines* for residential/parkland land use.
[2] 2011 Ontario Ministry of the Environment (OMOE) Table 3: Full Depth Generic Site Condition Standards in a Non-Potable Ground Water Condition, Residential/Parkland Land Use
[3] When the concentration was less than the RDL, half of the RDL was used in the benzo(a)pyrene potency equivalence factor (B(a)P TPE) calculations.

TABLE 3: POLYCYCLIC AROMATIC HYDROCARBONS in Soil - Human Health Guidelines
Client: Department of National Defence
Site Location: Former USAF Radar Station, Cartwright, NL
Englobe Project Number: P-0012285-0-16-200

PARAMETER	UNITS	CCME RESIDENTIAL/PARKLAND [1]		OMOE [2]	Stantec 2018 Phase II ESA				Englobe 2018 Phase III ESA											
					Former USAF Dump Area and Ammunition Storage Area															
		Ingestion and Dermal Contact	Produce, meat and milk	Soil Contact S1 Risk	CWT-SS8 0 - 0.3 m	CWT-SS10 0 - 0.3 m	CWT-TP2-BS2 0.3 - 0.7 m	CWT-TP5-BS2 0.3 - 0.6 m	CWT-TP5-18-A/1 0 - 0.3 m 15-Aug-18	CWT-TP5-18-A/2 0.3 - 0.9 m 15-Aug-18	CWT-TP5-18-B/1 0 - 0.3 m 15-Aug-18	CWT-TP5-18-C/1 0 - 0.3 m 15-Aug-18	CWT-TP5-18-C/2 0.3 - 0.9 m 15-Aug-18	CWT-TP5-18-D/1 0 - 0.2 m 15-Aug-18	CWT-TP5-18-D/2 0.2 - 0.9 m 15-Aug-18	CWT-TP2-18A 0.7 0.3 - 0.7 m 15-Aug-18	CWT-TP2-18B 0.7 0.3 - 0.7 m 15-Aug-18	CWT-TP2-18C 0.7 0.3 - 0.7 m 15-Aug-18	CWT-TP2-18D 0.7 0.3 - 0.7 m 15-Aug-18	CWT-TP2-18E 0.7 0.3 - 0.7 m 15-Aug-18
1-Methylnaphthalene	mg/kg	-	-	72	<0.01	<0.01	<0.01	0.04	<0.05	<0.05	<0.05	0.08	<0.05	<0.05	<0.05	<0.05	<0.05	0.53	<0.05	<0.05
2-Methylnaphthalene	mg/kg	-	-	72	<0.01	<0.01	<0.01	0.047	0.03	<0.01	<0.01	0.08	<0.01	<0.01	<0.01	<0.01	<0.01	0.7	<0.01	<0.01
Acenaphthene	mg/kg	-	-	78	<0.01	<0.01	<0.01	0.065	<0.00671	<0.00671	<0.00671	<0.00671	<0.00671	<0.00671	<0.00671	<0.00671	<0.00671	5.13	<0.00671	<0.00671
Acenaphthylene	mg/kg	-	-	7.8	<0.01	<0.01	<0.01	<0.01	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	0.285	0.432	<0.004
Acridine	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
Anthracene	mg/kg	-	-	5400	<0.01	<0.01	<0.01	<0.01	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	15.9	0.76	<0.03
Benzo(a)anthracene	mg/kg	-	NC	0.78	<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	19.7	1.03	<0.01
Benzo(a)pyrene	mg/kg	-	NC	0.078	<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	14.5	2.48	<0.01
Benzo(b)fluoranthene	mg/kg	-	NC	0.78	<0.01	<0.01	<0.01	<0.01	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	12.6	3.35	<0.05
Benzo(b+j)fluoranthene	mg/kg	-	NC	-	<0.01	<0.01	<0.01	<0.01	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	20.3	5.38	<0.1
Benzo(e)pyrene	mg/kg	-	NC	-	-	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	7.71	2.07	<0.05
Benzo(g,h,i)perylene	mg/kg	-	NC	7.8	0.15	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	8.19	0.8	<0.01
Benzo(k)fluoranthene	mg/kg	-	NC	0.78	<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	3.93	1.19	<0.01
Chrysene	mg/kg	-	NC	7.8	<0.01	<0.01	0.013	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	16.1	2.54	<0.01
Dibenz(a,h)anthracene	mg/kg	-	NC	0.078	<0.01	<0.01	<0.01	<0.01	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	1.9	0.249	<0.006
Fluoranthene	mg/kg	-	-	7.8	<0.01	<0.01	0.015	<0.01	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	59.5	0.46	<0.05
Fluorene	mg/kg	-	-	720	<0.01	<0.01	<0.01	0.034	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	6.02	0.07	<0.01
Indeno(1,2,3-cd)pyrene	mg/kg	-	NC	0.78	<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	9.27	1.07	<0.01
Naphthalene	mg/kg	-	-	360	<0.01	<0.01	0.015	0.054	<0.01	<0.01	<0.01	0.12	<0.01	<0.01	<0.01	<0.01	<0.01	0.08	<0.01	<0.01
Perylene	mg/kg	-	-	-	0.15	<0.01	<0.01	<0.01	<0.05	<0.05	0.31	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	3.57	0.68	<0.05
Phenanthrene	mg/kg	-	-	-	<0.01	<0.01	0.027	0.052	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	46.8	<0.03	<0.03
Pyrene	mg/kg	-	-	78	<0.01	<0.01	<0.01	<0.01	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	41.8	1.14	<0.05
Quinoline	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
B(a)P TPE [3]	-	5.3	-	-	0.0141	0.0126	0.0127	0.0126	0.0146	0.0146	0.0146	0.0146	0.0146	0.0146	0.0146	0.0146	0.0146	21.96	3.63	0.0146

Notes:

value	-value exceeds CCME	-	-no guideline or value
value	-value exceeds OMOE	NC	-not calculated
0.96	-guidelines based on 10^{-6} ILCR, therefore not used		

[1] 1999 (with 2018 update) CCME *Canadian Environmental Quality Guidelines* for residential/parkland land use.
[2] 2011 Ontario Ministry of the Environment (OMOE) Table 3: Full Depth Generic Site Condition Standards in a Non-Potable Ground Water Condition, Residential/Parkland Land Use
[3] When the concentration was less than the RDL, half of the RDL was used in the benzo(a)pyrene potency equivalence factor (B(a)P TPE) calculations.

Englobe

TABLE 4: POLYCYCLIC AROMATIC HYDROCARBONS in Soil - Ecological Health Guidelines
Client: Department of National Defence
Site Location: Former USAF Radar Station, Cartwright, NL
Englobe Project Number: P-0012285-0-16-200

PARAMETER	UNITS	CCME RESIDENTIAL/PARKLAND 1,2			OMOE 3		Stantec 2018 Phase II ESA – General Area				
		Soil contact[1]	Soil and food ingestion[1]	Interim/ provisional SQC[2]	Plants & Soil Organism	Mammals & Birds	CWT-SS49 0 - 0.2 m	CWT-SS52 0 - 0.2 m	CWT-SS55 0 - 0.2 m	CWT-SS58 0 - 0.2 m	CWT-SS61 0 - 0.2 m
1-Methylnaphthalene	mg/kg	-	-	-	-	-	<0.01	<0.01	<0.01	<0.01	<0.01
2-Methylnaphthalene	mg/kg	-	-	-	-	-	<0.01	<0.01	<0.01	<0.01	<0.01
Acenaphthene	mg/kg	NC	21.5	-	-	6600	<0.01	<0.01	<0.01	<0.01	<0.01
Acenaphthylene	mg/kg	NC	NC	-	-	-	<0.01	<0.01	<0.01	<0.01	<0.01
Acridine	mg/kg	-	-	-	-	-	-	-	-	-	-
Anthracene	mg/kg	2.5	61.5	-	3.1	38000	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo(a)anthracene	mg/kg	NC	6.2	-	0.63	-	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo(a)pyrene	mg/kg	20	0.6	-	-	-	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo(b)fluoranthene	mg/kg	NC	6.2	1	-	-	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo(b+j)fluoranthene	mg/kg	-	-	-	-	-	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo(e)pyrene	mg/kg	-	-	-	-	-	-	-	-	-	-
Benzo(g,h,i)perylene	mg/kg	NC	NC	-	8.3	-	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo(k)fluoranthene	mg/kg	NC	6.2	-	9.5	-	<0.01	<0.01	<0.01	<0.01	<0.01
Chrysene	mg/kg	NC	6.2	-	8.8	-	<0.01	<0.01	<0.01	<0.01	<0.01
Dibenz(a,h)anthracene	mg/kg	NC	NC	1	-	-	<0.01	<0.01	<0.01	<0.01	<0.01
Fluoranthene	mg/kg	50	15.4	-	63	0.69	<0.01	<0.01	<0.01	<0.01	<0.01
Fluorene	mg/kg	NC	15.4	-	-	-	<0.01	<0.01	<0.01	<0.01	<0.01
Indeno(1,2,3-cd)pyrene	mg/kg	NC	NC	-	0.48	-	<0.01	<0.01	<0.01	<0.01	<0.01
Naphthalene	mg/kg	NC	8.8	-	0.75	380	<0.01	<0.01	<0.01	<0.01	<0.01
Perylene	mg/kg	-	-	-	-	-	<0.01	<0.01	<0.01	<0.01	<0.01
Phenanthrene	mg/kg	NC	43	-	7.8	2700	<0.01	<0.01	<0.01	<0.01	<0.01
Pyrene	mg/kg	-	-	-	-	4700	<0.01	<0.01	<0.01	<0.01	<0.01
Quinoline	mg/kg	NC	7.7	-	-	-	-	-	-	-	-

PARAMETER	UNITS	CCME RESIDENTIAL/PARKLAND 1,2			OMOE 3		Stantec 2018 Phase II ESA – Former Contractor Village					Englobe 2018 Phase III ESA – Former Contractor Village							
		Soil contact[1]	Soil and food ingestion[1]	Interim/ provisional SQC[2]	Plants & Soil Organism	Mammals & Birds	CWT-SS63 0 - 0.2 m	CWT-SS66 0 - 0.3 m	CWT-TP36-BS2 1.2 - 1.7 m	CWT-TP41-BS1 0.9 - 1.4 m	CWT-TP104-BS2 1.2 - 1.7 m	CWT-MW3/1 0 - 0.3 m 19-Aug-18	CWT-MW3/2 0.3 - 0.6 m 19-Aug-18	CWT-MW3/3 0.6 - 1.2 m 19-Aug-18	CWT-MW3/4 1.2 - 1.8 m 19-Aug-18	CWT-TP36-18-A 0 - 0.6 m 18-Aug-18	CWT-TP36-18-B 0 - 0.6 m 18-Aug-18	CWT-TP36-18-C 0 - 0.6 m 18-Aug-18	CWT-TP36-18-D 0 - 0.6 m 18-Aug-18
1-Methylnaphthalene	mg/kg	-	-	-	-	-	<0.01	<0.01	0.083	<0.01	0.25	<0.05	<0.05	<0.05	0.05	<0.05	0.08	<0.05	<0.05
2-Methylnaphthalene	mg/kg	-	-	-	-	-	<0.01	<0.01	0.11	<0.01	0.51	<0.01	<0.01	0.05	0.11	<0.01	<0.01	<0.01	<0.01
Acenaphthene	mg/kg	NC	21.5	-	-	6600	<0.01	<0.01	<0.01	<0.01	0.013	<0.00671	<0.00671	<0.00671	<0.00671	<0.00671	<0.00671	<0.00671	<0.00671
Acenaphthylene	mg/kg	NC	NC	-	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.004	<0.004	<0.004	<0.004	0.011	<0.004	<0.004	<0.004
Acridine	mg/kg	-	-	-	-	-	-	-	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Anthracene	mg/kg	2.5	61.5	-	3.1	38000	<0.01	<0.01	<0.01	<0.01	<0.01	<0.03	<0.03	<0.03	<0.03	<0.03	0.04	<0.03	<0.03
Benzo(a)anthracene	mg/kg	NC	6.2	-	0.63	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	0.07	<0.01	<0.01
Benzo(a)pyrene	mg/kg	20	0.6	-	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.04	<0.01	<0.01
Benzo(b)fluoranthene	mg/kg	NC	6.2	1	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.05	<0.05	<0.05	<0.05	<0.05	0.07	<0.05	<0.05
Benzo(b+j)fluoranthene	mg/kg	-	-	-	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.1	<0.1	<0.1	<0.1	<0.1	0.11	<0.1	<0.1
Benzo(e)pyrene	mg/kg	-	-	-	-	-	-	-	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Benzo(g,h,i)perylene	mg/kg	NC	NC	-	8.3	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	0.02	<0.01	<0.01
Benzo(k)fluoranthene	mg/kg	NC	6.2	-	9.5	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.05	<0.01	<0.01
Chrysene	mg/kg	NC	6.2	-	8.8	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.03	0.08	<0.01	<0.01
Dibenz(a,h)anthracene	mg/kg	NC	NC	1	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.006	<0.006	<0.006	<0.006	<0.006	0.009	<0.006	<0.006
Fluoranthene	mg/kg	50	15.4	-	63	0.69	<0.01	<0.01	<0.01	<0.01	<0.01	<0.05	<0.05	<0.05	<0.05	<0.05	0.15	<0.05	<0.05
Fluorene	mg/kg	NC	15.4	-	-	-	<0.01	<0.01	<0.01	<0.01	0.021	<0.01	<0.01	<0.01	<0.01	<0.01	0.03	<0.01	<0.01
Indeno(1,2,3-cd)pyrene	mg/kg	NC	NC	-	0.48	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	0.03	<0.01	<0.01
Naphthalene	mg/kg	NC	8.8	-	0.75	380	<0.01	<0.01	<0.026	<0.01	0.21	<0.01	<0.01	<0.01	<0.01	<0.01	0.66	<0.01	<0.01
Perylene	mg/kg	-	-	-	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Phenanthrene	mg/kg	NC	43	-	7.8	2700	<0.01	<0.01	<0.01	<0.01	0.012	<0.03	<0.03	<0.03	<0.03	<0.03	0.05	<0.03	<0.03
Pyrene	mg/kg	-	-	-	-	4700	<0.01	<0.01	<0.01	<0.01	<0.01	<0.05	<0.05	<0.05	<0.05	<0.05	0.2	<0.05	<0.05
Quinoline	mg/kg	NC	7.7	-	-	-	-	-	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05

Notes:

value	-value exceeds CCME
[value]	-value exceeds OMOE
0.96	-guidelines based on 10^{-6} ILCR, therefore not used
-	-no guideline or value
NC	-not calculated

1 1999 (with 2018 update) CCME *Canadian Environmental Quality Guidelines* for residential/parkland land use.

2 1991 CCME Interim soil quality criteria for residential/parkland land use.

3 2011 Ontario Ministry of the Environment (OMOE) Table 3: Full Depth, Non-Potable Water Scenario, Residential/Parkland Land Use

TABLE 4: POLYCYCLIC AROMATIC HYDROCARBONS in Soil - Ecological Health Guidelines
Client: Department of National Defence
Site Location: Former USAF Radar Station, Cartwright, NL
Englobe Project Number: P-0012285-0-16-200

PARAMETER	UNITS	CCME RESIDENTIAL/PARKLAND [1,2]			OMOE [3]		Stantec 2018 Phase II ESA – Main Complex																		
		Soil contact[1]	Soil and food ingestion[1]	Interim/ provisional SQC[2]	Plants & Soil Organism	Mammals & Birds	CWT-SS13	CWT-SS20	CWT-SS23	CWT-SS32	CWT-SS35	CWT-SS37	CWT-TP7-BS1	CWT-TP8-BS2	CWT-TP11-BS1	CWT-TP15-BS2	CWT-TP17-BS1	CWT-TP19-BS1	CWT-TP22-BS1	CWT-TP25-BS2	CWT-TP26-BS1	CWT-TP28-BS1	CWT-TP30-BS1	CWT-TP31-BS1	CWT-TP101-BS1
							0 - 0.3 m	0 - 0.2 m	0 - 0.2 m	0 - 0.2 m	0 - 0.2 m	0 - 0.2 m	0 - 0.3 m	0.3 - 0.6 m	0 - 0.5 m	1.2 - 1.8 m	0 - 0.5 m	0 - 0.5 m	0 - 0.3 m	1.0 - 1.5 m	0 - 0.5 m	0 - 0.5 m	0.1 - 0.6 m	0.1 -0.6 m	0 - 0.5 m
1-Methylnaphthalene	mg/kg	-	-	-	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.053	<0.01	<0.01	<0.01	0.41	0.018	<0.01	<0.01	<0.01	<0.01	<0.01	0.019	<0.01	<0.01
2-Methylnaphthalene	mg/kg	-	-	-	-	-	<0.01	<0.01	<0.01	<0.01	0.018	<0.095	<0.01	<0.01	<0.01	0.68	0.039	<0.01	<0.01	0.016	<0.01	<0.01	0.044	<0.01	<0.01
Acenaphthene	mg/kg	NC	21.5	-	-	6600	0.029	<0.01	0.056	<0.01	<0.01	<0.049	<0.01	<0.01	<0.01	4	0.096	<0.01	<0.01	0.088	<0.01	<0.01	1.8	<0.01	<0.01
Acenaphthylene	mg/kg	NC	NC	-	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.088	<0.01	<0.01	0.019	0.043	0.048	<0.01	<0.01	<0.01	<0.01	<0.01	0.08	<0.01	<0.01
Acridine	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Anthracene	mg/kg	2.5	61.5	-	3.1	38000	0.069	0.015	0.062	<0.01	<0.01	<0.056	<0.01	<0.01	0.047	**5.6**	0.49	<0.01	<0.01	0.14	<0.01	<0.01	0.53	<0.01	<0.01
Benzo(a)anthracene	mg/kg	NC	6.2	-	0.63	-	0.13	0.038	0.18	<0.01	<0.01	<0.087	<0.01	<0.01	0.066	**9.1**	1.7	<0.01	<0.01	0.26	<0.01	<0.01	1.5	<0.01	<0.01
Benzo(a)pyrene	mg/kg	20	0.6	-	-	-	0.1	0.072	0.15	<0.01	<0.01	<0.01	<0.01	<0.01	0.042	**6.9**	**1.3**	<0.01	<0.01	0.25	<0.01	<0.01	0.36	<0.01	<0.01
Benzo(b)fluoranthene	mg/kg	NC	6.2	1	-	-	0.075	0.18	0.14	0.013	0.033	0.18	<0.01	<0.01	0.096	**5.7**	**1.8**	<0.01	<0.01	0.25	<0.01	<0.01	0.48	<0.01	<0.01
Benzo(b+j)fluoranthene	mg/kg	-	-	-	-	-	0.123	0.257	0.226	0.013	0.033	0.18	<0.01	<0.01	0.149	9.2	2.8	<0.01	<0.01	0.39	<0.01	<0.01	0.78	<0.01	<0.01
Benzo(e)pyrene	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Benzo(g,h,i)perylene	mg/kg	NC	NC	-	8.3	-	0.069	0.089	0.11	<0.01	<0.01	<0.035	<0.01	<0.01	0.027	3.1	0.57	<0.01	<0.01	0.15	<0.01	<0.01	0.087	<0.01	<0.01
Benzo(k)fluoranthene	mg/kg	NC	6.2	-	9.5	-	0.049	0.075	0.086	<0.01	<0.01	<0.025	<0.01	<0.01	0.052	3.4	1	<0.01	<0.01	0.14	<0.01	<0.01	0.28	<0.01	<0.01
Chrysene	mg/kg	NC	6.2	-	8.8	-	0.14	0.12	0.21	0.023	<0.01	1.1	<0.01	<0.01	0.19	**9.1**	2.1	<0.01	<0.01	0.32	<0.01	<0.01	1.2	<0.01	<0.01
Dibenz(a,h)anthracene	mg/kg	NC	NC	1	-	-	0.016	0.025	0.024	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.91	0.14	<0.01	<0.01	0.037	<0.01	<0.01	0.024	<0.01	<0.01
Fluoranthene	mg/kg	50	15.4	-	63	0.69	0.36	0.074	0.47	0.025	<0.01	0.05	<0.01	<0.01	0.22	**22**	4.2	<0.01	<0.01	0.7	<0.01	<0.01	9.8	<0.01	<0.01
Fluorene	mg/kg	NC	15.4	-	-	-	0.021	<0.01	0.041	<0.01	<0.01	<0.14	<0.01	<0.01	<0.01	3.4	0.18	<0.01	<0.01	0.072	<0.01	<0.01	1.3	<0.01	<0.01
Indeno(1,2,3-cd)pyrene	mg/kg	NC	NC	-	0.48	-	0.056	0.085	0.097	<0.01	0.018	<0.01	<0.01	<0.01	0.026	3.1	0.55	<0.01	<0.01	0.12	<0.01	<0.01	0.086	<0.01	<0.01
Naphthalene	mg/kg	NC	8.8	-	0.75	380	<0.01	<0.01	0.017	<0.01	<0.01	<0.12	<0.01	<0.01	<0.01	1.6	0.067	<0.01	<0.01	0.026	<0.01	<0.01	0.014	<0.01	<0.01
Perylene	mg/kg	-	-	-	-	-	0.032	0.02	0.038	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	1.8	0.26	<0.01	<0.01	0.073	<0.01	<0.01	0.098	<0.01	<0.01
Phenanthrene	mg/kg	NC	43	-	7.8	2700	0.22	0.022	0.34	<0.01	<0.01	<0.049	<0.01	<0.01	0.062	20	1.1	<0.01	<0.01	0.57	<0.01	<0.01	4.3	<0.01	<0.01
Pyrene	mg/kg	-	-	-	-	4700	0.27	0.066	0.33	0.022	0.025	0.24	<0.01	<0.01	0.18	16	4.9	<0.01	<0.01	0.52	<0.01	<0.01	6.1	<0.01	<0.01
Quinoline	mg/kg	NC	7.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

PARAMETER	UNITS	CCME RESIDENTIAL/PARKLAND [1,2]			OMOE [3]		Englobe 2018 Phase III ESA – Main Complex																	
		Soil contact[1]	Soil and food ingestion[1]	Interim/ provisional SQC[2]	Plants & Soil Organism	Mammals & Birds	CWT-MW7/1	CWT-MW13/1	CWT-MW13/3	CWT-TP15-18-A/1	CWT-TP15-18-A/3	CWT-TP15-18-B/1	CWT-TP15-18-B/3	CWT-TP15-18-C/1	CWT-TP15-18-C/2	CWT-TP15-18-D/1	CWT-TP15-18-D/3	CWT-TP15-18-E/3	CWT-TP15-18-F-A/1	CWT-TP15-18-F-A/3	CWT-MW14/1	CWT-TP17-18-A/1	CWT-TP17-18-B/1
							0 - 0.7 m	0 - 0.6 m	1.8 - 2 m	0 - 0.6 m	1.4 - 1.8 m	0 - 0.6 m	1.4 - 1.8 m	0 - 0.6 m	0.6 - 0.9 m	0 - 0.6 m	1.5 - 1.7 m	1.4 - 1.7 m	0.3 - 0.6 m	1.8 m	0 - 0.2 m	0 - 0.2 m	0 - 0.7 m
							18-Aug-18	18-Aug-18	18-Aug-18	16-Aug-18	16-Aug-18	16-Aug-18	16-Aug-18	16-Aug-18	16-Aug-18	16-Aug-18	16-Aug-18	16-Aug-18	16-Aug-18	16-Aug-18	16-Aug-18	16-Aug-18	16-Aug-18
1-Methylnaphthalene	mg/kg	-	-	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.47	0.1	<0.05	<0.05	1.07	<0.05	<0.05	0.12	<0.05	<0.05	<0.05
2-Methylnaphthalene	mg/kg	-	-	-	-	-	<0.01	0.01	0.06	<0.01	0.02	0.04	0.74	0.1	<0.01	<0.01	1.25	<0.01	<0.01	0.22	<0.01	<0.01	<0.01
Acenaphthene	mg/kg	NC	21.5	-	-	6600	<0.00671	0.0582	0.295	<0.00671	0.0602	0.117	2.97	0.114	0.0129	0.0308	0.0921	<0.00671	0.0149	0.0392	<0.00671	<0.00671	<0.00671
Acenaphthylene	mg/kg	NC	NC	-	-	-	<0.004	<0.004	0.031	<0.004	0.015	0.038	0.15	0.092	<0.004	<0.004	0.078	0.147	<0.004	0.086	<0.004	0.004	<0.004
Acridine	mg/kg	-	-	-	-	-	<0.05	<0.05	0.07	<0.05	<0.05	<0.05	0.79	<0.05	<0.05	<0.05	0.08	0.17	<0.05	0.08	<0.05	<0.05	<0.05
Anthracene	mg/kg	2.5	61.5	-	3.1	38000	<0.03	0.07	0.35	0.05	0.11	0.1	**4.55**	0.08	<0.03	0.04	0.07	0.05	<0.03	0.07	<0.03	<0.03	<0.03
Benzo(a)anthracene	mg/kg	NC	6.2	-	0.63	-	<0.01	0.19	0.93	0.15	0.27	0.29	**9.37**	0.35	0.05	0.1	0.2	0.03	0.05	0.06	<0.01	<0.01	<0.01
Benzo(a)pyrene	mg/kg	20	0.6	-	-	-	<0.01	0.16	**1.03**	<0.01	0.23	0.22	**5.34**	0.27	0.03	0.07	0.22	0.04	0.04	0.04	<0.01	0.02	<0.01
Benzo(b)fluoranthene	mg/kg	NC	6.2	1	-	-	<0.05	0.16	0.88	<0.05	0.3	<0.05	**4.64**	<0.05	<0.05	<0.05	0.22	<0.05	<0.05	<0.05	<0.05	0.05	<0.05
Benzo(b+j)fluoranthene	mg/kg	-	-	-	-	-	<0.1	0.24	1.55	<0.1	0.45	<0.1	10.3	<0.1	<0.1	<0.1	0.31	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(e)pyrene	mg/kg	-	-	-	-	-	<0.05	0.13	0.72	<0.05	0.26	0.25	3.08	0.36	<0.05	<0.05	0.17	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Benzo(g,h,i)perylene	mg/kg	NC	NC	-	8.3	-	<0.01	0.13	0.76	<0.01	0.25	<0.01	3.2	<0.01	0.04	0.03	0.17	0.04	0.03	0.03	0.02	0.03	<0.01
Benzo(k)fluoranthene	mg/kg	NC	6.2	-	9.5	-	<0.01	0.09	0.37	<0.01	0.11	<0.01	2.2	<0.01	0.02	<0.01	0.09	0.03	<0.01	0.03	<0.01	0.02	<0.01
Chrysene	mg/kg	NC	6.2	-	8.8	-	<0.01	0.19	0.92	0.17	0.3	0.36	**8.88**	0.39	0.05	0.1	0.23	0.04	0.06	0.11	<0.01	0.03	<0.01
Dibenz(a,h)anthracene	mg/kg	NC	NC	1	-	-	<0.006	0.029	0.168	<0.006	0.058	<0.006	**1.06**	<0.006	0.008	0.011	0.052	0.007	<0.006	0.008	<0.006	0.01	<0.006
Fluoranthene	mg/kg	50	15.4	-	63	0.69	<0.05	0.35	1.69	0.25	0.59	<0.05	**24.7**	<0.05	0.11	0.15	0.41	0.06	0.09	0.2	<0.05	<0.05	<0.05
Fluorene	mg/kg	NC	15.4	-	-	-	<0.01	0.04	0.27	<0.01	0.05	<0.01	2.76	<0.01	0.01	0.02	0.1	<0.01	0.01	0.08	<0.01	<0.01	<0.01
Indeno(1,2,3-cd)pyrene	mg/kg	NC	NC	-	0.48	-	<0.01	0.14	0.85	<0.01	0.24	<0.01	3.98	<0.01	0.03	0.03	0.18	0.04	0.03	0.03	0.02	0.03	<0.01
Naphthalene	mg/kg	NC	8.8	-	0.75	380	<0.01	0.01	0.16	<0.01	0.02	<0.01	1.5	<0.01	<0.01	<0.01	0.17	<0.01	<0.01	0.05	<0.01	<0.01	<0.01
Perylene	mg/kg	-	-	-	-	-	<0.05	<0.05	0.28	<0.05	0.06	<0.05	1.3	<0.05	<0.05	<0.05	0.06	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Phenanthrene	mg/kg	NC	43	-	7.8	2700	<0.03	0.28	1.69	0.29	0.39	0.48	22.5	0.26	0.07	0.18	0.26	0.04	0.1	0.36	<0.03	<0.03	<0.03
Pyrene	mg/kg	-	-	-	-	4700	<0.05	0.26	1.21	0.25	0.43	<0.05	16.4	<0.05	0.08	0.15	0.36	0.07	0.09	0.16	<0.05	<0.05	<0.05
Quinoline	mg/kg	NC	7.7	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.11	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05

Notes:

value	-value exceeds CCME	-	-no guideline or value
[value]	-value exceeds OMOE	NC	-not calculated
0.96	-guidelines based on 10^{-6} ILCR, therefore not used		

[1] 1999 (with 2018 update) CCME *Canadian Environmental Quality Guidelines* for residential/parkland land use.
[2] 1991 CCME Interim soil quality criteria for residential/parkland land use.
[3] 2011 Ontario Ministry of the Environment (OMOE) Table 3: Full Depth, Non-Potable Water Scenario, Residential/Parkland Land Use

TABLE 4: POLYCYCLIC AROMATIC HYDROCARBONS in Soil - Ecological Health Guidelines
Client: Department of National Defence
Site Location: Former USAF Radar Station, Cartwright, NL
Englobe Project Number: P-0012285-0-16-200

PARAMETER	UNITS	CCME RESIDENTIAL/PARKLAND [1,2]			OMOE [3]		Englobe 2018 Phase III ESA – Main Complex																	
		Soil contact[1]	Soil and food ingestion[1]	Interim/ provisional SQC[2]	Plants & Soil Organism	Mammals & Birds	CWT-TP17-18-C/1 0 - 0.3 m 16-Aug-18	CWT-TP17-18-D/1 0 - 0.3 m 16-Aug-18	CWT-MW15/1 0 - 0.6 m 16-Aug-18	CWT-TP25-18-A/1 0 - 0.3 m 17-Aug-18	CWT-TP25-18-A/2 0.3 - 0.9 m 17-Aug-18	CWT-TP25-18-B/2 0.9 - 1.5 m 17-Aug-18	CWT-TP25-18-C/2 0.7 - 1.5 m 17-Aug-18	CWT-TP25-18-D/1 0 - 0.4 m 17-Aug-18	CWT-TP25-18-D/2 0.4 - 1.6 m 17-Aug-18	CWT-SS13-18-A 0 - 0.25 m 16-Aug-18	CWT-SS13-18-B 0 - 0.3 m 16-Aug-18	CWT-SS13-18-C 0 - 0.2 m 16-Aug-18	CWT-SS13-18-D 0 - 0.3 m 16-Aug-18	CWT-SS23-18-A/1 0 - 0.3 m 16-Aug-18	CWT-SS23-18-B/1 0 - 0.3 m 16-Aug-18	CWT-SS23-18-C/1 0 - 0.3 m 16-Aug-18	CWT-TP11-18-A 0.5 m 17-Aug-18	CWT-TP11-18-B 0.4 m 17-Aug-18
1-Methylnaphthalene	mg/kg	-	-	-	-	-	<0.05	<0.05	<0.05	1.22	<0.05	<0.05	<0.05	1.01	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
2-Methylnaphthalene	mg/kg	-	-	-	-	-	<0.01	<0.01	0.02	1.26	0.02	<0.01	<0.01	0.89	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	<0.01
Acenaphthene	mg/kg	NC	21.5	-	-	6600	<0.00671	<0.00671	0.119	1.14	0.112	<0.00671	<0.00671	1.2	0.0515	0.013	<0.00671	<0.00671	<0.00671	<0.00671	<0.00671	0.0763	<0.00671	0.0397
Acenaphthylene	mg/kg	NC	NC	-	-	-	<0.004	<0.004	<0.004	<0.004	0.03	<0.004	<0.004	0.962	0.025	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	0.018
Acridine	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	<0.05	<0.05	<0.05	<0.05
Anthracene	mg/kg	2.5	61.5	-	3.1	38000	<0.03	<0.03	0.16	<0.03	0.16	<0.03	<0.03	0.85	0.07	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	0.15	<0.03	0.19
Benzo(a)anthracene	mg/kg	NC	6.2	-	0.63	-	<0.01	<0.01	0.38	3.31	0.42	<0.01	<0.01	3.13	0.21	0.03	<0.01	0.02	<0.01	<0.01	0.02	0.3	<0.01	0.35
Benzo(a)pyrene	mg/kg	20	0.6	-	-	-	<0.01	<0.01	0.32	**2.31**	0.36	<0.01	<0.01	**2.28**	0.19	0.03	<0.01	<0.01	<0.01	<0.01	0.01	0.24	<0.01	0.28
Benzo(b)fluoranthene	mg/kg	NC	6.2	1	-	-	<0.05	<0.05	0.29	**2.94**	0.32	<0.05	<0.05	<0.05	0.18	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.23	<0.05	0.33
Benzo(b+j)fluoranthene	mg/kg	-	-	-	-	-	<0.1	<0.1	0.52	4.97	0.54	<0.1	<0.1	<0.1	0.32	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.37	<0.1	0.46
Benzo(e)pyrene	mg/kg	-	-	-	-	-	<0.05	<0.05	0.24	2.65	0.26	<0.05	<0.05	2.58	0.16	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.22	<0.05	0.23
Benzo(g,h,i)perylene	mg/kg	NC	NC	-	8.3	-	<0.01	<0.01	0.23	2.36	0.25	<0.01	<0.01	2.26	0.17	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	0.31	<0.01	0.2
Benzo(k)fluoranthene	mg/kg	NC	6.2	-	9.5	-	<0.01	<0.01	0.14	3.51	0.17	<0.01	<0.01	<0.01	0.08	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.14	<0.01	0.14
Chrysene	mg/kg	NC	6.2	-	8.8	-	<0.01	<0.01	0.4	3.07	0.41	<0.01	<0.01	3.08	0.23	0.03	<0.01	0.01	<0.01	<0.01	0.02	0.32	<0.01	0.38
Dibenz(a,h)anthracene	mg/kg	NC	NC	1	-	-	<0.006	<0.006	0.07	**2.22**	0.061	<0.006	<0.006	**1.95**	0.035	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	0.06	<0.006	0.051
Fluoranthene	mg/kg	50	15.4	-	63	0.69	<0.05	<0.05	0.77	<0.05	0.85	<0.05	<0.05	1.7	0.43	0.07	<0.05	<0.05	<0.05	<0.05	<0.05	0.73	<0.05	0.83
Fluorene	mg/kg	NC	15.4	-	-	-	<0.01	<0.01	0.12	<0.01	0.09	<0.01	<0.01	1.14	0.05	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.07	<0.01	0.06
Indeno(1,2,3-cd)pyrene	mg/kg	NC	NC	-	0.48	-	<0.01	<0.01	0.23	2.38	0.25	<0.01	<0.01	2.23	0.16	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	0.21	<0.01	0.23
Naphthalene	mg/kg	NC	8.8	-	0.75	380	<0.01	<0.01	0.03	1.15	0.03	<0.01	<0.01	1.07	0.03	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	<0.01	<0.01
Perylene	mg/kg	-	-	-	-	-	<0.05	<0.05	0.1	2.26	0.09	<0.05	<0.05	2.11	0.06	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.07	<0.05	0.06
Phenanthrene	mg/kg	NC	43	-	7.8	2700	<0.03	<0.03	0.76	1.73	0.72	<0.03	<0.03	1.83	0.36	0.1	<0.03	<0.03	<0.03	<0.03	<0.03	0.49	<0.03	0.49
Pyrene	mg/kg	-	-	-	-	4700	<0.05	<0.05	0.54	<0.05	0.61	<0.05	<0.05	<0.05	0.34	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.52	<0.05	0.57
Quinoline	mg/kg	NC	7.7	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05

PARAMETER	UNITS	CCME RESIDENTIAL/PARKLAND [1,2]			OMOE [3]		Englobe 2018 Phase III ESA – Main Complex								
		Soil contact[1]	Soil and food ingestion[1]	Interim/ provisional SQC[2]	Plants & Soil Organism	Mammals & Birds	CWT-TP11-18-C 0.4 m 17-Aug-18	CWT-TP11-18-D 0.5 m 17-Aug-18	CWT-TP30-18-A/1 0 - 0.6 m 17-Aug-18	CWT-TP30-18-A/2 1 - 1.4 m 17-Aug-18	CWT-TP30-18-B/1 0 - 0.6 m 17-Aug-18	CWT-TP30-18-B/2 1 - 1.2 m 17-Aug-18	CWT-TP30-18-C/1 0 - 0.6 m 17-Aug-18	CWT-TP30-18-C/2 1 - 1.5 m 17-Aug-18	CWT-TP30-18-D/2 0.8 m 17-Aug-18
1-Methylnaphthalene	mg/kg	-	-	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	0.1	<0.05	0.42	<0.05
2-Methylnaphthalene	mg/kg	-	-	-	-	-	<0.01	0.01	<0.01	<0.01	<0.01	0.1	<0.01	0.39	<0.01
Acenaphthene	mg/kg	NC	21.5	-	-	6600	<0.00671	<0.00671	<0.00671	<0.00671	<0.00671	0.508	<0.00671	0.283	<0.00671
Acenaphthylene	mg/kg	NC	NC	-	-	-	0.006	0.014	<0.004	<0.004	<0.004	<0.004	<0.004	0.063	<0.004
Acridine	mg/kg	-	-	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	0.06	<0.05	<0.05	<0.05
Anthracene	mg/kg	2.5	61.5	-	3.1	38000	<0.03	<0.03	<0.03	<0.03	<0.03	0.17	<0.03	<0.03	<0.03
Benzo(a)anthracene	mg/kg	NC	6.2	-	0.63	-	0.04	0.02	<0.01	0.02	<0.01	0.17	<0.01	0.03	<0.01
Benzo(a)pyrene	mg/kg	20	0.6	-	-	-	0.06	0.02	<0.01	<0.01	<0.01	0.07	<0.01	<0.01	<0.01
Benzo(b)fluoranthene	mg/kg	NC	6.2	1	-	-	0.07	0.05	<0.05	<0.05	<0.05	0.06	<0.05	<0.05	<0.05
Benzo(b+j)fluoranthene	mg/kg	-	-	-	-	-	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(e)pyrene	mg/kg	-	-	-	-	-	0.06	0.06	<0.05	<0.05	<0.05	0.07	<0.05	<0.05	<0.05
Benzo(g,h,i)perylene	mg/kg	NC	NC	-	8.3	-	0.05	0.03	<0.01	<0.01	<0.01	0.04	<0.01	<0.01	<0.01
Benzo(k)fluoranthene	mg/kg	NC	6.2	-	9.5	-	0.03	0.02	<0.01	<0.01	<0.01	0.05	<0.01	<0.01	<0.01
Chrysene	mg/kg	NC	6.2	-	8.8	-	0.05	0.06	<0.01	0.02	<0.01	0.21	<0.01	0.02	<0.01
Dibenz(a,h)anthracene	mg/kg	NC	NC	1	-	-	0.013	0.011	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006
Fluoranthene	mg/kg	50	15.4	-	63	0.69	0.05	<0.05	<0.05	0.14	<0.05	1.18	<0.05	0.07	<0.05
Fluorene	mg/kg	NC	15.4	-	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	0.61	<0.01	0.21	<0.01
Indeno(1,2,3-cd)pyrene	mg/kg	NC	NC	-	0.48	-	0.05	0.03	<0.01	<0.01	<0.01	0.04	<0.01	<0.01	<0.01
Naphthalene	mg/kg	NC	8.8	-	0.75	380	<0.01	<0.01	<0.01	<0.01	<0.01	0.14	<0.01	0.14	<0.01
Perylene	mg/kg	-	-	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Phenanthrene	mg/kg	NC	43	-	7.8	2700	<0.03	<0.03	<0.03	0.05	<0.03	1.21	<0.03	0.11	<0.03
Pyrene	mg/kg	-	-	-	-	4700	0.05	<0.05	<0.05	0.12	<0.05	0.77	<0.05	0.05	<0.05
Quinoline	mg/kg	NC	7.7	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05

Notes:

value	-value exceeds CCME	-	-no guideline or value
[value]	-value exceeds OMOE	NC	-not calculated
0.96	-guidelines based on 10^{-6} ILCR, therefore not used		

[1] 1999 (with 2018 update) CCME *Canadian Environmental Quality Guidelines* for residential/parkland land use.

[2] 1991 CCME Interim soil quality criteria for residential/parkland land use.

[3] 2011 Ontario Ministry of the Environment (OMOE) Table 3: Full Depth, Non-Potable Water Scenario, Residential/Parkland Land Use

TABLE 4: POLYCYCLIC AROMATIC HYDROCARBONS in Soil - Ecological Health Guidelines
Client: Department of National Defence
Site Location: Former USAF Radar Station, Cartwright, NL
Englobe Project Number: P-0012285-0-16-200

PARAMETER	UNITS	CCME RESIDENTIAL/PARKLAND [1,2]			OMOE [3]		Stantec 2018 Phase II ESA				Englobe 2018 Phase III ESA											
							Former USAF Dump Area and Ammunition Storage Area															
		Soil contact[1]	Soil and food ingestion[1]	Interim/ provisional SQC[2]	Plants & Soil Organism	Mammals & Birds	CWT-SS8 0 - 0.3 m	CWT-SS10 0 - 0.3 m	CWT-TP2-BS2 0.3 - 0.7 m	CWT-TP5-BS2 0.3 - 0.6 m	CWT-TP5-18-A/1 0 - 0.3 m 15-Aug-18	CWT-TP5-18-A/2 0.3 - 0.9 m 15-Aug-18	CWT-TP5-18-B/1 0 - 0.3 m 15-Aug-18	CWT-TP5-18-C/1 0 - 0.3 m 15-Aug-18	CWT-TP5-18-C/2 0.3 - 0.9 m 15-Aug-18	CWT-TP5-18-D/1 0 - 0.2 m 15-Aug-18	CWT-TP5-18-D/2 0.2 - 0.9 m 15-Aug-18	CWT-TP2-18A 0.7 0.3 - 0.7 m 15-Aug-18	CWT-TP2-18B 0.7 0.3 - 0.7 m 15-Aug-18	CWT-TP2-18C 0.7 0.3 - 0.7 m 15-Aug-18	CWT-TP2-18D 0.7 0.3 - 0.7 m 15-Aug-18	CWT-TP2-18E 0.7 0.3 - 0.7 m 15-Aug-18
1-Methylnaphthalene	mg/kg	-	-	-	-	-	<0.01	<0.01	<0.01	0.04	<0.05	<0.05	<0.05	0.08	<0.05	<0.05	<0.05	<0.05	<0.05	0.53	<0.05	<0.05
2-Methylnaphthalene	mg/kg	-	-	-	-	-	<0.01	<0.01	<0.01	0.047	0.03	<0.01	<0.01	0.08	<0.01	<0.01	<0.01	<0.01	<0.01	0.7	<0.01	<0.01
Acenaphthene	mg/kg	NC	21.5	-	-	6600	<0.01	<0.01	<0.01	0.065	<0.00671	<0.00671	<0.00671	<0.00671	<0.00671	<0.00671	<0.00671	<0.00671	<0.00671	5.13	<0.00671	<0.00671
Acenaphthylene	mg/kg	NC	NC	-	-	-	<0.01	<0.01	<0.01	<0.01	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	0.285	0.432	<0.004
Acridine	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
Anthracene	mg/kg	2.5	61.5	-	3.1	38000	<0.01	<0.01	<0.01	<0.01	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	15.9	0.76	<0.03
Benzo(a)anthracene	mg/kg	NC	6.2	-	0.63	-	<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	19.7	1.03	<0.01
Benzo(a)pyrene	mg/kg	20	0.6	-	-	-	<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	14.5	2.48	<0.01
Benzo(b)fluoranthene	mg/kg	NC	6.2	1	-	-	<0.01	<0.01	<0.01	<0.01	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	12.6	3.35	<0.05
Benzo(b+j)fluoranthene	mg/kg	-	-	-	-	-	<0.01	<0.01	<0.01	<0.01	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	20.3	5.38	<0.1
Benzo(e)pyrene	mg/kg	-	-	-	-	-	-	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	7.71	2.07	<0.05
Benzo(g,h,i)perylene	mg/kg	NC	NC	-	8.3	-	0.15	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	8.19	0.8	<0.01
Benzo(k)fluoranthene	mg/kg	NC	6.2	-	9.5	-	<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	3.93	1.19	<0.01
Chrysene	mg/kg	NC	6.2	-	8.8	-	<0.01	<0.01	0.013	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	16.1	2.54	<0.01
Dibenz(a,h)anthracene	mg/kg	NC	NC	1	-	-	<0.01	<0.01	<0.01	<0.01	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	1.9	0.249	<0.006
Fluoranthene	mg/kg	50	15.4	-	63	0.69	<0.01	<0.01	0.015	<0.01	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	59.5	0.46	<0.05
Fluorene	mg/kg	NC	15.4	-	-	-	<0.01	<0.01	<0.01	0.034	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	6.02	0.07	<0.01
Indeno(1,2,3-cd)pyrene	mg/kg	NC	NC	-	0.48	-	<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	9.27	1.07	<0.01
Naphthalene	mg/kg	NC	8.8	-	0.75	380	<0.01	<0.01	0.015	0.054	<0.01	<0.01	<0.01	0.12	<0.01	<0.01	<0.01	<0.01	<0.01	0.08	<0.01	<0.01
Perylene	mg/kg	-	-	-	-	-	0.15	<0.01	<0.01	<0.01	<0.05	<0.05	0.31	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	3.57	0.68	<0.05
Phenanthrene	mg/kg	NC	43	-	7.8	2700	<0.01	<0.01	0.027	0.052	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	46.8	<0.03	<0.03
Pyrene	mg/kg	-	-	-	-	4700	<0.01	<0.01	<0.01	<0.01	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	41.8	1.14	<0.05
Quinoline	mg/kg	NC	7.7	-	-	-	-	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05

Notes:

value	-value exceeds CCME	-	-no guideline or value
value	-value exceeds OMOE	NC	-not calculated
0.96	-guidelines based on 10^{-6} ILCR, therefore not used		

[1] 1999 (with 2018 update) CCME *Canadian Environmental Quality Guidelines* for residential/parkland land use.

[2] 1991 CCME Interim soil quality criteria for residential/parkland land use.

[3] 2011 Ontario Ministry of the Environment (OMOE) Table 3: Full Depth, Non-Potable Water Scenario, Residential/Parkland Land Use

TABLE 5: METALS in Soil - Human Health Guidelines
Client: Department of National Defence
Site Location: Former USAF Radar Station, Cartwright, NL
Englobe Project Number: P-0012285-0-16-200

PARAMETER	UNITS	CCME RESIDENTIAL/PARKLAND [1,2]			OMOE [3]	Stantec 2018 Phase II ESA										
						General Area										
		Ingestion and Dermal Contact[1]	Produce, meat and milk check	Interim SQC[2]	Soil Contact S1 Risk	CWT-SS43	CWT-SS44	CWT-SS48	CWT-SS49	CWT-SS52	CWT-SS54	CWT-SS56	CWT-SS57	CWT-SS58	CWT-SS60	CWT-SS62
						0 - 0.2 m	0 - 0.2 m	0 - 0.2 m	0 - 0.2 m	0 - 0.2 m	0 - 0.2 m	0 - 0.2 m	0 - 0.2 m	0 - 0.2 m	0 - 0.2 m	0 - 0.2 m
Aluminum (Al)	mg/kg	-	-	-	-	4800	5100	3300	4700	3600	7700	1900	11000	25000	7800	6400
Antimony (Sb)	mg/kg	-	-	20	7.5	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Arsenic (As)	mg/kg	12	NC	-	0.95	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Barium (Ba)	mg/kg	6800	NC	-	3800	27	40	35	59	18	18	35	48	40	41	90
Beryllium (Be)	mg/kg	75	NC	-	38	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Bismuth (Bi)	mg/kg	-	-	-	-	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Boron (B)	mg/kg	-	-	-	4300	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Cadmium (Cd)	mg/kg	14	NC	-	0.69	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Chromium (Cr)	mg/kg	220	NC	-	28000	7.5	11	9.1	8.6	7.5	9.3	<2	4.4	19	11	5
Cobalt (Co)	mg/kg	-	-	50	22	1.5	3.1	2.1	2.3	<1	<1	<1	1.1	1.4	2.8	1.5
Copper (Cu)	mg/kg	1100	NC	-	600	6.9	6	2.5	7.7	<2	3.2	<2	<2	3	6.1	5.4
Iron (Fe)	mg/kg	-	-	-	-	10000	13000	15000	13000	6100	6900	6300	34000	36000	20000	23000
Lead (Pb)	mg/kg	140	NC	-	200	4.4	4.3	2.5	5.8	6.8	3.8	1.6	3.4	6.2	4.6	8.1
Lithium (Li)	mg/kg	-	-	-	-	<2	4	3.5	4.7	<2	<2	<2	3.2	3.1	4.4	3.7
Manganese (Mn)	mg/kg	-	-	-	-	110	150	160	220	46	64	80	340	240	260	510
Mercury	mg/kg	6.6	NC	-	9.8	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Molybdenum (Mo)	mg/kg	-	-	10	110	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Nickel (Ni)	mg/kg	200	NC	-	330	2.9	5.1	3.8	3.2	<2	<2	<2	<2	<2	3.5	<2
Rubidium (Rb)	mg/kg	-	-	-	-	3.9	6.9	5.5	11	3.3	2	10	8.5	8.1	6.7	8.1
Selenium (Se)	mg/kg	80	NC	-	110	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Silver (Ag)	mg/kg	-	-	-	77	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Strontium (Sr)	mg/kg	-	-	-	-	8.1	8.6	6.7	9.3	<5	6.4	<5	<5	<5	7.8	6.4
Thallium (Tl)	mg/kg	1	NC	-	0.29	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Tin (Sn)	mg/kg	-	-	50	-	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Uranium (U)	mg/kg	23	NC	-	23	0.26	0.35	0.25	0.27	0.37	0.44	<0.1	0.16	0.69	0.43	0.26
Vanadium (V)	mg/kg	NC	NC	-	39	19	28	29	21	24	16	<2	23	***45***	32	12
Zinc (Zn)	mg/kg	10000	NC	-	5600	48	23	22	39	6	8	11	42	42	29	54

PARAMETER	UNITS	CCME RESIDENTIAL/PARKLAND [1,2]			OMOE [3]	Stantec 2018 Phase II ESA									
						Former Contractor Village									
		Ingestion and Dermal Contact[1]	Produce, meat and milk check	Interim SQC[2]	Soil Contact S1 Risk	CWT-SS63	CWT-SS65	CWT-SS67	CWT-SS68	CWT-TP36-BS1	CWT-TP37-BS1	CWT-TP39-BS1	CWT-TP40-BS1	CWT-TP42-BS1	CWT-TP105-BS1
						0 - 0.2 m	0 - 0.3 m	0 - 0.3 m	0 - 0.3 m	0.1 - 0.6 m	0 - 0.5 m	0 - 0.5 m	0 - 0.5 m	0.1 - 0.6 m	0.1 - 0.6 m
Aluminum (Al)	mg/kg	-	-	-	-	2300	3700	2300	4300	3700	3500	3100	4100	4600	5300
Antimony (Sb)	mg/kg	-	-	20	7.5	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Arsenic (As)	mg/kg	12	NC	-	0.95	<2	<2	2.2	<2	<2	<2	<2	<2	<2	2.1
Barium (Ba)	mg/kg	6800	NC	-	3800	13	34	17	35	36	31	28	42	32	32
Beryllium (Be)	mg/kg	75	NC	-	38	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Bismuth (Bi)	mg/kg	-	-	-	-	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Boron (B)	mg/kg	-	-	-	4300	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Cadmium (Cd)	mg/kg	14	NC	-	0.69	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Chromium (Cr)	mg/kg	220	NC	-	28000	3.7	7.3	3.5	7.3	10	5.7	6.6	7.5	14	18
Cobalt (Co)	mg/kg	-	-	50	22	1.4	2	1.7	2.4	2.6	2	1.6	2.7	2.7	2.9
Copper (Cu)	mg/kg	1100	NC	-	600	3.1	5	4.6	4	6.3	8.5	5.2	7.4	4	4
Iron (Fe)	mg/kg	-	-	-	-	6900	8800	8800	11000	9600	7400	8500	8200	16000	21000
Lead (Pb)	mg/kg	140	NC	-	200	4	23	8.1	9.9	6.1	5	9	15	1.9	2.7
Lithium (Li)	mg/kg	-	-	-	-	2.8	4.6	3.1	4.4	3.3	3.3	2.9	3.8	5.5	5.8
Manganese (Mn)	mg/kg	-	-	-	-	71	120	95	140	130	110	95	120	120	150
Mercury	mg/kg	6.6	NC	-	9.8	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Molybdenum (Mo)	mg/kg	-	-	10	110	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Nickel (Ni)	mg/kg	200	NC	-	330	2.5	3.6	3	3.5	6.3	3	2.8	5.4	5	5
Rubidium (Rb)	mg/kg	-	-	-	-	3.2	6.3	3.8	7.4	6.4	7.7	4.6	8.1	6.3	6
Selenium (Se)	mg/kg	80	NC	-	110	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Silver (Ag)	mg/kg	-	-	-	77	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Strontium (Sr)	mg/kg	-	-	-	-	7.8	7.9	6.3	8.2	10	8.9	7	11	8	10
Thallium (Tl)	mg/kg	1	NC	-	0.29	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Tin (Sn)	mg/kg	-	-	50	-	2.4	<2	<2	<2	29	<2	<2	<2	<2	<2
Uranium (U)	mg/kg	23	NC	-	23	0.3	0.27	0.19	0.28	0.31	0.29	0.33	0.34	0.5	0.7
Vanadium (V)	mg/kg	NC	NC	-	39	9.3	15	8.6	19	19	14	15	16	***43***	***61***
Zinc (Zn)	mg/kg	10000	NC	-	5600	12	29	23	25	34	26	23	23	17	19

Notes:

value	-value exceeds CCME	-	-no guideline or value
value	-value exceeds OMOE	NC	-not calculated
0.96	-guidelines based on 10^{-6} ILCR, therefore not used		

[1] 1999 (with 2018 update) CCME *Canadian Environmental Quality Guidelines* for residential/parkland land use.

[2] 1991 CCME Interim soil quality criteria for residential/parkland land use.

[3] 2011 Ontario Ministry of the Environment (OMOE) Table 3: Full Depth Generic Site Condition Standards in a Non-Potable Ground Water Condition, Residential/Parkland

TABLE 5: METALS in Soil - Human Health Guidelines
Client: Department of National Defence
Site Location: Former USAF Radar Station, Cartwright, NL
Englobe Project Number: P-0012285-0-16-200

PARAMETER	UNITS	CCME RESIDENTIAL/PARKLAND [1,2]			OMOE [3]	Stantec 2018 Phase II ESA														
						Main Complex Area														
		Ingestion and Dermal Contact[1]	Produce, meat and milk check	Interim SQC[2]	Soil Contact S1 Risk	CWT-SS13 0 - 0.3 m	CWT-SS14 0 - 0.2 m	CWT-SS16 0 - 0.2 m	CWT-SS18 0 - 0.2 m	CWT-SS20 0 - 0.2 m	CWT-SS22 0 - 0.2 m	CWT-SS24 0 - 0.2 m	CWT-SS26 0 - 0.2 m	CWT-SS28 0 - 0.2 m	CWT-SS30 0 - 0.2 m	CWT-SS31 0 - 0.2 m	CWT-SS32 0 - 0.2 m	CWT-SS34 0 - 0.2 m	CWT-SS35 0 - 0.2 m	CWT-SS36 0 - 0.2 m
Aluminum (Al)	mg/kg	-	-	-	-	4800	4800	7800	6000	8100	5800	4100	5700	6000	5200	4800	8900	8900	6600	17000
Antimony (Sb)	mg/kg	-	-	20	7.5	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Arsenic (As)	mg/kg	12	NC	-	0.95	<2	<2	2.2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Barium (Ba)	mg/kg	6800	NC	-	3800	61	63	140	36	54	47	48	67	33	39	79	46	28	40	450
Beryllium (Be)	mg/kg	75	NC	-	38	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Bismuth (Bi)	mg/kg	-	-	-	-	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Boron (B)	mg/kg	-	-	-	4300	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Cadmium (Cd)	mg/kg	14	NC	-	0.69	2.3	0.82	0.76	<0.3	1.3	0.69	<0.3	<0.3	<0.3	1.1	0.77	**49**	1.2	<0.3	<0.3
Chromium (Cr)	mg/kg	220	NC	-	28000	14	14	21	11	17	11	9	9	11	11	8	13	18	12	73
Cobalt (Co)	mg/kg	-	-	50	22	3.2	3.1	4.8	2.8	3.2	2.9	2.5	2.4	2.8	3.3	1.8	2.6	3.4	2.5	14
Copper (Cu)	mg/kg	1100	NC	-	600	19	36	24	7	13	37	9	6	10	12	12	8	9	6	3
Iron (Fe)	mg/kg	-	-	-	-	18000	12000	22000	13000	20000	15000	13000	16000	14000	12000	17000	16000	20000	14000	31000
Lead (Pb)	mg/kg	140	NC	-	200	120	110	**200**	24	23	63	63	13	20	18	62	11	9.4	7.5	2.0
Lithium (Li)	mg/kg	-	-	-	-	4.9	5.7	8.3	4.8	5.1	5.0	4.0	5.8	4.0	5.4	3.7	4.3	4.2	3.1	8.2
Manganese (Mn)	mg/kg	-	-	-	-	240	220	380	200	310	260	220	280	160	220	460	180	180	170	290
Mercury	mg/kg	6.6	NC	-	9.8	0.14	<0.1	0	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Molybdenum (Mo)	mg/kg	-	-	10	110	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Nickel (Ni)	mg/kg	200	NC	-	330	7	6	12	5	6	5	4	4	6	6	3	4	7	4	40
Rubidium (Rb)	mg/kg	-	-	-	-	7.1	6	13	6	4.9	6	6	8	5.4	7	5.2	8	5	6	35
Selenium (Se)	mg/kg	80	NC	-	110	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Silver (Ag)	mg/kg	-	-	-	77	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Strontium (Sr)	mg/kg	-	-	-	-	16	29	17	11	22	14	9	10	13	16	11	20	11	11	10
Thallium (Tl)	mg/kg	1	NC	-	0.29	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.25
Tin (Sn)	mg/kg	-	-	50	-	3.2	6.8	3.3	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Uranium (U)	mg/kg	23	NC	-	23	0.3	0.3	0.6	0.4	0.7	0.4	0.3	0.4	0.4	0.5	0.3	0.4	0.6	0.5	0.2
Vanadium (V)	mg/kg	NC	NC	-	39	26	19	21	26	34	25	21	24	31	26	13	31	***41***	27	***88***
Zinc (Zn)	mg/kg	10000	NC	-	5600	310	170	750	71	290	130	55	62	73	86	120	1400	48	33	57

Notes:

value	-value exceeds CCME	-	-no guideline or value
value	-value exceeds OMOE	NC	-not calculated
0.96	-guidelines based on 10^{-6} ILCR, therefore not used		

[1] 1999 (with 2018 update) CCME *Canadian Environmental Quality Guidelines* for residential/parkland land use.

[2] 1991 CCME Interim soil quality criteria for residential/parkland land use.

[3] 2011 Ontario Ministry of the Environment (OMOE) Table 3: Full Depth Generic Site Condition Standards in a Non-Potable Ground Water Condition, Residential/Parkland

TABLE 5: METALS in Soil - Human Health Guidelines
Client: Department of National Defence
Site Location: Former USAF Radar Station, Cartwright, NL
Englobe Project Number: P-0012285-0-16-200

Stantec 2018 Phase II ESA – Main Complex Area

PARAMETER	UNITS	CCME RESIDENTIAL/PARKLAND [1,2] Ingestion and Dermal Contact[1]	CCME RESIDENTIAL/PARKLAND [1,2] Produce, meat and milk check	CCME RESIDENTIAL/PARKLAND [1,2] Interim SQC[2]	OMOE [3] Soil Contact S1 Risk	CWT-SS37 0 - 0.2 m	CWT-SS41 0 - 0.2 m	CWT-TP6-BS1 0 - 0.6 m	CWT-TP8-BS2 0.3 - 0.6 m	CWT-TP10-BS1 0 - 0.5 m	CWT-TP11-BS1 0 - 0.5 m	CWT-TP14-BS1 0.1 - 0.5 m	CWT-TP15-BS1 0.1 - 0.6 m	CWT-TP16-BS1 0 - 0.5 m	CWT-TP18-BS1 0 - 0.3 m
Aluminum (Al)	mg/kg	-	-	-	-	7700	9000	5100	7400	16000	6100	4900	6200	5600	5800
Antimony (Sb)	mg/kg	-	-	20	7.5	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Arsenic (As)	mg/kg	12	NC	-	0.95	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Barium (Ba)	mg/kg	6800	NC	-	3800	76	39	20	89	28	42	62	57	40	22
Beryllium (Be)	mg/kg	75	NC	-	38	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Bismuth (Bi)	mg/kg	-	-	-	-	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Boron (B)	mg/kg	-	-	-	4300	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Cadmium (Cd)	mg/kg	14	NC	-	0.69	0.34	6.5	<0.3	<0.3	<0.3	<0.3	<0.3	0.38	<0.3	<0.3
Chromium (Cr)	mg/kg	220	NC	-	28000	10	17	12	9	18	11	9	12	10	15
Cobalt (Co)	mg/kg	-	-	50	22	2.9	2.7	1.5	2.2	2.1	2	2.7	2.9	2.5	2.9
Copper (Cu)	mg/kg	1100	NC	-	600	6	10	4	5	4	7	6	13	5	7
Iron (Fe)	mg/kg	-	-	-	-	12000	21000	14000	21000	18000	15000	15000	16000	14000	17000
Lead (Pb)	mg/kg	140	NC	-	200	6.6	24	7.2	18	3.1	9.4	22	43	3	2.5
Lithium (Li)	mg/kg	-	-	-	-	2.3	3.0	<2	2.9	2.7	3.4	4.4	4.7	4.9	3.1
Manganese (Mn)	mg/kg	-	-	-	-	170	170	95	260	110	190	370	230	200	130
Mercury	mg/kg	6.6	NC	-	9.8	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Molybdenum (Mo)	mg/kg	-	-	10	110	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Nickel (Ni)	mg/kg	200	NC	-	330	5	6	3	3	4	4	3	6	4	5
Rubidium (Rb)	mg/kg	-	-	-	-	5.7	4	2.7	19	3.2	5	7	8	6.7	4
Selenium (Se)	mg/kg	80	NC	-	110	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Silver (Ag)	mg/kg	-	-	-	77	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Strontium (Sr)	mg/kg	-	-	-	-	12	14	12	11	11	13	17	17	10	10
Thallium (Tl)	mg/kg	1	NC	-	0.29	<0.1	<0.1	0.18	<0.1	0.13	<0.1	<0.1	<0.1	<0.1	<0.1
Tin (Sn)	mg/kg	-	-	50	-	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Uranium (U)	mg/kg	23	NC	-	23	0.5	0.4	0.4	0.4	0.5	0.4	0.3	0.5	0.5	0.4
Vanadium (V)	mg/kg	NC	NC	-	39	28	***42***	29	36	***45***	27	23	31	29	***41***
Zinc (Zn)	mg/kg	10000	NC	-	5600	51	300	37	42	16	45	86	120	27	16

PARAMETER	CWT-TP20-BS1 0.1 - 0.6 m	CWT-TP21-BS1 0 - 0.5 m	CWT-TP23-BS1 0 - 0.4 m	CWT-TP24-BS1 0.2 - 0.7 m	CWT-TP25-BS1 0 .1 - 0.5 m	CWT-TP26-BS1 0 - 0.5 m	CWT-TP27-BS2 1.1 - 1.6 m	CWT-TP28-BS1 0 - 0.5 m	CWT-TP29-BS2 1.2 - 1.7 m	CWT-TP30-BS1 0.1 - 0.6 m	CWT-TP31-BS2 1.2 - 1.7 m	CWT-TP100-BS1 0 - 0.3 m	CWT-TP101-BS1 0 - 0.5 m	CWT-TP102-BS1 0.1 - 0.6 m
Aluminum (Al)	5200	6900	7100	6200	8100	8000	6100	6400	6500	6300	13000	6100	6700	4500
Antimony (Sb)	<2	<2	<2	<2	<2	<2	<2	<2	<2	5.4	<2	<2	<2	<2
Arsenic (As)	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Barium (Ba)	28	43	22	40	66	94	25	28	28	73	170	27	64	26
Beryllium (Be)	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Bismuth (Bi)	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Boron (B)	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Cadmium (Cd)	<0.3	<0.3	<0.3	<0.3	2.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Chromium (Cr)	16	12	12	14	17	6	11	12	12	7	5	15	6	14
Cobalt (Co)	3.4	3.3	2.3	2.4	3	2	2.2	2.2	2.5	1.7	2.2	2.7	1.8	2.8
Copper (Cu)	7	7	12	10	20	5	5	8	6	9	7	7	4	7
Iron (Fe)	18000	15000	15000	13000	18000	29000	13000	12000	14000	18000	43000	16000	23000	16000
Lead (Pb)	3.2	7.4	5.2	9.0	92.0	7.5	4.4	6.9	5.1	14.0	5.3	2.9	5.9	2.3
Lithium (Li)	3.3	4.6	3.0	3.9	4.8	4.2	2.8	3.2	3.1	3.5	6.8	3.1	3.2	2.7
Manganese (Mn)	140	180	120	140	290	760	110	120	150	470	760	140	450	130
Mercury	<0.1	<0.1	<0.1	<0.1	0.18	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Molybdenum (Mo)	<2	<2	<2	<2	9.7	<2	<2	<2	<2	<2	<2	<2	<2	<2
Nickel (Ni)	5	5	4	4	7	<2	4	4	4	5	<2	5	<2	5
Rubidium (Rb)	4	7	3.2	6	5.2	13	5	5	5	6	18	4	9.2	3
Selenium (Se)	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Silver (Ag)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Strontium (Sr)	11	16	11	9	24	6	8	9	10	7	7	10	6	11
Thallium (Tl)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.11	<0.1	<0.1	<0.1
Tin (Sn)	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Uranium (U)	0.4	0.4	0.4	0.4	0.6	0.4	0.4	0.4	0.4	0.4	0.7	0.4	0.3	0.4
Vanadium (V)	***46***	32	35	32	32	19	31	30	33	18	8	37	19	38
Zinc (Zn)	18	34	50	36	570	77	50	68	25	110	120	18	55	14

Englobe 2018 Phase III ESA – Main Complex Area

PARAMETER	UNITS	CCME RESIDENTIAL/PARKLAND [1,2] Ingestion and Dermal Contact[1]	CCME RESIDENTIAL/PARKLAND [1,2] Produce, meat and milk check	CCME RESIDENTIAL/PARKLAND [1,2] Interim SQC[2]	OMOE [3] Soil Contact S1 Risk	CWT-SS16-18-A/1 0 - 0.3 m 17-Aug-18	CWT-SS16-18-B/1 0 - 0.3 m 17-Aug-18	CWT-SS16-18-C/1 0 - 0.3 m 17-Aug-18	CWT-SS32-18-A 0 - 0.3 m 17-Aug-18	CWT-SS32-18-B 0 - 0.4 m 17-Aug-18	CWT-SS32-18-C 0 - 0.4 m 17-Aug-18	CWT-SS32-18-D 0 - 0.3 m 17-Aug-18
Aluminum (Al)	mg/kg	-	-	-	-	-	-	-	-	-	-	-
Antimony (Sb)	mg/kg	-	-	20	7.5	-	-	-	-	-	-	-
Arsenic (As)	mg/kg	12	NC	-	0.95	-	-	-	-	-	-	-
Barium (Ba)	mg/kg	6800	NC	-	3800	-	-	-	-	-	-	-
Beryllium (Be)	mg/kg	75	NC	-	38	-	-	-	-	-	-	-
Bismuth (Bi)	mg/kg	-	-	-	-	-	-	-	-	-	-	-
Boron (B)	mg/kg	-	-	-	4300	-	-	-	-	-	-	-
Cadmium (Cd)	mg/kg	14	NC	-	0.69	-	-	-	0.8	0.7	1.1	0.7
Chromium (Cr)	mg/kg	220	NC	-	28000	-	-	-	-	-	-	-
Cobalt (Co)	mg/kg	-	-	50	22	-	-	-	-	-	-	-
Copper (Cu)	mg/kg	1100	NC	-	600	-	-	-	-	-	-	-
Iron (Fe)	mg/kg	-	-	-	-	-	-	-	-	-	-	-
Lead (Pb)	mg/kg	140	NC	-	200	-	-	-	-	-	-	-
Lithium (Li)	mg/kg	-	-	-	-	-	-	-	-	-	-	-
Manganese (Mn)	mg/kg	-	-	-	-	-	-	-	-	-	-	-
Mercury	mg/kg	6.6	NC	-	9.8	-	-	-	-	-	-	-
Molybdenum (Mo)	mg/kg	-	-	10	110	-	-	-	-	-	-	-
Nickel (Ni)	mg/kg	200	NC	-	330	-	-	-	-	-	-	-
Rubidium (Rb)	mg/kg	-	-	-	-	-	-	-	-	-	-	-
Selenium (Se)	mg/kg	80	NC	-	110	-	-	-	-	-	-	-
Silver (Ag)	mg/kg	-	-	-	77	-	-	-	-	-	-	-
Strontium (Sr)	mg/kg	-	-	-	-	-	-	-	-	-	-	-
Thallium (Tl)	mg/kg	1	NC	-	0.29	-	-	-	-	-	-	-
Tin (Sn)	mg/kg	-	-	50	-	-	-	-	-	-	-	-
Uranium (U)	mg/kg	23	NC	-	23	-	-	-	-	-	-	-
Vanadium (V)	mg/kg	NC	NC	-	39	-	-	-	-	-	-	-
Zinc (Zn)	mg/kg	10000	NC	-	5600	531	44	137	91	76	92	82

Notes:

value	-value exceeds CCME
value	-value exceeds OMOE
0.96	-guidelines based on 10^{-6} ILCR, therefore not used
-	-no guideline or value
NC	-not calculated

[1] 1999 (with 2018 update) CCME *Canadian Environmental Quality Guidelines* for residential/parkland land use.

[2] 1991 CCME Interim soil quality criteria for residential/parkland land use.

[3] 2011 Ontario Ministry of the Environment (OMOE) Table 3: Full Depth Generic Site Condition Standards in a Non-Potable Ground Water Condition, Residential/Parkland

TABLE 5: METALS in Soil - Human Health Guidelines
Client: Department of National Defence
Site Location: Former USAF Radar Station, Cartwright, NL
Englobe Project Number: P-0012285-0-16-200

PARAMETER	UNITS	CCME RESIDENTIAL/PARKLAND [1,2]			OMOE [3]	Stantec 2018 Phase II ESA														
						Former USAF Dump Area and Ammunition Storage Area														
		Ingestion and Dermal Contact[1]	Produce, meat and milk check	Interim SQC[2]	Soil Contact S1 Risk	CWT-SS1	CWT-SS2	CWT-SS3	CWT-SS4	CWT-SS7	CWT-SS8	CWT-SS10	CWT-SS11	CWT-SS12	CWT-SS70	CWT-TP1-BS1	CWT-TP2-BS2	CWT-TP3-BS2	CWT-TP4-BS1	CWT-TP5-BS2
						0 - 0.2 m	0 - 0.2 m	0 - 0.2 m	0 - 0.2 m	0 - 0.3 m	0 - 0.3 m	0 - 0.3 m	0 - 0.3 m	0 - 0.3 m	0 - 0.3 m	0 - 0.3 m	0.3 - 0.7 m	0.4 - 0.8 m	0 - 0.5 m	0.3 - 0.6 m
Aluminum (Al)	mg/kg	-	-	-	-	5300	3900	5000	3700	6600	5600	6200	4200	4400	6400	7900	6500	6200	7400	5800
Antimony (Sb)	mg/kg	-	-	20	7.5	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	2.7	3.2	<2	<2
Arsenic (As)	mg/kg	12	NC	-	0.95	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Barium (Ba)	mg/kg	6800	NC	-	3800	77	30	93	49	49	100	41	14	21	48	15	37	39	14	58
Beryllium (Be)	mg/kg	75	NC	-	38	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Bismuth (Bi)	mg/kg	-	-	-	-	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Boron (B)	mg/kg	-	-	-	4300	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Cadmium (Cd)	mg/kg	14	NC	-	0.69	<0.3	<0.3	<0.3	<0.3	<0.3	0.44	<0.3	<0.3	<0.3	<0.3	<0.3	0.65	2	<0.3	<0.3
Chromium (Cr)	mg/kg	220	NC	-	28000	6	6	5	5	11	4	13	7	9	12	10	13	13	10	12
Cobalt (Co)	mg/kg	-	-	50	22	2	1.5	1.7	1.8	2.5	1.4	2.7	1	<1	2.5	1.1	3.2	4.1	2.1	1.7
Copper (Cu)	mg/kg	1100	NC	-	600	7	4	7	11	9	7	8	<2	4	9	<2	47	25	5	3
Iron (Fe)	mg/kg	-	-	-	-	18000	11000	19000	13000	11000	30000	14000	13000	3300	11000	20000	18000	13000	13000	12000
Lead (Pb)	mg/kg	140	NC	-	200	9.8	12.0	11.0	25.0	3.7	5.4	5.1	6.6	4.6	3.4	5.1	65.0	**180.0**	6.6	3.2
Lithium (Li)	mg/kg	-	-	-	-	4.6	2.6	4.2	3.6	5.1	<2	3.7	<2	<2	4.8	<2	3.4	3.6	2.6	2.6
Manganese (Mn)	mg/kg	-	-	-	-	450	130	540	350	150	290	220	81	52	140	75	230	160	90	110
Mercury	mg/kg	6.6	NC	-	9.8	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.13	0.14	<0.1	<0.1
Molybdenum (Mo)	mg/kg	-	-	10	110	<2	<2	<2	<2	<2	2.6	<2	<2	<2	<2	<2	<2	6	<2	<2
Nickel (Ni)	mg/kg	200	NC	-	330	2	2	2	3	8	4	5	<2	2	7	<2	7	12	4	3
Rubidium (Rb)	mg/kg	-	-	-	-	5.9	6	6	6	5.3	2	6	6	2.4	5	2.7	5	5	3	4
Selenium (Se)	mg/kg	80	NC	-	110	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Silver (Ag)	mg/kg	-	-	-	77	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Strontium (Sr)	mg/kg	-	-	-	-	8	5	8	6	12	37	12	<5.0	5	11	5	10	12	6	12
Thallium (Tl)	mg/kg	1	NC	-	0.29	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Tin (Sn)	mg/kg	-	-	50	-	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	6.1	14	<2	<2
Uranium (U)	mg/kg	23	NC	-	23	0.4	0.3	0.3	0.3	0.6	0.4	0.5	0.3	0.4	0.5	0.5	0.4	0.4	0.5	0.5
Vanadium (V)	mg/kg	NC	NC	-	39	14	20	13	11	24	9	33	30	13	23	26	29	29	38	22
Zinc (Zn)	mg/kg	10000	NC	-	5600	78	26	80	45	150	380	29	12	6	130	11	170	1800	17	170

PARAMETER	UNITS	CCME RESIDENTIAL/PARKLAND [1,2]			OMOE [3]	Englobe 2018 Phase III ESA											
						Former USAF Dump Area and Ammunition Storage Area											
		Ingestion and Dermal Contact[1]	Produce, meat and milk check	Interim SQC[2]	Soil Contact S1 Risk	CWT-TP3-18-A/1	CWT-TP3-18-A/2	CWT-TP3-18-B/1	CWT-TP3-18-B/2	CWT-TP3-18-D/1	CWT-TP3-18-D/2	CWT-TP3-18-E/1	CWT-TP3-18-E/2	CWT-SS8-18-A/1	CWT-SS8-18-B/1	CWT-SS8-18-C/1	CWT-SS8-18-D/1
						0 - 0.8 m	0.8 - 1.5 m	0 - 0.8 m	0.8 - 1.5 m	0 - 0.3 m	0.3 - 0.8 m	0 - 0.3 m	0.3 - 0.9 m	0 - 0.6 m	0 - 0.6 m	0 - 0.6 m	0 - 0.6 m
						15-Aug-18	15-Aug-18	15-Aug-18	15-Aug-18	15-Aug-18	15-Aug-18	15-Aug-18	15-Aug-18	15-Aug-18	15-Aug-18	15-Aug-18	15-Aug-18
Aluminum (Al)	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Antimony (Sb)	mg/kg	-	-	20	7.5	-	-	-	-	-	-	-	-	-	-	-	-
Arsenic (As)	mg/kg	12	NC	-	0.95	-	-	-	-	-	-	-	-	-	-	-	-
Barium (Ba)	mg/kg	6800	NC	-	3800	-	-	-	-	-	-	-	-	-	-	-	-
Beryllium (Be)	mg/kg	75	NC	-	38	-	-	-	-	-	-	-	-	-	-	-	-
Bismuth (Bi)	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Boron (B)	mg/kg	-	-	-	4300	-	-	-	-	-	-	-	-	-	-	-	-
Cadmium (Cd)	mg/kg	14	NC	-	0.69	-	-	-	-	-	-	-	-	-	-	-	-
Chromium (Cr)	mg/kg	220	NC	-	28000	-	-	-	-	-	-	-	-	-	-	-	-
Cobalt (Co)	mg/kg	-	-	50	22	-	-	-	-	-	-	-	-	-	-	-	-
Copper (Cu)	mg/kg	1100	NC	-	600	-	-	-	-	-	-	-	-	-	-	-	-
Iron (Fe)	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lead (Pb)	mg/kg	140	NC	-	200	-	-	-	-	-	-	-	-	-	-	-	-
Lithium (Li)	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Manganese (Mn)	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mercury	mg/kg	6.6	NC	-	9.8	-	-	-	-	-	-	-	-	-	-	-	-
Molybdenum (Mo)	mg/kg	-	-	10	110	-	-	-	-	-	-	-	-	-	-	-	-
Nickel (Ni)	mg/kg	200	NC	-	330	-	-	-	-	-	-	-	-	-	-	-	-
Rubidium (Rb)	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Selenium (Se)	mg/kg	80	NC	-	110	-	-	-	-	-	-	-	-	-	-	-	-
Silver (Ag)	mg/kg	-	-	-	77	-	-	-	-	-	-	-	-	-	-	-	-
Strontium (Sr)	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Thallium (Tl)	mg/kg	1	NC	-	0.29	-	-	-	-	-	-	-	-	-	-	-	-
Tin (Sn)	mg/kg	-	-	50	-	-	-	-	-	-	-	-	-	-	-	-	-
Uranium (U)	mg/kg	23	NC	-	23	-	-	-	-	-	-	-	-	-	-	-	-
Vanadium (V)	mg/kg	NC	NC	-	39	-	-	-	-	-	-	-	-	-	-	-	-
Zinc (Zn)	mg/kg	10000	NC	-	5600	39	54	298	76	25	31	22	19	268	444	26	21

Notes:

value	-value exceeds CCME
value	-value exceeds OMOE
0.96	-guidelines based on 10^{-6} ILCR, therefore not used
-	-no guideline or value
NC	-not calculated

[1] 1999 (with 2018 update) CCME *Canadian Environmental Quality Guidelines* for residential/parkland land use.

[2] 1991 CCME Interim soil quality criteria for residential/parkland land use.

[3] 2011 Ontario Ministry of the Environment (OMOE) Table 3: Full Depth Generic Site Condition Standards in a Non-Potable Ground Water Condition, Residential/Parkland

TABLE 6: METALS in Soil - Ecological Health Guidelines
Client: Department of National Defence
Site Location: Former USAF Radar Station, Cartwright, NL
Englobe Project Number: P-0012285-0-16-200

PARAMETER	UNITS	CCME RESIDENTIAL/PARKLAND [1,2]			OMOE [3]		Stantec 2018 Phase II ESA General Area										
		Soil Contact[1]	Soil and food ingestion guideline [1]	Interim SQC[2]	Plants & Soil Organism	Mammals & Birds	CWT-SS43 0 - 0.2 m	CWT-SS44 0 - 0.2 m	CWT-SS48 0 - 0.2 m	CWT-SS49 0 - 0.2 m	CWT-SS52 0 - 0.2 m	CWT-SS54 0 - 0.2 m	CWT-SS56 0 - 0.2 m	CWT-SS57 0 - 0.2 m	CWT-SS58 0 - 0.2 m	CWT-SS60 0 - 0.2 m	CWT-SS62 0 - 0.2 m
Aluminum (Al)	mg/kg	-	-	-	-	-	4800	5100	3300	4700	3600	7700	1900	11000	25000	7800	6400
Antimony (Sb)	mg/kg	-	-	20	25	25	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Arsenic (As)	mg/kg	17	-	-	25	51	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Barium (Ba)	mg/kg	NC	-	-	1000	390	27	40	35	59	18	18	35	48	40	41	90
Beryllium (Be)	mg/kg	-	-	-	5	13	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Bismuth (Bi)	mg/kg	-	-	-	-	-	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Boron (B)	mg/kg	-	-	-	-	120	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Cadmium (Cd)	mg/kg	10	-	-	12	1.9	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Chromium (Cr)	mg/kg	64	-	-	390	160	7.5	11	9.1	8.6	7.5	9.3	<2	4.4	19	11	5
Cobalt (Co)	mg/kg	-	-	50	50	180	1.5	3.1	2.1	2.3	<1	<1	<1	1.1	1.4	2.8	1.5
Copper (Cu)	mg/kg	63	-	-	180	770	6.9	6	2.5	7.7	<2	3.2	<2	<2	3	6.1	5.4
Iron (Fe)	mg/kg	-	-	-	-	-	10000	13000	15000	13000	6100	6900	6300	34000	36000	20000	23000
Lead (Pb)	mg/kg	300	-	-	310	32	4.4	4.3	2.5	5.8	6.8	3.8	1.6	3.4	6.2	4.6	8.1
Lithium (Li)	mg/kg	-	-	-	-	-	<2	4	3.5	4.7	<2	<2	<2	3.2	3.1	4.4	3.7
Manganese (Mn)	mg/kg	-	-	-	-	-	110	150	160	220	46	64	80	340	240	260	510
Mercury	mg/kg	12	-	-	15	20	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Molybdenum (Mo)	mg/kg	-	-	10	40	6.9	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Nickel (Ni)	mg/kg	45	-	-	130	5000	2.9	5.1	3.8	3.2	<2	<2	<2	<2	<2	3.5	<2
Rubidium (Rb)	mg/kg	-	-	-	-	-	3.9	6.9	5.5	11	3.3	2	10	8.5	8.1	6.7	8.1
Selenium (Se)	mg/kg	1	-	-	13	2.4	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Silver (Ag)	mg/kg	-	-	-	25	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Strontium (Sr)	mg/kg	-	-	-	-	-	8.1	8.6	6.7	9.3	<5	6.4	<5	<5	<5	7.8	6.4
Thallium (Tl)	mg/kg	1.4	-	-	1.8	3.9	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Tin (Sn)	mg/kg	-	-	50	-	-	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Uranium (U)	mg/kg	500	-	-	500	33	0.26	0.35	0.25	0.27	0.37	0.44	<0.1	0.16	0.69	0.43	0.26
Vanadium (V)	mg/kg	130	-	-	250	18	19	28	29	21	24	16	<2	23	45	32	12
Zinc (Zn)	mg/kg	250	-	-	500	340	48	23	22	39	6	8	11	42	42	29	54

PARAMETER	UNITS	CCME RESIDENTIAL/PARKLAND [1,2]			OMOE [3]		Stantec 2018 Phase II ESA Former Contractor Village									
		Soil Contact[1]	Soil and food ingestion guideline [1]	Interim SQC[2]	Plants & Soil Organism	Mammals & Birds	CWT-SS63 0 - 0.2 m	CWT-SS65 0 - 0.3 m	CWT-SS67 0 - 0.3 m	CWT-SS68 0 - 0.3 m	CWT-TP36-BS1 0.1 - 0.6 m	CWT-TP37-BS1 0 - 0.5 m	CWT-TP39-BS1 0 - 0.5 m	CWT-TP40-BS1 0 - 0.5 m	CWT-TP42-BS1 0.1 - 0.6 m	CWT-TP105-BS1 0.1 - 0.6 m
Aluminum (Al)	mg/kg	-	-	-	-	-	2300	3700	2300	4300	3700	3500	3100	4100	4600	5300
Antimony (Sb)	mg/kg	-	-	20	25	25	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Arsenic (As)	mg/kg	17	-	-	25	51	<2	<2	2.2	<2	<2	<2	<2	<2	<2	2.1
Barium (Ba)	mg/kg	NC	-	-	1000	390	13	34	17	35	36	31	28	42	32	32
Beryllium (Be)	mg/kg	-	-	-	5	13	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Bismuth (Bi)	mg/kg	-	-	-	-	-	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Boron (B)	mg/kg	-	-	-	-	120	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Cadmium (Cd)	mg/kg	10	-	-	12	1.9	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Chromium (Cr)	mg/kg	64	-	-	390	160	3.7	7.3	3.5	7.3	10	5.7	6.6	7.5	14	18
Cobalt (Co)	mg/kg	-	-	50	50	180	1.4	2	1.7	2.4	2.6	2	1.6	2.7	2.7	2.9
Copper (Cu)	mg/kg	63	-	-	180	770	3.1	5	4.6	4	6.3	8.5	5.2	7.4	4	4
Iron (Fe)	mg/kg	-	-	-	-	-	6900	8800	8800	11000	9600	7400	8500	8200	16000	21000
Lead (Pb)	mg/kg	300	-	-	310	32	4	23	8.1	9.9	6.1	5	9	15	1.9	2.7
Lithium (Li)	mg/kg	-	-	-	-	-	2.8	4.6	3.1	4.4	3.3	3.3	2.9	3.8	5.5	5.8
Manganese (Mn)	mg/kg	-	-	-	-	-	71	120	95	140	130	110	95	120	120	150
Mercury	mg/kg	12	-	-	15	20	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Molybdenum (Mo)	mg/kg	-	-	10	40	6.9	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Nickel (Ni)	mg/kg	45	-	-	130	5000	2.5	3.6	3	3.5	6.3	3	2.8	5.4	5	4.9
Rubidium (Rb)	mg/kg	-	-	-	-	-	3.2	6.3	3.8	7.4	6.4	7.7	4.6	8.1	6.3	5.6
Selenium (Se)	mg/kg	1	-	-	13	2.4	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Silver (Ag)	mg/kg	-	-	-	25	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Strontium (Sr)	mg/kg	-	-	-	-	-	7.8	7.9	6.3	8.2	10	8.9	7	11	8	10
Thallium (Tl)	mg/kg	1.4	-	-	1.8	3.9	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Tin (Sn)	mg/kg	-	-	50	-	-	2.4	<2	<2	<2	29	<2	<2	<2	<2	<2
Uranium (U)	mg/kg	500	-	-	500	33	0.3	0.27	0.19	0.28	0.31	0.29	0.33	0.34	0.5	0.73
Vanadium (V)	mg/kg	130	-	-	250	18	9.3	15	8.6	19	19	14	15	16	43	61
Zinc (Zn)	mg/kg	250	-	-	500	340	12	29	23	25	34	26	23	23	17	19

Notes:

value	-value exceeds CCME
value	-value exceeds OMOE
0.96	-guidelines based on 10^{-6} ILCR, therefore not used
-	-no guideline or value
NC	-not calculated

[1] 1999 (with 2018 update) CCME *Canadian Environmental Quality Guidelines* for residential/parkland land use.
[2] 1991 CCME Interim soil quality criteria for residential/parkland land use.
[3] 2011 Ontario Ministry of the Environment (OMOE) Table 3: Full Depth, Non-Potable Water Scenario, Residential/Parkland Land Use

TABLE 6: METALS in Soil - Ecological Health Guidelines
Client: Department of National Defence
Site Location: Former USAF Radar Station, Cartwright, NL
Englobe Project Number: P-0012285-0-16-200

PARAMETER	UNITS	CCME RESIDENTIAL/PARKLAND [1,2]			OMOE [3]		Stantec 2018 Phase II ESA - Main Complex Area														
		Soil Contact[1]	Soil and food ingestion guideline [1]	Interim SQC[2]	Plants & Soil Organism	Mammals & Birds	CWT-SS13 0 - 0.3 m	CWT-SS14 0 - 0.2 m	CWT-SS16 0 - 0.2 m	CWT-SS18 0 - 0.2 m	CWT-SS20 0 - 0.2 m	CWT-SS22 0 - 0.2 m	CWT-SS24 0 - 0.2 m	CWT-SS26 0 - 0.2 m	CWT-SS28 0 - 0.2 m	CWT-SS30 0 - 0.2 m	CWT-SS31 0 - 0.2 m	CWT-SS32 0 - 0.2 m	CWT-SS34 0 - 0.2 m	CWT-SS35 0 - 0.2 m	CWT-SS36 0 - 0.2 m
Aluminum (Al)	mg/kg	-	-	-	-	-	4800	4800	7800	6000	8100	5800	4100	5700	6000	5200	4800	8900	8900	6600	17000
Antimony (Sb)	mg/kg	-	-	20	25	25	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Arsenic (As)	mg/kg	17	-	-	25	51	<2	<2	2.2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Barium (Ba)	mg/kg	NC	-	-	1000	390	61	63	140	36	54	47	48	67	33	39	79	46	28	40	450
Beryllium (Be)	mg/kg	-	-	-	5	13	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Bismuth (Bi)	mg/kg	-	-	-	-	-	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Boron (B)	mg/kg	-	-	-	-	120	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Cadmium (Cd)	mg/kg	10	-	-	12	1.9	2.3	0.82	0.76	<0.3	1.3	0.69	<0.3	<0.3	<0.3	1.1	0.77	**49**	1.2	<0.3	<0.3
Chromium (Cr)	mg/kg	64	-	-	390	160	14	14	21	11	17	11	9	9	11	11	8	13	18	12	**73**
Cobalt (Co)	mg/kg	-	-	50	50	180	3.2	3.1	4.8	2.8	3.2	2.9	2.5	2.4	2.8	3.3	1.8	2.6	3.4	2.5	14
Copper (Cu)	mg/kg	63	-	-	180	770	19	36	24	7	13	37	9	6	10	12	12	8	9	6	3
Iron (Fe)	mg/kg	-	-	-	-	-	18000	12000	22000	13000	20000	15000	13000	16000	14000	12000	17000	16000	20000	14000	31000
Lead (Pb)	mg/kg	300	-	-	310	32	***120***	***110***	***200***	24	23	***63***	***63***	13	20	18	***62***	11	9.4	7.5	2.0
Lithium (Li)	mg/kg	-	-	-	-	-	4.9	5.7	8.3	4.8	5.1	5.0	4.0	5.8	4.0	5.4	3.7	4.3	4.2	3.1	8.2
Manganese (Mn)	mg/kg	-	-	-	-	-	240	220	380	200	310	260	220	280	160	220	460	180	180	170	290
Mercury	mg/kg	12	-	-	15	20	0.14	<0.1	0	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Molybdenum (Mo)	mg/kg	-	-	10	40	6.9	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Nickel (Ni)	mg/kg	45	-	-	130	5000	7	6	12	5	6	5	4	4	6	6	3	4	7	4	40
Rubidium (Rb)	mg/kg	-	-	-	-	-	7.1	6	13	6	4.9	6	6	8	5.4	7	5.2	8	5	6	35
Selenium (Se)	mg/kg	1	-	-	13	2.4	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Silver (Ag)	mg/kg	-	-	-	25	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Strontium (Sr)	mg/kg	-	-	-	-	-	16	29	17	11	22	14	9	10	13	16	11	20	11	11	10
Thallium (Tl)	mg/kg	1.4	-	-	1.8	3.9	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.25
Tin (Sn)	mg/kg	-	-	50	-	-	3.2	6.8	3.3	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Uranium (U)	mg/kg	500	-	-	500	33	0.3	0.3	0.6	0.4	0.7	0.4	0.3	0.4	0.4	0.5	0.3	0.4	0.6	0.5	0.2
Vanadium (V)	mg/kg	130	-	-	250	18	26	19	21	26	34	25	21	24	31	26	13	31	41	27	88
Zinc (Zn)	mg/kg	250	-	-	500	340	**310**	170	**750**	71	**290**	130	55	62	73	86	120	**1400**	48	33	57

PARAMETER	UNITS	CCME RESIDENTIAL/PARKLAND [1,2]			OMOE [3]		Stantec 2018 Phase II ESA - Main Complex Area																	
		Soil Contact[1]	Soil and food ingestion guideline [1]	Interim SQC[2]	Plants & Soil Organism	Mammals & Birds	CWT-SS37 0 - 0.2 m	CWT-SS41 0 - 0.2 m	CWT-TP6-BS1 0 - 0.6 m	CWT-TP8-BS2 0.3 - 0.6 m	CWT-TP10-BS1 0 - 0.5 m	CWT-TP11-BS1 0 - 0.5 m	CWT-TP14-BS1 0.1 - 0.5 m	CWT-TP15-BS1 0.1 - 0.6 m	CWT-TP16-BS1 0 - 0.5 m	CWT-TP18-BS1 0 - 0.3 m	CWT-TP20-BS1 0.1 - 0.6 m	CWT-TP21-BS1 0 - 0.5 m	CWT-TP23-BS1 0 - 0.4 m	CWT-TP24-BS1 0.2 - 0.7 m	CWT-TP25-BS1 0 .1 - 0.5 m	CWT-TP26-BS1 0 - 0.5 m	CWT-TP27-BS2 1.1 - 1.6 m	CWT-TP28-BS1 0 - 0.5 m
Aluminum (Al)	mg/kg	-	-	-	-	-	7700	9000	5100	7400	16000	6100	4900	6200	5600	5800	5200	6900	7100	6200	8100	8000	6100	6400
Antimony (Sb)	mg/kg	-	-	20	25	25	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Arsenic (As)	mg/kg	17	-	-	25	51	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Barium (Ba)	mg/kg	NC	-	-	1000	390	76	39	20	89	28	42	62	57	40	22	28	43	22	40	66	94	25	28
Beryllium (Be)	mg/kg	-	-	-	5	13	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Bismuth (Bi)	mg/kg	-	-	-	-	-	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Boron (B)	mg/kg	-	-	-	-	120	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Cadmium (Cd)	mg/kg	10	-	-	12	1.9	0.34	6.5	<0.3	<0.3	<0.3	<0.3	<0.3	0.38	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	2.3	<0.3	<0.3	<0.3
Chromium (Cr)	mg/kg	64	-	-	390	160	10	17	12	9	18	11	9	12	10	15	16	12	12	14	17	6	11	12
Cobalt (Co)	mg/kg	-	-	50	50	180	2.9	2.7	1.5	2.2	2.1	2	2.7	2.9	2.5	2.9	3.4	3.3	2.3	2.4	3	2	2.2	2.2
Copper (Cu)	mg/kg	63	-	-	180	770	6	10	4	5	4	7	6	13	5	7	7	7	12	10	20	5	5	8
Iron (Fe)	mg/kg	-	-	-	-	-	12000	21000	14000	21000	18000	15000	15000	16000	14000	17000	18000	15000	15000	13000	18000	29000	13000	12000
Lead (Pb)	mg/kg	300	-	-	310	32	6.6	24	7.2	18	3.1	9.4	22	***43***	3.2	2.5	3.2	7.4	5.2	9.0	***92***	7.5	4.4	6.9
Lithium (Li)	mg/kg	-	-	-	-	-	2.3	3.0	<2	2.9	2.7	3.4	4.4	4.7	4.9	3.1	3.3	4.6	3.0	3.9	4.8	4.2	2.8	3.2
Manganese (Mn)	mg/kg	-	-	-	-	-	170	170	95	260	110	190	370	230	200	130	140	180	120	140	290	760	110	120
Mercury	mg/kg	12	-	-	15	20	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.18	<0.1	<0.1	<0.1
Molybdenum (Mo)	mg/kg	-	-	10	40	6.9	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	9.7	<2	<2	<2
Nickel (Ni)	mg/kg	45	-	-	130	5000	5	6	3	3	4	4	3	6	4	5	5	5	4	4	7	<2	4	4
Rubidium (Rb)	mg/kg	-	-	-	-	-	5.7	4	2.7	19	3.2	5	7	8	6.7	4	4	7	3.2	6	5.2	13	5	5
Selenium (Se)	mg/kg	1	-	-	13	2.4	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Silver (Ag)	mg/kg	-	-	-	25	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Strontium (Sr)	mg/kg	-	-	-	-	-	12	14	12	11	11	13	17	17	10	10	11	16	11	9	24	6	8	9
Thallium (Tl)	mg/kg	1.4	-	-	1.8	3.9	<0.1	<0.1	0.18	<0.1	0.13	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Tin (Sn)	mg/kg	-	-	50	-	-	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Uranium (U)	mg/kg	500	-	-	500	33	0.5	0.4	0.4	0.4	0.5	0.4	0.3	0.5	0.5	0.4	0.4	0.4	0.4	0.4	0.6	0.4	0.4	0.4
Vanadium (V)	mg/kg	130	-	-	250	18	28	42	29	36	45	27	23	31	29	41	46	32	35	32	32	19	31	30
Zinc (Zn)	mg/kg	250	-	-	500	340	51	**300**	37	42	16	45	86	120	27	16	18	34	50	36	**570**	77	50	68

Notes:

value	-value exceeds CCME
value	-value exceeds OMOE
0.96	-guidelines based on 10^{-5} ILCR, therefore not used

-
NC

[1] 1999 (with 2018 update) CCME *Canadian Environmental Quality Guidelines* for residential/parkland land use.

[2] 1991 CCME Interim soil quality criteria for residential/parkland land use.

[3] 2011 Ontario Ministry of the Environment (OMOE) Table 3: Full Depth, Non-Potable Water Scenario, Residential/Parkland Land Use

TABLE 6: METALS in Soil - Ecological Health Guidelines
Client: Department of National Defence
Site Location: Former USAF Radar Station, Cartwright, NL
Englobe Project Number: P-0012285-0-16-200

							Stantec 2018 Phase II ESA						Englobe 2018 Phase III ESA						
		CCME RESIDENTIAL/PARKLAND [1,2]			OMOE [3]		Main Complex Area												
PARAMETER	UNITS	Soil Contact[1]	Soil and food ingestion guideline [1]	Interim SQC[2]	Plants & Soil Organism	Mammals & Birds	CWT-TP29-BS2 1.2 - 1.7 m	CWT-TP30-BS1 0.1 - 0.6 m	CWT-TP31-BS2 1.2 - 1.7 m	CWT-TP100-BS1 0 - 0.3 m	CWT-TP101-BS1 0 - 0.5 m	CWT-TP102-BS1 0.1 - 0.6 m	CWT-SS16-18-A/1 0 - 0.3 m 17-Aug-18	CWT-SS16-18-B/1 0 - 0.3 m 17-Aug-18	CWT-SS16-18-C/1 0 - 0.3 m 17-Aug-18	CWT-SS32-18-A 0 - 0.3 m 17-Aug-18	CWT-SS32-18-B 0 - 0.4 m 17-Aug-18	CWT-SS32-18-C 0 - 0.4 m 17-Aug-18	CWT-SS32-18-D 0 - 0.3 m 17-Aug-18
Aluminum (Al)	mg/kg	-	-	-	-	-	6500	6300	13000	6100	6700	4500	-	-	-	-	-	-	-
Antimony (Sb)	mg/kg	-	-	20	25	25	<2	5.4	<2	<2	<2	<2	-	-	-	-	-	-	-
Arsenic (As)	mg/kg	17	-	-	25	51	<2	<2	<2	<2	<2	<2	-	-	-	-	-	-	-
Barium (Ba)	mg/kg	NC	-	-	1000	390	28	73	170	27	64	26	-	-	-	-	-	-	-
Beryllium (Be)	mg/kg	-	-	-	5	13	<2	<2	<2	<2	<2	<2	-	-	-	-	-	-	-
Bismuth (Bi)	mg/kg	-	-	-	-	-	<2	<2	<2	<2	<2	<2	-	-	-	-	-	-	-
Boron (B)	mg/kg	-	-	-	-	120	<50	<50	<50	<50	<50	<50	-	-	-	-	-	-	-
Cadmium (Cd)	mg/kg	10	-	-	12	1.9	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	-	-	-	0.8	0.7	1.1	0.7
Chromium (Cr)	mg/kg	64	-	-	390	160	12	7	5	15	6	14	-	-	-	-	-	-	-
Cobalt (Co)	mg/kg	-	-	50	50	180	2.5	1.7	2.2	2.7	1.8	2.8	-	-	-	-	-	-	-
Copper (Cu)	mg/kg	63	-	-	180	770	6	9	7	7	4	7	-	-	-	-	-	-	-
Iron (Fe)	mg/kg	-	-	-	-	-	14000	18000	43000	16000	23000	16000	-	-	-	-	-	-	-
Lead (Pb)	mg/kg	300	-	-	310	32	5.1	14	5.3	2.9	5.9	2.3	-	-	-	-	-	-	-
Lithium (Li)	mg/kg	-	-	-	-	-	3.1	3.5	6.8	3.1	3.2	2.7	-	-	-	-	-	-	-
Manganese (Mn)	mg/kg	-	-	-	-	-	150	470	760	140	450	130	-	-	-	-	-	-	-
Mercury	mg/kg	12	-	-	15	20	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	-	-	-	-
Molybdenum (Mo)	mg/kg	-	-	10	40	6.9	<2	<2	<2	<2	<2	<2	-	-	-	-	-	-	-
Nickel (Ni)	mg/kg	45	-	-	130	5000	4	5	<2	5	<2	5	-	-	-	-	-	-	-
Rubidium (Rb)	mg/kg	-	-	-	-	-	5	6	18.0	4	9.2	3	-	-	-	-	-	-	-
Selenium (Se)	mg/kg	1	-	-	13	2.4	<1	<1	<1	<1	<1	<1	-	-	-	-	-	-	-
Silver (Ag)	mg/kg	-	-	-	25	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	-	-	-	-	-	-	-
Strontium (Sr)	mg/kg	-	-	-	-	-	10	7	7	10	6	11	-	-	-	-	-	-	-
Thallium (Tl)	mg/kg	1.4	-	-	1.8	3.9	<0.1	<0.1	0.11	<0.1	<0.1	<0.1	-	-	-	-	-	-	-
Tin (Sn)	mg/kg	-	-	50	-	-	<2	<2	<2	<2	<2	<2	-	-	-	-	-	-	-
Uranium (U)	mg/kg	500	-	-	500	33	0.4	0.4	0.7	0.4	0.3	0.4	-	-	-	-	-	-	-
Vanadium (V)	mg/kg	130	-	-	250	18	33	18	8	37	19	38	-	-	-	-	-	-	-
Zinc (Zn)	mg/kg	250	-	-	500	340	25	110	120	18	55	14	**531**	44	137	91	76	92	82

							Stantec 2018 Phase II ESA														
		CCME RESIDENTIAL/PARKLAND [1,2]			OMOE [3]		Former USAF Dump Area and Ammunition Storage Area														
PARAMETER	UNITS	Soil Contact[1]	Soil and food ingestion guideline [1]	Interim SQC[2]	Plants & Soil Organism	Mammals & Birds	CWT-SS1 0 - 0.2 m	CWT-SS2 0 - 0.2 m	CWT-SS3 0 - 0.2 m	CWT-SS4 0 - 0.2 m	CWT-SS7 0 - 0.3 m	CWT-SS8 0 - 0.3 m	CWT-SS10 0 - 0.3 m	CWT-SS11 0 - 0.3 m	CWT-SS12 0 - 0.3 m	CWT-SS70 0 - 0.3 m	CWT-TP1-BS1 0 - 0.3 m	CWT-TP2-BS2 0.3 - 0.7 m	CWT-TP3-BS2 0.4 - 0.8 m	CWT-TP4-BS1 0 - 0.5 m	CWT-TP5-BS2 0.3 - 0.6 m
Aluminum (Al)	mg/kg	-	-	-	-	-	5300	3900	5000	3700	6600	5600	6200	4200	4400	6400	7900	6500	6200	7400	5800
Antimony (Sb)	mg/kg	-	-	20	25	25	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	2.7	3.2	<2	<2
Arsenic (As)	mg/kg	17	-	-	25	51	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Barium (Ba)	mg/kg	NC	-	-	1000	390	77	30	93	49	49	100	41	14	21	48	15	37	39	14	58
Beryllium (Be)	mg/kg	-	-	-	5	13	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Bismuth (Bi)	mg/kg	-	-	-	-	-	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Boron (B)	mg/kg	-	-	-	-	120	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Cadmium (Cd)	mg/kg	10	-	-	12	1.9	<0.3	<0.3	<0.3	<0.3	<0.3	0.44	<0.3	<0.3	<0.3	<0.3	<0.3	0.65	2	<0.3	<0.3
Chromium (Cr)	mg/kg	64	-	-	390	160	6	6	5	5	11	4	13	7	9	12	10	13	13	10	12
Cobalt (Co)	mg/kg	-	-	50	50	180	2	1.5	1.7	1.8	2.5	1.4	2.7	1	<1	2.5	1.1	3.2	4.1	2.1	1.7
Copper (Cu)	mg/kg	63	-	-	180	770	7	4	7	11	9	7	8	<2	4	9	<2	47	25	5	3
Iron (Fe)	mg/kg	-	-	-	-	-	18000	11000	19000	13000	11000	30000	14000	13000	3300	11000	20000	18000	13000	13000	12000
Lead (Pb)	mg/kg	300	-	-	310	32	9.8	12	11	25	3.7	5.4	5.1	6.6	4.6	3.4	5.1	***65***	***180***	6.6	3.2
Lithium (Li)	mg/kg	-	-	-	-	-	4.6	2.6	4.2	3.6	5.1	<2	3.7	<2	<2	4.8	<2	3.4	3.6	2.6	2.6
Manganese (Mn)	mg/kg	-	-	-	-	-	450	130	540	350	150	290	220	81	52	140	75	230	160	90	110
Mercury	mg/kg	12	-	-	15	20	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0	0	<0.1	<0.1
Molybdenum (Mo)	mg/kg	-	-	10	40	6.9	<2	<2	<2	<2	<2	2.6	<2	<2	<2	<2	<2	<2	6	<2	<2
Nickel (Ni)	mg/kg	45	-	-	130	5000	2	2	2	3	8	4	5	<2	2	7	<2	7	12	4	3
Rubidium (Rb)	mg/kg	-	-	-	-	-	5.9	6	6	6	5.3	2	6	6	2.4	5	2.7	5	5	3	4
Selenium (Se)	mg/kg	1	-	-	13	2.4	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Silver (Ag)	mg/kg	-	-	-	25	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Strontium (Sr)	mg/kg	-	-	-	-	-	8	5	8	6	12	37	12	<5.0	5	11	5	10	12	6	12
Thallium (Tl)	mg/kg	1.4	-	-	1.8	3.9	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Tin (Sn)	mg/kg	-	-	50	-	-	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	6.1	14	<2	<2
Uranium (U)	mg/kg	500	-	-	500	33	0.4	0.3	0.3	0.3	0.6	0.4	0.5	0.3	0.4	0.5	0.5	0.4	0.4	0.5	0.5
Vanadium (V)	mg/kg	130	-	-	250	18	14	20	13	11	24	9	33	30	13	23	26	29	29	38	22
Zinc (Zn)	mg/kg	250	-	-	500	340	78	26	80	45	150	**380**	29	12	6	130	11	170	**1800**	17	170

Notes:

value	-value exceeds CCME	-	-no guideline or value
value	-value exceeds OMOE	NC	-not calculated
0.96	-guidelines based on 10^{-6} ILCR, therefore not used		

[1] 1999 (with 2018 update) CCME *Canadian Environmental Quality Guidelines* for residential/parkland land use.

[2] 1991 CCME Interim soil quality criteria for residential/parkland use.

[3] 2011 Ontario Ministry of the Environment (OMOE) Table 3: Full Depth, Non-Potable Water Scenario, Residential/Parkland Land Use

TABLE 6: METALS in Soil - Ecological Health Guidelines
Client: Department of National Defence
Site Location: Former USAF Radar Station, Cartwright, NL
Englobe Project Number: P-0012285-0-16-200

PARAMETER	UNITS	CCME RESIDENTIAL/PARKLAND [1,2]			OMOE [3]		Englobe 2019 Phase III ESA — Former USAF Dump Area and Ammunition Storage Area											
		Soil Contact[1]	Soil and food ingestion guideline [1]	Interim SQC[2]	Plants & Soil Organism	Mammals & Birds	CWT-TP3-18-A/1 0 - 0.8 m 15-Aug-18	CWT-TP3-18-A/2 0.8 - 1.5 m 15-Aug-18	CWT-TP3-18-B/1 0 - 0.8 m 15-Aug-18	CWT-TP3-18-B/2 0.8 - 1.5 m 15-Aug-18	CWT-TP3-18-D/1 0 - 0.3 m 15-Aug-18	CWT-TP3-18-D/2 0.3 - 0.8 m 15-Aug-18	CWT-TP3-18-E/1 0 - 0.3 m 15-Aug-18	CWT-TP3-18-E/2 0.3 - 0.9 m 15-Aug-18	CWT-SS8-18-A/1 0 - 0.6 m 15-Aug-18	CWT-SS8-18-B/1 0 - 0.6 m 15-Aug-18	CWT-SS8-18-C/1 0 - 0.6 m 15-Aug-18	CWT-SS8-18-D/1 0 - 0.6 m 15-Aug-18
Aluminum (Al)	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Antimony (Sb)	mg/kg	-	-	20	25	25	-	-	-	-	-	-	-	-	-	-	-	-
Arsenic (As)	mg/kg	17	-	-	25	51	-	-	-	-	-	-	-	-	-	-	-	-
Barium (Ba)	mg/kg	NC	-	-	1000	390	-	-	-	-	-	-	-	-	-	-	-	-
Beryllium (Be)	mg/kg	-	-	-	5	13	-	-	-	-	-	-	-	-	-	-	-	-
Bismuth (Bi)	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Boron (B)	mg/kg	-	-	-	-	120	-	-	-	-	-	-	-	-	-	-	-	-
Cadmium (Cd)	mg/kg	10	-	-	12	1.9	-	-	-	-	-	-	-	-	-	-	-	-
Chromium (Cr)	mg/kg	64	-	-	390	160	-	-	-	-	-	-	-	-	-	-	-	-
Cobalt (Co)	mg/kg	-	-	50	50	180	-	-	-	-	-	-	-	-	-	-	-	-
Copper (Cu)	mg/kg	63	-	-	180	770	-	-	-	-	-	-	-	-	-	-	-	-
Iron (Fe)	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lead (Pb)	mg/kg	300	-	-	310	32	-	-	-	-	-	-	-	-	-	-	-	-
Lithium (Li)	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Manganese (Mn)	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mercury	mg/kg	12	-	-	15	20	-	-	-	-	-	-	-	-	-	-	-	-
Molybdenum (Mo)	mg/kg	-	-	10	40	6.9	-	-	-	-	-	-	-	-	-	-	-	-
Nickel (Ni)	mg/kg	45	-	-	130	5000	-	-	-	-	-	-	-	-	-	-	-	-
Rubidium (Rb)	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Selenium (Se)	mg/kg	1	-	-	13	2.4	-	-	-	-	-	-	-	-	-	-	-	-
Silver (Ag)	mg/kg	-	-	-	25	-	-	-	-	-	-	-	-	-	-	-	-	-
Strontium (Sr)	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Thallium (Tl)	mg/kg	1.4	-	-	1.8	3.9	-	-	-	-	-	-	-	-	-	-	-	-
Tin (Sn)	mg/kg	-	-	50	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Uranium (U)	mg/kg	500	-	-	500	33	-	-	-	-	-	-	-	-	-	-	-	-
Vanadium (V)	mg/kg	130	-	-	250	18	-	-	-	-	-	-	-	-	-	-	-	-
Zinc (Zn)	mg/kg	250	-	-	500	340	39	54	298	76	25	31	22	19	268	444	26	21

Notes:

value	-value exceeds CCME	-	-no guideline or value
value	-value exceeds OMOE	NC	-not calculated
0.96	-guidelines based on 10^{-6} ILCR, therefore not used		

[1] 1999 (with 2018 update) CCME *Canadian Environmental Quality Guidelines* for residential/parkland land use.
[2] 1991 CCME Interim soil quality criteria for residential/parkland land use.
[3] 2011 Ontario Ministry of the Environment (OMOE) Table 3: Full Depth, Non-Potable Water Scenario, Residential/Parkland Land Use

Englobe

TABLE 7: VOLATILE ORGANIC COMPOUNDS in Soil - Human Health Guidelines
Client: Department of National Defence
Site Location: Former USAF Radar Station, Cartwright, NL
Englobe Project Number: P-0012285-0-16-200

PARAMETER	UNITS	CCME RESIDENTIAL/PARKLAND [1,2]			OMOE [3]	Stantec 2018 Phase II ESA				
						Former Contractor Village			Former USAF Dump Area and Former Ammunition Storage Area	
		Dermal Contact / Ingestion[1]	Produce, meat and milk check	Interim SQC[2]	Soil Contact S1 Risk	CWT-SS67 0 - 0.3 m	CWT-TP36-BS2 1.2 - 1.7 m	CWT-TP104-BS2 1.2 - 1.7 m	CWT-SS11 0 - 0.3 m	CWT-TP5-BS2 0.3 - 0.6 m
1,1,1-Trichloroethane	ug/kg	-	-	50000	42000000	<25	<25	<25	<25	<25
1,1,1,2-Tetrachloroethane	ug/kg	-	-	-	30000	-	-	-	-	-
1,1,2,2-Tetrachloroethane	ug/kg	-	-	50000	4000	<25	<25	<150	<25	<25
1,1,2-Trichloroethane	ug/kg	-	-	50000	14000	<25	<25	<25	<25	<25
1,1-Dichloroethane	ug/kg	-	-	50000	840000	<25	<25	<25	<25	<25
1,1-Dichloroethylene	ug/kg	-	-	50000	1000000	<25	<25	<25	<25	<25
1,2-Dichlorobenzene	ug/kg	-	-	10000	6300000	<25	<25	<25	<25	<25
1,2-Dibromoethane	ug/kg	-	-	-	-	-	-	-	-	-
1,2-Dichloroethane	ug/kg	-	-	50000	8700	<25	<25	<25	<25	<25
1,2-Dichloropropane	ug/kg	-	-	50000	22000	<25	<25	<25	<25	<25
1,3-Dichlorobenzene	ug/kg	-	-	10000	420000	<25	<25	<25	<25	<25
1,4-Dichlorobenzene	ug/kg	-	-	10000	47000	<25	<25	<25	<25	<25
2-Hexanone	ug/kg	-	-	-	-	-	-	-	-	-
Acetone	ug/kg	-	-	-	560	-	-	-	-	-
Benzene	ug/kg	250000/110000	NC	-	9300	<25	<25	<25	<25	<25
Bromodichloromethane	ug/kg	-	-	-	13000	<25	<25	<25	<25	<25
Bromoform	ug/kg	-	-	-	100000	<25	<25	<25	<25	<25
Bromomethane	ug/kg	-	-	-	6300	<50	<50	<50	<50	<50
Carbon Tetrachloride	ug/kg	-	-	-	15000	<25	<25	<25	<25	<25
Chloromethane	ug/kg	-	-	-	-	-	-	-	-	-
Chlorobenzene	ug/kg	-	-	10000	1300000	<25	<25	<32	<25	<25
Chloroethane	ug/kg	-	-	50000	-	<200	<200	<200	<200	<200
Chloroform	ug/kg	-	-	50000	26000	<25	<25	<25	<25	<25
cis-1,2-Dichloroethylene	ug/kg	-	-	50000	630000	<25	<25	<25	<25	<25
cis-1,3-Dichloropropene	ug/kg	-	-	-	-	<25	<25	<25	<25	<25
Dibromochloromethane	ug/kg	-	-	-	9400	<25	<25	<25	<25	<25
Ethylbenzene	ug/kg	10000000/58000000	NC	-	2100000	<25	<25	<25	<25	<25
Ethylene Dibromide	ug/kg	-	-	-	220	<25	<25	<25	<25	<25
Methylene Chloride (Dichloromethane)	ug/kg	-	-	50000	110000	<25	36	<25	<25	<25
o-Xylene	ug/kg	-	-	-	-	<25	<25	63	<25	<25
m,p-Xylene	ug/kg	-	-	-	-	<25	<25	110	<25	<25
Styrene	ug/kg	-	-	50000	2500000	<25	<25	<25	<25	<25
Tetrachloroethylene	ug/kg	-	-	-	290000	<25	<25	<25	<25	<25
Toluene	ug/kg	220000000/22000000	NC	-	1700000	<25	<25	<25	<25	<25
trans-1,2-Dichloroethylene	ug/kg	-	-	50000	420000	<25	<25	<25	<25	<25
trans-1,3-Dichloropropene	ug/kg	-	-	50000	-	<25	<25	<25	<25	<25
Trichloroethylene	ug/kg	28000	140	50000	31000	<10	<10	<10	<10	<10
Trichlorofluoromethane (FREON 11)	ug/kg	-	-	-	6300000	<25	<25	<25	<25	<25
Vinyl Chloride	ug/kg	-	-	-	570	<20	<20	<20	<20	<20

Notes:

value	-value exceeds CCME	-	-no guideline or value
value	-value exceeds OMOE	NC	-not calculated
0.96	-guidelines based on 10^{-6} ILCR, therefore not used		

[1] 1999 (with 2018 update) CCME *Canadian Environmental Quality Guidelines* for residential/parkland land use.

[2] 1991 CCME Interim soil quality criteria

[3] 2011 Ontario Ministry of the Environment (OMOE) Table 3: Full Depth Generic Site Condition Standards in a Non-Potable Ground Water Condition, Residential/Parkland Land Use

TABLE 7: VOLATILE ORGANIC COMPOUNDS in Soil - Human Health Guidelines
Client: Department of National Defence
Site Location: Former USAF Radar Station, Cartwright, NL
Englobe Project Number: P-0012285-0-16-200

PARAMETER	UNITS	CCME RESIDENTIAL/PARKLAND [1,2]			OMOE [3]	Stantec 2018 Phase II ESA									Englobe 2018 Phase III ESA				
						Main Complex													
		Dermal Contact / Ingestion[1]	Produce, meat and milk check	Interim SQC[2]	Soil Contact S1 Risk	CWT-SS13 0 - 0.3 m	CWT-SS16 0 - 0.2 m	CWT-SS34 0 - 0.2 m	CWT-SS36 0 - 0.2 m	CWT-TP8-BS2 0.3 - 0.6 m	CWT-TP11-BS1 0 - 0.5 m	CWT-TP26-BS2 1.0 - 1.5 m	CWT-TP28-BS2 1.3 - 1.8 m	CWT-TP30-BS2 1.0 - 1.5 m	CWT-MW9/1 0 - 0.1 m 16-Aug-18	CWT-TP8-18-A/1 0 - 0.05 m 16-Aug-18	CWT-TP8-18-B/1 0 - 0.25 m 16-Aug-18	CWT-TP8-18-C/1 0 - 0.3 m 16-Aug-18	CWT-TP8-18-D/1 0 - 0.3 m 16-Aug-18
1,1,1-Trichloroethane	ug/kg	-	-	50000	42000000	<25	<25	<25	<25	<25	<25	<25	<25	<25	<30	<30	<30	<30	<30
1,1,1,2-Tetrachloroethane	ug/kg	-	-	-	30000	-	-	-	-	-	-	-	-	-	<100	<100	<100	<100	<100
1,1,2,2-Tetrachloroethane	ug/kg	-	-	50000	4000	<25	<25	<25	<25	<25	<25	<25	<25	<25	<50	<50	<50	<50	<50
1,1,2-Trichloroethane	ug/kg	-	-	50000	14000	<25	<25	<25	<25	<25	<25	<25	<25	<25	<30	<30	<30	<30	<30
1,1-Dichloroethane	ug/kg	-	-	50000	840000	<25	<25	<25	<25	<25	<25	<25	<25	<25	<100	<100	<100	<100	<100
1,1-Dichloroethylene	ug/kg	-	-	50000	1000000	<25	<25	<25	<25	<25	<25	<25	<25	<25	<50	<50	<50	<50	<50
1,2-Dichlorobenzene	ug/kg	-	-	10000	6300000	<25	<25	<25	<25	<25	<25	<25	<25	<25	<50	<50	<50	<50	<50
1,2-Dibromoethane	ug/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	<50	<50	<50	<50	<50
1,2-Dichloroethane	ug/kg	-	-	50000	8700	<25	<25	<25	<25	<25	<25	<25	<25	<25	<100	<100	<100	<100	<100
1,2-Dichloropropane	ug/kg	-	-	50000	22000	<25	<25	<25	<25	<25	<25	<25	<25	<25	<50	<50	<50	<50	<50
1,3-Dichlorobenzene	ug/kg	-	-	10000	420000	<25	<25	<25	<25	<25	<25	<25	<25	<25	<50	<50	<50	<50	<50
1,4-Dichlorobenzene	ug/kg	-	-	10000	47000	<25	<25	<25	<25	<25	<25	<25	<25	<25	<50	<50	<50	<50	<50
2-Hexanone	ug/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	<500	<500	<500	<500	<500
Acetone	ug/kg	-	-	-	560	-	-	-	-	-	-	-	-	-	<500	<500	<500	<500	<500
Benzene	ug/kg	250000/110000	NC	-	9300	<25	<25	<25	<25	<25	<25	<25	<25	<25	<6.8	<6.8	<6.8	<6.8	<6.8
Bromodichloromethane	ug/kg	-	-	-	13000	<25	<25	<25	<25	<25	<25	<25	<25	<25	<100	<100	<100	<100	<100
Bromoform	ug/kg	-	-	-	100000	<25	<25	<25	<25	<25	<25	<25	<25	<25	<100	<100	<100	<100	<100
Bromomethane	ug/kg	-	-	-	6300	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Carbon Tetrachloride	ug/kg	-	-	-	15000	<25	<25	<25	<25	<25	<25	<25	<25	<25	<50	<50	<50	<50	<50
Chloromethane	ug/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	<100	<100	<100	<100	<100
Chlorobenzene	ug/kg	-	-	10000	1300000	<25	<25	<25	<25	<25	<25	<25	<25	<25	<50	<50	<50	<50	<50
Chloroethane	ug/kg	-	-	50000	-	<200	<200	<200	<200	<200	<200	<200	<200	<200	<100	<100	<100	<100	<100
Chloroform	ug/kg	-	-	50000	26000	<25	<25	<25	<25	<25	<25	<25	<25	<25	<50	<50	<50	<50	<50
cis-1,2-Dichloroethylene	ug/kg	-	-	50000	630000	<25	<25	<25	<25	<25	<25	<25	<25	<25	<100	<100	<100	<100	<100
cis-1,3-Dichloropropene	ug/kg	-	-	-	-	<25	<25	<25	<25	<25	<25	<25	<25	<25	<100	<100	<100	<100	<100
Dibromochloromethane	ug/kg	-	-	-	9400	<25	<25	<25	<25	<25	<25	<25	<25	<25	<100	<100	<100	<100	<100
Ethylbenzene	ug/kg	10000000/58000000	NC	-	2100000	<25	<25	<25	<25	<25	<25	<25	<25	<25	<18	<18	<18	<18	<18
Ethylene Dibromide	ug/kg	-	-	-	220	<25	<25	<25	<25	<25	<25	<25	<25	<25	-	-	-	-	-
Methylene Chloride (Dichloromethane)	ug/kg	-	-	50000	110000	<25	<25	<25	<25	<25	<25	<25	<25	<25	<100	<100	<100	<100	<100
o-Xylene	ug/kg	-	-	-	-	<25	<25	<25	<25	<25	<25	<25	<25	<25	<100	<100	<100	<100	<100
m,p-Xylene	ug/kg	-	-	-	-	<25	<25	<25	<25	<25	<25	<25	<25	<25	<100	<100	<100	<100	<100
Styrene	ug/kg	-	-	50000	2500000	<25	<25	<25	<25	<25	<25	<25	<25	<25	<100	<100	<100	<100	<100
Tetrachloroethylene	ug/kg	-	-	-	290000	<25	170	<25	<25	<25	<25	<25	<25	<25	<100	<100	<100	<100	<100
Toluene	ug/kg	220000000/22000000	NC	-	1700000	<25	<25	<25	<25	<25	<25	<25	<25	<25	<80	<80	<80	<80	<80
trans-1,2-Dichloroethylene	ug/kg	-	-	50000	420000	<25	<25	<25	<25	<25	<25	<25	<25	<25	<80	<80	<80	<80	<80
trans-1,3-Dichloropropene	ug/kg	-	-	50000	-	<25	<25	<25	<25	<25	<25	<25	<25	<25	<100	<100	<100	<100	<100
Trichloroethylene	ug/kg	28000	140	50000	31000	<10	<10	<10	<10	14	<10	<10	<10	<10	<10	<10	<10	<10	<10
Trichlorofluoromethane (FREON 11)	ug/kg	-	-	-	6300000	<25	<25	<25	<25	<25	<25	<25	<25	<25	<100	<100	<100	<100	<100
Vinyl Chloride	ug/kg	-	-	-	570	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20

Notes:

value	-value exceeds CCME	-	-no guideline or value
value	-value exceeds OMOE	NC	-not calculated
0.96	-guidelines based on 10^{-6} ILCR, therefore not used		

[1] 1999 (with 2018 update) CCME *Canadian Environmental Quality Guidelines* for residential/parkland land use.

