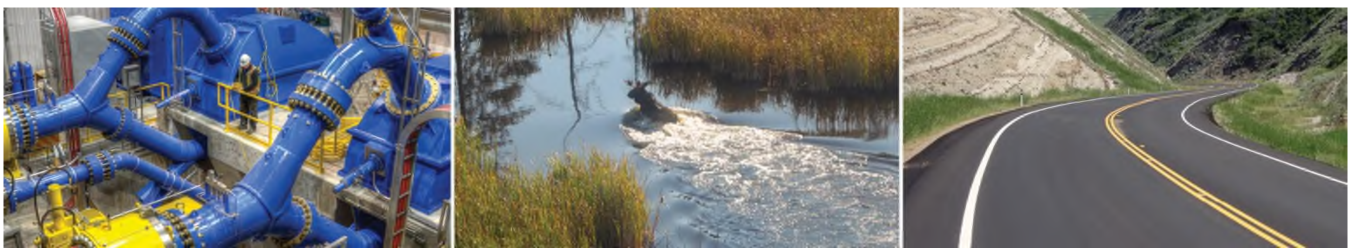
TETRA TECH EBA

OQM | Organizational Quality Management Program

DETAILED RISK ASSESSMENT
WATER LOT PORTION OF 1 PORT DRIVE
NANAIMO, BC



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EXECUTIVE SUMMARY

Background

Tetra Tech EBA Inc. (Tetra Tech EBA) was retained by City of Nanaimo (CON) to complete a Detailed Risk Assessment (DRA) of the marine water lot portion of a CON land parcel located at 1 Port Drive in Nanaimo, BC ("the Property"). Tetra Tech EBA recommended the DRA work be completed on the water lot (herein referred to as "the Site) to facilitate future re-development of the whole Property.

The objective of the DRA was to determine if there were any unacceptable risk to either human or ecological receptors posed by the sediment contamination identified previously on the Site. This DRA takes a moderately conservative approach, based on all available Site-specific information obtained through both the previous investigations and the specific works conducted during this assessment. Using this approach, there is high certainty that risks have not been underestimated.

The DRA was generally conducted in accordance with the BC Ministry of Environment (MOE) policies and guidance but did not include sampling/testing or assessment of any potential related sediment contamination that may exist beyond the Site boundaries, which may be required if a BC MOE legal instrument is ever required by the CON in the future.

Overall DRA Conclusions

For this DRA, the risks posed by sediment contamination to humans and ecological receptors based on the current Site uses and conditions were evaluated. It was determined that there is no operable pathway for human exposures to sediment contamination and therefore human health risks did not require quantification.

Risks to aquatic vegetation, invertebrates, birds and mammals and fish were assessed in detail using various lines of evidence.

The overall findings of the risk assessment indicated that the human health and ecological risks posed by the sediment contamination present on the Site are negligible.

This risk assessment is based on the following key assumptions:

- Current Site uses and conditions as an active commercial/industrial harbour; and
- No seafood for human consumption is collected from the Site.

If uses and conditions of the Site are modified significantly from that assumed in this report during future development, an update to this risk assessment may be required.

In addition, the risk assessment addresses contamination within the Site boundary only. Potential risks to off-Site receptors were not evaluated during this DRA.

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ACRONYMS & ABBREVIATIONS

AEC(s)	Area(s) of Environmental Concern
AEL	Acceptable Effect Level
APEC(s)	Area(s) of Potential Environmental Concern
AW	Aquatic Life
BTEXS	Benzene, Toluene, Ethylbenzene, Xylenes, and Styrene
BAF	Bioaccumulation Factor
BCF	Bioconcentration Factor
BGS	Below Ground Surface
CBR	Critical Body Residues
CCME	Canadian Council of Ministers of the Environment
CEM	Conceptual Exposure Model
COC(s)	Contaminant(s) of Concern
CofC	Certificate of Compliance
CON	City of Nanaimo
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CSAP	Society of Contaminated Sites Approved Professionals of British Columbia
CSR	Contaminated Sites Regulation
DRA	Detailed Risk Assessment
DSI	Detailed Site Investigation
Eco-SSL	Ecological Soil Screening Level
EDXX	Effective Dose that produces an effect in XX% of the population
EMA	Environmental Management Act
ERED	Environmental Residue-Effects Database
EPC	Exposure Point Concentration
FCSAP	Federal Contaminated Sites Action Plan
HC	Health Canada
HQ	Hazard Quotient
HWR	Hazardous Waste Regulation
LANL	Los Alamos National Laboratory
LCXX	Lethal concentration in which XX% of the population dies
LDXX	Lethal dose in which XX% of the population dies
LOE(s)	Line(s) of Evidence
LOAEL	Lowest Observed Adverse Effect Level
LOED	Lowest Observed Effect Dose
Log K_{ow}	Log Octanol-Water Partition Coefficient
PCOC	Potential Contaminants of Concern
NOAEL	No Observed Adverse Effect Level
NOED	No Observed Effect Dose
MOE	Ministry of Environment
OM	Organic Matter
PAH	Polycyclic Aromatic Hydrocarbon
PSA	Particle Size Analysis
PHCs	Petroleum Hydrocarbons

PSEP	Puget Sound Estuary Program
PSI	Preliminary Site Investigation
ROC(s)	Receptor(s) of Concern
SABCS	Science Advisory Board for Contaminated Sites
SNC	SNC-Lavalin
Tetra Tech EBA	Tetra Tech EBA Inc.
TG7	Technical Guidance Document 7
TOC	Total Organic Carbon
TRG	Tissue Residue Guideline
TRV	Toxicity Reference Value
UCLM	Upper Confidence Limit of the Arithmetic Mean
USEPA	United States Environmental Protection Agency
WOE	Weight of Evidence

LIMITATIONS OF REPORT

This report and its contents are intended for the sole use of the City of Nanaimo and their agents. Tetra Tech EBA Inc. (Tetra Tech EBA) does not accept any responsibility for the accuracy of any of the data, the analysis, or the recommendations contained or referenced in the report when the report is used or relied upon by any Party other than the City of Nanaimo, the BC Ministry of Environment, or for any Project other than the proposed development at the subject site. Any such unauthorized use of this report is at the sole risk of the user. Use of this report is subject to the terms and conditions stated in Tetra Tech EBA's Services Agreement. Tetra Tech EBA's General Conditions are provided in Appendix A of this report.

AS ACKNOWLEDGEMENT

The preparation of this Detailed Risk Assessment was carried out with assistance from the Green Municipal Fund, a Fund financed by the Government of Canada and administered by the Federation of Canadian Municipalities. Notwithstanding this support, the views expressed are the personal views of the authors, and the Federation of Canadian Municipalities and the Government of Canada accept no responsibility for them.

1.0 INTRODUCTION

Tetra Tech EBA Inc. (Tetra Tech EBA) was retained by City of Nanaimo (CON) to complete a Detailed Risk Assessment (DRA) of the marine water lot portion of a CON land parcel located at 1 Port Drive in Nanaimo, BC ("the Property"). Tetra Tech EBA recommended the DRA work be completed on the water lot (herein referred to as "the Site) to facilitate future re-development of the whole Property.

The objective of the DRA was to determine if there were any unacceptable risk to either human or ecological receptors posed by the sediment contamination identified previously on the Site. This DRA takes a moderately conservative approach, based on all available Site-specific information obtained through both the previous investigations and the specific works conducted during this assessment. Using this approach, there is high certainty that risks have not been underestimated.

The DRA was generally conducted in accordance with the BC Ministry of Environment (MOE) policies and guidance but did not include sampling/testing or assessment of any potential related sediment contamination that may exist beyond the Site boundaries, which may be required if a BC MOE legal instrument is ever required by the CON in the future.

2.0 BACKGROUND

2.1 Site Description

The Property is zoned CS3 for mixed commercial service use, which provides for transportation terminals, depots, corridors and other required infrastructure. The Site itself is zoned W2 for waterfront use which provides for active marine uses, such as ship yards, fishing fleet support, float homes, moorage and water-based transportation.

The cartographic co-ordinates for the approximate centre of the whole Property are:

- Latitude: 49º 09' 50.3" North
- Longitude: 123º 55' 50.7" West

Figure 1 shows where the Property and Site are located, and Figure 2 shows the current Site layout.

The legal description for the whole Property including the Site is as follows:

- Parcel Identification Number (PID): 029-036-500
- Lot A, Section 1, and Part of the Bed of the Public Harbour of Nanaimo, Nanaimo District Plan EPP27507

2.2 Site History

The current Property boundaries were established through a subdivision of the larger Canadian Pacific Railway Wellcox Yard completed by the CON after their purchase in 2013. The Property still contains a portion of the active rail yard plus a number of associated freight transportation and distribution related commercial and industrial operations.

The Property has a long history of industrial activity, dating from the nineteenth century. The Property was first developed by the Vancouver Coal Mining and Land Company in the late 1800s as a coal processing and shipping terminal for their nearby mining operations. The entire Property, with the exception of two small areas located along the northern boundary and the southwestern corner of the Property was originally occupied by waters of Nanaimo Harbour at that time, based on old mapping and other historical information. As development of the

Property continued, the shoreline was modified by infilling the marine area with coal mining waste, dredged fill from the Nanaimo Harbour, and other fill materials from unknown sources.

The Property changed ownership several times during the early 1900s but continued to be utilized for coal processing and offshore export until 1953, when all such operations ceased and the lands sold to Canadian Pacific Rail (CPR). CPR then developed the Property for use as a central hub for freight on Vancouver Island by constructing a rail yard operation (known as the Wellcox Yard) and an associated ferry transport terminal. CPR leased out several parcels of the unused portions of their Wellcox Yard to sawmills, transportation companies, marine industry, and other tenants during their ownership of the Property.

2.3 Site Characteristics and Layout

The water lot portion of the Property (the Site) is located within Nanaimo harbour on the northeast section of the Property. An area of the Site is currently leased by Seaspan Marine Corporation (Seaspan) and is used for freight distribution and transportation services. See Figure 2 for the current Site layout.

Access to the sediment on the Site by humans was considered limited as the upland area of the Property has a perimeter fence and is monitored by a security firm that restricts all public access. Site sediments are either subtidal or covered by a layer of rip rap. See Figure 2 for the marked intertidal area of the Site which is estimated to be an area of 1,000 m^2 and located in the southwest area of the Site.

2.4 Previous Site Investigations

Tetra Tech EBA completed a Stage 1 Preliminary Site Investigation (PSI) for the Property in 2014 which assessed the current and historical land uses on the Property and surrounding sites (Tetra Tech EBA 2014). The Stage 1 PSI reviewed all previous historical and subsurface environmental investigations and reports conducted for the Property between 1998 and 2009. Based on the information reviewed, Tetra Tech EBA identified six known Areas of Environmental Concern (AECs) and six Areas of Potential Environmental Concern (APECs). One of the AECs identified was documented impacted sediments located on the Site. The contaminants of concern (COCs) identified in sediments on the Site during the Stage 1 PSI (historically documented by SNC Lavalin Environmental (SNC)) were a number of select Polycyclic Aromatic Hydrocarbon (PAH) parameters including 2-methylnaphthalene, acenaphthene, acenaphthylene, anthracene, fluorene, naphthalene, phenanthrene, benzo(a)anthracene, chrysene, fluoranthene, pyrene and benzo(a)pyrene.

After the Stage 1 PSI was completed, Tetra Tech EBA recommended that a Detailed Site Investigation (DSI) to meet the BC Environmental Management Act's Contaminated Site Regulation (CSR) reporting requirements be conducted in order to determine more accurately the concentrations and extent of the COCs within all known AECs and also to investigate all potential contaminants of concern (PCOC) associated with all identified APECs on the Property.

2.4.1 Detailed Site Investigation

2.4.1.1 Applicable Standards

The DSI laboratory results were compared to the applicable numerical standards and criteria stipulated in the BC CSR (B.C. Reg. 375/96, including amendments up to January 31, 2014).

Criteria for both sensitive and typical sediment are regulated under Schedule 9 of the CSR and were developed for the protection of aquatic life only. Since the Site is located within an active industrial/commercial marine harbour, the less stringent quality criteria from Schedule 9 for typical marine/estuarine sediments, were considered applicable to sediments during the DSI.

2.4.1.2 Sediment Characterization

During the DSI, Tetra Tech EBA conducted two sediment sampling events, one in September 2014 and a follow-up in November 2014 on the Site. In September 2014, Tetra Tech EBA collected 18 shallow sediment samples (14SED01 to 14SED018) using a ponar device to assess the horizontal extent of the previously identified surficial sediment contamination across the Site. Sediment samples were selected for laboratory analysis based on the primary COCs associated with the marine AEC (polycyclic aromatic hydrocarbons (PAHs)) and one PCOC (metals).

In November 2014, Tetra Tech EBA collected 6 deeper subsurface sediment samples (14SED19 to 14SED24) using a sonic drill rig to assess the vertical extent of surficial sediment contamination from PAHs previously identified across the Site. In addition, four surficial sediment samples (14SED23A to 14SED23D) were collected in four directions from 14SED04 to try and assess the aerial extent of the potentially “high risk” PAH concentrations found at this specific sample location during the September 2014 investigation. During deeper drilling sediment samples were collected in 0.5 m intervals to a maximum depth of 2 metres below the top of the sediment layer. Sediment samples collected in November 2014 were all analyzed for PAHs since these were the only parameters identified as COCs after the completion of the September 2014 event.

The DSI sediment sampling program is summarized in more detail in the table below and sample locations shown on the attached Figure 2.

Table A: DSI Sediment Sample Locations

Stage 1 PSI Findings		DSI Sampling Locations	
AEC	**Issue**	**Test Location**	**Rationale**
Marine AEC 1	Sediment with PAHs concentrations exceeding the CSR Schedule 9 criteria from 2009 SNC report.	14SED01 to 14SED18 and 14SED23	Surficial samples at 30 m to 50 m grid spacing
		14SED19 to 14SED22 and 14SED24	Deeper samples to assess vertical extent of sediment contamination
		14SED23A to 14SED23D	Sampling in four directions to access aerial extent of PAH impacts exceeding upper cap concentrations found in sediment at 14SED04

2.4.1.3 Detailed Site Investigation Findings and Conclusions

The sediments on the Site were typically described as:

- Sand: with trace to some silt, poorly graded, fine grained, loose, brown to grey, with occasional shells and organic material;
- Silt: moist to wet, soft, brown to black, with some organic inclusions; and
- Fill: coal mining waste.

The sediment analysis performed (i.e., metals and PAHs) during the DSI resulted in select PAHs exceeding the applicable CSR sediment criteria. The DSI analytical testing results are included in Appendix B and summarized in the attached Tables 1 and 2. The sample locations with specific PAH exceedances are presented on the attached Figure 3.

The overall findings of the DSI pertaining to the Site are summarized in the following table with the recommendations for further works to assist with future re-development of 1 Port Drive bolded:

Table B: DSI Findings for the Site

TT EBA AEC/APEC	Sediment Contamination	Extent of Identified Contamination	Recommendation
Marine AEC 1 Active Harbour	PAHs[1] > CSR Typical Sediment Criteria from surface to maximum depth of 1.5 metres below ground surface with average thickness of ~1.0 metre below ground surface.	Estimated Area **28,069 m^2** Estimated Volume **28,069 m^3**	**DRA (this report) required to assess sediment impacts and evaluate potential future remediation options.** Offsite Delineation of contaminated sediments may be required for any future BC MOE legal instrument.

In summary, PAH contamination in surficial sediment was identified throughout the entire marine water lot portion of the Property. Deeper sediment sampling and testing indicated that the select PAH sediment contamination would extend to depths ranging from surface to ~1.0 metres below ground surface (mbgs). Concentrations of select PAHs in surface sediment at 14SED04 and the four step-out locations (14SED23A through 14SED23D) all exceeded the Upper Cap Concentrations listed in CSR Protocol 11, which is used in BC for the purposes of assessing whether the Site is considered by the MOE to be “high risk” or not. Since there is documented PAH concentrations in surficial sediment samples exceeding the upper cap concentration limits that extends over an area greater than 50 m^2 near 14SED04, the Property would now be considered a “high risk” site by the BC MOE.

Based on the findings of the DSI, the following primary recommendations were made by Tetra Tech EBA:

- Complete a DRA to assess if the PAH contamination present in sediments on the water lot could pose unacceptable risks to humans and marine biota potentially using this area and to assist in an evaluation of potential future remediation options.

2.5 Health and Safety

Tetra Tech EBA prepared a site-specific health and safety plan that was implemented during all the field investigation events on the Property (including the field events conducted for this DRA). In addition, Tetra Tech EBA field staff communicated with Seaspan and the Nanaimo Port Authority in order for all field work within the Nanaimo harbour to commence with their knowledge.

[1] PAHS that exceeded the CSR typical marine sediment criteria at least one location were 2-methylnaphthalene, acenaphthene, acenaphthylene, anthracene, benz(a)anthracene, chrysene, fluoranthene, fluorene, naphthalene, phenanthrene, pyrene, benzo(a)pyrene and total PAHs.

3.0 RISK ASSESSMENT PROCESS

3.1 Risk Assessment Methods

Risk assessment is a standard process used to characterize the potential for adverse human health or ecological effects to result from exposure to environmental hazards, in this case chemical contamination. The risk characterization is based on the estimated exposure level and the toxicity of the contaminants. In the case of this DRA, the objective is to conduct a conservative, site-specific risk assessment to determine if the identified COCs (PAHs in sediment) pose unacceptable risk to human or environmental health, based on the current and anticipated future Site use scenarios.

The fundamental principle in risk assessment is that a risk can only occur if there are links between sources of contaminants and the identified human or ecological receptors (e.g., aquatic plants, marine invertebrates and marine mammals/birds). In other words, the following three elements are required:

- Sources of chemicals must be present;
- Receptors (e.g., humans, plants and animals) must be present; and
- Exposure pathways must exist between the source of the chemicals and the receptors.

In the absence of any one of the three elements (chemicals, exposure pathway or receptor), risks cannot occur.

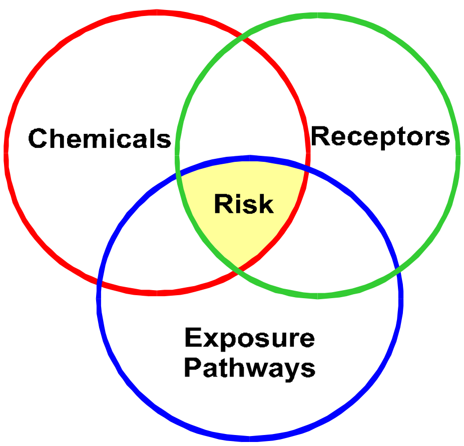

Figure A: Three Elements of Risk

The risk assessment process includes four components, which are described in more detail below:

- Problem Formulation;
- Exposure Assessment;
- Toxicity/Effects Assessment; and
- Risk Characterization.

3.1.1 Problem Formulation

The purpose of the problem formulation component is to identify the chemicals, receptors, and exposure pathways that are applicable for a site.

Chemicals identified as COCs on the Site are those exceeding the applicable criteria which, in the case of the Site, are chemicals in sediment at concentrations exceeding the BC CSR sediment criteria for typical marine sites.

Receptors are humans, plants or animals that have the potential to be present at the Site. Ecological receptors were chosen by focusing on aquatic receptors (e.g., aquatic plants, marine invertebrates and marine mammals/birds) that are or may be present in the vicinity of the Site, based on the current land use and conditions, those that are valued by local stakeholders, and those that are listed as sensitive or of concern by provincial or federal regulators. This DRA is performed based on existing site conditions as a conceptual development plan has not been finalized for redevelopment of the Property.

The objective of the exposure pathway identification is to determine all of the potential routes by which humans and ecological receptors could be exposed to COCs in contaminated media from the Site.

The results of the Problem Formulation phase are summarized in the development of a Conceptual Exposure Model (CEM) that depicts the contaminant sources, receptors and exposure pathways.

3.1.2 Exposure Assessment

The exposure assessment step involves quantification of the amount of chemical an ecological and human receptor may be exposed to through all of the applicable exposure pathways. The amount of exposure depends upon the concentrations of COCs in various media (e.g., concentrations measured in sediment and tissue), and the amount of time or number of events that a receptor is in contact with these media. The exposure assessment also considers how much of the chemical is taken into the body by considering the physiological characteristics of a receptor (e.g., body weight and inhalation rate).

3.1.3 Toxicity/Effects Assessment

The toxicity assessment involves identification of the potentially toxic effects of the COCs and the determination of the amount of the COC that can be taken into the receptor without experiencing adverse health effects. This value is called a Toxicity Reference Value (TRV). The TRVs used in the DRA were obtained from peer-reviewed toxicological databases.

In addition, Site-specific toxicity testing was employed in this DRA to evaluate the toxicity of Site sediments to marine invertebrates relative to local reference sediments and negative laboratory control sediments.

3.1.4 Risk Characterization

The final step in a risk assessment is the risk characterization. This step integrates the results of the exposure assessment and toxicity assessment and determines whether there is a potential for a chemical to pose an ecological or human health risk. From this, recommendations for remediation or risk management are made.

A weight of evidence (WOE) approach to risk characterization was applied in this risk assessment for select receptor groups which considered the results from multiple lines of evidence (LOEs).

3.2 Risk Assessment Guidance

In Canada, risk assessment has been accepted by provincial and federal governments as a valid method to guide management decisions. The methods for this assessment were based on the following provincial and federal guidance documents:

- BC MOE, 1998. Protocol 1: Recommended Guidance and Checklist for Tier 1 Ecological Risk Assessment of Contaminated Sites in British Columbia;
- BC MOE, 2013. Protocol 20: Detailed Ecological Risk Assessment Requirements;
- BC MOE, 2012. Technical Guidance Document 7 "*Supplemental Guidance for Risk Assessments*", Version 4.0, October 2015;
- Environment Canada, 2012. Federal Contaminated Sites Action Plan (FCSAP) Ecological Risk Assessment Guidance;
- Environment Canada, 2012. FCSAP Ecological Risk Assessment Guidance– Module 3: Standardization of Wildlife Receptor Characteristics;
- Environment Canada, 2010. FCSAP Ecological Risk Assessment Guidance – Toxicity Test Selection and Interpretation;
- Science Advisory Board for Contaminated Sites (SABCS) in BC, 2008. Detailed Ecological Risk Assessment in BC – Technical Guidance; and
- SABCS in BC, 2010. Guidance for a Weight of Evidence Approach in Conducting Detailed Ecological Risk Assessment (DERA) in British Columbia.

4.0 DETAILED RISK ASSESSMENT

4.1 Introduction

The problem formulation, exposure assessment, toxicity/effects assessment and risk characterization are detailed below.

4.2 Problem Formulation

Problem formulation consists primarily of the identification of COCs, relevant receptors and operable exposure pathways.

The COCs were identified as part of the DSI (Tetra Tech EBA 2015); however, further refinement of the COCs was completed here to focus the DRA on parameters that are most applicable to specific receptors.

Human and ecological receptors were chosen by focusing on those that are or may be present on the Site, based on the land use and Site conditions.

The Site conceptual exposure model based on current land use is presented in Figure 4.

4.2.1 Contaminants of Concern

A statistical summary of the COCs identified in Site surface sediment (upper 10 to 15 centimetre (cm)) by the DSI is presented below in Table C. Surficial sediment was considered for the DRA as human and ecological receptors are unlikely to have contact with sediments at greater depths under the current Site use. In addition, analytical results of subsurface sediment samples indicated PAH concentrations that were less than the PAH concentrations in the surficial sediments. Thus any future activities (e.g., maintenance dredging and sediment erosion) that could expose sediments at depth would not result in elevated risks beyond what is identified in this report for surficial sediments.

95% UCLM concentrations were calculated using ProUCL statistical software Version 5.0. 90th Percentile concentrations were calculated using Microsoft Office 2010 Excel statistical software. The attached Table 3 provides a summary. Appendix C contains the ProUCL output sheets that detail the statistics that were generated.

Table C: Statistical Summary of Contaminant Concentrations Identified in Site Surface Sediments - DSI

Parameters	Unit	Maximum	Median	Average	90th Percentile	95% UCLM
2-methylnaphthalene	mg/kg	**6.0**	1.4	2.0	**4.7**	**2.7**
Acenaphthene	mg/kg	1.1	0.5	0.5	0.9	0.6
Acenaphthylene	mg/kg	0.2	**0.1**	**0.1**	0.2	0.07
Anthracene	mg/kg	1.7	0.4	0.6	1.4	0.8
Benz(a)anthracene	mg/kg	1.9	**0.4**	**0.6**	1.1	**0.7**
Chrysene	mg/kg	2.9	**0.5**	**0.8**	1.9	1.1
Fluoranthene	mg/kg	17	**1.6**	2.9	6.7	5.1
Fluorene	mg/kg	1.2	0.5	0.5	1.0	0.6
Naphthalene	mg/kg	3.6	1.1	1.4	3.0	1.8
Phenanthrene	mg/kg	**7.4**	1.3	1.8	3.5	2.4
Pyrene	mg/kg	9.1	**1.5**	2.3	6.0	3.2
Benzo(a)pyrene	mg/kg	1.2	0.2	0.3	**0.6**	0.4
Total PAHs	mg/kg	41	**10.9**	**12.7**	**17.9**	**16.9**

Notes:

Bold Bold indicates an exceedance of the CSR Marine Sediment - Sensitive criterion.

Underlined Underlined indicates an exceedance of the CSR Marine Sediment - Typical criterion.

Bold and Shaded Bold and shaded indicates an exceedance of applicable Protocol 11 Upper Cap concentrations for Typical sediments.

Human Health COCs

The CSR sediment criteria (Schedule 9) are for protection of aquatic life and are not relevant to human health protection.

The Society of Contaminated Sites Approved Professionals of British Columbia (CSAP) Technical Guidance for Risk Assessment Contaminants of Potential Concern (COPC) Screening (CSAP 2012) provides the following guidance for identifying COCs to human health in sediments:

- *'In sediments, substances which are not bioaccumulative substances and which only exceed Schedule 9 standards should be considered COCs for ecological risk assessment only and not for human health risk assessment.'*
- *'In intertidal sediments, any substance which is not bioaccumulative and which exceeds Schedule 4 or Schedule 5 "intake of contaminated soil" standards, or Schedule 10 soil standards, if the substance is not listed in Schedule 4 or 5, should be considered a COPC for human risk assessments.'*
- *'Any bioaccumulative substance that exceeds any of the applicable Schedule 9, Schedule 4 or Schedule 5 "intake of contaminated soil", or Schedule 10 standards, should be considered a COPC in both human and ecological risk assessments.'*

The BC MOE defines a bioaccumulative substance as that with any of the following characteristics: bioaccumulation factors (BAF) greater than 5,000; bioconcentration factors (BCF) greater than 5,000; or Log octanol-water partition coefficients (Log K_{ow}) greater than 5.

Log K_{ow} values for the COCs are presented in the Table D below.

Table D: COC Screening for Human Health

Parameters	Maximum Concentration (mg/kg)	CSR - Marine Sediment – Typical (Schedule 9) (mg/kg)	CSR Commercial Land Use - Most Stringent Soil Standard (Schedules 4/5/10) (mg/kg)	Log K_{ow}[2]	Bioaccumulative?
2-methylnaphthalene	6.0	0.24	-	3.86	No
Acenaphthene	1.1	0.11	-	3.98	No
Acenaphthylene	0.2	0.15	-	4.07	No
Anthracene	1.7	0.29	-	4.5	No
Benz(a)anthracene	1.9	0.83	10	5.63	Yes
Chrysene	2.9	1	-	5.63	Yes
Fluoranthene	17.0	1.8	-	4.90	No
Fluorene	1.2	0.17	-	4.18	No

[2] BC MOE 1993 - PAHs and Their Characteristics

Parameters	Maximum Concentration (mg/kg)	CSR - Marine Sediment – Typical (Schedule 9) (mg/kg)	CSR Commercial Land Use - Most Stringent Soil Standard (Schedules 4/5/10) (mg/kg)	Log K_{ow}[2]	Bioaccumulative?
Naphthalene	3.6	0.47	50	3.37	No
Phenanthrene	7.4	0.65	50	4.46	No
Pyrene	9.1	1.7	100	4.88	No
Benzo(a)pyrene	1.2	0.92	15	6.06	Yes
Total PAHs	41.0	20	-	Not Defined	Not Defined

As per the first two bullets above, 2-methylnaphthalene, acenaphthene, acenaphthylene, anthracene, fluoranthene, fluorene, naphthalene, phenanthrene and pyrene were dismissed as COCs to human health because they are not bioaccumulative and do not exceed a standard other than the CSR Schedule 9 sediment criteria.

As per the third bullet, benzo(a)anthracene, chrysene, and benzo(a)pyrene were retained as COCs to human health because they are bioaccumulative and exceed their respective CSR Schedule 9 sediment criteria.

Ecological Health COCs

Each of the 13 PAHs, including total PAHs, identified as contaminants in sediment by the DSI were retained as COCs to ecological receptors.

Site COCs

Conclusion: COCs to human health carried forward for further evaluation include benz(a)anthracene, chrysene, and benzo(a)pyrene in sediment. Ecological COCs identified on the Site include the 13 PAHs, including total PAHs, identified as contaminants in sediment by the DSI.

4.2.2 Selection of Receptors of Concern

4.2.2.1 Human Receptors

Potential human receptors at the Site include workers on the Property and the public. Members of the public are not expected to be exposed to the sediment contamination at the Site given its strictly commercial/industrial usage and access restrictions from the upland portion of the Property (i.e., fencing and security) however they were included here as a conservative measure.

4.2.2.2 Ecological Receptors

The first step in the identification of ecological receptors was to compile lists of species potentially present at the Site. To do so, the ecozone and ecoregion in which the Site is located were identified and plant and animal species known to occur in this zone and region were inventoried.

Information from the following sources was reviewed:

- The Ecological Framework of Canada for information on the Pacific Maritime Ecozone (Ecological Framework of Canada 2015);
- Ministry of Forests Biogeoclimatic Zones of British Columbia;
- Ministry of Environment Habitat and Fisheries Inventory Data; and
- The Canadian Biodiversity Website for information on the Pacific Maritime Ecozone (Heritage Canada 2015).

A search of the Ministry of Forests Biogeoclimatic Zones of British Columbia indicated that the Site is located within the Coastal Douglas Fir (CDF) biogeoclimatic zone. The search also indicated that the Site is located within the moist maritime (mm) variant of the CDF known as CDFmm (CDFCP 2015).

A dive survey of the Site was conducted by Subtidal Surveying and Environmental Assessors (SSEA) of Nanoose Bay, BC to map seafloor physical features, habitats, and plant and animal species occurrences. The dive survey consisted of recording observations and video along ten transects on the Site (see Figure 5). The dive survey results provided a current account of the biophysical conditions at the Site, and the apparent health of the Site's invertebrate and plant communities. See Appendix D for detailed results.

The following groups and species for which habitat on the Site was concluded to be moderate or highly suitable based on the dive survey and desktop assessment were considered potential receptors at the Site:

- Birds: Raptors (Bald eagles), various shorebirds (black oystercatcher, loons, grebes, gulls, cormorants (the double crested cormorant is not known to be found in the immediate area of the Site), alcids and waterfowl (ducks, geese and swans);
- Mammals: Harbour seals and river otters;
- Various marine invertebrates (including Dungeness crab, red rock crab, hermit crab, giant sea cucumber, rock scallop, swimming scallop, Nuttall's cockle, Pacific gaper clam, fat gaper clam, horse clam, tubeworms, nudibranchs, anemones, sea stars, barnacles, and snails);
- Marine fish (including rock sole, rockfish, pipefish, shiner perch and greenling); and
- Vegetation: Rockweed, sea lettuce, sugar wrack kelp, Japanese weed, leafy algae, stringy algae, and flat kelp (primarily *Laminaria saccharina)*. Limited eel grass beds were identified in Transects 1 and 2 on the Site and were estimated to occupy a total area of 300 m^2. See Figure 5 for eel grass bed locations.

Species of Concern

Risk assessment guidance recommends that species listed as rare, endangered, or threatened with habitats confirmed to be present within the study area or likely to be present in the future, be included as receptors in a risk assessment (Environment Canada 2012a).

A search of the Ministry of Environment's Conservation Data Centre database (BC MOE 2015) yielded a number of potential species present within the South Island Forest District and the CDF with a habitat subtype of industrial, intertidal marine, sheltered waters marine, and subtidal marine. A list of the potential at risk species is located in Appendix E.

None of the species identified in these databases are expected to inhabit the Site.

Ecological Receptors Evaluated in the Risk Assessment

While there are many species that could be present in a marine setting, it is not practical to evaluate all species. Risk assessments must limit their focus on only some of the specific plants and animals that might use a site. Representative receptors selected for the risk assessment are those that have the greatest potential for exposure, that play a key role in the food web, and that have sufficient characterization data to facilitate calculations of exposure and health risks. A receptor of concern (ROC) is generally a single species which serves as a surrogate for the other related species. The following criteria from CCME (1996) and Environment Canada (2012b) were used to select the receptors evaluated in the risk assessment:

- Potentially sensitive to the substances identified on the Site;
- Known or expected habitat of animals recognized by the federal or provincial government as threatened or endangered or of special concern;
- Year round residents at the Site;
- Migratory birds, where a significant proportion of the population is concentrated in the vicinity of the Site during certain periods;
- Dominant within local biological communities, or functioning as keystone species within nearby ecosystems;
- Recognized as good indicators or surrogate species (i.e., representative of other similar organisms of a general type and feeding niche);
- Of aesthetic value or of value to the local human population; or
- Of recreational importance.

Consideration was also given to the following factors when making receptor selections:

- Visual evidence of the species at the Site during the biological survey;
- Presence based upon habitat quality identified during the biological survey;
- Roles in the food web;
- Home range small enough to have a significant portion of foraging and exposure occur at the Site;
- Small body size (increases exposure); and
- Ability to find a TRV within the same order (preferably family) for each receptor.

Based on the Site information provided above, ecological receptors representative of a broad range of biota were selected. The representative receptors selected for this DRA as well as the trophic level represented and rationale for selection is presented in the table below.

Table E: Ecological Receptors for the DRA

Selected Receptors	Rationale for Selected Receptors	Feeding Guild
Vegetation		
Aquatic Macrophytes	Algae were observed at the Site and are expected to be present on Site regardless of future land use. They are an important source of food for herbivorous animals and provide habitat to other animals. Small eelgrass beds were also identified on the southern portion of the Site.	Not Applicable
Aquatic Invertebrates		
Benthic Invertebrates	Benthic invertebrates were observed on the Site, are expected to be present on the Site regardless of future land use and have a high potential for contaminant exposure due to their constant contact with sediments. They are an important source of food for some animals and are also important for maintaining healthy ecosystems (i.e., nutrient cycling). Benthic invertebrates are also common species used in laboratory tests to determine toxicity of chemicals in sediment.	Carnivorous, omnivorous and herbivorous
Mammals		
River Otter	Observed at the Site during a field visit.	Carnivorous
Birds		
Lesser Scaup	There are diving ducks that may be present on the Site. Diving ducks would have direct sediment contact and feed on organisms in the sediments. A diving duck that could be present on the Site is the lesser scaup as its range includes the Site.	Omnivorous
Fish		
Rock Sole	The most commonly found fish during the dive survey. The Rock Sole would be in direct sediment contact and feed on marine invertebrates in the sediments.	Carnivorous

4.2.3 Exposure Pathway Identification and Screening

Exposure pathways are the means by which a receptor comes in contact with COCs. Receptors may be exposed to PAHs in Site sediment through direct contact or indirect pathways. Indirect exposure pathways are those in which the exposure results from a secondary source, such as ingestion of food items or contact with overlying surface water. All relevant exposure pathways are examined below.

4.2.3.1 Human Exposure Pathways

Exposure pathways between the sediment contamination and human receptors are not expected to be significant given:

- The current commercial/industrial use of the Site and active shipping lanes is likely to limit the potential for seafood harvesting;
- Land access to the Site is restricted as the upland area is fenced and also monitored by a security firm (i.e., restricted public access);
- The impacted sediments are either subtidal or covered nearshore by rip rap limiting the potential for direct sediment contact; and

- Maximum concentrations of all PAH constituents were less than applicable CSR soil standards indicating that direct sediment contact is not a concern to human health.

Therefore, it was determined that there is no significant exposure pathway for humans.

4.2.3.2 Ecological Exposure Pathways

The following ecological exposure pathways were considered: direct sediment contact, sediment and food ingestion, and surface water contact.

Direct Sediment Contact

Direct contact with sediment COCs is typically considered for surficial sediment, defined by BC MOE as sediments within the upper metre. Benthic invertebrates living on and within the sediments have the potential to be exposed via direct contact.

The majority of vegetation on the Site would be exposed via direct contact to suspended sediments only as most marine vegetation is attached to hard substrates via a holdfast. Plants such as eel grass would be exposed directly to impacted bedded sediment as their roots are embedded in soft sediments.

Therefore direct sediment contact was carried forward as a complete exposure pathway for benthic invertebrates and vegetation because this pathway is relevant, receptors are present, and COCs exceed the criteria.

Although direct contact with sediment contaminants via dermal exposure is possible for birds and mammals, it is considered a minor exposure pathway since feathers and fur effectively reduce dermal exposure by limiting COCs contact with skin (Sample et. al. 1996). Therefore, this pathway was not evaluated in the risk assessment.

Ingestion of Sediment

Birds, mammals, benthic invertebrates and fish may ingest sediment inadvertently when ingesting plants and prey. Benthic invertebrates may also ingest sediment purposely to obtain nutrients.

Therefore sediment ingestion was carried forward as a complete exposure pathway for birds, mammals, benthic invertebrates and fish because this pathway is relevant, receptors are present, and COCs exceed the criteria.

Ingestion of Plants and Animals

Aquatic plants and benthic invertebrates can take up COCs from sediments into their tissues, which may then be subsequently consumed by invertebrates, fish, birds and mammals. Hydrocarbons are not readily accumulated in plant or animal tissues, therefore food chain transfer is not considered to be a major component of exposure (CCME 2008).

Although not expected to be a major exposure pathway, the food chain was evaluated in the risk assessment for invertebrates, fish, birds and mammals.

Water Contact

PAHs in sediment could leach into surrounding porewater and surface water resulting in contact by plants, invertebrates and fish, albeit to a limited degree given the low solubility of most PAHs.

Therefore this exposure pathway was carried forward for evaluation for plants, invertebrates and fish because this pathway is relevant and receptors are present.

4.2.3.3 Summary of Exposure Pathway Evaluation

The table below is a summary of the exposure pathway evaluation for the Site. Bolded exposure pathways are considered complete and were carried forward in the DRA.

Table F: Summary of Complete Exposure Pathways

COC	Receptor and Complete Pathway(s)					
	Human Receptors	Aquatic Ecological Receptors				
		Plants	Benthic Invertebrates	Fish	Mammals	Birds
Select PAHs in Sediment	No complete exposure pathway for humans: Access to the Site is limited and impacted sediments are subtidal or covered by rip rap.	**Direct Sediment Contact, Water Contact**	**Direct Sediment Contact, Ingestion of Sediments, Ingestion of Plants and Animals, Water Contact**	**Direct Sediment Contact, Ingestion of Sediments, Ingestion of Plants and Animals, Water Contact**	**Ingestion of Sediments, Ingestion of Plants and Animals**	**Ingestion of Sediments, Ingestion of Plants and Animals**

The evaluation of risks to aquatic ecological receptors is the subject of the remainder of this report. Complete exposure pathways were not identified for human receptors and therefore human health risks are not evaluated further.

4.2.4 Conceptual Exposure Model

A summary of the contaminant transport mechanisms, potentially impacted media, ROCs, COCs, and potentially complete exposure pathways is presented pictorially in a comprehensive Site CEM for the current land use (Figure 4).

4.2.5 DRA Basis and Approach

In this section, the basis and overall approach of the ecological risk assessment are identified, including the following:

- Management Goal
- Protection Goals and Acceptable Effects Levels
- Assessment Endpoints
- Risk Hypotheses
- Measurement Endpoints and Lines of Evidence

4.2.5.1 Management Goal

The overall management goal for the project is to facilitate Property re-development.

4.2.5.2 Protection Goals and Acceptable Effects Levels

A protection goal is a narrative statement that defines the desirable level of protection for a receptor or receptor group.

According to BC MOE Technical Guidance 7 (2015), *"the primary goal of ecological risk assessment and/or ecological risk management is to ensure the continued presence, or successful re-introduction, of a biologically diverse, functional, self-sustaining, and interdependent community or ecosystem…"*

BC MOE Protocol 1 (1998) states, *"for environmental receptors such as plants or animals (i.e., not humans), the goal is not to protect each individual from any toxic effect, but rather to protect enough individuals so that a viable population and community of organisms can be maintained."*

Based on the foregoing, the ecological protection goals for the Site are:

- Minimal community-level impacts on plants and invertebrates; and
- Minimal population-level impacts on fish, bird and mammal species at the Site.

An acceptable effect level (AEL) operationalizes the protection goal by specifying the magnitude (or rate) of effects that would be acceptable (Environment Canada 2012a). For the assessment of plants, invertebrates, fish, birds and mammals at the Site, an AEL of 20% was used, based on BC MOE policy.

4.2.5.3 Assessment Endpoints

Assessment endpoints are explicit expressions of the values to be protected in the risk assessment (Suter, et. al. 2000). An assessment endpoint includes a ROC (e.g., aquatic mammals), and a specific property of that ROC (e.g., population abundance).

Considering the protection goals defined above, the assessment endpoints employed for the ecological risk assessment were:

- The diversity and abundance of the aquatic macrophyte community at the Site and its function as a food and habitat source for invertebrates, fish and wildlife.
- The diversity and abundance of the benthic invertebrate community at the Site and its function as a food source for fish and wildlife.
- The abundance of fish populations at the Site and their function as a food source for wildlife.
- The abundance of aquatic bird and mammal populations at the Site.

4.2.5.4 Risk Hypotheses

Risk hypotheses are statements that describe predicted relationships among stressor, exposure, and assessment endpoint responses (USEPA 1998). The risk hypotheses for the DRA are as follows:

Assessment Endpoint 1: Abundance and diversity of the aquatic macrophyte community at the Site and its function as a food and habitat source for invertebrates, fish and wildlife.

Risk Hypothesis 1: The abundance and diversity of the aquatic macrophyte community at the Site is not substantially reduced as a result of exposures to COCs.

Assessment Endpoint 2: Abundance and diversity of the benthic invertebrate community at the Site and its function as a food source for fish and wildlife.

Risk Hypothesis 2: The abundance and diversity of the benthic invertebrate community at the Site is not substantially reduced as a result of exposures to COCs.

Assessment Endpoint 3: Abundance of resident fish populations at the Site.

Risk Hypothesis 3: The abundance of resident fish populations at the Site is not substantially reduced as a result of exposures to COCs.

Assessment Endpoint 4: Abundance of bird and mammal populations at the Site.

Risk Hypothesis 4: The abundance of bird and mammal populations at the Site is not substantially reduced as a result of exposures to COCs.

4.2.5.5 Measurement Endpoints and Lines of Evidence

A measurement endpoint is a parameter that measures or describes exposure for, or an effect on, a ROC in response to a stressor to which it is exposed.

A Line of Evidence (LOE) is any pairing of exposure and effects measures that provides evidence for the evaluation of a specific assessment endpoint (Environment Canada 2012a). Various LOE were used in the DRA to test each of the risk hypotheses presented above.

Table G below summarizes the receptors, assessment endpoints, risk hypotheses, measurement endpoints and LOE used in the DRA.

Table G: Receptors, Assessment Endpoints, Risk Hypotheses, Measurement Endpoints and LOE used in the DRA

Receptor	Assessment Endpoint	Risk Hypothesis	Measurement Endpoints		Line of Evidence
			Measure of Exposure	Measure of Effect	
Aquatic Macrophytes	Abundance and diversity of the aquatic macrophyte community at the Site and its function as a food source for fish and wildlife	The abundance and diversity of the aquatic macrophyte community at the Site is not substantially reduced as a result of exposures to COCs	Measured COC concentrations in plant tissues at the Site	TRVs that represent maximum COC concentrations in plant tissues that do not result in significantly reduced survival, growth and reproduction.	LOE 1a: Comparison of tissue concentrations to tissue-based TRVs. The resulting value is a Hazard Quotient (HQ). The magnitude of the HQ is the LOE.
			Measured COC concentrations in plant tissues at the Site	Observable gross-scale adverse effects on plant abundance and diversity at the Site.	LOE 1b: Apparent health of the plant community at the Site.
Benthic Invertebrates	Abundance and diversity of the benthic invertebrate community at the Site and its function as a food source for fish and wildlife	The abundance and diversity of the benthic invertebrate community at the Site is not substantially reduced as a result of exposures to COCs	Measured COC concentrations in Site sediments	TRVs that represent maximum COC concentrations in sediment that are unlikely to result in significantly reduced invertebrate survival, growth and reproduction.	LOE 2a: Comparison of estimated exposure concentrations in sediment to TRVs. The resulting value is an HQ. The magnitude of the HQ is the LOE.
			Measured COC concentrations in Site sediments	The survival, growth and reproduction of marine invertebrates exposed to contaminated Site sediments in laboratory bioassays.	LOE 2b: Magnitude of effect on invertebrate survival, growth and reproduction relative to negative control or reference sediments, and degree of correlation with COC concentrations.
			Measured COC concentrations in invertebrate tissues at the Site	TRVs that represent maximum COC concentrations in invertebrate tissues that do not result in significantly reduced survival, growth and reproduction.	LOE 2c: Comparison of tissue concentrations to tissue-based TRVs. The resulting value is a HQ. The magnitude of the HQ is the LOE.

Table G: Receptors, Assessment Endpoints, Risk Hypotheses, Measurement Endpoints and LOE used in the DRA

Receptor	Assessment Endpoint	Risk Hypothesis	Measurement Endpoints		Line of Evidence
			Measure of Exposure	Measure of Effect	
Fish	Abundance of resident fish populations at the Site and their function as a food source for birds and mammals	The abundance of resident fish populations at the Site is not substantially reduced as a result of exposure to COCs	-	-	LOE 3a: Risk conclusion for plant and benthic invertebrate communities
Birds and Mammals	Abundance of wildlife populations at the Site	The abundance of bird and mammal populations at the Site is not substantially reduced as a result of exposure to COCs	Estimated total daily oral contaminant intakes based on: – Plant tissue chemistry – Benthic invertebrate tissue chemistry – Site-specific/ literature-based exposure characteristics	Literature-based TRVs that represent maximum COC doses that do not result in significantly reduced avian and mammalian survival, growth and reproduction.	LOE 4a: Comparison of total daily oral contaminant intakes to TRVs. The resulting value is a HQ. The magnitude of the HQ is the LOE.

4.2.6 DRA Analysis Plan

The details of how the various LOE identified above will be developed and interpreted are discussed below.

4.2.6.1 Assessment of Risks to the Aquatic Macrophyte Community

The risk evaluation for the aquatic macrophyte community considered the following two LOEs:

- LOE 1a: Plant tissue chemistry compared to TRVs (i.e., Hazard Quotient); and
- LOE 1b: Apparent health of the plant community.

To integrate the two LOEs into a risk conclusion for the aquatic macrophyte community at the Site, a WOE approach based on those described by the Science Advisory Board for Contaminated Sites in British Columbia (SABCS, 2010) and Chapman and Anderson (2005) was used. The WOE approach considered the magnitude of hazard or effect indicated by each LOE and the relative "weighting" of each LOE.

LOE Ranking

The LOE were ranked based on the magnitude of effect or hazard indicated as described in the below table. This ranking scheme was based on the AEL defined above (20%):

Table H: Scheme Used to Rank the Magnitude of Effect/Hazard in the Two LOEs for the Aquatic Macrophyte Community

LOE	RANKING		
	High Magnitude of Adverse Effects/Hazard (+)	**Moderate Magnitude of Adverse Effects/Hazard (+/-)**	**Negligible-to-low Magnitude of Effects/Hazard (-)**
1a: Plant Tissue Chemistry Compared with TRVs	One or more measured chemical parameters exceed TRV by more than 10 times (i.e., HQ>10)	One or more measured chemical parameters exceed TRV by no more than 10 times (i.e., 1<HQ≤10)	Measured chemical parameters are below TRVs (i.e., HQ≤1)
1b: Apparent Health of the Plant Community	Qualitative observations indicate obvious evidence of impairment to the health of the aquatic macrophyte community at the Site with observed difference between the Site and surrounding areas.	Qualitative observations indicate possible evidence of impairment to the health of the aquatic macrophyte community with some amount of observed difference between the Site and surrounding areas.	Qualitative observations indicate no evidence of impairment to the health of the aquatic macrophyte community at the Site with no apparent difference between the Site and surrounding areas.

Notes:
Adapted from Chapman and Anderson, 2005.

LOE Weighting

Weighting factors were developed for each LOE based on the strength of five attributes recommended by the SABCS (2010), including:

a) Strength of Association (relevance of LOE to assessment endpoint).

b) Sensitivity and Specificity (ability of LOE to detect change, specificity of LOE to COCs).

c) Data Quality and Study Design (quality of data and strength of study design).

d) Representativeness (spatial/temporal overlap among measurements/samples, stressors, and receptors).

e) Correlation/Causation/Consistency (ability of LOE to correlate effects with degree of exposure).

For each LOE, the five attributes (a through e) were given a score between 1 and 5 and the average of these scores was established as the LOE weighting factor. Table I below presents the weighting factors established for each LOE for the aquatic macrophyte assessment. Tables F1 and F2 in Appendix F details the attribute scores for each LOE along with rationale for the chosen score.

Table I: LOE Weighting Factors – Aquatic Macrophyte Community

LOE	LOE Weighting Factor						Average Weight (divide by 6)
	A Strength of Association (entered twice)		B Sensitivity/ Specificity	C Quality/Design	D Representativeness	E Causality	
1a: Plant Tissue Chemistry Compared to TRVs	3	3	2	4	3	4	3.2
1b: Apparent Health of the Plant Community	2	2	1	1	2	2	1.7

Following the ranking and weighting of the various LOE as per the above procedure, the risk indicated for the aquatic macrophyte community at the Site was determined using professional judgement.

4.2.6.2 Assessment of Risks to the Benthic Invertebrate Community

The risk evaluation for the benthic invertebrate community considered the following three LOE:

- LOE 2a: Bulk sediment chemistry compared to TRVs (i.e., Hazard Quotient).
- LOE 2b: Sediment toxicity test results (magnitude of effect on invertebrate survival, growth and reproduction by Site sediment relative to negative control or reference sediments, and degree of correlation with COCs).
- LOE 2c: Invertebrate tissue chemistry compared to TRVs (i.e., Hazard Quotient).

As described above for the aquatic macrophyte community, to integrate the three LOE into a risk conclusion for the benthic invertebrate community at the Site, a WOE approach based on those described by the SABCS (2010) and Chapman and Anderson (2005) was used. The WOE approach considered the magnitude of hazard or effect indicated by each LOE and the relative "weighting" of each LOE.

LOE Ranking

The LOE were ranked based on the magnitude of effect or hazard indicated as described in the below table. This ranking scheme was based on the AEL defined above (20%).

Table J: Scheme Used to Rank the Magnitude of Effect/Hazard in the Three LOE for Benthic Invertebrate Community

LOE	RANKING		
	High Magnitude of Adverse Effects/Hazard (+)	**Moderate Magnitude of Adverse Effects/Hazard (+/-)**	**Negligible-to-low Magnitude of Effects/Hazard (-)**
2a: Sediment Chemistry (bulk sediment) Compared with TRVs	One or more measured chemical parameters exceed TRV by more than 10 times (i.e., HQ>10)	One or more measured chemical parameters exceed TRV by no more than 10 times (i.e., 1<HQ≤10)	Measured chemical parameters are below TRVs (i.e., HQ≤1)
2b: Sediment Toxicity Test Results	Greater than 50% statistically significant reduction in multiple test outcomes relative to laboratory negative control sediments.	Between 20 and 50% statistically significant reduction in multiple toxicity test outcomes relative to laboratory negative control sediments or >50% reduction in no more than a single toxicity test outcomes relative to negative laboratory control sediments.	Less than 20% reduction or not statistically significant reduction in each toxicity test outcome, relative to negative laboratory control sediments, or 20-50% reduction in no more than a single toxicity test outcome relative to laboratory negative control sediments.
2c: Tissue Chemistry Compared with TRVs	One or more measured chemical parameters exceed TRV by more than 10 times (i.e., HQ>10)	One or more measured chemical parameters exceed TRV by no more than 10 times (i.e., 1<HQ≤10)	Measured chemical parameters are below TRVs (i.e., HQ≤1)

Notes:
Adapted from Chapman and Anderson, 2005.

LOE Weighting

As per aquatic macrophytes, weighting factors were developed for each LOE based on the strength of the five attributes recommended by the SABCS (2010).

Table K below presents the weighting factors established for each LOE for the benthic invertebrate assessment. Tables F3 to F5 in Appendix F details the attribute scores for each LOE along with rationale for the chosen score.

Table K: LOE Weighting Factors – Benthic Invertebrate Community

LOE	LOE Weighting Factor						Average Weight (divide by 6)
	A Strength of Association (entered twice)		B Sensitivity/ Specificity	C Quality/ Design	D Representativeness	E Causality	
2a: Sediment Chemistry Compared to TRVs	1	1	2	5	3	3	2.5
2b: Toxicity Test Results	4	4	4	5	4	4	4.2
2c: Tissue Chemistry Compared to TRVs	3	3	2	4	3	4	3.2

Following the ranking and weighting of the various LOE as per the above procedure, the risk indicated for the benthic invertebrate community at the Site was determined using professional judgement.

4.2.6.3 Assessment of Risks to Fish Populations

The risk assessment for fish populations was based solely on the risk conclusions determined for plant and invertebrate communities at the Site (LOE 3a). This is considered reasonable given that fish readily metabolize PAHs, they are generally more mobile than plants and invertebrates and are not expected to be in continuous direct contact with sediments, like plants and invertebrates. In other words, plants and invertebrates are likely to be more exposed to the COCs and at greater risk of adverse effects than fish.

4.2.6.4 Assessment of Risks to Bird and Mammal Populations

The risk assessment for birds and mammals relied on the deterministic hazard quotient method to evaluate whether the COCs identified in Site media could cause adverse effects on wildlife populations (LOE 4a). For birds and mammals, the hazard quotient method involved comparisons of estimated daily oral contaminant intakes to TRVs to derive HQs. An HQ of less than one (1) indicates that adverse effects to an ROC are unlikely at the predicted intake. HQs exceeding one (1) indicate that adverse effects could occur at the predicted intake.

4.3 Risk Assessment Sampling

Additional sampling conducted to support the risk assessment included sediment sampling for invertebrate toxicity testing (LOE 2b) and aquatic vegetation and benthic invertebrate tissue sampling (LOE 1a/2c). The sampling methods are presented in this section.

4.3.1 Sediment Sampling for Toxicity Testing

Ms. Shawneen Walker and Mr. Isaac Kitchingman of Tetra Tech EBA were on Site May 21 and 22, 2015 and collected 12 surficial sediment samples (15SED01 to 15SED12) from the Site and local off-Site reference locations for chemical analysis to support the selection of suitable samples for laboratory toxicity testing. Samples were collected using a stainless steel ponar grab sampler. 15SED01 to 15SED09 were collected on the Site and 15SED10 to 15SED12 were collected offsite at reference locations (15SED10 was collected east of Protection Island and 15SED11 and 15SED12 were collected northwest of Newcastle Island). The nine Site sample locations were selected to target previous sampling locations which had the highest PAH concentrations in sediment. The reference locations were selected to target areas with similar sediment physical characteristics (i.e., similar grain size and organic carbon content) to the Site but without Site-related contaminant impacts.

The sediment sample locations are summarized in more detail in the table below and are shown on Figures 6 and 7. The previous investigations sample locations (including the DSI locations) are shown on Figure 2.

Table L: Previous Investigations and DRA Test Locations

Stage 1 PSI Findings		DSI Sample Locations		DRA Sample Locations	
AECs	**Issue**	**Test Location**	**Rationale**	**Test Location**	**Rationale**
Marine AEC 1	Sediment with PAHs concentrations exceeding the CSR Schedule 9 standards from 2009 SNC report.	14SED01 to 14SED18	Surficial samples at 30 m to 50 m grid spacing.	15SED01 to 15SED09	Surficial samples in known areas of PAH impacts on Site to guide selection of samples for toxicity testing.
		14SED19 to 14SED24	Deeper samples to assess vertical extent of sediment contamination.		
		14SED23A to 14SED23D	5 m grid spacing to access extent of upper cap concentration exceedances found at 14SED04.	15SED10 to 15SED12	Offsite reference samples for potential use in toxicity testing.

Station locations were determined using a GPS. Once retrieved, the grab sampler was opened and its contents were emptied into a stainless steel container. Tetra Tech EBA's field representative wore new nitrile sampling gloves during the collection of each sediment sample to prevent cross-contamination. Multiple grabs were performed until sufficient sediment was collected for the sample (~8L). Once sufficient sediment was collected, the material was homogenized within the steel container using a stainless steel trowel. The ponar and container were cleaned with local seawater between samples. The sample was then transferred into a laboratory-provided plastic pail for toxicity testing purposes and 250mL glass jars for supporting chemical analysis. All sample jars and pails were stored in ice-chilled coolers then shipped under chain of custody protocol to Maxxam Analytical of Burnaby, BC (Maxxam).

Chemistry samples were submitted Maxxam for analysis of PAH, particle size analysis (PSA), and total organic carbon (TOC). In addition to PAH analysis, the reference samples were analyzed for metals. Toxicity testing samples (i.e., 8L pails) were submitted to Maxxam for archiving pending the results of the chemical analyses. Sediment analytical results are presented in Appendix B in the attached Tables 4 to 7 and on Figures 6 and 7.

Analytical results for PAHs in the sediment samples collected were similar to the DSI sediment analytical results. All nine of the sediment samples collected on the Site during the DRA contained five or more PAHs with exceedances of the Schedule 9 typical marine criteria.

At three separate reference locations sediment samples were collected and analyzed for PAHs and metals. No metals exceedances were detected in the reference sediment samples. One of the reference samples (14SED10) contained PAH exceedances. This location was offshore from Protection Island which did have reported historical coal mining activities. The other two reference locations (14SED11 and 14SED12) were located near Newcastle Island which is a protected park. No exceedances were found for PAH and metals in the samples collected at these two locations.

4.3.2 Sediment Toxicity Testing

Based on the chemical analytical results for the 12 sediment samples discussed above, the following six Site samples and one reference sample were selected for toxicity testing to support LOE 2b:

- 15SED02
- 15SED03
- 15SED05
- 15SED06
- 15SED07
- 15SED08
- 15SED11 (reference location)

Sample locations are illustrated on Figure 6 and 7.

The six Site samples were selected for toxicity testing as they cover the full range of COC concentrations and sediment physical conditions (i.e., PSA and TOC) identified in surface sediments on the Site. For example, sample 15SED03 contained the highest total PAH concentration (79 mg/kg) among samples collected during the DRA and previous Site investigations as well as the highest concentrations of individual PAH constituents, with the exception of 2-methylnaphthalene, fluorene and naphthalene.

The following invertebrate toxicity tests were conducted on these 7 samples:

- 10-day Survival of the Marine Amphipod *Eohaustorius estuarius*
- 20-day Survival and Growth of the Marine Polychaete *Neanthes arenaceodentata*
- 48-hour Bivalve Larval Development in Sediment Elutriate using *Mytilus galloprovincialis*

This trio of tests covers multiple distinct invertebrate receptor groups, exposure pathways, and test endpoints and is the test set most often applied in detailed marine sediment risk assessments in BC.

4.3.2.1 10-day Marine Amphipod Survival

The survival of *E. estuarius*, a deposit-feeding, free burrowing crustacean, was assessed when exposed to whole sediment samples from the Site for a 10-day duration according to test methods: Environment Canada (1998) Biological Test Method: Reference Method for Determining Acute Lethality of Sediment to Marine or Estuarine Amphipods (EPS 1/RM/35) and the Maxxam standard operating procedure (SOP) test method for the “Marine or Estuarine Amphipod 10 Day Survival and Re-burial Test (BBY2 SOP-00012). Method details are presented in Appendix G. The 10-day Marine Amphipod Survival test was selected as a measure of the acute toxicity of Site sediments and is considered ecologically relevant to the Site given the known presence of various epifaunal crustacean species at the Site and the expected presence of infaunal crustacean species, including *E. estuaries*, in Site sediments.

4.3.2.2 20-day Polychaete Survival and Growth

The survival and growth rate of juvenile *N. arenaceodentata*, an omnivorous deposit-feeding marine polychaete worm, when exposed to whole sediment samples from the Site for 20 days were assessed according to the Puget Sound Estuary Program (PSEP) Recommended Guidelines for Conducting Laboratory Bioassays on Puget Sound Sediments: Juvenile Polychaete Sediment Bioassay (PSEP 1995a) and the Maxxam SOP "*Neanthes arenaceodentata* Survival and Growth Test" (BBY2 SOP-00030). Method details are presented in Appendix G. The test is considered chronic since it evaluates both lethal and sub-lethal endpoints (i.e., growth) in juvenile polychaete worms and the exposure duration represents a significant portion of the organism's lifespan (>10%). This test is considered ecologically relevant given the expected presence of various polychaete worm species in Site sediments.

4.3.2.3 48-hour Bivalve Larval Development in Sediment Elutriate

The normal development and survival of *M. galloprovincialis* embryos was assessed when exposed to elutriates of sample sediments for 48hours. The test was conducted in accordance with methods outlined in the PSEP test method "Bivalve Larvae Sediment Bioassay" (PSEP 1995b) and the Maxxam SOP Test Method for the "Bivalve Larval Development Sediment Test" (BBY2 SOP-00032). Method details are presented in Appendix G. The bivalve test measures lethal and sub-lethal endpoints on a sensitive life-stage of the organism and therefore is expected to be more sensitive that the amphipod survival test. The test is considered a surrogate for a chronic test because it examines effects on a sensitive life stage but has an exposure duration that is less than 10% of the organism's lifespan. This test is considered ecologically relevant because it measures effects of sediment elutriates, which may result from prop wash and tidal/current action, on bivalve embryos, which normally reside in the water column.