[2] 1991 CCME Interim soil quality criteria

[3] 2011 Ontario Ministry of the Environment (OMOE) Table 3: Full Depth Generic Site Condition Standards in a Non-Potable Ground Water Condition, Residential/Parkland Land Use

TABLE 8: VOLATILE ORGANIC COMPOUNDS in Soil - Ecological Health Guidelines
Client: Department of National Defence
Site Location: Former USAF Radar Station, Cartwright, NL
Englobe Project Number: P-0012285-0-16-200

PARAMETER	UNITS	CCME RESIDENTIAL/PARKLAND [1,2]			OMOE [3]		Stantec 2018 Phase II ESA				
							Former Contractor Village			Former USAF Dump Area and Former Ammunition Storage Area	
		Ecological Contact[1]	Protection of GW for Aquatic Life[1]	Interim SQC[2]	Plants & Soil Organism	Mammals & Birds	CWT-SS67 0 - 0.3 m	CWT-TP36-BS2 1.2 - 1.7 m	CWT-TP104-BS2 1.2 - 1.7 m	CWT-SS11 0 - 0.3 m	CWT-TP5-BS2 0.3 - 0.6 m
1,1,1-Trichloroethane	ug/kg	-	-	50000	22000	820000	<25	<25	<25	<25	<25
1,1,1,2-Tetrachloroethane	ug/kg	-	-	-	-	-	-	-	-	-	-
1,1,2,2-Tetrachloroethane	ug/kg	-	-	50000	-	-	<25	<25	<150	<25	<25
1,1,2-Trichloroethane	ug/kg	-	-	50000	10000	-	<25	<25	<25	<25	<25
1,1-Dichloroethane	ug/kg	-	-	50000	11000	-	<25	<25	<25	<25	<25
1,1-Dichloroethylene	ug/kg	-	-	50000	63000	43000	<25	<25	<25	<25	<25
1,2-Dichlorobenzene	ug/kg	-	-	10000	4300	-	<25	<25	<25	<25	<25
1,2-Dibromoethane	ug/kg	-	-	-	-	-	-	-	-	-	-
1,2-Dichloroethane	ug/kg	-	-	50000	60000	2900	<25	<25	<25	<25	<25
1,2-Dichloropropane	ug/kg	-	-	50000	3100	-	<25	<25	<25	<25	<25
1,3-Dichlorobenzene	ug/kg	-	-	10000	6000	-	<25	<25	<25	<25	<25
1,4-Dichlorobenzene	ug/kg	-	-	10000	4500	-	<25	<25	<25	<25	<25
2-Hexanone	ug/kg	-	-	-	-	-	-	-	-	-	-
Acetone	ug/kg	-	-	-	-	56000	-	-	-	-	-
Benzene	ug/kg	31000	1000	-	60000	370000	<25	<25	<25	<25	<25
Bromodichloromethane	ug/kg	-	-	-	-	-	<25	<25	<25	<25	<25
Bromoform	ug/kg	-	-	-	-	-	<25	<25	<25	<25	<25
Bromomethane	ug/kg	-	-	-	-	-	<50	<50	<50	<50	<50
Carbon Tetrachloride	ug/kg	-	-	-	7300	7600	<25	<25	<25	<25	<25
Chloromethane	ug/kg	-	-	-	-	-	-	-	-	-	-
Chlorobenzene	ug/kg	-	-	10000	7500	-	<25	<25	<32	<25	<25
Chloroethane	ug/kg	-	-	50000	-	-	<200	<200	<200	<200	<200
Chloroform	ug/kg	-	-	50000	43000	81000	<25	<25	<25	<25	<25
cis-1,2-Dichloroethylene	ug/kg	-	-	50000	-	84000	<25	<25	<25	<25	<25
cis-1,3-Dichloropropene	ug/kg	-	-	-	-	-	<25	<25	<25	<25	<25
Dibromochloromethane	ug/kg	-	-	-	-	-	<25	<25	<25	<25	<25
Ethylbenzene	ug/kg	55000	50000	-	120000	90000	<25	<25	<25	<25	<25
Ethylene Dibromide	ug/kg	-	-	-	-	-	<25	<25	<25	<25	<25
Methylene Chloride (Dichloromethane)	ug/kg	-	-	50000	980	350000	<25	36	<25	<25	<25
o-Xylene	ug/kg	-	-	-	-	-	<25	<25	63	<25	<25
m,p-Xylene	ug/kg	-	-	-	-	-	<25	<25	110	<25	<25
Styrene	ug/kg	-	-	50000	22000	-	<25	<25	<25	<25	<25
Tetrachloroethylene	ug/kg	-	-	-	4800	4500	<25	<25	<25	<25	<25
Toluene	ug/kg	75000	100	-	220000	140000	<25	<25	<25	<25	<25
trans-1,2-Dichloroethylene	ug/kg	-	-	50000	-	84000	<25	<25	<25	<25	<25
trans-1,3-Dichloropropene	ug/kg	-	-	50000	-	-	<25	<25	<25	<25	<25
Trichloroethylene	ug/kg	3000	50	50000	130000	8100	<10	<10	<10	<10	<10
Trichlorofluoromethane (FREON 11)	ug/kg	-	-	-	20000	-	<25	<25	<25	<25	<25
Vinyl Chloride	ug/kg	-	-	-	4300	12000	<20	<20	<20	<20	<20

Notes:

value	-value exceeds CCME	-	-no guideline or value
value	-value exceeds OMOE	NC	-not calculated
0.96	-guidelines based on 10^{-6} ILCR, therefore not used		

[1] 1999 (with 2018 update) CCME *Canadian EnQualGuide* for commercial land use.

[2] 1991 CCME Interim soil quality criteria

[3] 2011 Ontario Ministry of the Environment (OMOE) Table 3: Full Depth, Non-Potable Water Scenario, Residential/Parkland Land Use

TABLE 8: VOLATILE ORGANIC COMPOUNDS in Soil - Ecological Health Guidelines
Client: Department of National Defence
Site Location: Former USAF Radar Station, Cartwright, NL
Englobe Project Number: P-0012285-0-16-200

PARAMETER	UNITS	CCME RESIDENTIAL/PARKLAND [1,2]			OMOE [3]		Stantec 2018 Phase II ESA									Englobe 2018 Phase III ESA				
							Main Complex													
		Ecological Contact[1]	Protection of GW for Aquatic Life[1]	Interim SQC[2]	Plants & Soil Organism	Mammals & Birds	CWT-SS13	CWT-SS16	CWT-SS34	CWT-SS36	CWT-TP8-BS2	CWT-TP11-BS1	CWT-TP26-BS2	CWT-TP28-BS2	CWT-TP30-BS2	CWT-MW9/1	CWT-TP8-18-A/1	CWT-TP8-18-B/1	CWT-TP8-18-C/1	CWT-TP8-18-D/1
																0 - 0.1 m	0 - 0.05 m	0 - 0.25 m	0 - 0.3 m	0 - 0.3 m
							0 - 0.3 m	0 - 0.2 m	0 - 0.2 m	0 - 0.2 m	0.3 - 0.6 m	0 - 0.5 m	1.0 - 1.5 m	1.3 - 1.8 m	1.0 - 1.5 m	16-Aug-18	16-Aug-18	16-Aug-18	16-Aug-18	16-Aug-18
1,1,1-Trichloroethane	ug/kg	-	-	50000	22000	820000	<25	<25	<25	<25	<25	<25	<25	<25	<25	<30	<30	<30	<30	<30
1,1,1,2-Tetrachloroethane	ug/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<100	<100	<100	<100	<100
1,1,2,2-Tetrachloroethane	ug/kg	-	-	50000	-	-	<25	<25	<25	<25	<25	<25	<25	<25	<25	<50	<50	<50	<50	<50
1,1,2-Trichloroethane	ug/kg	-	-	50000	10000	-	<25	<25	<25	<25	<25	<25	<25	<25	<25	<30	<30	<30	<30	<30
1,1-Dichloroethane	ug/kg	-	-	50000	11000	-	<25	<25	<25	<25	<25	<25	<25	<25	<25	<100	<100	<100	<100	<100
1,1-Dichloroethylene	ug/kg	-	-	50000	63000	43000	<25	<25	<25	<25	<25	<25	<25	<25	<25	<50	<50	<50	<50	<50
1,2-Dichlorobenzene	ug/kg	-	-	10000	4300	-	<25	<25	<25	<25	<25	<25	<25	<25	<25	<50	<50	<50	<50	<50
1,2-Dibromoethane	ug/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<50	<50	<50	<50	<50
1,2-Dichloroethane	ug/kg	-	-	50000	60000	2900	<25	<25	<25	<25	<25	<25	<25	<25	<25	<100	<100	<100	<100	<100
1,2-Dichloropropane	ug/kg	-	-	50000	3100	-	<25	<25	<25	<25	<25	<25	<25	<25	<25	<50	<50	<50	<50	<50
1,3-Dichlorobenzene	ug/kg	-	-	10000	6000	-	<25	<25	<25	<25	<25	<25	<25	<25	<25	<50	<50	<50	<50	<50
1,4-Dichlorobenzene	ug/kg	-	-	10000	4500	-	<25	<25	<25	<25	<25	<25	<25	<25	<25	<50	<50	<50	<50	<50
2-Hexanone	ug/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<500	<500	<500	<500	<500
Acetone	ug/kg	-	-	-	-	56000	-	-	-	-	-	-	-	-	-	<500	<500	<500	<500	<500
Benzene	ug/kg	31000	1000	-	60000	370000	<25	<25	<25	<25	<25	<25	<25	<25	<25	<6.8	<6.8	<6.8	<6.8	<6.8
Bromodichloromethane	ug/kg	-	-	-	-	-	<25	<25	<25	<25	<25	<25	<25	<25	<25	<100	<100	<100	<100	<100
Bromoform	ug/kg	-	-	-	-	-	<25	<25	<25	<25	<25	<25	<25	<25	<25	<100	<100	<100	<100	<100
Bromomethane	ug/kg	-	-	-	-	-	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Carbon Tetrachloride	ug/kg	-	-	-	7300	7600	<25	<25	<25	<25	<25	<25	<25	<25	<25	<50	<50	<50	<50	<50
Chloromethane	ug/kg	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<100	<100	<100	<100	<100
Chlorobenzene	ug/kg	-	-	10000	7500	-	<25	<25	<25	<25	<25	<25	<25	<25	<25	<50	<50	<50	<50	<50
Chloroethane	ug/kg	-	-	50000	-	-	<200	<200	<200	<200	<200	<200	<200	<200	<200	<100	<100	<100	<100	<100
Chloroform	ug/kg	-	-	50000	43000	81000	<25	<25	<25	<25	<25	<25	<25	<25	<25	<50	<50	<50	<50	<50
cis-1,2-Dichloroethylene	ug/kg	-	-	50000	-	84000	<25	<25	<25	<25	<25	<25	<25	<25	<25	<100	<100	<100	<100	<100
cis-1,3-Dichloropropene	ug/kg	-	-	-	-	-	<25	<25	<25	<25	<25	<25	<25	<25	<25	<100	<100	<100	<100	<100
Dibromochloromethane	ug/kg	-	-	-	-	-	<25	<25	<25	<25	<25	<25	<25	<25	<25	<100	<100	<100	<100	<100
Ethylbenzene	ug/kg	55000	50000	-	120000	90000	<25	<25	<25	<25	<25	<25	<25	<25	<25	<18	<18	<18	<18	<18
Ethylene Dibromide	ug/kg	-	-	-	-	-	<25	<25	<25	<25	<25	<25	<25	<25	<25	-	-	-	-	-
Methylene Chloride (Dichloromethane)	ug/kg	-	-	50000	980	350000	<25	<25	<25	<25	<25	<25	<25	<25	<25	<100	<100	<100	<100	<100
o-Xylene	ug/kg	-	-	-	-	-	<25	<25	<25	<25	<25	<25	<25	<25	<25	<100	<100	<100	<100	<100
m,p-Xylene	ug/kg	-	-	-	-	-	<25	<25	<25	<25	<25	<25	<25	<25	<25	<100	<100	<100	<100	<100
Styrene	ug/kg	-	-	50000	22000	-	<25	<25	<25	<25	<25	<25	<25	<25	<25	<100	<100	<100	<100	<100
Tetrachloroethylene	ug/kg	-	-	-	4800	4500	<25	170	<25	<25	<25	<25	<25	<25	<25	<100	<100	<100	<100	<100
Toluene	ug/kg	75000	100	-	220000	140000	<25	<25	<25	<25	<25	<25	<25	<25	<25	<80	<80	<80	<80	<80
trans-1,2-Dichloroethylene	ug/kg	-	-	50000	-	84000	<25	<25	<25	<25	<25	<25	<25	<25	<25	<80	<80	<80	<80	<80
trans-1,3-Dichloropropene	ug/kg	-	-	50000	-	-	<25	<25	<25	<25	<25	<25	<25	<25	<25	<100	<100	<100	<100	<100
Trichloroethylene	ug/kg	3000	50	50000	130000	8100	<10	<10	<10	<10	14	<10	<10	<10	<10	<10	<10	<10	<10	<10
Trichlorofluoromethane (FREON 11)	ug/kg	-	-	-	20000	-	<25	<25	<25	<25	<25	<25	<25	<25	<25	<100	<100	<100	<100	<100
Vinyl Chloride	ug/kg	-	-	-	4300	12000	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20

Notes:

value	-value exceeds CCME	-	-no guideline or value
value	-value exceeds OMOE	NC	-not calculated
0.96	-guidelines based on 10^{-6} ILCR, therefore not used		

[1] 1999 (with 2018 update) CCME *CanadianEnvQualGds* for commercial land use.

[2] 1991 CCME Interim soil quality criteria

[3] 2011 Ontario Ministry of the Environment (OMOE) Table 3: Full Depth, Non-Potable Water Scenario, Residential/Parkland Land Use

TABLE 9: POLYCHLORINATED BIPHENYLS in Soil - Human Health Guidelines
Client: Department of National Defence
Site Location: Former USAF Radar Station, Cartwright, NL
Englobe Project Number: P-0012285-0-16-200

PARAMETER	UNITS	CCME SQGs[1] Human Health			OMOE[2]	Stantec 2018 Phase II ESA											
						General Area											
		Guideline	Soil Ingestion	Produce, meat and milk check	Soil Contact S1 Risk	CWT-SS42	CWT-SS43	CWT-SS44	CWT-SS45	CWT-SS46	CWT-SS47	CWT-SS48	CWT-SS49	CWT-SS50	CWT-SS51	CWT-SS57	CWT-SS62
						0 - 0.2	0 - 0.2	0 - 0.2	0 - 0.2	0 - 0.2	0 - 0.2	0 - 0.2	0 - 0.2	0 - 0.2	0 - 0.2	0 - 0.2	0 - 0.2
Aroclor 1016	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
Aroclor 1221	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
Aroclor 1232	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
Aroclor 1248	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
Aroclor 1242	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
Aroclor 1254	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
Aroclor 1260	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
Calculated Total PCB	mg/kg	1.3	NC	NC	0.35	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05

PARAMETER	UNITS	CCME SQGs[1] Human Health			OMOE[2]	Stantec 2018 Phase II ESA									
						Former Contractors Village									
		Guideline	Soil Ingestion	Produce, meat and milk check	Soil Contact S1 Risk	CWT-SS64	CWT-SS66	CWT-SS68	CWT-TP35-BS1	CWT-TP37-BS1	CWT-TP38-BS1	CWT-TP39-BS1	CWT-TP41-BS1	CWT-TP42-BS1	CWT-TP105-BS1
						0 - 0.2	0 - 0.3	0 - 0.3	0.1 - 0.6	0 - 0.5	0 - 0.5	0 - 0.5	0.1 - 0.5	0.1 - 0.6	0.1 - 0.6
Aroclor 1016	mg/kg	-	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Aroclor 1221	mg/kg	-	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Aroclor 1232	mg/kg	-	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Aroclor 1248	mg/kg	-	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Aroclor 1242	mg/kg	-	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Aroclor 1254	mg/kg	-	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Aroclor 1260	mg/kg	-	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Calculated Total PCB	mg/kg	1.3	NC	NC	0.35	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05

TABLE 9: POLYCHLORINATED BIPHENYLS in Soil - Human Health Guidelines
Client: Department of National Defence
Site Location: Former USAF Radar Station, Cartwright, NL
Englobe Project Number: P-0012285-0-16-200

PARAMETER	UNITS	CCME SQGs[1] Human Health			OMOE[2]	Stantec 2018 Phase II ESA – Main Complex																
		Guideline	Soil Ingestion	Produce, meat and milk check	Soil Contact S1 Risk	CWT-SS15	CWT-SS17	CWT-SS19	CWT-SS21	CWT-SS23	CWT-SS25	CWT-SS27	CWT-SS29	CWT-SS31	CWT-SS33	CWT-SS34	CWT-SS36	CWT-TP6-BS1	CWT-TP8-BS2	CWT-TP9-BS1	CWT-TP10-BS1	CWT-TP12-BS1
						0 - 0.2	0 - 0.2	0 - 0.2	0 - 0.2	0 - 0.2	0 - 0.2	0 - 0.2	0 - 0.2	0 - 0.2	0 - 0.2	0 - 0.2	0 - 0.2	0 - 0.6	0.3 - 0.6	0 - 0.3	0 - 0.5	0 - 0.6
Aroclor 1016	mg/kg	-	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.15	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Aroclor 1221	mg/kg	-	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.15	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Aroclor 1232	mg/kg	-	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.15	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Aroclor 1248	mg/kg	-	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.15	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Aroclor 1242	mg/kg	-	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.15	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Aroclor 1254	mg/kg	-	-	-	-	<0.05	<0.05	<0.05	1.4	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.18	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Aroclor 1260	mg/kg	-	-	-	-	0.14	0.12	0.1	0.6	1.5	0.26	0.42	<0.05	2	0.15	<0.15	<0.05	<0.05	<0.05	0.20	<0.05	<0.05
Calculated Total PCB	mg/kg	1.3	NC	NC	0.35	0.14	0.12	0.1	**2**	**1.5**	0.26	0.42	<0.05	**2**	0.15	0.2	<0.05	<0.05	<0.05	0.20	<0.05	<0.05

PARAMETER	Stantec 2018 Phase II ESA – Main Complex																		
	CWT-TP13-BS2	CWT-TP15-BS1	CWT-TP16-BS1	CWT-TP17-BS1	CWT-TP18-BS1	CWT-TP20-BS1	CWT-TP21-BS1	CWT-TP23-BS1	CWT-TP25-BS1	CWT-TP26-BS1	CWT-TP27-BS1	CWT-TP28-BS1	CWT-TP29-BS1	CWT-TP30-BS1	CWT-TP31-BS1	CWT-TP100-BS1	CWT-TP101-BS1	CWT-TP102-BS1	CWT-TP110-BS2
	1.0 - 1.5	0.1 - 0.6	0 - 0.5	0 - 0.5	0 - 0.3	0.1 - 0.6	0 - 0.5	0 - 0.4	0.1 - 0.5	0 - 0.5	0.1 - 0.6	0 - 0.5	0.1 - 0.6	0.1 - 0.6	0.1 - 0.6	0 - 0.3	0 - 0.5	0.1 - 0.6	1.0 - 1.5
Aroclor 1016	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.10	<0.05	<0.05	<0.05	<0.05	<0.05
Aroclor 1221	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.10	<0.05	<0.05	<0.05	<0.05	<0.05
Aroclor 1232	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.10	<0.05	<0.05	<0.05	<0.05	<0.05
Aroclor 1248	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.10	<0.05	<0.05	<0.05	<0.05	<0.05
Aroclor 1242	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.10	<0.05	<0.05	<0.05	<0.05	<0.05
Aroclor 1254	0.12	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.69	<0.05	<0.05	<0.05	<0.05	<0.10	<0.05	<0.05	<0.05	<0.05	0.13
Aroclor 1260	<0.05	0.14	<0.05	<0.05	<0.05	0.25	0.14	0.078	0.57	<0.05	<0.05	<0.05	0.072	<0.10	<0.05	<0.05	<0.05	0.20	<0.05
Calculated Total PCB	0.12	0.14	<0.05	<0.05	<0.05	0.25	0.14	0.078	1.3	<0.05	<0.05	<0.05	0.072	<0.10	<0.05	<0.05	<0.05	0.20	0.13

PARAMETER	UNITS	CCME SQGs[1] Human Health			OMOE[2]	Stantec 2018 Phase II ESA – Former USAF Dump Area and Former Ammunition Storage Area												
		Guideline	Soil Ingestion	Produce, meat and milk check	Soil Contact S1 Risk	CWT-SS5	CWT-SS6	CWT-SS7	CWT-SS9	CWT-SS10	CWT-SS11	CWT-SS12	CWT-SS70	CWT-TP1-BS1	CWT-TP2-BS2	CWT-TP3-BS2	CWT-TP4-BS1	CWT-TP5-BS2
						0 - 0.2	0 - 0.2	0 - 0.3	0 - 0.3	0 - 0.3	0 - 0.3	0 - 0.3	0 - 0.3	0 - 0.3	0.3 - 0.7	0.4 - 0.8	0 - 0.5	0.3 - 0.6
Aroclor 1016	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
Aroclor 1221	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
Aroclor 1232	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
Aroclor 1248	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
Aroclor 1242	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
Aroclor 1254	mg/kg	-	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	1.0	<0.05	<0.05	<0.05
Aroclor 1260	mg/kg	-	-	-	-	1.4	2.6	3	0.48	0.11	<0.05	0.071	0.40	<0.05	1.2	24.0	0.3	<0.05
Calculated Total PCB	mg/kg	1.3	NC	NC	0.35	**1.4**	**2.6**	**3**	0.48	0.11	<0.05	0.071	0.40	<0.05	**2.2**	**24.0**	0.3	<0.05

Notes:

value	-value exceeds CCME	-	-no guideline or value
value	-value exceeds OMOE	NC	-not calculated
0.96	-guidelines based on 10^{-6} ILCR, therefore not used		

[1] 1999 (with 2018 update) CCME Canadian Environmental Quality Guidelines for residential/parkland land use.

[3] 2011 Ontario Ministry of the Environment (OMOE) Table 3: Full Depth Generic Site Condition Standards in a Non-Potable Ground Water Condition, Residential/Parkland Land Use

TABLE 10: POLYCHLORINATED BIPHENYLS in Soil - Ecological Health Guidelines
Client: Department of National Defence
Site Location: Former USAF Radar Station, Cartwright, NL
Englobe Project Number: P-0012285-0-16-200

PARAMETER	UNITS	CCME SQGs[1] Ecological Health				OMOE[2]		Stantec 2018 Phase II ESA - General Area											
		Guideline (tertiary	Soil Contact	Primary Consumer	Secondary Consumer	Plants and Soil Organisms	Mammals and Birds	CWT-SS42	CWT-SS43	CWT-SS44	CWT-SS45	CWT-SS46	CWT-SS47	CWT-SS48	CWT-SS49	CWT-SS50	CWT-SS51	CWT-SS57	CWT-SS62
								0 - 0.2	0 - 0.2	0 - 0.2	0 - 0.2	0 - 0.2	0 - 0.2	0 - 0.2	0 - 0.2	0 - 0.2	0 - 0.2	0 - 0.2	0 - 0.2
Aroclor 1016	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
Aroclor 1221	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
Aroclor 1232	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
Aroclor 1248	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
Aroclor 1242	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
Aroclor 1254	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
Aroclor 1260	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
Calculated Total PCB	mg/kg	1.3	33	25	1.8	41	1.1	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05

PARAMETER	UNITS	CCME SQGs[1] Ecological Health				OMOE[2]		Stantec 2018 Phase II ESA - Former Contractors Village									
		Guideline (tertiary consumer)	Soil Contact	Primary Consumer	Secondary Consumer	Plants and Soil Organisms	Mammals and Birds	CWT-SS64	CWT-SS66	CWT-SS68	CWT-TP35-BS1	CWT-TP37-BS1	CWT-TP38-BS1	CWT-TP39-BS1	CWT-TP41-BS1	CWT-TP42-BS1	CWT-TP105-BS1
								0 - 0.2	0 - 0.3	0 - 0.3	0.1 - 0.6	0 - 0.5	0 - 0.5	0 - 0.5	0.1 - 0.5	0.1 - 0.6	0.1 - 0.6
Aroclor 1016	mg/kg	-	-	-	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Aroclor 1221	mg/kg	-	-	-	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Aroclor 1232	mg/kg	-	-	-	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Aroclor 1248	mg/kg	-	-	-	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Aroclor 1242	mg/kg	-	-	-	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Aroclor 1254	mg/kg	-	-	-	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Aroclor 1260	mg/kg	-	-	-	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Calculated Total PCB	mg/kg	1.3	33	25	1.8	41	1.1	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05

TABLE 10: POLYCHLORINATED BIPHENYLS in Soil - Ecological Health Guidelines
Client: Department of National Defence
Site Location: Former USAF Radar Station, Cartwright, NL
Englobe Project Number: P-0012285-0-16-200

Stantec 2018 Phase II ESA — Main Complex

PARAMETER	UNITS	CCME SQGs[1] Ecological Health: Guideline (tertiary consumer)	CCME SQGs[1] Ecological Health: Soil Contact	CCME SQGs[1] Ecological Health: Primary Consumer	CCME SQGs[1] Ecological Health: Secondary Consumer	OMOE[2]: Plants and Soil Organisms	OMOE[2]: Mammals and Birds	CWT-SS15		CWT-SS17	CWT-SS19	CWT-SS21	CWT-SS23	CWT-SS25	CWT-SS27	CWT-SS29	CWT-SS31	CWT-SS33	CWT-SS34	CWT-SS36
								0 - 0.2		0 - 0.2	0 - 0.2	0 - 0.2	0 - 0.2	0 - 0.2	0 - 0.2	0 - 0.2	0 - 0.2	0 - 0.2	0 - 0.2	0 - 0.2
Aroclor 1016	mg/kg	-	-	-	-	-	-	<0.05		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.15	<0.05
Aroclor 1221	mg/kg	-	-	-	-	-	-	<0.05		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.15	<0.05
Aroclor 1232	mg/kg	-	-	-	-	-	-	<0.05		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.15	<0.05
Aroclor 1248	mg/kg	-	-	-	-	-	-	<0.05		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.15	<0.05
Aroclor 1242	mg/kg	-	-	-	-	-	-	<0.05		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.15	<0.05
Aroclor 1254	mg/kg	-	-	-	-	-	-	<0.05		<0.05	<0.05	1.4	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.18	<0.05
Aroclor 1260	mg/kg	-	-	-	-	-	-	0.14		0.12	0.1	0.6	1.5	0.26	0.42	<0.05	2	0.15	<0.15	<0.05
Calculated Total PCB	mg/kg	1.3	33	25	1.8	41	1.1	0.14		0.12	0.1	***2***	***1.5***	0.26	0.42	<0.05	***2***	0.15	0.2	<0.05

PARAMETER	CWT-TP6-BS1	CWT-TP8-BS2	CWT-TP9-BS1	CWT-TP10-BS1	CWT-TP12-BS1	CWT-TP13-BS2	CWT-TP15-BS1	CWT-TP16-BS1	CWT-TP17-BS1	CWT-TP18-BS1	CWT-TP20-BS1	CWT-TP21-BS1	CWT-TP23-BS1
	0 - 0.6	0.3 - 0.6	0 - 0.3	0 - 0.5	0 - 0.6	1.0 - 1.5	0.1 - 0.6	0 - 0.5	0 - 0.5	0 - 0.3	0.1 - 0.6	0 - 0.5	0 - 0.4
Aroclor 1016	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Aroclor 1221	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Aroclor 1232	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Aroclor 1248	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Aroclor 1242	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Aroclor 1254	<0.05	<0.05	<0.05	<0.05	<0.05	0.12	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Aroclor 1260	<0.05	<0.05	0.20	<0.05	<0.05	<0.05	0.14	<0.05	<0.05	<0.05	0.25	0.14	0.078
Calculated Total PCB	<0.05	<0.05	0.20	<0.05	<0.05	0.12	0.14	<0.05	<0.05	<0.05	0.25	0.14	0.078

PARAMETER	CWT-TP25-BS1	CWT-TP26-BS1	CWT-TP27-BS1	CWT-TP28-BS1	CWT-TP29-BS1	CWT-TP30-BS1	CWT-TP31-BS1	CWT-TP100-BS1	CWT-TP101-BS1	CWT-TP102-BS1	CWT-TP110-BS2
	0.1 - 0.5	0 - 0.5	0.1 - 0.6	0 - 0.5	0.1 - 0.6	0.1 - 0.6	0.1 - 0.6	0 - 0.3	0 - 0.5	0.1 - 0.6	1.0 - 1.5
Aroclor 1016	<0.05	<0.05	<0.05	<0.05	<0.05	<0.10	<0.05	<0.05	<0.05	<0.05	<0.05
Aroclor 1221	<0.05	<0.05	<0.05	<0.05	<0.05	<0.10	<0.05	<0.05	<0.05	<0.05	<0.05
Aroclor 1232	<0.05	<0.05	<0.05	<0.05	<0.05	<0.10	<0.05	<0.05	<0.05	<0.05	<0.05
Aroclor 1248	<0.05	<0.05	<0.05	<0.05	<0.05	<0.10	<0.05	<0.05	<0.05	<0.05	<0.05
Aroclor 1242	<0.05	<0.05	<0.05	<0.05	<0.05	<0.10	<0.05	<0.05	<0.05	<0.05	<0.05
Aroclor 1254	0.69	<0.05	<0.05	<0.05	<0.05	<0.10	<0.05	<0.05	<0.05	<0.05	0.13
Aroclor 1260	0.57	<0.05	<0.05	<0.05	0.072	<0.10	<0.05	<0.05	<0.05	0.20	<0.05
Calculated Total PCB	***1.3***	<0.05	<0.05	<0.05	0.072	<0.10	<0.05	<0.05	<0.05	0.20	0.13

Stantec 2018 Phase II ESA — Former USAF Dump Area and Former Ammunition Storage Area

PARAMETER	UNITS	CCME SQGs[1] Ecological Health: Guideline (tertiary consumer)	CCME SQGs[1] Ecological Health: Soil Contact	CCME SQGs[1] Ecological Health: Primary Consumer	CCME SQGs[1] Ecological Health: Secondary Consumer	OMOE[2]: Plants and Soil Organisms	OMOE[2]: Mammals and Birds	CWT-SS5	CWT-SS6	CWT-SS7	CWT-SS9	CWT-SS10	CWT-SS11	CWT-SS12	CWT-SS70	CWT-TP1-BS1	CWT-TP2-BS2	CWT-TP3-BS2	CWT-TP4-BS1	CWT-TP5-BS2
								0 - 0.2	0 - 0.2	0 - 0.3	0 - 0.3	0 - 0.3	0 - 0.3	0 - 0.3	0 - 0.3	0 - 0.3	0.3 - 0.7	0.4 - 0.8	0 - 0.5	0.3 - 0.6
Aroclor 1016	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
Aroclor 1221	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
Aroclor 1232	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
Aroclor 1248	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
Aroclor 1242	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
Aroclor 1254	mg/kg	-	-	-	-	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	1.0	<0.05	<0.05	<0.05
Aroclor 1260	mg/kg	-	-	-	-	-	-	1.4	2.6	3	0.48	0.11	<0.05	0.071	0.40	<0.05	1.2	24.0	0.3	<0.05
Calculated Total PCB	mg/kg	1.3	33	25	1.8	41	1.1	***1.4***	***2.6***	***3***	0.48	0.11	<0.05	0.071	0.40	<0.05	***2.2***	***24.0***	0.3	<0.05

Notes:

value	-value exceeds CCME	-	-no guideline or value	-no guideline or value
value	-value exceeds OMOE	NC	-not calculated	-not calculated
0.96	-guidelines based on 10^{-6} ILCR, therefore not used			

[1] 1999 (with 2018 update) CCME Canadian Environmental Quality Guidelines for residential/parkland land use.

[2] 2011 Ontario Ministry of the Environment (OMOE) Table 3: Full Depth Generic Site Condition Standards in a Non-Potable Ground Water Condition

TABLE 11: TOTAL PETROLEUM HYDROCARBON COMPOUNDS in Sediment - Human Health Guidelines
Client: Department of National Defence
Site Location: Former USAF Radar Station, Cartwright, NL
Englobe Project Number: P-0012285-0-16-200

PARAMETER		UNITS	CCME RESIDENTIAL/PARKLAND [1,2]			RBCA Tier II PSSL	OMOE[4]	Stantec 2018 Phase II ESA	
								General Area	
			Ingestion surface soil	Dermal Contact surface soil	Management Limits	Soil Ingestion Residential [3]	Soil Contact S1 Risk	CWT-SED-2	CWT-SED-3
BTEX	Benzene	mg/kg	110	250	-	66	9.3	<0.050	<0.025
	Toluene	mg/kg	22000	220000	-	20000	1 700	<0.050	<0.025
	Ethylbenzene	mg/kg	10000	58000	-	9300	2 100	<0.050	<0.025
	Xylenes (Total)	mg/kg	150000	NA	-	140000	4200	<0.10	<0.05
Modified TPH	Gas Range (C6-C10) (less BTEX)	mg/kg	-	-	-	-	-	<5	<2.5
	Fuel Range (>C10-C16)	mg/kg	-	-	-	-	-	<10	<10
	Fuel Range (>C16-C21)	mg/kg	-	-	-	-	-	<10	<10
	Lube Range (>C21-<C32)	mg/kg	-	-	-	-	-	<15	<15
Total Modified TPH - Tier I		mg/kg	-	-	-	15000 as gas 8600 as fuel oil 14000 as lube oil	-	<25	<25
CWS Fraction F1 (C6-C10)		mg/kg	12000 / NA[2]		700[2]		6900	<5	<2.5
CWS Fraction F2 (>C10-C16)		mg/kg	6800 / NA[2]		1000[2]		3100	<10	<10
CWS Fraction F3 (>C16-C34)		mg/kg	15000 / NA[2]		3500[2]	-	5800	30	<20
CWS Fraction F4 (>C34)		mg/kg	21000 / NA[2]		10000[2]	-	6100	-	-
Product Resemblance		-	-	-	-	-	-	-	-
Return to Baseline at C32		-	-	-	-	-	-	-	-

Notes:

value	-value exceeds CCME	-	-no guideline or value
[value]	-value exceeds RBCA	NA	-not applicable
value	-value exceeds OMOE		

[1] 1999 (with 2018 update) CCME *Canadian Environmental Quality Guidelines* for residential/parkland land use.

[2] 2008 (with 2012 Updates) CCME Canada Wide Standards (CWS) for Petroleum Hydrocarbons (PHC) in Soil, Tier 1 Values, Residential/Parkland Land Use - Coarse Grained Soil.

[3] 2012 Atlantic RBCA Tier II Pathway Specific Screening Levels (PSSL) for a residential property with non-potable groundwater and coarse-grained soil.

[4] 2011 Ontario Ministry of the Environment (OMOE) Table 3: Full Depth Generic Site Condition Standards in a Non-Potable Ground Water Condition, Residential/Parkland Land Use

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

FO/LO - One product in fuel/lube range.
LO - Lube oil fraction.
ULO - Unidentified compounds in lube oil range.
PLO - Possible lube oil fraction.

TABLE 11: TOTAL PETROLEUM HYDROCARBON COMPOUNDS in Sediment - Human Health Guidelines
Client: Department of National Defence
Site Location: Former USAF Radar Station, Cartwright, NL
Englobe Project Number: P-0012285-0-16-200

PARAMETER		UNITS	CCME RESIDENTIAL/PARKLAND [1,2]			RBCA Tier II PSSL	OMOE[4]	Stantec 2018 Phase II ESA		Englobe 2018 Phase III ESA
								Former Contractor Village		
			Ingestion surface soil	Dermal Contact surface soil	Management Limits	Soil Ingestion Residential [3]	Soil Contact S1 Risk	CWT-SED-4	CWT-SED-5	CWT-SED-5-18 3x Silica Gel
										15-Aug-18
BTEX	Benzene	mg/kg	110	250	-	66	9.3	<0.025	<0.025	<0.03
	Toluene	mg/kg	22000	220000	-	20000	1 700	<0.025	<0.025	<0.04
	Ethylbenzene	mg/kg	10000	58000	-	9300	2 100	<0.025	<0.025	<0.03
	Xylenes (Total)	mg/kg	150000	NA	-	140000	4200	<0.05	<0.05	<0.05
Modified TPH	Gas Range (C6-C10) (less BTEX)	mg/kg	-	-	-	-	-	<2.5	<2.5	15
	Fuel Range (>C10-C16)	mg/kg	-	-	-	-	-	<10	120	413
	Fuel Range (>C16-C21)	mg/kg	-	-	-	-	-	<10	300	110
	Lube Range (>C21-<C32)	mg/kg	-	-	-	-	-	<15	1000	64
Total Modified TPH - Tier I		mg/kg	-	-	-	15000 as gas 8600 as fuel oil 14000 as lube oil	-	<25	1400	602
CWS Fraction F1 (C6-C10)		mg/kg	12000 / NA[2]		700[2]		6900	<2.5	<2.5	15
CWS Fraction F2 (>C10-C16)		mg/kg	6800 / NA[2]		1000[2]		3100	<10	120	413
CWS Fraction F3 (>C16-C34)		mg/kg	15000 / NA[2]		3500[2]	-	5800	<20	1300	30
CWS Fraction F4 (>C34)		mg/kg	21000 / NA[2]		10000[2]	-	6100	-	-	-
Product Resemblance		-	-	-	-	-	-	-	FO/LO. LO	FR, UC
Return to Baseline at C32		-	-	-	-	-	-	-	N	Y

Notes:

value	-value exceeds CCME	-	-no guideline or value
[value]	-value exceeds RBCA	NA	-not applicable
value	-value exceeds OMOE		

[1] 1999 (with 2018 update) CCME *Canadian Environmental Quality Guidelines* for residential/parkland land use.
[2] 2008 (with 2012 Updates) CCME Canada Wide Standards (CWS) for Petroleum Hydrocarbons (PHC) in Soil, Tier 1 Values, Residential/Parkland Land Use - Coarse Grained Soil.
[3] 2012 Atlantic RBCA Tier II Pathway Specific Screening Levels (PSSL) for a residential property with non-potable groundwater and coarse-grained soil.
[4] 2011 Ontario Ministry of the Environment (OMOE) Table 3: Full Depth Generic Site Condition Standards in a Non-Potable Ground Water Condition, Residential/Parkland Land Use

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

FO/LO - One product in fuel/lube range.
LO - Lube oil fraction.
ULO - Unidentified compounds in lube oil range.
PLO - Possible lube oil fraction.

TABLE 11: TOTAL PETROLEUM HYDROCARBON COMPOUNDS in Sediment - Human Health Guidelines
Client: Department of National Defence
Site Location: Former USAF Radar Station, Cartwright, NL
Englobe Project Number: P-0012285-0-16-200

PARAMETER		UNITS	CCME RESIDENTIAL/PARKLAND [1,2]			RBCA Tier II PSSL	OMOE[4]	Stantec 2018 Phase II ESA
			Ingestion surface soil	Dermal Contact surface soil	Management Limits	Soil Ingestion Residential [3]	Soil Contact S1 Risk	Main Complex CWT-SED-6
BTEX	Benzene	mg/kg	110	250	-	66	9.3	<0.025
	Toluene	mg/kg	22000	220000	-	20000	1 700	<0.025
	Ethylbenzene	mg/kg	10000	58000	-	9300	2 100	<0.025
	Xylenes (Total)	mg/kg	150000	NA	-	140000	4200	<0.05
Modified TPH	Gas Range (C6-C10) (less BTEX)	mg/kg	-	-	-	-	-	<2.5
	Fuel Range (>C10-C16)	mg/kg	-	-	-	-	-	<10
	Fuel Range (>C16-C21)	mg/kg	-	-	-	-	-	<10
	Lube Range (>C21-<C32)	mg/kg	-	-	-	-	-	39
Total Modified TPH - Tier I		mg/kg	-	-	-	15000 as gas 8600 as fuel oil 14000 as lube oil	-	39
CWS Fraction F1 (C6-C10)		mg/kg	12000 / NA[2]		700[2]		6900	<2.5
CWS Fraction F2 (>C10-C16)		mg/kg	6800 / NA[2]		1000[2]		3100	<10
CWS Fraction F3 (>C16-C34)		mg/kg	15000 / NA[2]		3500[2]	-	5800	39
CWS Fraction F4 (>C34)		mg/kg	21000 / NA[2]		10000[2]	-	6100	-
Product Resemblance		-	-	-	-	-	-	ULO. PLO
Return to Baseline at C32		-	-	-	-	-	-	Y

Notes:

value	-value exceeds CCME	-	-no guideline or value
[value]	-value exceeds RBCA	NA	-not applicable
value	-value exceeds OMOE		

[1] 1999 (with 2018 update) CCME *Canadian Environmental Quality Guidelines* for residential/parkland land use.
[2] 2008 (with 2012 Updates) CCME Canada Wide Standards (CWS) for Petroleum Hydrocarbons (PHC) in Soil, Tier 1 Values, Residential/Parkland Land Use - Coarse Grained Soil.
[3] 2012 Atlantic RBCA Tier II Pathway Specific Screening Levels (PSSL) for a residential property with non-potable groundwater and coarse-grained soil.
[4] 2011 Ontario Ministry of the Environment (OMOE) Table 3: Full Depth Generic Site Condition Standards in a Non-Potable Ground Water Condition, Residential/Parkland Land Use

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

FO/LO - One product in fuel/lube range.
LO - Lube oil fraction.
ULO - Unidentified compounds in lube oil range.
PLO - Possible lube oil fraction.

TABLE 11: TOTAL PETROLEUM HYDROCARBON COMPOUNDS in Sediment - Human Health Guidelines
Client: Department of National Defence
Site Location: Former USAF Radar Station, Cartwright, NL
Englobe Project Number: P-0012285-0-16-200

PARAMETER		UNITS	CCME RESIDENTIAL/PARKLAND [1,2]			RBCA Tier II PSSL	OMOE[4]	Stantec 2018 Phase II ESA		Englobe 2018 Phase III ESA		
								Former USAF Dump Area and Ammunition Storage				
			Ingestion surface soil	Dermal Contact surface soil	Management Limits	Soil Ingestion Residential [3]	Soil Contact S1 Risk	CWT-SED-7	CWT-SED-8	CWT-SED-7-18	CWT-SED-8-18	
										3x Silica Gel	3x Silica Gel	3x Silica Gel
										24-Aug-18	15-Aug-18	24-Aug-18
BTEX	Benzene	mg/kg	110	250	-	66	9.3	<0.025	<0.025	<0.03	<0.03	<0.03
	Toluene	mg/kg	22000	220000	-	20000	1 700	0.1	<0.025	<0.04	1.76	<0.04
	Ethylbenzene	mg/kg	10000	58000	-	9300	2 100	nd	<0.025	<0.03	<0.03	<0.03
	Xylenes (Total)	mg/kg	150000	NA	-	140000	4200	<0.05	<0.05	<0.05	<0.05	<0.05
Modified TPH	Gas Range (C6-C10) (less BTEX)	mg/kg	-	-	-	-	-	<2.5	<2.5	<3	38	<3
	Fuel Range (>C10-C16)	mg/kg	-	-	-	-	-	<10	<10	94	<15	116
	Fuel Range (>C16-C21)	mg/kg	-	-	-	-	-	25	<10	102	44	129
	Lube Range (>C21-<C32)	mg/kg	-	-	-	-	-	110	590	383	551	558
Total Modified TPH - Tier I		mg/kg	-	-	-	15000 as gas 8600 as fuel oil 14000 as lube oil	-	140	590	580	633	800
CWS Fraction F1 (C6-C10)		mg/kg	12000 / NA[2]		700[2]		6900	<2.5	<2.5	<3	38	<3
CWS Fraction F2 (>C10-C16)		mg/kg	6800 / NA[2]		1000[2]		3100	<10	<10	94	<15	116
CWS Fraction F3 (>C16-C34)		mg/kg	15000 / NA[2]		3500[2]	-	5800	24	28	485	595	687
CWS Fraction F4 (>C34)		mg/kg	21000 / NA[2]		10000[2]	-	6100	-	-	-	-	-
Product Resemblance		-	-	-	-	-	-	ULO. PLO	ULO	UC+LR	UC	UC+LR
Return to Baseline at C32		-	-	-	-	-	-	Y	Y	Y	Y	Y

Notes:

value	-value exceeds CCME	-	-no guideline or value
[value]	-value exceeds RBCA	NA	-not applicable
value	-value exceeds OMOE		

[1] 1999 (with 2018 update) CCME *Canadian Environmental Quality Guidelines* for residential/parkland land use.
[2] 2008 (with 2012 Updates) CCME Canada Wide Standards (CWS) for Petroleum Hydrocarbons (PHC) in Soil, Tier 1 Values, Residential/Parkland Land Use - Coarse Grained Soil.
[3] 2012 Atlantic RBCA Tier II Pathway Specific Screening Levels (PSSL) for a residential property with non-potable groundwater and coarse-grained soil.
[4] 2011 Ontario Ministry of the Environment (OMOE) Table 3: Full Depth Generic Site Condition Standards in a Non-Potable Ground Water Condition, Residential/Parkland Land Use

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

FO/LO - One product in fuel/lube range.
LO - Lube oil fraction.
ULO - Unidentified compounds in lube oil range.
PLO - Possible lube oil fraction.

TABLE 11: TOTAL PETROLEUM HYDROCARBON COMPOUNDS in Sediment - Human Health Guidelines
Client: Department of National Defence
Site Location: Former USAF Radar Station, Cartwright, NL
Englobe Project Number: P-0012285-0-16-200

PARAMETER		UNITS	CCME RESIDENTIAL/PARKLAND [1,2]			RBCA Tier II PSSL	OMOE[4]	Englobe 2018 Phase III ESA							
								Background							
			Ingestion surface soil	Dermal Contact surface soil	Management Limits	Soil Ingestion Residential [3]	Soil Contact S1 Risk	CWT-SED-BK01	3x Silica Gel	CWT-SED-BK02	3x Silica Gel	CWT-SED-BK03	3x Silica Gel	CWT-SED-BK04	3x Silica Gel
								24-Aug-18	24-Aug-18	24-Aug-18	24-Aug-18	24-Aug-18	24-Aug-18	24-Aug-18	24-Aug-18
BTEX	Benzene	mg/kg	110	250	-	66	9.3	<0.03	-	<0.03	-	<0.03	-	<0.03	-
	Toluene	mg/kg	22000	220000	-	20000	1 700	<0.04	-	<0.04	-	<0.04	-	<0.04	-
	Ethylbenzene	mg/kg	10000	58000	-	9300	2 100	<0.03	-	<0.03	-	<0.03	-	<0.03	-
	Xylenes (Total)	mg/kg	150000	NA	-	140000	4200	<0.05	-	<0.05	-	<0.05	-	<0.05	-
Modified TPH	Gas Range (C6-C10) (less BTEX)	mg/kg	-	-	-	-	-	75	-	<3	-	<3	-	<3	-
	Fuel Range (>C10-C16)	mg/kg	-	-	-	-	-	137	163	396	157	72	150	85	<15
	Fuel Range (>C16-C21)	mg/kg	-	-	-	-	-	149	65	597	103	350	229	2760	132
	Lube Range (>C21-<C32)	mg/kg	-	-	-	-	-	1050	250	2620	558	1970	743	1190	344
Total Modified TPH - Tier I		mg/kg	-	-	-	15000 as gas 8600 as fuel oil 14000 as lube oil	-	1410	480	3610	820	2390	1120	4040	480
CWS Fraction F1 (C6-C10)		mg/kg	12000 / NA[2]		700[2]		6900	75	-	<3	-	<3	-	<3	-
CWS Fraction F2 (>C10-C16)		mg/kg	6800 / NA[2]		1000[2]		3100	137	163	396	157	72	150	85	<15
CWS Fraction F3 (>C16-C34)		mg/kg	15000 / NA[2]		3500[2]	-	5800	1199	315	3217	661	2320	972	3950	476
CWS Fraction F4 (>C34)		mg/kg	21000 / NA[2]		10000[2]	-	6100	-	-	-	-	-	-	-	-
Product Resemblance		-	-	-	-	-	-	UC+LR	-	UC+LR	-	UC+LR	-	UC	-
Return to Baseline at C32		-	-	-	-	-	-	N	Y	N	Y	N	Y	Y	Y

Notes:

value	-value exceeds CCME	-	-no guideline or value
[value]	-value exceeds RBCA	NA	-not applicable
value	-value exceeds OMOE		

[1] 1999 (with 2018 update) CCME *Canadian Environmental Quality Guidelines* for residential/parkland land use.
[2] 2008 (with 2012 Updates) CCME Canada Wide Standards (CWS) for Petroleum Hydrocarbons (PHC) in Soil, Tier 1 Values, Residential/Parkland Land Use - Coarse Grained Soil.
[3] 2012 Atlantic RBCA Tier II Pathway Specific Screening Levels (PSSL) for a residential property with non-potable groundwater and coarse-grained soil.
[4] 2011 Ontario Ministry of the Environment (OMOE) Table 3: Full Depth Generic Site Condition Standards in a Non-Potable Ground Water Condition, Residential/Parkland Land Use

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

FO/LO - One product in fuel/lube range.
LO - Lube oil fraction.
ULO - Unidentified compounds in lube oil range.
PLO - Possible lube oil fraction.

TABLE 12: TOTAL PETROLEUM HYDROCARBON COMPOUNDS in Sediment - Ecological Health Guidelines
Client: Department of National Defence
Site Location: Former USAF Radar Station, Cartwright, NL
Englobe Project Number: P-0012285-0-16-200

PARAMETER		UNITS	ATLANTIC RBCA Sediment ESLs [1] (Typical)	ESL adjusted for FOC	Stantec 2018 Phase II ESA General Area CWT-SED-2	Stantec 2018 Phase II ESA General Area CWT-SED-3
Fraction of Organic Carbon		g/g	-	NA	-	-
BTEX	Benzene	mg/kg	1.2	-	<0.050	<0.025
	Toluene	mg/kg	1.4	-	<0.050	<0.025
	Ethylbenzene	mg/kg	1.2	-	<0.050	<0.025
	Xylenes (Total)	mg/kg	1.3	-	<0.10	<0.05
Modified TPH	Gas Range (C6-C10) (less BTEX)	mg/kg	15	-	<5	<2.5
	Fuel Range (>C10-C16)	mg/kg	25	-	<10	<10
	Fuel Range (>C16-C21)	mg/kg		-	<10	<10
	Lube Range (>C21-<C32)	mg/kg	43	-	<15	<15
Total Modified TPH - Tier I		mg/kg	500 Max	-	<25	<25
Product Resemblance		-	-	-	-	-
Return to Baseline at C32		-	-	-	-	-

Notes:

[value]	-exceeds Atlantic RBCA "adjusted" value
[value]	-exceeds Atlantic RBCA "typical" value
NC	-not calculated

[1] 2012 (with 2015 Updates) Atlantic RBCA Ecological Screening Levels for the Protection of Freshwater and Marine Aquatic Life.

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
FO/LO - One product in fuel/lube range.
LO - Lube oil fraction.
ULO - Unidentified compounds in lube oil range.
PLO - Possible lube oil fraction.

TABLE 12: TOTAL PETROLEUM HYDROCARBON COMPOUNDS in Sediment - Ecological Health Guidelines

Client: Department of National Defence
Site Location: Former USAF Radar Station, Cartwright, NL
Englobe Project Number: P-0012285-0-16-200

PARAMETER		UNITS	ATLANTIC RBCA Sediment ESLs [1] (Typical)	ESL adjusted for FOC of 0.211	Stantec 2018 Phase II ESA		Englobe 2018 Phase III ESA
					Former Contractor Village		
					CWT-SED-4	CWT-SED-5	CWT-SED-5-18
							3x Silica Gel
							15-Aug-18
Fraction of Organic Carbon		g/g	-	0.211	-	-	0.236
BTEX	Benzene	mg/kg	1.2	-	<0.025	<0.025	<0.03
	Toluene	mg/kg	1.4	-	<0.025	<0.025	<0.04
	Ethylbenzene	mg/kg	1.2	-	<0.025	<0.025	<0.03
	Xylenes (Total)	mg/kg	1.3	-	<0.05	<0.05	<0.05
Modified TPH	Gas Range (C6-C10) (less BTEX)	mg/kg	15	316.5	<2.5	<2.5	15
	Fuel Range (>C10-C16)	mg/kg	25	527.5	<10	[120]	[413]
	Fuel Range (>C16-C21)	mg/kg			<10	[300]	[110]
	Lube Range (>C21-<C32)	mg/kg	43	907.3	<15	[1000]	[64]
Total Modified TPH - Tier I		mg/kg	500 Max	500 Max	<25	[1400]	[602]
Product Resemblance		-	-	-	-	FO/LO. LO	FR, UC
Return to Baseline at C32		-	-	-	-	N	Y

Notes:

[value]	-exceeds Atlantic RBCA "adjusted" value
[value]	-exceeds Atlantic RBCA "typical" value
NC	-not calculated

[1] 2012 (with 2015 Updates) Atlantic RBCA Ecological Screening Levels for the Protection of Freshwater and Marine Aquatic Life.

Resemblance Comment Key:
GF - Gasoline Fraction
WGF - Weathered Gasoline Fraction
GR - Product in Gasoline Range
FOF - Fuel Oil Fraction
WFOF - Weathered Fuel Oil Fraction
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LOF - Lube Oil Fraction
LR - Lube Range
UC - Unidentified Compounds
NR - No Resemblance
NA - Not Applicable
FO/LO - One product in fuel/lube range.
LO - Lube oil fraction.
ULO - Unidentified compounds in lube oil range.
PLO - Possible lube oil fraction.

TABLE 12: TOTAL PETROLEUM HYDROCARBON COMPOUNDS in Sediment - Ecological Health Guidelines
Client: Department of National Defence
Site Location: Former USAF Radar Station, Cartwright, NL
Englobe Project Number: P-0012285-0-16-200

PARAMETER		UNITS	ATLANTIC RBCA Sediment ESLs [1] (Typical)	ESL adjusted for FOC	Stantec 2018 Phase II ESA Main Complex CWT-SED-6
Fraction of Organic Carbon		g/g	-	NA	-
BTEX	**Benzene**	mg/kg	1.2	-	<0.025
	Toluene	mg/kg	1.4	-	<0.025
	Ethylbenzene	mg/kg	1.2	-	<0.025
	Xylenes (Total)	mg/kg	1.3	-	<0.05
Modified TPH	**Gas Range (C6-C10) (less BTEX)**	mg/kg	15	-	<2.5
	Fuel Range (>C10-C16)	mg/kg	25	-	<10
	Fuel Range (>C16-C21)	mg/kg		-	<10
	Lube Range (>C21-<C32)	mg/kg	43	-	39
Total Modified TPH - Tier I		mg/kg	500 Max	-	39
Product Resemblance		-	-	-	ULO. PLO
Return to Baseline at C32		-	-	-	Y

Notes:

[value]	-exceeds Atlantic RBCA "adjusted" value
[value]	-exceeds Atlantic RBCA "typical" value
NC	-not calculated

[1] 2012 (with 2015 Updates) Atlantic RBCA Ecological Screening Levels for the Protection of Freshwater and Marine Aquatic Life.

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

FO/LO - One product in fuel/lube range.
LO - Lube oil fraction.
ULO - Unidentified compounds in lube oil range.
PLO - Possible lube oil fraction.

TABLE 12: TOTAL PETROLEUM HYDROCARBON COMPOUNDS in Sediment - Ecological Health Guidelines
Client: Department of National Defence
Site Location: Former USAF Radar Station, Cartwright, NL
Englobe Project Number: P-0012285-0-16-200

PARAMETER		UNITS	ATLANTIC RBCA Sediment ESLs [1] (Typical)	ESL adjusted for FOC of 0.278	Stantec 2018 Phase II ESA		Englobe 2018 Phase III ESA		
					Former USAF Dump Area and Ammunition Storage				
					CWT-SED-7	CWT-SED-8	CWT-SED-7-18	CWT-SED-8-18	
							3x Silica Gel	3x Silica Gel	3x Silica Gel
							24-Aug-18	15-Aug-18	24-Aug-18
Fraction of Organic Carbon		g/g	-	0.278	-	-	0.278	0.473	0.607
BTEX	Benzene	mg/kg	1.2	-	<0.025	<0.025	<0.03	<0.03	<0.03
	Toluene	mg/kg	1.4	-	0.1	<0.025	<0.04	[1.76]	<0.04
	Ethylbenzene	mg/kg	1.2	-	<0.025	<0.025	<0.03	<0.03	<0.03
	Xylenes (Total)	mg/kg	1.3	-	<0.05	<0.05	<0.05	<0.05	<0.05
Modified TPH	Gas Range (C6-C10) (less BTEX)	mg/kg	15	417	<2.5	<2.5	<3	[38]	<3
	Fuel Range (>C10-C16)	mg/kg	25	695	<10	<10	[94]	<15	[116]
	Fuel Range (>C16-C21)	mg/kg			25	<10	[102]	[44]	[129]
	Lube Range (>C21-<C32)	mg/kg	43	1195.4	[110]	[590]	[383]	[551]	[558]
Total Modified TPH - Tier I		mg/kg	500 Max	500 Max	140	[590]	[580]	[633]	[800]
Product Resemblance		-	-	-	ULO. PLO	ULO	UC+LR	UC	UC+LR
Return to Baseline at C32		-	-	-	Y	Y	Y	Y	Y

Notes:

[value]	-exceeds Atlantic RBCA "adjusted" value
[value]	-exceeds Atlantic RBCA "typical" value
NC	-not calculated

[1] 2012 (with 2015 Updates) Atlantic RBCA Ecological Screening Levels for the Protection of Freshwater and Marine Aquatic Life.

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

FO/LO - One product in fuel/lube range.
LO - Lube oil fraction.
ULO - Unidentified compounds in lube oil range.
PLO - Possible lube oil fraction.

TABLE 12: TOTAL PETROLEUM HYDROCARBON COMPOUNDS in Sediment - Ecological Health Guidelines
Client: Department of National Defence
Site Location: Former USAF Radar Station, Cartwright, NL
Englobe Project Number: P-0012285-0-16-200

PARAMETER		UNITS	ATLANTIC RBCA Sediment ESLs [1] (Typical)	ESL adjusted for FOC of 0.467	Englobe 2018 Phase III ESA			
					Background			
					CWT-SED-BK01 3x Silica Gel	CWT-SED-BK02 3x Silica Gel	CWT-SED-BK03 3x Silica Gel	CWT-SED-BK04 3x Silica Gel
					24-Aug-18	24-Aug-18	24-Aug-18	24-Aug-18
Fraction of Organic Carbon		g/g	-	0.467	0.467	0.430	0.599	0.338
BTEX	Benzene	mg/kg	1.2	-	<0.03	<0.03	<0.03	<0.03
	Toluene	mg/kg	1.4	-	<0.04	<0.04	<0.04	<0.04
	Ethylbenzene	mg/kg	1.2	-	<0.03	<0.03	<0.03	<0.03
	Xylenes (Total)	mg/kg	1.3	-	<0.05	<0.05	<0.05	<0.05
Modified TPH	Gas Range (C6-C10) (less BTEX)	mg/kg	15	689	**[75]**	<3	<3	<3
	Fuel Range (>C10-C16)	mg/kg	25	1148	**[163]**	**[157]**	**[150]**	<15
	Fuel Range (>C16-C21)	mg/kg			**[65]**	**[103]**	**[229]**	**[132]**
	Lube Range (>C21-<C32)	mg/kg	43	1974	**[250]**	**[558]**	**[743]**	**[344]**
Total Modified TPH - Tier I		mg/kg	500 Max	500 Max	480	**[820]**	**[1120]**	480
Product Resemblance		-	-	-	UC+LR	UC+LR	UC+LR	UC
Return to Baseline at C32		-	-	-	Y	Y	Y	Y

Notes:

[value]	-exceeds Atlantic RBCA "adjusted" value
[value]	-exceeds Atlantic RBCA "typical" value
NC	-not calculated

[1] 2012 (with 2015 Updates) Atlantic RBCA Ecological Screening Levels for the Protection of Freshwater and Marine Aquatic Life.

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

FO/LO - One product in fuel/lube range.
LO - Lube oil fraction.
ULO - Unidentified compounds in lube oil range.
PLO - Possible lube oil fraction.

TABLE 13: POLYCYCLIC AROMATIC HYDROCARBONS in Sediment - Human Health Guidelines
Client: Department of National Defence
Site Location: Former USAF Radar Station, Cartwright, NL
Englobe Project Number: P-0012285-0-16-200

PARAMETER	UNITS	CCME RESIDENTIAL/PARKLAND GUIDELINES [1]	OMOE[2]	Stantec 2018 Phase II ESA							Englobe 2018 Phase III ESA	
		Ingestion and Dermal Contact	Soil Contact S1 Risk	General Area		Former Contractor Village		Main Complex	Former USAF Dump Area and Former Ammunition Storage Area		Former USAF Dump Area and Former Ammunition Storage Area	
				CWT-SED-2	CWT-SED-3	CWT-SED-4	CWT-SED-5	CWT-SED-6	CWT-SED-7	CWT-SED-8	CWT-SED-8-18 15-Aug-18	CWT-SED-8-18 24-Aug-18
1-Methylnaphthalene	mg/kg	-	72	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.05	<0.05
2-Methylnaphthalene	mg/kg	-	72	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Acenaphthene	mg/kg	-	78	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.00671	<0.00671
Acenaphthylene	mg/kg	-	7.8	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.004	<0.004
Acridine	mg/kg	-	-	-	-	-	-	-	-	-	<0.05	<0.05
Anthracene	mg/kg	-	5400	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.03	<0.03
Benzo(a)anthracene	mg/kg	-	0.78	<0.01	<0.01	<0.01	<0.01	0.022	<0.01	<0.01	<0.01	<0.01
Benzo(a)pyrene	mg/kg	-	0.078	<0.01	<0.01	<0.01	<0.01	0.064	<0.01	<0.01	<0.01	<0.01
Benzo(b)fluoranthene	mg/kg	-	0.78	<0.01	0.035	<0.01	0.016	0.026	<0.01	<0.01	<0.05	<0.05
Benzo(b/j)fluoranthene	mg/kg	-	-	<0.01	<0.01	<0.01	<0.01	0.059	<0.01	<0.01	<0.1	<0.1
Benzo(e)pyrene	mg/kg	-	7.8	-	-	-	-	-	-	-	<0.05	<0.05
Benzo(g,h,i)perylene	mg/kg	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo(k)fluoranthene	mg/kg	-	0.78	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Chrysene	mg/kg	-	7.8	<0.01	0.039	<0.01	0.16	<0.01	0.37	12	<0.01	<0.01
Dibenz(a,h)anthracene	mg/kg	-	0.078	<0.01	0.021	<0.01	<0.01	<0.01	<0.01	<0.01	<0.006	<0.006
Fluoranthene	mg/kg	-	7.8	-	-	-	-	-	-	-	<0.05	<0.05
Fluorene	mg/kg	-	720	-	-	-	-	-	-	-	<0.01	<0.01
Indeno(1,2,3-cd)pyrene	mg/kg	-	0.78	<0.01	0.028	<0.01	<0.01	0.022	<0.01	<0.01	<0.01	<0.01
Naphthalene	mg/kg	-	360	-	-	-	-	-	-	-	<0.01	<0.01
Perylene	mg/kg	-	-	-	-	-	-	-	-	-	<0.05	<0.05
Phenanthrene	mg/kg	-	-	-	-	-	-	-	-	-	<0.03	<0.03
Pyrene	mg/kg	-	-	-	-	-	-	-	-	-	<0.05	<0.05
Quinoline	mg/kg	-	78	-	-	-	-	-	-	-	<0.05	<0.05
B(a)P TPE[3]	-	5.3	-	0.035	0.050	0.035	0.037	0.095	0.039	0.155	0.039	0.039

Notes: 0.96 -guidelines based on 10^{-6} ILCR, therefore not used

[1] 1999 (with 2018 update) CCME Canadian Environmental Quality Guidelines for commercial land use.

[2] 2011 Ontario Ministry of the Environment (OMOE) Table 3: Full Depth Generic Site Condition Standards in a Non-Potable Ground Water Condition, Residential/Parkland Land Use

[3] When the concentration was less than the RDL, half of the RDL was used in the benzo(a)pyrene potency equivalence factor (B(a)P TPE) calculations.

TABLE 14: POLYCYCLIC AROMATIC HYDROCARBONS in Sediment - Ecological Health Guidelines
Client: Department of National Defence
Site Location: Former USAF Radar Station, Cartwright, NL
Englobe Project Number: P-0012285-0-16-200

PARAMETER	UNITS	CCME GUIDELINES [1]		Stantec 2018 Phase II ESA							Englobe 2018 Phase III ESA	
				General Area		Former Contractor Village		Main Complex	Former USAF Dump Area and Former Ammunition Storage Area		Former USAF Dump Area and Former Ammunition Storage Area	
		ISQGs	PELs	CWT-SED-2	CWT-SED-3	CWT-SED-4	CWT-SED-5	CWT-SED-6	CWT-SED-7	CWT-SED-8	CWT-SED-8-18 15-Aug-18	CWT-SED-8-18 24-Aug-18
1-Methylnaphthalene	mg/kg	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.05	<0.05
2-Methylnaphthalene	mg/kg	0.0202	0.201	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Acenaphthene	mg/kg	0.00671	0.0889	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.00671	<0.00671
Acenaphthylene	mg/kg	0.00587	0.128	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.004	<0.004
Acridine				-	-	-	-	-	-	-	<0.05	<0.05
Anthracene	mg/kg	0.0469	0.245	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.03	<0.03
Benzo(a)anthracene	mg/kg	0.0317	0.385	<0.01	<0.01	<0.01	<0.01	0.022	<0.01	<0.01	<0.01	<0.01
Benzo(a)pyrene	mg/kg	0.0319	0.782	<0.01	<0.01	<0.01	<0.01	**0.064**	<0.01	<0.01	<0.01	<0.01
Benzo(b)fluoranthene	mg/kg	-	-	<0.01	0.035	<0.01	0.016	0.026	<0.01	<0.01	<0.05	<0.05
Benzo(b/j)fluoranthene	mg/kg	-	-	<0.01	<0.01	<0.01	<0.01	0.059	<0.01	<0.01	<0.1	<0.1
Benzo(e)pyrene											<0.05	<0.05
Benzo(g,h,i)perylene	mg/kg	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo(k)fluoranthene	mg/kg	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Chrysene	mg/kg	0.0571	0.862	<0.01	0.039	<0.01	**0.16**	<0.01	**0.37**	12	<0.01	<0.01
Dibenz(a,h)anthracene	mg/kg	0.00622	0.135	<0.01	**0.021**	<0.01	<0.01	<0.01	<0.01	<0.01	<0.006	<0.006
Fluoranthene	mg/kg	0.111	2.355	-	-	-	-	-	-	-	<0.05	<0.05
Fluorene	mg/kg	0.0212	0.144	-	-	-	-	-	-	-	<0.01	<0.01
Indeno(1,2,3-cd)pyrene	mg/kg	-	-	<0.01	0.028	<0.01	<0.01	0.022	<0.01	<0.01	<0.01	<0.01
Naphthalene	mg/kg	0.0346	0.391	-	-	-	-	-	-	-	<0.01	<0.01
Perylene	mg/kg	-	-	-	-	-	-	-	-	-	<0.05	<0.05
Phenanthrene	mg/kg	0.0419	0.515	-	-	-	-	-	-	-	<0.03	<0.03
Pyrene				-	-	-	-	-	-	-	<0.05	<0.05
Quinoline	mg/kg	0.053	0.875	-	-	-	-	-	-	-	<0.05	<0.05

Notes:

value	-value exceeds CCME Freshwater PEL
value	-value exceeds CCME Freshwater ISQG
value	-laboratory detection limit is greater than the CCME Freshwater ISQG

[1] 1999 (with 2018 Updates) CCME Sediment Quality Guidelines for the Protection of Aquatic Life (Marine) Interim Sediment Quality Guidelines (ISQGs) and Probable Effects Levels (PELs)

Englobe

TABLE 15: METALS in Sediment - Human Health Guidelines
Client: Department of National Defence
Site Location: Former USAF Radar Station, Cartwright, NL
Englobe Project Number: P-0012285-0-16-200

PARAMETER	UNITS	CCME RESIDENTIAL/PARKLAND [1,2]			OMOE [3]	Stantec 2018 Phase II ESA						
						Former U.S. Military Cartwright Site - General Area		Former Contractors Village (1951 - 1953)		Main Complex	Former USAF Dump Area and Former Ammunition Storage Area	
		Ingestion and Dermal Contact[1]	Produce, meat and milk check	Interim SQC[2]	Soil Contact S1 Risk	CWT-SED-2	CWT-SED-3	CWT-SED-4	CWT-SED-5	CWT-SED-6	CWT-SED-7	CWT-SED-8
Aluminum (Al)	mg/kg	-	-	-	-	47000	4700	20000	3100	5900	6500	1100
Antimony (Sb)	mg/kg	-	-	20	7.5	<2	<2	<2	<2	<2	<2	<2
Arsenic (As)	mg/kg	12	NC	-	0.95	3	<2	2.8	<2	<2	<2	<2
Barium (Ba)	mg/kg	6800	NC	-	3800	45	30	180	19	32	68	120
Beryllium (Be)	mg/kg	75	NC	-	38	<2	<2	<2	<2	<2	<2	<2
Bismuth (Bi)	mg/kg	-	-	-	-	<2	<2	<2	<2	<2	<2	<2
Boron (B)	mg/kg	-	-	-	4300	<50	<50	<50	<50	<50	<50	<50
Cadmium (Cd)	mg/kg	14	NC	-	0.69	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	0.5
Chromium (Cr)	mg/kg	220	NC	-	28000	11	9.7	43	6.9	13	7.9	<2
Cobalt (Co)	mg/kg	-	-	50	22	1.4	2.2	15	1.4	2.8	1.7	2.1
Copper (Cu)	mg/kg	1100	NC	-	600	28	3	34	11	7	6	16
Iron (Fe)	mg/kg	-	-	-	-	12000	11000	37000	5400	18000	11000	18000
Lead (Pb)	mg/kg	140	NC	-	200	5.1	5.6	7.1	15	6.1	9.9	22
Lithium (Li)	mg/kg	-	-	-	-	<2	3	19	3.1	3.3	3.5	<2
Manganese (Mn)	mg/kg	-	-	-	-	49	100	470	93	180	230	250
Mercury	mg/kg	6.6	NC	-	9.8	0.26	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Molybdenum (Mo)	mg/kg	-	-	10	110	4.2	<2	<2	<2	<2	<2	2.1
Nickel (Ni)	mg/kg	200	NC	-	330	2.8	4.2	28	2.8	4.5	2.6	4.3
Rubidium (Rb)	mg/kg	-	-	-	-	<2	4.8	50	3.9	5.1	5.4	<2
Selenium (Se)	mg/kg	80	NC	-	110	3.2	<1	<1	<1	<1	<1	<1
Silver (Ag)	mg/kg	-	-	-	77	0.7	<0.5	<0.5	<0.5	<0.5	<0.5	1.5
Strontium (Sr)	mg/kg	-	-	-	-	15	11	43	11	15	12	43
Thallium (Tl)	mg/kg	1	NC	-	0.29	<0.1	<0.1	0.31	<0.1	<0.1	<0.1	<0.1
Tin (Sn)	mg/kg	-	-	50	-	<2	<2	<2	<2	<2	<2	3.7
Uranium (U)	mg/kg	23	NC	-	23	7	0.33	1.3	0.29	0.49	0.41	<0.1
Vanadium (V)	mg/kg	NC	NC	-	39	10	20	73	10	36	21	<2
Zinc (Zn)	mg/kg	10000	NC	-	5600	8	17	80	14	38	56	160

Notes:

value	-value exceeds CCME	-	-no guideline or value
value	-value exceeds OMOE	NC	-not calculated
0.96	-guidelines based on 10^{-6} ILCR, therefore not used		

[1] 1999 (with 2018 update) CCME *Canadian Environmental Quality Guidelines* for residential/parkland land use.

[2] 1991 CCME Interim soil quality criteria for residential/parkland land use.

[3] 2011 Ontario Ministry of the Environment (OMOE) Table 3: Full Depth Generic Site Condition Standards in a Non-Potable Ground Water Condition, Residential/Parkland

TABLE 16: METALS in Sediment - Ecological Health Guidelines
Client: Department of National Defence
Site Location: Former USAF Radar Station, Cartwright, NL
Englobe Project Number: P-0012285-0-16-200

PARAMETER	UNITS	CCME Guidelines [1]		Stantec 2018 Phase II ESA						
				Former U.S. Military Cartwright Site - General Area		Former Contractors Village (1951 - 1953)		Main Complex	Former USAF Dump Area and Former Ammunition Storage Area	
		ISQG	PEL	CWT-SED-2	CWT-SED-3	CWT-SED-4	CWT-SED-5	CWT-SED-6	CWT-SED-7	CWT-SED-8
Aluminum (Al)	mg/kg	-	-	47000	4700	20000	3100	5900	6500	1100
Antimony (Sb)	mg/kg	-	-	<2	<2	<2	<2	<2	<2	<2
Arsenic (As)	mg/kg	7.24	41.6	3	<2	2.8	<2	<2	<2	<2
Barium (Ba)	mg/kg	-	-	45	30	180	19	32	68	120
Beryllium (Be)	mg/kg	-	-	<2	<2	<2	<2	<2	<2	<2
Bismuth (Bi)	mg/kg	-	-	<2	<2	<2	<2	<2	<2	<2
Boron (B)	mg/kg	-	-	<50	<50	<50	<50	<50	<50	<50
Cadmium (Cd)	mg/kg	0.7	4.2	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	0.5
Chromium (Cr)	mg/kg	52.3	160	11	9.7	43	6.9	13	7.9	<2
Cobalt (Co)	mg/kg	-	-	1.4	2.2	15	1.4	2.8	1.7	2.1
Copper (Cu)	mg/kg	18.7	108	**28**	3	**34**	11	7	6	16
Iron (Fe)	mg/kg	-	-	12000	11000	37000	5400	18000	11000	18000
Lead (Pb)	mg/kg	30.2	112	5.1	5.6	7.1	15	6.1	9.9	22
Lithium (Li)	mg/kg	-	-	<2	3	19	3.1	3.3	3.5	<2
Manganese (Mn)	mg/kg	-	-	49	100	470	93	180	230	250
Mercury	mg/kg	0.13	0.7	**0.26**	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Molybdenum (Mo)	mg/kg	-	-	4.2	<2	<2	<2	<2	<2	2.1
Nickel (Ni)	mg/kg	-	-	2.8	4.2	28	2.8	4.5	2.6	4.3
Rubidium (Rb)	mg/kg	-	-	<2	4.8	50	3.9	5.1	5.4	<2
Selenium (Se)	mg/kg	-	-	3.2	<1	<1	<1	<1	<1	<1
Silver (Ag)	mg/kg	-	-	0.7	<0.5	<0.5	<0.5	<0.5	<0.5	1.5
Strontium (Sr)	mg/kg	-	-	15	11	43	11	15	12	43
Thallium (Tl)	mg/kg	-	-	<0.1	<0.1	0.31	<0.1	<0.1	<0.1	<0.1
Tin (Sn)	mg/kg	-	-	<2	<2	<2	<2	<2	<2	3.7
Uranium (U)	mg/kg	-	-	7	0.33	1.3	0.29	0.49	0.41	<0.1
Vanadium (V)	mg/kg	-	-	10	20	73	10	36	21	<2
Zinc (Zn)	mg/kg	124	271	8	17	80	14	38	56	**160**

Notes:

value -value exceeds CCME Marine PEL
value -value exceeds CCME Marine ISQG

[1] 1999 (with 2001 Updates) CCME Sediment Quality Guidelines for the Protection of Aquatic Life (Marine) Interim Sediment Quality Guidelines (ISQGs) and Probable Effects Levels (PELs)

TABLE 17: Polychlorinated Biphynyls in Sediment - Human Health Guidelines
Client: Department of National Defence
Site Location: Former USAF Radar Station, Cartwright, NL
Englobe Project Number: P-0012285-0-16-200

PARAMETER	UNITS	CCME SQGs[1] Human Health		OMOE[2]	Stantec 2018 Phase II ESA							Englobe 2018 Phase III ESA			
					General Area		Former Contractor Village		Main Complex	Former USAF Dump Area and Ammunition Storage Area		Background			
		Guideline	Soil Ingestion		CWT-SED-2	CWT-SED-3	CWT-SED-4	CWT-SED-5	CWT-SED-6	CWT-SED-7	CWT-SED-8	CWT-SED-BK01	CWT-SED-BK02	CWT-SED-BK03	CWT-SED-BK04
												24-Aug-18	24-Aug-18	24-Aug-18	24-Aug-18
Calculated Total PCB	mg/kg	1.3	NC	1.1	<0.05	<0.05	<0.05	<0.05	0.17	<0.05	<0.05	<0.02	<0.02	<0.02	<0.02

Notes:

[1] 1999 (with 2018 update) CCME Canadian Environmental Quality Guidelines for residential/parkland land use.

[2] 2011 Ontario Ministry of the Environment (OMOE) Table 3: Full Depth Generic Site Condition Standards in a Non-Potable Ground Water Condition

TABLE 18: Polychlorinated Biphynyls in Sediment - Ecological Health Guidelines
Client: Department of National Defence
Site Location: Former USAF Radar Station, Cartwright, NL
Englobe Project Number: P-0012285-0-16-200

PARAMETER	UNITS	CCME [1]		Stantec 2018 Phase II ESA							Englobe 2018 Phase III ESA			
				General Area		Former Contractor Village		Main Complex	Former USAF Dump Area and Ammunition Storage Area		Background			
		ISQG	PEL	CWT-SED-2	CWT-SED-3	CWT-SED-4	CWT-SED-5	CWT-SED-6	CWT-SED-7	CWT-SED-8	CWT-SED-BK01	CWT-SED-BK02	CWT-SED-BK03	CWT-SED-BK04
											24-Aug-18	24-Aug-18	24-Aug-18	24-Aug-18
Calculated Total PCB	mg/kg	0.0341	0.277	<0.05	<0.05	<0.05	<0.05	**0.17**	<0.05	<0.05	<0.02	<0.02	<0.02	<0.02

Notes:

value	-value exceeds CCME Freshwater PEL
value	-value exceeds CCME Freshwater ISQG
value	-laboratory detection limit is greater than the CCME Freshwater ISQG

[1] 1999 (with 2018 update) CCME *Sediment Quality Guidelines (ISQGs and PELs) for the Protection of Aquatic Life (Freshwater)*

Englobe

TABLE 19: TOTAL PETROLEUM HYDROCARBON COMPOUNDS in Groundwater - Ecological Health Guidelines
Client: Department of National Defence
Site Location: Former USAF Radar Station, Cartwright, NL
Englobe Project No.: P-0012285-0-16-200

PARAMETER		UNITS	ATLANTIC RBCA ESLs (Plant and Invertebrate - Direct Contact) [1]	ATLANTIC RBCA ESLs (Freshwater and Marine) [2]	Englobe 2018 Phase III ESA														
					Former Contractor Village			Former USAF Dump Area and Former Ammunition Storage Area			Main Complex								
					CWT-MW1-18 20-Aug-18	CWT-MW2-18 20-Aug-18	CWT-MW3-18 20-Aug-18	CWT-MW4-18 18-Aug-18	CWT-MW5-18 18-Aug-18	CWT-MW6-18 18-Aug-18	CWT-MW7-18 20-Aug-18	CWT-MW8-18 20-Aug-18	CWT-MW9-18 18-Aug-18	CWT-MW10-18 18-Aug-18	CWT-MW11-18 20-Aug-18	CWT-MW12-18 18-Aug-18	CWT-MW13-18 20-Aug-18	CWT-MW15-18 24-Aug-18	CWT-MW16-18 24-Aug-18
BTEX	Benzene	mg/L	61	4.6	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
	Toluene	mg/L	59	4.2	0.002	<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
	Ethylbenzene	mg/L	20	3.2	0.005	<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
	Xylenes (Total)	mg/L	31	2.8	0.035	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Modified TPH	Gas Range (C6-C10) (less BTEX)	mg/L	7.1	13	0.28	0.08	0.01	0.02	<0.01	0.02	<0.01	0.06	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01
	Fuel Range (>C10-C16)	mg/L	1.8	0.84	0.3	0.16	<0.05	0.2	<0.05	<0.05	<0.05	0.5	<0.05	<0.05	**[0.63]**	<0.05	<0.05	<0.05	<0.05
	Fuel Range (>C16-C21)	mg/L	-		<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.2	<0.10	<0.10	**[0.37]**	<0.10	<0.10	<0.10	<0.10
	Lube Range (>C21-C32)	mg/L	-	0.48	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Total Modified TPH - Tier I		mg/L	-	-	0.6	0.2	<0.1	0.2	<0.1	<0.1	<0.1	0.8	<0.1	<0.1	1	<0.1	<0.1	<0.1	<0.1
Product Resemblance		-	-	-	GF	FR	WGF	WFOF+UC	NR	UC	NR	WGF, WFOF	NR	NR	WFOF	NR	NR	NR	GR
Return to Baseline at C32		Y/N	-	-	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

Notes:

[value]	-value exceeds RBCA
-	-No guideline or value

[1] 2012 Atlantic RBCA Tier 1 Ecological Screening Levels (ESLs) for plant and soil invertebrate direct contact with shallow groundwater, residential/parkland/agricultural land use.

[2] 2012 Atlantic RBCA Tier 1 Ecological Screening Levels (ESLs) for the protection of freshwater and marine aquatic life.

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

TABLE 20: POLYCYCLIC AROMATIC HYDROCARBONS in Groundwater - Ecological Health Guidelines
Client: Department of National Defence
Site Location: Former USAF Radar Station, Cartwright, NL
Englobe Project No.: P-0012285-0-16-200

Parameter	Units	CCME [1] Freshwater Life (10x)	OMOE [2]	Englobe 2018 Phase III ESA															
				Former Contractor Village			Former USAF Dump Area and Former Ammunition Storage Area		Main Complex										
				CWT-MW1-18 20-Aug-18	CWT-MW2-18 20-Aug-18	CWT-MW3-18 20-Aug-18	CWT-MW4-18 18-Aug-18	CWT-MW5-18 18-Aug-18	CWT-MW6-18 18-Aug-18	CWT-MW7-18 20-Aug-18	CWT-MW8-18 20-Aug-18	CWT-MW9-18 18-Aug-18	CWT-MW10-18 18-Aug-18	CWT-MW11-18 20-Aug-18	CWT-MW12-18 18-Aug-18	CWT-MW13-18 20-Aug-18	CWT-MW14-18 20-Aug-18	CWT-MW15-18 24-Aug-18	CWT-MW16-18 24-Aug-18
1-Methylnaphthalene	µg/L	15000	1800	2.98	0.26	0.10	0.02	0.01	0.12	0.07	0.06	<0.01	0.01	<0.01	<0.01	0.13	<0.01	<0.01	<0.01
2-Methylnaphthalene	µg/L	15000	1800	4.17	0.09	0.03	0.02	0.01	0.13	0.09	<0.01	<0.01	0.01	<0.01	<0.01	0.11	<0.01	<0.01	<0.01
Acenaphthene	µg/L	58	600	0.17	0.14	<0.01	0.19	<0.01	0.12	<0.01	0.05	<0.01	0.01	<0.01	<0.01	0.02	<0.01	<0.01	<0.01
Acenaphthylene	µg/L	460	1.8	<0.01	<0.01	<0.01	0.14	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Acridine	µg/L	-	-	<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
Anthracene	µg/L	0.12	2.4	0.03	0.021	<0.012	<0.012	<0.012	<0.012	<0.012	<0.012	<0.012	<0.012	<0.012	<0.012	<0.012	<0.012	<0.012	<0.012
Benzo(a)anthracene	µg/L	0.18	4.7	<0.018	<0.018	<0.018	<0.018	<0.018	<0.018	<0.018	<0.018	<0.018	<0.018	<0.018	<0.018	<0.018	<0.018	<0.018	<0.018
Benzo(a)pyrene	µg/L	0.15	0.81	<0.010	<0.010	<0.010	<0.015	<0.015	<0.015	<0.010	<0.010	<0.015	<0.015	<0.010	<0.015	<0.010	<0.010	<0.015	<0.015
Benzo(b)fluoranthene	µg/L	4.8	0.75	<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
Benzo(e)pyrene	µg/L	4.8	0.75	<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
Benzo(g,h,i)perylene	µg/L	-	-	<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
Benzo(k)fluoranthene	µg/L	4.8	0.4	<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
Chrysene	µg/L	-	1	<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
Dibenz(a,h)anthracene	µg/L	2.6	0.52	<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
Fluoranthene	µg/L	0.4	130	0.05	0.07	<0.01	0.11	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Fluorene	µg/L	30	400	0.17	0.10	0.01	<0.01	0.01	0.05	<0.01	<0.01	<0.01	0.02	<0.01	<0.01	0.02	<0.01	<0.01	<0.01
Indeno(1,2,3-cd)pyrene	µg/L	2.1	0.2	<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
Naphthalene	µg/L	11	1400	5.39	0.42	0.08	<0.01	0.08	0.89	0.07	<0.01	0.01	0.02	<0.01	0.01	0.10	<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	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Phenanthrene	µg/L	4	580	0.19	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	<0.01	<0.01	<0.01
Pyrene	µg/L	0.25	68	0.03	0.05	<0.01	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
Quinoline	µg/L	34	-	<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

Notes:

value	-value exceedsCCME
value	-value exceeds OMOE
-	-No guideline or value

[1] 1999 (with 2018 updates) Canadian Council of Ministers of the Environment (CCME) Water Quality Guidelines for the Protection of Freshwater Aquatic Life. 10x the guideline has been applied as groundwater is > 10 m from surface water.

[2] 2011 Ontario Ministry of the Environment (OMOE) Table 9: Generic Site Condition Standards for Use within 30m of a Water Body in a Non-Potable Groundwater Condition

TABLE 21: METALS in Groundwater - Ecological Health Guidelines
Client: Department of National Defence
Site Location: Former USAF Radar Station, Cartwright, NL
Englobe Project No.: P-0012285-0-16-200

PARAMETER	UNITS	CCME FAL (10x)[1]	OMOE[2]	Englobe 2018 Phase III ESA															
				Former Contractor Village			Former USAF Dunp Area and Former Ammunition Storage Area			Main Complex									
				CWT-MW1-18	CWT-MW2-18	CWT-MW3-18	CWT-MW4-18	CWT-MW5-18	CWT-MW6-18	CWT-MW7-18	CWT-MW8-18	CWT-MW9-18	CWT-MW10-18	CWT-MW11-18	CWT-MW12-18	CWT-MW13-18	CWT-MW14-18	CWT-MW15-18	CWT-MW16-18
				20-Aug-18	20-Aug-18	20-Aug-18	18-Aug-18	18-Aug-18	18-Aug-18	20-Aug-18	20-Aug-18	18-Aug-18	18-Aug-18	20-Aug-18	18-Aug-18	20-Aug-18	20-Aug-18	24-Aug-18	24-Aug-18
Aluminum	µg/L	50 - 1000[3]	-	**792**	**860**	**261**	**186**	39	14	**8160**	**261**	**188**	115	**21700**	**990**	167	**255**	**154**	**108**
Antimony	µg/L	-	16000	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Arsenic	µg/L	50	1500	4	19	3	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Barium	µg/L	-	23000	32	25	17	28	35	90	114	42	25	93	345	68	63	30	11	70
Beryllium	µg/L	-	53	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Bismuth	µg/L	-	-	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Boron	µg/L	15000	36000	17	11	115	48	18	105	51	26	15	17	79	12	164	14	9	37
Cadmium	µg/L	0.4 - 3.7[4]	2.1	0.021	0.017	<0.017	0.020	0.035	<0.017	<0.017	0.037	0.109	0.042	0.317	0.035	0.697	<0.017	<0.09	<0.09
Chromium	µg/L	-	640	4	8	4	1	1	2	5	3	2	2	8	2	3	<1	1	1
Cobalt	µg/L	-	52	1	1	<1	<1	2	3	<1	<1	<1	<1	2	<1	<1	<1	<1	<1
Copper	µg/L	20 - 40[5]	69	9	3	<2	3	2	<2	6	4	5	3	18	7	9	8	6	3
Iron	µg/L	3000	-	**17400**	**30000**	**16000**	158	506	**16300**	**4050**	**3150**	74	65	**9790**	1050	1100	223	<50	1060
Lead	µg/L	10 - 70[6]	20	0.9	0.9	<0.5	<0.5	<0.5	<0.5	1.1	1.5	<0.5	<0.5	**15.8**	<0.5	2.1	<0.5	<0.5	<0.5
Manganese	µg/L	-	-	298	169	213	339	393	563	550	252	22	78	1270	336	355	126	35	1,650
Mercury	µg/L	0.26	0.29	<0.026	<0.026	<0.026	<0.026	<0.026	<0.026	<0.026	0.04	<0.026	<0.026	<0.026	<0.026	<0.026	<0.026	<0.026	<0.026
Molybdenum	µg/L	730	7300	<2	<2	<2	<2	<2	2	<2	<2	<2	<2	19	<2	<2	<2	<2	<2
Nickel	µg/L	250 - 1500[7]	390	5	3	<2	<2	3	2	6	2	<2	5	15	4	7	4	2.0	3.0
Selenium	µg/L	10	50	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Silver	µg/L	2.5	1.2	<0.1	0.2	<0.1	0.2	<0.1	0.7	0.8	<0.1	<0.1	<0.1	0.7	<0.1	<0.1	<0.1	<0.1	<0.1
Strontium	µg/L	-	-	30	21	79	137	40	71	69	64	51	72	147	51	144	13	11	42
Thallium	µg/L	8	400	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Tin	µg/L	-	-	<2	<2	<2	<2	<2	<2	4	<2	<2	<2	9	<2	<2	<2	<2	<2
Titanium	µg/L	-	-	20	20	10	<2	<2	<2	147	4	2	<2	344	71	4	12	<2	<2
Uranium	µg/L	150	330	0.3	0.4	0.2	<0.1	<0.1	<0.1	0.9	<0.1	<0.1	0.2	3.4	<0.1	<0.1	0.5	0.1	0.1
Vanadium	µg/L	-	200	13	10	19	<2	<2	<2	<2	3	<2	<2	3	<2	<2	<2	<2	<2
Zinc	µg/L	10-70[8]	890	17	12	<5	<5	11	**252**	11	<5	**130**	<5	51	16	**818**	8	21	18

Notes:

value	-value exceeds CCME
value	-value exceeds OMOE
-	-no guideline or value

[1] 1999 (with 2018 updates) Canadian Council of Ministers of the Environment (CCME) Water Quality Guidelines for the Protection of Freshwater Aquatic Life. 10x the guideline has been applied as groundwater is > 10 m from surface water.

[2] 2011 Ontario Ministry of the Environment (OMOE) Table 9: Generic Site Condition Standards for Use within 30m of a Water Body in a Non-Potable Groundwater Condition

[3] Aluminum Guideline = 5 ug/L at pH < 6.5 or 100 ug/l at pH >= 6.5

[4] Cadmium concentration = $10^{0.86[\log10(\text{hardness})]-3.2}$

[5] Copper concetration dependant on water hardness.

[6] Lead concentration dependant on water hardness.

[7] Nickel concentration dependant on water hardness.

[8] Zinc concentration dependant on dissolved organic carbon (DOC), hardness and pH.

Englobe

TABLE 22: GENERAL CHEMISTRY in Groundwater - Ecological Health Guidelines
Client: Department of National Defence
Site Location: Former USAF Radar Station, Cartwright, NL
Englobe Project No.: P-0012285-0-16-200

PARAMETER	UNITS	CCME FAL[1]	OMOE [2]	Englobe 2018 Phase III ESA															
				Former Contractor Village			Former USAF Dump Area and Former Ammunition Storage Area			Main Complex									
				CWT-MW1-18	CWT-MW2-18	CWT-MW3-18	CWT-MW4-18	CWT-MW5-18	CWT-MW6-18	CWT-MW7-18	CWT-MW8-18	CWT-MW9-18	CWT-MW10-18	CWT-MW11-18	CWT-MW12-18	CWT-MW13-18	CWT-MW14-18	CWT-MW15-18	CWT-MW16-18
				24-Aug-18	24-Aug-18	24-Aug-18	24-Aug-18	24-Aug-18	24-Aug-18	24-Aug-18	24-Aug-18	24-Aug-18	24-Aug-18	24-Aug-18	24-Aug-18	24-Aug-18	24-Aug-18	24-Aug-18	24-Aug-18
Field Readings																			
Field pH	unitless	6.5 - 9	-	**6.0**	**6.1**	**6.1**	**6.44**	**6.32**	6.98	**6.39**	**6.33**	**6.37**	6.75	6.84	**6.01**	6.66	**6.37**	**5.44**	**6.33**
pH	unitless	6.5 - 9	-	**6.42**	**5.91**	7	6.98	6.79	7.12	6.72	6.87	7.14	7.22	6.90	6.73	7.36	6.83	**5.99**	6.91
Reactive Silica as SiO2	mg/L	-	-	10.1	14.4	15	11.4	11.3	6.2	9.4	10.8	7.6	9.8	12.3	10.9	8.7	7.8	6.4	9.9
Chloride	mg/L	1200	1800	7	5	6	2	7	5	2	1	2	2	2	1	2	2	3	3
Fluoride	mg/L	-	-	<0.12	<0.12	0	<0.12	<0.12	<0.12	<0.12	<0.12	<0.12	<0.12	<0.12	<0.12	<0.12	<0.12	<0.12	<0.12
Sulphate	mg/L	-	-	2	<2	<2	4.00	5.00	<2	<2	<2	<2	2.00	4.00	<2	<2	2.00	<2	<2
Alkalinity	mg/L	-	-	27	24	58	73	54	73	66	62	47	101	162	48	98	15	7	39
True Color	TCU	-	-	488	378	315	17	6	8	28	83	52	25	96	29	47	19	5	23
Turbidity	NTU	-	-	131	24	32	297	63.4	318	569	86.1	31.4	51.9	133	767	85.5	*	4.2	190
Electrical Conductivity	umho/cm	-	-	76	79	148	169	142	181	142	133	111	215	339	108	207	55	31	91
Nitrate + Nitrite as N	mg/L	-	-	<0.05	<0.05	<0.05	0	0	<0.05	<0.05	<0.05	0	<0.05	<0.05	0	<0.05	0	0	<0.05
Nitrate as N	mg/L	-	-	<0.05	<0.05	<0.05	0.1	0.1	<0.05	<0.05	<0.05	0.2	<0.05	<0.05	0.1	<0.05	0.1	0.1	<0.05
Nitrite as N	mg/L	-	-	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Ammonia as N	mg/L	-	-	0.12	0.20	0.46	<0.03	0.13	0.23	<0.03	<0.03	<0.03	<0.03	0.16	<0.03	<0.03	<0.03	<0.03	<0.03
Total Organic Carbon	mg/L	-	-	26	16.4	10	<0.5	4.6	6	3.2	8.5	5.2	<0.5	32.3	<0.5	3.2	5.8	3.8	4.1
Ortho-Phosphate as P	mg/L	-	-	0.04	0.04	0	<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
Dissolved Sodium	mg/L	-	-	9.2	8.1	9.1	5.3	7.6	15.7	9.7	3.6	3.5	6.1	43.6	5.5	5.9	6.0	3.2	4.2
Dissolved Potassium	mg/L	-	-	1.3	1.5	2	4.3	1.3	2.9	4.3	5	2.2	7.4	5.2	4.4	4.8	2.5	0.7	1.9
Dissolved Calcium	mg/L	-	-	3.5	2.2	6.1	18.1	9.9	17.3	9.1	20.4	14.2	31.4	8.4	7.8	31.8	2.2	1.8	13.4
Dissolved Magnesium	mg/L	-	-	1.5	2.1	2.4	1.6	2.0	2.6	1.5	1.1	1.3	2.2	1.3	1.1	3.3	0.5	0.5	1.4
Bicarb. Alkalinity (as CaCO3)	mg/L	-	-	27	24	58	73.0	54.0	73.0	66.0	62.0	47.0	101.0	162.0	48.0	98.0	15.0	7.0	39.0
Carb. Alkalinity (as CaCO3)	mg/L	-	-	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Hydroxide	mg/L	-	-	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Calculated TDS	mg/L	-	-	59	65	77	80	67	105	79	72	53	112	195	51	109	25	14	50
Hardness	mg/L	-	-	14.9	14.1	25	51.8	33	53.9	28.9	55.5	40.8	87.5	26.3	24	93	7.6	6.6	39.2
Langelier Index (@20C)	NA	-	-	-3.17	-3.94	-2.21	-1.48	-2.05	-1.37	-2.08	-1.60	-1.60	-0.87	-1.58	-2.26	-0.74	-3.18	-4.41	-1.93
Langelier Index (@ 4C)	NA	-	-	-3.49	-4.26	-3	-1.8	-2.37	-1.69	-2.4	-1.92	-1.92	-1.19	-1.9	-2.58	-1.06	-3.5	-4.73	-2.25
Saturation pH (@ 20C)	NA	-	-	9.59	9.85	9.03	8.46	8.84	8.49	8.80	8.47	8.74	8.09	8.48	8.99	8.10	10.00	10.40	8.84
Saturation pH (@ 4C)	NA	-	-	9.9	10.2	9	8.78	9.16	8.81	9.12	8.79	9.06	8.41	8.80	9.31	8.42	10.30	10.70	9.16
Anion Sum	me/L	-	-	0.78	0.62	1.33	1.60	1.39	1.60	1.38	1.27	1.01	2.12	3.38	0.99	2.02	0.40	0.23	0.86
Cation sum	me/L	-	-	1.46	1.87	1.58	1.42	1.07	2.47	2.18	1.55	1.05	2.22	5.38	0.99	2.34	0.52	0.31	1.13
% Difference/ Ion Balance (NS)	%	-	-	30.5	50.0	8.7	6.2	12.9	21.3	22.6	9.9	2.0	2.4	22.8	0.1	7.3	12.3	13.9	13.2

Notes:

	value	-value exceeds CCME
	value	-value exceeds OMOE
	-	-no guideline or value

[1] 1999 (with 2018 updates) Canadian Council of Ministers of the Environment (CCME) Water Quality Guidelines for the Protection of Freshwater Aquatic Life. 10x the guideline has been applied as groundwater is > 10 m from surface water (with the exception of pH).

[2] 2011 Ontario Ministry of the Environment (OMOE) Table 9: Generic Site Condition Standards for Use within 30m of a Water Body in a Non-Potable Groundwater Condition

TABLE 23: VOLATILE ORGANIC COMPOUNDS in Groundwater - Ecological Health Guidelines
Client: Department of National Defence
Site Location: Former USAF Radar Station, Cartwright, NL
Englobe Project No.: P-0012285-0-16-200

PARAMETER	UNITS	CCME FAL (10x) 1	OMOE 2	Englobe 2018 Phase III ESA — SAMPLE ID / DATE SAMPLED: CWT-MW9-18 / 18-Aug-18
Chloromethane	µg/L	-	-	<1
Vinyl Chloride	µg/L	-	1	<0.5
Bromomethane	µg/L	-	5.6	<0.89
Chloroethane	µg/L	-	-	<5
Trichlorofluoromethane (FREON 11)	µg/L	-	2000	<5
Acetone	µg/L	-	-	<10
1,1-Dichloroethylene	µg/L	-	1.6	<0.6
Methylene Chloride (Dichloromethane)	µg/L	981	610	<2
trans-1,2-Dichloroethylene	µg/L	-	1.6	<1.6
1,1-Dichloroethane	µg/L	-	320	<1
cis-1,2-Dichloroethylene	µg/L	-	1.6	<1.6
Chloroform	µg/L	18	2.4	<1
1,2-Dichloroethane	µg/L	1000	1.6	<2
1,1,1-Trichloroethane	µg/L	-	640	<1
Carbon Tetrachloride	µg/L	133	0.79	<0.56
Benzene	µg/L	3700	44.0	<1
1,2-Dichloropropane	µg/L	-	16.0	<0.7
Trichloroethylene	µg/L	210	1.6	<1
Bromodichloromethane	µg/L	-	67000	<1
cis-1,3-Dichloropropene	µg/L	-	-	<0.5
trans-1,3-Dichloropropene	µg/L	-	-	<0.5
1,1,2-Trichloroethane	µg/L	-	4.7	<1
Toluene	µg/L	20	14000	<2
2-Hexanone	µg/L	-	-	<10.0
Dibromochloromethane	µg/L	-	65000	<1
1,2-Dibromoethane	µg/L	-	-	<0.2
Tetrachloroethylene	µg/L	1100	1.6	<1.6
1,1,1,2-Tetrachloroethane	µg/L	-	3.3	<0.5
Chlorobenzene	µg/L	-	500	<1.3
Ethylbenzene	µg/L	900	1800	<2
m,p-Xylene	µg/L	-	-	<4
Bromoform	µg/L	-	380	<1
Styrene	µg/L	720	1300	<1
1,1,2,2-Tetrachloroethane	µg/L	-	3.2	<1
o-Xylene	µg/L	-	-	<1
1,3-Dichlorobenzene	µg/L	1500	7600	<1
1,4-Dichlorobenzene	µg/L	260	8.0	<1
1,2-Dichlorobenzene	µg/L	7	4600	<0.7

Notes:

value	-value exceeds CCME
value	-value exceeds OMOE
-	-no guideline or value

1 1999 (with 2018 updates) Canadian Council of Ministers of the Environment (CCME) Water Quality Guidelines for the Protection of Freshwater Aquatic Life. 10x the guideline has been applied as groundwater is > 10 m from surface water.

2 2011 Ontario Ministry of the Environment (OMOE) Table 9: Generic Site Condition Standards for Use within 30m of a Water Body in a Non-Potable Groundwater Condition

TABLE 24: TOTAL PETROLEUM HYDROCARBON COMPOUNDS in Surface Water - Ecological Health Guidelines
Client: Department of National Defence
Site Location: Former USAF Radar Station, Cartwright, NL
Englobe Project No.: P-0012285-0-16-200

PARAMETER		UNITS	ATLANTIC RBCA Tier I ESLs [1]	Stantec 2018 Phase II ESA		Englobe 2018 Phase III ESA
				General Area		
				CWT-SW-2	CWT-SW-3	CWT-SW2-18 (Coring) 15-Aug-18
BTEX	Benzene	mg/L	2.1	<0.001	<0.001	<0.001
	Toluene	mg/L	0.77	<0.001	<0.001	<0.001
	Ethylbenzene	mg/L	0.32	<0.001	<0.001	<0.001
	Xylenes (Total)	mg/L	0.33	<0.002	<0.002	<0.002
Modified TPH	Gas Range (C6-C10) (less BTEX)	mg/L	-	<0.01	<0.01	<0.01
	Fuel Range (>C10-C16)	mg/L	-	<0.05	<0.05	<0.05
	Fuel Range (>C16-C21)	mg/L	-	<0.05	<0.05	<0.10
	Lube Range (>C21-C32)	mg/L	-	<0.1	<0.1	<0.1
Total Modified TPH - Tier I		mg/L	1.5 as gas 0.10 as fuel oil 0.10 as lube oil	<0.1	<0.1	<0.1
Product Resemblance		-	-	-	-	-
Return to Baseline at C32		Y/N	-	-	-	Y

PARAMETER		UNITS	ATLANTIC RBCA Tier I ESLs [1]	Stantec 2018 Phase II ESA	
				Former Contractor	Main Complex
				CWT-SW-5	CWT-SW-6
BTEX	Benzene	mg/L	2.1	<0.001	<0.001
	Toluene	mg/L	0.77	<0.001	<0.001
	Ethylbenzene	mg/L	0.32	<0.001	<0.001
	Xylenes (Total)	mg/L	0.33	<0.002	<0.002
Modified TPH	Gas Range (C6-C10) (less BTEX)	mg/L	-	<0.01	<0.01
	Fuel Range (>C10-C16)	mg/L	-	<0.05	<0.05
	Fuel Range (>C16-C21)	mg/L	-	<0.05	<0.05
	Lube Range (>C21-C32)	mg/L	-	<0.1	<0.1
Total Modified TPH - Tier I		mg/L	1.5 as gas 0.10 as fuel oil 0.10 as lube oil	<0.1	<0.1
Product Resemblance		-	-	-	-
Return to Baseline at C32		Y/N	-	-	-

Notes:

[value]	-exceeds Atlantic RBCA Tier I ESLs
-	-no guideline or value

[1] 2012 (revised 2015) Atlantic Risk-Based Corrective Action (RBCA) Tier I Ecological Screening Levels (ESLs) for the Protection of Freshwater and Marine Aquatic Life (Table 3a), Surface Water Guidelines.
Resemblance Comment Key:
ULO = Unidentified compounds in lube oil range.

TABLE 24: TOTAL PETROLEUM HYDROCARBON COMPOUNDS in Surface Water - Ecological Health Guidelines
Client: Department of National Defence
Site Location: Former USAF Radar Station, Cartwright, NL
Englobe Project No.: P-0012285-0-16-200

PARAMETER		UNITS	ATLANTIC RBCA Tier I ESLs [1]	Stantec 2018 Phase II ESA		Englobe 2018 Phase III ESA	
				Former USAF Dump Area and Former Ammunition Storage Area			
				CWT-SW-7	CWT-SW-8	CWT-SW-8-18 15-Aug-18	CWT-SW-8-18B 15-Aug-18
BTEX	Benzene	mg/L	2.1	<0.001	<0.001	<0.001	<0.001
	Toluene	mg/L	0.77	<0.001	<0.001	<0.001	<0.001
	Ethylbenzene	mg/L	0.32	<0.001	<0.001	<0.001	<0.001
	Xylenes (Total)	mg/L	0.33	<0.002	<0.002	<0.002	<0.002
Modified TPH	Gas Range (C6-C10) (less BTEX)	mg/L	-	<0.01	<0.01	<0.01	<0.01
	Fuel Range (>C10-C16)	mg/L	-	<0.05	<0.05	<0.05	<0.05
	Fuel Range (>C16-C21)	mg/L	-	<0.05	<0.05	<0.10	<0.10
	Lube Range (>C21-C32)	mg/L	-	<0.1	0.11	<0.1	<0.1
Total Modified TPH - Tier I		mg/L	1.5 as gas 0.10 as fuel oil 0.10 as lube oil	<0.1	**[0.11]**	<0.1	<0.1
Product Resemblance		-	-	-	ULO	-	-
Return to Baseline at C32		Y/N	-	-	Y	Y	Y

Notes:

[value]	-exceeds Atlantic RBCA Tier I ESLs
-	-no guideline or value

[1] 2012 (revised 2015) Atlantic Risk-Based Corrective Action (RBCA) Tier I Ecological Screening Levels (ESLs) for the Protection of Freshwater and Marine Aquatic Life (Table 3a), Surface Water Guidelines.
Resemblance Comment Key:
ULO = Unidentified compounds in lube oil range.

Englobe

TABLE 25: POLYCYCLIC AROMATIC HYDROCARBONS in Surface Water - Ecological Health Guidelines
Client: Department of National Defence
Site Location: Former USAF Radar Station, Cartwright, NL
Englobe Project No.: P-0012285-0-16-200

PARAMETER	UNITS	CCME FAL [1]	Stantec 2018 Phase II ESA					
			General Area		Former Contractors Village	Main Complex	Former USAF Dump Area and Former Ammunition Storage Area	
			CWT-SW2	CWT-SW-3	CWT-SW-5	CWT-SW-6	CWT-SW-7	CWT-SW-8
1-Methylnaphthalene	µg/L	-	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
2-Methylnaphthalene	µg/L	-	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Acenaphthene	µg/L	5.8	0.011	<0.010	<0.010	<0.010	<0.010	<0.010
Acenaphthylene	µg/L	-	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Anthracene	µg/L	0.012	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Benzo(a)anthracene	µg/L	0.018	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Benzo(a)pyrene	µg/L	0.015	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Benzo(b)fluoranthene	µg/L	0.48	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Benzo(g,h,i)perylene	µg/L	-	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Benzo(j)fluoranthene	µg/L	-	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Benzo(k)fluoranthene	µg/L	0.48	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Chrysene	µg/L	-	<0.010	<0.010	<0.010	0.011	<0.010	<0.010
Dibenzo(a,h,)anthracene	µg/L	0.26	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Fluoranthene	µg/L	0.04	0.025	<0.010	<0.010	0.022	0.010	0.011
Fluorene	µg/L	3	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Indeno(1,2,3-c,d) pyrene	µg/L	0.21	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Naphthalene	µg/L	1.1	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Perylene	µg/L	-	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Phenanthrene	µg/L	0.4	0.024	0.019	0.021	0.030	0.016	0.021
Pyrene	µg/L	0.025	0.016	<0.010	<0.010	0.014	<0.010	<0.010

Notes:

value	-exceeds CCME
-	-no guideline or value

[1] 1999 (with 2018 updates) Canadian Council of Ministers of the Environment (CCME) Water Quality Guidelines for the Protection of Freshwater Aquatic Life

TABLE 26: METALS in Surface Water - Ecological Health Guidelines
Client: Department of National Defence
Site Location: Former USAF Radar Station, Cartwright, NL
Englobe Project No.: P-0012285-0-16-200

PARAMETER	UNITS	CCME FAL [1]	Stantec 2018 Phase II ESA		Englobe 2018 Phase III ESA
			General Area		
			CWT-SW2	CWT-SW-3	CWT-SW2-18 (Coring)
					15-Aug-18
Aluminum	µg/L	5 - 100 [2]	130	520	144
Antimony	µg/L	-	<1	<1	<2
Arsenic	µg/L	5	<1	<1	<2
Barium	µg/L		2	7	<5
Beryllium	µg/L		<1	<1	<2
Bismuth	µg/L	-	<2	<2	<2
Boron	µg/L	1500	<50	<50	<5
Cadmium	µg/L	0.04 - 0.37 [3]	<0.01	0.01	<0.09
Calcium	µg/L	-	900	790	0.7
Chromium	µg/L	-	<1	<1	<1
Cobalt	µg/L		<0.4	<0.4	<1
Copper	µg/L	2 - 4 [4]	<2	<2	<1
Iron	µg/L	300	120	800	196
Lead	µg/L	1 - 7 [5]	<0.5	<0.5	<0.5
Magnesium	µg/L	-	460.0	670.0	0.4
Manganese	µg/L	-	2.2	17	6
Mercury (Total)	µg/L	0.026	-	-	<0.026
Molybdenum	µg/L	73	<2	<2	<2
Nickel	µg/L	25 - 150 [6]	<2	<2	<2
Phosphorus	µg/L	-	<100	<100	-
Potassium	µg/L	-	230	180	0.2
Selenium	µg/L	1	<1	<1	<1
Silver	µg/L	0.25	<0.1	<0.1	<0.1
Sodium	µg/L	-	3300	3900	2.4
Strontium	µg/L	-	6	9	6
Thallium	µg/L	0.8	<0.1	<0.1	<0.1
Tin	µg/L	-	6.2	<2	<2
Titanium	µg/L	-	2.2	10	<2
Uranium	µg/L	15	<0.1	<0.1	<0.1
Vanadium	µg/L	-	<2	<2	<2
Zinc	µg/L	7 [7]	<5	<5	<5

Notes:

value	-exceeds CCME
-	-no guideline or value

[1] 1999 (with 2018 updates) Canadian Council of Ministers of the Environment (CCME) Water Quality Guidelines for the Protection of Freshwater Aquatic Life

[2] Aluminum Guideline = 5 ug/L at pH < 6.5 or 100 ug/l at pH >= 6.5

[3] Cadmium concentration = $10^{0.86[\log10(\text{hardness})]-3.2}$

[4] Copper concentration dependant on water hardness.

[5] Lead concentration dependant on water hardness.

[6] Nickel concentration dependant on water hardness.

[7] Zinc concentration dependant on dissolved organic carbon (DOC), hardness and pH.

TABLE 26: METALS in Surface Water - Ecological Health Guidelines
Client: Department of National Defence
Site Location: Former USAF Radar Station, Cartwright, NL
Englobe Project No.: P-0012285-0-16-200

PARAMETER	UNITS	CCME FAL [1]	Stantec 2018 Phase II ESA	Englobe 2018 Phase III ESA
			Former Contractor Village	
			CWT-SW-5	CWT-SW-5-18
				24-Aug-18
Aluminum	µg/L	5 - 100 [2]	**750**	**1410**
Antimony	µg/L	-	<1	<2
Arsenic	µg/L	5	<1	<2
Barium	µg/L		5	10
Beryllium	µg/L		<1	<2
Bismuth	µg/L	-	<2	<2
Boron	µg/L	1500	<50	<5
Cadmium	µg/L	0.04 - 0.37 [3]	<0.01	<0.09
Calcium	µg/L	-	1100	1.0
Chromium	µg/L	-	<1	<1
Cobalt	µg/L		<0.4	<1
Copper	µg/L	2 - 4 [4]	**2.7**	<1
Iron	µg/L	300	**920**	**987**
Lead	µg/L	1 - 7 [5]	**2**	0.7
Magnesium	µg/L	-	910.0	0.6
Manganese	µg/L	-	8.2	9
Mercury (Total)	µg/L	0.026	-	<0.026
Molybdenum	µg/L	73	<2	<2
Nickel	µg/L	25 - 150 [6]	<2	<2
Phosphorus	µg/L	-	<100	60
Potassium	µg/L	-	290	0.2
Selenium	µg/L	1	<1	<1
Silver	µg/L	0.25	<0.1	<0.1
Sodium	µg/L	-	5700	4.2
Strontium	µg/L	-	16	12
Thallium	µg/L	0.8	<0.1	<0.1
Tin	µg/L	-	<2	<2
Titanium	µg/L	-	16	28
Uranium	µg/L	15	<0.1	0.1
Vanadium	µg/L	-	<2	<2
Zinc	µg/L	7 [7]	<5	7

Notes:

value	-exceeds CCME
-	-no guideline or value

[1] 1999 (with 2018 updates) Canadian Council of Ministers of the Environment (CCME) Water Quality Guidelines for the Protection of Freshwater Aquatic Life

[2] Aluminum Guideline = 5 ug/L at pH < 6.5 or 100 ug/l at pH >= 6.5

[3] Cadmium concentration = $10^{0.86[\log10(\text{hardness})]-3.2}$

[4] Copper concentration dependant on water hardness.

[5] Lead concentration dependant on water hardness.

[6] Nickel concentration dependant on water hardness.

[7] Zinc concentration dependant on dissolved organic carbon (DOC), hardness and pH.

TABLE 26: METALS in Surface Water - Ecological Health Guidelines
Client: Department of National Defence
Site Location: Former USAF Radar Station, Cartwright, NL
Englobe Project No.: P-0012285-0-16-200

PARAMETER	UNITS	CCME FAL [1]	Stantec 2018 Phase II ESA	Englobe 2018 Phase III ESA
			Main Complex	
			CWT-SW-6	CWT-SW-6-18
				24-Aug-18
Aluminum	µg/L	5 - 100 [2]	**3200**	**1130**
Antimony	µg/L	-	<1	<2
Arsenic	µg/L	5	<1	<2
Barium	µg/L		46	14
Beryllium	µg/L		<1	<2
Bismuth	µg/L	-	<2	<2
Boron	µg/L	1500	250	66
Cadmium	µg/L	0.04 - 0.37 [3]	**0.18**	<0.09
Calcium	µg/L	-	15000	3.1
Chromium	µg/L	-	5	<1
Cobalt	µg/L		0.92	<1
Copper	µg/L	2 - 4 [4]	**8.2**	**3**
Iron	µg/L	300	**13000**	**6340**
Lead	µg/L	1 - 7 [5]	**3**	**3.4**
Magnesium	µg/L	-	1400.0	0.8
Manganese	µg/L	-	120.0	86
Mercury (Total)	µg/L	0.026	-	<0.026
Molybdenum	µg/L	73	<2	<2
Nickel	µg/L	25 - 150 [6]	<2	<2
Phosphorus	µg/L	-	260	100
Potassium	µg/L	-	1900	0.3
Selenium	µg/L	1	<1	<1
Silver	µg/L	0.25	<0.1	<0.1
Sodium	µg/L	-	4100	3.5
Strontium	µg/L	-	78	19
Thallium	µg/L	0.8	<0.1	<0.1
Tin	µg/L	-	<2	<2
Titanium	µg/L	-	160	15
Uranium	µg/L	15	0.17	<0.1
Vanadium	µg/L	-	11	8
Zinc	µg/L	7 [7]	**20**	**33**

Notes:

value -exceeds CCME

\- -no guideline or value

[1] 1999 (with 2018 updates) Canadian Council of Ministers of the Environment (CCME) Water Quality Guidelines for the Protection of Freshwater Aquatic Life

[2] Aluminum Guideline = 5 ug/L at pH < 6.5 or 100 ug/l at pH >= 6.5

[3] Cadmium concentration = $10^{0.86[\log10(\text{hardness})]-3.2}$

[4] Copper concentration dependant on water hardness.

[5] Lead concentration dependant on water hardness.

[6] Nickel concentration dependant on water hardness.

[7] Zinc concentration dependant on dissolved organic carbon (DOC), hardness and pH.

TABLE 26: METALS in Surface Water - Ecological Health Guidelines
Client: Department of National Defence
Site Location: Former USAF Radar Station, Cartwright, NL
Englobe Project No.: P-0012285-0-16-200

PARAMETER	UNITS	CCME FAL [1]	Stantec 2018 Phase II ESA		Englobe 2018 Phase III ESA
			Former USAF Dump Area and Ammunition Storage Area		
			CWT-SW-7	CWT-SW-8	CWT-SW-7-18
					24-Aug-18
Aluminum	µg/L	5 - 100 [2]	**410**	**290**	**1600**
Antimony	µg/L	-	<1	<1	<2
Arsenic	µg/L	5	<1	<1	<2
Barium	µg/L		25	7	95
Beryllium	µg/L		<1	<1	<2
Bismuth	µg/L	-	<2	<2	<2
Boron	µg/L	1500	<50	<50	<5
Cadmium	µg/L	0.04 - 0.37 [3]	0.018	0.030	<0.09
Calcium	µg/L	-	1100	1600	2.0
Chromium	µg/L	-	1	<1	<1
Cobalt	µg/L		<0.4	<0.4	<1
Copper	µg/L	2 - 4 [4]	<2	<2	**4**
Iron	µg/L	300	**1000**	**640**	**1390**
Lead	µg/L	1 - 7 [5]	<0.5	**2.9**	**3.8**
Magnesium	µg/L	-	630.0	1200.0	0.7
Manganese	µg/L	-	12	44	25
Mercury (Total)	µg/L	0.026	-	-	<0.026
Molybdenum	µg/L	73	<2	<2	<2
Nickel	µg/L	25 - 150 [6]	<2	<2	<2
Phosphorus	µg/L	-	130	<100	160
Potassium	µg/L	-	380	110	0.7
Selenium	µg/L	1	<1	<1	<1
Silver	µg/L	0.25	<0.1	<0.1	<0.1
Sodium	µg/L	-	3300	2500	3.2
Strontium	µg/L	-	11	11	26
Thallium	µg/L	0.8	<0.1	<0.1	<0.1
Tin	µg/L	-	<2	<2	<2
Titanium	µg/L	-	4	10	24
Uranium	µg/L	15	<0.1	<0.1	0.1
Vanadium	µg/L	-	<2	<2	6
Zinc	µg/L	7 [7]	**12**	**18**	**22**

Notes:

value -exceeds CCME

\- -no guideline or value

[1] 1999 (with 2018 updates) Canadian Council of Ministers of the Environment (CCME) Water Quality Guidelines for the Protection of Freshwater Aquatic Life

[2] Aluminum Guideline = 5 ug/L at pH < 6.5 or 100 ug/l at pH >= 6.5

[3] Cadmium concentration = $10^{0.86[\log10(\text{hardness})]-3.2}$

[4] Copper concentration dependant on water hardness.

[5] Lead concentration dependant on water hardness.

[6] Nickel concentration dependant on water hardness.

[7] Zinc concentration dependant on dissolved organic carbon (DOC), hardness and pH.

TABLE 26: METALS in Surface Water - Ecological Health Guidelines
Client: Department of National Defence
Site Location: Former USAF Radar Station, Cartwright, NL
Englobe Project No.: P-0012285-0-16-200

PARAMETER	UNITS	CCME FAL [1]	Englobe 2018 Phase III ESA			
			Background			
			CWT-SW-BK01	CWT-SW-BK02	CWT-SW-BK03	CWT-SW-BK04
			24-Aug-18	24-Aug-18	24-Aug-18	24-Aug-18
Aluminum	µg/L	5 - 100 [2]	**686**	**540**	**569**	**959**
Antimony	µg/L	-	<2	<2	<2	<2
Arsenic	µg/L	5	<2	<2	<2	<2
Barium	µg/L		7	<5	28	19
Beryllium	µg/L		<2	<2	<2	<2
Bismuth	µg/L	-	<2	<2	<2	<2
Boron	µg/L	1500	<5	<5	<5	9
Cadmium	µg/L	0.04 - 0.37 [3]	<0.09	<0.09	<0.09	<0.09
Calcium	µg/L	-	1.5	0.4	0.6	1.9
Chromium	µg/L	-	<1	<1	<1	<1
Cobalt	µg/L		<1	<1	<1	<1
Copper	µg/L	2 - 4 [4]	1	<1	1	1
Iron	µg/L	300	**1580**	252	**1130**	**3060**
Lead	µg/L	1 - 7 [5]	0.6	<0.5	0.7	**1.5**
Magnesium	µg/L	-	0.6	0.4	0.8	1.7
Manganese	µg/L	-	20.0	<2	3	27
Mercury (Total)	µg/L	0.026	<0.026	<0.026	<0.026	<0.026
Molybdenum	µg/L	73	<2	<2	<2	<2
Nickel	µg/L	25 - 150 [6]	<2	<2	<2	<2
Phosphorus	µg/L	-	80	20	90	70
Potassium	µg/L	-	0.2	<0.1	0.7	0.8
Selenium	µg/L	1	<1	<1	<1	<1
Silver	µg/L	0.25	<0.1	<0.1	<0.1	<0.1
Sodium	µg/L	-	3.4	2.4	3.1	7.2
Strontium	µg/L	-	10	5	8	24
Thallium	µg/L	0.8	<0.1	<0.1	<0.1	<0.1
Tin	µg/L	-	<2	<2	<2	<2
Titanium	µg/L	-	14	4	6	18
Uranium	µg/L	15	<0.1	<0.1	<0.1	<0.1
Vanadium	µg/L	-	<2	<2	<2	2
Zinc	µg/L	7 [7]	5	<5	**11**	**14**

Notes:

value	-exceeds CCME
-	-no guideline or value

[1] 1999 (with 2018 updates) Canadian Council of Ministers of the Environment (CCME) Water Quality Guidelines for the Protection of Freshwater Aquatic Life

[2] Aluminum Guideline = 5 ug/L at pH < 6.5 or 100 ug/l at pH >= 6.5

[3] Cadmium concentration = $10^{0.86[\log10(\text{hardness})]-3.2}$

[4] Copper concentration dependant on water hardness.

[5] Lead concentration dependant on water hardness.

[6] Nickel concentration dependant on water hardness.

[7] Zinc concentration dependant on dissolved organic carbon (DOC), hardness and pH.

TABLE 27: GENERAL CHEMISTRY in Surface Water - Ecological Health Guidelines
Client: Department of National Defence
Site Location: Former USAF Radar Station, Cartwright, NL
Englobe Project No.: P-0012285-0-16-200

PARAMETER	UNITS	CCME FAL [1]	Stantec 2018 Phase II ESA	Englobe 2018 Phase III ESA
			General Area	
			CWT-SW-3	CWT-SW2-18 (Coring)
				15-Aug-18
Field pH	unitless	6.5 - 9	-	**6.09**
Anion Sum	me/L	-	0	0
Bicarb. Alkalinity (as CaCO3)	mg/L	-	<1	<5
Calculated TDS	mg/L	-	17	8
Carb. Alkalinity (as CaCO3)	mg/L	-	<1	<10
Cation sum	me/L	-	0	0
Hardness	mg/L	-	5	3
% Difference/ Ion Balance (NS)	%	-	25	29
Langelier Index (@20C)	NA	-	-	-5
Langelier Index (@ 4C)	NA	-	-	-5
Saturation pH (@ 20C)	NA	-	-	11
Saturation pH (@ 4C)	NA	-	-	11
Alkalinity	mg/L	-	<5	<5
Chloride	mg/L	120	6	4
Fluoride	mg/L	-	-	<0.12
True Color	TCU	-	190	59
Nitrate + Nitrite as N	mg/L	-	<0.05	<0.05
Nitrate as N	mg/L	-	-	<0.05
Nitrite as N	mg/L	-	-	<0.05
Nitrogen (Ammonia as Nitrogen)	mg/L	-	<0.05	0.04
Total Organic Carbon	mg/L	-	18.9	7.9
Ortho-Phosphate as P	mg/L	-	<0.01	<0.01
pH	unitless	6.5 - 9	**5.78**	**6.46**
Reactive Silica as SiO2	mg/L	-	4.2	1.1
Sulphate	mg/L	-	<2	<2
Turbidity	NTU	-	0.6	0.7
Electrical Conductivity	umho/cm	-	29	22
Hydroxide	mg/L	-	-	<5

Notes:

value	-exceeds guideline
-	-no guideline or value

[1] 1999 (with 2018 updates) Canadian Council of Ministers of the Environment (CCME) Water Quality Guidelines for the Protection of Freshwater Aquatic Life

TABLE 27: GENERAL CHEMISTRY in Surface Water - Ecological Health Guidelines
Client: Department of National Defence
Site Location: Former USAF Radar Station, Cartwright, NL
Englobe Project No.: P-0012285-0-16-200

PARAMETER	UNITS	CCME FAL [1]	Englobe 2018 Phase III ESA Former Contractor Village CWT-SW-5-18 24-Aug-18
Field pH	unitless	6.5 - 9	-
Anion Sum	me/L	-	0
Bicarb. Alkalinity (as CaCO3)	mg/L	-	<5
Calculated TDS	mg/L	-	13
Carb. Alkalinity (as CaCO3)	mg/L	-	<10
Cation sum	me/L	-	0
Hardness	mg/L	-	5
% Difference/ Ion Balance (NS)	%	-	55
Langelier Index (@20C)	NA	-	-6
Langelier Index (@ 4C)	NA	-	-6
Saturation pH (@ 20C)	NA	-	11
Saturation pH (@ 4C)	NA	-	11
Alkalinity	mg/L	-	<5
Chloride	mg/L	120	5
Fluoride	mg/L	-	<0.12
True Color	TCU	-	350
Nitrate + Nitrite as N	mg/L	-	<0.05
Nitrate as N	mg/L	-	<0.05
Nitrite as N	mg/L	-	<0.05
Nitrogen (Ammonia as Nitrogen)	mg/L	-	<0.03
Total Organic Carbon	mg/L	-	26.6
Ortho-Phosphate as P	mg/L	-	<0.01
pH	unitless	6.5 - 9	**5.32**
Reactive Silica as SiO2	mg/L	-	5.5
Sulphate	mg/L	-	<2
Turbidity	NTU	-	14.0
Electrical Conductivity	umho/cm	-	34
Hydroxide	mg/L	-	<5

Notes:

value	-exceeds guideline
-	-no guideline or value

[1] 1999 (with 2018 updates) Canadian Council of Ministers of the Environment (CCME) Water Quality Guidelines for the Protection of Freshwater Aquatic Life

Englobe

TABLE 27: GENERAL CHEMISTRY in Surface Water - Ecological Health Guidelines
Client: Department of National Defence
Site Location: Former USAF Radar Station, Cartwright, NL
Englobe Project No.: P-0012285-0-16-200

PARAMETER	UNITS	CCME FAL [1]	Stantec 2018 Phase II ESA	Englobe 2018 Phase III ESA
			Main Complex	
			CWT-SW-6	CWT-SW-6-18
				24-Aug-18
Field pH	unitless	6.5 - 9	-	-
Anion Sum	me/L	-	1	0
Bicarb. Alkalinity (as CaCO3)	mg/L	-	31	8
Calculated TDS	mg/L	-	79	24
Carb. Alkalinity (as CaCO3)	mg/L	-	<1	<10
Cation sum	me/L	-	2	1
Hardness	mg/L	-	44	11
% Difference/ Ion Balance (NS)	%	-	22	46
Langelier Index (@20C)	NA	-	-1	-4
Langelier Index (@ 4C)	NA	-	-2	-4
Saturation pH (@ 20C)	NA	-	9	10
Saturation pH (@ 4C)	NA	-	9	11
Alkalinity	mg/L	-	31	8.0
Chloride	mg/L	120	5	4
Fluoride	mg/L	-	-	<0.12
True Color	TCU	-	37	137
Nitrate + Nitrite as N	mg/L	-	0.5	<0.05
Nitrate as N	mg/L	-	-	<0.05
Nitrite as N	mg/L	-	-	<0.05
Nitrogen (Ammonia as Nitrogen)	mg/L	-	0.21	<0.03
Total Organic Carbon	mg/L	-	22.9	17.00
Ortho-Phosphate as P	mg/L	-	<0.01	<0.01
pH	unitless	6.5 - 9	7.16	**6.45**
Reactive Silica as SiO2	mg/L	-	5.6	4.4
Sulphate	mg/L	-	11.00	<2
Turbidity	NTU	-	92.0	20.6
Electrical Conductivity	umho/cm	-	97	39
Hydroxide	mg/L	-	-	<5

Notes:

value	-exceeds guideline
-	-no guideline or value

[1] 1999 (with 2018 updates) Canadian Council of Ministers of the Environment (CCME) Water Quality Guidelines for the Protection of Freshwater Aquatic Life

TABLE 27: GENERAL CHEMISTRY in Surface Water - Ecological Health Guidelines
Client: Department of National Defence
Site Location: Former USAF Radar Station, Cartwright, NL
Englobe Project No.: P-0012285-0-16-200

PARAMETER	UNITS	CCME FAL [1]	Stantec 2018 Phase II ESA		Englobe 2018 Phase III ESA		
			Former USAF Dump Area and Former Ammunition Storage Area				
			CWT-SW-7	CWT-SW-8	CWT-SW-7-18	CWT-SW-8-18	CWT-SW-8-18B
					24-Aug-18	15-Aug-18	15-Aug-18
Field pH	unitless	6.5 - 9	-	-	-	**5.75**	**6.32**
Anion Sum	me/L	-	0	0	0	-	-
Bicarb. Alkalinity (as CaCO3)	mg/L	-	6	<1	<5	-	-
Calculated TDS	mg/L	-	24	21	14	-	-
Carb. Alkalinity (as CaCO3)	mg/L	-	<1	<1	<10	-	-
Cation sum	me/L	-	0	0	1	-	-
Hardness	mg/L	-	5	9	8	-	-
% Difference/ Ion Balance (NS)	%	-	2	4	66	-	-
Langelier Index (@20C)	NA	-	-5	-	-5	-	-
Langelier Index (@ 4C)	NA	-	-5	-	-5	-	-
Saturation pH (@ 20C)	NA	-	11	-	11	-	-
Saturation pH (@ 4C)	NA	-	11	-	11	-	-
Alkalinity	mg/L	-	6	<5	<5	-	-
Chloride	mg/L	120	7	8	4	-	-
Fluoride	mg/L	-	-	-	<0.12	-	-
True Color	TCU	-	63	330	41	-	-
Nitrate + Nitrite as N	mg/L	-	<0.05	1.3	<0.05	-	-
Nitrate as N	mg/L	-	-	-	<0.05	-	-
Nitrite as N	mg/L	-	-	-	<0.05	-	-
Nitrogen (Ammonia as Nitrogen)	mg/L	-	0.058	0.087	<0.03	-	-
Total Organic Carbon	mg/L	-	18.9	38.9	10.1	-	-
Ortho-Phosphate as P	mg/L	-	<0.01	<0.01	<0.01	-	-
pH	unitless	6.5 - 9	**5.83**	**4.35**	**5.76**	**5.68**	6.61
Reactive Silica as SiO2	mg/L	-	6.9	0.8	1.9	-	-
Sulphate	mg/L	-	<2	<2	<2	-	-
Turbidity	NTU	-	160.0	1.3	79.7	-	-
Electrical Conductivity	umho/cm	-	35	79	28	-	-
Hydroxide	mg/L	-	-	-	<5	-	-

Notes:

value	-exceeds guideline
-	-no guideline or value

[1] 1999 (with 2018 updates) Canadian Council of Ministers of the Environment (CCME) Water Quality Guidelines for the Protection of Freshwater Aquatic Life

TABLE 27: GENERAL CHEMISTRY in Surface Water - Ecological Health Guidelines
Client: Department of National Defence
Site Location: Former USAF Radar Station, Cartwright, NL
Englobe Project No.: P-0012285-0-16-200

PARAMETER	UNITS	CCME FAL [1]	Englobe 2018 Phase III ESA			
			Background			
			CWT-SW-BK01	CWT-SW-BK02	CWT-SW-BK03	CWT-SW-BK04
			24-Aug-18	24-Aug-18	24-Aug-18	24-Aug-18
Field pH	unitless	6.5 - 9	**5.93**	**5.36**	**4.80**	**5.07**
Anion Sum	me/L	-	0	0	0	0
Bicarb. Alkalinity (as CaCO3)	mg/L	-	<5	<5	<5	<5
Calculated TDS	mg/L	-	11	6	10	25
Carb. Alkalinity (as CaCO3)	mg/L	-	<10	<10	<10	<10
Cation sum	me/L	-	0	0	0	1
Hardness	mg/L	-	6	3	5	12
% Difference/ Ion Balance (NS)	%	-	66	63	62	51
Langelier Index (@20C)	NA	-	-5	-6	-6	-5
Langelier Index (@ 4C)	NA	-	-5	-7	-6	-5
Saturation pH (@ 20C)	NA	-	11	11	11	11
Saturation pH (@ 4C)	NA	-	11	12	11	11
Alkalinity	mg/L	-	<5	<5	<5	<5
Chloride	mg/L	120	3	2	3	9
Fluoride	mg/L	-	<0.12	<0.12	<0.12	<0.12
True Color	TCU	-	235	240	190	440
Nitrate + Nitrite as N	mg/L	-	<0.05	<0.05	<0.05	<0.05
Nitrate as N	mg/L	-	<0.05	<0.05	<0.05	<0.05
Nitrite as N	mg/L	-	<0.05	<0.05	<0.05	<0.05
Nitrogen (Ammonia as Nitrogen)	mg/L	-	0.07	<0.03	0.07	<0.03
Total Organic Carbon	mg/L	-	14.7	19.1	23.5	31.5
Ortho-Phosphate as P	mg/L	-	<0.01	<0.01	<0.01	<0.01
pH	unitless	6.5 - 9	**5.56**	**4.73**	**5.25**	**5.62**
Reactive Silica as SiO2	mg/L	-	2.0	3.3	<0.5	2.0
Sulphate	mg/L	-	<2	<2	<2	<2
Turbidity	NTU	-	23.7	25.3	58.9	156.0
Electrical Conductivity	umho/cm	-	26	26	27	68
Hydroxide	mg/L	-	<5	<5	<5	<5

Notes:

value	-exceeds guideline
-	-no guideline or value

[1] 1999 (with 2018 updates) Canadian Council of Ministers of the Environment (CCME) Water Quality Guidelines for the Protection of Freshwater Aquatic Life

TABLE 28: POLYCHLORINATED BIPHENYLS in Surface Water - Ecological Health Guidelines
Client: Department of National Defence
Site Location: Former USAF Radar Station, Cartwright, NL
Englobe Project No.: P-0012285-0-16-200

PARAMETER	UNITS	Stantec 2018 Phase II ESA					
		General Area		Former Contractors Village	Main Complex	Former USAF Dump Area and Former Ammunition Storage Area	
		CWT-SW2	CWT-SW-3	CWT-SW-5	CWT-SW-6	CWT-SW-7	CWT-SW-8
Aroclor 1016	µg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Aroclor 1221	µg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Aroclor 1232	µg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Aroclor 1248	µg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Aroclor 1242	µg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Aroclor 1254	µg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Aroclor 1260	µg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Calculated Total PCB	µg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05

Notes:

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

TABLE 29: POLYCHLORINATED BIPHENYLS (PCBs) in Vegetation
Client: Department of National Defence
Site Location: Former USAF Radar Station, Cartwright, NL
Englobe Project No.: P-0012285-0-16-200

		Stantec 2018 Phase II ESA																Englobe 2018 Phase III ESA		
PARAMETER	UNITS	General Area			Former Contractor Village	Main Complex										Former USAF Dump Area and Ammunition Storage Area		Background		
		CWT-VEG-5	CWT-VEG-9	CWT-BER-5	CWT-VEG-12	CWT-VEG-3	CWT-VEG-4	CWT-VEG-7	CWT-VEG-8	CWT-VEG-10	CWT-VEG-11	CWT-BERRY3	CWT-BERRY 4	CWT-BERRY 7	CWT-BERRY 8	CWT-VEG-1	CWT-VEG-2	CWT-VEG-BK01	CWT-VEG-BK03	CWT-VEG-BK04
																		24-Aug-18	24-Aug-18	24-Aug-18
Aroclor 1016	ug/g	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.25	<0.25	<0.25
Aroclor 1221	ug/g	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.25	<0.25	<0.25
Aroclor 1232	ug/g	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.25	<0.25	<0.25
Aroclor 1248	ug/g	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.25	<0.25	<0.25
Aroclor 1242	ug/g	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.25	<0.25	<0.25
Aroclor 1254	ug/g	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.25	<0.25	<0.25
Aroclor 1260	ug/g	0.24	0.35	<0.05	0.33	0.51	0.13	0.11	0.15	0.075	0.069	<0.05	<0.05	<0.05	<0.05	0.088	0.2	<0.25	<0.25	<0.25
Calculated Total PCB	ug/g	0.24	0.350	<0.05	0.330	0.510	0.130	0.110	0.150	0.075	0.069	<0.05	<0.05	<0.05	<0.05	0.088	0.2	<0.25	<0.25	<0.25

Notes: - -no guideline or value
-No applicable guidelines available for PCB in vegetation.

Appendix D EPC Calculations

UCL Statistics for Uncensored Full Data Sets

User Selected Options	
Date/Time of Computation	ProUCL 5.12019-05-10 09:51:55
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Fraction F3 (>C16-C34) - General Area (Soil)

General Statistics

Total Number of Observations	24,00	Number of Distinct Observations	11,00
		Number of Missing Observations	0
Minimum	18,00	Mean	64,08
Maximum	550,0	Median	25,00
SD	110,4	Std. Error of Mean	22,53
Coefficient of Variation	1,722	Skewness	4,047

Normal GOF Test

Shapiro Wilk Test Statistic	0,420	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0,916	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0,378	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0,177	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	102,7	95% Adjusted-CLT UCL (Chen-1995)	121,0
		95% Modified-t UCL (Johnson-1978)	105,8

Gamma GOF Test

A-D Test Statistic	4,354	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0,770	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0,410	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0,183	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	1,072	k star (bias corrected MLE)	0,965
Theta hat (MLE)	59,81	Theta star (bias corrected MLE)	66,38
nu hat (MLE)	51,43	nu star (bias corrected)	46,34
MLE Mean (bias corrected)	64,08	MLE Sd (bias corrected)	65,22
		Approximate Chi Square Value (0,0500)	31,72
Adjusted Level of Significance	0,0392	Adjusted Chi Square Value	30,87

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	93,62	95% Adjusted Gamma UCL (use when n<50)	96,20

	A–E	F	G–K	L
51	**Lognormal GOF Test**			
52	Shapiro Wilk Test Statistic	0,654	**Shapiro Wilk Lognormal GOF Test**	
53	5% Shapiro Wilk Critical Value	0,916	Data Not Lognormal at 5% Significance Level	
54	Lilliefors Test Statistic	0,386	**Lilliefors Lognormal GOF Test**	
55	5% Lilliefors Critical Value	0,177	Data Not Lognormal at 5% Significance Level	
56	**Data Not Lognormal at 5% Significance Level**			
57				
58	**Lognormal Statistics**			
59	Minimum of Logged Data	2,890	Mean of logged Data	3,626
60	Maximum of Logged Data	6,310	SD of logged Data	0,845
61				
62	**Assuming Lognormal Distribution**			
63	95% H-UCL	81,06	90% Chebyshev (MVUE) UCL	82,60
64	95% Chebyshev (MVUE) UCL	96,19	97,5% Chebyshev (MVUE) UCL	115,0
65	99% Chebyshev (MVUE) UCL	152,1		
66				
67	**Nonparametric Distribution Free UCL Statistics**			
68	**Data do not follow a Discernible Distribution (0.05)**			
69				
70	**Nonparametric Distribution Free UCLs**			
71	95% CLT UCL	101,1	95% Jackknife UCL	102,7
72	95% Standard Bootstrap UCL	100,1	95% Bootstrap-t UCL	175,8
73	95% Hall's Bootstrap UCL	217,9	95% Percentile Bootstrap UCL	107,2
74	95% BCA Bootstrap UCL	127,2		
75	90% Chebyshev(Mean, Sd) UCL	131,7	95% Chebyshev(Mean, Sd) UCL	162,3
76	97,5% Chebyshev(Mean, Sd) UCL	204,8	99% Chebyshev(Mean, Sd) UCL	288,2
77				
78	**Suggested UCL to Use**			
79	95% Chebyshev (Mean, Sd) UCL	162,3		
80				
81	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
82	Recommendations are based upon data size, data distribution, and skewness.			
83	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
84	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
85				
86				
87	**Vanadium - General Area (Soil)**			
88				
89	**General Statistics**			
90	Total Number of Observations	11,00	Number of Distinct Observations	11,00
91			Number of Missing Observations	0
92	Minimum	2,000	Mean	22,82
93	Maximum	45,00	Median	23,00
94	SD	11,21	Std. Error of Mean	3,381
95	Coefficient of Variation	0,491	Skewness	0,121
96				
97	**Normal GOF Test**			
98	Shapiro Wilk Test Statistic	0,982	**Shapiro Wilk GOF Test**	
99	5% Shapiro Wilk Critical Value	0,850	Data appear Normal at 5% Significance Level	
100	Lilliefors Test Statistic	0,116	**Lilliefors GOF Test**	

	A–E	F	G–K	L
101	5% Lilliefors Critical Value	0,251	Data appear Normal at 5% Significance Level	
102	**Data appear Normal at 5% Significance Level**			
103				
104	**Assuming Normal Distribution**			
105	**95% Normal UCL**		**95% UCLs (Adjusted for Skewness)**	
106	95% Student's-t UCL	28,95	95% Adjusted-CLT UCL (Chen-1995)	28,51
107			95% Modified-t UCL (Johnson-1978)	28,97
108				
109	**Gamma GOF Test**			
110	A-D Test Statistic	0,603	**Anderson-Darling Gamma GOF Test**	
111	5% A-D Critical Value	0,735	Detected data appear Gamma Distributed at 5% Significance Level	
112	K-S Test Statistic	0,194	**Kolmogorov-Smirnov Gamma GOF Test**	
113	5% K-S Critical Value	0,257	Detected data appear Gamma Distributed at 5% Significance Level	
114	**Detected data appear Gamma Distributed at 5% Significance Level**			
115				
116	**Gamma Statistics**			
117	k hat (MLE)	2,680	k star (bias corrected MLE)	2,010
118	Theta hat (MLE)	8,514	Theta star (bias corrected MLE)	11,35
119	nu hat (MLE)	58,96	nu star (bias corrected)	44,22
120	MLE Mean (bias corrected)	22,82	MLE Sd (bias corrected)	16,10
121			Approximate Chi Square Value (0,0500)	29,96
122	Adjusted Level of Significance	0,0278	Adjusted Chi Square Value	28,06
123				
124	**Assuming Gamma Distribution**			
125	95% Approximate Gamma UCL (use when n>=50))	33,67	95% Adjusted Gamma UCL (use when n<50)	35,95
126				
127	**Lognormal GOF Test**			
128	Shapiro Wilk Test Statistic	0,762	**Shapiro Wilk Lognormal GOF Test**	
129	5% Shapiro Wilk Critical Value	0,850	Data Not Lognormal at 5% Significance Level	
130	Lilliefors Test Statistic	0,242	**Lilliefors Lognormal GOF Test**	
131	5% Lilliefors Critical Value	0,251	Data appear Lognormal at 5% Significance Level	
132	**Data appear Approximate Lognormal at 5% Significance Level**			
133				
134	**Lognormal Statistics**			
135	Minimum of Logged Data	0,693	Mean of logged Data	2,930
136	Maximum of Logged Data	3,807	SD of logged Data	0,822
137				
138	**Assuming Lognormal Distribution**			
139	95% H-UCL	52,50	90% Chebyshev (MVUE) UCL	44,90
140	95% Chebyshev (MVUE) UCL	53,80	97,5% Chebyshev (MVUE) UCL	66,15
141	99% Chebyshev (MVUE) UCL	90,42		
142				
143	**Nonparametric Distribution Free UCL Statistics**			
144	**Data appear to follow a Discernible Distribution at 5% Significance Level**			
145				
146	**Nonparametric Distribution Free UCLs**			
147	95% CLT UCL	28,38	95% Jackknife UCL	28,95
148	95% Standard Bootstrap UCL	28,16	95% Bootstrap-t UCL	29,10
149	95% Hall's Bootstrap UCL	30,06	95% Percentile Bootstrap UCL	28,55
150	95% BCA Bootstrap UCL	27,82		

	A–E	F	G–K	L
151	90% Chebyshev(Mean, Sd) UCL	32,96	95% Chebyshev(Mean, Sd) UCL	37,56
152	97,5% Chebyshev(Mean, Sd) UCL	43,93	99% Chebyshev(Mean, Sd) UCL	56,46
153				
154	**Suggested UCL to Use**			
155	95% Student's-t UCL	28,95		
156				
157	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
158	Recommendations are based upon data size, data distribution, and skewness.			
159	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
160	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
161				
162				
163	**Fraction F1 (C6-C10) - Former Contractor Village (Soil)**			
164				
165	**General Statistics**			
166	Total Number of Observations	27,00	Number of Distinct Observations	12,00
167			Number of Missing Observations	3,000
168	Minimum	2,500	Mean	48,24
169	Maximum	260,0	Median	3,000
170	SD	83,30	Std. Error of Mean	16,03
171	Coefficient of Variation	1,727	Skewness	1,721
172				
173	**Normal GOF Test**			
174	Shapiro Wilk Test Statistic	0,611	**Shapiro Wilk GOF Test**	
175	5% Shapiro Wilk Critical Value	0,923	Data Not Normal at 5% Significance Level	
176	Lilliefors Test Statistic	0,381	**Lilliefors GOF Test**	
177	5% Lilliefors Critical Value	0,167	Data Not Normal at 5% Significance Level	
178	**Data Not Normal at 5% Significance Level**			
179				
180	**Assuming Normal Distribution**			
181	**95% Normal UCL**		**95% UCLs (Adjusted for Skewness)**	
182	95% Student's-t UCL	75,58	95% Adjusted-CLT UCL (Chen-1995)	80,28
183			95% Modified-t UCL (Johnson-1978)	76,47
184				
185	**Gamma GOF Test**			
186	A-D Test Statistic	3,991	**Anderson-Darling Gamma GOF Test**	
187	5% A-D Critical Value	0,830	Data Not Gamma Distributed at 5% Significance Level	
188	K-S Test Statistic	0,343	**Kolmogorov-Smirnov Gamma GOF Test**	
189	5% K-S Critical Value	0,180	Data Not Gamma Distributed at 5% Significance Level	
190	**Data Not Gamma Distributed at 5% Significance Level**			
191				
192	**Gamma Statistics**			
193	k hat (MLE)	0,399	k star (bias corrected MLE)	0,379
194	Theta hat (MLE)	120,9	Theta star (bias corrected MLE)	127,2
195	nu hat (MLE)	21,55	nu star (bias corrected)	20,49
196	MLE Mean (bias corrected)	48,24	MLE Sd (bias corrected)	78,32
197			Approximate Chi Square Value (0,0500)	11,21
198	Adjusted Level of Significance	0,0401	Adjusted Chi Square Value	10,77
199				
200	**Assuming Gamma Distribution**			

	A–E	F	G–K	L
201	95% Approximate Gamma UCL (use when n>=50))	88,16	95% Adjusted Gamma UCL (use when n<50)	91,75
202				
203	**Lognormal GOF Test**			
204	Shapiro Wilk Test Statistic	0,704	**Shapiro Wilk Lognormal GOF Test**	
205	5% Shapiro Wilk Critical Value	0,923	Data Not Lognormal at 5% Significance Level	
206	Lilliefors Test Statistic	0,327	**Lilliefors Lognormal GOF Test**	
207	5% Lilliefors Critical Value	0,167	Data Not Lognormal at 5% Significance Level	
208	**Data Not Lognormal at 5% Significance Level**			
209				
210	**Lognormal Statistics**			
211	Minimum of Logged Data	0,916	Mean of logged Data	2,226
212	Maximum of Logged Data	5,561	SD of logged Data	1,798
213				
214	**Assuming Lognormal Distribution**			
215	95% H-UCL	172,7	90% Chebyshev (MVUE) UCL	95,45
216	95% Chebyshev (MVUE) UCL	120,2	97,5% Chebyshev (MVUE) UCL	154,6
217	99% Chebyshev (MVUE) UCL	222,2		
218				
219	**Nonparametric Distribution Free UCL Statistics**			
220	**Data do not follow a Discernible Distribution (0.05)**			
221				
222	**Nonparametric Distribution Free UCLs**			
223	95% CLT UCL	74,61	95% Jackknife UCL	75,58
224	95% Standard Bootstrap UCL	73,13	95% Bootstrap-t UCL	90,91
225	95% Hall's Bootstrap UCL	76,01	95% Percentile Bootstrap UCL	72,83
226	95% BCA Bootstrap UCL	77,59		
227	90% Chebyshev(Mean, Sd) UCL	96,33	95% Chebyshev(Mean, Sd) UCL	118,1
228	97,5% Chebyshev(Mean, Sd) UCL	148,3	99% Chebyshev(Mean, Sd) UCL	207,7
229				
230	**Suggested UCL to Use**			
231	95% Chebyshev (Mean, Sd) UCL	118,1		
232				
233	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
234	Recommendations are based upon data size, data distribution, and skewness.			
235	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
236	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
237				
238				
239	**Fraction F2 (>C10-C16) - Former Contractor Village (Soil)**			
240				
241	**General Statistics**			
242	Total Number of Observations	27,00	Number of Distinct Observations	16,00
243			Number of Missing Observations	3,000
244	Minimum	10,00	Mean	340,3
245	Maximum	4070	Median	17,00
246	SD	856,7	Std. Error of Mean	164,9
247	Coefficient of Variation	2,518	Skewness	3,633
248				
249	**Normal GOF Test**			
250	Shapiro Wilk Test Statistic	0,454	**Shapiro Wilk GOF Test**	

	A–E	F	G–K	L
251	5% Shapiro Wilk Critical Value	0,923	Data Not Normal at 5% Significance Level	
252	Lilliefors Test Statistic	0,397	**Lilliefors GOF Test**	
253	5% Lilliefors Critical Value	0,167	Data Not Normal at 5% Significance Level	
254	**Data Not Normal at 5% Significance Level**			
255				
256	**Assuming Normal Distribution**			
257	**95% Normal UCL**		**95% UCLs (Adjusted for Skewness)**	
258	95% Student's-t UCL	621,5	95% Adjusted-CLT UCL (Chen-1995)	734,7
259			95% Modified-t UCL (Johnson-1978)	640,7
260				
261	**Gamma GOF Test**			
262	A-D Test Statistic	3,574	**Anderson-Darling Gamma GOF Test**	
263	5% A-D Critical Value	0,845	Data Not Gamma Distributed at 5% Significance Level	
264	K-S Test Statistic	0,307	**Kolmogorov-Smirnov Gamma GOF Test**	
265	5% K-S Critical Value	0,182	Data Not Gamma Distributed at 5% Significance Level	
266	**Data Not Gamma Distributed at 5% Significance Level**			
267				
268	**Gamma Statistics**			
269	k hat (MLE)	0,336	k star (bias corrected MLE)	0,323
270	Theta hat (MLE)	1014	Theta star (bias corrected MLE)	1054
271	nu hat (MLE)	18,12	nu star (bias corrected)	17,44
272	MLE Mean (bias corrected)	340,3	MLE Sd (bias corrected)	598,8
273			Approximate Chi Square Value (0,0500)	8,986
274	Adjusted Level of Significance	0,0401	Adjusted Chi Square Value	8,599
275				
276	**Assuming Gamma Distribution**			
277	95% Approximate Gamma UCL (use when n>=50))	660,4	95% Adjusted Gamma UCL (use when n<50)	690,1
278				
279	**Lognormal GOF Test**			
280	Shapiro Wilk Test Statistic	0,792	**Shapiro Wilk Lognormal GOF Test**	
281	5% Shapiro Wilk Critical Value	0,923	Data Not Lognormal at 5% Significance Level	
282	Lilliefors Test Statistic	0,220	**Lilliefors Lognormal GOF Test**	
283	5% Lilliefors Critical Value	0,167	Data Not Lognormal at 5% Significance Level	
284	**Data Not Lognormal at 5% Significance Level**			
285				
286	**Lognormal Statistics**			
287	Minimum of Logged Data	2,303	Mean of logged Data	3,812
288	Maximum of Logged Data	8,311	SD of logged Data	1,848
289				
290	**Assuming Lognormal Distribution**			
291	95% H-UCL	985,1	90% Chebyshev (MVUE) UCL	513,6
292	95% Chebyshev (MVUE) UCL	648,8	97,5% Chebyshev (MVUE) UCL	836,4
293	99% Chebyshev (MVUE) UCL	1205		
294				
295	**Nonparametric Distribution Free UCL Statistics**			
296	**Data do not follow a Discernible Distribution (0.05)**			
297				
298	**Nonparametric Distribution Free UCLs**			
299	95% CLT UCL	611,5	95% Jackknife UCL	621,5
300	95% Standard Bootstrap UCL	603,5	95% Bootstrap-t UCL	1170

	A–E	F	G–K	L
301	95% Hall's Bootstrap UCL	1521	95% Percentile Bootstrap UCL	645,0
302	95% BCA Bootstrap UCL	776,7		
303	90% Chebyshev(Mean, Sd) UCL	834,9	95% Chebyshev(Mean, Sd) UCL	1059
304	97,5% Chebyshev(Mean, Sd) UCL	1370	99% Chebyshev(Mean, Sd) UCL	1981
305				
306	**Suggested UCL to Use**			
307	95% Chebyshev (Mean, Sd) UCL	1059		
308				
309	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
310	Recommendations are based upon data size, data distribution, and skewness.			
311	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
312	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
313				
314				
315	**Fraction F3 (>C16-C34) - Former Contractor Village (Soil)**			
316				
317	**General Statistics**			
318	Total Number of Observations	27,00	Number of Distinct Observations	18,00
319			Number of Missing Observations	3,000
320	Minimum	19,00	Mean	113,7
321	Maximum	465,0	Median	44,00
322	SD	130,2	Std. Error of Mean	25,06
323	Coefficient of Variation	1,146	Skewness	1,550
324				
325	**Normal GOF Test**			
326	Shapiro Wilk Test Statistic	0,733	**Shapiro Wilk GOF Test**	
327	5% Shapiro Wilk Critical Value	0,923	Data Not Normal at 5% Significance Level	
328	Lilliefors Test Statistic	0,252	**Lilliefors GOF Test**	
329	5% Lilliefors Critical Value	0,167	Data Not Normal at 5% Significance Level	
330	**Data Not Normal at 5% Significance Level**			
331				
332	**Assuming Normal Distribution**			
333	**95% Normal UCL**		**95% UCLs (Adjusted for Skewness)**	
334	95% Student's-t UCL	156,4	95% Adjusted-CLT UCL (Chen-1995)	162,9
335			95% Modified-t UCL (Johnson-1978)	157,7
336				
337	**Gamma GOF Test**			
338	A-D Test Statistic	1,948	**Anderson-Darling Gamma GOF Test**	
339	5% A-D Critical Value	0,773	Data Not Gamma Distributed at 5% Significance Level	
340	K-S Test Statistic	0,228	**Kolmogorov-Smirnov Gamma GOF Test**	
341	5% K-S Critical Value	0,173	Data Not Gamma Distributed at 5% Significance Level	
342	**Data Not Gamma Distributed at 5% Significance Level**			
343				
344	**Gamma Statistics**			
345	k hat (MLE)	1,007	k star (bias corrected MLE)	0,919
346	Theta hat (MLE)	112,9	Theta star (bias corrected MLE)	123,6
347	nu hat (MLE)	54,35	nu star (bias corrected)	49,65
348	MLE Mean (bias corrected)	113,7	MLE Sd (bias corrected)	118,5
349			Approximate Chi Square Value (0,0500)	34,47
350	Adjusted Level of Significance	0,0401	Adjusted Chi Square Value	33,66

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	163,7	95% Adjusted Gamma UCL (use when n<50)	167,6

Lognormal GOF Test

Shapiro Wilk Test Statistic	0,842	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0,923	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0,226	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0,167	Data Not Lognormal at 5% Significance Level

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	2,944	Mean of logged Data	4,160
Maximum of Logged Data	6,142	SD of logged Data	1,064

Assuming Lognormal Distribution

95% H-UCL	194,5	90% Chebyshev (MVUE) UCL	187,2
95% Chebyshev (MVUE) UCL	222,4	97,5% Chebyshev (MVUE) UCL	271,3
99% Chebyshev (MVUE) UCL	367,3		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	154,9	95% Jackknife UCL	156,4
95% Standard Bootstrap UCL	153,9	95% Bootstrap-t UCL	170,5
95% Hall's Bootstrap UCL	164,4	95% Percentile Bootstrap UCL	156,7
95% BCA Bootstrap UCL	163,0		
90% Chebyshev(Mean, Sd) UCL	188,9	95% Chebyshev(Mean, Sd) UCL	222,9
97,5% Chebyshev(Mean, Sd) UCL	270,2	99% Chebyshev(Mean, Sd) UCL	363,1

Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL	222,9		

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.

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 statistician.

Tin - Former Contractor Village (Soil)

General Statistics

Total Number of Observations	10,00	Number of Distinct Observations	3,000
		Number of Missing Observations	0
Minimum	2,000	Mean	4,740
Maximum	29,00	Median	2,000
SD	8,525	Std. Error of Mean	2,696
Coefficient of Variation	1,799	Skewness	3,161

	A	B	C	D	E	F	G	H	I	J	K	L
401	**Normal GOF Test**											
402					Shapiro Wilk Test Statistic	0,373	**Shapiro Wilk GOF Test**					
403					5% Shapiro Wilk Critical Value	0,842	Data Not Normal at 5% Significance Level					
404					Lilliefors Test Statistic	0,508	**Lilliefors GOF Test**					
405					5% Lilliefors Critical Value	0,262	Data Not Normal at 5% Significance Level					
406	**Data Not Normal at 5% Significance Level**											
407												
408	**Assuming Normal Distribution**											
409	**95% Normal UCL**						**95% UCLs (Adjusted for Skewness)**					
410					95% Student's-t UCL	9,682					95% Adjusted-CLT UCL (Chen-1995)	12,05
411											95% Modified-t UCL (Johnson-1978)	10,13
412												
413	**Gamma GOF Test**											
414					A-D Test Statistic	3,213	**Anderson-Darling Gamma GOF Test**					
415					5% A-D Critical Value	0,748	Data Not Gamma Distributed at 5% Significance Level					
416					K-S Test Statistic	0,503	**Kolmogorov-Smirnov Gamma GOF Test**					
417					5% K-S Critical Value	0,274	Data Not Gamma Distributed at 5% Significance Level					
418	**Data Not Gamma Distributed at 5% Significance Level**											
419												
420	**Gamma Statistics**											
421					k hat (MLE)	1,000					k star (bias corrected MLE)	0,767
422					Theta hat (MLE)	4,740					Theta star (bias corrected MLE)	6,183
423					nu hat (MLE)	20,00					nu star (bias corrected)	15,33
424					MLE Mean (bias corrected)	4,740					MLE Sd (bias corrected)	5,414
425											Approximate Chi Square Value (0,0500)	7,494
426					Adjusted Level of Significance	0,0267					Adjusted Chi Square Value	6,564
427												
428	**Assuming Gamma Distribution**											
429					95% Approximate Gamma UCL (use when n>=50))	9,699					95% Adjusted Gamma UCL (use when n<50)	11,07
430												
431	**Lognormal GOF Test**											
432					Shapiro Wilk Test Statistic	0,399	**Shapiro Wilk Lognormal GOF Test**					
433					5% Shapiro Wilk Critical Value	0,842	Data Not Lognormal at 5% Significance Level					
434					Lilliefors Test Statistic	0,449	**Lilliefors Lognormal GOF Test**					
435					5% Lilliefors Critical Value	0,262	Data Not Lognormal at 5% Significance Level					
436	**Data Not Lognormal at 5% Significance Level**											
437												
438	**Lognormal Statistics**											
439					Minimum of Logged Data	0,693					Mean of logged Data	0,979
440					Maximum of Logged Data	3,367					SD of logged Data	0,841
441												
442	**Assuming Lognormal Distribution**											
443					95% H-UCL	8,283					90% Chebyshev (MVUE) UCL	6,638
444					95% Chebyshev (MVUE) UCL	8,002					97,5% Chebyshev (MVUE) UCL	9,894
445					99% Chebyshev (MVUE) UCL	13,61						
446												
447	**Nonparametric Distribution Free UCL Statistics**											
448	**Data do not follow a Discernible Distribution (0.05)**											
449												
450	**Nonparametric Distribution Free UCLs**											

	A	B	C	D	E	F	G	H	I	J	K	L
451					95% CLT UCL	9,174					95% Jackknife UCL	9,682
452					95% Standard Bootstrap UCL	N/A					95% Bootstrap-t UCL	N/A
453					95% Hall's Bootstrap UCL	N/A					95% Percentile Bootstrap UCL	N/A
454					95% BCA Bootstrap UCL	N/A						
455					90% Chebyshev(Mean, Sd) UCL	12,83					95% Chebyshev(Mean, Sd) UCL	16,49
456					97,5% Chebyshev(Mean, Sd) UCL	21,58					99% Chebyshev(Mean, Sd) UCL	31,56
457												
458	**Suggested UCL to Use**											
459					95% Chebyshev (Mean, Sd) UCL	16,49						
460												
461	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
462	Recommendations are based upon data size, data distribution, and skewness.											
463	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
464	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
465												
466												
467	**Vanadium - Former Contractor Village (Soil)**											
468												
469	**General Statistics**											
470					Total Number of Observations	10,00					Number of Distinct Observations	8,000
471											Number of Missing Observations	0
472					Minimum	8,600					Mean	21,99
473					Maximum	61,00					Median	15,50
474					SD	16,73					Std. Error of Mean	5,290
475					Coefficient of Variation	0,761					Skewness	1,861
476												
477	**Normal GOF Test**											
478					Shapiro Wilk Test Statistic	0,726	**Shapiro Wilk GOF Test**					
479					5% Shapiro Wilk Critical Value	0,842	Data Not Normal at 5% Significance Level					
480					Lilliefors Test Statistic	0,371	**Lilliefors GOF Test**					
481					5% Lilliefors Critical Value	0,262	Data Not Normal at 5% Significance Level					
482	**Data Not Normal at 5% Significance Level**											
483												
484	**Assuming Normal Distribution**											
485	**95% Normal UCL**						**95% UCLs (Adjusted for Skewness)**					
486					95% Student's-t UCL	31,69					95% Adjusted-CLT UCL (Chen-1995)	34,02
487											95% Modified-t UCL (Johnson-1978)	32,21
488												
489	**Gamma GOF Test**											
490					A-D Test Statistic	0,839	**Anderson-Darling Gamma GOF Test**					
491					5% A-D Critical Value	0,733	Data Not Gamma Distributed at 5% Significance Level					
492					K-S Test Statistic	0,312	**Kolmogorov-Smirnov Gamma GOF Test**					
493					5% K-S Critical Value	0,269	Data Not Gamma Distributed at 5% Significance Level					
494	**Data Not Gamma Distributed at 5% Significance Level**											
495												
496	**Gamma Statistics**											
497					k hat (MLE)	2,739					k star (bias corrected MLE)	1,984
498					Theta hat (MLE)	8,029					Theta star (bias corrected MLE)	11,09
499					nu hat (MLE)	54,77					nu star (bias corrected)	39,67
500					MLE Mean (bias corrected)	21,99					MLE Sd (bias corrected)	15,61

		Approximate Chi Square Value (0,0500)	26,24
Adjusted Level of Significance	0,0267	Adjusted Chi Square Value	24,36

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	33,24	95% Adjusted Gamma UCL (use when n<50)	35,81

Lognormal GOF Test

Shapiro Wilk Test Statistic	0,881	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0,842	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0,269	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0,262	Data Not Lognormal at 5% Significance Level	

Data appear Approximate Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	2,152	Mean of logged Data	2,897
Maximum of Logged Data	4,111	SD of logged Data	0,613

Assuming Lognormal Distribution

95% H-UCL	35,60	90% Chebyshev (MVUE) UCL	34,15
95% Chebyshev (MVUE) UCL	39,93	97,5% Chebyshev (MVUE) UCL	47,95
99% Chebyshev (MVUE) UCL	63,70		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	30,69	95% Jackknife UCL	31,69
95% Standard Bootstrap UCL	30,27	95% Bootstrap-t UCL	56,86
95% Hall's Bootstrap UCL	92,45	95% Percentile Bootstrap UCL	31,12
95% BCA Bootstrap UCL	34,03		
90% Chebyshev(Mean, Sd) UCL	37,86	95% Chebyshev(Mean, Sd) UCL	45,05
97,5% Chebyshev(Mean, Sd) UCL	55,03	99% Chebyshev(Mean, Sd) UCL	74,63

Suggested UCL to Use

95% H-UCL	35,60		

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.

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 statistician.

ProUCL computes and outputs H-statistic based UCLs for historical reasons only.

H-statistic often results in unstable (both high and low) values of UCL95 as shown in examples in the Technical Guide.

It is therefore recommended to avoid the use of H-statistic based 95% UCLs.

Use of nonparametric methods are preferred to compute UCL95 for skewed data sets which do not follow a gamma distribution.

Fraction F1 (C6-C10) - Main Complex (Soil)

General Statistics

	A	B	C	D	E	F	G	H	I	J	K	L
551					Total Number of Observations	64,00					Number of Distinct Observations	6,000
552											Number of Missing Observations	0
553					Minimum	2,500					Mean	12,61
554					Maximum	248,0					Median	2,500
555					SD	42,23					Std. Error of Mean	5,278
556					Coefficient of Variation	3,349					Skewness	4,507
557												
558						**Normal GOF Test**						
559					Shapiro Wilk Test Statistic	0,273			**Shapiro Wilk GOF Test**			
560					5% Shapiro Wilk P Value	0			Data Not Normal at 5% Significance Level			
561					Lilliefors Test Statistic	0,528			**Lilliefors GOF Test**			
562					5% Lilliefors Critical Value	0,111			Data Not Normal at 5% Significance Level			
563						**Data Not Normal at 5% Significance Level**						
564												
565						**Assuming Normal Distribution**						
566			**95% Normal UCL**						**95% UCLs (Adjusted for Skewness)**			
567					95% Student's-t UCL	21,42					95% Adjusted-CLT UCL (Chen-1995)	24,47
568											95% Modified-t UCL (Johnson-1978)	21,92
569												
570						**Gamma GOF Test**						
571					A-D Test Statistic	23,17			**Anderson-Darling Gamma GOF Test**			
572					5% A-D Critical Value	0,822			Data Not Gamma Distributed at 5% Significance Level			
573					K-S Test Statistic	0,550			**Kolmogorov-Smirnov Gamma GOF Test**			
574					5% K-S Critical Value	0,118			Data Not Gamma Distributed at 5% Significance Level			
575						**Data Not Gamma Distributed at 5% Significance Level**						
576												
577						**Gamma Statistics**						
578					k hat (MLE)	0,474					k star (bias corrected MLE)	0,463
579					Theta hat (MLE)	26,58					Theta star (bias corrected MLE)	27,26
580					nu hat (MLE)	60,73					nu star (bias corrected)	59,21
581					MLE Mean (bias corrected)	12,61					MLE Sd (bias corrected)	18,54
582											Approximate Chi Square Value (0,0500)	42,52
583					Adjusted Level of Significance	0,0463					Adjusted Chi Square Value	42,19
584												
585						**Assuming Gamma Distribution**						
586					95% Approximate Gamma UCL (use when n>=50))	17,56					95% Adjusted Gamma UCL (use when n<50)	17,70
587												
588						**Lognormal GOF Test**						
589					Shapiro Wilk Test Statistic	0,291			**Shapiro Wilk Lognormal GOF Test**			
590					5% Shapiro Wilk P Value	0			Data Not Lognormal at 5% Significance Level			
591					Lilliefors Test Statistic	0,480			**Lilliefors Lognormal GOF Test**			
592					5% Lilliefors Critical Value	0,111			Data Not Lognormal at 5% Significance Level			
593						**Data Not Lognormal at 5% Significance Level**						
594												
595						**Lognormal Statistics**						
596					Minimum of Logged Data	0,916					Mean of logged Data	1,185
597					Maximum of Logged Data	5,513					SD of logged Data	1,005
598												
599						**Assuming Lognormal Distribution**						
600					95% H-UCL	7,212					90% Chebyshev (MVUE) UCL	7,756

	A	B	C	D	E	F	G	H	I	J	K	L
601					95% Chebyshev (MVUE) UCL	8,843					97,5% Chebyshev (MVUE) UCL	10,35
602					99% Chebyshev (MVUE) UCL	13,31						
603												
604	Nonparametric Distribution Free UCL Statistics											
605	Data do not follow a Discernible Distribution (0.05)											
606												
607	Nonparametric Distribution Free UCLs											
608					95% CLT UCL	21,29					95% Jackknife UCL	21,42
609					95% Standard Bootstrap UCL	21,45					95% Bootstrap-t UCL	37,83
610					95% Hall's Bootstrap UCL	24,17					95% Percentile Bootstrap UCL	22,27
611					95% BCA Bootstrap UCL	25,64						
612					90% Chebyshev(Mean, Sd) UCL	28,44					95% Chebyshev(Mean, Sd) UCL	35,62
613					97,5% Chebyshev(Mean, Sd) UCL	45,57					99% Chebyshev(Mean, Sd) UCL	65,13
614												
615	Suggested UCL to Use											
616					95% Chebyshev (Mean, Sd) UCL	35,62						
617												
618	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
619	Recommendations are based upon data size, data distribution, and skewness.											
620	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
621	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
622												
623												
624	Fraction F2 (>C10-C16) - Main Complex (Soil)											
625												
626	General Statistics											
627					Total Number of Observations	64,00					Number of Distinct Observations	20,00
628											Number of Missing Observations	0
629					Minimum	10,00					Mean	465,5
630					Maximum	12500					Median	10,00
631					SD	1959					Std. Error of Mean	244,9
632					Coefficient of Variation	4,209					Skewness	5,079
633												
634	Normal GOF Test											
635					Shapiro Wilk Test Statistic	0,269	Shapiro Wilk GOF Test					
636					5% Shapiro Wilk P Value	0	Data Not Normal at 5% Significance Level					
637					Lilliefors Test Statistic	0,466	Lilliefors GOF Test					
638					5% Lilliefors Critical Value	0,111	Data Not Normal at 5% Significance Level					
639	Data Not Normal at 5% Significance Level											
640												
641	Assuming Normal Distribution											
642	95% Normal UCL						95% UCLs (Adjusted for Skewness)					
643					95% Student's-t UCL	874,3					95% Adjusted-CLT UCL (Chen-1995)	1034
644											95% Modified-t UCL (Johnson-1978)	900,2
645												
646	Gamma GOF Test											
647					A-D Test Statistic	18,13	Anderson-Darling Gamma GOF Test					
648					5% A-D Critical Value	0,898	Data Not Gamma Distributed at 5% Significance Level					
649					K-S Test Statistic	0,454	Kolmogorov-Smirnov Gamma GOF Test					
650					5% K-S Critical Value	0,123	Data Not Gamma Distributed at 5% Significance Level					

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0,233	k star (bias corrected MLE)	0,232
Theta hat (MLE)	2000	Theta star (bias corrected MLE)	2004
nu hat (MLE)	29,79	nu star (bias corrected)	29,73
MLE Mean (bias corrected)	465,5	MLE Sd (bias corrected)	965,9
		Approximate Chi Square Value (0,0500)	18,28
Adjusted Level of Significance	0,0463	Adjusted Chi Square Value	18,07

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	757,0	95% Adjusted Gamma UCL (use when n<50)	765,7

Lognormal GOF Test

Shapiro Wilk Test Statistic	0,514	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk P Value	0	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0,327	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0,111	Data Not Lognormal at 5% Significance Level

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	2,303	Mean of logged Data	3,056
Maximum of Logged Data	9,433	SD of logged Data	1,682

Assuming Lognormal Distribution

95% H-UCL	153,8	90% Chebyshev (MVUE) UCL	157,1
95% Chebyshev (MVUE) UCL	190,6	97,5% Chebyshev (MVUE) UCL	237,1
99% Chebyshev (MVUE) UCL	328,4		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	868,3	95% Jackknife UCL	874,3
95% Standard Bootstrap UCL	862,3	95% Bootstrap-t UCL	1590
95% Hall's Bootstrap UCL	1108	95% Percentile Bootstrap UCL	931,1
95% BCA Bootstrap UCL	1117		
90% Chebyshev(Mean, Sd) UCL	1200	95% Chebyshev(Mean, Sd) UCL	1533
97,5% Chebyshev(Mean, Sd) UCL	1995	99% Chebyshev(Mean, Sd) UCL	2902

Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL	1533		

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.

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 statistician.

Fraction F3 (>C16-C34) - Main Complex (Soil)

701				
702	**General Statistics**			
703	Total Number of Observations	64,00	Number of Distinct Observations	49,00
704			Number of Missing Observations	0
705	Minimum	15,00	Mean	614,5
706	Maximum	27000	Median	47,50
707	SD	3371	Std. Error of Mean	421,3
708	Coefficient of Variation	5,485	Skewness	7,857
709				
710	**Normal GOF Test**			
711	Shapiro Wilk Test Statistic	0,178	**Shapiro Wilk GOF Test**	
712	5% Shapiro Wilk P Value	0	Data Not Normal at 5% Significance Level	
713	Lilliefors Test Statistic	0,429	**Lilliefors GOF Test**	
714	5% Lilliefors Critical Value	0,111	Data Not Normal at 5% Significance Level	
715	**Data Not Normal at 5% Significance Level**			
716				
717	**Assuming Normal Distribution**			
718	**95% Normal UCL**		**95% UCLs (Adjusted for Skewness)**	
719	95% Student's-t UCL	1318	95% Adjusted-CLT UCL (Chen-1995)	1750
720			95% Modified-t UCL (Johnson-1978)	1387
721				
722	**Gamma GOF Test**			
723	A-D Test Statistic	9,494	**Anderson-Darling Gamma GOF Test**	
724	5% A-D Critical Value	0,856	Data Not Gamma Distributed at 5% Significance Level	
725	K-S Test Statistic	0,263	**Kolmogorov-Smirnov Gamma GOF Test**	
726	5% K-S Critical Value	0,120	Data Not Gamma Distributed at 5% Significance Level	
727	**Data Not Gamma Distributed at 5% Significance Level**			
728				
729	**Gamma Statistics**			
730	k hat (MLE)	0,333	k star (bias corrected MLE)	0,327
731	Theta hat (MLE)	1848	Theta star (bias corrected MLE)	1877
732	nu hat (MLE)	42,56	nu star (bias corrected)	41,90
733	MLE Mean (bias corrected)	614,5	MLE Sd (bias corrected)	1074
734			Approximate Chi Square Value (0,0500)	28,06
735	Adjusted Level of Significance	0,0463	Adjusted Chi Square Value	27,80
736				
737	**Assuming Gamma Distribution**			
738	95% Approximate Gamma UCL (use when n>=50))	917,5	95% Adjusted Gamma UCL (use when n<50)	926,1
739				
740	**Lognormal GOF Test**			
741	Shapiro Wilk Test Statistic	0,846	**Shapiro Wilk Lognormal GOF Test**	
742	5% Shapiro Wilk P Value	7,3076E-9	Data Not Lognormal at 5% Significance Level	
743	Lilliefors Test Statistic	0,171	**Lilliefors Lognormal GOF Test**	
744	5% Lilliefors Critical Value	0,111	Data Not Lognormal at 5% Significance Level	
745	**Data Not Lognormal at 5% Significance Level**			
746				
747	**Lognormal Statistics**			
748	Minimum of Logged Data	2,708	Mean of logged Data	4,382
749	Maximum of Logged Data	10,20	SD of logged Data	1,472
750				

	A–E	F	G–K	L
751	**Assuming Lognormal Distribution**			
752	95% H-UCL	370,0	90% Chebyshev (MVUE) UCL	397,7
753	95% Chebyshev (MVUE) UCL	474,4	97,5% Chebyshev (MVUE) UCL	580,9
754	99% Chebyshev (MVUE) UCL	789,9		
755				
756	**Nonparametric Distribution Free UCL Statistics**			
757	**Data do not follow a Discernible Distribution (0.05)**			
758				
759	**Nonparametric Distribution Free UCLs**			
760	95% CLT UCL	1307	95% Jackknife UCL	1318
761	95% Standard Bootstrap UCL	1315	95% Bootstrap-t UCL	6494
762	95% Hall's Bootstrap UCL	4142	95% Percentile Bootstrap UCL	1443
763	95% BCA Bootstrap UCL	2267		
764	90% Chebyshev(Mean, Sd) UCL	1878	95% Chebyshev(Mean, Sd) UCL	2451
765	97,5% Chebyshev(Mean, Sd) UCL	3246	99% Chebyshev(Mean, Sd) UCL	4807
766				
767	**Suggested UCL to Use**			
768	95% Chebyshev (Mean, Sd) UCL	2451		
769				
770	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
771	Recommendations are based upon data size, data distribution, and skewness.			
772	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
773	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
774				
775				
776	**Total Modified TPH - Main Complex (Soil)**			
777				
778	**General Statistics**			
779	Total Number of Observations	64,00	Number of Distinct Observations	47,00
780			Number of Missing Observations	0
781	Minimum	15,00	Mean	1069
782	Maximum	27000	Median	47,50
783	SD	4037	Std. Error of Mean	504,7
784	Coefficient of Variation	3,778	Skewness	5,198
785				
786	**Normal GOF Test**			
787	Shapiro Wilk Test Statistic	0,302	**Shapiro Wilk GOF Test**	
788	5% Shapiro Wilk P Value	0	Data Not Normal at 5% Significance Level	
789	Lilliefors Test Statistic	0,450	**Lilliefors GOF Test**	
790	5% Lilliefors Critical Value	0,111	Data Not Normal at 5% Significance Level	
791	**Data Not Normal at 5% Significance Level**			
792				
793	**Assuming Normal Distribution**			
794	**95% Normal UCL**		**95% UCLs (Adjusted for Skewness)**	
795	95% Student's-t UCL	1911	95% Adjusted-CLT UCL (Chen-1995)	2249
796			95% Modified-t UCL (Johnson-1978)	1966
797				
798	**Gamma GOF Test**			
799	A-D Test Statistic	9,393	**Anderson-Darling Gamma GOF Test**	
800	5% A-D Critical Value	0,876	Data Not Gamma Distributed at 5% Significance Level	

	A–E	F	G–K	L
801	K-S Test Statistic	0,266	**Kolmogorov-Smirnov Gamma GOF Test**	
802	5% K-S Critical Value	0,122	Data Not Gamma Distributed at 5% Significance Level	
803	**Data Not Gamma Distributed at 5% Significance Level**			
804				
805	**Gamma Statistics**			
806	k hat (MLE)	0,277	k star (bias corrected MLE)	0,274
807	Theta hat (MLE)	3862	Theta star (bias corrected MLE)	3898
808	nu hat (MLE)	35,42	nu star (bias corrected)	35,09
809	MLE Mean (bias corrected)	1069	MLE Sd (bias corrected)	2041
810			Approximate Chi Square Value (0,0500)	22,54
811	Adjusted Level of Significance	0,0463	Adjusted Chi Square Value	22,31
812				
813	**Assuming Gamma Distribution**			
814	95% Approximate Gamma UCL (use when n>=50))	1664	95% Adjusted Gamma UCL (use when n<50)	1681
815				
816	**Lognormal GOF Test**			
817	Shapiro Wilk Test Statistic	0,841	**Shapiro Wilk Lognormal GOF Test**	
818	5% Shapiro Wilk P Value	3,8330E-9	Data Not Lognormal at 5% Significance Level	
819	Lilliefors Test Statistic	0,171	**Lilliefors Lognormal GOF Test**	
820	5% Lilliefors Critical Value	0,111	Data Not Lognormal at 5% Significance Level	
821	**Data Not Lognormal at 5% Significance Level**			
822				
823	**Lognormal Statistics**			
824	Minimum of Logged Data	2,708	Mean of logged Data	4,449
825	Maximum of Logged Data	10,20	SD of logged Data	1,835
826				
827	**Assuming Lognormal Distribution**			
828	95% H-UCL	891,8	90% Chebyshev (MVUE) UCL	865,2
829	95% Chebyshev (MVUE) UCL	1062	97,5% Chebyshev (MVUE) UCL	1334
830	99% Chebyshev (MVUE) UCL	1870		
831				
832	**Nonparametric Distribution Free UCL Statistics**			
833	**Data do not follow a Discernible Distribution (0.05)**			
834				
835	**Nonparametric Distribution Free UCLs**			
836	95% CLT UCL	1899	95% Jackknife UCL	1911
837	95% Standard Bootstrap UCL	1867	95% Bootstrap-t UCL	3475
838	95% Hall's Bootstrap UCL	3930	95% Percentile Bootstrap UCL	1987
839	95% BCA Bootstrap UCL	2410		
840	90% Chebyshev(Mean, Sd) UCL	2583	95% Chebyshev(Mean, Sd) UCL	3268
841	97,5% Chebyshev(Mean, Sd) UCL	4220	99% Chebyshev(Mean, Sd) UCL	6090
842				
843	**Suggested UCL to Use**			
844	95% Chebyshev (Mean, Sd) UCL	3268		
845				
846	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
847	Recommendations are based upon data size, data distribution, and skewness.			
848	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
849	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
850				

851				
852	Anthracene - Main Complex (Soil)			
853				
854	**General Statistics**			
855	Total Number of Observations	63,00	Number of Distinct Observations	24,00
856			Number of Missing Observations	3,000
857	Minimum	0,0100	Mean	0,241
858	Maximum	5,600	Median	0,0300
859	SD	0,898	Std. Error of Mean	0,113
860	Coefficient of Variation	3,728	Skewness	5,372
861				
862	**Normal GOF Test**			
863	Shapiro Wilk Test Statistic	0,267	**Shapiro Wilk GOF Test**	
864	5% Shapiro Wilk P Value	0	Data Not Normal at 5% Significance Level	
865	Lilliefors Test Statistic	0,427	**Lilliefors GOF Test**	
866	5% Lilliefors Critical Value	0,111	Data Not Normal at 5% Significance Level	
867	**Data Not Normal at 5% Significance Level**			
868				
869	**Assuming Normal Distribution**			
870	**95% Normal UCL**		**95% UCLs (Adjusted for Skewness)**	
871	95% Student's-t UCL	0,430	95% Adjusted-CLT UCL (Chen-1995)	0,509
872			95% Modified-t UCL (Johnson-1978)	0,443
873				
874	**Gamma GOF Test**			
875	A-D Test Statistic	9,737	**Anderson-Darling Gamma GOF Test**	
876	5% A-D Critical Value	0,837	Data Not Gamma Distributed at 5% Significance Level	
877	K-S Test Statistic	0,307	**Kolmogorov-Smirnov Gamma GOF Test**	
878	5% K-S Critical Value	0,120	Data Not Gamma Distributed at 5% Significance Level	
879	**Data Not Gamma Distributed at 5% Significance Level**			
880				
881	**Gamma Statistics**			
882	k hat (MLE)	0,411	k star (bias corrected MLE)	0,402
883	Theta hat (MLE)	0,586	Theta star (bias corrected MLE)	0,599
884	nu hat (MLE)	51,83	nu star (bias corrected)	50,70
885	MLE Mean (bias corrected)	0,241	MLE Sd (bias corrected)	0,380
886			Approximate Chi Square Value (0,0500)	35,35
887	Adjusted Level of Significance	0,0462	Adjusted Chi Square Value	35,05
888				
889	**Assuming Gamma Distribution**			
890	95% Approximate Gamma UCL (use when n>=50))	0,346	95% Adjusted Gamma UCL (use when n<50)	0,349
891				
892	**Lognormal GOF Test**			
893	Shapiro Wilk Test Statistic	0,832	**Shapiro Wilk Lognormal GOF Test**	
894	5% Shapiro Wilk P Value	1,5884E-9	Data Not Lognormal at 5% Significance Level	
895	Lilliefors Test Statistic	0,231	**Lilliefors Lognormal GOF Test**	
896	5% Lilliefors Critical Value	0,111	Data Not Lognormal at 5% Significance Level	
897	**Data Not Lognormal at 5% Significance Level**			
898				
899	**Lognormal Statistics**			
900	Minimum of Logged Data	-4,605	Mean of logged Data	-3,016

	A	B	C	D	E	F	G	H	I	J	K	L
901					Maximum of Logged Data	1,723					SD of logged Data	1,329
902												
903	**Assuming Lognormal Distribution**											
904					95% H-UCL	0,174					90% Chebyshev (MVUE) UCL	0,191
905					95% Chebyshev (MVUE) UCL	0,225					97,5% Chebyshev (MVUE) UCL	0,272
906					99% Chebyshev (MVUE) UCL	0,365						
907												
908	**Nonparametric Distribution Free UCL Statistics**											
909	**Data do not follow a Discernible Distribution (0.05)**											
910												
911	**Nonparametric Distribution Free UCLs**											
912					95% CLT UCL	0,427					95% Jackknife UCL	0,430
913					95% Standard Bootstrap UCL	0,428					95% Bootstrap-t UCL	1,467
914					95% Hall's Bootstrap UCL	1,259					95% Percentile Bootstrap UCL	0,441
915					95% BCA Bootstrap UCL	0,510						
916					90% Chebyshev(Mean, Sd) UCL	0,580					95% Chebyshev(Mean, Sd) UCL	0,734
917					97,5% Chebyshev(Mean, Sd) UCL	0,948					99% Chebyshev(Mean, Sd) UCL	1,367
918												
919	**Suggested UCL to Use**											
920					95% Chebyshev (Mean, Sd) UCL	0,734						
921												
922	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
923	Recommendations are based upon data size, data distribution, and skewness.											
924	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
925	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
926												
927												
928	**Benzo(a)anthracene - Main Complex (Soil)**											
929												
930	**General Statistics**											
931					Total Number of Observations	63,00					Number of Distinct Observations	31,00
932											Number of Missing Observations	3,000
933					Minimum	0,0100					Mean	0,537
934					Maximum	9,370					Median	0,0300
935					SD	1,706					Std. Error of Mean	0,215
936					Coefficient of Variation	3,178					Skewness	4,541
937												
938	**Normal GOF Test**											
939					Shapiro Wilk Test Statistic	0,346	**Shapiro Wilk GOF Test**					
940					5% Shapiro Wilk P Value	0	Data Not Normal at 5% Significance Level					
941					Lilliefors Test Statistic	0,416	**Lilliefors GOF Test**					
942					5% Lilliefors Critical Value	0,111	Data Not Normal at 5% Significance Level					
943	**Data Not Normal at 5% Significance Level**											
944												
945	**Assuming Normal Distribution**											
946	**95% Normal UCL**						**95% UCLs (Adjusted for Skewness)**					
947					95% Student's-t UCL	0,895					95% Adjusted-CLT UCL (Chen-1995)	1,021
948											95% Modified-t UCL (Johnson-1978)	0,916
949												
950	**Gamma GOF Test**											

	A	B	C	D	E	F	G	H	I	J	K	L
951					A-D Test Statistic	7,166	**Anderson-Darling Gamma GOF Test**					
952					5% A-D Critical Value	0,863	Data Not Gamma Distributed at 5% Significance Level					
953					K-S Test Statistic	0,232	**Kolmogorov-Smirnov Gamma GOF Test**					
954					5% K-S Critical Value	0,122	Data Not Gamma Distributed at 5% Significance Level					
955	**Data Not Gamma Distributed at 5% Significance Level**											
956												
957	**Gamma Statistics**											
958					k hat (MLE)	0,303					k star (bias corrected MLE)	0,299
959					Theta hat (MLE)	1,771					Theta star (bias corrected MLE)	1,793
960					nu hat (MLE)	38,19					nu star (bias corrected)	37,70
961					MLE Mean (bias corrected)	0,537					MLE Sd (bias corrected)	0,981
962											Approximate Chi Square Value (0,0500)	24,64
963					Adjusted Level of Significance	0,0462					Adjusted Chi Square Value	24,40
964												
965	**Assuming Gamma Distribution**											
966					95% Approximate Gamma UCL (use when n>=50))	0,821					95% Adjusted Gamma UCL (use when n<50)	0,829
967												
968	**Lognormal GOF Test**											
969					Shapiro Wilk Test Statistic	0,823	**Shapiro Wilk Lognormal GOF Test**					
970					5% Shapiro Wilk P Value	4,930E-10	Data Not Lognormal at 5% Significance Level					
971					Lilliefors Test Statistic	0,224	**Lilliefors Lognormal GOF Test**					
972					5% Lilliefors Critical Value	0,111	Data Not Lognormal at 5% Significance Level					
973	**Data Not Lognormal at 5% Significance Level**											
974												
975	**Lognormal Statistics**											
976					Minimum of Logged Data	-4,605					Mean of logged Data	-2,894
977					Maximum of Logged Data	2,238					SD of logged Data	1,937
978												
979	**Assuming Lognormal Distribution**											
980					95% H-UCL	0,757					90% Chebyshev (MVUE) UCL	0,697
981					95% Chebyshev (MVUE) UCL	0,862					97,5% Chebyshev (MVUE) UCL	1,091
982					99% Chebyshev (MVUE) UCL	1,540						
983												
984	**Nonparametric Distribution Free UCL Statistics**											
985	**Data do not follow a Discernible Distribution (0.05)**											
986												
987	**Nonparametric Distribution Free UCLs**											
988					95% CLT UCL	0,890					95% Jackknife UCL	0,895
989					95% Standard Bootstrap UCL	0,894					95% Bootstrap-t UCL	1,441
990					95% Hall's Bootstrap UCL	2,106					95% Percentile Bootstrap UCL	0,922
991					95% BCA Bootstrap UCL	1,072						
992					90% Chebyshev(Mean, Sd) UCL	1,181					95% Chebyshev(Mean, Sd) UCL	1,473
993					97,5% Chebyshev(Mean, Sd) UCL	1,879					99% Chebyshev(Mean, Sd) UCL	2,675
994												
995	**Suggested UCL to Use**											
996					95% Chebyshev (Mean, Sd) UCL	1,473						
997												
998	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
999	Recommendations are based upon data size, data distribution, and skewness.											
1000	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 statistician.

Benzo(a)pyrene - Main Complex (Soil)

General Statistics			
Total Number of Observations	63,00	Number of Distinct Observations	26,00
		Number of Missing Observations	3,000
Minimum	0,0100	Mean	0,371
Maximum	6,900	Median	0,0200
SD	1,148	Std. Error of Mean	0,145
Coefficient of Variation	3,096	Skewness	4,567

Normal GOF Test		
Shapiro Wilk Test Statistic	0,361	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0,408	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0,111	Data Not Normal at 5% Significance Level
Data Not Normal at 5% Significance Level		

Assuming Normal Distribution			
95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	0,612	95% Adjusted-CLT UCL (Chen-1995)	0,697
		95% Modified-t UCL (Johnson-1978)	0,626

Gamma GOF Test		
A-D Test Statistic	7,843	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0,859	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0,249	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0,121	Data Not Gamma Distributed at 5% Significance Level
Data Not Gamma Distributed at 5% Significance Level		

Gamma Statistics			
k hat (MLE)	0,321	k star (bias corrected MLE)	0,316
Theta hat (MLE)	1,155	Theta star (bias corrected MLE)	1,172
nu hat (MLE)	40,44	nu star (bias corrected)	39,85
MLE Mean (bias corrected)	0,371	MLE Sd (bias corrected)	0,659
		Approximate Chi Square Value (0,0500)	26,38
Adjusted Level of Significance	0,0462	Adjusted Chi Square Value	26,13

Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	0,560	95% Adjusted Gamma UCL (use when n<50)	0,565

Lognormal GOF Test		
Shapiro Wilk Test Statistic	0,786	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk P Value	3,808E-12	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0,282	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0,111	Data Not Lognormal at 5% Significance Level
Data Not Lognormal at 5% Significance Level		

	A	B	C	D	E	F	G	H	I	J	K	L
1051	**Lognormal Statistics**											
1052					Minimum of Logged Data	-4,605					Mean of logged Data	-3,117
1053					Maximum of Logged Data	1,932					SD of logged Data	1,844
1054												
1055	**Assuming Lognormal Distribution**											
1056					95% H-UCL	0,477					90% Chebyshev (MVUE) UCL	0,457
1057					95% Chebyshev (MVUE) UCL	0,562					97,5% Chebyshev (MVUE) UCL	0,707
1058					99% Chebyshev (MVUE) UCL	0,992						
1059												
1060	**Nonparametric Distribution Free UCL Statistics**											
1061	**Data do not follow a Discernible Distribution (0.05)**											
1062												
1063	**Nonparametric Distribution Free UCLs**											
1064					95% CLT UCL	0,609					95% Jackknife UCL	0,612
1065					95% Standard Bootstrap UCL	0,600					95% Bootstrap-t UCL	0,897
1066					95% Hall's Bootstrap UCL	1,380					95% Percentile Bootstrap UCL	0,626
1067					95% BCA Bootstrap UCL	0,728						
1068					90% Chebyshev(Mean, Sd) UCL	0,804					95% Chebyshev(Mean, Sd) UCL	1,001
1069					97,5% Chebyshev(Mean, Sd) UCL	1,274					99% Chebyshev(Mean, Sd) UCL	1,809
1070												
1071	**Suggested UCL to Use**											
1072					95% Chebyshev (Mean, Sd) UCL	1,001						
1073												
1074	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
1075	Recommendations are based upon data size, data distribution, and skewness.											
1076	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
1077	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
1078												
1079												
1080	**Benzo(a)fluoranthene - Main Complex (Soil)**											
1081												
1082	**General Statistics**											
1083					Total Number of Observations	63,00					Number of Distinct Observations	24,00
1084											Number of Missing Observations	3,000
1085					Minimum	0,0100					Mean	0,336
1086					Maximum	5,700					Median	0,0500
1087					SD	0,988					Std. Error of Mean	0,125
1088					Coefficient of Variation	2,938					Skewness	4,378
1089												
1090	**Normal GOF Test**											
1091					Shapiro Wilk Test Statistic	0,353	**Shapiro Wilk GOF Test**					
1092					5% Shapiro Wilk P Value	0	Data Not Normal at 5% Significance Level					
1093					Lilliefors Test Statistic	0,407	**Lilliefors GOF Test**					
1094					5% Lilliefors Critical Value	0,111	Data Not Normal at 5% Significance Level					
1095	**Data Not Normal at 5% Significance Level**											
1096												
1097	**Assuming Normal Distribution**											
1098	**95% Normal UCL**						**95% UCLs (Adjusted for Skewness)**					
1099					95% Student's-t UCL	0,544					95% Adjusted-CLT UCL (Chen-1995)	0,615
1100											95% Modified-t UCL (Johnson-1978)	0,556

	A–E	F	G–K	L
1101				
1102	**Gamma GOF Test**			
1103	A-D Test Statistic	8,711	**Anderson-Darling Gamma GOF Test**	
1104	5% A-D Critical Value	0,831	Data Not Gamma Distributed at 5% Significance Level	
1105	K-S Test Statistic	0,317	**Kolmogorov-Smirnov Gamma GOF Test**	
1106	5% K-S Critical Value	0,120	Data Not Gamma Distributed at 5% Significance Level	
1107	**Data Not Gamma Distributed at 5% Significance Level**			
1108				
1109	**Gamma Statistics**			
1110	k hat (MLE)	0,438	k star (bias corrected MLE)	0,428
1111	Theta hat (MLE)	0,767	Theta star (bias corrected MLE)	0,786
1112	nu hat (MLE)	55,25	nu star (bias corrected)	53,95
1113	MLE Mean (bias corrected)	0,336	MLE Sd (bias corrected)	0,514
1114			Approximate Chi Square Value (0,0500)	38,07
1115	Adjusted Level of Significance	0,0462	Adjusted Chi Square Value	37,76
1116				
1117	**Assuming Gamma Distribution**			
1118	95% Approximate Gamma UCL (use when n>=50))	0,477	95% Adjusted Gamma UCL (use when n<50)	0,481
1119				
1120	**Lognormal GOF Test**			
1121	Shapiro Wilk Test Statistic	0,840	**Shapiro Wilk Lognormal GOF Test**	
1122	5% Shapiro Wilk P Value	4,6974E-9	Data Not Lognormal at 5% Significance Level	
1123	Lilliefors Test Statistic	0,269	**Lilliefors Lognormal GOF Test**	
1124	5% Lilliefors Critical Value	0,111	Data Not Lognormal at 5% Significance Level	
1125	**Data Not Lognormal at 5% Significance Level**			
1126				
1127	**Lognormal Statistics**			
1128	Minimum of Logged Data	-4,605	Mean of logged Data	-2,568
1129	Maximum of Logged Data	1,740	SD of logged Data	1,422
1130				
1131	**Assuming Lognormal Distribution**			
1132	95% H-UCL	0,324	90% Chebyshev (MVUE) UCL	0,350
1133	95% Chebyshev (MVUE) UCL	0,416	97,5% Chebyshev (MVUE) UCL	0,507
1134	99% Chebyshev (MVUE) UCL	0,687		
1135				
1136	**Nonparametric Distribution Free UCL Statistics**			
1137	**Data do not follow a Discernible Distribution (0.05)**			
1138				
1139	**Nonparametric Distribution Free UCLs**			
1140	95% CLT UCL	0,541	95% Jackknife UCL	0,544
1141	95% Standard Bootstrap UCL	0,539	95% Bootstrap-t UCL	0,819
1142	95% Hall's Bootstrap UCL	0,623	95% Percentile Bootstrap UCL	0,579
1143	95% BCA Bootstrap UCL	0,629		
1144	90% Chebyshev(Mean, Sd) UCL	0,710	95% Chebyshev(Mean, Sd) UCL	0,879
1145	97,5% Chebyshev(Mean, Sd) UCL	1,114	99% Chebyshev(Mean, Sd) UCL	1,575
1146				
1147	**Suggested UCL to Use**			
1148	95% Chebyshev (Mean, Sd) UCL	0,879		
1149				
1150	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			

1151	Recommendations are based upon data size, data distribution, and skewness.			
1152	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
1153	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
1154				
1155				
1156	**Chrysene - Main Complex (Soil)**			
1157				
1158	**General Statistics**			
1159	Total Number of Observations	63,00	Number of Distinct Observations	30,00
1160			Number of Missing Observations	3,000
1161	Minimum	0,0100	Mean	0,554
1162	Maximum	9,100	Median	0,0400
1163	SD	1,659	Std. Error of Mean	0,209
1164	Coefficient of Variation	2,996	Skewness	4,495
1165				
1166	**Normal GOF Test**			
1167	Shapiro Wilk Test Statistic	0,364	**Shapiro Wilk GOF Test**	
1168	5% Shapiro Wilk P Value	0	Data Not Normal at 5% Significance Level	
1169	Lilliefors Test Statistic	0,408	**Lilliefors GOF Test**	
1170	5% Lilliefors Critical Value	0,111	Data Not Normal at 5% Significance Level	
1171	**Data Not Normal at 5% Significance Level**			
1172				
1173	**Assuming Normal Distribution**			
1174	**95% Normal UCL**		**95% UCLs (Adjusted for Skewness)**	
1175	95% Student's-t UCL	0,903	95% Adjusted-CLT UCL (Chen-1995)	1,024
1176			95% Modified-t UCL (Johnson-1978)	0,922
1177				
1178	**Gamma GOF Test**			
1179	A-D Test Statistic	5,920	**Anderson-Darling Gamma GOF Test**	
1180	5% A-D Critical Value	0,860	Data Not Gamma Distributed at 5% Significance Level	
1181	K-S Test Statistic	0,217	**Kolmogorov-Smirnov Gamma GOF Test**	
1182	5% K-S Critical Value	0,122	Data Not Gamma Distributed at 5% Significance Level	
1183	**Data Not Gamma Distributed at 5% Significance Level**			
1184				
1185	**Gamma Statistics**			
1186	k hat (MLE)	0,317	k star (bias corrected MLE)	0,313
1187	Theta hat (MLE)	1,745	Theta star (bias corrected MLE)	1,770
1188	nu hat (MLE)	39,99	nu star (bias corrected)	39,41
1189	MLE Mean (bias corrected)	0,554	MLE Sd (bias corrected)	0,990
1190			Approximate Chi Square Value (0,0500)	26,03
1191	Adjusted Level of Significance	0,0462	Adjusted Chi Square Value	25,78
1192				
1193	**Assuming Gamma Distribution**			
1194	95% Approximate Gamma UCL (use when n>=50))	0,838	95% Adjusted Gamma UCL (use when n<50)	0,847
1195				
1196	**Lognormal GOF Test**			
1197	Shapiro Wilk Test Statistic	0,840	**Shapiro Wilk Lognormal GOF Test**	
1198	5% Shapiro Wilk P Value	4,6445E-9	Data Not Lognormal at 5% Significance Level	
1199	Lilliefors Test Statistic	0,224	**Lilliefors Lognormal GOF Test**	
1200	5% Lilliefors Critical Value	0,111	Data Not Lognormal at 5% Significance Level	

	A–E	F	G–K	L
1201	**Data Not Lognormal at 5% Significance Level**			
1202				
1203	**Lognormal Statistics**			
1204	Minimum of Logged Data	-4,605	Mean of logged Data	-2,744
1205	Maximum of Logged Data	2,208	SD of logged Data	1,977
1206				
1207	**Assuming Lognormal Distribution**			
1208	95% H-UCL	0,977	90% Chebyshev (MVUE) UCL	0,884
1209	95% Chebyshev (MVUE) UCL	1,095	97,5% Chebyshev (MVUE) UCL	1,389
1210	99% Chebyshev (MVUE) UCL	1,965		
1211				
1212	**Nonparametric Distribution Free UCL Statistics**			
1213	**Data do not follow a Discernible Distribution (0.05)**			
1214				
1215	**Nonparametric Distribution Free UCLs**			
1216	95% CLT UCL	0,897	95% Jackknife UCL	0,903
1217	95% Standard Bootstrap UCL	0,895	95% Bootstrap-t UCL	1,544
1218	95% Hall's Bootstrap UCL	2,194	95% Percentile Bootstrap UCL	0,929
1219	95% BCA Bootstrap UCL	1,082		
1220	90% Chebyshev(Mean, Sd) UCL	1,181	95% Chebyshev(Mean, Sd) UCL	1,465
1221	97,5% Chebyshev(Mean, Sd) UCL	1,859	99% Chebyshev(Mean, Sd) UCL	2,633
1222				
1223	**Suggested UCL to Use**			
1224	95% Chebyshev (Mean, Sd) UCL	1,465		
1225				
1226	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
1227	Recommendations are based upon data size, data distribution, and skewness.			
1228	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
1229	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
1230				
1231				
1232	**Dibenzo(a,h)anthracene - Main Complex (Soil)**			
1233				
1234	**General Statistics**			
1235	Total Number of Observations	63,00	Number of Distinct Observations	24,00
1236			Number of Missing Observations	3,000
1237	Minimum	0,00600	Mean	0,116
1238	Maximum	2,220	Median	0,0100
1239	SD	0,400	Std. Error of Mean	0,0504
1240	Coefficient of Variation	3,437	Skewness	4,369
1241				
1242	**Normal GOF Test**			
1243	Shapiro Wilk Test Statistic	0,313	**Shapiro Wilk GOF Test**	
1244	5% Shapiro Wilk P Value	0	Data Not Normal at 5% Significance Level	
1245	Lilliefors Test Statistic	0,451	**Lilliefors GOF Test**	
1246	5% Lilliefors Critical Value	0,111	Data Not Normal at 5% Significance Level	
1247	**Data Not Normal at 5% Significance Level**			
1248				
1249	**Assuming Normal Distribution**			
1250	**95% Normal UCL**		**95% UCLs (Adjusted for Skewness)**	

	A	B	C	D	E	F	G	H	I	J	K	L
1251	95% Student's-t UCL					0,200	95% Adjusted-CLT UCL (Chen-1995)					0,229
1252							95% Modified-t UCL (Johnson-1978)					0,205
1253												
1254	**Gamma GOF Test**											
1255	A-D Test Statistic					12,67	**Anderson-Darling Gamma GOF Test**					
1256	5% A-D Critical Value					0,854	Data Not Gamma Distributed at 5% Significance Level					
1257	K-S Test Statistic					0,337	**Kolmogorov-Smirnov Gamma GOF Test**					
1258	5% K-S Critical Value					0,121	Data Not Gamma Distributed at 5% Significance Level					
1259	**Data Not Gamma Distributed at 5% Significance Level**											
1260												
1261	**Gamma Statistics**											
1262	k hat (MLE)					0,340	k star (bias corrected MLE)					0,335
1263	Theta hat (MLE)					0,342	Theta star (bias corrected MLE)					0,348
1264	nu hat (MLE)					42,88	nu star (bias corrected)					42,17
1265	MLE Mean (bias corrected)					0,116	MLE Sd (bias corrected)					0,201
1266							Approximate Chi Square Value (0,0500)					28,29
1267	Adjusted Level of Significance					0,0462	Adjusted Chi Square Value					28,02
1268												
1269	**Assuming Gamma Distribution**											
1270	95% Approximate Gamma UCL (use when n>=50))					0,173	95% Adjusted Gamma UCL (use when n<50)					0,175
1271												
1272	**Lognormal GOF Test**											
1273	Shapiro Wilk Test Statistic					0,693	**Shapiro Wilk Lognormal GOF Test**					
1274	5% Shapiro Wilk P Value					0	Data Not Lognormal at 5% Significance Level					
1275	Lilliefors Test Statistic					0,283	**Lilliefors Lognormal GOF Test**					
1276	5% Lilliefors Critical Value					0,111	Data Not Lognormal at 5% Significance Level					
1277	**Data Not Lognormal at 5% Significance Level**											
1278												
1279	**Lognormal Statistics**											
1280	Minimum of Logged Data					-5,116	Mean of logged Data					-4,136
1281	Maximum of Logged Data					0,798	SD of logged Data					1,463
1282												
1283	**Assuming Lognormal Distribution**											
1284	95% H-UCL					0,0732	90% Chebyshev (MVUE) UCL					0,0784
1285	95% Chebyshev (MVUE) UCL					0,0935	97,5% Chebyshev (MVUE) UCL					0,115
1286	99% Chebyshev (MVUE) UCL					0,156						
1287												
1288	**Nonparametric Distribution Free UCL Statistics**											
1289	**Data do not follow a Discernible Distribution (0.05)**											
1290												
1291	**Nonparametric Distribution Free UCLs**											
1292	95% CLT UCL					0,199	95% Jackknife UCL					0,200
1293	95% Standard Bootstrap UCL					0,200	95% Bootstrap-t UCL					0,297
1294	95% Hall's Bootstrap UCL					0,225	95% Percentile Bootstrap UCL					0,207
1295	95% BCA Bootstrap UCL					0,235						
1296	90% Chebyshev(Mean, Sd) UCL					0,267	95% Chebyshev(Mean, Sd) UCL					0,336
1297	97,5% Chebyshev(Mean, Sd) UCL					0,431	99% Chebyshev(Mean, Sd) UCL					0,617
1298												
1299	**Suggested UCL to Use**											
1300	95% Chebyshev (Mean, Sd) UCL					0,336						

	A–E	F	G–K	L
1301				
1302	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
1303	Recommendations are based upon data size, data distribution, and skewness.			
1304	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
1305	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
1306				
1307				
1308	**Fluoranthene - Main Complex (Soil)**			
1309				
1310	**General Statistics**			
1311	Total Number of Observations	63,00	Number of Distinct Observations	31,00
1312			Number of Missing Observations	3,000
1313	Minimum	0,0100	Mean	1,183
1314	Maximum	24,70	Median	0,0500
1315	SD	4,272	Std. Error of Mean	0,538
1316	Coefficient of Variation	3,612	Skewness	4,836
1317				
1318	**Normal GOF Test**			
1319	Shapiro Wilk Test Statistic	0,300	**Shapiro Wilk GOF Test**	
1320	5% Shapiro Wilk P Value	0	Data Not Normal at 5% Significance Level	
1321	Lilliefors Test Statistic	0,420	**Lilliefors GOF Test**	
1322	5% Lilliefors Critical Value	0,111	Data Not Normal at 5% Significance Level	
1323	**Data Not Normal at 5% Significance Level**			
1324				
1325	**Assuming Normal Distribution**			
1326	**95% Normal UCL**		**95% UCLs (Adjusted for Skewness)**	
1327	95% Student's-t UCL	2,081	95% Adjusted-CLT UCL (Chen-1995)	2,418
1328			95% Modified-t UCL (Johnson-1978)	2,136
1329				
1330	**Gamma GOF Test**			
1331	A-D Test Statistic	8,118	**Anderson-Darling Gamma GOF Test**	
1332	5% A-D Critical Value	0,865	Data Not Gamma Distributed at 5% Significance Level	
1333	K-S Test Statistic	0,264	**Kolmogorov-Smirnov Gamma GOF Test**	
1334	5% K-S Critical Value	0,122	Data Not Gamma Distributed at 5% Significance Level	
1335	**Data Not Gamma Distributed at 5% Significance Level**			
1336				
1337	**Gamma Statistics**			
1338	k hat (MLE)	0,297	k star (bias corrected MLE)	0,294
1339	Theta hat (MLE)	3,981	Theta star (bias corrected MLE)	4,029
1340	nu hat (MLE)	37,43	nu star (bias corrected)	36,98
1341	MLE Mean (bias corrected)	1,183	MLE Sd (bias corrected)	2,183
1342			Approximate Chi Square Value (0,0500)	24,06
1343	Adjusted Level of Significance	0,0462	Adjusted Chi Square Value	23,82
1344				
1345	**Assuming Gamma Distribution**			
1346	95% Approximate Gamma UCL (use when n>=50))	1,818	95% Adjusted Gamma UCL (use when n<50)	1,836
1347				
1348	**Lognormal GOF Test**			
1349	Shapiro Wilk Test Statistic	0,876	**Shapiro Wilk Lognormal GOF Test**	
1350	5% Shapiro Wilk P Value	7,3523E-7	Data Not Lognormal at 5% Significance Level	

	A	B	C	D	E	F	G	H	I	J	K	L
1351	Lilliefors Test Statistic					0,214	**Lilliefors Lognormal GOF Test**					
1352	5% Lilliefors Critical Value					0,111	Data Not Lognormal at 5% Significance Level					
1353	**Data Not Lognormal at 5% Significance Level**											
1354												
1355	**Lognormal Statistics**											
1356	Minimum of Logged Data					-4,605	Mean of logged Data					-2,157
1357	Maximum of Logged Data					3,207	SD of logged Data					1,854
1358												
1359	**Assuming Lognormal Distribution**											
1360	95% H-UCL					1,277	90% Chebyshev (MVUE) UCL					1,218
1361	95% Chebyshev (MVUE) UCL					1,498	97,5% Chebyshev (MVUE) UCL					1,885
1362	99% Chebyshev (MVUE) UCL					2,647						
1363												
1364	**Nonparametric Distribution Free UCL Statistics**											
1365	**Data do not follow a Discernible Distribution (0.05)**											
1366												
1367	**Nonparametric Distribution Free UCLs**											
1368	95% CLT UCL					2,068	95% Jackknife UCL					2,081
1369	95% Standard Bootstrap UCL					2,078	95% Bootstrap-t UCL					4,009
1370	95% Hall's Bootstrap UCL					5,617	95% Percentile Bootstrap UCL					2,113
1371	95% BCA Bootstrap UCL					2,479						
1372	90% Chebyshev(Mean, Sd) UCL					2,797	95% Chebyshev(Mean, Sd) UCL					3,529
1373	97,5% Chebyshev(Mean, Sd) UCL					4,544	99% Chebyshev(Mean, Sd) UCL					6,537
1374												
1375	**Suggested UCL to Use**											
1376	95% Chebyshev (Mean, Sd) UCL					3,529						
1377												
1378	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
1379	Recommendations are based upon data size, data distribution, and skewness.											
1380	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
1381	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
1382												
1383												
1384	**Phenanthrene - Main Complex (Soil)**											
1385												
1386	**General Statistics**											
1387	Total Number of Observations					63,00	Number of Distinct Observations					31,00
1388							Number of Missing Observations					3,000
1389	Minimum					0,0100	Mean					0,986
1390	Maximum					22,50	Median					0,0400
1391	SD					3,764	Std. Error of Mean					0,474
1392	Coefficient of Variation					3,818	Skewness					5,257
1393												
1394	**Normal GOF Test**											
1395	Shapiro Wilk Test Statistic					0,276	**Shapiro Wilk GOF Test**					
1396	5% Shapiro Wilk P Value					0	Data Not Normal at 5% Significance Level					
1397	Lilliefors Test Statistic					0,398	**Lilliefors GOF Test**					
1398	5% Lilliefors Critical Value					0,111	Data Not Normal at 5% Significance Level					
1399	**Data Not Normal at 5% Significance Level**											
1400												

	A	B	C	D	E	F	G	H	I	J	K	L
1401	**Assuming Normal Distribution**											
1402	**95% Normal UCL**						**95% UCLs (Adjusted for Skewness)**					
1403					95% Student's-t UCL	1,778					95% Adjusted-CLT UCL (Chen-1995)	2,102
1404											95% Modified-t UCL (Johnson-1978)	1,830
1405												
1406	**Gamma GOF Test**											
1407					A-D Test Statistic	6,973	**Anderson-Darling Gamma GOF Test**					
1408					5% A-D Critical Value	0,866	Data Not Gamma Distributed at 5% Significance Level					
1409					K-S Test Statistic	0,220	**Kolmogorov-Smirnov Gamma GOF Test**					
1410					5% K-S Critical Value	0,122	Data Not Gamma Distributed at 5% Significance Level					
1411	**Data Not Gamma Distributed at 5% Significance Level**											
1412												
1413	**Gamma Statistics**											
1414					k hat (MLE)	0,296					k star (bias corrected MLE)	0,293
1415					Theta hat (MLE)	3,327					Theta star (bias corrected MLE)	3,367
1416					nu hat (MLE)	37,34					nu star (bias corrected)	36,90
1417					MLE Mean (bias corrected)	0,986					MLE Sd (bias corrected)	1,822
1418											Approximate Chi Square Value (0,0500)	23,99
1419					Adjusted Level of Significance	0,0462					Adjusted Chi Square Value	23,75
1420												
1421	**Assuming Gamma Distribution**											
1422					95% Approximate Gamma UCL (use when n>=50))	1,516					95% Adjusted Gamma UCL (use when n<50)	1,532
1423												
1424	**Lognormal GOF Test**											
1425					Shapiro Wilk Test Statistic	0,884	**Shapiro Wilk Lognormal GOF Test**					
1426					5% Shapiro Wilk P Value	2,1359E-6	Data Not Lognormal at 5% Significance Level					
1427					Lilliefors Test Statistic	0,221	**Lilliefors Lognormal GOF Test**					
1428					5% Lilliefors Critical Value	0,111	Data Not Lognormal at 5% Significance Level					
1429	**Data Not Lognormal at 5% Significance Level**											
1430												
1431	**Lognormal Statistics**											
1432					Minimum of Logged Data	-4,605					Mean of logged Data	-2,346
1433					Maximum of Logged Data	3,114					SD of logged Data	1,903
1434												
1435	**Assuming Lognormal Distribution**											
1436					95% H-UCL	1,200					90% Chebyshev (MVUE) UCL	1,122
1437					95% Chebyshev (MVUE) UCL	1,383					97,5% Chebyshev (MVUE) UCL	1,747
1438					99% Chebyshev (MVUE) UCL	2,460						
1439												
1440	**Nonparametric Distribution Free UCL Statistics**											
1441	**Data do not follow a Discernible Distribution (0.05)**											
1442												
1443	**Nonparametric Distribution Free UCLs**											
1444					95% CLT UCL	1,766					95% Jackknife UCL	1,778
1445					95% Standard Bootstrap UCL	1,752					95% Bootstrap-t UCL	5,088
1446					95% Hall's Bootstrap UCL	5,418					95% Percentile Bootstrap UCL	1,851
1447					95% BCA Bootstrap UCL	2,231						
1448					90% Chebyshev(Mean, Sd) UCL	2,409					95% Chebyshev(Mean, Sd) UCL	3,053
1449					97,5% Chebyshev(Mean, Sd) UCL	3,948					99% Chebyshev(Mean, Sd) UCL	5,705
1450												

1451	**Suggested UCL to Use**			
1452	95% Chebyshev (Mean, Sd) UCL	3,053		
1453				
1454	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
1455	Recommendations are based upon data size, data distribution, and skewness.			
1456	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
1457	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
1458				
1459				
1460	**Cadmium - Main Complex (Soil)**			
1461				
1462	**General Statistics**			
1463	Total Number of Observations	43,00	Number of Distinct Observations	15,00
1464			Number of Missing Observations	0
1465	Minimum	0,300	Mean	1,827
1466	Maximum	49,00	Median	0,300
1467	SD	7,436	Std. Error of Mean	1,134
1468	Coefficient of Variation	4,070	Skewness	6,375
1469				
1470	**Normal GOF Test**			
1471	Shapiro Wilk Test Statistic	0,216	**Shapiro Wilk GOF Test**	
1472	5% Shapiro Wilk Critical Value	0,943	Data Not Normal at 5% Significance Level	
1473	Lilliefors Test Statistic	0,435	**Lilliefors GOF Test**	
1474	5% Lilliefors Critical Value	0,134	Data Not Normal at 5% Significance Level	
1475	**Data Not Normal at 5% Significance Level**			
1476				
1477	**Assuming Normal Distribution**			
1478	**95% Normal UCL**		**95% UCLs (Adjusted for Skewness)**	
1479	95% Student's-t UCL	3,734	95% Adjusted-CLT UCL (Chen-1995)	4,870
1480			95% Modified-t UCL (Johnson-1978)	3,918
1481				
1482	**Gamma GOF Test**			
1483	A-D Test Statistic	9,211	**Anderson-Darling Gamma GOF Test**	
1484	5% A-D Critical Value	0,812	Data Not Gamma Distributed at 5% Significance Level	
1485	K-S Test Statistic	0,321	**Kolmogorov-Smirnov Gamma GOF Test**	
1486	5% K-S Critical Value	0,143	Data Not Gamma Distributed at 5% Significance Level	
1487	**Data Not Gamma Distributed at 5% Significance Level**			
1488				
1489	**Gamma Statistics**			
1490	k hat (MLE)	0,511	k star (bias corrected MLE)	0,491
1491	Theta hat (MLE)	3,574	Theta star (bias corrected MLE)	3,720
1492	nu hat (MLE)	43,97	nu star (bias corrected)	42,23
1493	MLE Mean (bias corrected)	1,827	MLE Sd (bias corrected)	2,607
1494			Approximate Chi Square Value (0,0500)	28,33
1495	Adjusted Level of Significance	0,0444	Adjusted Chi Square Value	27,94
1496				
1497	**Assuming Gamma Distribution**			
1498	95% Approximate Gamma UCL (use when n>=50))	2,723	95% Adjusted Gamma UCL (use when n<50)	2,762
1499				
1500	**Lognormal GOF Test**			

	A–E	F	G–K	L
1501	Shapiro Wilk Test Statistic	0,633	**Shapiro Wilk Lognormal GOF Test**	
1502	5% Shapiro Wilk Critical Value	0,943	Data Not Lognormal at 5% Significance Level	
1503	Lilliefors Test Statistic	0,317	**Lilliefors Lognormal GOF Test**	
1504	5% Lilliefors Critical Value	0,134	Data Not Lognormal at 5% Significance Level	
1505	**Data Not Lognormal at 5% Significance Level**			
1506				
1507	**Lognormal Statistics**			
1508	Minimum of Logged Data	-1,204	Mean of logged Data	-0,636
1509	Maximum of Logged Data	3,892	SD of logged Data	1,014
1510				
1511	**Assuming Lognormal Distribution**			
1512	95% H-UCL	1,285	90% Chebyshev (MVUE) UCL	1,344
1513	95% Chebyshev (MVUE) UCL	1,559	97,5% Chebyshev (MVUE) UCL	1,857
1514	99% Chebyshev (MVUE) UCL	2,442		
1515				
1516	**Nonparametric Distribution Free UCL Statistics**			
1517	**Data do not follow a Discernible Distribution (0.05)**			
1518				
1519	**Nonparametric Distribution Free UCLs**			
1520	95% CLT UCL	3,692	95% Jackknife UCL	3,734
1521	95% Standard Bootstrap UCL	3,710	95% Bootstrap-t UCL	22,52
1522	95% Hall's Bootstrap UCL	12,73	95% Percentile Bootstrap UCL	4,082
1523	95% BCA Bootstrap UCL	6,122		
1524	90% Chebyshev(Mean, Sd) UCL	5,229	95% Chebyshev(Mean, Sd) UCL	6,770
1525	97,5% Chebyshev(Mean, Sd) UCL	8,909	99% Chebyshev(Mean, Sd) UCL	13,11
1526				
1527	**Suggested UCL to Use**			
1528	95% Chebyshev (Mean, Sd) UCL	6,770		
1529				
1530	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
1531	Recommendations are based upon data size, data distribution, and skewness.			
1532	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
1533	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
1534				
1535				
1536	**Chromium - Main Complex (Soil)**			
1537				
1538	**General Statistics**			
1539	Total Number of Observations	39,00	Number of Distinct Observations	20,00
1540			Number of Missing Observations	0
1541	Minimum	5,200	Mean	13,71
1542	Maximum	73,00	Median	12,00
1543	SD	10,38	Std. Error of Mean	1,663
1544	Coefficient of Variation	0,757	Skewness	5,114
1545				
1546	**Normal GOF Test**			
1547	Shapiro Wilk Test Statistic	0,474	**Shapiro Wilk GOF Test**	
1548	5% Shapiro Wilk Critical Value	0,939	Data Not Normal at 5% Significance Level	
1549	Lilliefors Test Statistic	0,288	**Lilliefors GOF Test**	
1550	5% Lilliefors Critical Value	0,140	Data Not Normal at 5% Significance Level	

1551	Data Not Normal at 5% Significance Level			
1552				
1553	**Assuming Normal Distribution**			
1554	**95% Normal UCL**		**95% UCLs (Adjusted for Skewness)**	
1555	95% Student's-t UCL	16,51	95% Adjusted-CLT UCL (Chen-1995)	17,90
1556			95% Modified-t UCL (Johnson-1978)	16,74
1557				
1558	**Gamma GOF Test**			
1559	A-D Test Statistic	2,187	**Anderson-Darling Gamma GOF Test**	
1560	5% A-D Critical Value	0,752	Data Not Gamma Distributed at 5% Significance Level	
1561	K-S Test Statistic	0,176	**Kolmogorov-Smirnov Gamma GOF Test**	
1562	5% K-S Critical Value	0,142	Data Not Gamma Distributed at 5% Significance Level	
1563	**Data Not Gamma Distributed at 5% Significance Level**			
1564				
1565	**Gamma Statistics**			
1566	k hat (MLE)	4,281	k star (bias corrected MLE)	3,968
1567	Theta hat (MLE)	3,202	Theta star (bias corrected MLE)	3,454
1568	nu hat (MLE)	333,9	nu star (bias corrected)	309,5
1569	MLE Mean (bias corrected)	13,71	MLE Sd (bias corrected)	6,881
1570			Approximate Chi Square Value (0,0500)	269,8
1571	Adjusted Level of Significance	0,0437	Adjusted Chi Square Value	268,3
1572				
1573	**Assuming Gamma Distribution**			
1574	95% Approximate Gamma UCL (use when n>=50))	15,73	95% Adjusted Gamma UCL (use when n<50)	15,81
1575				
1576	**Lognormal GOF Test**			
1577	Shapiro Wilk Test Statistic	0,872	**Shapiro Wilk Lognormal GOF Test**	
1578	5% Shapiro Wilk Critical Value	0,939	Data Not Lognormal at 5% Significance Level	
1579	Lilliefors Test Statistic	0,131	**Lilliefors Lognormal GOF Test**	
1580	5% Lilliefors Critical Value	0,140	Data appear Lognormal at 5% Significance Level	
1581	**Data appear Approximate Lognormal at 5% Significance Level**			
1582				
1583	**Lognormal Statistics**			
1584	Minimum of Logged Data	1,649	Mean of logged Data	2,497
1585	Maximum of Logged Data	4,290	SD of logged Data	0,435
1586				
1587	**Assuming Lognormal Distribution**			
1588	95% H-UCL	15,23	90% Chebyshev (MVUE) UCL	16,19
1589	95% Chebyshev (MVUE) UCL	17,49	97,5% Chebyshev (MVUE) UCL	19,31
1590	99% Chebyshev (MVUE) UCL	22,86		
1591				
1592	**Nonparametric Distribution Free UCL Statistics**			
1593	**Data appear to follow a Discernible Distribution at 5% Significance Level**			
1594				
1595	**Nonparametric Distribution Free UCLs**			
1596	95% CLT UCL	16,44	95% Jackknife UCL	16,51
1597	95% Standard Bootstrap UCL	16,29	95% Bootstrap-t UCL	20,50
1598	95% Hall's Bootstrap UCL	27,78	95% Percentile Bootstrap UCL	16,90
1599	95% BCA Bootstrap UCL	18,54		
1600	90% Chebyshev(Mean, Sd) UCL	18,70	95% Chebyshev(Mean, Sd) UCL	20,96

1601	97,5% Chebyshev(Mean, Sd) UCL	24,09	99% Chebyshev(Mean, Sd) UCL	30,25
1602				
1603	**Suggested UCL to Use**			
1604	95% Student's-t UCL	16,51	or 95% Modified-t UCL	16,74
1605	or 95% H-UCL	15,23		
1606				
1607	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
1608	Recommendations are based upon data size, data distribution, and skewness.			
1609	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
1610	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
1611				
1612	**ProUCL computes and outputs H-statistic based UCLs for historical reasons only.**			
1613	**H-statistic often results in unstable (both high and low) values of UCL95 as shown in examples in the Technical Guide.**			
1614	**It is therefore recommended to avoid the use of H-statistic based 95% UCLs.**			
1615	**Use of nonparametric methods are preferred to compute UCL95 for skewed data sets which do not follow a gamma distribution.**			
1616				
1617				
1618	Lead - Main Complex (Soil)			
1619				
1620	**General Statistics**			
1621	Total Number of Observations	39,00	Number of Distinct Observations	33,00
1622			Number of Missing Observations	0
1623	Minimum	2,000	Mean	27,08
1624	Maximum	200,0	Median	9,400
1625	SD	41,19	Std. Error of Mean	6,595
1626	Coefficient of Variation	1,521	Skewness	2,671
1627				
1628	**Normal GOF Test**			
1629	Shapiro Wilk Test Statistic	0,630	**Shapiro Wilk GOF Test**	
1630	5% Shapiro Wilk Critical Value	0,939	Data Not Normal at 5% Significance Level	
1631	Lilliefors Test Statistic	0,325	**Lilliefors GOF Test**	
1632	5% Lilliefors Critical Value	0,140	Data Not Normal at 5% Significance Level	
1633	**Data Not Normal at 5% Significance Level**			
1634				
1635	**Assuming Normal Distribution**			
1636	**95% Normal UCL**		**95% UCLs (Adjusted for Skewness)**	
1637	95% Student's-t UCL	38,20	95% Adjusted-CLT UCL (Chen-1995)	40,94
1638			95% Modified-t UCL (Johnson-1978)	38,67
1639				
1640	**Gamma GOF Test**			
1641	A-D Test Statistic	1,932	**Anderson-Darling Gamma GOF Test**	
1642	5% A-D Critical Value	0,788	Data Not Gamma Distributed at 5% Significance Level	
1643	K-S Test Statistic	0,186	**Kolmogorov-Smirnov Gamma GOF Test**	
1644	5% K-S Critical Value	0,147	Data Not Gamma Distributed at 5% Significance Level	
1645	**Data Not Gamma Distributed at 5% Significance Level**			
1646				
1647	**Gamma Statistics**			
1648	k hat (MLE)	0,763	k star (bias corrected MLE)	0,721
1649	Theta hat (MLE)	35,50	Theta star (bias corrected MLE)	37,54
1650	nu hat (MLE)	59,50	nu star (bias corrected)	56,26

MLE Mean (bias corrected)	27,08	MLE Sd (bias corrected)	31,88
		Approximate Chi Square Value (0,0500)	40,02
Adjusted Level of Significance	0,0437	Adjusted Chi Square Value	39,48

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	38,06	95% Adjusted Gamma UCL (use when n<50)	38,59

Lognormal GOF Test

Shapiro Wilk Test Statistic	0,942	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0,939	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0,128	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0,140	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	0,693	Mean of logged Data	2,516
Maximum of Logged Data	5,298	SD of logged Data	1,210

Assuming Lognormal Distribution

95% H-UCL	43,30	90% Chebyshev (MVUE) UCL	42,63
95% Chebyshev (MVUE) UCL	50,65	97,5% Chebyshev (MVUE) UCL	61,77
99% Chebyshev (MVUE) UCL	83,62		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	37,92	95% Jackknife UCL	38,20
95% Standard Bootstrap UCL	37,79	95% Bootstrap-t UCL	44,18
95% Hall's Bootstrap UCL	43,28	95% Percentile Bootstrap UCL	38,75
95% BCA Bootstrap UCL	41,30		
90% Chebyshev(Mean, Sd) UCL	46,86	95% Chebyshev(Mean, Sd) UCL	55,82
97,5% Chebyshev(Mean, Sd) UCL	68,26	99% Chebyshev(Mean, Sd) UCL	92,70

Suggested UCL to Use

95% H-UCL	43,30		

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.
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 statistician.

ProUCL computes and outputs H-statistic based UCLs for historical reasons only.
H-statistic often results in unstable (both high and low) values of UCL95 as shown in examples in the Technical Guide.
It is therefore recommended to avoid the use of H-statistic based 95% UCLs.
Use of nonparametric methods are preferred to compute UCL95 for skewed data sets which do not follow a gamma distribution.

Molybdenum - Main Complex (Soil)

	A–E	F	G–K	L
1701	**General Statistics**			
1702	Total Number of Observations	39,00	Number of Distinct Observations	2,000
1703			Number of Missing Observations	0
1704	Minimum	2,000	Mean	2,197
1705	Maximum	9,700	Median	2,000
1706	SD	1,233	Std. Error of Mean	0,197
1707	Coefficient of Variation	0,561	Skewness	6,245
1708				
1709	**Normal GOF Test**			
1710	Shapiro Wilk Test Statistic	0,163	**Shapiro Wilk GOF Test**	
1711	5% Shapiro Wilk Critical Value	0,939	Data Not Normal at 5% Significance Level	
1712	Lilliefors Test Statistic	0,538	**Lilliefors GOF Test**	
1713	5% Lilliefors Critical Value	0,140	Data Not Normal at 5% Significance Level	
1714	**Data Not Normal at 5% Significance Level**			
1715				
1716	**Assuming Normal Distribution**			
1717	**95% Normal UCL**		**95% UCLs (Adjusted for Skewness)**	
1718	95% Student's-t UCL	2,530	95% Adjusted-CLT UCL (Chen-1995)	2,733
1719			95% Modified-t UCL (Johnson-1978)	2,563
1720				
1721	**Gamma GOF Test**			
1722	A-D Test Statistic	14,71	**Anderson-Darling Gamma GOF Test**	
1723	5% A-D Critical Value	0,748	Data Not Gamma Distributed at 5% Significance Level	
1724	K-S Test Statistic	0,544	**Kolmogorov-Smirnov Gamma GOF Test**	
1725	5% K-S Critical Value	0,141	Data Not Gamma Distributed at 5% Significance Level	
1726	**Data Not Gamma Distributed at 5% Significance Level**			
1727				
1728	**Gamma Statistics**			
1729	k hat (MLE)	9,482	k star (bias corrected MLE)	8,770
1730	Theta hat (MLE)	0,232	Theta star (bias corrected MLE)	0,251
1731	nu hat (MLE)	739,6	nu star (bias corrected)	684,0
1732	MLE Mean (bias corrected)	2,197	MLE Sd (bias corrected)	0,742
1733			Approximate Chi Square Value (0,0500)	624,4
1734	Adjusted Level of Significance	0,0437	Adjusted Chi Square Value	622,1
1735				
1736	**Assuming Gamma Distribution**			
1737	95% Approximate Gamma UCL (use when n>=50))	2,407	95% Adjusted Gamma UCL (use when n<50)	2,416
1738				
1739	**Lognormal GOF Test**			
1740	Shapiro Wilk Test Statistic	0,163	**Shapiro Wilk Lognormal GOF Test**	
1741	5% Shapiro Wilk Critical Value	0,939	Data Not Lognormal at 5% Significance Level	
1742	Lilliefors Test Statistic	0,538	**Lilliefors Lognormal GOF Test**	
1743	5% Lilliefors Critical Value	0,140	Data Not Lognormal at 5% Significance Level	
1744	**Data Not Lognormal at 5% Significance Level**			
1745				
1746	**Lognormal Statistics**			
1747	Minimum of Logged Data	0,693	Mean of logged Data	0,734
1748	Maximum of Logged Data	2,272	SD of logged Data	0,253
1749				
1750	**Assuming Lognormal Distribution**			

	A	B	C	D	E	F	G	H	I	J	K	L
1751					95% H-UCL	2,312					90% Chebyshev (MVUE) UCL	2,413
1752					95% Chebyshev (MVUE) UCL	2,532					97,5% Chebyshev (MVUE) UCL	2,699
1753					99% Chebyshev (MVUE) UCL	3,025						
1754												
1755	**Nonparametric Distribution Free UCL Statistics**											
1756	**Data do not follow a Discernible Distribution (0.05)**											
1757												
1758	**Nonparametric Distribution Free UCLs**											
1759					95% CLT UCL	2,522					95% Jackknife UCL	N/A
1760					95% Standard Bootstrap UCL	N/A					95% Bootstrap-t UCL	N/A
1761					95% Hall's Bootstrap UCL	N/A					95% Percentile Bootstrap UCL	N/A
1762					95% BCA Bootstrap UCL	N/A						
1763					90% Chebyshev(Mean, Sd) UCL	2,790					95% Chebyshev(Mean, Sd) UCL	3,058
1764					97,5% Chebyshev(Mean, Sd) UCL	3,430					99% Chebyshev(Mean, Sd) UCL	4,162
1765												
1766	**Suggested UCL to Use**											
1767					95% Student's-t UCL	2,530					or 95% Modified-t UCL	2,563
1768												
1769	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
1770	Recommendations are based upon data size, data distribution, and skewness.											
1771	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
1772	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
1773												
1774												
1775	**Tin - Main Complex (Soil)**											
1776												
1777	**General Statistics**											
1778					Total Number of Observations	39,00					Number of Distinct Observations	4,000
1779											Number of Missing Observations	0
1780					Minimum	2,000					Mean	2,187
1781					Maximum	6,800					Median	2,000
1782					SD	0,808					Std. Error of Mean	0,129
1783					Coefficient of Variation	0,369					Skewness	5,277
1784												
1785	**Normal GOF Test**											
1786					Shapiro Wilk Test Statistic	0,264	**Shapiro Wilk GOF Test**					
1787					5% Shapiro Wilk Critical Value	0,939	Data Not Normal at 5% Significance Level					
1788					Lilliefors Test Statistic	0,515	**Lilliefors GOF Test**					
1789					5% Lilliefors Critical Value	0,140	Data Not Normal at 5% Significance Level					
1790	**Data Not Normal at 5% Significance Level**											
1791												
1792	**Assuming Normal Distribution**											
1793	**95% Normal UCL**						**95% UCLs (Adjusted for Skewness)**					
1794					95% Student's-t UCL	2,405					95% Adjusted-CLT UCL (Chen-1995)	2,517
1795											95% Modified-t UCL (Johnson-1978)	2,424
1796												
1797	**Gamma GOF Test**											
1798					A-D Test Statistic	12,55	**Anderson-Darling Gamma GOF Test**					
1799					5% A-D Critical Value	0,747	Data Not Gamma Distributed at 5% Significance Level					
1800					K-S Test Statistic	0,525	**Kolmogorov-Smirnov Gamma GOF Test**					

	A–E	F	G–K	L
1801	5% K-S Critical Value	0,141	Data Not Gamma Distributed at 5% Significance Level	
1802	**Data Not Gamma Distributed at 5% Significance Level**			
1803				
1804	**Gamma Statistics**			
1805	k hat (MLE)	15,23	k star (bias corrected MLE)	14,07
1806	Theta hat (MLE)	0,144	Theta star (bias corrected MLE)	0,155
1807	nu hat (MLE)	1188	nu star (bias corrected)	1098
1808	MLE Mean (bias corrected)	2,187	MLE Sd (bias corrected)	0,583
1809			Approximate Chi Square Value (0,0500)	1022
1810	Adjusted Level of Significance	0,0437	Adjusted Chi Square Value	1019
1811				
1812	**Assuming Gamma Distribution**			
1813	95% Approximate Gamma UCL (use when n>=50))	2,350	95% Adjusted Gamma UCL (use when n<50)	2,356
1814				
1815	**Lognormal GOF Test**			
1816	Shapiro Wilk Test Statistic	0,295	**Shapiro Wilk Lognormal GOF Test**	
1817	5% Shapiro Wilk Critical Value	0,939	Data Not Lognormal at 5% Significance Level	
1818	Lilliefors Test Statistic	0,524	**Lilliefors Lognormal GOF Test**	
1819	5% Lilliefors Critical Value	0,140	Data Not Lognormal at 5% Significance Level	
1820	**Data Not Lognormal at 5% Significance Level**			
1821				
1822	**Lognormal Statistics**			
1823	Minimum of Logged Data	0,693	Mean of logged Data	0,749
1824	Maximum of Logged Data	1,917	SD of logged Data	0,220
1825				
1826	**Assuming Lognormal Distribution**			
1827	95% H-UCL	2,308	90% Chebyshev (MVUE) UCL	2,398
1828	95% Chebyshev (MVUE) UCL	2,503	97,5% Chebyshev (MVUE) UCL	2,648
1829	99% Chebyshev (MVUE) UCL	2,934		
1830				
1831	**Nonparametric Distribution Free UCL Statistics**			
1832	**Data do not follow a Discernible Distribution (0.05)**			
1833				
1834	**Nonparametric Distribution Free UCLs**			
1835	95% CLT UCL	2,400	95% Jackknife UCL	2,405
1836	95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
1837	95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
1838	95% BCA Bootstrap UCL	N/A		
1839	90% Chebyshev(Mean, Sd) UCL	2,575	95% Chebyshev(Mean, Sd) UCL	2,751
1840	97,5% Chebyshev(Mean, Sd) UCL	2,995	99% Chebyshev(Mean, Sd) UCL	3,474
1841				
1842	**Suggested UCL to Use**			
1843	95% Student's-t UCL	2,405	or 95% Modified-t UCL	2,424
1844				
1845	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
1846	Recommendations are based upon data size, data distribution, and skewness.			
1847	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
1848	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
1849				
1850				

	A–E	F	G–K	L
1851	Vanadium - Main Complex (Soil)			
1852				
1853	**General Statistics**			
1854	Total Number of Observations	39,00	Number of Distinct Observations	26,00
1855			Number of Missing Observations	0
1856	Minimum	7,500	Mean	30,60
1857	Maximum	88,00	Median	30,00
1858	SD	12,65	Std. Error of Mean	2,025
1859	Coefficient of Variation	0,413	Skewness	2,370
1860				
1861	**Normal GOF Test**			
1862	Shapiro Wilk Test Statistic	0,823	**Shapiro Wilk GOF Test**	
1863	5% Shapiro Wilk Critical Value	0,939	Data Not Normal at 5% Significance Level	
1864	Lilliefors Test Statistic	0,148	**Lilliefors GOF Test**	
1865	5% Lilliefors Critical Value	0,140	Data Not Normal at 5% Significance Level	
1866	**Data Not Normal at 5% Significance Level**			
1867				
1868	**Assuming Normal Distribution**			
1869	**95% Normal UCL**		**95% UCLs (Adjusted for Skewness)**	
1870	95% Student's-t UCL	34,02	95% Adjusted-CLT UCL (Chen-1995)	34,76
1871			95% Modified-t UCL (Johnson-1978)	34,15
1872				
1873	**Gamma GOF Test**			
1874	A-D Test Statistic	0,752	**Anderson-Darling Gamma GOF Test**	
1875	5% A-D Critical Value	0,750	Data Not Gamma Distributed at 5% Significance Level	
1876	K-S Test Statistic	0,103	**Kolmogorov-Smirnov Gamma GOF Test**	
1877	5% K-S Critical Value	0,142	Detected data appear Gamma Distributed at 5% Significance Level	
1878	**Detected data follow Appr. Gamma Distribution at 5% Significance Level**			
1879				
1880	**Gamma Statistics**			
1881	k hat (MLE)	7,023	k star (bias corrected MLE)	6,500
1882	Theta hat (MLE)	4,358	Theta star (bias corrected MLE)	4,708
1883	nu hat (MLE)	547,8	nu star (bias corrected)	507,0
1884	MLE Mean (bias corrected)	30,60	MLE Sd (bias corrected)	12,00
1885			Approximate Chi Square Value (0,0500)	455,8
1886	Adjusted Level of Significance	0,0437	Adjusted Chi Square Value	453,8
1887				
1888	**Assuming Gamma Distribution**			
1889	95% Approximate Gamma UCL (use when n>=50)	34,04	95% Adjusted Gamma UCL (use when n<50)	34,18
1890				
1891	**Lognormal GOF Test**			
1892	Shapiro Wilk Test Statistic	0,935	**Shapiro Wilk Lognormal GOF Test**	
1893	5% Shapiro Wilk Critical Value	0,939	Data Not Lognormal at 5% Significance Level	
1894	Lilliefors Test Statistic	0,128	**Lilliefors Lognormal GOF Test**	
1895	5% Lilliefors Critical Value	0,140	Data appear Lognormal at 5% Significance Level	
1896	**Data appear Approximate Lognormal at 5% Significance Level**			
1897				
1898	**Lognormal Statistics**			
1899	Minimum of Logged Data	2,015	Mean of logged Data	3,348
1900	Maximum of Logged Data	4,477	SD of logged Data	0,394

Assuming Lognormal Distribution			
95% H-UCL	34,60	90% Chebyshev (MVUE) UCL	36,67
95% Chebyshev (MVUE) UCL	39,39	97,5% Chebyshev (MVUE) UCL	43,15
99% Chebyshev (MVUE) UCL	50,55		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	33,93	95% Jackknife UCL	34,02
95% Standard Bootstrap UCL	34,02	95% Bootstrap-t UCL	35,24
95% Hall's Bootstrap UCL	38,39	95% Percentile Bootstrap UCL	34,03
95% BCA Bootstrap UCL	34,83		
90% Chebyshev(Mean, Sd) UCL	36,68	95% Chebyshev(Mean, Sd) UCL	39,43
97,5% Chebyshev(Mean, Sd) UCL	43,25	99% Chebyshev(Mean, Sd) UCL	50,75
Suggested UCL to Use			
95% Adjusted Gamma UCL	34,18		
When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test			
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL			
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.			
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 statistician.			
Zinc - Main Complex (Soil)			
General Statistics			
Total Number of Observations	47,00	Number of Distinct Observations	40,00
		Number of Missing Observations	0
Minimum	14,00	Mean	143,3
Maximum	1400	Median	68,00
SD	240,4	Std. Error of Mean	35,06
Coefficient of Variation	1,678	Skewness	3,801
Normal GOF Test			
Shapiro Wilk Test Statistic	0,523	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0,946	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0,340	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0,128	Data Not Normal at 5% Significance Level	
Data Not Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	202,1	95% Adjusted-CLT UCL (Chen-1995)	221,7
		95% Modified-t UCL (Johnson-1978)	205,4

	A	B	C	D	E	F	G	H	I	J	K	L
1951												
1952	**Gamma GOF Test**											
1953					A-D Test Statistic	2,898	**Anderson-Darling Gamma GOF Test**					
1954					5% A-D Critical Value	0,783	Data Not Gamma Distributed at 5% Significance Level					
1955					K-S Test Statistic	0,213	**Kolmogorov-Smirnov Gamma GOF Test**					
1956					5% K-S Critical Value	0,134	Data Not Gamma Distributed at 5% Significance Level					
1957	**Data Not Gamma Distributed at 5% Significance Level**											
1958												
1959	**Gamma Statistics**											
1960					k hat (MLE)	0,903					k star (bias corrected MLE)	0,860
1961					Theta hat (MLE)	158,7					Theta star (bias corrected MLE)	166,7
1962					nu hat (MLE)	84,88					nu star (bias corrected)	80,79
1963					MLE Mean (bias corrected)	143,3					MLE Sd (bias corrected)	154,5
1964											Approximate Chi Square Value (0,0500)	61,08
1965					Adjusted Level of Significance	0,0449					Adjusted Chi Square Value	60,54
1966												
1967	**Assuming Gamma Distribution**											
1968					95% Approximate Gamma UCL (use when n>=50))	189,5					95% Adjusted Gamma UCL (use when n<50)	191,2
1969												
1970	**Lognormal GOF Test**											
1971					Shapiro Wilk Test Statistic	0,942	**Shapiro Wilk Lognormal GOF Test**					
1972					5% Shapiro Wilk Critical Value	0,946	Data Not Lognormal at 5% Significance Level					
1973					Lilliefors Test Statistic	0,123	**Lilliefors Lognormal GOF Test**					
1974					5% Lilliefors Critical Value	0,128	Data appear Lognormal at 5% Significance Level					
1975	**Data appear Approximate Lognormal at 5% Significance Level**											
1976												
1977	**Lognormal Statistics**											
1978					Minimum of Logged Data	2,639					Mean of logged Data	4,318
1979					Maximum of Logged Data	7,244					SD of logged Data	1,025
1980												
1981	**Assuming Lognormal Distribution**											
1982					95% H-UCL	181,2					90% Chebyshev (MVUE) UCL	190,9
1983					95% Chebyshev (MVUE) UCL	220,8					97,5% Chebyshev (MVUE) UCL	262,3
1984					99% Chebyshev (MVUE) UCL	344,0						
1985												
1986	**Nonparametric Distribution Free UCL Statistics**											
1987	**Data appear to follow a Discernible Distribution at 5% Significance Level**											
1988												
1989	**Nonparametric Distribution Free UCLs**											
1990					95% CLT UCL	200,9					95% Jackknife UCL	202,1
1991					95% Standard Bootstrap UCL	200,3					95% Bootstrap-t UCL	247,8
1992					95% Hall's Bootstrap UCL	384,9					95% Percentile Bootstrap UCL	203,3
1993					95% BCA Bootstrap UCL	224,1						
1994					90% Chebyshev(Mean, Sd) UCL	248,5					95% Chebyshev(Mean, Sd) UCL	296,1
1995					97,5% Chebyshev(Mean, Sd) UCL	362,2					99% Chebyshev(Mean, Sd) UCL	492,1
1996												
1997	**Suggested UCL to Use**											
1998					95% H-UCL	181,2						
1999												
2000	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.