4.3.2.4 Chemical Analysis

The following additional chemical analyses were conducted to support the interpretation of the toxicity test results:

- Total organic carbon (TOC)
- Particle Size (PS)
- Ammonia – sediment porewater and overlying water
- Sulphide – sediment porewater and overlying water
- pH, salinity and temperature – sediment porewater and overlying water

TOC and PS were analyzed given their ability to influence contaminant bioavailability. TOC was analyzed as the quantity of organic matter (OM) in sediments is associated with the partitioning and bio-availability of sediment associated contaminants (USEPA 2002). Determining TOC is essential for site characterization since it can influence how chemicals will react in the sediment (USEPA 2002). Ammonia and sulphides may be naturally occurring in marine sediments and/or related to anthropogenic sources (e.g., organic releases and decaying organic matter). These compounds are toxic to aquatic invertebrates at sufficiently high concentrations and are common sources of interference in sediment toxicity tests.

Results of these chemical analyses are presented in the attached Tables 4 to 7. The toxicity test results are presented in Appendix G and are interpreted in Section 4.5.1.2.

4.3.3 Tissue Sampling

Concurrent with the species/habitat survey, invertebrate and vegetation tissue samples were collected for chemical analysis to determine the degree to which contaminants of concern are being taken up by biota at the Site. A total of 24 tissue samples (eight dungeness crab (*Metacarcinus magister*), eight Nutall's cockle (*Clinocardium nuttallii*) and eight rockweed samples) was collected by diver grab for analysis of PAH, moisture and lipid content. Applicable collection permits were obtained prior to carrying out this task. Approximate locations of the tissue sample locations are presented in Figure 5.

Tissue samples were collected during the dive survey by SSEA conducted April 20 to 23, 2015. Once each sample was retrieved by the divers and brought to the water surface, the sample was transferred into a plastic bag for supporting chemical analysis by Ms. Kristy Gabelhouse and Ms. Shawneen Walker of Tetra Tech EBA. Samples were shipped in ice-chilled coolers under chain of custody to Maxxam. The results of the tissue analytical tests performed are in Appendix B and presented in the attached Table 8.

4.4 Exposure Assessment

As detailed above in Table G, various data types (i.e., measurement endpoints) collected from the Site were developed into lines of evidence and used to support risk conclusions for each receptor group. The measures of exposure employed in the DRA are identified below. The sediment and tissue data used in the exposure assessment are presented in the attached Tables 1-8 and Appendix B at the end of the report.

4.4.1 Measures of Exposure

4.4.1.1 Aquatic Macrophytes

Exposures to PAHs by aquatic vegetation at the Site were estimated by the concentrations detected in 8 algal samples collected along the Site's foreshore. These tissue data form the 'exposure' portion of LOE 1a and 1b, as indicated in the above Table G. Of the PAHs analyzed in plant tissue, most were below the laboratory detection limit. The PAHs that were found to be above the detection limit were phenanthrene, anthracene, fluoranthene, pyrene, benzo(a)anthracene, and chrysene. Maximum tissue concentrations were assumed to represent the Exposure Point Concentrations (EPC) for aquatic vegetation. Analytical results for tissue were presented in wet weight (ww). Dry weight (dw) values were calculated using the average tissue moisture result and the formula presented below:

$$Maximum\ Tissue\ Concentration\ (dw) = \frac{Maximum\ Tissue\ Concentration\ (ww)}{100\% - \ Moisture\ \%\ in\ ww\ sample} X\ 100$$

Results of the plant tissue chemical analyses and calculated maximums (in wet and dry weight) are presented in the table below and the attached Table 8. Locations of the plant tissue samples are shown in Figure 5.

Table M: Aquatic Macrophyte Exposure Point Concentrations - Plant Tissues

Parameters	Maximum (mg/kg ww)	Maximum (mg/kg dw) *
2-methylnaphthalene	-	-
Acenaphthene	<0.0025	<0.015
Acenaphthylene	<0.0025	<0.015
Anthracene	<0.0025	<0.015
Benz(a)anthracene	0.0031	0.018
Chrysene	0.0056	0.033
Fluoranthene	0.01	0.06
Fluorene	<0.0025	<0.015
Naphthalene	<0.0025	<0.015
Phenanthrene	0.0034	0.020
Pyrene	0.0072	0.042
Benzo(a)pyrene	<0.0050	<0.029
Total PAHs	-	-

Note:
* Assumes 83% moisture content in the wet weight sample which is the average of the samples (n=8).

4.4.1.2 Benthic Invertebrates

Exposures to PAHs by benthic invertebrates at the Site were estimated by two measures: sediment chemistry and invertebrate tissue chemistry. These data form the ‘exposure’ portion of LOE 2a, 2b and 2c, as indicated in the above Table G.

For sediment chemistry, the 90th Percentile PAH concentrations were selected as sediment EPCs for invertebrates (see Table 9 appended and Table N below). The 90th Percentile is the recommended exposure statistic for animals that are fairly immobile where exposure is not averaged in space or time (Suter 2007). For the majority of the COCs the 90th Percentile results exceeded the CSR typical marine sediment criteria.

Table N: Benthic Invertebrate Exposure Point Concentrations - Sediment

Parameters	90th Percentile (mg/kg dw)
2-methylnaphthalene	4.3
Acenaphthene	0.9
Acenaphthylene	0.2
Anthracene	1.5
Benz(a)anthracene	1.2
Chrysene	2.0
Fluoranthene	7.2
Fluorene	1.0
Naphthalene	3.1
Phenanthrene	3.6
Pyrene	6.1
Benzo(a)pyrene	0.6
Total PAHs	17.7

Invertebrate exposures were also estimated by the concentrations detected in the tissues of eight crab and eight clam samples collected from the Site. Of the PAHs analyzed most were below the detection limit. The PAHs that were found to be above the detection limit were phenanthrene, anthracene, fluoranthene, pyrene, benzo(a)anthracene, and chrysene in clam tissue. Maximum tissue concentrations were assumed to represent the EPC for invertebrates. Analytical results for tissue was presented in wet weight (ww). Dry weight (dw) values were calculated using the average tissue moisture result and the formula presented above.

Results of the invertebrate tissue chemical analyses and calculated maximums (in wet and dry weight) are presented in Tables O and P below and the attached Table 9. Locations of the invertebrate tissue samples are shown in Figure 5.

Table O: Benthic Invertebrate Exposure Point Concentrations - Crustacean Tissue

Source	COC	Maximum (mg/kg ww)	Maximum (mg/kg dw) *
Aquatic Invertebrates – Crustacean	2-methylnaphthalene	-	-
	Acenaphthene	<0.0025	<0.013
	Acenaphthylene	<0.0025	<0.013
	Anthracene	<0.0025	<0.013
	Benz(a)anthracene	<0.0025	<0.013
	Chrysene	<0.0025	<0.013
	Fluoranthene	<0.0025	<0.013
	Fluorene	<0.0025	<0.013
	Naphthalene	<0.0025	<0.013
	Phenanthrene	<0.0025	<0.013
	Pyrene	<0.0025	<0.013
	Benzo(a)pyrene	<0.0050	<0.025
	Total PAHs	-	-

Note:
* Assumes 80% moisture which is the average of the samples.

Table P: Benthic Invertebrate Exposure Point Concentrations - Mollusk Tissue

Source	COC	Maximum (mg/kg ww)	Maximum (mg/kg dw) *
Aquatic Invertebrates – Mollusk	2-methylnaphthalene	-	-
	Acenaphthene	<0.0025	<0.017
	Acenaphthylene	<0.0025	<0.017
	Anthracene	0.0059	0.039
	Benz(a)anthracene	0.0043	0.029
	Chrysene	0.0064	0.043
	Fluoranthene	0.0118	0.079
	Fluorene	<0.0025	<0.017
	Naphthalene	<0.0025	<0.017
	Phenanthrene	0.0068	0.045
	Pyrene	0.0077	0.051
	Benzo(a)pyrene	<0.0050	0.033
	Total PAHs	-	-

Note:
* Assumes 80% moisture which is the average of the samples.

4.4.1.3 Birds/Mammals

A diet uptake model was used to estimate the total daily oral intake of each COC for the representative mammal and bird species identified above in Table E (i.e., the river otter and the lesser scaup). The resulting estimated intakes served as the ‘exposure’ portion of LOE 4a.

Exposure Equations

The exposure estimations for wildlife were based on a modified wildlife dietary exposure model by Sample and Suter (1994). This model derives exposure for receptors using concentrations of COCs in sediment and food items as presented below.

Total Daily Dose of COC:

$$E_{total} = (E_{food} + E_{sediment}) \times SUF$$

Where:

E_{total} = total exposure from all pathways (mg/kg – day)

E_{food} = exposure from food consumption (mg/kg - day)

$E_{sediment}$ = exposure from sediment consumption (mg/kg - day)

SUF = site use factor (unitless). Applied a value of 1 for SUF (i.e., assumes receptor spends all its time on the Site).

Food Ingestion:

E_{food} = P x (IR_{food} X C_{food})

Where:

E_{food} = exposure from food consumption (mg/day)

P = proportion of the food type in the diet, as identified in Table H1 of Appendix H. The River Otter was assumed to have a diet composed 100% of invertebrates while the scaup had a diet composed of 90% invertebrates and 10% plants.

IR_{food} = food ingestion rate (kg/kg BW/day) dry weight

C_{food} = COC concentration in food (mg/kg) dry weight

Food Ingestion Rates (IR_{food}), which are body weight normalized based on the weight of the ROC, are presented in Table H1 of the Wildlife Diet Model, in Appendix H.

The tissue concentrations assumed for invertebrates and plants were the maximum concentrations (in dry weight) measured in crustacean/mollusks and algal tissues on-Site, respectively. Note that for the otter, it was assumed that fish and small mammals/birds have the same tissue concentrations as crustacean/mollusk tissue. For the scaup, it was assumed that insect body burden was the same as crustacean/mollusk.

Ingestion of Sediments:

$E_{sediment}$ = $IR_{sediment}$ X $C_{sediment}$

Where:

$E_{sediment}$ = exposure from sediment ingestion (mg/day)

$IR_{sediment}$ = Incidental sediment ingestion rates was assumed to be 2% of IR_{food}

$C_{sediment}$ = COC concentration in sediment (mg/kg) dry weight

The sediment concentration applied was the calculated 95% UCLM concentration found for each COC (see Table 9).

The table below and Table H2 of the Wildlife Diet Model, in Appendix H, presents the estimated daily intake of each COC for the river otter and scaup.

Table Q: Estimated Daily COC Intakes – River Otter and Lesser Scaup

Receptor	COC	Sum of Site-Specific Exposure: E_{total} (mg/kg -day) = (E_{food} + $E_{sediment}$) * SUF
River Otter	2-methylnaphthalene	-
	Acenaphthene	0.0009
	Acenaphthylene	0.0006
	Anthracene	0.002
	Benz(a)anthracene	0.001
	Chrysene	0.002

Receptor	COC	Sum of Site-Specific Exposure: E_{total} (mg/kg -day) = (E_{food} + $E_{sediment}$) * SUF
	Fluoranthene	0.006
	Fluorene	0.0009
	Naphthalene	0.002
	Phenanthrene	0.003
	Pyrene	0.004
	Benzo(a)pyrene	0.001
	Total PAHs	-
Lesser Scaup	2-methylnaphthalene	-
	Acenaphthene	0.002
	Acenaphthylene	0.001
	Anthracene	0.002
	Benz(a)anthracene	0.003
	Chrysene	0.004
	Fluoranthene	0.01
	Fluorene	0.002
	Naphthalene	0.003
	Phenanthrene	0.01
	Pyrene	0.01
	Benzo(a)pyrene	0.003
	Total PAHs	-

4.5 Toxicity/Effects Assessment

The objective of the toxicity/effects assessment was to develop the measures of effect specified in the above Table G. Generally, the measures of effect employed in the DRA attempted to define the acceptable intake or concentration of each COC that plants and animals can be exposed to on a chronic basis without risk of adverse health effects. These acceptable intakes and concentrations are the TRVs. The DRA used literature-derived TRVs based on long-term chronic exposure. For example chronic reproductive exposures would include exposure for any duration greater than 1/3 of gestation, and chronic growth measures would include exposure for any duration greater than 1/10 of a plant or animal's lifespan.

For environmental receptors such as plants and animals, the goal is not to protect each individual from any potentially toxic effect, but rather to protect enough individuals so that a viable population and community of organisms can be maintained (SABCS 2006). Various online databases and print resources were used to gather the relevant TRVs presented in Tables I1 to I4 of Appendix I. These included:

- U.S. Army Corps of Engineers/U.S. Environmental Protection Agency Environmental Residue-Effects Database (ERED) for TRVs for plant and invertebrate tissue;
- BC CSR Sediment criteria for typical sediments (Schedule 9) for TRVs for benthic invertebrates; and
- Environment Canada FCSAP Ecological Risk Assessment Guidance – Default TRVs Recommended for use at FCSAP Sites – Draft Version May 5 2015 for TRVs for mammals and birds.

4.5.1 Measures of Effects

The measures of effect used in the DRA are presented in the following sections.

4.5.1.1 Aquatic Macrophytes

For aquatic macrophytes, two measures of effect were employed: plant tissue-based TRVs and observed plant community health. These data form the 'effects' portion of LOE 1a and 1b, respectively.

Plant Tissue TRVs

A summary of plant tissue-based TRVs obtained from the ERED database is presented in the table below. These TRVs represent the 'effects' portion of LOE 1a, as indicated above in Table G. Table I1 of Appendix I contains additional information, and the reference from which the TRV was obtained.

Table R: Summary of Toxicity Reference Values - Plant Tissue

Receptor	COC	Molecular Weight	TRV (mg/kg ww)	Test Endpoint	Type of Effect	Modified TRV (mg/kg ww) **
Aquatic Macrophyte	2-methylnaphthalene	Low	25.1 *	-	-	5.02
	Acenaphthene	Low	25.1 *	-	-	5.02
	Acenaphthylene	Low	25.1 *	-	-	5.02
	Anthracene	Low	25.1	ED50	Reproduction	5.02
	Benz(a)anthracene	High	21.8	ED50	Reproduction	4.4
	Chrysene	High	21.8 *	-	-	4.4
	Fluoranthene	Low	17.8	ED50	Reproduction	3.6
	Fluorene	Low	17.8 *	-	-	3.6
	Naphthalene	Low	25.1 *	-	-	5.02
	Phenanthrene	Low	910.3	ED50	Reproduction	182.1
	Pyrene	High	23.3	ED50	Reproduction	4.7
	Benzo(a)pyrene	High	23.3 *	-	-	4.7
	Total PAHs	n/a	-	-	-	-

Notes:

Molecular Weight is based on the chemical structure reported in BC MOE 1993. PAH molecular weight varies based on chemical structure. Lower molecular weight PAHs are in the two to three ring group and high molecular weight are in the four to seven ring group (BC MOE 1993).

ED50: Effective Dose that produces an effect in 50% of the population.

* No TRV found. Applied the TRV from PAHs with a TRV available based on similar chemical structure (BC MOE 1993).

** ED20 was estimated from the ED50 using a modifying factor of five based on professional judgement.

Apparent Health of the Plant Community

The dive survey indicated that there was no evidence of phytotoxicity observed and no evidence of vegetation stress on the Site. Mr. Shane Servant of SSEA stated that the vegetation was observed to be typical for the area with no conspicuous absence of macrophyte coverage on the Site. See Appendix D for detailed results of the dive survey.

4.5.1.2 Benthic Invertebrates

For benthic invertebrates, three measures of effect were employed: sediment-based TRVs, results of sediment toxicity testing, and tissue-based TRVs. These data form the 'effects' portion of LOE 2a, 2b and 2c, respectively.

Sediment TRVs

A summary of sediment TRVs selected for invertebrates is presented in the table below. The TRVs used are the BC CSR sediment criteria for typical marine sites (Schedule 9) and were considered applicable as they are based on an AEL of 20% which is in line with the protection goal outlined above in Section 4.2.6.

Table S: Summary of Toxicity Reference Values - Sediment

Receptor	COC	TRV (mg/kg dw)
Aquatic Invertebrates	2-methylnaphthalene	0.24
	Acenaphthene	0.11
	Acenaphthylene	0.15
	Anthracene	0.29
	Benz(a)anthracene	0.83
	Chrysene	1.0
	Fluoranthene	1.8
	Fluorene	0.17
	Naphthalene	0.47
	Phenanthrene	0.65
	Pyrene	1.7
	Benzo(a)pyrene	0.92
	Total PAHs	20

Tissue-based TRVs

A summary of tissue-based TRVs selected from the ERED database for invertebrates (crustacean and mollusk) is presented in the tables below. Table I2 of Appendix I contains additional information regarding the rationale behind the TRV selection, and the reference from which the TRV was obtained.

Table T: Summary of Toxicity Reference Values - Crustacean Tissue

Receptor	COC	Molecular Weight	TRV (mg/kg ww)	Test Endpoint	Type of Effect	Modified TRV (mg/kg ww) **
Aquatic Invertebrates	2-methylnaphthalene	Low	9.09 *	-	-	9.09
	Acenaphthene	Low	9.09 *	-	-	9.09
	Acenaphthylene	Low	9.09 *	-	-	9.09
	Anthracene	Low	9.09	LD22	Mortality	9.09
	Benz(a)anthracene	High	8.26	LD22	Mortality	8.26
	Chrysene	High	3.15	LD22	Mortality	3.15
	Fluoranthene	Low	40.5	ED25	Reproduction	40.5
	Fluorene	Low	85.38	ED17	Growth	85.38
	Naphthalene	Low	346.06	ED50	Mortality	69.2
	Phenanthrene	Low	303.0	ED50	Mortality	60.6
	Pyrene	High	1233.79	ED50	Mortality	246.76
	Benzo(a)pyrene	High	23	LC50	Mortality	4.6
	Total PAHs	n/a	0.096	LD10	Mortality	0.096

Notes:

Molecular Weight is based on the chemical structure reported in BC MOE 1993. PAH molecular weight varies based on chemical structure. Lower molecular weight PAHs are in the two to three ring group and high molecular weight are in the four to seven ring group (BC MOE 1993).

EDXX: Effective Dose that produces an effect in XX% of the population

LDXX: Lethal dose in which XX% of the population dies

LC50: Lethal concentration in which 50% of the population dies

* No TRV found. Applied the TRV from PAHs with a TRV available based on similar chemical structure (BC MOE 1993).

** If applicable, an ED20 or LC20 was estimated from the ED50 or LC50 using a modifying factor of five based on professional judgement.

Table U: Summary of Toxicity Reference Values - Mollusk Tissue

Receptor	COC	Molecular Weight	TRV (mg/kg ww)	Test Endpoint	Type of Effect	Modified TRV (mg/kg ww) **
Aquatic Invertebrates	2-methylnaphthalene	Low	29.4 *	-	-	5.9
	Acenaphthene	Low	29.4	ED50	Growth	5.9
	Acenaphthylene	Low	29.4 *	-	-	5.9
	Anthracene	Low	29.4 *	-	-	5.9
	Benz(a)anthracene	High	0.6	NOED	Mortality	0.6
	Chrysene	High	0.93	NOED	Mortality	0.93
	Fluoranthene	Low	1.5	LOED	Mortality	1.5
	Fluorene	Low	1.5 *	-	-	1.5
	Naphthalene	Low	31.3	ED50	Growth	6.3
	Phenanthrene	Low	1.5 *	-	-	1.5
	Pyrene	High	1.08	NOED	Mortality	1.08
	Benzo(a)pyrene	High	3.2	LOED	Mortality	3.2
	Total PAHs	n/a	10.4	NOED	Mortality	10.4

Notes:

Molecular Weight is based on the chemical structure reported in BC MOE 1993. PAH molecular weight varies based on chemical structure. Lower molecular weight PAHs are in the two to three ring group and high molecular weight are in the four to seven ring group (BC MOE 1993).

ED50: Effective Dose that produces an effect in 50% of the population

NOED: No observed effect dose

LOED: Low observed effect dose

* No TRV found. Applied the TRV from PAHs with a TRV available based on similar chemical structure.

** If applicable, an ED20 was estimated from the ED50 using a modifying factor of five based on professional judgement.

Sediment Toxicity Testing

Sediment toxicity testing was the third measure of effect used for benthic invertebrates. As per accepted practice, comparing the Site sediment toxicity results with a negative laboratory control provided indications of the toxicity of Site sediments and allowed for interpretation of the COC impacts to the Site. Test responses in the reference sample (15SED11) were found to have no statistically significant differences to that of the negative control sediment and therefore the reference sample results was not used in the interpretation of the Site sample results.

Maximum Permissible Adverse Effects

In accordance with BC MOE policy and the AELs established for the DRA, statistically significant reductions in a test endpoint (e.g., mean survival, growth rate and normal development) of greater than 20% in a test sample relative to control sediments were considered to be indicative of moderate toxicity. Statistically significant reductions in a test endpoint of greater than 50% in a test sample relative to control sediments were considered to be indicative of substantial toxicity.

The results of the three sediment toxicity tests are presented below.

10-day Marine Amphipod Survival

Results of the amphipod survival tests are presented in the table below. Detailed results are presented in Appendix G.

Table V: Results of 10-day Amphipod Survival Test on *Eohaustorius estuarius*

Sample ID	Mean Survival (%)	Mean Control Adjusted Survival (%)	Magnitude of Reduction in Survival Relative to Control Sediment (%)
Negative Control Sediment	99	100	-
15SED02	99	100	<20
15SED03	95	96	<20
15SED05	98	99	<20
15SED06	97	98	<20
15SED07	99	100	<20
15SED08	98	99	<20

Notes:
BOLD – Magnitude of reduction in survival relative to negative sediment control is statistically significant and greater than 20%

None of the six Site samples tested had a statistically significant reduction in amphipod survival of greater than 20% relative to the laboratory negative control sediment.

The test results were considered by the testing laboratory to be valid based on the following quality assurance/quality control results:

- Mean percent survival in the laboratory negative control sediment was greater than 90%.
- Results of reference toxicity tests conducted to assess the sensitivity and quality of the amphipods used in the tests were within acceptable limits.

20-day Polychaete Survival and Growth

Results of the polychaete survival and growth tests are presented in the tables below. Detailed results are presented in Appendix G.

Table W: Results of 20-day Polychaete Survival and Growth Test on *Neanthes arenaceodentata* – Survival Endpoint

Sample ID	Mean Survival (%)	Mean Control Adjusted Survival (%)	Magnitude of Reduction in Survival Relative to Control Sediment (%)
Negative Control Sediment	92	100	-
15SED02	100	100	<20
15SED03	92	100	<20
15SED05	100	100	<20
15SED06	92	100	<20
15SED07	100	100	<20
15SED08	96	100	<20

Notes:
BOLD – Magnitude of reduction in survival relative to negative sediment control is statistically significant and greater than 20%

None of the six Site samples tested exhibited greater than 20% reduction in polychaete survival relative to the laboratory negative control sediment.

Table X: Results of 20-day Polychaete Survival and Growth Test on *Neanthes arenaceodentata* – Growth Endpoint

Sample ID	Mean Growth Rate (mg/day)	Mean Control Adjusted Growth Rate (%)	Magnitude of Reduction in Growth Rate Relative to Control Sediment (%)
Negative Control Sediment	0.80	100	-
15SED02	0.69	86	<20
15SED03	0.73	91	<20
15SED05	0.69	86	<20
15SED06	0.61	76	24
15SED07	0.72	90	<20
15SED08	0.66	83	<20

Notes:
BOLD – Magnitude of reduction in growth rate relative to negative sediment control is statistically significant and greater than 20%

None of the six Site samples tested had a statistically significant reduction in polychaete growth of greater than 20% relative to the laboratory negative control sediment (15SED06 showed a 24% growth rate reduction but was deemed not a statistically significant reduction in growth).

The test results were considered by the testing laboratory to be valid based on the following quality assurance/quality control results:

- Mean percent survival in the laboratory negative control sediment was greater than 90%.
- Mean growth rate in the negative control sediment was greater than 0.38 mg/individual/day.
- Initial mean dry worm weights were greater than 0.25 mg/worm and less than 1 mg/worm.

- Results of reference toxicity tests conducted to assess the sensitivity and quality of the worms used in the tests were within acceptable limits.

48-hour Bivalve Larval Development in Sediment Elutriate

Results of the bivalve larval development tests are presented in the tables below. Detailed results are presented in Appendix G.

Table Y: Results of 48-hour Bivalve Larval Development Test on *Mytilus galloprovincialis* – *Normal Development Endpoint*

Sample ID	Mean Normal Development (%)	Mean Control Adjusted Normal Development (%)	Magnitude of Reduction in Normal Development Relative to Control Sediment (%)
Negative Control Seawater	86	-	-
Negative Control Sediment	80	100	-
15SED02	88	100	<20
15SED03	86	100	<20
15SED05	80	100	<20
15SED06	88	100	<20
15SED07	83	100	<20
15SED08	87	100	<20

Notes:
BOLD - Magnitude of reduction in normal development relative to negative sediment control is statistically significant and greater than 20%

None of the six Site samples tested exhibited greater than 20% reduction in bivalve larval normal development relative to the laboratory negative control sediment.

The test results were considered by the testing laboratory to be valid based on the following quality assurance/quality control results:

- Mean percent survival and normal development in the laboratory negative seawater controls were greater than 70%.
- Results of reference toxicity tests conducted to assess the sensitivity and quality of the bivalve larvae used in the tests were within acceptable limits.

4.5.1.3 Birds/Mammals

Dose-based TRVs were used as the measures of effect for birds and mammals in LOE 4a and were selected from the FCSAP Ecological Risk Assessment Guidance: Default TRVs Recommended for use at FCSAP Sites (Environment Canada 2015). A summary of TRVs selected for birds and mammals is presented in the table below and Tables I3 and I4 of Appendix I contain additional information regarding the rationale behind the TRV selection, and the reference from which the TRV was obtained.

Table Z: Summary of Toxicity Reference Values - Birds and Mammals

COC	Molecular Weight	TRV (mg/kg bw-day)		Test Endpoint		Type of Effect	
		Mammals	Birds	Mammals	Birds	Mammals	Birds
2-methylnaphthalene	Low	65.6 *	15 **	-	-	-	-
Acenaphthene	Low	65.6 *	15 **	-	-	-	-
Acenaphthylene	Low	65.6 *	15 **	-	-	-	-
Anthracene	Low	65.6 *	15 **	-	-	-	-
Benz(a)anthracene	High	0.615 *	0.107	-	NOEL	-	Survival, reproduction and growth effects.
Chrysene	High	0.615 *	0.107 **	-	-	-	-
Fluoranthene	Low	65.6 *	15 **	-	-	-	-
Fluorene	Low	65.6 *	15 **	-	-	-	
Naphthalene	Low	65.6	15	The highest bounded NOAEL that is lower than the lowest bounded LOAEL	NOEL	Reproduction, growth and survival	Mortality
Phenanthrene	Low	65.6 *	15 **	-	-	-	-
Pyrene	High	0.615 *	20.5	-	NOEL	-	Mortality
Benzo(a)pyrene	High	0.615	0.107 **	The highest bounded NOAEL that is lower than the lowest bounded LOAEL	-	Reproduction, growth and survival	-
Total PAHs	n/a	-	-	-	-	-	-

Notes:

Molecular Weight is based on the chemical structure reported in BC MOE 1993. PAH molecular weight varies based on chemical structure. Lower molecular weight PAHs are in the two to three ring group and high molecular weight are in the four to seven ring group (BC MOE 1993).

- Not Applicable

* No TRV available. Applied the TRV from naphthalene to the other low molecular weight PAHs and applied the TRV from benzo(a)pyrene to the other high molecular weight PAHs.

** No TRV available. Applied the TRV from naphthalene to the other low molecular weight PAHs and applied the TRV from benzo(a)anthracene to the other high molecular weight PAHs.

NOEL: No Observed Adverse Effect Level

LOEL: Lowest Observed Adverse Effect Level

4.6 Risk Characterization

Risk characterization integrates the measures of exposure and effect developed above into estimates of the likelihood of unacceptable risks to each ROC. The following sections detail risk characterizations for each receptor type assessed in the DRA.

4.6.1 Aquatic Macrophytes

In this section, the effects or hazards indicated by each LOE are identified and a risk conclusion for the aquatic plant community is presented based on the overall WOE.

The LOEs considered for aquatic plants were as follows:

- LOE 1a: Plant tissue chemistry compared to TRVs (i.e., Hazard Quotient).
- LOE1b: Apparent health of the plant community at the Site.

LOE 1a - Plant Tissue-Based Hazard Quotients

The plant tissue chemistry assessment involved comparing COC concentrations measured in Site plant tissues to published effects threshold values.

Comparison between the measured tissue concentrations and the selected threshold values were completed by calculating HQs. HQs were calculated using the following formula:

$$HQ = \frac{Maximum\ Tissue\ Concentration}{Toxicity\ Reference\ Value}$$

The resultant HQs were then used to quantify hazard levels as follows:

- Negligible Hazard: HQs are equal to or less than one.
- Moderate Hazard: 10≥ HQ>1.
- High Hazard: HQ>10.

The table below presents the results of the tissue chemistry assessment.

Table AA: Hazard Quotients for Aquatic Plants

Receptor	COC	Maximum Measured Tissue Concentration (mg/kg ww)	Tissue Threshold Effect Level (mg/kg ww)	HQ	Hazard Level
Aquatic Macrophyte	2-methylnaphthalene	-	5.02	-	-
	Acenaphthene	<0.0025	5.02	0.0005	Negligible
	Acenaphthylene	<0.0025	5.02	0.0005	Negligible
	Anthracene	<0.0025	5.02	0.0005	Negligible
	Benz(a)anthracene	0.0031	4.36	0.0007	Negligible
	Chrysene	0.0056	4.36	0.001	Negligible
	Fluoranthene	0.01	3.56	0.003	Negligible
	Fluorene	<0.0025	3.56	0.001	Negligible
	Naphthalene	<0.0025	5.02	0.0005	Negligible
	Phenanthrene	0.0034	182.06	0.00002	Negligible
	Pyrene	0.0072	4.66	0.002	Negligible
	Benzo(a)pyrene	<0.0050	4.66	0.001	Negligible
	Total PAHs	-	-	-	-

Notes:

- Results not available.

Maximum measured concentrations of PAHs in plant tissues were less than the selected tissue-based TRVs (i.e., HQ<1) for each COC, indicating negligible hazard.

Based on the foregoing evaluation, the tissue concentrations detected in plant specimens collected on the Site are considered to be indicative of **negligible** hazard.

LOE 1b - Apparent Health of the Plant Community

As no indications of adverse effects due to Site contamination were noted for the aquatic macrophyte community during the dive survey (see Section 4.5.1.1), the effect level indicated by LOE 1b is considered to be **negligible**.

Weight of Evidence Evaluation – Aquatic Macrophyte Community

The weighting factors applied to each LOE in the problem formulation were re-evaluated in terms of ranking values selected for the sensitivity, data quality / study design and representativeness attributes. Re-evaluation indicates that the weighting factors applied to each LOE are still considered appropriate. No issues that relate to these attributes were identified as part of the investigation / assessment.

The magnitude of effect/hazard and weighting factor for each LOE is summarized in the below table.

Table AB: Summary of Magnitude of Effect/Hazard for Aquatic Plant LOEs

LOE	Plant Tissue Chemistry (LOE 1a)	Apparent Health of Plant Community (LOE 1b)
Magnitude of Effect/Hazard	Negligible	Negligible
LOE Weighting Factor	3.2	1

The two LOEs indicate a negligible effect/hazard to aquatic plants at the Site. Consequently, risks to the aquatic plant community at the Site are considered to be **negligible**.

4.6.2 Benthic Invertebrates

In this section, the effects or hazards indicated by each LOE are identified and a risk conclusion for the benthic invertebrate community is presented based on the overall WOE.

The LOEs considered for benthic invertebrates were as follows:

- LOE 2a: Bulk sediment chemistry compared to TRVs (i.e., Hazard Quotient).
- LOE 2b: Sediment toxicity test results (magnitude of effect of Site sediment on invertebrate survival, growth and reproduction in relative to negative control sediments, and degree of correlation with COCs).
- LOE 2c: Invertebrate chemistry compared to TRVs (i.e., Hazard Quotient).

<u>LOE 2a – Sediment-Based Hazard Quotients</u>

Benthic invertebrate HQs based on sediment concentrations were calculated by dividing sediment EPCs by sediment TRVs. The table below provides the HQ results for this receptor group. Recall that the following criteria were applied when determining the hazard indicated by the HQs:

- Negligible Hazard: HQs are equal to or less than one.
- Moderate Hazard: 10≥ HQ>1.
- High Hazard: HQ>10.

Table AC: Hazard Quotients for Benthic Invertebrates – Sediment Chemistry

Receptor	COC	EPC (mg/kg dw)	TRV (mg/kg dw)	HQ	Hazard Level
Benthic Invertebrates	2-methylnaphthalene	4.3	0.24	17.9	High
	Acenaphthene	0.9	0.11	8.2	Moderate
	Acenaphthylene	0.2	0.15	1.3	Moderate
	Anthracene	1.5	0.29	5.2	Moderate
	Benz(a)anthracene	1.2	0.83	1.4	Moderate
	Chrysene	2.0	1.0	2.0	Moderate
	Fluoranthene	7.2	1.8	4.0	Moderate
	Fluorene	1.0	0.17	5.9	Moderate
	Naphthalene	3.1	0.47	6.6	Moderate
	Phenanthrene	3.6	0.65	5.5	Moderate
	Pyrene	6.1	1.7	3.6	Moderate
	Benzo(a)pyrene	0.6	0.92	0.7	Negligible
	Total PAHs	17.7	20	0.9	Negligible

In total, 11 sediment COCs have been classified as posing a moderate or high hazard to the benthic invertebrate community while two pose a negligible hazard, based on the sediment concentrations present.

Overall, the hazard level indicated by LOE 2a is considered **moderate**.

LOE 2b – Toxicity Test Results

As detailed in Section 4.5.1.2 above, a battery of laboratory toxicity tests were run on several sediment samples from the Site. Of the six samples tested in the 10-day amphipod survival and 20-day polychaete survival bioassays, all exhibited no or negligible effects on survival. Of the six samples tested in the 48-hour bivalve larval development bioassay, all exhibited no or negligible effects on normal development. Of the six samples tested in the 20-day polychaete growth bioassay, all but one exhibited no or negligible effects. The single sample for which effects were observed exhibited a 24% reduction in growth rate relative to the negative control sediment which marginally exceeds the mandated protection goal of 20%. However, the effect was not statistically significant.

Overall, the effect level indicated by LOE 2b is considered **negligible**.

LOE 2c - Benthic Invertebrate Tissue-Based Hazard Quotients

The benthic invertebrate tissue chemistry assessment involved comparing COC concentrations measured in Site invertebrate tissues to published effects threshold values.

Comparison between the measured tissue concentrations and the selected threshold values were completed by calculating HQs.

Recall that the following criteria were applied when determining the hazard indicated by the HQs:

- Negligible Hazard: HQs are equal to or less than one.
- Moderate Hazard: 10≥ HQ>1.
- High Hazard: HQ>10.

See the tables below for the calculated HQs for invertebrate tissue chemistry (crustacean and mollusk).

Table AD: Hazard Quotients for Benthic Invertebrates – Crustacean Tissue

Source	COC	EPC (mg/kg ww)	TRV (mg/kg ww)	HQ	Hazard Level
Aquatic Invertebrates - Crustacean	2-methylnaphthalene	-	9.09	-	-
	Acenaphthene	<0.0025	9.09	0.0003	Negligible
	Acenaphthylene	<0.0025	9.09	0.0003	Negligible
	Anthracene	<0.0025	9.09	0.0003	Negligible
	Benz(a)anthracene	<0.0025	8.26	0.0003	Negligible
	Chrysene	<0.0025	3.15	0.001	Negligible
	Fluoranthene	<0.0025	40.5	0.0001	Negligible
	Fluorene	<0.0025	85.38	0.00003	Negligible
	Naphthalene	<0.0025	69.21	0.00004	Negligible
	Phenanthrene	<0.0025	60.6	0.00004	Negligible
	Pyrene	<0.0025	246.76	0.00001	Negligible
	Benzo(a)pyrene	<0.0050	4.66	0.001	Negligible
	Total PAHs	-	0.096	-	-

Notes: - Hazard level not assessed as no HQ calculated

Table AE: Hazard Quotients for Benthic Invertebrates – Mollusk Tissue

Source	COC	EPC (mg/kg ww)	TRV (mg/kg ww)	HQ	Hazard Level
Aquatic Invertebrates – Mollusk	2-methylnaphthalene	-	5.88	-	-
	Acenaphthene	<0.0025	5.88	0.0004	Negligible
	Acenaphthylene	<0.0025	5.88	0.0004	Negligible
	Anthracene	0.0059	5.88	0.001	Negligible
	Benz(a)anthracene	0.0043	0.6	0.007	Negligible
	Chrysene	0.0064	0.93	0.007	Negligible
	Fluoranthene	0.0118	1.5	0.008	Negligible
	Fluorene	<0.0025	1.5	0.002	Negligible
	Naphthalene	<0.0025	6.26	0.0004	Negligible
	Phenanthrene	0.0068	1.5	0.005	Negligible
	Pyrene	0.0077	1.08	0.007	Negligible
	Benzo(a)pyrene	<0.0050	3.2	0.002	Negligible
	Total PAHs	-	10.4	-	-

Notes: - Hazard level not assessed as no HQ calculated

Maximum tissue concentrations detected in invertebrate tissues for both crustaceans and mollusks on the Site were less than the selected tissue-based TRVs (i.e., HQ<1) for each COC, indicating **negligible** hazard.

Weight of Evidence Evaluation - Marine Benthic Invertebrate Community

The weighting factors applied to each LOE in the problem formulation were re-evaluated in terms of weighting values selected for the sensitivity, data quality / study design and representativeness attributes. Re-evaluation indicates that the weighting factors applied to each LOE are still considered appropriate. No issues that relate to these attributes were identified as part of the investigation / assessment.

The magnitude of effect/hazard and weighting factor for each LOE is summarized in the table below.

Table AF: Summary of Magnitude of Effect/Hazard for Marine Benthic Invertebrate LOEs

LOE	Sediment Chemistry (LOE 2a)	Tissue Chemistry (LOE 2c)	Toxicity Test Results – Amphipod Survival (LOE 2b)	Toxicity Test Results – Polychaete Survival/ Growth (LOE 2b)	Toxicity Test Results – Bivalve Development (LOE 2b)
Magnitude of Effect /Hazard	Moderate	Negligible	Negligible	Negligible	Negligible
LOE Weighting Factor	2.5	3.2	4.2	4.2	4.2

Moderate hazard was indicated by LOE 2a (sediment chemistry). However this finding was refuted by the remaining, higher weighted LOE which all indicated negligible effects. Consequently, risks to the benthic invertebrate community at the Site are considered to be **negligible**.

4.6.3 Fish

In this section, the effects or hazards indicated for the LOE identified and a risk conclusion for the fish community is presented.

LOE 3a – Risk Conclusion for Plant and Benthic Invertebrate Communities

As indicated in Section 4.2.6.3, the characterization of risks to marine fish was based on the results of benthic invertebrate and aquatic macrophyte risk assessments. As risks to the marine benthic invertebrate and macrophyte communities are classified as **negligible**, the same risk classification is assumed for marine fish.

Basing the fish risk classification on the benthic invertebrate and plant results presents some uncertainty. However, as this uncertainty is biased in an overprotective manner, this approach is considered to be protective of fish. Uncertainty is considered to be biased in an overprotective manner given that fish species are generally more mobile than benthic invertebrates and plants and are not in continuous contact with sediment. For these reasons, fish exposure to sediment contamination is likely to be less.

4.6.4 Birds/Mammals

In this section, the effects or hazards indicated by the LOE identified and a risk conclusion for birds and mammals is presented.

LOE 4a – Comparison of Total Daily Oral Contaminant Doses to TRVs

For birds and mammals, the hazard quotient method involved comparisons of estimated daily oral contaminant intakes for select surrogate species to TRVs to derive HQs for each COC/ROC combination.

The resultant HQs were then used to quantify hazard levels as follows:

- Negligible Hazard: HQs are equal to or less than one.
- Moderate Hazard: 10≥ HQ>1.
- High Hazard: HQ>10.

See the table below and in Appendix H (Table H4) for the calculated HQ results.

Table AG: Hazard Quotients for Mammals and Birds

Source	COC	Total Exposure (mg/kg-day)	TRV (mg/kg-day)	HQ	Hazard Level
Mammals	2-methylnaphthalene	-	65.6	-	-
	Acenaphthene	0.0009	65.6	0.00001	Negligible
	Acenaphthylene	0.0006	65.6	0.00001	Negligible
	Anthracene	0.002	65.6	0.00003	Negligible
	Benz(a)anthracene	0.001	0.615	0.002	Negligible
	Chrysene	0.002	0.615	0.003	Negligible
	Fluoranthene	0.006	65.6	0.00008	Negligible
	Fluorene	0.0009	65.6	0.00001	Negligible
	Naphthalene	0.002	65.6	0.00002	Negligible
	Phenanthrene	0.003	65.6	0.00005	Negligible
	Pyrene	0.004	0.615	0.006	Negligible
	Benzo(a)pyrene	0.001	0.615	0.002	Negligible
	Total PAHs	-	-	-	-
Birds	2-methylnaphthalene	-	15	-	-
	Acenaphthene	0.002	15	0.0001	Negligible
	Acenaphthylene	0.001	15	0.00008	Negligible
	Anthracene	0.002	15	0.0002	Negligible
	Benz(a)anthracene	0.003	0.107	0.03	Negligible
	Chrysene	0.004	0.107	0.04	Negligible
	Fluoranthene	0.01	15	0.001	Negligible
	Fluorene	0.002	15	0.0001	Negligible
	Naphthalene	0.003	15	0.0002	Negligible
	Phenanthrene	0.01	15	0.0004	Negligible
	Pyrene	0.01	20.5	0.0004	Negligible
	Benzo(a)pyrene	0.003	0.107	0.03	Negligible
	Total PAHs	-	-	-	-

Notes: - *Exposure data was not available*

Estimated intakes calculated for both mammals and birds on the Site were less than the selected TRVs (i.e., HQ<1) for each COC, indicating **negligible** hazard.

Consequently, risks to bird and mammal populations at the Site are considered to be **negligible**.

5.0 DRA UNCERTAINTY ASSESSMENT

The risk assessment process has inherent uncertainties associated with the calculations and assumptions used. When data were not available, assumptions used in the risk assessment erred on the side of conservatism to prevent underestimating risks. Thus, the potential risks presented in the risk assessment are likely to be higher than the actual risks experienced by potentially exposed receptors. The overall intent of the uncertainty analysis is to identify sources of uncertainty that contribute to the overall level of confidence that can be placed on the risk estimates, which aids the process of making decisions regarding the potential use of mitigation or remediation measures at a site.

Included in the attached Appendix J is the Protocol 20: Detailed Ecological Risk Assessment Requirements checklist.

5.1 Data Collection/Evaluation Uncertainties

Tetra Tech EBA is confident that measured tissue and sediment concentrations represent the range of concentrations present at the Site. A moderate to high degree of certainty exists for data representing natural variability (over space and time) at the Site for tissue and sediment.

5.2 Exposure Assessment Uncertainties

5.2.1 Exposure Point Concentrations and Exposure Estimate Uncertainties

The main uncertainties associated with the exposure point concentrations and exposure estimates are:

- If Site utilization by the identified receptors is not uniform (for example, if receptors had access to only a small portion of the Site), it is possible that COC concentrations in these areas may be lower or higher than those used in this assessment, thereby resulting in lower or higher risk estimates. However, the sample coverage is thought to be adequate based on reasons given above in Section 5.1, and therefore it is not expected that the risks associated with sub-areas would differ significantly from those estimated for the entire Site. Therefore, the overall effect of non-uniform site use is thought to be risk-neutral.

- Use of a deterministic (point estimate) approach to characterize risks likely overestimates risks since it assumes that receptors are exposed to one upper bound COC concentration only (95% UCLM, 90th percentile or maximum) and not the range of concentrations at a Site. This approach is standard for a risk assessment so that risks are not underestimated.

5.2.2 Wildlife Diet Model Uncertainties

For the river otter, it was assumed that fish and small mammals/birds dietary components contain the same tissue concentrations as measured in crustacean/mollusk tissue at the Site.

It is possible that by using tissue concentrations from other species to estimate exposure that exposure may be lower or higher than those used in this assessment, thereby resulting in lower or higher risk estimates. However, the diet exposure estimate is thought to be adequate due to the fact that the majority of the COCs on the Site are not bioaccumulative in tissues and do not biomagnify up the food chain and using a lower food chain species would not underestimate the COC concentration in tissues. Therefore, the overall effect of using tissue results from a lower food chain species is thought to be risk-neutral.

5.3 Effects Assessment Uncertainties

In the problem formulation, it was stated that for the assessment of plants, invertebrates, fish, birds and mammals at the Site, an AEL of 20% was used, based on BC MOE policy. During the toxicity/effects assessment a literature review of available tissue and dose-based toxicity endpoints for the COCs identified on the Site resulted in some endpoints that were greater than 20% (i.e., ED50 and LC50) for plants and invertebrates. During the assessment we estimated an ED20 or LC20 value using the ED50 or LC50 value by applying a modifying factor of five based on professional judgement.

Applying the modifying factor to estimate a 20% AEL contributes uncertainty to the accuracy of the risk estimates. However, the resulting hazard quotients were at least 25 times below unity (1) and therefore this uncertainty is not expected to influence overall risk conclusions.

For plant, invertebrate, bird and mammal hazard quotient calculations, TRVs were applied from PAHs with a TRV available to PAHs that did not have TRVs available. PAHs with similar chemical structure were used. This may cause an overestimate or underestimate of risk. However, TRVs for PAHs are often grouped based on chemical structure and the groups exhibit similar effects.

5.4 Risk Characterization Uncertainties

Risk characterization integrates measures of exposure and effect into estimates of the likelihood of unacceptable risks to each ROC. As stated above, a WOE approach to risk characterization was applied in this risk assessment for select receptor groups which considered the results from multiple LOEs. There is uncertainty associated with a WOE method.

5.4.1 LOE Weightings

Uncertainty is associated with the weightings assigned to each LOE considered in the risk characterizations for benthic invertebrates and plants. LOEs were weighted according to the guidance provided by SABCS (2010). Although the weightings assigned may be somewhat uncertain when considered individually, there is a high degree of confidence that the weightings are appropriate when considered relative to one another, which is a more important factor in risk characterization.

5.4.2 Applying Benthic Invertebrate and Plant Risk Results to Fish (LOE 3a)

Basing risk classification for fish (LOE3a) on that of benthic invertebrates and plants presents some uncertainty. However, as this uncertainty is biased in an overprotective manner, this approach is considered to be protective of fish. Uncertainty is considered to be biased in an overprotective manner given that fish species are generally more mobile than benthic invertebrates and plants and are not in continuous contact with sediment. For these reasons, fish exposure to sediment contamination is likely to be less.

6.0 CONCLUSIONS

For this DRA, the risks posed by sediment contamination to humans and ecological receptors based on the current Site uses and conditions were evaluated. It was determined that there is no operable pathway for human exposures to sediment contamination and therefore human health risks did not require quantification.

Risks to aquatic vegetation, invertebrates, birds and mammals and fish were assessed in detail using various lines of evidence.

The overall findings of the risk assessment indicated that the human health and ecological risks posed by the sediment contamination present on the Site are negligible.

This risk assessment is based on the following key assumptions:

- Current Site uses and conditions as an active commercial/industrial harbour; and
- No seafood for human consumption is collected from the Site.

If uses and conditions of the Site are modified significantly from that assumed in this report during future development, an update to this risk assessment may be required.

In addition, the risk assessment addresses contamination within the Site boundary only. Potential risks to off-Site receptors were not evaluated during this DRA.

7.0 QUALIFICATIONS OF ASSESSORS

Kristy Gabelhouse, R.P.Bio. – Report Author

Ms. Gabelhouse has seven years of contaminated sites experience including Stage 1/2 Preliminary Site Investigations, detailed site investigations and human health and ecological risk assessments.

Ms. Gabelhouse was the author of this report.

Scott Steer, R.P.Bio., CSAP – Senior Review

Mr. Steer is an Approved Risk Assessment Specialist with the Society of Contaminated Sites Approved Professionals of British Columbia with more than 15 years of experience in contaminated site assessment, human health and ecological risk assessment, and environmental toxicology.

Mr. Steer provided senior input and the primary senior reviewer of this report.

Martin Jarman, P.Geo., CSAP – Senior Review

Mr. Jarman is a Senior Environmental Scientist with 20 years of experience in conducting the investigation and remediation of contaminated sites and overall environmental management. As a Member of the BC Contaminated Sites Approved Professional Society (CSAP), Mr. Jarman has been involved in the detailed review of all stages of environmental reports and completed over 20 recommendations to the Ministry of Environment for legal instruments for various sites across BC since 2007.

Mr. Jarman provided senior input and also senior review on portions of this report.

8.0 CLOSURE

We trust this report meets your present requirements. Should you have any questions or comments, please contact the undersigned.

Respectfully submitted,
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TABLES

Table 1: DSI Sediment Analytical Results - PAHs

Parameters	Unit	CSR - Marine Sediment - Sensitive	CSR - Marine Sediment - Typical	Protocol 11 - Typical	Location	09-43	09-44	09-45	09-46	09-47	09-48	14SED01	14SED02	14SED03
					Date	4/28/2009	4/28/2009	4/28/2009	4/28/2009	4/28/2009	4/28/2009	9/18/2014	9/18/2014	9/18/2014
Depth (mbgs)						Surficial	Surficial	Surficial	Surficial	Surficial	Surficial	Surficial	Surficial	Surficial
Physical Parameters														
pH (Lab)	pH Units	-	-	-		-	-	-	-	-	-	7.67	8.2	-
Moisture	%	-	-	-		-	-	-	-	-	-	27	33	21
pH (aqueous extract)	pH Units	-	-	-		-	-	-	-	-	-	7.67	8.2	-
IARC Cancer	-	-	-	-		-	-	-	-	-	-	-	-	-
TEQ Total	-	-	-	-		-	-	-	-	-	-	-	-	-
Polycyclic Aromatic Hydrocarbons (PAHs)														
2-methylnaphthalene	µg/g	0.12	0.24	2.4		0.18	6	1.5	3.9	2.8	4.5	1.4	1.8	0.45
Acenaphthene	µg/g	0.055	0.11	1.1		0.04	0.26	0.47	0.92	0.63	0.89	0.44	0.68	0.12
Acenaphthylene	µg/g	0.079	0.15	1.5		0.01	0.1	0.05	0.2	0.08	0.2	0.05	0.05	0.05
Anthracene	µg/g	0.15	0.29	2.9		0.03	0.32	0.29	1.5	0.99	1.5	0.44	0.35	0.082
Benzo(a)anthracene	µg/g	0.43	0.83	8.3		0.03	0.33	0.28	1.4	0.65	1.9	0.42	0.45	0.073
Chrysene	µg/g	0.52	1	10		0.03	0.3	0.39	2	0.87	2.9	0.53	0.58	0.07
Fluoranthene	µg/g	0.93	1.8	18		0.12	0.83	1.4	6.1	3.2	8.2	1.7	2.6	0.29
Fluorene	µg/g	0.089	0.17	1.7		0.04	0.39	0.43	1.2	0.81	1.2	0.39	0.55	0.1
Naphthalene	µg/g	0.24	0.47	4.7		0.16	3.1	1.3	2.6	1.7	3	1.1	1.7	0.33
Phenanthrene	µg/g	0.34	0.65	6.5		0.1	1.9	1	3.4	2.1	3.8	1	1.6	0.24
Pyrene	µg/g	0.87	1.7	17		0.11	1.1	1.1	5.8	2.7	7.3	1.7	1.9	0.32
Benzo(a)pyrene	µg/g	0.47	0.92	9.2		0.01	0.16	0.14	0.78	0.3	1.2	0.22	0.22	0.05
Total PAHs	µg/g	10	20	200		-	-	-	-	-	-	9.3	12	2.1

NOTES:

-	Not analyzed or no applicable CSR standard
CSR	BC Contaminated Sites Regulation (BC Reg. 324/04, includes amendments up to B.C. Reg. 4/2014 - January 31, 2014 - Schedule 9).
CSR - Sediment	CSR Quality Criteria for the protection of sensitive marine sediment.
Non-Detect Value	A value below the laboratory detection limit.
Bold	Bold indicates an exceedance of the CSR Marine Sediment - Sensitive standard.
Red and Underlined	Red and underlined indicates an exceedance of the CSR Marine Sediment - Typical standard.
Bold and Shaded	Bold and shaded indicates an exceedance of applicable Protocol 11 Upper Cap concentrations for Typical sediments.

Table 1: DSI Sediment Analytical Results - PAHs

Parameters	Unit	CSR - Marine Sediment - Sensitive	CSR - Marine Sediment - Typical	Protocol 11 - Typical	Location	14SED04	14SED05	14SED06	14SED07	14SED08	14SED09	14SED10	14SED11	14SED12	14SED13
					Date	9/18/2014	9/18/2014	9/18/2014	9/18/2014	9/18/2014	9/18/2014	9/18/2014	9/18/2014	9/18/2014	9/18/2014
Depth (mbgs)						Surficial	Surficial	Surficial	Surficial	Surficial	Surficial	Surficial	Surficial	Surficial	Surficial
Physical Parameters															
pH (Lab)	pH Units	-	-	-		8.22	-	7.86	-	8.26	-	-	7.99	-	-
Moisture	%	-	-	-		23	29	18	24	30	31	23	27	39	28
pH (aqueous extract)	pH Units	-	-	-		8.22	-	7.86	-	8.26	-	-	7.99	-	-
IARC Cancer	-	-	-	-		-	-	-	-	-	-	-	-	-	-
TEQ Total	-	-	-	-		-	-	-	-	-	-	-	-	-	-
Polycyclic Aromatic Hydrocarbons (PAHs)															
2-methylnaphthalene	µg/g	0.12	0.24	2.4		**2.3**	**0.92**	**0.56**	**1**	**0.81**	**0.59**	**1.2**	**0.8**	**0.97**	**1.2**
Acenaphthene	µg/g	0.055	0.11	1.1		**1.1**	**0.98**	**0.16**	**0.31**	**0.53**	**0.29**	**0.29**	**0.27**	**0.39**	**0.5**
Acenaphthylene	µg/g	0.079	0.15	1.5		**0.16**	**0.15**	0.05	0.05	0.057	0.05	0.05	0.05	0.05	0.05
Anthracene	µg/g	0.15	0.29	2.9		**0.95**	**0.63**	0.1	**0.25**	**1.7**	**0.25**	**0.18**	**0.23**	**0.39**	**0.31**
Benzo(a)anthracene	µg/g	0.43	0.83	8.3		**1.1**	**1.2**	0.089	0.33	**0.85**	**0.45**	0.16	0.19	**0.53**	0.31
Chrysene	µg/g	0.52	1	10		**1.9**	**2.4**	0.092	0.4	**1.1**	0.45	0.16	0.22	**0.69**	0.36
Fluoranthene	µg/g	0.93	1.8	18		**11**	**17**	0.37	**1.3**	**4.7**	**2.2**	0.7	0.84	**1.5**	**1.4**
Fluorene	µg/g	0.089	0.17	1.7		**1.1**	**0.94**	**0.13**	**0.36**	**0.55**	**0.26**	**0.24**	**0.25**	**0.37**	**0.4**
Naphthalene	µg/g	0.24	0.47	4.7		**1.6**	**1**	**0.47**	**0.68**	**0.8**	**0.59**	**0.77**	**0.58**	**0.72**	**0.96**
Phenanthrene	µg/g	0.34	0.65	6.5		**7.4**	**5.4**	0.32	**0.86**	**2.6**	**0.73**	**0.62**	**0.66**	**1.1**	**0.97**
Pyrene	µg/g	0.87	1.7	17		**6.4**	**9.1**	0.38	**1.2**	**3**	**0.99**	0.7	0.81	**1.3**	**2**
Benzo(a)pyrene	µg/g	0.47	0.92	9.2		0.41	**0.62**	0.05	0.19	0.33	0.19	0.067	0.086	0.29	0.18
Total PAHs	µg/g	10	20	200		**35**	**41**	2.7	6.9	**17**	7	5	4.9	8.2	8.5

NOTES:

-	Not analyzed or no applicable CSR standard
CSR	BC Contaminated Sites Regulation (BC Reg. 324/04, includes amendments up to B.C. Reg. 4/2014 - January 31, 2014 - Schedule 9).
CSR - Sediment	CSR Quality Criteria for the protection of sensitive marine sediment.
Non-Detect Value	A value below the laboratory detection limit.
Bold	Bold indicates an exceedance of the CSR Marine Sediment - Sensitive standard.
Red and Underlined	Red and underlined indicates an exceedance of the CSR Marine Sediment - Typical standard.
Bold and Shaded	Bold and shaded indicates an exceedance of applicable Protocol 11 Upper Cap concentrations for Typical sediments.

Table 1: DSI Sediment Analytical Results - PAHs

Parameters	Unit	CSR - Marine Sediment - Sensitive	CSR - Marine Sediment - Typical	Protocol 11 - Typical	Location	14SED14	14SED15	14SED16	14SED17	14SED18	14SED023-A	14SED023-B	14SED023-C	14SED023-D
					Date	9/18/2014	9/18/2014	9/18/2014	9/18/2014	9/18/2014	11/6/2014	11/6/2014	11/6/2014	11/6/2014
Depth (mbgs)						Surficial	Surficial	Surficial	Surficial	Surficial	Surficial	Surficial	Surficial	Surficial
Physical Parameters														
pH (Lab)	pH Units	-	-	-		8.1	-	7.79	8	7.84	-	-	-	-
Moisture	%	-	-	-		31	26	33	33	43	29	30	25	29
pH (aqueous extract)	pH Units	-	-	-		8.1	-	7.79	8	7.84	-	-	-	-
IARC Cancer	-	-	-	-		-	-	-	-	-	0.26	0.27	1	0.29
TEQ Total	-	-	-	-		-	-	-	-	-	4	4.3	13	4.3
Polycyclic Aromatic Hydrocarbons (PAHs)														
2-methylnaphthalene	µg/g	0.12	0.24	2.4		**1.3**	**1.6**	**1.9**	**0.94**	**1.2**	**5.3**	**3.4**	**2.7**	**5.9**
Acenaphthene	µg/g	0.055	0.11	1.1		**0.48**	**0.47**	**0.68**	**0.54**	**0.51**	**0.83**	**0.66**	**0.49**	**0.86**
Acenaphthylene	µg/g	0.079	0.15	1.5		0.053	0.05	0.064	0.05	0.061	0.035	0.034	**0.15**	0.042
Anthracene	µg/g	0.15	0.29	2.9		**0.5**	**0.31**	**0.71**	**0.4**	**0.64**	**0.55**	**0.55**	**1.3**	**0.64**
Benzo(a)anthracene	µg/g	0.43	0.83	8.3		**0.63**	0.31	**0.66**	**0.44**	**0.74**	0.38	**0.43**	**0.94**	0.41
Chrysene	µg/g	0.52	1	10		**0.96**	0.38	**0.89**	0.49	**1.1**	0.38	0.47	**0.91**	0.41
Fluoranthene	µg/g	0.93	1.8	18		**2.9**	**1**	**2.3**	**2**	**2.4**	**1.1**	**1.5**	**2.6**	**1.1**
Fluorene	µg/g	0.089	0.17	1.7		**0.44**	**0.37**	**0.63**	**0.54**	**0.51**	**0.61**	**0.63**	**0.68**	**0.65**
Naphthalene	µg/g	0.24	0.47	4.7		**1**	**1.1**	**1.4**	**0.77**	**0.97**	**3.3**	**2.2**	**1.7**	**3.6**
Phenanthrene	µg/g	0.34	0.65	6.5		**1.2**	**0.99**	**1.6**	**1.7**	**1.2**	**1.7**	**1.4**	**3**	**1.8**
Pyrene	µg/g	0.87	1.7	17		**3**	**1.2**	**2.5**	**1.7**	**2.8**	**1**	**1.2**	**2.6**	**1.1**
Benzo(a)pyrene	µg/g	0.47	0.92	9.2		0.38	0.13	0.39	0.19	0.44	0.15	0.16	**0.67**	0.17
Total PAHs	µg/g	10	20	200		**13**	7.9	**14**	9.7	**13**	**15**	**13**	**18**	**17**

NOTES:

-	Not analyzed or no applicable CSR standard
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Bold	Bold indicates an exceedance of the CSR Marine Sediment - Sensitive standard.
Red and Underlined	Red and underlined indicates an exceedance of the CSR Marine Sediment - Typical standard.
Bold and Shaded	Bold and shaded indicates an exceedance of applicable Protocol 11 Upper Cap concentrations for Typical sediments.

Table 1: DSI Sediment Analytical Results - PAHs

Parameters	Unit	CSR - Marine Sediment - Sensitive	CSR - Marine Sediment - Typical	Protocol 11 - Typical	Location	14SED019@1.1	14SED020@1.0	14SED021@1.5	14SED022@1.5	14SED023@1.8	14SED024@1.3				
					Date	11/6/2014	11/6/2014	11/6/2014	11/6/2014	11/6/2014	11/6/2014				
Depth (mbgs)						1.1	1.0	1.5	1.5	1.8	1.3				
Physical Parameters															
pH (Lab)	pH Units	-	-	-		-	-	-	-	-	-				
Moisture	%	-	-	-		31	7.1	10	20	15	19				
pH (aqueous extract)	pH Units	-	-	-		-	-	-	-	-	-				
IARC Cancer	-	-	-	-		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1				
TEQ Total	-	-	-	-		0.11	<0.1	<0.1	0.11	0.11	0.11				
Polycyclic Aromatic Hydrocarbons (PAHs)												Max	Median	Average	90th percentile
2-methylnaphthalene	µg/g	0.12	0.24	2.4		0.01	0.0017	0.029	0.045	0.058	0.092	6.000	1.350	2.040	4.740
Acenaphthene	µg/g	0.055	0.11	1.1		<0.005	<0.0005	0.0075	0.0057	0.011	<0.0081	1.100	0.495	0.528	0.899
Acenaphthylene	µg/g	0.079	0.15	1.5		<0.005	<0.0005	<0.0005	<0.005	<0.005	<0.005	0.200	0.050	0.073	0.153
Anthracene	µg/g	0.15	0.29	2.9		<0.01	<0.001	0.0037	<0.01	<0.01	<0.01	1.700	0.420	0.575	1.360
Benzo(a)anthracene	µg/g	0.43	0.83	8.3		<0.01	<0.001	0.0041	<0.01	<0.01	<0.01	1.900	0.435	0.560	1.130
Chrysene	µg/g	0.52	1	10		<0.01	<0.001	0.0058	<0.01	<0.01	<0.01	2.900	0.480	0.765	1.930
Fluoranthene	µg/g	0.93	1.8	18		<0.01	0.0016	0.0061	0.018	0.021	<0.01	17.000	1.600	2.941	6.730
Fluorene	µg/g	0.089	0.17	1.7		<0.01	<0.001	0.0041	<0.01	<0.01	<0.01	1.200	0.475	0.528	0.988
Naphthalene	µg/g	0.24	0.47	4.7		<0.01	0.0013	0.014	0.023	0.034	0.062	3.600	1.050	1.400	3.030
Phenanthrene	µg/g	0.34	0.65	6.5		0.011	0.0016	0.02	0.023	0.022	0.023	7.400	1.300	1.800	3.520
Pyrene	µg/g	0.87	1.7	17		<0.01	0.0014	0.0066	0.014	0.026	<0.01	9.100	1.500	2.322	5.980
Benzo(a)pyrene	µg/g	0.47	0.92	9.2		<0.01	<0.001	0.0026	<0.01	<0.01	<0.01	1.200	0.190	0.292	0.635
Total PAHs	µg/g	10	20	200		0.021	0.0076	0.1	0.13	0.17	0.18	41.000	10.850	12.736	17.900

NOTES:

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Non-Detect Value	A value below the laboratory detection limit.
Bold	Bold indicates an exceedance of the CSR Marine Sediment - Sensitive standard.
Red and Underlined	Red and underlined indicates an exceedance of the CSR Marine Sediment - Typical standard.
Bold and Shaded	Bold and shaded indicates an exceedance of applicable Protocol 11 Upper Cap concentrations for Typical sediments.

Table 2: DSI Sediment Analytical Results - Metals

Parameters	Unit	CSR - Marine Sediment - Sensitive	CSR - Marine Sediment - Typical	Location	14SED01	14SED02	14SED04	14SED06	14SED08	14SED11	14SED14	14SED16	14SED17	14SED18
				Date	**9/18/2014**	**9/18/2014**	**9/18/2014**	**9/18/2014**	**9/18/2014**	**9/18/2014**	**9/18/2014**	**9/18/2014**	**9/18/2014**	**9/18/2014**
Depth (mbgs)					Surficial	Surficial	Surficial	Surficial	Surficial	Surficial	Surficial	Surficial	Surficial	Surficial
Metals														
Aluminium	µg/g	-	-		13,000	14,800	13,600	12,900	12,800	11,300	13,400	10,700	13,900	13,400
Antimony	µg/g	-	-		0.12	0.16	0.19	0.1	0.2	0.13	0.2	0.19	0.13	0.3
Arsenic	µg/g	26	50		4.1	4.07	4.04	3.3	4.29	3.48	4.13	5.1	4.05	5.52
Barium	µg/g	-	-		40.7	41.8	41.9	31.5	42.1	38.3	45.1	46.6	42.6	46.4
Beryllium	µg/g	-	-		<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
Bismuth	µg/g	-	-		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Cadmium	µg/g	2.6	5		0.42	0.719	0.378	0.294	0.538	0.376	0.51	0.714	0.517	0.735
Calcium	µg/g	-	-		7740	17,200	11,200	7880	56,500	7560	10,100	8350	10,000	11,200
Chromium	µg/g	99	190		18.9	23.8	22.6	17.2	20.6	18.4	21.2	23.8	21	25.1
Cobalt	µg/g	-	-		6.46	6.98	6.62	6.37	6.33	6.21	6.47	6.26	6.84	6.53
Copper	µg/g	67	130		40.3	39.8	47.5	23	32.5	28	30.2	41.4	44.7	41.5
Iron	µg/g	-	-		16,100	18,800	17,000	15,600	18,000	15,100	16,800	16,100	17,800	18,800
Lead	µg/g	69	130		15.8	6.97	6.86	3.61	6.11	4.65	7.79	9.46	7.01	11.7
Lithium	µg/g	-	-		17.2	19.5	17	15.4	18.8	17.4	18.3	18.8	18.6	18.3
Magnesium	µg/g	-	-		6040	6740	6170	5960	6670	5480	6220	5850	6510	6730
Manganese	µg/g	-	-		209	232	220	217	214	214	209	204	222	211
Mercury	µg/g	0.43	0.84		0.065	0.071	0.069	<0.05	0.069	<0.05	0.077	0.081	0.063	0.123
Molybdenum	µg/g	-	-		1.04	1.61	1	0.76	1.68	0.8	1.46	1.94	1.29	2.46
Nickel	µg/g	-	-		18.3	20.7	25.8	16.2	19.5	18.2	19.3	24.7	18.5	20.4
Phosphorus (P)	µg/g	-	-		455	537	443	425	481	423	521	447	498	518
Potassium	µg/g	-	-		926	1160	939	729	1110	790	1010	940	1060	1200
Selenium	µg/g	-	-		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Silver	µg/g	-	-		<0.05	0.084	0.06	<0.05	0.075	<0.05	0.083	0.101	0.072	0.093
Sodium	µg/g	-	-		2990	3600	2710	2390	5460	2450	3550	4350	4270	6430
Strontium	µg/g	-	-		47.7	84.8	59.8	37.5	291	46.5	57.1	71.1	52.4	68
Thallium	µg/g	-	-		0.22	0.217	0.22	0.187	0.182	0.214	0.246	0.189	0.202	0.232
Tin	µg/g	-	-		0.56	0.73	0.56	0.29	0.7	0.39	0.65	0.99	0.72	1.48
Titanium	µg/g	-	-		1190	1270	1100	1300	1030	1220	1140	910	1260	1120
Uranium	µg/g	-	-		0.507	0.77	0.492	0.602	0.761	0.511	0.8	0.669	0.758	0.83
Vanadium	µg/g	-	-		45	52.8	45.9	43.9	45	44.6	47.3	42.6	48.7	46.5
Zinc	µg/g	170	330		40.5	53.2	44.7	32.7	50.7	39.2	45.6	53.9	46.1	63.1
Zirconium	µg/g	-	-		4.34	4.62	4.23	4.19	3.98	4.66	4.22	4.26	4.39	4.62

NOTES:

-	Not analyzed or no applicable CSR standard
<	Concentration is less than the laboratory detection limit indicated.
CSR	BC Contaminated Sites Regulation (BC Reg. 324/04, includes amendments up to B.C. Reg. 4/2014 - January 31, 2014 - Schedule 9).
CSR - Sediment	CSR Quality Criteria for the protection of sensitive marine sediment.
Non-Detect Value	A value below the laboratory detection limit.
Bold	Bold indicates an exceedance of the CSR Marine Sediment - Sensitive standard.
Red and Underlined	Red and underlined indicates an exceedance of the CSR Marine Sediment - Typical standard.

Table 3: Statistical Summary - DSI (Sediment)

Parameters	Unit	CSR - Marine Sediment - Sensitive	CSR - Marine Sediment - Typical	CSR - Most Stringent Soil Standard	Protocol 11 - Typical	Total # of Samples	# of Non-Detects	Maximum	Median	Average	90th Percentile	Goodness of Fit Test Distribution	95% UCLM Selected	95% UCLM
2-methylnaphthalene	µg/g	0.12	0.24	-	2.4	28	0	**6.0**	**1.4**	**2.0**	**4.7**	Gamma	95% Adjusted Gamma UCL	**2.7**
Acenaphthene	µg/g	0.055	0.11	-	1.1	28	0	**1.1**	**0.5**	**0.5**	**0.9**	Normal	95% Student's-t UCL	**0.6**
Acenaphthylene	µg/g	0.079	0.15	-	1.5	28	18	**0.2**	0.05	0.07	**0.2**	Kaplan-Meier (KM)	95% KM (t) UCL	0.07
Anthracene	µg/g	0.15	0.29	-	2.9	28	0	**1.7**	**0.4**	**0.6**	**1.4**	Gamma	95% Adjusted Gamma UCL	**0.8**
Benz(a)anthracene	µg/g	0.43	0.83	10	8.3	28	0	**1.9**	**0.4**	**0.6**	**1.1**	Gamma	95% Adjusted Gamma UCL	**0.7**
Chrysene	µg/g	0.52	1	-	10	28	0	**2.9**	**0.5**	**0.8**	**1.9**	Gamma	95% Adjusted Gamma UCL	**1.1**
Fluoranthene	µg/g	0.93	1.8	-	18	28	0	**17.0**	**1.6**	**2.9**	**6.7**	Lognormal	95% H-UCL	**5.1**
Fluorene	µg/g	0.089	0.17	-	1.7	28	0	**1.2**	**0.5**	**0.5**	**1.0**	Normal	95% Student's-t UCL	**0.6**
Naphthalene	µg/g	0.24	0.47	50	4.7	28	0	**3.6**	**1.1**	**1.4**	**3.0**	Gamma	95% Adjusted Gamma UCL	**1.8**
Phenanthrene	µg/g	0.34	0.65	50	6.5	28	0	**7.4**	**1.3**	**1.8**	**3.5**	Gamma	95% Adjusted Gamma UCL	**2.4**
Pyrene	µg/g	0.87	1.7	100	17	28	0	**9.1**	**1.5**	**2.3**	**6.0**	Gamma	95% Adjusted Gamma UCL	**3.2**
Benzo(a)pyrene	µg/g	0.47	0.92	15	9.2	28	3	**1.2**	0.2	0.3	**0.6**	Gamma	95% Adjusted Gamma UCL	0.4
Total PAHs	µg/g	10	20	-	200	22	0	**41.0**	**10.9**	**12.7**	**17.9**	Gamma	95% Adjusted Gamma UCL	**16.9**

NOTES:

-	Not analyzed or no applicable CSR standard
<	Concentration is less than the laboratory detection limit indicated.
CSR	BC Contaminated Sites Regulation (BC Reg. 324/04, includes amendments up to B.C. Reg. 4/2014 - January 31, 2014 - Schedule 9).
CSR - Sediment	CSR Quality Criteria for the protection of sensitive marine sediment.
Bold	Bold indicates an exceedance of the CSR Marine Sediment - Sensitive standard.
Red and Underlined	Red and underlined indicates an exceedance of the CSR Marine Sediment - Typical standard.
Bold and Shaded	Bold and shaded indicates an exceedance of applicable Protocol 11 Upper Cap concentrations for Typical sediments.

Table 4: DRA Sediment Analytical Results - Particle Size Analysis

Parameter	Unit	15SED01	15SED02	15SED03	15SED04	15SED05	15SED06	15SED07	15SED08	15SED09	15SED10	15SED11	15SED12
		22-May-2015	21-May-2015	21-May-2015	21-May-2015	21-May-2015	21-May-2015	21-May-2015	21-May-2015	21-May-2015	22-May-2015	22-May-2015	22-May-2015
Physical Parameters													
pH (2:1)	pH Units	-	-	-	-	-	-	-	-	-	6.27	8.49	7.32
Moisture	%	35	42	32	19	38	39	37	43	34	22	12	22
Sediment Texture													
Sand	%	83	83	80	93	84	76	76	71	81	90	96	96
Silt	%	13	14	17	5.9	12	21	20	26	17	8.0	4.1	4.1
Clay	%	3.4	3.2	3.5	<2.0	3.4	3.9	3.7	3.7	2.3	<2.0	<2.0	<2.0
Texture	N/A	Loamy Sand	Loamy Sand	Loamy Sand	Sand	Loamy Sand	Loamy Sand	Loamy Sand	Sandy Loam	Loamy Sand	Sand	Sand	Sand

NOTES:

- \- Not analyzed.
- < Concentration is less than the laboratory detection limit indicated.

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Table 5: DRA Sediment and Porewater Analytical Results - TOC, Ammonia and Sulphide

Parameter	Unit	15SED02	15SED03	15SED05	15SED06	15SED07	15SED08	15SED11
		21-May-2015	21-May-2015	21-May-2015	21-May-2015	21-May-2015	21-May-2015	22-May-2015
Sediment Physical Parameters								
pH (2:1)	pH Units	-	-	-	-	-	-	8.49
Moisture	%	42	32	38	39	37	43	12
Total Organic Carbon	µg/g	32,000	18,000	61,000	4,100	61,000	52,000	4,900
Porewater Results								
pH	pH units	7.5	7.6	7.5	7.7	7.6	7.5	7.7
Salinity	%	26	24	23	24	24	25	25
Temperature	°C	18.6	19.5	19.6	19.7	20.4	25	19.6
Ammonia	mg/L	8.6	13	6	6.5	5	19	67
Sulphide	mg/L	0.205	0.284	0.454	0.295	0.141	10.1	0.253

NOTES:

-	Not analyzed or no applicable CSR standard.
<	Concentration is less than the laboratory detection limit indicated.

Table 6: DRA Sediment Analytical Results - Polycyclic Aromatic Hydrocarbons

Parameter	Unit	CSR - Marine Sediment - Sensitive	CSR - Marine Sediment - Typical	Protocol 11 - Typical	15SED01	15SED02	15SED03	15SED04	15SED05	15SED06	15SED07	15SED08	15SED09	15SED10	15SED11	15SED12
					22-May-2015	21-May-2015	21-May-2015	21-May-2015	21-May-2015	21-May-2015	21-May-2015	21-May-2015	21-May-2015	22-May-2015	22-May-2015	22-May-2015
Physical Parameters																
pH (2:1)	pH Units	-	-	-	-	-	-	-	-	-	-	-	-	6.27	8.49	7.32
Moisture	%	-	-	-	35	42	32	19	38	39	37	43	34	22	12	22
Carbon																
Total Organic Carbon	µg/g	-	-	-	24,000	32,000	18,000	11,000	61,000	4,100	61,000	52,000	38,000	110,000	4,900	2,700
Polycyclic Aromatic Hydrocarbons (PAHs)																
Index of Additive Cancer Risk-Coarse	N/A	-	-	-	-	12	68	1.8	15	13	15	17	7.9	-	-	-
Benzo[a]pyrene Equivalency	N/A	-	-	-	-	0.74	4.1	0.11	0.86	0.77	0.87	1.0	0.48	-	-	-
2-methylnaphthalene	µg/g	0.12	0.24	2.4	**0.90**	**0.73**	**1.0**	**2.3** (2)	**2.0** (2)	**1.5**	**1.9** (2)	**2.0** (2)	**1.4**	**6.6**	<0.050	<0.050
Acenaphthene	µg/g	0.055	0.11	1.1	**0.33**	**0.60**	**1.2**	**0.44**	**0.62**	**0.56**	**0.59**	**0.65**	**0.37**	**<0.43** (1)	<0.050	<0.050
Acenaphthylene	µg/g	0.079	0.15	1.5	<0.05	0.077	**0.16**	<0.0052 (1)	0.063	0.077	**0.081**	**0.10**	0.045	<0.050	<0.050	<0.050
Anthracene	µg/g	0.15	0.29	2.9	**0.27**	**0.57**	**4.8** (2)	**0.24**	**1.0**	**0.84**	**1.2**	**1.2**	**0.39**	**0.29**	<0.050	<0.050
Benzo(a)anthracene	µg/g	0.43	0.83	8.3	0.38	**0.91**	**6.1** (2)	0.16	**0.93**	**0.78**	**0.94**	**0.98**	0.42	0.14	<0.050	<0.050
Benzo(a) pyrene	µg/g	0.47	0.92	9.2	0.17	0.45	**2.7** (2)	0.067	**0.52**	0.47	**0.54**	**0.64**	0.31	0.051	<0.050	<0.050
Benzo(b)fluoranthene	µg/g	-	-	-	0.21	-	-	-	-	-	-	-	-	<0.050	<0.050	<0.050
Benzo(b+j)fluoranthene	µg/g	-	-	-	0.33	0.96	5.2 (2)	0.13	1.2	1.1	1.3	1.4	0.69	0.067	<0.050	<0.050
Benzo(g,h,i)perylene	µg/g	-	-	-	<0.05	0.13 (1)	0.59 (1)	0.025 (1)	0.17 (1)	0.17 (2)	0.17 (2)	0.19 (2)	0.10 (2)	<0.050	<0.050	<0.050
Benzo(k)fluoranthene	µg/g	-	-	-	0.10	0.24	0.73	0.030	0.30	0.26	0.28	0.35	0.17	<0.050	<0.050	<0.050
Chrysene	µg/g	0.52	1.0	10	0.42	**1.1**	**9.3** (2)	0.16	**1.3**	**1.2**	**1.3**	**1.6**	**0.56**	0.14	<0.050	<0.050
Dibenz(a,h)anthracene	µg/g	0.084	0.16	1.6	<0.05	0.049	**0.14**	0.011	0.060	0.052	0.055	0.067	0.031	<0.050	<0.050	<0.050
Fluoranthene	µg/g	0.93	1.8	18	**1.5**	**3.4 (2)**	**25** (2)	**1.1**	**3.6** (2)	**3.2** (2)	**3.2** (2)	**3.5** (2)	**1.4** (2)	0.14	<0.050	<0.050
Fluorene	µg/g	0.089	0.17	1.7	**0.28**	**0.50**	**0.94**	**0.34**	**0.58**	**0.56**	**0.57**	**0.68**	**0.31**	**0.26**	<0.050	<0.050
Indeno(1,2,3-c,d)pyrene	µg/g	-	-	-	<0.05	0.14	0.38	0.019	0.15	0.13	0.14	0.16	0.076	<0.050	<0.050	<0.050
Naphthalene	µg/g	0.24	0.47	4.7	**0.75**	**0.62**	**3.4** (2)	**1.7** (2)	**1.2**	**1.0**	**1.1**	**1.2**	**0.90**	**4.0**	<0.050	<0.050
Phenanthrene	µg/g	0.34	0.65	6.5	**0.77**	**1.2**	**11** (2)	**0.99**	**1.8** (2)	**1.6** (2)	**1.6** (2)	**1.7** (2)	**0.85**	**1.4**	<0.050	<0.050
Pyrene	µg/g	0.87	1.7	17	**1.0**	**2.4 (2)**	**13** (2)	0.73	**3.4** (2)	**3.3** (2)	**3.4** (2)	**3.7** (2)	**1.4** (2)	0.17	<0.050	<0.050
Low Molecular Wt. PAH Sum	µg/g	-	-	-	3.3	4.3	23	6.0	7.3	6.1	6.9	7.6	4.2	13	<0.050	<0.050
High Molecular Wt. PAH Sum	µg/g	-	-	-	3.5	8.2	57	2.2	9.8	9.0	9.4	10	4.2	0.65	<0.050	<0.050
PAHs (Sum of total)	µg/g	10.0	20.0	200	6.9	**13**	**79**	8.2	**17**	**15**	**16**	**18**	8.4	**13**	<0.050	<0.050

NOTES:

-	Not analyzed or no applicable CSR standard.
<	Concentration is less than the laboratory detection limit indicated.
(1)	Detection limit raised due to matrix interferences.
(2)	Detection limits raised due to dilution to bring analyte within the calibrated range.
CSR	BC Contaminated Sites Regulation (BC Reg. 324/04, includes amendments up to B.C. Reg. 4/2014 - January 31, 2014 - Schedule 9).
Protocol 11	Protocol 11 for Contaminated Sites. Upper Cap Concentrations for Substances Listed in the Contaminated Sites Regulation Version 2.1. February 5, 2014. Table 6 for Marine and Estuarine Sediment, Typical.
Bold	Bold indicates an exceedance of the CSR Marine Sediment - Sensitive standard.
Red and Underlined	Red and underlined indicates an exceedance of the CSR Marine Sediment - Typical standard.
Shaded	Bold and shaded indicates an exceedance of applicable Protocol 11 Upper Cap concentrations for Typical sediments.

Table 7: DRA Sediment Analytical Results - Total Metals

Parameter	Unit	CSR - Marine Sediment - Sensitive	CSR - Marine Sediment - Typical	Protocol 11 - Typical	15SED10	15SED11	15SED12
					22-May-2015	22-May-2015	22-May-2015
Physical Parameters							
pH (2:1)	pH Units	-	-	-	6.27	8.49	7.32
Moisture	%	-	-	-	22	12	22
Total Metals							
Aluminum	µg/g	-	-	-	13,000	8630	5480
Antimony	µg/g	-	-	-	0.26	0.13	0.11
Arsenic	µg/g	26.0	50.0	500	9.48	5.12	2.53
Barium	µg/g	-	-	-	142	14.1	17.7
Beryllium	µg/g	-	-	-	<0.40	<0.40	<0.40
Bismuth	µg/g	-	-	-	0.13	<0.10	<0.10
Cadmium	µg/g	2.6	5.0	50	0.208	0.366	0.284
Calcium	µg/g	-	-	-	35,700	31,000	4180
Chromium	µg/g	99.0	190.0	1900	44.1	15.7	11.5
Cobalt	µg/g	-	-	-	8.58	6.33	3.41
Copper	µg/g	67.0	130.0	1300	63.2	16.8	7.06
Iron	µg/g	-	-	-	19,500	15,300	7840
Lead	µg/g	69.0	130.0	1300	7.49	3.87	3.19
Lithium	µg/g	-	-	-	23.9	8.5	5.7
Magnesium	µg/g	-	-	-	10,200	5570	3010
Manganese	µg/g	-	-	-	274	184	119
Mercury	µg/g	0.43	0.84	8.4	0.127	<0.050	<0.050
Molybdenum	µg/g	-	-	-	1.04	0.62	0.41
Nickel	µg/g	-	-	-	66.6	15.5	12.4
Phosphorus	µg/g	-	-	-	581	463	342
Potassium	µg/g	-	-	-	1300	566	444
Selenium	µg/g	-	-	-	0.66	<0.50	<0.50
Silver	µg/g	-	-	-	0.103	<0.050	<0.050
Sodium	µg/g	-	-	-	2880	2700	1840
Strontium	µg/g	-	-	-	334	210	16.3
Thallium	µg/g	-	-	-	0.098	0.325	0.161
Tin	µg/g	-	-	-	0.49	0.41	0.29
Titanium	µg/g	-	-	-	80.4	1170	741
Uranium	µg/g	-	-	-	0.398	0.394	0.411
Vanadium	µg/g	-	-	-	47.4	44.2	25.5
Zinc	µg/g	170	330	3300	54.5	37.6	20.0
Zirconium	µg/g	-	-	-	2.63	5.57	3.18

NOTES:

-	Not analyzed or no applicable CSR standard.
<	Concentration is less than the laboratory detection limit indicated.
(1)	Detection limit raised due to matrix interferences.
(2)	Detection limits raised due to dilution to bring analyte within the calibrated range.
CSR	BC Contaminated Sites Regulation (BC Reg. 324/04, includes amendments up to B.C. Reg. 4/2014 - January 31, 2014 - Schedule 9).
Protocol 11	Protocol 11 for Contaminated Sites. Upper Cap Concentrations for Substances Listed in the Contaminated Sites Regulation Version 2.1. February 5, 2014. Table 6 for Marine and Estuarine Sediment, Typical.
Bold	Bold indicates an exceedance of the CSR Marine Sediment - Sensitive standard.
Red and Underlined	Red and underlined indicates an exceedance of the CSR Marine Sediment - Typical standard.
Shaded	Bold and shaded indicates an exceedance of applicable Protocol 11 Upper Cap concentrations for Typical sediments.

Table 8: DRA Tissue Analytical Results

Parameter	Units	CRAB1	CLAM1	VEG1	CRAB2	CLAM2	VEG2	CRAB3	CLAM3	VEG3	CRAB4	CLAM4	VEG4
		20-Apr-2015	21-Apr-2015		20-Apr-2015	21-Apr-2015		21-Apr-2015			21-Apr-2015		
Physical Parameters													
Lipid Content	%	7.16	7.46	2.02	14.4	6.6	2.89	6.05	6.67	2.47	10.8	6.6	3.03
Moisture	%	79	84	81	81	86	85	78	86	83	79	84	83
Polyaromatic Hydrocarbons													
2-methylnaphthalene	µg/g in wet weight (ww)	-	-	-	-	-	-	-	-	-	-	-	-
Naphthalene	µg/g (ww)	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025
Acenaphthylene	µg/g (ww)	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025
Acenaphthene	µg/g (ww)	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025
Fluorene	µg/g (ww)	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025
Phenanthrene	µg/g (ww)	<0.0025	0.004	<0.0025	<0.0025	0.0049	<0.0025	<0.0025	0.0031	<0.0025	<0.0025	0.0055	<0.0025
Anthracene	µg/g (ww)	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	0.0059	<0.0025
Fluoranthene	µg/g (ww)	<0.0025	0.0072	<0.0025	<0.0025	0.0075	<0.0025	<0.0025	0.0044	<0.0025	<0.0025	0.0096	<0.0025
Pyrene	µg/g (ww)	<0.0025	0.0049	<0.0025	<0.0025	0.0059	<0.0025	<0.0025	0.0031	<0.0025	<0.0025	0.0065	<0.0025
Benzo(a)anthracene	µg/g (ww)	<0.0025	0.0039	<0.0025	<0.0025	0.0034	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	0.0031	<0.0025
Chrysene	µg/g (ww)	<0.0025	0.0064	<0.0025	<0.0025	0.0054	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	0.0043	<0.0025
Benzo(b)fluoranthene	µg/g (ww)	<0.0025	<0.0025	<0.0025	<0.0025	0.0033	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025
Benzo(k)fluoranthene	µg/g (ww)	<0.0025	<0.0025	<0.0025	<0.0025	0.003	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025
Benzo(a)pyrene	µg/g (ww)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Indeno(1,2,3-cd)pyrene	µg/g (ww)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Dibenz(a,h)anthracene	µg/g (ww)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Benzo(g,h,i)perylene	µg/g (ww)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Laboratory Work Order Number		MC7076-01R	MC7084-01R	MC7097-01R	MC7077-01R	MC7085-01R	MC7098-01R	MC7078-01R	MC7086-01R	MC7099-01R	MC7079-01R	MC7087-01R	MC7100-01R
Laboratory Identification Number		AEJ242	AEJ250	AEJ258	AEJ243	AEJ251	AEJ259	AEJ244	AEJ252	AEJ260	AEJ245	AEJ253	AEJ261

Parameter	Units	CRAB5	CLAM5	VEG5	CRAB6	CLAM6	VEG6	CRAB7	CLAM7	VEG7	CRAB8	CLAM8	VEG8	Crab Max	Clam Max	Plant Max
		21-Apr-2015			21-Apr-2015		22-Apr-2015	22-Apr-2015			22-Apr-2015					
Physical Parameters																
Lipid Content	%	25.8	9.54	2.46	13.6	7.96	1.98	17.9	7.25	2.78	7.84	7.14	2.78	-	-	-
Moisture	%	76	86	83	82	86	83	79	86	82	82	84	84	-	-	-
Polyaromatic Hydrocarbons																
2-methylnaphthalene	µg/g in wet weight (ww)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Naphthalene	µg/g (ww)	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025
Acenaphthylene	µg/g (ww)	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025
Acenaphthene	µg/g (ww)	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025
Fluorene	µg/g (ww)	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025
Phenanthrene	µg/g (ww)	<0.0025	<0.0025	<0.0025	<0.0025	0.0036	<0.0025	<0.0025	0.0068	0.0034	<0.0025	0.0039	<0.0025	<0.0025	0.0068	0.0034
Anthracene	µg/g (ww)	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	0.0059	0.0025
Fluoranthene	µg/g (ww)	<0.0025	<0.0025	<0.0025	<0.0025	0.0049	<0.0025	<0.0025	0.0118	0.01	<0.0025	0.0045	0.0054	<0.0025	0.0118	0.0100
Pyrene	µg/g (ww)	<0.0025	<0.0025	<0.0025	<0.0025	0.004	<0.0025	<0.0025	0.0077	0.0072	<0.0025	0.0026	0.004	<0.0025	0.0077	0.0072
Benzo(a)anthracene	µg/g (ww)	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	0.0043	0.0031	<0.0025	<0.0025	<0.0025	<0.0025	0.0043	0.0031
Chrysene	µg/g (ww)	<0.0025	<0.0025	<0.0025	<0.0025	0.0028	<0.0025	<0.0025	0.0051	0.0056	<0.0025	<0.0025	<0.0025	<0.0025	0.0064	0.0056
Benzo(b)fluoranthene	µg/g (ww)	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	0.005	<0.0025	<0.0025	<0.0025	<0.0025	0.0033	0.005
Benzo(k)fluoranthene	µg/g (ww)	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	0.0045	<0.0025	<0.0025	<0.0025	<0.0025	0.003	0.0045
Benzo(a)pyrene	µg/g (ww)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Indeno(1,2,3-cd)pyrene	µg/g (ww)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Dibenz(a,h)anthracene	µg/g (ww)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Benzo(g,h,i)perylene	µg/g (ww)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Laboratory Work Order Number		MC7080-01R	MC7093-01R	MC7101-01R	MC7081-01R	MC7094-01R	MC7102-01R	MC7082-01R	MC7095-01R	MC7103-01R	MC7083-01R	MC7096-01R	MC7104-01R	-	-	-
Laboratory Identification Number		AEJ246	AEJ254	AEJ262	AEJ247	AEJ255	AEJ263	AEJ248	AEJ256	AEJ264	AEJ249	AEJ257	AEJ265	-	-	-

NOTES:

<	Concentration is less than the laboratory detection limit indicated.
RDL	Laboratory Reportable Detection Limit

TETRA TECH EBA

Table 9: Statistical Summary - DSI and DRA (Sediment)

Parameters	Unit	CSR - Marine Sediment - Sensitive	CSR - Marine Sediment - Typical	Protocol 11 - Typical	Total # of Samples	# of Non-Detects	Maximum	Median	Average	90th Percentile	Goodness of Fit Test Distribution	95% UCLM Selected	95% UCLM
2-methylnaphthalene	µg/g	0.12	0.24	2.4	37	0	**6.0**	1.4	1.9	4.3	Gamma	95% Adjusted Gamma UCL	2.4
Acenaphthene	µg/g	0.055	0.11	1.1	37	0	1.1	0.5	0.5	0.9	Normal	95% Student's-t UCL	0.6
Acenaphthylene	ug/g	0.079	0.15	1.5	37	20	0.2	0.05	0.07	0.2	Kaplan-Meier (KM) Statistics	95% KM (t) UCL	0.07
Anthracene	µg/g	0.15	0.29	2.9	37	0	**4.8**	0.5	0.7	1.5	Gamma	95% Adjusted Gamma UCL	0.9
Benz(a)anthracene	µg/g	0.43	0.83	8.3	37	0	6.1	0.4	**0.7**	1.2	Gamma	95% Adjusted Gamma UCL	1.0
Chrysene	µg/g	0.52	1	10	37	0	9.3	0.5	**1.0**	2.0	Gamma	95% Adjusted Gamma UCL	1.4
Fluoranthene	µg/g	0.93	1.8	18	37	0	**25.0**	2.1	3.5	7.2	Lognormal Distribution	95% H-UCL	5.3
Fluorene	ug/g	0.089	0.17	1.7	37	0	1.2	0.5	0.5	1.0	Normal	95% Student's-t UCL	0.6
Naphthalene	µg/g	0.24	0.47	4.7	37	0	3.6	1.0	1.4	3.1	Gamma	95% Adjusted Gamma UCL	1.7
Phenanthrene	µg/g	0.34	0.65	6.5	37	0	**11.0**	1.6	2.0	3.6	Lognormal Distribution	95% H-UCL	2.7
Pyrene	µg/g	0.87	1.7	17	37	0	13.0	1.8	2.7	6.1	Gamma	95% Adjusted Gamma UCL	3.4
Benzo(a)pyrene	µg/g	0.47	0.92	9.2	37	3	1.2	0.2	0.3	**0.6**	Nonparametric Distribution	95% Chebyshev (Mean, Sd) UCL	**0.7**
Total PAHs	ug/g	10	20	200	31	0	41.0	**10.9**	**12.5**	**17.7**	Nonparametric Distribution	95% Chebyshev (Mean, Sd) UCL	26.2

NOTES:

-	Not analyzed or no applicable CSR standard
<	Concentration is less than the laboratory detection limit indicated.
CSR	BC Contaminated Sites Regulation (BC Reg. 324/04, includes amendments up to B.C. Reg. 4/2014 - January 31, 2014 - Schedule 9).
CSR - Sediment	CSR Quality Criteria for the protection of sensitive marine sediment.
Bold	Bold indicates an exceedance of the CSR Marine Sediment - Sensitive standard.
Red and Underlined	Red and underlined indicates an exceedance of the CSR Marine Sediment - Typical standard.
Bold and Shaded	Bold and shaded indicates an exceedance of applicable Protocol 11 Upper Cap concentrations for Typical sediments.

FIGURES

LEGEND

- Subject Property
- Subject Site
- Road
- Railway
- Building
- Residential Area
- Park
- Contour (40 m)
- Watercourse
- Waterbody
- Vegetation

NOTES
Property boundaries are approximate.
Base data source:
CanVec 1:50,000 (Sheet 092G04).

DETAILED RISK ASSESSMENT, 1 PORT DRIVE, NANAIMO, BC

Site Location Plan

PROJECTION	DATUM	CLIENT
UTM Zone 10	NAD83	CITY OF NANAIMO THE HARBOUR CITY

Scale: 1:20,000
400 200 0 400
Metres

TETRA TECH EBA

FILE NO.
IND03511-01_Figure01_DSISiteLocation.mxd

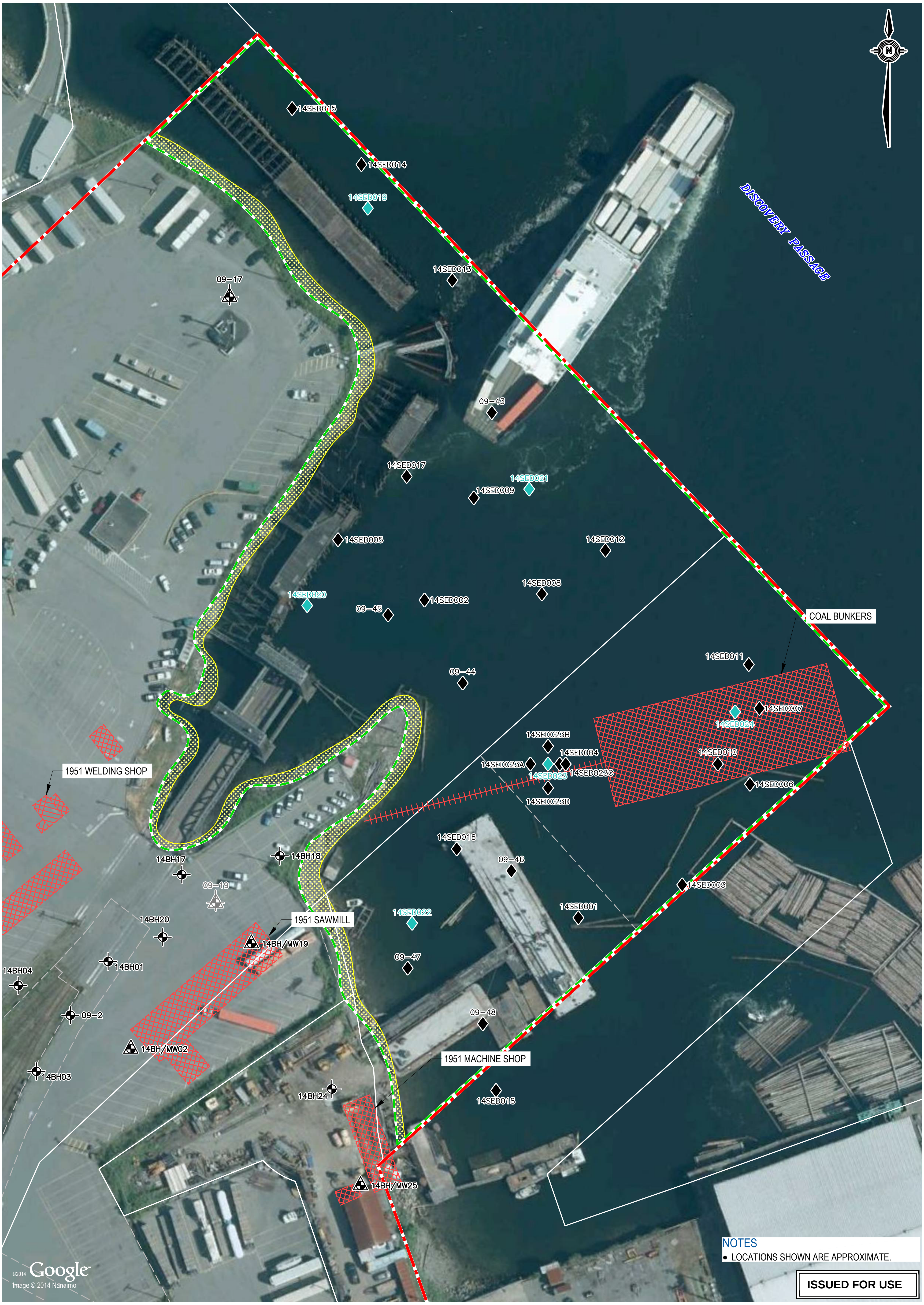
PROJECT NO.	DWN	CKD	APVD	REV
ENVIND03511-01	SL	MEZ	KG	0

OFFICE	DATE
Tt EBA-VANC	June 30, 2015

Figure 1

ISSUED FOR USE

Q:\Vancouver\GIS\ENVIRONMENTAL\IND\IND03511-01\Maps\IND03511-01_Figure01_DSISiteLocation.mxd modified 6/30/2015 by morgan.zondervan



LEGEND

- Subject Property
- Subject Site
- 1951 Historical Buildings (Approximate)
- Borehole
- Monitoring Well
- Borehole & Monitoring Well
- Test Pit
- Destroyed Monitoring Well
- Surface Sediment Sample
- Intertidal Area
- Deeper Drilled location to 2 m

HORIZONTAL SCALE 1:1000

10 0 10 20 40m

CLIENT

CITY OF NANAIMO
THE HARBOUR CITY

TETRA TECH EBA

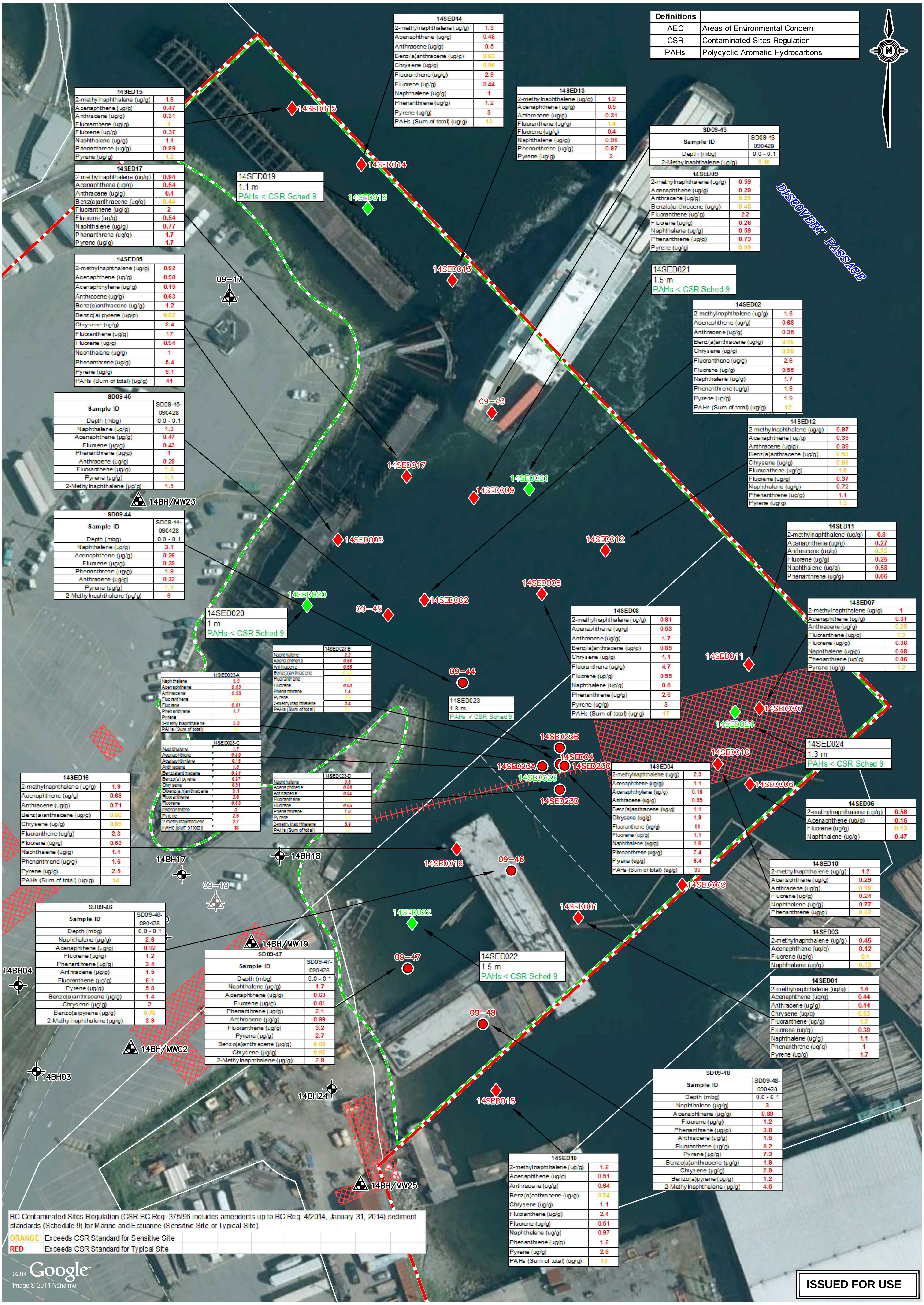
DETAILED RISK ASSESSMENT
1 PORT DRIVE, NANAIMO, BC

SITE PLAN WITH DSI TEST LOCATIONS

PROJECT NO.	DWN	CKD	REV
ENVIND03511-02	SF	KG	0

OFFICE	DATE
VANC	August 6, 2015

Figure 2



LEGEND

- Subject Property
- Subject Site
- Borehole
- Monitoring Well
- Sediment Sample
- High Risk Sediment Sample
- Test Pit
- Destroyed Monitoring Well installed prior to 2001

HORIZONTAL SCALE 1:1000

10 0 10 20 40m

NOTES

- LOCATIONS SHOWN ARE APPROXIMATE.
- LOCATIONS 14SED019 TO 14SED024 WERE DRILLED TO 2 m bgs.

CLIENT

CITY OF NANAIMO
THE HARBOUR CITY

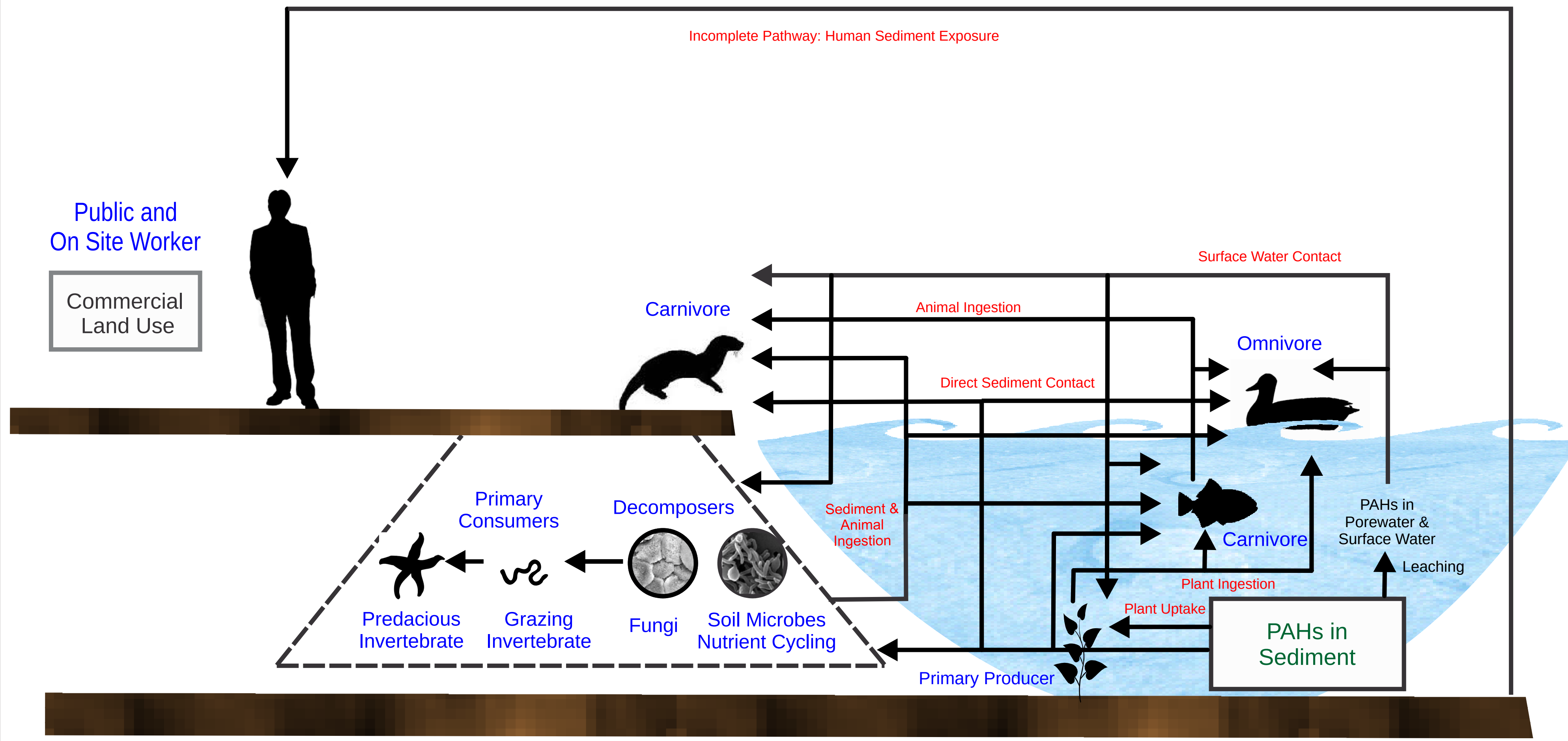
TETRA TECH EBA

DETAILED RISK ASSESSMENT
1 PORT DRIVE, NANAIMO, BC

DSI SEDIMENT ANALYTICAL RESULTS

PROJECT NO.	DWN	CKD	REV
ENVIND03511-02	SF	KG	0
OFFICE	DATE		
VANC	September 10, 2015		

Figure 3



Text Legend

Receptor
Pathway
Source

Land Use Land Use Applied

NOTES

1. No pathway was found to be operable for humans.

Status: Issued for Use

CLIENT

City of Nanaimo

TETRA TECH

DETAILED RISK ASSESSMENT
1 Port Drive in Nanaimo, BC

Conceptual Site Model - Current Land Use

PROJECT NO.	DWN	CKD	REV
ENVIND03511-02.001	KG	SS	0

OFFICE	DATE
EBA-NAN	September 2015

Figure 4

Q:\Vancouver\Drafting\Environmental\ENVIND\ENVIND03511-01\tsk 001\Detailed Site Investigation\Detailed Risk Assessment\ENVIND03511-02.001_FIG 1-3, 5-7_R0 - Detailed Risk Assessment.dwg [FIGURE 5] August 13, 2015 - 1:53:01 pm (BY: FOURNIER, SAMUEL)

NOTES
- LOCATIONS SHOWN ARE APPROXIMATE.

ISSUED FOR USE

LEGEND

- Subject Property
- Subject Site
- 1951 Historical Buildings (Approximate)
- V Veg Tissue Sample
- C Crab Tissue Sample
- ● Clam Tissue Sample
- T1 - T10 Dive Transects
- Eel Grass

HORIZONTAL SCALE 1:1000

10 0 10 20 40m

CLIENT

CITY OF NANAIMO
THE HARBOUR CITY

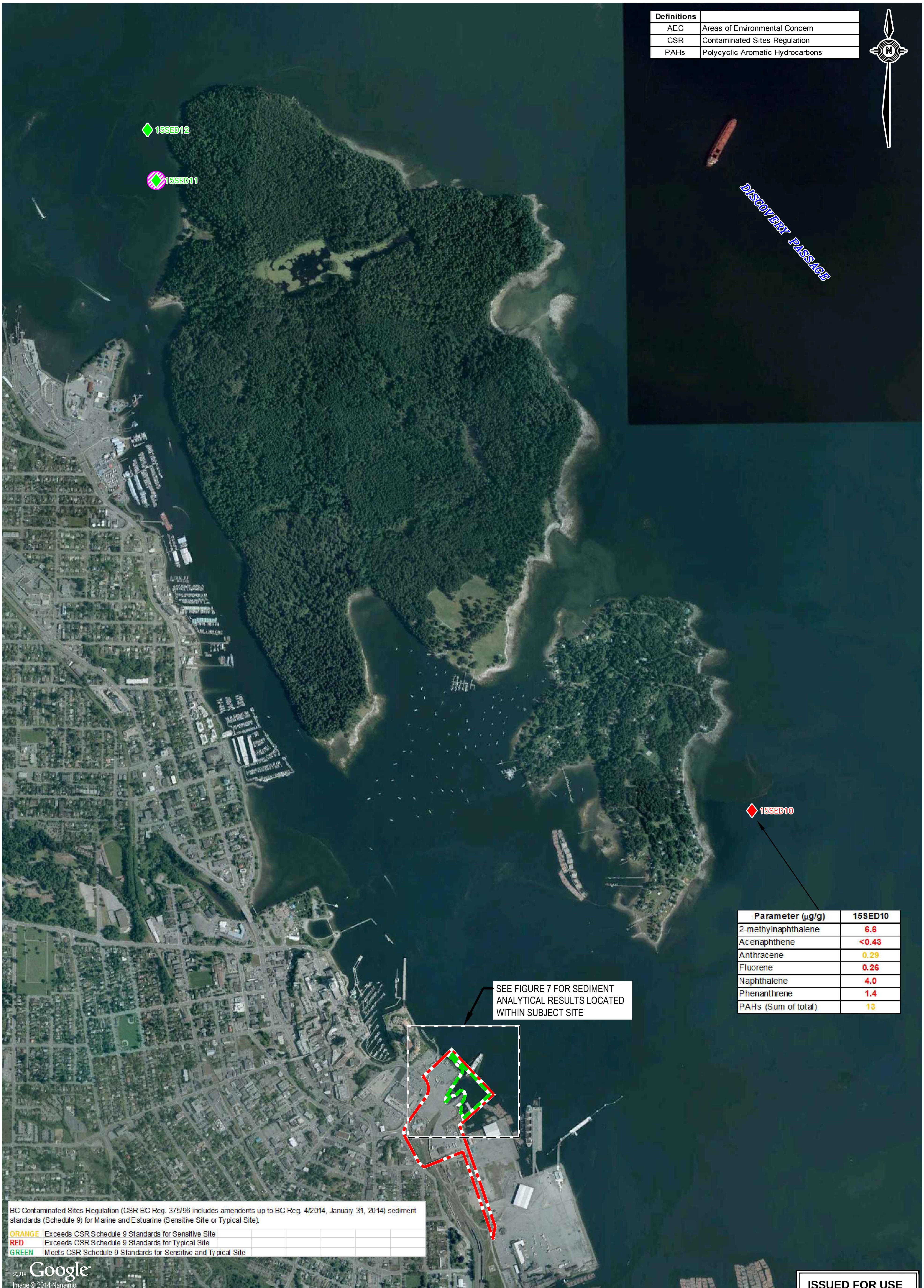
TETRA TECH EBA

DETAILED RISK ASSESSMENT
1 PORT DRIVE, NANAIMO, BC

DRA TISSUE ANALYTICAL RESULTS

PROJECT NO.	DWN	CKD	REV	
ENVIND03511-02	SF	KG	0	**Figure 5**
OFFICE	DATE			
VANC	August 6, 2015			

Q:\Vancouver\Drafting\Environmental\ENVIND\ENVIND03511-01\tsk 001\Detailed Site Investigation\Detailed Risk Assessment\ENVIND03511-02.001_FIG 1-3, 5-7_R0 - Detailed Risk Assessment.dwg [FIGURE 6] August 06, 2015 - 10:24:00 am (BY: FOURNIER, SAMUEL)



Definitions	
AEC	Areas of Environmental Concern
CSR	Contaminated Sites Regulation
PAHs	Polycyclic Aromatic Hydrocarbons

Parameter (µg/g)	15SED10
2-methylnaphthalene	6.6
Acenaphthene	<0.43
Anthracene	0.29
Fluorene	0.26
Naphthalene	4.0
Phenanthrene	1.4
PAHs (Sum of total)	13

BC Contaminated Sites Regulation (CSR BC Reg. 375/96 includes amendents up to BC Reg. 4/2014, January 31, 2014) sediment standards (Schedule 9) for Marine and Estuarine (Sensitive Site or Typical Site).

ORANGE	Exceeds CSR Schedule 9 Standards for Sensitive Site
RED	Exceeds CSR Schedule 9 Standards for Typical Site
GREEN	Meets CSR Schedule 9 Standards for Sensitive and Typical Site

LEGEND

- Subject Property
- Subject Site
- Sediment Sample
- Ecotoxicity Test was Performed

HORIZONTAL SCALE 1:1000

10 0 10 20 40m

NOTES

- LOCATIONS SHOWN ARE APPROXIMATE.
- LOCATIONS 14SED019 TO 14SED024 WERE DRILLED TO 2 m bgs.

CLIENT

CITY OF NANAIMO
THE HARBOUR CITY

TETRA TECH EBA

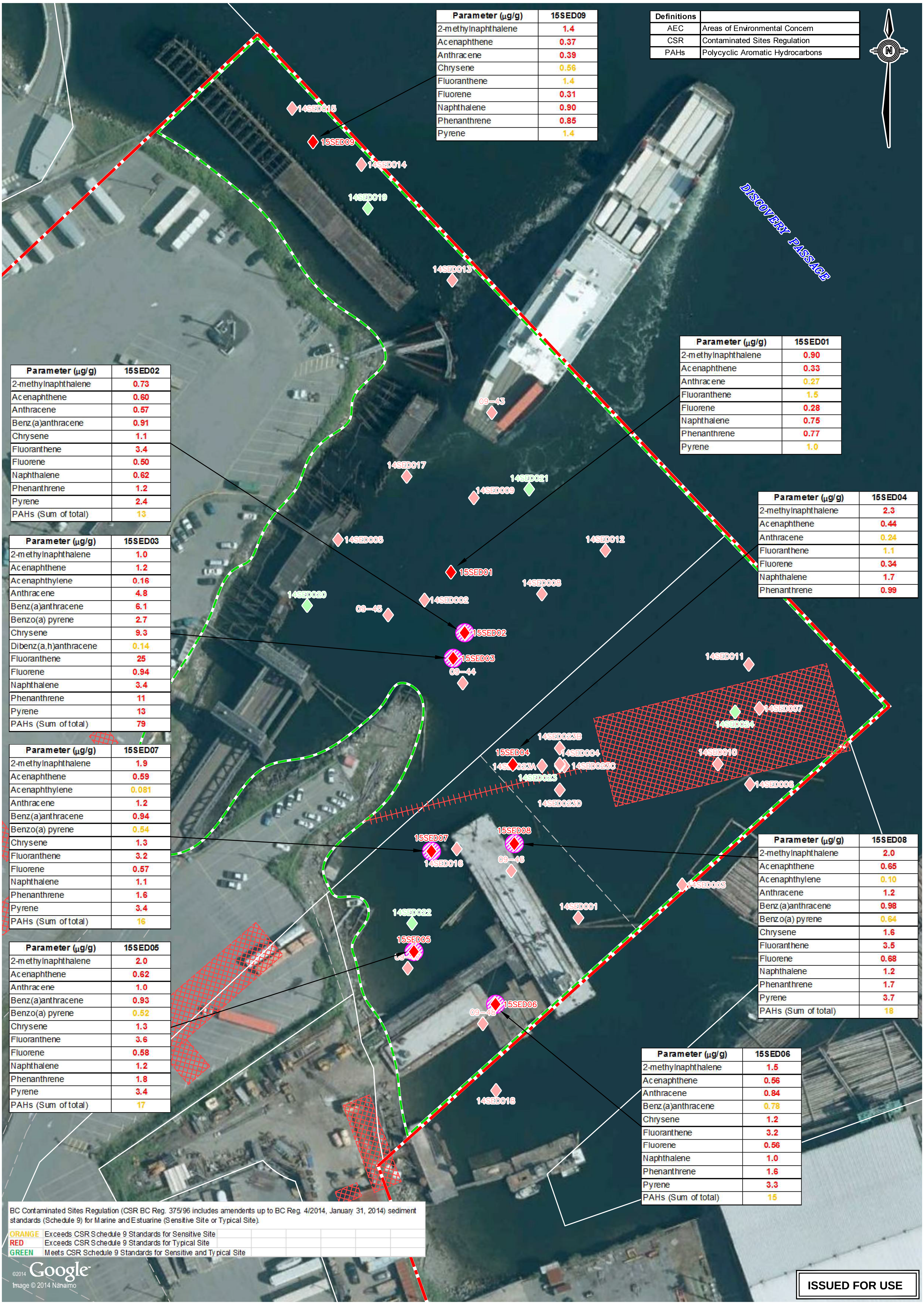
DETAILED RISK ASSESSMENT
1 PORT DRIVE, NANAIMO, BC

DRA SEDIMENT ANALYTICAL RESULTS - REFERENCE LOCATIONS

PROJECT NO.	DWN	CKD	REV
ENVIND03511-02	SF	KG	0
OFFICE	DATE		
VANC	August 6, 2015		

Figure 6

Q:\Vancouver\Drafting\Environmental\ENVIND\ENVIND03511-01\tsk 001\Detailed Site Investigation\Detailed Risk Assessment\ENVIND03511-02.001_FIG 1-3, 5-7_R0 - Detailed Risk Assessment.dwg [FIGURE 7] August 06, 2015 - 10:23:50 am (BY: FOURNIER, SAMUEL)



Parameter (µg/g)	15SED09
2-methylnaphthalene	1.4
Acenaphthene	0.37
Anthracene	0.39
Chrysene	0.56
Fluoranthene	1.4
Fluorene	0.31
Naphthalene	0.90
Phenanthrene	0.85
Pyrene	1.4

Definitions	
AEC	Areas of Environmental Concern
CSR	Contaminated Sites Regulation
PAHs	Polycyclic Aromatic Hydrocarbons

Parameter (µg/g)	15SED01
2-methylnaphthalene	0.90
Acenaphthene	0.33
Anthracene	0.27
Fluoranthene	1.5
Fluorene	0.28
Naphthalene	0.75
Phenanthrene	0.77
Pyrene	1.0

Parameter (µg/g)	15SED02
2-methylnaphthalene	0.73
Acenaphthene	0.60
Anthracene	0.57
Benz(a)anthracene	0.91
Chrysene	1.1
Fluoranthene	3.4
Fluorene	0.50
Naphthalene	0.62
Phenanthrene	1.2
Pyrene	2.4
PAHs (Sum of total)	13

Parameter (µg/g)	15SED03
2-methylnaphthalene	1.0
Acenaphthene	1.2
Acenaphthylene	0.16
Anthracene	4.8
Benz(a)anthracene	6.1
Benzo(a) pyrene	2.7
Chrysene	9.3
Dibenz(a,h)anthracene	0.14
Fluoranthene	25
Fluorene	0.94
Naphthalene	3.4
Phenanthrene	11
Pyrene	13
PAHs (Sum of total)	79

Parameter (µg/g)	15SED04
2-methylnaphthalene	2.3
Acenaphthene	0.44
Anthracene	0.24
Fluoranthene	1.1
Fluorene	0.34
Naphthalene	1.7
Phenanthrene	0.99

Parameter (µg/g)	15SED07
2-methylnaphthalene	1.9
Acenaphthene	0.59
Acenaphthylene	0.081
Anthracene	1.2
Benz(a)anthracene	0.94
Benzo(a) pyrene	0.54
Chrysene	1.3
Fluoranthene	3.2
Fluorene	0.57
Naphthalene	1.1
Phenanthrene	1.6
Pyrene	3.4
PAHs (Sum of total)	16

Parameter (µg/g)	15SED08
2-methylnaphthalene	2.0
Acenaphthene	0.65
Acenaphthylene	0.10
Anthracene	1.2
Benz(a)anthracene	0.98
Benzo(a) pyrene	0.64
Chrysene	1.6
Fluoranthene	3.5
Fluorene	0.68
Naphthalene	1.2
Phenanthrene	1.7
Pyrene	3.7
PAHs (Sum of total)	18

Parameter (µg/g)	15SED05
2-methylnaphthalene	2.0
Acenaphthene	0.62
Anthracene	1.0
Benz(a)anthracene	0.93
Benzo(a) pyrene	0.52
Chrysene	1.3
Fluoranthene	3.6
Fluorene	0.58
Naphthalene	1.2
Phenanthrene	1.8
Pyrene	3.4
PAHs (Sum of total)	17

Parameter (µg/g)	15SED06
2-methylnaphthalene	1.5
Acenaphthene	0.56
Anthracene	0.84
Benz(a)anthracene	0.78
Chrysene	1.2
Fluoranthene	3.2
Fluorene	0.56
Naphthalene	1.0
Phenanthrene	1.6
Pyrene	3.3
PAHs (Sum of total)	15

BC Contaminated Sites Regulation (CSR BC Reg. 375/96 includes amendents up to BC Reg. 4/2014, January 31, 2014) sediment standards (Schedule 9) for Marine and Estuarine (Sensitive Site or Typical Site).

ORANGE	Exceeds CSR Schedule 9 Standards for Sensitive Site
RED	Exceeds CSR Schedule 9 Standards for Typical Site
GREEN	Meets CSR Schedule 9 Standards for Sensitive and Typical Site

ISSUED FOR USE

LEGEND

- Subject Property
- Subject Site
- Sediment Sample
- Ecotoxicity Test was Performed

HORIZONTAL SCALE 1:1000

10 0 10 20 40m

NOTES

- LOCATIONS SHOWN ARE APPROXIMATE.
- LOCATIONS 14SED019 TO 14SED024 WERE DRILLED TO 2 m bgs.