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 statistician.

ProUCL computes and outputs H-statistic based UCLs for historical reasons only.

H-statistic often results in unstable (both high and low) values of UCL95 as shown in examples in the Technical Guide.

It is therefore recommended to avoid the use of H-statistic based 95% UCLs.

Use of nonparametric methods are preferred to compute UCL95 for skewed data sets which do not follow a gamma distribution.

Calculated Total PCB

General Statistics

Total Number of Observations	36,00	Number of Distinct Observations	16,00
		Number of Missing Observations	2,000
Minimum	0,0500	Mean	0,288
Maximum	2,000	Median	0,100
SD	0,523	Std. Error of Mean	0,0872
Coefficient of Variation	1,820	Skewness	2,663

Normal GOF Test

Shapiro Wilk Test Statistic	0,494	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0,935	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0,382	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0,145	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	0,435	95% Adjusted-CLT UCL (Chen-1995)	0,472
		95% Modified-t UCL (Johnson-1978)	0,441

Gamma GOF Test

A-D Test Statistic	4,529	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0,792	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0,258	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0,153	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0,714	k star (bias corrected MLE)	0,673
Theta hat (MLE)	0,403	Theta star (bias corrected MLE)	0,427
nu hat (MLE)	51,38	nu star (bias corrected)	48,43
MLE Mean (bias corrected)	0,288	MLE Sd (bias corrected)	0,351
		Approximate Chi Square Value (0,0500)	33,46
Adjusted Level of Significance	0,0428	Adjusted Chi Square Value	32,89

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	0,416	95% Adjusted Gamma UCL (use when n<50)	0,423

	A	B	C	D	E	F	G	H	I	J	K	L
2051	**Lognormal GOF Test**											
2052					Shapiro Wilk Test Statistic	0,778	**Shapiro Wilk Lognormal GOF Test**					
2053					5% Shapiro Wilk Critical Value	0,935	Data Not Lognormal at 5% Significance Level					
2054					Lilliefors Test Statistic	0,208	**Lilliefors Lognormal GOF Test**					
2055					5% Lilliefors Critical Value	0,145	Data Not Lognormal at 5% Significance Level					
2056	**Data Not Lognormal at 5% Significance Level**											
2057												
2058	**Lognormal Statistics**											
2059					Minimum of Logged Data	-2,996					Mean of logged Data	-2,091
2060					Maximum of Logged Data	0,693					SD of logged Data	1,113
2061												
2062	**Assuming Lognormal Distribution**											
2063					95% H-UCL	0,369					90% Chebyshev (MVUE) UCL	0,372
2064					95% Chebyshev (MVUE) UCL	0,439					97,5% Chebyshev (MVUE) UCL	0,532
2065					99% Chebyshev (MVUE) UCL	0,715						
2066												
2067	**Nonparametric Distribution Free UCL Statistics**											
2068	**Data do not follow a Discernible Distribution (0.05)**											
2069												
2070	**Nonparametric Distribution Free UCLs**											
2071					95% CLT UCL	0,431					95% Jackknife UCL	0,435
2072					95% Standard Bootstrap UCL	0,433					95% Bootstrap-t UCL	0,570
2073					95% Hall's Bootstrap UCL	0,423					95% Percentile Bootstrap UCL	0,431
2074					95% BCA Bootstrap UCL	0,466						
2075					90% Chebyshev(Mean, Sd) UCL	0,549					95% Chebyshev(Mean, Sd) UCL	0,668
2076					97,5% Chebyshev(Mean, Sd) UCL	0,832					99% Chebyshev(Mean, Sd) UCL	1,155
2077												
2078	**Suggested UCL to Use**											
2079					95% Chebyshev (Mean, Sd) UCL	0,668						
2080												
2081	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
2082	Recommendations are based upon data size, data distribution, and skewness.											
2083	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
2084	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
2085												
2086												
2087	**Fraction F3 (>C16-C34) - Former USAF Dump Area and Former Ammunition Storage Area (Soil)**											
2088												
2089	**General Statistics**											
2090					Total Number of Observations	21,00					Number of Distinct Observations	13,00
2091											Number of Missing Observations	0
2092					Minimum	20,00					Mean	431,6
2093					Maximum	6380					Median	29,00
2094					SD	1397					Std. Error of Mean	304,8
2095					Coefficient of Variation	3,237					Skewness	4,265
2096												
2097	**Normal GOF Test**											
2098					Shapiro Wilk Test Statistic	0,325	**Shapiro Wilk GOF Test**					
2099					5% Shapiro Wilk Critical Value	0,908	Data Not Normal at 5% Significance Level					
2100					Lilliefors Test Statistic	0,443	**Lilliefors GOF Test**					

	A	B	C	D	E	F	G	H	I	J	K	L
2101	5% Lilliefors Critical Value					0,188	Data Not Normal at 5% Significance Level					
2102	**Data Not Normal at 5% Significance Level**											
2103												
2104	**Assuming Normal Distribution**											
2105	**95% Normal UCL**						**95% UCLs (Adjusted for Skewness)**					
2106	95% Student's-t UCL					957,4	95% Adjusted-CLT UCL (Chen-1995)					1236
2107							95% Modified-t UCL (Johnson-1978)					1005
2108												
2109	**Gamma GOF Test**											
2110	A-D Test Statistic					3,993	**Anderson-Darling Gamma GOF Test**					
2111	5% A-D Critical Value					0,836	Data Not Gamma Distributed at 5% Significance Level					
2112	K-S Test Statistic					0,348	**Kolmogorov-Smirnov Gamma GOF Test**					
2113	5% K-S Critical Value					0,204	Data Not Gamma Distributed at 5% Significance Level					
2114	**Data Not Gamma Distributed at 5% Significance Level**											
2115												
2116	**Gamma Statistics**											
2117	k hat (MLE)					0,348	k star (bias corrected MLE)					0,330
2118	Theta hat (MLE)					1239	Theta star (bias corrected MLE)					1307
2119	nu hat (MLE)					14,63	nu star (bias corrected)					13,87
2120	MLE Mean (bias corrected)					431,6	MLE Sd (bias corrected)					751,1
2121							Approximate Chi Square Value (0,0500)					6,482
2122	Adjusted Level of Significance					0,0383	Adjusted Chi Square Value					6,097
2123												
2124	**Assuming Gamma Distribution**											
2125	95% Approximate Gamma UCL (use when n>=50))					923,5	95% Adjusted Gamma UCL (use when n<50)					981,9
2126												
2127	**Lognormal GOF Test**											
2128	Shapiro Wilk Test Statistic					0,709	**Shapiro Wilk Lognormal GOF Test**					
2129	5% Shapiro Wilk Critical Value					0,908	Data Not Lognormal at 5% Significance Level					
2130	Lilliefors Test Statistic					0,302	**Lilliefors Lognormal GOF Test**					
2131	5% Lilliefors Critical Value					0,188	Data Not Lognormal at 5% Significance Level					
2132	**Data Not Lognormal at 5% Significance Level**											
2133												
2134	**Lognormal Statistics**											
2135	Minimum of Logged Data					2,996	Mean of logged Data					4,135
2136	Maximum of Logged Data					8,761	SD of logged Data					1,544
2137												
2138	**Assuming Lognormal Distribution**											
2139	95% H-UCL					661,6	90% Chebyshev (MVUE) UCL					410,3
2140	95% Chebyshev (MVUE) UCL					512,6	97,5% Chebyshev (MVUE) UCL					654,5
2141	99% Chebyshev (MVUE) UCL					933,2						
2142												
2143	**Nonparametric Distribution Free UCL Statistics**											
2144	**Data do not follow a Discernible Distribution (0.05)**											
2145												
2146	**Nonparametric Distribution Free UCLs**											
2147	95% CLT UCL					933,0	95% Jackknife UCL					957,4
2148	95% Standard Bootstrap UCL					916,5	95% Bootstrap-t UCL					6846
2149	95% Hall's Bootstrap UCL					4598	95% Percentile Bootstrap UCL					1015
2150	95% BCA Bootstrap UCL					1378						

	A–E	F	G–K	L
2151	90% Chebyshev(Mean, Sd) UCL	1346	95% Chebyshev(Mean, Sd) UCL	1760
2152	97,5% Chebyshev(Mean, Sd) UCL	2335	99% Chebyshev(Mean, Sd) UCL	3465
2153				
2154	**Suggested UCL to Use**			
2155	95% Chebyshev (Mean, Sd) UCL	1760		
2156				
2157	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
2158	Recommendations are based upon data size, data distribution, and skewness.			
2159	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
2160	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
2161				
2162				
2163	**Anthracene - Former USAF Dump Area and Former Ammunition Storage Area (Soil)**			
2164				
2165	**General Statistics**			
2166	Total Number of Observations	16,00	Number of Distinct Observations	4,000
2167			Number of Missing Observations	0
2168	Minimum	0,0100	Mean	1,063
2169	Maximum	15,90	Median	0,0300
2170	SD	3,961	Std. Error of Mean	0,990
2171	Coefficient of Variation	3,728	Skewness	3,986
2172				
2173	**Normal GOF Test**			
2174	Shapiro Wilk Test Statistic	0,292	**Shapiro Wilk GOF Test**	
2175	5% Shapiro Wilk Critical Value	0,887	Data Not Normal at 5% Significance Level	
2176	Lilliefors Test Statistic	0,478	**Lilliefors GOF Test**	
2177	5% Lilliefors Critical Value	0,213	Data Not Normal at 5% Significance Level	
2178	**Data Not Normal at 5% Significance Level**			
2179				
2180	**Assuming Normal Distribution**			
2181	**95% Normal UCL**		**95% UCLs (Adjusted for Skewness)**	
2182	95% Student's-t UCL	2,798	95% Adjusted-CLT UCL (Chen-1995)	3,746
2183			95% Modified-t UCL (Johnson-1978)	2,963
2184				
2185	**Gamma GOF Test**			
2186	A-D Test Statistic	4,292	**Anderson-Darling Gamma GOF Test**	
2187	5% A-D Critical Value	0,873	Data Not Gamma Distributed at 5% Significance Level	
2188	K-S Test Statistic	0,521	**Kolmogorov-Smirnov Gamma GOF Test**	
2189	5% K-S Critical Value	0,237	Data Not Gamma Distributed at 5% Significance Level	
2190	**Data Not Gamma Distributed at 5% Significance Level**			
2191				
2192	**Gamma Statistics**			
2193	k hat (MLE)	0,223	k star (bias corrected MLE)	0,223
2194	Theta hat (MLE)	4,769	Theta star (bias corrected MLE)	4,772
2195	nu hat (MLE)	7,129	nu star (bias corrected)	7,126
2196	MLE Mean (bias corrected)	1,063	MLE Sd (bias corrected)	2,252
2197			Approximate Chi Square Value (0,0500)	2,240
2198	Adjusted Level of Significance	0,0335	Adjusted Chi Square Value	1,941
2199				
2200	**Assuming Gamma Distribution**			

	A–E	F	G–K	L
2201	95% Approximate Gamma UCL (use when n>=50))	3,380	95% Adjusted Gamma UCL (use when n<50)	3,901
2202				
2203	**Lognormal GOF Test**			
2204	Shapiro Wilk Test Statistic	0,601	**Shapiro Wilk Lognormal GOF Test**	
2205	5% Shapiro Wilk Critical Value	0,887	Data Not Lognormal at 5% Significance Level	
2206	Lilliefors Test Statistic	0,442	**Lilliefors Lognormal GOF Test**	
2207	5% Lilliefors Critical Value	0,213	Data Not Lognormal at 5% Significance Level	
2208	**Data Not Lognormal at 5% Significance Level**			
2209				
2210	**Lognormal Statistics**			
2211	Minimum of Logged Data	-4,605	Mean of logged Data	-3,187
2212	Maximum of Logged Data	2,766	SD of logged Data	1,880
2213				
2214	**Assuming Lognormal Distribution**			
2215	95% H-UCL	1,892	90% Chebyshev (MVUE) UCL	0,502
2216	95% Chebyshev (MVUE) UCL	0,643	97,5% Chebyshev (MVUE) UCL	0,840
2217	99% Chebyshev (MVUE) UCL	1,225		
2218				
2219	**Nonparametric Distribution Free UCL Statistics**			
2220	**Data do not follow a Discernible Distribution (0.05)**			
2221				
2222	**Nonparametric Distribution Free UCLs**			
2223	95% CLT UCL	2,691	95% Jackknife UCL	2,798
2224	95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
2225	95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
2226	95% BCA Bootstrap UCL	N/A		
2227	90% Chebyshev(Mean, Sd) UCL	4,033	95% Chebyshev(Mean, Sd) UCL	5,379
2228	97,5% Chebyshev(Mean, Sd) UCL	7,247	99% Chebyshev(Mean, Sd) UCL	10,92
2229				
2230	**Suggested UCL to Use**			
2231	99% Chebyshev (Mean, Sd) UCL	10,92		
2232				
2233	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
2234	Recommendations are based upon data size, data distribution, and skewness.			
2235	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
2236	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
2237				
2238				
2239	**Benzo(a)anthracene - Former USAF Dump Area and Former Ammunition Storage Area (Soil)**			
2240				
2241	**General Statistics**			
2242	Total Number of Observations	16,00	Number of Distinct Observations	3,000
2243			Number of Missing Observations	0
2244	Minimum	0,0100	Mean	1,304
2245	Maximum	19,70	Median	0,0100
2246	SD	4,912	Std. Error of Mean	1,228
2247	Coefficient of Variation	3,766	Skewness	3,982
2248				
2249	**Normal GOF Test**			
2250	Shapiro Wilk Test Statistic	0,293	**Shapiro Wilk GOF Test**	

	A	B	C	D	E	F	G	H	I	J	K	L
2251					5% Shapiro Wilk Critical Value	0,887	Data Not Normal at 5% Significance Level					
2252					Lilliefors Test Statistic	0,479	**Lilliefors GOF Test**					
2253					5% Lilliefors Critical Value	0,213	Data Not Normal at 5% Significance Level					
2254	**Data Not Normal at 5% Significance Level**											
2255												
2256	**Assuming Normal Distribution**											
2257	**95% Normal UCL**						**95% UCLs (Adjusted for Skewness)**					
2258					95% Student's-t UCL	3,457					95% Adjusted-CLT UCL (Chen-1995)	4,631
2259											95% Modified-t UCL (Johnson-1978)	3,661
2260												
2261	**Gamma GOF Test**											
2262					A-D Test Statistic	5,059	**Anderson-Darling Gamma GOF Test**					
2263					5% A-D Critical Value	0,901	Data Not Gamma Distributed at 5% Significance Level					
2264					K-S Test Statistic	0,547	**Kolmogorov-Smirnov Gamma GOF Test**					
2265					5% K-S Critical Value	0,240	Data Not Gamma Distributed at 5% Significance Level					
2266	**Data Not Gamma Distributed at 5% Significance Level**											
2267												
2268	**Gamma Statistics**											
2269					k hat (MLE)	0,182					k star (bias corrected MLE)	0,189
2270					Theta hat (MLE)	7,173					Theta star (bias corrected MLE)	6,887
2271					nu hat (MLE)	5,819					nu star (bias corrected)	6,061
2272					MLE Mean (bias corrected)	1,304					MLE Sd (bias corrected)	2,997
2273											Approximate Chi Square Value (0,0500)	1,671
2274					Adjusted Level of Significance	0,0335					Adjusted Chi Square Value	1,423
2275												
2276	**Assuming Gamma Distribution**											
2277					95% Approximate Gamma UCL (use when n>=50))	4,731					95% Adjusted Gamma UCL (use when n<50)	5,554
2278												
2279	**Lognormal GOF Test**											
2280					Shapiro Wilk Test Statistic	0,412	**Shapiro Wilk Lognormal GOF Test**					
2281					5% Shapiro Wilk Critical Value	0,887	Data Not Lognormal at 5% Significance Level					
2282					Lilliefors Test Statistic	0,513	**Lilliefors Lognormal GOF Test**					
2283					5% Lilliefors Critical Value	0,213	Data Not Lognormal at 5% Significance Level					
2284	**Data Not Lognormal at 5% Significance Level**											
2285												
2286	**Lognormal Statistics**											
2287					Minimum of Logged Data	-4,605					Mean of logged Data	-3,841
2288					Maximum of Logged Data	2,981					SD of logged Data	2,155
2289												
2290	**Assuming Lognormal Distribution**											
2291					95% H-UCL	3,109					90% Chebyshev (MVUE) UCL	0,440
2292					95% Chebyshev (MVUE) UCL	0,570					97,5% Chebyshev (MVUE) UCL	0,750
2293					99% Chebyshev (MVUE) UCL	1,105						
2294												
2295	**Nonparametric Distribution Free UCL Statistics**											
2296	**Data do not follow a Discernible Distribution (0.05)**											
2297												
2298	**Nonparametric Distribution Free UCLs**											
2299					95% CLT UCL	3,324					95% Jackknife UCL	3,457
2300					95% Standard Bootstrap UCL	N/A					95% Bootstrap-t UCL	N/A

95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	4,988	95% Chebyshev(Mean, Sd) UCL	6,657
97,5% Chebyshev(Mean, Sd) UCL	8,973	99% Chebyshev(Mean, Sd) UCL	13,52
Suggested UCL to Use			
99% Chebyshev (Mean, Sd) UCL	13,52		
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.			
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 statistician.			
Benzo(a)pyrene			
General Statistics			
Total Number of Observations	16,00	Number of Distinct Observations	3,000
		Number of Missing Observations	0
Minimum	0,0100	Mean	1,070
Maximum	14,50	Median	0,0100
SD	3,634	Std. Error of Mean	0,908
Coefficient of Variation	3,396	Skewness	3,824
Normal GOF Test			
Shapiro Wilk Test Statistic	0,334	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0,887	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0,490	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0,213	Data Not Normal at 5% Significance Level	
Data Not Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	2,663	95% Adjusted-CLT UCL (Chen-1995)	3,492
		95% Modified-t UCL (Johnson-1978)	2,807
Gamma GOF Test			
A-D Test Statistic	4,945	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0,892	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0,551	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0,239	Data Not Gamma Distributed at 5% Significance Level	
Data Not Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	0,191	k star (bias corrected MLE)	0,197
Theta hat (MLE)	5,593	Theta star (bias corrected MLE)	5,428
nu hat (MLE)	6,122	nu star (bias corrected)	6,307
MLE Mean (bias corrected)	1,070	MLE Sd (bias corrected)	2,410
		Approximate Chi Square Value (0,0500)	1,799
Adjusted Level of Significance	0,0335	Adjusted Chi Square Value	1,539

Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	3,752	95% Adjusted Gamma UCL (use when n<50)	4,385
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0,413	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0,887	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0,516	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0,213	Data Not Lognormal at 5% Significance Level	
Data Not Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	-4,605	Mean of logged Data	-3,806
Maximum of Logged Data	2,674	SD of logged Data	2,208
Assuming Lognormal Distribution			
95% H-UCL	4,092	90% Chebyshev (MVUE) UCL	0,505
95% Chebyshev (MVUE) UCL	0,656	97,5% Chebyshev (MVUE) UCL	0,865
99% Chebyshev (MVUE) UCL	1,276		
Nonparametric Distribution Free UCL Statistics			
Data do not follow a Discernible Distribution (0.05)			
Nonparametric Distribution Free UCLs			
95% CLT UCL	2,564	95% Jackknife UCL	2,663
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	3,795	95% Chebyshev(Mean, Sd) UCL	5,030
97,5% Chebyshev(Mean, Sd) UCL	6,743	99% Chebyshev(Mean, Sd) UCL	10,11
Suggested UCL to Use			
99% Chebyshev (Mean, Sd) UCL	10,11		
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.			
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 statistician.			
Benzo(a)fluoranthene - Former USAF Dump Area and Former Ammunition Storage Area (Soil)			
General Statistics			
Total Number of Observations	16,00	Number of Distinct Observations	4,000
		Number of Missing Observations	0
Minimum	0,0100	Mean	1,031
Maximum	12,60	Median	0,0500
SD	3,194	Std. Error of Mean	0,798
Coefficient of Variation	3,099	Skewness	3,619

	A–E	F	G–K	L
2401	**Normal GOF Test**			
2402	Shapiro Wilk Test Statistic	0,366	**Shapiro Wilk GOF Test**	
2403	5% Shapiro Wilk Critical Value	0,887	Data Not Normal at 5% Significance Level	
2404	Lilliefors Test Statistic	0,496	**Lilliefors GOF Test**	
2405	5% Lilliefors Critical Value	0,213	Data Not Normal at 5% Significance Level	
2406	**Data Not Normal at 5% Significance Level**			
2407				
2408	**Assuming Normal Distribution**			
2409	**95% Normal UCL**		**95% UCLs (Adjusted for Skewness)**	
2410	95% Student's-t UCL	2,430	95% Adjusted-CLT UCL (Chen-1995)	3,116
2411			95% Modified-t UCL (Johnson-1978)	2,551
2412				
2413	**Gamma GOF Test**			
2414	A-D Test Statistic	3,670	**Anderson-Darling Gamma GOF Test**	
2415	5% A-D Critical Value	0,860	Data Not Gamma Distributed at 5% Significance Level	
2416	K-S Test Statistic	0,512	**Kolmogorov-Smirnov Gamma GOF Test**	
2417	5% K-S Critical Value	0,236	Data Not Gamma Distributed at 5% Significance Level	
2418	**Data Not Gamma Distributed at 5% Significance Level**			
2419				
2420	**Gamma Statistics**			
2421	k hat (MLE)	0,252	k star (bias corrected MLE)	0,246
2422	Theta hat (MLE)	4,096	Theta star (bias corrected MLE)	4,188
2423	nu hat (MLE)	8,052	nu star (bias corrected)	7,876
2424	MLE Mean (bias corrected)	1,031	MLE Sd (bias corrected)	2,077
2425			Approximate Chi Square Value (0,0500)	2,663
2426	Adjusted Level of Significance	0,0335	Adjusted Chi Square Value	2,330
2427				
2428	**Assuming Gamma Distribution**			
2429	95% Approximate Gamma UCL (use when n>=50))	3,048	95% Adjusted Gamma UCL (use when n<50)	3,483
2430				
2431	**Lognormal GOF Test**			
2432	Shapiro Wilk Test Statistic	0,672	**Shapiro Wilk Lognormal GOF Test**	
2433	5% Shapiro Wilk Critical Value	0,887	Data Not Lognormal at 5% Significance Level	
2434	Lilliefors Test Statistic	0,417	**Lilliefors Lognormal GOF Test**	
2435	5% Lilliefors Critical Value	0,213	Data Not Lognormal at 5% Significance Level	
2436	**Data Not Lognormal at 5% Significance Level**			
2437				
2438	**Lognormal Statistics**			
2439	Minimum of Logged Data	-4,605	Mean of logged Data	-2,790
2440	Maximum of Logged Data	2,534	SD of logged Data	1,965
2441				
2442	**Assuming Lognormal Distribution**			
2443	95% H-UCL	3,960	90% Chebyshev (MVUE) UCL	0,876
2444	95% Chebyshev (MVUE) UCL	1,127	97,5% Chebyshev (MVUE) UCL	1,475
2445	99% Chebyshev (MVUE) UCL	2,159		
2446				
2447	**Nonparametric Distribution Free UCL Statistics**			
2448	**Data do not follow a Discernible Distribution (0.05)**			
2449				
2450	**Nonparametric Distribution Free UCLs**			

	A–E	F	G–K	L
2451	95% CLT UCL	2,344	95% Jackknife UCL	2,430
2452	95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
2453	95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
2454	95% BCA Bootstrap UCL	N/A		
2455	90% Chebyshev(Mean, Sd) UCL	3,426	95% Chebyshev(Mean, Sd) UCL	4,511
2456	97,5% Chebyshev(Mean, Sd) UCL	6,017	99% Chebyshev(Mean, Sd) UCL	8,975
2457				
2458	**Suggested UCL to Use**			
2459	99% Chebyshev (Mean, Sd) UCL	8,975		
2460				
2461	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
2462	Recommendations are based upon data size, data distribution, and skewness.			
2463	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
2464	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
2465				
2466				
2467	Chryene - Former USAF Dump Area and Former Ammunition Storage Area (Soil)			
2468				
2469	**General Statistics**			
2470	Total Number of Observations	16,00	Number of Distinct Observations	4,000
2471			Number of Missing Observations	0
2472	Minimum	0,0100	Mean	1,174
2473	Maximum	16,10	Median	0,0100
2474	SD	4,030	Std. Error of Mean	1,007
2475	Coefficient of Variation	3,433	Skewness	3,848
2476				
2477	**Normal GOF Test**			
2478	Shapiro Wilk Test Statistic	0,330	**Shapiro Wilk GOF Test**	
2479	5% Shapiro Wilk Critical Value	0,887	Data Not Normal at 5% Significance Level	
2480	Lilliefors Test Statistic	0,488	**Lilliefors GOF Test**	
2481	5% Lilliefors Critical Value	0,213	Data Not Normal at 5% Significance Level	
2482	**Data Not Normal at 5% Significance Level**			
2483				
2484	**Assuming Normal Distribution**			
2485	**95% Normal UCL**		**95% UCLs (Adjusted for Skewness)**	
2486	95% Student's-t UCL	2,940	95% Adjusted-CLT UCL (Chen-1995)	3,867
2487			95% Modified-t UCL (Johnson-1978)	3,102
2488				
2489	**Gamma GOF Test**			
2490	A-D Test Statistic	4,889	**Anderson-Darling Gamma GOF Test**	
2491	5% A-D Critical Value	0,894	Data Not Gamma Distributed at 5% Significance Level	
2492	K-S Test Statistic	0,536	**Kolmogorov-Smirnov Gamma GOF Test**	
2493	5% K-S Critical Value	0,239	Data Not Gamma Distributed at 5% Significance Level	
2494	**Data Not Gamma Distributed at 5% Significance Level**			
2495				
2496	**Gamma Statistics**			
2497	k hat (MLE)	0,188	k star (bias corrected MLE)	0,195
2498	Theta hat (MLE)	6,230	Theta star (bias corrected MLE)	6,027
2499	nu hat (MLE)	6,030	nu star (bias corrected)	6,233
2500	MLE Mean (bias corrected)	1,174	MLE Sd (bias corrected)	2,660

	A	B	C	D	E	F	G	H	I	J	K	L
2501							Approximate Chi Square Value (0,0500)					1,760
2502	Adjusted Level of Significance					0,0335	Adjusted Chi Square Value					1,504
2503												
2504	**Assuming Gamma Distribution**											
2505	95% Approximate Gamma UCL (use when n>=50))					4,157	95% Adjusted Gamma UCL (use when n<50)					4,866
2506												
2507	**Lognormal GOF Test**											
2508	Shapiro Wilk Test Statistic					0,425	**Shapiro Wilk Lognormal GOF Test**					
2509	5% Shapiro Wilk Critical Value					0,887	Data Not Lognormal at 5% Significance Level					
2510	Lilliefors Test Statistic					0,475	**Lilliefors Lognormal GOF Test**					
2511	5% Lilliefors Critical Value					0,213	Data Not Lognormal at 5% Significance Level					
2512	**Data Not Lognormal at 5% Significance Level**											
2513												
2514	**Lognormal Statistics**											
2515	Minimum of Logged Data					-4,605	Mean of logged Data					-3,781
2516	Maximum of Logged Data					2,779	SD of logged Data					2,227
2517												
2518	**Assuming Lognormal Distribution**											
2519	95% H-UCL					4,564	90% Chebyshev (MVUE) UCL					0,537
2520	95% Chebyshev (MVUE) UCL					0,697	97,5% Chebyshev (MVUE) UCL					0,920
2521	99% Chebyshev (MVUE) UCL					1,358						
2522												
2523	**Nonparametric Distribution Free UCL Statistics**											
2524	**Data do not follow a Discernible Distribution (0.05)**											
2525												
2526	**Nonparametric Distribution Free UCLs**											
2527	95% CLT UCL					2,831	95% Jackknife UCL					2,940
2528	95% Standard Bootstrap UCL					N/A	95% Bootstrap-t UCL					N/A
2529	95% Hall's Bootstrap UCL					N/A	95% Percentile Bootstrap UCL					N/A
2530	95% BCA Bootstrap UCL					N/A						
2531	90% Chebyshev(Mean, Sd) UCL					4,196	95% Chebyshev(Mean, Sd) UCL					5,566
2532	97,5% Chebyshev(Mean, Sd) UCL					7,466	99% Chebyshev(Mean, Sd) UCL					11,20
2533												
2534	**Suggested UCL to Use**											
2535	99% Chebyshev (Mean, Sd) UCL					11,20						
2536												
2537	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
2538	Recommendations are based upon data size, data distribution, and skewness.											
2539	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
2540	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
2541												
2542												
2543	**Dibenzo(a,h)anthracene - Former USAF Dump Area and Former Ammunition Storage Area (Soil)**											
2544												
2545	**General Statistics**											
2546	Total Number of Observations					16,00	Number of Distinct Observations					4,000
2547							Number of Missing Observations					0
2548	Minimum					0,00600	Mean					0,141
2549	Maximum					1,900	Median					0,00600
2550	SD					0,473	Std. Error of Mean					0,118

	A	B	C	D	E	F	G	H	I	J	K	L
2551					Coefficient of Variation	3,365					Skewness	3,897
2552												
2553	**Normal GOF Test**											
2554					Shapiro Wilk Test Statistic	0,322	**Shapiro Wilk GOF Test**					
2555					5% Shapiro Wilk Critical Value	0,887	Data Not Normal at 5% Significance Level					
2556					Lilliefors Test Statistic	0,484	**Lilliefors GOF Test**					
2557					5% Lilliefors Critical Value	0,213	Data Not Normal at 5% Significance Level					
2558	**Data Not Normal at 5% Significance Level**											
2559												
2560	**Assuming Normal Distribution**											
2561	**95% Normal UCL**						**95% UCLs (Adjusted for Skewness)**					
2562					95% Student's-t UCL	0,348					95% Adjusted-CLT UCL (Chen-1995)	0,458
2563											95% Modified-t UCL (Johnson-1978)	0,367
2564												
2565	**Gamma GOF Test**											
2566					A-D Test Statistic	4,458	**Anderson-Darling Gamma GOF Test**					
2567					5% A-D Critical Value	0,844	Data Not Gamma Distributed at 5% Significance Level					
2568					K-S Test Statistic	0,511	**Kolmogorov-Smirnov Gamma GOF Test**					
2569					5% K-S Critical Value	0,234	Data Not Gamma Distributed at 5% Significance Level					
2570	**Data Not Gamma Distributed at 5% Significance Level**											
2571												
2572	**Gamma Statistics**											
2573					k hat (MLE)	0,286					k star (bias corrected MLE)	0,274
2574					Theta hat (MLE)	0,492					Theta star (bias corrected MLE)	0,513
2575					nu hat (MLE)	9,141					nu star (bias corrected)	8,760
2576					MLE Mean (bias corrected)	0,141					MLE Sd (bias corrected)	0,269
2577											Approximate Chi Square Value (0,0500)	3,183
2578					Adjusted Level of Significance	0,0335					Adjusted Chi Square Value	2,811
2579												
2580	**Assuming Gamma Distribution**											
2581					95% Approximate Gamma UCL (use when n>=50))	0,387					95% Adjusted Gamma UCL (use when n<50)	0,438
2582												
2583	**Lognormal GOF Test**											
2584					Shapiro Wilk Test Statistic	0,507	**Shapiro Wilk Lognormal GOF Test**					
2585					5% Shapiro Wilk Critical Value	0,887	Data Not Lognormal at 5% Significance Level					
2586					Lilliefors Test Statistic	0,426	**Lilliefors Lognormal GOF Test**					
2587					5% Lilliefors Critical Value	0,213	Data Not Lognormal at 5% Significance Level					
2588	**Data Not Lognormal at 5% Significance Level**											
2589												
2590	**Lognormal Statistics**											
2591					Minimum of Logged Data	-5,116					Mean of logged Data	-4,396
2592					Maximum of Logged Data	0,642					SD of logged Data	1,628
2593												
2594	**Assuming Lognormal Distribution**											
2595					95% H-UCL	0,227					90% Chebyshev (MVUE) UCL	0,0956
2596					95% Chebyshev (MVUE) UCL	0,121					97,5% Chebyshev (MVUE) UCL	0,156
2597					99% Chebyshev (MVUE) UCL	0,226						
2598												
2599	**Nonparametric Distribution Free UCL Statistics**											
2600	**Data do not follow a Discernible Distribution (0.05)**											

Nonparametric Distribution Free UCLs

95% CLT UCL	0,335	95% Jackknife UCL	0,348
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	0,495	95% Chebyshev(Mean, Sd) UCL	0,656
97,5% Chebyshev(Mean, Sd) UCL	0,879	99% Chebyshev(Mean, Sd) UCL	1,317

Suggested UCL to Use

99% Chebyshev (Mean, Sd) UCL	1,317		

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.
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 statistician.

Fluoranthene - Former USAF Dump Area and Former Ammunition Storage Area (Soil)

General Statistics

Total Number of Observations	16,00	Number of Distinct Observations	5,000
		Number of Missing Observations	0
Minimum	0,0100	Mean	3,782
Maximum	59,50	Median	0,0500
SD	14,86	Std. Error of Mean	3,715
Coefficient of Variation	3,929	Skewness	4,000

Normal GOF Test

Shapiro Wilk Test Statistic	0,276	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0,887	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0,526	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0,213	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	10,29	95% Adjusted-CLT UCL (Chen-1995)	13,86
		95% Modified-t UCL (Johnson-1978)	10,91

Gamma GOF Test

A-D Test Statistic	4,498	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0,901	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0,512	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0,240	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0,181	k star (bias corrected MLE)	0,189
Theta hat (MLE)	20,86	Theta star (bias corrected MLE)	20,01

	A–E	F	G–K	L
2651	nu hat (MLE)	5,801	nu star (bias corrected)	6,047
2652	MLE Mean (bias corrected)	3,782	MLE Sd (bias corrected)	8,699
2653			Approximate Chi Square Value (0,0500)	1,664
2654	Adjusted Level of Significance	0,0335	Adjusted Chi Square Value	1,417
2655				
2656	**Assuming Gamma Distribution**			
2657	95% Approximate Gamma UCL (use when n>=50))	13,74	95% Adjusted Gamma UCL (use when n<50)	16,14
2658				
2659	**Lognormal GOF Test**			
2660	Shapiro Wilk Test Statistic	0,622	**Shapiro Wilk Lognormal GOF Test**	
2661	5% Shapiro Wilk Critical Value	0,887	Data Not Lognormal at 5% Significance Level	
2662	Lilliefors Test Statistic	0,415	**Lilliefors Lognormal GOF Test**	
2663	5% Lilliefors Critical Value	0,213	Data Not Lognormal at 5% Significance Level	
2664	**Data Not Lognormal at 5% Significance Level**			
2665				
2666	**Lognormal Statistics**			
2667	Minimum of Logged Data	-4,605	Mean of logged Data	-2,791
2668	Maximum of Logged Data	4,086	SD of logged Data	2,060
2669				
2670	**Assuming Lognormal Distribution**			
2671	95% H-UCL	5,852	90% Chebyshev (MVUE) UCL	1,045
2672	95% Chebyshev (MVUE) UCL	1,349	97,5% Chebyshev (MVUE) UCL	1,771
2673	99% Chebyshev (MVUE) UCL	2,601		
2674				
2675	**Nonparametric Distribution Free UCL Statistics**			
2676	**Data do not follow a Discernible Distribution (0.05)**			
2677				
2678	**Nonparametric Distribution Free UCLs**			
2679	95% CLT UCL	9,892	95% Jackknife UCL	10,29
2680	95% Standard Bootstrap UCL	9,759	95% Bootstrap-t UCL	3205
2681	95% Hall's Bootstrap UCL	1539	95% Percentile Bootstrap UCL	11,19
2682	95% BCA Bootstrap UCL	14,93		
2683	90% Chebyshev(Mean, Sd) UCL	14,93	95% Chebyshev(Mean, Sd) UCL	19,97
2684	97,5% Chebyshev(Mean, Sd) UCL	26,98	99% Chebyshev(Mean, Sd) UCL	40,74
2685				
2686	**Suggested UCL to Use**			
2687	99% Chebyshev (Mean, Sd) UCL	40,74		
2688				
2689	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
2690	Recommendations are based upon data size, data distribution, and skewness.			
2691	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
2692	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
2693				
2694				
2695	**Phenanthrene - Former USAF Dump Area and Former Ammunition Storage Area (Soil)**			
2696				
2697	**General Statistics**			
2698	Total Number of Observations	16,00	Number of Distinct Observations	5,000
2699			Number of Missing Observations	0
2700	Minimum	0,0100	Mean	2,952

	A	B	C	D	E	F	G	H	I	J	K	L
2701					Maximum	46,80					Median	0,0300
2702					SD	11,69					Std. Error of Mean	2,923
2703					Coefficient of Variation	3,961					Skewness	4,000
2704												
2705	**Normal GOF Test**											
2706					Shapiro Wilk Test Statistic	0,273	**Shapiro Wilk GOF Test**					
2707					5% Shapiro Wilk Critical Value	0,887	Data Not Normal at 5% Significance Level					
2708					Lilliefors Test Statistic	0,535	**Lilliefors GOF Test**					
2709					5% Lilliefors Critical Value	0,213	Data Not Normal at 5% Significance Level					
2710	**Data Not Normal at 5% Significance Level**											
2711												
2712	**Assuming Normal Distribution**											
2713	**95% Normal UCL**						**95% UCLs (Adjusted for Skewness)**					
2714					95% Student's-t UCL	8,076					95% Adjusted-CLT UCL (Chen-1995)	10,88
2715											95% Modified-t UCL (Johnson-1978)	8,564
2716												
2717	**Gamma GOF Test**											
2718					A-D Test Statistic	5,456	**Anderson-Darling Gamma GOF Test**					
2719					5% A-D Critical Value	0,905	Data Not Gamma Distributed at 5% Significance Level					
2720					K-S Test Statistic	0,548	**Kolmogorov-Smirnov Gamma GOF Test**					
2721					5% K-S Critical Value	0,240	Data Not Gamma Distributed at 5% Significance Level					
2722	**Data Not Gamma Distributed at 5% Significance Level**											
2723												
2724	**Gamma Statistics**											
2725					k hat (MLE)	0,177					k star (bias corrected MLE)	0,185
2726					Theta hat (MLE)	16,68					Theta star (bias corrected MLE)	15,92
2727					nu hat (MLE)	5,661					nu star (bias corrected)	5,933
2728					MLE Mean (bias corrected)	2,952					MLE Sd (bias corrected)	6,855
2729											Approximate Chi Square Value (0,0500)	1,606
2730					Adjusted Level of Significance	0,0335					Adjusted Chi Square Value	1,364
2731												
2732	**Assuming Gamma Distribution**											
2733					95% Approximate Gamma UCL (use when n>=50))	10,91					95% Adjusted Gamma UCL (use when n<50)	12,84
2734												
2735	**Lognormal GOF Test**											
2736					Shapiro Wilk Test Statistic	0,428	**Shapiro Wilk Lognormal GOF Test**					
2737					5% Shapiro Wilk Critical Value	0,887	Data Not Lognormal at 5% Significance Level					
2738					Lilliefors Test Statistic	0,448	**Lilliefors Lognormal GOF Test**					
2739					5% Lilliefors Critical Value	0,213	Data Not Lognormal at 5% Significance Level					
2740	**Data Not Lognormal at 5% Significance Level**											
2741												
2742	**Lognormal Statistics**											
2743					Minimum of Logged Data	-4,605					Mean of logged Data	-3,157
2744					Maximum of Logged Data	3,846					SD of logged Data	1,912
2745												
2746	**Assuming Lognormal Distribution**											
2747					95% H-UCL	2,214					90% Chebyshev (MVUE) UCL	0,549
2748					95% Chebyshev (MVUE) UCL	0,705					97,5% Chebyshev (MVUE) UCL	0,921
2749					99% Chebyshev (MVUE) UCL	1,346						
2750												

Nonparametric Distribution Free UCL Statistics			
Data do not follow a Discernible Distribution (0.05)			
Nonparametric Distribution Free UCLs			
95% CLT UCL	7,760	95% Jackknife UCL	8,076
95% Standard Bootstrap UCL	7,650	95% Bootstrap-t UCL	5061
95% Hall's Bootstrap UCL	3690	95% Percentile Bootstrap UCL	8,798
95% BCA Bootstrap UCL	11,72		
90% Chebyshev(Mean, Sd) UCL	11,72	95% Chebyshev(Mean, Sd) UCL	15,69
97,5% Chebyshev(Mean, Sd) UCL	21,21	99% Chebyshev(Mean, Sd) UCL	32,04
Suggested UCL to Use			
99% Chebyshev (Mean, Sd) UCL	32,04		
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.			
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 statistician.			
Cadmium - Former USAF Dump Area and Former Ammunition Storage Area (Soil)			
General Statistics			
Total Number of Observations	15,00	Number of Distinct Observations	4,000
		Number of Missing Observations	0
Minimum	0,300	Mean	0,446
Maximum	2,000	Median	0,300
SD	0,440	Std. Error of Mean	0,114
Coefficient of Variation	0,987	Skewness	3,599
Normal GOF Test			
Shapiro Wilk Test Statistic	0,388	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0,881	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0,430	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0,220	Data Not Normal at 5% Significance Level	
Data Not Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	0,646	95% Adjusted-CLT UCL (Chen-1995)	0,746
		95% Modified-t UCL (Johnson-1978)	0,664
Gamma GOF Test			
A-D Test Statistic	3,812	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0,745	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0,458	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0,224	Data Not Gamma Distributed at 5% Significance Level	
Data Not Gamma Distributed at 5% Significance Level			
Gamma Statistics			

	A–E	F	G–K	L
2801	k hat (MLE)	2,746	k star (bias corrected MLE)	2,241
2802	Theta hat (MLE)	0,162	Theta star (bias corrected MLE)	0,199
2803	nu hat (MLE)	82,39	nu star (bias corrected)	67,24
2804	MLE Mean (bias corrected)	0,446	MLE Sd (bias corrected)	0,298
2805			Approximate Chi Square Value (0,0500)	49,37
2806	Adjusted Level of Significance	0,0324	Adjusted Chi Square Value	47,49
2807				
2808	**Assuming Gamma Distribution**			
2809	95% Approximate Gamma UCL (use when n>=50))	0,607	95% Adjusted Gamma UCL (use when n<50)	0,632
2810				
2811	**Lognormal GOF Test**			
2812	Shapiro Wilk Test Statistic	0,474	**Shapiro Wilk Lognormal GOF Test**	
2813	5% Shapiro Wilk Critical Value	0,881	Data Not Lognormal at 5% Significance Level	
2814	Lilliefors Test Statistic	0,453	**Lilliefors Lognormal GOF Test**	
2815	5% Lilliefors Critical Value	0,220	Data Not Lognormal at 5% Significance Level	
2816	**Data Not Lognormal at 5% Significance Level**			
2817				
2818	**Lognormal Statistics**			
2819	Minimum of Logged Data	-1,204	Mean of logged Data	-1,000
2820	Maximum of Logged Data	0,693	SD of logged Data	0,516
2821				
2822	**Assuming Lognormal Distribution**			
2823	95% H-UCL	0,560	90% Chebyshev (MVUE) UCL	0,587
2824	95% Chebyshev (MVUE) UCL	0,665	97,5% Chebyshev (MVUE) UCL	0,773
2825	99% Chebyshev (MVUE) UCL	0,984		
2826				
2827	**Nonparametric Distribution Free UCL Statistics**			
2828	**Data do not follow a Discernible Distribution (0.05)**			
2829				
2830	**Nonparametric Distribution Free UCLs**			
2831	95% CLT UCL	0,633	95% Jackknife UCL	0,646
2832	95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
2833	95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
2834	95% BCA Bootstrap UCL	N/A		
2835	90% Chebyshev(Mean, Sd) UCL	0,787	95% Chebyshev(Mean, Sd) UCL	0,941
2836	97,5% Chebyshev(Mean, Sd) UCL	1,156	99% Chebyshev(Mean, Sd) UCL	1,577
2837				
2838	**Suggested UCL to Use**			
2839	95% Chebyshev (Mean, Sd) UCL	0,941		
2840				
2841	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
2842	Recommendations are based upon data size, data distribution, and skewness.			
2843	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
2844	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
2845				
2846				
2847	**Lead - Former USAF Dump Area and Former Ammunition Storage Area (Soil)**			
2848				
2849	**General Statistics**			
2850	Total Number of Observations	15,00	Number of Distinct Observations	13,00

	A	B	C	D	E	F	G	H	I	J	K	L
2851											Number of Missing Observations	0
2852					Minimum	3,200					Mean	23,10
2853					Maximum	180,0					Median	6,600
2854					SD	46,16					Std. Error of Mean	11,92
2855					Coefficient of Variation	1,998					Skewness	3,247
2856												
2857	**Normal GOF Test**											
2858					Shapiro Wilk Test Statistic	0,478	**Shapiro Wilk GOF Test**					
2859					5% Shapiro Wilk Critical Value	0,881	Data Not Normal at 5% Significance Level					
2860					Lilliefors Test Statistic	0,395	**Lilliefors GOF Test**					
2861					5% Lilliefors Critical Value	0,220	Data Not Normal at 5% Significance Level					
2862	**Data Not Normal at 5% Significance Level**											
2863												
2864	**Assuming Normal Distribution**											
2865	**95% Normal UCL**						**95% UCLs (Adjusted for Skewness)**					
2866					95% Student's-t UCL	44,09					95% Adjusted-CLT UCL (Chen-1995)	53,38
2867											95% Modified-t UCL (Johnson-1978)	45,76
2868												
2869	**Gamma GOF Test**											
2870					A-D Test Statistic	1,947	**Anderson-Darling Gamma GOF Test**					
2871					5% A-D Critical Value	0,780	Data Not Gamma Distributed at 5% Significance Level					
2872					K-S Test Statistic	0,325	**Kolmogorov-Smirnov Gamma GOF Test**					
2873					5% K-S Critical Value	0,231	Data Not Gamma Distributed at 5% Significance Level					
2874	**Data Not Gamma Distributed at 5% Significance Level**											
2875												
2876	**Gamma Statistics**											
2877					k hat (MLE)	0,679					k star (bias corrected MLE)	0,588
2878					Theta hat (MLE)	34,02					Theta star (bias corrected MLE)	39,30
2879					nu hat (MLE)	20,37					nu star (bias corrected)	17,63
2880					MLE Mean (bias corrected)	23,10					MLE Sd (bias corrected)	30,13
2881											Approximate Chi Square Value (0,0500)	9,125
2882					Adjusted Level of Significance	0,0324					Adjusted Chi Square Value	8,380
2883												
2884	**Assuming Gamma Distribution**											
2885					95% Approximate Gamma UCL (use when n>=50))	44,63					95% Adjusted Gamma UCL (use when n<50)	48,60
2886												
2887	**Lognormal GOF Test**											
2888					Shapiro Wilk Test Statistic	0,818	**Shapiro Wilk Lognormal GOF Test**					
2889					5% Shapiro Wilk Critical Value	0,881	Data Not Lognormal at 5% Significance Level					
2890					Lilliefors Test Statistic	0,223	**Lilliefors Lognormal GOF Test**					
2891					5% Lilliefors Critical Value	0,220	Data Not Lognormal at 5% Significance Level					
2892	**Data Not Lognormal at 5% Significance Level**											
2893												
2894	**Lognormal Statistics**											
2895					Minimum of Logged Data	1,163					Mean of logged Data	2,246
2896					Maximum of Logged Data	5,193					SD of logged Data	1,146
2897												
2898	**Assuming Lognormal Distribution**											
2899					95% H-UCL	45,41					90% Chebyshev (MVUE) UCL	33,88
2900					95% Chebyshev (MVUE) UCL	41,49					97,5% Chebyshev (MVUE) UCL	52,06

	A	B	C	D	E	F	G	H	I	J	K	L
2901					99% Chebyshev (MVUE) UCL	72,83						
2902												
2903	**Nonparametric Distribution Free UCL Statistics**											
2904	**Data do not follow a Discernible Distribution (0.05)**											
2905												
2906	**Nonparametric Distribution Free UCLs**											
2907					95% CLT UCL	42,70					95% Jackknife UCL	44,09
2908					95% Standard Bootstrap UCL	42,02					95% Bootstrap-t UCL	156,0
2909					95% Hall's Bootstrap UCL	131,3					95% Percentile Bootstrap UCL	43,63
2910					95% BCA Bootstrap UCL	57,93						
2911					90% Chebyshev(Mean, Sd) UCL	58,86					95% Chebyshev(Mean, Sd) UCL	75,05
2912					97,5% Chebyshev(Mean, Sd) UCL	97,53					99% Chebyshev(Mean, Sd) UCL	141,7
2913												
2914	**Suggested UCL to Use**											
2915					95% Chebyshev (Mean, Sd) UCL	75,05						
2916												
2917	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
2918	Recommendations are based upon data size, data distribution, and skewness.											
2919	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
2920	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
2921												
2922												
2923	**Molybdenum - Former USAF Dump Area and Former Ammunition Storage Area (Soil)**											
2924												
2925	**General Statistics**											
2926					Total Number of Observations	15,00					Number of Distinct Observations	3,000
2927											Number of Missing Observations	0
2928					Minimum	2,000					Mean	2,307
2929					Maximum	6,000					Median	2,000
2930					SD	1,033					Std. Error of Mean	0,267
2931					Coefficient of Variation	0,448					Skewness	3,737
2932												
2933	**Normal GOF Test**											
2934					Shapiro Wilk Test Statistic	0,341	**Shapiro Wilk GOF Test**					
2935					5% Shapiro Wilk Critical Value	0,881	Data Not Normal at 5% Significance Level					
2936					Lilliefors Test Statistic	0,483	**Lilliefors GOF Test**					
2937					5% Lilliefors Critical Value	0,220	Data Not Normal at 5% Significance Level					
2938	**Data Not Normal at 5% Significance Level**											
2939												
2940	**Assuming Normal Distribution**											
2941	**95% Normal UCL**						**95% UCLs (Adjusted for Skewness)**					
2942					95% Student's-t UCL	2,777					95% Adjusted-CLT UCL (Chen-1995)	3,021
2943											95% Modified-t UCL (Johnson-1978)	2,820
2944												
2945	**Gamma GOF Test**											
2946					A-D Test Statistic	4,504	**Anderson-Darling Gamma GOF Test**					
2947					5% A-D Critical Value	0,737	Data Not Gamma Distributed at 5% Significance Level					
2948					K-S Test Statistic	0,495	**Kolmogorov-Smirnov Gamma GOF Test**					
2949					5% K-S Critical Value	0,222	Data Not Gamma Distributed at 5% Significance Level					
2950	**Data Not Gamma Distributed at 5% Significance Level**											

	A–E	F	G–K	L
2951				
2952	**Gamma Statistics**			
2953	k hat (MLE)	9,793	k star (bias corrected MLE)	7,879
2954	Theta hat (MLE)	0,236	Theta star (bias corrected MLE)	0,293
2955	nu hat (MLE)	293,8	nu star (bias corrected)	236,4
2956	MLE Mean (bias corrected)	2,307	MLE Sd (bias corrected)	0,822
2957			Approximate Chi Square Value (0,0500)	201,8
2958	Adjusted Level of Significance	0,0324	Adjusted Chi Square Value	197,8
2959				
2960	**Assuming Gamma Distribution**			
2961	95% Approximate Gamma UCL (use when n>=50))	2,702	95% Adjusted Gamma UCL (use when n<50)	2,756
2962				
2963	**Lognormal GOF Test**			
2964	Shapiro Wilk Test Statistic	0,370	**Shapiro Wilk Lognormal GOF Test**	
2965	5% Shapiro Wilk Critical Value	0,881	Data Not Lognormal at 5% Significance Level	
2966	Lilliefors Test Statistic	0,491	**Lilliefors Lognormal GOF Test**	
2967	5% Lilliefors Critical Value	0,220	Data Not Lognormal at 5% Significance Level	
2968	**Data Not Lognormal at 5% Significance Level**			
2969				
2970	**Lognormal Statistics**			
2971	Minimum of Logged Data	0,693	Mean of logged Data	0,784
2972	Maximum of Logged Data	1,792	SD of logged Data	0,287
2973				
2974	**Assuming Lognormal Distribution**			
2975	95% H-UCL	2,634	90% Chebyshev (MVUE) UCL	2,786
2976	95% Chebyshev (MVUE) UCL	3,018	97,5% Chebyshev (MVUE) UCL	3,339
2977	99% Chebyshev (MVUE) UCL	3,970		
2978				
2979	**Nonparametric Distribution Free UCL Statistics**			
2980	**Data do not follow a Discernible Distribution (0.05)**			
2981				
2982	**Nonparametric Distribution Free UCLs**			
2983	95% CLT UCL	2,746	95% Jackknife UCL	2,777
2984	95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
2985	95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
2986	95% BCA Bootstrap UCL	N/A		
2987	90% Chebyshev(Mean, Sd) UCL	3,107	95% Chebyshev(Mean, Sd) UCL	3,470
2988	97,5% Chebyshev(Mean, Sd) UCL	3,973	99% Chebyshev(Mean, Sd) UCL	4,961
2989				
2990	**Suggested UCL to Use**			
2991	95% Student's-t UCL	2,777	or 95% Modified-t UCL	2,820
2992				
2993	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
2994	Recommendations are based upon data size, data distribution, and skewness.			
2995	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
2996	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
2997				
2998				
2999	**Tin - Former USAF Dump Area and Former Ammunition Storage Area (Soil)**			
3000				

	A–E	F	G–K	L
3001	**General Statistics**			
3002	Total Number of Observations	15,00	Number of Distinct Observations	3,000
3003			Number of Missing Observations	0
3004	Minimum	2,000	Mean	3,073
3005	Maximum	14,00	Median	2,000
3006	SD	3,202	Std. Error of Mean	0,827
3007	Coefficient of Variation	1,042	Skewness	3,305
3008				
3009	**Normal GOF Test**			
3010	Shapiro Wilk Test Statistic	0,396	**Shapiro Wilk GOF Test**	
3011	5% Shapiro Wilk Critical Value	0,881	Data Not Normal at 5% Significance Level	
3012	Lilliefors Test Statistic	0,498	**Lilliefors GOF Test**	
3013	5% Lilliefors Critical Value	0,220	Data Not Normal at 5% Significance Level	
3014	**Data Not Normal at 5% Significance Level**			
3015				
3016	**Assuming Normal Distribution**			
3017	**95% Normal UCL**		**95% UCLs (Adjusted for Skewness)**	
3018	95% Student's-t UCL	4,529	95% Adjusted-CLT UCL (Chen-1995)	5,187
3019			95% Modified-t UCL (Johnson-1978)	4,647
3020				
3021	**Gamma GOF Test**			
3022	A-D Test Statistic	4,363	**Anderson-Darling Gamma GOF Test**	
3023	5% A-D Critical Value	0,746	Data Not Gamma Distributed at 5% Significance Level	
3024	K-S Test Statistic	0,519	**Kolmogorov-Smirnov Gamma GOF Test**	
3025	5% K-S Critical Value	0,224	Data Not Gamma Distributed at 5% Significance Level	
3026	**Data Not Gamma Distributed at 5% Significance Level**			
3027				
3028	**Gamma Statistics**			
3029	k hat (MLE)	2,370	k star (bias corrected MLE)	1,941
3030	Theta hat (MLE)	1,297	Theta star (bias corrected MLE)	1,584
3031	nu hat (MLE)	71,10	nu star (bias corrected)	58,22
3032	MLE Mean (bias corrected)	3,073	MLE Sd (bias corrected)	2,206
3033			Approximate Chi Square Value (0,0500)	41,68
3034	Adjusted Level of Significance	0,0324	Adjusted Chi Square Value	39,96
3035				
3036	**Assuming Gamma Distribution**			
3037	95% Approximate Gamma UCL (use when n>=50))	4,293	95% Adjusted Gamma UCL (use when n<50)	4,478
3038				
3039	**Lognormal GOF Test**			
3040	Shapiro Wilk Test Statistic	0,427	**Shapiro Wilk Lognormal GOF Test**	
3041	5% Shapiro Wilk Critical Value	0,881	Data Not Lognormal at 5% Significance Level	
3042	Lilliefors Test Statistic	0,509	**Lilliefors Lognormal GOF Test**	
3043	5% Lilliefors Critical Value	0,220	Data Not Lognormal at 5% Significance Level	
3044	**Data Not Lognormal at 5% Significance Level**			
3045				
3046	**Lognormal Statistics**			
3047	Minimum of Logged Data	0,693	Mean of logged Data	0,897
3048	Maximum of Logged Data	2,639	SD of logged Data	0,561
3049				
3050	**Assuming Lognormal Distribution**			

	A–E	F	G–K	L
3051	95% H-UCL	3,954	90% Chebyshev (MVUE) UCL	4,115
3052	95% Chebyshev (MVUE) UCL	4,694	97,5% Chebyshev (MVUE) UCL	5,498
3053	99% Chebyshev (MVUE) UCL	7,076		
3054				
3055	**Nonparametric Distribution Free UCL Statistics**			
3056	**Data do not follow a Discernible Distribution (0.05)**			
3057				
3058	**Nonparametric Distribution Free UCLs**			
3059	95% CLT UCL	4,433	95% Jackknife UCL	4,529
3060	95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
3061	95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
3062	95% BCA Bootstrap UCL	N/A		
3063	90% Chebyshev(Mean, Sd) UCL	5,554	95% Chebyshev(Mean, Sd) UCL	6,677
3064	97,5% Chebyshev(Mean, Sd) UCL	8,236	99% Chebyshev(Mean, Sd) UCL	11,30
3065				
3066	**Suggested UCL to Use**			
3067	95% Chebyshev (Mean, Sd) UCL	6,677		
3068				
3069	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
3070	Recommendations are based upon data size, data distribution, and skewness.			
3071	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
3072	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
3073				
3074				
3075	**Zinc - Former USAF Dump Area and Former Ammunition Storage Area (Soil)**			
3076				
3077	**General Statistics**			
3078	Total Number of Observations	27,00	Number of Distinct Observations	25,00
3079			Number of Missing Observations	0
3080	Minimum	6,100	Mean	164,0
3081	Maximum	1800	Median	45,00
3082	SD	347,7	Std. Error of Mean	66,92
3083	Coefficient of Variation	2,121	Skewness	4,319
3084				
3085	**Normal GOF Test**			
3086	Shapiro Wilk Test Statistic	0,450	**Shapiro Wilk GOF Test**	
3087	5% Shapiro Wilk Critical Value	0,923	Data Not Normal at 5% Significance Level	
3088	Lilliefors Test Statistic	0,325	**Lilliefors GOF Test**	
3089	5% Lilliefors Critical Value	0,167	Data Not Normal at 5% Significance Level	
3090	**Data Not Normal at 5% Significance Level**			
3091				
3092	**Assuming Normal Distribution**			
3093	**95% Normal UCL**		**95% UCLs (Adjusted for Skewness)**	
3094	95% Student's-t UCL	278,1	95% Adjusted-CLT UCL (Chen-1995)	333,5
3095			95% Modified-t UCL (Johnson-1978)	287,4
3096				
3097	**Gamma GOF Test**			
3098	A-D Test Statistic	1,398	**Anderson-Darling Gamma GOF Test**	
3099	5% A-D Critical Value	0,797	Data Not Gamma Distributed at 5% Significance Level	
3100	K-S Test Statistic	0,189	**Kolmogorov-Smirnov Gamma GOF Test**	

	A B C D E	F	G H I J K	L
3101	5% K-S Critical Value	0,177	Data Not Gamma Distributed at 5% Significance Level	
3102	**Data Not Gamma Distributed at 5% Significance Level**			
3103				
3104	**Gamma Statistics**			
3105	k hat (MLE)	0,615	k star (bias corrected MLE)	0,571
3106	Theta hat (MLE)	266,8	Theta star (bias corrected MLE)	287,2
3107	nu hat (MLE)	33,18	nu star (bias corrected)	30,83
3108	MLE Mean (bias corrected)	164,0	MLE Sd (bias corrected)	217,0
3109			Approximate Chi Square Value (0,0500)	19,15
3110	Adjusted Level of Significance	0,0401	Adjusted Chi Square Value	18,56
3111				
3112	**Assuming Gamma Distribution**			
3113	95% Approximate Gamma UCL (use when n>=50))	264,0	95% Adjusted Gamma UCL (use when n<50)	272,4
3114				
3115	**Lognormal GOF Test**			
3116	Shapiro Wilk Test Statistic	0,962	**Shapiro Wilk Lognormal GOF Test**	
3117	5% Shapiro Wilk Critical Value	0,923	Data appear Lognormal at 5% Significance Level	
3118	Lilliefors Test Statistic	0,134	**Lilliefors Lognormal GOF Test**	
3119	5% Lilliefors Critical Value	0,167	Data appear Lognormal at 5% Significance Level	
3120	**Data appear Lognormal at 5% Significance Level**			
3121				
3122	**Lognormal Statistics**			
3123	Minimum of Logged Data	1,808	Mean of logged Data	4,098
3124	Maximum of Logged Data	7,496	SD of logged Data	1,341
3125				
3126	**Assuming Lognormal Distribution**			
3127	95% H-UCL	325,1	90% Chebyshev (MVUE) UCL	270,7
3128	95% Chebyshev (MVUE) UCL	330,2	97,5% Chebyshev (MVUE) UCL	412,7
3129	99% Chebyshev (MVUE) UCL	574,7		
3130				
3131	**Nonparametric Distribution Free UCL Statistics**			
3132	**Data appear to follow a Discernible Distribution at 5% Significance Level**			
3133				
3134	**Nonparametric Distribution Free UCLs**			
3135	95% CLT UCL	274,0	95% Jackknife UCL	278,1
3136	95% Standard Bootstrap UCL	272,9	95% Bootstrap-t UCL	498,6
3137	95% Hall's Bootstrap UCL	662,4	95% Percentile Bootstrap UCL	293,8
3138	95% BCA Bootstrap UCL	334,6		
3139	90% Chebyshev(Mean, Sd) UCL	364,7	95% Chebyshev(Mean, Sd) UCL	455,7
3140	97,5% Chebyshev(Mean, Sd) UCL	581,9	99% Chebyshev(Mean, Sd) UCL	829,8
3141				
3142	**Suggested UCL to Use**			
3143	95% H-UCL	325,1		
3144				
3145	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
3146	Recommendations are based upon data size, data distribution, and skewness.			
3147	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
3148	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
3149				
3150	**ProUCL computes and outputs H-statistic based UCLs for historical reasons only.**			

H-statistic often results in unstable (both high and low) values of UCL95 as shown in examples in the Technical Guide.

It is therefore recommended to avoid the use of H-statistic based 95% UCLs.

Use of nonparametric methods are preferred to compute UCL95 for skewed data sets which do not follow a gamma distribution.

Calculated Total PCB - Former USAF Dump Area and Former Ammunition Storage Area (Soil)

General Statistics			
Total Number of Observations	13,00	Number of Distinct Observations	11,00
		Number of Missing Observations	0
Minimum	0,0500	Mean	2,668
Maximum	24,00	Median	0,400
SD	6,497	Std. Error of Mean	1,802
Coefficient of Variation	2,435	Skewness	3,441
Normal GOF Test			
Shapiro Wilk Test Statistic	0,441	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0,866	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0,403	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0,234	Data Not Normal at 5% Significance Level	
Data Not Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	5,879	95% Adjusted-CLT UCL (Chen-1995)	7,469
		95% Modified-t UCL (Johnson-1978)	6,166
Gamma GOF Test			
A-D Test Statistic	0,904	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0,815	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0,212	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0,254	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data follow Appr. Gamma Distribution at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	0,373	k star (bias corrected MLE)	0,338
Theta hat (MLE)	7,153	Theta star (bias corrected MLE)	7,889
nu hat (MLE)	9,697	nu star (bias corrected)	8,792
MLE Mean (bias corrected)	2,668	MLE Sd (bias corrected)	4,588
		Approximate Chi Square Value (0,0500)	3,202
Adjusted Level of Significance	0,0301	Adjusted Chi Square Value	2,740
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50)	7,325	95% Adjusted Gamma UCL (use when n<50)	8,561
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0,915	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0,866	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0,147	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0,234	Data appear Lognormal at 5% Significance Level	

	A	B	C	D	E	F	G	H	I	J	K	L
3201	**Data appear Lognormal at 5% Significance Level**											
3202												
3203	**Lognormal Statistics**											
3204					Minimum of Logged Data	-2,996					Mean of logged Data	-0,803
3205					Maximum of Logged Data	3,178					SD of logged Data	1,967
3206												
3207	**Assuming Lognormal Distribution**											
3208					95% H-UCL	45,35					90% Chebyshev (MVUE) UCL	6,296
3209					95% Chebyshev (MVUE) UCL	8,135					97,5% Chebyshev (MVUE) UCL	10,69
3210					99% Chebyshev (MVUE) UCL	15,70						
3211												
3212	**Nonparametric Distribution Free UCL Statistics**											
3213	**Data appear to follow a Discernible Distribution at 5% Significance Level**											
3214												
3215	**Nonparametric Distribution Free UCLs**											
3216					95% CLT UCL	5,632					95% Jackknife UCL	5,879
3217					95% Standard Bootstrap UCL	5,504					95% Bootstrap-t UCL	17,38
3218					95% Hall's Bootstrap UCL	16,52					95% Percentile Bootstrap UCL	6,108
3219					95% BCA Bootstrap UCL	7,955						
3220					90% Chebyshev(Mean, Sd) UCL	8,074					95% Chebyshev(Mean, Sd) UCL	10,52
3221					97,5% Chebyshev(Mean, Sd) UCL	13,92					99% Chebyshev(Mean, Sd) UCL	20,60
3222												
3223	**Suggested UCL to Use**											
3224					95% Adjusted Gamma UCL	8,561						
3225												
3226	When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test											
3227	When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL											
3228												
3229	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
3230	Recommendations are based upon data size, data distribution, and skewness.											
3231	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
3232	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
3233												

	A	B	C	D	E	F	G	H	I	J	K	L
1					**Outlier Tests for Selected Uncensored Variables**							
2	**User Selected Options**											
3	Date/Time of Computation			ProUCL 5.12019-05-10 09:56:27								
4				From File	WorkSheet.xls							
5				Full Precision	OFF							
6												
7												
8	**n's Outlier Test for Fraction F3 (>C16-C34) - General Area (S**											
9												
10	Number of Observations = 24											
11	10% critical value: 0,367											
12	5% critical value: 0,413											
13	1% critical value: 0,497											
14												
15	**1. Observation Value 550 is a Potential Outlier (Upper Tail)?**											
16												
17	Test Statistic: 0,779											
18												
19	For 10% significance level, 550 is an outlier.											
20	For 5% significance level, 550 is an outlier.											
21	For 1% significance level, 550 is an outlier.											
22												
23	**2. Observation Value 18 is a Potential Outlier (Lower Tail)?**											
24												
25	Test Statistic: 0,049											
26												
27	For 10% significance level, 18 is not an outlier.											
28	For 5% significance level, 18 is not an outlier.											
29	For 1% significance level, 18 is not an outlier.											
30												
31												
32	**Dixon's Outlier Test for Vanadium - General Area (Soil)**											
33												
34	Number of Observations = 11											
35	10% critical value: 0,517											
36	5% critical value: 0,576											
37	1% critical value: 0,679											
38												
39	**1. Observation Value 45 is a Potential Outlier (Upper Tail)?**											
40												
41	Test Statistic: 0,485											
42												
43	For 10% significance level, 45 is not an outlier.											
44	For 5% significance level, 45 is not an outlier.											
45	For 1% significance level, 45 is not an outlier.											
46												
47	**2. Observation Value 2 is a Potential Outlier (Lower Tail)?**											
48												
49	Test Statistic: 0,467											
50												

For 10% significance level, 2 is not an outlier.

For 5% significance level, 2 is not an outlier.

For 1% significance level, 2 is not an outlier.

Rosner's Outlier Test for Fraction F1 (C6-C10) - Former Contractor Village (Soil)

Mean	**48,24**
Standard Deviation	**83,30**
Number of data	**27**
Number of suspected outliers	**1**

#	Mean	sd	Potential outlier	Obs. Number	Test value	Critical value (5%)	Critical value (1%)
1	48,24	81,74	260,0	12,00	2,591	2,860	3,180

For 5% Significance Level, there is no Potential Outlier

For 1% Significance Level, there is no Potential Outlier

Rosner's Outlier Test for Fraction F2 (>C10-C16) - Former Contractor Village (Soil)

Mean	**340,3**
Standard Deviation	**856,7**
Number of data	**27**
Number of suspected outliers	**1**

#	Mean	sd	Potential outlier	Obs. Number	Test value	Critical value (5%)	Critical value (1%)
1	340,3	840,7	4070	20,00	4,436	2,860	3,180

For 5% Significance Level, there is 1 Potential Outlier

Potential outliers is: 4070

For 1% Significance Level, there is 1 Potential Outlier

Potential outliers is: 4070

Rosner's Outlier Test for Fraction F3 (>C16-C34) - Former Contractor Village (Soil)

Mean	**113,7**
Standard Deviation	**130,2**
Number of data	**27**
Number of suspected outliers	**1**

			Potential	Obs.	Test	Critical	Critical

	A	B	C	D	E	F	G	H	I	J	K	L
101	#	Mean	sd	outlier	Number	value	value (5%)	value (1%)				
102	1	113,7	127,8	465,0	20,00	2,749	2,860	3,180				
103												
104	For 5% Significance Level, there is no Potential Outlier											
105												
106	For 1% Significance Level, there is no Potential Outlier											
107												
108												
109	**Dixon's Outlier Test for Tin - Former Contractor Village (Soil)**											
110												
111	Number of Observations = 10											
112	10% critical value: 0,409											
113	5% critical value: 0,477											
114	1% critical value: 0,597											
115												
116	**1. Observation Value 29 is a Potential Outlier (Upper Tail)?**											
117												
118	Test Statistic: 0,985											
119												
120	For 10% significance level, 29 is an outlier.											
121	For 5% significance level, 29 is an outlier.											
122	For 1% significance level, 29 is an outlier.											
123												
124	**2. Observation Value 2 is a Potential Outlier (Lower Tail)?**											
125												
126	Test Statistic: 0,000											
127												
128	For 10% significance level, 2 is not an outlier.											
129	For 5% significance level, 2 is not an outlier.											
130	For 1% significance level, 2 is not an outlier.											
131												
132												
133	**on's Outlier Test for Vanadium - Former Contractor Village (S**											
134												
135	Number of Observations = 10											
136	10% critical value: 0,409											
137	5% critical value: 0,477											
138	1% critical value: 0,597											
139												
140	**1. Observation Value 61 is a Potential Outlier (Upper Tail)?**											
141												
142	Test Statistic: 0,348											
143												
144	For 10% significance level, 61 is not an outlier.											
145	For 5% significance level, 61 is not an outlier.											
146	For 1% significance level, 61 is not an outlier.											
147												
148	**2. Observation Value 8,6 is a Potential Outlier (Lower Tail)?**											
149												
150	Test Statistic: 0,020											

For 10% significance level, 8,6 is not an outlier.
For 5% significance level, 8,6 is not an outlier.
For 1% significance level, 8,6 is not an outlier.

Rosner's Outlier Test for Fraction F1 (C6-C10) - Main Complex (Soil)

Mean	**12,61**
Standard Deviation	**42,23**
Number of data	**64**
Number of suspected outliers	**1**

			Potential	Obs.	Test	Critical	Critical
#	Mean	sd	outlier	Number	value	value (5%)	value (1%)
1	12,61	41,90	248,0	61,00	5,618	3,224	3,584

For 5% Significance Level, there is 1 Potential Outlier
Potential outliers is: 248,0

For 1% Significance Level, there is 1 Potential Outlier
Potential outliers is: 248,0

Rosner's Outlier Test for Fraction F2 (>C10-C16) - Main Complex (Soil)

Mean	**465,5**
Standard Deviation	**1959**
Number of data	**64**
Number of suspected outliers	**1**

			Potential	Obs.	Test	Critical	Critical
#	Mean	sd	outlier	Number	value	value (5%)	value (1%)
1	465,5	1944	12500	61,00	6,191	3,224	3,584

For 5% Significance Level, there is 1 Potential Outlier
Potential outliers is: 12500

For 1% Significance Level, there is 1 Potential Outlier
Potential outliers is: 12500

Rosner's Outlier Test for Fraction F3 (>C16-C34) - Main Complex (Soil)

Mean	**614,5**
Standard Deviation	**3371**
Number of data	**64**

Number of suspected outliers 1

#	Mean	sd	Potential outlier	Obs. Number	Test value	Critical value (5%)	Critical value (1%)
1	614,5	3344	27000	20,00	7,890	3,224	3,584

For 5% Significance Level, there is 1 Potential Outlier

Potential outliers is: 27000

For 1% Significance Level, there is 1 Potential Outlier

Potential outliers is: 27000

Rosner's Outlier Test for Total Modified TPH - Main Complex (Soil)

Mean	**1069**
Standard Deviation	**4037**
Number of data	**64**
Number of suspected outliers	**1**

#	Mean	sd	Potential outlier	Obs. Number	Test value	Critical value (5%)	Critical value (1%)
1	1069	4006	27000	20,00	6,474	3,224	3,584

For 5% Significance Level, there is 1 Potential Outlier

Potential outliers is: 27000

For 1% Significance Level, there is 1 Potential Outlier

Potential outliers is: 27000

Rosner's Outlier Test for Anthracene - Main Complex (Soil)

Mean	**0,241**
Standard Deviation	**0,898**
Number of data	**63**
Number of suspected outliers	**1**

#	Mean	sd	Potential outlier	Obs. Number	Test value	Critical value (5%)	Critical value (1%)
1	0,241	0,891	5,600	10,00	6,014	3,218	3,578

For 5% Significance Level, there is 1 Potential Outlier

Potential outliers is: 5,600

For 1% Significance Level, there is 1 Potential Outlier

Potential outliers is: 5,600

Rosner's Outlier Test for Benzo(a)anthracene - Main Complex (Soil)

Mean	**0,537**
Standard Deviation	**1,706**
Number of data	**63**
Number of suspected outliers	**1**

#	Mean	sd	Potential outlier	Obs. Number	Test value	Critical value (5%)	Critical value (1%)
1	0,537	1,692	9,370	26,00	5,221	3,218	3,578

For 5% Significance Level, there is 1 Potential Outlier

Potential outliers is: 9,370

For 1% Significance Level, there is 1 Potential Outlier

Potential outliers is: 9,370

Rosner's Outlier Test for Benzo(a)pyrene - Main Complex (Soil)

Mean	**0,371**
Standard Deviation	**1,148**
Number of data	**63**
Number of suspected outliers	**1**

#	Mean	sd	Potential outlier	Obs. Number	Test value	Critical value (5%)	Critical value (1%)
1	0,371	1,139	6,900	10,00	5,735	3,218	3,578

For 5% Significance Level, there is 1 Potential Outlier

Potential outliers is: 6,900

For 1% Significance Level, there is 1 Potential Outlier

Potential outliers is: 6,900

Rosner's Outlier Test for Benzo(a)fluoranthene - Main Complex (Soil)

Mean	**0,336**
Standard Deviation	**0,988**
Number of data	**63**
Number of suspected outliers	**1**

#	Mean	sd	Potential outlier	Obs. Number	Test value	Critical value (5%)	Critical value (1%)
1	0,336	0,981	5,700	10,00	5,470	3,218	3,578

For 5% Significance Level, there is 1 Potential Outlier

Potential outliers is: 5,700

For 1% Significance Level, there is 1 Potential Outlier

Potential outliers is: 5,700

Rosner's Outlier Test for Chrysene - Main Complex (Soil)

Mean	**0,554**
Standard Deviation	**1,659**
Number of data	**63**
Number of suspected outliers	**1**

#	Mean	sd	Potential outlier	Obs. Number	Test value	Critical value (5%)	Critical value (1%)
1	0,554	1,646	9,100	10,00	5,194	3,218	3,578

For 5% Significance Level, there is 1 Potential Outlier

Potential outliers is: 9,100

For 1% Significance Level, there is 1 Potential Outlier

Potential outliers is: 9,100

Rosner's Outlier Test for Dibenzo(a,h)anthracene - Main Complex (Soil)

Mean	**0,116**
Standard Deviation	**0,400**
Number of data	**63**
Number of suspected outliers	**1**

#	Mean	sd	Potential outlier	Obs. Number	Test value	Critical value (5%)	Critical value (1%)
1	0,116	0,397	2,220	40,00	5,305	3,218	3,578

For 5% Significance Level, there is 1 Potential Outlier

Potential outliers is: 2,220

For 1% Significance Level, there is 1 Potential Outlier

Potential outliers is: 2,220

Rosner's Outlier Test for Fluoranthene - Main Complex (Soil)

Mean	**1,183**

Standard Deviation	**4,272**
Number of data	**63**
Number of suspected outliers	**1**

#	Mean	sd	Potential outlier	Obs. Number	Test value	Critical value (5%)	Critical value (1%)
1	1,183	4,238	24,70	26,00	5,550	3,218	3,578

For 5% Significance Level, there is 1 Potential Outlier

Potential outliers is: 24,70

For 1% Significance Level, there is 1 Potential Outlier

Potential outliers is: 24,70

Rosner's Outlier Test for Phenanthrene - Main Complex (Soil)

Mean	**0,986**
Standard Deviation	**3,764**
Number of data	**63**
Number of suspected outliers	**1**

#	Mean	sd	Potential outlier	Obs. Number	Test value	Critical value (5%)	Critical value (1%)
1	0,986	3,734	22,50	26,00	5,761	3,218	3,578

For 5% Significance Level, there is 1 Potential Outlier

Potential outliers is: 22,50

For 1% Significance Level, there is 1 Potential Outlier

Potential outliers is: 22,50

Rosner's Outlier Test for Cadmium - Main Complex (Soil)

Mean	**1,827**
Standard Deviation	**7,436**
Number of data	**43**
Number of suspected outliers	**1**

#	Mean	sd	Potential outlier	Obs. Number	Test value	Critical value (5%)	Critical value (1%)
1	1,827	7,349	49,00	12,00	6,419	3,070	3,410

For 5% Significance Level, there is 1 Potential Outlier

Potential outliers is: 49,00

For 1% Significance Level, there is 1 Potential Outlier

Potential outliers is: 49,00

Rosner's Outlier Test for Chromium - Main Complex (Soil)

Mean	**13,71**
Standard Deviation	**10,38**
Number of data	**39**
Number of suspected outliers	**1**

#	Mean	sd	Potential outlier	Obs. Number	Test value	Critical value (5%)	Critical value (1%)
1	13,71	10,25	73,00	15,00	5,785	3,030	3,370

For 5% Significance Level, there is 1 Potential Outlier

Potential outliers is: 73,00

For 1% Significance Level, there is 1 Potential Outlier

Potential outliers is: 73,00

Rosner's Outlier Test for Lead - Main Complex (Soil)

Mean	**27,08**
Standard Deviation	**41,19**
Number of data	**39**
Number of suspected outliers	**1**

#	Mean	sd	Potential outlier	Obs. Number	Test value	Critical value (5%)	Critical value (1%)
1	27,08	40,65	200,0	3,000	4,254	3,030	3,370

For 5% Significance Level, there is 1 Potential Outlier

Potential outliers is: 200,0

For 1% Significance Level, there is 1 Potential Outlier

Potential outliers is: 200,0

Rosner's Outlier Test for Molybdenum - Main Complex (Soil)

Mean	**2,197**
Standard Deviation	**1,233**
Number of data	**39**
Number of suspected outliers	**1**

			Potential	Obs.	Test	Critical	Critical

#	Mean	sd	outlier	Number	value	value (5%)	value (1%)
1	2,197	1,217	9,700	30,00	6,164	3,030	3,370

For 5% Significance Level, there is 1 Potential Outlier

Potential outliers is: 9,700

For 1% Significance Level, there is 1 Potential Outlier

Potential outliers is: 9,700

Rosner's Outlier Test for Tin - Main Complex (Soil)

Mean	**2,187**
Standard Deviation	**0,808**
Number of data	**39**
Number of suspected outliers	**1**

			Potential	Obs.	Test	Critical	Critical
#	Mean	sd	outlier	Number	value	value (5%)	value (1%)
1	2,187	0,797	6,800	2,000	5,784	3,030	3,370

For 5% Significance Level, there is 1 Potential Outlier

Potential outliers is: 6,800

For 1% Significance Level, there is 1 Potential Outlier

Potential outliers is: 6,800

Rosner's Outlier Test for Vanadium - Main Complex (Soil)

Mean	**30,60**
Standard Deviation	**12,65**
Number of data	**39**
Number of suspected outliers	**1**

			Potential	Obs.	Test	Critical	Critical
#	Mean	sd	outlier	Number	value	value (5%)	value (1%)
1	30,60	12,48	88,00	15,00	4,598	3,030	3,370

For 5% Significance Level, there is 1 Potential Outlier

Potential outliers is: 88,00

For 1% Significance Level, there is 1 Potential Outlier

Potential outliers is: 88,00

Rosner's Outlier Test for Zinc - Main Complex (Soil)

Mean	**143,3**
Standard Deviation	**240,4**
Number of data	**47**
Number of suspected outliers	**1**

#	Mean	sd	Potential outlier	Obs. Number	Test value	Critical value (5%)	Critical value (1%)
1	143,3	237,8	1400	12,00	5,285	3,100	3,460

For 5% Significance Level, there is 1 Potential Outlier

Potential outliers is: 1400

For 1% Significance Level, there is 1 Potential Outlier

Potential outliers is: 1400

Rosner's Outlier Test for Calculated Total PCB

Mean	**0,288**
Standard Deviation	**0,523**
Number of data	**36**
Number of suspected outliers	**1**

#	Mean	sd	Potential outlier	Obs. Number	Test value	Critical value (5%)	Critical value (1%)
1	0,288	0,516	2,000	4,000	3,320	2,990	3,330

For 5% Significance Level, there is 1 Potential Outlier

Potential outliers is: 2,000

For 1% Significance Level, there is no Potential Outlier

on F3 (>C16-C34) - Former USAF Dump Area and Former Ar

Number of Observations = 21

10% critical value: 0,391

5% critical value: 0,44

1% critical value: 0,524

1. Observation Value 6380 is a Potential Outlier (Upper Tail)

Test Statistic: 0,957

For 10% significance level, 6380 is an outlier.

For 5% significance level, 6380 is an outlier.

For 1% significance level, 6380 is an outlier.

2. Observation Value 20 is a Potential Outlier (Lower Tail)?

Test Statistic: 0,011

For 10% significance level, 20 is not an outlier.
For 5% significance level, 20 is not an outlier.
For 1% significance level, 20 is not an outlier.

Anthracene - Former USAF Dump Area and Former Ammuni

Number of Observations = 16
10% critical value: 0,454
5% critical value: 0,507
1% critical value: 0,595

1. Observation Value 15,9 is a Potential Outlier (Upper Tail)

Test Statistic: 0,999

For 10% significance level, 15,9 is an outlier.
For 5% significance level, 15,9 is an outlier.
For 1% significance level, 15,9 is an outlier.

2. Observation Value 0,01 is a Potential Outlier (Lower Tail)?

Test Statistic: 0,000

For 10% significance level, 0,01 is not an outlier.
For 5% significance level, 0,01 is not an outlier.
For 1% significance level, 0,01 is not an outlier.

zo(a)anthracene - Former USAF Dump Area and Former Amr

Number of Observations = 16
10% critical value: 0,454
5% critical value: 0,507
1% critical value: 0,595

1. Observation Value 19,7 is a Potential Outlier (Upper Tail)

Test Statistic: 1,000

For 10% significance level, 19,7 is an outlier.
For 5% significance level, 19,7 is an outlier.
For 1% significance level, 19,7 is an outlier.

2. Observation Value 0,01 is a Potential Outlier (Lower Tail)?

Test Statistic: Non Numérique

For 10% significance level, 0,01 is an outlier.
For 5% significance level, 0,01 is an outlier.
For 1% significance level, 0,01 is an outlier.

Dixon's Outlier Test for Benzo(a)pyrene

Number of Observations = 16
10% critical value: 0,454
5% critical value: 0,507
1% critical value: 0,595

1. Observation Value 14,5 is a Potential Outlier (Upper Tail)

Test Statistic: 1,000

For 10% significance level, 14,5 is an outlier.
For 5% significance level, 14,5 is an outlier.
For 1% significance level, 14,5 is an outlier.

2. Observation Value 0,01 is a Potential Outlier (Lower Tail)?

Test Statistic: Non Numérique

For 10% significance level, 0,01 is an outlier.
For 5% significance level, 0,01 is an outlier.
For 1% significance level, 0,01 is an outlier.

o(a)fluoranthene - Former USAF Dump Area and Former Am

Number of Observations = 16
10% critical value: 0,454
5% critical value: 0,507
1% critical value: 0,595

1. Observation Value 12,6 is a Potential Outlier (Upper Tail)

Test Statistic: 0,997

For 10% significance level, 12,6 is an outlier.
For 5% significance level, 12,6 is an outlier.
For 1% significance level, 12,6 is an outlier.

2. Observation Value 0,01 is a Potential Outlier (Lower Tail)?

Test Statistic: 0,000

For 10% significance level, 0,01 is not an outlier.
For 5% significance level, 0,01 is not an outlier.
For 1% significance level, 0,01 is not an outlier.

r Chryene - Former USAF Dump Area and Former Ammunitic

Number of Observations = 16
10% critical value: 0,454
5% critical value: 0,507
1% critical value: 0,595

1. Observation Value 16,1 is a Potential Outlier (Upper Tail)

Test Statistic: 1,000

For 10% significance level, 16,1 is an outlier.
For 5% significance level, 16,1 is an outlier.
For 1% significance level, 16,1 is an outlier.

2. Observation Value 0,01 is a Potential Outlier (Lower Tail)?

Test Statistic: 0,000

For 10% significance level, 0,01 is not an outlier.
For 5% significance level, 0,01 is not an outlier.
For 1% significance level, 0,01 is not an outlier.

zo(a,h)anthracene - Former USAF Dump Area and Former Ar

Number of Observations = 16
10% critical value: 0,454
5% critical value: 0,507
1% critical value: 0,595

1. Observation Value 1,9 is a Potential Outlier (Upper Tail)?

Test Statistic: 0,998

For 10% significance level, 1,9 is an outlier.
For 5% significance level, 1,9 is an outlier.
For 1% significance level, 1,9 is an outlier.

2. Observation Value 0,006 is a Potential Outlier (Lower Tail)

Test Statistic: 0,000

For 10% significance level, 0,006 is not an outlier.
For 5% significance level, 0,006 is not an outlier.

For 1% significance level, 0,006 is not an outlier.

Fluoranthene - Former USAF Dump Area and Former Ammun

Number of Observations = 16
10% critical value: 0,454
5% critical value: 0,507
1% critical value: 0,595

1. Observation Value 59,5 is a Potential Outlier (Upper Tail)?

Test Statistic: 0,999

For 10% significance level, 59,5 is an outlier.
For 5% significance level, 59,5 is an outlier.
For 1% significance level, 59,5 is an outlier.

2. Observation Value 0,01 is a Potential Outlier (Lower Tail)?

Test Statistic: 0,000

For 10% significance level, 0,01 is not an outlier.
For 5% significance level, 0,01 is not an outlier.
For 1% significance level, 0,01 is not an outlier.

Phenanthrene - Former USAF Dump Area and Former Ammur

Number of Observations = 16
10% critical value: 0,454
5% critical value: 0,507
1% critical value: 0,595

1. Observation Value 46,8 is a Potential Outlier (Upper Tail)?

Test Statistic: 1,000

For 10% significance level, 46,8 is an outlier.
For 5% significance level, 46,8 is an outlier.
For 1% significance level, 46,8 is an outlier.

2. Observation Value 0,01 is a Potential Outlier (Lower Tail)?

Test Statistic: 0,850

For 10% significance level, 0,01 is an outlier.
For 5% significance level, 0,01 is an outlier.
For 1% significance level, 0,01 is an outlier.

r Cadmium - Former USAF Dump Area and Former Ammuniti

Number of Observations = 15
10% critical value: 0,472
5% critical value: 0,525
1% critical value: 0,616

1. Observation Value 2 is a Potential Outlier (Upper Tail)?

Test Statistic: 0,918

For 10% significance level, 2 is an outlier.
For 5% significance level, 2 is an outlier.
For 1% significance level, 2 is an outlier.

2. Observation Value 0,3 is a Potential Outlier (Lower Tail)?

Test Statistic: 0,000

For 10% significance level, 0,3 is not an outlier.
For 5% significance level, 0,3 is not an outlier.
For 1% significance level, 0,3 is not an outlier.

for Lead - Former USAF Dump Area and Former Ammunition

Number of Observations = 15
10% critical value: 0,472
5% critical value: 0,525
1% critical value: 0,616

1. Observation Value 180 is a Potential Outlier (Upper Tail)?

Test Statistic: 0,879

For 10% significance level, 180 is an outlier.
For 5% significance level, 180 is an outlier.
For 1% significance level, 180 is an outlier.

2. Observation Value 3,2 is a Potential Outlier (Lower Tail)?

Test Statistic: 0,023

For 10% significance level, 3,2 is not an outlier.
For 5% significance level, 3,2 is not an outlier.
For 1% significance level, 3,2 is not an outlier.

Molybdenum - Former USAF Dump Area and Former Ammun

Number of Observations = 15
10% critical value: 0,472
5% critical value: 0,525
1% critical value: 0,616

1. Observation Value 6 is a Potential Outlier (Upper Tail)?

Test Statistic: 1,000

For 10% significance level, 6 is an outlier.
For 5% significance level, 6 is an outlier.
For 1% significance level, 6 is an outlier.

2. Observation Value 2 is a Potential Outlier (Lower Tail)?

Test Statistic: Non Numérique

For 10% significance level, 2 is an outlier.
For 5% significance level, 2 is an outlier.
For 1% significance level, 2 is an outlier.

t for Tin - Former USAF Dump Area and Former Ammunition

Number of Observations = 15
10% critical value: 0,472
5% critical value: 0,525
1% critical value: 0,616

1. Observation Value 14 is a Potential Outlier (Upper Tail)?

Test Statistic: 1,000

For 10% significance level, 14 is an outlier.
For 5% significance level, 14 is an outlier.
For 1% significance level, 14 is an outlier.

2. Observation Value 2 is a Potential Outlier (Lower Tail)?

Test Statistic: Non Numérique

For 10% significance level, 2 is an outlier.
For 5% significance level, 2 is an outlier.
For 1% significance level, 2 is an outlier.

osner's Outlier Test for Zinc - Former USAF Dump Area and Former Ammunition Storage Area (So

Mean	164,0
Standard Deviation	347,7
Number of data	27
Number of suspected outliers	1

#	Mean	sd	Potential outlier	Obs. Number	Test value	Critical value (5%)	Critical value (1%)
1	164,0	341,2	1800	13,00	4,795	2,860	3,180

For 5% Significance Level, there is 1 Potential Outlier

Potential outliers is: 1800

For 1% Significance Level, there is 1 Potential Outlier

Potential outliers is: 1800

ulated Total PCB - Former USAF Dump Area and Former Am

Number of Observations = 13

10% critical value: 0,467

5% critical value: 0,521

1% critical value: 0,615

1. Observation Value 24 is a Potential Outlier (Upper Tail)?

Test Statistic: 0,894

For 10% significance level, 24 is an outlier.

For 5% significance level, 24 is an outlier.

For 1% significance level, 24 is an outlier.

2. Observation Value 0,05 is a Potential Outlier (Lower Tail)?

Test Statistic: 0,000

For 10% significance level, 0,05 is not an outlier.

For 5% significance level, 0,05 is not an outlier.

For 1% significance level, 0,05 is not an outlier.

UCL Statistics for Uncensored Full Data Sets

User Selected Options	
Date/Time of Computation	ProUCL 5.12019-05-10 10:14:00
From File	WorkSheet.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Fraction F3 (>C16-C34) - General Area (Soil)

General Statistics

Total Number of Observations	23,00	Number of Distinct Observations	10,00
		Number of Missing Observations	1,000
Minimum	18,00	Mean	42,96
Maximum	140,0	Median	25,00
SD	39,16	Std. Error of Mean	8,165
Coefficient of Variation	0,912	Skewness	1,910

Normal GOF Test

Shapiro Wilk Test Statistic	0,559	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0,914	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0,431	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0,180	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	56,98	95% Adjusted-CLT UCL (Chen-1995)	59,86
		95% Modified-t UCL (Johnson-1978)	57,52

Gamma GOF Test

A-D Test Statistic	4,607	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0,754	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0,419	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0,184	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	2,143	k star (bias corrected MLE)	1,892
Theta hat (MLE)	20,05	Theta star (bias corrected MLE)	22,70
nu hat (MLE)	98,57	nu star (bias corrected)	87,04
MLE Mean (bias corrected)	42,96	MLE Sd (bias corrected)	31,23
		Approximate Chi Square Value (0,0500)	66,54
Adjusted Level of Significance	0,0389	Adjusted Chi Square Value	65,24

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	56,20	95% Adjusted Gamma UCL (use when n<50)	57,32

Lognormal GOF Test

Shapiro Wilk Test Statistic	0,632	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0,914	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0,392	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0,180	Data Not Lognormal at 5% Significance Level	

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	2,890	Mean of logged Data	3,509
Maximum of Logged Data	4,942	SD of logged Data	0,636

Assuming Lognormal Distribution

95% H-UCL	54,36	90% Chebyshev (MVUE) UCL	57,55
95% Chebyshev (MVUE) UCL	65,29	97,5% Chebyshev (MVUE) UCL	76,03
99% Chebyshev (MVUE) UCL	97,12		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	56,39	95% Jackknife UCL	56,98
95% Standard Bootstrap UCL	56,13	95% Bootstrap-t UCL	64,13
95% Hall's Bootstrap UCL	54,21	95% Percentile Bootstrap UCL	57,04
95% BCA Bootstrap UCL	59,74		
90% Chebyshev(Mean, Sd) UCL	67,45	95% Chebyshev(Mean, Sd) UCL	78,55
97,5% Chebyshev(Mean, Sd) UCL	93,94	99% Chebyshev(Mean, Sd) UCL	124,2

Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL	78,55		

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.
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 statistician.

Vanadium - General Area (Soil)

General Statistics

Total Number of Observations	11,00	Number of Distinct Observations	11,00
		Number of Missing Observations	0
Minimum	2,000	Mean	22,82
Maximum	45,00	Median	23,00
SD	11,21	Std. Error of Mean	3,381
Coefficient of Variation	0,491	Skewness	0,121

Normal GOF Test

Shapiro Wilk Test Statistic	0,982	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0,850	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0,116	**Lilliefors GOF Test**	

	A	B	C	D	E	F	G	H	I	J	K	L
101					5% Lilliefors Critical Value	0,251	Data appear Normal at 5% Significance Level					
102	**Data appear Normal at 5% Significance Level**											
103												
104	**Assuming Normal Distribution**											
105	**95% Normal UCL**						**95% UCLs (Adjusted for Skewness)**					
106					95% Student's-t UCL	28,95					95% Adjusted-CLT UCL (Chen-1995)	28,51
107											95% Modified-t UCL (Johnson-1978)	28,97
108												
109	**Gamma GOF Test**											
110					A-D Test Statistic	0,603	**Anderson-Darling Gamma GOF Test**					
111					5% A-D Critical Value	0,735	Detected data appear Gamma Distributed at 5% Significance Level					
112					K-S Test Statistic	0,194	**Kolmogorov-Smirnov Gamma GOF Test**					
113					5% K-S Critical Value	0,257	Detected data appear Gamma Distributed at 5% Significance Level					
114	**Detected data appear Gamma Distributed at 5% Significance Level**											
115												
116	**Gamma Statistics**											
117					k hat (MLE)	2,680					k star (bias corrected MLE)	2,010
118					Theta hat (MLE)	8,514					Theta star (bias corrected MLE)	11,35
119					nu hat (MLE)	58,96					nu star (bias corrected)	44,22
120					MLE Mean (bias corrected)	22,82					MLE Sd (bias corrected)	16,10
121											Approximate Chi Square Value (0,0500)	29,96
122					Adjusted Level of Significance	0,0278					Adjusted Chi Square Value	28,06
123												
124	**Assuming Gamma Distribution**											
125					95% Approximate Gamma UCL (use when n>=50))	33,67					95% Adjusted Gamma UCL (use when n<50)	35,95
126												
127	**Lognormal GOF Test**											
128					Shapiro Wilk Test Statistic	0,762	**Shapiro Wilk Lognormal GOF Test**					
129					5% Shapiro Wilk Critical Value	0,850	Data Not Lognormal at 5% Significance Level					
130					Lilliefors Test Statistic	0,242	**Lilliefors Lognormal GOF Test**					
131					5% Lilliefors Critical Value	0,251	Data appear Lognormal at 5% Significance Level					
132	**Data appear Approximate Lognormal at 5% Significance Level**											
133												
134	**Lognormal Statistics**											
135					Minimum of Logged Data	0,693					Mean of logged Data	2,930
136					Maximum of Logged Data	3,807					SD of logged Data	0,822
137												
138	**Assuming Lognormal Distribution**											
139					95% H-UCL	52,50					90% Chebyshev (MVUE) UCL	44,90
140					95% Chebyshev (MVUE) UCL	53,80					97,5% Chebyshev (MVUE) UCL	66,15
141					99% Chebyshev (MVUE) UCL	90,42						
142												
143	**Nonparametric Distribution Free UCL Statistics**											
144	**Data appear to follow a Discernible Distribution at 5% Significance Level**											
145												
146	**Nonparametric Distribution Free UCLs**											
147					95% CLT UCL	28,38					95% Jackknife UCL	28,95
148					95% Standard Bootstrap UCL	28,17					95% Bootstrap-t UCL	28,89
149					95% Hall's Bootstrap UCL	29,86					95% Percentile Bootstrap UCL	28,27
150					95% BCA Bootstrap UCL	28,45						

	A	B	C	D	E	F	G	H	I	J	K	L
151					90% Chebyshev(Mean, Sd) UCL	32,96					95% Chebyshev(Mean, Sd) UCL	37,56
152					97,5% Chebyshev(Mean, Sd) UCL	43,93					99% Chebyshev(Mean, Sd) UCL	56,46
153												
154						**Suggested UCL to Use**						
155					95% Student's-t UCL	28,95						
156												
157	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
158	Recommendations are based upon data size, data distribution, and skewness.											
159	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
160	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
161												
162												
163	**Fraction F1 (C6-C10) - Former Contractor Village (Soil)**											
164												
165						**General Statistics**						
166					Total Number of Observations	27,00					Number of Distinct Observations	12,00
167											Number of Missing Observations	3,000
168					Minimum	2,500					Mean	48,24
169					Maximum	260,0					Median	3,000
170					SD	83,30					Std. Error of Mean	16,03
171					Coefficient of Variation	1,727					Skewness	1,721
172												
173						**Normal GOF Test**						
174					Shapiro Wilk Test Statistic	0,611			**Shapiro Wilk GOF Test**			
175					5% Shapiro Wilk Critical Value	0,923			Data Not Normal at 5% Significance Level			
176					Lilliefors Test Statistic	0,381			**Lilliefors GOF Test**			
177					5% Lilliefors Critical Value	0,167			Data Not Normal at 5% Significance Level			
178						**Data Not Normal at 5% Significance Level**						
179												
180						**Assuming Normal Distribution**						
181			**95% Normal UCL**						**95% UCLs (Adjusted for Skewness)**			
182					95% Student's-t UCL	75,58					95% Adjusted-CLT UCL (Chen-1995)	80,28
183											95% Modified-t UCL (Johnson-1978)	76,47
184												
185						**Gamma GOF Test**						
186					A-D Test Statistic	3,991			**Anderson-Darling Gamma GOF Test**			
187					5% A-D Critical Value	0,830			Data Not Gamma Distributed at 5% Significance Level			
188					K-S Test Statistic	0,343			**Kolmogorov-Smirnov Gamma GOF Test**			
189					5% K-S Critical Value	0,180			Data Not Gamma Distributed at 5% Significance Level			
190						**Data Not Gamma Distributed at 5% Significance Level**						
191												
192						**Gamma Statistics**						
193					k hat (MLE)	0,399					k star (bias corrected MLE)	0,379
194					Theta hat (MLE)	120,9					Theta star (bias corrected MLE)	127,2
195					nu hat (MLE)	21,55					nu star (bias corrected)	20,49
196					MLE Mean (bias corrected)	48,24					MLE Sd (bias corrected)	78,32
197											Approximate Chi Square Value (0,0500)	11,21
198					Adjusted Level of Significance	0,0401					Adjusted Chi Square Value	10,77
199												
200						**Assuming Gamma Distribution**						

95% Approximate Gamma UCL (use when n>=50))	88,16	95% Adjusted Gamma UCL (use when n<50)	91,75
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0,704	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0,923	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0,327	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0,167	Data Not Lognormal at 5% Significance Level	
Data Not Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	0,916	Mean of logged Data	2,226
Maximum of Logged Data	5,561	SD of logged Data	1,798
Assuming Lognormal Distribution			
95% H-UCL	172,7	90% Chebyshev (MVUE) UCL	95,45
95% Chebyshev (MVUE) UCL	120,2	97,5% Chebyshev (MVUE) UCL	154,6
99% Chebyshev (MVUE) UCL	222,2		
Nonparametric Distribution Free UCL Statistics			
Data do not follow a Discernible Distribution (0.05)			
Nonparametric Distribution Free UCLs			
95% CLT UCL	74,61	95% Jackknife UCL	75,58
95% Standard Bootstrap UCL	73,96	95% Bootstrap-t UCL	86,42
95% Hall's Bootstrap UCL	77,32	95% Percentile Bootstrap UCL	75,30
95% BCA Bootstrap UCL	80,09		
90% Chebyshev(Mean, Sd) UCL	96,33	95% Chebyshev(Mean, Sd) UCL	118,1
97,5% Chebyshev(Mean, Sd) UCL	148,3	99% Chebyshev(Mean, Sd) UCL	207,7
Suggested UCL to Use			
95% Chebyshev (Mean, Sd) UCL	118,1		
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.			
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 statistician.			
Fraction F2 (>C10-C16) - Former Contractor Village (Soil)			
General Statistics			
Total Number of Observations	26,00	Number of Distinct Observations	15,00
		Number of Missing Observations	4,000
Minimum	10,00	Mean	196,8
Maximum	1800	Median	16,00
SD	430,7	Std. Error of Mean	84,46
Coefficient of Variation	2,188	Skewness	2,812
Normal GOF Test			
Shapiro Wilk Test Statistic	0,509	**Shapiro Wilk GOF Test**	

	A	B	C	D	E	F	G	H	I	J	K	L
251					5% Shapiro Wilk Critical Value	0,920	Data Not Normal at 5% Significance Level					
252					Lilliefors Test Statistic	0,414	**Lilliefors GOF Test**					
253					5% Lilliefors Critical Value	0,170	Data Not Normal at 5% Significance Level					
254	**Data Not Normal at 5% Significance Level**											
255												
256	**Assuming Normal Distribution**											
257	**95% Normal UCL**						**95% UCLs (Adjusted for Skewness)**					
258					95% Student's-t UCL	341,1					95% Adjusted-CLT UCL (Chen-1995)	385,5
259											95% Modified-t UCL (Johnson-1978)	348,9
260												
261	**Gamma GOF Test**											
262					A-D Test Statistic	3,498	**Anderson-Darling Gamma GOF Test**					
263					5% A-D Critical Value	0,830	Data Not Gamma Distributed at 5% Significance Level					
264					K-S Test Statistic	0,285	**Kolmogorov-Smirnov Gamma GOF Test**					
265					5% K-S Critical Value	0,183	Data Not Gamma Distributed at 5% Significance Level					
266	**Data Not Gamma Distributed at 5% Significance Level**											
267												
268	**Gamma Statistics**											
269					k hat (MLE)	0,400					k star (bias corrected MLE)	0,380
270					Theta hat (MLE)	491,8					Theta star (bias corrected MLE)	518,4
271					nu hat (MLE)	20,82					nu star (bias corrected)	19,75
272					MLE Mean (bias corrected)	196,8					MLE Sd (bias corrected)	319,4
273											Approximate Chi Square Value (0,0500)	10,66
274					Adjusted Level of Significance	0,0398					Adjusted Chi Square Value	10,22
275												
276	**Assuming Gamma Distribution**											
277					95% Approximate Gamma UCL (use when n>=50))	364,5					95% Adjusted Gamma UCL (use when n<50)	380,2
278												
279	**Lognormal GOF Test**											
280					Shapiro Wilk Test Statistic	0,785	**Shapiro Wilk Lognormal GOF Test**					
281					5% Shapiro Wilk Critical Value	0,920	Data Not Lognormal at 5% Significance Level					
282					Lilliefors Test Statistic	0,226	**Lilliefors Lognormal GOF Test**					
283					5% Lilliefors Critical Value	0,170	Data Not Lognormal at 5% Significance Level					
284	**Data Not Lognormal at 5% Significance Level**											
285												
286	**Lognormal Statistics**											
287					Minimum of Logged Data	2,303					Mean of logged Data	3,639
288					Maximum of Logged Data	7,496					SD of logged Data	1,647
289												
290	**Assuming Lognormal Distribution**											
291					95% H-UCL	458,4					90% Chebyshev (MVUE) UCL	294,5
292					95% Chebyshev (MVUE) UCL	367,9					97,5% Chebyshev (MVUE) UCL	469,8
293					99% Chebyshev (MVUE) UCL	670,0						
294												
295	**Nonparametric Distribution Free UCL Statistics**											
296	**Data do not follow a Discernible Distribution (0.05)**											
297												
298	**Nonparametric Distribution Free UCLs**											
299					95% CLT UCL	335,8					95% Jackknife UCL	341,1
300					95% Standard Bootstrap UCL	333,1					95% Bootstrap-t UCL	516,5

301	95% Hall's Bootstrap UCL	406,0	95% Percentile Bootstrap UCL	336,3
302	95% BCA Bootstrap UCL	389,8		
303	90% Chebyshev(Mean, Sd) UCL	450,2	95% Chebyshev(Mean, Sd) UCL	565,0
304	97,5% Chebyshev(Mean, Sd) UCL	724,3	99% Chebyshev(Mean, Sd) UCL	1037
305				
306	**Suggested UCL to Use**			
307	95% Chebyshev (Mean, Sd) UCL	565,0		
308				
309	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
310	Recommendations are based upon data size, data distribution, and skewness.			
311	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
312	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
313				
314				
315	**Fraction F3 (>C16-C34) - Former Contractor Village (Soil)**			
316				
317	**General Statistics**			
318	Total Number of Observations	27,00	Number of Distinct Observations	18,00
319			Number of Missing Observations	3,000
320	Minimum	19,00	Mean	113,7
321	Maximum	465,0	Median	44,00
322	SD	130,2	Std. Error of Mean	25,06
323	Coefficient of Variation	1,146	Skewness	1,550
324				
325	**Normal GOF Test**			
326	Shapiro Wilk Test Statistic	0,733	**Shapiro Wilk GOF Test**	
327	5% Shapiro Wilk Critical Value	0,923	Data Not Normal at 5% Significance Level	
328	Lilliefors Test Statistic	0,252	**Lilliefors GOF Test**	
329	5% Lilliefors Critical Value	0,167	Data Not Normal at 5% Significance Level	
330	**Data Not Normal at 5% Significance Level**			
331				
332	**Assuming Normal Distribution**			
333	**95% Normal UCL**		**95% UCLs (Adjusted for Skewness)**	
334	95% Student's-t UCL	156,4	95% Adjusted-CLT UCL (Chen-1995)	162,9
335			95% Modified-t UCL (Johnson-1978)	157,7
336				
337	**Gamma GOF Test**			
338	A-D Test Statistic	1,948	**Anderson-Darling Gamma GOF Test**	
339	5% A-D Critical Value	0,773	Data Not Gamma Distributed at 5% Significance Level	
340	K-S Test Statistic	0,228	**Kolmogorov-Smirnov Gamma GOF Test**	
341	5% K-S Critical Value	0,173	Data Not Gamma Distributed at 5% Significance Level	
342	**Data Not Gamma Distributed at 5% Significance Level**			
343				
344	**Gamma Statistics**			
345	k hat (MLE)	1,007	k star (bias corrected MLE)	0,919
346	Theta hat (MLE)	112,9	Theta star (bias corrected MLE)	123,6
347	nu hat (MLE)	54,35	nu star (bias corrected)	49,65
348	MLE Mean (bias corrected)	113,7	MLE Sd (bias corrected)	118,5
349			Approximate Chi Square Value (0,0500)	34,47
350	Adjusted Level of Significance	0,0401	Adjusted Chi Square Value	33,66

Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	163,7	95% Adjusted Gamma UCL (use when n<50)	167,6
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0,842	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0,923	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0,226	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0,167	Data Not Lognormal at 5% Significance Level	
Data Not Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	2,944	Mean of logged Data	4,160
Maximum of Logged Data	6,142	SD of logged Data	1,064
Assuming Lognormal Distribution			
95% H-UCL	194,5	90% Chebyshev (MVUE) UCL	187,2
95% Chebyshev (MVUE) UCL	222,4	97,5% Chebyshev (MVUE) UCL	271,3
99% Chebyshev (MVUE) UCL	367,3		
Nonparametric Distribution Free UCL Statistics			
Data do not follow a Discernible Distribution (0.05)			
Nonparametric Distribution Free UCLs			
95% CLT UCL	154,9	95% Jackknife UCL	156,4
95% Standard Bootstrap UCL	153,3	95% Bootstrap-t UCL	167,4
95% Hall's Bootstrap UCL	160,5	95% Percentile Bootstrap UCL	156,4
95% BCA Bootstrap UCL	163,4		
90% Chebyshev(Mean, Sd) UCL	188,9	95% Chebyshev(Mean, Sd) UCL	222,9
97,5% Chebyshev(Mean, Sd) UCL	270,2	99% Chebyshev(Mean, Sd) UCL	363,1
Suggested UCL to Use			
95% Chebyshev (Mean, Sd) UCL	222,9		
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.			
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 statistician.			
Tin - Former Contractor Village (Soil)			
General Statistics			
Total Number of Observations	9,000	Number of Distinct Observations	2,000
		Number of Missing Observations	1,000
Minimum	2,000	Mean	2,044
Maximum	2,400	Median	2,000
SD	0,133	Std. Error of Mean	0,0444
Coefficient of Variation	0,0652	Skewness	3,000

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.

For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).

Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.1

Normal GOF Test

Shapiro Wilk Test Statistic	0,390	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0,829	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0,519	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0,274	Data Not Normal at 5% Significance Level	

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	2,127	95% Adjusted-CLT UCL (Chen-1995)	2,165
		95% Modified-t UCL (Johnson-1978)	2,134

Gamma GOF Test

A-D Test Statistic	2,899	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0,720	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0,527	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0,279	Data Not Gamma Distributed at 5% Significance Level	

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	290,7	k star (bias corrected MLE)	193,9
Theta hat (MLE)	0,00703	Theta star (bias corrected MLE)	0,0105
nu hat (MLE)	5233	nu star (bias corrected)	3490
MLE Mean (bias corrected)	2,044	MLE Sd (bias corrected)	0,147
		Approximate Chi Square Value (0,0500)	3353
Adjusted Level of Significance	0,0231	Adjusted Chi Square Value	3325

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	2,128	95% Adjusted Gamma UCL (use when n<50)	2,146

Lognormal GOF Test

Shapiro Wilk Test Statistic	0,390	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0,829	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0,519	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0,274	Data Not Lognormal at 5% Significance Level	

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	0,693	Mean of logged Data	0,713
Maximum of Logged Data	0,875	SD of logged Data	0,0608

Assuming Lognormal Distribution

95% H-UCL	N/A	90% Chebyshev (MVUE) UCL	2,169
95% Chebyshev (MVUE) UCL	2,225	97,5% Chebyshev (MVUE) UCL	2,303
99% Chebyshev (MVUE) UCL	2,456		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	2,118	95% Jackknife UCL	N/A
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	2,178	95% Chebyshev(Mean, Sd) UCL	2,238
97,5% Chebyshev(Mean, Sd) UCL	2,322	99% Chebyshev(Mean, Sd) UCL	2,487

Suggested UCL to Use

95% Student's-t UCL	2,127	or 95% Modified-t UCL	2,134

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.
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 statistician.

Vanadium - Former Contractor Village (Soil)

General Statistics

Total Number of Observations	10,00	Number of Distinct Observations	8,000
		Number of Missing Observations	0
Minimum	8,600	Mean	21,99
Maximum	61,00	Median	15,50
SD	16,73	Std. Error of Mean	5,290
Coefficient of Variation	0,761	Skewness	1,861

Normal GOF Test

Shapiro Wilk Test Statistic	0,726	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0,842	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0,371	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0,262	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	31,69	95% Adjusted-CLT UCL (Chen-1995)	34,02
		95% Modified-t UCL (Johnson-1978)	32,21

Gamma GOF Test

A-D Test Statistic	0,839	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0,733	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0,312	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0,269	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

	A	B	C	D	E	F	G	H	I	J	K	L
501	**Gamma Statistics**											
502					k hat (MLE)	2,739					k star (bias corrected MLE)	1,984
503					Theta hat (MLE)	8,029					Theta star (bias corrected MLE)	11,09
504					nu hat (MLE)	54,77					nu star (bias corrected)	39,67
505					MLE Mean (bias corrected)	21,99					MLE Sd (bias corrected)	15,61
506											Approximate Chi Square Value (0,0500)	26,24
507					Adjusted Level of Significance	0,0267					Adjusted Chi Square Value	24,36
508												
509	**Assuming Gamma Distribution**											
510					95% Approximate Gamma UCL (use when n>=50))	33,24					95% Adjusted Gamma UCL (use when n<50)	35,81
511												
512	**Lognormal GOF Test**											
513					Shapiro Wilk Test Statistic	0,881	**Shapiro Wilk Lognormal GOF Test**					
514					5% Shapiro Wilk Critical Value	0,842	Data appear Lognormal at 5% Significance Level					
515					Lilliefors Test Statistic	0,269	**Lilliefors Lognormal GOF Test**					
516					5% Lilliefors Critical Value	0,262	Data Not Lognormal at 5% Significance Level					
517	**Data appear Approximate Lognormal at 5% Significance Level**											
518												
519	**Lognormal Statistics**											
520					Minimum of Logged Data	2,152					Mean of logged Data	2,897
521					Maximum of Logged Data	4,111					SD of logged Data	0,613
522												
523	**Assuming Lognormal Distribution**											
524					95% H-UCL	35,60					90% Chebyshev (MVUE) UCL	34,15
525					95% Chebyshev (MVUE) UCL	39,93					97,5% Chebyshev (MVUE) UCL	47,95
526					99% Chebyshev (MVUE) UCL	63,70						
527												
528	**Nonparametric Distribution Free UCL Statistics**											
529	**Data appear to follow a Discernible Distribution at 5% Significance Level**											
530												
531	**Nonparametric Distribution Free UCLs**											
532					95% CLT UCL	30,69					95% Jackknife UCL	31,69
533					95% Standard Bootstrap UCL	30,13					95% Bootstrap-t UCL	56,67
534					95% Hall's Bootstrap UCL	92,58					95% Percentile Bootstrap UCL	30,60
535					95% BCA Bootstrap UCL	33,43						
536					90% Chebyshev(Mean, Sd) UCL	37,86					95% Chebyshev(Mean, Sd) UCL	45,05
537					97,5% Chebyshev(Mean, Sd) UCL	55,03					99% Chebyshev(Mean, Sd) UCL	74,63
538												
539	**Suggested UCL to Use**											
540					95% H-UCL	35,60						
541												
542	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
543	Recommendations are based upon data size, data distribution, and skewness.											
544	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
545	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
546												
547	**ProUCL computes and outputs H-statistic based UCLs for historical reasons only.**											
548	**H-statistic often results in unstable (both high and low) values of UCL95 as shown in examples in the Technical Guide.**											
549	**It is therefore recommended to avoid the use of H-statistic based 95% UCLs.**											
550	**Use of nonparametric methods are preferred to compute UCL95 for skewed data sets which do not follow a gamma distribution.**											

Fraction F1 (C6-C10) - Main Complex (Soil)

General Statistics			
Total Number of Observations	63,00	Number of Distinct Observations	5,000
		Number of Missing Observations	1,000
Minimum	2,500	Mean	8,873
Maximum	195,0	Median	2,500
SD	30,07	Std. Error of Mean	3,788
Coefficient of Variation	3,389	Skewness	5,088
Normal GOF Test			
Shapiro Wilk Test Statistic	0,239	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk P Value	0	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0,530	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0,111	Data Not Normal at 5% Significance Level	
Data Not Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	15,20	95% Adjusted-CLT UCL (Chen-1995)	17,70
		95% Modified-t UCL (Johnson-1978)	15,60
Gamma GOF Test			
A-D Test Statistic	23,50	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0,808	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0,547	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0,118	Data Not Gamma Distributed at 5% Significance Level	
Data Not Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	0,582	k star (bias corrected MLE)	0,565
Theta hat (MLE)	15,25	Theta star (bias corrected MLE)	15,72
nu hat (MLE)	73,29	nu star (bias corrected)	71,13
MLE Mean (bias corrected)	8,873	MLE Sd (bias corrected)	11,81
		Approximate Chi Square Value (0,0500)	52,72
Adjusted Level of Significance	0,0462	Adjusted Chi Square Value	52,35
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	11,97	95% Adjusted Gamma UCL (use when n<50)	12,06
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0,255	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk P Value	0	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0,482	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0,111	Data Not Lognormal at 5% Significance Level	
Data Not Lognormal at 5% Significance Level			
Lognormal Statistics			

Minimum of Logged Data	0,916	Mean of logged Data	1,116
Maximum of Logged Data	5,273	SD of logged Data	0,849

Assuming Lognormal Distribution

95% H-UCL	5,507	90% Chebyshev (MVUE) UCL	5,929
95% Chebyshev (MVUE) UCL	6,648	97,5% Chebyshev (MVUE) UCL	7,646
99% Chebyshev (MVUE) UCL	9,606		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	15,10	95% Jackknife UCL	15,20
95% Standard Bootstrap UCL	14,91	95% Bootstrap-t UCL	20,97
95% Hall's Bootstrap UCL	14,48	95% Percentile Bootstrap UCL	15,48
95% BCA Bootstrap UCL	18,28		
90% Chebyshev(Mean, Sd) UCL	20,24	95% Chebyshev(Mean, Sd) UCL	25,39
97,5% Chebyshev(Mean, Sd) UCL	32,53	99% Chebyshev(Mean, Sd) UCL	46,56

Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL	25,39		

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.

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 statistician.

Fraction F2 (>C10-C16) - Main Complex (Soil)

General Statistics

Total Number of Observations	63,00	Number of Distinct Observations	19,00
		Number of Missing Observations	1,000
Minimum	10,00	Mean	274,5
Maximum	8360	Median	10,00
SD	1236	Std. Error of Mean	155,7
Coefficient of Variation	4,502	Skewness	5,671

Normal GOF Test

Shapiro Wilk Test Statistic	0,245	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0,466	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0,111	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	534,4	95% Adjusted-CLT UCL (Chen-1995)	649,4
		95% Modified-t UCL (Johnson-1978)	553,0

	A–E	F	G–K	L
651	**Gamma GOF Test**			
652	A-D Test Statistic	18,03	**Anderson-Darling Gamma GOF Test**	
653	5% A-D Critical Value	0,882	Data Not Gamma Distributed at 5% Significance Level	
654	K-S Test Statistic	0,450	**Kolmogorov-Smirnov Gamma GOF Test**	
655	5% K-S Critical Value	0,123	Data Not Gamma Distributed at 5% Significance Level	
656	**Data Not Gamma Distributed at 5% Significance Level**			
657				
658	**Gamma Statistics**			
659	k hat (MLE)	0,265	k star (bias corrected MLE)	0,263
660	Theta hat (MLE)	1037	Theta star (bias corrected MLE)	1045
661	nu hat (MLE)	33,34	nu star (bias corrected)	33,09
662	MLE Mean (bias corrected)	274,5	MLE Sd (bias corrected)	535,6
663			Approximate Chi Square Value (0,0500)	20,94
664	Adjusted Level of Significance	0,0462	Adjusted Chi Square Value	20,71
665				
666	**Assuming Gamma Distribution**			
667	95% Approximate Gamma UCL (use when n>=50))	433,8	95% Adjusted Gamma UCL (use when n<50)	438,5
668				
669	**Lognormal GOF Test**			
670	Shapiro Wilk Test Statistic	0,508	**Shapiro Wilk Lognormal GOF Test**	
671	5% Shapiro Wilk P Value	0	Data Not Lognormal at 5% Significance Level	
672	Lilliefors Test Statistic	0,330	**Lilliefors Lognormal GOF Test**	
673	5% Lilliefors Critical Value	0,111	Data Not Lognormal at 5% Significance Level	
674	**Data Not Lognormal at 5% Significance Level**			
675				
676	**Lognormal Statistics**			
677	Minimum of Logged Data	2,303	Mean of logged Data	2,955
678	Maximum of Logged Data	9,031	SD of logged Data	1,486
679				
680	**Assuming Lognormal Distribution**			
681	95% H-UCL	92,21	90% Chebyshev (MVUE) UCL	98,15
682	95% Chebyshev (MVUE) UCL	117,3	97,5% Chebyshev (MVUE) UCL	143,9
683	99% Chebyshev (MVUE) UCL	196,0		
684				
685	**Nonparametric Distribution Free UCL Statistics**			
686	**Data do not follow a Discernible Distribution (0.05)**			
687				
688	**Nonparametric Distribution Free UCLs**			
689	95% CLT UCL	530,5	95% Jackknife UCL	534,4
690	95% Standard Bootstrap UCL	525,5	95% Bootstrap-t UCL	1740
691	95% Hall's Bootstrap UCL	1846	95% Percentile Bootstrap UCL	556,0
692	95% BCA Bootstrap UCL	705,9		
693	90% Chebyshev(Mean, Sd) UCL	741,5	95% Chebyshev(Mean, Sd) UCL	953,1
694	97,5% Chebyshev(Mean, Sd) UCL	1247	99% Chebyshev(Mean, Sd) UCL	1823
695				
696	**Suggested UCL to Use**			
697	95% Chebyshev (Mean, Sd) UCL	953,1		
698				
699	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
700	Recommendations are based upon data size, data distribution, and skewness.			