CLIENT

CITY OF NANAIMO THE HARBOUR CITY

TETRA TECH EBA

DETAILED RISK ASSESSMENT
1 PORT DRIVE, NANAIMO, BC

DRA SEDIMENT ANALYTICAL RESULTS - SITE LOCATIONS

PROJECT NO.	DWN	CKD	REV
ENVIND03511-02	SF	KG	0
OFFICE	DATE		
VANC	August 6, 2015		

Figure 7

APPENDIX A
TETRA TECH EBA'S GENERAL CONDITIONS

GENERAL CONDITIONS

GEOENVIRONMENTAL REPORT

This report incorporates and is subject to these "General Conditions".

1.0 USE OF REPORT AND OWNERSHIP

This report pertains to a specific site, a specific development, and a specific scope of work. It is not applicable to any other sites, nor should it be relied upon for types of development other than those to which it refers. Any variation from the site or proposed development would necessitate a supplementary investigation and assessment.

This report and the assessments and recommendations contained in it are intended for the sole use of Tetra Tech EBA's client. Tetra Tech EBA does not accept any responsibility for the accuracy of any of the data, the analysis or the recommendations contained or referenced in the report when the report is used or relied upon by any party other than Tetra Tech EBA's Client unless otherwise authorized in writing by Tetra Tech EBA. Any unauthorized use of the report is at the sole risk of the user.

This report is subject to copyright and shall not be reproduced either wholly or in part without the prior, written permission of Tetra Tech EBA. Additional copies of the report, if required, may be obtained upon request.

2.0 ALTERNATE REPORT FORMAT

Where Tetra Tech EBA submits both electronic file and hard copy versions of reports, drawings and other project-related documents and deliverables (collectively termed Tetra Tech EBA's instruments of professional service), only the signed and/or sealed versions shall be considered final and legally binding. The original signed and/or sealed version archived by Tetra Tech EBA shall be deemed to be the original for the Project.

Both electronic file and hard copy versions of Tetra Tech EBA's instruments of professional service shall not, under any circumstances, no matter who owns or uses them, be altered by any party except Tetra Tech EBA. The Client warrants that Tetra Tech EBA's instruments of professional service will be used only and exactly as submitted by Tetra Tech EBA.

Electronic files submitted by Tetra Tech EBA have been prepared and submitted using specific software and hardware systems. Tetra Tech EBA makes no representation about the compatibility of these files with the Client's current or future software and hardware systems.

3.0 NOTIFICATION OF AUTHORITIES

In certain instances, the discovery of hazardous substances or conditions and materials may require that regulatory agencies and other persons be informed and the client agrees that notification to such bodies or persons as required may be done by Tetra Tech EBA in its reasonably exercised discretion.

4.0 INFORMATION PROVIDED TO TETRA TECH EBA BY OTHERS

During the performance of the work and the preparation of the report, Tetra Tech EBA may rely on information provided by persons other than the Client. While Tetra Tech EBA endeavours to verify the accuracy of such information when instructed to do so by the Client, Tetra Tech EBA accepts no responsibility for the accuracy or the reliability of such information which may affect the report.

APPENDIX B

MAXXAM ANALYTICAL RESULTS – SEDIMENT DATA USED IN THE DRA

Your Project #: ENVIND03511-01
Site Location: 1 PORT DR, NANAIMO
Your C.O.C. #: G079948, G079949

Attention:Lora J Paul

Tetra Tech EBA
#1 - 4376 Boban Drive
Nanaimo, BC
CANADA V9T 6A7

Report Date: 2014/09/30

Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B483823
Received: 2014/09/19, 08:10

Sample Matrix: Sediment
Samples Received: 20

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Elements by ICPMS (total)	12	2014/09/24	2014/09/24	BBY7SOP-00001	EPA 6020a R1 m
Moisture	20	N/A	2014/09/26	BBY8SOP-00017	OMOE E3139 3.1 m
PAH in Soil by GC/MS (SIM)	5	2014/09/25	2014/09/26	BBY8SOP-00022	EPA 8270d R4 m
PAH in Soil by GC/MS (SIM)	13	2014/09/25	2014/09/27	BBY8SOP-00022	EPA 8270d R4 m
PAH in Soil by GC/MS (SIM)	1	2014/09/25	2014/09/29	BBY8SOP-00022	EPA 8270d R4 m
PAH in Soil by GC/MS (SIM)	1	2014/09/27	2014/09/28	BBY8SOP-00022	EPA 8270d R4 m
Total LMW, HMW, Total PAH Calc	20	N/A	2014/09/29	BBY WI-00033	Auto Calc
pH (2:1 DI Water Extract)	12	2014/09/24	2014/09/24	BBY6SOP-00028	BCMOE BCLM Mar2005 m

* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Crystal Ireland, B.Sc., Account Specialist
Email: CIreland@maxxam.ca
Phone# (604)638-5016
==
This report has been generated and distributed using a secure automated process.
Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Maxxam Job #: B483823
Report Date: 2014/09/30

Tetra Tech EBA
Client Project #: ENVIND03511-01
Site Location: 1 PORT DR, NANAIMO

PHYSICAL TESTING (SEDIMENT)

Maxxam ID		KQ5506	KQ5507	KQ5508	KQ5509	KQ5510	KQ5511	KQ5512		
Sampling Date		2014/09/18	2014/09/18	2014/09/18	2014/09/18	2014/09/18	2014/09/18	2014/09/18		
COC Number		G079948	G079948	G079948	G079948	G079948	G079948	G079948		
	Units	**14SED01**	**14SED02**	**14SED03**	**14SED04**	**14SED05**	**14SED06**	**14SED07**	**RDL**	**QC Batch**
Physical Properties										
Moisture	%	27	33	21	23	29	18	24	0.30	7653594

RDL = Reportable Detection Limit

Maxxam ID		KQ5513	KQ5514	KQ5515	KQ5516	KQ5517	KQ5518	KQ5519		
Sampling Date		2014/09/18	2014/09/18	2014/09/18	2014/09/18	2014/09/18	2014/09/18	2014/09/18		
COC Number		G079948	G079948	G079948	G079948	G079948	G079949	G079949		
	Units	**14SED08**	**14SED09**	**14SED10**	**14SED11**	**14SED12**	**14SED13**	**14SED14**	**RDL**	**QC Batch**
Physical Properties										
Moisture	%	30	31	23	27	39	28	31	0.30	7653594

RDL = Reportable Detection Limit

Maxxam ID		KQ5520	KQ5520	KQ5521	KQ5522	KQ5523	KQ5524	KQ5525		
Sampling Date		2014/09/18	2014/09/18	2014/09/18	2014/09/18	2014/09/18	2014/09/18	2014/09/18		
COC Number		G079949	G079949	G079949	G079949	G079949	G079949	G079949		
	Units	**14SED15**	**14SED15 Lab-Dup**	**14SED16**	**14SED17**	**14SED18**	**14SED-DUP1**	**14SED-DUP2**	**RDL**	**QC Batch**
Physical Properties										
Moisture	%	26	24	33	33	43	26	33	0.30	7653594

RDL = Reportable Detection Limit
Lab-Dup = Laboratory Initiated Duplicate

Maxxam Job #: B483823
Report Date: 2014/09/30

Tetra Tech EBA
Client Project #: ENVIND03511-01
Site Location: 1 PORT DR, NANAIMO

CSR/CCME METALS IN SOIL (SEDIMENT)

Maxxam ID		KQ5506	KQ5507	KQ5509	KQ5511	KQ5513		KQ5516		
Sampling Date		2014/09/18	2014/09/18	2014/09/18	2014/09/18	2014/09/18		2014/09/18		
COC Number		G079948	G079948	G079948	G079948	G079948		G079948		
	Units	**14SED01**	**14SED02**	**14SED04**	**14SED06**	**14SED08**	**QC Batch**	**14SED11**	**RDL**	**QC Batch**
Physical Properties										
Soluble (2:1) pH	pH	7.67	8.20	8.22	7.86	8.26	7650915	7.99	N/A	7650856
Total Metals by ICPMS										
Total Aluminum (Al)	mg/kg	13000	14800	13600	12900	12800	7650867	11300	100	7650845
Total Antimony (Sb)	mg/kg	0.12	0.16	0.19	0.10	0.20	7650867	0.13	0.10	7650845
Total Arsenic (As)	mg/kg	4.10	4.07	4.04	3.30	4.29	7650867	3.48	0.50	7650845
Total Barium (Ba)	mg/kg	40.7	41.8	41.9	31.5	42.1	7650867	38.3	0.10	7650845
Total Beryllium (Be)	mg/kg	<0.40	<0.40	<0.40	<0.40	<0.40	7650867	<0.40	0.40	7650845
Total Bismuth (Bi)	mg/kg	<0.10	<0.10	<0.10	<0.10	<0.10	7650867	<0.10	0.10	7650845
Total Cadmium (Cd)	mg/kg	0.420	0.719	0.378	0.294	0.538	7650867	0.376	0.050	7650845
Total Calcium (Ca)	mg/kg	7740	17200	11200	7880	56500	7650867	7560	100	7650845
Total Chromium (Cr)	mg/kg	18.9	23.8	22.6	17.2	20.6	7650867	18.4	1.0	7650845
Total Cobalt (Co)	mg/kg	6.46	6.98	6.62	6.37	6.33	7650867	6.21	0.30	7650845
Total Copper (Cu)	mg/kg	40.3	39.8	47.5	23.0	32.5	7650867	28.0	0.50	7650845
Total Iron (Fe)	mg/kg	16100	18800	17000	15600	18000	7650867	15100	100	7650845
Total Lead (Pb)	mg/kg	15.8	6.97	6.86	3.61	6.11	7650867	4.65	0.10	7650845
Total Lithium (Li)	mg/kg	17.2	19.5	17.0	15.4	18.8	7650867	17.4	5.0	7650845
Total Magnesium (Mg)	mg/kg	6040	6740	6170	5960	6670	7650867	5480	100	7650845
Total Manganese (Mn)	mg/kg	209	232	220	217	214	7650867	214	0.20	7650845
Total Mercury (Hg)	mg/kg	0.065	0.071	0.069	<0.050	0.069	7650867	<0.050	0.050	7650845
Total Molybdenum (Mo)	mg/kg	1.04	1.61	1.00	0.76	1.68	7650867	0.80	0.10	7650845
Total Nickel (Ni)	mg/kg	18.3	20.7	25.8	16.2	19.5	7650867	18.2	0.80	7650845
Total Phosphorus (P)	mg/kg	455	537	443	425	481	7650867	423	10	7650845
Total Potassium (K)	mg/kg	926	1160	939	729	1110	7650867	790	100	7650845
Total Selenium (Se)	mg/kg	<0.50	<0.50	<0.50	<0.50	<0.50	7650867	<0.50	0.50	7650845
Total Silver (Ag)	mg/kg	<0.050	0.084	0.060	<0.050	0.075	7650867	<0.050	0.050	7650845
Total Sodium (Na)	mg/kg	2990	3600	2710	2390	5460	7650867	2450	100	7650845
Total Strontium (Sr)	mg/kg	47.7	84.8	59.8	37.5	291	7650867	46.5	0.10	7650845
Total Thallium (Tl)	mg/kg	0.220	0.217	0.220	0.187	0.182	7650867	0.214	0.050	7650845
Total Tin (Sn)	mg/kg	0.56	0.73	0.56	0.29	0.70	7650867	0.39	0.10	7650845
Total Titanium (Ti)	mg/kg	1190	1270	1100	1300	1030	7650867	1220	1.0	7650845
Total Uranium (U)	mg/kg	0.507	0.770	0.492	0.602	0.761	7650867	0.511	0.050	7650845
Total Vanadium (V)	mg/kg	45.0	52.8	45.9	43.9	45.0	7650867	44.6	2.0	7650845
Total Zinc (Zn)	mg/kg	40.5	53.2	44.7	32.7	50.7	7650867	39.2	1.0	7650845
Total Zirconium (Zr)	mg/kg	4.34	4.62	4.23	4.19	3.98	7650867	4.66	0.50	7650845

RDL = Reportable Detection Limit
N/A = Not Applicable

Maxxam Job #: B483823
Report Date: 2014/09/30

Tetra Tech EBA
Client Project #: ENVIND03511-01
Site Location: 1 PORT DR, NANAIMO

CSR/CCME METALS IN SOIL (SEDIMENT)

Maxxam ID		KQ5519		KQ5521	KQ5521		KQ5522	KQ5523		
Sampling Date		2014/09/18		2014/09/18	2014/09/18		2014/09/18	2014/09/18		
COC Number		G079949		G079949	G079949		G079949	G079949		
	Units	**14SED14**	**QC Batch**	**14SED16**	**14SED16 Lab-Dup**	**QC Batch**	**14SED17**	**14SED18**	**RDL**	**QC Batch**
Physical Properties										
Soluble (2:1) pH	pH	8.10	7650915	7.79	7.82	7650856	8.00	7.84	N/A	7650915
Total Metals by ICPMS										
Total Aluminum (Al)	mg/kg	13400	7650867	10700	11100	7650845	13900	13400	100	7650867
Total Antimony (Sb)	mg/kg	0.20	7650867	0.19	0.18	7650845	0.13	0.30	0.10	7650867
Total Arsenic (As)	mg/kg	4.13	7650867	5.10	4.98	7650845	4.05	5.52	0.50	7650867
Total Barium (Ba)	mg/kg	45.1	7650867	46.6	47.9	7650845	42.6	46.4	0.10	7650867
Total Beryllium (Be)	mg/kg	<0.40	7650867	<0.40	<0.40	7650845	<0.40	<0.40	0.40	7650867
Total Bismuth (Bi)	mg/kg	<0.10	7650867	<0.10	<0.10	7650845	<0.10	<0.10	0.10	7650867
Total Cadmium (Cd)	mg/kg	0.510	7650867	0.714	0.716	7650845	0.517	0.735	0.050	7650867
Total Calcium (Ca)	mg/kg	10100	7650867	8350	8230	7650845	10000	11200	100	7650867
Total Chromium (Cr)	mg/kg	21.2	7650867	23.8	24.2	7650845	21.0	25.1	1.0	7650867
Total Cobalt (Co)	mg/kg	6.47	7650867	6.26	6.43	7650845	6.84	6.53	0.30	7650867
Total Copper (Cu)	mg/kg	30.2	7650867	41.4	38.4	7650845	44.7	41.5	0.50	7650867
Total Iron (Fe)	mg/kg	16800	7650867	16100	16400	7650845	17800	18800	100	7650867
Total Lead (Pb)	mg/kg	7.79	7650867	9.46	9.04	7650845	7.01	11.7	0.10	7650867
Total Lithium (Li)	mg/kg	18.3	7650867	18.8	19.0	7650845	18.6	18.3	5.0	7650867
Total Magnesium (Mg)	mg/kg	6220	7650867	5850	6170	7650845	6510	6730	100	7650867
Total Manganese (Mn)	mg/kg	209	7650867	204	206	7650845	222	211	0.20	7650867
Total Mercury (Hg)	mg/kg	0.077	7650867	0.081	0.080	7650845	0.063	0.123	0.050	7650867
Total Molybdenum (Mo)	mg/kg	1.46	7650867	1.94	1.88	7650845	1.29	2.46	0.10	7650867
Total Nickel (Ni)	mg/kg	19.3	7650867	24.7	25.9	7650845	18.5	20.4	0.80	7650867
Total Phosphorus (P)	mg/kg	521	7650867	447	475	7650845	498	518	10	7650867
Total Potassium (K)	mg/kg	1010	7650867	940	960	7650845	1060	1200	100	7650867
Total Selenium (Se)	mg/kg	<0.50	7650867	<0.50	<0.50	7650845	<0.50	<0.50	0.50	7650867
Total Silver (Ag)	mg/kg	0.083	7650867	0.101	0.091	7650845	0.072	0.093	0.050	7650867
Total Sodium (Na)	mg/kg	3550	7650867	4350	4380	7650845	4270	6430	100	7650867
Total Strontium (Sr)	mg/kg	57.1	7650867	71.1	71.0	7650845	52.4	68.0	0.10	7650867
Total Thallium (Tl)	mg/kg	0.246	7650867	0.189	0.223	7650845	0.202	0.232	0.050	7650867
Total Tin (Sn)	mg/kg	0.65	7650867	0.99	1.01	7650845	0.72	1.48	0.10	7650867
Total Titanium (Ti)	mg/kg	1140	7650867	910	939	7650845	1260	1120	1.0	7650867
Total Uranium (U)	mg/kg	0.800	7650867	0.669	0.633	7650845	0.758	0.830	0.050	7650867
Total Vanadium (V)	mg/kg	47.3	7650867	42.6	43.4	7650845	48.7	46.5	2.0	7650867
Total Zinc (Zn)	mg/kg	45.6	7650867	53.9	55.3	7650845	46.1	63.1	1.0	7650867
Total Zirconium (Zr)	mg/kg	4.22	7650867	4.26	4.31	7650845	4.39	4.62	0.50	7650867

RDL = Reportable Detection Limit
Lab-Dup = Laboratory Initiated Duplicate
N/A = Not Applicable

Maxxam Analytics International Corporation o/a Maxxam Analytics Burnaby: 4606 Canada Way V5G 1K5 Telephone(604) 734-7276 Fax(604) 731-2386

Maxxam Job #: B483823
Report Date: 2014/09/30

Tetra Tech EBA
Client Project #: ENVIND03511-01
Site Location: 1 PORT DR, NANAIMO

CSR/CCME METALS IN SOIL (SEDIMENT)

Maxxam ID		KQ5524	KQ5525		
Sampling Date		2014/09/18	2014/09/18		
COC Number		G079949	G079949		
	Units	**14SED-DUP1**	**14SED-DUP2**	**RDL**	**QC Batch**
Physical Properties					
Soluble (2:1) pH	pH	7.79	8.09	N/A	7651113
Total Metals by ICPMS					
Total Aluminum (Al)	mg/kg	12400	13200	100	7651107
Total Antimony (Sb)	mg/kg	0.38	0.20	0.10	7651107
Total Arsenic (As)	mg/kg	3.92	4.85	0.50	7651107
Total Barium (Ba)	mg/kg	40.2	48.5	0.10	7651107
Total Beryllium (Be)	mg/kg	<0.40	<0.40	0.40	7651107
Total Bismuth (Bi)	mg/kg	<0.10	<0.10	0.10	7651107
Total Cadmium (Cd)	mg/kg	0.495	0.754	0.050	7651107
Total Calcium (Ca)	mg/kg	7730	11600	100	7651107
Total Chromium (Cr)	mg/kg	20.4	22.6	1.0	7651107
Total Cobalt (Co)	mg/kg	6.57	6.78	0.30	7651107
Total Copper (Cu)	mg/kg	30.7	41.9	0.50	7651107
Total Iron (Fe)	mg/kg	15800	17400	100	7651107
Total Lead (Pb)	mg/kg	4.38	10.0	0.10	7651107
Total Lithium (Li)	mg/kg	17.2	19.5	5.0	7651107
Total Magnesium (Mg)	mg/kg	5780	6470	100	7651107
Total Manganese (Mn)	mg/kg	212	226	0.20	7651107
Total Mercury (Hg)	mg/kg	0.059	0.084	0.050	7651107
Total Molybdenum (Mo)	mg/kg	1.00	1.86	0.10	7651107
Total Nickel (Ni)	mg/kg	18.8	20.8	0.80	7651107
Total Phosphorus (P)	mg/kg	465	499	10	7651107
Total Potassium (K)	mg/kg	853	1110	100	7651107
Total Selenium (Se)	mg/kg	<0.50	<0.50	0.50	7651107
Total Silver (Ag)	mg/kg	0.070	0.130	0.050	7651107
Total Sodium (Na)	mg/kg	2740	4370	100	7651107
Total Strontium (Sr)	mg/kg	44.0	75.4	0.10	7651107
Total Thallium (Tl)	mg/kg	0.221	0.241	0.050	7651107
Total Tin (Sn)	mg/kg	0.71	0.74	0.10	7651107
Total Titanium (Ti)	mg/kg	1170	1200	1.0	7651107
Total Uranium (U)	mg/kg	0.916	0.870	0.050	7651107
Total Vanadium (V)	mg/kg	45.9	48.3	2.0	7651107
Total Zinc (Zn)	mg/kg	42.1	51.6	1.0	7651107
Total Zirconium (Zr)	mg/kg	4.30	4.65	0.50	7651107

RDL = Reportable Detection Limit
N/A = Not Applicable

Maxxam Job #: B483823
Report Date: 2014/09/30

Tetra Tech EBA
Client Project #: ENVIND03511-01
Site Location: 1 PORT DR, NANAIMO

CSR PAH IN SOIL BY GC-MS (SEDIMENT)

Maxxam ID		KQ5506	KQ5507	KQ5508	KQ5509		KQ5510		KQ5511		
Sampling Date		2014/09/18	2014/09/18	2014/09/18	2014/09/18		2014/09/18		2014/09/18		
COC Number		G079948	G079948	G079948	G079948		G079948		G079948		
	Units	**14SED01**	**14SED02**	**14SED03**	**14SED04**	**RDL**	**14SED05**	**RDL**	**14SED06**	**RDL**	**QC Batch**
Polycyclic Aromatics											
Naphthalene	mg/kg	1.1	1.7	0.33	1.6	0.050	1.0	0.050	0.47	0.050	7655428
2-Methylnaphthalene	mg/kg	1.4	1.8	0.45	2.3	0.050	0.92	0.050	0.56	0.050	7655428
Acenaphthylene	mg/kg	<0.050	<0.050	<0.050	0.16	0.050	0.15	0.050	<0.050	0.050	7655428
Acenaphthene	mg/kg	0.44	0.68	0.12	1.1	0.050	0.98	0.050	0.16	0.050	7655428
Fluorene	mg/kg	0.39	0.55	0.10	1.1	0.050	0.94	0.050	0.13	0.050	7655428
Phenanthrene	mg/kg	1.0	1.6	0.24	7.4	0.050	5.4	0.050	0.32	0.050	7655428
Anthracene	mg/kg	0.44	0.35	0.082	0.95	0.050	0.63	0.050	0.10	0.050	7655428
Fluoranthene	mg/kg	1.7	2.6	0.29	11	0.050	17 (1)	0.50	0.37	0.050	7655428
Pyrene	mg/kg	1.7	1.9	0.32	6.4	0.050	9.1	0.050	0.38	0.050	7655428
Benzo(a)anthracene	mg/kg	0.42	0.45	0.073	1.1	0.050	1.2	0.050	0.089	0.050	7655428
Chrysene	mg/kg	0.53	0.58	0.070	1.9	0.050	2.4	0.050	0.092	0.050	7655428
Benzo(b&j)fluoranthene	mg/kg	0.45	0.47	0.065	1.1	0.050	1.9	0.050	0.076	0.050	7655428
Benzo(b)fluoranthene	mg/kg	0.28	0.31	<0.050	0.72	0.050	1.3	0.050	<0.050	0.050	7655428
Benzo(k)fluoranthene	mg/kg	0.13	0.13	<0.050	0.36	0.050	0.56	0.050	<0.050	0.050	7655428
Benzo(a)pyrene	mg/kg	0.22	0.22	<0.050	0.41	0.050	0.62	0.050	<0.050	0.050	7655428
Indeno(1,2,3-cd)pyrene	mg/kg	0.073	0.070	<0.050	0.13	0.050	0.23	0.050	<0.050	0.050	7655428
Dibenz(a,h)anthracene	mg/kg	<0.050	<0.050	<0.050	<0.050	0.050	0.061	0.050	<0.050	0.050	7655428
Benzo(g,h,i)perylene	mg/kg	0.081	0.073	<0.050	0.13	0.050	0.21	0.050	<0.050	0.050	7655428
Low Molecular Weight PAH`s	mg/kg	4.8	6.7	1.3	15	0.050	10	0.050	1.7	0.050	7649306
High Molecular Weight PAH`s	mg/kg	4.6	5.7	0.75	21	0.050	31	0.50	0.93	0.050	7649306
Total PAH	mg/kg	9.3	12	2.1	35	0.050	41	0.50	2.7	0.050	7649306
Surrogate Recovery (%)											
D10-ANTHRACENE (sur.)	%	94	96	101	86		87		97		7655428
D8-ACENAPHTHYLENE (sur.)	%	86	91	87	85		87		88		7655428
D8-NAPHTHALENE (sur.)	%	97	97	91	97		89		91		7655428
TERPHENYL-D14 (sur.)	%	92	92	88	86		85		90		7655428

RDL = Reportable Detection Limit

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

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Maxxam Job #: B483823
Report Date: 2014/09/30

Tetra Tech EBA
Client Project #: ENVIND03511-01
Site Location: 1 PORT DR, NANAIMO

CSR PAH IN SOIL BY GC-MS (SEDIMENT)

Maxxam ID		KQ5512	KQ5512		KQ5513	KQ5514	KQ5515	KQ5516		
Sampling Date		2014/09/18	2014/09/18		2014/09/18	2014/09/18	2014/09/18	2014/09/18		
COC Number		G079948	G079948		G079948	G079948	G079948	G079948		
	Units	**14SED07**	**14SED07 Lab-Dup**	**QC Batch**	**14SED08**	**14SED09**	**14SED10**	**14SED11**	**RDL**	**QC Batch**
Polycyclic Aromatics										
Naphthalene	mg/kg	0.68	0.69	7656338	0.80	0.59	0.77	0.58	0.050	7655428
2-Methylnaphthalene	mg/kg	1.0	0.91	7656338	0.81	0.59	1.2	0.80	0.050	7655428
Acenaphthylene	mg/kg	<0.050	<0.050	7656338	0.057	<0.050	<0.050	<0.050	0.050	7655428
Acenaphthene	mg/kg	0.31	0.32	7656338	0.53	0.29	0.29	0.27	0.050	7655428
Fluorene	mg/kg	0.36	0.37	7656338	0.55	0.26	0.24	0.25	0.050	7655428
Phenanthrene	mg/kg	0.86	0.94	7656338	2.6	0.73	0.62	0.66	0.050	7655428
Anthracene	mg/kg	0.25	0.27	7656338	1.7	0.25	0.18	0.23	0.050	7655428
Fluoranthene	mg/kg	1.3	1.2	7656338	4.7	2.2	0.70	0.84	0.050	7655428
Pyrene	mg/kg	1.2	1.1	7656338	3.0	0.99	0.70	0.81	0.050	7655428
Benzo(a)anthracene	mg/kg	0.33	0.27	7656338	0.85	0.45	0.16	0.19	0.050	7655428
Chrysene	mg/kg	0.40	0.28	7656338	1.1	0.45	0.16	0.22	0.050	7655428
Benzo(b&j)fluoranthene	mg/kg	0.39	0.25	7656338	0.76	0.39	0.14	0.18	0.050	7655428
Benzo(b)fluoranthene	mg/kg	0.26	0.16	7656338	0.50	0.25	0.090	0.12	0.050	7655428
Benzo(k)fluoranthene	mg/kg	0.13	0.080	7656338	0.24	0.11	<0.050	0.054	0.050	7655428
Benzo(a)pyrene	mg/kg	0.19	0.13	7656338	0.33	0.19	0.067	0.086	0.050	7655428
Indeno(1,2,3-cd)pyrene	mg/kg	0.064	<0.050	7656338	0.10	0.052	<0.050	<0.050	0.050	7655428
Dibenz(a,h)anthracene	mg/kg	<0.050	<0.050	7656338	<0.050	<0.050	<0.050	<0.050	0.050	7655428
Benzo(g,h,i)perylene	mg/kg	0.091	0.062	7656338	0.099	0.051	<0.050	<0.050	0.050	7655428
Low Molecular Weight PAH`s	mg/kg	3.5		7649306	7.0	2.7	3.3	2.8	0.050	7649306
High Molecular Weight PAH`s	mg/kg	3.4		7649306	10	4.3	1.8	2.1	0.050	7649306
Total PAH	mg/kg	6.9		7649306	17	7.0	5.0	4.9	0.050	7649306
Surrogate Recovery (%)										
D10-ANTHRACENE (sur.)	%	110	93	7656338	90	92	94	92		7655428
D8-ACENAPHTHYLENE (sur.)	%	100	88	7656338	84	86	87	85		7655428
D8-NAPHTHALENE (sur.)	%	111	92	7656338	87	88	93	90		7655428
TERPHENYL-D14 (sur.)	%	99	85	7656338	83	87	90	87		7655428

RDL = Reportable Detection Limit
Lab-Dup = Laboratory Initiated Duplicate

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Maxxam Job #: B483823
Report Date: 2014/09/30

Tetra Tech EBA
Client Project #: ENVIND03511-01
Site Location: 1 PORT DR, NANAIMO

CSR PAH IN SOIL BY GC-MS (SEDIMENT)

Maxxam ID		KQ5517	KQ5518	KQ5519	KQ5520	KQ5521	KQ5522	KQ5523		
Sampling Date		2014/09/18	2014/09/18	2014/09/18	2014/09/18	2014/09/18	2014/09/18	2014/09/18		
COC Number		G079948	G079949	G079949	G079949	G079949	G079949	G079949		
	Units	14SED12	14SED13	14SED14	14SED15	14SED16	14SED17	14SED18	RDL	QC Batch
Polycyclic Aromatics										
Naphthalene	mg/kg	0.72	0.96	1.0	1.1	1.4	0.77	0.97	0.050	7655428
2-Methylnaphthalene	mg/kg	0.97	1.2	1.3	1.6	1.9	0.94	1.2	0.050	7655428
Acenaphthylene	mg/kg	<0.050	<0.050	0.053	<0.050	0.064	<0.050	0.061	0.050	7655428
Acenaphthene	mg/kg	0.39	0.50	0.48	0.47	0.68	0.54	0.51	0.050	7655428
Fluorene	mg/kg	0.37	0.40	0.44	0.37	0.63	0.54	0.51	0.050	7655428
Phenanthrene	mg/kg	1.1	0.97	1.2	0.99	1.6	1.7	1.2	0.050	7655428
Anthracene	mg/kg	0.39	0.31	0.50	0.31	0.71	0.40	0.64	0.050	7655428
Fluoranthene	mg/kg	1.5	1.4	2.9	1.0	2.3	2.0	2.4	0.050	7655428
Pyrene	mg/kg	1.3	2.0	3.0	1.2	2.5	1.7	2.8	0.050	7655428
Benzo(a)anthracene	mg/kg	0.53	0.31	0.63	0.31	0.66	0.44	0.74	0.050	7655428
Chrysene	mg/kg	0.69	0.36	0.96	0.38	0.89	0.49	1.1	0.050	7655428
Benzo(b&j)fluoranthene	mg/kg	0.60	0.37	0.83	0.26	0.79	0.41	0.97	0.050	7655428
Benzo(b)fluoranthene	mg/kg	0.40	0.24	0.54	0.17	0.52	0.27	0.64	0.050	7655428
Benzo(k)fluoranthene	mg/kg	0.18	0.11	0.25	0.076	0.24	0.12	0.28	0.050	7655428
Benzo(a)pyrene	mg/kg	0.29	0.18	0.38	0.13	0.39	0.19	0.44	0.050	7655428
Indeno(1,2,3-cd)pyrene	mg/kg	0.092	<0.050	0.12	<0.050	0.13	0.061	0.15	0.050	7655428
Dibenz(a,h)anthracene	mg/kg	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0.051	0.050	7655428
Benzo(g,h,i)perylene	mg/kg	0.097	0.054	0.13	<0.050	0.13	0.067	0.16	0.050	7655428
Low Molecular Weight PAH`s	mg/kg	3.9	4.3	5.0	4.8	7.1	4.9	5.1	0.050	7649306
High Molecular Weight PAH`s	mg/kg	4.3	4.2	7.9	3.0	6.8	4.9	7.5	0.050	7649306
Total PAH	mg/kg	8.2	8.5	13	7.9	14	9.7	13	0.050	7649306
Surrogate Recovery (%)										
D10-ANTHRACENE (sur.)	%	92	90	88	89	89	94	91		7655428
D8-ACENAPHTHYLENE (sur.)	%	86	84	85	84	86	88	85		7655428
D8-NAPHTHALENE (sur.)	%	90	91	92	95	96	93	93		7655428
TERPHENYL-D14 (sur.)	%	89	89	86	89	89	91	84		7655428
RDL = Reportable Detection Limit										

Maxxam Job #: B483823
Report Date: 2014/09/30

Tetra Tech EBA
Client Project #: ENVIND03511-01
Site Location: 1 PORT DR, NANAIMO

CSR PAH IN SOIL BY GC-MS (SEDIMENT)

Maxxam ID		KQ5524	KQ5525		
Sampling Date		2014/09/18	2014/09/18		
COC Number		G079949	G079949		
	Units	**14SED-DUP1**	**14SED-DUP2**	**RDL**	**QC Batch**
Polycyclic Aromatics					
Naphthalene	mg/kg	0.94	1.2	0.050	7655428
2-Methylnaphthalene	mg/kg	1.3	1.5	0.050	7655428
Acenaphthylene	mg/kg	<0.050	0.061	0.050	7655428
Acenaphthene	mg/kg	0.39	0.57	0.050	7655428
Fluorene	mg/kg	0.35	0.54	0.050	7655428
Phenanthrene	mg/kg	0.99	1.7	0.050	7655428
Anthracene	mg/kg	0.37	0.57	0.050	7655428
Fluoranthene	mg/kg	1.4	3.0	0.050	7655428
Pyrene	mg/kg	1.5	3.0	0.050	7655428
Benzo(a)anthracene	mg/kg	0.37	0.69	0.050	7655428
Chrysene	mg/kg	0.51	1.1	0.050	7655428
Benzo(b&j)fluoranthene	mg/kg	0.48	0.93	0.050	7655428
Benzo(b)fluoranthene	mg/kg	0.31	0.62	0.050	7655428
Benzo(k)fluoranthene	mg/kg	0.14	0.27	0.050	7655428
Benzo(a)pyrene	mg/kg	0.23	0.40	0.050	7655428
Indeno(1,2,3-cd)pyrene	mg/kg	0.082	0.12	0.050	7655428
Dibenz(a,h)anthracene	mg/kg	<0.050	<0.050	0.050	7655428
Benzo(g,h,i)perylene	mg/kg	0.093	0.12	0.050	7655428
Low Molecular Weight PAH`s	mg/kg	4.3	6.1	0.050	7649306
High Molecular Weight PAH`s	mg/kg	4.0	8.2	0.050	7649306
Total PAH	mg/kg	8.3	14	0.050	7649306
Surrogate Recovery (%)					
D10-ANTHRACENE (sur.)	%	91	88		7655428
D8-ACENAPHTHYLENE (sur.)	%	84	85		7655428
D8-NAPHTHALENE (sur.)	%	93	92		7655428
TERPHENYL-D14 (sur.)	%	88	85		7655428
RDL = Reportable Detection Limit					

GENERAL COMMENTS

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

Package 1	4.3°C
Package 2	6.7°C

Results relate only to the items tested.

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Maxxam Job #: B483823
Report Date: 2014/09/30

QUALITY ASSURANCE REPORT

Tetra Tech EBA
Client Project #: ENVIND03511-01
Site Location: 1 PORT DR, NANAIMO

			Matrix Spike		Spiked Blank		Method Blank		RPD		QC Standard	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	Units	Value (%)	QC Limits	% Recovery	QC Limits
7655428	D10-ANTHRACENE (sur.)	2014/09/26	93	60 - 130	118	60 - 130	119	%				
7655428	D8-ACENAPHTHYLENE (sur.)	2014/09/26	87	50 - 130	89	50 - 130	86	%				
7655428	D8-NAPHTHALENE (sur.)	2014/09/26	95	50 - 130	91	50 - 130	88	%				
7655428	TERPHENYL-D14 (sur.)	2014/09/26	90	60 - 130	88	60 - 130	86	%				
7656338	D10-ANTHRACENE (sur.)	2014/09/27	95	60 - 130	97	60 - 130	97	%				
7656338	D8-ACENAPHTHYLENE (sur.)	2014/09/27	97	50 - 130	97	50 - 130	100	%				
7656338	D8-NAPHTHALENE (sur.)	2014/09/27	99	50 - 130	100	50 - 130	100	%				
7656338	TERPHENYL-D14 (sur.)	2014/09/27	97	60 - 130	96	60 - 130	95	%				
7650845	Total Aluminum (Al)	2014/09/24					<100	mg/kg	3.8	35	108	70 - 130
7650845	Total Antimony (Sb)	2014/09/24	85	75 - 125	98	75 - 125	<0.10	mg/kg	NC	30	105	70 - 130
7650845	Total Arsenic (As)	2014/09/24	93	75 - 125	95	75 - 125	<0.50	mg/kg	2.3	30	102	70 - 130
7650845	Total Barium (Ba)	2014/09/24	NC	75 - 125	101	75 - 125	<0.10	mg/kg	2.7	35	106	70 - 130
7650845	Total Beryllium (Be)	2014/09/24	99	75 - 125	100	75 - 125	<0.40	mg/kg	NC	30		
7650845	Total Bismuth (Bi)	2014/09/24					<0.10	mg/kg	NC	30		
7650845	Total Cadmium (Cd)	2014/09/24	98	75 - 125	100	75 - 125	<0.050	mg/kg	0.34	30	113	70 - 130
7650845	Total Calcium (Ca)	2014/09/24					<100	mg/kg	1.4	30	99	70 - 130
7650845	Total Chromium (Cr)	2014/09/24	91	75 - 125	96	75 - 125	<1.0	mg/kg	1.7	30	111	70 - 130
7650845	Total Cobalt (Co)	2014/09/24	92	75 - 125	100	75 - 125	<0.30	mg/kg	2.6	30	96	70 - 130
7650845	Total Copper (Cu)	2014/09/24	NC	75 - 125	103	75 - 125	<0.50	mg/kg	7.6	30	96	70 - 130
7650845	Total Iron (Fe)	2014/09/24					<100	mg/kg	1.7	30	98	70 - 130
7650845	Total Lead (Pb)	2014/09/24	93	75 - 125	103	75 - 125	<0.10	mg/kg	4.5	35	102	70 - 130
7650845	Total Lithium (Li)	2014/09/24	101	75 - 125	99	75 - 125	<5.0	mg/kg	NC	30		
7650845	Total Magnesium (Mg)	2014/09/24					<100	mg/kg	5.4	30	96	70 - 130
7650845	Total Manganese (Mn)	2014/09/24	NC	75 - 125	101	75 - 125	<0.20	mg/kg	1.2	30	101	70 - 130
7650845	Total Mercury (Hg)	2014/09/24	107	75 - 125	95	75 - 125	<0.050	mg/kg	NC	35	111	70 - 130
7650845	Total Molybdenum (Mo)	2014/09/24	108	75 - 125	105	75 - 125	<0.10	mg/kg	3.0	35	118	70 - 130
7650845	Total Nickel (Ni)	2014/09/24	97	75 - 125	101	75 - 125	<0.80	mg/kg	4.8	30	103	70 - 130
7650845	Total Phosphorus (P)	2014/09/24					<10	mg/kg	6.0	30	93	70 - 130
7650845	Total Potassium (K)	2014/09/24					<100	mg/kg	2.2	35		
7650845	Total Selenium (Se)	2014/09/24	95	75 - 125	97	75 - 125	<0.50	mg/kg	NC	30		
7650845	Total Silver (Ag)	2014/09/24	93	75 - 125	103	75 - 125	<0.050	mg/kg	NC	35		
7650845	Total Sodium (Na)	2014/09/24					<100	mg/kg	0.74	35		

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QUALITY ASSURANCE REPORT(CONT'D)

Tetra Tech EBA
Client Project #: ENVIND03511-01
Site Location: 1 PORT DR, NANAIMO

			Matrix Spike		Spiked Blank		Method Blank		RPD		QC Standard	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	Units	Value (%)	QC Limits	% Recovery	QC Limits
7650845	Total Strontium (Sr)	2014/09/24	NC	75 - 125	100	75 - 125	<0.10	mg/kg	0.24	35	110	70 - 130
7650845	Total Thallium (Tl)	2014/09/24	88	75 - 125	103	75 - 125	<0.050	mg/kg	NC	30	101	70 - 130
7650845	Total Tin (Sn)	2014/09/24	94	75 - 125	98	75 - 125	<0.10	mg/kg	1.6	35		
7650845	Total Titanium (Ti)	2014/09/24	NC	75 - 125	94	75 - 125	<1.0	mg/kg	3.1	35	111	70 - 130
7650845	Total Uranium (U)	2014/09/24	96	75 - 125	99	75 - 125	<0.050	mg/kg	5.5	30	103	70 - 130
7650845	Total Vanadium (V)	2014/09/24	NC	75 - 125	98	75 - 125	<2.0	mg/kg	1.9	30	111	70 - 130
7650845	Total Zinc (Zn)	2014/09/24	NC	75 - 125	102	75 - 125	<1.0	mg/kg	2.5	30	95	70 - 130
7650845	Total Zirconium (Zr)	2014/09/24					<0.50	mg/kg	1.1	30		
7650856	Soluble (2:1) pH	2014/09/24			100	97 - 103			0.38	N/A		
7650867	Total Aluminum (Al)	2014/09/24					<100	mg/kg	1.3	35	103	70 - 130
7650867	Total Antimony (Sb)	2014/09/24	93	75 - 125	102	75 - 125	<0.10	mg/kg	NC	30	109	70 - 130
7650867	Total Arsenic (As)	2014/09/24	102	75 - 125	97	75 - 125	0.51 ,RDL=0.50	mg/kg	1.3	30	102	70 - 130
7650867	Total Barium (Ba)	2014/09/24	NC	75 - 125	102	75 - 125	<0.10	mg/kg	0.79	35	107	70 - 130
7650867	Total Beryllium (Be)	2014/09/24	101	75 - 125	108	75 - 125	<0.40	mg/kg	NC	30		
7650867	Total Bismuth (Bi)	2014/09/24					<0.10	mg/kg	NC	30		
7650867	Total Cadmium (Cd)	2014/09/24	104	75 - 125	104	75 - 125	<0.050	mg/kg	3.5	30	104	70 - 130
7650867	Total Calcium (Ca)	2014/09/24					<100	mg/kg	6.1	30	96	70 - 130
7650867	Total Chromium (Cr)	2014/09/24	105	75 - 125	99	75 - 125	<1.0	mg/kg	2.0	30	108	70 - 130
7650867	Total Cobalt (Co)	2014/09/24	102	75 - 125	100	75 - 125	<0.30	mg/kg	4.5	30	90	70 - 130
7650867	Total Copper (Cu)	2014/09/24	102	75 - 125	104	75 - 125	<0.50	mg/kg	1.2	30	95	70 - 130
7650867	Total Iron (Fe)	2014/09/24					<100	mg/kg	2.2	30	95	70 - 130
7650867	Total Lead (Pb)	2014/09/24	106	75 - 125	106	75 - 125	<0.10	mg/kg	0.14	35	101	70 - 130
7650867	Total Lithium (Li)	2014/09/24	100	75 - 125	105	75 - 125	<5.0	mg/kg	NC	30		
7650867	Total Magnesium (Mg)	2014/09/24					<100	mg/kg	2.3	30	95	70 - 130
7650867	Total Manganese (Mn)	2014/09/24	NC	75 - 125	103	75 - 125	<0.20	mg/kg	2.2	30	100	70 - 130
7650867	Total Mercury (Hg)	2014/09/24	105	75 - 125	99	75 - 125	<0.050	mg/kg	NC	35	84	70 - 130
7650867	Total Molybdenum (Mo)	2014/09/24	109	75 - 125	109	75 - 125	<0.10	mg/kg	3.2	35	116	70 - 130
7650867	Total Nickel (Ni)	2014/09/24	NC	75 - 125	101	75 - 125	<0.80	mg/kg	0.54	30	99	70 - 130
7650867	Total Phosphorus (P)	2014/09/24					<10	mg/kg	3.0	30	91	70 - 130
7650867	Total Potassium (K)	2014/09/24					<100	mg/kg	0.20	35		
7650867	Total Selenium (Se)	2014/09/24	103	75 - 125	100	75 - 125	<0.50	mg/kg	NC	30		
7650867	Total Silver (Ag)	2014/09/24	99	75 - 125	100	75 - 125	<0.050	mg/kg	NC	35		

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Maxxam Job #: B483823
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QUALITY ASSURANCE REPORT(CONT'D)

Tetra Tech EBA
Client Project #: ENVIND03511-01
Site Location: 1 PORT DR, NANAIMO

			Matrix Spike		Spiked Blank		Method Blank		RPD		QC Standard	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	Units	Value (%)	QC Limits	% Recovery	QC Limits
7650867	Total Sodium (Na)	2014/09/24					<100	mg/kg	NC	35		
7650867	Total Strontium (Sr)	2014/09/24	NC	75 - 125	103	75 - 125	<0.10	mg/kg	1.2	35	107	70 - 130
7650867	Total Thallium (Tl)	2014/09/24	91	75 - 125	102	75 - 125	<0.050	mg/kg	NC	30	99	70 - 130
7650867	Total Tin (Sn)	2014/09/24	99	75 - 125	98	75 - 125	<0.10	mg/kg	5.7	35		
7650867	Total Titanium (Ti)	2014/09/24	NC	75 - 125	97	75 - 125	<1.0	mg/kg	8.6	35	114	70 - 130
7650867	Total Uranium (U)	2014/09/24	105	75 - 125	101	75 - 125	<0.050	mg/kg	4.1	30	103	70 - 130
7650867	Total Vanadium (V)	2014/09/24	NC	75 - 125	97	75 - 125	<2.0	mg/kg	1.9	30	108	70 - 130
7650867	Total Zinc (Zn)	2014/09/24	NC	75 - 125	105	75 - 125	<1.0	mg/kg	2.0	30	96	70 - 130
7650867	Total Zirconium (Zr)	2014/09/24					<0.50	mg/kg	3.2	30		
7650915	Soluble (2:1) pH	2014/09/24			100	97 - 103			0.37	N/A		
7651107	Total Aluminum (Al)	2014/09/24					<100	mg/kg	6.7	35	126	70 - 130
7651107	Total Antimony (Sb)	2014/09/24	95	75 - 125	106	75 - 125	<0.10	mg/kg	NC	30	103	70 - 130
7651107	Total Arsenic (As)	2014/09/24	104	75 - 125	99	75 - 125	<0.50	mg/kg	2.0	30	101	70 - 130
7651107	Total Barium (Ba)	2014/09/24	NC	75 - 125	105	75 - 125	<0.10	mg/kg	0.25	35	105	70 - 130
7651107	Total Beryllium (Be)	2014/09/24	98	75 - 125	99	75 - 125	<0.40	mg/kg	NC	30		
7651107	Total Bismuth (Bi)	2014/09/24					<0.10	mg/kg	NC	30		
7651107	Total Cadmium (Cd)	2014/09/24	104	75 - 125	103	75 - 125	<0.050	mg/kg	10	30	105	70 - 130
7651107	Total Calcium (Ca)	2014/09/24					<100	mg/kg	1.5	30	105	70 - 130
7651107	Total Chromium (Cr)	2014/09/24	103	75 - 125	106	75 - 125	<1.0	mg/kg	4.9	30	120	70 - 130
7651107	Total Cobalt (Co)	2014/09/24	102	75 - 125	108	75 - 125	<0.30	mg/kg	3.3	30	99	70 - 130
7651107	Total Copper (Cu)	2014/09/24	NC	75 - 125	107	75 - 125	<0.50	mg/kg	6.9	30	98	70 - 130
7651107	Total Iron (Fe)	2014/09/24					<100	mg/kg	2.2	30	105	70 - 130
7651107	Total Lead (Pb)	2014/09/24	104	75 - 125	109	75 - 125	<0.10	mg/kg	2.9	35	106	70 - 130
7651107	Total Lithium (Li)	2014/09/24	98	75 - 125	100	75 - 125	<5.0	mg/kg	NC	30		
7651107	Total Magnesium (Mg)	2014/09/24					<100	mg/kg	0.90	30	104	70 - 130
7651107	Total Manganese (Mn)	2014/09/24	NC	75 - 125	107	75 - 125	<0.20	mg/kg	2.4	30	104	70 - 130
7651107	Total Mercury (Hg)	2014/09/24	102	75 - 125	110	75 - 125	<0.050	mg/kg	NC	35	86	70 - 130
7651107	Total Molybdenum (Mo)	2014/09/24	116	75 - 125	103	75 - 125	<0.10	mg/kg	2.4	35	116	70 - 130
7651107	Total Nickel (Ni)	2014/09/24	NC	75 - 125	106	75 - 125	<0.80	mg/kg	7.1	30	99	70 - 130
7651107	Total Phosphorus (P)	2014/09/24					<10	mg/kg	2.9	30	97	70 - 130
7651107	Total Potassium (K)	2014/09/24					<100	mg/kg	5.0	35		
7651107	Total Selenium (Se)	2014/09/24	103	75 - 125	104	75 - 125	<0.50	mg/kg	NC	30		

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QUALITY ASSURANCE REPORT(CONT'D)

			Matrix Spike		Spiked Blank		Method Blank		RPD		QC Standard	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	Units	Value (%)	QC Limits	% Recovery	QC Limits
7651107	Total Silver (Ag)	2014/09/24	105	75 - 125	99	75 - 125	<0.050	mg/kg	NC	35		
7651107	Total Sodium (Na)	2014/09/24					<100	mg/kg	NC	35		
7651107	Total Strontium (Sr)	2014/09/24	NC	75 - 125	101	75 - 125	<0.10	mg/kg	0.26	35	108	70 - 130
7651107	Total Thallium (Tl)	2014/09/24	85	75 - 125	108	75 - 125	<0.050	mg/kg	NC	30	106	70 - 130
7651107	Total Tin (Sn)	2014/09/24	100	75 - 125	101	75 - 125	<0.10	mg/kg	2.4	35		
7651107	Total Titanium (Ti)	2014/09/24	NC	75 - 125	101	75 - 125	<1.0	mg/kg	1.8	35	124	70 - 130
7651107	Total Uranium (U)	2014/09/24	104	75 - 125	105	75 - 125	<0.050	mg/kg	8.2	30	108	70 - 130
7651107	Total Vanadium (V)	2014/09/24	NC	75 - 125	105	75 - 125	<2.0	mg/kg	7.7	30	118	70 - 130
7651107	Total Zinc (Zn)	2014/09/24	NC	75 - 125	105	75 - 125	<1.0	mg/kg	3.7	30	94	70 - 130
7651107	Total Zirconium (Zr)	2014/09/24					<0.50	mg/kg	0.82	30		
7651113	Soluble (2:1) pH	2014/09/24			99	97 - 103			0.73	N/A		
7653594	Moisture	2014/09/26					<0.30	%	7.6	20		
7655428	2-Methylnaphthalene	2014/09/26			96	50 - 130	<0.050	mg/kg				
7655428	Acenaphthene	2014/09/26			98	50 - 130	<0.050	mg/kg				
7655428	Acenaphthylene	2014/09/26			91	50 - 130	<0.050	mg/kg				
7655428	Anthracene	2014/09/26			98	60 - 130	<0.050	mg/kg				
7655428	Benzo(a)anthracene	2014/09/26			96	60 - 130	<0.050	mg/kg				
7655428	Benzo(a)pyrene	2014/09/26			96	60 - 130	<0.050	mg/kg				
7655428	Benzo(b&j)fluoranthene	2014/09/26			96	60 - 130	<0.050	mg/kg				
7655428	Benzo(b)fluoranthene	2014/09/26					<0.050	mg/kg				
7655428	Benzo(g,h,i)perylene	2014/09/26			90	60 - 130	<0.050	mg/kg				
7655428	Benzo(k)fluoranthene	2014/09/26			101	60 - 130	<0.050	mg/kg				
7655428	Chrysene	2014/09/26			97	60 - 130	<0.050	mg/kg				
7655428	Dibenz(a,h)anthracene	2014/09/26			81	60 - 130	<0.050	mg/kg				
7655428	Fluoranthene	2014/09/26			96	60 - 130	<0.050	mg/kg				
7655428	Fluorene	2014/09/26			94	50 - 130	<0.050	mg/kg				
7655428	Indeno(1,2,3-cd)pyrene	2014/09/26			89	60 - 130	<0.050	mg/kg				
7655428	Naphthalene	2014/09/26			94	50 - 130	<0.050	mg/kg				
7655428	Phenanthrene	2014/09/26			95	60 - 130	<0.050	mg/kg				
7655428	Pyrene	2014/09/26			96	60 - 130	<0.050	mg/kg				
7656338	2-Methylnaphthalene	2014/09/28	96	50 - 130	95	50 - 130	<0.050	mg/kg	NC	50		
7656338	Acenaphthene	2014/09/28	93	50 - 130	93	50 - 130	<0.050	mg/kg	NC	50		

QUALITY ASSURANCE REPORT(CONT'D)

			Matrix Spike		Spiked Blank		Method Blank		RPD		QC Standard	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	Units	Value (%)	QC Limits	% Recovery	QC Limits
7656338	Acenaphthylene	2014/09/28	92	50 - 130	94	50 - 130	<0.050	mg/kg	NC	50		
7656338	Anthracene	2014/09/28	94	60 - 130	91	60 - 130	<0.050	mg/kg	NC	50		
7656338	Benzo(a)anthracene	2014/09/28	91	60 - 130	93	60 - 130	<0.050	mg/kg	NC	50		
7656338	Benzo(a)pyrene	2014/09/28	95	60 - 130	95	60 - 130	<0.050	mg/kg	NC	50		
7656338	Benzo(b&j)fluoranthene	2014/09/28	96	60 - 130	94	60 - 130	<0.050	mg/kg	NC	50		
7656338	Benzo(b)fluoranthene	2014/09/28					<0.050	mg/kg	NC	50		
7656338	Benzo(g,h,i)perylene	2014/09/28	88	60 - 130	88	60 - 130	<0.050	mg/kg	NC	50		
7656338	Benzo(k)fluoranthene	2014/09/28	97	60 - 130	102	60 - 130	<0.050	mg/kg	NC	50		
7656338	Chrysene	2014/09/28	94	60 - 130	95	60 - 130	<0.050	mg/kg	NC	50		
7656338	Dibenz(a,h)anthracene	2014/09/28	87	60 - 130	86	60 - 130	<0.050	mg/kg	NC	50		
7656338	Fluoranthene	2014/09/28	92	60 - 130	90	60 - 130	<0.050	mg/kg	NC	50		
7656338	Fluorene	2014/09/28	93	50 - 130	93	50 - 130	<0.050	mg/kg	NC	50		
7656338	Indeno(1,2,3-cd)pyrene	2014/09/28	91	60 - 130	91	60 - 130	<0.050	mg/kg	NC	50		
7656338	Naphthalene	2014/09/28	96	50 - 130	97	50 - 130	<0.050	mg/kg	NC	50		
7656338	Phenanthrene	2014/09/28	86	60 - 130	88	60 - 130	<0.050	mg/kg	NC	50		
7656338	Pyrene	2014/09/28	94	60 - 130	94	60 - 130	<0.050	mg/kg	NC	50		

N/A = Not Applicable

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

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

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

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

Surrogate: A pure or isotopically labeled compound whose behavior mirrors the analytes of interest. Used to evaluate extraction efficiency.

NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spiked amount was too small to permit a reliable recovery calculation (matrix spike concentration was less than 2x that of the native sample concentration).

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (one or both samples < 5x RDL).

Maxxam Job #: B483823
Report Date: 2014/09/30

Tetra Tech EBA
Client Project #: ENVIND03511-01
Site Location: 1 PORT DR, NANAIMO

VALIDATION SIGNATURE PAGE

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

Andy Lu, Data Validation Coordinator

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

Maxxam Analytics International Corporation o/a Maxxam Analytics Burnaby: 4606 Canada Way V5G 1K5 Telephone(604) 734-7276 Fax(604) 731-2386

Maxxam

4606 Canada Way, Burnaby, BC Canada V5G 1K5 Ph: 604 734 7276 Toll Free: 1 800 665 8566 Fax: 604 731 2386

Maxxam Job#: B483823

CHAIN OF CUSTODY RECORD

Page: ___ of ___

G 079948

Invoice To: Require Report? Yes [ ] No [ ]

Company Name: Tetra Tech EBA
Contact Name: Lora Paul
Address: #1-4376 Boban Dr Nanaimo PC: V9T 6A7
Phone / Fax#: 250 756 2256
E-mail: lora.paul@tetratech.com

Report To:

Company Name: Same as invoice
Contact Name:
Address:
PC:
Phone / Fax#: Ph: Fax:
E-mail

PO #:
Quotation #:
Project #: ENVIND03511-01
Proj. Name:
Location: 1 Port Dr. Nanaimo
Sampled By: S. Walker + K Gabelhouse

REGULATORY REQUIREMENTS SERVICE REQUESTED:

- [X] CSR
- [ ] CCME
- [ ] BC Water Quality
- [ ] Other
- [ ] DRINKING WATER

- [ ] Regular Turn Around Time (TAT) (5 days for most tests)
- [ ] RUSH (Please contact the lab) [ ] 1 Day [ ] 2 Day [ ] 3 Day
- Date Required:

Special Instructions:

Return Cooler [ ] **Ship Sample Bottles (please specify)** [ ]

ANALYSIS REQUESTED

BTEX/VPH, MTBE, VOC/VPH, EPH, TEH, PAH, LEPH/HEPH, CCME-PHC (Fractions 1-4 Plus BTEX), CCME-PHC (Fractions 2-4), CCME BTEX (Fraction 1 Plus BTEX), PCB, Phenols by 4AAP, Phenols by GCMS, TOG, MOG, SWOG, Dissolved Metals, Field Filtered? Y N, Field Acidified? Y N, Totals Metals Field Acidified? Y N, Nitrate, Nitrite, Ammonia, Chloride, Fluoride, Sulphate, Total Suspended Solids-TSS, TDS, pH, Conductivity, Alkalinity, BOD, COD, Coliform, Total & E.coli, Fecal, Asbestos, Metals, HOLD [X], 6/11

#	Sample Identification	Lab Identification	Sample Type	Date/Time Sampled	PAH	Metals
1	SD14-01	KQ5506	Sediment	14/18/09	X	X
2	SD14-02	KQ5507	"	"	X	X
3	SD14-03	KQ5508	"	"	X	
4	SD14-04	KQ5509	"	"	X	X
5	SD14-05	KQ5510	"	"	X	
6	SD14-06	KQ5511	"	"	X	X
7	SD14-07	KQ5512	"	"	X	
8	SD14-08	KQ5513	"	"	X	X
9	SD14-09	KQ5514	"	"	X	
10	SD14-10	KQ5515	"	"	X	
11	SD14-11	KQ5516	"	"	X	X
12	SD14-12	KQ5517	"	"	X	

B483823

Samples are from a Drinking Water Source? YES NO
Does source supply multiple households? YES NO

*Relinquished by:	Date (YY/MM/DD):	Time:	Received by:	Date (YY/MM/DD):	Time:	Time Sensitive	Temperature on Receipt (°C)	Custody Seal Intact on Cooler?
S Walker	14/09/18	13:23	M. Laurel Berthier	2014/09/19	08:10	[ ]	5, 4, 4 / 6, 9, 5	NA Yes No

Laboratory Use Only

*IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORD. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.

White: Maxxam Yellow: Client

COC-1020 (05/10)

Maxxam International Corporation o/a Maxxam Analytics

Maxxam

4606 Canada Way, Burnaby, BC Canada V5G 1K5 Ph: 604 734 7276 Toll Free: 1 800 665 8566 Fax: 604 731 2386

Maxxam Job#: B483823

CHAIN OF CUSTODY RECORD

Page: ___ of ___

G 079949

Invoice To: Require Report? Yes [ ] No [ ]

Company Name: Tetra Tech EBA
Contact Name: Lora Paul
Address: #1-4376 Boban Dr
Nanaimo PC: V9T 6A7
Phone / Fax#: 250 756 2256
E-mail: lora.paul@tetratech.com

Report To:

Company Name: Same as invoice
Contact Name:
Address:
PC:
Ph: Fax:
Email

PO #:
Quotation #:
Project #: ENVIND03511-01
Proj. Name:
Location: 1 Port Dr. Nanaimo
Sampled By: S. Walker & E. Gabelhouse

REGULATORY REQUIREMENTS SERVICE REQUESTED:

- [ ] CSR
- [ ] CCME
- [ ] BC Water Quality
- [ ] Other
- DRINKING WATER

- [ ] Regular Turn Around Time (TAT) (5 days for most tests)
- [ ] RUSH (Please contact the lab)
- [ ] 1 Day [ ] 2 Day [ ] 3 Day
- Date Required:

Special Instructions:

Return Cooler [ ] **Ship Sample Bottles (please specify)** [ ]

ANALYSIS REQUESTED

BTEX/VPH, MTBE, VOC/VPH, EPH, TEH, PAH, LEPH/HEPH, CCME-PHC (Fractions 1-4 Plus BTEX), CCME-PHC (Fractions 2-4), CCME BTEX (Fraction 1 Plus BTEX), PCB, Phenols by 4AAP, Phenols by GCMS, TOG, MOG, SWOG, Dissolved Metals (Field Filtered? Y N), Metals (Field Acidified? Y N), Totals Metals Field Acidified? Y N, Nitrate, Nitrite, Ammonia, Chloride, Fluoride, Sulphate, Total Suspended Solids-TSS, TDS, pH, Conductivity, Alkalinity, BOD, COD, Coliform, Total & E.coli, Fecal, Asbestos, ~~Metals~~, Metals, HOLD ☒ 110

#	Sample Identification	Lab Identification	Sample Type	Date/Time Sampled	PAH	~~Metals~~	Metals
1	SD14-13	KQ5518	Sed.	Sep18/14	X	X	
2	SD14-14	KQ5519	"	"	X		X
3	SD14-15	KQ5520	"	"	X	X	
4	SD14-16	KQ5521	"	"	X		X
5	SD14-17	KQ5522	"	"	X	X	X
6	SD14-18	KQ5523	"	"	X	X	X
7	SD14-Dup1	KQ5524	"	"	X	X	X
8	SD14-Dup2	KQ5525	"	"	X		X
9							
10							
11							
12							

B483823

Samples are from a Drinking Water Source? YES [ ] NO [ ]
Does source supply multiple households? YES [ ] NO [ ]

*Relinquished by:	Date (YY/MM/DD):	Time:	Received by:	*Date (YY/MM/DD):	Time:
[signature]	14/09/18	3:23	Mélanie Berthier	2014/09/19	08:10

Laboratory Use Only

Time Sensitive [ ]

Temperature on Receipt (°C): 5,4,4 / 6,9,5

Custody Seal Intact on Cooler? Yes [ ] No [ ] — NA

*IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORD. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.