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 statistician.

Fraction F3 (>C16-C34) - Main Complex (Soil)

General Statistics			
Total Number of Observations	63,00	Number of Distinct Observations	48,00
		Number of Missing Observations	1,000
Minimum	15,00	Mean	195,7
Maximum	2030	Median	47,00
SD	370,6	Std. Error of Mean	46,70
Coefficient of Variation	1,894	Skewness	3,341
Normal GOF Test			
Shapiro Wilk Test Statistic	0,530	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk P Value	0	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0,313	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0,111	Data Not Normal at 5% Significance Level	
Data Not Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	273,6	95% Adjusted-CLT UCL (Chen-1995)	293,5
		95% Modified-t UCL (Johnson-1978)	276,9
Gamma GOF Test			
A-D Test Statistic	5,042	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0,804	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0,206	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0,118	Data Not Gamma Distributed at 5% Significance Level	
Data Not Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	0,623	k star (bias corrected MLE)	0,603
Theta hat (MLE)	314,3	Theta star (bias corrected MLE)	324,2
nu hat (MLE)	78,44	nu star (bias corrected)	76,03
MLE Mean (bias corrected)	195,7	MLE Sd (bias corrected)	251,9
		Approximate Chi Square Value (0,0500)	56,95
Adjusted Level of Significance	0,0462	Adjusted Chi Square Value	56,56
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	261,2	95% Adjusted Gamma UCL (use when n<50)	263,0
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0,860	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk P Value	8,2640E-8	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0,184	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0,111	Data Not Lognormal at 5% Significance Level	
Data Not Lognormal at 5% Significance Level			

	A–E	F	G–K	L
751				
752	**Lognormal Statistics**			
753	Minimum of Logged Data	2,708	Mean of logged Data	4,289
754	Maximum of Logged Data	7,616	SD of logged Data	1,283
755				
756	**Assuming Lognormal Distribution**			
757	95% H-UCL	239,5	90% Chebyshev (MVUE) UCL	262,9
758	95% Chebyshev (MVUE) UCL	308,4	97,5% Chebyshev (MVUE) UCL	371,7
759	99% Chebyshev (MVUE) UCL	495,9		
760				
761	**Nonparametric Distribution Free UCL Statistics**			
762	**Data do not follow a Discernible Distribution (0.05)**			
763				
764	**Nonparametric Distribution Free UCLs**			
765	95% CLT UCL	272,5	95% Jackknife UCL	273,6
766	95% Standard Bootstrap UCL	271,8	95% Bootstrap-t UCL	321,4
767	95% Hall's Bootstrap UCL	303,7	95% Percentile Bootstrap UCL	276,2
768	95% BCA Bootstrap UCL	297,6		
769	90% Chebyshev(Mean, Sd) UCL	335,7	95% Chebyshev(Mean, Sd) UCL	399,2
770	97,5% Chebyshev(Mean, Sd) UCL	487,3	99% Chebyshev(Mean, Sd) UCL	660,3
771				
772	**Suggested UCL to Use**			
773	95% Chebyshev (Mean, Sd) UCL	399,2		
774				
775	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
776	Recommendations are based upon data size, data distribution, and skewness.			
777	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
778	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
779				
780				
781	**Total Modified TPH - Main Complex (Soil)**			
782				
783	**General Statistics**			
784	Total Number of Observations	63,00	Number of Distinct Observations	46,00
785			Number of Missing Observations	1,000
786	Minimum	15,00	Mean	657,0
787	Maximum	14800	Median	47,00
788	SD	2355	Std. Error of Mean	296,7
789	Coefficient of Variation	3,584	Skewness	4,937
790				
791	**Normal GOF Test**			
792	Shapiro Wilk Test Statistic	0,307	**Shapiro Wilk GOF Test**	
793	5% Shapiro Wilk P Value	0	Data Not Normal at 5% Significance Level	
794	Lilliefors Test Statistic	0,427	**Lilliefors GOF Test**	
795	5% Lilliefors Critical Value	0,111	Data Not Normal at 5% Significance Level	
796	**Data Not Normal at 5% Significance Level**			
797				
798	**Assuming Normal Distribution**			
799	**95% Normal UCL**		**95% UCLs (Adjusted for Skewness)**	
800	95% Student's-t UCL	1152	95% Adjusted-CLT UCL (Chen-1995)	1342

	A	B	C	D	E	F	G	H	I	J	K	L
801											95% Modified-t UCL (Johnson-1978)	1183
802												
803						**Gamma GOF Test**						
804					A-D Test Statistic	8,218			**Anderson-Darling Gamma GOF Test**			
805					5% A-D Critical Value	0,859			Data Not Gamma Distributed at 5% Significance Level			
806					K-S Test Statistic	0,244			**Kolmogorov-Smirnov Gamma GOF Test**			
807					5% K-S Critical Value	0,121			Data Not Gamma Distributed at 5% Significance Level			
808						**Data Not Gamma Distributed at 5% Significance Level**						
809												
810						**Gamma Statistics**						
811					k hat (MLE)	0,320					k star (bias corrected MLE)	0,316
812					Theta hat (MLE)	2051					Theta star (bias corrected MLE)	2082
813					nu hat (MLE)	40,36					nu star (bias corrected)	39,77
814					MLE Mean (bias corrected)	657,0					MLE Sd (bias corrected)	1169
815											Approximate Chi Square Value (0,0500)	26,32
816					Adjusted Level of Significance	0,0462					Adjusted Chi Square Value	26,07
817												
818						**Assuming Gamma Distribution**						
819					95% Approximate Gamma UCL (use when n>=50))	992,7					95% Adjusted Gamma UCL (use when n<50)	1002
820												
821						**Lognormal GOF Test**						
822					Shapiro Wilk Test Statistic	0,853			**Shapiro Wilk Lognormal GOF Test**			
823					5% Shapiro Wilk P Value	2,9684E-8			Data Not Lognormal at 5% Significance Level			
824					Lilliefors Test Statistic	0,166			**Lilliefors Lognormal GOF Test**			
825					5% Lilliefors Critical Value	0,111			Data Not Lognormal at 5% Significance Level			
826						**Data Not Lognormal at 5% Significance Level**						
827												
828						**Lognormal Statistics**						
829					Minimum of Logged Data	2,708					Mean of logged Data	4,358
830					Maximum of Logged Data	9,602					SD of logged Data	1,697
831												
832						**Assuming Lognormal Distribution**						
833					95% H-UCL	591,7					90% Chebyshev (MVUE) UCL	596,6
834					95% Chebyshev (MVUE) UCL	725,2					97,5% Chebyshev (MVUE) UCL	903,7
835					99% Chebyshev (MVUE) UCL	1254						
836												
837						**Nonparametric Distribution Free UCL Statistics**						
838						**Data do not follow a Discernible Distribution (0.05)**						
839												
840						**Nonparametric Distribution Free UCLs**						
841					95% CLT UCL	1145					95% Jackknife UCL	1152
842					95% Standard Bootstrap UCL	1137					95% Bootstrap-t UCL	1927
843					95% Hall's Bootstrap UCL	1411					95% Percentile Bootstrap UCL	1239
844					95% BCA Bootstrap UCL	1457						
845					90% Chebyshev(Mean, Sd) UCL	1547					95% Chebyshev(Mean, Sd) UCL	1950
846					97,5% Chebyshev(Mean, Sd) UCL	2510					99% Chebyshev(Mean, Sd) UCL	3609
847												
848						**Suggested UCL to Use**						
849					95% Chebyshev (Mean, Sd) UCL	1950						
850												

851	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
852	Recommendations are based upon data size, data distribution, and skewness.			
853	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
854	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
855				
856				
857	**Anthracene - Main Complex (Soil)**			
858				
859	**General Statistics**			
860	Total Number of Observations	62,00	Number of Distinct Observations	23,00
861			Number of Missing Observations	4,000
862	Minimum	0,0100	Mean	0,155
863	Maximum	4,550	Median	0,0300
864	SD	0,585	Std. Error of Mean	0,0742
865	Coefficient of Variation	3,783	Skewness	7,233
866				
867	**Normal GOF Test**			
868	Shapiro Wilk Test Statistic	0,244	**Shapiro Wilk GOF Test**	
869	5% Shapiro Wilk P Value	0	Data Not Normal at 5% Significance Level	
870	Lilliefors Test Statistic	0,402	**Lilliefors GOF Test**	
871	5% Lilliefors Critical Value	0,112	Data Not Normal at 5% Significance Level	
872	**Data Not Normal at 5% Significance Level**			
873				
874	**Assuming Normal Distribution**			
875	**95% Normal UCL**		**95% UCLs (Adjusted for Skewness)**	
876	95% Student's-t UCL	0,278	95% Adjusted-CLT UCL (Chen-1995)	0,349
877			95% Modified-t UCL (Johnson-1978)	0,290
878				
879	**Gamma GOF Test**			
880	A-D Test Statistic	7,798	**Anderson-Darling Gamma GOF Test**	
881	5% A-D Critical Value	0,815	Data Not Gamma Distributed at 5% Significance Level	
882	K-S Test Statistic	0,281	**Kolmogorov-Smirnov Gamma GOF Test**	
883	5% K-S Critical Value	0,119	Data Not Gamma Distributed at 5% Significance Level	
884	**Data Not Gamma Distributed at 5% Significance Level**			
885				
886	**Gamma Statistics**			
887	k hat (MLE)	0,516	k star (bias corrected MLE)	0,502
888	Theta hat (MLE)	0,299	Theta star (bias corrected MLE)	0,308
889	nu hat (MLE)	64,01	nu star (bias corrected)	62,24
890	MLE Mean (bias corrected)	0,155	MLE Sd (bias corrected)	0,218
891			Approximate Chi Square Value (0,0500)	45,10
892	Adjusted Level of Significance	0,0461	Adjusted Chi Square Value	44,75
893				
894	**Assuming Gamma Distribution**			
895	95% Approximate Gamma UCL (use when n>=50))	0,213	95% Adjusted Gamma UCL (use when n<50)	0,215
896				
897	**Lognormal GOF Test**			
898	Shapiro Wilk Test Statistic	0,863	**Shapiro Wilk Lognormal GOF Test**	
899	5% Shapiro Wilk P Value	1,6332E-7	Data Not Lognormal at 5% Significance Level	
900	Lilliefors Test Statistic	0,233	**Lilliefors Lognormal GOF Test**	

	A	B	C	D	E	F	G	H	I	J	K	L
901	5% Lilliefors Critical Value					0,112	Data Not Lognormal at 5% Significance Level					
902	**Data Not Lognormal at 5% Significance Level**											
903												
904	**Lognormal Statistics**											
905	Minimum of Logged Data					-4,605	Mean of logged Data					-3,092
906	Maximum of Logged Data					1,515	SD of logged Data					1,193
907												
908	**Assuming Lognormal Distribution**											
909	95% H-UCL					0,131	90% Chebyshev (MVUE) UCL					0,142
910	95% Chebyshev (MVUE) UCL					0,165	97,5% Chebyshev (MVUE) UCL					0,198
911	99% Chebyshev (MVUE) UCL					0,261						
912												
913	**Nonparametric Distribution Free UCL Statistics**											
914	**Data do not follow a Discernible Distribution (0.05)**											
915												
916	**Nonparametric Distribution Free UCLs**											
917	95% CLT UCL					0,277	95% Jackknife UCL					0,278
918	95% Standard Bootstrap UCL					0,280	95% Bootstrap-t UCL					0,735
919	95% Hall's Bootstrap UCL					0,672	95% Percentile Bootstrap UCL					0,299
920	95% BCA Bootstrap UCL					0,398						
921	90% Chebyshev(Mean, Sd) UCL					0,377	95% Chebyshev(Mean, Sd) UCL					0,478
922	97,5% Chebyshev(Mean, Sd) UCL					0,618	99% Chebyshev(Mean, Sd) UCL					0,893
923												
924	**Suggested UCL to Use**											
925	95% Chebyshev (Mean, Sd) UCL					0,478						
926												
927	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
928	Recommendations are based upon data size, data distribution, and skewness.											
929	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
930	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
931												
932												
933	**Benzo(a)anthracene - Main Complex (Soil)**											
934												
935	**General Statistics**											
936	Total Number of Observations					62,00	Number of Distinct Observations					30,00
937							Number of Missing Observations					4,000
938	Minimum					0,0100	Mean					0,394
939	Maximum					9,100	Median					0,0300
940	SD					1,287	Std. Error of Mean					0,163
941	Coefficient of Variation					3,265	Skewness					5,612
942												
943	**Normal GOF Test**											
944	Shapiro Wilk Test Statistic					0,341	**Shapiro Wilk GOF Test**					
945	5% Shapiro Wilk P Value					0	Data Not Normal at 5% Significance Level					
946	Lilliefors Test Statistic					0,395	**Lilliefors GOF Test**					
947	5% Lilliefors Critical Value					0,112	Data Not Normal at 5% Significance Level					
948	**Data Not Normal at 5% Significance Level**											
949												
950	**Assuming Normal Distribution**											

	A	B	C	D	E	F	G	H	I	J	K	L
951	**95% Normal UCL**						**95% UCLs (Adjusted for Skewness)**					
952					95% Student's-t UCL	0,667					95% Adjusted-CLT UCL (Chen-1995)	0,788
953											95% Modified-t UCL (Johnson-1978)	0,687
954												
955	**Gamma GOF Test**											
956					A-D Test Statistic	6,566	**Anderson-Darling Gamma GOF Test**					
957					5% A-D Critical Value	0,856	Data Not Gamma Distributed at 5% Significance Level					
958					K-S Test Statistic	0,229	**Kolmogorov-Smirnov Gamma GOF Test**					
959					5% K-S Critical Value	0,122	Data Not Gamma Distributed at 5% Significance Level					
960	**Data Not Gamma Distributed at 5% Significance Level**											
961												
962	**Gamma Statistics**											
963					k hat (MLE)	0,332					k star (bias corrected MLE)	0,326
964					Theta hat (MLE)	1,189					Theta star (bias corrected MLE)	1,208
965					nu hat (MLE)	41,12					nu star (bias corrected)	40,47
966					MLE Mean (bias corrected)	0,394					MLE Sd (bias corrected)	0,690
967											Approximate Chi Square Value (0,0500)	26,89
968					Adjusted Level of Significance	0,0461					Adjusted Chi Square Value	26,63
969												
970	**Assuming Gamma Distribution**											
971					95% Approximate Gamma UCL (use when n>=50))	0,593					95% Adjusted Gamma UCL (use when n<50)	0,599
972												
973	**Lognormal GOF Test**											
974					Shapiro Wilk Test Statistic	0,827	**Shapiro Wilk Lognormal GOF Test**					
975					5% Shapiro Wilk P Value	1,3123E-9	Data Not Lognormal at 5% Significance Level					
976					Lilliefors Test Statistic	0,232	**Lilliefors Lognormal GOF Test**					
977					5% Lilliefors Critical Value	0,112	Data Not Lognormal at 5% Significance Level					
978	**Data Not Lognormal at 5% Significance Level**											
979												
980	**Lognormal Statistics**											
981					Minimum of Logged Data	-4,605					Mean of logged Data	-2,976
982					Maximum of Logged Data	2,208					SD of logged Data	1,837
983												
984	**Assuming Lognormal Distribution**											
985					95% H-UCL	0,546					90% Chebyshev (MVUE) UCL	0,520
986					95% Chebyshev (MVUE) UCL	0,639					97,5% Chebyshev (MVUE) UCL	0,803
987					99% Chebyshev (MVUE) UCL	1,127						
988												
989	**Nonparametric Distribution Free UCL Statistics**											
990	**Data do not follow a Discernible Distribution (0.05)**											
991												
992	**Nonparametric Distribution Free UCLs**											
993					95% CLT UCL	0,663					95% Jackknife UCL	0,667
994					95% Standard Bootstrap UCL	0,651					95% Bootstrap-t UCL	1,114
995					95% Hall's Bootstrap UCL	1,485					95% Percentile Bootstrap UCL	0,709
996					95% BCA Bootstrap UCL	0,818						
997					90% Chebyshev(Mean, Sd) UCL	0,885					95% Chebyshev(Mean, Sd) UCL	1,107
998					97,5% Chebyshev(Mean, Sd) UCL	1,415					99% Chebyshev(Mean, Sd) UCL	2,021
999												
1000	**Suggested UCL to Use**											

95% Chebyshev (Mean, Sd) UCL	1,107		

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.
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 statistician.

Benzo(a)pyrene - Main Complex (Soil)

General Statistics			
Total Number of Observations	62,00	Number of Distinct Observations	25,00
		Number of Missing Observations	4,000
Minimum	0,0100	Mean	0,265
Maximum	5,340	Median	0,0150
SD	0,793	Std. Error of Mean	0,101
Coefficient of Variation	2,987	Skewness	5,041
Normal GOF Test			
Shapiro Wilk Test Statistic	0,372	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk P Value	0	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0,374	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0,112	Data Not Normal at 5% Significance Level	
Data Not Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	0,434	95% Adjusted-CLT UCL (Chen-1995)	0,500
		95% Modified-t UCL (Johnson-1978)	0,444
Gamma GOF Test			
A-D Test Statistic	7,253	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0,850	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0,260	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0,122	Data Not Gamma Distributed at 5% Significance Level	
Data Not Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	0,358	k star (bias corrected MLE)	0,351
Theta hat (MLE)	0,742	Theta star (bias corrected MLE)	0,755
nu hat (MLE)	44,37	nu star (bias corrected)	43,56
MLE Mean (bias corrected)	0,265	MLE Sd (bias corrected)	0,448
		Approximate Chi Square Value (0,0500)	29,43
Adjusted Level of Significance	0,0461	Adjusted Chi Square Value	29,15
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	0,393	95% Adjusted Gamma UCL (use when n<50)	0,397
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0,786	**Shapiro Wilk Lognormal GOF Test**	

	A–E	F	G–K	L
1051	5% Shapiro Wilk P Value	6,505E-12	Data Not Lognormal at 5% Significance Level	
1052	Lilliefors Test Statistic	0,290	**Lilliefors Lognormal GOF Test**	
1053	5% Lilliefors Critical Value	0,112	Data Not Lognormal at 5% Significance Level	
1054	**Data Not Lognormal at 5% Significance Level**			
1055				
1056	**Lognormal Statistics**			
1057	Minimum of Logged Data	-4,605	Mean of logged Data	-3,199
1058	Maximum of Logged Data	1,675	SD of logged Data	1,742
1059				
1060	**Assuming Lognormal Distribution**			
1061	95% H-UCL	0,347	90% Chebyshev (MVUE) UCL	0,342
1062	95% Chebyshev (MVUE) UCL	0,417	97,5% Chebyshev (MVUE) UCL	0,521
1063	99% Chebyshev (MVUE) UCL	0,726		
1064				
1065	**Nonparametric Distribution Free UCL Statistics**			
1066	**Data do not follow a Discernible Distribution (0.05)**			
1067				
1068	**Nonparametric Distribution Free UCLs**			
1069	95% CLT UCL	0,431	95% Jackknife UCL	0,434
1070	95% Standard Bootstrap UCL	0,430	95% Bootstrap-t UCL	0,676
1071	95% Hall's Bootstrap UCL	0,892	95% Percentile Bootstrap UCL	0,441
1072	95% BCA Bootstrap UCL	0,552		
1073	90% Chebyshev(Mean, Sd) UCL	0,567	95% Chebyshev(Mean, Sd) UCL	0,704
1074	97,5% Chebyshev(Mean, Sd) UCL	0,894	99% Chebyshev(Mean, Sd) UCL	1,267
1075				
1076	**Suggested UCL to Use**			
1077	95% Chebyshev (Mean, Sd) UCL	0,704		
1078				
1079	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
1080	Recommendations are based upon data size, data distribution, and skewness.			
1081	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
1082	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
1083				
1084				
1085	**Benzo(a)fluoranthene - Main Complex (Soil)**			
1086				
1087	**General Statistics**			
1088	Total Number of Observations	62,00	Number of Distinct Observations	23,00
1089			Number of Missing Observations	4,000
1090	Minimum	0,0100	Mean	0,250
1091	Maximum	4,640	Median	0,0500
1092	SD	0,717	Std. Error of Mean	0,0910
1093	Coefficient of Variation	2,868	Skewness	4,952
1094				
1095	**Normal GOF Test**			
1096	Shapiro Wilk Test Statistic	0,348	**Shapiro Wilk GOF Test**	
1097	5% Shapiro Wilk P Value	0	Data Not Normal at 5% Significance Level	
1098	Lilliefors Test Statistic	0,375	**Lilliefors GOF Test**	
1099	5% Lilliefors Critical Value	0,112	Data Not Normal at 5% Significance Level	
1100	**Data Not Normal at 5% Significance Level**			

	A–E	F	G–K	L
1101				
1102	**Assuming Normal Distribution**			
1103	**95% Normal UCL**		**95% UCLs (Adjusted for Skewness)**	
1104	95% Student's-t UCL	0,402	95% Adjusted-CLT UCL (Chen-1995)	0,461
1105			95% Modified-t UCL (Johnson-1978)	0,412
1106				
1107	**Gamma GOF Test**			
1108	A-D Test Statistic	7,741	**Anderson-Darling Gamma GOF Test**	
1109	5% A-D Critical Value	0,815	Data Not Gamma Distributed at 5% Significance Level	
1110	K-S Test Statistic	0,319	**Kolmogorov-Smirnov Gamma GOF Test**	
1111	5% K-S Critical Value	0,120	Data Not Gamma Distributed at 5% Significance Level	
1112	**Data Not Gamma Distributed at 5% Significance Level**			
1113				
1114	**Gamma Statistics**			
1115	k hat (MLE)	0,507	k star (bias corrected MLE)	0,493
1116	Theta hat (MLE)	0,493	Theta star (bias corrected MLE)	0,507
1117	nu hat (MLE)	62,82	nu star (bias corrected)	61,12
1118	MLE Mean (bias corrected)	0,250	MLE Sd (bias corrected)	0,356
1119			Approximate Chi Square Value (0,0500)	44,14
1120	Adjusted Level of Significance	0,0461	Adjusted Chi Square Value	43,79
1121				
1122	**Assuming Gamma Distribution**			
1123	95% Approximate Gamma UCL (use when n>=50))	0,346	95% Adjusted Gamma UCL (use when n<50)	0,349
1124				
1125	**Lognormal GOF Test**			
1126	Shapiro Wilk Test Statistic	0,851	**Shapiro Wilk Lognormal GOF Test**	
1127	5% Shapiro Wilk P Value	3,1301E-8	Data Not Lognormal at 5% Significance Level	
1128	Lilliefors Test Statistic	0,268	**Lilliefors Lognormal GOF Test**	
1129	5% Lilliefors Critical Value	0,112	Data Not Lognormal at 5% Significance Level	
1130	**Data Not Lognormal at 5% Significance Level**			
1131				
1132	**Lognormal Statistics**			
1133	Minimum of Logged Data	-4,605	Mean of logged Data	-2,638
1134	Maximum of Logged Data	1,535	SD of logged Data	1,322
1135				
1136	**Assuming Lognormal Distribution**			
1137	95% H-UCL	0,253	90% Chebyshev (MVUE) UCL	0,276
1138	95% Chebyshev (MVUE) UCL	0,325	97,5% Chebyshev (MVUE) UCL	0,393
1139	99% Chebyshev (MVUE) UCL	0,527		
1140				
1141	**Nonparametric Distribution Free UCL Statistics**			
1142	**Data do not follow a Discernible Distribution (0.05)**			
1143				
1144	**Nonparametric Distribution Free UCLs**			
1145	95% CLT UCL	0,400	95% Jackknife UCL	0,402
1146	95% Standard Bootstrap UCL	0,395	95% Bootstrap-t UCL	0,668
1147	95% Hall's Bootstrap UCL	0,802	95% Percentile Bootstrap UCL	0,406
1148	95% BCA Bootstrap UCL	0,490		
1149	90% Chebyshev(Mean, Sd) UCL	0,523	95% Chebyshev(Mean, Sd) UCL	0,647
1150	97,5% Chebyshev(Mean, Sd) UCL	0,818	99% Chebyshev(Mean, Sd) UCL	1,156

Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL	0,647

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.

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 statistician.

Chrysene - Main Complex (Soil)

General Statistics

Total Number of Observations	62,00	Number of Distinct Observations	29,00
		Number of Missing Observations	4,000
Minimum	0,0100	Mean	0,416
Maximum	8,880	Median	0,0350
SD	1,257	Std. Error of Mean	0,160
Coefficient of Variation	3,022	Skewness	5,522

Normal GOF Test

Shapiro Wilk Test Statistic	0,366	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0,389	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0,112	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	0,682	95% Adjusted-CLT UCL (Chen-1995)	0,798
		95% Modified-t UCL (Johnson-1978)	0,701

Gamma GOF Test

A-D Test Statistic	5,362	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0,853	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0,213	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0,122	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0,346	k star (bias corrected MLE)	0,340
Theta hat (MLE)	1,202	Theta star (bias corrected MLE)	1,223
nu hat (MLE)	42,91	nu star (bias corrected)	42,17
MLE Mean (bias corrected)	0,416	MLE Sd (bias corrected)	0,713
		Approximate Chi Square Value (0,0500)	28,28
Adjusted Level of Significance	0,0461	Adjusted Chi Square Value	28,01

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	0,620	95% Adjusted Gamma UCL (use when n<50)	0,626

	A	B	C	D	E	F	G	H	I	J	K	L
1201	**Lognormal GOF Test**											
1202					Shapiro Wilk Test Statistic	0,842	**Shapiro Wilk Lognormal GOF Test**					
1203					5% Shapiro Wilk P Value	8,7187E-9	Data Not Lognormal at 5% Significance Level					
1204					Lilliefors Test Statistic	0,230	**Lilliefors Lognormal GOF Test**					
1205					5% Lilliefors Critical Value	0,112	Data Not Lognormal at 5% Significance Level					
1206	**Data Not Lognormal at 5% Significance Level**											
1207												
1208	**Lognormal Statistics**											
1209					Minimum of Logged Data	-4,605					Mean of logged Data	-2,824
1210					Maximum of Logged Data	2,184					SD of logged Data	1,888
1211												
1212	**Assuming Lognormal Distribution**											
1213					95% H-UCL	0,723					90% Chebyshev (MVUE) UCL	0,674
1214					95% Chebyshev (MVUE) UCL	0,831					97,5% Chebyshev (MVUE) UCL	1,048
1215					99% Chebyshev (MVUE) UCL	1,476						
1216												
1217	**Nonparametric Distribution Free UCL Statistics**											
1218	**Data do not follow a Discernible Distribution (0.05)**											
1219												
1220	**Nonparametric Distribution Free UCLs**											
1221					95% CLT UCL	0,678					95% Jackknife UCL	0,682
1222					95% Standard Bootstrap UCL	0,678					95% Bootstrap-t UCL	1,066
1223					95% Hall's Bootstrap UCL	1,515					95% Percentile Bootstrap UCL	0,709
1224					95% BCA Bootstrap UCL	0,835						
1225					90% Chebyshev(Mean, Sd) UCL	0,895					95% Chebyshev(Mean, Sd) UCL	1,112
1226					97,5% Chebyshev(Mean, Sd) UCL	1,413					99% Chebyshev(Mean, Sd) UCL	2,004
1227												
1228	**Suggested UCL to Use**											
1229					95% Chebyshev (Mean, Sd) UCL	1,112						
1230												
1231	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
1232	Recommendations are based upon data size, data distribution, and skewness.											
1233	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
1234	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
1235												
1236												
1237	**Dibenzo(a,h)anthracene - Main Complex (Soil)**											
1238												
1239	**General Statistics**											
1240					Total Number of Observations	62,00					Number of Distinct Observations	23,00
1241											Number of Missing Observations	4,000
1242					Minimum	0,00600					Mean	0,0824
1243					Maximum	1,950					Median	0,0100
1244					SD	0,298					Std. Error of Mean	0,0378
1245					Coefficient of Variation	3,615					Skewness	5,128
1246												
1247	**Normal GOF Test**											
1248					Shapiro Wilk Test Statistic	0,292	**Shapiro Wilk GOF Test**					
1249					5% Shapiro Wilk P Value	0	Data Not Normal at 5% Significance Level					
1250					Lilliefors Test Statistic	0,436	**Lilliefors GOF Test**					

	A	B	C	D	E	F	G	H	I	J	K	L
1251					5% Lilliefors Critical Value	0,112	Data Not Normal at 5% Significance Level					
1252	**Data Not Normal at 5% Significance Level**											
1253												
1254	**Assuming Normal Distribution**											
1255	**95% Normal UCL**						**95% UCLs (Adjusted for Skewness)**					
1256					95% Student's-t UCL	0,146					95% Adjusted-CLT UCL (Chen-1995)	0,171
1257											95% Modified-t UCL (Johnson-1978)	0,150
1258												
1259	**Gamma GOF Test**											
1260					A-D Test Statistic	12,00	**Anderson-Darling Gamma GOF Test**					
1261					5% A-D Critical Value	0,844	Data Not Gamma Distributed at 5% Significance Level					
1262					K-S Test Statistic	0,340	**Kolmogorov-Smirnov Gamma GOF Test**					
1263					5% K-S Critical Value	0,121	Data Not Gamma Distributed at 5% Significance Level					
1264	**Data Not Gamma Distributed at 5% Significance Level**											
1265												
1266	**Gamma Statistics**											
1267					k hat (MLE)	0,385					k star (bias corrected MLE)	0,377
1268					Theta hat (MLE)	0,214					Theta star (bias corrected MLE)	0,218
1269					nu hat (MLE)	47,74					nu star (bias corrected)	46,77
1270					MLE Mean (bias corrected)	0,0824					MLE Sd (bias corrected)	0,134
1271											Approximate Chi Square Value (0,0500)	32,07
1272					Adjusted Level of Significance	0,0461					Adjusted Chi Square Value	31,78
1273												
1274	**Assuming Gamma Distribution**											
1275					95% Approximate Gamma UCL (use when n>=50))	0,120					95% Adjusted Gamma UCL (use when n<50)	0,121
1276												
1277	**Lognormal GOF Test**											
1278					Shapiro Wilk Test Statistic	0,703	**Shapiro Wilk Lognormal GOF Test**					
1279					5% Shapiro Wilk P Value	3,331E-16	Data Not Lognormal at 5% Significance Level					
1280					Lilliefors Test Statistic	0,281	**Lilliefors Lognormal GOF Test**					
1281					5% Lilliefors Critical Value	0,112	Data Not Lognormal at 5% Significance Level					
1282	**Data Not Lognormal at 5% Significance Level**											
1283												
1284	**Lognormal Statistics**											
1285					Minimum of Logged Data	-5,116					Mean of logged Data	-4,216
1286					Maximum of Logged Data	0,668					SD of logged Data	1,331
1287												
1288	**Assuming Lognormal Distribution**											
1289					95% H-UCL	0,0530					90% Chebyshev (MVUE) UCL	0,0577
1290					95% Chebyshev (MVUE) UCL	0,0680					97,5% Chebyshev (MVUE) UCL	0,0824
1291					99% Chebyshev (MVUE) UCL	0,111						
1292												
1293	**Nonparametric Distribution Free UCL Statistics**											
1294	**Data do not follow a Discernible Distribution (0.05)**											
1295												
1296	**Nonparametric Distribution Free UCLs**											
1297					95% CLT UCL	0,145					95% Jackknife UCL	0,146
1298					95% Standard Bootstrap UCL	0,143					95% Bootstrap-t UCL	0,214
1299					95% Hall's Bootstrap UCL	0,153					95% Percentile Bootstrap UCL	0,148
1300					95% BCA Bootstrap UCL	0,174						

	A B C D E	F	G H I J K	L
1301	90% Chebyshev(Mean, Sd) UCL	0,196	95% Chebyshev(Mean, Sd) UCL	0,247
1302	97,5% Chebyshev(Mean, Sd) UCL	0,319	99% Chebyshev(Mean, Sd) UCL	0,459
1303				
1304	**Suggested UCL to Use**			
1305	95% Chebyshev (Mean, Sd) UCL	0,247		
1306				
1307	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
1308	Recommendations are based upon data size, data distribution, and skewness.			
1309	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
1310	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
1311				
1312				
1313	**Fluoranthene - Main Complex (Soil)**			
1314				
1315	**General Statistics**			
1316	Total Number of Observations	62,00	Number of Distinct Observations	30,00
1317			Number of Missing Observations	4,000
1318	Minimum	0,0100	Mean	0,803
1319	Maximum	22,00	Median	0,0500
1320	SD	3,055	Std. Error of Mean	0,388
1321	Coefficient of Variation	3,803	Skewness	6,104
1322				
1323	**Normal GOF Test**			
1324	Shapiro Wilk Test Statistic	0,283	**Shapiro Wilk GOF Test**	
1325	5% Shapiro Wilk P Value	0	Data Not Normal at 5% Significance Level	
1326	Lilliefors Test Statistic	0,398	**Lilliefors GOF Test**	
1327	5% Lilliefors Critical Value	0,112	Data Not Normal at 5% Significance Level	
1328	**Data Not Normal at 5% Significance Level**			
1329				
1330	**Assuming Normal Distribution**			
1331	**95% Normal UCL**		**95% UCLs (Adjusted for Skewness)**	
1332	95% Student's-t UCL	1,451	95% Adjusted-CLT UCL (Chen-1995)	1,763
1333			95% Modified-t UCL (Johnson-1978)	1,502
1334				
1335	**Gamma GOF Test**			
1336	A-D Test Statistic	7,118	**Anderson-Darling Gamma GOF Test**	
1337	5% A-D Critical Value	0,856	Data Not Gamma Distributed at 5% Significance Level	
1338	K-S Test Statistic	0,266	**Kolmogorov-Smirnov Gamma GOF Test**	
1339	5% K-S Critical Value	0,122	Data Not Gamma Distributed at 5% Significance Level	
1340	**Data Not Gamma Distributed at 5% Significance Level**			
1341				
1342	**Gamma Statistics**			
1343	k hat (MLE)	0,335	k star (bias corrected MLE)	0,329
1344	Theta hat (MLE)	2,401	Theta star (bias corrected MLE)	2,441
1345	nu hat (MLE)	41,49	nu star (bias corrected)	40,81
1346	MLE Mean (bias corrected)	0,803	MLE Sd (bias corrected)	1,400
1347			Approximate Chi Square Value (0,0500)	27,17
1348	Adjusted Level of Significance	0,0461	Adjusted Chi Square Value	26,91
1349				
1350	**Assuming Gamma Distribution**			

	A	B	C	D	E	F	G	H	I	J	K	L
1351					95% Approximate Gamma UCL (use when n>=50))	1,207					95% Adjusted Gamma UCL (use when n<50)	1,219
1352												
1353	**Lognormal GOF Test**											
1354					Shapiro Wilk Test Statistic	0,889	**Shapiro Wilk Lognormal GOF Test**					
1355					5% Shapiro Wilk P Value	5,4533E-6	Data Not Lognormal at 5% Significance Level					
1356					Lilliefors Test Statistic	0,216	**Lilliefors Lognormal GOF Test**					
1357					5% Lilliefors Critical Value	0,112	Data Not Lognormal at 5% Significance Level					
1358	**Data Not Lognormal at 5% Significance Level**											
1359												
1360	**Lognormal Statistics**											
1361					Minimum of Logged Data	-4,605					Mean of logged Data	-2,244
1362					Maximum of Logged Data	3,091					SD of logged Data	1,736
1363												
1364	**Assuming Lognormal Distribution**											
1365					95% H-UCL	0,889					90% Chebyshev (MVUE) UCL	0,878
1366					95% Chebyshev (MVUE) UCL	1,071					97,5% Chebyshev (MVUE) UCL	1,339
1367					99% Chebyshev (MVUE) UCL	1,865						
1368												
1369	**Nonparametric Distribution Free UCL Statistics**											
1370	**Data do not follow a Discernible Distribution (0.05)**											
1371												
1372	**Nonparametric Distribution Free UCLs**											
1373					95% CLT UCL	1,442					95% Jackknife UCL	1,451
1374					95% Standard Bootstrap UCL	1,435					95% Bootstrap-t UCL	3,875
1375					95% Hall's Bootstrap UCL	3,948					95% Percentile Bootstrap UCL	1,504
1376					95% BCA Bootstrap UCL	1,939						
1377					90% Chebyshev(Mean, Sd) UCL	1,967					95% Chebyshev(Mean, Sd) UCL	2,495
1378					97,5% Chebyshev(Mean, Sd) UCL	3,226					99% Chebyshev(Mean, Sd) UCL	4,664
1379												
1380	**Suggested UCL to Use**											
1381					95% Chebyshev (Mean, Sd) UCL	2,495						
1382												
1383	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
1384	Recommendations are based upon data size, data distribution, and skewness.											
1385	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
1386	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
1387												
1388												
1389	**Phenanthrene - Main Complex (Soil)**											
1390												
1391	**General Statistics**											
1392					Total Number of Observations	62,00					Number of Distinct Observations	30,00
1393											Number of Missing Observations	4,000
1394					Minimum	0,0100					Mean	0,639
1395					Maximum	20,00					Median	0,0350
1396					SD	2,587					Std. Error of Mean	0,329
1397					Coefficient of Variation	4,049					Skewness	7,147
1398												
1399	**Normal GOF Test**											
1400					Shapiro Wilk Test Statistic	0,254	**Shapiro Wilk GOF Test**					

	A	B	C	D	E	F	G	H	I	J	K	L
1401					5% Shapiro Wilk P Value	0	Data Not Normal at 5% Significance Level					
1402					Lilliefors Test Statistic	0,404	**Lilliefors GOF Test**					
1403					5% Lilliefors Critical Value	0,112	Data Not Normal at 5% Significance Level					
1404	**Data Not Normal at 5% Significance Level**											
1405												
1406	**Assuming Normal Distribution**											
1407	**95% Normal UCL**						**95% UCLs (Adjusted for Skewness)**					
1408					95% Student's-t UCL	1,188					95% Adjusted-CLT UCL (Chen-1995)	1,498
1409											95% Modified-t UCL (Johnson-1978)	1,237
1410												
1411	**Gamma GOF Test**											
1412					A-D Test Statistic	5,710	**Anderson-Darling Gamma GOF Test**					
1413					5% A-D Critical Value	0,854	Data Not Gamma Distributed at 5% Significance Level					
1414					K-S Test Statistic	0,227	**Kolmogorov-Smirnov Gamma GOF Test**					
1415					5% K-S Critical Value	0,122	Data Not Gamma Distributed at 5% Significance Level					
1416	**Data Not Gamma Distributed at 5% Significance Level**											
1417												
1418	**Gamma Statistics**											
1419					k hat (MLE)	0,340					k star (bias corrected MLE)	0,334
1420					Theta hat (MLE)	1,878					Theta star (bias corrected MLE)	1,910
1421					nu hat (MLE)	42,19					nu star (bias corrected)	41,48
1422					MLE Mean (bias corrected)	0,639					MLE Sd (bias corrected)	1,105
1423											Approximate Chi Square Value (0,0500)	27,72
1424					Adjusted Level of Significance	0,0461					Adjusted Chi Square Value	27,45
1425												
1426	**Assuming Gamma Distribution**											
1427					95% Approximate Gamma UCL (use when n>=50))	0,956					95% Adjusted Gamma UCL (use when n<50)	0,965
1428												
1429	**Lognormal GOF Test**											
1430					Shapiro Wilk Test Statistic	0,894	**Shapiro Wilk Lognormal GOF Test**					
1431					5% Shapiro Wilk P Value	1,1423E-5	Data Not Lognormal at 5% Significance Level					
1432					Lilliefors Test Statistic	0,226	**Lilliefors Lognormal GOF Test**					
1433					5% Lilliefors Critical Value	0,112	Data Not Lognormal at 5% Significance Level					
1434	**Data Not Lognormal at 5% Significance Level**											
1435												
1436	**Lognormal Statistics**											
1437					Minimum of Logged Data	-4,605					Mean of logged Data	-2,434
1438					Maximum of Logged Data	2,996					SD of logged Data	1,785
1439												
1440	**Assuming Lognormal Distribution**											
1441					95% H-UCL	0,826					90% Chebyshev (MVUE) UCL	0,802
1442					95% Chebyshev (MVUE) UCL	0,982					97,5% Chebyshev (MVUE) UCL	1,231
1443					99% Chebyshev (MVUE) UCL	1,722						
1444												
1445	**Nonparametric Distribution Free UCL Statistics**											
1446	**Data do not follow a Discernible Distribution (0.05)**											
1447												
1448	**Nonparametric Distribution Free UCLs**											
1449					95% CLT UCL	1,179					95% Jackknife UCL	1,188
1450					95% Standard Bootstrap UCL	1,173					95% Bootstrap-t UCL	3,291

	A–E	F	G–K	L
1451	95% Hall's Bootstrap UCL	3,095	95% Percentile Bootstrap UCL	1,262
1452	95% BCA Bootstrap UCL	1,657		
1453	90% Chebyshev(Mean, Sd) UCL	1,624	95% Chebyshev(Mean, Sd) UCL	2,071
1454	97,5% Chebyshev(Mean, Sd) UCL	2,690	99% Chebyshev(Mean, Sd) UCL	3,908
1455				
1456	**Suggested UCL to Use**			
1457	95% Chebyshev (Mean, Sd) UCL	2,071		
1458				
1459	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
1460	Recommendations are based upon data size, data distribution, and skewness.			
1461	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
1462	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
1463				
1464				
1465	**Cadmium - Main Complex (Soil)**			
1466				
1467	**General Statistics**			
1468	Total Number of Observations	42,00	Number of Distinct Observations	14,00
1469			Number of Missing Observations	1,000
1470	Minimum	0,300	Mean	0,704
1471	Maximum	6,500	Median	0,300
1472	SD	1,037	Std. Error of Mean	0,160
1473	Coefficient of Variation	1,474	Skewness	4,624
1474				
1475	**Normal GOF Test**			
1476	Shapiro Wilk Test Statistic	0,434	**Shapiro Wilk GOF Test**	
1477	5% Shapiro Wilk Critical Value	0,942	Data Not Normal at 5% Significance Level	
1478	Lilliefors Test Statistic	0,349	**Lilliefors GOF Test**	
1479	5% Lilliefors Critical Value	0,135	Data Not Normal at 5% Significance Level	
1480	**Data Not Normal at 5% Significance Level**			
1481				
1482	**Assuming Normal Distribution**			
1483	**95% Normal UCL**		**95% UCLs (Adjusted for Skewness)**	
1484	95% Student's-t UCL	0,973	95% Adjusted-CLT UCL (Chen-1995)	1,089
1485			95% Modified-t UCL (Johnson-1978)	0,992
1486				
1487	**Gamma GOF Test**			
1488	A-D Test Statistic	6,005	**Anderson-Darling Gamma GOF Test**	
1489	5% A-D Critical Value	0,768	Data Not Gamma Distributed at 5% Significance Level	
1490	K-S Test Statistic	0,342	**Kolmogorov-Smirnov Gamma GOF Test**	
1491	5% K-S Critical Value	0,139	Data Not Gamma Distributed at 5% Significance Level	
1492	**Data Not Gamma Distributed at 5% Significance Level**			
1493				
1494	**Gamma Statistics**			
1495	k hat (MLE)	1,419	k star (bias corrected MLE)	1,333
1496	Theta hat (MLE)	0,496	Theta star (bias corrected MLE)	0,528
1497	nu hat (MLE)	119,2	nu star (bias corrected)	112,0
1498	MLE Mean (bias corrected)	0,704	MLE Sd (bias corrected)	0,609
1499			Approximate Chi Square Value (0,0500)	88,58
1500	Adjusted Level of Significance	0,0443	Adjusted Chi Square Value	87,84

Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	0,890	95% Adjusted Gamma UCL (use when n<50)	0,897
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0,661	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0,942	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0,353	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0,135	Data Not Lognormal at 5% Significance Level	
Data Not Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	-1,204	Mean of logged Data	-0,743
Maximum of Logged Data	1,872	SD of logged Data	0,736
Assuming Lognormal Distribution			
95% H-UCL	0,793	90% Chebyshev (MVUE) UCL	0,850
95% Chebyshev (MVUE) UCL	0,955	97,5% Chebyshev (MVUE) UCL	1,101
99% Chebyshev (MVUE) UCL	1,387		
Nonparametric Distribution Free UCL Statistics			
Data do not follow a Discernible Distribution (0.05)			
Nonparametric Distribution Free UCLs			
95% CLT UCL	0,967	95% Jackknife UCL	0,973
95% Standard Bootstrap UCL	0,964	95% Bootstrap-t UCL	1,331
95% Hall's Bootstrap UCL	1,993	95% Percentile Bootstrap UCL	0,996
95% BCA Bootstrap UCL	1,169		
90% Chebyshev(Mean, Sd) UCL	1,184	95% Chebyshev(Mean, Sd) UCL	1,401
97,5% Chebyshev(Mean, Sd) UCL	1,703	99% Chebyshev(Mean, Sd) UCL	2,296
Suggested UCL to Use			
95% Chebyshev (Mean, Sd) UCL	1,401		

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.

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 statistician.

Chromium - Main Complex (Soil)

General Statistics			
Total Number of Observations	38,00	Number of Distinct Observations	19,00
		Number of Missing Observations	1,000
Minimum	5,200	Mean	12,15
Maximum	21,00	Median	12,00
SD	3,635	Std. Error of Mean	0,590
Coefficient of Variation	0,299	Skewness	0,218

	A	B	C	D	E	F	G	H	I	J	K	L
1551	**Normal GOF Test**											
1552	Shapiro Wilk Test Statistic					0,973	**Shapiro Wilk GOF Test**					
1553	5% Shapiro Wilk Critical Value					0,938	Data appear Normal at 5% Significance Level					
1554	Lilliefors Test Statistic					0,148	**Lilliefors GOF Test**					
1555	5% Lilliefors Critical Value					0,142	Data Not Normal at 5% Significance Level					
1556	**Data appear Approximate Normal at 5% Significance Level**											
1557												
1558	**Assuming Normal Distribution**											
1559	**95% Normal UCL**						**95% UCLs (Adjusted for Skewness)**					
1560	95% Student's-t UCL					13,14	95% Adjusted-CLT UCL (Chen-1995)					13,14
1561							95% Modified-t UCL (Johnson-1978)					13,15
1562												
1563	**Gamma GOF Test**											
1564	A-D Test Statistic					0,450	**Anderson-Darling Gamma GOF Test**					
1565	5% A-D Critical Value					0,748	Detected data appear Gamma Distributed at 5% Significance Level					
1566	K-S Test Statistic					0,125	**Kolmogorov-Smirnov Gamma GOF Test**					
1567	5% K-S Critical Value					0,143	Detected data appear Gamma Distributed at 5% Significance Level					
1568	**Detected data appear Gamma Distributed at 5% Significance Level**											
1569												
1570	**Gamma Statistics**											
1571	k hat (MLE)					10,65	k star (bias corrected MLE)					9,825
1572	Theta hat (MLE)					1,141	Theta star (bias corrected MLE)					1,236
1573	nu hat (MLE)					809,2	nu star (bias corrected)					746,7
1574	MLE Mean (bias corrected)					12,15	MLE Sd (bias corrected)					3,875
1575							Approximate Chi Square Value (0,0500)					684,3
1576	Adjusted Level of Significance					0,0434	Adjusted Chi Square Value					681,8
1577												
1578	**Assuming Gamma Distribution**											
1579	95% Approximate Gamma UCL (use when n>=50))					13,26	95% Adjusted Gamma UCL (use when n<50)					13,30
1580												
1581	**Lognormal GOF Test**											
1582	Shapiro Wilk Test Statistic					0,949	**Shapiro Wilk Lognormal GOF Test**					
1583	5% Shapiro Wilk Critical Value					0,938	Data appear Lognormal at 5% Significance Level					
1584	Lilliefors Test Statistic					0,147	**Lilliefors Lognormal GOF Test**					
1585	5% Lilliefors Critical Value					0,142	Data Not Lognormal at 5% Significance Level					
1586	**Data appear Approximate Lognormal at 5% Significance Level**											
1587												
1588	**Lognormal Statistics**											
1589	Minimum of Logged Data					1,649	Mean of logged Data					2,449
1590	Maximum of Logged Data					3,045	SD of logged Data					0,324
1591												
1592	**Assuming Lognormal Distribution**											
1593	95% H-UCL					13,43	90% Chebyshev (MVUE) UCL					14,15
1594	95% Chebyshev (MVUE) UCL					15,03	97,5% Chebyshev (MVUE) UCL					16,27
1595	99% Chebyshev (MVUE) UCL					18,69						
1596												
1597	**Nonparametric Distribution Free UCL Statistics**											
1598	**Data appear to follow a Discernible Distribution at 5% Significance Level**											
1599												
1600	**Nonparametric Distribution Free UCLs**											

	A–E	F	G–K	L
1601	95% CLT UCL	13,12	95% Jackknife UCL	13,14
1602	95% Standard Bootstrap UCL	13,07	95% Bootstrap-t UCL	13,22
1603	95% Hall's Bootstrap UCL	13,17	95% Percentile Bootstrap UCL	13,10
1604	95% BCA Bootstrap UCL	13,08		
1605	90% Chebyshev(Mean, Sd) UCL	13,92	95% Chebyshev(Mean, Sd) UCL	14,72
1606	97,5% Chebyshev(Mean, Sd) UCL	15,83	99% Chebyshev(Mean, Sd) UCL	18,01
1607				
1608	**Suggested UCL to Use**			
1609	95% Student's-t UCL	13,14		
1610				
1611	When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test			
1612	When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL			
1613				
1614	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
1615	Recommendations are based upon data size, data distribution, and skewness.			
1616	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
1617	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
1618				
1619				
1620	**Lead - Main Complex (Soil)**			
1621				
1622	**General Statistics**			
1623	Total Number of Observations	38,00	Number of Distinct Observations	32,00
1624			Number of Missing Observations	1,000
1625	Minimum	2,000	Mean	22,53
1626	Maximum	120,0	Median	9,200
1627	SD	30,21	Std. Error of Mean	4,901
1628	Coefficient of Variation	1,341	Skewness	2,091
1629				
1630	**Normal GOF Test**			
1631	Shapiro Wilk Test Statistic	0,669	**Shapiro Wilk GOF Test**	
1632	5% Shapiro Wilk Critical Value	0,938	Data Not Normal at 5% Significance Level	
1633	Lilliefors Test Statistic	0,296	**Lilliefors GOF Test**	
1634	5% Lilliefors Critical Value	0,142	Data Not Normal at 5% Significance Level	
1635	**Data Not Normal at 5% Significance Level**			
1636				
1637	**Assuming Normal Distribution**			
1638	**95% Normal UCL**		**95% UCLs (Adjusted for Skewness)**	
1639	95% Student's-t UCL	30,79	95% Adjusted-CLT UCL (Chen-1995)	32,36
1640			95% Modified-t UCL (Johnson-1978)	31,07
1641				
1642	**Gamma GOF Test**			
1643	A-D Test Statistic	1,706	**Anderson-Darling Gamma GOF Test**	
1644	5% A-D Critical Value	0,783	Data Not Gamma Distributed at 5% Significance Level	
1645	K-S Test Statistic	0,184	**Kolmogorov-Smirnov Gamma GOF Test**	
1646	5% K-S Critical Value	0,148	Data Not Gamma Distributed at 5% Significance Level	
1647	**Data Not Gamma Distributed at 5% Significance Level**			
1648				
1649	**Gamma Statistics**			
1650	k hat (MLE)	0,873	k star (bias corrected MLE)	0,822

Theta hat (MLE)	25,80	Theta star (bias corrected MLE)	27,42
nu hat (MLE)	66,35	nu star (bias corrected)	62,45
MLE Mean (bias corrected)	22,53	MLE Sd (bias corrected)	24,85
		Approximate Chi Square Value (0,0500)	45,27
Adjusted Level of Significance	0,0434	Adjusted Chi Square Value	44,66
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	31,07	95% Adjusted Gamma UCL (use when n<50)	31,50
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0,941	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0,938	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0,123	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0,142	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	0,693	Mean of logged Data	2,442
Maximum of Logged Data	4,787	SD of logged Data	1,135
Assuming Lognormal Distribution			
95% H-UCL	35,27	90% Chebyshev (MVUE) UCL	35,44
95% Chebyshev (MVUE) UCL	41,84	97,5% Chebyshev (MVUE) UCL	50,71
99% Chebyshev (MVUE) UCL	68,15		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	30,59	95% Jackknife UCL	30,79
95% Standard Bootstrap UCL	30,52	95% Bootstrap-t UCL	34,04
95% Hall's Bootstrap UCL	32,42	95% Percentile Bootstrap UCL	30,71
95% BCA Bootstrap UCL	32,54		
90% Chebyshev(Mean, Sd) UCL	37,23	95% Chebyshev(Mean, Sd) UCL	43,89
97,5% Chebyshev(Mean, Sd) UCL	53,13	99% Chebyshev(Mean, Sd) UCL	71,29
Suggested UCL to Use			
95% H-UCL	35,27		

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.

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 statistician.

ProUCL computes and outputs H-statistic based UCLs for historical reasons only.

H-statistic often results in unstable (both high and low) values of UCL95 as shown in examples in the Technical Guide.

It is therefore recommended to avoid the use of H-statistic based 95% UCLs.

Use of nonparametric methods are preferred to compute UCL95 for skewed data sets which do not follow a gamma distribution.

	A	B	C	D	E	F	G	H	I	J	K	L
1701	Molybdenum - Main Complex (Soil)											
1702												
1703	**General Statistics**											
1704					Total Number of Observations	38,00					Number of Distinct Observations	1,000
1705											Number of Missing Observations	1,000
1706					Minimum	2,000					Mean	2,000
1707					Maximum	2,000					Median	2,000
1708												
1709	**Warning: There is only one distinct observation value in this data set - resulting in '0' variance!**											
1710	**ProUCL (or any other software) should not be used on such a data set!**											
1711	**The data set for variable Molybdenum - Main Complex (Soil) was not processed!**											
1712												
1713	**If possible, compute and collect Data Quality Objectives (DQOs) based sample size and analytical results.**											
1714	**The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).**											
1715												
1716												
1717												
1718	Tin - Main Complex (Soil)											
1719												
1720	**General Statistics**											
1721					Total Number of Observations	38,00					Number of Distinct Observations	3,000
1722											Number of Missing Observations	1,000
1723					Minimum	2,000					Mean	2,066
1724					Maximum	3,300					Median	2,000
1725					SD	0,283					Std. Error of Mean	0,0459
1726					Coefficient of Variation	0,137					Skewness	4,185
1727												
1728	**Normal GOF Test**											
1729					Shapiro Wilk Test Statistic	0,246	**Shapiro Wilk GOF Test**					
1730					5% Shapiro Wilk Critical Value	0,938	Data Not Normal at 5% Significance Level					
1731					Lilliefors Test Statistic	0,539	**Lilliefors GOF Test**					
1732					5% Lilliefors Critical Value	0,142	Data Not Normal at 5% Significance Level					
1733	**Data Not Normal at 5% Significance Level**											
1734												
1735	**Assuming Normal Distribution**											
1736	**95% Normal UCL**						**95% UCLs (Adjusted for Skewness)**					
1737					95% Student's-t UCL	2,143					95% Adjusted-CLT UCL (Chen-1995)	2,175
1738											95% Modified-t UCL (Johnson-1978)	2,148
1739												
1740	**Gamma GOF Test**											
1741					A-D Test Statistic	13,64	**Anderson-Darling Gamma GOF Test**					
1742					5% A-D Critical Value	0,746	Data Not Gamma Distributed at 5% Significance Level					
1743					K-S Test Statistic	0,541	**Kolmogorov-Smirnov Gamma GOF Test**					
1744					5% K-S Critical Value	0,143	Data Not Gamma Distributed at 5% Significance Level					
1745	**Data Not Gamma Distributed at 5% Significance Level**											
1746												
1747	**Gamma Statistics**											
1748					k hat (MLE)	73,50					k star (bias corrected MLE)	67,71
1749					Theta hat (MLE)	0,0281					Theta star (bias corrected MLE)	0,0305
1750					nu hat (MLE)	5586					nu star (bias corrected)	5146

	A B C D E	F	G H I J K	L
1751	MLE Mean (bias corrected)	2,066	MLE Sd (bias corrected)	0,251
1752			Approximate Chi Square Value (0,0500)	4980
1753	Adjusted Level of Significance	0,0434	Adjusted Chi Square Value	4974
1754				
1755	**Assuming Gamma Distribution**			
1756	95% Approximate Gamma UCL (use when n>=50))	2,135	95% Adjusted Gamma UCL (use when n<50)	2,137
1757				
1758	**Lognormal GOF Test**			
1759	Shapiro Wilk Test Statistic	0,246	**Shapiro Wilk Lognormal GOF Test**	
1760	5% Shapiro Wilk Critical Value	0,938	Data Not Lognormal at 5% Significance Level	
1761	Lilliefors Test Statistic	0,539	**Lilliefors Lognormal GOF Test**	
1762	5% Lilliefors Critical Value	0,142	Data Not Lognormal at 5% Significance Level	
1763	**Data Not Lognormal at 5% Significance Level**			
1764				
1765	**Lognormal Statistics**			
1766	Minimum of Logged Data	0,693	Mean of logged Data	0,719
1767	Maximum of Logged Data	1,194	SD of logged Data	0,110
1768				
1769	**Assuming Lognormal Distribution**			
1770	95% H-UCL	2,129	90% Chebyshev (MVUE) UCL	2,174
1771	95% Chebyshev (MVUE) UCL	2,225	97,5% Chebyshev (MVUE) UCL	2,294
1772	99% Chebyshev (MVUE) UCL	2,431		
1773				
1774	**Nonparametric Distribution Free UCL Statistics**			
1775	**Data do not follow a Discernible Distribution (0.05)**			
1776				
1777	**Nonparametric Distribution Free UCLs**			
1778	95% CLT UCL	2,141	95% Jackknife UCL	2,143
1779	95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
1780	95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
1781	95% BCA Bootstrap UCL	N/A		
1782	90% Chebyshev(Mean, Sd) UCL	2,204	95% Chebyshev(Mean, Sd) UCL	2,266
1783	97,5% Chebyshev(Mean, Sd) UCL	2,353	99% Chebyshev(Mean, Sd) UCL	2,523
1784				
1785	**Suggested UCL to Use**			
1786	95% Student's-t UCL	2,143	or 95% Modified-t UCL	2,148
1787				
1788	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
1789	Recommendations are based upon data size, data distribution, and skewness.			
1790	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
1791	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
1792				
1793				
1794	**Vanadium - Main Complex (Soil)**			
1795				
1796	**General Statistics**			
1797	Total Number of Observations	38,00	Number of Distinct Observations	25,00
1798			Number of Missing Observations	1,000
1799	Minimum	7,500	Mean	29,09
1800	Maximum	46,00	Median	29,50

	A–E	F	G–K	L
1801	SD	8,538	Std. Error of Mean	1,385
1802	Coefficient of Variation	0,293	Skewness	-0,178
1803				
1804	**Normal GOF Test**			
1805	Shapiro Wilk Test Statistic	0,984	**Shapiro Wilk GOF Test**	
1806	5% Shapiro Wilk Critical Value	0,938	Data appear Normal at 5% Significance Level	
1807	Lilliefors Test Statistic	0,0772	**Lilliefors GOF Test**	
1808	5% Lilliefors Critical Value	0,142	Data appear Normal at 5% Significance Level	
1809	**Data appear Normal at 5% Significance Level**			
1810				
1811	**Assuming Normal Distribution**			
1812	**95% Normal UCL**		**95% UCLs (Adjusted for Skewness)**	
1813	95% Student's-t UCL	31,43	95% Adjusted-CLT UCL (Chen-1995)	31,33
1814			95% Modified-t UCL (Johnson-1978)	31,42
1815				
1816	**Gamma GOF Test**			
1817	A-D Test Statistic	0,519	**Anderson-Darling Gamma GOF Test**	
1818	5% A-D Critical Value	0,748	Detected data appear Gamma Distributed at 5% Significance Level	
1819	K-S Test Statistic	0,117	**Kolmogorov-Smirnov Gamma GOF Test**	
1820	5% K-S Critical Value	0,143	Detected data appear Gamma Distributed at 5% Significance Level	
1821	**Detected data appear Gamma Distributed at 5% Significance Level**			
1822				
1823	**Gamma Statistics**			
1824	k hat (MLE)	9,783	k star (bias corrected MLE)	9,028
1825	Theta hat (MLE)	2,974	Theta star (bias corrected MLE)	3,222
1826	nu hat (MLE)	743,5	nu star (bias corrected)	686,1
1827	MLE Mean (bias corrected)	29,09	MLE Sd (bias corrected)	9,682
1828			Approximate Chi Square Value (0,0500)	626,3
1829	Adjusted Level of Significance	0,0434	Adjusted Chi Square Value	624,0
1830				
1831	**Assuming Gamma Distribution**			
1832	95% Approximate Gamma UCL (use when n>=50))	31,87	95% Adjusted Gamma UCL (use when n<50)	31,99
1833				
1834	**Lognormal GOF Test**			
1835	Shapiro Wilk Test Statistic	0,898	**Shapiro Wilk Lognormal GOF Test**	
1836	5% Shapiro Wilk Critical Value	0,938	Data Not Lognormal at 5% Significance Level	
1837	Lilliefors Test Statistic	0,143	**Lilliefors Lognormal GOF Test**	
1838	5% Lilliefors Critical Value	0,142	Data Not Lognormal at 5% Significance Level	
1839	**Data Not Lognormal at 5% Significance Level**			
1840				
1841	**Lognormal Statistics**			
1842	Minimum of Logged Data	2,015	Mean of logged Data	3,318
1843	Maximum of Logged Data	3,829	SD of logged Data	0,353
1844				
1845	**Assuming Lognormal Distribution**			
1846	95% H-UCL	32,65	90% Chebyshev (MVUE) UCL	34,50
1847	95% Chebyshev (MVUE) UCL	36,83	97,5% Chebyshev (MVUE) UCL	40,07
1848	99% Chebyshev (MVUE) UCL	46,44		
1849				
1850	**Nonparametric Distribution Free UCL Statistics**			

	A	B	C	D	E	F	G	H	I	J	K	L
1851	**Data appear to follow a Discernible Distribution at 5% Significance Level**											
1852												
1853	**Nonparametric Distribution Free UCLs**											
1854					95% CLT UCL	31,37					95% Jackknife UCL	31,43
1855					95% Standard Bootstrap UCL	31,32					95% Bootstrap-t UCL	31,34
1856					95% Hall's Bootstrap UCL	31,38					95% Percentile Bootstrap UCL	31,29
1857					95% BCA Bootstrap UCL	31,32						
1858					90% Chebyshev(Mean, Sd) UCL	33,25					95% Chebyshev(Mean, Sd) UCL	35,13
1859					97,5% Chebyshev(Mean, Sd) UCL	37,74					99% Chebyshev(Mean, Sd) UCL	42,87
1860												
1861	**Suggested UCL to Use**											
1862					95% Student's-t UCL	31,43						
1863												
1864	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
1865	Recommendations are based upon data size, data distribution, and skewness.											
1866	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
1867	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
1868												
1869	**Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be**											
1870	**reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.**											
1871												
1872												
1873	**Zinc - Main Complex (Soil)**											
1874												
1875	**General Statistics**											
1876					Total Number of Observations	46,00					Number of Distinct Observations	39,00
1877											Number of Missing Observations	1,000
1878					Minimum	14,00					Mean	116,0
1879					Maximum	750,0					Median	65,00
1880					SD	152,3					Std. Error of Mean	22,46
1881					Coefficient of Variation	1,314					Skewness	2,804
1882												
1883	**Normal GOF Test**											
1884					Shapiro Wilk Test Statistic	0,613	**Shapiro Wilk GOF Test**					
1885					5% Shapiro Wilk Critical Value	0,945	Data Not Normal at 5% Significance Level					
1886					Lilliefors Test Statistic	0,294	**Lilliefors GOF Test**					
1887					5% Lilliefors Critical Value	0,129	Data Not Normal at 5% Significance Level					
1888	**Data Not Normal at 5% Significance Level**											
1889												
1890	**Assuming Normal Distribution**											
1891	**95% Normal UCL**						**95% UCLs (Adjusted for Skewness)**					
1892					95% Student's-t UCL	153,7					95% Adjusted-CLT UCL (Chen-1995)	162,8
1893											95% Modified-t UCL (Johnson-1978)	155,2
1894												
1895	**Gamma GOF Test**											
1896					A-D Test Statistic	2,095	**Anderson-Darling Gamma GOF Test**					
1897					5% A-D Critical Value	0,775	Data Not Gamma Distributed at 5% Significance Level					
1898					K-S Test Statistic	0,184	**Kolmogorov-Smirnov Gamma GOF Test**					
1899					5% K-S Critical Value	0,134	Data Not Gamma Distributed at 5% Significance Level					
1900	**Data Not Gamma Distributed at 5% Significance Level**											

Gamma Statistics			
k hat (MLE)	1,139	k star (bias corrected MLE)	1,079
Theta hat (MLE)	101,8	Theta star (bias corrected MLE)	107,4
nu hat (MLE)	104,8	nu star (bias corrected)	99,31
MLE Mean (bias corrected)	116,0	MLE Sd (bias corrected)	111,6
		Approximate Chi Square Value (0,0500)	77,32
Adjusted Level of Significance	0,0448	Adjusted Chi Square Value	76,70
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	148,9	95% Adjusted Gamma UCL (use when n<50)	150,2
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0,952	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0,945	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0,105	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0,129	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	2,639	Mean of logged Data	4,254
Maximum of Logged Data	6,620	SD of logged Data	0,938
Assuming Lognormal Distribution			
95% H-UCL	149,9	90% Chebyshev (MVUE) UCL	159,5
95% Chebyshev (MVUE) UCL	182,9	97,5% Chebyshev (MVUE) UCL	215,4
99% Chebyshev (MVUE) UCL	279,2		
Nonparametric Distribution Free UCL Statistics			
Data appear to follow a Discernible Distribution at 5% Significance Level			
Nonparametric Distribution Free UCLs			
95% CLT UCL	152,9	95% Jackknife UCL	153,7
95% Standard Bootstrap UCL	152,3	95% Bootstrap-t UCL	175,5
95% Hall's Bootstrap UCL	163,7	95% Percentile Bootstrap UCL	154,3
95% BCA Bootstrap UCL	160,1		
90% Chebyshev(Mean, Sd) UCL	183,3	95% Chebyshev(Mean, Sd) UCL	213,8
97,5% Chebyshev(Mean, Sd) UCL	256,2	99% Chebyshev(Mean, Sd) UCL	339,4
Suggested UCL to Use			
95% H-UCL	149,9		

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.
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 statistician.

ProUCL computes and outputs H-statistic based UCLs for historical reasons only.
H-statistic often results in unstable (both high and low) values of UCL95 as shown in examples in the Technical Guide.
It is therefore recommended to avoid the use of H-statistic based 95% UCLs.

Use of nonparametric methods are preferred to compute UCL95 for skewed data sets which do not follow a gamma distribution.

Calculated Total PCB

General Statistics			
Total Number of Observations	34,00	Number of Distinct Observations	15,00
		Number of Missing Observations	4,000
Minimum	0,0500	Mean	0,187
Maximum	1,500	Median	0,0890
SD	0,320	Std. Error of Mean	0,0548
Coefficient of Variation	1,711	Skewness	3,568
Normal GOF Test			
Shapiro Wilk Test Statistic	0,454	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0,933	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0,336	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0,150	Data Not Normal at 5% Significance Level	
Data Not Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	0,279	95% Adjusted-CLT UCL (Chen-1995)	0,313
		95% Modified-t UCL (Johnson-1978)	0,285
Gamma GOF Test			
A-D Test Statistic	3,569	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0,776	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0,235	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0,155	Data Not Gamma Distributed at 5% Significance Level	
Data Not Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	1,000	k star (bias corrected MLE)	0,932
Theta hat (MLE)	0,187	Theta star (bias corrected MLE)	0,200
nu hat (MLE)	68,02	nu star (bias corrected)	63,36
MLE Mean (bias corrected)	0,187	MLE Sd (bias corrected)	0,193
		Approximate Chi Square Value (0,0500)	46,04
Adjusted Level of Significance	0,0422	Adjusted Chi Square Value	45,31
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	0,257	95% Adjusted Gamma UCL (use when n<50)	0,261
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0,793	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0,933	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0,235	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0,150	Data Not Lognormal at 5% Significance Level	
Data Not Lognormal at 5% Significance Level			

Lognormal Statistics

Minimum of Logged Data	-2,996	Mean of logged Data	-2,255
Maximum of Logged Data	0,405	SD of logged Data	0,904

Assuming Lognormal Distribution

95% H-UCL	0,228	90% Chebyshev (MVUE) UCL	0,237
95% Chebyshev (MVUE) UCL	0,274	97,5% Chebyshev (MVUE) UCL	0,326
99% Chebyshev (MVUE) UCL	0,427		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	0,277	95% Jackknife UCL	0,279
95% Standard Bootstrap UCL	0,274	95% Bootstrap-t UCL	0,530
95% Hall's Bootstrap UCL	0,718	95% Percentile Bootstrap UCL	0,282
95% BCA Bootstrap UCL	0,330		
90% Chebyshev(Mean, Sd) UCL	0,351	95% Chebyshev(Mean, Sd) UCL	0,426
97,5% Chebyshev(Mean, Sd) UCL	0,529	99% Chebyshev(Mean, Sd) UCL	0,732

Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL	0,426		

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.
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 statistician.

Fraction F3 (>C16-C34) - Former USAF Dump Area and Former Ammunition Storage Area (Soil)

General Statistics

Total Number of Observations	20,00	Number of Distinct Observations	12,00
		Number of Missing Observations	1,000
Minimum	20,00	Mean	134,2
Maximum	1422	Median	27,00
SD	314,4	Std. Error of Mean	70,29
Coefficient of Variation	2,342	Skewness	4,002

Normal GOF Test

Shapiro Wilk Test Statistic	0,397	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0,905	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0,376	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0,192	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	255,7	95% Adjusted-CLT UCL (Chen-1995)	317,0
		95% Modified-t UCL (Johnson-1978)	266,2

	A–E	F	G–K	L
2051				
2052	**Gamma GOF Test**			
2053	A-D Test Statistic	3,179	**Anderson-Darling Gamma GOF Test**	
2054	5% A-D Critical Value	0,792	Data Not Gamma Distributed at 5% Significance Level	
2055	K-S Test Statistic	0,338	**Kolmogorov-Smirnov Gamma GOF Test**	
2056	5% K-S Critical Value	0,203	Data Not Gamma Distributed at 5% Significance Level	
2057	**Data Not Gamma Distributed at 5% Significance Level**			
2058				
2059	**Gamma Statistics**			
2060	k hat (MLE)	0,618	k star (bias corrected MLE)	0,559
2061	Theta hat (MLE)	217,2	Theta star (bias corrected MLE)	240,3
2062	nu hat (MLE)	24,72	nu star (bias corrected)	22,34
2063	MLE Mean (bias corrected)	134,2	MLE Sd (bias corrected)	179,6
2064			Approximate Chi Square Value (0,0500)	12,59
2065	Adjusted Level of Significance	0,0380	Adjusted Chi Square Value	12,02
2066				
2067	**Assuming Gamma Distribution**			
2068	95% Approximate Gamma UCL (use when n>=50))	238,1	95% Adjusted Gamma UCL (use when n<50)	249,5
2069				
2070	**Lognormal GOF Test**			
2071	Shapiro Wilk Test Statistic	0,726	**Shapiro Wilk Lognormal GOF Test**	
2072	5% Shapiro Wilk Critical Value	0,905	Data Not Lognormal at 5% Significance Level	
2073	Lilliefors Test Statistic	0,319	**Lilliefors Lognormal GOF Test**	
2074	5% Lilliefors Critical Value	0,192	Data Not Lognormal at 5% Significance Level	
2075	**Data Not Lognormal at 5% Significance Level**			
2076				
2077	**Lognormal Statistics**			
2078	Minimum of Logged Data	2,996	Mean of logged Data	3,904
2079	Maximum of Logged Data	7,260	SD of logged Data	1,152
2080				
2081	**Assuming Lognormal Distribution**			
2082	95% H-UCL	205,1	90% Chebyshev (MVUE) UCL	172,5
2083	95% Chebyshev (MVUE) UCL	209,1	97,5% Chebyshev (MVUE) UCL	260,0
2084	99% Chebyshev (MVUE) UCL	360,0		
2085				
2086	**Nonparametric Distribution Free UCL Statistics**			
2087	**Data do not follow a Discernible Distribution (0.05)**			
2088				
2089	**Nonparametric Distribution Free UCLs**			
2090	95% CLT UCL	249,8	95% Jackknife UCL	255,7
2091	95% Standard Bootstrap UCL	247,0	95% Bootstrap-t UCL	597,8
2092	95% Hall's Bootstrap UCL	619,2	95% Percentile Bootstrap UCL	266,5
2093	95% BCA Bootstrap UCL	360,4		
2094	90% Chebyshev(Mean, Sd) UCL	345,1	95% Chebyshev(Mean, Sd) UCL	440,6
2095	97,5% Chebyshev(Mean, Sd) UCL	573,2	99% Chebyshev(Mean, Sd) UCL	833,6
2096				
2097	**Suggested UCL to Use**			
2098	95% Chebyshev (Mean, Sd) UCL	440,6		
2099				
2100	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			

Row				
2101	Recommendations are based upon data size, data distribution, and skewness.			
2102	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
2103	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
2104				
2105				
2106	**Anthracene - Former USAF Dump Area and Former Ammunition Storage Area (Soil)**			
2107				
2108	**General Statistics**			
2109	Total Number of Observations	15,00	Number of Distinct Observations	3,000
2110			Number of Missing Observations	1,000
2111	Minimum	0,0100	Mean	0,0733
2112	Maximum	0,760	Median	0,0300
2113	SD	0,190	Std. Error of Mean	0,0491
2114	Coefficient of Variation	2,593	Skewness	3,858
2115				
2116	**Normal GOF Test**			
2117	Shapiro Wilk Test Statistic	0,319	**Shapiro Wilk GOF Test**	
2118	5% Shapiro Wilk Critical Value	0,881	Data Not Normal at 5% Significance Level	
2119	Lilliefors Test Statistic	0,523	**Lilliefors GOF Test**	
2120	5% Lilliefors Critical Value	0,220	Data Not Normal at 5% Significance Level	
2121	**Data Not Normal at 5% Significance Level**			
2122				
2123	**Assuming Normal Distribution**			
2124	**95% Normal UCL**		**95% UCLs (Adjusted for Skewness)**	
2125	95% Student's-t UCL	0,160	95% Adjusted-CLT UCL (Chen-1995)	0,206
2126			95% Modified-t UCL (Johnson-1978)	0,168
2127				
2128	**Gamma GOF Test**			
2129	A-D Test Statistic	3,508	**Anderson-Darling Gamma GOF Test**	
2130	5% A-D Critical Value	0,784	Data Not Gamma Distributed at 5% Significance Level	
2131	K-S Test Statistic	0,503	**Kolmogorov-Smirnov Gamma GOF Test**	
2132	5% K-S Critical Value	0,232	Data Not Gamma Distributed at 5% Significance Level	
2133	**Data Not Gamma Distributed at 5% Significance Level**			
2134				
2135	**Gamma Statistics**			
2136	k hat (MLE)	0,631	k star (bias corrected MLE)	0,550
2137	Theta hat (MLE)	0,116	Theta star (bias corrected MLE)	0,133
2138	nu hat (MLE)	18,94	nu star (bias corrected)	16,49
2139	MLE Mean (bias corrected)	0,0733	MLE Sd (bias corrected)	0,0989
2140			Approximate Chi Square Value (0,0500)	8,307
2141	Adjusted Level of Significance	0,0324	Adjusted Chi Square Value	7,601
2142				
2143	**Assuming Gamma Distribution**			
2144	95% Approximate Gamma UCL (use when n>=50))	0,146	95% Adjusted Gamma UCL (use when n<50)	0,159
2145				
2146	**Lognormal GOF Test**			
2147	Shapiro Wilk Test Statistic	0,622	**Shapiro Wilk Lognormal GOF Test**	
2148	5% Shapiro Wilk Critical Value	0,881	Data Not Lognormal at 5% Significance Level	
2149	Lilliefors Test Statistic	0,404	**Lilliefors Lognormal GOF Test**	
2150	5% Lilliefors Critical Value	0,220	Data Not Lognormal at 5% Significance Level	

Data Not Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	-4,605	Mean of logged Data	-3,584
Maximum of Logged Data	-0,274	SD of logged Data	1,041
Assuming Lognormal Distribution			
95% H-UCL	0,104	90% Chebyshev (MVUE) UCL	0,0856
95% Chebyshev (MVUE) UCL	0,104	97,5% Chebyshev (MVUE) UCL	0,129
99% Chebyshev (MVUE) UCL	0,179		
Nonparametric Distribution Free UCL Statistics			
Data do not follow a Discernible Distribution (0.05)			
Nonparametric Distribution Free UCLs			
95% CLT UCL	0,154	95% Jackknife UCL	0,160
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	0,221	95% Chebyshev(Mean, Sd) UCL	0,287
97,5% Chebyshev(Mean, Sd) UCL	0,380	99% Chebyshev(Mean, Sd) UCL	0,562
Suggested UCL to Use			
95% Chebyshev (Mean, Sd) UCL	0,287		
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.			
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 statistician.			
Benzo(a)anthracene - Former USAF Dump Area and Former Ammunition Storage Area (Soil)			
General Statistics			
Total Number of Observations	15,00	Number of Distinct Observations	2,000
		Number of Missing Observations	1,000
Minimum	0,0100	Mean	0,0780
Maximum	1,030	Median	0,0100
SD	0,263	Std. Error of Mean	0,0680
Coefficient of Variation	3,376	Skewness	3,873
Normal GOF Test			
Shapiro Wilk Test Statistic	0,284	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0,881	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0,535	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0,220	Data Not Normal at 5% Significance Level	
Data Not Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	

	A	B	C	D	E	F	G	H	I	J	K	L
2201					95% Student's-t UCL	0,198					95% Adjusted-CLT UCL (Chen-1995)	0,263
2202											95% Modified-t UCL (Johnson-1978)	0,209
2203												
2204	**Gamma GOF Test**											
2205					A-D Test Statistic	5,587	**Anderson-Darling Gamma GOF Test**					
2206					5% A-D Critical Value	0,818	Data Not Gamma Distributed at 5% Significance Level					
2207					K-S Test Statistic	0,581	**Kolmogorov-Smirnov Gamma GOF Test**					
2208					5% K-S Critical Value	0,238	Data Not Gamma Distributed at 5% Significance Level					
2209	**Data Not Gamma Distributed at 5% Significance Level**											
2210												
2211	**Gamma Statistics**											
2212					k hat (MLE)	0,380					k star (bias corrected MLE)	0,349
2213					Theta hat (MLE)	0,205					Theta star (bias corrected MLE)	0,224
2214					nu hat (MLE)	11,41					nu star (bias corrected)	10,46
2215					MLE Mean (bias corrected)	0,0780					MLE Sd (bias corrected)	0,132
2216											Approximate Chi Square Value (0,0500)	4,230
2217					Adjusted Level of Significance	0,0324					Adjusted Chi Square Value	3,754
2218												
2219	**Assuming Gamma Distribution**											
2220					95% Approximate Gamma UCL (use when n>=50))	0,193					95% Adjusted Gamma UCL (use when n<50)	0,217
2221												
2222	**Lognormal GOF Test**											
2223					Shapiro Wilk Test Statistic	0,284	**Shapiro Wilk Lognormal GOF Test**					
2224					5% Shapiro Wilk Critical Value	0,881	Data Not Lognormal at 5% Significance Level					
2225					Lilliefors Test Statistic	0,535	**Lilliefors Lognormal GOF Test**					
2226					5% Lilliefors Critical Value	0,220	Data Not Lognormal at 5% Significance Level					
2227	**Data Not Lognormal at 5% Significance Level**											
2228												
2229	**Lognormal Statistics**											
2230					Minimum of Logged Data	-4,605					Mean of logged Data	-4,296
2231					Maximum of Logged Data	0,0296					SD of logged Data	1,197
2232												
2233	**Assuming Lognormal Distribution**											
2234					95% H-UCL	0,0744					90% Chebyshev (MVUE) UCL	0,0527
2235					95% Chebyshev (MVUE) UCL	0,0648					97,5% Chebyshev (MVUE) UCL	0,0817
2236					99% Chebyshev (MVUE) UCL	0,115						
2237												
2238	**Nonparametric Distribution Free UCL Statistics**											
2239	**Data do not follow a Discernible Distribution (0.05)**											
2240												
2241	**Nonparametric Distribution Free UCLs**											
2242					95% CLT UCL	0,190					95% Jackknife UCL	N/A
2243					95% Standard Bootstrap UCL	N/A					95% Bootstrap-t UCL	N/A
2244					95% Hall's Bootstrap UCL	N/A					95% Percentile Bootstrap UCL	N/A
2245					95% BCA Bootstrap UCL	N/A						
2246					90% Chebyshev(Mean, Sd) UCL	0,282					95% Chebyshev(Mean, Sd) UCL	0,374
2247					97,5% Chebyshev(Mean, Sd) UCL	0,503					99% Chebyshev(Mean, Sd) UCL	0,755
2248												
2249	**Suggested UCL to Use**											
2250					95% Chebyshev (Mean, Sd) UCL	0,374						

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.

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 statistician.

Benzo(a)pyrene

General Statistics

Total Number of Observations	15,00	Number of Distinct Observations	2,000
		Number of Missing Observations	1,000
Minimum	0,0100	Mean	0,175
Maximum	2,480	Median	0,0100
SD	0,638	Std. Error of Mean	0,165
Coefficient of Variation	3,651	Skewness	3,873

Normal GOF Test

Shapiro Wilk Test Statistic	0,284	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0,881	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0,535	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0,220	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	0,465	95% Adjusted-CLT UCL (Chen-1995)	0,621
		95% Modified-t UCL (Johnson-1978)	0,492

Gamma GOF Test

A-D Test Statistic	5,602	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0,845	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0,585	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0,241	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0,280	k star (bias corrected MLE)	0,268
Theta hat (MLE)	0,624	Theta star (bias corrected MLE)	0,651
nu hat (MLE)	8,394	nu star (bias corrected)	8,048
MLE Mean (bias corrected)	0,175	MLE Sd (bias corrected)	0,337
		Approximate Chi Square Value (0,0500)	2,763
Adjusted Level of Significance	0,0324	Adjusted Chi Square Value	2,396

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	0,509	95% Adjusted Gamma UCL (use when n<50)	0,587

Lognormal GOF Test

Shapiro Wilk Test Statistic	0,284	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0,881	Data Not Lognormal at 5% Significance Level

Lilliefors Test Statistic	0,535	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0,220	Data Not Lognormal at 5% Significance Level	

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-4,605	Mean of logged Data	-4,238
Maximum of Logged Data	0,908	SD of logged Data	1,424

Assuming Lognormal Distribution

95% H-UCL	0,149	90% Chebyshev (MVUE) UCL	0,0797
95% Chebyshev (MVUE) UCL	0,0998	97,5% Chebyshev (MVUE) UCL	0,128
99% Chebyshev (MVUE) UCL	0,182		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	0,446	95% Jackknife UCL	N/A
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	0,669	95% Chebyshev(Mean, Sd) UCL	0,892
97,5% Chebyshev(Mean, Sd) UCL	1,203	99% Chebyshev(Mean, Sd) UCL	1,813

Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL	0,892		

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.

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 statistician.

Benzo(a)fluoranthene - Former USAF Dump Area and Former Ammunition Storage Area (Soil)

General Statistics

Total Number of Observations	15,00	Number of Distinct Observations	3,000
		Number of Missing Observations	1,000
Minimum	0,0100	Mean	0,259
Maximum	3,350	Median	0,0500
SD	0,855	Std. Error of Mean	0,221
Coefficient of Variation	3,298	Skewness	3,870

Normal GOF Test

Shapiro Wilk Test Statistic	0,299	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0,881	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0,530	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0,220	Data Not Normal at 5% Significance Level	

Data Not Normal at 5% Significance Level

	A–E	F	G–K	L
2351	**Assuming Normal Distribution**			
2352	**95% Normal UCL**		**95% UCLs (Adjusted for Skewness)**	
2353	95% Student's-t UCL	0,648	95% Adjusted-CLT UCL (Chen-1995)	0,858
2354			95% Modified-t UCL (Johnson-1978)	0,685
2355				
2356	**Gamma GOF Test**			
2357	A-D Test Statistic	3,689	**Anderson-Darling Gamma GOF Test**	
2358	5% A-D Critical Value	0,820	Data Not Gamma Distributed at 5% Significance Level	
2359	K-S Test Statistic	0,519	**Kolmogorov-Smirnov Gamma GOF Test**	
2360	5% K-S Critical Value	0,238	Data Not Gamma Distributed at 5% Significance Level	
2361	**Data Not Gamma Distributed at 5% Significance Level**			
2362				
2363	**Gamma Statistics**			
2364	k hat (MLE)	0,371	k star (bias corrected MLE)	0,341
2365	Theta hat (MLE)	0,699	Theta star (bias corrected MLE)	0,760
2366	nu hat (MLE)	11,13	nu star (bias corrected)	10,24
2367	MLE Mean (bias corrected)	0,259	MLE Sd (bias corrected)	0,444
2368			Approximate Chi Square Value (0,0500)	4,092
2369	Adjusted Level of Significance	0,0324	Adjusted Chi Square Value	3,626
2370				
2371	**Assuming Gamma Distribution**			
2372	95% Approximate Gamma UCL (use when n>=50))	0,649	95% Adjusted Gamma UCL (use when n<50)	0,732
2373				
2374	**Lognormal GOF Test**			
2375	Shapiro Wilk Test Statistic	0,646	**Shapiro Wilk Lognormal GOF Test**	
2376	5% Shapiro Wilk Critical Value	0,881	Data Not Lognormal at 5% Significance Level	
2377	Lilliefors Test Statistic	0,391	**Lilliefors Lognormal GOF Test**	
2378	5% Lilliefors Critical Value	0,220	Data Not Lognormal at 5% Significance Level	
2379	**Data Not Lognormal at 5% Significance Level**			
2380				
2381	**Lognormal Statistics**			
2382	Minimum of Logged Data	-4,605	Mean of logged Data	-3,145
2383	Maximum of Logged Data	1,209	SD of logged Data	1,407
2384				
2385	**Assuming Lognormal Distribution**			
2386	95% H-UCL	0,423	90% Chebyshev (MVUE) UCL	0,231
2387	95% Chebyshev (MVUE) UCL	0,289	97,5% Chebyshev (MVUE) UCL	0,370
2388	99% Chebyshev (MVUE) UCL	0,528		
2389				
2390	**Nonparametric Distribution Free UCL Statistics**			
2391	**Data do not follow a Discernible Distribution (0.05)**			
2392				
2393	**Nonparametric Distribution Free UCLs**			
2394	95% CLT UCL	0,623	95% Jackknife UCL	0,648
2395	95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
2396	95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
2397	95% BCA Bootstrap UCL	N/A		
2398	90% Chebyshev(Mean, Sd) UCL	0,922	95% Chebyshev(Mean, Sd) UCL	1,222
2399	97,5% Chebyshev(Mean, Sd) UCL	1,638	99% Chebyshev(Mean, Sd) UCL	2,456
2400				

Suggested UCL to Use			
95% Chebyshev (Mean, Sd) UCL	1,222		
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.			
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 statistician.			
Chryene - Former USAF Dump Area and Former Ammunition Storage Area (Soil)			
General Statistics			
Total Number of Observations	15,00	Number of Distinct Observations	3,000
		Number of Missing Observations	1,000
Minimum	0,0100	Mean	0,179
Maximum	2,540	Median	0,0100
SD	0,653	Std. Error of Mean	0,169
Coefficient of Variation	3,652	Skewness	3,873
Normal GOF Test			
Shapiro Wilk Test Statistic	0,285	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0,881	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0,534	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0,220	Data Not Normal at 5% Significance Level	
Data Not Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	0,476	95% Adjusted-CLT UCL (Chen-1995)	0,636
		95% Modified-t UCL (Johnson-1978)	0,504
Gamma GOF Test			
A-D Test Statistic	5,507	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0,845	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0,561	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0,241	Data Not Gamma Distributed at 5% Significance Level	
Data Not Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	0,279	k star (bias corrected MLE)	0,268
Theta hat (MLE)	0,640	Theta star (bias corrected MLE)	0,668
nu hat (MLE)	8,380	nu star (bias corrected)	8,038
MLE Mean (bias corrected)	0,179	MLE Sd (bias corrected)	0,346
		Approximate Chi Square Value (0,0500)	2,757
Adjusted Level of Significance	0,0324	Adjusted Chi Square Value	2,390
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	0,521	95% Adjusted Gamma UCL (use when n<50)	0,601
Lognormal GOF Test			

	A–E	F	G–K	L
2451	Shapiro Wilk Test Statistic	0,303	**Shapiro Wilk Lognormal GOF Test**	
2452	5% Shapiro Wilk Critical Value	0,881	Data Not Lognormal at 5% Significance Level	
2453	Lilliefors Test Statistic	0,473	**Lilliefors Lognormal GOF Test**	
2454	5% Lilliefors Critical Value	0,220	Data Not Lognormal at 5% Significance Level	
2455	**Data Not Lognormal at 5% Significance Level**			
2456				
2457	**Lognormal Statistics**			
2458	Minimum of Logged Data	-4,605	Mean of logged Data	-4,219
2459	Maximum of Logged Data	0,932	SD of logged Data	1,426
2460				
2461	**Assuming Lognormal Distribution**			
2462	95% H-UCL	0,153	90% Chebyshev (MVUE) UCL	0,0817
2463	95% Chebyshev (MVUE) UCL	0,102	97,5% Chebyshev (MVUE) UCL	0,131
2464	99% Chebyshev (MVUE) UCL	0,187		
2465				
2466	**Nonparametric Distribution Free UCL Statistics**			
2467	**Data do not follow a Discernible Distribution (0.05)**			
2468				
2469	**Nonparametric Distribution Free UCLs**			
2470	95% CLT UCL	0,456	95% Jackknife UCL	0,476
2471	95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
2472	95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
2473	95% BCA Bootstrap UCL	N/A		
2474	90% Chebyshev(Mean, Sd) UCL	0,685	95% Chebyshev(Mean, Sd) UCL	0,914
2475	97,5% Chebyshev(Mean, Sd) UCL	1,232	99% Chebyshev(Mean, Sd) UCL	1,857
2476				
2477	**Suggested UCL to Use**			
2478	95% Chebyshev (Mean, Sd) UCL	0,914		
2479				
2480	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
2481	Recommendations are based upon data size, data distribution, and skewness.			
2482	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
2483	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
2484				
2485				
2486	**Dibenzo(a,h)anthracene - Former USAF Dump Area and Former Ammunition Storage Area (Soil)**			
2487				
2488	**General Statistics**			
2489	Total Number of Observations	15,00	Number of Distinct Observations	3,000
2490			Number of Missing Observations	1,000
2491	Minimum	0,00600	Mean	0,0233
2492	Maximum	0,249	Median	0,00600
2493	SD	0,0625	Std. Error of Mean	0,0161
2494	Coefficient of Variation	2,685	Skewness	3,867
2495				
2496	**Normal GOF Test**			
2497	Shapiro Wilk Test Statistic	0,303	**Shapiro Wilk GOF Test**	
2498	5% Shapiro Wilk Critical Value	0,881	Data Not Normal at 5% Significance Level	
2499	Lilliefors Test Statistic	0,517	**Lilliefors GOF Test**	
2500	5% Lilliefors Critical Value	0,220	Data Not Normal at 5% Significance Level	

	A	B	C	D	E	F	G	H	I	J	K	L
2501	**Data Not Normal at 5% Significance Level**											
2502												
2503	**Assuming Normal Distribution**											
2504	**95% Normal UCL**						**95% UCLs (Adjusted for Skewness)**					
2505					95% Student's-t UCL	0,0517					95% Adjusted-CLT UCL (Chen-1995)	0,0670
2506											95% Modified-t UCL (Johnson-1978)	0,0544
2507												
2508	**Gamma GOF Test**											
2509					A-D Test Statistic	4,418	**Anderson-Darling Gamma GOF Test**					
2510					5% A-D Critical Value	0,784	Data Not Gamma Distributed at 5% Significance Level					
2511					K-S Test Statistic	0,492	**Kolmogorov-Smirnov Gamma GOF Test**					
2512					5% K-S Critical Value	0,232	Data Not Gamma Distributed at 5% Significance Level					
2513	**Data Not Gamma Distributed at 5% Significance Level**											
2514												
2515	**Gamma Statistics**											
2516					k hat (MLE)	0,632					k star (bias corrected MLE)	0,550
2517					Theta hat (MLE)	0,0368					Theta star (bias corrected MLE)	0,0423
2518					nu hat (MLE)	18,95					nu star (bias corrected)	16,50
2519					MLE Mean (bias corrected)	0,0233					MLE Sd (bias corrected)	0,0314
2520											Approximate Chi Square Value (0,0500)	8,313
2521					Adjusted Level of Significance	0,0324					Adjusted Chi Square Value	7,607
2522												
2523	**Assuming Gamma Distribution**											
2524					95% Approximate Gamma UCL (use when n>=50))	0,0462					95% Adjusted Gamma UCL (use when n<50)	0,0505
2525												
2526	**Lognormal GOF Test**											
2527					Shapiro Wilk Test Statistic	0,446	**Shapiro Wilk Lognormal GOF Test**					
2528					5% Shapiro Wilk Critical Value	0,881	Data Not Lognormal at 5% Significance Level					
2529					Lilliefors Test Statistic	0,381	**Lilliefors Lognormal GOF Test**					
2530					5% Lilliefors Critical Value	0,220	Data Not Lognormal at 5% Significance Level					
2531	**Data Not Lognormal at 5% Significance Level**											
2532												
2533	**Lognormal Statistics**											
2534					Minimum of Logged Data	-5,116					Mean of logged Data	-4,731
2535					Maximum of Logged Data	-1,390					SD of logged Data	0,953
2536												
2537	**Assuming Lognormal Distribution**											
2538					95% H-UCL	0,0274					90% Chebyshev (MVUE) UCL	0,0240
2539					95% Chebyshev (MVUE) UCL	0,0288					97,5% Chebyshev (MVUE) UCL	0,0356
2540					99% Chebyshev (MVUE) UCL	0,0487						
2541												
2542	**Nonparametric Distribution Free UCL Statistics**											
2543	**Data do not follow a Discernible Distribution (0.05)**											
2544												
2545	**Nonparametric Distribution Free UCLs**											
2546					95% CLT UCL	0,0498					95% Jackknife UCL	0,0517
2547					95% Standard Bootstrap UCL	N/A					95% Bootstrap-t UCL	N/A
2548					95% Hall's Bootstrap UCL	N/A					95% Percentile Bootstrap UCL	N/A
2549					95% BCA Bootstrap UCL	N/A						
2550					90% Chebyshev(Mean, Sd) UCL	0,0717					95% Chebyshev(Mean, Sd) UCL	0,0936

97,5% Chebyshev(Mean, Sd) UCL	0,124	99% Chebyshev(Mean, Sd) UCL	0,184
Suggested UCL to Use			
95% Chebyshev (Mean, Sd) UCL	0,0936		
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.			
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 statistician.			
Fluoranthene - Former USAF Dump Area and Former Ammunition Storage Area (Soil)			
General Statistics			
Total Number of Observations	15,00	Number of Distinct Observations	4,000
		Number of Missing Observations	1,000
Minimum	0,0100	Mean	0,0670
Maximum	0,460	Median	0,0500
SD	0,110	Std. Error of Mean	0,0284
Coefficient of Variation	1,644	Skewness	3,700
Normal GOF Test			
Shapiro Wilk Test Statistic	0,403	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0,881	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0,495	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0,220	Data Not Normal at 5% Significance Level	
Data Not Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	0,117	95% Adjusted-CLT UCL (Chen-1995)	0,143
		95% Modified-t UCL (Johnson-1978)	0,122
Gamma GOF Test			
A-D Test Statistic	2,266	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0,762	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0,413	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0,228	Data Not Gamma Distributed at 5% Significance Level	
Data Not Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	1,050	k star (bias corrected MLE)	0,884
Theta hat (MLE)	0,0638	Theta star (bias corrected MLE)	0,0758
nu hat (MLE)	31,49	nu star (bias corrected)	26,52
MLE Mean (bias corrected)	0,0670	MLE Sd (bias corrected)	0,0713
		Approximate Chi Square Value (0,0500)	15,78
Adjusted Level of Significance	0,0324	Adjusted Chi Square Value	14,77
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	0,113	95% Adjusted Gamma UCL (use when n<50)	0,120

	A	B	C	D	E	F	G	H	I	J	K	L
2601												
2602	**Lognormal GOF Test**											
2603					Shapiro Wilk Test Statistic	0,744	**Shapiro Wilk Lognormal GOF Test**					
2604					5% Shapiro Wilk Critical Value	0,881	Data Not Lognormal at 5% Significance Level					
2605					Lilliefors Test Statistic	0,337	**Lilliefors Lognormal GOF Test**					
2606					5% Lilliefors Critical Value	0,220	Data Not Lognormal at 5% Significance Level					
2607	**Data Not Lognormal at 5% Significance Level**											
2608												
2609	**Lognormal Statistics**											
2610					Minimum of Logged Data	-4,605					Mean of logged Data	-3,250
2611					Maximum of Logged Data	-0,777					SD of logged Data	0,970
2612												
2613	**Assuming Lognormal Distribution**											
2614					95% H-UCL	0,125					90% Chebyshev (MVUE) UCL	0,108
2615					95% Chebyshev (MVUE) UCL	0,130					97,5% Chebyshev (MVUE) UCL	0,161
2616					99% Chebyshev (MVUE) UCL	0,221						
2617												
2618	**Nonparametric Distribution Free UCL Statistics**											
2619	**Data do not follow a Discernible Distribution (0.05)**											
2620												
2621	**Nonparametric Distribution Free UCLs**											
2622					95% CLT UCL	0,114					95% Jackknife UCL	0,117
2623					95% Standard Bootstrap UCL	N/A					95% Bootstrap-t UCL	N/A
2624					95% Hall's Bootstrap UCL	N/A					95% Percentile Bootstrap UCL	N/A
2625					95% BCA Bootstrap UCL	N/A						
2626					90% Chebyshev(Mean, Sd) UCL	0,152					95% Chebyshev(Mean, Sd) UCL	0,191
2627					97,5% Chebyshev(Mean, Sd) UCL	0,245					99% Chebyshev(Mean, Sd) UCL	0,350
2628												
2629	**Suggested UCL to Use**											
2630					95% Chebyshev (Mean, Sd) UCL	0,191						
2631												
2632	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
2633	Recommendations are based upon data size, data distribution, and skewness.											
2634	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
2635	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
2636												
2637												
2638	**Phenanthrene - Former USAF Dump Area and Former Ammunition Storage Area (Soil)**											
2639												
2640	**General Statistics**											
2641					Total Number of Observations	15,00					Number of Distinct Observations	4,000
2642											Number of Missing Observations	1,000
2643					Minimum	0,0100					Mean	0,0286
2644					Maximum	0,0520					Median	0,0300
2645					SD	0,00950					Std. Error of Mean	0,00245
2646					Coefficient of Variation	0,332					Skewness	-0,00295
2647												
2648	**Normal GOF Test**											
2649					Shapiro Wilk Test Statistic	0,665	**Shapiro Wilk GOF Test**					
2650					5% Shapiro Wilk Critical Value	0,881	Data Not Normal at 5% Significance Level					

	A	B	C	D	E	F	G	H	I	J	K	L
2651					Lilliefors Test Statistic	0,375	**Lilliefors GOF Test**					
2652					5% Lilliefors Critical Value	0,220	Data Not Normal at 5% Significance Level					
2653	**Data Not Normal at 5% Significance Level**											
2654												
2655	**Assuming Normal Distribution**											
2656	**95% Normal UCL**						**95% UCLs (Adjusted for Skewness)**					
2657					95% Student's-t UCL	0,0329					95% Adjusted-CLT UCL (Chen-1995)	0,0326
2658											95% Modified-t UCL (Johnson-1978)	0,0329
2659												
2660	**Gamma GOF Test**											
2661					A-D Test Statistic	3,003	**Anderson-Darling Gamma GOF Test**					
2662					5% A-D Critical Value	0,738	Data Not Gamma Distributed at 5% Significance Level					
2663					K-S Test Statistic	0,400	**Kolmogorov-Smirnov Gamma GOF Test**					
2664					5% K-S Critical Value	0,222	Data Not Gamma Distributed at 5% Significance Level					
2665	**Data Not Gamma Distributed at 5% Significance Level**											
2666												
2667	**Gamma Statistics**											
2668					k hat (MLE)	7,404					k star (bias corrected MLE)	5,968
2669					Theta hat (MLE)	0,00386					Theta star (bias corrected MLE)	0,00479
2670					nu hat (MLE)	222,1					nu star (bias corrected)	179,0
2671					MLE Mean (bias corrected)	0,0286					MLE Sd (bias corrected)	0,0117
2672											Approximate Chi Square Value (0,0500)	149,1
2673					Adjusted Level of Significance	0,0324					Adjusted Chi Square Value	145,7
2674												
2675	**Assuming Gamma Distribution**											
2676					95% Approximate Gamma UCL (use when n>=50))	0,0343					95% Adjusted Gamma UCL (use when n<50)	0,0351
2677												
2678	**Lognormal GOF Test**											
2679					Shapiro Wilk Test Statistic	0,608	**Shapiro Wilk Lognormal GOF Test**					
2680					5% Shapiro Wilk Critical Value	0,881	Data Not Lognormal at 5% Significance Level					
2681					Lilliefors Test Statistic	0,408	**Lilliefors Lognormal GOF Test**					
2682					5% Lilliefors Critical Value	0,220	Data Not Lognormal at 5% Significance Level					
2683	**Data Not Lognormal at 5% Significance Level**											
2684												
2685	**Lognormal Statistics**											
2686					Minimum of Logged Data	-4,605					Mean of logged Data	-3,623
2687					Maximum of Logged Data	-2,957					SD of logged Data	0,424
2688												
2689	**Assuming Lognormal Distribution**											
2690					95% H-UCL	0,0366					90% Chebyshev (MVUE) UCL	0,0388
2691					95% Chebyshev (MVUE) UCL	0,0432					97,5% Chebyshev (MVUE) UCL	0,0493
2692					99% Chebyshev (MVUE) UCL	0,0614						
2693												
2694	**Nonparametric Distribution Free UCL Statistics**											
2695	**Data do not follow a Discernible Distribution (0.05)**											
2696												
2697	**Nonparametric Distribution Free UCLs**											
2698					95% CLT UCL	0,0326					95% Jackknife UCL	0,0329
2699					95% Standard Bootstrap UCL	N/A					95% Bootstrap-t UCL	N/A
2700					95% Hall's Bootstrap UCL	N/A					95% Percentile Bootstrap UCL	N/A

	A	B	C	D	E	F	G	H	I	J	K	L
2701					95% BCA Bootstrap UCL	N/A						
2702					90% Chebyshev(Mean, Sd) UCL	0,0360					95% Chebyshev(Mean, Sd) UCL	0,0393
2703					97,5% Chebyshev(Mean, Sd) UCL	0,0439					99% Chebyshev(Mean, Sd) UCL	0,0530
2704												
2705	**Suggested UCL to Use**											
2706					95% Student's-t UCL	0,0329					or 95% Modified-t UCL	0,0329
2707												
2708	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
2709	Recommendations are based upon data size, data distribution, and skewness.											
2710	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
2711	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
2712												
2713	**Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be**											
2714	**reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.**											
2715												
2716												
2717	**Cadmium - Former USAF Dump Area and Former Ammunition Storage Area (Soil)**											
2718												
2719	**General Statistics**											
2720					Total Number of Observations	14,00					Number of Distinct Observations	3,000
2721											Number of Missing Observations	1,000
2722					Minimum	0,300					Mean	0,335
2723					Maximum	0,650					Median	0,300
2724					SD	0,0980					Std. Error of Mean	0,0262
2725					Coefficient of Variation	0,293					Skewness	3,038
2726												
2727	**Normal GOF Test**											
2728					Shapiro Wilk Test Statistic	0,424	**Shapiro Wilk GOF Test**					
2729					5% Shapiro Wilk Critical Value	0,874	Data Not Normal at 5% Significance Level					
2730					Lilliefors Test Statistic	0,497	**Lilliefors GOF Test**					
2731					5% Lilliefors Critical Value	0,226	Data Not Normal at 5% Significance Level					
2732	**Data Not Normal at 5% Significance Level**											
2733												
2734	**Assuming Normal Distribution**											
2735	**95% Normal UCL**						**95% UCLs (Adjusted for Skewness)**					
2736					95% Student's-t UCL	0,381					95% Adjusted-CLT UCL (Chen-1995)	0,401
2737											95% Modified-t UCL (Johnson-1978)	0,385
2738												
2739	**Gamma GOF Test**											
2740					A-D Test Statistic	3,914	**Anderson-Darling Gamma GOF Test**					
2741					5% A-D Critical Value	0,734	Data Not Gamma Distributed at 5% Significance Level					
2742					K-S Test Statistic	0,506	**Kolmogorov-Smirnov Gamma GOF Test**					
2743					5% K-S Critical Value	0,228	Data Not Gamma Distributed at 5% Significance Level					
2744	**Data Not Gamma Distributed at 5% Significance Level**											
2745												
2746	**Gamma Statistics**											
2747					k hat (MLE)	18,17					k star (bias corrected MLE)	14,33
2748					Theta hat (MLE)	0,0184					Theta star (bias corrected MLE)	0,0234
2749					nu hat (MLE)	508,9					nu star (bias corrected)	401,2
2750					MLE Mean (bias corrected)	0,335					MLE Sd (bias corrected)	0,0885

	A–E	F	G–K	L
2751			Approximate Chi Square Value (0,0500)	355,7
2752	Adjusted Level of Significance	0,0312	Adjusted Chi Square Value	350,1
2753				
2754	**Assuming Gamma Distribution**			
2755	95% Approximate Gamma UCL (use when n>=50))	0,378	95% Adjusted Gamma UCL (use when n<50)	0,384
2756				
2757	**Lognormal GOF Test**			
2758	Shapiro Wilk Test Statistic	0,438	**Shapiro Wilk Lognormal GOF Test**	
2759	5% Shapiro Wilk Critical Value	0,874	Data Not Lognormal at 5% Significance Level	
2760	Lilliefors Test Statistic	0,501	**Lilliefors Lognormal GOF Test**	
2761	5% Lilliefors Critical Value	0,226	Data Not Lognormal at 5% Significance Level	
2762	**Data Not Lognormal at 5% Significance Level**			
2763				
2764	**Lognormal Statistics**			
2765	Minimum of Logged Data	-1,204	Mean of logged Data	-1,121
2766	Maximum of Logged Data	-0,431	SD of logged Data	0,223
2767				
2768	**Assuming Lognormal Distribution**			
2769	95% H-UCL	0,374	90% Chebyshev (MVUE) UCL	0,394
2770	95% Chebyshev (MVUE) UCL	0,421	97,5% Chebyshev (MVUE) UCL	0,459
2771	99% Chebyshev (MVUE) UCL	0,533		
2772				
2773	**Nonparametric Distribution Free UCL Statistics**			
2774	**Data do not follow a Discernible Distribution (0.05)**			
2775				
2776	**Nonparametric Distribution Free UCLs**			
2777	95% CLT UCL	0,378	95% Jackknife UCL	0,381
2778	95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
2779	95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
2780	95% BCA Bootstrap UCL	N/A		
2781	90% Chebyshev(Mean, Sd) UCL	0,414	95% Chebyshev(Mean, Sd) UCL	0,449
2782	97,5% Chebyshev(Mean, Sd) UCL	0,499	99% Chebyshev(Mean, Sd) UCL	0,596
2783				
2784	**Suggested UCL to Use**			
2785	95% Student's-t UCL	0,381	or 95% Modified-t UCL	0,385
2786				
2787	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
2788	Recommendations are based upon data size, data distribution, and skewness.			
2789	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
2790	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
2791				
2792				
2793	**Lead - Former USAF Dump Area and Former Ammunition Storage Area (Soil)**			
2794				
2795	**General Statistics**			
2796	Total Number of Observations	14,00	Number of Distinct Observations	12,00
2797			Number of Missing Observations	1,000
2798	Minimum	3,200	Mean	11,89
2799	Maximum	65,00	Median	6,000
2800	SD	16,30	Std. Error of Mean	4,358

	A	B	C	D	E	F	G	H	I	J	K	L
2801					Coefficient of Variation	1,371					Skewness	3,077
2802												
2803	**Normal GOF Test**											
2804					Shapiro Wilk Test Statistic	0,548	**Shapiro Wilk GOF Test**					
2805					5% Shapiro Wilk Critical Value	0,874	Data Not Normal at 5% Significance Level					
2806					Lilliefors Test Statistic	0,355	**Lilliefors GOF Test**					
2807					5% Lilliefors Critical Value	0,226	Data Not Normal at 5% Significance Level					
2808	**Data Not Normal at 5% Significance Level**											
2809												
2810	**Assuming Normal Distribution**											
2811	**95% Normal UCL**						**95% UCLs (Adjusted for Skewness)**					
2812					95% Student's-t UCL	19,61					95% Adjusted-CLT UCL (Chen-1995)	22,89
2813											95% Modified-t UCL (Johnson-1978)	20,21
2814												
2815	**Gamma GOF Test**											
2816					A-D Test Statistic	1,307	**Anderson-Darling Gamma GOF Test**					
2817					5% A-D Critical Value	0,755	Data Not Gamma Distributed at 5% Significance Level					
2818					K-S Test Statistic	0,259	**Kolmogorov-Smirnov Gamma GOF Test**					
2819					5% K-S Critical Value	0,234	Data Not Gamma Distributed at 5% Significance Level					
2820	**Data Not Gamma Distributed at 5% Significance Level**											
2821												
2822	**Gamma Statistics**											
2823					k hat (MLE)	1,276					k star (bias corrected MLE)	1,051
2824					Theta hat (MLE)	9,317					Theta star (bias corrected MLE)	11,32
2825					nu hat (MLE)	35,74					nu star (bias corrected)	29,42
2826					MLE Mean (bias corrected)	11,89					MLE Sd (bias corrected)	11,60
2827											Approximate Chi Square Value (0,0500)	18,03
2828					Adjusted Level of Significance	0,0312					Adjusted Chi Square Value	16,86
2829												
2830	**Assuming Gamma Distribution**											
2831					95% Approximate Gamma UCL (use when n>=50))	19,40					95% Adjusted Gamma UCL (use when n<50)	20,75
2832												
2833	**Lognormal GOF Test**											
2834					Shapiro Wilk Test Statistic	0,861	**Shapiro Wilk Lognormal GOF Test**					
2835					5% Shapiro Wilk Critical Value	0,874	Data Not Lognormal at 5% Significance Level					
2836					Lilliefors Test Statistic	0,213	**Lilliefors Lognormal GOF Test**					
2837					5% Lilliefors Critical Value	0,226	Data appear Lognormal at 5% Significance Level					
2838	**Data appear Approximate Lognormal at 5% Significance Level**											
2839												
2840	**Lognormal Statistics**											
2841					Minimum of Logged Data	1,163					Mean of logged Data	2,036
2842					Maximum of Logged Data	4,174					SD of logged Data	0,835
2843												
2844	**Assuming Lognormal Distribution**											
2845					95% H-UCL	19,52					90% Chebyshev (MVUE) UCL	18,03
2846					95% Chebyshev (MVUE) UCL	21,43					97,5% Chebyshev (MVUE) UCL	26,16
2847					99% Chebyshev (MVUE) UCL	35,44						
2848												
2849	**Nonparametric Distribution Free UCL Statistics**											
2850	**Data appear to follow a Discernible Distribution at 5% Significance Level**											

Nonparametric Distribution Free UCLs

95% CLT UCL	19,06	95% Jackknife UCL	19,61
95% Standard Bootstrap UCL	18,85	95% Bootstrap-t UCL	46,04
95% Hall's Bootstrap UCL	49,07	95% Percentile Bootstrap UCL	19,76
95% BCA Bootstrap UCL	23,51		
90% Chebyshev(Mean, Sd) UCL	24,97	95% Chebyshev(Mean, Sd) UCL	30,89
97,5% Chebyshev(Mean, Sd) UCL	39,11	99% Chebyshev(Mean, Sd) UCL	55,25

Suggested UCL to Use

95% H-UCL	19,52		

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.
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 statistician.

ProUCL computes and outputs H-statistic based UCLs for historical reasons only.
H-statistic often results in unstable (both high and low) values of UCL95 as shown in examples in the Technical Guide.
It is therefore recommended to avoid the use of H-statistic based 95% UCLs.
Use of nonparametric methods are preferred to compute UCL95 for skewed data sets which do not follow a gamma distribution.

Molybdenum - Former USAF Dump Area and Former Ammunition Storage Area (Soil)

General Statistics

Total Number of Observations	14,00	Number of Distinct Observations	2,000
		Number of Missing Observations	1,000
Minimum	2,000	Mean	2,043
Maximum	2,600	Median	2,000
SD	0,160	Std. Error of Mean	0,0429
Coefficient of Variation	0,0785	Skewness	3,742

Normal GOF Test

Shapiro Wilk Test Statistic	0,297	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0,874	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0,534	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0,226	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	2,119	95% Adjusted-CLT UCL (Chen-1995)	2,159
		95% Modified-t UCL (Johnson-1978)	2,126

Gamma GOF Test

A-D Test Statistic	4,873	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0,733	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0,538	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0,228	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	203,3	k star (bias corrected MLE)	159,8
Theta hat (MLE)	0,0101	Theta star (bias corrected MLE)	0,0128
nu hat (MLE)	5691	nu star (bias corrected)	4473
MLE Mean (bias corrected)	2,043	MLE Sd (bias corrected)	0,162
		Approximate Chi Square Value (0,0500)	4319
Adjusted Level of Significance	0,0312	Adjusted Chi Square Value	4299
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	2,116	95% Adjusted Gamma UCL (use when n<50)	2,126
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0,297	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0,874	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0,534	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0,226	Data Not Lognormal at 5% Significance Level	
Data Not Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	0,693	Mean of logged Data	0,712
Maximum of Logged Data	0,956	SD of logged Data	0,0701
Assuming Lognormal Distribution			
95% H-UCL	N/A	90% Chebyshev (MVUE) UCL	2,157
95% Chebyshev (MVUE) UCL	2,209	97,5% Chebyshev (MVUE) UCL	2,282
99% Chebyshev (MVUE) UCL	2,424		
Nonparametric Distribution Free UCL Statistics			
Data do not follow a Discernible Distribution (0.05)			
Nonparametric Distribution Free UCLs			
95% CLT UCL	2,113	95% Jackknife UCL	N/A
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	2,171	95% Chebyshev(Mean, Sd) UCL	2,230
97,5% Chebyshev(Mean, Sd) UCL	2,310	99% Chebyshev(Mean, Sd) UCL	2,469
Suggested UCL to Use			
95% Student's-t UCL	2,119	or 95% Modified-t UCL	2,126
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.			
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 statistician.			
Tin - Former USAF Dump Area and Former Ammunition Storage Area (Soil)			

2951				
2952	**General Statistics**			
2953	Total Number of Observations	14,00	Number of Distinct Observations	2,000
2954			Number of Missing Observations	1,000
2955	Minimum	2,000	Mean	2,293
2956	Maximum	6,100	Median	2,000
2957	SD	1,096	Std. Error of Mean	0,293
2958	Coefficient of Variation	0,478	Skewness	3,742
2959				
2960	**Normal GOF Test**			
2961	Shapiro Wilk Test Statistic	0,297	**Shapiro Wilk GOF Test**	
2962	5% Shapiro Wilk Critical Value	0,874	Data Not Normal at 5% Significance Level	
2963	Lilliefors Test Statistic	0,534	**Lilliefors GOF Test**	
2964	5% Lilliefors Critical Value	0,226	Data Not Normal at 5% Significance Level	
2965	**Data Not Normal at 5% Significance Level**			
2966				
2967	**Assuming Normal Distribution**			
2968	**95% Normal UCL**		**95% UCLs (Adjusted for Skewness)**	
2969	95% Student's-t UCL	2,811	95% Adjusted-CLT UCL (Chen-1995)	3,087
2970			95% Modified-t UCL (Johnson-1978)	2,860
2971				
2972	**Gamma GOF Test**			
2973	A-D Test Statistic	4,897	**Anderson-Darling Gamma GOF Test**	
2974	5% A-D Critical Value	0,735	Data Not Gamma Distributed at 5% Significance Level	
2975	K-S Test Statistic	0,541	**Kolmogorov-Smirnov Gamma GOF Test**	
2976	5% K-S Critical Value	0,229	Data Not Gamma Distributed at 5% Significance Level	
2977	**Data Not Gamma Distributed at 5% Significance Level**			
2978				
2979	**Gamma Statistics**			
2980	k hat (MLE)	8,936	k star (bias corrected MLE)	7,068
2981	Theta hat (MLE)	0,257	Theta star (bias corrected MLE)	0,324
2982	nu hat (MLE)	250,2	nu star (bias corrected)	197,9
2983	MLE Mean (bias corrected)	2,293	MLE Sd (bias corrected)	0,862
2984			Approximate Chi Square Value (0,0500)	166,4
2985	Adjusted Level of Significance	0,0312	Adjusted Chi Square Value	162,5
2986				
2987	**Assuming Gamma Distribution**			
2988	95% Approximate Gamma UCL (use when n>=50))	2,728	95% Adjusted Gamma UCL (use when n<50)	2,792
2989				
2990	**Lognormal GOF Test**			
2991	Shapiro Wilk Test Statistic	0,297	**Shapiro Wilk Lognormal GOF Test**	
2992	5% Shapiro Wilk Critical Value	0,874	Data Not Lognormal at 5% Significance Level	
2993	Lilliefors Test Statistic	0,534	**Lilliefors Lognormal GOF Test**	
2994	5% Lilliefors Critical Value	0,226	Data Not Lognormal at 5% Significance Level	
2995	**Data Not Lognormal at 5% Significance Level**			
2996				
2997	**Lognormal Statistics**			
2998	Minimum of Logged Data	0,693	Mean of logged Data	0,773
2999	Maximum of Logged Data	1,808	SD of logged Data	0,298
3000				

	A	B	C	D	E	F	G	H	I	J	K	L
3001	**Assuming Lognormal Distribution**											
3002					95% H-UCL	2,648					90% Chebyshev (MVUE) UCL	2,802
3003					95% Chebyshev (MVUE) UCL	3,049					97,5% Chebyshev (MVUE) UCL	3,391
3004					99% Chebyshev (MVUE) UCL	4,064						
3005												
3006	**Nonparametric Distribution Free UCL Statistics**											
3007	**Data do not follow a Discernible Distribution (0.05)**											
3008												
3009	**Nonparametric Distribution Free UCLs**											
3010					95% CLT UCL	2,775					95% Jackknife UCL	N/A
3011					95% Standard Bootstrap UCL	N/A					95% Bootstrap-t UCL	N/A
3012					95% Hall's Bootstrap UCL	N/A					95% Percentile Bootstrap UCL	N/A
3013					95% BCA Bootstrap UCL	N/A						
3014					90% Chebyshev(Mean, Sd) UCL	3,171					95% Chebyshev(Mean, Sd) UCL	3,569
3015					97,5% Chebyshev(Mean, Sd) UCL	4,122					99% Chebyshev(Mean, Sd) UCL	5,207
3016												
3017	**Suggested UCL to Use**											
3018					95% Student's-t UCL	2,811					or 95% Modified-t UCL	2,860
3019												
3020	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
3021	Recommendations are based upon data size, data distribution, and skewness.											
3022	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
3023	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
3024												
3025												
3026	**Zinc - Former USAF Dump Area and Former Ammunition Storage Area (Soil)**											
3027												
3028	**General Statistics**											
3029					Total Number of Observations	26,00					Number of Distinct Observations	24,00
3030											Number of Missing Observations	1,000
3031					Minimum	6,100					Mean	101,0
3032					Maximum	444,0					Median	42,00
3033					SD	120,7					Std. Error of Mean	23,67
3034					Coefficient of Variation	1,195					Skewness	1,679
3035												
3036	**Normal GOF Test**											
3037					Shapiro Wilk Test Statistic	0,748	**Shapiro Wilk GOF Test**					
3038					5% Shapiro Wilk Critical Value	0,920	Data Not Normal at 5% Significance Level					
3039					Lilliefors Test Statistic	0,261	**Lilliefors GOF Test**					
3040					5% Lilliefors Critical Value	0,170	Data Not Normal at 5% Significance Level					
3041	**Data Not Normal at 5% Significance Level**											
3042												
3043	**Assuming Normal Distribution**											
3044	**95% Normal UCL**						**95% UCLs (Adjusted for Skewness)**					
3045					95% Student's-t UCL	141,5					95% Adjusted-CLT UCL (Chen-1995)	148,3
3046											95% Modified-t UCL (Johnson-1978)	142,8
3047												
3048	**Gamma GOF Test**											
3049					A-D Test Statistic	0,890	**Anderson-Darling Gamma GOF Test**					
3050					5% A-D Critical Value	0,778	Data Not Gamma Distributed at 5% Significance Level					

	A	B	C	D	E	F	G	H	I	J	K	L
3051					K-S Test Statistic	0,174	**Kolmogorov-Smirnov Gamma GOF Test**					
3052					5% K-S Critical Value	0,177	Detected data appear Gamma Distributed at 5% Significance Level					
3053	**Detected data follow Appr. Gamma Distribution at 5% Significance Level**											
3054												
3055	**Gamma Statistics**											
3056					k hat (MLE)	0,901					k star (bias corrected MLE)	0,823
3057					Theta hat (MLE)	112,1					Theta star (bias corrected MLE)	122,8
3058					nu hat (MLE)	46,87					nu star (bias corrected)	42,79
3059					MLE Mean (bias corrected)	101,0					MLE Sd (bias corrected)	111,4
3060											Approximate Chi Square Value (0,0500)	28,80
3061					Adjusted Level of Significance	0,0398					Adjusted Chi Square Value	28,04
3062												
3063	**Assuming Gamma Distribution**											
3064					95% Approximate Gamma UCL (use when n>=50)	150,2					95% Adjusted Gamma UCL (use when n<50)	154,2
3065												
3066	**Lognormal GOF Test**											
3067					Shapiro Wilk Test Statistic	0,959	**Shapiro Wilk Lognormal GOF Test**					
3068					5% Shapiro Wilk Critical Value	0,920	Data appear Lognormal at 5% Significance Level					
3069					Lilliefors Test Statistic	0,136	**Lilliefors Lognormal GOF Test**					
3070					5% Lilliefors Critical Value	0,170	Data appear Lognormal at 5% Significance Level					
3071	**Data appear Lognormal at 5% Significance Level**											
3072												
3073	**Lognormal Statistics**											
3074					Minimum of Logged Data	1,808					Mean of logged Data	3,967
3075					Maximum of Logged Data	6,096					SD of logged Data	1,179
3076												
3077	**Assuming Lognormal Distribution**											
3078					95% H-UCL	202,2					90% Chebyshev (MVUE) UCL	184,3
3079					95% Chebyshev (MVUE) UCL	221,8					97,5% Chebyshev (MVUE) UCL	273,9
3080					99% Chebyshev (MVUE) UCL	376,2						
3081												
3082	**Nonparametric Distribution Free UCL Statistics**											
3083	**Data appear to follow a Discernible Distribution at 5% Significance Level**											
3084												
3085	**Nonparametric Distribution Free UCLs**											
3086					95% CLT UCL	140,0					95% Jackknife UCL	141,5
3087					95% Standard Bootstrap UCL	139,2					95% Bootstrap-t UCL	156,2
3088					95% Hall's Bootstrap UCL	148,2					95% Percentile Bootstrap UCL	141,3
3089					95% BCA Bootstrap UCL	148,7						
3090					90% Chebyshev(Mean, Sd) UCL	172,1					95% Chebyshev(Mean, Sd) UCL	204,2
3091					97,5% Chebyshev(Mean, Sd) UCL	248,9					99% Chebyshev(Mean, Sd) UCL	336,6
3092												
3093	**Suggested UCL to Use**											
3094					95% Adjusted Gamma UCL	154,2						
3095												
3096	When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test											
3097	When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL											
3098												
3099	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
3100	Recommendations are based upon data size, data distribution, and skewness.											