White: Maxxam Yellow: Client

COC-1020 (05/10)

Maxxam International Corporation o/a Maxxam Analytics

Your Project #: ENVIN003511-01.004
Site#: SEDIMENT DRILLING
Site Location: PORT DRIVE
Your C.O.C. #: G089219, G089220, G089221

Attention:Lora J Paul

Tetra Tech EBA
#1 - 4376 Boban Drive
Nanaimo, BC
CANADA V9T 6A7

Report Date: 2014/11/18
Report #: R1686056
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B4A2450
Received: 2014/11/08, 10:20

Sample Matrix: Sediment
Samples Received: 11

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Moisture	11	N/A	2014/11/13	BBY8SOP-00017	OMOE E3139 3.1 m
Benzo[a]pyrene Equivalency	11	N/A	2014/11/18	BBY WI-00033	Auto Calc
PAH in Soil by GC/MS Lowlevel (Extended)	11	2014/11/12	2014/11/18	BBY8SOP-00022	EPA 8270d R4 m
Total LMW, HMW, Total PAH Calc	11	N/A	2014/11/18	BBY WI-00033	Auto Calc

* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Crystal Ireland, B.Sc., Account Specialist
Email: CIreland@maxxam.ca
Phone# (604)638-5016
==
This report has been generated and distributed using a secure automated process.
Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Maxxam Job #: B4A2450
Report Date: 2014/11/18

Tetra Tech EBA
Client Project #: ENVIN003511-01.004
Site Location: PORT DRIVE
Sampler Initials: SW

PHYSICAL TESTING (SEDIMENT)

Maxxam ID		LC5349	LC5349	LC5352	LC5356	LC5367		
Sampling Date		2014/11/06	2014/11/06	2014/11/06	2014/11/06	2014/11/06		
COC Number		G089219	G089219	G089219	G089219	G089220		
	Units	**14SED019@1.1**	**14SED019@1.1 Lab-Dup**	**14SED020@1.0**	**14SED021@1.5**	**14SED022@1.5**	**RDL**	**QC Batch**
Physical Properties								
Moisture	%	31	29	7.1	10	20	0.30	7714474

RDL = Reportable Detection Limit
Lab-Dup = Laboratory Initiated Duplicate

Maxxam ID		LC5371	LC5372	LC5373	LC5374	LC5375	LC5376		
Sampling Date		2014/11/06	2014/11/06	2014/11/06	2014/11/06	2014/11/06	2014/11/06		
COC Number		G089220	G089220	G089220	G089220	G089220	G089220		
	Units	**14SED023@1.8**	**14SED023-A**	**14SED023-B**	**14SED023-C**	**14SED023-D**	**DUP1**	**RDL**	**QC Batch**
Physical Properties									
Moisture	%	15	29	30	25	29	16	0.30	7714474

RDL = Reportable Detection Limit

Maxxam ID		LC5379		
Sampling Date		2014/11/06		
COC Number		G089221		
	Units	**14SED024@1.3**	**RDL**	**QC Batch**
Physical Properties				
Moisture	%	19	0.30	7714474

RDL = Reportable Detection Limit

Maxxam Job #: B4A2450
Report Date: 2014/11/18

Tetra Tech EBA
Client Project #: ENVIN003511-01.004
Site Location: PORT DRIVE
Sampler Initials: SW

CCME PAH IN SEDIMENTS BY GC-MS (SEDIMENT)

Maxxam ID		LC5349		LC5352	LC5356		LC5367		
Sampling Date		2014/11/06		2014/11/06	2014/11/06		2014/11/06		
COC Number		G089219		G089219	G089219		G089220		
	Units	**14SED019@1.1**	**RDL**	**14SED020@1.0**	**14SED021@1.5**	**RDL**	**14SED022@1.5**	**RDL**	**QC Batch**
Calculated Parameters									
Index of Additive Cancer Risk(IARC)	N/A	0.11	0.10	<0.10	<0.10	0.10	0.11	0.10	7714409
Benzo[a]pyrene equivalency	N/A	<0.10	0.10	<0.10	<0.10	0.10	<0.10	0.10	7714409
Polycyclic Aromatics									
Naphthalene	mg/kg	<0.010 (1)	0.010	0.0013	0.014	0.0010	0.023 (1)	0.010	7722301
2-Methylnaphthalene	mg/kg	0.010 (1)	0.010	0.0017	0.029	0.0010	0.045 (1)	0.010	7722301
Acenaphthylene	mg/kg	<0.0050 (1)	0.0050	<0.00050	<0.00050	0.00050	<0.0050 (1)	0.0050	7722301
Acenaphthene	mg/kg	<0.0050 (1)	0.0050	<0.00050	0.0075	0.00050	0.0057 (1)	0.0050	7722301
Fluorene	mg/kg	<0.010 (1)	0.010	<0.0010	0.0041	0.0010	<0.010 (1)	0.010	7722301
Phenanthrene	mg/kg	0.011 (1)	0.010	0.0016	0.020	0.0010	0.023 (1)	0.010	7722301
Anthracene	mg/kg	<0.010 (1)	0.010	<0.0010	0.0037	0.0010	<0.010 (1)	0.010	7722301
Fluoranthene	mg/kg	<0.010 (1)	0.010	0.0016	0.0061	0.0010	0.018 (1)	0.010	7722301
Pyrene	mg/kg	<0.010 (1)	0.010	0.0014	0.0066	0.0010	0.014 (1)	0.010	7722301
Benzo(a)anthracene	mg/kg	<0.010 (1)	0.010	<0.0010	0.0041	0.0010	<0.010 (1)	0.010	7722301
Chrysene	mg/kg	<0.010 (1)	0.010	<0.0010	0.0058	0.0010	<0.010 (1)	0.010	7722301
Benzo(b)fluoranthene	mg/kg	<0.010 (1)	0.010	<0.0010	0.0026	0.0010	<0.010 (1)	0.010	7722301
Benzo(b&j)fluoranthene	mg/kg	<0.010 (1)	0.010	<0.0010	0.0037	0.0010	<0.010 (1)	0.010	7722301
Benzo(k)fluoranthene	mg/kg	<0.010 (1)	0.010	<0.0010	<0.0010	0.0010	<0.010 (1)	0.010	7722301
Benzo(a)pyrene	mg/kg	<0.010 (1)	0.010	<0.0010	0.0026	0.0010	<0.010 (1)	0.010	7722301
Indeno(1,2,3-cd)pyrene	mg/kg	<0.020 (1)	0.020	<0.0020	<0.0020	0.0020	<0.020 (1)	0.020	7722301
Dibenz(a,h)anthracene	mg/kg	<0.0050 (1)	0.0050	<0.00050	<0.00050	0.00050	<0.0050 (1)	0.0050	7722301
Benzo(g,h,i)perylene	mg/kg	<0.020 (1)	0.020	<0.0020	0.0029	0.0020	<0.020 (1)	0.020	7722301
Low Molecular Weight PAH`s	mg/kg	0.021	0.010	0.0046	0.078	0.0010	0.097	0.010	7713593
High Molecular Weight PAH`s	mg/kg	<0.010	0.010	0.0030	0.025	0.0010	0.032	0.010	7713593
Total PAH	mg/kg	0.021	0.010	0.0076	0.10	0.0010	0.13	0.010	7713593
Surrogate Recovery (%)									
D10-ANTHRACENE (sur.)	%	94		79	75		88		7722301
D8-ACENAPHTHYLENE (sur.)	%	68		72	68		64		7722301
D8-NAPHTHALENE (sur.)	%	77		70	68		72		7722301
TERPHENYL-D14 (sur.)	%	87		85	82		84		7722301

RDL = Reportable Detection Limit
(1) Detection limits raised due to dilution as a result of sample matrix inteference.

Maxxam Analytics International Corporation o/a Maxxam Analytics Burnaby: 4606 Canada Way V5G 1K5 Telephone(604) 734-7276 Fax(604) 731-2386

Maxxam Job #: B4A2450
Report Date: 2014/11/18

Tetra Tech EBA
Client Project #: ENVIN003511-01.004
Site Location: PORT DRIVE
Sampler Initials: SW

CCME PAH IN SEDIMENTS BY GC-MS (SEDIMENT)

Maxxam ID		LC5371	LC5372	LC5373	LC5373	LC5374	LC5375		
Sampling Date		2014/11/06	2014/11/06	2014/11/06	2014/11/06	2014/11/06	2014/11/06		
COC Number		G089220	G089220	G089220	G089220	G089220	G089220		
	Units	14SED023@1.8	14SED023-A	14SED023-B	14SED023-B Lab-Dup	14SED023-C	14SED023-D	RDL	QC Batch
Calculated Parameters									
Index of Additive Cancer Risk(IARC)	N/A	0.11	4.0	4.3		13	4.3	0.10	7714409
Benzo[a]pyrene equivalency	N/A	<0.10	0.26	0.27		1.0	0.29	0.10	7714409
Polycyclic Aromatics									
Naphthalene	mg/kg	0.034 (1)	3.3 (1)	2.2 (1)	2.3 (1)	1.7 (1)	3.6 (1)	0.010	7722301
2-Methylnaphthalene	mg/kg	0.058 (1)	5.3 (1)	3.4 (1)	3.5 (1)	2.7 (1)	5.9 (1)	0.010	7722301
Acenaphthylene	mg/kg	<0.0050 (1)	0.035 (1)	0.034 (1)	0.037 (1)	0.15 (1)	0.042 (1)	0.0050	7722301
Acenaphthene	mg/kg	0.011 (1)	0.83 (1)	0.66 (1)	0.66 (1)	0.49 (1)	0.86 (1)	0.0050	7722301
Fluorene	mg/kg	<0.010 (1)	0.61 (1)	0.63 (1)	0.67 (1)	0.68 (1)	0.65 (1)	0.010	7722301
Phenanthrene	mg/kg	0.022 (1)	1.7 (1)	1.4 (1)	1.7 (1)	3.0 (1)	1.8 (1)	0.010	7722301
Anthracene	mg/kg	<0.010 (1)	0.55 (1)	0.55 (1)	0.57 (1)	1.3 (1)	0.64 (1)	0.010	7722301
Fluoranthene	mg/kg	0.021 (1)	1.1 (1)	1.5 (1)	1.7 (1)	2.6 (1)	1.1 (1)	0.010	7722301
Pyrene	mg/kg	0.026 (1)	1.0 (1)	1.2 (1)	1.4 (1)	2.6 (1)	1.1 (1)	0.010	7722301
Benzo(a)anthracene	mg/kg	<0.010 (1)	0.38 (1)	0.43 (1)	0.50 (1)	0.94 (1)	0.41 (1)	0.010	7722301
Chrysene	mg/kg	<0.010 (1)	0.38 (1)	0.47 (1)	0.55 (1)	0.91 (1)	0.41 (1)	0.010	7722301
Benzo(b)fluoranthene	mg/kg	<0.010 (1)	0.17 (1)	0.18 (1)	0.21 (1)	0.50 (1)	0.18 (1)	0.010	7722301
Benzo(b&j)fluoranthene	mg/kg	<0.010 (1)	0.27 (1)	0.28 (1)	0.33 (1)	0.83 (1)	0.28 (1)	0.010	7722301
Benzo(k)fluoranthene	mg/kg	<0.010 (1)	0.069 (1)	0.079 (1)	0.098 (1)	0.31 (1)	0.073 (1)	0.010	7722301
Benzo(a)pyrene	mg/kg	<0.010 (1)	0.15 (1)	0.16 (1)	0.21 (1)	0.67 (1)	0.17 (1)	0.010	7722301
Indeno(1,2,3-cd)pyrene	mg/kg	<0.020 (1)	0.038 (1)	0.044 (1)	0.061 (1)	0.26 (1)	0.047 (1)	0.020	7722301
Dibenz(a,h)anthracene	mg/kg	<0.0050 (1)	0.027 (1)	0.025 (1)	0.033 (1)	0.10 (1)	0.030 (1)	0.0050	7722301
Benzo(g,h,i)perylene	mg/kg	<0.020 (1)	0.070 (1)	0.067 (1)	0.089 (1)	0.28 (1)	0.081 (1)	0.020	7722301
Low Molecular Weight PAH`s	mg/kg	0.12	12	8.9		10	13	0.010	7713593
High Molecular Weight PAH`s	mg/kg	0.047	3.1	3.8		7.9	3.2	0.010	7713593
Total PAH	mg/kg	0.17	15	13		18	17	0.010	7713593
Surrogate Recovery (%)									
D10-ANTHRACENE (sur.)	%	87	70	79	78	78	67		7722301
D8-ACENAPHTHYLENE (sur.)	%	66	61	57	61	61	64		7722301
D8-NAPHTHALENE (sur.)	%	68	98	91	92	83	107		7722301
TERPHENYL-D14 (sur.)	%	79	80	82	83	84	83		7722301

RDL = Reportable Detection Limit
Lab-Dup = Laboratory Initiated Duplicate
(1) Detection limits raised due to dilution as a result of sample matrix inteference.

Maxxam Analytics International Corporation o/a Maxxam Analytics Burnaby: 4606 Canada Way V5G 1K5 Telephone(604) 734-7276 Fax(604) 731-2386

Maxxam Job #: B4A2450
Report Date: 2014/11/18

Tetra Tech EBA
Client Project #: ENVIN003511-01.004
Site Location: PORT DRIVE
Sampler Initials: SW

CCME PAH IN SEDIMENTS BY GC-MS (SEDIMENT)

Maxxam ID		LC5376		LC5379		
Sampling Date		2014/11/06		2014/11/06		
COC Number		G089220		G089221		
	Units	**DUP1**	**RDL**	**14SED024@1.3**	**RDL**	**QC Batch**
Calculated Parameters						
Index of Additive Cancer Risk(IARC)	N/A	0.11	0.10	0.11	0.10	7714409
Benzo[a]pyrene equivalency	N/A	<0.10	0.10	<0.10	0.10	7714409
Polycyclic Aromatics						
Naphthalene	mg/kg	0.036 (1)	0.010	0.062 (1)	0.010	7722301
2-Methylnaphthalene	mg/kg	0.057 (1)	0.010	0.092 (1)	0.010	7722301
Acenaphthylene	mg/kg	<0.0050 (1)	0.0050	<0.0050 (1)	0.0050	7722301
Acenaphthene	mg/kg	0.0080 (1)	0.0050	<0.0081 (2)	0.0081	7722301
Fluorene	mg/kg	<0.010 (1)	0.010	<0.010 (1)	0.010	7722301
Phenanthrene	mg/kg	0.024 (1)	0.010	0.023 (1)	0.010	7722301
Anthracene	mg/kg	<0.010 (1)	0.010	<0.010 (1)	0.010	7722301
Fluoranthene	mg/kg	0.020 (1)	0.010	<0.010 (1)	0.010	7722301
Pyrene	mg/kg	0.021 (1)	0.010	<0.010 (1)	0.010	7722301
Benzo(a)anthracene	mg/kg	<0.010 (1)	0.010	<0.010 (1)	0.010	7722301
Chrysene	mg/kg	<0.010 (1)	0.010	<0.010 (1)	0.010	7722301
Benzo(b)fluoranthene	mg/kg	<0.010 (1)	0.010	<0.010 (1)	0.010	7722301
Benzo(b&j)fluoranthene	mg/kg	<0.010 (1)	0.010	<0.010 (1)	0.010	7722301
Benzo(k)fluoranthene	mg/kg	<0.010 (1)	0.010	<0.010 (1)	0.010	7722301
Benzo(a)pyrene	mg/kg	<0.010 (1)	0.010	<0.010 (1)	0.010	7722301
Indeno(1,2,3-cd)pyrene	mg/kg	<0.020 (1)	0.020	<0.020 (1)	0.020	7722301
Dibenz(a,h)anthracene	mg/kg	<0.0050 (1)	0.0050	<0.0050 (1)	0.0050	7722301
Benzo(g,h,i)perylene	mg/kg	<0.020 (1)	0.020	<0.020 (1)	0.020	7722301
Low Molecular Weight PAH`s	mg/kg	0.12	0.010	0.18	0.010	7713593
High Molecular Weight PAH`s	mg/kg	0.041	0.010	<0.010	0.010	7713593
Total PAH	mg/kg	0.17	0.010	0.18	0.010	7713593
Surrogate Recovery (%)						
D10-ANTHRACENE (sur.)	%	99		91		7722301
D8-ACENAPHTHYLENE (sur.)	%	72		66		7722301
D8-NAPHTHALENE (sur.)	%	72		71		7722301
TERPHENYL-D14 (sur.)	%	87		84		7722301

RDL = Reportable Detection Limit
(1) Detection limits raised due to dilution as a result of sample matrix inteference.
(2) RDL raised due to sample matrix interference.

Maxxam Analytics International Corporation o/a Maxxam Analytics Burnaby: 4606 Canada Way V5G 1K5 Telephone(604) 734-7276 Fax(604) 731-2386

Maxxam Job #: B4A2450
Report Date: 2014/11/18

Tetra Tech EBA
Client Project #: ENVIN003511-01.004
Site Location: PORT DRIVE
Sampler Initials: SW

GENERAL COMMENTS

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

Package 1	4.7°C

Results relate only to the items tested.

Maxxam
A Bureau Veritas Group Company

Success Through Science®

Maxxam Job #: B4A2450
Report Date: 2014/11/18

QUALITY ASSURANCE REPORT

Tetra Tech EBA
Client Project #: ENVIN003511-01.004
Site Location: PORT DRIVE
Sampler Initials: SW

			Matrix Spike		Spiked Blank		Method Blank		RPD	
QC Batch	**Parameter**	**Date**	**% Recovery**	**QC Limits**	**% Recovery**	**QC Limits**	**Value**	**Units**	**Value (%)**	**QC Limits**
7722301	D10-ANTHRACENE (sur.)	2014/11/18	117	60 - 130	79	60 - 130	83	%		
7722301	D8-ACENAPHTHYLENE (sur.)	2014/11/18	88	50 - 130	75	50 - 130	79	%		
7722301	D8-NAPHTHALENE (sur.)	2014/11/18	137 (1)	50 - 130	74	50 - 130	78	%		
7722301	TERPHENYL-D14 (sur.)	2014/11/18	127	60 - 130	83	60 - 130	86	%		
7714474	Moisture	2014/11/13					<0.30	%	4.3	20
7722301	2-Methylnaphthalene	2014/11/18	NC	40 - 130	77	40 - 130	<0.0010	mg/kg	1.6 (2)	50
7722301	Acenaphthene	2014/11/18	NC	40 - 130	79	40 - 130	<0.00050	mg/kg	0.43 (2)	50
7722301	Acenaphthylene	2014/11/18	82	40 - 130	74	40 - 130	<0.00050	mg/kg	9.3 (2)	50
7722301	Anthracene	2014/11/18	NC	40 - 130	81	40 - 130	<0.0010	mg/kg	3.8 (2)	50
7722301	Benzo(a)anthracene	2014/11/18	NC	40 - 130	76	40 - 130	<0.0010	mg/kg	15 (2)	50
7722301	Benzo(a)pyrene	2014/11/18	93	40 - 130	77	40 - 130	<0.0010	mg/kg	28 (2)	50
7722301	Benzo(b&j)fluoranthene	2014/11/18	NC	40 - 130	82	40 - 130	<0.0010	mg/kg	18 (2)	50
7722301	Benzo(b)fluoranthene	2014/11/18	109	N/A			<0.0010	mg/kg	15 (2)	50
7722301	Benzo(g,h,i)perylene	2014/11/18	70	40 - 130	80	40 - 130	<0.0020	mg/kg	NC (2)	50
7722301	Benzo(k)fluoranthene	2014/11/18	87	40 - 130	76	40 - 130	<0.0010	mg/kg	22 (2)	50
7722301	Chrysene	2014/11/18	NC	40 - 130	79	40 - 130	<0.0010	mg/kg	16 (2)	50
7722301	Dibenz(a,h)anthracene	2014/11/18	87	40 - 130	69	40 - 130	<0.00050	mg/kg	NC (2)	50
7722301	Fluoranthene	2014/11/18	NC	40 - 130	81	40 - 130	<0.0010	mg/kg	12 (2)	50
7722301	Fluorene	2014/11/18	NC	40 - 130	75	40 - 130	<0.0010	mg/kg	5.3 (2)	50
7722301	Indeno(1,2,3-cd)pyrene	2014/11/18	75	40 - 130	76	40 - 130	<0.0020	mg/kg	NC (2)	50
7722301	Naphthalene	2014/11/18	NC	40 - 130	73	40 - 130	<0.0010	mg/kg	1.3 (2)	50
7722301	Phenanthrene	2014/11/18	NC	40 - 130	77	40 - 130	<0.0010	mg/kg	21 (2)	50

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Maxxam Job #: B4A2450
Report Date: 2014/11/18

QUALITY ASSURANCE REPORT(CONT'D)

Tetra Tech EBA
Client Project #: ENVIN003511-01.004
Site Location: PORT DRIVE
Sampler Initials: SW

			Matrix Spike		Spiked Blank		Method Blank		RPD	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	Units	Value (%)	QC Limits
7722301	Pyrene	2014/11/18	NC	40 - 130	82	40 - 130	<0.0010	mg/kg	18 (2)	50

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

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

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

Surrogate: A pure or isotopically labeled compound whose behavior mirrors the analytes of interest. Used to evaluate extraction efficiency.

NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spiked amount was too small to permit a reliable recovery calculation (matrix spike concentration was less than 2x that of the native sample concentration).

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (one or both samples < 5x RDL).

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

(2) Detection limits raised due to dilution as a result of sample matrix inteference.

Maxxam Analytics International Corporation o/a Maxxam Analytics Burnaby: 4606 Canada Way V5G 1K5 Telephone(604) 734-7276 Fax(604) 731-2386

Maxxam Job #: B4A2450
Report Date: 2014/11/18

Tetra Tech EBA
Client Project #: ENVIN003511-01.004
Site Location: PORT DRIVE
Sampler Initials: SW

VALIDATION SIGNATURE PAGE

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

Rob Reinert, Data Validation Coordinator

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

Maxxam

4606 Canada Way, Burnaby, BC Canada V5G 1K5 Ph: 604 734 7276 Toll Free: 1 800 665 8566 Fax: 604 731 2386

Maxxam Job#: B4A2450

CHAIN OF CUSTODY RECORD

Page: 2 of 3

G 089220

Invoice To: Require Report? Yes ☑ No ☐

Company Name: Tetra Tech EBA
Contact Name: Lora Paul
Address: #1-4376 Boban Dr Nanaimo BC V9T 6A7
Phone / Fax#: 250 756 2256
E-mail: lora.paul@tetratech.com

Report To:

Company Name: same
Contact Name:
Address:
PC:
Phone / Fax#: Ph: Fax:
E-mail:

PO #:
Quotation #:
Project #: ENVIND03511-01.004
Proj. Name: Sed. Drilling
Location: Port Drive
Sampled By: Shawneen Walker

REGULATORY REQUIREMENTS SERVICE REQUESTED:

- ☒ CSR
- ☒ CCME
- ☐ BC Water Quality
- ☐ Other
- ☐ DRINKING WATER

- ☒ Regular Turn Around Time (TAT) (5 days for most tests)
- ☐ RUSH (Please contact the lab)
- ☐ 1 Day ☐ 2 Day ☐ 3 Day
- Date Required:

Special Instructions:

Return Cooler ☐ **Ship Sample Bottles (please specify)** ☐

ANALYSIS REQUESTED

BTEX/VPH, MTBE, VOC/VPH, EPH, TEH, PAH, LEPH/HEPH, CCME-PHC (Fractions 1-4 Plus BTEX), CCME-PHC (Fractions 2-4), CCME BTEX (Fraction 1 Plus BTEX), PCB, Phenols by 4AAP, Phenols by GCMS, TOG, MOG, SWOG, Dissolved Metals (Field Filtered? Y/N, Field Acidified? Y/N), Totals Metals Field Acidified? Y/N, Nitrate, Nitrite, Ammonia, Chloride, Fluoride, Sulphate, Total Suspended Solids-TSS, TDS, pH, Conductivity, Alkalinity, BOD, COD, Coliform, Total & E.coli, Fecal, Asbestos, HOLD

#	Sample Identification	Lab Identification	Sample Type	Date/Time Sampled	PAH	HOLD
1	14Sed022@1.0	LC5366				X
2	@1.5	LC5367			X	
3	@2.0	LC5368				X
4	14Sed023@0.5	LC5369				X
5	14Sed023@1.0	LC5370				X
6	14Sed023@1.8	LC5371			X	
7	14Sed023-A	LC5372			X	
8	14Sed023-B	LC5373			X	
9	14Sed023-C	LC5374			X	
10	14Sed023-D	LC5375			X	
11	Dupl	LC5376			X	
12						

B4A2450

Samples are from a Drinking Water Source? YES NO

Does source supply multiple households? YES NO

Laboratory Use Only

*Relinquished by:	Date (YY/MM/DD):	Time:	Received by:	Date (YY/MM/DD):	Time:	Time Sensitive	Temperature on Receipt (°C)	Custody Seal Intact on Cooler?
S Walker	14/11/07	13:30	DARIA IVANOVA	2014/11/08	10:20		5, 5, 4	Yes / No N/A

*IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORD. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.

White: Maxxam Yellow: Client

COC-1020 (05/10)

Maxxam International Corporation o/a Maxxam Analytics

Maxxam

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Maxxam Job#: B4A2450

CHAIN OF CUSTODY RECORD

Page: 1 of 3

G 089219

Invoice To: Require Report? Yes [✓] No [ ]

Company Name: Tetra Tech EBA
Contact Name: Lora Paul
Address: #1-4376 Boban Dr
Nanaimo BC V9T 6A7
Phone / Fax#: 250 756-2256
E-mail: lora.paul@tetratech.com

Report To:

Company Name: same
Contact Name:
Address:
PC:
Ph: Fax:
E-mail:

PO #:
Quotation #:
Project # ENVIND03511-01.004
Proj. Name: Sediment Drilling
Location: Port Drive
Sampled By: Shaimeen Walker

REGULATORY REQUIREMENTS SERVICE REQUESTED:

- [X] CSR
- [X] CCME
- [ ] BC Water Quality
- [ ] Other
- [ ] DRINKING WATER

- [X] Regular Turn Around Time (TAT) (5 days for most tests)
- [ ] RUSH (Please contact the lab)
- [ ] 1 Day [ ] 2 Day [ ] 3 Day
- Date Required:

Special Instructions:

Return Cooler [ ] **Ship Sample Bottles (please specify)** [ ]

ANALYSIS REQUESTED

Analysis columns: MTBE, BTEX/VPH, VOC/VPH, TEH, EPH, LEPH/HEPH, PAH [X], CCME-PHC (Fractions 1-4 Plus BTEX), CCME-PHC (Fractions 2-4), CCME BTEX (Fraction 1 Plus BTEX), PCB, Phenols by GC/MS, Phenols by 4AAP, SWOG, MOG, TOG, Dissolved Metals (Field Filtered? Y N), Field Acidified? (Y N), Totals Metals Field Acidified? (Y N), Ammonia, Nitrite, Nitrate, Sulphate, Fluoride, Chloride, TDS, Total Suspended Solids-TSS, Alkalinity, Conductivity, pH, BOD, COD, Fecal, Coliform, Total & E.coli, Asbestos, HOLD

	Sample Identification	Lab Identification	Sample Type	Date/Time Sampled	PAH	HOLD
1	14Sed019 @0.5	LC5347				X
2	14Sed019 @1.0	LC5348				X
3	14Sed019 @1.1	LC5349			X	
4	14Sed019 @1.5	LC5350				X
5	14Sed020 @0.5	LC5351				
6	14Sed020 @1.0	LC5352			X	
7	14Sed020 @1.5	LC5353				X
8	14Sed021 @0.5	LC5354				X
9	14Sed021 @1.0	LC5355				X
10	14Sed021 @1.5	LC5356			X	
11	14Sed021 @2.0	LC5357				X
12	14Sed022 @0.5	LC5358				X

B4A2450

Samples are from a Drinking Water Source? YES NO

Does source supply multiple households? YES NO

Laboratory Use Only

*Relinquished by:	Date (YY/MM/DD):	Time:	Received by:	Date (YY/MM/DD):	Time:	Time Sensitive	Temperature on Receipt (°C)	Custody Seal Intact on Cooler?
[signature]	14/11/07	13:30	DARIA IVANOVA	2014/11/08	10:20		5,5,4	Yes / No

*IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORD. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.

White: Maxxam Yellow: Client

COC-1020 (05/10)

Maxxam International Corporation o/a Maxxam Analytics

W/A

Maxxam

4606 Canada Way, Burnaby, BC Canada V5G 1K5 Ph: 604 734 7276 Toll Free: 1 800 665 8566 Fax: 604 731 2386

Maxxam Job#: B4A2450

CHAIN OF CUSTODY RECORD

Page: 3 of 3

G 089221

Invoice To: Require Report? Yes ✓ No

Company Name: TetraTech EBA
Contact Name: Lora Paul
Address: #1-4376 Boban Dr Nanaimo BC PC: V9T 6A7
Phone / Fax#: 250 756 2256
E-mail: lora.paul@tetratech.com

Report To:

Company Name: Same
Contact Name:
Address:
PC:
Ph: Fax:
E-mail:

PO #:
Quotation #:
Project #: ENVIND03511-01.004
Proj. Name: Sediment drilling
Location: Port Drive
Sampled By: Shawneen Walker

REGULATORY REQUIREMENTS SERVICE REQUESTED:

- [X] CSR
- [X] CCME
- [ ] BC Water Quality
- [ ] Other
- [ ] DRINKING WATER

- [ ] Regular Turn Around Time (TAT) (5 days for most tests)
- [ ] RUSH (Please contact the lab)
- [ ] 1 Day [ ] 2 Day [ ] 3 Day
- Date Required:

Special Instructions:
Return Cooler [ ] **Ship Sample Bottles (please specify)** [ ]

ANALYSIS REQUESTED

	Sample Identification	Lab Identification	Sample Type	Date/Time Sampled	PAH (LEPH/HEPH)	HOLD
1	14Sed024@0.5	LC5377	Sed.	Nov 6/14		X
2	14Sed024@1.0	LC5378	"	"		X
3	14Sed024@1.3	LC5379	"	"	X	
4						
5						
6						
7						
8						
9						
10						
11						
12						

Analysis columns: BTEX/VPH, MTBE, VOC/VPH, EPH, TEH, PAH, LEPH/HEPH, CCME-PHC (Fractions 1-4 Plus BTEX), CCME-PHC (Fractions 2-4), CCME BTEX (Fraction 1 Plus BTEX), PCB, Phenols by 4AAP, Phenols by GCMS, TOG, MOG, SVOG, Dissolved Metals (Field Filtered? Y/N, Field Acidified? Y/N), Total Metals Field Acidified? Y/N, Nitrate, Nitrite, Ammonia, Chloride, Fluoride, Sulphate, Total Suspended Solids-TSS, TDS, pH, Conductivity, Alkalinity, BOD, COD, Coliform, Total & E.coli, Fecal, Asbestos, HOLD

Samples are from a Drinking Water Source? YES / NO
Does source supply multiple households? YES / NO

B4A2450

*Relinquished by:	Date (YY/MM/DD):	Time:	Received by:	Date (YY/MM/DD):	Time:	Time Sensitive	Temperature on Receipt (°C)	Custody Seal Intact on Cooler?
SWalker	14/11/07	13:30	DARIA IVANOVA	2014/11/08	10:20		5,5,4	Yes / No N/A

Laboratory Use Only

*IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORD. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.

White: Maxxam Yellow: Client

COC-1020 (06/10)

Maxxam International Corporation o/a Maxxam Analytics

Success Through Science®

Your Project #: ENVIND03511-02
Site Location: CITY OF NANAIMO, 1 PORT DRIVE NANAIMO
Your C.O.C. #: G079957

Attention:KRISTY GABELHOUSE

TETRA TECH EBA
#1 - 4376 Boban Drive
Nanaimo, BC
CANADA V9T 6A7

Report Date: 2015/07/10
Report #: R1994901
Version: 2 - Revision

CERTIFICATE OF ANALYSIS – REVISED REPORT

MAXXAM JOB #: B542802
Received: 2015/05/23, 10:15

Sample Matrix: Sediment
Samples Received: 4

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Ecotox Report Attachment	1	2015/07/10	2015/07/10		
Ecotox Report Attachment	1	2015/07/10	2015/07/10		
Elements by ICPMS (total)	3	2015/05/28	2015/05/28	BBY7SOP-00001	EPA 6020a R1 m
Moisture	4	N/A	2015/05/26	BBY8SOP-00017	OMOE E3139 3.1 m
PAH in Soil by GC/MS (SIM)	4	2015/05/25	2015/05/28	BBY8SOP-00022	EPA 8270d R4 m
Total LMW, HMW, Total PAH Calc	1	N/A	2015/05/28	BBY WI-00033	Auto Calc
Total LMW, HMW, Total PAH Calc	3	N/A	2015/05/29	BBY WI-00033	Auto Calc
pH (2:1 DI Water Extract)	3	2015/05/28	2015/05/28	BBY6SOP-00028	BCMOE BCLM Mar2005 m
Texture Class	4	N/A	2015/05/29	Calc	
Texture by Hydrometer (Sand, Silt, Clay)	4	N/A	2015/05/29	BBY6SOP-00051	Carter 2nd ed 55.3
TOC Soil Subcontract (1)	4	2015/06/01	2015/06/01		

Reference Method suffix “m” indicates test methods incorporate validated modifications from specific reference methods to improve performance.
* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.
(1) This test was performed by Maxxam Ontario (From Burnaby)

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Tabitha Rudkin, AScT, Burnaby Project Manager
Email: TRudkin@maxxam.ca
Phone# (604)638-2639
==
Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Maxxam Analytics International Corporation o/a Maxxam Analytics Burnaby: 4606 Canada Way V5G 1K5 Telephone(604) 734-7276 Fax(604) 731-2386

Maxxam Job #: B542802
Report Date: 2015/07/10

TETRA TECH EBA
Client Project #: ENVIND03511-02
Site Location: CITY OF NANAIMO, 1 PORT DRIVE NANAIMO
Sampler Initials: SW

RESULTS OF CHEMICAL ANALYSES OF SEDIMENT

Maxxam ID		MH4918	MH4919	MH4920	MH4921		
Sampling Date		2015/05/22	2015/05/22	2015/05/22	2015/05/22		
COC Number		G079957	G079957	G079957	G079957		
	Units	**15 SED 01**	**15 SED 10**	**15 SED 11**	**15 SED 12**	**RDL**	**QC Batch**
Parameter							
Subcontract Parameter	N/A	ATTACHED	ATTACHED	ATTACHED	ATTACHED	N/A	7919366
Ecotox							
No Parameter	N/A			ATTACHED		N/A	7963155
Physical Properties							
Texture	N/A	LOAMY SAND	SAND	SAND	SAND	N/A	7912854
% sand by hydrometer	%	83	90	96	96	2.0	7915180
% silt by hydrometer	%	13	8.0	4.1	4.1	2.0	7915180
Clay Content	%	3.4	<2.0	<2.0	<2.0	2.0	7915180

RDL = Reportable Detection Limit
N/A = Not Applicable

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Maxxam Job #: B542802
Report Date: 2015/07/10

TETRA TECH EBA
Client Project #: ENVIND03511-02
Site Location: CITY OF NANAIMO, 1 PORT DRIVE NANAIMO
Sampler Initials: SW

PHYSICAL TESTING (SEDIMENT)

Maxxam ID		MH4918	MH4919	MH4920	MH4921		
Sampling Date		2015/05/22	2015/05/22	2015/05/22	2015/05/22		
COC Number		G079957	G079957	G079957	G079957		
	Units	**15 SED 01**	**15 SED 10**	**15 SED 11**	**15 SED 12**	**RDL**	**QC Batch**
Physical Properties							
Moisture	%	35	22	12	22	0.30	7912253
RDL = Reportable Detection Limit							

Maxxam
A Bureau Veritas Group Company

Maxxam Job #: B542802
Report Date: 2015/07/10

TETRA TECH EBA
Client Project #: ENVIND03511-02
Site Location: CITY OF NANAIMO, 1 PORT DRIVE NANAIMO
Sampler Initials: SW

CSR/CCME METALS IN SOIL (SEDIMENT)

Maxxam ID		MH4919	MH4920	MH4921		
Sampling Date		2015/05/22	2015/05/22	2015/05/22		
COC Number		G079957	G079957	G079957		
	Units	15 SED 10	15 SED 11	15 SED 12	RDL	QC Batch
Physical Properties						
Soluble (2:1) pH	pH	6.27	8.49	7.32	N/A	7915294
Total Metals by ICPMS						
Total Aluminum (Al)	mg/kg	13000	8630	5480	100	7915273
Total Antimony (Sb)	mg/kg	0.26	0.13	0.11	0.10	7915273
Total Arsenic (As)	mg/kg	9.48	5.12	2.53	0.50	7915273
Total Barium (Ba)	mg/kg	142	14.1	17.7	0.10	7915273
Total Beryllium (Be)	mg/kg	<0.40	<0.40	<0.40	0.40	7915273
Total Bismuth (Bi)	mg/kg	0.13	<0.10	<0.10	0.10	7915273
Total Cadmium (Cd)	mg/kg	0.208	0.366	0.284	0.050	7915273
Total Calcium (Ca)	mg/kg	35700	31000	4180	100	7915273
Total Chromium (Cr)	mg/kg	44.1	15.7	11.5	1.0	7915273
Total Cobalt (Co)	mg/kg	8.58	6.33	3.41	0.30	7915273
Total Copper (Cu)	mg/kg	63.2	16.8	7.06	0.50	7915273
Total Iron (Fe)	mg/kg	19500	15300	7840	100	7915273
Total Lead (Pb)	mg/kg	7.49	3.87	3.19	0.10	7915273
Total Lithium (Li)	mg/kg	23.9	8.5	5.7	5.0	7915273
Total Magnesium (Mg)	mg/kg	10200	5570	3010	100	7915273
Total Manganese (Mn)	mg/kg	274	184	119	0.20	7915273
Total Mercury (Hg)	mg/kg	0.127	<0.050	<0.050	0.050	7915273
Total Molybdenum (Mo)	mg/kg	1.04	0.62	0.41	0.10	7915273
Total Nickel (Ni)	mg/kg	66.6	15.5	12.4	0.80	7915273
Total Phosphorus (P)	mg/kg	581	463	342	10	7915273
Total Potassium (K)	mg/kg	1300	566	444	100	7915273
Total Selenium (Se)	mg/kg	0.66	<0.50	<0.50	0.50	7915273
Total Silver (Ag)	mg/kg	0.103	<0.050	<0.050	0.050	7915273
Total Sodium (Na)	mg/kg	2880	2700	1840	100	7915273
Total Strontium (Sr)	mg/kg	334	210	16.3	0.10	7915273
Total Thallium (Tl)	mg/kg	0.098	0.325	0.161	0.050	7915273
Total Tin (Sn)	mg/kg	0.49	0.41	0.29	0.10	7915273
Total Titanium (Ti)	mg/kg	80.4	1170	741	1.0	7915273
Total Uranium (U)	mg/kg	0.398	0.394	0.411	0.050	7915273
Total Vanadium (V)	mg/kg	47.4	44.2	25.5	2.0	7915273
Total Zinc (Zn)	mg/kg	54.5	37.6	20.0	1.0	7915273
Total Zirconium (Zr)	mg/kg	2.63	5.57	3.18	0.50	7915273

RDL = Reportable Detection Limit
N/A = Not Applicable

Maxxam Job #: B542802
Report Date: 2015/07/10

TETRA TECH EBA
Client Project #: ENVIND03511-02
Site Location: CITY OF NANAIMO, 1 PORT DRIVE NANAIMO
Sampler Initials: SW

CSR PAH IN SOIL BY GC-MS (SEDIMENT)

Maxxam ID		MH4918		MH4919		MH4919		MH4920	MH4921		
Sampling Date		2015/05/22		2015/05/22		2015/05/22		2015/05/22	2015/05/22		
COC Number		G079957		G079957		G079957		G079957	G079957		
	Units	15 SED 01	RDL	15 SED 10	RDL	15 SED 10 Lab-Dup	RDL	15 SED 11	15 SED 12	RDL	QC Batch
Polycyclic Aromatics											
Naphthalene	mg/kg	0.75	0.050	4.0 (1)	0.050	2.3 (2)	0.050	<0.050	<0.050	0.050	7915357
2-Methylnaphthalene	mg/kg	0.90	0.050	6.6	0.050	5.0	0.050	<0.050	<0.050	0.050	7915357
Acenaphthylene	mg/kg	<0.050	0.050	<0.050	0.050	<0.050	0.050	<0.050	<0.050	0.050	7915357
Acenaphthene	mg/kg	0.33	0.050	<0.43 (3)	0.43	<0.52 (3)	0.52	<0.050	<0.050	0.050	7915357
Fluorene	mg/kg	0.28	0.050	0.26	0.050	0.31	0.050	<0.050	<0.050	0.050	7915357
Phenanthrene	mg/kg	0.77	0.050	1.4	0.050	1.3	0.050	<0.050	<0.050	0.050	7915357
Anthracene	mg/kg	0.27	0.050	0.29	0.050	0.37	0.050	<0.050	<0.050	0.050	7915357
Fluoranthene	mg/kg	1.5	0.050	0.14	0.050	0.18	0.050	<0.050	<0.050	0.050	7915357
Pyrene	mg/kg	1.0	0.050	0.17	0.050	0.24	0.050	<0.050	<0.050	0.050	7915357
Benzo(a)anthracene	mg/kg	0.38	0.050	0.14 (4)	0.050	0.17	0.050	<0.050	<0.050	0.050	7915357
Chrysene	mg/kg	0.42	0.050	0.14 (4)	0.050	0.17	0.050	<0.050	<0.050	0.050	7915357
Benzo(b&j)fluoranthene	mg/kg	0.33	0.050	0.067 (4)	0.050	0.090	0.050	<0.050	<0.050	0.050	7915357
Benzo(b)fluoranthene	mg/kg	0.21	0.050	<0.050 (4)	0.050	0.060	0.050	<0.050	<0.050	0.050	7915357
Benzo(k)fluoranthene	mg/kg	0.10	0.050	<0.050 (4)	0.050	<0.050	0.050	<0.050	<0.050	0.050	7915357
Benzo(a)pyrene	mg/kg	0.17	0.050	0.051 (4)	0.050	0.066	0.050	<0.050	<0.050	0.050	7915357
Indeno(1,2,3-cd)pyrene	mg/kg	<0.050	0.050	<0.050 (4)	0.050	<0.050	0.050	<0.050	<0.050	0.050	7915357
Dibenz(a,h)anthracene	mg/kg	<0.050	0.050	<0.050 (4)	0.050	<0.050	0.050	<0.050	<0.050	0.050	7915357
Benzo(g,h,i)perylene	mg/kg	<0.050	0.050	<0.050 (4)	0.050	<0.050	0.050	<0.050	<0.050	0.050	7915357
Low Molecular Weight PAH`s	mg/kg	3.3	0.050	13	0.43			<0.050	<0.050	0.050	7911437
High Molecular Weight PAH`s	mg/kg	3.5	0.050	0.65	0.050			<0.050	<0.050	0.050	7911437
Total PAH	mg/kg	6.8	0.050	13	0.43			<0.050	<0.050	0.050	7911437
Surrogate Recovery (%)											
D10-ANTHRACENE (sur.)	%	79		70		67		82	87		7915357
D8-ACENAPHTHYLENE (sur.)	%	79		58		58		83	86		7915357
D8-NAPHTHALENE (sur.)	%	82		75		73		82	88		7915357
TERPHENYL-D14 (sur.)	%	80		73		71		84	90		7915357

RDL = Reportable Detection Limit
Lab-Dup = Laboratory Initiated Duplicate
(1) Duplicate RPD above control limit - Insufficient sample - Increased variability of results
(2) Recovery or RPD for this parameter is outside control limits. The overall quality control for this analysis meets acceptability criteria.
(3) Detection limits raised due to matrix interference.
(4) Matrix spike recovery below control limit - Insufficient sample - Pot. low bias

GENERAL COMMENTS

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

Package 1	3.7°C
Package 2	6.3°C
Package 3	4.0°C
Package 4	5.0°C

Results relate only to the items tested.

QUALITY ASSURANCE REPORT

			Matrix Spike		Spiked Blank		Method Blank		RPD		QC Standard	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	Units	Value (%)	QC Limits	% Recovery	QC Limits
7915357	D10-ANTHRACENE (sur.)	2015/05/28	70	60 - 130	86	60 - 130	86	%				
7915357	D8-ACENAPHTHYLENE (sur.)	2015/05/28	65	50 - 130	89	50 - 130	90	%				
7915357	D8-NAPHTHALENE (sur.)	2015/05/28	76	50 - 130	83	50 - 130	90	%				
7915357	TERPHENYL-D14 (sur.)	2015/05/28	73	60 - 130	91	60 - 130	91	%				
7912253	Moisture	2015/05/26					<0.30	%	2.3	20		
7915180	% sand by hydrometer	2015/05/29							0.14	35	98	N/A
7915180	% silt by hydrometer	2015/05/29							0.39	35		
7915180	Clay Content	2015/05/29							NC	35		
7915273	Total Aluminum (Al)	2015/05/28					<100	mg/kg			105	70 - 130
7915273	Total Antimony (Sb)	2015/05/28	95	75 - 125	97	75 - 125	<0.10	mg/kg			105	70 - 130
7915273	Total Arsenic (As)	2015/05/28	99	75 - 125	100	75 - 125	<0.50	mg/kg			99	70 - 130
7915273	Total Barium (Ba)	2015/05/28	NC	75 - 125	103	75 - 125	<0.10	mg/kg	5.1	35	105	70 - 130
7915273	Total Beryllium (Be)	2015/05/28	112	75 - 125	105	75 - 125	<0.40	mg/kg				
7915273	Total Bismuth (Bi)	2015/05/28					<0.10	mg/kg				
7915273	Total Cadmium (Cd)	2015/05/28	106	75 - 125	107	75 - 125	<0.050	mg/kg			104	70 - 130
7915273	Total Calcium (Ca)	2015/05/28					<100	mg/kg			101	70 - 130
7915273	Total Chromium (Cr)	2015/05/28	107	75 - 125	107	75 - 125	<1.0	mg/kg			112	70 - 130
7915273	Total Cobalt (Co)	2015/05/28	106	75 - 125	106	75 - 125	<0.30	mg/kg			97	70 - 130
7915273	Total Copper (Cu)	2015/05/28	108	75 - 125	101	75 - 125	<0.50	mg/kg			101	70 - 130
7915273	Total Iron (Fe)	2015/05/28					<100	mg/kg			103	70 - 130
7915273	Total Lead (Pb)	2015/05/28	98	75 - 125	106	75 - 125	<0.10	mg/kg			102	70 - 130
7915273	Total Lithium (Li)	2015/05/28	109	75 - 125	107	75 - 125	<5.0	mg/kg				
7915273	Total Magnesium (Mg)	2015/05/28					<100	mg/kg			99	70 - 130
7915273	Total Manganese (Mn)	2015/05/28	NC	75 - 125	110	75 - 125	<0.20	mg/kg			99	70 - 130
7915273	Total Mercury (Hg)	2015/05/28	104	75 - 125	99	75 - 125	<0.050	mg/kg			80	70 - 130
7915273	Total Molybdenum (Mo)	2015/05/28	104	75 - 125	98	75 - 125	<0.10	mg/kg			116	70 - 130
7915273	Total Nickel (Ni)	2015/05/28	105	75 - 125	104	75 - 125	<0.80	mg/kg			104	70 - 130
7915273	Total Phosphorus (P)	2015/05/28					<10	mg/kg			95	70 - 130
7915273	Total Potassium (K)	2015/05/28					<100	mg/kg				
7915273	Total Selenium (Se)	2015/05/28	100	75 - 125	102	75 - 125	<0.50	mg/kg				
7915273	Total Silver (Ag)	2015/05/28	98	75 - 125	100	75 - 125	<0.050	mg/kg			95	60 - 140

QUALITY ASSURANCE REPORT(CONT'D)

			Matrix Spike		Spiked Blank		Method Blank		RPD		QC Standard	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	Units	Value (%)	QC Limits	% Recovery	QC Limits
7915273	Total Sodium (Na)	2015/05/28					<100	mg/kg				
7915273	Total Strontium (Sr)	2015/05/28	NC	75 - 125	99	75 - 125	<0.10	mg/kg			100	70 - 130
7915273	Total Thallium (Tl)	2015/05/28	102	75 - 125	103	75 - 125	<0.050	mg/kg			93	70 - 130
7915273	Total Tin (Sn)	2015/05/28	94	75 - 125	92	75 - 125	<0.10	mg/kg	0.97	35		
7915273	Total Titanium (Ti)	2015/05/28	NC	75 - 125	102	75 - 125	<1.0	mg/kg			113	70 - 130
7915273	Total Uranium (U)	2015/05/28	104	75 - 125	102	75 - 125	<0.050	mg/kg			115	70 - 130
7915273	Total Vanadium (V)	2015/05/28	NC	75 - 125	105	75 - 125	<2.0	mg/kg			111	70 - 130
7915273	Total Zinc (Zn)	2015/05/28	NC	75 - 125	104	75 - 125	<1.0	mg/kg			97	70 - 130
7915273	Total Zirconium (Zr)	2015/05/28					<0.50	mg/kg				
7915294	Soluble (2:1) pH	2015/05/28			101	97 - 103			0.12	N/A		
7915357	2-Methylnaphthalene	2015/05/28	NC	50 - 130	78	50 - 130	<0.050	mg/kg	28	50		
7915357	Acenaphthene	2015/05/28	77	50 - 130	88	50 - 130	<0.050	mg/kg	NC (2)	50		
7915357	Acenaphthylene	2015/05/28	63	50 - 130	85	50 - 130	<0.050	mg/kg	NC	50		
7915357	Anthracene	2015/05/28	66	60 - 130	85	60 - 130	<0.050	mg/kg	25	50		
7915357	Benzo(a)anthracene	2015/05/28	59 (1)	60 - 130	87	60 - 130	<0.050	mg/kg	NC	50		
7915357	Benzo(a)pyrene	2015/05/28	47 (1)	60 - 130	91	60 - 130	<0.050	mg/kg	NC	50		
7915357	Benzo(b&j)fluoranthene	2015/05/28	52 (1)	60 - 130	90	60 - 130	<0.050	mg/kg	NC	50		
7915357	Benzo(b)fluoranthene	2015/05/28	52 (1)	60 - 130	90	60 - 130	<0.050	mg/kg	NC	50		
7915357	Benzo(g,h,i)perylene	2015/05/28	32 (1)	60 - 130	73	60 - 130	<0.050	mg/kg	NC	50		
7915357	Benzo(k)fluoranthene	2015/05/28	49 (1)	60 - 130	87	60 - 130	<0.050	mg/kg	NC	50		
7915357	Chrysene	2015/05/28	56 (1)	60 - 130	91	60 - 130	<0.050	mg/kg	NC	50		
7915357	Dibenz(a,h)anthracene	2015/05/28	45 (1)	60 - 130	73	60 - 130	<0.050	mg/kg	NC	50		
7915357	Fluoranthene	2015/05/28	63	60 - 130	87	60 - 130	<0.050	mg/kg	NC	50		
7915357	Fluorene	2015/05/28	72	50 - 130	87	50 - 130	<0.050	mg/kg	20	50		
7915357	Indeno(1,2,3-cd)pyrene	2015/05/28	37 (1)	60 - 130	75	60 - 130	<0.050	mg/kg	NC	50		
7915357	Naphthalene	2015/05/28	NC	50 - 130	78	50 - 130	<0.050	mg/kg	54 (1)	50		
7915357	Phenanthrene	2015/05/28	NC	60 - 130	84	60 - 130	<0.050	mg/kg	0.95	50		

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QUALITY ASSURANCE REPORT(CONT'D)

			Matrix Spike		Spiked Blank		Method Blank		RPD		QC Standard	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	Units	Value (%)	QC Limits	% Recovery	QC Limits
7915357	Pyrene	2015/05/28	60	60 - 130	82	60 - 130	<0.050	mg/kg	NC	50		

N/A = Not Applicable

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

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

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

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

Surrogate: A pure or isotopically labeled compound whose behavior mirrors the analytes of interest. Used to evaluate extraction efficiency.

NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spiked amount was too small to permit a reliable recovery calculation (matrix spike concentration was less than 2x that of the native sample concentration).

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (one or both samples < 5x RDL).

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

(2) Detection limits raised due to matrix interference.

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Maxxam Job #: B542802
Report Date: 2015/07/10

TETRA TECH EBA
Client Project #: ENVIND03511-02
Site Location: CITY OF NANAIMO, 1 PORT DRIVE NANAIMO
Sampler Initials: SW

VALIDATION SIGNATURE PAGE

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

Rob Reinert, Data Validation Coordinator

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

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Maxxam

4606 Canada Way, Burnaby, BC Canada V5G 1K5 Ph: 604 734 7276 Toll Free: 1 800 665 8566 Fax: 604 731 2386

Maxxam Job#: B542802

CHAIN OF CUSTODY RECORD

Page: 1 of 1

G 079957

Invoice To: Require Report? Yes [ ] No [ ]

Company Name: Tetra Tech EBA
Contact Name: Lora Paul
Address: #1-4376 Boban Dr
Nanaimo BC PC: V9T 6A7
Phone / Fax#: 250 756 2256
E-mail: lora.paul@tetratech.com

Report To:

Company Name: Tetra Tech EBA
Contact Name: Kristy Gabelhouse
Address:
PC:
Ph: Fax:
E-mail: kristy.gabelhouse@tetratech.com

PO #:
Quotation #:
Project #: ENVIND03511-02
Proj. Name: City of Nanaimo
Location: 1 Port Drive, Nanaimo
Sampled By: Shawneen Walker

REGULATORY REQUIREMENTS
- [X] CSR
- [ ] CCME
- [ ] BC Water Quality
- [ ] Other
- DRINKING WATER

SERVICE REQUESTED:
- [X] Regular Turn Around Time (TAT) (5 days for most tests)
- [ ] RUSH (Please contact the lab)
- [ ] 1 Day [ ] 2 Day [ ] 3 Day
- Date Required:

Special Instructions:
Return Cooler [ ] Ship Sample Bottles (please specify) [ ]

ANALYSIS REQUESTED: BTEX/VPH, MTBE, VOC/VPH, EPH, TEH, PAH, LEPH/HEPH, CCME-PHC (Fractions 1-4 Plus BTEX), CCME-PHC (Fractions 2-4), CCME BTEX (Fraction 1 Plus BTEX), PCB, Phenols by 4AAP, Phenols by GC/MS, TOG, MOG, SWOG, Dissolved Metals (Field Filtered? N/Y), Field Acidified? N/Y, Totals Metals Field Acidified? N/Y, Nitrate, Nitrite, Ammonia, Chloride, Fluoride, Sulphate, Total Suspended Solids-TSS, TDS, pH, Conductivity, Alkalinity, BOD, COD, Coliform, Total & E.coli, Fecal, Asbestos, TOC, Grain Size, Toxicity, HOLD

	Sample Identification	Lab Identification	Sample Type	Date/Time Sampled	PAH	TOC	Grain Size	Toxicity
1	15 Sed 01	MH4918	sed	15/5/22	X	X	X	X
2	15 Sed 10	MH4919		"	X	X	X	X
3	15 Sed 11	MH4920		"	X	X	X	X
4	15 Sed 12	MH4921			X	X	X	X
5								
6								
7								
8								
9								
10								
11								
12								

B542802

Samples are from a Drinking Water Source? YES NO
Does source supply multiple households? YES NO

*Relinquished by:	Date (YY/MM/DD):	Time:	Received by:	Date (YY/MM/DD):	Time:
S Walker	15/5/22		Nahed Amer	2015/05/23	10:15

Laboratory Use Only

Time Sensitive [ ]

Temperature on Receipt (°C): 3,4,4 / 9,6,4 / 4,4,4 / 5,6,4

Custody Seal Intact on Cooler? Yes No

N/A

*IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORD. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.

White: Maxxam Yellow: Client

COC-1020 (05/10)

Maxxam International Corporation o/a Maxxam Analytics

Success Through Science®

Your Project #: B542802
Your C.O.C. #: na

Attention:Tabitha Rudkin

Maxxam Analytics
4606 Canada Way
Burnaby, BC
V5G 1K5

Report Date: 2015/06/01
Report #: R3449201
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B599498
Received: 2015/05/27, 09:00

Sample Matrix: SEDIMENT
Samples Received: 4

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Reference
Total Organic Carbon in Soil	4	N/A	2015/06/01	CAM SOP-00468	LECO 203-601-224

Reference Method suffix “m” indicates test methods incorporate validated modifications from specific reference methods to improve performance.
* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Marijane Cruz, Senior Project Manager
Email: MCruz@maxxam.ca
Phone# (905)817-5756
==
Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Maxxam Job #: B599498
Report Date: 2015/06/01

Maxxam Analytics
Client Project #: B542802

RESULTS OF ANALYSES OF SEDIMENT

Maxxam ID		AIO535	AIO536	AIO537	AIO538			
Sampling Date		2015/05/22	2015/05/22	2015/05/22	2015/05/22			
COC Number		na	na	na	na			
	Units	**MH4918 \ 15 SED 01**	**MH4919 \ 15 SED 10**	**MH4920 \ 15 SED 11**	**MH4921 \ 15 SED 12**	**RDL**	**MDL**	**QC Batch**
Inorganics								
Total Organic Carbon	mg/kg	24000	110000	4900	2700	500	100	4043137

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

Maxxam Analytics International Corporation o/a Maxxam Analytics 6740 Campobello Road, Mississauga, Ontario, L5N 2L8 Tel: (905) 817-5700 Toll-Free: 800-563-6266 Fax: (905) 817-5777 www.maxxam.ca

Maxxam Job #: B599498
Report Date: 2015/06/01

Maxxam Analytics
Client Project #: B542802

GENERAL COMMENTS

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

Package 1	5.7°C

Results relate only to the items tested.