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 statistician.

Calculated Total PCB - Former USAF Dump Area and Former Ammunition Storage Area (Soil)

General Statistics			
Total Number of Observations	12,00	Number of Distinct Observations	10,00
		Number of Missing Observations	1,000
Minimum	0,0500	Mean	0,890
Maximum	3,000	Median	0,335
SD	1,110	Std. Error of Mean	0,320
Coefficient of Variation	1,247	Skewness	1,082
Normal GOF Test			
Shapiro Wilk Test Statistic	0,764	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0,859	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0,311	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0,243	Data Not Normal at 5% Significance Level	
Data Not Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	1,465	95% Adjusted-CLT UCL (Chen-1995)	1,524
		95% Modified-t UCL (Johnson-1978)	1,482
Gamma GOF Test			
A-D Test Statistic	0,667	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0,777	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0,190	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0,257	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	0,606	k star (bias corrected MLE)	0,510
Theta hat (MLE)	1,469	Theta star (bias corrected MLE)	1,746
nu hat (MLE)	14,54	nu star (bias corrected)	12,24
MLE Mean (bias corrected)	0,890	MLE Sd (bias corrected)	1,247
		Approximate Chi Square Value (0,0500)	5,384
Adjusted Level of Significance	0,0290	Adjusted Chi Square Value	4,708
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50)	2,023	95% Adjusted Gamma UCL (use when n<50)	2,313
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0,876	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0,859	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0,161	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0,243	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			

	A	B	C	D	E	F	G	H	I	J	K	L
3151												
3152	**Lognormal Statistics**											
3153					Minimum of Logged Data	-2,996					Mean of logged Data	-1,135
3154					Maximum of Logged Data	1,099					SD of logged Data	1,632
3155												
3156	**Assuming Lognormal Distribution**											
3157					95% H-UCL	9,463					90% Chebyshev (MVUE) UCL	2,523
3158					95% Chebyshev (MVUE) UCL	3,218					97,5% Chebyshev (MVUE) UCL	4,181
3159					99% Chebyshev (MVUE) UCL	6,075						
3160												
3161	**Nonparametric Distribution Free UCL Statistics**											
3162	**Data appear to follow a Discernible Distribution at 5% Significance Level**											
3163												
3164	**Nonparametric Distribution Free UCLs**											
3165					95% CLT UCL	1,417					95% Jackknife UCL	1,465
3166					95% Standard Bootstrap UCL	1,387					95% Bootstrap-t UCL	1,633
3167					95% Hall's Bootstrap UCL	1,373					95% Percentile Bootstrap UCL	1,413
3168					95% BCA Bootstrap UCL	1,508						
3169					90% Chebyshev(Mean, Sd) UCL	1,851					95% Chebyshev(Mean, Sd) UCL	2,286
3170					97,5% Chebyshev(Mean, Sd) UCL	2,890					99% Chebyshev(Mean, Sd) UCL	4,077
3171												
3172	**Suggested UCL to Use**											
3173					95% Adjusted Gamma UCL	2,313						
3174												
3175	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
3176	Recommendations are based upon data size, data distribution, and skewness.											
3177	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
3178	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
3179												

UCL Statistics for Uncensored Full Data Sets				
User Selected Options				
Date/Time of Computation	ProUCL 5.12019-04-26 09:35:18			
From File	WorkSheet.xls			
Full Precision	OFF			
Confidence Coefficient	95%			
Number of Bootstrap Operations	2000			
Aluminum (Main Complex - Groundwater)				
General Statistics				
Total Number of Observations	10,00		Number of Distinct Observations	10,00
			Number of Missing Observations	1,000
Minimum	108,0		Mean	3210
Maximum	21700		Median	221,5
SD	6958		Std. Error of Mean	2200
Coefficient of Variation	2,168		Skewness	2,572
Normal GOF Test				
Shapiro Wilk Test Statistic	0,533	Shapiro Wilk GOF Test		
5% Shapiro Wilk Critical Value	0,842	Data Not Normal at 5% Significance Level		
Lilliefors Test Statistic	0,425	Lilliefors GOF Test		
5% Lilliefors Critical Value	0,262	Data Not Normal at 5% Significance Level		
Data Not Normal at 5% Significance Level				
Assuming Normal Distribution				
95% Normal UCL		95% UCLs (Adjusted for Skewness)		
95% Student's-t UCL	7243		95% Adjusted-CLT UCL (Chen-1995)	8741
			95% Modified-t UCL (Johnson-1978)	7541
Gamma GOF Test				
A-D Test Statistic	1,552	Anderson-Darling Gamma GOF Test		
5% A-D Critical Value	0,804	Data Not Gamma Distributed at 5% Significance Level		
K-S Test Statistic	0,383	Kolmogorov-Smirnov Gamma GOF Test		
5% K-S Critical Value	0,286	Data Not Gamma Distributed at 5% Significance Level		
Data Not Gamma Distributed at 5% Significance Level				
Gamma Statistics				
k hat (MLE)	0,355		k star (bias corrected MLE)	0,315
Theta hat (MLE)	9053		Theta star (bias corrected MLE)	10194
nu hat (MLE)	7,091		nu star (bias corrected)	6,297
MLE Mean (bias corrected)	3210		MLE Sd (bias corrected)	5720
			Approximate Chi Square Value (0,0500)	1,794
Adjusted Level of Significance	0,0267		Adjusted Chi Square Value	1,408
Assuming Gamma Distribution				
95% Approximate Gamma UCL (use when n>=50))	11270		95% Adjusted Gamma UCL (use when n<50)	14352

Lognormal GOF Test

Shapiro Wilk Test Statistic	0,768	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0,842	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0,329	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0,262	Data Not Lognormal at 5% Significance Level	

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	4,682	Mean of logged Data	6,181
Maximum of Logged Data	9,985	SD of logged Data	1,868

Assuming Lognormal Distribution

95% H-UCL	65298	90% Chebyshev (MVUE) UCL	5558
95% Chebyshev (MVUE) UCL	7189	97,5% Chebyshev (MVUE) UCL	9453
99% Chebyshev (MVUE) UCL	13900		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	6829	95% Jackknife UCL	7243
95% Standard Bootstrap UCL	6658	95% Bootstrap-t UCL	81675
95% Hall's Bootstrap UCL	87601	95% Percentile Bootstrap UCL	6884
95% BCA Bootstrap UCL	8967		
90% Chebyshev(Mean, Sd) UCL	9810	95% Chebyshev(Mean, Sd) UCL	12800
97,5% Chebyshev(Mean, Sd) UCL	16950	99% Chebyshev(Mean, Sd) UCL	25101

Suggested UCL to Use

99% Chebyshev (Mean, Sd) UCL	25101		

Recommended UCL exceeds the maximum observation

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.

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 statistician.

Iron (Main Complex - Groundwater)

General Statistics

Total Number of Observations	10,00	Number of Distinct Observations	10,00
		Number of Missing Observations	1,000
Minimum	50,00	Mean	2061
Maximum	9790	Median	1055
SD	3040	Std. Error of Mean	961,4
Coefficient of Variation	1,475	Skewness	2,164

Normal GOF Test

Shapiro Wilk Test Statistic	0,707	**Shapiro Wilk GOF Test**	

	A	B	C	D	E	F	G	H	I	J	K	L
101					5% Shapiro Wilk Critical Value	0,842	Data Not Normal at 5% Significance Level					
102					Lilliefors Test Statistic	0,324	**Lilliefors GOF Test**					
103					5% Lilliefors Critical Value	0,262	Data Not Normal at 5% Significance Level					
104	**Data Not Normal at 5% Significance Level**											
105												
106	**Assuming Normal Distribution**											
107	**95% Normal UCL**						**95% UCLs (Adjusted for Skewness)**					
108					95% Student's-t UCL	3824					95% Adjusted-CLT UCL (Chen-1995)	4345
109											95% Modified-t UCL (Johnson-1978)	3933
110												
111	**Gamma GOF Test**											
112					A-D Test Statistic	0,375	**Anderson-Darling Gamma GOF Test**					
113					5% A-D Critical Value	0,775	Detected data appear Gamma Distributed at 5% Significance Level					
114					K-S Test Statistic	0,173	**Kolmogorov-Smirnov Gamma GOF Test**					
115					5% K-S Critical Value	0,280	Detected data appear Gamma Distributed at 5% Significance Level					
116	**Detected data appear Gamma Distributed at 5% Significance Level**											
117												
118	**Gamma Statistics**											
119					k hat (MLE)	0,524					k star (bias corrected MLE)	0,433
120					Theta hat (MLE)	3934					Theta star (bias corrected MLE)	4756
121					nu hat (MLE)	10,48					nu star (bias corrected)	8,668
122					MLE Mean (bias corrected)	2061					MLE Sd (bias corrected)	3131
123											Approximate Chi Square Value (0,0500)	3,128
124					Adjusted Level of Significance	0,0267					Adjusted Chi Square Value	2,578
125												
126	**Assuming Gamma Distribution**											
127					95% Approximate Gamma UCL (use when n>=50)	5712					95% Adjusted Gamma UCL (use when n<50)	6930
128												
129	**Lognormal GOF Test**											
130					Shapiro Wilk Test Statistic	0,917	**Shapiro Wilk Lognormal GOF Test**					
131					5% Shapiro Wilk Critical Value	0,842	Data appear Lognormal at 5% Significance Level					
132					Lilliefors Test Statistic	0,211	**Lilliefors Lognormal GOF Test**					
133					5% Lilliefors Critical Value	0,262	Data appear Lognormal at 5% Significance Level					
134	**Data appear Lognormal at 5% Significance Level**											
135												
136	**Lognormal Statistics**											
137					Minimum of Logged Data	3,912					Mean of logged Data	6,427
138					Maximum of Logged Data	9,189					SD of logged Data	1,876
139												
140	**Assuming Lognormal Distribution**											
141					95% H-UCL	86860					90% Chebyshev (MVUE) UCL	7200
142					95% Chebyshev (MVUE) UCL	9316					97,5% Chebyshev (MVUE) UCL	12252
143					99% Chebyshev (MVUE) UCL	18021						
144												
145	**Nonparametric Distribution Free UCL Statistics**											
146	**Data appear to follow a Discernible Distribution at 5% Significance Level**											
147												
148	**Nonparametric Distribution Free UCLs**											
149					95% CLT UCL	3643					95% Jackknife UCL	3824
150					95% Standard Bootstrap UCL	3540					95% Bootstrap-t UCL	6083

	A–E	F	G–K	L
151	95% Hall's Bootstrap UCL	9082	95% Percentile Bootstrap UCL	3732
152	95% BCA Bootstrap UCL	4278		
153	90% Chebyshev(Mean, Sd) UCL	4945	95% Chebyshev(Mean, Sd) UCL	6252
154	97,5% Chebyshev(Mean, Sd) UCL	8065	99% Chebyshev(Mean, Sd) UCL	11627
155				
156	**Suggested UCL to Use**			
157	95% Adjusted Gamma UCL	6930		
158				
159	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
160	Recommendations are based upon data size, data distribution, and skewness.			
161	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
162	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
163				
164				
165	**Lead (Main Complex - Groundwater)**			
166				
167	**General Statistics**			
168	Total Number of Observations	10,00	Number of Distinct Observations	5,000
169			Number of Missing Observations	1,000
170	Minimum	0,500	Mean	2,350
171	Maximum	15,80	Median	0,500
172	SD	4,758	Std. Error of Mean	1,505
173	Coefficient of Variation	2,025	Skewness	3,084
174				
175	**Normal GOF Test**			
176	Shapiro Wilk Test Statistic	0,452	**Shapiro Wilk GOF Test**	
177	5% Shapiro Wilk Critical Value	0,842	Data Not Normal at 5% Significance Level	
178	Lilliefors Test Statistic	0,421	**Lilliefors GOF Test**	
179	5% Lilliefors Critical Value	0,262	Data Not Normal at 5% Significance Level	
180	**Data Not Normal at 5% Significance Level**			
181				
182	**Assuming Normal Distribution**			
183	**95% Normal UCL**		**95% UCLs (Adjusted for Skewness)**	
184	95% Student's-t UCL	5,108	95% Adjusted-CLT UCL (Chen-1995)	6,393
185			95% Modified-t UCL (Johnson-1978)	5,353
186				
187	**Gamma GOF Test**			
188	A-D Test Statistic	1,802	**Anderson-Darling Gamma GOF Test**	
189	5% A-D Critical Value	0,761	Data Not Gamma Distributed at 5% Significance Level	
190	K-S Test Statistic	0,325	**Kolmogorov-Smirnov Gamma GOF Test**	
191	5% K-S Critical Value	0,277	Data Not Gamma Distributed at 5% Significance Level	
192	**Data Not Gamma Distributed at 5% Significance Level**			
193				
194	**Gamma Statistics**			
195	k hat (MLE)	0,695	k star (bias corrected MLE)	0,553
196	Theta hat (MLE)	3,380	Theta star (bias corrected MLE)	4,247
197	nu hat (MLE)	13,91	nu star (bias corrected)	11,07
198	MLE Mean (bias corrected)	2,350	MLE Sd (bias corrected)	3,159
199			Approximate Chi Square Value (0,0500)	4,619
200	Adjusted Level of Significance	0,0267	Adjusted Chi Square Value	3,921

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	5,630	95% Adjusted Gamma UCL (use when n<50)	6,633

Lognormal GOF Test

Shapiro Wilk Test Statistic	0,692	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0,842	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0,328	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0,262	Data Not Lognormal at 5% Significance Level

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-0,693	Mean of logged Data	-0,0156
Maximum of Logged Data	2,760	SD of logged Data	1,117

Assuming Lognormal Distribution

95% H-UCL	6,383	90% Chebyshev (MVUE) UCL	3,558
95% Chebyshev (MVUE) UCL	4,408	97,5% Chebyshev (MVUE) UCL	5,587
99% Chebyshev (MVUE) UCL	7,905		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	4,825	95% Jackknife UCL	5,108
95% Standard Bootstrap UCL	4,737	95% Bootstrap-t UCL	25,31
95% Hall's Bootstrap UCL	19,51	95% Percentile Bootstrap UCL	5,310
95% BCA Bootstrap UCL	6,840		
90% Chebyshev(Mean, Sd) UCL	6,864	95% Chebyshev(Mean, Sd) UCL	8,909
97,5% Chebyshev(Mean, Sd) UCL	11,75	99% Chebyshev(Mean, Sd) UCL	17,32

Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL	8,909		

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.

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 statistician.

Zinc (Main Complex - Groundwater)

General Statistics

Total Number of Observations	10,00	Number of Distinct Observations	9,000
		Number of Missing Observations	1,000
Minimum	5,000	Mean	108,3
Maximum	818,0	Median	17,00
SD	252,2	Std. Error of Mean	79,76
Coefficient of Variation	2,329	Skewness	3,038

251	**Normal GOF Test**			
252	Shapiro Wilk Test Statistic	0,469	**Shapiro Wilk GOF Test**	
253	5% Shapiro Wilk Critical Value	0,842	Data Not Normal at 5% Significance Level	
254	Lilliefors Test Statistic	0,390	**Lilliefors GOF Test**	
255	5% Lilliefors Critical Value	0,262	Data Not Normal at 5% Significance Level	
256	**Data Not Normal at 5% Significance Level**			
257				
258	**Assuming Normal Distribution**			
259	**95% Normal UCL**		**95% UCLs (Adjusted for Skewness)**	
260	95% Student's-t UCL	254,5	95% Adjusted-CLT UCL (Chen-1995)	321,4
261			95% Modified-t UCL (Johnson-1978)	267,3
262				
263	**Gamma GOF Test**			
264	A-D Test Statistic	1,213	**Anderson-Darling Gamma GOF Test**	
265	5% A-D Critical Value	0,789	Data Not Gamma Distributed at 5% Significance Level	
266	K-S Test Statistic	0,324	**Kolmogorov-Smirnov Gamma GOF Test**	
267	5% K-S Critical Value	0,283	Data Not Gamma Distributed at 5% Significance Level	
268	**Data Not Gamma Distributed at 5% Significance Level**			
269				
270	**Gamma Statistics**			
271	k hat (MLE)	0,435	k star (bias corrected MLE)	0,371
272	Theta hat (MLE)	249,2	Theta star (bias corrected MLE)	292,0
273	nu hat (MLE)	8,693	nu star (bias corrected)	7,418
274	MLE Mean (bias corrected)	108,3	MLE Sd (bias corrected)	177,8
275			Approximate Chi Square Value (0,0500)	2,403
276	Adjusted Level of Significance	0,0267	Adjusted Chi Square Value	1,937
277				
278	**Assuming Gamma Distribution**			
279	95% Approximate Gamma UCL (use when n>=50))	334,3	95% Adjusted Gamma UCL (use when n<50)	414,7
280				
281	**Lognormal GOF Test**			
282	Shapiro Wilk Test Statistic	0,877	**Shapiro Wilk Lognormal GOF Test**	
283	5% Shapiro Wilk Critical Value	0,842	Data appear Lognormal at 5% Significance Level	
284	Lilliefors Test Statistic	0,237	**Lilliefors Lognormal GOF Test**	
285	5% Lilliefors Critical Value	0,262	Data appear Lognormal at 5% Significance Level	
286	**Data appear Lognormal at 5% Significance Level**			
287				
288	**Lognormal Statistics**			
289	Minimum of Logged Data	1,609	Mean of logged Data	3,191
290	Maximum of Logged Data	6,707	SD of logged Data	1,594
291				
292	**Assuming Lognormal Distribution**			
293	95% H-UCL	910,6	90% Chebyshev (MVUE) UCL	179,5
294	95% Chebyshev (MVUE) UCL	229,5	97,5% Chebyshev (MVUE) UCL	298,8
295	99% Chebyshev (MVUE) UCL	435,1		
296				
297	**Nonparametric Distribution Free UCL Statistics**			
298	**Data appear to follow a Discernible Distribution at 5% Significance Level**			
299				
300	**Nonparametric Distribution Free UCLs**			

301	95% CLT UCL	239,5	95% Jackknife UCL	254,5
302	95% Standard Bootstrap UCL	232,5	95% Bootstrap-t UCL	1811
303	95% Hall's Bootstrap UCL	1352	95% Percentile Bootstrap UCL	258,1
304	95% BCA Bootstrap UCL	337,8		
305	90% Chebyshev(Mean, Sd) UCL	347,6	95% Chebyshev(Mean, Sd) UCL	456,0
306	97,5% Chebyshev(Mean, Sd) UCL	606,4	99% Chebyshev(Mean, Sd) UCL	901,9
307				
308	**Suggested UCL to Use**			
309	99% Chebyshev (Mean, Sd) UCL	901,9		
310				
311	**Recommended UCL exceeds the maximum observation**			
312				
313	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
314	Recommendations are based upon data size, data distribution, and skewness.			
315	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
316	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
317				
318				
319	**Fuel Range (>C10-C16) (Main Complex - Groundwater)**			
320				
321	**General Statistics**			
322	Total Number of Observations	10,00	Number of Distinct Observations	3,000
323			Number of Missing Observations	1,000
324	Minimum	0,0500	Mean	0,153
325	Maximum	0,630	Median	0,0500
326	SD	0,219	Std. Error of Mean	0,0693
327	Coefficient of Variation	1,433	Skewness	1,864
328				
329	**Normal GOF Test**			
330	Shapiro Wilk Test Statistic	0,534	**Shapiro Wilk GOF Test**	
331	5% Shapiro Wilk Critical Value	0,842	Data Not Normal at 5% Significance Level	
332	Lilliefors Test Statistic	0,481	**Lilliefors GOF Test**	
333	5% Lilliefors Critical Value	0,262	Data Not Normal at 5% Significance Level	
334	**Data Not Normal at 5% Significance Level**			
335				
336	**Assuming Normal Distribution**			
337	**95% Normal UCL**		**95% UCLs (Adjusted for Skewness)**	
338	95% Student's-t UCL	0,280	95% Adjusted-CLT UCL (Chen-1995)	0,311
339			95% Modified-t UCL (Johnson-1978)	0,287
340				
341	**Gamma GOF Test**			
342	A-D Test Statistic	2,606	**Anderson-Darling Gamma GOF Test**	
343	5% A-D Critical Value	0,751	Data Not Gamma Distributed at 5% Significance Level	
344	K-S Test Statistic	0,503	**Kolmogorov-Smirnov Gamma GOF Test**	
345	5% K-S Critical Value	0,274	Data Not Gamma Distributed at 5% Significance Level	
346	**Data Not Gamma Distributed at 5% Significance Level**			
347				
348	**Gamma Statistics**			
349	k hat (MLE)	0,919	k star (bias corrected MLE)	0,710
350	Theta hat (MLE)	0,167	Theta star (bias corrected MLE)	0,216

nu hat (MLE)	18,37	nu star (bias corrected)	14,19
MLE Mean (bias corrected)	0,153	MLE Sd (bias corrected)	0,182
		Approximate Chi Square Value (0,0500)	6,704
Adjusted Level of Significance	0,0267	Adjusted Chi Square Value	5,833
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	0,324	95% Adjusted Gamma UCL (use when n<50)	0,372
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0,521	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0,842	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0,482	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0,262	Data Not Lognormal at 5% Significance Level	
Data Not Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	-2,996	Mean of logged Data	-2,512
Maximum of Logged Data	-0,462	SD of logged Data	1,021
Assuming Lognormal Distribution			
95% H-UCL	0,399	90% Chebyshev (MVUE) UCL	0,257
95% Chebyshev (MVUE) UCL	0,315	97,5% Chebyshev (MVUE) UCL	0,397
99% Chebyshev (MVUE) UCL	0,556		
Nonparametric Distribution Free UCL Statistics			
Data do not follow a Discernible Distribution (0.05)			
Nonparametric Distribution Free UCLs			
95% CLT UCL	0,267	95% Jackknife UCL	0,280
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	0,361	95% Chebyshev(Mean, Sd) UCL	0,455
97,5% Chebyshev(Mean, Sd) UCL	0,586	99% Chebyshev(Mean, Sd) UCL	0,843
Suggested UCL to Use			
95% Chebyshev (Mean, Sd) UCL	0,455		
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.			
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 statistician.			
Fuel Range (>C16-C21) (Main Complex - Groundwater)			
General Statistics			
Total Number of Observations	10,00	Number of Distinct Observations	3,000
		Number of Missing Observations	1,000
Minimum	0,100	Mean	0,137

	A–E	F	G–K	L
401	Maximum	0,370	Median	0,100
402	SD	0,0877	Std. Error of Mean	0,0277
403	Coefficient of Variation	0,640	Skewness	2,573
404				
405	**Normal GOF Test**			
406	Shapiro Wilk Test Statistic	0,510	**Shapiro Wilk GOF Test**	
407	5% Shapiro Wilk Critical Value	0,842	Data Not Normal at 5% Significance Level	
408	Lilliefors Test Statistic	0,463	**Lilliefors GOF Test**	
409	5% Lilliefors Critical Value	0,262	Data Not Normal at 5% Significance Level	
410	**Data Not Normal at 5% Significance Level**			
411				
412	**Assuming Normal Distribution**			
413	**95% Normal UCL**		**95% UCLs (Adjusted for Skewness)**	
414	95% Student's-t UCL	0,188	95% Adjusted-CLT UCL (Chen-1995)	0,207
415			95% Modified-t UCL (Johnson-1978)	0,192
416				
417	**Gamma GOF Test**			
418	A-D Test Statistic	2,420	**Anderson-Darling Gamma GOF Test**	
419	5% A-D Critical Value	0,729	Data Not Gamma Distributed at 5% Significance Level	
420	K-S Test Statistic	0,483	**Kolmogorov-Smirnov Gamma GOF Test**	
421	5% K-S Critical Value	0,268	Data Not Gamma Distributed at 5% Significance Level	
422	**Data Not Gamma Distributed at 5% Significance Level**			
423				
424	**Gamma Statistics**			
425	k hat (MLE)	4,521	k star (bias corrected MLE)	3,231
426	Theta hat (MLE)	0,0303	Theta star (bias corrected MLE)	0,0424
427	nu hat (MLE)	90,41	nu star (bias corrected)	64,62
428	MLE Mean (bias corrected)	0,137	MLE Sd (bias corrected)	0,0762
429			Approximate Chi Square Value (0,0500)	47,13
430	Adjusted Level of Significance	0,0267	Adjusted Chi Square Value	44,54
431				
432	**Assuming Gamma Distribution**			
433	95% Approximate Gamma UCL (use when n>=50))	0,188	95% Adjusted Gamma UCL (use when n<50)	0,199
434				
435	**Lognormal GOF Test**			
436	Shapiro Wilk Test Statistic	0,535	**Shapiro Wilk Lognormal GOF Test**	
437	5% Shapiro Wilk Critical Value	0,842	Data Not Lognormal at 5% Significance Level	
438	Lilliefors Test Statistic	0,473	**Lilliefors Lognormal GOF Test**	
439	5% Lilliefors Critical Value	0,262	Data Not Lognormal at 5% Significance Level	
440	**Data Not Lognormal at 5% Significance Level**			
441				
442	**Lognormal Statistics**			
443	Minimum of Logged Data	-2,303	Mean of logged Data	-2,102
444	Maximum of Logged Data	-0,994	SD of logged Data	0,446
445				
446	**Assuming Lognormal Distribution**			
447	95% H-UCL	0,186	90% Chebyshev (MVUE) UCL	0,191
448	95% Chebyshev (MVUE) UCL	0,217	97,5% Chebyshev (MVUE) UCL	0,253
449	99% Chebyshev (MVUE) UCL	0,324		
450				

	A–E	F	G–K	L
451	Nonparametric Distribution Free UCL Statistics			
452	Data do not follow a Discernible Distribution (0.05)			
453				
454	**Nonparametric Distribution Free UCLs**			
455	95% CLT UCL	0,183	95% Jackknife UCL	0,188
456	95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
457	95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
458	95% BCA Bootstrap UCL	N/A		
459	90% Chebyshev(Mean, Sd) UCL	0,220	95% Chebyshev(Mean, Sd) UCL	0,258
460	97,5% Chebyshev(Mean, Sd) UCL	0,310	99% Chebyshev(Mean, Sd) UCL	0,413
461				
462	**Suggested UCL to Use**			
463	95% Student's-t UCL	0,188	or 95% Modified-t UCL	0,192
464				
465	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
466	Recommendations are based upon data size, data distribution, and skewness.			
467	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
468	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
469				
470				
471	**Fuel Range (>C10-C21) (Main Complex - Groundwater)**			
472				
473	**General Statistics**			
474	Total Number of Observations	10,00	Number of Distinct Observations	3,000
475			Number of Missing Observations	1,000
476	Minimum	0,150	Mean	0,290
477	Maximum	1,000	Median	0,150
478	SD	0,303	Std. Error of Mean	0,0960
479	Coefficient of Variation	1,047	Skewness	2,012
480				
481	**Normal GOF Test**			
482	Shapiro Wilk Test Statistic	0,540	**Shapiro Wilk GOF Test**	
483	5% Shapiro Wilk Critical Value	0,842	Data Not Normal at 5% Significance Level	
484	Lilliefors Test Statistic	0,478	**Lilliefors GOF Test**	
485	5% Lilliefors Critical Value	0,262	Data Not Normal at 5% Significance Level	
486	**Data Not Normal at 5% Significance Level**			
487				
488	**Assuming Normal Distribution**			
489	**95% Normal UCL**		**95% UCLs (Adjusted for Skewness)**	
490	95% Student's-t UCL	0,466	95% Adjusted-CLT UCL (Chen-1995)	0,513
491			95% Modified-t UCL (Johnson-1978)	0,476
492				
493	**Gamma GOF Test**			
494	A-D Test Statistic	2,539	**Anderson-Darling Gamma GOF Test**	
495	5% A-D Critical Value	0,738	Data Not Gamma Distributed at 5% Significance Level	
496	K-S Test Statistic	0,497	**Kolmogorov-Smirnov Gamma GOF Test**	
497	5% K-S Critical Value	0,271	Data Not Gamma Distributed at 5% Significance Level	
498	**Data Not Gamma Distributed at 5% Significance Level**			
499				
500	**Gamma Statistics**			

	A–E	F	G–K	L
501	k hat (MLE)	1,733	k star (bias corrected MLE)	1,280
502	Theta hat (MLE)	0,167	Theta star (bias corrected MLE)	0,227
503	nu hat (MLE)	34,66	nu star (bias corrected)	25,59
504	MLE Mean (bias corrected)	0,290	MLE Sd (bias corrected)	0,256
505			Approximate Chi Square Value (0,0500)	15,07
506	Adjusted Level of Significance	0,0267	Adjusted Chi Square Value	13,68
507				
508	**Assuming Gamma Distribution**			
509	95% Approximate Gamma UCL (use when n>=50))	0,493	95% Adjusted Gamma UCL (use when n<50)	0,543
510				
511	**Lognormal GOF Test**			
512	Shapiro Wilk Test Statistic	0,532	**Shapiro Wilk Lognormal GOF Test**	
513	5% Shapiro Wilk Critical Value	0,842	Data Not Lognormal at 5% Significance Level	
514	Lilliefors Test Statistic	0,481	**Lilliefors Lognormal GOF Test**	
515	5% Lilliefors Critical Value	0,262	Data Not Lognormal at 5% Significance Level	
516	**Data Not Lognormal at 5% Significance Level**			
517				
518	**Lognormal Statistics**			
519	Minimum of Logged Data	-1,897	Mean of logged Data	-1,553
520	Maximum of Logged Data	0	SD of logged Data	0,730
521				
522	**Assuming Lognormal Distribution**			
523	95% H-UCL	0,517	90% Chebyshev (MVUE) UCL	0,459
524	95% Chebyshev (MVUE) UCL	0,545	97,5% Chebyshev (MVUE) UCL	0,665
525	99% Chebyshev (MVUE) UCL	0,902		
526				
527	**Nonparametric Distribution Free UCL Statistics**			
528	**Data do not follow a Discernible Distribution (0.05)**			
529				
530	**Nonparametric Distribution Free UCLs**			
531	95% CLT UCL	0,448	95% Jackknife UCL	0,466
532	95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
533	95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
534	95% BCA Bootstrap UCL	N/A		
535	90% Chebyshev(Mean, Sd) UCL	0,578	95% Chebyshev(Mean, Sd) UCL	0,708
536	97,5% Chebyshev(Mean, Sd) UCL	0,889	99% Chebyshev(Mean, Sd) UCL	1,245
537				
538	**Suggested UCL to Use**			
539	95% Chebyshev (Mean, Sd) UCL	0,708		
540				
541	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
542	Recommendations are based upon data size, data distribution, and skewness.			
543	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
544	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
545				

	A	B	C	D	E	F	G	H	I	J	K	L
1					Outlier Tests for Selected Uncensored Variables							
2			User Selected Options									
3		Date/Time of Computation		ProUCL 5.12019-04-26 09:35:26								
4				From File	WorkSheet.xls							
5				Full Precision	OFF							
6												
7												
8	xon's Outlier Test for Aluminum (Main Complex - Groundwate											
9												
10	Number of Observations = 10											
11	10% critical value: 0,409											
12	5% critical value: 0,477											
13	1% critical value: 0,597											
14												
15	1. Observation Value 21700 is a Potential Outlier (Upper Ta											
16												
17	Test Statistic: 0,627											
18												
19	For 10% significance level, 21700 is an outlier.											
20	For 5% significance level, 21700 is an outlier.											
21	For 1% significance level, 21700 is an outlier.											
22												
23	2. Observation Value 108 is a Potential Outlier (Lower Tail)?											
24												
25	Test Statistic: 0,001											
26												
27	For 10% significance level, 108 is not an outlier.											
28	For 5% significance level, 108 is not an outlier.											
29	For 1% significance level, 108 is not an outlier.											
30												
31												
32	Dixon's Outlier Test for Iron (Main Complex - Groundwater)											
33												
34	Number of Observations = 10											
35	10% critical value: 0,409											
36	5% critical value: 0,477											
37	1% critical value: 0,597											
38												
39	1. Observation Value 9790 is a Potential Outlier (Upper Tail)											
40												
41	Test Statistic: 0,590											
42												
43	For 10% significance level, 9790 is an outlier.											
44	For 5% significance level, 9790 is an outlier.											
45	For 1% significance level, 9790 is not an outlier.											
46												
47	2. Observation Value 50 is a Potential Outlier (Lower Tail)?											
48												
49	Test Statistic: 0,004											
50												

For 10% significance level, 50 is not an outlier.
For 5% significance level, 50 is not an outlier.
For 1% significance level, 50 is not an outlier.

Dixon's Outlier Test for Lead (Main Complex - Groundwater)

Number of Observations = 10
10% critical value: 0,409
5% critical value: 0,477
1% critical value: 0,597

1. Observation Value 15,8 is a Potential Outlier (Upper Tail)

Test Statistic: 0,895

For 10% significance level, 15,8 is an outlier.
For 5% significance level, 15,8 is an outlier.
For 1% significance level, 15,8 is an outlier.

2. Observation Value 0,5 is a Potential Outlier (Lower Tail)?

Test Statistic: 0,000

For 10% significance level, 0,5 is not an outlier.
For 5% significance level, 0,5 is not an outlier.
For 1% significance level, 0,5 is not an outlier.

Dixon's Outlier Test for Zinc (Main Complex - Groundwater)

Number of Observations = 10
10% critical value: 0,409
5% critical value: 0,477
1% critical value: 0,597

1. Observation Value 818 is a Potential Outlier (Upper Tail)?

Test Statistic: 0,846

For 10% significance level, 818 is an outlier.
For 5% significance level, 818 is an outlier.
For 1% significance level, 818 is an outlier.

2. Observation Value 5 is a Potential Outlier (Lower Tail)?

Test Statistic: 0,000

For 10% significance level, 5 is not an outlier.
For 5% significance level, 5 is not an outlier.

For 1% significance level, 5 is not an outlier.

utlier Test for Fuel Range (>C10-C16) (Main Complex - Grou

Number of Observations = 10

10% critical value: 0,409

5% critical value: 0,477

1% critical value: 0,597

1. Observation Value 0,63 is a Potential Outlier (Upper Tail)

Test Statistic: 0,224

For 10% significance level, 0,63 is not an outlier.

For 5% significance level, 0,63 is not an outlier.

For 1% significance level, 0,63 is not an outlier.

2. Observation Value 0,05 is a Potential Outlier (Lower Tail)?

Test Statistic: 0,000

For 10% significance level, 0,05 is not an outlier.

For 5% significance level, 0,05 is not an outlier.

For 1% significance level, 0,05 is not an outlier.

utlier Test for Fuel Range (>C16-C21) (Main Complex - Grou

Number of Observations = 10

10% critical value: 0,409

5% critical value: 0,477

1% critical value: 0,597

1. Observation Value 0,37 is a Potential Outlier (Upper Tail)

Test Statistic: 0,630

For 10% significance level, 0,37 is an outlier.

For 5% significance level, 0,37 is an outlier.

For 1% significance level, 0,37 is an outlier.

2. Observation Value 0,1 is a Potential Outlier (Lower Tail)?

Test Statistic: 0,000

For 10% significance level, 0,1 is not an outlier.

For 5% significance level, 0,1 is not an outlier.

For 1% significance level, 0,1 is not an outlier.

utlier Test for Fuel Range (>C10-C21) (Main Complex - Grou

Number of Observations = 10

10% critical value: 0,409

5% critical value: 0,477

1% critical value: 0,597

1. Observation Value 1 is a Potential Outlier (Upper Tail)?

Test Statistic: 0,353

For 10% significance level, 1 is not an outlier.

For 5% significance level, 1 is not an outlier.

For 1% significance level, 1 is not an outlier.

2. Observation Value 0,15 is a Potential Outlier (Lower Tail)?

Test Statistic: 0,000

For 10% significance level, 0,15 is not an outlier.

For 5% significance level, 0,15 is not an outlier.

For 1% significance level, 0,15 is not an outlier.

	A	B	C	D	E	F	G	H	I	J	K	L
1	UCL Statistics for Uncensored Full Data Sets											
2												
3	User Selected Options											
4	Date/Time of Computation			ProUCL 5.12019-04-26 09:39:40								
5	From File			WorkSheet.xls								
6	Full Precision			OFF								
7	Confidence Coefficient			95%								
8	Number of Bootstrap Operations			2000								
9												
10												
11	Aluminum (Main Complex - Groundwater)											
12												
13	General Statistics											
14	Total Number of Observations					9,000	Number of Distinct Observations					9,000
15							Number of Missing Observations					2,000
16	Minimum					108,0	Mean					1155
17	Maximum					8160	Median					188,0
18	SD					2641	Std. Error of Mean					880,3
19	Coefficient of Variation					2,286	Skewness					2,941
20												
21	Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use											
22	guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.											
23	For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).											
24	Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.1											
25												
26	Normal GOF Test											
27	Shapiro Wilk Test Statistic					0,458	Shapiro Wilk GOF Test					
28	5% Shapiro Wilk Critical Value					0,829	Data Not Normal at 5% Significance Level					
29	Lilliefors Test Statistic					0,414	Lilliefors GOF Test					
30	5% Lilliefors Critical Value					0,274	Data Not Normal at 5% Significance Level					
31	Data Not Normal at 5% Significance Level											
32												
33	Assuming Normal Distribution											
34	95% Normal UCL						95% UCLs (Adjusted for Skewness)					
35	95% Student's-t UCL					2792	95% Adjusted-CLT UCL (Chen-1995)					3526
36							95% Modified-t UCL (Johnson-1978)					2936
37												
38	Gamma GOF Test											
39	A-D Test Statistic					1,615	Anderson-Darling Gamma GOF Test					
40	5% A-D Critical Value					0,772	Data Not Gamma Distributed at 5% Significance Level					
41	K-S Test Statistic					0,409	Kolmogorov-Smirnov Gamma GOF Test					
42	5% K-S Critical Value					0,294	Data Not Gamma Distributed at 5% Significance Level					
43	Data Not Gamma Distributed at 5% Significance Level											
44												
45	Gamma Statistics											
46	k hat (MLE)					0,492	k star (bias corrected MLE)					0,402
47	Theta hat (MLE)					2347	Theta star (bias corrected MLE)					2872
48	nu hat (MLE)					8,861	nu star (bias corrected)					7,241
49	MLE Mean (bias corrected)					1155	MLE Sd (bias corrected)					1822
50							Approximate Chi Square Value (0,0500)					2,304

	A–E	F	G–K	L
51	Adjusted Level of Significance	0,0231	Adjusted Chi Square Value	1,762
52				
53	**Assuming Gamma Distribution**			
54	95% Approximate Gamma UCL (use when n>=50))	3631	95% Adjusted Gamma UCL (use when n<50)	4749
55				
56	**Lognormal GOF Test**			
57	Shapiro Wilk Test Statistic	0,750	**Shapiro Wilk Lognormal GOF Test**	
58	5% Shapiro Wilk Critical Value	0,829	Data Not Lognormal at 5% Significance Level	
59	Lilliefors Test Statistic	0,334	**Lilliefors Lognormal GOF Test**	
60	5% Lilliefors Critical Value	0,274	Data Not Lognormal at 5% Significance Level	
61	**Data Not Lognormal at 5% Significance Level**			
62				
63	**Lognormal Statistics**			
64	Minimum of Logged Data	4,682	Mean of logged Data	5,759
65	Maximum of Logged Data	9,007	SD of logged Data	1,384
66				
67	**Assuming Lognormal Distribution**			
68	95% H-UCL	6290	90% Chebyshev (MVUE) UCL	1700
69	95% Chebyshev (MVUE) UCL	2154	97,5% Chebyshev (MVUE) UCL	2784
70	99% Chebyshev (MVUE) UCL	4021		
71				
72	**Nonparametric Distribution Free UCL Statistics**			
73	**Data do not follow a Discernible Distribution (0.05)**			
74				
75	**Nonparametric Distribution Free UCLs**			
76	95% CLT UCL	2603	95% Jackknife UCL	2792
77	95% Standard Bootstrap UCL	2528	95% Bootstrap-t UCL	45978
78	95% Hall's Bootstrap UCL	17726	95% Percentile Bootstrap UCL	2839
79	95% BCA Bootstrap UCL	3801		
80	90% Chebyshev(Mean, Sd) UCL	3796	95% Chebyshev(Mean, Sd) UCL	4993
81	97,5% Chebyshev(Mean, Sd) UCL	6653	99% Chebyshev(Mean, Sd) UCL	9914
82				
83	**Suggested UCL to Use**			
84	95% Hall's Bootstrap UCL	17726		
85				
86	**Recommended UCL exceeds the maximum observation**			
87				
88	**In Case Bootstrap t and/or Hall's Bootstrap yields an unreasonably large UCL value, use 97.5% or 99% Chebyshev (Mean, Sd) UCL**			
89				
90	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
91	Recommendations are based upon data size, data distribution, and skewness.			
92	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
93	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
94				
95				
96	**Iron (Main Complex - Groundwater)**			
97				
98	**General Statistics**			
99	Total Number of Observations	9,000	Number of Distinct Observations	9,000
100			Number of Missing Observations	2,000

	A–E	F	G–K	L
101	Minimum	50,00	Mean	1202
102	Maximum	4050	Median	1050
103	SD	1450	Std. Error of Mean	483,2
104	Coefficient of Variation	1,206	Skewness	1,324
105				
106	**Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use**			
107	**guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.**			
108	**For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).**			
109	**Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.1**			
110				
111	**Normal GOF Test**			
112	Shapiro Wilk Test Statistic	0,787	**Shapiro Wilk GOF Test**	
113	5% Shapiro Wilk Critical Value	0,829	Data Not Normal at 5% Significance Level	
114	Lilliefors Test Statistic	0,306	**Lilliefors GOF Test**	
115	5% Lilliefors Critical Value	0,274	Data Not Normal at 5% Significance Level	
116	**Data Not Normal at 5% Significance Level**			
117				
118	**Assuming Normal Distribution**			
119	**95% Normal UCL**		**95% UCLs (Adjusted for Skewness)**	
120	95% Student's-t UCL	2101	95% Adjusted-CLT UCL (Chen-1995)	2225
121			95% Modified-t UCL (Johnson-1978)	2137
122				
123	**Gamma GOF Test**			
124	A-D Test Statistic	0,463	**Anderson-Darling Gamma GOF Test**	
125	5% A-D Critical Value	0,761	Detected data appear Gamma Distributed at 5% Significance Level	
126	K-S Test Statistic	0,192	**Kolmogorov-Smirnov Gamma GOF Test**	
127	5% K-S Critical Value	0,292	Detected data appear Gamma Distributed at 5% Significance Level	
128	**Detected data appear Gamma Distributed at 5% Significance Level**			
129				
130	**Gamma Statistics**			
131	k hat (MLE)	0,631	k star (bias corrected MLE)	0,495
132	Theta hat (MLE)	1905	Theta star (bias corrected MLE)	2430
133	nu hat (MLE)	11,36	nu star (bias corrected)	8,908
134	MLE Mean (bias corrected)	1202	MLE Sd (bias corrected)	1709
135			Approximate Chi Square Value (0,0500)	3,272
136	Adjusted Level of Significance	0,0231	Adjusted Chi Square Value	2,594
137				
138	**Assuming Gamma Distribution**			
139	95% Approximate Gamma UCL (use when n>=50)	3274	95% Adjusted Gamma UCL (use when n<50)	4130
140				
141	**Lognormal GOF Test**			
142	Shapiro Wilk Test Statistic	0,884	**Shapiro Wilk Lognormal GOF Test**	
143	5% Shapiro Wilk Critical Value	0,829	Data appear Lognormal at 5% Significance Level	
144	Lilliefors Test Statistic	0,244	**Lilliefors Lognormal GOF Test**	
145	5% Lilliefors Critical Value	0,274	Data appear Lognormal at 5% Significance Level	
146	**Data appear Lognormal at 5% Significance Level**			
147				
148	**Lognormal Statistics**			
149	Minimum of Logged Data	3,912	Mean of logged Data	6,121
150	Maximum of Logged Data	8,306	SD of logged Data	1,702

	A	B	C	D	E	F	G	H	I	J	K	L
151												
152	Assuming Lognormal Distribution											
153					95% H-UCL	38074					90% Chebyshev (MVUE) UCL	3967
154					95% Chebyshev (MVUE) UCL	5108					97,5% Chebyshev (MVUE) UCL	6691
155					99% Chebyshev (MVUE) UCL	9802						
156												
157	Nonparametric Distribution Free UCL Statistics											
158	Data appear to follow a Discernible Distribution at 5% Significance Level											
159												
160	Nonparametric Distribution Free UCLs											
161					95% CLT UCL	1997					95% Jackknife UCL	2101
162					95% Standard Bootstrap UCL	1951					95% Bootstrap-t UCL	3116
163					95% Hall's Bootstrap UCL	7221					95% Percentile Bootstrap UCL	1980
164					95% BCA Bootstrap UCL	2175						
165					90% Chebyshev(Mean, Sd) UCL	2652					95% Chebyshev(Mean, Sd) UCL	3309
166					97,5% Chebyshev(Mean, Sd) UCL	4220					99% Chebyshev(Mean, Sd) UCL	6010
167												
168	Suggested UCL to Use											
169					95% Adjusted Gamma UCL	4130						
170												
171	Recommended UCL exceeds the maximum observation											
172												
173	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
174	Recommendations are based upon data size, data distribution, and skewness.											
175	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
176	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
177												
178												
179	Lead (Main Complex - Groundwater)											
180												
181	General Statistics											
182					Total Number of Observations	9,000					Number of Distinct Observations	4,000
183											Number of Missing Observations	2,000
184					Minimum	0,500					Mean	0,856
185					Maximum	2,100					Median	0,500
186					SD	0,590					Std. Error of Mean	0,197
187					Coefficient of Variation	0,689					Skewness	1,520
188												
189	Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use											
190	guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.											
191	For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).											
192	Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.1											
193												
194	Normal GOF Test											
195					Shapiro Wilk Test Statistic	0,689	Shapiro Wilk GOF Test					
196					5% Shapiro Wilk Critical Value	0,829	Data Not Normal at 5% Significance Level					
197					Lilliefors Test Statistic	0,393	Lilliefors GOF Test					
198					5% Lilliefors Critical Value	0,274	Data Not Normal at 5% Significance Level					
199	Data Not Normal at 5% Significance Level											
200												

Assuming Normal Distribution			
95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	1,221	95% Adjusted-CLT UCL (Chen-1995)	1,285
		95% Modified-t UCL (Johnson-1978)	1,238
Gamma GOF Test			
A-D Test Statistic	1,445	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0,727	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0,417	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0,281	Data Not Gamma Distributed at 5% Significance Level	
Data Not Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	3,133	k star (bias corrected MLE)	2,163
Theta hat (MLE)	0,273	Theta star (bias corrected MLE)	0,396
nu hat (MLE)	56,39	nu star (bias corrected)	38,93
MLE Mean (bias corrected)	0,856	MLE Sd (bias corrected)	0,582
		Approximate Chi Square Value (0,0500)	25,64
Adjusted Level of Significance	0,0231	Adjusted Chi Square Value	23,38
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50))	1,299	95% Adjusted Gamma UCL (use when n<50)	1,424
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0,692	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0,829	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0,406	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0,274	Data Not Lognormal at 5% Significance Level	
Data Not Lognormal at 5% Significance Level			
Lognormal Statistics			
Minimum of Logged Data	-0,693	Mean of logged Data	-0,324
Maximum of Logged Data	0,742	SD of logged Data	0,577
Assuming Lognormal Distribution			
95% H-UCL	1,388	90% Chebyshev (MVUE) UCL	1,328
95% Chebyshev (MVUE) UCL	1,551	97,5% Chebyshev (MVUE) UCL	1,860
99% Chebyshev (MVUE) UCL	2,466		
Nonparametric Distribution Free UCL Statistics			
Data do not follow a Discernible Distribution (0.05)			
Nonparametric Distribution Free UCLs			
95% CLT UCL	1,179	95% Jackknife UCL	1,221
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	1,445	95% Chebyshev(Mean, Sd) UCL	1,712
97,5% Chebyshev(Mean, Sd) UCL	2,083	99% Chebyshev(Mean, Sd) UCL	2,811

Suggested UCL to Use			
95% Chebyshev (Mean, Sd) UCL	1,712		

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.
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 statistician.

Zinc (Main Complex - Groundwater)

General Statistics			
Total Number of Observations	9,000	Number of Distinct Observations	8,000
		Number of Missing Observations	2,000
Minimum	5,000	Mean	29,44
Maximum	130,0	Median	16,00
SD	40,24	Std. Error of Mean	13,41
Coefficient of Variation	1,367	Skewness	2,409

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.1

Normal GOF Test			
Shapiro Wilk Test Statistic	0,650	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0,829	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0,361	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0,274	Data Not Normal at 5% Significance Level	
Data Not Normal at 5% Significance Level			

Assuming Normal Distribution			
95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	54,39	95% Adjusted-CLT UCL (Chen-1995)	63,02
		95% Modified-t UCL (Johnson-1978)	56,18

Gamma GOF Test			
A-D Test Statistic	0,606	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0,744	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0,267	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0,287	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			

Gamma Statistics			
k hat (MLE)	0,992	k star (bias corrected MLE)	0,736
Theta hat (MLE)	29,67	Theta star (bias corrected MLE)	40,02
nu hat (MLE)	17,86	nu star (bias corrected)	13,24
MLE Mean (bias corrected)	29,44	MLE Sd (bias corrected)	34,33
		Approximate Chi Square Value (0,0500)	6,056
Adjusted Level of Significance	0,0231	Adjusted Chi Square Value	5,068

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50)	64,39	95% Adjusted Gamma UCL (use when n<50)	76,93

Lognormal GOF Test

Shapiro Wilk Test Statistic	0,926	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0,829	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0,187	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0,274	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	1,609	Mean of logged Data	2,800
Maximum of Logged Data	4,868	SD of logged Data	1,069

Assuming Lognormal Distribution

95% H-UCL	105,0	90% Chebyshev (MVUE) UCL	56,32
95% Chebyshev (MVUE) UCL	69,73	97,5% Chebyshev (MVUE) UCL	88,35
99% Chebyshev (MVUE) UCL	124,9		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	51,51	95% Jackknife UCL	54,39
95% Standard Bootstrap UCL	49,86	95% Bootstrap-t UCL	144,0
95% Hall's Bootstrap UCL	169,5	95% Percentile Bootstrap UCL	53,78
95% BCA Bootstrap UCL	66,56		
90% Chebyshev(Mean, Sd) UCL	69,68	95% Chebyshev(Mean, Sd) UCL	87,91
97,5% Chebyshev(Mean, Sd) UCL	113,2	99% Chebyshev(Mean, Sd) UCL	162,9

Suggested UCL to Use

95% Adjusted Gamma UCL	76,93		

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.

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 statistician.

Fuel Range (>C10-C16) (Main Complex - Groundwater)

General Statistics

Total Number of Observations	10,00	Number of Distinct Observations	3,000
		Number of Missing Observations	1,000
Minimum	0,0500	Mean	0,153
Maximum	0,630	Median	0,0500
SD	0,219	Std. Error of Mean	0,0693
Coefficient of Variation	1,433	Skewness	1,864

	A	B	C	D	E	F	G	H	I	J	K	L
351	**Normal GOF Test**											
352	Shapiro Wilk Test Statistic					0,534	**Shapiro Wilk GOF Test**					
353	5% Shapiro Wilk Critical Value					0,842	Data Not Normal at 5% Significance Level					
354	Lilliefors Test Statistic					0,481	**Lilliefors GOF Test**					
355	5% Lilliefors Critical Value					0,262	Data Not Normal at 5% Significance Level					
356	**Data Not Normal at 5% Significance Level**											
357												
358	**Assuming Normal Distribution**											
359	**95% Normal UCL**						**95% UCLs (Adjusted for Skewness)**					
360	95% Student's-t UCL					0,280	95% Adjusted-CLT UCL (Chen-1995)					0,311
361							95% Modified-t UCL (Johnson-1978)					0,287
362												
363	**Gamma GOF Test**											
364	A-D Test Statistic					2,606	**Anderson-Darling Gamma GOF Test**					
365	5% A-D Critical Value					0,751	Data Not Gamma Distributed at 5% Significance Level					
366	K-S Test Statistic					0,503	**Kolmogorov-Smirnov Gamma GOF Test**					
367	5% K-S Critical Value					0,274	Data Not Gamma Distributed at 5% Significance Level					
368	**Data Not Gamma Distributed at 5% Significance Level**											
369												
370	**Gamma Statistics**											
371	k hat (MLE)					0,919	k star (bias corrected MLE)					0,710
372	Theta hat (MLE)					0,167	Theta star (bias corrected MLE)					0,216
373	nu hat (MLE)					18,37	nu star (bias corrected)					14,19
374	MLE Mean (bias corrected)					0,153	MLE Sd (bias corrected)					0,182
375							Approximate Chi Square Value (0,0500)					6,704
376	Adjusted Level of Significance					0,0267	Adjusted Chi Square Value					5,833
377												
378	**Assuming Gamma Distribution**											
379	95% Approximate Gamma UCL (use when n>=50))					0,324	95% Adjusted Gamma UCL (use when n<50)					0,372
380												
381	**Lognormal GOF Test**											
382	Shapiro Wilk Test Statistic					0,521	**Shapiro Wilk Lognormal GOF Test**					
383	5% Shapiro Wilk Critical Value					0,842	Data Not Lognormal at 5% Significance Level					
384	Lilliefors Test Statistic					0,482	**Lilliefors Lognormal GOF Test**					
385	5% Lilliefors Critical Value					0,262	Data Not Lognormal at 5% Significance Level					
386	**Data Not Lognormal at 5% Significance Level**											
387												
388	**Lognormal Statistics**											
389	Minimum of Logged Data					-2,996	Mean of logged Data					-2,512
390	Maximum of Logged Data					-0,462	SD of logged Data					1,021
391												
392	**Assuming Lognormal Distribution**											
393	95% H-UCL					0,399	90% Chebyshev (MVUE) UCL					0,257
394	95% Chebyshev (MVUE) UCL					0,315	97,5% Chebyshev (MVUE) UCL					0,397
395	99% Chebyshev (MVUE) UCL					0,556						
396												
397	**Nonparametric Distribution Free UCL Statistics**											
398	**Data do not follow a Discernible Distribution (0.05)**											
399												
400	**Nonparametric Distribution Free UCLs**											

95% CLT UCL	0,267	95% Jackknife UCL	0,280
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	0,361	95% Chebyshev(Mean, Sd) UCL	0,455
97,5% Chebyshev(Mean, Sd) UCL	0,586	99% Chebyshev(Mean, Sd) UCL	0,843
Suggested UCL to Use			
95% Chebyshev (Mean, Sd) UCL	0,455		
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.			
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 statistician.			
Fuel Range (>C16-C21) (Main Complex - Groundwater)			
General Statistics			
Total Number of Observations	9,000	Number of Distinct Observations	2,000
		Number of Missing Observations	2,000
Minimum	0,100	Mean	0,111
Maximum	0,200	Median	0,100
SD	0,0333	Std. Error of Mean	0,0111
Coefficient of Variation	0,300	Skewness	3,000
Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use			
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.			
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).			
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.1			
Normal GOF Test			
Shapiro Wilk Test Statistic	0,390	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0,829	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0,519	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0,274	Data Not Normal at 5% Significance Level	
Data Not Normal at 5% Significance Level			
Assuming Normal Distribution			
95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	0,132	95% Adjusted-CLT UCL (Chen-1995)	0,141
		95% Modified-t UCL (Johnson-1978)	0,134
Gamma GOF Test			
A-D Test Statistic	2,905	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0,721	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0,528	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0,279	Data Not Gamma Distributed at 5% Significance Level	
Data Not Gamma Distributed at 5% Significance Level			

Gamma Statistics

k hat (MLE)	17,81	k star (bias corrected MLE)	11,94
Theta hat (MLE)	0,00624	Theta star (bias corrected MLE)	0,00930
nu hat (MLE)	320,5	nu star (bias corrected)	215,0
MLE Mean (bias corrected)	0,111	MLE Sd (bias corrected)	0,0321
		Approximate Chi Square Value (0,0500)	182,1
Adjusted Level of Significance	0,0231	Adjusted Chi Square Value	175,7

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	0,131	95% Adjusted Gamma UCL (use when n<50)	0,136

Lognormal GOF Test

Shapiro Wilk Test Statistic	0,390	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0,829	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0,519	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0,274	Data Not Lognormal at 5% Significance Level

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-2,303	Mean of logged Data	-2,226
Maximum of Logged Data	-1,609	SD of logged Data	0,231

Assuming Lognormal Distribution

95% H-UCL	0,130	90% Chebyshev (MVUE) UCL	0,136
95% Chebyshev (MVUE) UCL	0,148	97,5% Chebyshev (MVUE) UCL	0,164
99% Chebyshev (MVUE) UCL	0,196		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	0,129	95% Jackknife UCL	N/A
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	0,144	95% Chebyshev(Mean, Sd) UCL	0,160
97,5% Chebyshev(Mean, Sd) UCL	0,180	99% Chebyshev(Mean, Sd) UCL	0,222

Suggested UCL to Use

95% Student's-t UCL	0,132	or 95% Modified-t UCL	0,134

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.

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 statistician.

Fuel Range (>C10-C21) (Main Complex - Groundwater)

General Statistics

	A	B	C	D	E	F	G	H	I	J	K	L
501					Total Number of Observations	10,00					Number of Distinct Observations	3,000
502											Number of Missing Observations	1,000
503					Minimum	0,150					Mean	0,290
504					Maximum	1,000					Median	0,150
505					SD	0,303					Std. Error of Mean	0,0960
506					Coefficient of Variation	1,047					Skewness	2,012
507												
508	**Normal GOF Test**											
509					Shapiro Wilk Test Statistic	0,540	**Shapiro Wilk GOF Test**					
510					5% Shapiro Wilk Critical Value	0,842	Data Not Normal at 5% Significance Level					
511					Lilliefors Test Statistic	0,478	**Lilliefors GOF Test**					
512					5% Lilliefors Critical Value	0,262	Data Not Normal at 5% Significance Level					
513	**Data Not Normal at 5% Significance Level**											
514												
515	**Assuming Normal Distribution**											
516	**95% Normal UCL**						**95% UCLs (Adjusted for Skewness)**					
517					95% Student's-t UCL	0,466					95% Adjusted-CLT UCL (Chen-1995)	0,513
518											95% Modified-t UCL (Johnson-1978)	0,476
519												
520	**Gamma GOF Test**											
521					A-D Test Statistic	2,539	**Anderson-Darling Gamma GOF Test**					
522					5% A-D Critical Value	0,738	Data Not Gamma Distributed at 5% Significance Level					
523					K-S Test Statistic	0,497	**Kolmogorov-Smirnov Gamma GOF Test**					
524					5% K-S Critical Value	0,271	Data Not Gamma Distributed at 5% Significance Level					
525	**Data Not Gamma Distributed at 5% Significance Level**											
526												
527	**Gamma Statistics**											
528					k hat (MLE)	1,733					k star (bias corrected MLE)	1,280
529					Theta hat (MLE)	0,167					Theta star (bias corrected MLE)	0,227
530					nu hat (MLE)	34,66					nu star (bias corrected)	25,59
531					MLE Mean (bias corrected)	0,290					MLE Sd (bias corrected)	0,256
532											Approximate Chi Square Value (0,0500)	15,07
533					Adjusted Level of Significance	0,0267					Adjusted Chi Square Value	13,68
534												
535	**Assuming Gamma Distribution**											
536					95% Approximate Gamma UCL (use when n>=50))	0,493					95% Adjusted Gamma UCL (use when n<50)	0,543
537												
538	**Lognormal GOF Test**											
539					Shapiro Wilk Test Statistic	0,532	**Shapiro Wilk Lognormal GOF Test**					
540					5% Shapiro Wilk Critical Value	0,842	Data Not Lognormal at 5% Significance Level					
541					Lilliefors Test Statistic	0,481	**Lilliefors Lognormal GOF Test**					
542					5% Lilliefors Critical Value	0,262	Data Not Lognormal at 5% Significance Level					
543	**Data Not Lognormal at 5% Significance Level**											
544												
545	**Lognormal Statistics**											
546					Minimum of Logged Data	-1,897					Mean of logged Data	-1,553
547					Maximum of Logged Data	0					SD of logged Data	0,730
548												
549	**Assuming Lognormal Distribution**											
550					95% H-UCL	0,517					90% Chebyshev (MVUE) UCL	0,459

551
552

Appendix E HHRA Calculation Sheets

UPTAKE FACTORS

To evaluate the level of exposure for each ecological receptor to each potential COPC evaluated in the terrestrial ERA, it is necessary to first estimate the concentration of each COPC in various media or biological tissues (*e.g.*, for the current site, this would include soil and representative plant and animal tissues).

To estimate the potential environmental effects at the site for each receptor, EPC values for soil, terrestrial plants, soil invertebrates, and terrestrial prey, if not measured, were calculated using environmental fate and transport equations or uptake factors which describe the relationships between chemical concentrations in environmental media and concentrations in biota. In the following sections, details of the equations and methods used to derive EPC values for biota in the ERA are discussed.

Common sources of error in environmental fate and transport calculations involve confusion between wet and dry weight units for chemical concentrations in soil, sediment, and biota. To manage this problem in this ERA, for soil, all concentrations are expressed on a dry weight basis (mg/kg dry weight soil or sediment). For plant and animal tissues, all concentrations are expressed on a wet weight basis (mg/kg wet weight tissue).

The uptake factor literature is likewise inconsistent, with some uptake factors being expressed on a wet tissue basis, others on a dry tissue basis, and still others being normalized on the basis of tissue lipid to sediment organic carbon content. The ERA model requires EPC values on a wet tissue basis for biota that are ingested as foods by ecological receptors. Therefore, where possible, uptake factors are expressed on a wet tissue basis; where necessary, correction factors are applied in order to convert from dry weight tissue units to a wet tissue basis.

Biological Uptake Factors

The generalized uptake factor equation used to calculate a COPC concentration in an organism or biological tissue (*e.g.*, soil invertebrates) from the concentration in a surrounding medium (*e.g.*, soil) is as follows:

$$EPC_j = EPC_i \times UP_{ij}$$

Where:	EPC_j	=	exposure point concentration in biological compartment j (*e.g.,* mg/kg wet weight soil invertebrate tissue);
	EPC_i	=	exposure point concentration in environmental medium i (*e.g.,* mg/kg dry soil); and
	UP_{ij}	=	uptake factor from surrounding medium (in this case soil) to the target biological tissue (*e.g.,* mg/kg wet tissue / mg/kg dry soil).

Soil to Terrestrial Plants, UP_{SP}

Most uptake factors are initially reported in dry weight units (*i.e.*, mg/kg dry weight plant / mg/kg dry weight soil) and converted to wet weight for plants by assuming an 85% water and 15% dry solids content (typical value for dicots; USEPA 2007). The conversion is effected by multiplying dry weight transfer factors obtained empirically or from the literature by the fraction of dry solids content, typically assumed to be 0.15 for herbaceous terrestrial plants.

Soil-to-terrestrial-plant uptake factors UP_{SP} for organic compounds were based on the equations presented in Attachment 4-1, Guidance for Developing Ecological Soil Screening Levels (Eco-SSLs) (USEPA 2007, Table 4b).

Bioavailability of selected compounds to plants may be modified using a soil-to-plant bioavailability factor (unitless, potentially ranging from 0 to 1). This empirically represents factors that limit the potential for organic compounds to cross the soil-root barrier, where this is not already factored into the uptake models based on empirical data. Compounds that have a high tendency to sorb to soil solids become inactivated or have low bioavailability. Graham-Bryce (1984) noted that this occurs for substances that have K_d values greater than 1,000 L/kg (log K_{OW} = 3), and Ryan *et al.* (1988) relate this to organic compounds having log K_{OW} values of between 5 and 6, or greater. The Ryan *et al.* (1988) model reflects variable bioavailability by including partitioning and competition between soil organic carbon and plants for uptake of organic contaminants in soil pore water. Presently, the bioavailability factor is set at 1 (*i.e.*, all contaminants are fully bioavailable). Exceptions could be made based on professional judgment where the model of Ryan *et al.* (1988) is not already being used.

In addition to having limited bioavailability, some organic compounds are also potentially metabolized by plants, or may be volatilized across plant leaf surfaces. Therefore, the potential loss of selected organic compounds from plant tissues can be represented using an empirical metabolic factor (unitless, potentially ranging from 0 to 1). Presently, this factor is set at 1 for all contaminants (*i.e.*, contaminants are not metabolized or volatilized). Exceptions can be made based on professional judgment, but a rationale based on evidence of metabolism or volatility should be provided.

Soil to Terrestrial Invertebrates, UP_{SI}

Uptake factors for soil-to-terrestrial invertebrates (UP_{SI}) are generally reported for earthworms due to the availability of information in the literature for earthworms, and a relative paucity of information with regards to insects. The ERA, therefore, focuses on earthworms as the "model" soil invertebrate, due to the relative abundance of data and models to predict contaminant uptake, as well as the perceived importance of earthworms in food webs.

The soil-to-earthworm uptake factors UP_{SI} for organic compounds were obtained from Attachment 4-1, Guidance for Developing Ecological Soil Screening Levels (Eco-SSLs) (USEPA 2007, Table 4b), and presented here to give the uptake factor on the dry weight basis for the earthworm (mg/kg dw tissue / mg/kg dw soil) as:

$$UP_{SI} = ((f_{water} + (f_{lipid} \times K_{ow})) / (F_{oc} \times K_{oc})) / 0.16$$

Where: f_{water} is the water content of the worm (0.84),
f_{lipid} is the lipid content of the worm (0.01),
f_{OC} is the fraction of organic carbon in soil (assumed to be 0.01), and
K_{OC} is the water to organic carbon partitioning coefficient (L/kg OC).

The value 0.16 is the dry solids content of the worm. Log K_{OW} values were obtained from various sources and Log K_{OC} values were calculated as Log K_{OW} x 0.41. Bioavailability and metabolic factors (unitless) for use with this equation as multipliers before calculating the final concentration in earthworms were estimated based on K_{OW}. Estimated values for bioavailability range from 0.1 to 1 while values for metabolic factor range from 0.05 to 1.

Soil or Plant to Terrestrial Prey, UP_{SA}

This section is applicable to terrestrial prey including small mammals and small birds.

Concentrations of contaminants in terrestrial prey are generally estimated using uptake or biotransfer factors directly from soil, or in some cases using biotransfer factors from feed (vegetation). Uptake factors are technically dimensionless and direct (*i.e.*, mg/kg dry weight terrestrial prey / mg/kg dry weight soil). Biotransfer factors (BA) are slightly different, with units of day/kg, and are multiplied by a soil or feed intake rate (kg/day) to generate an uptake factor, which is then multiplied by the contaminant concentration in the soil or feed (mg/kg) to estimate the concentration in the animal. It is very important to maintain consistency in wet weight or dry weight units.

To ensure this consistency, all uptake factors are initially reported in dry weight units (*i.e.*, mg/kg dry weight terrestrial prey / mg/kg dry weight soil) and subsequently converted to wet weight assuming that terrestrial prey typically have approximately 68% water content and 32% dry solids content (data for terrestrial prey; USEPA, 2007). The conversion to wet-weight terrestrial prey units is accomplished by multiplying dry-weight transfer factors by the dry solids fraction of 0.32 for terrestrial prey.

For biotransfer factors for organic contaminants, the most recent literature (*e.g.*, USEPA 2005 and RTI 2005) focuses on transfer from feed to lipid fraction in the animal. The lipid content of terrestrial prey on a dry matter basis varies considerably, both seasonally and between species, with low-range values of <3% recorded for snowshoe hares, and high-range values of >40% recorded for Guinea Pig (Dierenfeld *et al.* 2002). Typical lipid content values for wild voles and mice appear to be in the range of 20% (of dry weight), and this can be converted to a value of 6.4% (wet weight). This value (0.064) will be adopted for the purposes of deriving terrestrial prey transfer factors from feed to lipid and whole body. Thus, where the biotransfer factor has provided an estimate of the contaminant concentration in the lipid fraction of terrestrial prey, multiplying this value by a correction factor of 0.064 will convert to whole animal wet weight units.

PAHs and PCBs

For reasons that will be explained below, biotransfer into terrestrial prey tissue for some organic contaminants is modeled on the basis of measured or expected contaminant concentration in feed (plant tissue) as well as from soils. Thus, the soil-and-plant-to-animal (SPA) biotransfer factor is defined as BA_{SPA} (day/kg).

The uptake factor for soil and plant to terrestrial prey (UP_{SPA}, mg/kg wet weight animal / mg/kg soil or plant) for PAHs was derived from BA_{SPA} values obtained following *"Methodology for Predicting Cattle Biotransfer Values"* (RTI 2005). This work was performed by Research Triangle Institute (RTI) on behalf of the United States Environmental Protection Agency, and is endorsed by the USEPA through the *Human Health Risk Assessment Protocol*. A key assumption is that the best available predictor of the contaminant concentration in terrestrial prey tissue would be the contaminant concentration in a cow occupying the same habitat. Because the available BA_{SPA} values were developed for cattle, and must be multiplied by feed or soil intake rates and concentrations in order to convert them to animal tissue values, the appropriate feed ingestion rate is that of cattle. To multiply by the feed ingestion rate of individual VEC organisms, which range in weight from <10 g to more than 10^5 g, would make the expected contaminant concentration in tissues directly proportional to the feed ingestion rate, which is clearly not appropriate.

The UP_{SPA} value can therefore be visualized as the product of the cattle biotransfer factor (BA_{SPA}, day/kg, from RTI 2005) and the cattle food or soil ingestion rates (kg/day). When multiplied by the contaminant concentrations in the soil and feed (mg/kg) the result is the predicted contaminant concentration for the lipid compartment in cattle (mg/kg lipid). As always, careful attention to wet weight and dry weight units in the application of this approach is essential.

The biotransfer factor from soil or plant to animal (BA_{SPA}) is thus estimated as:

$$BA_{SPA} = 0.064 \times 10^{((-0.099 \log Kow^2) + (1.07 \log Kow) - 3.56)}$$

Where 0.064 is the lipid content of the terrestrial prey relative to its wet weight (Dierenfeld *et al.* 2002); and the remaining equation (from RTI 2005) predicts the tendency for an organic contaminant compound to be concentrated in lipid, as a function of the log K_{OW} value. Note that the lipid fraction identified here for terrestrial prey is lower than the lipid fraction for cattle as defined by RTI (2005). The equation is valid in the range of log K_{OW} values between -0.67 and 8.2, and the log K_{OW} values outside this range should be capped at the upper or lower range limits, respectively.

It is important also to note that the equation developed by RTI (2005) is applicable to organic compounds that are both bioavailable (*i.e.*, readily absorbed from feed), and relatively persistent (*i.e.*, resistant to metabolic breakdown and excretion). It is noted by RTI (2005) that many compounds are susceptible to breakdown and excretion, and such compounds were methodically removed from the database used to develop the equation predicting BA_{SPA} values. Further, it is noted by RTI (2005) that metabolic factors ranging from 0 to 1 can be implemented to better predict the bioaccumulation of non-persistent organic compounds.

The expected contaminant concentration in terrestrial prey is then estimated based on cattle tissue concentrations as:

$$C_{terrestrial\ prey} = BA_{SPA} \times ((60 \times C_{plant}) + (0.4 \times C_{soil})) \times B_i \times M_i,$$

Where $C_{terrestrial\ prey}$ is the contaminant concentration in animal tissue (mg/kg wet weight), BA_{SPA} is the biotransfer factor from soil or plant to animal (day/kg), 60 is the plant feed intake rate (60 kg wet weight/day for cattle), C_{plant} is the contaminant concentration in plants (mg/kg wet weight), 0.4 is the soil ingestion rate (0.4 kg dry weight/day for cattle), C_{soil} is the contaminant concentration in soil (mg/kg dry weight), B_i is the bioavailability of the contaminant in feed and soils (unitless, ranging from 0 to the default value of 1), and M_i is the metabolic factor for the contaminant (unitless, ranging from 0 to the default value of 1).

As a further check on bioconcentration by terrestrial prey, which have relatively short life spans compared with cattle, a mass limitation is imposed on the bioaccumulation of contaminants. This mass limitation is based on the meadow vole, assuming a median 90 day lifespan (USEPA 1993), the daily food ingestion rate (0.011 kg wet weight/day), the daily soil ingestion rate (3.15E-04 kg dry weight/day) and the contaminant concentrations in wet food and dry soil, respectively. No credit is taken for metabolic losses or excretion of contaminants. The total lifetime contaminant intake (mg) is divided by the body mass of the meadow vole (0.042 kg) to derive the maximum theoretical contaminant concentration in meadow vole tissues (C_{max}) as: $C_{max} = (90 \times ((0.011 \times C_{plant}) + (0.000315 \times C_{soil})) \times Bi) / 0.042$, where C_{max} is lower than $C_{terrestrial\ prey}$, C_{max} is selected as the maximum possible contaminant concentration in terrestrial prey tissue.

TOXICITY PROFILE

Benzo(a)pyrene [B(a)P]

B(a)P occurs as part of the polyaromtic hydrocarbons (PAHs) mixture. No B(a)P-specific human toxicity data were identified. In animals, the primary target organs following oral exposure to B(a)P include the hematopoietic system (for example, bone marrow depression, aplastic anemia, and pancytopenia) and reproduction and development (decreased gonadal weights, reduced fertility, sterility in offspring, stillbirths, resorptions, and malformations). Other target organs for B(a)P toxicity include the immune system (for example, depressed antibody response). Numerous epidemiologic studies have shown a clear association between exposures to various mixtures of PAHs containing B(a)P (for example, coke oven emissions and cigarette smoke) and increased risk of lung cancer and other tumours. In animal studies, B(a)P has been shown to cause cancers of the forestomach, lungs, mammary glands, respiratory and upper digestive tracts, and skin (ATSDR, 1995).

Assessment of Carcinogenicity

Available data from animal studies indicate that B(a)P is carcinogenic to animals by the oral route. The results of dermal studies indicate that B(a)P is tumorigenic in mice following dermal exposure. B(a)P has consistently been demonstrated to be one of the most potent of the carcinogenic PAHs and therefore, it is the most studied. Available literature on PAHs are primarily related to B(a)P. A quantitative cancer risk estimate (i.e., cancer slope factor or CSF) has been developed for B(a)P only.

US EPA has performed weight-of-evidence evaluations of several of the PAHs discussed herein. The carcinogenicity classifications currently verified by USEPA's Carcinogenicity Risk Assessment Verification Endeavor Work Group identifies B(a)P as probable human carcinogen (Group B2) with sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans. The Canadian Environmental Protection Agency (CEPA) classified B(a)P as Group II, probably carcinogenic to humans (sufficient evidence in animals; inadequate or no data in man).

Susceptible Populations

Developmental effects have been observed in animals following PAHs exposure. The relevance of findings in animal studies with regard to human exposure is that B(a)P may produce adverse effects in the unborn and offspring of women exposed to B(a)P (ATSDR, 1995).

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 lack of suitable positive non-carcinogenic data precludes the derivation of an tolerable daily intake for B(a)P.

Cancer Toxicity Reference Values

The only carcinogenesis bioassay in which B(a)P has been administered orally to animals is that of Neal and Rigdon (1967). This study is, therefore, the most appropriate for assessing the risk associated with the ingestion of B(a)P in drinking water. In this investigation, CFW strain mice were given B(a)P in laboratory chow diet at concentrations of 0.001, 0.01, 0.02, 0.03, 0.04, 0.045, 0.05, 0.10 and 0.25 mg/g of food, for approximately 110 days. Stomach tumours mostly squamous cell papillomas with some carcinomas were found, and their frequency was significant relative to controls and dose-related.

Cancer risks have been estimated on the basis of the feeding study of Neal and Rigdon (1967) using CFW strain mice. Incorporating a surface area correction and using the robust linear extrapolation model for the significant increase in stomach tumours (squamous cell papillomas and some carcinomas), the estimated lifetime risk associated with the ingestion of 1 µg/L BaP in drinking water is 5×10^{-5}. The estimated concentrations in drinking water corresponding to lifetime risks of 10^{-5}, 10^{-6} and 10^{-7} for these tumour types based on the model described above are 0.2, 0.02 and 0.002 µg/L, respectively.

The Health Canada (2010) TRV of 2.3 mg/kg-day^{-1} was used as the exposure limit in this assessment based on the above mentioned study.

Inhalation Exposure

Non-Carcinogenic Toxicity Reference Values

The lack of suitable positive non-carcinogenic data precludes the derivation of an tolerable daily intake for B(a)P.

Cancer Toxicity Reference Values

The carcinogenic effects of exposure to PAHs by inhalation have been examined in only a few limited identified studies, all of which were restricted to B(a)P (Heinrich *et al.,* 1986; Laskin *et al.,* 1970; Thyssen *et al.,* 1981); moreover, in two of the investigations, animals were concomitantly exposed to other compounds (Heinrich *et al.,* 1986; Laskin *et al.,* 1970). In the study by Heinrich *et al.* (1986), the incidence of lung tumours was increased in female Wistar rats exposed to combustion gases of a coal furnace for an average of 16 hours/day, 5 days/week over a maximum of 22 months. The incidence of respiratory tract tumours was also increased in rats that inhaled 10 ppm (103 mg/m^3) B(a)P and the atmospheric irritant, sulphur dioxide (S02) (Laskin *et al.,* 1970).

In a study by Thyssen *et al.* (1981), groups of 24 male Syrian golden hamsters were exposed by inhalation (nose only) to 0, 2.2, 9.5, and 45.6 mg/m^3 B(a)P for 4.5 hours/day, 7 days a week for the first 10 weeks, and for 3 hours/day for the rest of the exposure period (up to 96 weeks). Though there was a decrease in body weight gain in exposed animals during the first 10 weeks of the study, from the tenth to the sixtieth week, the body weights of all surviving exposed animals were similar to those of the controls (with the exception of the high exposure group). Mean survival was also decreased in the group exposed to 46.5 mg/m^3. The incidences of unspecified tumours of the respiratory tract (nasal cavity, larynx, and trachea) were 0/27 for controls, 0/27 for the low-dose group, 9/26 (34.6%) for the mid-dose group, and 13/25 (52%) for the high-dose group. Exposure-related neoplasms (unspecified) were present in the pharynx (0, 0, 23, and 56% for control, low-, mid-, and high-dose, respectively), oesophagus (0, 0, 0, and 8% for control, low-, mid-, and high-dose, respectively), and forestomach (0, 0, 4, and 4% for control, low-, mid-, and high-dose, respectively). Lung tumours were not observed.

The Health Canada (2010) TRV of 0.13 mg/kg-day^{-1} was used as the exposure limit in this assessment based on the Thyssen *et al.* (1981) study.

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 0.148 (Health Canada, 2010).

Conclusion

The following table presents B(a)P 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
B(a)P	Non-carcinogenic TRV	NE			
	Carcinogenic Slope Factor – oral	2.3	gastric tumours	GCDWQ	Health Canada, 2010
	Carcinogenic Slope Factor - inhalation	0.13	respiratory tract tumours	PSL1	Health Canada, 2010

[a] Units: Carcinogenic COPC (mg/kg/day^{-1}) , NE – Not Evaluated

References

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General Area HHRA Calculations

Exposure Point Concentrations for Cartwright Former USAF Radar Station - General Area

Constituent	CAS-RN	Measured Soil Concentration (mg/kg dw)	Predicted Terrestrial Plant Concentration (mg/kg ww)	Maximum PCB concentration in vegetation (mg/kg ww)	Maximum PCB concentration in berries (mg/kg ww)	Predicted Terrestrial Invertebrate Concentration (mg/kg ww)	Predicted Ruffed Grouse Meat Concentration (mg/kg ww)	Predicted Moose Meat Concentration (mg/kg ww)	Predicted Meat Concentration (mg/kg ww)
PCB									
Total Calculated PCB	1336-36-3	0.025	3.79E-04	0.350	0.025	0.008	9.73E-04	1.78E-02	7.45E-03

Predicted Terrestrial Plant Concentrations

$C_{terrestrial\ plant\ tissue} = C_{soil} \times B_V \times$ dry weight to wet weight conversion (0.15) (CCME, 2006)

Where:

B_V = chemical specific bioconcentration factor

$= 10^{(2.53 - 0.4965*\log Kow)}$

log Bv = 2.53 - 0.4965 log Kow

K_{ow} = octanol water partitioning coefficient (RAIS, 2014)

Total Caculated PCB 1.26E+07

Predicted Terrestrial Invertebrate Concentrations

$C_{terrestrial\ invertebrate\ tissue} = C_{soil} \times UF_{SI} \times$ dry weight to wet weight conversion (0.16) (USEPA, 2007)

$\ln(C_{terrestrial\ invertebrate\ tissue}) = 1.7903 + 1.2909(\ln[C_{soil}]) \times$ dry weight to wet weight conversion (0.16) (Sample et al., 1998)

Predicted Concentration in Ruffed Grouse

$Ba_{chicken}$= Biotransfer factor for chicken (day/kg)

$Ba_{bchicken} = 10^{(logBafat)}*0.14$ (EPA, 2005)

$Ba_{chicken} =$ 0.015578945

Where:

$\log Ba_{fat} = -0.099 (\log K_{ow})^2 + 1.07 \log K_{ow} - 3.56$ (EPA, 2005)

$\log Ba_{fat} =$ -0.954

K_{ow} = octanol water partitioning coefficient

Total Caculated PCB	1.26E+07	PCBs LogKow	7.10E+00	(RAIS, 2014)

C_{grouse}= ((plant feed intake rate × C_{plant}) + (soil intake rate × C_{soil})+(invertebrate intake rate x Cinv)) × $Ba_{chicken}$× Mf (EPA, 2005)

Plant feed intake rate = 0.20907 kg wet weight/day for ruffed grouse x fraction of diet plants (0.85) (FCSAP, 2012)

Soil intake rate = 0.0006624 kg dry weight/day for ruffed grouse (FCSAP, 2012)

Invertebtrate intake rate = 0.20907 kg wet weight/day for ruffed grouse x fraction of diet plants (0.15) (FCSAP, 2012)

C_{plant} = predicted/measured terrestrial plant concentration (mg/kg ww)

C_{inv} = predicted terrestrial invertebrate concentration (mg/kg ww)

Mf = metabolic factor (default value of 1)

Predicted Concentration in Moose

Ba_{beef} = Biotransfer factor for beef (day/kg)

$Ba_{beef} = 10^{(logBafat)*0.19}$ (EPA, 2005)

Ba_{beef} = 0.021142854

Where:

$\log Ba_{fat} = -0.099 (\log K_{ow})^2 + 1.07 \log K_{ow} - 3.56$ (EPA, 2005)

$\log Ba_{fat}$ = -0.954

K_{ow} = octanol water partitioning coefficient

Total Caculated PCB	1.26E+07	PCBs LogKow	7.10E+00	(RAIS, 2014)

C_{moose} = ((plant feed intake rate × C_{plant}) + (soil intake rate × C_{soil})+(invertebrate int (EPA, 2005)

Plant feed intake rate = 8 kg wet weight/day for moose x fraction of diet plants (1) (FCSAP, 2012)
Soil intake rate = 0.0256 kg dry weight/day for moose (FCSAP, 2012)
Invertebtrate intake rate = 8 kg wet weight/day for moose x fraction of diet plants (0) (FCSAP, 2012)
C_{plant} = predicted/measured terrestrial plant concentration (mg/kg ww)
C_{inv} = predicted terrestrial invertebrate concentration (mg/kg ww)
Mf = metabolic factor (default value of 1)

Hazard Quotient for Human Health (Non-carcinogenic Substances) - Toddler at General Area

Site Name: General Area **Receptor:** Toddler
Exposure Scenario: Visitor - Occassional **Dust Levels:** Default

Time on site:	Site-Specific	
Hours per day (inhalation)	6	(ingestion/dermal contact always assumed 24 h/d)
Days per Week	3	
Weeks per Year	25	

Default Scenario? No. User Defined. If User Defined, is it a Chronic Exposure? Not applicable (no amortization)

$$Dose_{Soil} = \frac{Cs \times IR_s \times RAF_{oral} \times D2 \times D3}{BW} = 6.24E-09$$

$$Dose_{Dust} = \frac{Cs \times P_{air} \times IR_A \times RAF_{inh} \times D1 \times D2 \times D3}{BW} = 5.93E-14$$

$$Dose_{Dermal} = \frac{[Cs \times SDR] \times RAF_{Derm} \times D2 \times D3}{BW} = 3.01E-09$$

$$Dose_{gw} = \frac{Cw \times IR_w \times RAF_{oral} \times D2 \times D3}{BW} = 0.00$$

$$Dose_{Berries} = \frac{C_{berries} \times IR_{berries} \times RAF_{oral} \times D_{ing}}{BW \times 365} = 3.64E-06$$

$$Dose_{Meat} = \frac{C_{meat} \times IR_{meat} \times RAF_{oral} \times D_{ing}}{BW \times 365} = 1.64E-05$$

$$HQ_{soil,dust,dermal} = \frac{Dose_{soil,dust,dermal}}{TDI-EDI} = 0.00$$

$$HQ_{gw} = \frac{Dose_{gw}}{TDI-EDI} = 0.00$$

$$HQ_{berries} = \frac{Dose_{berries}}{TDI-EDI} = 0.03$$

$$HQ_{meat} = \frac{Dose_{meat}}{TDI-EDI} = 0.13$$

Value	Definition (units)	Reference
16.5	BW = body weight (kg)	Health Canada (2010) - Toddler
2.5E-02	CS = concentration of contaminant in soil (mg/kg)	Site Specific
	Cw = concentration of contaminant in drinking water (mg/L)	Site Specific
2.50E-02	$C_{berries}$ = concentration of contaminant in berries (mg/kg)	Site Specific
7.45E-03	C_{meat} = concentration of contaminant in meat (mg/kg)	Site Specific
0.25	D1 = hours per day exposed/24 hours [6 hours per day]	Site Specific
0.43	D2 = days per week exposed/7 days [3 day per week]	Site Specific
0.48	D3 = weeks per year exposed/52 weeks [25 weeks per year]	Site Specific
156	$D_{ing-game}$ = days per year ingested	Site Specific
365	$D_{ing-berries}$ = days per year ingested	Site Specific
8.3	IRA = receptor air intake (inhalation) rate (m3/day)	Health Canada (2010) - Toddler
0.00002	IRS = receptor soil ingestion rate (kg/d)	Health Canada (2010) - Toddler
0.6	IRw = receptor water intake rate (L/d)	Health Canada (2010) - Toddler
0.0024	IRberries = Ingestion rate of berries (kg/d)	Wein et. al. (1991)
0.085	IRmeat = Ingestion rate of wild game (kg/d)	Health Canada (2010) - Toddler
7.6E-10	PAir = particulate concentration in air (kg/m3)	Health Canada (2010) - Toddler
0.14	RAFDerm = relative dermal absorption factor (unitless)	Health Canada (2010)
1	RAFInh = relative absorption factor by inhalation (unitless)	Assumed
1	RAFOral = relative absorption factor from the gastrointestinal tract (unitless)	Assumed
430	SAH = surface area of hands exposed for soil loading (cm2)	Health Canada (2010) - Toddler
2580	SAO = surface area exposed other than hands (cm2)	Health Canada (2010) - Toddler
0.1	SLH = soil loading rate to exposed skin of hands (mg/cm2-event)	Health Canada (2010) - Toddler
0.01	SLO = soil loading rate to exposed skin other than hands (mg/cm2-event)	Health Canada (2010) - Toddler
0.0000688	SDR = soil dermal contact rate (kg/day) = (SA hands x M hands) + (SA body x M body) x 1E-6 (kg/mg)	calculated
1.3E-04	TDI = reference dose (mg/kg bw-day)	Health Canada (2010b)
	EDI = estimated daily intake (multimedia exposure assessment) (mg/kg bw-day)	

Site-Specific Target Levels for Human Health (Non-Threshold Substances in Soil) - at General Area

Site Name: General Area
Receptor: Toddler
Dust Levels: Default
Exposure Scenario:

$$SSTL = \frac{TR \times BW \times LE}{ED \times [(AF_{gut} \times SIR \times ET_{ing} \times SF_o) + (AF_{lung} \times IR_{soil} \times ET_{inh} \times SF_i) + (AF_{skin} \times SDR \times ET_{derm} \times SF_o)]} + BSC$$

$$ILCR = \frac{C_s \times [ED \times ((AF_{gut} \times SIR \times ET_{ing} \times SF_o) + (AF_{lung} \times IR_{soil} \times ET_{inh} \times SF_i) + (AF_{skin} \times SDR \times ET_{derm} \times SF_o))]}{BW \times LE}$$

Time on site:	Default	User Defined	
Hours per day (inhalation)	#N/A	6	(ingestion/dermal contact always assumed 24 h/d)
Days per Week	#N/A	3	
Weeks per Year	#N/A	25	
Years Exposed	35	4.5	
Life Expectancy	80	80	

Default Scenario? No

Compound	**SF_o** $(mg/kg\text{-}d)^{-1}$	**SF_i** $(mg/kg\text{-}d)^{-1}$	**BSC** (mg/kg)	**AF_{gut}**	**AF_{lung}**	**AF_{skin}**	**SSTL** (mg/kg)	**Maximum** (mg/kg)	**ILCR** (unitless)
PCBs	2	2	0	1	1	0.14	79	0.025	3.1E-09

Parameter	Definition (units)	Default Value	Reference
SF_o =	oral slope factor [1/(mg/kg bw-day)]	chemical specific	Health Canada (2010) / IRIS 2015b
SF_i =	inhalation slope factor [1/(mg/kg bw-day)]	chemical specific	Health Canada (2010) / IRIS 2015b
C_S =	concentration in soil (mg/kg)	site specific	Calculated Exposure Point Concentration (EPC)
TR =	target risk	1.00E-05	Health Canada (2010)
BSC =	background soil concentration	chemical specific	No background value available
BW =	body weight (kg)	16.5	Health Canada (2010) - Toddler
AF_{gut} =	absorption factor for gut (unitless)	chemical specific	Assumed
AF_{lung} =	absorption factor for lung (unitless)	chemical specific	Assumed
AF_{skin} =	absorption factor skin (unitless)	chemical specific	Health Canada (2010)
SIR =	soil ingestion rate (kg/day)	8.00E-05	Health Canada (2010) - Toddler
IR_{soil} =	soil inhalation rate (kg/day) = CRP (kg/m^3) x IR_{air} (m^3/day)	6.31E-09	Calculated
SDR =	soil dermal contact rate (kg/day) = $(SA_{hands} \times M_{hands}) + (SA_{body} \times M_{body})$ x 1E-6 (kg/mg)	6.88E-05	Calculated
ET_{ing} =	exposure term for soil ingestion pathway (unitless)	0.206	Site Specific [24 Hours per Day, 3 Days per Week, 25 Weeks per Year]
ET_{inh} =	exposure term for soil inhalation pathway (unitless)	0.052	Site Specific [6 Hours per Day, 3 Days per Week, 25 Weeks per Year]
ET_{derm} =	exposure term for soil dermal contact pathway (unitless)	0.206	Site Specific [24 Hours per Day, 3 Days per Week, 25 Weeks per Year]
CRP =	concentration of respirable particles (kg/m^3)	7.60E-10	Health Canada (2010) - Default
IR_{air} =	daily inhalation rate $(m^3$ air-yr/kg bw-day)	8.3	Health Canada (2010) - Toddler
SA_{hands} =	skin surface area - hands $(cm^2$-yr/kg bw-day)	430	Health Canada (2010) - Toddler
SA_{body} =	skin surface area - arms $(cm^2$-yr/kg bw-day)	2580	Health Canada (2010) - Toddler
M_{hands} =	soil to skin adherence factor - hands (mg/cm^2)	0.1	Health Canada (2010) - Toddler
M_{body} =	soil to skin adherence factor - rest of body (mg/cm^2)	0.01	Health Canada (2010) - Toddler

Site-Specific Target Levels for Human Health (Non-Threshold Substances in Soil) - Lifetime at General Area

Site Name: General Area
Receptor: Lifetime
Dust Levels: Default
Exposure Scenario:

$$SSTL = \frac{TR \times LE}{(AF_{gut} \times SIR_{adj} \times ET_{ing} \times SF_o) + (AF_{lung} \times IR_{soil\ adj} \times ET_{inh} \times SF_i) + (AF_{skin} \times SDR_{adj} \times ET_{derm} \times SF_o)} + BSC$$

$$ILCR = \frac{C_s \times [(AF_{gut} \times SIR_{adj} \times ET_{ing} \times SF_o) + (AF_{lung} \times IR_{soil\ adj} \times ET_{inh} \times SF_i) + (AF_{skin} \times SDR_{adj} \times ET_{derm} \times SF_o)]}{LE}$$

Time on site:	Default	User Defined	
Hours per day (inhalation)	#N/A	6	(ingestion/dermal contact always assumed 24 h/d)
Days per Week	#N/A	3	
Weeks per Year	#N/A	25	
Years Exposed	80	80	
Life Expectancy	80	80	

Default Scenario? No. User Defined.

Compound	**SF_o** $(mg/kg\text{-}d)^{-1}$	**SF_i** $(mg/kg\text{-}d)^{-1}$	**BSC** (mg/kg)	**AF_{gut}**	**AF_{lung}**	**AF_{skin}**	**SSTL** (mg/kg)	**Maximum** (mg/kg)	**ILCR** (unitless)
PCBs	2	2	0	1	1	0.14	28	0.025	8.8E-09

Parameter	**Definition (units)**	**Default Value**	**Reference**
SF_o =	oral slope factor [1/(mg/kg bw-day)]	chemical specific	Health Canada (2010) / IRIS 2015b
SF_i =	inhalation slope factor [1/(mg/kg bw-day)]	chemical specific	Health Canada (2010) / IRIS 2015b
C_S =	concentration in soil (mg/kg)	site specific	Maximum concentration
TR =	target risk	1.00E-05	Health Canada (2010)
BSC =	background soil concentration	chemical specific	No background value available
AF_{gut} =	absorption factor for gut (unitless)	chemical specific	Assumed
AF_{lung} =	absorption factor for lung (unitless)	chemical specific	Assumed
AF_{skin} =	absorption factor skin (unitless)	chemical specific	Health Canada (2010)
SIR_{adj} =	soil ingestion rate (kg soil-yr/kg bw-day)	4.69E-05	Health Canada (2010) - Lifetime
$IR_{soil\ adj}$ =	soil inhalation rate (kg soil -yr/kg bw-day) = CRP (kg/m^3) x IR_{air} (m^3 air-yr/kg bw-day)	1.65E-08	Calculated
SDR_{adj} =	soil dermal contact rate (kg soil- yr/kg bw-day) = (SA_{hands} x M_{hands}) + (SA_{body} x M_{body}) x 10^{-6} (kg/mg)	1.54E-04	Calculated
ET_{ing} =	exposure term for soil ingestion pathway (unitless)	0.206	Site Specific [24 Hours per Day, 3 Days per Week, 25 Weeks per Year]
ET_{inh} =	exposure term for soil inhalation pathway (unitless)	0.052	Site Specific [6 Hours per Day, 3 Days per Week, 25 Weeks per Year]
ET_{derm} =	exposure term for soil dermal contact pathway (unitless)	0.206	Site Specific [24 Hours per Day, 3 Days per Week, 25 Weeks per Year]
CRP =	concentration of respirable particles (kg/m^3)	7.60E-10	Health Canada (2010) - Default
$IR_{air\ adj}$ =	daily inhalation rate (m^3 air-yr/kg bw-day)	21.7	Health Canada (2010) - Lifetime
$SA_{hands\ adj}$ =	skin surface area - hands (cm^2-yr/kg bw-day)	1125	Health Canada (2010) - Lifetime
$SA_{body\ adj}$ =	skin surface area - arms (cm^2-yr/kg bw-day)	4181	Health Canada (2010) - Lifetime
M_{hands} =	soil to skin adherence factor - hands (mg/cm^2)	0.1	Health Canada (2010) - Lifetime
M_{body} =	soil to skin adherence factor - rest of body (mg/cm^2)	0.01	Health Canada (2010) - Lifetime

Former Contractor Village HHRA Calculations

Exposure Point Concentrations for Cartwright Former USAF Radar Station - Former Contractor Village

Constituent	CAS-RN	Measured Soil Concentration (mg/kg dw)	Predicted Terrestrial Plant Concentration (mg/kg ww)	Maximum PCB concentration in vegetation (mg/kg ww)	Maximum PCB concentration in berries (mg/kg ww)	Predicted Terrestrial Invertebrate Concentration (mg/kg ww)	Predicted Ruffed Grouse Meat Concentration (mg/kg ww)	Predicted Moose Meat Concentration (mg/kg ww)	Predicted Meat Concentration (mg/kg ww)
PCB									
Total Calculated PCB	1336-36-3	0.025	3.79E-04	0.330	0.025	0.008	9.18E-04	1.67E-02	7.03E-03

Predicted Terrestrial Plant Concentrations

$C_{terrestrial\ plant\ tissue} = C_{soil} \times B_V \times$ dry weight to wet weight conversion (0.15) (CCME, 2006)

Where:

B_V = chemical specific bioconcentration factor

$= 10^{(2.53 - 0.4965*\log Kow)}$

log Bv = 2.53 - 0.4965 log Kow

K_{ow} = octanol water partitioning coefficient (RAIS, 2014)

Total Caculated PCB 1.26E+07

Predicted Terrestrial Invertebrate Concentrations

$C_{terrestrial\ invertebrate\ tissue} = C_{soil} \times UF_{SI} \times$ dry weight to wet weight conversion (0.16) (USEPA, 2007)

$\ln(C_{terrestrial\ invertebrate\ tissue}) = 1.7903 + 1.2909(\ln[C_{soil}])$ x dry weight to wet weight conversion (0.16) (Sample et al., 1998)

Predicted Concentration in Ruffed Grouse

$Ba_{chicken}$= Biotransfer factor for chicken (day/kg)

$Ba_{bchicken} = 10^{(logBafat)}*0.14$ (EPA, 2005)

$Ba_{chicken}$ = 0.015578945

Where:

$\log Ba_{fat} = -0.099 (\log K_{ow})^2 + 1.07 \log K_{ow} -3.56$ (EPA, 2005)

$\log Ba_{fat}$ = -0.954

K_{ow} = octanol water partitioning coefficient

Total Caculated PCB	1.26E+07	PCBs LogKow	7.10E+00	(RAIS, 2014)

C_{grouse}= ((plant feed intake rate × C_{plant}) + (soil intake rate × C_{soil})+(invertebrate intake rate x Cinv)) × $Ba_{chicken}$× Mf (EPA, 2005)

Plant feed intake rate = 0.20907 kg wet weight/day for ruffed grouse x fraction of diet plants (0.85) (FCSAP, 2012)

Soil intake rate = 0.0006624 kg dry weight/day for ruffed grouse (FCSAP, 2012)

Invertebtrate intake rate = 0.20907 kg wet weight/day for ruffed grouse x fraction of diet plants (0.15) (FCSAP, 2012)

C_{plant} = predicted/measured terrestrial plant concentration (mg/kg ww)

C_{inv} = predicted terrestrial invertebrate concentration (mg/kg ww)

Mf = metabolic factor (default value of 1)

Predicted Concentration in Moose

Ba_{beef} = Biotransfer factor for beef (day/kg)

$Ba_{beef} = 10^{(logBafat)*0.19}$ (EPA, 2005)

Ba_{beef} = 0.021142854

Where:

$\log Ba_{fat} = -0.099 (\log K_{ow})^2 + 1.07 \log K_{ow} -3.56$ (EPA, 2005)

$\log Ba_{fat}$ = -0.954

K_{ow} = octanol water partitioning coefficient

Total Caculated PCB	1.26E+07	PCBs LogKow	7.10E+00	(RAIS, 2014)

C_{moose} = ((plant feed intake rate × C_{plant}) + (soil intake rate × C_{soil})+(invertebrate intake rate x Cinv)) × Ba_{beef} × MF (EPA, 2005)

- Plant feed intake rate = 8 kg wet weight/day for moose x fraction of diet plants (1) (FCSAP, 2012)
- Soil intake rate = 0.0256 kg dry weight/day for moose (FCSAP, 2012)
- Invertebtrate intake rate = 8 kg wet weight/day for moose x fraction of diet plants (0) (FCSAP, 2012)
- C_{plant} = predicted/measured terrestrial plant concentration (mg/kg ww)
- C_{inv} = predicted terrestrial invertebrate concentration (mg/kg ww)
- Mf = metabolic factor (default value of 1)

Hazard Quotient for Human Health (Non-carcinogenic Substances) - Toddler at Former Contractor Village

Site Name: Former Contractor Village **Receptor:** Toddler
Exposure Scenario: Visitor - Occassional **Dust Levels:** Default

Time on site:	Site-Specific	
Hours per day (inhalation)	6	(ingestion/dermal contact always assumed 24 h/d)
Days per Week	3	
Weeks per Year	25	

Default Scenario? No. User Defined. If User Defined, is it a Chronic Exposure? Not applicable (no amortization)

$$Dose_{Soil} = \frac{Cs \times IR_s \times RAF_{oral} \times D2 \times D3}{BW} = 6.24E-09$$

$$Dose_{Dust} = \frac{Cs \times P_{air} \times IR_A \times RAF_{Inh} \times D1 \times D2 \times D3}{BW} = 5.93E-14$$

$$Dose_{Dermal} = \frac{[Cs \times SDR] \times RAF_{Derm} \times D2 \times D3}{BW} = 3.01E-09$$

$$Dose_{gw} = \frac{Cw \times IR_w \times RAF_{oral} \times D2 \times D3}{BW} = 0.00$$

$$Dose_{Berries} = \frac{C_{berries} \times IR_{berries} \times RAF_{oral} \times D_{ing}}{BW \times 365} = 0.00E+00$$

$$Dose_{Meat} = \frac{C_{meat} \times IR_{meat} \times RAF_{oral} \times D_{ing}}{BW \times 365} = 1.55E-05$$

$$HQ_{soil,dust,dermal} = \frac{Dose_{soil,dust,dermal}}{TDI-EDI} = 0.00$$

$$HQ_{gw} = \frac{Dose_{gw}}{TDI-EDI} = 0.00$$

$$HQ_{berries} = \frac{Dose_{berries}}{TDI-EDI} = 0.00$$

$$HQ_{meat} = \frac{Dose_{meat}}{TDI-EDI} = 0.12$$

Value	Definition (units)	Reference
16.5	BW = body weight (kg)	Health Canada (2010) - Toddler
2.5E-02	CS = concentration of contaminant in soil (mg/kg)	Site Specific
	Cw = concentration of contaminant in drinking water (mg/L)	Site Specific
	$C_{berries}$ = concentration of contaminant in berries (mg/kg)	Site Specific
7.03E-03	C_{meat} = concentration of contaminant in meat (mg/kg)	Site Specific
0.25	D1 = hours per day exposed/24 hours [6 hours per day]	Site Specific
0.43	D2 = days per week exposed/7 days [3 day per week]	Site Specific
0.48	D3 = weeks per year exposed/52 weeks [25 weeks per year]	Site Specific
156	$D_{ing-game}$ = days per year ingested	Site Specific
365	$D_{ing-berries}$ = days per year ingested	Site Specific
8.3	IRA = receptor air intake (inhalation) rate (m3/day)	Health Canada (2010) - Toddler
0.00002	IRS = receptor soil ingestion rate (kg/d)	Health Canada (2010) - Toddler
0.6	IRw = receptor water intake rate (L/d)	Health Canada (2010) - Toddler
0.0024	IRberries = Ingestion rate of berries (kg/d)	Wein et. al. (1991)
0.085	IRmeat = Ingestion rate of wild game (kg/d)	Health Canada (2010) - Toddler
7.6E-10	PAir = particulate concentration in air (kg/m3)	Health Canada (2010) - Toddler
0.14	RAFDerm = relative dermal absorption factor (unitless)	Health Canada (2010)
1	RAFInh = relative absorption factor by inhalation (unitless)	Assumed
1	RAFOral = relative absorption factor from the gastrointestinal tract (unitless)	Assumed
430	SAH = surface area of hands exposed for soil loading (cm2)	Health Canada (2010) - Toddler
2580	SAO = surface area exposed other than hands (cm2)	Health Canada (2010) - Toddler
0.1	SLH = soil loading rate to exposed skin of hands (mg/cm2-event)	Health Canada (2010) - Toddler
0.01	SLO = soil loading rate to exposed skin other than hands (mg/cm2-event)	Health Canada (2010) - Toddler
0.0000688	SDR = soil dermal contact rate (kg/day) = (SA hands x M hands) + (SA body x M body) x 1E-6 (kg/mg)	calculated
1.3E-04	TDI = reference dose (mg/kg bw-day)	Health Canada (2010b)
	EDI = estimated daily intake (multimedia exposure assessment) (mg/kg bw-day)	

Site-Specific Target Levels for Human Health (Non-Threshold Substances in Soil) - at Former Contractor Village

Site Name: Former Contractor Village
Receptor: Toddler
Dust Levels: Default
Exposure Scenario:

$$SSTL = \frac{TR \times BW \times LE}{ED \times [(AF_{gut} \times SIR \times ET_{ing} \times SF_o) + (AF_{lung} \times IR_{soil} \times ET_{inh} \times SF_i) + (AF_{skin} \times SDR \times ET_{derm} \times SF_o)]} + BSC$$

$$ILCR = \frac{C_s \times [ED \times ((AF_{gut} \times SIR \times ET_{ing} \times SF_o) + (AF_{lung} \times IR_{soil} \times ET_{inh} \times SF_i) + (AF_{skin} \times SDR \times ET_{derm} \times SF_o))]}{BW \times LE}$$

Time on site:	Default	User Defined	
Hours per day (inhalation)	#N/A	6	(ingestion/dermal contact always assumed 24 h/d)
Days per Week	#N/A	3	
Weeks per Year	#N/A	25	
Years Exposed	35	4.5	
Life Expectancy	80	80	

Default Scenario? No

Compound	**SF_o** $(mg/kg\text{-}d)^{-1}$	**SF_i** $(mg/kg\text{-}d)^{-1}$	**BSC** (mg/kg)	**AF_{gut}**	**AF_{lung}**	**AF_{skin}**	**SSTL** (mg/kg)	**Maximum** (mg/kg)	**ILCR** (unitless)
PCBs	2	2	0	1	1	0.14	79	0.025	3.1E-09

Parameter	Definition (units)	Default Value	Reference
SF_o =	oral slope factor [1/(mg/kg bw-day)]	chemical specific	Health Canada (2010) / IRIS 2015b
SF_i =	inhalation slope factor [1/(mg/kg bw-day)]	chemical specific	Health Canada (2010) / IRIS 2015b
C_S =	concentration in soil (mg/kg)	site specific	Calculated Exposure Point Concentration (EPC)
TR =	target risk	1.00E-05	Health Canada (2010)
BSC =	background soil concentration	chemical specific	No background value available
BW =	body weight (kg)	16.5	Health Canada (2010) - Toddler
AF_{gut} =	absorption factor for gut (unitless)	chemical specific	Assumed
AF_{lung} =	absorption factor for lung (unitless)	chemical specific	Assumed
AF_{skin} =	absorption factor skin (unitless)	chemical specific	Health Canada (2010)
SIR =	soil ingestion rate (kg/day)	8.00E-05	Health Canada (2010) - Toddler
IR_{soil} =	soil inhalation rate (kg/day) = CRP (kg/m^3) x IR_{air} (m^3/day)	6.31E-09	Calculated
SDR =	soil dermal contact rate (kg/day) = (SA_{hands} x M_{hands}) + (SA_{body} x M_{body}) x 1E-6 (kg/mg)	6.88E-05	Calculated
ET_{ing} =	exposure term for soil ingestion pathway (unitless)	0.206	Site Specific [24 Hours per Day, 3 Days per Week, 25 Weeks per Year]
ET_{inh} =	exposure term for soil inhalation pathway (unitless)	0.052	Site Specific [6 Hours per Day, 3 Days per Week, 25 Weeks per Year]
ET_{derm} =	exposure term for soil dermal contact pathway (unitless)	0.206	Site Specific [24 Hours per Day, 3 Days per Week, 25 Weeks per Year]
CRP =	concentration of respirable particles (kg/m^3)	7.60E-10	Health Canada (2010) - Default
IR_{air} =	daily inhalation rate (m^3 air-yr/kg bw-day)	8.3	Health Canada (2010) - Toddler
SA_{hands} =	skin surface area - hands (cm^2-yr/kg bw-day)	430	Health Canada (2010) - Toddler
SA_{body} =	skin surface area - arms (cm^2-yr/kg bw-day)	2580	Health Canada (2010) - Toddler
M_{hands} =	soil to skin adherence factor - hands (mg/cm^2)	0.1	Health Canada (2010) - Toddler
M_{body} =	soil to skin adherence factor - rest of body (mg/cm^2)	0.01	Health Canada (2010) - Toddler

Site-Specific Target Levels for Human Health (Non-Threshold Substances in Soil) - Lifetime at Former Contractor Village

Site Name: Former Contractor Village
Receptor: Lifetime
Dust Levels: Default
Exposure Scenario:

$$SSTL = \frac{TR \times LE}{(AF_{gut} \times SIR_{adj} \times ET_{ing} \times SF_o) + (AF_{lung} \times IR_{soil\ adj} \times ET_{inh} \times SF_i) + (AF_{skin} \times SDR_{adj} \times ET_{derm} \times SF_o)} + BSC$$

$$ILCR = \frac{C_s \times [(AF_{gut} \times SIR_{adj} \times ET_{ing} \times SF_o) + (AF_{lung} \times IR_{soil\ adj} \times ET_{inh} \times SF_i) + (AF_{skin} \times SDR_{adj} \times ET_{derm} \times SF_o)]}{LE}$$

Time on site:	Default	User Defined	
Hours per day (inhalation)	#N/A	6	(ingestion/dermal contact always assumed 24 h/d)
Days per Week	#N/A	3	
Weeks per Year	#N/A	25	
Years Exposed	80	80	
Life Expectancy	80	80	

Default Scenario? No. User Defined.

Compound	SF_o (mg/kg-d)$^{-1}$	SF_i (mg/kg-d)$^{-1}$	BSC (mg/kg)	AF_{gut}	AF_{lung}	AF_{skin}	SSTL (mg/kg)	Maximum (mg/kg)	ILCR (unitless)
PCBs	2	2	0	1	1	0.14	28	0.025	8.8E-09

Parameter	Definition (units)	Default Value	Reference
SF_o =	oral slope factor [1/(mg/kg bw-day)]	chemical specific	Health Canada (2010) / IRIS 2015b
SF_i =	inhalation slope factor [1/(mg/kg bw-day)]	chemical specific	Health Canada (2010) / IRIS 2015b
C_S =	concentration in soil (mg/kg)	site specific	Maximum concentration
TR =	target risk	1.00E-05	Health Canada (2010)
BSC =	background soil concentration	chemical specific	No background value available
AF_{gut} =	absorption factor for gut (unitless)	chemical specific	Assumed
AF_{lung} =	absorption factor for lung (unitless)	chemical specific	Assumed
AF_{skin} =	absorption factor skin (unitless)	chemical specific	Health Canada (2010)
SIR_{adj} =	soil ingestion rate (kg soil-yr/kg bw-day)	4.69E-05	Health Canada (2010) - Lifetime
$IR_{soil\ adj}$ =	soil inhalation rate (kg soil -yr/kg bw-day) = CRP (kg/m^3) x IR_{air} (m^3 air-yr/kg bw-day)	1.65E-08	Calculated
SDR_{adj} =	soil dermal contact rate (kg soil- yr/kg bw-day) = (SA_{hands} x M_{hands}) + (SA_{body} x M_{body}) x 10^{-6} (kg/mg)	1.54E-04	Calculated
ET_{ing} =	exposure term for soil ingestion pathway (unitless)	0.206	Site Specific [24 Hours per Day, 3 Days per Week, 25 Weeks per Year]
ET_{inh} =	exposure term for soil inhalation pathway (unitless)	0.052	Site Specific [6 Hours per Day, 3 Days per Week, 25 Weeks per Year]
ET_{derm} =	exposure term for soil dermal contact pathway (unitless)	0.206	Site Specific [24 Hours per Day, 3 Days per Week, 25 Weeks per Year]
CRP =	concentration of respirable particles (kg/m^3)	7.60E-10	Health Canada (2010) - Default
$IR_{air\ adj}$ =	daily inhalation rate (m^3 air-yr/kg bw-day)	21.7	Health Canada (2010) - Lifetime
$SA_{hands\ adj}$ =	skin surface area - hands (cm^2-yr/kg bw-day)	1125	Health Canada (2010) - Lifetime
$SA_{body\ adj}$ =	skin surface area - arms (cm^2-yr/kg bw-day)	4181	Health Canada (2010) - Lifetime
M_{hands} =	soil to skin adherence factor - hands (mg/cm^2)	0.1	Health Canada (2010) - Lifetime
M_{body} =	soil to skin adherence factor - rest of body (mg/cm^2)	0.01	Health Canada (2010) - Lifetime

Main Complex HHRA Calculations

Exposure Point Concentrations for Cartwright Former USAF Radar Station - Main Complex

Constituent	CAS-RN	Measured Soil Concentration (mg/kg dw)	Predicted Terrestrial Plant Concentration (mg/kg ww)	Maximum PCB concentration in vegetation (mg/kg ww)	Maximum PCB concentration in berries (mg/kg ww)	Predicted Terrestrial Invertebrate Concentration (mg/kg ww)	Predicted Ruffed Grouse Meat Concentration (mg/kg ww)	Predicted Moose Meat Concentration (mg/kg ww)	Predicted Meat Concentration (mg/kg ww)
PCB									
Total Calculated PCB	1336-36-3	0.670	1.02E-02	0.510	0.025	0.572	1.70E-03	2.59E-02	1.10E-02

Predicted Terrestrial Plant Concentrations

$C_{terrestrial\ plant\ tissue} = C_{soil} \times B_V \times$ dry weight to wet weight conversion (0.15) (CCME, 2006)

Where:

B_V = chemical specific bioconcentration factor

$= 10^{(2.53 - 0.4965*\log Kow)}$

log Bv = 2.53 - 0.4965 log Kow

(RAIS, 2014)

K_{ow} = octanol water partitioning coefficient

Total Caculated PCB 1.26E+07

Predicted Terrestrial Invertebrate Concentrations

$C_{terrestrial\ invertebrate\ tissue} = C_{soil} \times UF_{SI} \times$ dry weight to wet weight conversion (0.16) (USEPA, 2007)

$\ln(C_{terrestrial\ invertebrate\ tissue}) = 1.7903 + 1.2909(\ln[C_{soil}]) \times$ dry weight to wet weight conversion (0.16) (Sample et al., 1998)

Predicted Concentration in Ruffed Grouse

$Ba_{chicken}$= Biotransfer factor for chicken (day/kg)

$Ba_{bchicken} = 10^{(logBafat)}*0.14$ (EPA, 2005)

$Ba_{chicken}$ = 0.015578945

Where:

log $Ba_{fat} = -0.099 (\log K_{ow})^2 + 1.07 \log K_{ow} -3.56$ (EPA, 2005)

log Ba_{fat} = -0.954

K_{ow} = octanol water partitioning coefficient

Total Caculated PCB	1.26E+07	PCBs LogKow	7.10E+00	(RAIS, 2014)

C_{grouse}= ((plant feed intake rate × C_{plant}) + (soil intake rate × C_{soil})+(invertebrate intake rate x Cinv)) × $Ba_{chicken}$× Mf (EPA, 2005)

Plant feed intake rate = 0.20907 kg wet weight/day for ruffed grouse x fraction of diet plants (0.85) (FCSAP, 2012)
Soil intake rate = 0.0006624 kg dry weight/day for ruffed grouse (FCSAP, 2012)
Invertebtrate intake rate = 0.20907 kg wet weight/day for ruffed grouse x fraction of diet plants (0.15) (FCSAP, 2012)
C_{plant} = predicted/measured terrestrial plant concentration (mg/kg ww)
C_{inv} = predicted terrestrial invertebrate concentration (mg/kg ww)
Mf = metabolic factor (default value of 1)

Predicted Concentration in Moose

Ba_{beef} = Biotransfer factor for beef (day/kg)

$Ba_{beef} = 10^{(logBafat)}*0.19$ (EPA, 2005)

Ba_{beef} = 0.021142854

Where:

$\log Ba_{fat} = -0.099 (\log K_{ow})^2 + 1.07 \log K_{ow} - 3.56$ (EPA, 2005)

$\log Ba_{fat}$ = -0.954

K_{ow} = octanol water partitioning coefficient

Total Caculated PCB	1.26E+07	PCBs LogKow	7.10E+00	(RAIS, 2014)

C_{moose} = ((plant feed intake rate × C_{plant}) + (soil intake rate × C_{soil})+(invertebrate intake rate x Cinv)) × Ba_{beef} × MF (EPA, 2005)

Plant feed intake rate = 8 kg wet weight/day for moose x fraction of diet plants (1) (FCSAP, 2012)

Soil intake rate = 0.0256 kg dry weight/day for moose (FCSAP, 2012)

Invertebtrate intake rate = 8 kg wet weight/day for moose x fraction of diet plants (0) (FCSAP, 2012)

C_{plant} = predicted/measured terrestrial plant concentration (mg/kg ww)

C_{inv} = predicted terrestrial invertebrate concentration (mg/kg ww)

Mf = metabolic factor (default value of 1)

Hazard Quotient for Human Health (Non-carcinogenic Substances) - Toddler at Main Complex

Site Name: Main Complex **Receptor:** Toddler
Exposure Scenario: Visitor - Occassional **Dust Levels:** Default

Time on site:	Site-Specific	
Hours per day (inhalation)	6	(ingestion/dermal contact always assumed 24 h/d)
Days per Week	3	
Weeks per Year	25	

Default Scenario? No. User Defined. If User Defined, is it a Chronic Exposure? Not applicable (no amortization)

$$Dose_{Soil} = \frac{Cs \times IR_s \times RAF_{oral} \times D2 \times D3}{BW} = 1.67E-07$$

$$Dose_{Dust} = \frac{Cs \times P_{air} \times IR_A \times RAF_{Inh} \times D1 \times D2 \times D3}{BW} = 1.59E-12$$

$$Dose_{Dermal} = \frac{[Cs \times SDR] \times RAF_{Derm} \times D2 \times D3}{BW} = 8.06E-08$$

$$Dose_{gw} = \frac{Cw \times IR_w \times RAF_{oral} \times D2 \times D3}{BW} = 0.00$$

$$Dose_{Berries} = \frac{C_{berries} \times IR_{berries} \times RAF_{oral} \times D_{ing}}{BW \times 365} = 3.64E-06$$

$$Dose_{Meat} = \frac{C_{meat} \times IR_{meat} \times RAF_{oral} \times D_{ing}}{BW \times 365} = 2.42E-05$$

$$HQ_{soil,dust,dermal} = \frac{Dose_{soil,dust,dermal}}{TDI-EDI} = 1.9E-03$$

$$HQ_{gw} = \frac{Dose_{gw}}{TDI-EDI} = 0.00$$

$$HQ_{berries} = \frac{Dose_{berries}}{TDI-EDI} = 0.03$$

$$HQ_{meat} = \frac{Dose_{meat}}{TDI-EDI} = 0.19$$

Value	Definition (units)	Reference
16.5	BW = body weight (kg)	Health Canada (2010) - Toddler
6.7E-01	CS = concentration of contaminant in soil (mg/kg)	Site Specific
	Cw = concentration of contaminant in drinking water (mg/L)	Site Specific
2.50E-02	$C_{berries}$ = concentration of contaminant in berries (mg/kg)	Site Specific
1.10E-02	C_{meat} = concentration of contaminant in meat (mg/kg)	Site Specific
0.25	D1 = hours per day exposed/24 hours [6 hours per day]	Site Specific
0.43	D2 = days per week exposed/7 days [3 day per week]	Site Specific
0.48	D3 = weeks per year exposed/52 weeks [25 weeks per year]	Site Specific
156	$D_{ing-game}$ = days per year ingested	Site Specific
365	$D_{ing-berries}$ = days per year ingested	Site Specific
8.3	IRA = receptor air intake (inhalation) rate (m3/day)	Health Canada (2010) - Toddler
0.00002	IRS = receptor soil ingestion rate (kg/d)	Health Canada (2010) - Toddler
0.6	IRw = receptor water intake rate (L/d)	Health Canada (2010) - Toddler
0.0024	IRberries = Ingestion rate of berries (kg/d)	Wein et. al. (1991)
0.085	IRmeat = Ingestion rate of wild game (kg/d)	Health Canada (2010) - Toddler
7.6E-10	PAir = particulate concentration in air (kg/m3)	Health Canada (2010) - Toddler
0.14	RAFDerm = relative dermal absorption factor (unitless)	Health Canada (2010)
1	RAFInh = relative absorption factor by inhalation (unitless)	Assumed
1	RAFOral = relative absorption factor from the gastrointestinal tract (unitless)	Assumed
430	SAH = surface area of hands exposed for soil loading (cm2)	Health Canada (2010) - Toddler
2580	SAO = surface area exposed other than hands (cm2)	Health Canada (2010) - Toddler
0.1	SLH = soil loading rate to exposed skin of hands (mg/cm2-event)	Health Canada (2010) - Toddler
0.01	SLO = soil loading rate to exposed skin other than hands (mg/cm2-event)	Health Canada (2010) - Toddler
0.0000688	SDR = soil dermal contact rate (kg/day) = (SA hands x M hands) + (SA body x M body) x 1E-6 (kg/mg)	calculated
1.3E-04	TDI = reference dose (mg/kg bw-day)	Health Canada (2010b)
	EDI = estimated daily intake (multimedia exposure assessment) (mg/kg bw-day)	

Site Specific Target Levels for Human Health (Non-carcinogenic Substances in Soil) - Toddler at Main Complex

Site Name: Main Complex **Receptor:** Toddler **Dust Levels:** Default
Exposure Scenario: Visitor - Occassional

$$SSTL = \frac{(TDI - EDI) \times THQ \times BW}{(AF_{gut} \times SIR \times ET_{ing}) + (AF_{lung} \times IR_{soil} \times ET_{inh}) + (AF_{skin} \times SDR \times ET_{derm})} + BSC$$

$$HQ = \frac{Cs \times [(AF_{gut} \times SIR \times ET_{ing}) + (AF_{lung} \times IR_{soil} \times ET_{inh}) + (AF_{skin} \times SDR \times ET_{derm})]}{(TDI - EDI) \times BW}$$

Time on site:	Default	Site-Specific	
Hours per day (inhalation)		6	(ingestion/dermal contact always assumed 24 h/d)
Days per Week		3	
Weeks per Year		25	

Default Scenario? No. User Defined. If User Defined, is it a Chronic Exposure? Not applicable (no amortization)

Compound	TDI (oral)	EDI	THQ	BSC	AF_{gut}	AF_{lung}	AF_{skin}	SSTL (mg/kg)	Comments
PCBs	**1.3E-04**		1		1	1	**0.14**	56	No EDI. Assuming 0.2 THQ. Developmental Toxicant. No Amortization.