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Maxxam Job #: B599498
Report Date: 2015/06/01

QUALITY ASSURANCE REPORT

Maxxam Analytics
Client Project #: B542802

			Method Blank		RPD		QC Standard	
QC Batch	Parameter	Date	Value	Units	Value (%)	QC Limits	% Recovery	QC Limits
4043137	Total Organic Carbon	2015/06/01	<500	mg/kg	3.3	35	99	75 - 125

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

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

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

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Maxxam Job #: B599498
Report Date: 2015/06/01

Maxxam Analytics
Client Project #: B542802

VALIDATION SIGNATURE PAGE

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

Brad Newman, Scientific Specialist

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Success Through Science®

Your Project #: ENVIND03511-02
Your C.O.C. #: G089222

Attention:KRISTY GABELHOUSE

TETRA TECH EBA
#1 - 4376 Boban Drive
Nanaimo, BC
CANADA V9T 6A7

Report Date: 2015/06/02
Report #: R1969276
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B542517
Received: 2015/05/22, 13:50

Sample Matrix: Sediment
Samples Received: 8

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Moisture	8	N/A	2015/05/27	BBY8SOP-00017	OMOE E3139 3.1 m
Benzo[a]pyrene Equivalency	8	N/A	2015/05/29	BBY WI-00033	Auto Calc
PAH in Soil by GC/MS Lowlevel (Extended)	8	2015/05/26	2015/05/29	BBY8SOP-00022	EPA 8270d R4 m
Total LMW, HMW, Total PAH Calc	8	N/A	2015/05/29	BBY WI-00033	Auto Calc
Texture Class	8	N/A	2015/05/29	Calc	
Texture by Hydrometer (Sand, Silt, Clay)	8	N/A	2015/05/29	BBY6SOP-00051	Carter 2nd ed 55.3
TOC Soil Subcontract (1)	8	2015/06/02	2015/06/02		

Reference Method suffix “m” indicates test methods incorporate validated modifications from specific reference methods to improve performance.
* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.
(1) This test was performed by Maxxam Ontario (From Burnaby)

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Tabitha Rudkin, AScT, Burnaby Project Manager
Email: TRudkin@maxxam.ca
Phone# (604)638-2639
==
This report has been generated and distributed using a secure automated process.
Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Maxxam Analytics International Corporation o/a Maxxam Analytics Burnaby: 4606 Canada Way V5G 1K5 Telephone(604) 734-7276 Fax(604) 731-2386

Maxxam Job #: B542517
Report Date: 2015/06/02

TETRA TECH EBA
Client Project #: ENVIND03511-02

RESULTS OF CHEMICAL ANALYSES OF SEDIMENT

Maxxam ID		MH3566	MH3567	MH3568	MH3569	MH3570		
Sampling Date		2015/05/21	2015/05/21	2015/05/21	2015/05/21	2015/05/21		
COC Number		G089222	G089222	G089222	G089222	G089222		
	Units	**15SED02**	**15SED03**	**15SED04**	**15SED05**	**15SED06**	**RDL**	**QC Batch**
Parameter								
Subcontract Parameter	N/A	ATTACHED	ATTACHED	ATTACHED	ATTACHED	ATTACHED	N/A	7920667
Physical Properties								
Texture	N/A	LOAMY SAND	LOAMY SAND	SAND	LOAMY SAND	LOAMY SAND	N/A	7912854
% sand by hydrometer	%	83	80	93	84	76	2.0	7915180
% silt by hydrometer	%	14	17	5.9	12	21	2.0	7915180
Clay Content	%	3.2	3.5	<2.0	3.4	3.9	2.0	7915180

RDL = Reportable Detection Limit
N/A = Not Applicable

Maxxam ID		MH3571	MH3572	MH3572	MH3573		
Sampling Date		2015/05/21	2015/05/21	2015/05/21	2015/05/21		
COC Number		G089222	G089222	G089222	G089222		
	Units	**15SED07**	**15SED08**	**15SED08 Lab-Dup**	**15SED09**	**RDL**	**QC Batch**
Parameter							
Subcontract Parameter	N/A	ATTACHED	ATTACHED		ATTACHED	N/A	7920667
Physical Properties							
Texture	N/A	LOAMY SAND	SANDY LOAM		LOAMY SAND	N/A	7912854
% sand by hydrometer	%	76	71	71	81	2.0	7915180
% silt by hydrometer	%	20	26	26	17	2.0	7915180
Clay Content	%	3.7	3.7	3.7	2.3	2.0	7915180

RDL = Reportable Detection Limit
Lab-Dup = Laboratory Initiated Duplicate
N/A = Not Applicable

Maxxam Job #: B542517
Report Date: 2015/06/02

TETRA TECH EBA
Client Project #: ENVIND03511-02

PHYSICAL TESTING (SEDIMENT)

Maxxam ID		MH3566	MH3567	MH3568	MH3569	MH3570	MH3571	MH3572		
Sampling Date		2015/05/21	2015/05/21	2015/05/21	2015/05/21	2015/05/21	2015/05/21	2015/05/21		
COC Number		G089222	G089222	G089222	G089222	G089222	G089222	G089222		
	Units	**15SED02**	**15SED03**	**15SED04**	**15SED05**	**15SED06**	**15SED07**	**15SED08**	**RDL**	**QC Batch**
Physical Properties										
Moisture	%	42	32	19	38	39	37	43	0.30	7912942
RDL = Reportable Detection Limit										

Maxxam ID		MH3573		
Sampling Date		2015/05/21		
COC Number		G089222		
	Units	**15SED09**	**RDL**	**QC Batch**
Physical Properties				
Moisture	%	34	0.30	7912942
RDL = Reportable Detection Limit				

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Maxxam Job #: B542517
Report Date: 2015/06/02

TETRA TECH EBA
Client Project #: ENVIND03511-02

CCME PAH IN SEDIMENTS BY GC-MS (SEDIMENT)

Maxxam ID		MH3566		MH3567		MH3568		MH3569		
Sampling Date		2015/05/21		2015/05/21		2015/05/21		2015/05/21		
COC Number		G089222		G089222		G089222		G089222		
	Units	**15SED02**	**RDL**	**15SED03**	**RDL**	**15SED04**	**RDL**	**15SED05**	**RDL**	**QC Batch**
Calculated Parameters										
Index of Additive Cancer Risk(IARC)	N/A	12	0.10	68	0.10	1.8	0.10	15	0.10	7912848
Benzo[a]pyrene equivalency	N/A	0.74	0.10	4.1	0.10	0.11	0.10	0.86	0.10	7912848
Polycyclic Aromatics										
Naphthalene	mg/kg	0.62	0.0010	3.4 (1)	0.020	1.7 (1)	0.010	1.2	0.0010	7915376
2-Methylnaphthalene	mg/kg	0.73	0.0010	1.0	0.0010	2.3 (1)	0.010	2.0 (1)	0.010	7915376
Acenaphthylene	mg/kg	0.077	0.00050	0.16	0.00050	<0.0052 (2)	0.0052	0.063	0.00050	7915376
Acenaphthene	mg/kg	0.60	0.00050	1.2	0.00050	0.44	0.00050	0.62	0.00050	7915376
Fluorene	mg/kg	0.50	0.0010	0.94	0.0010	0.34	0.0010	0.58	0.0010	7915376
Phenanthrene	mg/kg	1.2	0.0010	11 (1)	0.020	0.99	0.0010	1.8 (1)	0.010	7915376
Anthracene	mg/kg	0.57	0.0010	4.8 (1)	0.020	0.24	0.0010	1.0	0.0010	7915376
Fluoranthene	mg/kg	3.4 (1)	0.010	25 (1)	0.020	1.1	0.0010	3.6 (1)	0.010	7915376
Pyrene	mg/kg	2.4 (1)	0.010	13 (1)	0.020	0.73	0.0010	3.4 (1)	0.010	7915376
Benzo(a)anthracene	mg/kg	0.91	0.0010	6.1 (1)	0.020	0.16	0.0010	0.93	0.0010	7915376
Chrysene	mg/kg	1.1	0.0010	9.3 (1)	0.020	0.16	0.0010	1.3	0.0010	7915376
Benzo(b&j)fluoranthene	mg/kg	0.96	0.0010	5.2 (1)	0.020	0.13	0.0010	1.2	0.0010	7915376
Benzo(k)fluoranthene	mg/kg	0.24	0.0010	0.73	0.0010	0.030	0.0010	0.30	0.0010	7915376
Benzo(a)pyrene	mg/kg	0.45	0.0010	2.7 (1)	0.020	0.067	0.0010	0.52	0.0010	7915376
Indeno(1,2,3-cd)pyrene	mg/kg	0.14	0.0020	0.38	0.0020	0.019	0.0020	0.15	0.0020	7915376
Dibenz(a,h)anthracene	mg/kg	0.049	0.00050	0.14	0.00050	0.011	0.00050	0.060	0.00050	7915376
Benzo(g,h,i)perylene	mg/kg	0.13 (2)	0.020	0.59 (2)	0.040	0.025 (2)	0.020	0.17 (2)	0.020	7915376
Low Molecular Weight PAH`s	mg/kg	4.3	0.0010	23	0.020	6.0	0.010	7.3	0.010	7912849
High Molecular Weight PAH`s	mg/kg	8.2	0.010	57	0.020	2.2	0.0010	9.8	0.010	7912849
Total PAH	mg/kg	13	0.010	79	0.020	8.2	0.010	17	0.010	7912849
Surrogate Recovery (%)										
D10-ANTHRACENE (sur.)	%	71		87		73		70		7915376
D8-ACENAPHTHYLENE (sur.)	%	65		63		55		52		7915376
D8-NAPHTHALENE (sur.)	%	65		59		51		54		7915376
TERPHENYL-D14 (sur.)	%	86		93		72		87		7915376

RDL = Reportable Detection Limit
(1) Detection limits raised due to dilution to bring analyte within the calibrated range.
(2) Detection limits raised due to matrix interference.

Maxxam Job #: B542517
Report Date: 2015/06/02

TETRA TECH EBA
Client Project #: ENVIND03511-02

CCME PAH IN SEDIMENTS BY GC-MS (SEDIMENT)

Maxxam ID		MH3570		MH3571	MH3572		MH3573	MH3573		
Sampling Date		2015/05/21		2015/05/21	2015/05/21		2015/05/21	2015/05/21		
COC Number		G089222		G089222	G089222		G089222	G089222		
	Units	15SED06	RDL	15SED07	15SED08	RDL	15SED09	15SED09 Lab-Dup	RDL	QC Batch
Calculated Parameters										
Index of Additive Cancer Risk(IARC)	N/A	13	0.10	15	17	0.10	7.9		0.10	7912848
Benzo[a]pyrene equivalency	N/A	0.77	0.10	0.87	1.0	0.10	0.48		0.10	7912848
Polycyclic Aromatics										
Naphthalene	mg/kg	1.0	0.0010	1.1	1.2	0.0010	0.90	0.73	0.0010	7915376
2-Methylnaphthalene	mg/kg	1.5	0.0010	1.9 (1)	2.0 (1)	0.010	1.4	1.1	0.0010	7915376
Acenaphthylene	mg/kg	0.077	0.00050	0.081	0.10	0.00050	0.045	0.045	0.00050	7915376
Acenaphthene	mg/kg	0.56	0.00050	0.59	0.65	0.00050	0.37	0.35	0.00050	7915376
Fluorene	mg/kg	0.56	0.0010	0.57	0.68	0.0010	0.31	0.32	0.0010	7915376
Phenanthrene	mg/kg	1.6 (1)	0.010	1.6 (1)	1.7 (1)	0.010	0.85	0.86	0.0010	7915376
Anthracene	mg/kg	0.84	0.0010	1.2	1.2	0.0010	0.39	0.37	0.0010	7915376
Fluoranthene	mg/kg	3.2 (1)	0.010	3.2 (1)	3.5 (1)	0.010	1.4 (1)	1.7 (1)	0.010	7915376
Pyrene	mg/kg	3.3 (1)	0.010	3.4 (1)	3.7 (1)	0.010	1.4 (1)	1.6 (1)	0.010	7915376
Benzo(a)anthracene	mg/kg	0.78	0.0010	0.94	0.98	0.0010	0.42	0.40	0.0010	7915376
Chrysene	mg/kg	1.2	0.0010	1.3	1.6	0.0010	0.56	0.55	0.0010	7915376
Benzo(b&j)fluoranthene	mg/kg	1.1	0.0010	1.3	1.4	0.0010	0.69	0.54	0.0010	7915376
Benzo(k)fluoranthene	mg/kg	0.26	0.0010	0.28	0.35	0.0010	0.17	0.13	0.0010	7915376
Benzo(a)pyrene	mg/kg	0.47	0.0010	0.54	0.64	0.0010	0.31	0.21	0.0010	7915376
Indeno(1,2,3-cd)pyrene	mg/kg	0.13	0.0020	0.14	0.16	0.0020	0.076	0.055	0.0020	7915376
Dibenz(a,h)anthracene	mg/kg	0.052	0.00050	0.055	0.067	0.00050	0.031	0.024	0.00050	7915376
Benzo(g,h,i)perylene	mg/kg	0.17 (1)	0.020	0.17 (1)	0.19 (1)	0.020	0.10 (1)	0.083 (1)	0.020	7915376
Low Molecular Weight PAH`s	mg/kg	6.1	0.010	6.9	7.6	0.010	4.2		0.0010	7912849
High Molecular Weight PAH`s	mg/kg	9.0	0.010	9.4	10	0.010	4.2		0.010	7912849
Total PAH	mg/kg	15	0.010	16	18	0.010	8.4		0.010	7912849
Surrogate Recovery (%)										
D10-ANTHRACENE (sur.)	%	74		71	73		66	71		7915376
D8-ACENAPHTHYLENE (sur.)	%	61		51	60		56	55		7915376
D8-NAPHTHALENE (sur.)	%	60		52	60		55	54		7915376
TERPHENYL-D14 (sur.)	%	95		92	93		78	84		7915376

RDL = Reportable Detection Limit

Lab-Dup = Laboratory Initiated Duplicate

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

Maxxam Analytics International Corporation o/a Maxxam Analytics Burnaby: 4606 Canada Way V5G 1K5 Telephone(604) 734-7276 Fax(604) 731-2386

GENERAL COMMENTS

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

Package 1	4.0°C
Package 2	4.7°C
Package 3	5.0°C
Package 4	5.3°C
Package 5	5.7°C
Package 6	5.7°C
Package 7	6.3°C
Package 8	5.3°C

Results relate only to the items tested.

QUALITY ASSURANCE REPORT

			Matrix Spike		Spiked Blank		Method Blank		RPD		QC Standard	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	Units	Value (%)	QC Limits	% Recovery	QC Limits
7915376	D10-ANTHRACENE (sur.)	2015/05/28	73	60 - 130	81	60 - 130	80	%				
7915376	D8-ACENAPHTHYLENE (sur.)	2015/05/28	58	50 - 130	80	50 - 130	82	%				
7915376	D8-NAPHTHALENE (sur.)	2015/05/28	57	50 - 130	83	50 - 130	85	%				
7915376	TERPHENYL-D14 (sur.)	2015/05/28	86	60 - 130	80	60 - 130	79	%				
7912942	Moisture	2015/05/27					<0.30	%	0.80	20		
7915180	% sand by hydrometer	2015/05/29							0.14	35	98	N/A
7915180	% silt by hydrometer	2015/05/29							0.39	35		
7915180	Clay Content	2015/05/29							NC	35		
7915376	2-Methylnaphthalene	2015/05/29	NC	40 - 130	76	40 - 130	<0.0010	mg/kg	19	50		
7915376	Acenaphthene	2015/05/29	NC	40 - 130	80	40 - 130	<0.00050	mg/kg	2.9	50		
7915376	Acenaphthylene	2015/05/29	55	40 - 130	77	40 - 130	<0.00050	mg/kg	0.66	50		
7915376	Anthracene	2015/05/29	NC	40 - 130	83	40 - 130	<0.0010	mg/kg	3.6	50		
7915376	Benzo(a)anthracene	2015/05/29	NC	40 - 130	82	40 - 130	<0.0010	mg/kg	5.1	50		
7915376	Benzo(a)pyrene	2015/05/29	NC	40 - 130	87	40 - 130	<0.0010	mg/kg	36	50		
7915376	Benzo(b&j)fluoranthene	2015/05/29	NC	40 - 130	85	40 - 130	<0.0010	mg/kg	24	50		
7915376	Benzo(g,h,i)perylene	2015/05/29	51	40 - 130	80	40 - 130	<0.0020	mg/kg	NC (1)	50		
7915376	Benzo(k)fluoranthene	2015/05/29	55	40 - 130	77	40 - 130	<0.0010	mg/kg	31	50		
7915376	Chrysene	2015/05/29	NC	40 - 130	84	40 - 130	<0.0010	mg/kg	1.6	50		
7915376	Dibenz(a,h)anthracene	2015/05/29	60	40 - 130	81	40 - 130	<0.00050	mg/kg	27	50		
7915376	Fluoranthene	2015/05/29	NC	40 - 130	80	40 - 130	<0.0010	mg/kg	17 (1)	50		
7915376	Fluorene	2015/05/29	NC	40 - 130	80	40 - 130	<0.0010	mg/kg	0.96	50		
7915376	Indeno(1,2,3-cd)pyrene	2015/05/29	53	40 - 130	83	40 - 130	<0.0020	mg/kg	31	50		
7915376	Naphthalene	2015/05/29	NC	40 - 130	79	40 - 130	<0.0010	mg/kg	21	50		
7915376	Phenanthrene	2015/05/29	NC	40 - 130	76	40 - 130	<0.0010	mg/kg	1.6	50		

			Matrix Spike		Spiked Blank		Method Blank		RPD		QC Standard	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	Units	Value (%)	QC Limits	% Recovery	QC Limits
7915376	Pyrene	2015/05/29	NC	40 - 130	76	40 - 130	<0.0010	mg/kg	8.8 (1)	50		

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

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

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

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

Surrogate: A pure or isotopically labeled compound whose behavior mirrors the analytes of interest. Used to evaluate extraction efficiency.

NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spiked amount was too small to permit a reliable recovery calculation (matrix spike concentration was less than 2x that of the native sample concentration).

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (one or both samples < 5x RDL).

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

VALIDATION SIGNATURE PAGE

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

Andy Lu, Data Validation Coordinator

Maxxam

4606 Canada Way, Burnaby, BC Canada V5G 1K5 Ph: 604 734 7276 Toll Free: 1 800 665 8566 Fax: 604 731 2386

Maxxam Job#: B542517

CHAIN OF CUSTODY RECORD

Page: 1 of 1

G 089222

Invoice To: Require Report? Yes [X] No [ ]

Company Name: Tetra Tech EBA
Contact Name: Lora Paul
Address: #1-4376 Boban Dr
Nanaimo BC PC: V9T 6A7
Phone / Fax#: 250 756 2256
E-mail: lora.paul@tetratech.com

Report To:

Company Name: Tetra Tech EBA
Contact Name: Kristy Gabelhouse
Address: same ←
PC:
Ph: Fax:
E-mail: kristy.gabelhouse@tetratech.com

PO #:
Quotation #:
Project #: ENVIND03511-02
Proj. Name:
Location: 1 Port Drive, Nanaimo
Sampled By: Shawneen Walker

REGULATORY REQUIREMENTS SERVICE REQUESTED:

- [X] CSR
- [ ] CCME
- [ ] BC Water Quality
- [ ] Other
- [ ] DRINKING WATER

- [X] Regular Turn Around Time (TAT) (5 days for most tests)
- [ ] RUSH (Please contact the lab)
- [ ] 1 Day [ ] 2 Day [ ] 3 Day
- Date Required:

Special Instructions:

Return Cooler [ ] Ship Sample Bottles (please specify) [ ]

ANALYSIS REQUESTED

BTEX/VPH, MTBE, VOC/VPH, EPH, TEH, PAH, LEPH/HEPH, CCME-PHC (Fractions 1-4 Plus BTEX), CCME-PHC (Fractions 2-4), CCME BTEX (Fraction 1 Plus BTEX), PCB, Phenols by 4AAP, Phenols by GC/MS, TOG, MOG, SWOG, Dissolved Metals (N/Y Field Filtered?), Totals Metals (N/Y Field Acidified?), Totals Metals Field Acidified? (N/Y), Nitrate, Nitrite, Ammonia, Chloride, Fluoride, Sulphate, Total Suspended Solids-TSS, TDS, pH, Conductivity, Alkalinity, BOD, COD, Coliform, Total & E.coli, Fecal, Asbestos, TOC, grain size, HOLD [X] for toxicity tests

#	Sample Identification	Lab Identification	Sample Type	Date/Time Sampled	PAH	TOC	grain size	HOLD
1	15Sed01		Sed	2015/5/21	X	X	X	X
2	15 Sed 02	MH3566	↓	↓	X	X	X	X
3	15 Sed 03	MH3567			X	X	X	X
4	15 Sed 04	MH3568			X	X	X	X
5	15 Sed 05	MH3569			X	X	X	X
6	15 Sed 06	MH3570			X	X	X	X
7	15 Sed 07	MH3571			X	X	X	X
8	15 Sed 08	MH3572			X	X	X	X
9	15 Sed 09	MH3573			X	X	X	X
10	15Sed10				X	X	X	X
11	15Sed11				X	X	X	X
12	15Sed12				X	X	X	X

B542517

Samples are from a Drinking Water Source? YES NO
Does source supply multiple households? YES NO

*Relinquished by:	Date (YY/MM/DD):	Time:	Received by:	Date (YY/MM/DD):	Time:
SWalker	15/05/21	15:51	Mat Laurel-Heather	2015/05/22	13:50

Laboratory Use Only: Time Sensitive [ ] | Temperature on Receipt (°C): 5,4,3 / 3,5,6 | Custody Seal Intact on Cooler? N/A Yes No

4,4,7 / 4,6,6 / 4,7,6 / 6,6,5 / 6,7,6 / 5,6,5

*IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORD. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.

White: Maxxam Yellow: Client

COC-1020 (05/10)

Maxxam International Corporation o/a Maxxam Analytics

Success Through Science®

Your Project #: B542517
Your C.O.C. #: na

Attention:Tabitha Rudkin

Maxxam Analytics
4606 Canada Way
Burnaby, BC
V5G 1K5

Report Date: 2015/06/02
Report #: R3450390
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B599505
Received: 2015/05/27, 09:00

Sample Matrix: SEDIMENT
Samples Received: 8

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Reference
Total Organic Carbon in Soil	8	N/A	2015/06/02	CAM SOP-00468	LECO 203-601-224

Reference Method suffix “m” indicates test methods incorporate validated modifications from specific reference methods to improve performance.
* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Marijane Cruz, Senior Project Manager
Email: MCruz@maxxam.ca
Phone# (905)817-5756
==
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RESULTS OF ANALYSES OF SEDIMENT

Maxxam ID		AIO557	AIO557	AIO558	AIO559			
Sampling Date		2015/05/21	2015/05/21	2015/05/21	2015/05/21			
COC Number		na	na	na	na			
	Units	MH3566 \ 15SED02	MH3566 \ 15SED02 Lab-Dup	MH3567 \ 15SED03	MH3568 \ 15SED04	RDL	MDL	QC Batch
Inorganics								
Total Organic Carbon	mg/kg	32000	34000	18000	11000	500	100	4045672

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
Lab-Dup = Laboratory Initiated Duplicate

Maxxam ID		AIO560	AIO561	AIO562	AIO563			
Sampling Date		2015/05/21	2015/05/21	2015/05/21	2015/05/21			
COC Number		na	na	na	na			
	Units	MH3569 \ 15SED05	MH3570 \ 15SED06	MH3571 \ 15SED07	MH3572 \ 15SED08	RDL	MDL	QC Batch
Inorganics								
Total Organic Carbon	mg/kg	61000	41000	61000	52000	500	100	4045672

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

Maxxam ID		AIO564			
Sampling Date		2015/05/21			
COC Number		na			
	Units	MH3573 \ 15SED09	RDL	MDL	QC Batch
Inorganics					
Total Organic Carbon	mg/kg	38000	500	100	4045672

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch

GENERAL COMMENTS

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

Package 1	5.7°C

Results relate only to the items tested.

Maxxam Analytics International Corporation o/a Maxxam Analytics 6740 Campobello Road, Mississauga, Ontario, L5N 2L8 Tel: (905) 817-5700 Toll-Free: 800-563-6266 Fax: (905) 817-5777 www.maxxam.ca

Maxxam Job #: B599505
Report Date: 2015/06/02

QUALITY ASSURANCE REPORT

Maxxam Analytics
Client Project #: B542517

			Method Blank		RPD		QC Standard	
QC Batch	Parameter	Date	Value	Units	Value (%)	QC Limits	% Recovery	QC Limits
4045672	Total Organic Carbon	2015/06/02	<500	mg/kg	5.6	35	106	75 - 125

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

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

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

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Maxxam Job #: B599505
Report Date: 2015/06/02

Maxxam Analytics
Client Project #: B542517

VALIDATION SIGNATURE PAGE

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

Ewa Pranjic, M.Sc., C.Chem, Scientific Specialist

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Your Project #: ENVINDO3511-02.001
Site Location: CONDRA

Attention:KRISTY GABELHOUSE

TETRA TECH EBA
#1 - 4376 Boban Drive
Nanaimo, BC
CANADA V9T 6A7

Your C.O.C. #: G079951, G079952, G079953, G079954

Report Date: 2015/05/14
Report #: R1916566
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B533315
Received: 2015/04/24, 07:55

Sample Matrix: TISSUE
Samples Received: 32

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
% Lipid Content (2)	15	N/A	2015/05/13	BBY8SOP-00028	BCMOE BCLM Dec 2000
% Lipid Content (2)	17	N/A	2015/05/14	BBY8SOP-00028	BCMOE BCLM Dec 2000
Moisture in Tissue	17	N/A	2015/05/13	BBY8SOP-00017	OMOE E3139 3.1 m
Moisture in Tissue	15	N/A	2015/05/14	BBY8SOP-00017	OMOE E3139 3.1 m
PAH IN Tissue Subcontract (1)	26	2015/05/14	2015/05/14		

Reference Method suffix “m” indicates test methods incorporate validated modifications from specific reference methods to improve performance.
* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.
(1) This test was performed by MAXXAM BURNABY FOOD RESIDUE
(2) Sample(s) analyzed using methodologies that have not been subjected to Maxxam’s standard validation process for the submitted matrix and is not an Accredited method. Analysis performed with client consent, however results should be viewed with discretion.

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Tabitha Rudkin, AScT, Burnaby Project Manager
Email: TRudkin@maxxam.ca
Phone# (604)638-2639
==
This report has been generated and distributed using a secure automated process.
Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Maxxam Job #: B533315
Report Date: 2015/05/14

TETRA TECH EBA
Client Project #: ENVINDO3511-02.001
Site Location: CONDRA
Sampler Initials: KA

RESULTS OF CHEMICAL ANALYSES OF TISSUE

Maxxam ID		MC7076	MC7077	MC7078	MC7079	MC7080		
Sampling Date		2015/04/20	2015/04/20	2015/04/21	2015/04/21	2015/04/21		
COC Number		G079951	G079951	G079951	G079951	G079951		
	Units	**CRAB 1**	**CRAB 2**	**CRAB 3**	**CRAB 4**	**CRAB 5**	**RDL**	**QC Batch**
Parameter								
Lipid Content	%	7.16	14.4	6.05	10.8	25.8	0.10	7897465
Subcontract Parameter	N/A	ATTACHED	ATTACHED	ATTACHED	ATTACHED	ATTACHED	N/A	7902115

RDL = Reportable Detection Limit
N/A = Not Applicable

Maxxam ID		MC7081	MC7082	MC7083	MC7084	MC7085		
Sampling Date		2015/04/21	2015/04/22	2015/04/22	2015/04/21	2015/04/21		
COC Number		G079951	G079951	G079951	G079951	G079951		
	Units	**CRAB 6**	**CRAB 7**	**CRAB 8**	**CLAM 1**	**CLAM 2**	**RDL**	**QC Batch**
Parameter								
Lipid Content	%	13.6	17.9	7.84	7.46	6.60	0.10	7897465
Subcontract Parameter	N/A	ATTACHED	ATTACHED	ATTACHED	ATTACHED	ATTACHED	N/A	7902115

RDL = Reportable Detection Limit
N/A = Not Applicable

Maxxam ID		MC7086	MC7087	MC7093	MC7094	MC7095		
Sampling Date		2015/04/21	2015/04/21	2015/04/21	2015/04/21	2015/04/22		
COC Number		G079951	G079951	G079952	G079952	G079952		
	Units	**CLAM 3**	**CLAM 4**	**CLAM 5**	**CLAM 6**	**CLAM 7**	**RDL**	**QC Batch**
Parameter								
Lipid Content	%	6.67	6.60	9.54	7.96	7.25	0.10	7897465
Subcontract Parameter	N/A	ATTACHED	ATTACHED	ATTACHED	ATTACHED	ATTACHED	N/A	7902115

RDL = Reportable Detection Limit
N/A = Not Applicable

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A Bureau Veritas Group Company

Maxxam Job #: B533315
Report Date: 2015/05/14

TETRA TECH EBA
Client Project #: ENVINDO3511-02.001
Site Location: CONDRA
Sampler Initials: KA

RESULTS OF CHEMICAL ANALYSES OF TISSUE

Maxxam ID		MC7096	MC7096	MC7097	MC7098	MC7099	MC7100		
Sampling Date		2015/04/22	2015/04/22	2015/04/21	2015/04/21	2015/04/21	2015/04/21		
COC Number		G079952	G079952	G079952	G079952	G079952	G079952		
	Units	**CLAM 8**	**CLAM 8 Lab-Dup**	**VEG 1**	**VEG 2**	**VEG 3**	**VEG 4**	**RDL**	**QC Batch**
Parameter									
Lipid Content	%	7.14	5.34	2.02	2.89	2.47	3.03	0.10	7899504
Subcontract Parameter	N/A	ATTACHED		ATTACHED	ATTACHED	ATTACHED	ATTACHED	N/A	7902115

RDL = Reportable Detection Limit
Lab-Dup = Laboratory Initiated Duplicate
N/A = Not Applicable

Maxxam ID		MC7101	MC7102		MC7103	MC7104	MC7106		
Sampling Date		2015/04/21	2015/04/22		2015/04/22	2015/04/22	2015/04/21		
COC Number		G079952	G079952		G079952	G079952	G079953		
	Units	**VEG 5**	**VEG 6**	**QC Batch**	**VEG 7**	**VEG 8**	**CRAB REF 1**	**RDL**	**QC Batch**
Parameter									
Lipid Content	%	2.46	1.98	7899504	2.78	2.78	20.3	0.10	7900147
Subcontract Parameter	N/A	ATTACHED	ATTACHED	7902115	ATTACHED	ATTACHED		N/A	7902115

RDL = Reportable Detection Limit

Maxxam ID		MC7107	MC7110	MC7111	MC7111	MC7114	MC7115	MC7130		
Sampling Date		2015/04/21	2015/04/21	2015/04/21	2015/04/21	2015/04/21	2015/04/21	2015/04/21		
COC Number		G079953	G079953	G079953	G079953	G079953	G079953	G079954		
	Units	**CRAB REF 2**	**CLAM REF 1**	**CLAM REF 2**	**CLAM REF 2 Lab-Dup**	**VEG REF 1**	**VEG REF 2**	**CLAM DUP**	**RDL**	**QC Batch**
Parameter										
Lipid Content	%	19.3	7.54	5.68	6.67	1.81	3.59	7.93	0.10	7900147
Subcontract Parameter	N/A							ATTACHED	N/A	7902115

RDL = Reportable Detection Limit
Lab-Dup = Laboratory Initiated Duplicate
N/A = Not Applicable

Maxxam Job #: B533315
Report Date: 2015/05/14

TETRA TECH EBA
Client Project #: ENVINDO3511-02.001
Site Location: CONDRA
Sampler Initials: KA

RESULTS OF CHEMICAL ANALYSES OF TISSUE

Maxxam ID		MC7131		
Sampling Date		2015/04/22		
COC Number		G079954		
	Units	**VEG DUP**	**RDL**	**QC Batch**
Parameter				
Lipid Content	%	2.36	0.10	7900147
Subcontract Parameter	N/A	ATTACHED	N/A	7902115

RDL = Reportable Detection Limit
N/A = Not Applicable

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Maxxam Job #: B533315
Report Date: 2015/05/14

TETRA TECH EBA
Client Project #: ENVINDO3511-02.001
Site Location: CONDRA
Sampler Initials: KA

PHYSICAL TESTING (TISSUE)

Maxxam ID		MC7076	MC7077	MC7078	MC7079	MC7080	MC7081	MC7081		
Sampling Date		2015/04/20	2015/04/20	2015/04/21	2015/04/21	2015/04/21	2015/04/21	2015/04/21		
COC Number		G079951	G079951	G079951	G079951	G079951	G079951	G079951		
	Units	**CRAB 1**	**CRAB 2**	**CRAB 3**	**CRAB 4**	**CRAB 5**	**CRAB 6**	**CRAB 6 Lab-Dup**	**RDL**	**QC Batch**
Physical Properties										
Moisture	%	79	81	78	79	76	82	82	0.30	7900777

RDL = Reportable Detection Limit
Lab-Dup = Laboratory Initiated Duplicate

Maxxam ID		MC7082	MC7083	MC7084	MC7085	MC7086	MC7087	MC7093		
Sampling Date		2015/04/22	2015/04/22	2015/04/21	2015/04/21	2015/04/21	2015/04/21	2015/04/21		
COC Number		G079951	G079951	G079951	G079951	G079951	G079951	G079952		
	Units	**CRAB 7**	**CRAB 8**	**CLAM 1**	**CLAM 2**	**CLAM 3**	**CLAM 4**	**CLAM 5**	**RDL**	**QC Batch**
Physical Properties										
Moisture	%	79	82	84	86	86	84	86	0.30	7900777

RDL = Reportable Detection Limit

Maxxam ID		MC7094	MC7095		MC7096	MC7097	MC7098	MC7099		
Sampling Date		2015/04/21	2015/04/22		2015/04/22	2015/04/21	2015/04/21	2015/04/21		
COC Number		G079952	G079952		G079952	G079952	G079952	G079952		
	Units	**CLAM 6**	**CLAM 7**	**QC Batch**	**CLAM 8**	**VEG 1**	**VEG 2**	**VEG 3**	**RDL**	**QC Batch**
Physical Properties										
Moisture	%	86	86	7900777	84	81	85	83	0.30	7899988

RDL = Reportable Detection Limit

Maxxam ID		MC7100	MC7101	MC7102	MC7103	MC7104	MC7106	MC7106		
Sampling Date		2015/04/21	2015/04/21	2015/04/22	2015/04/22	2015/04/22	2015/04/21	2015/04/21		
COC Number		G079952	G079952	G079952	G079952	G079952	G079953	G079953		
	Units	**VEG 4**	**VEG 5**	**VEG 6**	**VEG 7**	**VEG 8**	**CRAB REF 1**	**CRAB REF 1 Lab-Dup**	**RDL**	**QC Batch**
Physical Properties										
Moisture	%	83	83	83	82	84	76	76	0.30	7899988

RDL = Reportable Detection Limit
Lab-Dup = Laboratory Initiated Duplicate

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Maxxam Job #: B533315
Report Date: 2015/05/14

TETRA TECH EBA
Client Project #: ENVINDO3511-02.001
Site Location: CONDRA
Sampler Initials: KA

PHYSICAL TESTING (TISSUE)

Maxxam ID		MC7107	MC7110	MC7111	MC7114	MC7115	MC7130	MC7131		
Sampling Date		2015/04/21	2015/04/21	2015/04/21	2015/04/21	2015/04/21	2015/04/21	2015/04/22		
COC Number		G079953	G079953	G079953	G079953	G079953	G079954	G079954		
	Units	CRAB REF 2	CLAM REF 1	CLAM REF 2	VEG REF 1	VEG REF 2	CLAM DUP	VEG DUP	RDL	QC Batch
Physical Properties										
Moisture	%	79	85	85	82	85	84	80	0.30	7899988
RDL = Reportable Detection Limit										

Maxxam Job #: B533315
Report Date: 2015/05/14

TETRA TECH EBA
Client Project #: ENVINDO3511-02.001
Site Location: CONDRA
Sampler Initials: KA

GENERAL COMMENTS

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

Package 1	1.0°C
Package 2	1.0°C
Package 3	1.7°C

Results relate only to the items tested.

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Success Through Science®

Maxxam Job #: B533315
Report Date: 2015/05/14

QUALITY ASSURANCE REPORT

TETRA TECH EBA
Client Project #: ENVINDO3511-02.001
Site Location: CONDRA
Sampler Initials: KA

			Method Blank		RPD	
QC Batch	Parameter	Date	Value	Units	Value (%)	QC Limits
7897465	Lipid Content	2015/05/13	<0.10	%		
7899504	Lipid Content	2015/05/14	<0.10	%	29	50
7899988	Moisture	2015/05/13	<0.30	%	0.26	20
7900147	Lipid Content	2015/05/14	<0.10	%	16	50
7900777	Moisture	2015/05/14	<0.30	%	0.12	20

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

Maxxam Analytics International Corporation o/a Maxxam Analytics Burnaby: 4606 Canada Way V5G 1K5 Telephone(604) 734-7276 Fax(604) 731-2386

Maxxam Job #: B533315
Report Date: 2015/05/14

TETRA TECH EBA
Client Project #: ENVINDO3511-02.001
Site Location: CONDRA
Sampler Initials: KA

VALIDATION SIGNATURE PAGE

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

Andy Lu, Data Validation Coordinator

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Maxxam

4606 Canada Way, Burnaby, BC Canada V5G 1K5 Ph. 604 734 7276 Toll Free. 1 800 665 8566 Fax: 604 731 2386

CHAIN OF CUSTODY RECORD

Page: 1 of 4

G 079951

Maxxam Job#: B533315

Invoice To: Require Report? Yes [X] No [ ]

Company Name: TetraTech EBA
Contact Name: Lora Paul
Address: Nanaimo
PC:
Phone / Fax#: Ph: Fax:
E-mail: Nanaimo lora.paul@tetratech.com

Report To:

Company Name: Tetra T h B
Contact Name: Kristy Gabelh e
Address:
PC:
Phone / Fax#: Ph: Fax:
E-mail: Kristy.gabelhouse@tetratech.com

PO #:
Quotation #:
Project #: E VIND 351 2 1
Proj. Name: CON D. A
Location:
Sampled By: K Gab lhouse

REGULATORY REQUIREMENTS

- [X] CSR
- [ ] CCME
- [ ] BC Water Quality
- [ ] Other
- [ ] DRINKING WATER

SERVICE REQUESTED:

- [X] Regular Turn Around Time (TAT) (5 days for most tests)
- [ ] RUSH (Please contact the lab) [ ] 1 Day [ ] 2 Day [ ] 3 Day
- Date Required:

Special Instructions:

Return Cooler [ ] Ship Sample Bottles (please specify) [ ]

ANALYSIS REQUESTED

Printed analysis columns: MTBE, BTEX/VPH, VOC/VPH, TEH, EPH, LEPH/HEPH, PAH, CCME-PHC (Fractions 1-4 Plus BTEX), CCME-PHC (Fractions 2-4), CCME BTEX (Fraction 1 Plus BTEX), PCB, Phenols by GCMS, Phenols by 4AAP, SVOG, MOG, TOG, N/Y Field Filtered?, N/Y Field Acidified?, Dissolved Metals, N/Y Total Metals Field Acidified?, Ammonia, Nitrite, Nitrate, Sulphate, Fluoride, Chloride, TDS, Total Suspended Solids-TSS, pH, Alkalinity, Conductivity, BOD, COD, Fecal, Coliform, Total & E.coli, Asbestos, HOLD

#	Sample Identification	Lab Identification	Sample Type	Date/Time Sampled	PAH	moisture	lipid analysis
1	Crab 1	MC7076	Tissue	April 20/15	X	X	X
2	Crab 2	MC7077		April 20/15	X	X	X
3	Crab 3	MC7078		April 21/15	X	X	X
4	Crab 4	MC7079			X	X	X
5	Crab 5	MC7080			X	X	Y
6	Crab 6	MC7081			X	X	X
7	Crab 7	MC7082		April 22/15	X	X	X
8	Crab 8	MC7083		April 22/15	X	X	X
9	Clam 1	MC7084		April 21/15	X	X	X
10	Clam 2	MC7085			X	X	X
11	Clam 3	MC7086			X	X	X
12	Clam 4	MC7087			X	X	X

B533315

Samples are from a Drinking Water Source? YES / NO
Does source supply multiple households? YES / NO

Laboratory Use Only

*Relinquished by:	Date (YY/MM/DD):	Time:	Received by:	Date (YY/MM/DD):	Time:	Time Sensitive	Temperature on Receipt (°C)	Custody Seal Intact on Cooler?
KGabel	15/04/23	4:00 pm				[ ]		Yes [ ] No [ ]

*IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORD. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.

White: Maxxam Yellow: Client

COC-1020 (05/10)

Maxxam International Corporation o/a Maxxam Analytics

Maxxam

4606 Canada Way, Burnaby, BC Canada V5G 1K5 Ph: 604 734 7276 Toll Free: 1 800 665 8566 Fax: 604 731 2386

Maxxam Job#: B533315

CHAIN OF CUSTODY RECORD

Page: 2 of 3

G 079952

Invoice To: Require Report? Yes ☒ No ☐

Company Name: Tetra Tech EBA
Contact Name: Nanaimo
Address:
PC:
Phone / Fax#: Ph: Fax:
E-mail: Lora.paul@tetratech.com

Report To:

Company Name: Tetra Tech EBA
Contact Name: Kristy Gabelhouse
Address:
PC:
Phone / Fax#: Ph: Fax:
E-mail: Kristy.gabelhouse@tetratech.com

PO #:
Quotation #:
Project #: ENVIND03311-02 001
Proj. Name: CON DRA
Location:
Sampled By: K. Gabelhouse

REGULATORY REQUIREMENTS

☒ CSR
☐ CCME
☐ BC Water Quality
☐ Other
☐ DRINKING WATER

SERVICE REQUESTED:

☒ Regular Turn Around Time (TAT) (5 days for most tests)
☐ RUSH (Please contact the lab)
☐ 1 Day ☐ 2 Day ☐ 3 Day
Date Required:

Special Instructions:

Return Cooler ☐ Ship Sample Bottles (please specify) ☐

ANALYSIS REQUESTED

BTEX/VPH, MTBE, VOC/VPH, EPH, TEH, PAH, LEPH/HEPH, CCME-PHC (Fractions 1-4 Plus BTEX), CCME-PHC (Fractions 2-4), CCME BTEX (Fraction 1 Plus BTEX), PCB, Phenols by 4AAP, Phenols by GCMS, TOG, MOG, SWOG, Dissolved Metals (Field Filtered? Y/N), Field Acidified? Y/N, Totals Metals Field Acidified? Y/N, Nitrate, Nitrite, Ammonia, Chloride, Fluoride, Sulphate, Total Suspended Solids-TSS, TDS, pH, Conductivity, Alkalinity, BOD, COD, Coliform, Total & E.coli, Fecal, Asbestos, PAH, moisture, lipid analysis, HOLD

	Sample Identification	Lab Identification	Sample Type	Date/Time Sampled	PAH	moisture	lipid analysis	HOLD
1	Clam 5	MC7093	Tissue	Apr. 21/15	X	X	X	
2	Clam 6	MC7094	↓	↓	X	X	X	
3	Clam 7	MC7095		Apr. 22/15	X	X	X	
4	clam 8	MC7096		"	X	X	X	
5	veg 1	MC7097		Apr. 21/15	X	X	X	
6	Veg 2	MC7098			X	X	X	
7	Veg 3	MC7099			X	X	X	
8	Veg 4	MC7100			X	X	X	
9	Veg 5	MC7101		↓	X	X	X	
10	Veg 6	MC7102		Apr. 22/15	X	X	X	
11	Veg 7	MC7103	↓		X	X	X	
12	Veg 8	MC7104		↓	X	X	X	

Samples are from a Drinking Water Source? YES ☐ NO ☐

Does source supply multiple households? YES ☐ NO ☐

B533315

Laboratory Use Only

*Relinquished by:	Date (YY/MM/DD):	Time:	Received by:	Date (YY/MM/DD):	Time:	Time Sensitive	Temperature on Receipt (°C)	Custody Seal Intact on Cooler?
[signature]	15/04/23	4:00 pm				☐		Yes ☐ No ☐

*IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORD. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.

White: Maxxam Yellow: Client

COC-1020 (05/10)

Maxxam International Corporation o/a Maxxam Analytics

Maxxam

4606 Canada Way, Burnaby, BC Canada V5G 1K5 Ph: 604 734 7276 Toll Free: 1 800 665 8566 Fax: 604 731 2386

Maxxam Job#: B533315

CHAIN OF CUSTODY RECORD
Page: 3 of 4
G 079953

Invoice To: Require Report? Yes [X] No [ ]		Report To:	
Company Name:	TetraTechEBA	Company Name:	TetraTechEBA
Contact Name:	Cora Paul	Contact Name:	Kristy Gabelhouse
Address:		Address:	
PC:		PC:	
Phone / Fax#:	Ph: Fax:	Phone / Fax#:	Ph: Fax:
E-mail	Cora.Paul@tetratech.c…	E-mail	kristy.gabelhouse@tetratech…

PO #:	
Quotation #:	
Project #:	ENVIND03511-02.001
Proj. Name:	CON DIA
Location:	
Sampled By:	K. Gabelhouse

REGULATORY REQUIREMENTS SERVICE REQUESTED:

- [X] CSR
- [ ] CCME
- [ ] BC Water Quality
- [ ] Other
- [ ] DRINKING WATER
- [X] Regular Turn Around Time (TAT) (5 days for most tests)
- [ ] RUSH (Please contact the lab) [ ] 1 Day [ ] 2 Day [ ] 3 Day
- Date Required:

Special Instructions:
Return Cooler [ ] Ship Sample Bottles (please specify) [ ]
PAH extraction only for Reference Samples

ANALYSIS REQUESTED

Printed analysis columns: BTEX/VPH, MTBE, VOC/VPH, EPH, TEH, PAH, LEPH/HEPH, CCME-PHC (Fractions 1-4 Plus BTEX), CCME-PHC (Fractions 2-4), CCME BTEX (Fraction 1 Plus BTEX), PCB, Phenols by 4AAP, Phenols by GCMS, TOG, MOG, SWOG, Dissolved Metals (Field Filtered? Y/N), Field Acidified? (Y/N), Totals Metals Field Acidified? (Y/N), Nitrate, Nitrite, Ammonia, Chloride, Fluoride, Sulphate, Total Suspended Solids-TSS, TDS, pH, Conductivity, Alkalinity, BOD, COD, Coliform, Total & E.coli, Fecal, Asbestos; handwritten: Lipid, moisture, PAH extraction, HOLD for PAH analysis; HOLD

#	Sample Identification	Lab Identification	Sample Type	Date/Time Sampled	Lipid	moisture	PAH extraction	HOLD for PAH analysis	HOLD
1	Crab Ref 1	MC7106	Tissue	April 2115	X	X	X	X	
2	Crab Ref 2	MC7107			X	X	X	X	
3	Crab Ref 3	MC7108			~~X~~	~~X~~	~~X~~	~~X~~	X
4	Crab Ref 4	MC7109			~~X~~	~~X~~	~~X~~	~~X~~	X
5	Clam Ref 1	MC7110			X	X	X	X	
6	Clam Ref 2	MC7111			X	X	X	X	
7	Clam Ref 3	MC7112			~~X~~	~~X~~	~~X~~	~~X~~	X
8	Clam Ref 4	MC7113			~~X~~	~~X~~	~~X~~	~~X~~	X
9	Veg Ref 1	MC7114			X	X	X	X	
10	Veg Ref 2	MC7115			X	X	X	X	
11	Veg Ref 3	MC7116			~~X~~	~~X~~	~~X~~	~~X~~	X
12	Veg Ref 4	MC7117			~~X~~	~~X~~	~~X~~	~~X~~	X

B533315

Samples are from a Drinking Water Source? YES [ ] NO [ ]
Does source supply multiple households? YES [ ] NO [ ]

*Relinquished by:	Date (YY/MM/DD):	Time:	Received by:	Date (YY/MM/DD):	Time:
(signature)	15/04/23	4:00pm			

Laboratory Use Only: Time Sensitive [ ] | Temperature on Receipt (°C) | Custody Seal Intact on Cooler? Yes [ ] No [ ]

*IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORD. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.

White: Maxxam Yellow: Client

COC-1020 (05/10)

Maxxam International Corporation o/a Maxxam Analytics

Maxxam

4606 Canada Way, Burnaby, BC Canada V5G 1K5 Ph: 604 734 7276 Toll Free: 1 800 665 8566 Fax: 604 731 2386

Maxxam Job#: B533215

CHAIN OF CUSTODY RECORD

Page: 4 of 4

G 79954

Invoice To: Require Report? Yes [X] No [ ]

Company Name: TetraTech EBA
Contact Name: Lora Paul
Address:
PC:
Phone / Fax#: Ph: Fax:
E-mail: lora.paul@tetratech.com

Report To:

Company Name: EBA
Contact Name:
Address:
PC:
Phone / Fax#: Ph Fax
E-mail: Kristy.luth...e@tetratech.c...

PO #:
Quotation #:
Project #: ENVINDOS 11 02.001
Proj. Name:
Location:
Sampled By: EA Lethouse

REGULATORY REQUIREMENTS SERVICE REQUESTED:

- [X] CSR
- [ ] CCME
- [ ] BC Water Quality
- [ ] Other
- [ ] DRINKING WATER

- [X] Regular Turn Around Time (TAT) (5 days for most tests)
- [ ] RUSH (Please contact the lab) [ ] 1 Day [ ] 2 Day [ ] 3 Day
- Date Required:

Special Instructions:

Return Cooler [ ] Ship Sample Bottles (please specify) [ ]

ANALYSIS REQUESTED

Analysis columns: BTEX/VPH, MTBE, VOC/VPH, EPH, TEH, PAH, LEPH/HEPH, CCME-PHC (Fractions 1-4 Plus BTEX), CCME-PHC (Fractions 2-4), CCME BTEX (Fraction 1 Plus BTEX), PCB, Phenols by 4AAP, Phenols by GCMS, TOG, MOG, SWOG, Dissolved Metals (Field Filtered? Y/N), Field Acidified? Y/N, Totals Metals Field Acidified? Y/N, Nitrate, Nitrite, Ammonia, Chloride, Fluoride, Sulphate, Total Suspended Solids-TSS, TDS, pH, Conductivity, Alkalinity, BOD, COD, Coliform, Total & E.coli, Fecal, Asbestos, PAH, moisture, lipid analysis, HOLD

#	Sample Identification	Lab Identification	Sample Type	Date/Time Sampled	PAH	moisture	lipid analysis
1	Clam Dup	MC7130	tissue	Apr. 12/15	X	X	X
2	Veg Dup	MC7131	tissue	Apr. 22/15	X	X	X
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							

Samples are from a Drinking Water Source? YES / NO
Does source supply multiple households? YES / NO

B533315

Laboratory Use Only

*Relinquished by:	Date (YY/MM/DD):	Time:	Received by:	Date (YY/MM/DD):	Time:	Time Sensitive	Temperature on Receipt (°C)	Custody Seal Intact on Cooler?
[signature]	15/04/23	4:00pm				[ ]		Yes / No

*IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORD. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.

White: Maxxam Yellow: Client

COC-1020 (05/10)

Maxxam International Corporation o/a Maxxam Analytics

Success Through Science®

Your Project #: ENVINDO3511-02.001
Site Location: CONDRA

Attention:Kristy Gabelhouse

Tetra Tech EBA Inc.
Nanaimo
#1 - 4376 Boban Drive
Nanaimo, BC
Canada V9T 6A7

Report Date: 2015/05/13
Report #: R3427208
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B576434
Received: 2015/04/28, 09:25

Sample Matrix: TISSUE
Samples Received: 26

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Reference
Polycyclic Aromatic Hydrocarbons (PAH)	11	2015/05/07	2015/05/09	BBY4SOP-00108	SOPPOPWSB,ENVCAN.04
Polycyclic Aromatic Hydrocarbons (PAH)	15	2015/05/07	2015/05/10	BBY4SOP-00108	SOPPOPWSB,ENVCAN.04

Reference Method suffix “m” indicates test methods incorporate validated modifications from specific reference methods to improve performance.
* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Brian Jang, B.Sc., CS Rep-Food Science and Safety Division
Email: BJang@maxxam.ca
Phone# (604)639-2604
==
Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Maxxam Job #: B576434
Report Date: 2015/05/13

Tetra Tech EBA Inc.
Client Project #: ENVINDO3511-02.001
Site Location: CONDRA

RESULTS OF ANALYSES OF TISSUE

Maxxam ID		AEJ242	AEJ243	AEJ244			
Sampling Date		2015/04/20	2015/04/20	2015/04/21			
	Units	**MC7076-01R/ CRAB 1**	**MC7077-01R/ CRAB 2**	**MC7078-01R/ CRAB 3**	**RDL**	**MDL**	**QC Batch**
Polyaromatic Hydrocarbons							
Naphthalene	ug/g	<0.0025	<0.0025	<0.0025	0.0025	N/A	4014546
Acenaphthylene	ug/g	<0.0025	<0.0025	<0.0025	0.0025	N/A	4014546
Acenaphthene	ug/g	<0.0025	<0.0025	<0.0025	0.0025	N/A	4014546
Fluorene	ug/g	<0.0025	<0.0025	<0.0025	0.0025	N/A	4014546
Phenanthrene	ug/g	<0.0025	<0.0025	<0.0025	0.0025	N/A	4014546
Anthracene	ug/g	<0.0025	<0.0025	<0.0025	0.0025	N/A	4014546
Fluoranthene	ug/g	<0.0025	<0.0025	<0.0025	0.0025	N/A	4014546
Pyrene	ug/g	<0.0025	<0.0025	<0.0025	0.0025	N/A	4014546
Benzo(a)anthracene	ug/g	<0.0025	<0.0025	<0.0025	0.0025	N/A	4014546
Chrysene	ug/g	<0.0025	<0.0025	<0.0025	0.0025	N/A	4014546
Benzo(b)fluoranthene	ug/g	<0.0025	<0.0025	<0.0025	0.0025	N/A	4014546
Benzo(k)fluoranthene	ug/g	<0.0025	<0.0025	<0.0025	0.0025	N/A	4014546
Benzo(a)pyrene	ug/g	<0.0050	<0.0050	<0.0050	0.0050	N/A	4014546
Indeno(1,2,3-cd)pyrene	ug/g	<0.0050	<0.0050	<0.0050	0.0050	N/A	4014546
Dibenz(a,h)anthracene	ug/g	<0.0050	<0.0050	<0.0050	0.0050	N/A	4014546
Benzo(g,h,i)perylene	ug/g	<0.0050	<0.0050	<0.0050	0.0050	N/A	4014546
Surrogate Recovery (%)							
D10-Acenaphthene	%	75	56	77			4014546
D10-Phenanthrene	%	77	59	77			4014546
D12-Chrysene	%	82	64	86			4014546
D12-Perylene	%	100	100	100			4014546
D8-Naphthalene	%	64	46	64			4014546

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
N/A = Not Applicable

Maxxam Analytics International Corporation o/a Maxxam Analytics 4606 Canada Way, Burnaby, BC V5G 1K5 Tel: (604) 734-7276, Toll Free 1-800-665-8566, Fax: (604) 731-2386 www.maxxamanalytics.com

Maxxam Job #: B576434
Report Date: 2015/05/13

Tetra Tech EBA Inc.
Client Project #: ENVINDO3511-02.001
Site Location: CONDRA

RESULTS OF ANALYSES OF TISSUE

Maxxam ID		AEJ245	AEJ246	AEJ247			
Sampling Date		2015/04/21	2015/04/21	2015/04/21			
	Units	**MC7079-01R/ CRAB 4**	**MC7080-01R/ CRAB 5**	**MC7081-01R/ CRAB 6**	**RDL**	**MDL**	**QC Batch**
Polyaromatic Hydrocarbons							
Naphthalene	ug/g	<0.0025	<0.0025	<0.0025	0.0025	N/A	4014546
Acenaphthylene	ug/g	<0.0025	<0.0025	<0.0025	0.0025	N/A	4014546
Acenaphthene	ug/g	<0.0025	<0.0025	<0.0025	0.0025	N/A	4014546
Fluorene	ug/g	<0.0025	<0.0025	<0.0025	0.0025	N/A	4014546
Phenanthrene	ug/g	<0.0025	<0.0025	<0.0025	0.0025	N/A	4014546
Anthracene	ug/g	<0.0025	<0.0025	<0.0025	0.0025	N/A	4014546
Fluoranthene	ug/g	<0.0025	<0.0025	<0.0025	0.0025	N/A	4014546
Pyrene	ug/g	<0.0025	<0.0025	<0.0025	0.0025	N/A	4014546
Benzo(a)anthracene	ug/g	<0.0025	<0.0025	<0.0025	0.0025	N/A	4014546
Chrysene	ug/g	<0.0025	<0.0025	<0.0025	0.0025	N/A	4014546
Benzo(b)fluoranthene	ug/g	<0.0025	<0.0025	<0.0025	0.0025	N/A	4014546
Benzo(k)fluoranthene	ug/g	<0.0025	<0.0025	<0.0025	0.0025	N/A	4014546
Benzo(a)pyrene	ug/g	<0.0050	<0.0050	<0.0050	0.0050	N/A	4014546
Indeno(1,2,3-cd)pyrene	ug/g	<0.0050	<0.0050	<0.0050	0.0050	N/A	4014546
Dibenz(a,h)anthracene	ug/g	<0.0050	<0.0050	<0.0050	0.0050	N/A	4014546
Benzo(g,h,i)perylene	ug/g	<0.0050	<0.0050	<0.0050	0.0050	N/A	4014546
Surrogate Recovery (%)							
D10-Acenaphthene	%	68	63	64			4014546
D10-Phenanthrene	%	71	67	67			4014546
D12-Chrysene	%	70	71	72			4014546
D12-Perylene	%	100	100	100			4014546
D8-Naphthalene	%	55	51	53			4014546

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
N/A = Not Applicable

Maxxam Job #: B576434
Report Date: 2015/05/13

Tetra Tech EBA Inc.
Client Project #: ENVINDO3511-02.001
Site Location: CONDRA

RESULTS OF ANALYSES OF TISSUE

Maxxam ID		AEJ248	AEJ249	AEJ250			
Sampling Date		2015/04/22	2015/04/22	2015/04/21			
	Units	MC7082-01R/ CRAB 7	MC7083-01R/ CRAB 8	MC7084-01R/ CLAM 1	RDL	MDL	QC Batch
Polyaromatic Hydrocarbons							
Naphthalene	ug/g	<0.0025	<0.0025	<0.0025	0.0025	N/A	4014546
Acenaphthylene	ug/g	<0.0025	<0.0025	<0.0025	0.0025	N/A	4014546
Acenaphthene	ug/g	<0.0025	<0.0025	<0.0025	0.0025	N/A	4014546
Fluorene	ug/g	<0.0025	<0.0025	<0.0025	0.0025	N/A	4014546
Phenanthrene	ug/g	<0.0025	<0.0025	0.0040	0.0025	N/A	4014546
Anthracene	ug/g	<0.0025	<0.0025	<0.0025	0.0025	N/A	4014546
Fluoranthene	ug/g	<0.0025	<0.0025	0.0072	0.0025	N/A	4014546
Pyrene	ug/g	<0.0025	<0.0025	0.0049	0.0025	N/A	4014546
Benzo(a)anthracene	ug/g	<0.0025	<0.0025	0.0039	0.0025	N/A	4014546
Chrysene	ug/g	<0.0025	<0.0025	0.0064	0.0025	N/A	4014546
Benzo(b)fluoranthene	ug/g	<0.0025	<0.0025	<0.0025	0.0025	N/A	4014546
Benzo(k)fluoranthene	ug/g	<0.0025	<0.0025	<0.0025	0.0025	N/A	4014546
Benzo(a)pyrene	ug/g	<0.0050	<0.0050	<0.0050	0.0050	N/A	4014546
Indeno(1,2,3-cd)pyrene	ug/g	<0.0050	<0.0050	<0.0050	0.0050	N/A	4014546
Dibenz(a,h)anthracene	ug/g	<0.0050	<0.0050	<0.0050	0.0050	N/A	4014546
Benzo(g,h,i)perylene	ug/g	<0.0050	<0.0050	<0.0050	0.0050	N/A	4014546
Surrogate Recovery (%)							
D10-Acenaphthene	%	56	72	76			4014546
D10-Phenanthrene	%	61	77	79			4014546
D12-Chrysene	%	61	85	83			4014546
D12-Perylene	%	100	100	100			4014546
D8-Naphthalene	%	45	58	62			4014546

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
N/A = Not Applicable

Maxxam Analytics International Corporation o/a Maxxam Analytics 4606 Canada Way, Burnaby, BC V5G 1K5 Tel: (604) 734-7276, Toll Free 1-800-665-8566, Fax: (604) 731-2386 www.maxxamanalytics.com

Maxxam Job #: B576434
Report Date: 2015/05/13

Tetra Tech EBA Inc.
Client Project #: ENVINDO3511-02.001
Site Location: CONDRA

RESULTS OF ANALYSES OF TISSUE

Maxxam ID		AEJ251	AEJ252	AEJ253			
Sampling Date		2015/04/21	2015/04/21	2015/04/21			
	Units	**MC7085-01R/ CLAM 2**	**MC7086-01R/ CLAM 3**	**MC7087-01R/ CLAM 4**	**RDL**	**MDL**	**QC Batch**
Polyaromatic Hydrocarbons							
Naphthalene	ug/g	<0.0025	<0.0025	<0.0025	0.0025	N/A	4014546
Acenaphthylene	ug/g	<0.0025	<0.0025	<0.0025	0.0025	N/A	4014546
Acenaphthene	ug/g	<0.0025	<0.0025	<0.0025	0.0025	N/A	4014546
Fluorene	ug/g	<0.0025	<0.0025	<0.0025	0.0025	N/A	4014546
Phenanthrene	ug/g	0.0049	0.0031	0.0055	0.0025	N/A	4014546
Anthracene	ug/g	<0.0025	<0.0025	0.0059	0.0025	N/A	4014546
Fluoranthene	ug/g	0.0075	0.0044	0.0096	0.0025	N/A	4014546
Pyrene	ug/g	0.0059	0.0031	0.0065	0.0025	N/A	4014546
Benzo(a)anthracene	ug/g	0.0034	<0.0025	0.0031	0.0025	N/A	4014546
Chrysene	ug/g	0.0054	<0.0025	0.0043	0.0025	N/A	4014546
Benzo(b)fluoranthene	ug/g	0.0033	<0.0025	<0.0025	0.0025	N/A	4014546
Benzo(k)fluoranthene	ug/g	0.0030	<0.0025	<0.0025	0.0025	N/A	4014546
Benzo(a)pyrene	ug/g	<0.0050	<0.0050	<0.0050	0.0050	N/A	4014546
Indeno(1,2,3-cd)pyrene	ug/g	<0.0050	<0.0050	<0.0050	0.0050	N/A	4014546
Dibenz(a,h)anthracene	ug/g	<0.0050	<0.0050	<0.0050	0.0050	N/A	4014546
Benzo(g,h,i)perylene	ug/g	<0.0050	<0.0050	<0.0050	0.0050	N/A	4014546
Surrogate Recovery (%)							
D10-Acenaphthene	%	67	74	71			4014546
D10-Phenanthrene	%	70	77	76			4014546
D12-Chrysene	%	78	76	81			4014546
D12-Perylene	%	100	100	100			4014546
D8-Naphthalene	%	56	62	56			4014546

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
N/A = Not Applicable

Maxxam Job #: B576434
Report Date: 2015/05/13

Tetra Tech EBA Inc.
Client Project #: ENVINDO3511-02.001
Site Location: CONDRA

RESULTS OF ANALYSES OF TISSUE

Maxxam ID		AEJ254	AEJ255	AEJ256			
Sampling Date		2015/04/21	2015/04/21	2015/04/22			
	Units	MC7093-01R/ CLAM 5	MC7094-01R/ CLAM 6	MC7095-01R/ CLAM 7	RDL	MDL	QC Batch
Polyaromatic Hydrocarbons							
Naphthalene	ug/g	<0.0025	<0.0025	<0.0025	0.0025	N/A	4014546
Acenaphthylene	ug/g	<0.0025	<0.0025	<0.0025	0.0025	N/A	4014546
Acenaphthene	ug/g	<0.0025	<0.0025	<0.0025	0.0025	N/A	4014546
Fluorene	ug/g	<0.0025	<0.0025	<0.0025	0.0025	N/A	4014546
Phenanthrene	ug/g	<0.0025	0.0036	0.0068	0.0025	N/A	4014546
Anthracene	ug/g	<0.0025	<0.0025	<0.0025	0.0025	N/A	4014546
Fluoranthene	ug/g	<0.0025	0.0049	0.0118	0.0025	N/A	4014546
Pyrene	ug/g	<0.0025	0.0040	0.0077	0.0025	N/A	4014546
Benzo(a)anthracene	ug/g	<0.0025	<0.0025	0.0043	0.0025	N/A	4014546
Chrysene	ug/g	<0.0025	0.0028	0.0051	0.0025	N/A	4014546
Benzo(b)fluoranthene	ug/g	<0.0025	<0.0025	<0.0025	0.0025	N/A	4014546
Benzo(k)fluoranthene	ug/g	<0.0025	<0.0025	<0.0025	0.0025	N/A	4014546
Benzo(a)pyrene	ug/g	<0.0050	<0.0050	<0.0050	0.0050	N/A	4014546
Indeno(1,2,3-cd)pyrene	ug/g	<0.0050	<0.0050	<0.0050	0.0050	N/A	4014546
Dibenz(a,h)anthracene	ug/g	<0.0050	<0.0050	<0.0050	0.0050	N/A	4014546
Benzo(g,h,i)perylene	ug/g	<0.0050	<0.0050	<0.0050	0.0050	N/A	4014546
Surrogate Recovery (%)							
D10-Acenaphthene	%	64	76	74			4014546
D10-Phenanthrene	%	69	77	76			4014546
D12-Chrysene	%	69	76	80			4014546
D12-Perylene	%	100	100	100			4014546
D8-Naphthalene	%	52	63	57			4014546

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
N/A = Not Applicable

Maxxam Job #: B576434
Report Date: 2015/05/13

Tetra Tech EBA Inc.
Client Project #: ENVINDO3511-02.001
Site Location: CONDRA

RESULTS OF ANALYSES OF TISSUE

Maxxam ID		AEJ257		AEJ258	AEJ259			
Sampling Date		2015/04/22		2015/04/21	2015/04/21			
	Units	MC7096-01R/ CLAM 8	QC Batch	MC7097-01R/ VEG 1	MC7098-01R/ VEG 2	RDL	MDL	QC Batch
Polyaromatic Hydrocarbons								
Naphthalene	ug/g	<0.0025	4014546	<0.0025	<0.0025	0.0025	N/A	4009777
Acenaphthylene	ug/g	<0.0025	4014546	<0.0025	<0.0025	0.0025	N/A	4009777
Acenaphthene	ug/g	<0.0025	4014546	<0.0025	<0.0025	0.0025	N/A	4009777
Fluorene	ug/g	<0.0025	4014546	<0.0025	<0.0025	0.0025	N/A	4009777
Phenanthrene	ug/g	0.0039	4014546	<0.0025	<0.0025	0.0025	N/A	4009777
Anthracene	ug/g	<0.0025	4014546	<0.0025	<0.0025	0.0025	N/A	4009777
Fluoranthene	ug/g	0.0045	4014546	<0.0025	<0.0025	0.0025	N/A	4009777
Pyrene	ug/g	0.0026	4014546	<0.0025	<0.0025	0.0025	N/A	4009777
Benzo(a)anthracene	ug/g	<0.0025	4014546	<0.0025	<0.0025	0.0025	N/A	4009777
Chrysene	ug/g	<0.0025	4014546	<0.0025	<0.0025	0.0025	N/A	4009777
Benzo(b)fluoranthene	ug/g	<0.0025	4014546	<0.0025	<0.0025	0.0025	N/A	4009777
Benzo(k)fluoranthene	ug/g	<0.0025	4014546	<0.0025	<0.0025	0.0025	N/A	4009777
Benzo(a)pyrene	ug/g	<0.0050	4014546	<0.0050	<0.0050	0.0050	N/A	4009777
Indeno(1,2,3-cd)pyrene	ug/g	<0.0050	4014546	<0.0050	<0.0050	0.0050	N/A	4009777
Dibenz(a,h)anthracene	ug/g	<0.0050	4014546	<0.0050	<0.0050	0.0050	N/A	4009777
Benzo(g,h,i)perylene	ug/g	<0.0050	4014546	<0.0050	<0.0050	0.0050	N/A	4009777
Surrogate Recovery (%)								
D10-Acenaphthene	%	66	4014546	91	90			4009777
D10-Phenanthrene	%	69	4014546	89	89			4009777
D12-Chrysene	%	71	4014546	93	104			4009777
D12-Perylene	%	100	4014546	100	100			4009777
D8-Naphthalene	%	56	4014546	82	84			4009777

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
N/A = Not Applicable

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Maxxam Job #: B576434
Report Date: 2015/05/13

Tetra Tech EBA Inc.
Client Project #: ENVINDO3511-02.001
Site Location: CONDRA

RESULTS OF ANALYSES OF TISSUE

Maxxam ID		AEJ260	AEJ261	AEJ262	AEJ263			
Sampling Date		2015/04/21	2015/04/21	2015/04/21	2015/04/22			
	Units	**MC7099-01R/ VEG 3**	**MC7100-01R/ VEG 4**	**MC7101-01R/ VEG 5**	**MC7102-01R/ VEG 6**	**RDL**	**MDL**	**QC Batch**
Polyaromatic Hydrocarbons								
Naphthalene	ug/g	<0.0025	<0.0025	<0.0025	<0.0025	0.0025	N/A	4009777
Acenaphthylene	ug/g	<0.0025	<0.0025	<0.0025	<0.0025	0.0025	N/A	4009777
Acenaphthene	ug/g	<0.0025	<0.0025	<0.0025	<0.0025	0.0025	N/A	4009777
Fluorene	ug/g	<0.0025	<0.0025	<0.0025	<0.0025	0.0025	N/A	4009777
Phenanthrene	ug/g	<0.0025	<0.0025	<0.0025	<0.0025	0.0025	N/A	4009777
Anthracene	ug/g	<0.0025	<0.0025	<0.0025	<0.0025	0.0025	N/A	4009777
Fluoranthene	ug/g	<0.0025	<0.0025	<0.0025	<0.0025	0.0025	N/A	4009777
Pyrene	ug/g	<0.0025	<0.0025	<0.0025	<0.0025	0.0025	N/A	4009777
Benzo(a)anthracene	ug/g	<0.0025	<0.0025	<0.0025	<0.0025	0.0025	N/A	4009777
Chrysene	ug/g	<0.0025	<0.0025	<0.0025	<0.0025	0.0025	N/A	4009777
Benzo(b)fluoranthene	ug/g	<0.0025	<0.0025	<0.0025	<0.0025	0.0025	N/A	4009777
Benzo(k)fluoranthene	ug/g	<0.0025	<0.0025	<0.0025	<0.0025	0.0025	N/A	4009777
Benzo(a)pyrene	ug/g	<0.0050	<0.0050	<0.0050	<0.0050	0.0050	N/A	4009777
Indeno(1,2,3-cd)pyrene	ug/g	<0.0050	<0.0050	<0.0050	<0.0050	0.0050	N/A	4009777
Dibenz(a,h)anthracene	ug/g	<0.0050	<0.0050	<0.0050	<0.0050	0.0050	N/A	4009777
Benzo(g,h,i)perylene	ug/g	<0.0050	<0.0050	<0.0050	<0.0050	0.0050	N/A	4009777
Surrogate Recovery (%)								
D10-Acenaphthene	%	90	86	93	93			4009777
D10-Phenanthrene	%	87	86	89	91			4009777
D12-Chrysene	%	101	98	104	104			4009777
D12-Perylene	%	100	100	100	100			4009777
D8-Naphthalene	%	85	80	85	84			4009777

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
N/A = Not Applicable

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Maxxam Job #: B576434
Report Date: 2015/05/13

Tetra Tech EBA Inc.
Client Project #: ENVINDO3511-02.001
Site Location: CONDRA

RESULTS OF ANALYSES OF TISSUE

Maxxam ID		AEJ264	AEJ265		AEJ272			
Sampling Date		2015/04/22	2015/04/22		2015/04/21			
	Units	**MC7103-01R/ VEG 7**	**MC7104-01R/ VEG 8**	**QC Batch**	**MC7130-01R/ CLAM DUP**	**RDL**	**MDL**	**QC Batch**
Polyaromatic Hydrocarbons								
Naphthalene	ug/g	<0.0025	<0.0025	4009777	<0.0025	0.0025	N/A	4014546
Acenaphthylene	ug/g	<0.0025	<0.0025	4009777	<0.0025	0.0025	N/A	4014546
Acenaphthene	ug/g	<0.0025	<0.0025	4009777	<0.0025	0.0025	N/A	4014546
Fluorene	ug/g	<0.0025	<0.0025	4009777	<0.0025	0.0025	N/A	4014546
Phenanthrene	ug/g	0.0034	<0.0025	4009777	0.0140	0.0025	N/A	4014546
Anthracene	ug/g	<0.0025	<0.0025	4009777	0.0062	0.0025	N/A	4014546
Fluoranthene	ug/g	0.0100	0.0054	4009777	0.0287	0.0025	N/A	4014546
Pyrene	ug/g	0.0072	0.0040	4009777	0.0243	0.0025	N/A	4014546
Benzo(a)anthracene	ug/g	0.0031	<0.0025	4009777	0.0116	0.0025	N/A	4014546
Chrysene	ug/g	0.0056	<0.0025	4009777	0.0137	0.0025	N/A	4014546
Benzo(b)fluoranthene	ug/g	0.0050	<0.0025	4009777	0.0061	0.0025	N/A	4014546
Benzo(k)fluoranthene	ug/g	0.0045	<0.0025	4009777	0.0072	0.0025	N/A	4014546
Benzo(a)pyrene	ug/g	<0.0050	<0.0050	4009777	0.0077	0.0050	N/A	4014546
Indeno(1,2,3-cd)pyrene	ug/g	<0.0050	<0.0050	4009777	<0.0050	0.0050	N/A	4014546
Dibenz(a,h)anthracene	ug/g	<0.0050	<0.0050	4009777	<0.0050	0.0050	N/A	4014546
Benzo(g,h,i)perylene	ug/g	<0.0050	<0.0050	4009777	<0.0050	0.0050	N/A	4014546
Surrogate Recovery (%)								
D10-Acenaphthene	%	91	90	4009777	76			4014546
D10-Phenanthrene	%	89	87	4009777	78			4014546
D12-Chrysene	%	105	98	4009777	87			4014546
D12-Perylene	%	100	100	4009777	100			4014546
D8-Naphthalene	%	84	85	4009777	64			4014546

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
N/A = Not Applicable

Maxxam Job #: B576434
Report Date: 2015/05/13

Tetra Tech EBA Inc.
Client Project #: ENVINDO3511-02.001
Site Location: CONDRA

RESULTS OF ANALYSES OF TISSUE

Maxxam ID		AEJ273			
Sampling Date		2015/04/21			
	Units	**MC7131-01R/ VEG DUP**	**RDL**	**MDL**	**QC Batch**
Polyaromatic Hydrocarbons					
Naphthalene	ug/g	<0.0025	0.0025	N/A	4009777
Acenaphthylene	ug/g	<0.0025	0.0025	N/A	4009777
Acenaphthene	ug/g	<0.0025	0.0025	N/A	4009777
Fluorene	ug/g	<0.0025	0.0025	N/A	4009777
Phenanthrene	ug/g	<0.0025	0.0025	N/A	4009777
Anthracene	ug/g	<0.0025	0.0025	N/A	4009777
Fluoranthene	ug/g	0.0040	0.0025	N/A	4009777
Pyrene	ug/g	0.0030	0.0025	N/A	4009777
Benzo(a)anthracene	ug/g	<0.0025	0.0025	N/A	4009777
Chrysene	ug/g	0.0033	0.0025	N/A	4009777
Benzo(b)fluoranthene	ug/g	<0.0025	0.0025	N/A	4009777
Benzo(k)fluoranthene	ug/g	<0.0025	0.0025	N/A	4009777
Benzo(a)pyrene	ug/g	<0.0050	0.0050	N/A	4009777
Indeno(1,2,3-cd)pyrene	ug/g	<0.0050	0.0050	N/A	4009777
Dibenz(a,h)anthracene	ug/g	<0.0050	0.0050	N/A	4009777
Benzo(g,h,i)perylene	ug/g	<0.0050	0.0050	N/A	4009777
Surrogate Recovery (%)					
D10-Acenaphthene	%	89			4009777
D10-Phenanthrene	%	88			4009777
D12-Chrysene	%	104			4009777
D12-Perylene	%	100			4009777
D8-Naphthalene	%	81			4009777

RDL = Reportable Detection Limit
QC Batch = Quality Control Batch
N/A = Not Applicable

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Tetra Tech EBA Inc.
Client Project #: ENVINDO3511-02.001
Site Location: CONDRA

GENERAL COMMENTS

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

Package 1	5.7°C

Results relate only to the items tested.

QUALITY ASSURANCE REPORT

			Spiked Blank		Method Blank		RPD		Reagent Blank	
QC Batch	Parameter	Date	% Recovery	QC Limits	Value	Units	Value (%)	QC Limits	Value	Units
4009777	D10-Acenaphthene	2015/05/09	102	33 - 124	78	%			79	%
4009777	D10-Phenanthrene	2015/05/09	101	39 - 123	77	%			80	%
4009777	D12-Chrysene	2015/05/09	94	37 - 121	70	%			77	%
4009777	D12-Perylene	2015/05/09	100	36 - 126	100	%			100	%
4009777	D8-Naphthalene	2015/05/09	96	22 - 117	73	%			71	%
4014546	D10-Acenaphthene	2015/05/09	78	33 - 124	76	%			89	%
4014546	D10-Phenanthrene	2015/05/09	82	39 - 123	79	%			91	%
4014546	D12-Chrysene	2015/05/09	89	37 - 121	83	%			96	%
4014546	D12-Perylene	2015/05/09	100	36 - 126	100	%			100	%
4014546	D8-Naphthalene	2015/05/09	66	22 - 117	62	%			75	%
4009777	Acenaphthene	2015/05/09	97	30 - 130	<0.0025	ug/g	NC	35	<0.0025	ug/g
4009777	Acenaphthylene	2015/05/09	96	30 - 130	<0.0025	ug/g	NC	35	<0.0025	ug/g
4009777	Anthracene	2015/05/09	96	25 - 130	<0.0025	ug/g	NC	35	<0.0025	ug/g
4009777	Benzo(a)anthracene	2015/05/09	89	30 - 140	<0.0025	ug/g	NC	35	<0.0025	ug/g
4009777	Benzo(a)pyrene	2015/05/09	96	30 - 130	<0.0050	ug/g	NC	35	<0.0050	ug/g
4009777	Benzo(b)fluoranthene	2015/05/09	98	30 - 130	<0.0025	ug/g	NC	35	<0.0025	ug/g
4009777	Benzo(g,h,i)perylene	2015/05/09	97	30 - 130	<0.0050	ug/g	NC	35	<0.0050	ug/g
4009777	Benzo(k)fluoranthene	2015/05/09	97	30 - 130	<0.0025	ug/g	NC	35	<0.0025	ug/g
4009777	Chrysene	2015/05/09	89	30 - 130	<0.0025	ug/g	NC	35	<0.0025	ug/g
4009777	Dibenz(a,h)anthracene	2015/05/09	96	30 - 130	<0.0050	ug/g	NC	35	<0.0050	ug/g
4009777	Fluoranthene	2015/05/09	97	30 - 130	<0.0025	ug/g	NC	35	<0.0025	ug/g
4009777	Fluorene	2015/05/09	96	30 - 130	<0.0025	ug/g	NC	35	<0.0025	ug/g
4009777	Indeno(1,2,3-cd)pyrene	2015/05/09	96	30 - 130	<0.0050	ug/g	NC	35	<0.0050	ug/g
4009777	Naphthalene	2015/05/09	100	20 - 130	<0.0025	ug/g	NC	35	<0.0025	ug/g
4009777	Phenanthrene	2015/05/09	98	30 - 130	<0.0025	ug/g	NC	35	<0.0025	ug/g
4009777	Pyrene	2015/05/09	96	30 - 130	<0.0025	ug/g	NC	35	<0.0025	ug/g
4014546	Acenaphthene	2015/05/09	77	30 - 130	<0.0025	ug/g	NC	35	<0.0025	ug/g
4014546	Acenaphthylene	2015/05/09	76	30 - 130	<0.0025	ug/g	NC	35	<0.0025	ug/g
4014546	Anthracene	2015/05/09	80	25 - 130	<0.0025	ug/g	NC	35	<0.0025	ug/g
4014546	Benzo(a)anthracene	2015/05/09	92	30 - 140	<0.0025	ug/g	NC	35	<0.0025	ug/g
4014546	Benzo(a)pyrene	2015/05/09	87	30 - 130	<0.0050	ug/g	NC	35	<0.0050	ug/g
4014546	Benzo(b)fluoranthene	2015/05/09	88	30 - 130	<0.0025	ug/g	NC	35	<0.0025	ug/g

QUALITY ASSURANCE REPORT(CONT'D)

			Spiked Blank		Method Blank		RPD		Reagent Blank	
QC Batch	Parameter	Date	% Recovery	QC Limits	Value	Units	Value (%)	QC Limits	Value	Units
4014546	Benzo(g,h,i)perylene	2015/05/09	88	30 - 130	<0.0050	ug/g	NC	35	<0.0050	ug/g
4014546	Benzo(k)fluoranthene	2015/05/09	88	30 - 130	<0.0025	ug/g	NC	35	<0.0025	ug/g
4014546	Chrysene	2015/05/09	90	30 - 130	<0.0025	ug/g	NC	35	<0.0025	ug/g
4014546	Dibenz(a,h)anthracene	2015/05/09	88	30 - 130	<0.0050	ug/g	NC	35	<0.0050	ug/g
4014546	Fluoranthene	2015/05/09	87	30 - 130	<0.0025	ug/g	NC	35	<0.0025	ug/g
4014546	Fluorene	2015/05/09	78	30 - 130	<0.0025	ug/g	NC	35	<0.0025	ug/g
4014546	Indeno(1,2,3-cd)pyrene	2015/05/09	88	30 - 130	<0.0050	ug/g	NC	35	<0.0050	ug/g
4014546	Naphthalene	2015/05/09	68	20 - 130	<0.0025	ug/g	NC	35	<0.0025	ug/g
4014546	Phenanthrene	2015/05/09	84	30 - 130	<0.0025	ug/g	NC	35	<0.0025	ug/g
4014546	Pyrene	2015/05/09	85	30 - 130	<0.0025	ug/g	NC	35	<0.0025	ug/g

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Reagent Blank: A blank matrix containing all reagents used in the analytical procedure. Used to determine any analytical contamination.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

Surrogate: A pure or isotopically labeled compound whose behavior mirrors the analytes of interest. Used to evaluate extraction efficiency.

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (one or both samples < 5x RDL).

Maxxam Job #: B576434
Report Date: 2015/05/13

Tetra Tech EBA Inc.
Client Project #: ENVINDO3511-02.001
Site Location: CONDRA

VALIDATION SIGNATURE PAGE

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

Heather White, Lab Supervisor

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

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APPENDIX C
PROUCL STATISTICAL OUTPUT

DSI Statistical ProUCL Output

	A–E	F	G–K	L
1	**UCL Statistics for Data Sets with Non-Detects**			
2				
3	User Selected Options			
4	Date/Time of Computation	8/10/2015 7:18:04 AM		
5	From File	proucl dsi.xls		
6	Full Precision	OFF		
7	Confidence Coefficient	95%		
8	Number of Bootstrap Operations	2000		
9				
10				
11	**2-methylnaphthalene**			
12				
13	**General Statistics**			
14	Total Number of Observations	28	Number of Distinct Observations	26
15			Number of Missing Observations	0
16	Minimum	0.18	Mean	2.04
17	Maximum	6	Median	1.35
18	SD	1.67	Std. Error of Mean	0.316
19	Coefficient of Variation	0.819	Skewness	1.289
20				
21	**Normal GOF Test**			
22	Shapiro Wilk Test Statistic	0.827	**Shapiro Wilk GOF Test**	
23	5% Shapiro Wilk Critical Value	0.924	Data Not Normal at 5% Significance Level	
24	Lilliefors Test Statistic	0.212	**Lilliefors GOF Test**	
25	5% Lilliefors Critical Value	0.167	Data Not Normal at 5% Significance Level	
26	**Data Not Normal at 5% Significance Level**			
27				
28	**Assuming Normal Distribution**			
29	**95% Normal UCL**		**95% UCLs (Adjusted for Skewness)**	
30	95% Student's-t UCL	2.578	95% Adjusted-CLT UCL (Chen-1995)	2.641
31			95% Modified-t UCL (Johnson-1978)	2.59
32				
33	**Gamma GOF Test**			
34	A-D Test Statistic	0.538	**Anderson-Darling Gamma GOF Test**	
35	5% A-D Critical Value	0.76	Detected data appear Gamma Distributed at 5% Significance Level	
36	K-S Test Statistic	0.127	**Kolmogrov-Smirnoff Gamma GOF Test**	
37	5% K-S Critical Value	0.168	Detected data appear Gamma Distributed at 5% Significance Level	
38	**Detected data appear Gamma Distributed at 5% Significance Level**			
39				
40	**Gamma Statistics**			
41	k hat (MLE)	1.746	k star (bias corrected MLE)	1.583
42	Theta hat (MLE)	1.169	Theta star (bias corrected MLE)	1.289
43	nu hat (MLE)	97.76	nu star (bias corrected)	88.62
44	MLE Mean (bias corrected)	2.04	MLE Sd (bias corrected)	1.622
45			Approximate Chi Square Value (0.05)	67.92
46	Adjusted Level of Significance	0.0404	Adjusted Chi Square Value	66.8

	A–E	F	G–K	L
47				
48	**Assuming Gamma Distribution**			
49	95% Approximate Gamma UCL (use when n>=50)	2.662	95% Adjusted Gamma UCL (use when n<50)	2.707
50				
51	**Lognormal GOF Test**			
52	Shapiro Wilk Test Statistic	0.97	**Shapiro Wilk Lognormal GOF Test**	
53	5% Shapiro Wilk Critical Value	0.924	Data appear Lognormal at 5% Significance Level	
54	Lilliefors Test Statistic	0.0844	**Lilliefors Lognormal GOF Test**	
55	5% Lilliefors Critical Value	0.167	Data appear Lognormal at 5% Significance Level	
56	**Data appear Lognormal at 5% Significance Level**			
57				
58	**Lognormal Statistics**			
59	Minimum of Logged Data	-1.715	Mean of logged Data	0.4
60	Maximum of Logged Data	1.792	SD of logged Data	0.833
61				
62	**Assuming Lognormal Distribution**			
63	95% H-UCL	3.033	90% Chebyshev (MVUE) UCL	3.163
64	95% Chebyshev (MVUE) UCL	3.655	97.5% Chebyshev (MVUE) UCL	4.338
65	99% Chebyshev (MVUE) UCL	5.679		
66				
67	**Nonparametric Distribution Free UCL Statistics**			
68	**Data appear to follow a Discernible Distribution at 5% Significance Level**			
69				
70	**Nonparametric Distribution Free UCLs**			
71	95% CLT UCL	2.559	95% Jackknife UCL	2.578
72	95% Standard Bootstrap UCL	2.562	95% Bootstrap-t UCL	2.693
73	95% Hall's Bootstrap UCL	2.61	95% Percentile Bootstrap UCL	2.585
74	95% BCA Bootstrap UCL	2.619		
75	90% Chebyshev(Mean, Sd) UCL	2.987	95% Chebyshev(Mean, Sd) UCL	3.416
76	97.5% Chebyshev(Mean, Sd) UCL	4.011	99% Chebyshev(Mean, Sd) UCL	5.18
77				
78	**Suggested UCL to Use**			
79	95% Adjusted Gamma UCL	2.707		
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	These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)			
83	and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.			
84	For additional insight the user may want to consult a statistician.			
85				
86				

	A–E	F	G–K	L
87	Acenaphthene			
88				
89	**General Statistics**			
90	Total Number of Observations	28	Number of Distinct Observations	25
91			Number of Missing Observations	0
92	Minimum	0.04	Mean	0.528
93	Maximum	1.1	Median	0.495
94	SD	0.27	Std. Error of Mean	0.051
95	Coefficient of Variation	0.511	Skewness	0.301
96				
97	**Normal GOF Test**			
98	Shapiro Wilk Test Statistic	0.972	**Shapiro Wilk GOF Test**	
99	5% Shapiro Wilk Critical Value	0.924	Data appear Normal at 5% Significance Level	
100	Lilliefors Test Statistic	0.125	**Lilliefors GOF Test**	
101	5% Lilliefors Critical Value	0.167	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	0.615	95% Adjusted-CLT UCL (Chen-1995)	0.615
107			95% Modified-t UCL (Johnson-1978)	0.616
108				
109	**Gamma GOF Test**			
110	A-D Test Statistic	0.451	**Anderson-Darling Gamma GOF Test**	
111	5% A-D Critical Value	0.754	Detected data appear Gamma Distributed at 5% Significance Level	
112	K-S Test Statistic	0.144	**Kolmogrov-Smirnoff Gamma GOF Test**	
113	5% K-S Critical Value	0.167	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)	2.927	k star (bias corrected MLE)	2.637
118	Theta hat (MLE)	0.18	Theta star (bias corrected MLE)	0.2
119	nu hat (MLE)	163.9	nu star (bias corrected)	147.7
120	MLE Mean (bias corrected)	0.528	MLE Sd (bias corrected)	0.325
121			Approximate Chi Square Value (0.05)	120.6
122	Adjusted Level of Significance	0.0404	Adjusted Chi Square Value	119.1
123				
124	**Assuming Gamma Distribution**			
125	95% Approximate Gamma UCL (use when n>=50))	0.647	95% Adjusted Gamma UCL (use when n<50)	0.655
126				

	A	B	C	D	E	F	G	H	I	J	K	L
127	**Lognormal GOF Test**											
128					Shapiro Wilk Test Statistic	0.873	**Shapiro Wilk Lognormal GOF Test**					
129					5% Shapiro Wilk Critical Value	0.924	Data Not Lognormal at 5% Significance Level					
130					Lilliefors Test Statistic	0.179	**Lilliefors Lognormal GOF Test**					
131					5% Lilliefors Critical Value	0.167	Data Not Lognormal at 5% Significance Level					
132	**Data Not Lognormal at 5% Significance Level**											
133												
134	**Lognormal Statistics**											
135					Minimum of Logged Data	-3.219					Mean of logged Data	-0.819
136					Maximum of Logged Data	0.0953					SD of logged Data	0.711
137												
138	**Assuming Lognormal Distribution**											
139					95% H-UCL	0.76					90% Chebyshev (MVUE) UCL	0.806
140					95% Chebyshev (MVUE) UCL	0.917					97.5% Chebyshev (MVUE) UCL	1.071
141					99% Chebyshev (MVUE) UCL	1.374						
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	0.612					95% Jackknife UCL	0.615
148					95% Standard Bootstrap UCL	0.61					95% Bootstrap-t UCL	0.62
149					95% Hall's Bootstrap UCL	0.616					95% Percentile Bootstrap UCL	0.607
150					95% BCA Bootstrap UCL	0.616						
151					90% Chebyshev(Mean, Sd) UCL	0.681					95% Chebyshev(Mean, Sd) UCL	0.751
152					97.5% Chebyshev(Mean, Sd) UCL	0.847					99% Chebyshev(Mean, Sd) UCL	1.036
153												
154	**Suggested UCL to Use**											
155					95% Student's-t UCL	0.615						
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	These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)											
159	and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.											
160	For additional insight the user may want to consult a statistician.											
161												

162	**Acenaphthylene**			
163				
164	**General Statistics**			
165	Total Number of Observations	28	Number of Distinct Observations	14
166	Number of Detects	10	Number of Non-Detects	18
167	Number of Distinct Detects	9	Number of Distinct Non-Detects	5
168	Minimum Detect	0.034	Minimum Non-Detect	0.01
169	Maximum Detect	0.16	Maximum Non-Detect	0.2
170	Variance Detects	0.00263	Percent Non-Detects	64.29%
171	Mean Detects	0.0806	SD Detects	0.0513
172	Median Detects	0.059	CV Detects	0.636
173	Skewness Detects	0.896	Kurtosis Detects	-1.227
174	Mean of Logged Detects	-2.688	SD of Logged Detects	0.601
175				
176	**Normal GOF Test on Detects Only**			
177	Shapiro Wilk Test Statistic	0.768	**Shapiro Wilk GOF Test**	
178	5% Shapiro Wilk Critical Value	0.842	Detected Data Not Normal at 5% Significance Level	
179	Lilliefors Test Statistic	0.327	**Lilliefors GOF Test**	
180	5% Lilliefors Critical Value	0.28	Detected Data Not Normal at 5% Significance Level	
181	**Detected Data Not Normal at 5% Significance Level**			
182				
183	**Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs**			
184	Mean	0.0493	Standard Error of Mean	0.00931
185	SD	0.0404	95% KM (BCA) UCL	0.065
186	95% KM (t) UCL	0.0651	95% KM (Percentile Bootstrap) UCL	0.0655
187	95% KM (z) UCL	0.0646	95% KM Bootstrap t UCL	0.0691
188	90% KM Chebyshev UCL	0.0772	95% KM Chebyshev UCL	0.0898
189	97.5% KM Chebyshev UCL	0.107	99% KM Chebyshev UCL	0.142
190				
191	**Gamma GOF Tests on Detected Observations Only**			
192	A-D Test Statistic	0.839	**Anderson-Darling GOF Test**	
193	5% A-D Critical Value	0.732	Detected Data Not Gamma Distributed at 5% Significance Level	
194	K-S Test Statistic	0.278	**Kolmogrov-Smirnoff GOF**	
195	5% K-S Critical Value	0.268	Detected Data Not Gamma Distributed at 5% Significance Level	
196	**Detected Data Not Gamma Distributed at 5% Significance Level**			
197				
198	**Gamma Statistics on Detected Data Only**			
199	k hat (MLE)	3.105	k star (bias corrected MLE)	2.24
200	Theta hat (MLE)	0.026	Theta star (bias corrected MLE)	0.036
201	nu hat (MLE)	62.09	nu star (bias corrected)	44.8
202	MLE Mean (bias corrected)	0.0806	MLE Sd (bias corrected)	0.0539
203				
204	**Gamma Kaplan-Meier (KM) Statistics**			
205	k hat (KM)	1.485	nu hat (KM)	83.15
206	Approximate Chi Square Value (83.15, α)	63.13	Adjusted Chi Square Value (83.15, β)	62.06
207	95% Gamma Approximate KM-UCL (use when n>=50)	0.0649	95% Gamma Adjusted KM-UCL (use when n<50)	0.066
208				

	A–E	F	G–K	L
209	**Gamma ROS Statistics using Imputed Non-Detects**			
210	GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs			
211	GROS may not be used when kstar of detected data is small such as < 0.1			
212	For such situations, GROS method tends to yield inflated values of UCLs and BTVs			
213	For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates			
214	Minimum	0.01	Mean	0.0441
215	Maximum	0.16	Median	0.0337
216	SD	0.0424	CV	0.963
217	k hat (MLE)	1.491	k star (bias corrected MLE)	1.355
218	Theta hat (MLE)	0.0296	Theta star (bias corrected MLE)	0.0325
219	nu hat (MLE)	83.52	nu star (bias corrected)	75.9
220	MLE Mean (bias corrected)	0.0441	MLE Sd (bias corrected)	0.0379
221			Adjusted Level of Significance (β)	0.0404
222	Approximate Chi Square Value (75.90, α)	56.83	Adjusted Chi Square Value (75.90, β)	55.81
223	95% Gamma Approximate UCL (use when n>=50)	0.0589	95% Gamma Adjusted UCL (use when n<50)	0.0599
224				
225	**Lognormal GOF Test on Detected Observations Only**			
226	Shapiro Wilk Test Statistic	0.855	**Shapiro Wilk GOF Test**	
227	5% Shapiro Wilk Critical Value	0.842	Detected Data appear Lognormal at 5% Significance Level	
228	Lilliefors Test Statistic	0.24	**Lilliefors GOF Test**	
229	5% Lilliefors Critical Value	0.28	Detected Data appear Lognormal at 5% Significance Level	
230	**Detected Data appear Lognormal at 5% Significance Level**			
231				
232	**Lognormal ROS Statistics Using Imputed Non-Detects**			
233	Mean in Original Scale	0.0485	Mean in Log Scale	-3.261
234	SD in Original Scale	0.0397	SD in Log Scale	0.665
235	95% t UCL (assumes normality of ROS data)	0.0612	95% Percentile Bootstrap UCL	0.0619
236	95% BCA Bootstrap UCL	0.0639	95% Bootstrap t UCL	0.0671
237	95% H-UCL (Log ROS)	0.0625		
238				
239	**UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed**			
240	KM Mean (logged)	-3.292	95% H-UCL (KM -Log)	0.0685
241	KM SD (logged)	0.762	95% Critical H Value (KM-Log)	2.185
242	KM Standard Error of Mean (logged)	0.248		
243				
244	**DL/2 Statistics**			
245	**DL/2 Normal**		**DL/2 Log-Transformed**	
246	Mean in Original Scale	0.0509	Mean in Log Scale	-3.248
247	SD in Original Scale	0.0423	SD in Log Scale	0.745
248	95% t UCL (Assumes normality)	0.0645	95% H-Stat UCL	0.0699
249	**DL/2 is not a recommended method, provided for comparisons and historical reasons**			
250				
251	**Nonparametric Distribution Free UCL Statistics**			
252	**Detected Data appear Lognormal Distributed at 5% Significance Level**			
253				
254	**Suggested UCL to Use**			
255	95% KM (t) UCL	0.0651	95% KM (% Bootstrap) UCL	0.0655
256				
257	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
258	Recommendations are based upon data size, data distribution, and skewness.			
259	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
260	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			
261				

	A	B	C	D	E	F	G	H	I	J	K	L
262												
263	Anthracene											
264												
265						General Statistics						
266					Total Number of Observations	28					Number of Distinct Observations	23
267											Number of Missing Observations	0
268					Minimum	0.03					Mean	0.575
269					Maximum	1.7					Median	0.42
270					SD	0.452					Std. Error of Mean	0.0855
271					Coefficient of Variation	0.787					Skewness	1.231
272												
273						Normal GOF Test						
274					Shapiro Wilk Test Statistic	0.859			Shapiro Wilk GOF Test			
275					5% Shapiro Wilk Critical Value	0.924			Data Not Normal at 5% Significance Level			
276					Lilliefors Test Statistic	0.193			Lilliefors GOF Test			
277					5% Lilliefors Critical Value	0.167			Data Not Normal at 5% Significance Level			
278						Data Not Normal at 5% Significance Level						
279												
280						Assuming Normal Distribution						
281				95% Normal UCL					95% UCLs (Adjusted for Skewness)			
282					95% Student's-t UCL	0.72					95% Adjusted-CLT UCL (Chen-1995)	0.737
283											95% Modified-t UCL (Johnson-1978)	0.724
284												
285						Gamma GOF Test						
286					A-D Test Statistic	0.29			Anderson-Darling Gamma GOF Test			
287					5% A-D Critical Value	0.761			Detected data appear Gamma Distributed at 5% Significance Level			
288					K-S Test Statistic	0.0945			Kolmogrov-Smirnoff Gamma GOF Test			
289					5% K-S Critical Value	0.168			Detected data appear Gamma Distributed at 5% Significance Level			
290						Detected data appear Gamma Distributed at 5% Significance Level						
291												
292						Gamma Statistics						
293					k hat (MLE)	1.661					k star (bias corrected MLE)	1.506
294					Theta hat (MLE)	0.346					Theta star (bias corrected MLE)	0.381
295					nu hat (MLE)	92.99					nu star (bias corrected)	84.36
296					MLE Mean (bias corrected)	0.575					MLE Sd (bias corrected)	0.468
297											Approximate Chi Square Value (0.05)	64.19
298					Adjusted Level of Significance	0.0404					Adjusted Chi Square Value	63.1
299												

	A	B	C	D	E	F	G	H	I	J	K	L
300	**Assuming Gamma Distribution**											
301					95% Approximate Gamma UCL (use when n>=50)	0.755					95% Adjusted Gamma UCL (use when n<50)	0.768
302												
303	**Lognormal GOF Test**											
304					Shapiro Wilk Test Statistic	0.947	**Shapiro Wilk Lognormal GOF Test**					
305					5% Shapiro Wilk Critical Value	0.924	Data appear Lognormal at 5% Significance Level					
306					Lilliefors Test Statistic	0.118	**Lilliefors Lognormal GOF Test**					
307					5% Lilliefors Critical Value	0.167	Data appear Lognormal at 5% Significance Level					
308	**Data appear Lognormal at 5% Significance Level**											
309												
310	**Lognormal Statistics**											
311					Minimum of Logged Data	-3.507					Mean of logged Data	-0.884
312					Maximum of Logged Data	0.531					SD of logged Data	0.915
313												
314	**Assuming Lognormal Distribution**											
315					95% H-UCL	0.95					90% Chebyshev (MVUE) UCL	0.974
316					95% Chebyshev (MVUE) UCL	1.136					97.5% Chebyshev (MVUE) UCL	1.362
317					99% Chebyshev (MVUE) UCL	1.805						
318												
319	**Nonparametric Distribution Free UCL Statistics**											
320	**Data appear to follow a Discernible Distribution at 5% Significance Level**											
321												
322	**Nonparametric Distribution Free UCLs**											
323					95% CLT UCL	0.715					95% Jackknife UCL	0.72
324					95% Standard Bootstrap UCL	0.714					95% Bootstrap-t UCL	0.76
325					95% Hall's Bootstrap UCL	0.734					95% Percentile Bootstrap UCL	0.707
326					95% BCA Bootstrap UCL	0.736						
327					90% Chebyshev(Mean, Sd) UCL	0.831					95% Chebyshev(Mean, Sd) UCL	0.947
328					97.5% Chebyshev(Mean, Sd) UCL	1.109					99% Chebyshev(Mean, Sd) UCL	1.425
329												
330	**Suggested UCL to Use**											
331					95% Adjusted Gamma UCL	0.768						
332												
333	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
334	These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)											
335	and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.											
336	For additional insight the user may want to consult a statistician.											
337												
338												

	A–E	F	G–K	L
339	**Benz(a)anthracene**			
340				
341	**General Statistics**			
342	Total Number of Observations	28	Number of Distinct Observations	25
343			Number of Missing Observations	0
344	Minimum	0.03	Mean	0.56
345	Maximum	1.9	Median	0.435
346	SD	0.429	Std. Error of Mean	0.081
347	Coefficient of Variation	0.766	Skewness	1.48
348				
349	**Normal GOF Test**			
350	Shapiro Wilk Test Statistic	0.875	**Shapiro Wilk GOF Test**	
351	5% Shapiro Wilk Critical Value	0.924	Data Not Normal at 5% Significance Level	
352	Lilliefors Test Statistic	0.208	**Lilliefors GOF Test**	
353	5% Lilliefors Critical Value	0.167	Data Not Normal at 5% Significance Level	
354	**Data Not Normal at 5% Significance Level**			
355				
356	**Assuming Normal Distribution**			
357	**95% Normal UCL**		**95% UCLs (Adjusted for Skewness)**	
358	95% Student's-t UCL	0.698	95% Adjusted-CLT UCL (Chen-1995)	0.718
359			95% Modified-t UCL (Johnson-1978)	0.702
360				
361	**Gamma GOF Test**			
362	A-D Test Statistic	0.291	**Anderson-Darling Gamma GOF Test**	
363	5% A-D Critical Value	0.76	Detected data appear Gamma Distributed at 5% Significance Level	
364	K-S Test Statistic	0.115	**Kolmogrov-Smirnoff Gamma GOF Test**	
365	5% K-S Critical Value	0.168	Detected data appear Gamma Distributed at 5% Significance Level	
366	**Detected data appear Gamma Distributed at 5% Significance Level**			
367				
368	**Gamma Statistics**			
369	k hat (MLE)	1.732	k star (bias corrected MLE)	1.57
370	Theta hat (MLE)	0.323	Theta star (bias corrected MLE)	0.357
371	nu hat (MLE)	96.98	nu star (bias corrected)	87.93
372	MLE Mean (bias corrected)	0.56	MLE Sd (bias corrected)	0.447
373			Approximate Chi Square Value (0.05)	67.31
374	Adjusted Level of Significance	0.0404	Adjusted Chi Square Value	66.19
375				
376	**Assuming Gamma Distribution**			
377	95% Approximate Gamma UCL (use when n>=50)	0.732	95% Adjusted Gamma UCL (use when n<50)	0.744
378				

	A	B	C	D	E	F	G	H	I	J	K	L
379	**Lognormal GOF Test**											
380					Shapiro Wilk Test Statistic	0.937	**Shapiro Wilk Lognormal GOF Test**					
381					5% Shapiro Wilk Critical Value	0.924	Data appear Lognormal at 5% Significance Level					
382					Lilliefors Test Statistic	0.166	**Lilliefors Lognormal GOF Test**					
383					5% Lilliefors Critical Value	0.167	Data appear Lognormal at 5% Significance Level					
384	**Data appear Lognormal at 5% Significance Level**											
385												
386	**Lognormal Statistics**											
387					Minimum of Logged Data	-3.507					Mean of logged Data	-0.895
388					Maximum of Logged Data	0.642					SD of logged Data	0.909
389												
390	**Assuming Lognormal Distribution**											
391					95% H-UCL	0.931					90% Chebyshev (MVUE) UCL	0.955
392					95% Chebyshev (MVUE) UCL	1.114					97.5% Chebyshev (MVUE) UCL	1.334
393					99% Chebyshev (MVUE) UCL	1.767						
394												
395	**Nonparametric Distribution Free UCL Statistics**											
396	**Data appear to follow a Discernible Distribution at 5% Significance Level**											
397												
398	**Nonparametric Distribution Free UCLs**											
399					95% CLT UCL	0.693					95% Jackknife UCL	0.698
400					95% Standard Bootstrap UCL	0.689					95% Bootstrap-t UCL	0.735
401					95% Hall's Bootstrap UCL	0.755					95% Percentile Bootstrap UCL	0.701
402					95% BCA Bootstrap UCL	0.722						
403					90% Chebyshev(Mean, Sd) UCL	0.803					95% Chebyshev(Mean, Sd) UCL	0.913
404					97.5% Chebyshev(Mean, Sd) UCL	1.066					99% Chebyshev(Mean, Sd) UCL	1.366
405												
406	**Suggested UCL to Use**											
407					95% Adjusted Gamma UCL	0.744						
408												
409	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
410	These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)											
411	and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.											
412	For additional insight the user may want to consult a statistician.											
413												
414												

	A	B	C	D	E	F	G	H	I	J	K	L
415	Chrysene											
416												
417	**General Statistics**											
418	Total Number of Observations					28	Number of Distinct Observations					26
419							Number of Missing Observations					0
420	Minimum					0.03	Mean					0.765
421	Maximum					2.9	Median					0.48
422	SD					0.718	Std. Error of Mean					0.136
423	Coefficient of Variation					0.938	Skewness					1.677
424												
425	**Normal GOF Test**											
426	Shapiro Wilk Test Statistic					0.802	**Shapiro Wilk GOF Test**					
427	5% Shapiro Wilk Critical Value					0.924	Data Not Normal at 5% Significance Level					
428	Lilliefors Test Statistic					0.209	**Lilliefors GOF Test**					
429	5% Lilliefors Critical Value					0.167	Data Not Normal at 5% Significance Level					
430	**Data Not Normal at 5% Significance Level**											
431												
432	**Assuming Normal Distribution**											
433	**95% Normal UCL**						**95% UCLs (Adjusted for Skewness)**					
434	95% Student's-t UCL					0.997	95% Adjusted-CLT UCL (Chen-1995)					1.035
435							95% Modified-t UCL (Johnson-1978)					1.004
436												
437	**Gamma GOF Test**											
438	A-D Test Statistic					0.431	**Anderson-Darling Gamma GOF Test**					
439	5% A-D Critical Value					0.767	Detected data appear Gamma Distributed at 5% Significance Level					
440	K-S Test Statistic					0.11	**Kolmogrov-Smirnoff Gamma GOF Test**					
441	5% K-S Critical Value					0.169	Detected data appear Gamma Distributed at 5% Significance Level					
442	**Detected data appear Gamma Distributed at 5% Significance Level**											
443												
444	**Gamma Statistics**											
445	k hat (MLE)					1.302	k star (bias corrected MLE)					1.186
446	Theta hat (MLE)					0.588	Theta star (bias corrected MLE)					0.645
447	nu hat (MLE)					72.89	nu star (bias corrected)					66.42
448	MLE Mean (bias corrected)					0.765	MLE Sd (bias corrected)					0.703
449							Approximate Chi Square Value (0.05)					48.66
450	Adjusted Level of Significance					0.0404	Adjusted Chi Square Value					47.72
451												

	A	B	C	D	E	F	G	H	I	J	K	L
452	**Assuming Gamma Distribution**											
453					95% Approximate Gamma UCL (use when n>=50)	1.045					95% Adjusted Gamma UCL (use when n<50)	1.065
454												
455	**Lognormal GOF Test**											
456					Shapiro Wilk Test Statistic	0.95	**Shapiro Wilk Lognormal GOF Test**					
457					5% Shapiro Wilk Critical Value	0.924	Data appear Lognormal at 5% Significance Level					
458					Lilliefors Test Statistic	0.164	**Lilliefors Lognormal GOF Test**					
459					5% Lilliefors Critical Value	0.167	Data appear Lognormal at 5% Significance Level					
460	**Data appear Lognormal at 5% Significance Level**											
461												
462	**Lognormal Statistics**											
463					Minimum of Logged Data	-3.507					Mean of logged Data	-0.698
464					Maximum of Logged Data	1.065					SD of logged Data	1.043
465												
466	**Assuming Lognormal Distribution**											
467					95% H-UCL	1.417					90% Chebyshev (MVUE) UCL	1.401
468					95% Chebyshev (MVUE) UCL	1.658					97.5% Chebyshev (MVUE) UCL	2.015
469					99% Chebyshev (MVUE) UCL	2.716						
470												
471	**Nonparametric Distribution Free UCL Statistics**											
472	**Data appear to follow a Discernible Distribution at 5% Significance Level**											
473												
474	**Nonparametric Distribution Free UCLs**											
475					95% CLT UCL	0.989					95% Jackknife UCL	0.997
476					95% Standard Bootstrap UCL	0.987					95% Bootstrap-t UCL	1.064
477					95% Hall's Bootstrap UCL	1.065					95% Percentile Bootstrap UCL	1
478					95% BCA Bootstrap UCL	1.025						
479					90% Chebyshev(Mean, Sd) UCL	1.173					95% Chebyshev(Mean, Sd) UCL	1.357
480					97.5% Chebyshev(Mean, Sd) UCL	1.613					99% Chebyshev(Mean, Sd) UCL	2.116
481												
482	**Suggested UCL to Use**											
483					95% Adjusted Gamma UCL	1.065						
484												
485	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
486	These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)											
487	and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.											
488	For additional insight the user may want to consult a statistician.											
489												
490												

	A	B	C	D	E	F	G	H	I	J	K	L
491	Fluoranthene											
492												
493						General Statistics						
494					Total Number of Observations	28					Number of Distinct Observations	24
495											Number of Missing Observations	0
496					Minimum	0.12					Mean	2.941
497					Maximum	17					Median	1.6
498					SD	3.676					Std. Error of Mean	0.695
499					Coefficient of Variation	1.25					Skewness	2.693
500												
501						Normal GOF Test						
502					Shapiro Wilk Test Statistic	0.658			Shapiro Wilk GOF Test			
503					5% Shapiro Wilk Critical Value	0.924			Data Not Normal at 5% Significance Level			
504					Lilliefors Test Statistic	0.293			Lilliefors GOF Test			
505					5% Lilliefors Critical Value	0.167			Data Not Normal at 5% Significance Level			
506						Data Not Normal at 5% Significance Level						
507												
508						Assuming Normal Distribution						
509			95% Normal UCL						95% UCLs (Adjusted for Skewness)			
510					95% Student's-t UCL	4.124					95% Adjusted-CLT UCL (Chen-1995)	4.462
511											95% Modified-t UCL (Johnson-1978)	4.183
512												
513						Gamma GOF Test						
514					A-D Test Statistic	0.826			Anderson-Darling Gamma GOF Test			
515					5% A-D Critical Value	0.772			Data Not Gamma Distributed at 5% Significance Level			
516					K-S Test Statistic	0.17			Kolmogrov-Smirnoff Gamma GOF Test			
517					5% K-S Critical Value	0.17			Data Not Gamma Distributed at 5% Significance Level			
518						Data Not Gamma Distributed at 5% Significance Level						
519												
520						Gamma Statistics						
521					k hat (MLE)	1.083					k star (bias corrected MLE)	0.991
522					Theta hat (MLE)	2.716					Theta star (bias corrected MLE)	2.969
523					nu hat (MLE)	60.65					nu star (bias corrected)	55.48
524					MLE Mean (bias corrected)	2.941					MLE Sd (bias corrected)	2.955
525											Approximate Chi Square Value (0.05)	39.36
526					Adjusted Level of Significance	0.0404					Adjusted Chi Square Value	38.52
527												
528						Assuming Gamma Distribution						
529					95% Approximate Gamma UCL (use when n>=50))	4.145					95% Adjusted Gamma UCL (use when n<50)	4.236
530												

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.976	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.924	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.103	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.167	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-2.12	Mean of logged Data	0.551
Maximum of Logged Data	2.833	SD of logged Data	1.061

Assuming Lognormal Distribution

95% H-UCL	5.105	90% Chebyshev (MVUE) UCL	5.014
95% Chebyshev (MVUE) UCL	5.946	97.5% Chebyshev (MVUE) UCL	7.24
99% Chebyshev (MVUE) UCL	9.782		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	4.084	95% Jackknife UCL	4.124
95% Standard Bootstrap UCL	4.058	95% Bootstrap-t UCL	5.069
95% Hall's Bootstrap UCL	5.757	95% Percentile Bootstrap UCL	4.129
95% BCA Bootstrap UCL	4.618		
90% Chebyshev(Mean, Sd) UCL	5.025	95% Chebyshev(Mean, Sd) UCL	5.97
97.5% Chebyshev(Mean, Sd) UCL	7.28	99% Chebyshev(Mean, Sd) UCL	9.854

Suggested UCL to Use

95% H-UCL	5.105

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)
and Singh and Singh (2003). 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–E	F	G–K	L
572	Fluorene			
573				
574	**General Statistics**			
575	Total Number of Observations	28	Number of Distinct Observations	23
576			Number of Missing Observations	0
577	Minimum	0.04	Mean	0.528
578	Maximum	1.2	Median	0.475
579	SD	0.305	Std. Error of Mean	0.0576
580	Coefficient of Variation	0.578	Skewness	0.781
581				
582	**Normal GOF Test**			
583	Shapiro Wilk Test Statistic	0.931	**Shapiro Wilk GOF Test**	
584	5% Shapiro Wilk Critical Value	0.924	Data appear Normal at 5% Significance Level	
585	Lilliefors Test Statistic	0.13	**Lilliefors GOF Test**	
586	5% Lilliefors Critical Value	0.167	Data appear Normal at 5% Significance Level	
587	**Data appear Normal at 5% Significance Level**			
588				
589	**Assuming Normal Distribution**			
590	**95% Normal UCL**		**95% UCLs (Adjusted for Skewness)**	
591	95% Student's-t UCL	0.626	95% Adjusted-CLT UCL (Chen-1995)	0.631
592			95% Modified-t UCL (Johnson-1978)	0.627
593				
594	**Gamma GOF Test**			
595	A-D Test Statistic	0.409	**Anderson-Darling Gamma GOF Test**	
596	5% A-D Critical Value	0.756	Detected data appear Gamma Distributed at 5% Significance Level	
597	K-S Test Statistic	0.146	**Kolmogrov-Smirnoff Gamma GOF Test**	
598	5% K-S Critical Value	0.167	Detected data appear Gamma Distributed at 5% Significance Level	
599	**Detected data appear Gamma Distributed at 5% Significance Level**			
600				
601	**Gamma Statistics**			
602	k hat (MLE)	2.56	k star (bias corrected MLE)	2.309
603	Theta hat (MLE)	0.206	Theta star (bias corrected MLE)	0.228
604	nu hat (MLE)	143.3	nu star (bias corrected)	129.3
605	MLE Mean (bias corrected)	0.528	MLE Sd (bias corrected)	0.347
606			Approximate Chi Square Value (0.05)	104
607	Adjusted Level of Significance	0.0404	Adjusted Chi Square Value	102.6
608				

	A	B	C	D	E	F	G	H	I	J	K	L
609	**Assuming Gamma Distribution**											
610					95% Approximate Gamma UCL (use when n>=50))	0.656					95% Adjusted Gamma UCL (use when n<50)	0.665
611												
612	**Lognormal GOF Test**											
613					Shapiro Wilk Test Statistic	0.895	**Shapiro Wilk Lognormal GOF Test**					
614					5% Shapiro Wilk Critical Value	0.924	Data Not Lognormal at 5% Significance Level					
615					Lilliefors Test Statistic	0.194	**Lilliefors Lognormal GOF Test**					
616					5% Lilliefors Critical Value	0.167	Data Not Lognormal at 5% Significance Level					
617	**Data Not Lognormal at 5% Significance Level**											
618												
619	**Lognormal Statistics**											
620					Minimum of Logged Data	-3.219					Mean of logged Data	-0.847
621					Maximum of Logged Data	0.182					SD of logged Data	0.75
622												
623	**Assuming Lognormal Distribution**											
624					95% H-UCL	0.777					90% Chebyshev (MVUE) UCL	0.82
625					95% Chebyshev (MVUE) UCL	0.938					97.5% Chebyshev (MVUE) UCL	1.101
626					99% Chebyshev (MVUE) UCL	1.422						
627												
628	**Nonparametric Distribution Free UCL Statistics**											
629	**Data appear to follow a Discernible Distribution at 5% Significance Level**											
630												
631	**Nonparametric Distribution Free UCLs**											
632					95% CLT UCL	0.622					95% Jackknife UCL	0.626
633					95% Standard Bootstrap UCL	0.62					95% Bootstrap-t UCL	0.631
634					95% Hall's Bootstrap UCL	0.644					95% Percentile Bootstrap UCL	0.625
635					95% BCA Bootstrap UCL	0.628						
636					90% Chebyshev(Mean, Sd) UCL	0.7					95% Chebyshev(Mean, Sd) UCL	0.779
637					97.5% Chebyshev(Mean, Sd) UCL	0.887					99% Chebyshev(Mean, Sd) UCL	1.101
638												
639	**Suggested UCL to Use**											
640					95% Student's-t UCL	0.626						
641												
642	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
643	These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)											
644	and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.											
645	For additional insight the user may want to consult a statistician.											
646												
647												

Row	A–E	F	G–K	L
648	Naphthalene			
649				
650	**General Statistics**			
651	Total Number of Observations	28	Number of Distinct Observations	23
652			Number of Missing Observations	0
653	Minimum	0.16	Mean	1.4
654	Maximum	3.6	Median	1.05
655	SD	0.947	Std. Error of Mean	0.179
656	Coefficient of Variation	0.676	Skewness	1.038
657				
658	**Normal GOF Test**			
659	Shapiro Wilk Test Statistic	0.88	**Shapiro Wilk GOF Test**	
660	5% Shapiro Wilk Critical Value	0.924	Data Not Normal at 5% Significance Level	
661	Lilliefors Test Statistic	0.196	**Lilliefors GOF Test**	
662	5% Lilliefors Critical Value	0.167	Data Not Normal at 5% Significance Level	
663	**Data Not Normal at 5% Significance Level**			
664				
665	**Assuming Normal Distribution**			
666	**95% Normal UCL**		**95% UCLs (Adjusted for Skewness)**	
667	95% Student's-t UCL	1.705	95% Adjusted-CLT UCL (Chen-1995)	1.732
668			95% Modified-t UCL (Johnson-1978)	1.711
669				
670	**Gamma GOF Test**			
671	A-D Test Statistic	0.355	**Anderson-Darling Gamma GOF Test**	
672	5% A-D Critical Value	0.757	Detected data appear Gamma Distributed at 5% Significance Level	
673	K-S Test Statistic	0.123	**Kolmogrov-Smirnoff Gamma GOF Test**	
674	5% K-S Critical Value	0.167	Detected data appear Gamma Distributed at 5% Significance Level	
675	**Detected data appear Gamma Distributed at 5% Significance Level**			
676				
677	**Gamma Statistics**			
678	k hat (MLE)	2.333	k star (bias corrected MLE)	2.107
679	Theta hat (MLE)	0.6	Theta star (bias corrected MLE)	0.664
680	nu hat (MLE)	130.7	nu star (bias corrected)	118
681	MLE Mean (bias corrected)	1.4	MLE Sd (bias corrected)	0.964
682			Approximate Chi Square Value (0.05)	93.92
683	Adjusted Level of Significance	0.0404	Adjusted Chi Square Value	92.6
684				
685	**Assuming Gamma Distribution**			
686	95% Approximate Gamma UCL (use when n>=50)	1.759	95% Adjusted Gamma UCL (use when n<50)	1.784
687				

	A	B	C	D	E	F	G	H	I	J	K	L
688	**Lognormal GOF Test**											
689					Shapiro Wilk Test Statistic	0.966	**Shapiro Wilk Lognormal GOF Test**					
690					5% Shapiro Wilk Critical Value	0.924	Data appear Lognormal at 5% Significance Level					
691					Lilliefors Test Statistic	0.0779	**Lilliefors Lognormal GOF Test**					
692					5% Lilliefors Critical Value	0.167	Data appear Lognormal at 5% Significance Level					
693	**Data appear Lognormal at 5% Significance Level**											
694												
695	**Lognormal Statistics**											
696					Minimum of Logged Data	-1.833					Mean of logged Data	0.107
697					Maximum of Logged Data	1.281					SD of logged Data	0.725
698												
699	**Assuming Lognormal Distribution**											
700					95% H-UCL	1.955					90% Chebyshev (MVUE) UCL	2.07
701					95% Chebyshev (MVUE) UCL	2.359					97.5% Chebyshev (MVUE) UCL	2.761
702					99% Chebyshev (MVUE) UCL	3.549						
703												
704	**Nonparametric Distribution Free UCL Statistics**											
705	**Data appear to follow a Discernible Distribution at 5% Significance Level**											
706												
707	**Nonparametric Distribution Free UCLs**											
708					95% CLT UCL	1.694					95% Jackknife UCL	1.705
709					95% Standard Bootstrap UCL	1.686					95% Bootstrap-t UCL	1.734
710					95% Hall's Bootstrap UCL	1.741					95% Percentile Bootstrap UCL	1.699
711					95% BCA Bootstrap UCL	1.715						
712					90% Chebyshev(Mean, Sd) UCL	1.937					95% Chebyshev(Mean, Sd) UCL	2.18
713					97.5% Chebyshev(Mean, Sd) UCL	2.517					99% Chebyshev(Mean, Sd) UCL	3.18
714												
715	**Suggested UCL to Use**											
716					95% Adjusted Gamma UCL	1.784						
717												
718	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
719	These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)											
720	and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.											
721	For additional insight the user may want to consult a statistician.											
722												
723												

	A	B	C	D	E	F	G	H	I	J	K	L
724	Phenanthrene											
725												
726	**General Statistics**											
727	Total Number of Observations					28	Number of Distinct Observations					24
728							Number of Missing Observations					0
729	Minimum					0.1	Mean					1.8
730	Maximum					7.4	Median					1.3
731	SD					1.603	Std. Error of Mean					0.303
732	Coefficient of Variation					0.891	Skewness					2.097
733												
734	**Normal GOF Test**											
735	Shapiro Wilk Test Statistic					0.788	**Shapiro Wilk GOF Test**					
736	5% Shapiro Wilk Critical Value					0.924	Data Not Normal at 5% Significance Level					
737	Lilliefors Test Statistic					0.225	**Lilliefors GOF Test**					
738	5% Lilliefors Critical Value					0.167	Data Not Normal at 5% Significance Level					
739	**Data Not Normal at 5% Significance Level**											
740												
741	**Assuming Normal Distribution**											
742	**95% Normal UCL**						**95% UCLs (Adjusted for Skewness)**					
743	95% Student's-t UCL					2.316	95% Adjusted-CLT UCL (Chen-1995)					2.426
744							95% Modified-t UCL (Johnson-1978)					2.336
745												
746	**Gamma GOF Test**											
747	A-D Test Statistic					0.383	**Anderson-Darling Gamma GOF Test**					
748	5% A-D Critical Value					0.762	Detected data appear Gamma Distributed at 5% Significance Level					
749	K-S Test Statistic					0.119	**Kolmogrov-Smirnoff Gamma GOF Test**					
750	5% K-S Critical Value					0.168	Detected data appear Gamma Distributed at 5% Significance Level					
751	**Detected data appear Gamma Distributed at 5% Significance Level**											
752												
753	**Gamma Statistics**											
754	k hat (MLE)					1.597	k star (bias corrected MLE)					1.45
755	Theta hat (MLE)					1.127	Theta star (bias corrected MLE)					1.241
756	nu hat (MLE)					89.43	nu star (bias corrected)					81.18
757	MLE Mean (bias corrected)					1.8	MLE Sd (bias corrected)					1.495
758							Approximate Chi Square Value (0.05)					61.42
759	Adjusted Level of Significance					0.0404	Adjusted Chi Square Value					60.35

	A–E	F	G–K	L
760				
761	**Assuming Gamma Distribution**			
762	95% Approximate Gamma UCL (use when n>=50)	2.379	95% Adjusted Gamma UCL (use when n<50)	2.421
763				
764	**Lognormal GOF Test**			
765	Shapiro Wilk Test Statistic	0.96	**Shapiro Wilk Lognormal GOF Test**	
766	5% Shapiro Wilk Critical Value	0.924	Data appear Lognormal at 5% Significance Level	
767	Lilliefors Test Statistic	0.132	**Lilliefors Lognormal GOF Test**	
768	5% Lilliefors Critical Value	0.167	Data appear Lognormal at 5% Significance Level	
769	**Data appear Lognormal at 5% Significance Level**			
770				
771	**Lognormal Statistics**			
772	Minimum of Logged Data	-2.303	Mean of logged Data	0.243
773	Maximum of Logged Data	2.001	SD of logged Data	0.908
774				
775	**Assuming Lognormal Distribution**			
776	95% H-UCL	2.901	90% Chebyshev (MVUE) UCL	2.979
777	95% Chebyshev (MVUE) UCL	3.474	97.5% Chebyshev (MVUE) UCL	4.16
778	99% Chebyshev (MVUE) UCL	5.508		
779				
780	**Nonparametric Distribution Free UCL Statistics**			
781	**Data appear to follow a Discernible Distribution at 5% Significance Level**			
782				
783	**Nonparametric Distribution Free UCLs**			
784	95% CLT UCL	2.298	95% Jackknife UCL	2.316
785	95% Standard Bootstrap UCL	2.28	95% Bootstrap-t UCL	2.564
786	95% Hall's Bootstrap UCL	2.734	95% Percentile Bootstrap UCL	2.301
787	95% BCA Bootstrap UCL	2.46		
788	90% Chebyshev(Mean, Sd) UCL	2.709	95% Chebyshev(Mean, Sd) UCL	3.12
789	97.5% Chebyshev(Mean, Sd) UCL	3.692	99% Chebyshev(Mean, Sd) UCL	4.814
790				
791	**Suggested UCL to Use**			
792	95% Adjusted Gamma UCL	2.421		
793				
794	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
795	These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)			
796	and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.			
797	For additional insight the user may want to consult a statistician.			
798				
799				

	A	B	C	D	E	F	G	H	I	J	K	L
800	Pyrene											
801												
802	General Statistics											
803					Total Number of Observations	28					Number of Distinct Observations	22
804											Number of Missing Observations	0
805					Minimum	0.11					Mean	2.322
806					Maximum	9.1					Median	1.5
807					SD	2.214					Std. Error of Mean	0.418
808					Coefficient of Variation	0.953					Skewness	1.822
809												
810	Normal GOF Test											
811					Shapiro Wilk Test Statistic	0.77	Shapiro Wilk GOF Test					
812					5% Shapiro Wilk Critical Value	0.924	Data Not Normal at 5% Significance Level					
813					Lilliefors Test Statistic	0.237	Lilliefors GOF Test					
814					5% Lilliefors Critical Value	0.167	Data Not Normal at 5% Significance Level					
815	Data Not Normal at 5% Significance Level											
816												
817	Assuming Normal Distribution											
818	95% Normal UCL						95% UCLs (Adjusted for Skewness)					
819					95% Student's-t UCL	3.034					95% Adjusted-CLT UCL (Chen-1995)	3.164
820											95% Modified-t UCL (Johnson-1978)	3.058
821												
822	Gamma GOF Test											
823					A-D Test Statistic	0.627	Anderson-Darling Gamma GOF Test					
824					5% A-D Critical Value	0.765	Detected data appear Gamma Distributed at 5% Significance Level					
825					K-S Test Statistic	0.133	Kolmogrov-Smirnoff Gamma GOF Test					
826					5% K-S Critical Value	0.169	Detected data appear Gamma Distributed at 5% Significance Level					
827	Detected data appear Gamma Distributed at 5% Significance Level											
828												
829	Gamma Statistics											
830					k hat (MLE)	1.407					k star (bias corrected MLE)	1.28
831					Theta hat (MLE)	1.651					Theta star (bias corrected MLE)	1.814
832					nu hat (MLE)	78.77					nu star (bias corrected)	71.66
833					MLE Mean (bias corrected)	2.322					MLE Sd (bias corrected)	2.052
834											Approximate Chi Square Value (0.05)	53.17
835					Adjusted Level of Significance	0.0404					Adjusted Chi Square Value	52.18
836												
837	Assuming Gamma Distribution											
838					95% Approximate Gamma UCL (use when n>=50)	3.129					95% Adjusted Gamma UCL (use when n<50)	3.188
839												

	A	B	C	D	E	F	G	H	I	J	K	L
840	**Lognormal GOF Test**											
841					Shapiro Wilk Test Statistic	0.957	**Shapiro Wilk Lognormal GOF Test**					
842					5% Shapiro Wilk Critical Value	0.924	Data appear Lognormal at 5% Significance Level					
843					Lilliefors Test Statistic	0.139	**Lilliefors Lognormal GOF Test**					
844					5% Lilliefors Critical Value	0.167	Data appear Lognormal at 5% Significance Level					
845	**Data appear Lognormal at 5% Significance Level**											
846												
847	**Lognormal Statistics**											
848					Minimum of Logged Data	-2.207					Mean of logged Data	0.446
849					Maximum of Logged Data	2.208					SD of logged Data	0.961
850												
851	**Assuming Lognormal Distribution**											
852					95% H-UCL	3.871					90% Chebyshev (MVUE) UCL	3.922
853					95% Chebyshev (MVUE) UCL	4.601					97.5% Chebyshev (MVUE) UCL	5.543
854					99% Chebyshev (MVUE) UCL	7.394						
855												
856	**Nonparametric Distribution Free UCL Statistics**											
857	**Data appear to follow a Discernible Distribution at 5% Significance Level**											
858												
859	**Nonparametric Distribution Free UCLs**											
860					95% CLT UCL	3.01					95% Jackknife UCL	3.034
861					95% Standard Bootstrap UCL	2.994					95% Bootstrap-t UCL	3.29
862					95% Hall's Bootstrap UCL	3.2					95% Percentile Bootstrap UCL	3.045
863					95% BCA Bootstrap UCL	3.182						
864					90% Chebyshev(Mean, Sd) UCL	3.577					95% Chebyshev(Mean, Sd) UCL	4.145
865					97.5% Chebyshev(Mean, Sd) UCL	4.934					99% Chebyshev(Mean, Sd) UCL	6.484
866												
867	**Suggested UCL to Use**											
868					95% Adjusted Gamma UCL	3.188						
869												
870	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
871	These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)											
872	and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.											
873	For additional insight the user may want to consult a statistician.											
874												

Benzo(a)pyrene

General Statistics			
Total Number of Observations	28	Number of Distinct Observations	23
Number of Detects	25	Number of Non-Detects	3
Number of Distinct Detects	21	Number of Distinct Non-Detects	2
Minimum Detect	0.067	Minimum Non-Detect	0.01
Maximum Detect	1.2	Maximum Non-Detect	0.05
Variance Detects	0.0671	Percent Non-Detects	10.71%
Mean Detects	0.323	SD Detects	0.259
Median Detects	0.22	CV Detects	0.803
Skewness Detects	2.005	Kurtosis Detects	4.588
Mean of Logged Detects	-1.374	SD of Logged Detects	0.69
Normal GOF Test on Detects Only			
Shapiro Wilk Test Statistic	0.784	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.918	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.214	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.177	Detected Data Not Normal at 5% Significance Level	
Detected Data Not Normal at 5% Significance Level			
Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs			
Mean	0.289	Standard Error of Mean	0.0499
SD	0.259	95% KM (BCA) UCL	0.377
95% KM (t) UCL	0.374	95% KM (Percentile Bootstrap) UCL	0.373
95% KM (z) UCL	0.371	95% KM Bootstrap t UCL	0.411
90% KM Chebyshev UCL	0.439	95% KM Chebyshev UCL	0.506
97.5% KM Chebyshev UCL	0.601	99% KM Chebyshev UCL	0.785
Gamma GOF Tests on Detected Observations Only			
A-D Test Statistic	0.672	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.755	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.179	**Kolmogrov-Smirnoff GOF**	
5% K-S Critical Value	0.177	Detected Data Not Gamma Distributed at 5% Significance Level	
Detected data follow Appr. Gamma Distribution at 5% Significance Level			
Gamma Statistics on Detected Data Only			
k hat (MLE)	2.219	k star (bias corrected MLE)	1.979
Theta hat (MLE)	0.145	Theta star (bias corrected MLE)	0.163
nu hat (MLE)	110.9	nu star (bias corrected)	98.95
MLE Mean (bias corrected)	0.323	MLE Sd (bias corrected)	0.229
Gamma Kaplan-Meier (KM) Statistics			
k hat (KM)	1.249	nu hat (KM)	69.96
Approximate Chi Square Value (69.96, α)	51.7	Adjusted Chi Square Value (69.96, β)	50.73
95% Gamma Approximate KM-UCL (use when n>=50)	0.391	95% Gamma Adjusted KM-UCL (use when n<50)	0.399

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.289
Maximum	1.2	Median	0.19
SD	0.263	CV	0.911
k hat (MLE)	1.184	k star (bias corrected MLE)	1.081
Theta hat (MLE)	0.244	Theta star (bias corrected MLE)	0.267
nu hat (MLE)	66.28	nu star (bias corrected)	60.51
MLE Mean (bias corrected)	0.289	MLE Sd (bias corrected)	0.278
		Adjusted Level of Significance (β)	0.0404
Approximate Chi Square Value (60.51, α)	43.62	Adjusted Chi Square Value (60.51, β)	42.74
95% Gamma Approximate UCL (use when n>=50)	0.401	95% Gamma Adjusted UCL (use when n<50)	0.409

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.973	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.918	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.141	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.177	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.294	Mean in Log Scale	-1.544
SD in Original Scale	0.259	SD in Log Scale	0.822
95% t UCL (assumes normality of ROS data)	0.377	95% Percentile Bootstrap UCL	0.377
95% BCA Bootstrap UCL	0.392	95% Bootstrap t UCL	0.408
95% H-UCL (Log ROS)	0.427		

UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed

KM Mean (logged)	-1.72	95% H-UCL (KM -Log)	0.669
KM SD (logged)	1.186	95% Critical H Value (KM-Log)	2.693
KM Standard Error of Mean (logged)	0.229		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.29	Mean in Log Scale	-1.679
SD in Original Scale	0.262	SD in Log Scale	1.138
95% t UCL (Assumes normality)	0.374	95% H-Stat UCL	0.634

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Gamma Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (BCA) UCL	0.377	95% GROS Adjusted Gamma UCL	0.409
95% Adjusted Gamma KM-UCL	0.399		

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.