Parameter	Definition (units)	Default Value	Reference
TDI =	reference dose (mg/kg bw-day)	chemical specific	AMEC et al (2015)
EDI =	estimated daily intake (multimedia exposure assessment) (mg/kg bw-day)	chemical specific	
C_S =	concentration in soil (mg/kg)	site specific	Calculated Exposure Point Concentration (EPC)
THQ =	target hazard quotient (unitless)	chemical specific	Assumed 1, except for when an EDI is not available or EDI>TDI then assumed 0.2.
BW =	body weight (kg)	16.5	Health Canada (2010) - Toddler
BSC =	background soil concentration (mg/kg)	chemical specific	
AF_{gut} =	absorption factor for gut (unitless)	chemical specific	Assumed 1, except for chemical specific data.
AF_{lung} =	absorption factor for lung (unitless)	chemical specific	Assumed 1.
AF_{skin} =	absorption factor skin (unitless)	chemical specific	italics = Health Canada; underline = IRIS; bold = OMOE
SIR =	soil ingestion rate (kg/day)	0.00008	Health Canada (2010) - Toddler
IR_{soil} =	soil inhalation rate (kg/day) = CRP (kg/m^3) x IR_{air} (m^3/day)	6.3E-09	Calculated
SDR =	soil dermal contact rate (kg/day) = (SA_{hands} x M_{hands}) + (SA_{body} x M_{body}) x 1E-6 (kg/mg)	0.0000688	Calculated
ET_{ing} =	exposure term for soil ingestion pathway (unitless)	0.2060	Site Specific [24 Hours per Day, 3 Days per Week, 25 Weeks per Year]
ET_{inh} =	exposure term for soil inhalation pathway (unitless)	0.0515	Site Specific [6 Hours per Day, 3 Days per Week, 25 Weeks per Year]
ET_{derm} =	exposure term for soil dermal contact pathway (unitless)	0.2060	Site Specific [24 Hours per Day, 3 Days per Week, 25 Weeks per Year]
ET_{ing} =	exposure term for soil ingestion pathway (unitless) - developmental toxicant	0.4286	Site Specific [24 Hours per Day, 3 Days per Week]
ET_{inh} =	exposure term for soil inhalation pathway (unitless) - developmental toxicant	0.1071	Site Specific [6 Hours per Day, 3 Days per Week]
ET_{derm} =	exposure term for soil dermal contact pathway (unitless) - developmental toxicant	0.4286	Site Specific [24 Hours per Day, 3 Days per Week]
CRP =	concentration of respirable particles (kg/m^3)	7.60E-10	Health Canada (2010) - Default
IR_{air} =	daily inhalation rate (m^3/day)	8.3	Health Canada (2010) - Toddler
SA_{hands} =	skin surface area - hands (cm^2/day)	430	Health Canada (2010) - Toddler
SA_{body} =	skin surface area - rest of body (cm^2/day)	2580	Health Canada (2010) - Toddler - arms and legs
M_{hands} =	soil to skin adherence factor - hands (mg/cm^2)	0.1	Health Canada (2010) - Toddler
M_{body} =	soil to skin adherence factor - rest of body (mg/cm^2)	0.01	Health Canada (2010) - Toddler

Site-Specific Target Levels for Human Health (Non-Threshold Substances in Soil) - at Main Complex

Site Name: Main Complex
Receptor: Toddler
Dust Levels: Default
Exposure Scenario:

$$SSTL = \frac{TR \times BW \times LE}{ED \times [(AF_{gut} \times SIR \times ET_{ing} \times SF_o) + (AF_{lung} \times IR_{soil} \times ET_{inh} \times SF_i) + (AF_{skin} \times SDR \times ET_{derm} \times SF_o)]} + BSC$$

$$ILCR = \frac{C_s \times [ED \times ((AF_{gut} \times SIR \times ET_{ing} \times SF_o) + (AF_{lung} \times IR_{soil} \times ET_{inh} \times SF_i) + (AF_{skin} \times SDR \times ET_{derm} \times SF_o))]}{BW \times LE}$$

Time on site:	Default	User Defined	
Hours per day (inhalation)	#N/A	6	(ingestion/dermal contact always assumed 24 h/d)
Days per Week	#N/A	3	
Weeks per Year	#N/A	25	
Years Exposed	35	4.5	
Life Expectancy	80	80	

Default Scenario? No

Compound	SF_o (mg/kg-d)$^{-1}$	SF_i (mg/kg-d)$^{-1}$	BSC (mg/kg)	AF_{gut}	AF_{lung}	AF_{skin}	SSTL (mg/kg)	Maximum (mg/kg)	ILCR (unitless)
BaP	2	0.13	0	1	1	0.148	69	10.41	1.5E-06
PCBs	2	2	0	1	1	0.14	79	2.00	2.5E-07

Parameter	Definition (units)	Default Value	Reference
SF_o =	oral slope factor [1/(mg/kg bw-day)]	chemical specific	Health Canada (2010) / IRIS 2015b
SF_i =	inhalation slope factor [1/(mg/kg bw-day)]	chemical specific	Health Canada (2010) / IRIS 2015b
C_S =	concentration in soil (mg/kg)	site specific	Calculated Exposure Point Concentration (EPC)
TR =	target risk	1.00E-05	Health Canada (2010)
BSC =	background soil concentration	chemical specific	No background value available
BW =	body weight (kg)	16.5	Health Canada (2010) - Toddler
AF_{gut} =	absorption factor for gut (unitless)	chemical specific	Assumed
AF_{lung} =	absorption factor for lung (unitless)	chemical specific	Assumed
AF_{skin} =	absorption factor skin (unitless)	chemical specific	Health Canada (2010)
SIR =	soil ingestion rate (kg/day)	8.00E-05	Health Canada (2010) - Toddler
IR_{soil} =	soil inhalation rate (kg/day) = CRP (kg/m^3) x IR_{air} (m^3/day)	6.31E-09	Calculated
SDR =	soil dermal contact rate (kg/day) = (SA_{hands} x M_{hands}) + (SA_{body} x M_{body}) x 1E-6 (kg/mg)	6.88E-05	Calculated
ET_{ing} =	exposure term for soil ingestion pathway (unitless)	0.206	Site Specific [24 Hours per Day, 3 Days per Week, 25 Weeks per Year]
ET_{inh} =	exposure term for soil inhalation pathway (unitless)	0.052	Site Specific [6 Hours per Day, 3 Days per Week, 25 Weeks per Year]
ET_{derm} =	exposure term for soil dermal contact pathway (unitless)	0.206	Site Specific [24 Hours per Day, 3 Days per Week, 25 Weeks per Year]
CRP =	concentration of respirable particles (kg/m^3)	7.60E-10	Health Canada (2010) - Default
IR_{air} =	daily inhalation rate (m^3 air-yr/kg bw-day)	8.3	Health Canada (2010) - Toddler
SA_{hands} =	skin surface area - hands (cm^2-yr/kg bw-day)	430	Health Canada (2010) - Toddler
SA_{body} =	skin surface area - arms (cm^2-yr/kg bw-day)	2580	Health Canada (2010) - Toddler
M_{hands} =	soil to skin adherence factor - hands (mg/cm^2)	0.1	Health Canada (2010) - Toddler
M_{body} =	soil to skin adherence factor - rest of body (mg/cm^2)	0.01	Health Canada (2010) - Toddler

Site-Specific Target Levels for Human Health (Non-Threshold Substances in Soil) - Lifetime at Main Complex

Site Name: Main Complex
Receptor: Lifetime
Dust Levels: Default
Exposure Scenario:

$$SSTL = \frac{TR \times LE}{(AF_{gut} \times SIR_{adj} \times ET_{ing} \times SF_o) + (AF_{lung} \times IR_{soil\ adj} \times ET_{inh} \times SF_i) + (AF_{skin} \times SDR_{adj} \times ET_{derm} \times SF_o)} + BSC$$

$$ILCR = \frac{C_s \times [(AF_{gut} \times SIR_{adj} \times ET_{ing} \times SF_o) + (AF_{lung} \times IR_{soil\ adj} \times ET_{inh} \times SF_i) + (AF_{skin} \times SDR_{adj} \times ET_{derm} \times SF_o)]}{LE}$$

Time on site:	Default	User Defined	
Hours per day (inhalation)	#N/A	6	(ingestion/dermal contact always assumed 24 h/d)
Days per Week	#N/A	3	
Weeks per Year	#N/A	25	
Years Exposed	80	80	
Life Expectancy	80	80	

Default Scenario? No. User Defined.

Compound	**SF_o** (mg/kg-d)$^{-1}$	**SF_i** (mg/kg-d)$^{-1}$	**BSC** (mg/kg)	**AF_{gut}**	**AF_{lung}**	**AF_{skin}**	**SSTL** (mg/kg)	**Maximum** (mg/kg)	**ILCR** (unitless)
BaP	2	0.13	0	1	1	0.148	24	10.41	4.3E-06
PCBs	2	2	0	1	1	0.14	28	2.00	7.1E-07

Parameter	**Definition (units)**	**Default Value**	**Reference**
SF_o =	oral slope factor [1/(mg/kg bw-day)]	chemical specific	Health Canada (2010) / IRIS 2015b
SF_i =	inhalation slope factor [1/(mg/kg bw-day)]	chemical specific	Health Canada (2010) / IRIS 2015b
C_S =	concentration in soil (mg/kg)	site specific	Maximum concentration
TR =	target risk	1.00E-05	Health Canada (2010)
BSC =	background soil concentration	chemical specific	No background value available
AF_{gut} =	absorption factor for gut (unitless)	chemical specific	Assumed
AF_{lung} =	absorption factor for lung (unitless)	chemical specific	Assumed
AF_{skin} =	absorption factor skin (unitless)	chemical specific	Health Canada (2010)
SIR_{adj} =	soil ingestion rate (kg soil-yr/kg bw-day)	4.69E-05	Health Canada (2010) - Lifetime
$IR_{soil\ adj}$ =	soil inhalation rate (kg soil -yr/kg bw-day) = CRP (kg/m^3) x IR_{air} (m^3 air-yr/kg bw-day)	1.65E-08	Calculated
SDR_{adj} =	soil dermal contact rate (kg soil- yr/kg bw-day) = (SA_{hands} x M_{hands}) + (SA_{body} x M_{body}) x 10^{-6} (kg/mg)	1.54E-04	Calculated
ET_{ing} =	exposure term for soil ingestion pathway (unitless)	0.206	Site Specific [24 Hours per Day, 3 Days per Week, 25 Weeks per Year]
ET_{inh} =	exposure term for soil inhalation pathway (unitless)	0.052	Site Specific [6 Hours per Day, 3 Days per Week, 25 Weeks per Year]
ET_{derm} =	exposure term for soil dermal contact pathway (unitless)	0.206	Site Specific [24 Hours per Day, 3 Days per Week, 25 Weeks per Year]
CRP =	concentration of respirable particles (kg/m^3)	7.60E-10	Health Canada (2010) - Default
$IR_{air\ adj}$ =	daily inhalation rate (m^3 air-yr/kg bw-day)	21.7	Health Canada (2010) - Lifetime
$SA_{hands\ adj}$ =	skin surface area - hands (cm^2-yr/kg bw-day)	1125	Health Canada (2010) - Lifetime
$SA_{body\ adj}$ =	skin surface area - arms (cm^2-yr/kg bw-day)	4181	Health Canada (2010) - Lifetime
M_{hands} =	soil to skin adherence factor - hands (mg/cm^2)	0.1	Health Canada (2010) - Lifetime
M_{body} =	soil to skin adherence factor - rest of body (mg/cm^2)	0.01	Health Canada (2010) - Lifetime

Former USAF Dump Area and Former Ammunition Storage Area
HHRA Calculations

Exposure Point Concentrations for Cartwright Former USAF Radar Station - Former USAF Dump Area and Former Ammunition Storage Area

Constituent	CAS-RN	Measured Soil Concentration (mg/kg dw)	Predicted Terrestrial Plant Concentration (mg/kg ww)	Maximum PCB concentration in vegetation (mg/kg ww)	Maximum PCB concentration in berries (mg/kg ww)	Predicted Terrestrial Invertebrate Concentration (mg/kg ww)	Predicted Ruffed Grouse Meat Concentration (mg/kg ww)	Predicted Moose Meat Concentration (mg/kg ww)	Predicted Meat Concentration (mg/kg ww)
PCB									
Total Calculated PCB	1336-36-3	8.600	1.30E-01	0.200	-	15.416	8.17E-03	1.01E-02	7.00E-03

Predicted Terrestrial Plant Concentrations

$C_{terrestrial\ plant\ tissue} = C_{soil} \times B_V \times$ dry weight to wet weight conversion (0.15) (CCME, 2006)

Where:

B_V = chemical specific bioconcentration factor

$= 10^{(2.53\ -\ 0.4965*\log Kow)}$

log Bv = 2.53 - 0.4965 log Kow

K_{ow} = octanol water partitioning coefficient (RAIS, 2014)

Total Caculated PCB 1.26E+07

Predicted Terrestrial Invertebrate Concentrations

$C_{terrestrial\ invertebrate\ tissue} = C_{soil} \times UF_{SI} \times$ dry weight to wet weight conversion (0.16) (USEPA, 2007)

$\ln(C_{terrestrial\ invertebrate\ tissue}) = 1.7903 + 1.2909(\ln[C_{soil}]) \times$ dry weight to wet weight conversion (0.16) (Sample et al., 1998)

Predicted Concentration in Ruffed Grouse

$Ba_{chicken}$= Biotransfer factor for chicken (day/kg)

$Ba_{bchicken} = 10^{(logBafat)}*0.14$ (EPA, 2005)

$Ba_{chicken}$ = 0.015578945

Where:

log Ba_{fat} = -0.099 (log K_{ow})^2 + 1.07 log K_{ow} -3.56 (EPA, 2005)

log Ba_{fat} = -0.954

K_{ow} = octanol water partitioning coefficient

Total Caculated PCB	1.26E+07	PCBs LogKow	7.10E+00	RAIS, 2014

C_{grouse}= ((plant feed intake rate × C_{plant}) + (soil intake rate × C_{soil})+(invertebrate intake rate x Cinv)) × $Ba_{chicken}$× Mf (EPA, 2005)

Plant feed intake rate = 0.20907 kg wet weight/day for ruffed grouse x fraction of diet plants (0.85) (FCSAP, 2012)
Soil intake rate = 0.0006624 kg dry weight/day for ruffed grouse (FCSAP, 2012)
Invertebtrate intake rate = 0.20907 kg wet weight/day for ruffed grouse x fraction of diet plants (0.15) (FCSAP, 2012)
C_{plant} = predicted/measured terrestrial plant concentration (mg/kg ww)
C_{inv} = predicted terrestrial invertebrate concentration (mg/kg ww)
Mf = metabolic factor (default value of 1)

Predicted Concentration in Moose

Ba_{beef} = Biotransfer factor for beef (day/kg)

$Ba_{beef} = 10^{(logBafat)*0.19}$ (EPA, 2005)

Ba_{beef} = 0.021142854

Where:

log Ba_{fat} = -0.099 (log K_{ow})^2 + 1.07 log K_{ow} -3.56 (EPA, 2005)

log Ba_{fat} = -0.954

K_{ow} = octanol water partitioning coefficient

Total Caculated PCB	1.26E+07	PCBs LogKow	7.10E+00	(RAIS, 2014)

C_{moose} = ((plant feed intake rate × C_{plant}) + (soil intake rate × C_{soil})+(invertebrate intake rate x Cinv)) × Ba_{beef} × MF (EPA, 2005)

Plant feed intake rate = 8 kg wet weight/day for moose x fraction of diet plants (1) (FCSAP, 2012)
Soil intake rate = 0.0256 kg dry weight/day for moose (FCSAP, 2012)
Invertebtrate intake rate = 8 kg wet weight/day for moose x fraction of diet plants (0) (FCSAP, 2012)
C_{plant} = predicted/measured terrestrial plant concentration (mg/kg ww)
C_{inv} = predicted terrestrial invertebrate concentration (mg/kg ww)
Mf = metabolic factor (default value of 1)

Hazard Quotient for Human Health (Non-carcinogenic Substances) - Toddler at Former USAF Dump Area and Former Ammunition Storage Area

Site Name: Former USAF Dump Area and Former Ammunition Storage Area **Receptor:** Toddler
Exposure Scenario: Visitor - Occassional **Dust Levels:** Default

Time on site:	Site-Specific	
Hours per day (inhalation)	6	(ingestion/dermal contact always assumed 24 h/d)
Days per Week	3	
Weeks per Year	25	

Default Scenario? No. User Defined. If User Defined, is it a Chronic Exposure? Not applicable (no amortization)

$$Dose_{Soil} = \frac{Cs \times IR_s \times RAF_{oral} \times D2 \times D3}{BW} = 2.15E-06$$

$$Dose_{Dust} = \frac{Cs \times P_{air} \times IR_A \times RAF_{Inh} \times D1 \times D2 \times D3}{BW} = 2.04E-11$$

$$Dose_{Dermal} = \frac{[Cs \times SDR] \times RAF_{Derm} \times D2 \times D3}{BW} = 1.03E-06$$

$$Dose_{gw} = \frac{Cw \times IR_w \times RAF_{oral} \times D2 \times D3}{BW} = 0.00$$

$$Dose_{Berries} = \frac{C_{berries} \times IR_{berries} \times RAF_{oral} \times D_{ing}}{BW \times 365} = 0.00$$

$$Dose_{Meat} = \frac{C_{meat} \times IR_{meat} \times RAF_{oral} \times D_{ing}}{BW \times 365} = 1.54E-05$$

$$HQ_{soil,dust,dermal} = \frac{Dose_{soil,dust,dermal}}{TDI-EDI} = 0.02$$

$$HQ_{gw} = \frac{Dose_{gw}}{TDI-EDI} = 0.00$$

$$HQ_{berries} = \frac{Dose_{berries}}{TDI-EDI} = 0.00$$

$$HQ_{meat} = \frac{Dose_{meat}}{TDI-EDI} = 0.12$$

Value	Definition (units)	Reference
16.5	BW = body weight (kg)	Health Canada (2010) - Toddler
8.6E+00	CS = concentration of contaminant in soil (mg/kg)	Site Specific
	Cw = concentration of contaminant in drinking water (mg/L)	Site Specific
	$C_{berries}$ = concentration of contaminant in berries (mg/kg)	Site Specific
7.00E-03	C_{meat} = concentration of contaminant in meat (mg/kg)	Site Specific
0.25	D1 = hours per day exposed/24 hours [6 hours per day]	Site Specific
0.43	D2 = days per week exposed/7 days [3 day per week]	Site Specific
0.48	D3 = weeks per year exposed/52 weeks [25 weeks per year]	Site Specific
156	$D_{ing-game}$ = days per year ingested	Site Specific
365	$D_{ing-berries}$ = days per year ingested	Site Specific
8.3	IRA = receptor air intake (inhalation) rate (m3/day)	Health Canada (2010) - Toddler
0.00002	IRS = receptor soil ingestion rate (kg/d)	Health Canada (2010) - Toddler
0.6	IRw = receptor water intake rate (L/d)	Health Canada (2010) - Toddler
0.0024	IRberries = Ingestion rate of berries (kg/d)	Wein et. al. (1991)
0.085	IRmeat = Ingestion rate of wild game (kg/d)	Health Canada (2010) - Toddler
7.6E-10	PAir = particulate concentration in air (kg/m3)	Health Canada (2010) - Toddler
0.14	RAFDerm = relative dermal absorption factor (unitless)	Health Canada (2010)
1	RAFInh = relative absorption factor by inhalation (unitless)	Assumed
1	RAFOral = relative absorption factor from the gastrointestinal tract (unitless)	Assumed
430	SAH = surface area of hands exposed for soil loading (cm2)	Health Canada (2010) - Toddler
2580	SAO = surface area exposed other than hands (cm2)	Health Canada (2010) - Toddler
0.1	SLH = soil loading rate to exposed skin of hands (mg/cm2-event)	Health Canada (2010) - Toddler
0.01	SLO = soil loading rate to exposed skin other than hands (mg/cm2-event)	Health Canada (2010) - Toddler
0.0000688	SDR = soil dermal contact rate (kg/day) = (SA hands x M hands) + (SA body x M body) x 1E-6 (kg/mg)	calculated
1.3E-04	TDI = reference dose (mg/kg bw-day)	Health Canada (2010b)
	EDI = estimated daily intake (multimedia exposure assessment) (mg/kg bw-day)	

Site Specific Target Levels for Human Health (Non-carcinogenic Substances in Soil) - Toddler at Former USAF Dump Area and Former Ammunition Storage Area

Site Name: Former USAF Dump Area and Former Am **Receptor:** Toddler **Dust Levels:** Default
Exposure Scenario: Visitor - Occassional

$$SSTL = \frac{(TDI - EDI) \times THQ \times BW}{(AF_{gut} \times SIR \times ET_{ing}) + (AF_{lung} \times IR_{soil} \times ET_{inh}) + (AF_{skin} \times SDR \times ET_{derm})} + BSC$$

$$HQ = \frac{Cs \times [(AF_{gut} \times SIR \times ET_{ing}) + (AF_{lung} \times IR_{soil} \times ET_{inh}) + (AF_{skin} \times SDR \times ET_{derm})]}{(TDI - EDI) \times BW}$$

Time on site:	Default	Site-Specific	
Hours per day (inhalation)		6	(ingestion/dermal contact always assumed 24 h/d)
Days per Week		3	
Weeks per Year		25	

Default Scenario? No. User Defined. If User Defined, is it a Chronic Exposure? Not applicable (no amortization)

Compound	TDI (oral)	EDI	THQ	BSC	AF_{gut}	AF_{lung}	AF_{skin}	SSTL (mg/kg)	Comments
PCBs	**1.3E-04**		1		1	1	**0.14**	56	No EDI. Assuming 0.2 THQ. Developmental Toxicant. No Amortization.

Parameter	Definition (units)	Default Value	Reference
TDI =	reference dose (mg/kg bw-day)	chemical specific	AMEC et al (2015)
EDI =	estimated daily intake (multimedia exposure assessment) (mg/kg bw-day)	chemical specific	
C_S =	concentration in soil (mg/kg)	site specific	Calculated Exposure Point Concentration (EPC)
THQ =	target hazard quotient (unitless)	chemical specific	Assumed 1, except for when an EDI is not available or EDI>TDI then assumed 0.2.
BW =	body weight (kg)	16.5	Health Canada (2010) - Toddler
BSC =	background soil concentration (mg/kg)	chemical specific	
AF_{gut} =	absorption factor for gut (unitless)	chemical specific	Assumed 1, except for chemical specific data.
AF_{lung} =	absorption factor for lung (unitless)	chemical specific	Assumed 1.
AF_{skin} =	absorption factor skin (unitless)	chemical specific	italics = Health Canada; underline = IRIS; bold = OMOE
SIR =	soil ingestion rate (kg/day)	0.00008	Health Canada (2010) - Toddler
IR_{soil} =	soil inhalation rate (kg/day) = CRP (kg/m^3) x IR_{air} (m^3/day)	6.3E-09	Calculated
SDR =	soil dermal contact rate (kg/day) = (SA_{hands} x M_{hands}) + (SA_{body} x M_{body}) x 1E-6 (kg/mg)	0.0000688	Calculated
ET_{ing} =	exposure term for soil ingestion pathway (unitless)	0.2060	Site Specific [24 Hours per Day, 3 Days per Week, 25 Weeks per Year]
ET_{inh} =	exposure term for soil inhalation pathway (unitless)	0.0515	Site Specific [6 Hours per Day, 3 Days per Week, 25 Weeks per Year]
ET_{derm} =	exposure term for soil dermal contact pathway (unitless)	0.2060	Site Specific [24 Hours per Day, 3 Days per Week, 25 Weeks per Year]
ET_{ing} =	exposure term for soil ingestion pathway (unitless) - developmental toxicant	0.4286	Site Specific [24 Hours per Day, 3 Days per Week]
ET_{inh} =	exposure term for soil inhalation pathway (unitless) - developmental toxicant	0.1071	Site Specific [6 Hours per Day, 3 Days per Week]
ET_{derm} =	exposure term for soil dermal contact pathway (unitless) - developmental toxicant	0.4286	Site Specific [24 Hours per Day, 3 Days per Week]
CRP =	concentration of respirable particles (kg/m^3)	7.60E-10	Health Canada (2010) - Default
IR_{air} =	daily inhalation rate (m^3/day)	8.3	Health Canada (2010) - Toddler
SA_{hands} =	skin surface area - hands (cm^2/day)	430	Health Canada (2010) - Toddler
SA_{body} =	skin surface area - rest of body (cm^2/day)	2580	Health Canada (2010) - Toddler - arms and legs
M_{hands} =	soil to skin adherence factor - hands (mg/cm^2)	0.1	Health Canada (2010) - Toddler
M_{body} =	soil to skin adherence factor - rest of body (mg/cm^2)	0.01	Health Canada (2010) - Toddler

Site-Specific Target Levels for Human Health (Non-Threshold Substances in Soil) - at Former USAF Dump Area and Former Ammunition Storage Area

Site Name: Former USAF Dump Area and Former Ammunition Storage Area
Receptor: Toddler
Dust Levels: Default
Exposure Scenario:

$$SSTL = \frac{TR \times BW \times LE}{ED \times [(AF_{gut} \times SIR \times ET_{ing} \times SF_o) + (AF_{lung} \times IR_{soil} \times ET_{inh} \times SF_i) + (AF_{skin} \times SDR \times ET_{derm} \times SF_o)]} + BSC$$

$$ILCR = \frac{C_s \times [ED \times ((AF_{gut} \times SIR \times ET_{ing} \times SF_o) + (AF_{lung} \times IR_{soil} \times ET_{inh} \times SF_i) + (AF_{skin} \times SDR \times ET_{derm} \times SF_o))]}{BW \times LE}$$

Time on site:	Default	User Defined	
Hours per day (inhalation)	#N/A	6	(ingestion/dermal contact always assumed 24 h/d)
Days per Week	#N/A	3	
Weeks per Year	#N/A	25	
Years Exposed	35	4.5	
Life Expectancy	80	80	

Default Scenario? No

Compound	SF_o (mg/kg-d)$^{-1}$	SF_i (mg/kg-d)$^{-1}$	BSC (mg/kg)	AF_{gut}	AF_{lung}	AF_{skin}	SSTL (mg/kg)	Maximum (mg/kg)	ILCR (unitless)
BaP	2.3	0.13	0	1	1	0.148	69	21.96	3.2E-06
PCBs	2	2	0	1	1	0.14	79	24.00	3.0E-06

Parameter	Definition (units)	Default Value	Reference
SF_o =	oral slope factor [1/(mg/kg bw-day)]	chemical specific	Health Canada (2010) / IRIS 2015b
SF_i =	inhalation slope factor [1/(mg/kg bw-day)]	chemical specific	Health Canada (2010) / IRIS 2015b
C_S =	concentration in soil (mg/kg)	site specific	Calculated Exposure Point Concentration (EPC)
TR =	target risk	1.00E-05	Health Canada (2010)
BSC =	background soil concentration	chemical specific	No background value available
BW =	body weight (kg)	16.5	Health Canada (2010) - Toddler
AF_{gut} =	absorption factor for gut (unitless)	chemical specific	Assumed
AF_{lung} =	absorption factor for lung (unitless)	chemical specific	Assumed
AF_{skin} =	absorption factor skin (unitless)	chemical specific	Health Canada (2010)
SIR =	soil ingestion rate (kg/day)	8.00E-05	Health Canada (2010) - Toddler
IR_{soil} =	soil inhalation rate (kg/day) = CRP (kg/m^3) x IR_{air} (m^3/day)	6.31E-09	Calculated
SDR =	soil dermal contact rate (kg/day) = (SA_{hands} x M_{hands}) + (SA_{body} x M_{body}) x 1E-6 (kg/mg)	6.88E-05	Calculated
ET_{ing} =	exposure term for soil ingestion pathway (unitless)	0.206	Site Specific [24 Hours per Day, 3 Days per Week, 25 Weeks per Year]
ET_{inh} =	exposure term for soil inhalation pathway (unitless)	0.052	Site Specific [6 Hours per Day, 3 Days per Week, 25 Weeks per Year]
ET_{derm} =	exposure term for soil dermal contact pathway (unitless)	0.206	Site Specific [24 Hours per Day, 3 Days per Week, 25 Weeks per Year]
CRP =	concentration of respirable particles (kg/m^3)	7.60E-10	Health Canada (2010) - Default
IR_{air} =	daily inhalation rate (m^3 air-yr/kg bw-day)	8.3	Health Canada (2010) - Toddler
SA_{hands} =	skin surface area - hands (cm^2-yr/kg bw-day)	430	Health Canada (2010) - Toddler
SA_{body} =	skin surface area - arms (cm^2-yr/kg bw-day)	2580	Health Canada (2010) - Toddler
M_{hands} =	soil to skin adherence factor - hands (mg/cm^2)	0.1	Health Canada (2010) - Toddler
M_{body} =	soil to skin adherence factor - rest of body (mg/cm^2)	0.01	Health Canada (2010) - Toddler

Site-Specific Target Levels for Human Health (Non-Threshold Substances in Soil) - Lifetime at Former USAF Dump Area and Former Ammunition Storage Area

Site Name: Former USAF Dump Area and Former Ammunition Storage Area
Receptor: Lifetime
Dust Levels: Default
Exposure Scenario:

$$SSTL = \frac{TR \times LE}{(AF_{gut} \times SIR_{adj} \times ET_{ing} \times SF_o) + (AF_{lung} \times IR_{soil\ adj} \times ET_{inh} \times SF_i) + (AF_{skin} \times SDR_{adj} \times ET_{derm} \times SF_o)} + BSC$$

$$ILCR = \frac{C_s \times [(AF_{gut} \times SIR_{adj} \times ET_{ing} \times SF_o) + (AF_{lung} \times IR_{soil\ adj} \times ET_{inh} \times SF_i) + (AF_{skin} \times SDR_{adj} \times ET_{derm} \times SF_o)]}{LE}$$

Time on site:	Default	User Defined	
Hours per day (inhalation)	#N/A	6	(ingestion/dermal contact always assumed 24 h/d)
Days per Week	#N/A	3	
Weeks per Year	#N/A	25	
Years Exposed	80	80	
Life Expectancy	80	80	

Default Scenario? No. User Defined.

Compound	SF_o $(mg/kg\text{-}d)^{-1}$	SF_i $(mg/kg\text{-}d)^{-1}$	BSC (mg/kg)	AF_{gut}	AF_{lung}	AF_{skin}	SSTL (mg/kg)	Maximum (mg/kg)	ILCR (unitless)
BaP	2.3	0.13	0	1	1	0.148	24	21.96	9.1E-06
PCBs	2	2	0	1	1	0.14	28	24.00	8.5E-06

Parameter	Definition (units)	Default Value	Reference
SF_o =	oral slope factor [1/(mg/kg bw-day)]	chemical specific	Health Canada (2010) / IRIS 2015b
SF_i =	inhalation slope factor [1/(mg/kg bw-day)]	chemical specific	Health Canada (2010) / IRIS 2015b
C_S =	concentration in soil (mg/kg)	site specific	Maximum concentration
TR =	target risk	1.00E-05	Health Canada (2010)
BSC =	background soil concentration	chemical specific	No background value available
AF_{gut} =	absorption factor for gut (unitless)	chemical specific	Assumed
AF_{lung} =	absorption factor for lung (unitless)	chemical specific	Assumed
AF_{skin} =	absorption factor skin (unitless)	chemical specific	Health Canada (2010)
SIR_{adj} =	soil ingestion rate (kg soil-yr/kg bw-day)	4.69E-05	Health Canada (2010) - Lifetime
$IR_{soil\ adj}$ =	soil inhalation rate (kg soil -yr/kg bw-day) = CRP (kg/m^3) x IR_{air} (m^3 air-yr/kg bw-day)	1.65E-08	Calculated
SDR_{adj} =	soil dermal contact rate (kg soil- yr/kg bw-day) = (SA_{hands} x M_{hands}) + (SA_{body} x M_{body}) x 10^{-6} (kg/mg)	1.54E-04	Calculated
ET_{ing} =	exposure term for soil ingestion pathway (unitless)	0.206	Site Specific [24 Hours per Day, 3 Days per Week, 25 Weeks per Year]
ET_{inh} =	exposure term for soil inhalation pathway (unitless)	0.052	Site Specific [6 Hours per Day, 3 Days per Week, 25 Weeks per Year]
ET_{derm} =	exposure term for soil dermal contact pathway (unitless)	0.206	Site Specific [24 Hours per Day, 3 Days per Week, 25 Weeks per Year]
CRP =	concentration of respirable particles (kg/m^3)	7.60E-10	Health Canada (2010) - Default
$IR_{air\ adj}$ =	daily inhalation rate (m^3 air-yr/kg bw-day)	21.7	Health Canada (2010) - Lifetime
$SA_{hands\ adj}$ =	skin surface area - hands (cm^2-yr/kg bw-day)	1125	Health Canada (2010) - Lifetime
$SA_{body\ adj}$ =	skin surface area - arms (cm^2-yr/kg bw-day)	4181	Health Canada (2010) - Lifetime
M_{hands} =	soil to skin adherence factor - hands (mg/cm^2)	0.1	Health Canada (2010) - Lifetime
M_{body} =	soil to skin adherence factor - rest of body (mg/cm^2)	0.01	Health Canada (2010) - Lifetime

HUMAN HEALTH RISK ESTIMATION UNCERTAINTIES

Risk estimates normally include an element of uncertainty, and generally these uncertainties are addressed by incorporating conservative assumptions in the analysis. As a result, risk assessments tend to overstate the actual risk. Although many factors are considered in preparation of a risk analysis, analysis results are generally only sensitive to very few of these factors. The uncertainty analysis is included to demonstrate that assumptions used are conservative, or that the analysis result is not sensitive to the key assumptions.

A risk assessment containing a high degree of confidence will be based on:

- Conditions where the problem is defined with a high level of certainty based on data and physical observations;
- An acceptable and reasonable level of conservatism in assumptions which will ensure that risks are overstated; or,
- An appreciation of the bounds and limitations of the final solution.

The exposure assessment performed as part of this study was based on:

- Available data to describe existing surface soil conditions;
- Sound conservative assumptions for certain parameters, as required; and
- Well-understood and generally accepted methods for risk prediction.

Uncertainties in Toxicological Information

Uncertainties in Toxicological Information are provided in the toxicity profile.

Modeling Assumptions

Table 1 contains a summary of the assumptions used in the human health risk analysis, providing an evaluation for each assumption and an opinion as to whether the assumption is acceptable.

Table 1 Evaluation of Assumptions in the Risk Analysis

Risk Analysis Study Factor/Assumption	Justification	Analysis Likely to Over/Under Estimate Risk?	Acceptable Assumption?
Hazard Screening/ Identification			
Measured concentrations are representative.	Sampling program focused on areas of highest impacts (i.e., biased high).	Over-Estimate	Yes
Modeled exposure to COPC exposure point concentration.	Conservative estimate of exposure over the subject area.	Over-Estimate to neutral	Yes
Receptor Characteristics			
Receptors at the site include toddler visitors.	Based on the unrestricted access to the site visitors are possible including a toddler.	Neutral	Yes
A toddler is assumed to be present on the property 1 days a week, 2 hours a day, 36 weeks per year.	The exposure times represent a reasonable estimate, and remove periods of the year that the Site is expected to be snow covered.	Neutral	Yes
Risk Characterization			
Exposure was modeled for one potential exposure pathway: soil ingestion/dermal contact/inhalation of particulates.	Other exposures are expected to produce negligible risks.	Neutral	Yes
Note: Over-estimation of risk indicates that the assumption was conservative, and could possibly overestimate the risks at the site (*i.e.* higher than actual). Underestimating the risk indicates that the assumptions made could slightly underestimate the level of risk at the site. Based on the assessment conducted on the site, the assumptions with underestimates are very slight and are not likely to pose a concern (*i.e.* assumption is acceptable).			

Appendix F ERA Calculation Sheets

UPTAKE FACTORS

To evaluate the level of exposure for each ecological receptor to each potential COPC evaluated in the terrestrial ERA, it is necessary to first estimate the concentration of each COPC in various media or biological tissues (*e.g.*, for the current site, this would include soil and representative plant and animal tissues).

To estimate the potential environmental effects at the site for each receptor, EPC values for soil, terrestrial plants, soil invertebrates, and terrestrial prey, if not measured, were calculated using environmental fate and transport equations or uptake factors which describe the relationships between chemical concentrations in environmental media and concentrations in biota. In the following sections, details of the equations and methods used to derive EPC values for biota in the ERA are discussed.

Common sources of error in environmental fate and transport calculations involve confusion between wet and dry weight units for chemical concentrations in soil, sediment, and biota. To manage this problem in this ERA, for soil, all concentrations are expressed on a dry weight basis (mg/kg dry weight soil or sediment). For plant and animal tissues, all concentrations are expressed on a wet weight basis (mg/kg wet weight tissue).

The uptake factor literature is likewise inconsistent, with some uptake factors being expressed on a wet tissue basis, others on a dry tissue basis, and still others being normalized on the basis of tissue lipid to sediment organic carbon content. The ERA model requires EPC values on a wet tissue basis for biota that are ingested as foods by ecological receptors. Therefore, where possible, uptake factors are expressed on a wet tissue basis; where necessary, correction factors are applied in order to convert from dry weight tissue units to a wet tissue basis.

Biological Uptake Factors

The generalized uptake factor equation used to calculate a COPC concentration in an organism or biological tissue (*e.g.*, soil invertebrates) from the concentration in a surrounding medium (*e.g.*, soil) is as follows:

$$EPC_j = EPC_i \times UP_{ij}$$

Where:	EPC_j	=	exposure point concentration in biological compartment j (*e.g.,* mg/kg wet weight soil invertebrate tissue);
	EPC_i	=	exposure point concentration in environmental medium i (*e.g.,* mg/kg dry soil); and
	UP_{ij}	=	uptake factor from surrounding medium (in this case soil) to the target biological tissue (*e.g.,* mg/kg wet tissue / mg/kg dry soil).

Soil to Terrestrial Plants, UP_{SP}

Most uptake factors are initially reported in dry weight units (*i.e.*, mg/kg dry weight plant / mg/kg dry weight soil) and converted to wet weight for plants by assuming an 85% water and 15% dry solids content (typical value for dicots; USEPA 2007). The conversion is effected by multiplying dry weight transfer factors obtained empirically or from the literature by the fraction of dry solids content, typically assumed to be 0.15 for herbaceous terrestrial plants.

Soil-to-terrestrial-plant uptake factors UP_{SP} for organic compounds were based on the equations presented in Attachment 4-1, Guidance for Developing Ecological Soil Screening Levels (Eco-SSLs) (USEPA 2007, Table 4b).

Bioavailability of selected compounds to plants may be modified using a soil-to-plant bioavailability factor (unitless, potentially ranging from 0 to 1). This empirically represents factors that limit the potential for organic compounds to cross the soil-root barrier, where this is not already factored into the uptake models based on empirical data. Compounds that have a high tendency to sorb to soil solids become inactivated or have low bioavailability. Graham-Bryce (1984) noted that this occurs for substances that have K_d values greater than 1,000 L/kg (log K_{OW} = 3), and Ryan *et al.* (1988) relate this to organic compounds having log K_{OW} values of between 5 and 6, or greater. The Ryan *et al.* (1988) model reflects variable bioavailability by including partitioning and competition between soil organic carbon and plants for uptake of organic contaminants in soil pore water. Presently, the bioavailability factor is set at 1 (*i.e.*, all contaminants are fully bioavailable). Exceptions could be made based on professional judgment where the model of Ryan *et al.* (1988) is not already being used.

In addition to having limited bioavailability, some organic compounds are also potentially metabolized by plants, or may be volatilized across plant leaf surfaces. Therefore, the potential loss of selected organic compounds from plant tissues can be represented using an empirical metabolic factor (unitless, potentially ranging from 0 to 1). Presently, this factor is set at 1 for all contaminants (*i.e.*, contaminants are not metabolized or volatilized). Exceptions can be made based on professional judgment, but a rationale based on evidence of metabolism or volatility should be provided.

Soil to Terrestrial Invertebrates, UP_{SI}

Uptake factors for soil-to-terrestrial invertebrates (UP_{SI}) are generally reported for earthworms due to the availability of information in the literature for earthworms, and a relative paucity of information with regards to insects. The ERA, therefore, focuses on earthworms as the "model" soil invertebrate, due to the relative abundance of data and models to predict contaminant uptake, as well as the perceived importance of earthworms in food webs.

The soil-to-earthworm uptake factors UP_{SI} for organic compounds were obtained from Attachment 4-1, Guidance for Developing Ecological Soil Screening Levels (Eco-SSLs) (USEPA 2007, Table 4b), and presented here to give the uptake factor on the dry weight basis for the earthworm (mg/kg dw tissue / mg/kg dw soil) as:

$$UP_{SI} = ((f_{water} + (f_{lipid} \times K_{ow})) / (F_{oc} \times K_{oc})) / 0.16$$

Where: f_{water} is the water content of the worm (0.84),
f_{lipid} is the lipid content of the worm (0.01),
f_{OC} is the fraction of organic carbon in soil (assumed to be 0.01), and
K_{OC} is the water to organic carbon partitioning coefficient (L/kg OC).

The value 0.16 is the dry solids content of the worm. Log K_{OW} values were obtained from various sources and Log K_{OC} values were calculated as Log K_{OW} x 0.41. Bioavailability and metabolic factors (unitless) for use with this equation as multipliers before calculating the final concentration in earthworms were estimated based on K_{OW}. Estimated values for bioavailability range from 0.1 to 1 while values for metabolic factor range from 0.05 to 1.

Soil or Plant to Terrestrial Prey, UP_{SA}

This section is applicable to terrestrial prey including small mammals and small birds.

Concentrations of contaminants in terrestrial prey are generally estimated using uptake or biotransfer factors directly from soil, or in some cases using biotransfer factors from feed (vegetation). Uptake factors are technically dimensionless and direct (*i.e.*, mg/kg dry weight terrestrial prey / mg/kg dry weight soil). Biotransfer factors (BA) are slightly different, with units of day/kg, and are multiplied by a soil or feed intake rate (kg/day) to generate an uptake factor, which is then multiplied by the contaminant concentration in the soil or feed (mg/kg) to estimate the concentration in the animal. It is very important to maintain consistency in wet weight or dry weight units.

To ensure this consistency, all uptake factors are initially reported in dry weight units (*i.e.*, mg/kg dry weight terrestrial prey / mg/kg dry weight soil) and subsequently converted to wet weight assuming that terrestrial prey typically have approximately 68% water content and 32% dry solids content (data for terrestrial prey; USEPA, 2007). The conversion to wet-weight terrestrial prey units is accomplished by multiplying dry-weight transfer factors by the dry solids fraction of 0.32 for terrestrial prey.

For biotransfer factors for organic contaminants, the most recent literature (*e.g.*, USEPA 2005 and RTI 2005) focuses on transfer from feed to lipid fraction in the animal. The lipid content of terrestrial prey on a dry matter basis varies considerably, both seasonally and between species, with low-range values of <3% recorded for snowshoe hares, and high-range values of >40% recorded for Guinea Pig (Dierenfeld *et al.* 2002). Typical lipid content values for wild voles and mice appear to be in the range of 20% (of dry weight), and this can be converted to a value of 6.4% (wet weight). This value (0.064) will be adopted for the purposes of deriving terrestrial prey transfer factors from feed to lipid and whole body. Thus, where the biotransfer factor has provided an estimate of the contaminant concentration in the lipid fraction of terrestrial prey, multiplying this value by a correction factor of 0.064 will convert to whole animal wet weight units.

PAHs and PCBs

For reasons that will be explained below, biotransfer into terrestrial prey tissue for some organic contaminants is modeled on the basis of measured or expected contaminant concentration in feed (plant tissue) as well as from soils. Thus, the soil-and-plant-to-animal (SPA) biotransfer factor is defined as BA_{SPA} (day/kg).

The uptake factor for soil and plant to terrestrial prey (UP_{SPA}, mg/kg wet weight animal / mg/kg soil or plant) for PAHs was derived from BA_{SPA} values obtained following *"Methodology for Predicting Cattle Biotransfer Values"* (RTI 2005). This work was performed by Research Triangle Institute (RTI) on behalf of the United States Environmental Protection Agency, and is endorsed by the USEPA through the *Human Health Risk Assessment Protocol*. A key assumption is that the best available predictor of the contaminant concentration in terrestrial prey tissue would be the contaminant concentration in a cow occupying the same habitat. Because the available BA_{SPA} values were developed for cattle, and must be multiplied by feed or soil intake rates and concentrations in order to convert them to animal tissue values, the appropriate feed ingestion rate is that of cattle. To multiply by the feed ingestion rate of individual VEC organisms, which range in weight from <10 g to more than 10^5 g, would make the expected contaminant concentration in tissues directly proportional to the feed ingestion rate, which is clearly not appropriate.

The UP_{SPA} value can therefore be visualized as the product of the cattle biotransfer factor (BA_{SPA}, day/kg, from RTI 2005) and the cattle food or soil ingestion rates (kg/day). When multiplied by the contaminant concentrations in the soil and feed (mg/kg) the result is the predicted contaminant concentration for the lipid compartment in cattle (mg/kg lipid). As always, careful attention to wet weight and dry weight units in the application of this approach is essential.

The biotransfer factor from soil or plant to animal (BA_{SPA}) is thus estimated as:

$$BA_{SPA} = 0.064 \times 10^{((-0.099 \log Kow^2) + (1.07 \log Kow) - 3.56)}$$

Where 0.064 is the lipid content of the terrestrial prey relative to its wet weight (Dierenfeld *et al.* 2002); and the remaining equation (from RTI 2005) predicts the tendency for an organic contaminant compound to be concentrated in lipid, as a function of the log K_{OW} value. Note that the lipid fraction identified here for terrestrial prey is lower than the lipid fraction for cattle as defined by RTI (2005). The equation is valid in the range of log K_{OW} values between -0.67 and 8.2, and the log K_{OW} values outside this range should be capped at the upper or lower range limits, respectively.

It is important also to note that the equation developed by RTI (2005) is applicable to organic compounds that are both bioavailable (*i.e.*, readily absorbed from feed), and relatively persistent (*i.e.*, resistant to metabolic breakdown and excretion). It is noted by RTI (2005) that many compounds are susceptible to breakdown and excretion, and such compounds were methodically removed from the database used to develop the equation predicting BA_{SPA} values. Further, it is noted by RTI (2005) that metabolic factors ranging from 0 to 1 can be implemented to better predict the bioaccumulation of non-persistent organic compounds.

The expected contaminant concentration in terrestrial prey is then estimated based on cattle tissue concentrations as:

$$C_{terrestrial\ prey} = BA_{SPA} \times ((60 \times C_{plant}) + (0.4 \times C_{soil})) \times B_i \times M_i,$$

Where $C_{terrestrial\ prey}$ is the contaminant concentration in animal tissue (mg/kg wet weight), BA_{SPA} is the biotransfer factor from soil or plant to animal (day/kg), 60 is the plant feed intake rate (60 kg wet weight/day for cattle), C_{plant} is the contaminant concentration in plants (mg/kg wet weight), 0.4 is the soil ingestion rate (0.4 kg dry weight/day for cattle), C_{soil} is the contaminant concentration in soil (mg/kg dry weight), B_i is the bioavailability of the contaminant in feed and soils (unitless, ranging from 0 to the default value of 1), and M_i is the metabolic factor for the contaminant (unitless, ranging from 0 to the default value of 1).

As a further check on bioconcentration by terrestrial prey, which have relatively short life spans compared with cattle, a mass limitation is imposed on the bioaccumulation of contaminants. This mass limitation is based on the meadow vole, assuming a median 90 day lifespan (USEPA 1993), the daily food ingestion rate (0.011 kg wet weight/day), the daily soil ingestion rate (3.15E-04 kg dry weight/day) and the contaminant concentrations in wet food and dry soil, respectively. No credit is taken for metabolic losses or excretion of contaminants. The total lifetime contaminant intake (mg) is divided by the body mass of the meadow vole (0.042 kg) to derive the maximum theoretical contaminant concentration in meadow vole tissues (C_{max}) as: $C_{max} = (90 \times ((0.011 \times C_{plant}) + (0.000315 \times C_{soil})) \times Bi) / 0.042$, where C_{max} is lower than $C_{terrestrial\ prey}$, C_{max} is selected as the maximum possible contaminant concentration in terrestrial prey tissue.

Vulpes vulpes - (Linnaeus, 1758)
Red Fox

Google
Search for Images on Google

Other English Common Names: red fox
Taxonomic Status: Accepted
Related ITIS Name(s): *Vulpes vulpes* (Linnaeus, 1758) (TSN 180604)
French Common Names: renard roux
Unique Identifier: ELEMENT_GLOBAL.2.105935
Element Code: AMAJA03010
Informal Taxonomy: Animals, Vertebrates - Mammals - Carnivores

Kingdom	Phylum	Class	Order	Family	Genus
Animalia	Craniata	Mammalia	Carnivora	Canidae	Vulpes

Genus Size: C - Small genus (6-20 species)

Check this box to expand all report sections: ☑

Concept Reference

Concept Reference: Wilson, D. E., and D. M. Reeder (editors). 1993. Mammal species of the world: a taxonomic and geographic reference. Second edition. Smithsonian Institution Press, Washington, DC. xviii + 1206 pp. Available online at: http://www.nmnh.si.edu/msw/.
Concept Reference Code: B93WIL01NAUS
Name Used in Concept Reference: *Vulpes vulpes*
Taxonomic Comments: American populations formerly known as *V. fulva* or *V. fulvus*, now are regarded as conspecific with Old World red fox (*V. vulpes*).

Conservation Status

NatureServe Status

Global Status: G5
Global Status Last Reviewed: 05Apr2016
Global Status Last Changed: 15Nov1996
Ranking Methodology Used: Ranked by inspection
Rounded Global Status: G5 - Secure
Nation: United States
National Status: N5 (05Sep1996)
Nation: Canada
National Status: N5 (21Feb2016)

U.S. & Canada State/Province Status
Due to latency between updates made in state, provincial or other NatureServe Network databases and when they appear on NatureServe Explorer, for state or provincial information you may wish to contact the data steward in your jurisdiction to obtain the most current data. Please refer to our Distribution Data Sources to find contact information for your jurisdiction.

United States	Alabama (S4), Alaska (S5), Arizona (S3), Arkansas (S4), California (SNR), Colorado (S5), Connecticut (S5), Delaware (S5), District of Columbia (S4), Florida (SNR), Georgia (S5), Idaho (S4), Illinois (S5), Indiana (S4), Iowa (S4), Kansas (S4), Kentucky (S5), Louisiana (S4), Maine (S5), Maryland (S5), Massachusetts (S5), Michigan (S5), Minnesota (SNR), Mississippi (S4S5), Missouri (S4), Montana (S5), Navajo Nation (S5), Nebraska (S5), Nevada (S3), New Hampshire (S5), New Jersey (S5), New Mexico (S3), New York (S5), North Carolina (S5), North Dakota (SNR), Ohio (SNR), Oklahoma (S3), Oregon (S4?), Pennsylvania (S5), Rhode Island (S5), South Carolina (SNR), South Dakota (S5), Tennessee (SNA), Texas (S4), Utah (S5), Vermont (S5), Virginia (S5), Washington (S5), West Virginia (S5), Wisconsin (S4S5), Wyoming (S5)
Canada	Alberta (S5), British Columbia (S5), Labrador (S5), Manitoba (S5), New Brunswick (S5), Newfoundland Island (S4), Northwest Territories (S5), Nova Scotia (S5), Nunavut (S5), Ontario (S5), Prince Edward Island (S5), Quebec (S5), Saskatchewan (S5), Yukon Territory (S5)

Other Statuses

Implied Status under the U.S. Endangered Species Act (USESA): PS:C
Comments on USESA: Subspecies *necator* (the Sierra Nevada Red Fox known from California) has been added to the candidate list.
IUCN Red List Category: LC - Least concern
Convention on International Trade in Endangered Species Protection Status (CITES): Appendix III

NatureServe Global Conservation Status Factors

Range Extent Comments: Holarctic. Throughout North America north of Mexico except for parts of the Southwest (but see Mikesic and Larue 2003) and Rocky Mountains. Though the species is native to North America, introductions were made in eastern North America during colonial times, resulting in increased numbers and/or range expansion in some areas. Range expanded in North Amercia in the 1900s (Nowak 1991).

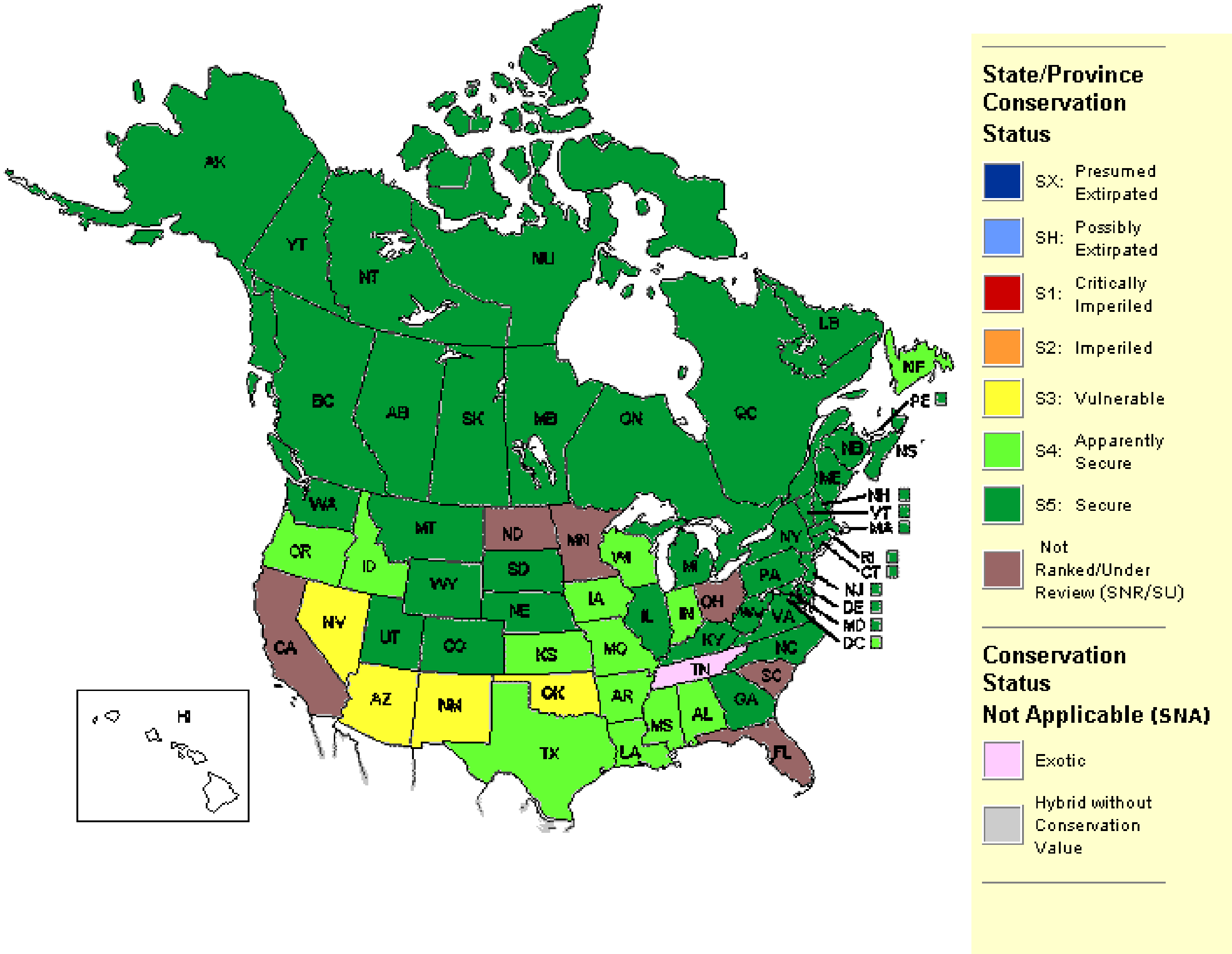
Other NatureServe Conservation Status Information

Distribution

Global Range: Holarctic. Throughout North America north of Mexico except for parts of the Southwest (but see Mikesic and Larue 2003) and Rocky Mountains. Though the species is native to North America, introductions were made in eastern North America during colonial times, resulting in increased numbers and/or range expansion in some areas. Range expanded in North Amercia in the 1900s (Nowak 1991).

U.S. States and Canadian Provinces

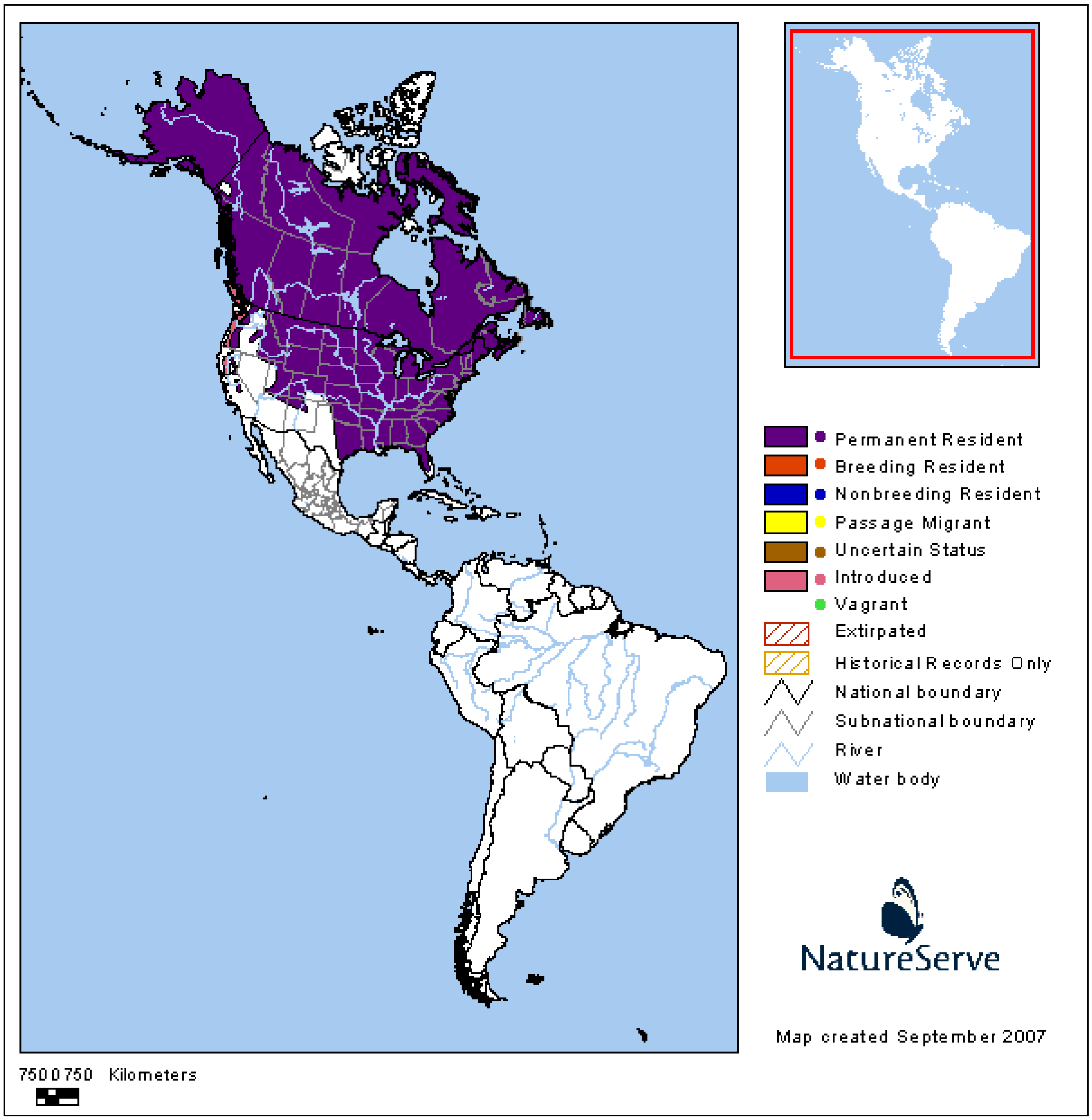
Due to latency between updates made in state, provincial or other NatureServe Network databases and when they appear on NatureServe Explorer, for state or provincial information you may wish to contact the data steward in your jurisdiction to obtain the most current data. Please refer to **our Distribution Data Sources** to find contact information for your jurisdiction.



Endemism: occurs (regularly, as a native taxon) in multiple nations

U.S. & Canada State/Province Distribution	
United States	AK, AL, AR, AZ, CA, CO, CT, DC, DE, FL, GA, IA, ID, IL, IN, KS, KY, LA, MA, MD, ME, MI, MN, MO, MS, MT, NC, ND, NE, NH, NJ, NM, NN, NV, NY, OH, OK, OR, PA, RI, SC, SD, TN , TX, UT, VA, VT, WA, WI, WV, WY
Canada	AB, BC, LB, MB, NB, NF, NS, NT, NU, ON, PE, QC, SK, YT

Range Map
Note: Range depicted for New World only. The scale of the maps may cause narrow coastal ranges or ranges on small islands not to appear. Not all vagrant or small disjunct occurrences are depicted. For migratory birds, some individuals occur outside of the passage migrant range depicted. For information on how to obtain shapefiles of species ranges see our Species Mapping pages at **www.natureserve.org/conservation-tools/data-maps-tools.**



Range Map Compilers: NatureServe, 2005; Sechrest, 2002

U.S. Distribution by County	
State	**County Name (FIPS Code)**
AZ	Apache (04001), Navajo (04017)*
CA	Alpine (06003), Amador (06005)*, Butte (06007)*, El Dorado (06017), Fresno (06019), Inyo (06027), Lassen (06035), Madera (06039), Mariposa (06043)*, Modoc (06049), Mono (06051), Nevada (06057), Placer (06061), Plumas (06063), Shasta (06089), Sierra (06091)*, Siskiyou (06093), Tehama (06103), Trinity (06105)*, Tulare (06107), Tuolumne (06109)
NM	Mckinley (35031), San Juan (35045)
NV	Elko (32007), White Pine (32033)*
OR	Deschutes (41017), Douglas (41019)*, Hood River (41027), Jackson (41029), Jefferson (41031), Klamath (41035), Lane (41039), Linn (41043)
UT	San Juan (49037)*
WA	Chelan (53007), Kittitas (53037), Lewis (53041), Okanogan (53047), Pierce (53053), Skamania (53059), Yakima (53077)

* Extirpated/possibly extirpated

U.S. Distribution by Watershed	
Watershed Region	**Watershed Name (Watershed Code)**
14	Chaco (14080106)+, Chinle (14080204)+, Lower San Juan (14080205)+*

15	Upper Puerco (15020006)+
16	Northern Great Salt Lake Desert (16020308)+, Truckee (16050102)+, Upper Carson (16050201)+*, East Walker (16050301)+, West Walker (16050302)+, Long-Ruby Valleys (16060007)+, Spring-Steptoe Valleys (16060008)+*
17	Methow (17020008)+, Upper Yakima (17030001)+, Naches (17030002)+, Lower Yakima, Washington (17030003)+, Bruneau (17050102)+, Middle Columbia-Hood (17070105)+, Klickitat (17070106)+, Upper Deschutes (17070301)+, Lower Deschutes (17070306)+, Upper Cowlitz (17080004)+, Middle Fork Willamette (17090001)+, Mckenzie (17090004)+, North Umpqua (17100301)+, Upper Rogue (17100307)+, Upper Skagit (17110005)+, Puyallup (17110014)+, Nisqually (17110015)+
18	Williamson (18010201)+, Upper Klamath Lake (18010203)+, Shasta (18010207)+*, Scott (18010208)+*, Trinity (18010211)+*, Upper Pit (18020002)+, Lower Pit (18020003)+, Mccloud (18020004)+, Sacramento headwaters (18020005)+, North Fork Feather (18020121)+, East Branch North Fork Feather (18020122)+, Middle Fork Feather (18020123)+*, Upper Yuba (18020125)+, Upper Bear (18020126)+, North Fork American (18020128)+, South Fork American (18020129)+*, Battle Creek (18020153)+, Thomes Creek-Sacramento River (18020156)+, Big Chico Creek-Sacramento River (18020157)+, Butte Creek (18020158)+*, Upper Kern (18030001)+*, South Fork Kern (18030002)+, Upper Kaweah (18030007)+*, Upper Dry (18030009)+*, Upper King (18030010)+*, Middle San Joaquin-Lower (18040001)+, Upper San Joaquin (18040006)+, Upper Chowchilla-Upper Fresno (18040007)+, Upper Merced (18040008)+*, Upper Tuolumne (18040009)+, Upper Stanislaus (18040010)+, Upper Mokelumne (18040012)+, Upper Cosumnes (18040013)+*, Surprise Valley (18080001)+*, Honey-Eagle Lakes (18080003)+, Mono Lake (18090101)+, Crowley Lake (18090102)+, Owens Lake (18090103)+*

+ Natural heritage record(s) exist for this watershed
* Extirpated/possibly extirpated

Ecology & Life History

Reproduction Comments: Breeds in winter. Gestation lasts 51-56 (average 53) days. Litter of 1-10 (average 4-5) young is born in March-April. Young are weaned in 8-10 weeks, when young leave den and learn to hunt with parents. Male and female may divide young between two dens. Young become independent in fall. Sexually mature the winter after their birth.
Ecology Comments: Summer home range varies greatly, 142-1280 acres (Ables 1969); winter ranges more extensive; home range diameter usually 2-4 km, up to 8 km or more if food scarce (see Caire et al. 1989). Social groups in a city in England exhibited drifting territoriality; ranges averaged about 40 ha (Doncaster and MacDonald 1991). In Japan, spring-summer home range was 357-631 ha; foxes moved about 6 km each night in going from village to village (Cavallini, 1992, J. Mamm. 73:321-325). Averages one family (about 7 foxes) per 4 sq miles (Baker 1983). May be excluded by coyote from some areas of otherwise suitable habitat.
Non-Migrant: Y
Locally Migrant: N
Long Distance Migrant: N
Palustrine Habitat(s): Riparian
Terrestrial Habitat(s): Cropland/hedgerow, Forest - Conifer, Forest - Hardwood, Forest - Mixed, Grassland/herbaceous, Old field, Savanna, Shrubland/chaparral, Suburban/orchard, Woodland - Conifer, Woodland - Hardwood, Woodland - Mixed
Special Habitat Factors: Burrowing in or using soil
Habitat Comments: Various open and semi-open habitats. Usually avoids dense forest, although open woodlands frequently are used. Sometimes occurs in suburban areas or even cities (e.g., in England). May range onto sea ice (Labrador). Maternity dens are in burrows dug by fox or abandoned by other mammals, often in open fields or wooded areas, sometimes under rural buildings, in hollow logs, under stumps, etc.
Adult Food Habits: Carnivore, Frugivore, Invertivore
Immature Food Habits: Carnivore, Frugivore, Invertivore
Food Comments: Opportunistic omnivore; eats whatever is available--small mammals, carrion, birds, insects, fruit, human refuse, etc. Rabbits and mice are common prey. Often uses same foraging route.
Adult Phenology: Crepuscular, Nocturnal
Immature Phenology: Crepuscular, Nocturnal
Phenology Comments: Mainly crepuscular and nocturnal.
Length: 103 centimeters
Weight: 6800 grams

Economic Attributes

Economic Comments: Harvested for pelt in some areas.

Management Summary

Species Impacts: In California, expanding non-native red fox populations pose a threat to endangered kit fox populations (Ralls and White 1995).
Management Requirements: Sterile red foxes have been used to eliminate introduced arctic foxes from Alaskan islands (to restore habitat for birds) (Bailey 1992, 1993).

Control of red fox predation on duck nests in the prairie pothole region can be facilitated by managing for the presence of low number of coyotes, which exclude the more destructive foxes (NBS news release, 29 June 1994).
Monitoring Requirements: See Kreeger et al. (1990) for information on physiological responses to foothold traps.

Population/Occurrence Delineation

Use Class: Not applicable
Subtype(s): Den
Minimum Criteria for an Occurrence: Evidence of historical presence, or current and likely recurring presence, at a given location. Such evidence minimally includes reliable observation and documentation of one or more individuals in appropriate habitat where the species is presumed to be established and breeding.
Separation Barriers: Major water barriers (arbitrarily set at 300 meters wide at low water) that do not freeze.
Separation Distance for Unsuitable Habitat: 5 km
Separation Distance for Suitable Habitat: 15 km
Separation Justification: Red foxes are highly mobile, and dispersal can be extensive (e.g., averaging 31 km in males and 11 km in females, Storm et al. 1976).

Home range size is highly variable, ranging from dozens to thousands of hectares, reflecting differences in habitat quality (reviewed by Lariviere and Pasitschniak-Arts 1996). Grzimek (1975) reported home ranges varying from 500 to 1200 hectares in good habitat, 2000 to 5000 hectares in poor habitat. Sargent (1972) and Storm et al. (1976) record a range of 150 to 1500 hectares. In northwestern British Columbia tundra, a mean home range of 1600 hectares was reported (Jones and Theberge 1982). Winter home ranges usually 2-4 kilometers in diameter; summer ranges smaller (Caire et al. 1989). A theoretical circular home range of 1000 hectares has a diameter of about 3.5 kilometers.

Separation distance is arbitrary but attempts to balance the high mobility of these mammals against the need for occurrences of reasonable size for conservation use. Occurrence delineation requires attention to seasonal changes in location and habitat use (if any); different parts of the annual home range are of course included in the same occurrence regardless of how far apart they are.

Unsuitable habitat includes extensive, dense, unbroken forest (although maternity dens may be located in the outer parts such habitat).
Inferred Minimum Extent of Habitat Use (when actual extent is unknown): 3 km
Inferred Minimum Extent Justification: Based on a home range of 700 hectares.
Date: 22Sep2004
Author: Hammerson, G., and S. Cannings

Population/Occurrence Viability

Justification: [Use the Generic Guidelines for the Application of Occurrence Ranks (2008).](#)
[The Key for Ranking Species Occurrences Using the Generic Approach provides a step-wise process for implementing this method.](#)
[Key for Ranking Species Element Occurrences Using the Generic Approach (2008).](#)

U.S. Invasive Species Impact Rank (I-Rank)

Not yet assessed

Authors/Contributors

Element Ecology & Life History Edition Date: 06Feb1995
Element Ecology & Life History Author(s): Hammerson, G.

Zoological data developed by NatureServe and its network of natural heritage programs (see **Local Programs**) and other contributors and cooperators (see **Sources**).

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Note: All species and ecological community data presented in NatureServe Explorer at http://explorer.natureserve.org were updated to be current with NatureServe's central databases as of **March 2019**.
Note: This report was printed on **June 12, 2019**

agencies. If ground-disturbing activities are proposed on a site, the appropriate state natural heritage program(s) or conservation data center can be contacted for a site-specific review of the project area (see **Visit Local Programs**).

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Sorex cinereus - Kerr, 1792
Cinereus Shrew

Google
Search for Images on Google

Other English Common Names: Masked Shrew, masked shrew
Taxonomic Status: Accepted
Related ITIS Name(s): *Sorex cinereus* Kerr, 1792 (TSN 179929)
French Common Names: musaraigne cendrée
Unique Identifier: ELEMENT_GLOBAL.2.101993
Element Code: AMABA01010
Informal Taxonomy: Animals, Vertebrates - Mammals - Other Mammals

Kingdom	Phylum	Class	Order	Family	Genus
Animalia	Craniata	Mammalia	Soricomorpha	Soricidae	Sorex

Genus Size: D - Medium to large genus (21+ species)

Check this box to expand all report sections: ☑

Concept Reference

Concept Reference: Wilson, D. E., and D. M. Reeder (editors). 1993. Mammal species of the world: a taxonomic and geographic reference. Second edition. Smithsonian Institution Press, Washington, DC. xviii + 1206 pp. Available online at: http://www.nmnh.si.edu/msw/.
Concept Reference Code: B93WIL01NAUS
Name Used in Concept Reference: *Sorex cinereus*
Taxonomic Comments: Several formerly recognized subspecies recently have been regarded as distinct species (e.g., see van Zyll de Jong 1983). A population in western Washington and adjacent British Columbia was recognized as a distinct species (*S. rohweri*) by Rausch et al. (2007).

According to George (1988), electrophoretic data contradict morphometric evidence that *S. fontinalis* is conspecific with *S. cinereus*. However, results of a recent analysis of cranial morphology do not support the view that *fontinalis* is specifically distinct from *S. cinereus*; electrophoretic support for separation of the two as distinct species is based on a small sample size from one small geographic area (van Zyll de Jong 1989). Van Zyll de Jong (1999) and Demboski and Cook (2003) concluded that *S. fontinalis* should be regraded as a subspecies of *S. cinereus*, but the North American mammal checklist by Baker et al. (2003) kept *S. fontinalis* as a species, based on electrophoretic results of George (1988).

The same study (George 1988) supports separation of *S. haydeni* and *S. cinereus* as independent species. Despite distinct morphological and karyotypic (Volobouev and van Zyll de Jong 1994) differences between *S. haydeni* and *S. cinereus*, in Alberta these taxa were less genetically differentiated than were conspecific populations of *S. cinereus* across Canada; there were no fixed allele differences among the populations sampled, but there was a unique allele at a moderate frequency in *S. haydeni*; this may be indicative of no gene flow between these two taxa, and thus they may be valid species; evidently *S. cinereus* is a paraphyletic taxon (Stewart et al. 1993).

Based on evidence of bidirectional mtDNA introgression in Minnesota, Brunet et al. (2002) concluded that *S. haydeni* does not warrant specific status, but Demboski and Cook (2003) found that *S. cinereus* and *S. haydeni* do not appear to be sister species and regarded *S. haydeni* as a valid species (based on a mtDNA phylogeny). The North American mammal checklist by Baker et al. (2003) maintained

S. haydeni as a distinct species.

MtDNA data are not concordant with currently accepted subspecific designations in *S. cinereus* (Stewart and Baker 1997).

Sorex milleri of Mexico apparently represents a relict population of *S. cinereus* and may not have attained specific status (van Zyll de Jong 1989).

See Stewart and Baker (1992) for information on genetic differentiation and biogeography of island and mainland populations in southeastern Canada, where certain island populations have diverged genetically to a level that may be indicative of incipient speciation or subspeciation.

Rausch and Rausch (1995) examined karyotypic and morphological characteristics of shrews on St. Lawrence Island and the Alaskan mainland and found no significant differences; they concluded that *S. jacksoni* should be regarded as a subspecies of *S. cinereus*. However, van Zyll de Jong (in Wilson and Ruff 1999) and Demboski and Cook (2003) continued to recognize *S. jacksoni* as a species. Based on the data of Demboski and Cook (2003), the North American mammal checklist by Baker et al. (2003) recognized *S. jacksoni* as a valid species.

Demboski and Cook (2003) used DNA sequence data to examine phylogenetic relationships among 8 members of the *Sorex cinereus* group (*S. camtschatica*, *S. cinereus*, *S. haydeni*, *S. jacksoni*, *S. portenkoi*, *S. preblei*, *S. pribilofensis*, and *S. ugyunak*) and *S. longirostris*. Phylogenetic analyses recovered 2 major clades within the species group: a northern clade that includes the Beringian species (*S. camtschatica*, *S. jacksoni*, *S. portenkoi*, *S. pribilofensis*, and *S. ugyunak*), *S. haydeni*

Conservation Status

NatureServe Status

Global Status: G5
Global Status Last Reviewed: 05Apr2016
Global Status Last Changed: 01Nov1996
Ranking Methodology Used: Ranked by inspection
Rounded Global Status: G5 - Secure
Nation: United States
National Status: N5 (05Sep1996)
Nation: Canada
National Status: N5 (21Feb2016)

U.S. & Canada State/Province Status Due to latency between updates made in state, provincial or other NatureServe Network databases and when they appear on NatureServe Explorer, for state or provincial information you may wish to contact the data steward in your jurisdiction to obtain the most current data. Please refer to **our Distribution Data Sources** to find contact information for your jurisdiction.	
United States	Alaska (S5), Colorado (S5), Connecticut (S5), Delaware (S5), Georgia (S2S3), Idaho (S5), Illinois (S5), Indiana (S4), Iowa (SNR), Kentucky (S3), Maine (S5), Maryland (S5), Massachusetts (S5), Michigan (S5), Minnesota (S5), Missouri (SNR), Montana (S5), New Hampshire (S5), New Jersey (S5), New Mexico (S2), New York (S5), North Carolina (S4), North Dakota (SNR), Ohio (S5), Pennsylvania (S5), Rhode Island (S5), South Carolina (S2), South Dakota (S5), Tennessee (S4), Utah (S3?), Vermont (S5), Virginia (S5), Washington (S4S5), West Virginia (S5), Wisconsin (S5), Wyoming (S5)
Canada	Alberta (S5), British Columbia (S5), Labrador (S5), Manitoba (S5), New Brunswick (S5), Newfoundland Island (SNA), Northwest Territories (S5), Nova Scotia (S5), Nunavut (S5), Ontario (S5), Prince Edward Island (S5), Quebec (S5), Saskatchewan (S4S5), Yukon Territory (S5)

Other Statuses

IUCN Red List Category: LC - Least concern

NatureServe Global Conservation Status Factors

Range Extent: >2,500,000 square km (greater than 1,000,000 square miles)
Range Extent Comments: Alaska to Labrador/Newfoundland, south to Washington, Utah, New Mexico, the Northern Great Plains,

southern Indiana and Ohio, through the Appalachian Mountains to northern Georgia and western South Carolina, and on the east coast to New Jersey and northern Maryland (Laerm et al. 1995, Brimleyana 22:15-21; Whitaker 2004).

Overall Threat Impact Comments: This and other generalist insectivores are not likely to be impacted negatively by selective insecticides such as BACILLUS THURINGIENSIS (Bellocq et al. 1992).

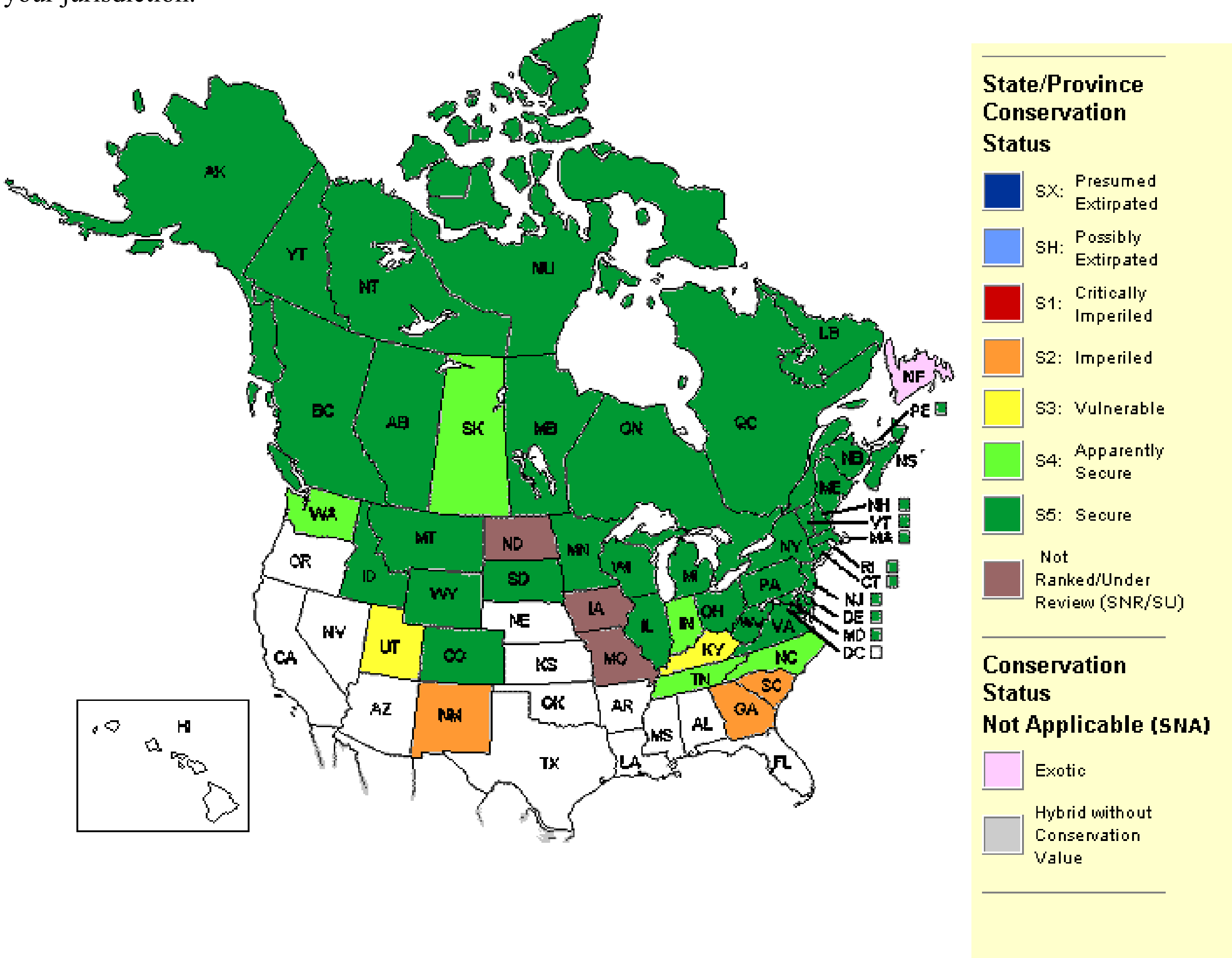
Other NatureServe Conservation Status Information

Distribution

Global Range: (>2,500,000 square km (greater than 1,000,000 square miles)) Alaska to Labrador/Newfoundland, south to Washington, Utah, New Mexico, the Northern Great Plains, southern Indiana and Ohio, through the Appalachian Mountains to northern Georgia and western South Carolina, and on the east coast to New Jersey and northern Maryland (Laerm et al. 1995, Brimleyana 22:15-21; Whitaker 2004).

U.S. States and Canadian Provinces

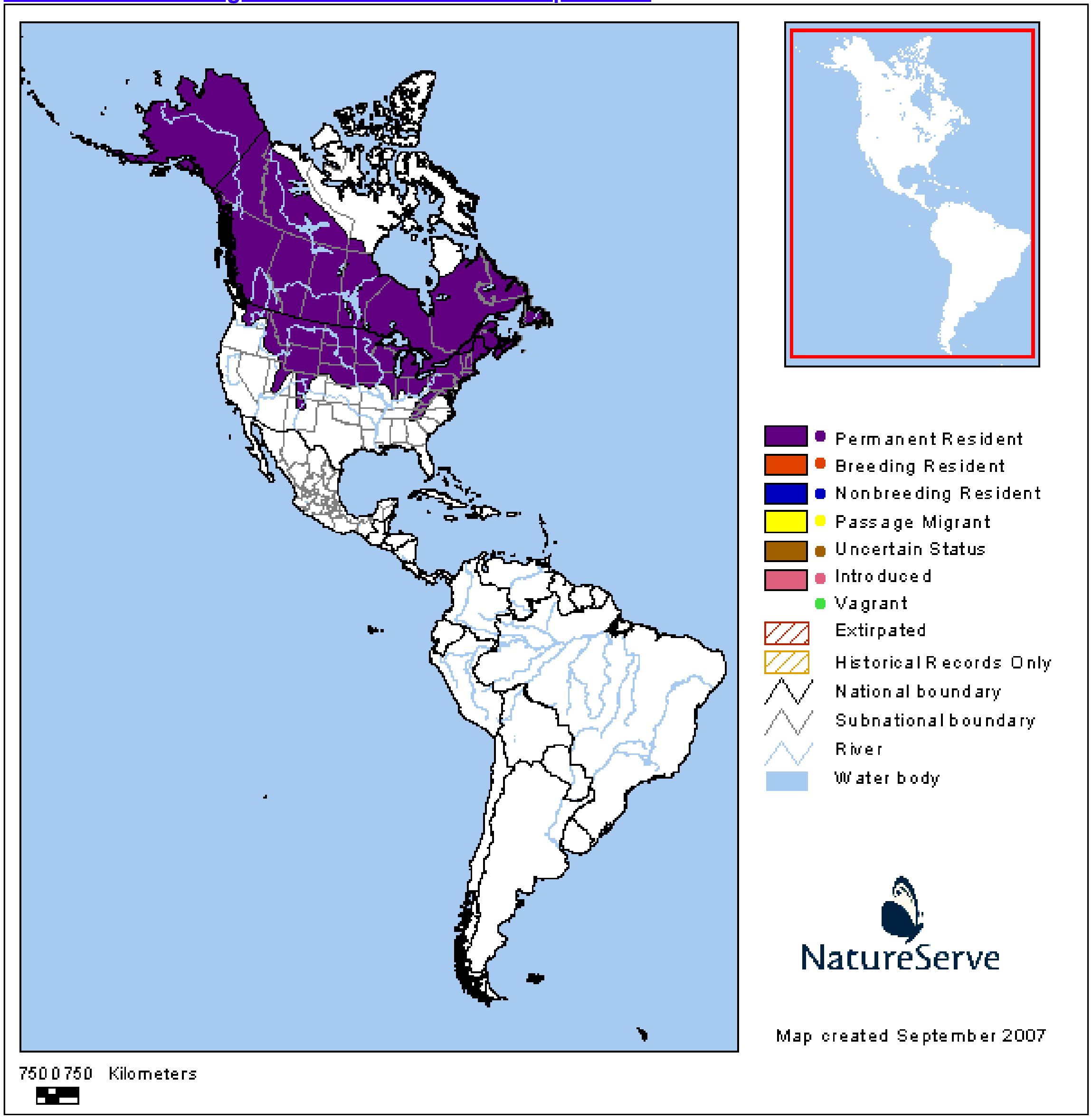
Due to latency between updates made in state, provincial or other NatureServe Network databases and when they appear on NatureServe Explorer, for state or provincial information you may wish to contact the data steward in your jurisdiction to obtain the most current data. Please refer to **our Distribution Data Sources** to find contact information for your jurisdiction.



Endemism: occurs (regularly, as a native taxon) in multiple nations

U.S. & Canada State/Province Distribution	
United States	AK, CO, CT, DE, GA, IA, ID, IL, IN, KY, MA, MD, ME, MI, MN, MO, MT, NC, ND, NH, NJ, NM, NY, OH, PA, RI, SC, SD, TN, UT, VA, VT, WA, WI, WV, WY
Canada	AB, BC, LB, MB, NB, NF, NS, NT, NU, ON, PE, QC, SK, YT

Range Map
Note: Range depicted for New World only. The scale of the maps may cause narrow coastal ranges or ranges on small islands not to appear. Not all vagrant or small disjunct occurrences are depicted. For migratory birds, some individuals occur outside of the passage migrant range depicted. For information on how to obtain shapefiles of species ranges see our Species Mapping pages at **www.natureserve.org/conservation-tools/data-maps-tools.**



Range Map Compilers: NatureServe, 2005

U.S. Distribution by County	
State	**County Name (FIPS Code)**
GA	Rabun (13241)*, Towns (13281)*, White (13311)*
KY	Bell (21013)*, Harlan (21095), Henderson (21101)*, Letcher (21133), Union (21225)*
NM	Colfax (35007)*, Mora (35033), Rio Arriba (35039), Santa Fe (35049)*, Taos (35055)
SC	Greenville (45045), Oconee (45073)
TN	Anderson (47001), Campbell (47013), Carroll (47017), Carter (47019), Claiborne (47025), Cocke (47029), Coffee (47031), Cumberland (47035), Fentress (47049)*, Franklin (47051), Gibson (47053), Hawkins (47073)*, Johnson (47091), Marion (47115), Monroe (47123), Montgomery (47125), Morgan (47129), Polk (47139), Putnam (47141)*, Roane (47145), Sevier (47155), Stewart (47161), Unicoi (47171)
UT	Daggett (49009)*, Duchesne (49013), Garfield (49017), Grand (49019), Juab (49023)*, Piute (49031)*, Rich (49033)*, Salt Lake (49035)*, Sanpete (49039), Sevier (49041)*, Summit (49043), Uintah (49047)*, Utah (49049)*, Wayne (49055)

* Extirpated/possibly extirpated

U.S. Distribution by Watershed

Watershed Region	Watershed Name (Watershed Code)
03	Saluda (03050109)+, Seneca (03060101)+, Tugaloo (03060102)+, Upper Chattahoochee (03130001)+*
05	North Fork Kentucky (05100201)+, Middle Fork Kentucky (05100202)+, Lower Green (05110005)+*, Upper Cumberland (05130101)+, South Fork Cumberland (05130104)+*, Upper Cumberland-Cordell Hull (05130106)+*, Collins (05130107)+, Lower Cumberland (05130205)+, Red (05130206)+, Highland-Pigeon (05140202)+*
06	South Fork Holston (06010102)+, Watauga (06010103)+, Upper French Broad (06010105)+, Pigeon (06010106)+*, Lower French Broad (06010107)+, Nolichucky (06010108)+, Watts Bar Lake (06010201)+*, Upper Little Tennessee (06010202)+*, Lower Little Tennessee (06010204)+, Upper Clinch (06010205)+, Powell (06010206)+, Lower Clinch (06010207)+, Emory (06010208)+, Middle Tennessee-Chickamauga (06020001)+, Hiwassee (06020002)+*, Ocoee (06020003)+, Guntersville Lake (06030001)+, Upper Elk (06030003)+, Upper Duck (06040002)+
08	South Fork Obion (08010203)+
11	Cimarron (11080002)+*, Mora (11080004)+
13	Upper Rio Grande (13020101)+, Rio Chama (13020102)+, Rio Grande-Santa Fe (13020201)+*
14	Upper Colorado-Kane Springs (14030005)+, Upper Green-Flaming Gorge Reservoir (14040106)+*, Ashley-Brush (14060002)+*, Duchesne (14060003)+, San Rafael (14060009)+, Muddy (14070002)+, Fremont (14070003)+, Escalante (14070005)+
16	Upper Bear (16010101)+, Upper Weber (16020101)+*, Utah Lake (16020201)+*, Spanish Fork (16020202)+*, Provo (16020203)+, Jordan (16020204)+*, East Fork Sevier (16030002)+, San Pitch (16030004)+

+ Natural heritage record(s) exist for this watershed
* Extirpated/possibly extirpated

Ecology & Life History

General Description: A medium-sized shrew (adults usually 9-11 cm total length, tail 35-45 mm, 3-6 g) with a sharply pointed snout, beady eyes, and small ears nearly hidden in the fine soft pelage; dorsal pelage varies from dark brown to gray, depending on the season and location; five small unicuspidate teeth behind the upper incisors (the fifth is minute, the fourth generally is smaller than [less commonly equal to, or sometimes larger than in subspecies OHIOENSIS] the third, and both of these are smaller than the first and second; tips of teeth are dark chestnut; feet are delicate, with slender weak claws; condylobasal length of skull 14.6-16.9 mm; maxillary breadth less than 4.6 mm; posterior border of infraorbital foramen even with, or anterior to, plane of space between M1 and M2 (Armstrong 1987, Hall 1981, Godin 1977).

Diagnostic Characteristics: Generally paler and smaller than S. FUMEUS (95-129 mm total length) (Godin 1977). See Hall (1981) for a (somewhat outdated) key to North American species of SOREX. See Carraway (1995) for a key to western North American soricids based primarily on dentaries.

Reproduction Comments: Breeding season may last from March through September (there is evidence of mid-winter births in at least some years in Nova Scotia) (Stewart et al. 1989). Usually 2 litters, may be 3. Gestation lasts 18 days. Litter size is 2-10 (average around 7). Young are weaned in 3 weeks. Sexually mature in 20-26 weeks. Some young may breed in the year of their birth.

Ecology Comments: Large annual fluctuations in population size. Density estimates range from 1-12 shrews per acre (Buckner 1966). Home range about 0.10 acre. Usually in scattered, locally abundant populations. Rarely lives past second summer.

Non-Migrant: Y

Locally Migrant: N

Long Distance Migrant: N

Estuarine Habitat(s): Herbaceous wetland

Palustrine Habitat(s): Bog/fen, FORESTED WETLAND, HERBACEOUS WETLAND, Riparian

Terrestrial Habitat(s): Forest - Conifer, Forest - Hardwood, Forest - Mixed, Grassland/herbaceous, Old field, Savanna, Shrubland/chaparral, Woodland - Conifer, Woodland - Hardwood, Woodland - Mixed

Special Habitat Factors: Burrowing in or using soil, Fallen log/debris, Standing snag/hollow tree

Habitat Comments: Occupies most terrestrial habitats excluding areas with very little or no vegetation. Thick leaf litter in damp forests may represent favored habitat, although appears adaptable to major successional disturbances. In Nova Scotia, diet indicated that much foraging was done among wrack on beaches (Stewart et al. 1989). Nest sites are typically in shallow burrows or above ground in logs and stumps.

Adult Food Habits: Invertivore

Immature Food Habits: Invertivore

Food Comments: A generalist, opportunistic invertivore. Eats primarily insects and other invertebrates, carrion, small vertebrates, occasionally seeds. Echolocation may be used for detecting prey (Gould et al. 1964). Consumes daily its own weight in food.

Adult Phenology: Circadian
Immature Phenology: Circadian
Phenology Comments: Active throughout the day (and the year) to secure enough food to maintain high metabolic rate. Peak active period 0100-0200 (van Zyll de Jong 1983). Cloudy, rainy nights increase nocturnal activity.
Length: 10 centimeters
Weight: 5 grams

Economic Attributes — Not yet assessed

Management Summary — Not yet assessed

Population/Occurrence Delineation

Group Name: Shrews

Use Class: Not applicable
Minimum Criteria for an Occurrence: An area of suitable habitat where there is evidence of presence (or historical presence), with potential for continued presence; evidence minimally including a specimen or, in the case of certain species, a determination by a reliable observer of a live specimen in the hand.
Separation Barriers: Arbitrarily set at rivers wider than 50 meters at low water. Some shrews are relatively strong, active swimmers (notably SOREX PALUSTRIS, S. BENDIRII, SOREX ALASKANUS). No data on dispersal or other movement across water barriers.
Separation Distance for Unsuitable Habitat: 1 km
Separation Distance for Suitable Habitat: 5 km
Separation Justification: Dispersal distances of shrews are poorly known, but these mammals are mobile enough to cover fairly large distances. Mature males especially may wander widely (Hawes 1977). Separation distance for suitable habitat attempts to reflect the small home range size of shrews, their secretive habits and consequent apparent absence in areas where they do in fact occur, and the seemingly low probability that two occupied locations separated by a gap of less than several kilometers of suitable habitat would represent independent populations.

Home ranges small: for breeding SOREX VAGRANS in British Columbia, 338 - 5261 square meters (Hawes 1977); in California, mean of about 372 square meters (Ingles 1961); for breeding S. MONTICOLUS (=OBSCURUS) in British Columbia, mean of 4020 square meters (Hawes 1977); for S. ARANEUS in England, a fall and winter home range of about 2800 square meters, with females occupying exclusive ranges (Buckner 1969).
Date: 21Sep2004
Author: Cannings, S., and G. Hammerson

Population/Occurrence Viability

Justification: **Use the Generic Guidelines for the Application of Occurrence Ranks (2008).**
The Key for Ranking Species Occurrences Using the Generic Approach provides a step-wise process for implementing this method.
Key for Ranking Species Element Occurrences Using the Generic Approach (2008).

U.S. Invasive Species Impact Rank (I-Rank) — Not yet assessed

Authors/Contributors

NatureServe Conservation Status Factors Edition Date: 28Feb2005
Element Ecology & Life History Edition Date: 08Apr1996

Zoological data developed by NatureServe and its network of natural heritage programs (see **Local Programs**) and other contributors and cooperators (see **Sources**).

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Use Guidelines & Citation

Use Guidelines and Citation

Citation for data on website including State Distribution, Watershed, and Reptile Range maps:
NatureServe. 2019. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available http://explorer.natureserve.org. (Accessed: June 12, 2019).

Citation for Bird Range Maps of North America:
Ridgely, R.S., T.F. Allnutt, T. Brooks, D.K. McNicol, D.W. Mehlman, B.E. Young, and J.R. Zook. 2003. Digital Distribution Maps of the Birds of the Western Hemisphere, version 1.0. NatureServe, Arlington, Virginia, USA.

Acknowledgement Statement for Bird Range Maps of North America:
"Data provided by NatureServe in collaboration with Robert Ridgely, James Zook, The Nature Conservancy - Migratory Bird Program, Conservation International - CABS, World Wildlife Fund - US, and Environment Canada - WILDSPACE."

Citation for Mammal Range Maps of North America:
Patterson, B.D., G. Ceballos, W. Sechrest, M.F. Tognelli, T. Brooks, L. Luna, P. Ortega, I. Salazar, and B.E. Young. 2003. Digital Distribution Maps of the Mammals of the Western Hemisphere, version 1.0. NatureServe, Arlington, Virginia, USA.

Acknowledgement Statement for Mammal Range Maps of North America:
"Data provided by NatureServe in collaboration with Bruce Patterson, Wes Sechrest, Marcelo Tognelli, Gerardo Ceballos, The Nature Conservancy-Migratory Bird Program, Conservation International-CABS, World Wildlife Fund-US, and Environment Canada-WILDSPACE."

Citation for Amphibian Range Maps of the Western Hemisphere:
IUCN, Conservation International, and NatureServe. 2004. Global Amphibian Assessment. IUCN, Conservation International, and NatureServe, Washington, DC and Arlington, Virginia, USA.

Acknowledgement Statement for Amphibian Range Maps of the Western Hemisphere:
"Data developed as part of the Global Amphibian Assessment and provided by IUCN-World Conservation Union, Conservation International and NatureServe."

NOTE: Full metadata for the Bird Range Maps of North America is available at:
http://www.natureserve.org/library/birdDistributionmapsmetadatav1.pdf.

Full metadata for the Mammal Range Maps of North America is available at:
http://www.natureserve.org/library/mammalsDistributionmetadatav1.pdf.

Gulo gulo - (Linnaeus, 1758)
Wolverine
Taxonomic Status: Accepted
Related ITIS Name(s): *Gulo gulo* (Linnaeus, 1758) (TSN 180551)
French Common Names: carcajou
Unique Identifier: ELEMENT_GLOBAL.2.103092
Element Code: AMAJF03010
Informal Taxonomy: Animals, Vertebrates - Mammals - Carnivores

Kingdom	Phylum	Class	Order	Family	Genus
Animalia	Craniata	Mammalia	Carnivora	Mustelidae	Gulo

Genus Size: A - Monotypic genus

Check this box to expand all report sections: ☑

Concept Reference

Concept Reference: Wilson, D. E., and D. M. Reeder (editors). 1993. Mammal species of the world: a taxonomic and geographic reference. Second edition. Smithsonian Institution Press, Washington, DC. xviii + 1206 pp. Available online at: http://www.nmnh.si.edu/msw/.
Concept Reference Code: B93WIL01NAUS
Name Used in Concept Reference: *Gulo gulo*
Taxonomic Comments: Some authors (e.g., Hall 1981) have regarded the North American wolverine as a species (*Gulo luscus*) distinct from the Eurasian wolverine (*Gulo gulo*). Most recent accounts (e.g., Jones et al. 1992; Wozencraft, in Wilson and Reeder 1993, 2005; Pasitschniak-Arts and Lariviere 1995) treat *luscus* as a subspecies of *Gulo gulo*, following Degerbol (1935) and Kurten and Rausch (1959).

Conservation Status

NatureServe Status

Global Status: G4
Global Status Last Reviewed: 04Apr2016
Global Status Last Changed: 26Sep1997
Ranking Methodology Used: Ranked by inspection
Rounded Global Status: G4 - Apparently Secure
Reasons: Large range in northern Canada and Alaska, where populations probably are in good condition; occurs also in northern Eurasia; status is not well known in many portions of the range; extirpated from most of range in contiguous United States, with promising signs of semi-recovery in selected western states.
Nation: United States
National Status: N4 (05Sep1996)
Nation: Canada
National Status: N3 (01Jan2018)

U.S. & Canada State/Province Status

Due to latency between updates made in state, provincial or other NatureServe Network databases and when they appear on NatureServe Explorer, for state or provincial information you may wish to contact the data steward in your jurisdiction to obtain the most current data. Please refer to **our Distribution Data Sources** to find contact information for your jurisdiction.

United States	Alaska (S4), California (S1), Colorado (S1), Idaho (S1), Indiana (SX), Iowa (SX), Massachusetts (SX), Michigan (SX), Minnesota (SX), Montana (S3), Nebraska (SX), Nevada (SH), New Hampshire (SX), New York (SX), North Dakota (SX), Ohio (SX), Oregon (S1), Pennsylvania (SX), South Dakota (SX), Utah (S2), Vermont (SX), Washington (S1), Wisconsin (SX), Wyoming (S2)
Canada	Alberta (S3), British Columbia (S3), Labrador (S1), Manitoba (S3S4), New Brunswick (SX), Northwest Territories (S3?), Nunavut (S3), Ontario (S2S3), Quebec (S1), Saskatchewan (S2S3), Yukon Territory (S3)

Other Statuses

U.S. Fish & Wildlife Service Lead Region: R6 - Rocky Mountain
Canadian Species at Risk Act (SARA) Schedule 1/Annexe 1 Status: SC (29May2018)
Committee on the Status of Endangered Wildlife in Canada (COSEWIC): Special Concern (02May2014)
Comments on COSEWIC: Reason for Designation: This wide-ranging carnivore has an estimated Canadian population likely exceeding 10,000 mature individuals. Although population increases appear to be occurring in portions of the Northwest Territories, Nunavut, Manitoba and Ontario, declines have been reported in the southern part of the range, e.g. in British Columbia, and populations in a large part of the range (Quebec and Labrador) have not recovered. The species may be extirpated from Vancouver Island. Population estimates are very limited, and trends are not known. Most data are limited to harvest records, and harvest levels may be under-reported because many pelts used domestically are not included in official statistics. There is no evidence, however, of a decline in harvest over the last 3 generations. This species' habitat is increasingly fragmented by industrial activity, especially in the southern part of its range, and increased motorized access increases harvest pressure. Climate change is likely impacting animals in the southern part of the range, and this impact is expected to increase northward. The species has a low reproductive rate, is sensitive to human disturbance, and requires vast secure areas to maintain viable populations.

Status History: The species was considered a single unit and designated Special Concern in April 1982. Split into two populations in April 1989 (Western and Eastern populations). The original designation was de-activated. In May 2014, the Eastern and Western populations were considered as a single unit across the Canadian range and was designated Special Concern.
IUCN Red List Category: LC - Least concern

NatureServe Global Conservation Status Factors

Range Extent: >2,500,000 square km (greater than 1,000,000 square miles)
Range Extent Comments: Holarctic; northern Europe, northern Asia, and northern North America (Pasitschniak-Arts and Lariviere 1995, Aubry et al. 2007). The species occupies a wide elevational range; for example, in California, wolverines have been recorded at elevations of 400 to 4,300 meters (average 2425 m) (California DF&G 1990, Wilson 1982).

Historical range in North America: arctic islands to the mountains of California, Colorado, and Utah (Predator Conservation Alliance 2001), and parts of the northcentral and northeastern U.S. (where records are sketchy and scarce). Presently extirpated from most of the southern part of the range, including all of the northcentral and northeastern U.S. and most of southeastern and south-central Canada.

In Canada, the wolverine retains its original distribution in the arctic region and in the western mountain and boreal regions but has disappeared from the prairies and from areas south of the boreal forest in eastern Canada; within the boreal region a large gap distributional has developed southeast of Hudson Bay (Dauphine, 1989 COSEWIC report). There have been no verified reports of wolverines in Quebec since 1978, or in Labrador since 1950, but there are unconfirmed reports almost every year (Environment Canada, Species at Risk website).

Recent surveys in the contiguous United States indicate that wolverines appear to occupy (and are essentially limited to) the montane regions of Idaho, Montana, Wyoming, and Washington (Copeland 1996; Washington Department of Wildlife 1998; Inman et al. 2002; Giddings, pers. comm., 2003 cited by USFWS 2003; Squires, pers. comm., 2003, cited by USFWS 2003). Until recently, there had been no confirmed records of wolverine in California since 1922 (Grinnell et al. 1937); attempts to locate wolverines by means of photographic bait stations during the winters of 1991-1992 and 1992-1993 yielded no records (Barrett et al. 1994). In 2008-2010, a single male wolverine was photographed by camera traps in the central Sierra Nevada of California. However, genetic data indicate that this male is related to wolverines in the northern Rocky Mountains and not a remnant of the native California population. See Predator Conservation Alliance (2001) and Wilson (1982) for a state-by-state review of occurrence in the contiguous United States.

Data on the distribution in Eurasia are sketchy. The range in Scandinavia appears to be concentrated in the mountainous central and northern portions of Norway and Sweden, as well as in Finland (Kvam et al. 1988; Nyholm 1993 and Andersson 1995, cited by Blomqvist 1995). Wolverines also occupy the taiga and northern coniferous forest of the former Soviet Union (M. S. Blinnikov, pers. comm.). [from Petersen 1997]

Number of Occurrences: Unknown
Number of Occurrences Comments: Number of occurrences is unknown but there are many in North America and Eurasia. However, occurrences must be defined on a very large scale, so the number of distinct occurrences in a large region will be one or a few at most.

Population Size: 10,000 to >1,000,000 individuals
Population Size Comments: Total population size is unknown but probably is at least in the hundreds of thousands. Substantial populations occur in northern Canada and Alaska. Estimates reported in 2003 put the total population in western Canada at 15,000-19,000 individuals (Environment Canada, Species at Risk website).

Outside of Alaska, Montana and Idaho likely have the largest populations in the United States (perhaps a few hundred individuals in each state). Acknowledging a lack of substantial data, Predator Conservation alliance (2001) stated that extrapolation of the best available information indicates an estimated population of fewer than 750 wolverines in the contiguous United States, including an estimated 400-600 in the U.S. northern Rocky Mountains, and perhaps 100 across the Northwest and Sierra Nevada.

In North America, population density estimates range from one wolverine per 65 sq km in Montana (Hornocker and Hash 1981) to less than one per 200 sq km in northern British Columbia (Quick 1953), Alaska (Becker and Gardner 1992), and the Northwest Territories (Lee and Niptanatiak 1993). [from Petersen 1997]

In Eurasia, data on current populations are scarce. In Norway, the population was estimated to be 120 to 180 individuals (Kvam et al. 1988), in Sweden less than 100 individuals (Andersson 1995, cited by Blomqvist 1995), and in Finland approximately 90 individuals (Nyholm 1993, cited by Blomqvist 1995). In the conservation parks of Russia, the average number of encounters with wolverine tracks along 10 km transects ranged from 0.03 to 1.8 (Russian Research Center 1992). [from Petersen 1997]

Number of Occurrences with Good Viability/Integrity: Unknown

Overall Threat Impact: High
Overall Threat Impact Comments: Decline may have been due primarily to fur trapping. Habitat has been degraded through timber harvesting, ski area construction, road construction, and general human disturbance (Biosystems Analysis 1989). There are conflicts with backcountry trappers.

Excessive hunter harvesting and loss of ungulate wintering areas (Banci 1994), as well as displacement of ungulate populations due to excessive timber harvest and urbanization, may adversely impact wolverines (www.wolverinefoundation.org).

In western Canada, with the extensive human settlement that began in the mid-19th century, the wolverine has undergone range contractions and population reductions. Wolf control programs that were in effect from the 1950s and into the 1990s contributed to this species' decline. The habitat, particularly in the southern part of the range, is subject to loss, degradation, and fragmentation from oil, gas, and mineral exploration and extraction, forestry, roads, agriculture, and urban development. Although Wolverines are known to use snowmobile trails and scavenge from traps, backcountry recreation can lead to habitat alienation for these secretive animals. Increased access of motorized vehicles into remote areas may also increase harvest pressure on the wolverine and on its ungulate prey, particularly the threatened Southern Mountain population of Woodland Caribou. In the arctic tundra, developments frequently attract wolverines, which are then at risk of being killed as nuisance animals. As an economically valuable furbearer, the wolverine is subject to trapping and has been over-harvested in some areas. Declines in the population in eastern Canada are related to a combination of factors: hunting and trapping in the late 19th century, dwindling caribou herds in the early 20th century, human encroachment on habitat, reduction in the number of wolves, and the indiscriminate use of poison baits. [From Environment Canada Species at Risk website. See Dauphine (1989 COSEWIC report) for further information on threats in Canada.]

Among the limiting factors in Alberta are the loss of isolated habitat, a reduction in the availability of large ungulate carrion, and trapping pressure (Petersen 1997).

Short-term Trend: Decline of <30% to relatively stable
Short-term Trend Comments: Environment Canada - Species at Risk website (http://www.speciesatrisk.gc.ca) reported the following

information for the western population:

In the Yukon, populations are healthy and stable in all regions. In the Northwest Territories, densities vary with location; they are highest in the southwest and lowest on the Arctic Islands and on the mainland east of the Thelon Wildlife Sanctuary. In Nunavut, densities are moderate in the west and low on the Arctic Islands and in the east. Populations are believed to be stable over much of British Columbia, but are declining in the southern mountains. A distinct subspecies may no longer be extant on Vancouver Island, where Wolverines have not been seen since 1992; their decline may be related to that of the endangered Vancouver Island marmot, a potential summer food. In Alberta, wolverines are most abundant in the west, but appear to be declining throughout the province. In Saskatchewan, they are common in the north, but are rare and possibly declining in the southern boreal forest. In Manitoba, the highest densities are in the northeast and northwest, while numbers in the north central part of the province are unknown. Wolverines are found in small numbers in northwestern Ontario; they may have increased recently in some areas, but are known to have disappeared from others. Overall numbers for Ontario indicate a decline. Although records exist for their occurrence in the Prairie and Great Lakes Plains ecological areas, wolverine populations may never have been viable in these regions.

See also Dauphine (1989 COSEWIC report) for information on status in Canada.

In Alberta, trapping data suggest that the highest populations are found in the western parts of the province, and that populations have declined in most regions of Alberta in the past two decades (Petersen 1997).

Long-term Trend:
Long-term Trend Comments: Wolverines have been extirpated from large portions of their range in southern and eastern Canada and are now considered to be 'endangered' in eastern regions of Canada. Western and northern Canada have healthier populations, although the wolverine is considered to be 'vulnerable' in these areas, and at risk of further population declines and range contractions (Petersen 1997).

Numbers apparently declined steadily in the U.S. beginning in the latter half of the 1800s. In the United States, the species no longer occurs east of Montana and Wyoming. The last reliable sighting in California was in 1922 (K. Aubrey, cited by Rowland et al. 2003). Wolverines are now very rare or extirpated at the southern periphery of the range in Colorado (Fitzgerald et al. 1994). The species apparently has made a comeback in recent years in Idaho, Montana , and some other western states. Some areas of the U.S. along the continental divide have been recolonized from Canada (Wilson 1982). Hornaker and Hash (1981) asserted stable populations on their study area in Montana, with high dispersal patterns maintaining the stability, rebounding from near extinction in Montana from 1920-1940 (Newby and Wright 1955).

Subspecies *katschemakensis* of Alaska's Kenai Peninsula totaled about 50 individuals in the 1980s; apparently was declining due to an excessively long hunting season (see Nowak 1991).

Intrinsic Vulnerability: Highly vulnerable
Intrinsic Vulnerability Comments: Species has a low reproductive output because of poor breeding success, high juvenile mortality, and slow sexual maturity (Petersen 1997).

Other NatureServe Conservation Status Information

Inventory Needs: Need an accurate population count and distribution map.

Protection Needs: Kyle and Strobeck (2002) confirmed that high levels of gene flow occur among all the northern wolverine populations sampled. They "also observed progressively increasing genetic structure at the periphery of their southern and eastern distributions, suggesting that these populations may have been partially fragmented from what was once a panmictic unit. Peripheral populations may be more susceptible to extirpation and, therefore, may be the most appropriate targets for concerted conservation efforts to prevent the elimination of wolverines from yet more of their historical range."

Protection of natal denning habitat from human disturbance may be critical. Montane coniferous forests, suitable for winter foraging and summer kit rearing, may only be useful if connected with subalpine cirque habitats required for natal denning, security areas, and summer foraging. In addition, these habitats must be available during the proper season. Subalpine cirque areas, important for natal denning, may be made unavailable by winter recreational activities. Conversely, high road densities, timber sales, or housing developments on the fringes of subalpine habitats may reduce potential for winter foraging and kit rearing, and increase the probability of human-caused wolverine mortality. [from www.wolverinefoundation.org].

See also Predator Conservation Alliance (2001) for a summary of protection needs.

Keep trappers out of known wolverine areas.

Distribution

Global Range: (>2,500,000 square km (greater than 1,000,000 square miles)) Holarctic; northern Europe, northern Asia, and northern North America (Pasitschniak-Arts and Lariviere 1995, Aubry et al. 2007). The species occupies a wide elevational range; for example, in California, wolverines have been recorded at elevations of 400 to 4,300 meters (average 2425 m) (California DF&G 1990, Wilson 1982).

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U.S. States and Canadian Provinces

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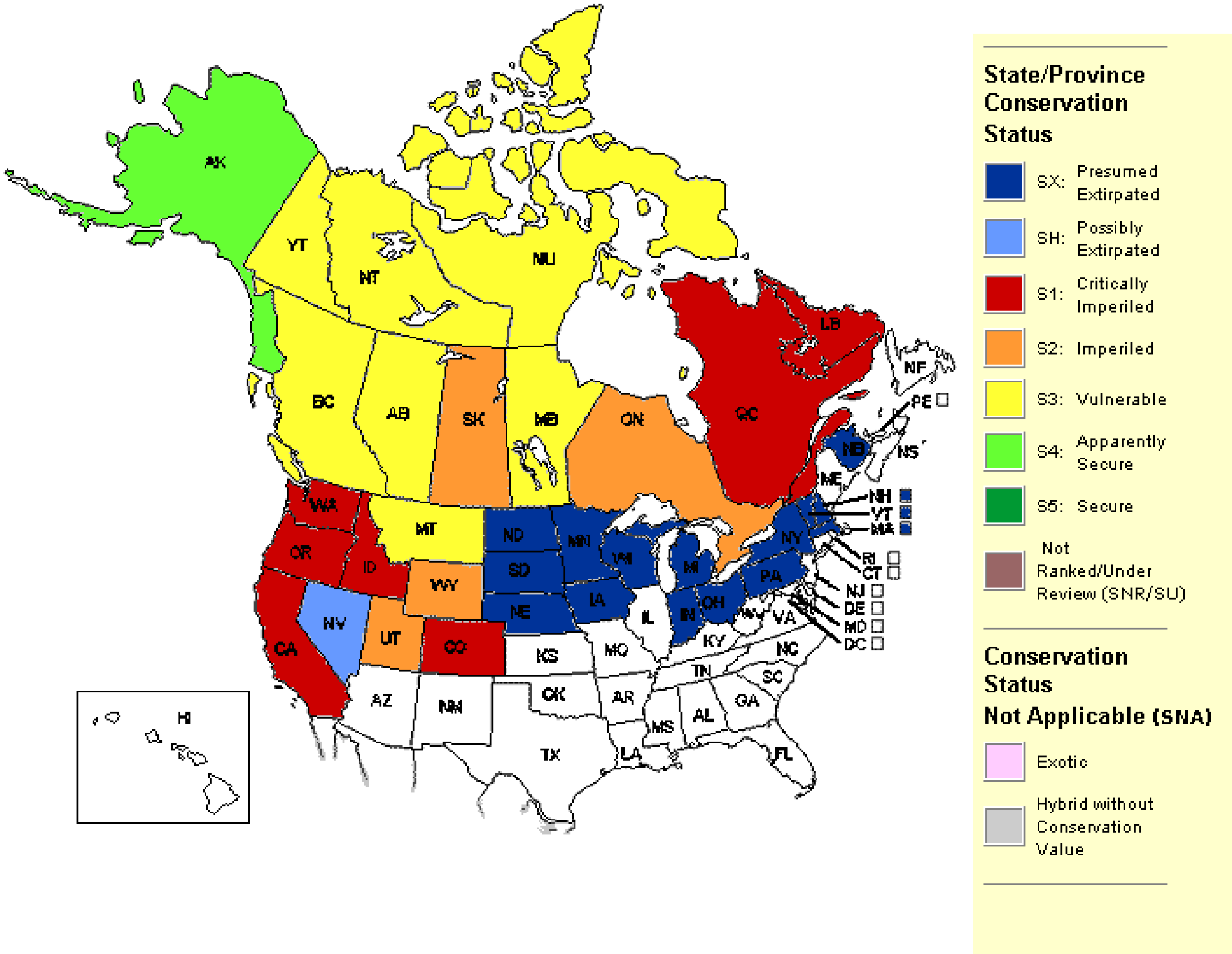
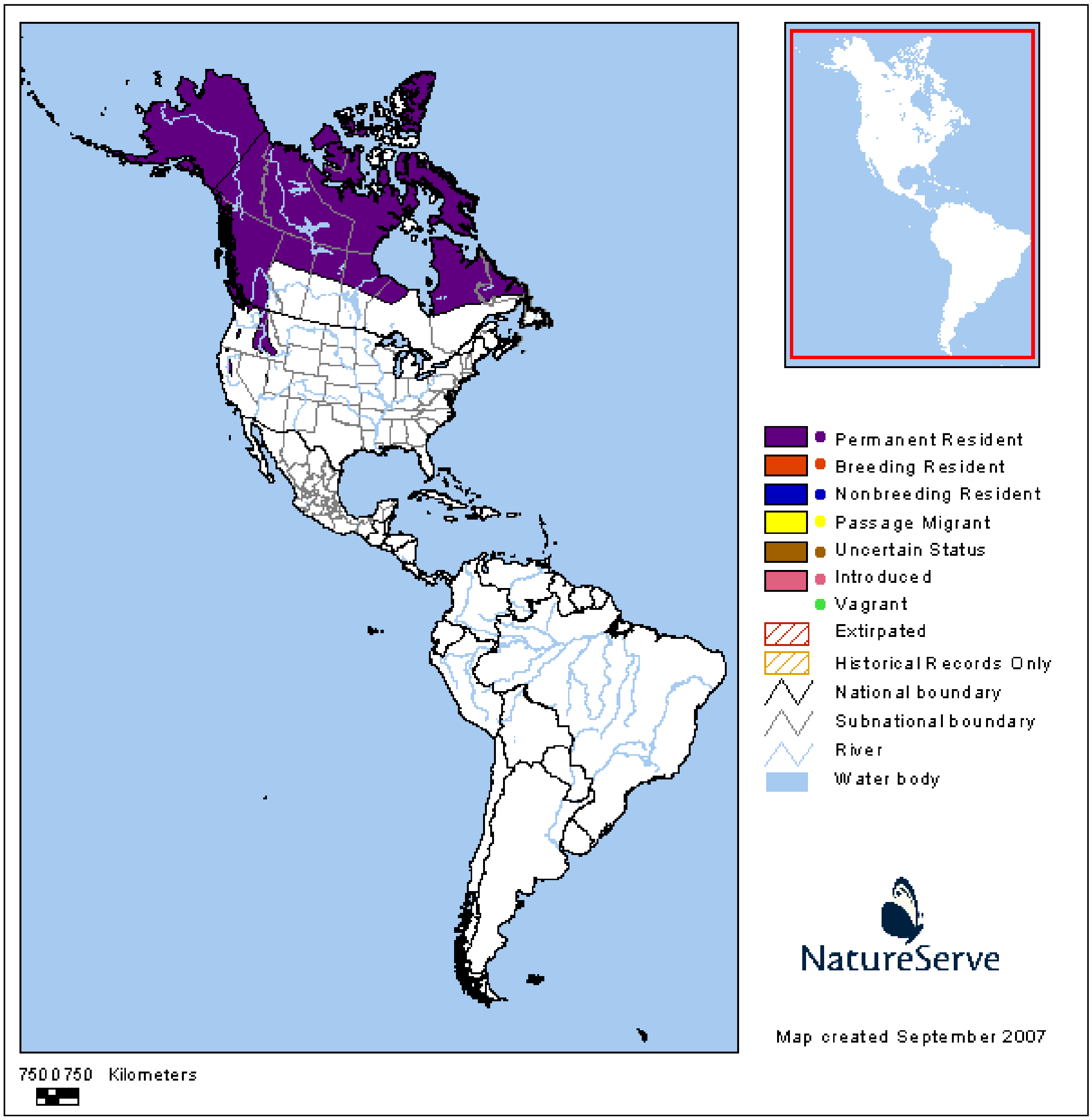


Endemism: occurs (regularly, as a native taxon) in multiple nations

U.S. & Canada State/Province Distribution	
United States	AK, CA, CO, IA, ID, IN, MA, MI, MN, MT, ND, NE, NH, NV, NY, OH, OR, PA, SD, UT, VT, WA, WI, WY
Canada	AB, BC, LB, MB, NB, NT, NU, ON, QC, SK, YT

Range Map
Note: Range depicted for New World only. The scale of the maps may cause narrow coastal ranges or ranges on small islands not to appear. Not all vagrant or small disjunct occurrences are depicted. For migratory birds, some individuals occur outside of the passage migrant range depicted. For information on how to obtain shapefiles of species ranges see our Species Mapping pages at **www.natureserve.org/conservation-tools/data-maps-tools.**



Range Map Compilers: Sechrest, 2002

U.S. Distribution by County	
State	**County Name (FIPS Code)**
CA	Alpine (06003), Amador (06005)*, Del Norte (06015)*, El Dorado (06017), Fresno (06019), Inyo (06027), Kern (06029)*, Lake (06033)*, Lassen (06035)*, Madera (06039), Mariposa (06043)*, Mendocino (06045), Modoc (06049)*, Mono (06051), Nevada (06057), Placer (06061)*, Plumas (06063)*, Shasta (06089), Sierra (06091), Siskiyou (06093), Trinity (06105), Tulare (06107), Tuolumne (06109)
CO	Alamosa (08003)*, Archuleta (08007)*, Boulder (08013)*, Conejos (08021)*, Costilla (08023)*, Delta (08029)*, Dolores (08033)*, Eagle (08037), Garfield (08045)*, Gilpin (08047)*, Grand (08049), Gunnison (08051), Hinsdale (08053)*, Huerfano (08055)*, Jackson (08057), La Plata (08067)*, Larimer (08069)*, Mineral (08079)*, Moffat (08081)*, Montezuma (08083)*, Montrose (08085)*, Ouray (08091)*, Park (08093), Pitkin (08097)*, Pueblo (08101)*, Rio Blanco (08103), Routt (08107)*, Saguache (08109)*, San Miguel (08113)*, Summit (08117)*
ID	Ada (16001), Adams (16003), Bannock (16005), Bear Lake (16007), Benewah (16009), Blaine (16013), Boise (16015), Bonner (16017), Bonneville (16019), Boundary (16021), Butte (16023), Camas (16025), Canyon (16027)*, Caribou (16029), Clark (16033), Clearwater (16035), Custer (16037), Elmore (16039), Franklin (16041), Fremont (16043), Idaho (16049), Jerome (16053), Kootenai (16055), Latah (16057), Lemhi (16059), Madison (16065), Shoshone (16079), Twin Falls (16083), Valley (16085)
MT	Beaverhead (30001), Broadwater (30007), Carbon (30009), Cascade (30013), Deer Lodge (30023), Flathead (30029), Gallatin (30031), Glacier (30035), Granite (30039), Jefferson (30043), Judith Basin (30045), Lake (30047), Lewis and Clark (30049), Lincoln (30053), Madison (30057), Meagher (30059), Mineral (30061), Missoula (30063), Park (30067), Pondera (30073), Powell (30077), Ravalli (30081), Sanders (30089), Silver Bow (30093), Stillwater (30095), Sweet Grass (30097), Teton (30099), Wheatland (30107)
OR	Baker (41001), Union (41061), Wallowa (41063)

UT	Beaver (49001)*, Cache (49005), Daggett (49009)*, Duchesne (49013), Garfield (49017)*, Morgan (49029)*, Piute (49031)*, Salt Lake (49035)*, San Juan (49037)*, Sanpete (49039), Summit (49043), Uintah (49047)*, Utah (49049)*, Wasatch (49051)*, Wayne (49055)*, Weber (49057)*
WA	Asotin (53003), Benton (53005), Chelan (53007), Clallam (53009), Columbia (53013), Ferry (53019), Franklin (53021), Garfield (53023), Jefferson (53031), King (53033), Kittitas (53037), Klickitat (53039), Lewis (53041), Mason (53045), Okanogan (53047), Pend Oreille (53051), Pierce (53053), Skagit (53057), Skamania (53059), Snohomish (53061), Spokane (53063), Stevens (53065), Thurston (53067), Walla Walla (53071), Whatcom (53073), Yakima (53077)
WY	Albany (56001), Carbon (56007), Fremont (56013), Goshen (56015), Johnson (56019), Laramie (56021), Lincoln (56023), Park (56029), Sheridan (56033), Sublette (56035), Teton (56039)

* Extirpated/possibly extirpated

U.S. Distribution by Watershed

Watershed Region	Watershed Name (Watershed Code)
09	St. Marys (09040001)+, Belly (09040002)+
10	Red Rock (10020001)+, Beaverhead (10020002)+, Ruby (10020003)+, Big Hole (10020004)+, Jefferson (10020005)+, Boulder (10020006)+, Madison (10020007)+, Gallatin (10020008)+, Upper Missouri (10030101)+, Upper Missouri-Dearborn (10030102)+, Smith (10030103)+, Sun (10030104)+, Belt (10030105)+, Two Medicine (10030201)+, Cut Bank (10030202)+, Teton (10030205)+, Arrow (10040102)+, Judith (10040103)+, Upper Musselshell (10040201)+, Milk Headwaters (10050001)+, Yellowstone Headwaters (10070001)+, Upper Yellowstone (10070002)+, Shields (10070003)+, Stillwater (10070005)+, Clarks Fork Yellowstone (10070006)+, Upper Wind (10080001)+, Popo Agie (10080003)+, Nowood (10080008)+, Greybull (10080009)+, North Fork Shoshone (10080012)+, South Fork Shoshone (10080013)+, Little Bighorn (10080016)+, Upper Tongue (10090101)+, Crazy Woman (10090205)+, Clear (10090206)+, North Platte Headwaters (10180001)+, Upper North Platte (10180002)+, Medicine Bow (10180004)+, Middle North Platte-Scotts Bluff (10180009)+, Upper Laramie (10180010)+, Horse (10180012)+, South Platte Headwaters (10190001)+, Upper South Platte (10190002)+, St. Vrain (10190005)+*, Big Thompson (10190006)+*, Cache La Poudre (10190007)+, Crow (10190009)+, Upper Lodgepole (10190015)+
11	Upper Arkansas (11020002)+*, Huerfano (11020006)+*
13	Rio Grande headwaters (13010001)+*, Alamosa-Trinchera (13010002)+*, San Luis (13010003)+*, Conejos (13010005)+*, Rio Chama (13020102)+*
14	Colorado headwaters (14010001)+, Blue (14010002)+*, Eagle (14010003)+, Roaring Fork (14010004)+, Colorado headwaters-Plateau (14010005)+*, East-Taylor (14020001)+*, Upper Gunnison (14020002)+*, Tomichi (14020003)+*, North Fork Gunnison (14020004)+*, Uncompahange (14020006)+*, Upper Dolores (14030002)+*, San Miguel (14030003)+*, Upper Colorado-Kane Springs (14030005)+*, Upper Green (14040101)+, New Fork (14040102)+, Upper Green-Flaming Gorge Reservoir (14040106)+, Blacks Fork (14040107)+, Upper Yampa (14050001)+, Lower Yampa (14050002)+*, Little Snake (14050003)+*, Upper White (14050005)+, Piceance-Yellow (14050006)+*, Lower Green-Diamond (14060001)+*, Ashley-Brush (14060002)+*, Duchesne (14060003)+, Price (14060007)+, San Rafael (14060009)+, Fremont (14070003)+*, Escalante (14070005)+*, Upper San Juan (14080101)+*, Middle San Juan (14080105)+*, Mancos (14080107)+*
16	Upper Bear (16010101)+, Central Bear (16010102)+, Middle Bear (16010202)+, Little Bear-Logan (16010203)+, Upper Weber (16020101)+*, Lower Weber (16020102)+*, Utah Lake (16020201)+*, Provo (16020203)+*, Jordan (16020204)+*, Middle Sevier (16030003)+*, San Pitch (16030004)+*, Beaver Bottoms-Upper Beaver (16030007)+*, Lake Tahoe (16050101)+, Truckee (16050102)+, Upper Carson (16050201)+, East Walker (16050301)+*, West Walker (16050302)+*, Fish Lake-Soda Spring Valleys (16060010)+*
17	Upper Kootenai (17010101)+, Fisher (17010102)+, Yaak (17010103)+, Lower Kootenai (17010104)+, Moyie (17010105)+, Elk (17010106)+, Upper Clark Fork (17010201)+, Flint-Rock (17010202)+, Blackfoot (17010203)+, Middle Clark Fork (17010204)+, Bitterroot (17010205)+, North Fork Flathead (17010206)+, Middle Fork Flathead (17010207)+, Flathead Lake (17010208)+, South Fork Flathead (17010209)+, Stillwater (17010210)+, Swan (17010211)+, Lower Flathead (17010212)+, Lower Clark Fork (17010213)+, Pend Oreille Lake (17010214)+, Priest (17010215)+, Pend Oreille (17010216)+, Upper Coeur D'alene (17010301)+, South Fork Coeur D'alene (17010302)+, Coeur D'alene Lake (17010303)+, St. Joe (17010304)+, Upper Spokane (17010305)+, Little Spokane (17010308)+, Franklin D. Roosevelt Lake (17020001)+, Kettle (17020002)+, Colville (17020003)+, Sanpoil (17020004)+, Chief Joseph (17020005)+, Okanogan (17020006)+, Similkameen (17020007)+, Methow (17020008)+, Lake Chelan (17020009)+, Upper Columbia-Entiat (17020010)+, Wenatchee (17020011)+, Upper Columbia-Priest Rapids (17020016)+, Upper Yakima (17030001)+, Naches (17030002)+, Lower Yakima, Washington (17030003)+, Snake headwaters (17040101)+, Gros Ventre (17040102)+, Greys-Hobock (17040103)+, Palisades (17040104)+, Salt (17040105)+, Idaho Falls (17040201)+, Upper Henrys (17040202)+, Lower Henrys (17040203)+, Teton (17040204)+, Portneuf (17040208)+, Upper Snake-

	Rock (17040212)+, Beaver-Camas (17040214)+, Medicine Lodge (17040215)+, Birch (17040216)+, Little Lost (17040217)+, Big Lost (17040218)+, Big Wood (17040219)+, Camas (17040220)+, Little Wood (17040221)+, C. J. Idaho (17050101)+, North and Middle Forks Boise (17050111)+, Boise-Mores (17050112)+, South Fork Boise (17050113)+, Lower Boise (17050114)+, South Fork Payette (17050120)+, Payette (17050122)+, North Fork Payette (17050123)+, Brownlee Reservoir (17050201)+, Powder (17050203)+, Imnaha (17060102)+, Lower Snake-Asotin (17060103)+, Upper Grande Ronde (17060104)+, Wallowa (17060105)+, Lower Grande Ronde (17060106)+, Lower Snake-Tucannon (17060107)+, Lower Snake (17060110)+, Upper Salmon (17060201)+, Pahsimeroi (17060202)+, Middle Salmon-Panther (17060203)+, Lemhi (17060204)+, Upper Middle Fork Salmon (17060205)+, Lower Middle Fork Salmon (17060206)+, Middle Salmon-Chamberlain (17060207)+, South Fork Salmon (17060208)+, Lower Salmon (17060209)+, Little Salmon (17060210)+, Upper Selway (17060301)+, Lower Selway (17060302)+, Lochsa (17060303)+, South Fork Clearwater (17060305)+, Clearwater (17060306)+, Upper North Fork Clearwater (17060307)+, Lower North Fork Clearwater (17060308)+, Middle Columbia-Lake Wallula (17070101)+, Walla Walla (17070102)+, Middle Columbia-Hood (17070105)+, Klickitat (17070106)+, Lewis (17080002)+, Upper Cowlitz (17080004)+, Lower Cowlitz (17080005)+, Hoh-Quillayute (17100101)+, Upper Chehalis (17100103)+, Nooksack (17110004)+, Upper Skagit (17110005)+, Sauk (17110006)+, Lower Skagit (17110007)+, Stillaguamish (17110008)+, Skykomish (17110009)+, Snoqualmie (17110010)+, Duwamish (17110013)+, Puyallup (17110014)+, Skokomish (17110017)+, Hood Canal (17110018)+
18	Smith (18010101)+*, Upper Eel (18010103)+*, Middle Fork Eel (18010104)+, Shasta (18010207)+*, Scott (18010208)+, Lower Klamath (18010209)+, Salmon (18010210)+, Trinity (18010211)+, South Fork Trinity (18010212)+, Lower Pit (18020003)+, Mccloud (18020004)+, Sacramento headwaters (18020005)+, North Fork Feather (18020121)+*, East Branch North Fork Feather (18020122)+*, Middle Fork Feather (18020123)+, Upper Yuba (18020125)+, North Fork American (18020128)+*, South Fork American (18020129)+, Battle Creek (18020153)+*, Clear Creek-Sacramento River (18020154)+, Upper Kern (18030001)+*, South Fork Kern (18030002)+, Upper Poso (18030004)+*, Upper Tule (18030006)+*, Upper Kaweah (18030007)+, Upper King (18030010)+*, Upper San Joaquin (18040006)+, Upper Merced (18040008)+*, Upper Tuolumne (18040009)+, Upper Stanislaus (18040010)+*, Upper Mokelumne (18040012)+*, Surprise Valley (18080001)+*, Honey-Eagle Lakes (18080003)+*, Mono Lake (18090101)+, Crowley Lake (18090102)+, Owens Lake (18090103)+

+ Natural heritage record(s) exist for this watershed
* Extirpated/possibly extirpated

Ecology & Life History

Basic Description: A large mustelid.
General Description: A somewhat bearlike mustelid with massive limbs and long, dense, dark brown pelage, paler on the head, with two broad yellowish stripes extending from the shoulders and joining on the rump; bushy tail; relatively large feet; 650-1125 mm total length, 170-260 mm tail, 180-192 mm hind foot; mass 7-32 kg; females average about 10% less than males in linear measurements and 30% less in mass (Hall 1981, Ingles 1965, Nowak 1991).
Diagnostic Characteristics: Differs from the fisher in having yellowish stripes on the sides. Differs from the badger in having darker overall coloration (badger is yellowish gray), yellowish lateral stripes, and longer limbs; lacks the white stripe that in the badger extends from the snout over the top of the head to at least the neck.
Reproduction Comments: Breeds April-October (but variable), usually in summer. Implantation is delayed generally until winter. Gestation lasts 7-9 months; active gestation 30-40 days. One to six (usually 2-4) young are born January-April, mainly February or March (reportedly April-June in the Pacific states, Ingles 1965). Young are weaned beginning at about 7-8 weeks, separate from the mother in the fall. Sexually mature generally in the second or third year. Males sexually mature sometimes as yearlings (Alaska and Yukon); males over three years old were sexually mature in British Columbia. Some females mature at 12-15 months and produce their first litter when two years old. (Wilson 1982). In some areas, females may produce litters only every 2-3 years. In British Columbia, most mature females were reproductively active. Lives to an age of up to about 10 years, or sometimes 15-18 years or so.
Ecology Comments: Solitary and wide ranging. Occurs at relatively low population densities (e.g., 1 per 65 sq km in one area in Montana).

Males in some areas apparently are territorial, but in Montana there was extensive overlap of the ranges of both the same and opposite sexes. Apparently territory/range size depends on availability of denning sites and food supply (see Wilson 1982). Some individuals travel regularly over the same route (Wilson 1982).

There are no important predators other than humans. See Whitman et al. (1986).
Habitat Type: Terrestrial
Non-Migrant: Y
Locally Migrant: Y
Long Distance Migrant: N

Mobility and Migration Comments: Tends to occupy higher elevations in summer, lower elevations in winter (Hornocker and Hash 1981, Whitman et al. 1986).

Male home ranges large: up to 1,000 square kilometers (RIC 1999); averaging 422 square kilometers in Montana (Hornocker and Hash 1981) and 535 square kilometers in Alaska (Whitman et al. 1986). Home ranges of females with young much smaller, ranging from 73 to 416 square kilometers (Hornocker and Hash 1981, Gardner 1985, Magoun 1985, Whitman et al. 1986, Banci 1987, Copeland 1996).
Terrestrial Habitat(s): Alpine, Forest - Conifer, Grassland/herbaceous, Shrubland/chaparral, Tundra, Woodland - Conifer
Special Habitat Factors: Burrowing in or using soil, Fallen log/debris
Habitat Comments: Alpine and arctic tundra, boreal and mountain forests (primarily coniferous). Limited to mountains in the south, especially large wilderness areas. Usually in areas with snow on the ground in winter. Riparian areas may be important winter habitat. May disperse through atypical habitat. When inactive, occupies den in cave, rock crevice, under fallen tree, in thicket, or similar site. Terrestrial and may climb trees.

Young are born in a den among rocks or tree roots, in hollow log, under fallen tree, or in dense vegetation, including sites under snow.
Adult Food Habits: Carnivore
Immature Food Habits: Carnivore
Food Comments: Opportunistic. Feeds on a wide variety of roots, berries, small mammmals, birds' eggs and young, fledglings, and fish (Hatler 1989). May attack moose, caribou, and deer hampered by deep snow. Small and medium size rodents and carrion (especially ungulate carcasses) often make up a large percentage of the diet. Prey are captured by pursuit, ambush, digging out dens (Biosystems Analysis 1989), or climbing into trees. May cache prey in fork of tree branches or under snow.
Adult Phenology: Circadian, Nocturnal
Immature Phenology: Circadian, Nocturnal
Phenology Comments: Active throughout the year. Active both day and night but primarily nocturnal.
Length: 100 centimeters
Weight: 15000 grams

Economic Attributes

Economic Comments: Fur is favorable for trimming parkas, but limited numbers make the wolverine relatively unimportant as a furbearer. In the 1970s, annual harvest was several hundred in Alaska and a few dozen in Montana (Wilson 1982). In the early 1980s, the harvest in Canada, Alaska, and Montana was 1377 (Nowak 1991).

Sometimes regarded as a nuisance; may rob traplines or destroy human food caches. Was intensively hunted in Scandinavia because of alleged predation on domestic reindeer (Nowak 1991).

Management Summary

Preserve Selection & Design Considerations: Maintaining wilderness and roadless areas is critical. In timber harvest areas, roads should be minimized.

Although wolverines maintain large home ranges, they exhibit fidelity to discrete areas, and populations in scattered sites within areas such as the Northwest Territories (Canada) are genetically independent, suggesting the need to consider preservation of multiple populations if genetic diveristy is to be maintained (Wilson et al. 2000).
Management Requirements: Management programs must be regional, rather than local, for this wide-ranging, low-density species.

Rowland et al. (2003) evaluated performance of landscape models for wolverines within their historical range at 2 scales based on recent observations (n = 421) from Washington, Oregon, Idaho, and Montana. At the subbasin scale, simple overlays of habitat and road-density classes were effective in predicting observations of wolverines. At the watershed scale, they used a Bayesian belief network model to provide spatially explicit estimates of relative habitat capability. The model had 3 inputs: amount of habitat, human population density, and road density. At both scales, the best models revealed strong correspondence between means of predicted counts of wolverines and means of observed counts. Their results can be used to guide regional conservation planning for wolverines.

See Predator Conservation Alliance (2001) for a summary of management needs.
Monitoring Requirements: Survey techniques were summarized by McKay (1991) and Butts (1992).

Population/Occurrence Delineation

Use Class: Not applicable
Minimum Criteria for an Occurrence: Evidence of historical presence, or current and likely recurring presence, at a given location. Such evidence minimally includes collection or reliable observation and documentation of one or more individuals in appropriate habitat where the species is presumed to be established and breeding.

Separation Barriers: None.
Alternate Separation Procedure: Occurrences generally should be based on major occupied physiographic or ecogeographic units that are separated along areas of relatively low wolverine density or use. These units may be based on available sightings/records or on movements of radio-tagged individuals, or they may be based on the subjective determinations by biologists familiar with wolverines and their habitats. Where occupied habitat is exceptionally extensive and continuous, that habitat may be subdivided into multiple contiguous occurrences as long as that does not reduce the occurrence rank (i.e., do not split up an A occurrence into multiple occurrences that would be ranked less than A). The dividing lines should be made as much as possible along lines of limited wolverine use; for example, along very rugged alpine ridges or very wide bodies of water.
Separation Justification: Available evidence indicates that juveniles disperse usually around 30-100 km from their natal range, though dispersal movements of more than 300 km are known (Magoun 1985, Gardner et al. 1986). Kyle and Strobeck (2002) confirmed that high levels of gene flow do occur among all the northern wolverine populations sampled, although they also observed progressively increasing genetic structure at the periphery of their southern and eastern distributions. Thus available evidence indicates that populations or metapopulations may occupy vast areas. For this and other wide-ranging, low density mammals, it seems most reasonable to base occurrences (and conservation efforts) on major occupied landscape features rather than on specific prescribed separation distances (e.g., see Rowland et al. 2003)

Mountain ranges and large rivers are not barriers to the same extent that they are for many related species (Hornocker and Hash 1981, Banci 1987).
Inferred Minimum Extent of Habitat Use (when actual extent is unknown): 25 km
Inferred Minimum Extent Justification: Based on a home range of about 500 square kilometers (see Separation Justification).
Date: 09Mar2005
Author: Hammerson, G., and S. Cannings

Population/Occurrence Viability

Justification: **Use the Generic Guidelines for the Application of Occurrence Ranks (2008).**
The Key for Ranking Species Occurrences Using the Generic Approach provides a step-wise process for implementing this method.
Key for Ranking Species Element Occurrences Using the Generic Approach (2008).

U.S. Invasive Species Impact Rank (I-Rank) — Not yet assessed

Authors/Contributors

NatureServe Conservation Status Factors Edition Date: 04Mar2011
NatureServe Conservation Status Factors Author: Hammerson, G., J. Griffin, and F. Dirrigl, Jr.
Element Ecology & Life History Edition Date: 04Mar2005
Element Ecology & Life History Author(s): Hammerson, G.

Zoological data developed by NatureServe and its network of natural heritage programs (see **Local Programs**) and other contributors and cooperators (see **Sources**).

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Use Guidelines & Citation

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Citation for Bird Range Maps of North America:
Ridgely, R.S., T.F. Allnutt, T. Brooks, D.K. McNicol, D.W. Mehlman, B.E. Young, and J.R. Zook. 2003. Digital Distribution Maps of the Birds of the Western Hemisphere, version 1.0. NatureServe, Arlington, Virginia, USA.

Acknowledgement Statement for Bird Range Maps of North America:
"Data provided by NatureServe in collaboration with Robert Ridgely, James Zook, The Nature Conservancy - Migratory Bird Program, Conservation International - CABS, World Wildlife Fund - US, and Environment Canada - WILDSPACE."

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Patterson, B.D., G. Ceballos, W. Sechrest, M.F. Tognelli, T. Brooks, L. Luna, P. Ortega, I. Salazar, and B.E. Young. 2003. Digital Distribution Maps of the Mammals of the Western Hemisphere, version 1.0. NatureServe, Arlington, Virginia, USA.

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IUCN, Conservation International, and NatureServe. 2004. Global Amphibian Assessment. IUCN, Conservation International, and NatureServe, Washington, DC and Arlington, Virginia, USA.

Acknowledgement Statement for Amphibian Range Maps of the Western Hemisphere:
"Data developed as part of the Global Amphibian Assessment and provided by IUCN-World Conservation Union, Conservation International and NatureServe."

NOTE: Full metadata for the Bird Range Maps of North America is available at:
http://www.natureserve.org/library/birdDistributionmapsmetadatav1.pdf.

Full metadata for the Mammal Range Maps of North America is available at:
http://www.natureserve.org/library/mammalsDistributionmetadatav1.pdf.

Euphagus carolinus - (Müller, 1776)
Rusty Blackbird
Other English Common Names: rusty blackbird
Taxonomic Status: Accepted
Related ITIS Name(s): *Euphagus carolinus* (Statius Muller, 1776) (TSN 179091)
French Common Names: quiscale rouilleux
Spanish Common Names: Tordo Canadiense
Unique Identifier: ELEMENT_GLOBAL.2.101597
Element Code: ABPBXB5010
Informal Taxonomy: Animals, Vertebrates - Birds - Perching Birds


© Jeff Nadler

Kingdom	Phylum	Class	Order	Family	Genus
Animalia	Craniata	Aves	Passeriformes	Icteridae	Euphagus

Genus Size: B - Very small genus (2-5 species)

Check this box to expand all report sections: ☑

Concept Reference

Concept Reference: American Ornithologists' Union (AOU). 1998. Check-list of North American birds. Seventh edition. American Ornithologists' Union, Washington, D.C. [as modified by subsequent supplements and corrections published in *The Auk*]. Also available online: http://www.aou.org/.
Concept Reference Code: B98AOU01NAUS
Name Used in Concept Reference: *Euphagus carolinus*
Taxonomic Comments: Two subspecies are recognized in North America: *Euphagus carolinus carolinus*, which occupies most of the species' range, and the darker *E. c. nigrans*, which breeds in Newfoundland, Nova Scotia, Magdalen Island, and possibly eastern New Brunswick (AOU 1957, Avery 1995).

Few comprehensive molecular or morphological studies have been conducted on relationships between rusty blackbirds and other members of the sizeable family Icteridae. Brewer's blackbird (*Euphagus cyanocephalus*) is likely the closest relative. Species in the genus *Euphagus* are probably more closely allied with the grackles (*Quiscalus*) than to *Agelaius* blackbirds (Avery 1995).

Conservation Status

NatureServe Status

Global Status: G4
Global Status Last Reviewed: 07Apr2016
Global Status Last Changed: 16Sep2003
Ranking Methodology Used: Ranked by inspection
Rounded Global Status: G4 - Apparently Secure
Reasons: The reasons behind current trends are poorly understood but several threats are suspected to be causing the declines. The

destruction and conversion of boreal wetlands (predominantly in the southern boreal forests) is a significant threat to the species. Strip-mining for tar sands is expected to increase in the future, with up to 300,000 ha of Canada's boreal forest and wetland predicted to be directly affected over the next 30 to 50 years (Wellsÿet al.ÿ2008). Other possible threats include boreal wetland drying and chemical change resulting from global climate change, depletion of available calcium resulting from acid precipitation, increase in methyl mercury, loss of wooded wetlands in the south-east U.S. winter range, and mortality associated with past and ongoing blackbird control efforts. (Birdlife International, 2014).

Nation: United States
National Status: N4B,N4N (05Jan1997)
Nation: Canada
National Status: N4B,NUN,N4M (08Jan2018)

U.S. & Canada State/Province Status Due to latency between updates made in state, provincial or other NatureServe Network databases and when they appear on NatureServe Explorer, for state or provincial information you may wish to contact the data steward in your jurisdiction to obtain the most current data. Please refer to **our Distribution Data Sources** to find contact information for your jurisdiction.	
United States	Alabama (S4N), Alaska (S4B,S3N), Arkansas (S5N), Colorado (SNA), Connecticut (SNA), Delaware (SNA), District of Columbia (S3N), Florida (S2S3N), Georgia (S3), Illinois (SNA), Indiana (S2S3N), Iowa (S3N), Kansas (SNA), Kentucky (S3S4N), Louisiana (S3N), Maine (S3N,S3S4B), Maryland (S2S3N), Massachusetts (S1?B,S3N), Michigan (SNRN), Minnesota (SNRB), Mississippi (S2N), Missouri (SNRN), Montana (SNA), Navajo Nation (SNR), Nebraska (SNRN), New Hampshire (S3B), New Jersey (S4N), New Mexico (S2N), New York (S2B), North Carolina (S3N), North Dakota (SNA), Ohio (SNA), Oklahoma (S3N), Pennsylvania (S3N), Rhode Island (SNA), South Carolina (SNRN), South Dakota (S2N), Tennessee (S4N), Texas (S3), Vermont (S3B), Virginia (SNRN), Washington (SNA), West Virginia (S1N), Wisconsin (SNA), Wyoming (SNA)
Canada	Alberta (S3S4B), British Columbia (S3S4B), Labrador (S3B,SUM), Manitoba (S3S4B), New Brunswick (S3B,S3M), Newfoundland Island (S2S3B,SUM), Northwest Territories (S3B), Nova Scotia (S2B), Nunavut (SUB,SUM), Ontario (S4B), Prince Edward Island (S1B), Quebec (S3S4), Saskatchewan (S4B), Yukon Territory (S3B)

Other Statuses

Canadian Species at Risk Act (SARA) Schedule 1/Annexe 1 Status: SC (05Mar2009)
Committee on the Status of Endangered Wildlife in Canada (COSEWIC): Special Concern (28Apr2017)
Comments on COSEWIC: Reason for designation: Factors that threaten the persistence of this species in Canada have not been reversed or effectively managed since it was assessed as Special Concern in 2006. This species experienced steep population declines through the twentieth century, which may have stabilized recently. This may only be a temporary reprieve, as many important threats contributing to these declines have not been corrected, particularly on the U.S. wintering range. These problems include loss and degradation of wintering habitat due to wetland conversion and dam construction, blackbird control programs in agricultural areas, and impacts from the use of agricultural pesticides. Continuing threats on Canadian breeding grounds include mercury contamination and degradation of wetland habitat due to warming, acidification, and drying climates.

Status history: Designated Special Concern in April 2006. Status re-examined and confirmed in April 2017.
IUCN Red List Category: VU - Vulnerable

NatureServe Global Conservation Status Factors

Range Extent: >2,500,000 square km (greater than 1,000,000 square miles)
Range Extent Comments: Breeding range extends from western and north-central Alaska to southern Keewatin and Labrador, south to central British Columbia, central Saskatchewan, northern shores of Lake Superior and Lake Huron, southeastern Ontario, Vermont, New Hampshire, Maine, northeastern New York, Massachusetts, and Nova Scotia (Avery 1995). During the nonbreeding season, this species ranges from southcoastal Alaska, southern Canada, and northern United States south to Texas, Gulf Coast, and northern Florida (but primarily in the southeastern United States) (Avery 1995).

Area of Occupancy: >12,500 4-km2 grid cells
Area of Occupancy Comments: Estimate but probably reasonable given population size still despite declines.

Number of Occurrences: 81 to >300
Number of Occurrences Comments: With a population estimate of over 5 million (Partners in Flight, 2013) and a distribution across all of northern Canada (Birdlife International, 2014), ther are undoubtedly at least 81 element occurrences for this species. But this species is classifed as vulnerable by Birdlife International

Population Size: >1,000,000 individuals
Population Size Comments: Post-breeding global abundance estimated at 4,900,000 individuals by Blancher (2003) based on analysis of North American Breeding Bird Survey (BBS) and Canadian Breeding Bird Census (BBC) data. For the same time period, Rich et al. (2004) estimated a global population of about 2,000,000 birds based on BBS survey data. The disparity between population estimates demonstrates the current lack of abundance data and the potential inadequacies of using the BBS to survey for this species due, in part, to the relative inaccessibility of most of the species breeding range (Hannah 2004).

Results from the North American BBS indicate a survey-wide average of 0.27 birds/survey route for 1966-2004 (Sauer et al. 2005). Breeding densities are generally very low, even at the center of the breeding range (Flood 1987, Hannah 2004). Densities are generally higher in northwestern Canada than in Atlantic Canada. In northern Saskatchewan, densities ranged from 2 to 31 individuals/km2 (Hobson et al 2000); in the Hudson Bay lowlands of northern Manitoba densities were 20 individuals/km2 (Gillespie and Kendeigh 1982); in the Old Crow region, Yukon Territory, densities range from 18 to 90 individuals/km2; and in British Columbia, densities of 5 individuals/km2 were reported (Erskine 1977). In Alaska, densities are relatively high, ranging from 10 to 30 territories/km2 (Hannah 2004).

Number of Occurrences with Good Viability/Integrity: Some to very many (13 to >125)
Viability/Integrity Comments: Wide estimate range because of apparent decline in population numbers

Overall Threat Impact Comments: On wintering grounds, potential threats and/or causes for observed population decline include destruction of wooded wetlands and blackbird control programs; on breeding grounds, acid precipitation and conversion of boreal forest wetlands have been implied (Greenberg and Droege 1999).

Habitat degradation: Land-use practices that degrade or reduce wooded wetlands are detrimental to this species' habitat needs (Avery 1995). Greatest loss of wooded wetlands is on the wintering grounds. Between the mid-1950s and mid-1980s, about 25% of remaining wooded wetlands in the southeastern U.S, an area that encompasses most of the species' winter range, were drained and converted (Hefner and Brown 1984, Greenberg and Droege 1999). However, modern rates of wooded wetland conversion may not be sufficient to explain the severity of recent declines; changes on the breeding grounds may also be limiting this species (Greenberg and Droege 1999). Several other species that utilize high-latitude wetland habitats for breeding, such as the Horned Grebe (*Podiceps auritius*) and Lesser Yellowlegs (*Tringa flavipes*), are also experiencing survey-wide (BBS) declines (Sauer et al. 2005).

Clearcut logging on breeding grounds removes habitat and may also encourage establishment of competitors Common Grackles and Red-winged Blackbirds (*Agelaius phoeniceus*) (Ellison 1990), or encourage invasion by Brown-headed Cowbirds (*Molothrus ater*), a common and potentially problematic nest parasite (Avery 1995). Conversely, recently logged habitat, when saturated with water, may provide breeding habitat for this species; Ellison (1990) found several Rusty Blackbird nests and fledglings in recent clearcuts in Vermont. Although recent clearcuts may satisfy habitat requirements for this species, no data exists on the relative quality of these sites (Hannah 2000, 2004).

Blackbird control programs: Rusty Blackbirds may form mixed-species flocks in winter with other blackbirds and starlings, regularly exceeding 1 million birds. As a result, species has been subjected to lethal control to reduce nuisance, health, and crop damage problems (Avery 1995). Winter roost control programs in the eastern U.S. coincided with declines in Common Grackle populations (Avery 1995, Greenberg and Droege 1999). The overall effect on Rusty Blackbird populations is unknown but suspected localized and nominal, as this species typically constitutes <1% of winter roosts (Avery 1995).

Wetland acidification: Acidification of boreal wetlands due to industrial emissions is also of concern, particularly in eastern North America, but overall effects are unknown (Greenberg and Droege 1999). Since Rusty Blackbirds inhabit areas with naturally high soil acidity, it is difficult to determine the real impact of acidification (Darveau et al. 1989, Savignac 2004). Declines in snail abundance in acidified soils in the Netherlands have been linked to declines in passerine production (Graveland et al. 1994); given the high proportion of snails and mollusks in Rusty Blackbird diets, the impacts of acidification on food resources could be of concern (Greenberg and Droege 1999).

Short-term Trend Comments: A statistically significant, survey-wide decline of -10.3% per year ($P < 0.01$, $n = 96$), 1966-2004, is indicated by North American Breeding Bird Survey data (Sauer et al. 2005). The latest 2002 - 2012 results show a 3.49% annual decline (Sauer, et. al. 2014), which translates to a 70% decline in numbers over the 10 year time period

Long-term Trend: Decline of >90%
Long-term Trend Comments: A significant, range-wide decline of approximately 90% over the past 4-5 decades is indicated by data from the Breeding Bird Survey, Christmas Bird Counts, and Quebec Checklist Program (Greenberg and Droege 1999, Niven et al.

2004, Savignac 2004, Sauer et al. 2005). Analyses of abundance classifications in bird distribution books and annotated checklists reveal a long-term decline dating back to at least the early part of the 1900s (Greenberg and Droege 1999). The latest BBS (Sauer, et. al. 2014) has a 5.56% decline over the 1966 - 2012 time period.

Intrinsic Vulnerability: Highly to moderately vulnerable.
Intrinsic Vulnerability Comments: This species breeds in boreal wetlands of Canada, a region that will be affected by climate change (Avery, 2013). Acid rain and mercury accumulation within its distributioni may also be factors (National Audubon Society, 2014).

Environmental Specificity: Narrow to moderate.
Environmental Specificity Comments: Limited to boreal regions of Canada for breeding.

Other NatureServe Conservation Status Information

Inventory Needs: BBS and other traditional large-scale monitoring programs are insufficient for this species; methods to better survey remote roadless and wetland areas should be explored, including efforts similar to the Off-road Breeding Bird Survey (ORBBS) and the Alaska Landbird Monitoring Survey (ALMS); the status of breeding populations needs to be clarified throughout the range (Hannah 2004).

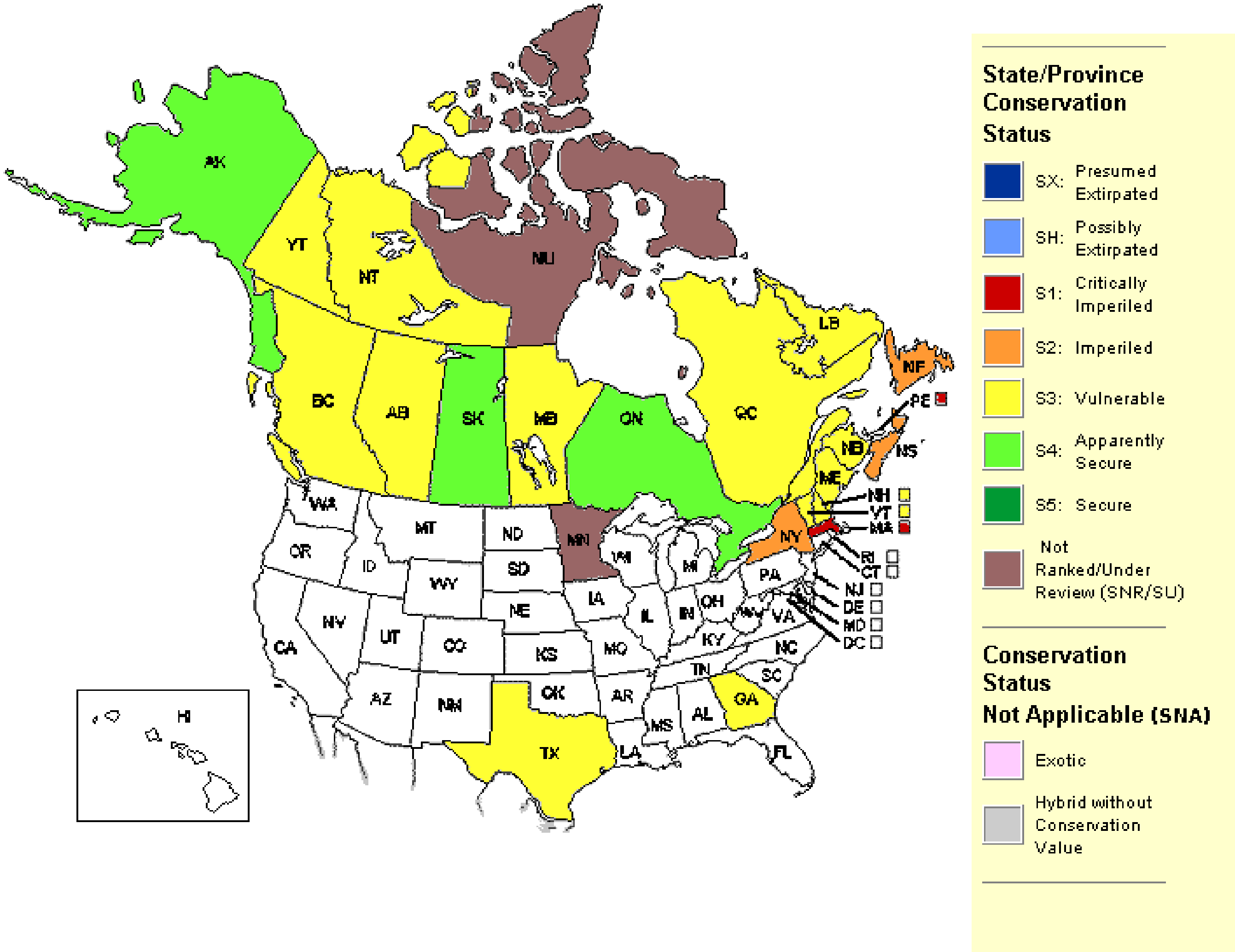
Protection Needs: Stop lethal control of blackbirds in areas where Rusty Blackbirds are known to winter in high numbers

Distribution

Global Range: (>2,500,000 square km (greater than 1,000,000 square miles)) Breeding range extends from western and north-central Alaska to southern Keewatin and Labrador, south to central British Columbia, central Saskatchewan, northern shores of Lake Superior and Lake Huron, southeastern Ontario, Vermont, New Hampshire, Maine, northeastern New York, Massachusetts, and Nova Scotia (Avery 1995). During the nonbreeding season, this species ranges from southcoastal Alaska, southern Canada, and northern United States south to Texas, Gulf Coast, and northern Florida (but primarily in the southeastern United States) (Avery 1995).

U.S. States and Canadian Provinces

Due to latency between updates made in state, provincial or other NatureServe Network databases and when they appear on NatureServe Explorer, for state or provincial information you may wish to contact the data steward in your jurisdiction to obtain the most current data. Please refer to **our Distribution Data Sources** to find contact information for your jurisdiction.



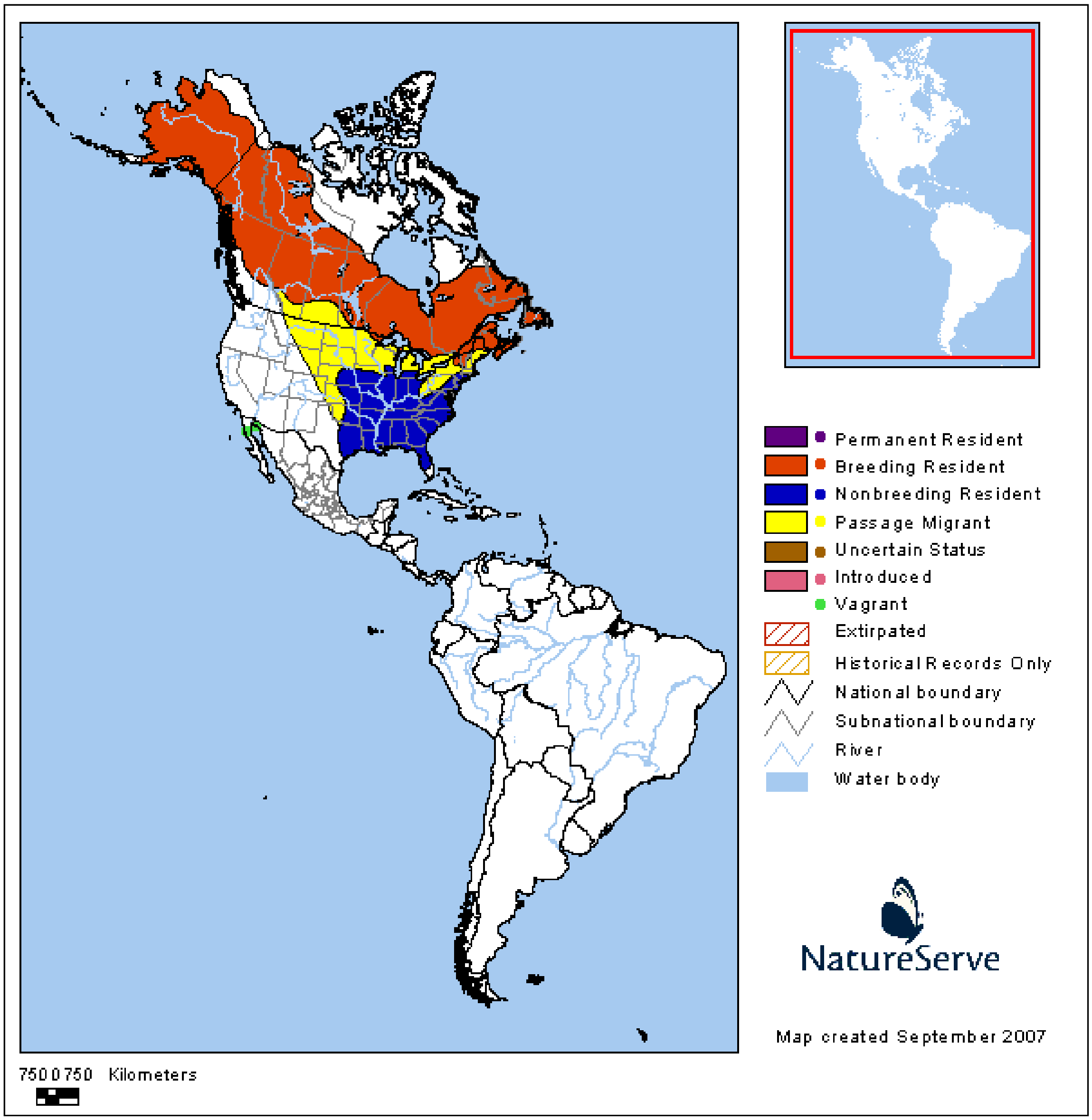
NOTE: The maps for birds represent the breeding status by state and province. In some jurisdictions, the subnational statuses for common species have not been assessed and the status is shown as not-assessed (SNR). In some jurisdictions, the subnational status refers to the status as a non-breeder; these errors will be corrected in future versions of these maps. A species is not shown in a jurisdiction if it is not known to breed in the jurisdiction or if it occurs only accidentally or casually in the jurisdiction. Thus, the species may occur in a jurisdiction as a seasonal non-breeding resident or as a migratory transient but this will not be indicated on these maps. See other maps on this web site that depict the Western Hemisphere ranges of these species at all seasons of the year.

Endemism: occurs (regularly, as a native taxon) in multiple nations

U.S. & Canada State/Province Distribution	
United States	AK, AL, AR, CO, CT, DC, DE, FL, GA, IA, IL, IN, KS, KY, LA, MA, MD, ME, MI, MN, MO, MS, MT, NC, ND, NE, NH, NJ, NM, NN, NY, OH, OK, PA, RI, SC, SD, TN, TX, VA, VT, WA, WI, WV, WY
Canada	AB, BC, LB, MB, NB, NF, NS, NT, NU, ON, PE, QC, SK, YT

Range Map

Note: Range depicted for New World only. The scale of the maps may cause narrow coastal ranges or ranges on small islands not to appear. Not all vagrant or small disjunct occurrences are depicted. For migratory birds, some individuals occur outside of the passage migrant range depicted. For information on how to obtain shapefiles of species ranges see our Species Mapping pages at www.natureserve.org/conservation-tools/data-maps-tools.



Range Map Compilers: NatureServe, 2002; WILDSPACETM 2002

U.S. Distribution by County

State	County Name (FIPS Code)
AK	Aleutians West (CA) (02016), Anchorage (02020), Bethel (CA) (02050), Bristol Bay (02060), Denali (02068), Dillingham (CA) (02070), Fairbanks North Star (02090), Haines (02100), Juneau (02110), Kenai Peninsula (02122), Ketchikan Gateway (02130)*, Lake and Peninsula (02164), Matanuska-Susitna (02170), Nome (CA) (02180), North Slope (02185), Northwest Arctic (02188), Prince of Wales-Outer Ketchikan (CA) (02201)*, Sitka (02220)*, Skagway-Hoonah-Angoon (CA) (02232), Southeast Fairbanks (CA) (02240), Valdez-Cordova (CA) (02261), Wade Hampton (CA) (02270), Wrangell-Petersburg (CA) (02280), Yakutat (02282), Yukon-Koyukuk (CA) (02290)
ID	Ada (16001), Blaine (16013), Bonner (16017), Jefferson (16051), Kootenai (16055), Latah (16057)
MS	Clay (28025), Coahoma (28027), DeSoto (28033), George (28039), Grenada (28043), Hancock (28045), Hinds (28049), Issaquena (28055), Itawamba (28057), Jackson (28059), Lafayette (28071), Lauderdale (28075), Lee (28081), Lowndes (28087), Madison (28089), Noxubee (28103), Oktibbeha (28105), Panola (28107), Pearl River (28109), Rankin (28121), Tate (28137), Tishomingo (28141), Tunica (28143), Warren (28149), Washington (28151), Yalobusha (28161)
NH	Carroll (33003), Coos (33007), Grafton (33009), Hillsborough (33011)
NY	Essex (36031), Franklin (36033), Hamilton (36041), St. Lawrence (36089)
VT	Bennington (50003), Caledonia (50005), Essex (50009), Lamoille (50015), Orleans (50019), Rutland (50021), Washington (50023), Windham (50025), Windsor (50027)

* Extirpated/possibly extirpated

U.S. Distribution by Watershed

Watershed Region	Watershed Name (Watershed Code)
01	Saco (01060002)+, Pemigewasset (01070001)+, Contoocook (01070003)+, Upper Connecticut (01080101)+, Passumpsic (01080102)+, Waits (01080103)+, White (01080105)+, Black-Ottauquechee (01080106)+, West (01080107)+
02	Upper Hudson (02020001)+, Hudson-Hoosic (02020003)+
03	Upper Tombigbee (03160101)+, Town (03160102)+, Tibbee (03160104)+, Middle Tombigbee-Lubbub (03160106)+, Noxubee (03160108)+, Sucarnoochee (03160202)+, Chunky-Okatibbee (03170001)+, Pascagoula (03170006)+, Black (03170007)+, Escatawpa (03170008)+, Mississippi Coastal (03170009)+, Middle Pearl-Strong (03180002)+, Lower Pearl. Mississippi (03180004)+
04	Black (04150101)+, Grass (04150304)+, Raquette (04150305)+, St. Regis (04150306)+, English-Salmon (04150307)+, Winooski River (04150403)+, Ausable River (04150404)+, Lamoille River (04150405)+, St. Francois River (04150500)+
08	Horn Lake-Nonconnah (08010211)+*, Lower Mississippi-Greenville (08030100)+, Little Tallahatchie (08030201)+, Tallahatchie (08030202)+, Yocona (08030203)+, Coldwater (08030204)+, Yalobusha (08030205)+, Lower Yazoo (08030208)+, Deer-Steele (08030209)+, Lower Mississippi-Natchez (08060100)+
17	Pend Oreille Lake (17010214)+, Coeur D'alene Lake (17010303)+, Idaho Falls (17040201)+, Little Wood (17040221)+, Lower Boise (17050114)+, Palouse (17060108)+
19	Southeast Mainland (19010101)+, Ketchikan (19010102)+*, Mainland (19010201)+, Kuiu-Kupreanof-Mitkof-Etolin-Zarembo-Wrangell Isla (19010202)+, Admiralty Island (19010204)+*, Lynn Canal (19010301)+, Glacier Bay (19010302)+*, Chilkat-Skagway Rivers (19010303)+, Taku River (19010304)+, Yakutat Bay (19010401)+, Icy Strait-Chatham Strait (19010500)+, Upper Copper River (19020101)+, Middle Copper River (19020102)+, Chitina River (19020103)+, Lower Copper River (19020104)+, Eastern Prince William Sound (19020201)+, Western Prince William Sound (19020202)+, Prince William Sound (19020203)+, Lower Kenai Peninsula (19020301)+, Upper Kenai Peninsula (19020302)+, Anchorage (19020401)+, Matansuka (19020402)+, Upper Susitna River (19020501)+, Chulitna River (19020502)+, Talkeetna River (19020503)+, Yentna River (19020504)+, Lower Susitna River (19020505)+, Shelikof Straight (19020702)+*, Cook Inlet (19020800)+, Pribilof Islands (19030104)+, Ugashik Bay (19030202)+, Egegik Bay (19030203)+, Naknek (19030204)+, Lake Clark (19030205)+, Lake Iliamna (19030206)+, Upper Nushagak River (19030301)+, Lower Nushagak River (19030303)+, Wood River (19030304)+, Togiak (19030305)+, Nushagak Bay (19030306)+, North Fork Kuskokwim River (19030401)+*, Takotna River (19030403)+, Stony River (19030405)+, Aniak (19030501)+, Kuskokwim Delta (19030502)+, White River (19040101)+, Ladue River (19040102)+, Sheenjek River (19040203)+, Black River (19040204)+, Porcupine Flats (19040205)+, Grass River (19040206)+, Eagle To Circle (19040401)+, Birch-Beaver Creeks (19040402)+, Yukon Flats (19040403)+, Nebesna-Chisana Rivers (19040501)+, Tok (19040502)+, Delta River (19040504)+, Salcha River (19040505)+, Chena River (19040506)+, Tanana River (19040507)+, Nenana River (19040508)+, Tolovana River (19040509)+, Kantishna River (19040510)+*, Upper Koyukuk River (19040601)+, South Fork Koyukuk River (19040602)+, Alatna River (19040603)+, Kanuti River (19040604)+, Allakaket River (19040605)+, Kateel River (19040609)+, Galena (19040705)+, Anvik River (19040801)+, Lower Innoko River (19040803)+, Anvik to Pilot Station (19040804)+, Yukon Delta (19040805)+, St. Lawrence Island (19050101)+*, Unalakleet (19050102)+, Norton Bay (19050103)+, Nome (19050104)+, Imuruk Basin (19050105)+, Shishmaref (19050201)+, Goodhope-Spafarief Bay (19050202)+, Selawik Lake (19050301)+, Upper Kobuk River (19050302)+, Middle Kobuk River (19050303)+, Lower Kobuk River (19050304)+, Upper Noatak River (19050401)+, Middle Noatak River (19050402)+*, Lower Noatak River (19050403)+, Wulik-Kivalina Rivers (19050404)+*, Kotzebue Sound (19050500)+, Killik River (19060302)+*, Chandler-Anaktuvuk Rivers (19060303)+*, Kuparuk River (19060401)+, Sagavanirktok River (19060402)+, Canning River (19060501)+*

+ Natural heritage record(s) exist for this watershed
* Extirpated/possibly extirpated

Ecology & Life History

Basic Description: A medium-sized passerine.
Reproduction Comments: Clutch size is 4-5. Incubation, by female, lasts 14 days. Young are tended by both parents, leave nest at about 13 days.
Non-Migrant: N
Locally Migrant: N
Long Distance Migrant: Y
Mobility and Migration Comments: Arrives in northern U.S. February-April (Terres 1980).
Palustrine Habitat(s): Bog/fen, FORESTED WETLAND, Riparian, SCRUB-SHRUB WETLAND
Terrestrial Habitat(s): Cropland/hedgerow, Grassland/herbaceous, Shrubland/chaparral, Woodland - Conifer

Habitat Comments: Breeding habitat includes moist woodland (primarily coniferous), bushy bogs and fens, and wooded edges of water courses and beaver ponds. Nests are in trees or shrubs, usually in or near water, frequently in a conifer to about 6 meters above ground. During migration and winter, habitat is primarily wooded wetlands and riparian areas but also includes various open woodlands, scrub, pastures, and cultivated lands (AOU 1983).
Adult Food Habits: Frugivore, Granivore, Invertivore
Immature Food Habits: Frugivore, Granivore, Invertivore
Food Comments: Eats insects and various other invertebrates, some small amphibians and fishes, seeds, grains, small fruits; forages on ground and in shallow water (Terres 1980).
Adult Phenology: Diurnal
Immature Phenology: Diurnal
Length: 23 centimeters
Weight: 64 grams

Economic Attributes

Not yet assessed

Management Summary

Biological Research Needs: Research using stable isotopes to link wintering and breeding populations, and to connect demographic changes with specific regions of North America, is underway in the United States and Canada (CWS 2005). Additional research is needed to understand the cause(s) of the population decline. Natural history and breeding biology, including productivity and courtship behavior, require further study. Also needed is information on foraging behavior and diet, flocking habits, and habitat and resource use during the nonbreeding season (Greenberg and Droege 1999). Loss of key wetland habitat on wintering grounds has been extensive, but this bird appears to be more flexible than previously thought in its use of wintering habitat. We need better data on use of wintering habitat in this species, and on diet in those areas.Vocal behavior on the breeding grounds is not well understood, particularly the functions of the 2 types of male song and the function of the female song. Social organization during the nesting season appears variable and perhaps is influenced by the type and structure of the available habitat. Unambiguous evidence of colonial nesting is needed; also, factors governing whether the species nests singly or in colonies should be investigated. (Avery, 2013).

Population/Occurrence Delineation

Group Name: Passerines

Use Class: Breeding
Subtype(s): Foraging Area, Nest Site, Nesting Colony
Minimum Criteria for an Occurrence: Evidence of historical breeding, or current and likely recurring breeding, at a given location, minimally a reliable observation of one or more breeding pairs in appropriate habitat. Be cautious about creating EOs for observations that may represent single breeding events outside the normal breeding distribution.

Mapping Guidance: Breeding occurrences include nesting areas as well as foraging areas.

For swallows and other species that have separate nesting and foraging areas, separations are based on nest sites or nesting areas, not to locations of foraging individuals. For example, nesting areas separated by a gap larger than the separation distance are different occurrences, regardless of the foraging locations of individuals from those nesting areas. This separation procedure is appropriate because nesting areas are the critical aspect of swallow breeding occurrences, tend to be relatively stable or at least somwhat predictable in general location, and so are the basis for effective conservation; foraging areas are much more flexible and not necessarily static.
Separation Distance for Unsuitable Habitat: 5 km
Separation Distance for Suitable Habitat: 5 km
Separation Justification: Significant dispersal and associated high potential for gene flow among populations of birds separated by tens of kilometers (e.g., Moore and Dolbeer 1989), and increasing evidence that individuals leave their usual home range to engage in extrapair copulations, as well as long foraging excursions of some species, make it difficult to circumscribe occurrences on the basis of meaningful population units without occurrences becoming too large. Hence, a moderate, standardized separation distance has been adopted for songbirds and flycatchers; it should yield occurrences that are not too spatially expansive while also accounting for the likelihood of gene flow among populations within a few kilometers of each other.

Be careful not to separate a population's nesting areas and foraging areas as different occurrences; include them in the same occurrence even if they are more than 5 km apart. Mean foraging radius (from nesting area) of Brown-headed Cowbird females was 4.0 kilometers in California, 1.2 kilometers in Illinois-Missouri (Thompson 1994). Yellow-headed Blackbirds, Brewer's Blackbirds, and probably Red-winged Blackbirds all forage up to 1.6 kilometers away from breeding colony (Willson 1966, Horn 1968). In one study, Brewer's Blackbirds were found as far as 10 kilometers from nesting area (Williams 1952), but this may be unusual.

For swallows and other parrerines with similar behavioral ecology, separation distance pertains to nest sites or nesting colonies, not to locations of foraging individuals. For example, nesting areas separated by a gap of more than 5 km are different occurrences, regardless of the foraging locations of individuals from those nesting areas. This separation procedure is appropriate because nesting areas are the critical aspect of swallow breeding occurrences, tend to be relatively stable or at least somwhat predictable in general location, and so are the basis for effective conservation; foraging areas are much more flexible and not necessarily static.

Be cautious about creating EOs for observations that may represent single breeding events outside the normal breeding distribution.

Unsuitable habitat: Habitat not normally used for breeding/feeding by a particular species. For example, unsuitable habitat for grassland and shrubland birds includes forest/woodland, urban/suburban, and aquatic habitats. Most habitats would be suitable for birds with versatile foraging habits (e.g., most corvids).
Date: 10Sep2004
Author: Hammerson, G.

Use Class: Migratory stopover
Subtype(s): Foraging Area, Roost Site
Minimum Criteria for an Occurrence: For most passerines: Evidence of recurring presence of migrating individuals (including historical) and potential recurring presence at a given location; minimally a reliable observation of 25 birds in appropriate habitat.

For swallows: Evidence of recurring presence of migrating flocks (including historical) and potential recurring presence at a given location; minimally a reliable observation of 100 birds in appropriate habitat (e.g., traditional roost sites).

Occurrences should be locations where the species is resident for some time during the appropriate season; it is preferable to have observations documenting presence over at least 7 days annually.

EOs should not be described for species that are nomadic during nonbreeding season: e.g., Lark Bunting.

Be cautious about creating EOs for observations that may represent single events.
Separation Distance for Unsuitable Habitat: 5 km
Separation Distance for Suitable Habitat: 5 km
Separation Justification: Separation distance somewhat arbitrary but intended to define occurrences of managable size for conservation purposes. Occurrences defined primarily on the basis of areas supporting concentrations of birds, rather than on the basis of distinct populations.

For swallows and other species with similar behavioral ecology, the separation distance pertains to communal roost sites rather than to foraging areas; the former tend to be more stable and specific over time than the latter.

Date: 03Sep2004
Author: Hammerson, G., and S. Cannings

Use Class: Nonbreeding
Subtype(s): Foraging Area, Roost Site
Minimum Criteria for an Occurrence: Any area used traditionally in the nonbreeding season (used for populations that are not resident in a location year-round). Minimally, reliable observations of 10 or more individuals in appropriate habitat for 20 or more days at a time. For G1-G3 species, observations of fewer individuals could constitute an occurrence of conservation value. Sites used during migration should be documented under the 'migratory stopover' location use class.

Separation Distance for Unsuitable Habitat: 5 km
Separation Distance for Suitable Habitat: 5 km
Separation Justification: Separation distance is necessarily arbitrary but attempts to balance the high mobility of birds with the need for occurrences of reasonable spatial scope. Note that a population's roost sites and foraging areas are parts of the same occurrence, even if they are more than 5 km apart.

For swallows and other species with similar behavioral ecology, the separation distance pertains to communal roost sites rather than to foraging areas; the former tend to be more stable and specific over time than the latter.
Date: 03Sep2004

Author: Hammerson, G.

Use Class: Nonmigratory
Minimum Criteria for an Occurrence: Occurrences are based on evidence of historical presence, or current and likely recurring presence, at a particular location. Such evidence minimally includes collection or reliable observation and documentation of one or more individuals in or near appropriate habitat.

These occurrence specifications are used for nonmigratory populations of passerine birds.
Separation Barriers: None.
Separation Distance for Unsuitable Habitat: 5 km
Separation Distance for Suitable Habitat: 5 km
Separation Justification: Significant dispersal and associated high potential for gene flow among populations of birds separated by tens of kilometers (e.g., Moore and Dolbeer 1989), and increasing evidence that individuals leave their usual home range to engage in extrapair copulations, as well as long foraging excursions of some species, make it difficult to circumscribe occurrences on the basis of meaningful population units without occurrences becoming too large. Hence, a moderate, standardized separation distance has been adopted for songbirds and flycatchers; it should yield occurrences that are not too spatially expansive while also accounting for the likelihood of gene flow among populations within a few kilometers of each other.

Be careful not to separate a population's nesting areas and breeding-season foraging areas as different occurrences; include them in the same occurrence even if they are more than 5 km apart. Blue jays have small summer home ranges but fly up to 4 kilometers to harvest mast (Tarvin and Woolfenden 1999). Flocks of pinyon jays range over 21-29 square kilometers (Ligon 1971, Balda and Bateman 1971); nesting and foraging areas may be widely separated. Tricolored blackbirds forage in flocks that range widely to more than 15 kilometers from the nesting colony (Beedy and Hamilton 1999).

Unsuitable habitat: Habitat not normally used for breeding/feeding by a particular species. For example, unsuitable habitat for grassland and shrubland birds includes forest/woodland, urban/suburban, and aquatic habitats. Most habitats would be suitable for birds with versatile foraging habits (e.g., most corvids).
Date: 10Sep2004
Author: Hammerson, G.
Notes: These specs pertain to nonmigratory species.

Population/Occurrence Viability

Justification: **Use the Generic Guidelines for the Application of Occurrence Ranks (2008).**
The Key for Ranking Species Occurrences Using the Generic Approach provides a step-wise process for implementing this method.
Key for Ranking Species Element Occurrences Using the Generic Approach (2008).

U.S. Invasive Species Impact Rank (I-Rank) — Not yet assessed

Authors/Contributors

NatureServe Conservation Status Factors Edition Date: 25Nov2014
NatureServe Conservation Status Factors Author: Jue, Dean K.
Element Ecology & Life History Edition Date: 01Aug2007
Element Ecology & Life History Author(s): Hammerson, G.

Zoological data developed by NatureServe and its network of natural heritage programs (see **Local Programs**) and other contributors and cooperators (see **Sources**).

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Note: All species and ecological community data presented in NatureServe Explorer at http://explorer.natureserve.org were updated to be current with NatureServe's central databases as of **March 2019**.
Note: This report was printed on **June 12, 2019**

agencies. If ground-disturbing activities are proposed on a site, the appropriate state natural heritage program(s) or conservation data center can be contacted for a site-specific review of the project area (see **Visit Local Programs**).

Feedback Request: NatureServe encourages users to let us know of any errors or significant omissions that you find in the data through (see **Contact Us**). Your comments will be very valuable in improving the overall quality of our databases for the benefit of all users.

Exposure Point Concentrations for Cartwright Former USAF Radar Station - General Area

Constituent	CAS-RN	Measured Soil Concentration (mg/kg dw)	Predicted Terrestrial Plant Concentration (mg/kg ww)	Predicted Terrestrial Invertebrate Concentration (mg/kg ww)	Predicted Terrestrial Prey Concentration (mg/kg ww)
PCBs					
Total Calculated PCB	1336-36-3	0.025	0.00038	0.01	0.1496

Predicted Terrestrial Plant Concentrations

Organics

Anthracene	$\ln(\text{terrestrial plant tissue}) = 0.7784 \times \ln[C_{Soil}] - 0.9887$ (USEPA, 2007) x dry weight to wet weight conversion (0.15)
Benzo(a)anthracene	$\ln(\text{terrestrial plant tissue}) = 0.5944 \times \ln[C_{Soil}] - 2.7078$ (USEPA, 2007) x dry weight to wet weight conversion (0.15)
Benzo(a)pyrene	$\ln(\text{terrestrial plant tissue}) = 0.975 \times \ln[C_{Soil}] - 2.0615$ (USEPA, 2007) x dry weight to wet weight conversion (0.15)
Benzo(b)fluoranthene	$C_{\text{terrestrial plant tissue}} = C_{soil} \times 0.310$ (USEPA, 2007) x dry weight to wet weight conversion (0.15)
Chrysene	$\ln(\text{terrestrial plant tissue}) = 0.5944 \times \ln[C_{Soil}] - 2.7078$ (USEPA, 2007) x dry weight to wet weight conversion (0.15)
Dibenzo(a,h)anthracene	Cterrestrial plant tissue = Csoil x 0.11 (USEPA, 2007) x dry weight to wet weight conversion (0.15)
Fluoranthene	$C_{\text{terrestrial plant tissue}} = C_{soil} \times 0.5$ (USEPA, 2007) x dry weight to wet weight conversion (0.15)

PCBs

$C_{\text{terrestrial plant tissue}} = C_{soil} \times B_V$ x dry weight to wet weight conversion (0.15) (CCME, 2006)

Where:

B_V = chemical specific bioconcentration factor

$= 10^{(2.53 - 0.4965*\log Kow)}$

log Bv = 2.53 - 0.4965 log Kow

K_{ow} = octanol water partitioning coefficient

Total Caculated PCB 1.26E+07

Maximum PCB concentration from Phase II ESA (Stantec, 2 0.35 mg/kg

Predicted Terrestrial Invertebrate Concentrations

Organics

$C_{\text{terrestrial invertebrate tissue}} = C_{soil} \times UF_{SI}$ x dry weight to wet weight conversion (0.16)

Where:

UF_{SI} = soil to invertebrate uptake factor

Anthracene	2.42	USEPA, 2007
Benzo(a)anthracene	1.59	USEPA, 2007
Benzo(a)pyrene	1.33	USEPA, 2007
Benzo(b)fluoranthene	2.6	USEPA, 2007
Chrysene	2.29	USEPA, 2007
Dibenzo(a,h)anthracene	2.31	USEPA, 2007
Fluoranthene	3.04	USEPA, 2007

PCBs

$\ln(C_{\text{terrestrial invertebrate tissue}}) = 1.7903 + 1.2909(\ln[C_{soil}])$ x dry weight to wet weight conversion (0.16) Sample et al., 1998

Predicted Terrestrial Prey Concentrations

Organics

Minimum value between $C_{terrestrial\ prey\ tissue}$ and C_{max}, calculated as follows:

$C_{terrestrial\ prey\ tissue}$ = BA_{SPA} × ((plant feed intake rate × C_{plant}) + (soil intake rate × C_{soil})) × B_i (RTI, 2005)

Where:

BA_{SPA} = biotransfer factor from soil or plant to animal (day/kg)

= $0.064 \times 10^{(-0.099 \text{ x log Kow}^2) + (1.07 \text{ x log Kow}) - 3.56}$ (RTI, 2005)

Anthracene	0.011
Benzo(a)anthracene	0.013
Benzo(a)pyrene	0.012
Benzo(b)fluoranthene	0.013
Chrysene	0.013
Dibenzo(a,h)anthracene	0.009
Fluoranthene	0.014
Total Calculated PCB	0.007

K_{ow} = octanol water partitioning coefficient

Anthracene	2.82E+04	RAIS, 2014		
Benzo(a)anthracene	5.75E+05	RAIS, 2014		
Benzo(a)pyrene	1.35E+06	RAIS, 2014	PCBs LogKow	7.10E+00
Benzo(b)fluoranthene	6.03E+05	RAIS, 2014	Anthracene LogKow	4.45E+00
Chrysene	6.46E+05	RAIS, 2014	Benzo(b)fluoranthene LogK	5.78E+00
Dibenzo(a,h)anthracene	5.62E+06	RAIS, 2014	Dibenzo(a,h)anthracene Log	6.75E+00
Fluoranthene	1.45E+05	RAIS, 2014		
Total Caculated PCB	1.26E+07	RAIS, 2014		

Plant feed intake rate = 60 kg wet weight/day for cattle (RTI, 2005)

Soil intake rate = 0.4 kg dry weight/day for cattle (RTI, 2005)

C_{plant} = predicted terrestrial plant concentration (mg/kg ww)

B_i = bioavailability in feed and soils (default value of 1)

M_i = metabolic factor (default value of 1)

C_{max} = (lifespan x ((food ingestion rate x C_{plant}) + (soil ingestion rate x C_{soil})) x B_i)/BW (RTI, 2005)

Where:

Life Span = 90 days (USEPA, 1993)

Food ingestion rate = 0.011 kg wet weight/day (USEPA, 1993)

Soil ingestion rate = 0.000315 kg dry weight/day (USEPA, 1993)

BW = body weight = 0.042 kg (USEPA, 1993)

Exposure Point Concentrations for Cartwright Former USAF Radar Station - Former Contractor Village

Constituent	CAS-RN	Measured Soil Concentration (mg/kg dw)	Predicted Terrestrial Plant Concentration (mg/kg ww)	Predicted Terrestrial Invertebrate Concentration (mg/kg ww)	Predicted Terrestrial Prey Concentration (mg/kg ww)
PCBs					
Total Calculated PCB	1336-36-3	0.025	0.00038	0.01	0.1411

Predicted Terrestrial Plant Concentrations

Organics

Anthracene	ln(terrestrial plant tissue) = 0.7784 x ln[C_{Soil}] - 0.9887 (USEPA, 2007) x dry weight to wet weight conversion (0.15)
Benzo(a)anthracene	ln(terrestrial plant tissue) = 0.5944 x ln[C_{Soil}] - 2.7078 (USEPA, 2007) x dry weight to wet weight conversion (0.15)
Benzo(a)pyrene	ln(terrestrial plant tissue) = 0.975 x ln[C_{Soil}] - 2.0615 (USEPA, 2007) x dry weight to wet weight conversion (0.15)
Benzo(b)fluoranthene	$C_{terrestrial\ plant\ tissue}$ = C_{soil} x 0.310 (USEPA, 2007) x dry weight to wet weight conversion (0.15)
Chrysene	ln(terrestrial plant tissue) = 0.5944 x ln[C_{Soil}] - 2.7078 (USEPA, 2007) x dry weight to wet weight conversion (0.15)
Dibenzo(a,h)anthracene	Cterrestrial plant tissue = Csoil x 0.11 (USEPA, 2007) x dry weight to wet weight conversion (0.15)
Fluoranthene	$C_{terrestrial\ plant\ tissue}$ = C_{soil} x 0.5 (USEPA, 2007) x dry weight to wet weight conversion (0.15)

PCBs

$C_{terrestrial\ plant\ tissue}$ = C_{soil} x B_V x dry weight to wet weight conversion (0.15) (CCME, 2006)

Where:

B_V = chemical specific bioconcentration factor

= $10^{(2.53\ -\ 0.4965*\log Kow)}$

log Bv = 2.53 - 0.4965 log Kow

K_{ow} = octanol water partitioning coefficient

Total Caculated PCB 1.26E+07

Maximum PCB concentration from Phase II ESA (Stantec, 2 0.33 mg/kg

Predicted Terrestrial Invertebrate Concentrations

Organics

$C_{terrestrial\ invertebrate\ tissue}$ = C_{soil} x UF_{SI} x dry weight to wet weight conversion (0.16)

Where:

UF_{SI} = soil to invertebrate uptake factor

Anthracene	2.42	USEPA, 2007
Benzo(a)anthracene	1.59	USEPA, 2007
Benzo(a)pyrene	1.33	USEPA, 2007
Benzo(b)fluoranthene	2.6	USEPA, 2007
Chrysene	2.29	USEPA, 2007
Dibenzo(a,h)anthracene	2.31	USEPA, 2007
Fluoranthene	3.04	USEPA, 2007

PCBs

ln($C_{terrestrial\ invertebrate\ tissue}$) = 1.7903 +1.2909(ln[$C_{soil}$]) x dry weight to wet weight conversion (0.16) Sample et al., 1998

Predicted Terrestrial Prey Concentrations

Organics

Minimum value between $C_{terrestrial\ prey\ tissue}$ and C_{max}, calculated as follows:

$C_{terrestrial\ prey\ tissue}$ = BA_{SPA} × ((plant feed intake rate × C_{plant}) + (soil intake rate × C_{soil})) × B_i × M_i,

Where:

BA_{SPA} = biotransfer factor from soil or plant to animal (day/kg)

= $0.064 \times 10^{(-0.099 \text{ x log Kow\^{}2}) + (1.07 \text{ x log Kow}) - 3.56)}$ (RTI, 2005)

Anthracene	0.011
Benzo(a)anthracene	0.013
Benzo(a)pyrene	0.012
Benzo(b)fluoranthene	0.013
Chrysene	0.013
Dibenzo(a,h)anthracene	0.009
Fluoranthene	0.014
Total Calculated PCB	0.007

K_{ow} = octanol water partitioning coefficient

Anthracene	2.82E+04	RAIS, 2014		
Benzo(a)anthracene	5.75E+05	RAIS, 2014		
Benzo(a)pyrene	1.35E+06	RAIS, 2014	PCBs LogKow	7.10E+00
Benzo(b)fluoranthene	6.03E+05	RAIS, 2014	Anthracene LogKow	4.45E+00
Chrysene	6.46E+05	RAIS, 2014	Benzo(b)fluoranthene LogK	5.78E+00
Dibenzo(a,h)anthracene	5.62E+06	RAIS, 2014	Dibenzo(a,h)anthracene Log	6.75E+00
Fluoranthene	1.45E+05	RAIS, 2014		
Total Caculated PCB	1.26E+07	RAIS, 2014		

Plant feed intake rate = 60 kg wet weight/day for cattle (RTI, 2005)

Soil intake rate = 0.4 kg dry weight/day for cattle (RTI, 2005)

C_{plant} = predicted terrestrial plant concentration (mg/kg ww)

B_i = bioavailability in feed and soils (default value of 1)

M_i = metabolic factor (default value of 1)

C_{max} = (lifespan x ((food ingestion rate x C_{plant}) + (soil ingestion rate x C_{soil})) x B_i)/BW (RTI, 2005)

Where:

Life Span = 90 days (USEPA, 1993)

Food ingestion rate = 0.011 kg wet weight/day (USEPA, 1993)

Soil ingestion rate = 0.000315 kg dry weight/day (USEPA, 1993)

BW = body weight = 0.042 kg (USEPA, 1993)

Exposure Point Concentrations for Cartwright Former USAF Radar Station - Main Complex

Constituent	CAS-RN	Measured Soil Concentration (mg/kg dw)	Predicted Terrestrial Plant Concentration (mg/kg ww)	Predicted Terrestrial Invertebrate Concentration (mg/kg ww)	Predicted Terrestrial Prey Concentration (mg/kg ww)
Polyaromatic Hydrocarbons					
Benzo(a)pyrene	50-32-8	1.001	0.019	0.213	0.019
PCBs					
Total Calculated PCB	1336-36-3	0.668	0.010	0.569	0.220

Predicted Terrestrial Plant Concentrations

Organics

Anthracene	ln(terrestrial plant tissue) = 0.7784 x ln[C_{Soil}] - 0.9887 (USEPA, 2007) x dry weight to wet weight conversion (0.15)
Benzo(a)anthracene	ln(terrestrial plant tissue) = 0.5944 x ln[C_{Soil}] - 2.7078 (USEPA, 2007) x dry weight to wet weight conversion (0.15)
Benzo(a)pyrene	ln(terrestrial plant tissue) = 0.975 x ln[C_{Soil}] - 2.0615 (USEPA, 2007) x dry weight to wet weight conversion (0.15)
Benzo(b)fluoranthene	$C_{terrestrial\ plant\ tissue}$ = C_{soil} x 0.310 (USEPA, 2007) x dry weight to wet weight conversion (0.15)
Chrysene	ln(terrestrial plant tissue) = 0.5944 x ln[C_{Soil}] - 2.7078 (USEPA, 2007) x dry weight to wet weight conversion (0.15)
Dibenzo(a,h)anthracene	Cterrestrial plant tissue = Csoil x 0.11 (USEPA, 2007) x dry weight to wet weight conversion (0.15)
Fluoranthene	$C_{terrestrial\ plant\ tissue}$ = C_{soil} x 0.5 (USEPA, 2007) x dry weight to wet weight conversion (0.15)

PCBs

$C_{terrestrial\ plant\ tissue}$ = C_{soil} x B_V x dry weight to wet weight conversion (0.15) (CCME, 2006)

Where:

B_V = chemical specific bioconcentration factor

= $10^{(2.53 - 0.4965*\log Kow)}$

log Bv = 2.53 - 0.4965 log Kow

K_{ow} = octanol water partitioning coefficient

Total Caculated PCB 1.26E+07

Maximum PCB concentration from Phase II ESA (Stantec, 2 0.51 mg/kg

Predicted Terrestrial Invertebrate Concentrations

Organics

$C_{terrestrial\ invertebrate\ tissue}$ = C_{soil} x UF_{SI} x dry weight to wet weight conversion (0.16)

Where:

UF_{SI} = soil to invertebrate uptake factor

Anthracene	2.42	USEPA, 2007
Benzo(a)anthracene	1.59	USEPA, 2007
Benzo(a)pyrene	1.33	USEPA, 2007
Benzo(b)fluoranthene	2.6	USEPA, 2007
Chrysene	2.29	USEPA, 2007
Dibenzo(a,h)anthracene	2.31	USEPA, 2007
Fluoranthene	3.04	USEPA, 2007

PCBs

ln($C_{terrestrial\ invertebrate\ tissue}$) = 1.7903 +1.2909(ln[$C_{soil}$]) x dry weight to wet weight conversion (0.16) Sample et al., 1998

Predicted Terrestrial Prey Concentrations

Organics

Minimum value between $C_{terrestrial\ prey\ tissue}$ and C_{max}, calculated as follows:

$C_{terrestrial\ prey\ tissue}$ = BA_{SPA} × ((plant feed intake rate × C_{plant}) + (soil intake rate × C_{soil})) × B_i × M_i,

Where:

BA_{SPA} = biotransfer factor from soil or plant to animal (day/kg)

$= 0.064 \times 10^{(-0.099 \times \log Kow^2) + (1.07 \times \log Kow) - 3.56)}$ (RTI, 2005)

Anthracene	0.011
Benzo(a)anthracene	0.013
Benzo(a)pyrene	0.012
Benzo(b)fluoranthene	0.013
Chrysene	0.013
Dibenzo(a,h)anthracene	0.009
Fluoranthene	0.014
Total Calculated PCB	0.007

K_{ow} = octanol water partitioning coefficient

Anthracene	2.82E+04	RAIS, 2014		
Benzo(a)anthracene	5.75E+05	RAIS, 2014		
Benzo(a)pyrene	1.35E+06	RAIS, 2014	PCBs LogKow	7.10E+00
Benzo(b)fluoranthene	6.03E+05	RAIS, 2014	Anthracene LogKow	4.45E+00
Chrysene	6.46E+05	RAIS, 2014	Benzo(b)fluoranthene LogK	5.78E+00
Dibenzo(a,h)anthracene	5.62E+06	RAIS, 2014	Dibenzo(a,h)anthracene Log	6.75E+00
Fluoranthene	1.45E+05	RAIS, 2014		
Total Caculated PCB	1.26E+07	RAIS, 2014		

Plant feed intake rate = 60 kg wet weight/day for cattle (RTI, 2005)

Soil intake rate = 0.4 kg dry weight/day for cattle (RTI, 2005)

C_{plant} = predicted terrestrial plant concentration (mg/kg ww)

B_i = bioavailability in feed and soils (default value of 1)

M_i = metabolic factor (default value of 1)

C_{max} = (lifespan x ((food ingestion rate x C_{plant}) + (soil ingestion rate x C_{soil})) x B_i)/BW (RTI, 2005)

Where:

Life Span = 90 days (USEPA, 1993)

Food ingestion rate = 0.011 kg wet weight/day (USEPA, 1993)

Soil ingestion rate = 0.000315 kg dry weight/day (USEPA, 1993)

BW = body weight = 0.042 kg (USEPA, 1993)

Exposure Point Concentrations for Cartwright Former USAF Radar Station - Former USAF Dump Area and Former Ammunition Storage Area

Constituent	CAS-RN	Measured Soil Concentration (mg/kg dw)	Predicted Terrestrial Plant Concentration (mg/kg ww)	Predicted Terrestrial Invertebrate Concentration (mg/kg ww)	Predicted Terrestrial Prey Concentration (mg/kg ww)
Polyaromatic Hydrocarbons					
Anthracene	120-12-7	10.920	0.359	4.228	0.289
Benzo(a)anthracene	56-55-3	13.520	0.047	3.439	0.110
Benzo(a)pyrene	50-32-8	10.110	0.182	2.151	0.182
Benzo(b)fluoranthene	205-99-2	8.975	0.417	3.734	0.380
Chrysene	218-01-9	11.200	0.042	4.104	0.093
Dibenzo(a,h)anthracene	53-70-3	1.317	0.022	0.487	0.017
Fluoranthene	206-44-0	40.740	3.056	19.816	2.702
PCBs					
Total Calculated PCB	1336-36-3	8.561	0.130	15.326	0.110

Predicted Terrestrial Plant Concentrations

Organics

Anthracene	ln(terrestrial plant tissue) = 0.7784 x ln[C_{Soil}] - 0.9887 (USEPA, 2007) x dry weight to wet weight conversion (0.15)
Benzo(a)anthracene	ln(terrestrial plant tissue) = 0.5944 x ln[C_{Soil}] - 2.7078 (USEPA, 2007) x dry weight to wet weight conversion (0.15)
Benzo(a)pyrene	ln(terrestrial plant tissue) = 0.975 x ln[C_{Soil}] - 2.0615 (USEPA, 2007) x dry weight to wet weight conversion (0.15)
Benzo(b)fluoranthene	$C_{terrestrial\ plant\ tissue}$ = C_{soil} x 0.310 (USEPA, 2007) x dry weight to wet weight conversion (0.15)
Chrysene	ln(terrestrial plant tissue) = 0.5944 x ln[C_{Soil}] - 2.7078 (USEPA, 2007) x dry weight to wet weight conversion (0.15)
Dibenzo(a,h)anthracene	Cterrestrial plant tissue = Csoil x 0.11 (USEPA, 2007) x dry weight to wet weight conversion (0.15)
Fluoranthene	$C_{terrestrial\ plant\ tissue}$ = C_{soil} x 0.5 (USEPA, 2007) x dry weight to wet weight conversion (0.15)

PCBs

$C_{terrestrial\ plant\ tissue}$ = C_{soil} x B_V x dry weight to wet weight conversion (0.15) (CCME, 2006)

Where:

B_V = chemical specific bioconcentration factor

= $10^{(2.53 - 0.4965 * \log Kow)}$

log Bv = 2.53 - 0.4965 log Kow

K_{ow} = octanol water partitioning coefficient

Total Caculated PCB 1.26E+07

Maximum PCB concentration from Phase II ESA (Stantec, 2 0.2 mg/kg

Predicted Terrestrial Invertebrate Concentrations

Organics

$C_{terrestrial\ invertebrate\ tissue}$ = C_{soil} x UF_{SI} x dry weight to wet weight conversion (0.16) (USEPA, 2007)

Where:

UF_{SI} = soil to invertebrate uptake factor

Anthracene	2.42	USEPA, 2007
Benzo(a)anthracene	1.59	USEPA, 2007
Benzo(a)pyrene	1.33	USEPA, 2007
Benzo(b)fluoranthene	2.6	USEPA, 2007
Chrysene	2.29	USEPA, 2007
Dibenzo(a,h)anthracene	2.31	USEPA, 2007
Fluoranthene	3.04	USEPA, 2007

PCBs

ln($C_{terrestrial\ invertebrate\ tissue}$) = 1.7903 +1.2909(ln[$C_{soil}$]) x dry weight to wet weight conversion (0.16) (Sample et al., 1998)

Predicted Terrestrial Prey Concentrations

Organics

Minimum value between $C_{terrestrial\ prey\ tissue}$ and C_{max}, calculated as follows:

$C_{terrestrial\ prey\ tissue}$ = BA_{SPA} × ((plant feed intake rate × C_{plant}) + (soil intake rate × C_{soil})) × B_i (RTI, 2005)

Where:

BA_{SPA} = biotransfer factor from soil or plant to animal (day/kg)

$= 0.064 \times 10^{(-0.099 \text{ x log Kow}^2) + (1.07 \text{ x log Kow}) - 3.56}$ (RTI, 2005)

Anthracene	0.011
Benzo(a)anthracene	0.013
Benzo(a)pyrene	0.012
Benzo(b)fluoranthene	0.013
Chrysene	0.013
Dibenzo(a,h)anthracene	0.009
Fluoranthene	0.014
Total Calculated PCB	0.007

K_{ow} = octanol water partitioning coefficient

Anthracene	2.82E+04	RAIS, 2014		
Benzo(a)anthracene	5.75E+05	RAIS, 2014		
Benzo(a)pyrene	1.35E+06	RAIS, 2014	PCBs LogKow	7.10E+00
Benzo(b)fluoranthene	6.03E+05	RAIS, 2014	Anthracene LogKow	4.45E+00
Chrysene	6.46E+05	RAIS, 2014	Benzo(b)fluoranthene LogK	5.78E+00
Dibenzo(a,h)anthracene	5.62E+06	RAIS, 2014	Dibenzo(a,h)anthracene Log	6.75E+00
Fluoranthene	1.45E+05	RAIS, 2014		
Total Caculated PCB	1.26E+07	RAIS, 2014		

Plant feed intake rate = 60 kg wet weight/day for cattle (RTI, 2005)

Soil intake rate = 0.4 kg dry weight/day for cattle (RTI, 2005)

C_{plant} = predicted terrestrial plant concentration (mg/kg ww)

B_i = bioavailability in feed and soils (default value of 1)

M_i = metabolic factor (default value of 1)

C_{max} = (lifespan x ((food ingestion rate x C_{plant}) + (soil ingestion rate x C_{soil})) x B_i)/BW (RTI, 2005)

Where:

Life Span = 90 days (USEPA, 1993)

Food ingestion rate = 0.011 kg wet weight/day (USEPA, 1993)

Soil ingestion rate = 0.000315 kg dry weight/day (USEPA, 1993)

BW = body weight = 0.042 kg (USEPA, 1993)

Food Web Model - General Area

Parameter	Red Fox	Masked Shrew	Meadow Vole	Moose	Black Bear	Ruffed Grouse	American Robin	Peregrine Falcon
	PCBs	PCBs	PCBs	PCBs	PCBs	PCBs	PCBs	PCBs
Body weight (kg)	3.8	0.0041	0.0349	400	68	0.552	0.079	0.8145
Ingestion rate of Food (kg/day (wet))	0.342	0.009264292	0.011517	8	11.83625	0.20907	0.09559	0.15271875
Ingestion rate of Water L/day	0.342	0.000697	0.007329	20	4.08	0.03864	0.01106	0.04887
Ingestion rate of Soil (kg/day (dry))	0.003016	0.00002788	4.42253E-05	0.0256	0.0408	0.0006624	0.000596482	0.0009774
Ingestion rate of Sediment	0.003016	0.00002788	4.42253E-05	0.0256	0.0408	0.0006624	0.000596482	0.0009774
Fraction of diet (inverts)	0.25	0.95	0	0	0.05	0.15	0.4	0
Fraction of diet (plants)	0.15	0.05	1	1	0.8	0.85	0.6	0
Fraction of diet (mammals/birds)	0.6	0	0	0	0.15	0	0	1
Soil EPC (mg/kg)	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025
Invertebrate EPC (mg/kg)	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Plant EPC (mg/kg)	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35
Prey EPC (mg/kg)	0.1496	0.1496	0.1496	0.1496	0.1496	0.1496	0.1496	0.1496
Surface Water EPC (ug/L)	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025
Sediment EPC (mg/kg)	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025
Dose from soil (mg/kg/day)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dose from invertebrate (mg/kg/day)	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00
Dose from plant (mg/kg/day)	0.00	0.04	0.12	0.01	0.05	0.11	0.25	0.00
Dose from prey (mg/kg/day)	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.03
Dose from surface water (mg/kg/day)	0.00	0.00	0.00	0.01	0.02	0.00	0.00	0.00
Dose from sediment (mg/kg/day)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total dose (mg/kg/day)	0.01	0.06	0.12	0.02	0.07	0.11	0.26	0.03
TRV (mg/kg/day) - LOAELs	0.68	0.68	0.68	0.68	0.68	1.8	1.8	1.8
TRV (mg/kg/day) - NOAELs	0.14	0.14	0.14	0.14	0.14	0.18	0.18	0.18
Hazard quotient LOAELs	0.020	0.090	0.170	0.027	0.104	0.063	0.144	0.016
Hazard quotient NOAELs	0.099	0.436	0.825	0.133	0.507	0.631	1.441	0.157

Food Web Model - Former Contractor Village

Parameter	Red Fox	Masked Shrew	Meadow Vole	Moose	Black Bear	Ruffed Grouse	American Robin	Peregrine Falcon
	PCBs	PCBs	PCBs	PCBs	PCBs	PCBs	PCBs	PCBs
Body weight (kg)	3.8	0.0041	0.0349	400	68	0.552	0.079	0.8145
Ingestion rate of Food (kg/day (wet))	0.342	0.009264292	0.011517	8	11.83625	0.20907	0.09559	0.15271875
Ingestion rate of Water L/day	0.342	0.000697	0.007329	20	4.08	0.03864	0.01106	0.04887
Ingestion rate of Soil (kg/day (dry))	0.003016	0.00002788	4.42253E-05	0.0256	0.0408	0.0006624	0.000596482	0.0009774
Ingestion rate of Sediment	0.003016	0.00002788	4.42253E-05	0.0256	0.0408	0.0006624	0.000596482	0.0009774
Fraction of diet (inverts)	0.25	0.95	0	0	0.05	0.15	0.4	0
Fraction of diet (plants)	0.15	0.05	1	1	0.8	0.85	0.6	0
Fraction of diet (mammals/birds)	0.6	0	0	0	0.15	0	0	1
Soil EPC (mg/kg)	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025
Invertebrate EPC (mg/kg)	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Plant EPC (mg/kg)	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33
Prey EPC (mg/kg)	0.1411	0.1411	0.1411	0.1411	0.1411	0.1411	0.1411	0.1411
Surface Water EPC (ug/L)	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025
Sediment EPC (mg/kg)	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025
Dose from soil (mg/kg/day)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dose from invertebrate (mg/kg/day)	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00
Dose from plant (mg/kg/day)	0.00	0.04	0.11	0.01	0.05	0.11	0.24	0.00
Dose from prey (mg/kg/day)	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.03
Dose from surface water (mg/kg/day)	0.00	0.00	0.00	0.01	0.02	0.00	0.00	0.00
Dose from sediment (mg/kg/day)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total dose (mg/kg/day)	0.01	0.06	0.11	0.02	0.07	0.11	0.24	0.03
TRV (mg/kg/day) - LOAELs	0.68	0.68	0.68	0.68	0.68	1.8	1.8	1.8
TRV (mg/kg/day) - NOAELs	0.14	0.14	0.14	0.14	0.14	0.18	0.18	0.18
Hazard quotient LOAELs	0.019	0.086	0.160	0.027	0.100	0.060	0.136	0.015
Hazard quotient NOAELs	0.094	0.420	0.778	0.130	0.486	0.595	1.360	0.148

Food Web Model - Main Complex

Parameter	Red Fox		Masked Shrew		Meadow Vole		Moose		Black Bear	
	Benzo(a)pyrene	PCBs	Benzo(a)pyrene	PCBs	Benzo(a)pyrene	PCBs	Benzo(a)pyrene	PCBs	Benzo(a)pyrene	PCBs
Body weight (kg)	3.8	3.8	0.0041	0.0041	0.0349	0.0349	400	400	68	68
Ingestion rate of Food (kg/day (wet))	0.342	0.342	0.009264292	0.009264292	0.011517	0.011517	8	8	11.83625	11.83625
Ingestion rate of Water L/day	0.342	0.342	0.000697	0.000697	0.007329	0.007329	20	20	4.08	4.08
Ingestion rate of Soil (kg/day (dry))	0.002427516	0.003016	0.00002788	0.00002788	4.42253E-05	4.42253E-05	0.0256	0.0256	0.0408	0.0408
Ingestion rate of Sediment	0.002427516	0.003016	0.00002788	0.00002788	4.42253E-05	4.42253E-05	0.0256	0.0256	0.0408	0.0408
Fraction of diet (inverts)	0.25	0.25	0.95	0.95	0	0	0	0	0.05	0.05
Fraction of diet (plants)	0.15	0.15	0.05	0.05	1	1	1	1	0.8	0.8
Fraction of diet (mammals/birds)	0.6	0.6	0	0	0	0	0	0	0.15	0.15
Soil EPC (mg/kg)	1.001	0.668	1.001	0.668	1.001	0.668	1.001	0.668	1.001	0.668
Invertebrate EPC (mg/kg)	0.213	0.569	0.213	0.569	0.213	0.569	0.213	0.569	0.213	0.569
Plant EPC (mg/kg)	0.019	0.51	0.019	0.51	0.019	0.51	0.019	0.51	0.019	0.51
Prey EPC (mg/kg)	0.019	0.22	0.019	0.22	0.019	0.22	0.019	0.22	0.019	0.22
Surface Water EPC (ug/L)	0.005	0.025	0.005	0.025	0.005	0.025	0.005	0.025	0.005	0.025
Sediment EPC (mg/kg)	0.064	0.17	0.064	0.17	0.064	0.17	0.064	0.17	0.064	0.17
Dose from soil (mg/kg/day)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
Dose from invertebrate (mg/kg/day)	0.00	0.01	0.46	1.22	0.00	0.00	0.00	0.00	0.00	0.00
Dose from plant (mg/kg/day)	0.00	0.01	0.00	0.06	0.01	0.17	0.00	0.01	0.00	0.07
Dose from prey (mg/kg/day)	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Dose from surface water (mg/kg/day)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.02
Dose from sediment (mg/kg/day)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00
Total dose (mg/kg/day)	0.01	0.03	0.46	1.28	0.01	0.17	0.01	0.03	0.02	0.11
TRV (mg/kg/day) - LOAELs	32	0.68	32	0.68	32	0.68	32	0.68	32	0.68
TRV (mg/kg/day) - NOAELs	15	0.14	15	0.14	15	0.14	15	0.14	15	0.14
Hazard quotient LOAELs	2.06E-04	0.049	0.014	1.881	1.97E-04	0.248	2.18E-04	0.046	5.17E-04	0.157
Hazard quotient NOAELs	4.40E-04	0.236	0.031	9.137	4.20E-04	1.203	4.66E-04	0.224	1.10E-03	0.761

Food Web Model - Main Complex

Parameter	Ruffed Grouse		American Robin		Peregrine Falcon	
	Benzo(a)pyrene	PCBs	Benzo(a)pyrene	PCBs	Benzo(a)pyrene	PCBs
Body weight (kg)	0.552	0.552	0.079	0.079	0.8145	0.8145
Ingestion rate of Food (kg/day (wet))	0.20907	0.20907	0.09559	0.09559	0.15271875	0.15271875
Ingestion rate of Water L/day	0.03864	0.03864	0.01106	0.01106	0.04887	0.04887
Ingestion rate of Soil (kg/day (dry))	0.0006624	0.0006624	0.000596482	0.000596482	0.0009774	0.0009774
Ingestion rate of Sediment	0.0006624	0.0006624	0.000596482	0.000596482	0.0009774	0.0009774
Fraction of diet (inverts)	0.15	0.15	0.4	0.4	0	0
Fraction of diet (plants)	0.85	0.85	0.6	0.6	0	0
Fraction of diet (mammals/birds)	0	0	0	0	1	1
Soil EPC (mg/kg)	1.001	0.668	1.001	0.668	1.001	0.668
Invertebrate EPC (mg/kg)	0.213	0.569	0.213	0.569	0.213	0.569
Plant EPC (mg/kg)	0.019	0.51	0.019	0.51	0.019	0.51
Prey EPC (mg/kg)	0.019	0.22	0.019	0.22	0.019	0.22
Surface Water EPC (ug/L)	0.005	0.025	0.005	0.025	0.005	0.025
Sediment EPC (mg/kg)	0.064	0.17	0.064	0.17	0.064	0.17
Dose from soil (mg/kg/day)	0.00	0.00	0.00	0.00	0.00	0.00
Dose from invertebrate (mg/kg/day)	0.01	0.03	0.10	0.28	0.00	0.00
Dose from plant (mg/kg/day)	0.01	0.16	0.01	0.37	0.00	0.00
Dose from prey (mg/kg/day)	0.00	0.00	0.00	0.00	0.00	0.04
Dose from surface water (mg/kg/day)	0.00	0.00	0.00	0.00	0.00	0.00
Dose from sediment (mg/kg/day)	0.00	0.00	0.00	0.00	0.00	0.00
Total dose (mg/kg/day)	0.02	0.20	0.12	0.65	0.00	0.04
TRV (mg/kg/day) - LOAELs	NC	1.8	NC	1.8	NC	1.8
TRV (mg/kg/day) - NOAELs	NC	0.18	NC	0.18	NC	0.18
Hazard quotient LOAELs	#VALUE!	0.109	#VALUE!	0.359	#VALUE!	0.023
Hazard quotient NOAELs	#VALUE!	1.095	#VALUE!	3.592	#VALUE!	0.231

Food Web Model - Former USAF Dump Area and Former Ammunition Storage Area

Parameter	Red Fox							
	Anthracene	Benzo(a)anthracene	Benzo(a)pyrene	Benzo(b)fluoranthene	Chrysene	Dibenzo(a)anthracene	Fluoranthene	PCBs
Body weight (kg)	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8
Ingestion rate of Food (kg/day (wet))	0.342	0.342	0.342	0.342	0.342	0.342	0.342	0.342
Ingestion rate of Water L/day	0.342	0.342	0.342	0.342	0.342	0.342	0.342	0.342
Ingestion rate of Soil (kg/day (dry))	0.002427516	0.002427516	0.002427516	0.002427516	0.002427516	0.002427516	0.003016	0.003016
Ingestion rate of Sediment	0.002427516	0.002427516	0.002427516	0.002427516	0.002427516	0.002427516	0.003016	0.003016
Fraction of diet (inverts)	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Fraction of diet (plants)	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Fraction of diet (mammals/birds)	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Soil EPC (mg/kg)	10.92	13.52	10.11	8.975	11.2	1.317	40.74	8.561
Invertebrate EPC (mg/kg)	4.228	3.439	2.151	3.734	4.104	0.487	19.816	15.326
Plant EPC (mg/kg)	0.359	0.047	0.182	0.417	0.042	0.022	3.056	0.2
Prey EPC (mg/kg)	0.289	0.11	0.182	0.38	0.093	0.017	2.702	0.11
Surface Water EPC (ug/L)	0.005	0.005	0.005	0.005	0.005	0.005	0.011	0.025
Sediment EPC (mg/kg)	0.005	0.005	0.005	0.005	12	0.005	0.005	0.025
Dose from soil (mg/kg/day)	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
Dose from invertebrate (mg/kg/day)	0.10	0.08	0.05	0.08	0.09	0.01	0.45	0.34
Dose from plant (mg/kg/day)	0.00	0.00	0.00	0.01	0.00	0.00	0.04	0.00
Dose from prey (mg/kg/day)	0.02	0.01	0.01	0.02	0.01	0.00	0.15	0.01
Dose from surface water (mg/kg/day)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dose from sediment (mg/kg/day)	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00
Total dose (mg/kg/day)	0.12	0.09	0.06	0.11	0.13	0.01	0.64	0.36
TRV (mg/kg/day) - LOAELs	367	32	32	32	32	32	367	0.68
TRV (mg/kg/day) - NOAELs	180	15	15	15	15	15	180	0.14
Hazard quotient LOAELs	3.22E-04	2.72E-03	1.97E-03	3.51E-03	4.05E-03	3.95E-04	1.76E-03	0.524
Hazard quotient NOAELs	6.56E-04	5.80E-03	4.20E-03	7.49E-03	8.64E-03	8.42E-04	3.58E-03	2.547

Food Web Model - Former USAF Dump Area and Former Ar

Parameter	Masked Shrew							
	Anthracene	Benzo(a)anthracene	Benzo(a)pyrene	Benzo(b)fluoranthene	Chrysene	Dibenzo(a)anthracene	Fluoranthene	PCBs
Body weight (kg)	0.0041	0.0041	0.0041	0.0041	0.0041	0.0041	0.0041	0.0041
Ingestion rate of Food (kg/day (wet))	0.009264292	0.009264292	0.009264292	0.009264292	0.009264292	0.009264292	0.009264292	0.009264292
Ingestion rate of Water L/day	0.000697	0.000697	0.000697	0.000697	0.000697	0.000697	0.000697	0.000697
Ingestion rate of Soil (kg/day (dry))	0.00002788	0.00002788	0.00002788	0.00002788	0.00002788	0.00002788	0.00002788	0.00002788
Ingestion rate of Sediment	0.00002788	0.00002788	0.00002788	0.00002788	0.00002788	0.00002788	0.00002788	0.00002788
Fraction of diet (inverts)	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Fraction of diet (plants)	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Fraction of diet (mammals/birds)	0	0	0	0	0	0	0	0
Soil EPC (mg/kg)	10.92	13.52	10.11	8.975	11.2	1.317	40.74	8.561
Invertebrate EPC (mg/kg)	4.228	3.439	2.151	3.734	4.104	0.487	19.816	15.326
Plant EPC (mg/kg)	0.359	0.047	0.182	0.417	0.042	0.022	3.056	0.2
Prey EPC (mg/kg)	0.289	0.11	0.182	0.38	0.093	0.017	2.702	0.11
Surface Water EPC (ug/L)	0.005	0.005	0.005	0.005	0.005	0.005	0.011	0.025
Sediment EPC (mg/kg)	0.005	0.005	0.005	0.005	12	0.005	0.005	0.025
Dose from soil (mg/kg/day)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dose from invertebrate (mg/kg/day)	9.08	7.38	4.62	8.02	8.81	1.05	42.54	32.90
Dose from plant (mg/kg/day)	0.04	0.01	0.02	0.05	0.00	0.00	0.35	0.02
Dose from prey (mg/kg/day)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dose from surface water (mg/kg/day)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dose from sediment (mg/kg/day)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total dose (mg/kg/day)	9.12	7.39	4.64	8.06	8.82	1.05	42.88	32.92
TRV (mg/kg/day) - LOAELs	367	32	32	32	32	32	367	0.68
TRV (mg/kg/day) - NOAELs	180	15	15	15	15	15	180	0.14
Hazard quotient LOAELs	2.48E-02	2.31E-01	1.45E-01	2.52E-01	2.75E-01	3.27E-02	1.17E-01	48.415
Hazard quotient NOAELs	5.07E-02	4.93E-01	3.09E-01	5.38E-01	5.88E-01	6.99E-02	2.38E-01	235.157

Food Web Model - Former USAF Dump Area and Former Ar

Parameter	Meadow Vole							
	Anthracene	Benzo(a)anthracene	Benzo(a)pyrene	Benzo(b)fluoranthene	Chrysene	Dibenzo(a)anthracene	Fluoranthene	PCBs
Body weight (kg)	0.0349	0.0349	0.0349	0.0349	0.0349	0.0349	0.0349	0.0349
Ingestion rate of Food (kg/day (wet))	0.011517	0.011517	0.011517	0.011517	0.011517	0.011517	0.011517	0.011517
Ingestion rate of Water L/day	0.007329	0.007329	0.007329	0.007329	0.007329	0.007329	0.007329	0.007329
Ingestion rate of Soil (kg/day (dry))	4.42253E-05	4.42253E-05	4.42253E-05	4.42253E-05	4.42253E-05	4.42253E-05	4.42253E-05	4.42253E-05
Ingestion rate of Sediment	4.42253E-05	4.42253E-05	4.42253E-05	4.42253E-05	4.42253E-05	4.42253E-05	4.42253E-05	4.42253E-05
Fraction of diet (inverts)	0	0	0	0	0	0	0	0
Fraction of diet (plants)	1	1	1	1	1	1	1	1
Fraction of diet (mammals/birds)	0	0	0	0	0	0	0	0
Soil EPC (mg/kg)	10.92	13.52	10.11	8.975	11.2	1.317	40.74	8.561
Invertebrate EPC (mg/kg)	4.228	3.439	2.151	3.734	4.104	0.487	19.816	15.326
Plant EPC (mg/kg)	0.359	0.047	0.182	0.417	0.042	0.022	3.056	0.2
Prey EPC (mg/kg)	0.289	0.11	0.182	0.38	0.093	0.017	2.702	0.11
Surface Water EPC (ug/L)	0.005	0.005	0.005	0.005	0.005	0.005	0.011	0.025
Sediment EPC (mg/kg)	0.005	0.005	0.005	0.005	12	0.005	0.005	0.025
Dose from soil (mg/kg/day)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dose from invertebrate (mg/kg/day)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dose from plant (mg/kg/day)	0.12	0.02	0.06	0.14	0.01	0.01	1.01	0.07
Dose from prey (mg/kg/day)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dose from surface water (mg/kg/day)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dose from sediment (mg/kg/day)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total dose (mg/kg/day)	0.12	0.02	0.06	0.14	0.01	0.01	1.01	0.07
TRV (mg/kg/day) - LOAELs	367	32	32	32	32	32	367	0.68
TRV (mg/kg/day) - NOAELs	180	15	15	15	15	15	180	0.14
Hazard quotient LOAELs	3.23E-04	4.91E-04	1.88E-03	4.30E-03	4.49E-04	2.28E-04	2.75E-03	0.097
Hazard quotient NOAELs	6.59E-04	1.05E-03	4.01E-03	9.18E-03	9.58E-04	4.86E-04	5.61E-03	0.473

Food Web Model - Former USAF Dump Area and Former Ar

Parameter	Moose							
	Anthracene	Benzo(a)anthracene	Benzo(a)pyrene	Benzo(b)fluoranthene	Chrysene	Dibenzo(a)anthracene	Fluoranthene	PCBs
Body weight (kg)	400	400	400	400	400	400	400	400
Ingestion rate of Food (kg/day (wet))	8	8	8	8	8	8	8	8
Ingestion rate of Water L/day	20	20	20	20	20	20	20	20
Ingestion rate of Soil (kg/day (dry))	0.0256	0.0256	0.0256	0.0256	0.0256	0.0256	0.0256	0.0256
Ingestion rate of Sediment	0.0256	0.0256	0.0256	0.0256	0.0256	0.0256	0.0256	0.0256
Fraction of diet (inverts)	0	0	0	0	0	0	0	0
Fraction of diet (plants)	1	1	1	1	1	1	1	1
Fraction of diet (mammals/birds)	0	0	0	0	0	0	0	0
Soil EPC (mg/kg)	10.92	13.52	10.11	8.975	11.2	1.317	40.74	8.561
Invertebrate EPC (mg/kg)	4.228	3.439	2.151	3.734	4.104	0.487	19.816	15.326
Plant EPC (mg/kg)	0.359	0.047	0.182	0.417	0.042	0.022	3.056	0.2
Prey EPC (mg/kg)	0.289	0.11	0.182	0.38	0.093	0.017	2.702	0.11
Surface Water EPC (ug/L)	0.005	0.005	0.005	0.005	0.005	0.005	0.011	0.025
Sediment EPC (mg/kg)	0.005	0.005	0.005	0.005	12	0.005	0.005	0.025
Dose from soil (mg/kg/day)	0.01	0.01	0.01	0.00	0.01	0.00	0.02	0.00
Dose from invertebrate (mg/kg/day)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dose from plant (mg/kg/day)	0.01	0.00	0.00	0.01	0.00	0.00	0.06	0.00
Dose from prey (mg/kg/day)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dose from surface water (mg/kg/day)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Dose from sediment (mg/kg/day)	0.00	0.00	0.00	0.00	0.77	0.00	0.00	0.00
Total dose (mg/kg/day)	0.02	0.01	0.01	0.02	0.78	0.00	0.09	0.02
TRV (mg/kg/day) - LOAELs	367	32	32	32	32	32	367	0.68
TRV (mg/kg/day) - NOAELs	180	15	15	15	15	15	180	0.14
Hazard quotient LOAELs	4.11E-05	3.18E-04	3.48E-04	4.77E-04	2.43E-02	1.07E-04	2.36E-04	0.029
Hazard quotient NOAELs	8.38E-05	6.79E-04	7.42E-04	1.02E-03	5.18E-02	2.29E-04	4.82E-04	0.143

Food Web Model - Former USAF Dump Area and Former Ar

Parameter	Black Bear							
	Anthracene	Benzo(a)anthracene	Benzo(a)pyrene	Benzo(b)fluoranthene	Chrysene	Dibenzo(a)anthracene	Fluoranthene	PCBs
Body weight (kg)	68	68	68	68	68	68	68	68
Ingestion rate of Food (kg/day (wet))	11.83625	11.83625	11.83625	11.83625	11.83625	11.83625	11.83625	11.83625
Ingestion rate of Water L/day	4.08	4.08	4.08	4.08	4.08	4.08	4.08	4.08
Ingestion rate of Soil (kg/day (dry))	0.0408	0.0408	0.0408	0.0408	0.0408	0.0408	0.0408	0.0408
Ingestion rate of Sediment	0.0408	0.0408	0.0408	0.0408	0.0408	0.0408	0.0408	0.0408
Fraction of diet (inverts)	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Fraction of diet (plants)	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Fraction of diet (mammals/birds)	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Soil EPC (mg/kg)	10.92	13.52	10.11	8.975	11.2	1.317	40.74	8.561
Invertebrate EPC (mg/kg)	4.228	3.439	2.151	3.734	4.104	0.487	19.816	15.326
Plant EPC (mg/kg)	0.359	0.047	0.182	0.417	0.042	0.022	3.056	0.2
Prey EPC (mg/kg)	0.289	0.11	0.182	0.38	0.093	0.017	2.702	0.11
Surface Water EPC (ug/L)	0.005	0.005	0.005	0.005	0.005	0.005	0.011	0.025
Sediment EPC (mg/kg)	0.005	0.005	0.005	0.005	12	0.005	0.005	0.025
Dose from soil (mg/kg/day)	0.08	0.10	0.07	0.06	0.08	0.01	0.29	0.06
Dose from invertebrate (mg/kg/day)	0.04	0.03	0.02	0.03	0.04	0.00	0.17	0.13
Dose from plant (mg/kg/day)	0.05	0.01	0.03	0.06	0.01	0.00	0.43	0.03
Dose from prey (mg/kg/day)	0.01	0.00	0.00	0.01	0.00	0.00	0.07	0.00
Dose from surface water (mg/kg/day)	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02
Dose from sediment (mg/kg/day)	0.00	0.00	0.00	0.00	0.17	0.00	0.00	0.00
Total dose (mg/kg/day)	0.18	0.14	0.12	0.17	0.30	0.02	0.97	0.24
TRV (mg/kg/day) - LOAELs	367	32	32	32	32	32	367	0.68
TRV (mg/kg/day) - NOAELs	180	15	15	15	15	15	180	0.14
Hazard quotient LOAELs	4.78E-04	4.34E-03	3.88E-03	5.25E-03	9.25E-03	6.47E-04	2.63E-03	0.357
Hazard quotient NOAELs	9.75E-04	9.27E-03	8.28E-03	1.12E-02	1.97E-02	1.38E-03	5.37E-03	1.736

Food Web Model - Former USAF Dump Area and Former Ar

Parameter	Ruffed Grouse							
	Anthracene	Benzo(a)anthracene	Benzo(a)pyrene	Benzo(b)fluoranthene	Chrysene	Dibenzo(a)anthracene	Fluoranthene	PCBs
Body weight (kg)	0.552	0.552	0.552	0.552	0.552	0.552	0.552	0.552
Ingestion rate of Food (kg/day (wet))	0.20907	0.20907	0.20907	0.20907	0.20907	0.20907	0.20907	0.20907
Ingestion rate of Water L/day	0.03864	0.03864	0.03864	0.03864	0.03864	0.03864	0.03864	0.03864
Ingestion rate of Soil (kg/day (dry))	0.0006624	0.0006624	0.0006624	0.0006624	0.0006624	0.0006624	0.0006624	0.0006624
Ingestion rate of Sediment	0.0006624	0.0006624	0.0006624	0.0006624	0.0006624	0.0006624	0.0006624	0.0006624
Fraction of diet (inverts)	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Fraction of diet (plants)	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85
Fraction of diet (mammals/birds)	0	0	0	0	0	0	0	0
Soil EPC (mg/kg)	10.92	13.52	10.11	8.975	11.2	1.317	40.74	8.561
Invertebrate EPC (mg/kg)	4.228	3.439	2.151	3.734	4.104	0.487	19.816	15.326
Plant EPC (mg/kg)	0.359	0.047	0.182	0.417	0.042	0.022	3.056	0.2
Prey EPC (mg/kg)	0.289	0.11	0.182	0.38	0.093	0.017	2.702	0.11
Surface Water EPC (ug/L)	0.005	0.005	0.005	0.005	0.005	0.005	0.011	0.025
Sediment EPC (mg/kg)	0.005	0.005	0.005	0.005	12	0.005	0.005	0.025
Dose from soil (mg/kg/day)	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
Dose from invertebrate (mg/kg/day)	0.24	0.20	0.12	0.21	0.23	0.03	1.13	0.87
Dose from plant (mg/kg/day)	0.12	0.02	0.06	0.13	0.01	0.01	0.98	0.06
Dose from prey (mg/kg/day)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dose from surface water (mg/kg/day)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dose from sediment (mg/kg/day)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total dose (mg/kg/day)	0.36	0.21	0.18	0.35	0.25	0.04	2.12	0.94
TRV (mg/kg/day) - LOAELs	32	NC	NC	NC	NC	NC	32	1.8
TRV (mg/kg/day) - NOAELs	7.7	NC	NC	NC	NC	NC	7.7	0.18
Hazard quotient LOAELs	1.12E-02	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	6.63E-02	0.521
Hazard quotient NOAELs	4.66E-02	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	2.75E-01	5.209

Food Web Model - Former USAF Dump Area and Former Ar

Parameter	American Robin							
	Anthracene	Benzo(a)anthracene	Benzo(a)pyrene	Benzo(b)fluoranthene	Chrysene	Dibenzo(a)anthracene	Fluoranthene	PCBs
Body weight (kg)	0.079	0.079	0.079	0.079	0.079	0.079	0.079	0.079
Ingestion rate of Food (kg/day (wet))	0.09559	0.09559	0.09559	0.09559	0.09559	0.09559	0.09559	0.09559
Ingestion rate of Water L/day	0.01106	0.01106	0.01106	0.01106	0.01106	0.01106	0.01106	0.01106
Ingestion rate of Soil (kg/day (dry))	0.000596482	0.000596482	0.000596482	0.000596482	0.000596482	0.000596482	0.000596482	0.000596482
Ingestion rate of Sediment	0.000596482	0.000596482	0.000596482	0.000596482	0.000596482	0.000596482	0.000596482	0.000596482
Fraction of diet (inverts)	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Fraction of diet (plants)	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Fraction of diet (mammals/birds)	0	0	0	0	0	0	0	0
Soil EPC (mg/kg)	10.92	13.52	10.11	8.975	11.2	1.317	40.74	8.561
Invertebrate EPC (mg/kg)	4.228	3.439	2.151	3.734	4.104	0.487	19.816	15.326
Plant EPC (mg/kg)	0.359	0.047	0.182	0.417	0.042	0.022	3.056	0.2
Prey EPC (mg/kg)	0.289	0.11	0.182	0.38	0.093	0.017	2.702	0.11
Surface Water EPC (ug/L)	0.005	0.005	0.005	0.005	0.005	0.005	0.011	0.025
Sediment EPC (mg/kg)	0.005	0.005	0.005	0.005	12	0.005	0.005	0.025
Dose from soil (mg/kg/day)	0.01	0.01	0.01	0.01	0.01	0.00	0.03	0.01
Dose from invertebrate (mg/kg/day)	2.05	1.66	1.04	1.81	1.99	0.24	9.59	7.42
Dose from plant (mg/kg/day)	0.26	0.03	0.13	0.30	0.03	0.02	2.22	0.15
Dose from prey (mg/kg/day)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dose from surface water (mg/kg/day)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dose from sediment (mg/kg/day)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total dose (mg/kg/day)	2.31	1.71	1.18	2.12	2.03	0.25	11.84	7.57
TRV (mg/kg/day) - LOAELs	32	NC	NC	NC	NC	NC	32	1.8
TRV (mg/kg/day) - NOAELs	7.7	NC	NC	NC	NC	NC	7.7	0.18
Hazard quotient LOAELs	7.23E-02	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	3.70E-01	4.205
Hazard quotient NOAELs	3.01E-01	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	1.54E+00	42.053

Food Web Model - Former USAF Dump Area and Former Ar

Parameter	Peregrine Falcon							
	Anthracene	Benzo(a)anthracene	Benzo(a)pyrene	Benzo(b)fluoranthene	Chrysene	Dibenzo(a)anthracene	Fluoranthene	PCBs
Body weight (kg)	0.8145	0.8145	0.8145	0.8145	0.8145	0.8145	0.8145	0.8145
Ingestion rate of Food (kg/day (wet))	0.15271875	0.15271875	0.15271875	0.15271875	0.15271875	0.15271875	0.15271875	0.15271875
Ingestion rate of Water L/day	0.04887	0.04887	0.04887	0.04887	0.04887	0.04887	0.04887	0.04887
Ingestion rate of Soil (kg/day (dry))	0.0009774	0.0009774	0.0009774	0.0009774	0.0009774	0.0009774	0.0009774	0.0009774
Ingestion rate of Sediment	0.0009774	0.0009774	0.0009774	0.0009774	0.0009774	0.0009774	0.0009774	0.0009774
Fraction of diet (inverts)	0	0	0	0	0	0	0	0
Fraction of diet (plants)	0	0	0	0	0	0	0	0
Fraction of diet (mammals/birds)	1	1	1	1	1	1	1	1
Soil EPC (mg/kg)	10.92	13.52	10.11	8.975	11.2	1.317	40.74	8.561
Invertebrate EPC (mg/kg)	4.228	3.439	2.151	3.734	4.104	0.487	19.816	15.326
Plant EPC (mg/kg)	0.359	0.047	0.182	0.417	0.042	0.022	3.056	0.2
Prey EPC (mg/kg)	0.289	0.11	0.182	0.38	0.093	0.017	2.702	0.11
Surface Water EPC (ug/L)	0.005	0.005	0.005	0.005	0.005	0.005	0.011	0.025
Sediment EPC (mg/kg)	0.005	0.005	0.005	0.005	12	0.005	0.005	0.025
Dose from soil (mg/kg/day)	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
Dose from invertebrate (mg/kg/day)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dose from plant (mg/kg/day)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dose from prey (mg/kg/day)	0.05	0.02	0.03	0.07	0.02	0.00	0.51	0.02
Dose from surface water (mg/kg/day)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dose from sediment (mg/kg/day)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total dose (mg/kg/day)	0.06	0.02	0.04	0.07	0.02	0.00	0.51	0.02
TRV (mg/kg/day) - LOAELs	32	NC	NC	NC	NC	NC	32	1.8
TRV (mg/kg/day) - NOAELs	7.7	NC	NC	NC	NC	NC	7.7	0.18
Hazard quotient LOAELs	1.76E-03	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	1.61E-02	0.012
Hazard quotient NOAELs	7.30E-03	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	6.68E-02	0.125

ERA UNCERTAINTY ANALYSIS

Uncertainty is inherent to risk analysis. It includes two main components, the global variability related to empirical quantities such as measurement errors, systematic errors (bias), natural variation (random), and the true uncertainty due to lack of knowledge or subjective judgements.
It is believed that the actual risk assessment results present a reasonable detailed evaluation of the risks to human health and ecological receptors present at the Site. Where uncertainty was encountered in the development of the risk estimates, reasonable assumptions were made or data/criteria were selected in order to ensure that risks were neither grossly underestimated nor overestimated. Uncertainties are inherent in every aspect of the risk assessment process, as discussed in this section.
The ERA incorporates assumptions that lead to uncertainty. This section qualitatively discusses some significant aspects of uncertainty inherent in this risk assessment.

Habitat Survey and Receptor Selection. Quantitative or semi-quantitative surveys of site vegetation were not undertaken. Rather, observations for this receptor group were limited to qualitative and visual evaluations related to presence, types, and apparent health of site vegetation (relative to surrounding properties and areas). This was considered a reasonable and appropriate level of effort.

Utilization of Receptors as Surrogates to Represent Other Organisms. The use of receptors as surrogates is intended to limit the number of ecological receptors evaluated. The receptors selected are considered to be sensitive and would be highly exposed to the COPCs present at the site 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 site.

Species at Risk. Based on a review of the available ACCDC data on species at risk that have been reported near the site, and a review of the habitat requirements of those species, species at risk have been identified as having the potential to frequent habitat present within the subject site. While some SAR may occasionally occur on or near the site, they would not be expected to spend sufficient time at this location (foraging, nesting, breeding or resting) to incur significant exposures to COPCs in site soil/vegetation. In addition, the representative mammalian and avian receptors chosen as part of the ERA were deemed to be representative of species that could potentially frequent the site.

Receptor-Specific Toxicity Data. For most COPCs and receptors, toxicity data are available in some form. However, it is important to note that toxicity data are not necessarily available for the particular receptor species under consideration. Toxicity values are not necessarily specific to the receptor species, or to a reproductive or population-level endpoint. As a result, there is uncertainty associated with the extrapolations that may be used to translate toxicity data from one species into a TRV for a second species despite the fact that the toxicity data represent organisms that are expected to be sensitive to the COPC and that the conversion factors are scientifically based, and are applied in a reasonable manner.

Data Limitations. The uncertainty of a risk assessment calculation often depends on the sample size (power of the study, the number of samples), sample design (representativeness of samples), extent of contamination spatially and temporally, and variability of the data set. A larger sample size generally increases the precision of the assessment.

The subject site is considered to be adequately characterized, as the portions that could be sampled provide good spatial coverage of the property. Further sampling is considered unlikely to alter outcomes and conclusions of the current ERA. There was a lack of background data for PCBs in vegetation. Limited sampling data was available from off-site. As a result, background concentrations were assumed to be negligible.

Treatment of data for the ERA was conducted in a manner that is intentionally conservative. This approach was taken to ensure that exposures and risks associated with chemicals present in subject property soil/vegetation would not be underestimated. For example, concentrations of chemicals in soil/vegetation that were reported below the laboratory RDL were assumed to be present at half the RDL.

Selection of COPCs.

The COPCs were selected independently in each of the media and/or areas evaluated in the ecological risk assessment, and the analysis was completed to include all relevant media and/or areas if the substance exceeded screening criteria for any one of these. For each of the media, there are gaps in understanding of the toxicology of constituents of concern, and the physical and chemical properties of these chemicals. The approach for selecting COPCs included comparison of detected chemical concentrations in soil values that are believed to be protective of most North American species, in most ecosystems. However, contaminant concentrations in soil are likely to be stable or decline over time. Because empirical data do not exist for all possible COPCs and media, it is possible that relevant test species and sometimes even the same environmental media have not been evaluated in the proper context for comparison.

The current ERA only assesses chemical stressors present in subject site soil and vegetation. While other common ecological stressors such as predation, disease, habitat loss/fragmentation, competition, salinity from sea spray, limited food resources etc. are likely having some influence on the resident biota of the area; these stressors were not evaluated in either a quantitative or qualitative manner. On any given site, non- chemical stressors may interact with chemical stressors in complex ways, and can often be of greater biological or ecological significance than the presence of chemical contaminants in site media. For the subject property, key non-contaminant related stressors would likely include salt spray (salinity), low soil nutrients, and limited habitat/food resources.

Chemical Speciation. The fate, food chain interactions, and toxicity of a number of inorganic contaminants (such as aluminum) depend to a large extent upon their chemical form. Oral reference doses, however, are typically based on chemical forms that have high bioavailability (*e.g.*, salts). When administered in food or water to laboratory animals, it is expected that the bioavailability of the toxicant is maximal. When trace elements are ingested by wildlife, some portion will be of natural origin, distributed through soil fractions ranging from inorganic soil particles to biological materials, having widely varying bioaccessibility. Another portion may be present in soils as a contaminant, and the speciation and bioaccessibility of the contaminant fraction will also vary, depending upon site conditions and the source of the contaminant. As such, conservative assumptions about chemical form, bioavailability, and absorption over the gut were generally carried forward in the risk assessment, and the potential for toxicity is likely to be overstated. For example, it has been assumed that 100% of each ingested COPC is absorbed from ingested food, and is available to the organism as a potentially toxic substance. This may be reasonable for some COPCs, but will be highly conservative for others. For soil and vegetation, bioaccessibility was conservatively assumed to be 1.0.

Food Chain Interactions. Very limited "real world" data exist that allow quantification of the true relationship between a chemical in an environmental medium and chemical transfer through the food chain. Only a few classes of chemicals (excluding metals) appear to be magnified through the food chain. The extent of food chain magnification is another uncertainty that is generally treated in a conservative manner. Collection and chemical analysis of tissue samples from mammalian and avian species could have further reduced uncertainties associated with these values but were beyond the scope of the ecological field program.

Wildlife Exposure Factors. Virtually every factor incorporated into dose calculations for wildlife species possesses a site-specific component. Validity of each exposure factor is dependent on consideration of the site-specific nature of these factors. In the absence of site-specific validation, exposure factors are incorporated based on validations performed elsewhere for other cases and sometimes for other species. Considerations such as food ingestion rates, water ingestion rates, incidental soil ingestion rates, dietary composition, home range, and time spent at the site were collected from the scientific literature based on other sites and locations.

Measurement Endpoints from the Toxicity Data. The paucity of toxicity data for many chemicals limited the measurement endpoints that were available. The risk of a toxic effect is evaluated based on a LOAEL-based toxicity benchmark for receptors with no conservation status and NOAEL-based toxicity benchmark for species at risk. Given the overall tendency to introduce conservatism (through the use of data or assumptions that are likely to overstate, rather than understate risk) into risk assessments, it is likely that no adverse effect will exist below the HQ target value of less than 1.0. This approach is conservative, and if observed HQ values are lower than the target HQ values, it is assumed that there is little potential for observable adverse effects at the population or individual level, respectively.

Risk Estimates Risk estimates are often based on the use of the upper conservative statistical parameters such as the maximum value or the upper confidence limit on the arithmetic mean (UCLM); however, this approach often overestimates risk.

Weight of Evidence The weight of evidence approach considers various lines of evidence (i.e. concentrations of COPC, spatial extent of exceedances, observed or visual impairment to assess the potential ecological risks. This approach does not present risk estimates solely based on calculations and hazard quotients, but presents an integrated conclusion based on all the data to determine, if necessary, the level of action or remedial objectives.

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