	A–E	F	G–K	L
976				
977	**Total PAHs**			
978				
979	**General Statistics**			
980	Total Number of Observations	22	Number of Distinct Observations	19
981			Number of Missing Observations	0
982	Minimum	2.1	Mean	12.74
983	Maximum	41	Median	10.85
984	SD	9.389	Std. Error of Mean	2.002
985	Coefficient of Variation	0.737	Skewness	1.901
986				
987	**Normal GOF Test**			
988	Shapiro Wilk Test Statistic	0.8	**Shapiro Wilk GOF Test**	
989	5% Shapiro Wilk Critical Value	0.911	Data Not Normal at 5% Significance Level	
990	Lilliefors Test Statistic	0.197	**Lilliefors GOF Test**	
991	5% Lilliefors Critical Value	0.189	Data Not Normal at 5% Significance Level	
992	**Data Not Normal at 5% Significance Level**			
993				
994	**Assuming Normal Distribution**			
995	**95% Normal UCL**		**95% UCLs (Adjusted for Skewness)**	
996	95% Student's-t UCL	16.18	95% Adjusted-CLT UCL (Chen-1995)	16.9
997			95% Modified-t UCL (Johnson-1978)	16.32
998				
999	**Gamma GOF Test**			
1000	A-D Test Statistic	0.393	**Anderson-Darling Gamma GOF Test**	
1001	5% A-D Critical Value	0.754	Detected data appear Gamma Distributed at 5% Significance Level	
1002	K-S Test Statistic	0.128	**Kolmogrov-Smirnoff Gamma GOF Test**	
1003	5% K-S Critical Value	0.187	Detected data appear Gamma Distributed at 5% Significance Level	
1004	**Detected data appear Gamma Distributed at 5% Significance Level**			
1005				
1006	**Gamma Statistics**			
1007	k hat (MLE)	2.353	k star (bias corrected MLE)	2.062
1008	Theta hat (MLE)	5.413	Theta star (bias corrected MLE)	6.176
1009	nu hat (MLE)	103.5	nu star (bias corrected)	90.74
1010	MLE Mean (bias corrected)	12.74	MLE Sd (bias corrected)	8.869
1011			Approximate Chi Square Value (0.05)	69.77
1012	Adjusted Level of Significance	0.0386	Adjusted Chi Square Value	68.4
1013				
1014	**Assuming Gamma Distribution**			
1015	95% Approximate Gamma UCL (use when n>=50)	16.56	95% Adjusted Gamma UCL (use when n<50)	16.9
1016				

	A	B	C	D	E	F	G	H	I	J	K	L
1017	**Lognormal GOF Test**											
1018					Shapiro Wilk Test Statistic	0.965	**Shapiro Wilk Lognormal GOF Test**					
1019					5% Shapiro Wilk Critical Value	0.911	Data appear Lognormal at 5% Significance Level					
1020					Lilliefors Test Statistic	0.118	**Lilliefors Lognormal GOF Test**					
1021					5% Lilliefors Critical Value	0.189	Data appear Lognormal at 5% Significance Level					
1022	**Data appear Lognormal at 5% Significance Level**											
1023												
1024	**Lognormal Statistics**											
1025					Minimum of Logged Data	0.742					Mean of logged Data	2.317
1026					Maximum of Logged Data	3.714					SD of logged Data	0.708
1027												
1028	**Assuming Lognormal Distribution**											
1029					95% H-UCL	18.34					90% Chebyshev (MVUE) UCL	19.09
1030					95% Chebyshev (MVUE) UCL	21.92					97.5% Chebyshev (MVUE) UCL	25.84
1031					99% Chebyshev (MVUE) UCL	33.54						
1032												
1033	**Nonparametric Distribution Free UCL Statistics**											
1034	**Data appear to follow a Discernible Distribution at 5% Significance Level**											
1035												
1036	**Nonparametric Distribution Free UCLs**											
1037					95% CLT UCL	16.03					95% Jackknife UCL	16.18
1038					95% Standard Bootstrap UCL	15.91					95% Bootstrap-t UCL	18.34
1039					95% Hall's Bootstrap UCL	34.28					95% Percentile Bootstrap UCL	16.16
1040					95% BCA Bootstrap UCL	16.8						
1041					90% Chebyshev(Mean, Sd) UCL	18.74					95% Chebyshev(Mean, Sd) UCL	21.46
1042					97.5% Chebyshev(Mean, Sd) UCL	25.24					99% Chebyshev(Mean, Sd) UCL	32.65
1043												
1044	**Suggested UCL to Use**											
1045					95% Adjusted Gamma UCL	16.9						
1046												
1047	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
1048	These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)											
1049	and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.											
1050	For additional insight the user may want to consult a statistician.											
1051												

DSI and DRA Statistical ProUCL Output

	A	B	C	D	E	F	G	H	I	J	K	L
1	UCL Statistics for Data Sets with Non-Detects											
2												
3	User Selected Options											
4	Date/Time of Computation			8/10/2015 7:25:48 AM								
5	From File			proucl dsi and dra.xls								
6	Full Precision			OFF								
7	Confidence Coefficient			95%								
8	Number of Bootstrap Operations			2000								
9												
10												
11	2-methylnaphthalene											
12												
13	General Statistics											
14	Total Number of Observations					37	Number of Distinct Observations					29
15							Number of Missing Observations					0
16	Minimum					0.18	Mean					1.915
17	Maximum					6	Median					1.4
18	SD					1.487	Std. Error of Mean					0.244
19	Coefficient of Variation					0.777	Skewness					1.565
20												
21	Normal GOF Test											
22	Shapiro Wilk Test Statistic					0.813	Shapiro Wilk GOF Test					
23	5% Shapiro Wilk Critical Value					0.936	Data Not Normal at 5% Significance Level					
24	Lilliefors Test Statistic					0.207	Lilliefors GOF Test					
25	5% Lilliefors Critical Value					0.146	Data Not Normal at 5% Significance Level					
26	Data Not Normal at 5% Significance Level											
27												
28	Assuming Normal Distribution											
29	95% Normal UCL						95% UCLs (Adjusted for Skewness)					
30	95% Student's-t UCL					2.328	95% Adjusted-CLT UCL (Chen-1995)					2.384
31							95% Modified-t UCL (Johnson-1978)					2.338
32												
33	Gamma GOF Test											
34	A-D Test Statistic					0.614	Anderson-Darling Gamma GOF Test					
35	5% A-D Critical Value					0.759	Detected data appear Gamma Distributed at 5% Significance Level					
36	K-S Test Statistic					0.113	Kolmogrov-Smirnoff Gamma GOF Test					
37	5% K-S Critical Value					0.147	Detected data appear Gamma Distributed at 5% Significance Level					
38	Detected data appear Gamma Distributed at 5% Significance Level											
39												

	A	B	C	D	E	F	G	H	I	J	K	L
40	**Gamma Statistics**											
41					k hat (MLE)	2.067					k star (bias corrected MLE)	1.918
42					Theta hat (MLE)	0.926					Theta star (bias corrected MLE)	0.998
43					nu hat (MLE)	153					nu star (bias corrected)	141.9
44					MLE Mean (bias corrected)	1.915					MLE Sd (bias corrected)	1.383
45											Approximate Chi Square Value (0.05)	115.4
46					Adjusted Level of Significance	0.0431					Adjusted Chi Square Value	114.4
47												
48	**Assuming Gamma Distribution**											
49					95% Approximate Gamma UCL (use when n>=50)	2.355					95% Adjusted Gamma UCL (use when n<50)	2.376
50												
51	**Lognormal GOF Test**											
52					Shapiro Wilk Test Statistic	0.975	**Shapiro Wilk Lognormal GOF Test**					
53					5% Shapiro Wilk Critical Value	0.936	Data appear Lognormal at 5% Significance Level					
54					Lilliefors Test Statistic	0.0715	**Lilliefors Lognormal GOF Test**					
55					5% Lilliefors Critical Value	0.146	Data appear Lognormal at 5% Significance Level					
56	**Data appear Lognormal at 5% Significance Level**											
57												
58	**Lognormal Statistics**											
59					Minimum of Logged Data	-1.715					Mean of logged Data	0.389
60					Maximum of Logged Data	1.792					SD of logged Data	0.747
61												
62	**Assuming Lognormal Distribution**											
63					95% H-UCL	2.539					90% Chebyshev (MVUE) UCL	2.713
64					95% Chebyshev (MVUE) UCL	3.066					97.5% Chebyshev (MVUE) UCL	3.558
65					99% Chebyshev (MVUE) UCL	4.522						
66												
67	**Nonparametric Distribution Free UCL Statistics**											
68	**Data appear to follow a Discernible Distribution at 5% Significance Level**											
69												
70	**Nonparametric Distribution Free UCLs**											
71					95% CLT UCL	2.317					95% Jackknife UCL	2.328
72					95% Standard Bootstrap UCL	2.312					95% Bootstrap-t UCL	2.427
73					95% Hall's Bootstrap UCL	2.416					95% Percentile Bootstrap UCL	2.333
74					95% BCA Bootstrap UCL	2.395						
75					90% Chebyshev(Mean, Sd) UCL	2.648					95% Chebyshev(Mean, Sd) UCL	2.981
76					97.5% Chebyshev(Mean, Sd) UCL	3.442					99% Chebyshev(Mean, Sd) UCL	4.347
77												
78	**Suggested UCL to Use**											
79					95% Adjusted Gamma UCL	2.376						
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	These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)											
83	and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.											
84	For additional insight the user may want to consult a statistician.											
85												

	A–E	F	G–K	L
86				
87	Acenaphthene			
88				
89	**General Statistics**			
90	Total Number of Observations	37	Number of Distinct Observations	33
91			Number of Missing Observations	0
92	Minimum	0.04	Mean	0.545
93	Maximum	1.2	Median	0.51
94	SD	0.264	Std. Error of Mean	0.0435
95	Coefficient of Variation	0.485	Skewness	0.507
96				
97	**Normal GOF Test**			
98	Shapiro Wilk Test Statistic	0.971	**Shapiro Wilk GOF Test**	
99	5% Shapiro Wilk Critical Value	0.936	Data appear Normal at 5% Significance Level	
100	Lilliefors Test Statistic	0.115	**Lilliefors GOF Test**	
101	5% Lilliefors Critical Value	0.146	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	0.618	95% Adjusted-CLT UCL (Chen-1995)	0.62
107			95% Modified-t UCL (Johnson-1978)	0.619
108				
109	**Gamma GOF Test**			
110	A-D Test Statistic	0.468	**Anderson-Darling Gamma GOF Test**	
111	5% A-D Critical Value	0.753	Detected data appear Gamma Distributed at 5% Significance Level	
112	K-S Test Statistic	0.125	**Kolmogrov-Smirnoff Gamma GOF Test**	
113	5% K-S Critical Value	0.146	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)	3.399	k star (bias corrected MLE)	3.142
118	Theta hat (MLE)	0.16	Theta star (bias corrected MLE)	0.173
119	nu hat (MLE)	251.6	nu star (bias corrected)	232.5
120	MLE Mean (bias corrected)	0.545	MLE Sd (bias corrected)	0.307
121			Approximate Chi Square Value (0.05)	198.2
122	Adjusted Level of Significance	0.0431	Adjusted Chi Square Value	196.8
123				
124	**Assuming Gamma Distribution**			
125	95% Approximate Gamma UCL (use when n>=50))	0.639	95% Adjusted Gamma UCL (use when n<50)	0.643
126				

	A–E	F	G–K	L
127	Lognormal GOF Test			
128	Shapiro Wilk Test Statistic	0.877	**Shapiro Wilk Lognormal GOF Test**	
129	5% Shapiro Wilk Critical Value	0.936	Data Not Lognormal at 5% Significance Level	
130	Lilliefors Test Statistic	0.166	**Lilliefors Lognormal GOF Test**	
131	5% Lilliefors Critical Value	0.146	Data Not Lognormal at 5% Significance Level	
132	**Data Not Lognormal at 5% Significance Level**			
133				
134	**Lognormal Statistics**			
135	Minimum of Logged Data	-3.219	Mean of logged Data	-0.762
136	Maximum of Logged Data	0.182	SD of logged Data	0.649
137				
138	**Assuming Lognormal Distribution**			
139	95% H-UCL	0.718	90% Chebyshev (MVUE) UCL	0.769
140	95% Chebyshev (MVUE) UCL	0.858	97.5% Chebyshev (MVUE) UCL	0.982
141	99% Chebyshev (MVUE) UCL	1.226		
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	0.616	95% Jackknife UCL	0.618
148	95% Standard Bootstrap UCL	0.615	95% Bootstrap-t UCL	0.62
149	95% Hall's Bootstrap UCL	0.625	95% Percentile Bootstrap UCL	0.617
150	95% BCA Bootstrap UCL	0.614		
151	90% Chebyshev(Mean, Sd) UCL	0.675	95% Chebyshev(Mean, Sd) UCL	0.734
152	97.5% Chebyshev(Mean, Sd) UCL	0.816	99% Chebyshev(Mean, Sd) UCL	0.977
153				
154	**Suggested UCL to Use**			
155	95% Student's-t UCL	0.618		
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	These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)			
159	and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.			
160	For additional insight the user may want to consult a statistician.			
161				

Acenaphthylene

General Statistics			
Total Number of Observations	37	Number of Distinct Observations	19
Number of Detects	17	Number of Non-Detects	20
Number of Distinct Detects	14	Number of Distinct Non-Detects	6
Minimum Detect	0.034	Minimum Non-Detect	0.0052
Maximum Detect	0.16	Maximum Non-Detect	0.2
Variance Detects	0.00199	Percent Non-Detects	54.05%
Mean Detects	0.0829	SD Detects	0.0446
Median Detects	0.064	CV Detects	0.538
Skewness Detects	0.884	Kurtosis Detects	-0.693
Mean of Logged Detects	-2.619	SD of Logged Detects	0.517
Normal GOF Test on Detects Only			
Shapiro Wilk Test Statistic	0.837	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.892	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.223	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.215	Detected Data Not Normal at 5% Significance Level	
Detected Data Not Normal at 5% Significance Level			
Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs			
Mean	0.0538	Standard Error of Mean	0.00839
SD	0.0433	95% KM (BCA) UCL	0.0685
95% KM (t) UCL	0.068	95% KM (Percentile Bootstrap) UCL	0.0681
95% KM (z) UCL	0.0676	95% KM Bootstrap t UCL	0.0697
90% KM Chebyshev UCL	0.079	95% KM Chebyshev UCL	0.0904
97.5% KM Chebyshev UCL	0.106	99% KM Chebyshev UCL	0.137
Gamma GOF Tests on Detected Observations Only			
A-D Test Statistic	0.651	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.743	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.166	**Kolmogrov-Smirnoff GOF**	
5% K-S Critical Value	0.21	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics on Detected Data Only			
k hat (MLE)	4.049	k star (bias corrected MLE)	3.374
Theta hat (MLE)	0.0205	Theta star (bias corrected MLE)	0.0246
nu hat (MLE)	137.7	nu star (bias corrected)	114.7
MLE Mean (bias corrected)	0.0829	MLE Sd (bias corrected)	0.0451
Gamma Kaplan-Meier (KM) Statistics			
k hat (KM)	1.543	nu hat (KM)	114.2
Approximate Chi Square Value (114.15, α)	90.49	Adjusted Chi Square Value (114.15, β)	89.57
95% Gamma Approximate KM-UCL (use when n>=50)	0.0679	95% Gamma Adjusted KM-UCL (use when n<50)	0.0686

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detected data is small such as < 0.1

For such situations, GROS method tends to yield inflated values of UCLs and BTVs

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.0516
Maximum	0.16	Median	0.0403
SD	0.0433	CV	0.84
k hat (MLE)	1.618	k star (bias corrected MLE)	1.505
Theta hat (MLE)	0.0319	Theta star (bias corrected MLE)	0.0343
nu hat (MLE)	119.7	nu star (bias corrected)	111.4
MLE Mean (bias corrected)	0.0516	MLE Sd (bias corrected)	0.042
		Adjusted Level of Significance (β)	0.0431
Approximate Chi Square Value (111.37, α)	88.01	Adjusted Chi Square Value (111.37, β)	87.11
95% Gamma Approximate UCL (use when n>=50)	0.0653	95% Gamma Adjusted UCL (use when n<50)	0.0659

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.924	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.892	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.154	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.215	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.0554	Mean in Log Scale	-3.107
SD in Original Scale	0.0404	SD in Log Scale	0.65
95% t UCL (assumes normality of ROS data)	0.0666	95% Percentile Bootstrap UCL	0.0667
95% BCA Bootstrap UCL	0.0685	95% Bootstrap t UCL	0.0691
95% H-UCL (Log ROS)	0.0689		

UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed

KM Mean (logged)	-3.346	95% H-UCL (KM -Log)	0.0966
KM SD (logged)	1.068	95% Critical H Value (KM-Log)	2.467
KM Standard Error of Mean (logged)	0.28		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.0556	Mean in Log Scale	-3.196
SD in Original Scale	0.0432	SD in Log Scale	0.866
95% t UCL (Assumes normality)	0.0676	95% H-Stat UCL	0.0823

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Gamma Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.068	95% GROS Adjusted Gamma UCL	0.0659
95% Adjusted Gamma KM-UCL	0.0686		

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.

	A	B	C	D	E	F	G	H	I	J	K	L
263												
264	Anthracene											
265												
266	**General Statistics**											
267	Total Number of Observations					37	Number of Distinct Observations					30
268							Number of Missing Observations					0
269	Minimum					0.03	Mean					0.719
270	Maximum					4.8	Median					0.5
271	SD					0.814	Std. Error of Mean					0.134
272	Coefficient of Variation					1.133	Skewness					3.716
273												
274	**Normal GOF Test**											
275	Shapiro Wilk Test Statistic					0.636	**Shapiro Wilk GOF Test**					
276	5% Shapiro Wilk Critical Value					0.936	Data Not Normal at 5% Significance Level					
277	Lilliefors Test Statistic					0.214	**Lilliefors GOF Test**					
278	5% Lilliefors Critical Value					0.146	Data Not Normal at 5% Significance Level					
279	**Data Not Normal at 5% Significance Level**											
280												
281	**Assuming Normal Distribution**											
282	**95% Normal UCL**						**95% UCLs (Adjusted for Skewness)**					
283	95% Student's-t UCL					0.945	95% Adjusted-CLT UCL (Chen-1995)					1.027
284							95% Modified-t UCL (Johnson-1978)					0.959
285												
286	**Gamma GOF Test**											
287	A-D Test Statistic					0.538	**Anderson-Darling Gamma GOF Test**					
288	5% A-D Critical Value					0.769	Detected data appear Gamma Distributed at 5% Significance Level					
289	K-S Test Statistic					0.114	**Kolmogrov-Smirnoff Gamma GOF Test**					
290	5% K-S Critical Value					0.148	Detected data appear Gamma Distributed at 5% Significance Level					
291	**Detected data appear Gamma Distributed at 5% Significance Level**											
292												
293	**Gamma Statistics**											
294	k hat (MLE)					1.373	k star (bias corrected MLE)					1.28
295	Theta hat (MLE)					0.523	Theta star (bias corrected MLE)					0.562
296	nu hat (MLE)					101.6	nu star (bias corrected)					94.73
297	MLE Mean (bias corrected)					0.719	MLE Sd (bias corrected)					0.635
298							Approximate Chi Square Value (0.05)					73.28
299	Adjusted Level of Significance					0.0431	Adjusted Chi Square Value					72.46
300												
301	**Assuming Gamma Distribution**											
302	95% Approximate Gamma UCL (use when n>=50)					0.929	95% Adjusted Gamma UCL (use when n<50)					0.94
303												

	A	B	C	D	E	F	G	H	I	J	K	L
304	**Lognormal GOF Test**											
305	Shapiro Wilk Test Statistic					0.975	**Shapiro Wilk Lognormal GOF Test**					
306	5% Shapiro Wilk Critical Value					0.936	Data appear Lognormal at 5% Significance Level					
307	Lilliefors Test Statistic					0.11	**Lilliefors Lognormal GOF Test**					
308	5% Lilliefors Critical Value					0.146	Data appear Lognormal at 5% Significance Level					
309	**Data appear Lognormal at 5% Significance Level**											
310												
311	**Lognormal Statistics**											
312	Minimum of Logged Data					-3.507	Mean of logged Data					-0.736
313	Maximum of Logged Data					1.569	SD of logged Data					0.942
314												
315	**Assuming Lognormal Distribution**											
316	95% H-UCL					1.075	90% Chebyshev (MVUE) UCL					1.125
317	95% Chebyshev (MVUE) UCL					1.302	97.5% Chebyshev (MVUE) UCL					1.547
318	99% Chebyshev (MVUE) UCL					2.03						
319												
320	**Nonparametric Distribution Free UCL Statistics**											
321	**Data appear to follow a Discernible Distribution at 5% Significance Level**											
322												
323	**Nonparametric Distribution Free UCLs**											
324	95% CLT UCL					0.939	95% Jackknife UCL					0.945
325	95% Standard Bootstrap UCL					0.935	95% Bootstrap-t UCL					1.104
326	95% Hall's Bootstrap UCL					1.903	95% Percentile Bootstrap UCL					0.959
327	95% BCA Bootstrap UCL					1.08						
328	90% Chebyshev(Mean, Sd) UCL					1.121	95% Chebyshev(Mean, Sd) UCL					1.303
329	97.5% Chebyshev(Mean, Sd) UCL					1.555	99% Chebyshev(Mean, Sd) UCL					2.051
330												
331	**Suggested UCL to Use**											
332	95% Adjusted Gamma UCL					0.94						
333												
334	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
335	These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)											
336	and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.											
337	For additional insight the user may want to consult a statistician.											
338												
339												

	A	B	C	D	E	F	G	H	I	J	K	L
340	Benz(a)anthracene											
341												
342						**General Statistics**						
343					Total Number of Observations	37					Number of Distinct Observations	30
344											Number of Missing Observations	0
345					Minimum	0.03					Mean	0.737
346					Maximum	6.1					Median	0.45
347					SD	0.991					Std. Error of Mean	0.163
348					Coefficient of Variation	1.344					Skewness	4.655
349												
350						**Normal GOF Test**						
351					Shapiro Wilk Test Statistic	0.515			**Shapiro Wilk GOF Test**			
352					5% Shapiro Wilk Critical Value	0.936			Data Not Normal at 5% Significance Level			
353					Lilliefors Test Statistic	0.268			**Lilliefors GOF Test**			
354					5% Lilliefors Critical Value	0.146			Data Not Normal at 5% Significance Level			
355						**Data Not Normal at 5% Significance Level**						
356												
357						**Assuming Normal Distribution**						
358				**95% Normal UCL**					**95% UCLs (Adjusted for Skewness)**			
359					95% Student's-t UCL	1.012					95% Adjusted-CLT UCL (Chen-1995)	1.138
360											95% Modified-t UCL (Johnson-1978)	1.033
361												
362						**Gamma GOF Test**						
363					A-D Test Statistic	0.888			**Anderson-Darling Gamma GOF Test**			
364					5% A-D Critical Value	0.771			Data Not Gamma Distributed at 5% Significance Level			
365					K-S Test Statistic	0.129			**Kolmogrov-Smirnoff Gamma GOF Test**			
366					5% K-S Critical Value	0.148			Detected data appear Gamma Distributed at 5% Significance Level			
367						**Detected data follow Appr. Gamma Distribution at 5% Significance Level**						
368												
369						**Gamma Statistics**						
370					k hat (MLE)	1.286					k star (bias corrected MLE)	1.2
371					Theta hat (MLE)	0.573					Theta star (bias corrected MLE)	0.614
372					nu hat (MLE)	95.19					nu star (bias corrected)	88.81
373					MLE Mean (bias corrected)	0.737					MLE Sd (bias corrected)	0.673
374											Approximate Chi Square Value (0.05)	68.08
375					Adjusted Level of Significance	0.0431					Adjusted Chi Square Value	67.29
376												

	A	B	C	D	E	F	G	H	I	J	K	L
377	**Assuming Gamma Distribution**											
378					95% Approximate Gamma UCL (use when n>=50)	0.962					95% Adjusted Gamma UCL (use when n<50)	0.973
379												
380	**Lognormal GOF Test**											
381					Shapiro Wilk Test Statistic	0.959	**Shapiro Wilk Lognormal GOF Test**					
382					5% Shapiro Wilk Critical Value	0.936	Data appear Lognormal at 5% Significance Level					
383					Lilliefors Test Statistic	0.137	**Lilliefors Lognormal GOF Test**					
384					5% Lilliefors Critical Value	0.146	Data appear Lognormal at 5% Significance Level					
385	**Data appear Lognormal at 5% Significance Level**											
386												
387	**Lognormal Statistics**											
388					Minimum of Logged Data	-3.507					Mean of logged Data	-0.741
389					Maximum of Logged Data	1.808					SD of logged Data	0.955
390												
391	**Assuming Lognormal Distribution**											
392					95% H-UCL	1.09					90% Chebyshev (MVUE) UCL	1.139
393					95% Chebyshev (MVUE) UCL	1.32					97.5% Chebyshev (MVUE) UCL	1.571
394					99% Chebyshev (MVUE) UCL	2.065						
395												
396	**Nonparametric Distribution Free UCL Statistics**											
397	**Data appear to follow a Discernible Distribution at 5% Significance Level**											
398												
399	**Nonparametric Distribution Free UCLs**											
400					95% CLT UCL	1.005					95% Jackknife UCL	1.012
401					95% Standard Bootstrap UCL	1.006					95% Bootstrap-t UCL	1.365
402					95% Hall's Bootstrap UCL	2.109					95% Percentile Bootstrap UCL	1.033
403					95% BCA Bootstrap UCL	1.169						
404					90% Chebyshev(Mean, Sd) UCL	1.226					95% Chebyshev(Mean, Sd) UCL	1.447
405					97.5% Chebyshev(Mean, Sd) UCL	1.754					99% Chebyshev(Mean, Sd) UCL	2.358
406												
407	**Suggested UCL to Use**											
408					95% Adjusted Gamma UCL	0.973						
409												
410	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
411	These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)											
412	and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.											
413	For additional insight the user may want to consult a statistician.											
414												
415												

	A	B	C	D	E	F	G	H	I	J	K	L
416	Chrysene											
417												
418						General Statistics						
419					Total Number of Observations	37					Number of Distinct Observations	32
420											Number of Missing Observations	0
421					Minimum	0.03					Mean	1.037
422					Maximum	9.3					Median	0.56
423					SD	1.547					Std. Error of Mean	0.254
424					Coefficient of Variation	1.491					Skewness	4.499
425												
426						Normal GOF Test						
427					Shapiro Wilk Test Statistic	0.523			Shapiro Wilk GOF Test			
428					5% Shapiro Wilk Critical Value	0.936			Data Not Normal at 5% Significance Level			
429					Lilliefors Test Statistic	0.27			Lilliefors GOF Test			
430					5% Lilliefors Critical Value	0.146			Data Not Normal at 5% Significance Level			
431						Data Not Normal at 5% Significance Level						
432												
433						Assuming Normal Distribution						
434			95% Normal UCL						95% UCLs (Adjusted for Skewness)			
435					95% Student's-t UCL	1.466					95% Adjusted-CLT UCL (Chen-1995)	1.656
436											95% Modified-t UCL (Johnson-1978)	1.498
437												
438						Gamma GOF Test						
439					A-D Test Statistic	0.77			Anderson-Darling Gamma GOF Test			
440					5% A-D Critical Value	0.776			Detected data appear Gamma Distributed at 5% Significance Level			
441					K-S Test Statistic	0.124			Kolmogrov-Smirnoff Gamma GOF Test			
442					5% K-S Critical Value	0.149			Detected data appear Gamma Distributed at 5% Significance Level			
443						Detected data appear Gamma Distributed at 5% Significance Level						
444												
445						Gamma Statistics						
446					k hat (MLE)	1.029					k star (bias corrected MLE)	0.964
447					Theta hat (MLE)	1.007					Theta star (bias corrected MLE)	1.076
448					nu hat (MLE)	76.18					nu star (bias corrected)	71.34
449					MLE Mean (bias corrected)	1.037					MLE Sd (bias corrected)	1.056
450											Approximate Chi Square Value (0.05)	52.89
451					Adjusted Level of Significance	0.0431					Adjusted Chi Square Value	52.2
452												

	A–E	F	G–K	L
453	**Assuming Gamma Distribution**			
454	95% Approximate Gamma UCL (use when n>=50)	1.399	95% Adjusted Gamma UCL (use when n<50)	1.417
455				
456	**Lognormal GOF Test**			
457	Shapiro Wilk Test Statistic	0.975	**Shapiro Wilk Lognormal GOF Test**	
458	5% Shapiro Wilk Critical Value	0.936	Data appear Lognormal at 5% Significance Level	
459	Lilliefors Test Statistic	0.134	**Lilliefors Lognormal GOF Test**	
460	5% Lilliefors Critical Value	0.146	Data appear Lognormal at 5% Significance Level	
461	**Data appear Lognormal at 5% Significance Level**			
462				
463	**Lognormal Statistics**			
464	Minimum of Logged Data	-3.507	Mean of logged Data	-0.522
465	Maximum of Logged Data	2.23	SD of logged Data	1.089
466				
467	**Assuming Lognormal Distribution**			
468	95% H-UCL	1.688	90% Chebyshev (MVUE) UCL	1.715
469	95% Chebyshev (MVUE) UCL	2.017	97.5% Chebyshev (MVUE) UCL	2.436
470	99% Chebyshev (MVUE) UCL	3.26		
471				
472	**Nonparametric Distribution Free UCL Statistics**			
473	**Data appear to follow a Discernible Distribution at 5% Significance Level**			
474				
475	**Nonparametric Distribution Free UCLs**			
476	95% CLT UCL	1.455	95% Jackknife UCL	1.466
477	95% Standard Bootstrap UCL	1.454	95% Bootstrap-t UCL	1.997
478	95% Hall's Bootstrap UCL	3.147	95% Percentile Bootstrap UCL	1.503
479	95% BCA Bootstrap UCL	1.732		
480	90% Chebyshev(Mean, Sd) UCL	1.8	95% Chebyshev(Mean, Sd) UCL	2.146
481	97.5% Chebyshev(Mean, Sd) UCL	2.625	99% Chebyshev(Mean, Sd) UCL	3.567
482				
483	**Suggested UCL to Use**			
484	95% Adjusted Gamma UCL	1.417		
485				
486	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
487	These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)			
488	and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.			
489	For additional insight the user may want to consult a statistician.			
490				
491				

Row				
492	**Fluoranthene**			
493				
494	**General Statistics**			
495	Total Number of Observations	37	Number of Distinct Observations	28
496			Number of Missing Observations	0
497	Minimum	0.12	Mean	3.466
498	Maximum	25	Median	2
499	SD	4.86	Std. Error of Mean	0.799
500	Coefficient of Variation	1.402	Skewness	3.257
501				
502	**Normal GOF Test**			
503	Shapiro Wilk Test Statistic	0.585	**Shapiro Wilk GOF Test**	
504	5% Shapiro Wilk Critical Value	0.936	Data Not Normal at 5% Significance Level	
505	Lilliefors Test Statistic	0.327	**Lilliefors GOF Test**	
506	5% Lilliefors Critical Value	0.146	Data Not Normal at 5% Significance Level	
507	**Data Not Normal at 5% Significance Level**			
508				
509	**Assuming Normal Distribution**			
510	**95% Normal UCL**		**95% UCLs (Adjusted for Skewness)**	
511	95% Student's-t UCL	4.815	95% Adjusted-CLT UCL (Chen-1995)	5.238
512			95% Modified-t UCL (Johnson-1978)	4.886
513				
514	**Gamma GOF Test**			
515	A-D Test Statistic	1.39	**Anderson-Darling Gamma GOF Test**	
516	5% A-D Critical Value	0.776	Data Not Gamma Distributed at 5% Significance Level	
517	K-S Test Statistic	0.194	**Kolmogrov-Smirnoff Gamma GOF Test**	
518	5% K-S Critical Value	0.149	Data Not Gamma Distributed at 5% Significance Level	
519	**Data Not Gamma Distributed at 5% Significance Level**			
520				
521	**Gamma Statistics**			
522	k hat (MLE)	1.04	k star (bias corrected MLE)	0.974
523	Theta hat (MLE)	3.332	Theta star (bias corrected MLE)	3.559
524	nu hat (MLE)	76.98	nu star (bias corrected)	72.07
525	MLE Mean (bias corrected)	3.466	MLE Sd (bias corrected)	3.512
526			Approximate Chi Square Value (0.05)	53.53
527	Adjusted Level of Significance	0.0431	Adjusted Chi Square Value	52.83
528				

	A	B	C	D	E	F	G	H	I	J	K	L
529	**Assuming Gamma Distribution**											
530					95% Approximate Gamma UCL (use when n>=50))	4.667					95% Adjusted Gamma UCL (use when n<50)	4.729
531												
532	**Lognormal GOF Test**											
533					Shapiro Wilk Test Statistic	0.971	**Shapiro Wilk Lognormal GOF Test**					
534					5% Shapiro Wilk Critical Value	0.936	Data appear Lognormal at 5% Significance Level					
535					Lilliefors Test Statistic	0.124	**Lilliefors Lognormal GOF Test**					
536					5% Lilliefors Critical Value	0.146	Data appear Lognormal at 5% Significance Level					
537	**Data appear Lognormal at 5% Significance Level**											
538												
539	**Lognormal Statistics**											
540					Minimum of Logged Data	-2.12					Mean of logged Data	0.691
541					Maximum of Logged Data	3.219					SD of logged Data	1.045
542												
543	**Assuming Lognormal Distribution**											
544					95% H-UCL	5.266					90% Chebyshev (MVUE) UCL	5.404
545					95% Chebyshev (MVUE) UCL	6.326					97.5% Chebyshev (MVUE) UCL	7.606
546					99% Chebyshev (MVUE) UCL	10.12						
547												
548	**Nonparametric Distribution Free UCL Statistics**											
549	**Data appear to follow a Discernible Distribution at 5% Significance Level**											
550												
551	**Nonparametric Distribution Free UCLs**											
552					95% CLT UCL	4.78					95% Jackknife UCL	4.815
553					95% Standard Bootstrap UCL	4.774					95% Bootstrap-t UCL	6.142
554					95% Hall's Bootstrap UCL	9.991					95% Percentile Bootstrap UCL	4.885
555					95% BCA Bootstrap UCL	5.335						
556					90% Chebyshev(Mean, Sd) UCL	5.863					95% Chebyshev(Mean, Sd) UCL	6.949
557					97.5% Chebyshev(Mean, Sd) UCL	8.456					99% Chebyshev(Mean, Sd) UCL	11.42
558												
559	**Suggested UCL to Use**											
560					95% H-UCL	5.266						
561												
562	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
563	These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)											
564	and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.											
565	For additional insight the user may want to consult a statistician.											
566												
567	**ProUCL computes and outputs H-statistic based UCLs for historical reasons only.**											
568	**H-statistic often results in unstable (both high and low) values of UCL95 as shown in examples in the Technical Guide.**											
569	**It is therefore recommended to avoid the use of H-statistic based 95% UCLs.**											
570	**Use of nonparametric methods are preferred to compute UCL95 for skewed data sets which do not follow a gamma distribution.**											
571												
572												

	A	B	C	D	E	F	G	H	I	J	K	L
573	Fluorene											
574												
575						General Statistics						
576					Total Number of Observations	37					Number of Distinct Observations	30
577											Number of Missing Observations	0
578					Minimum	0.04					Mean	0.528
579					Maximum	1.2					Median	0.51
580					SD	0.281					Std. Error of Mean	0.0463
581					Coefficient of Variation	0.533					Skewness	0.781
582												
583						Normal GOF Test						
584					Shapiro Wilk Test Statistic	0.938			Shapiro Wilk GOF Test			
585					5% Shapiro Wilk Critical Value	0.936			Data appear Normal at 5% Significance Level			
586					Lilliefors Test Statistic	0.132			Lilliefors GOF Test			
587					5% Lilliefors Critical Value	0.146			Data appear Normal at 5% Significance Level			
588						Data appear Normal at 5% Significance Level						
589												
590						Assuming Normal Distribution						
591			95% Normal UCL						95% UCLs (Adjusted for Skewness)			
592					95% Student's-t UCL	0.606					95% Adjusted-CLT UCL (Chen-1995)	0.61
593											95% Modified-t UCL (Johnson-1978)	0.607
594												
595						Gamma GOF Test						
596					A-D Test Statistic	0.454			Anderson-Darling Gamma GOF Test			
597					5% A-D Critical Value	0.754			Detected data appear Gamma Distributed at 5% Significance Level			
598					K-S Test Statistic	0.096			Kolmogrov-Smirnoff Gamma GOF Test			
599					5% K-S Critical Value	0.146			Detected data appear Gamma Distributed at 5% Significance Level			
600						Detected data appear Gamma Distributed at 5% Significance Level						
601												
602						Gamma Statistics						
603					k hat (MLE)	3.03					k star (bias corrected MLE)	2.802
604					Theta hat (MLE)	0.174					Theta star (bias corrected MLE)	0.188
605					nu hat (MLE)	224.2					nu star (bias corrected)	207.4
606					MLE Mean (bias corrected)	0.528					MLE Sd (bias corrected)	0.315
607											Approximate Chi Square Value (0.05)	175
608					Adjusted Level of Significance	0.0431					Adjusted Chi Square Value	173.8
609												

	A–E	F	G–K	L
610	**Assuming Gamma Distribution**			
611	95% Approximate Gamma UCL (use when n>=50))	0.625	95% Adjusted Gamma UCL (use when n<50)	0.63
612				
613	**Lognormal GOF Test**			
614	Shapiro Wilk Test Statistic	0.895	**Shapiro Wilk Lognormal GOF Test**	
615	5% Shapiro Wilk Critical Value	0.936	Data Not Lognormal at 5% Significance Level	
616	Lilliefors Test Statistic	0.136	**Lilliefors Lognormal GOF Test**	
617	5% Lilliefors Critical Value	0.146	Data appear Lognormal at 5% Significance Level	
618	**Data appear Approximate Lognormal at 5% Significance Level**			
619				
620	**Lognormal Statistics**			
621	Minimum of Logged Data	-3.219	Mean of logged Data	-0.813
622	Maximum of Logged Data	0.182	SD of logged Data	0.679
623				
624	**Assuming Lognormal Distribution**			
625	95% H-UCL	0.705	90% Chebyshev (MVUE) UCL	0.755
626	95% Chebyshev (MVUE) UCL	0.846	97.5% Chebyshev (MVUE) UCL	0.972
627	99% Chebyshev (MVUE) UCL	1.22		
628				
629	**Nonparametric Distribution Free UCL Statistics**			
630	**Data appear to follow a Discernible Distribution at 5% Significance Level**			
631				
632	**Nonparametric Distribution Free UCLs**			
633	95% CLT UCL	0.604	95% Jackknife UCL	0.606
634	95% Standard Bootstrap UCL	0.603	95% Bootstrap-t UCL	0.611
635	95% Hall's Bootstrap UCL	0.611	95% Percentile Bootstrap UCL	0.602
636	95% BCA Bootstrap UCL	0.604		
637	90% Chebyshev(Mean, Sd) UCL	0.667	95% Chebyshev(Mean, Sd) UCL	0.73
638	97.5% Chebyshev(Mean, Sd) UCL	0.817	99% Chebyshev(Mean, Sd) UCL	0.988
639				
640	**Suggested UCL to Use**			
641	95% Student's-t UCL	0.606		
642				
643	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
644	These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)			
645	and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.			
646	For additional insight the user may want to consult a statistician.			
647				
648				

	A	B	C	D	E	F	G	H	I	J	K	L
649	Naphthalene											
650												
651	General Statistics											
652	Total Number of Observations					37	Number of Distinct Observations					28
653							Number of Missing Observations					0
654	Minimum					0.16	Mean					1.38
655	Maximum					3.6	Median					1.1
656	SD					0.911	Std. Error of Mean					0.15
657	Coefficient of Variation					0.66	Skewness					1.2
658												
659	Normal GOF Test											
660	Shapiro Wilk Test Statistic					0.851	Shapiro Wilk GOF Test					
661	5% Shapiro Wilk Critical Value					0.936	Data Not Normal at 5% Significance Level					
662	Lilliefors Test Statistic					0.2	Lilliefors GOF Test					
663	5% Lilliefors Critical Value					0.146	Data Not Normal at 5% Significance Level					
664	Data Not Normal at 5% Significance Level											
665												
666	Assuming Normal Distribution											
667	95% Normal UCL						95% UCLs (Adjusted for Skewness)					
668	95% Student's-t UCL					1.633	95% Adjusted-CLT UCL (Chen-1995)					1.658
669							95% Modified-t UCL (Johnson-1978)					1.638
670												
671	Gamma GOF Test											
672	A-D Test Statistic					0.653	Anderson-Darling Gamma GOF Test					
673	5% A-D Critical Value					0.756	Detected data appear Gamma Distributed at 5% Significance Level					
674	K-S Test Statistic					0.125	Kolmogrov-Smirnoff Gamma GOF Test					
675	5% K-S Critical Value					0.146	Detected data appear Gamma Distributed at 5% Significance Level					
676	Detected data appear Gamma Distributed at 5% Significance Level											
677												
678	Gamma Statistics											
679	k hat (MLE)					2.595	k star (bias corrected MLE)					2.403
680	Theta hat (MLE)					0.532	Theta star (bias corrected MLE)					0.575
681	nu hat (MLE)					192	nu star (bias corrected)					177.8
682	MLE Mean (bias corrected)					1.38	MLE Sd (bias corrected)					0.89
683							Approximate Chi Square Value (0.05)					147.9
684	Adjusted Level of Significance					0.0431	Adjusted Chi Square Value					146.8
685												

	A	B	C	D	E	F	G	H	I	J	K	L
686	**Assuming Gamma Distribution**											
687					95% Approximate Gamma UCL (use when n>=50)	1.659					95% Adjusted Gamma UCL (use when n<50)	1.672
688												
689	**Lognormal GOF Test**											
690					Shapiro Wilk Test Statistic	0.962	**Shapiro Wilk Lognormal GOF Test**					
691					5% Shapiro Wilk Critical Value	0.936	Data appear Lognormal at 5% Significance Level					
692					Lilliefors Test Statistic	0.0831	**Lilliefors Lognormal GOF Test**					
693					5% Lilliefors Critical Value	0.146	Data appear Lognormal at 5% Significance Level					
694	**Data appear Lognormal at 5% Significance Level**											
695												
696	**Lognormal Statistics**											
697					Minimum of Logged Data	-1.833					Mean of logged Data	0.117
698					Maximum of Logged Data	1.281					SD of logged Data	0.671
699												
700	**Assuming Lognormal Distribution**											
701					95% H-UCL	1.772					90% Chebyshev (MVUE) UCL	1.898
702					95% Chebyshev (MVUE) UCL	2.124					97.5% Chebyshev (MVUE) UCL	2.439
703					99% Chebyshev (MVUE) UCL	3.056						
704												
705	**Nonparametric Distribution Free UCL Statistics**											
706	**Data appear to follow a Discernible Distribution at 5% Significance Level**											
707												
708	**Nonparametric Distribution Free UCLs**											
709					95% CLT UCL	1.627					95% Jackknife UCL	1.633
710					95% Standard Bootstrap UCL	1.621					95% Bootstrap-t UCL	1.681
711					95% Hall's Bootstrap UCL	1.662					95% Percentile Bootstrap UCL	1.635
712					95% BCA Bootstrap UCL	1.648						
713					90% Chebyshev(Mean, Sd) UCL	1.83					95% Chebyshev(Mean, Sd) UCL	2.033
714					97.5% Chebyshev(Mean, Sd) UCL	2.316					99% Chebyshev(Mean, Sd) UCL	2.87
715												
716	**Suggested UCL to Use**											
717					95% Adjusted Gamma UCL	1.672						
718												
719	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
720	These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)											
721	and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.											
722	For additional insight the user may want to consult a statistician.											
723												
724												

Row	A–E	F	G–K	L
725	Phenanthrene			
726				
727	**General Statistics**			
728	Total Number of Observations	37	Number of Distinct Observations	27
729			Number of Missing Observations	0
730	Minimum	0.1	Mean	1.943
731	Maximum	11	Median	1.4
732	SD	2.084	Std. Error of Mean	0.343
733	Coefficient of Variation	1.072	Skewness	3.002
734				
735	**Normal GOF Test**			
736	Shapiro Wilk Test Statistic	0.655	**Shapiro Wilk GOF Test**	
737	5% Shapiro Wilk Critical Value	0.936	Data Not Normal at 5% Significance Level	
738	Lilliefors Test Statistic	0.292	**Lilliefors GOF Test**	
739	5% Lilliefors Critical Value	0.146	Data Not Normal at 5% Significance Level	
740	**Data Not Normal at 5% Significance Level**			
741				
742	**Assuming Normal Distribution**			
743	**95% Normal UCL**		**95% UCLs (Adjusted for Skewness)**	
744	95% Student's-t UCL	2.522	95% Adjusted-CLT UCL (Chen-1995)	2.687
745			95% Modified-t UCL (Johnson-1978)	2.55
746				
747	**Gamma GOF Test**			
748	A-D Test Statistic	1.215	**Anderson-Darling Gamma GOF Test**	
749	5% A-D Critical Value	0.766	Data Not Gamma Distributed at 5% Significance Level	
750	K-S Test Statistic	0.186	**Kolmogrov-Smirnoff Gamma GOF Test**	
751	5% K-S Critical Value	0.148	Data Not Gamma Distributed at 5% Significance Level	
752	**Data Not Gamma Distributed at 5% Significance Level**			
753				
754	**Gamma Statistics**			
755	k hat (MLE)	1.508	k star (bias corrected MLE)	1.404
756	Theta hat (MLE)	1.289	Theta star (bias corrected MLE)	1.385
757	nu hat (MLE)	111.6	nu star (bias corrected)	103.9
758	MLE Mean (bias corrected)	1.943	MLE Sd (bias corrected)	1.64
759			Approximate Chi Square Value (0.05)	81.35
760	Adjusted Level of Significance	0.0431	Adjusted Chi Square Value	80.48
761				
762	**Assuming Gamma Distribution**			
763	95% Approximate Gamma UCL (use when n>=50))	2.481	95% Adjusted Gamma UCL (use when n<50)	2.508

	A	B	C	D	E	F	G	H	I	J	K	L
764												
765	**Lognormal GOF Test**											
766					Shapiro Wilk Test Statistic	0.954	**Shapiro Wilk Lognormal GOF Test**					
767					5% Shapiro Wilk Critical Value	0.936	Data appear Lognormal at 5% Significance Level					
768					Lilliefors Test Statistic	0.131	**Lilliefors Lognormal GOF Test**					
769					5% Lilliefors Critical Value	0.146	Data appear Lognormal at 5% Significance Level					
770	**Data appear Lognormal at 5% Significance Level**											
771												
772	**Lognormal Statistics**											
773					Minimum of Logged Data	-2.303					Mean of logged Data	0.297
774					Maximum of Logged Data	2.398					SD of logged Data	0.875
775												
776	**Assuming Lognormal Distribution**											
777					95% H-UCL	2.744					90% Chebyshev (MVUE) UCL	2.897
778					95% Chebyshev (MVUE) UCL	3.328					97.5% Chebyshev (MVUE) UCL	3.925
779					99% Chebyshev (MVUE) UCL	5.097						
780												
781	**Nonparametric Distribution Free UCL Statistics**											
782	**Data appear to follow a Discernible Distribution at 5% Significance Level**											
783												
784	**Nonparametric Distribution Free UCLs**											
785					95% CLT UCL	2.507					95% Jackknife UCL	2.522
786					95% Standard Bootstrap UCL	2.498					95% Bootstrap-t UCL	2.961
787					95% Hall's Bootstrap UCL	4.713					95% Percentile Bootstrap UCL	2.573
788					95% BCA Bootstrap UCL	2.718						
789					90% Chebyshev(Mean, Sd) UCL	2.971					95% Chebyshev(Mean, Sd) UCL	3.437
790					97.5% Chebyshev(Mean, Sd) UCL	4.083					99% Chebyshev(Mean, Sd) UCL	5.352
791												
792	**Suggested UCL to Use**											
793					95% H-UCL	2.744						
794												
795	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
796	These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)											
797	and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.											
798	For additional insight the user may want to consult a statistician.											
799												
800	**ProUCL computes and outputs H-statistic based UCLs for historical reasons only.**											
801	**H-statistic often results in unstable (both high and low) values of UCL95 as shown in examples in the Technical Guide.**											
802	**It is therefore recommended to avoid the use of H-statistic based 95% UCLs.**											
803	**Use of nonparametric methods are preferred to compute UCL95 for skewed data sets which do not follow a gamma distribution.**											
804												
805												

Pyrene

General Statistics			
Total Number of Observations	37	Number of Distinct Observations	29
		Number of Missing Observations	0
Minimum	0.11	Mean	2.631
Maximum	13	Median	1.7
SD	2.652	Std. Error of Mean	0.436
Coefficient of Variation	1.008	Skewness	2.325
Normal GOF Test			
Shapiro Wilk Test Statistic	0.745	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.936	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.224	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.146	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	3.367	95% Adjusted-CLT UCL (Chen-1995)	3.526
		95% Modified-t UCL (Johnson-1978)	3.395
Gamma GOF Test			
A-D Test Statistic	0.638	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.769	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.113	**Kolmogrov-Smirnoff Gamma GOF Test**	
5% K-S Critical Value	0.148	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	1.387	k star (bias corrected MLE)	1.292
Theta hat (MLE)	1.897	Theta star (bias corrected MLE)	2.036
nu hat (MLE)	102.6	nu star (bias corrected)	95.63
MLE Mean (bias corrected)	2.631	MLE Sd (bias corrected)	2.314
		Approximate Chi Square Value (0.05)	74.07
Adjusted Level of Significance	0.0431	Adjusted Chi Square Value	73.25
Assuming Gamma Distribution			
95% Approximate Gamma UCL (use when n>=50)	3.396	95% Adjusted Gamma UCL (use when n<50)	3.435

	A	B	C	D	E	F	G	H	I	J	K	L
846	**Lognormal GOF Test**											
847					Shapiro Wilk Test Statistic	0.973	**Shapiro Wilk Lognormal GOF Test**					
848					5% Shapiro Wilk Critical Value	0.936	Data appear Lognormal at 5% Significance Level					
849					Lilliefors Test Statistic	0.11	**Lilliefors Lognormal GOF Test**					
850					5% Lilliefors Critical Value	0.146	Data appear Lognormal at 5% Significance Level					
851	**Data appear Lognormal at 5% Significance Level**											
852												
853	**Lognormal Statistics**											
854					Minimum of Logged Data	-2.207					Mean of logged Data	0.565
855					Maximum of Logged Data	2.565					SD of logged Data	0.948
856												
857	**Assuming Lognormal Distribution**											
858					95% H-UCL	3.988					90% Chebyshev (MVUE) UCL	4.169
859					95% Chebyshev (MVUE) UCL	4.828					97.5% Chebyshev (MVUE) UCL	5.744
860					99% Chebyshev (MVUE) UCL	7.543						
861												
862	**Nonparametric Distribution Free UCL Statistics**											
863	**Data appear to follow a Discernible Distribution at 5% Significance Level**											
864												
865	**Nonparametric Distribution Free UCLs**											
866					95% CLT UCL	3.348					95% Jackknife UCL	3.367
867					95% Standard Bootstrap UCL	3.336					95% Bootstrap-t UCL	3.689
868					95% Hall's Bootstrap UCL	3.82					95% Percentile Bootstrap UCL	3.412
869					95% BCA Bootstrap UCL	3.505						
870					90% Chebyshev(Mean, Sd) UCL	3.939					95% Chebyshev(Mean, Sd) UCL	4.531
871					97.5% Chebyshev(Mean, Sd) UCL	5.353					99% Chebyshev(Mean, Sd) UCL	6.968
872												
873	**Suggested UCL to Use**											
874					95% Adjusted Gamma UCL	3.435						
875												
876	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
877	These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)											
878	and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.											
879	For additional insight the user may want to consult a statistician.											
880												

Benzo(a)pyrene

General Statistics

Total Number of Observations	37	Number of Distinct Observations	30
Number of Detects	34	Number of Non-Detects	3
Number of Distinct Detects	28	Number of Distinct Non-Detects	2
Minimum Detect	0.067	Minimum Non-Detect	0.01
Maximum Detect	2.7	Maximum Non-Detect	0.05
Variance Detects	0.222	Percent Non-Detects	8.108%
Mean Detects	0.41	SD Detects	0.471
Median Detects	0.295	CV Detects	1.149
Skewness Detects	3.794	Kurtosis Detects	17.41
Mean of Logged Detects	-1.243	SD of Logged Detects	0.799

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.599	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.933	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.233	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.152	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

Mean	0.377	Standard Error of Mean	0.0764
SD	0.458	95% KM (BCA) UCL	0.53
95% KM (t) UCL	0.506	95% KM (Percentile Bootstrap) UCL	0.52
95% KM (z) UCL	0.503	95% KM Bootstrap t UCL	0.624
90% KM Chebyshev UCL	0.607	95% KM Chebyshev UCL	0.71
97.5% KM Chebyshev UCL	0.855	99% KM Chebyshev UCL	1.138

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.863	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.765	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.136	**Kolmogrov-Smirnoff GOF**
5% K-S Critical Value	0.154	Detected data appear Gamma Distributed at 5% Significance Level

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.572	k star (bias corrected MLE)	1.453
Theta hat (MLE)	0.261	Theta star (bias corrected MLE)	0.282
nu hat (MLE)	106.9	nu star (bias corrected)	98.78
MLE Mean (bias corrected)	0.41	MLE Sd (bias corrected)	0.34

Gamma Kaplan-Meier (KM) Statistics

k hat (KM)	0.679	nu hat (KM)	50.23
Approximate Chi Square Value (50.23, α)	34.96	Adjusted Chi Square Value (50.23, β)	34.4
95% Gamma Approximate KM-UCL (use when n>=50)	0.542	95% Gamma Adjusted KM-UCL (use when n<50)	0.551

Row	A–E	F	G–K	L
928	Gamma ROS Statistics using Imputed Non-Detects			
929	GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs			
930	GROS may not be used when kstar of detected data is small such as < 0.1			
931	For such situations, GROS method tends to yield inflated values of UCLs and BTVs			
932	For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates			
933	Minimum	0.01	Mean	0.377
934	Maximum	2.7	Median	0.22
935	SD	0.464	CV	1.23
936	k hat (MLE)	1.06	k star (bias corrected MLE)	0.992
937	Theta hat (MLE)	0.356	Theta star (bias corrected MLE)	0.38
938	nu hat (MLE)	78.44	nu star (bias corrected)	73.41
939	MLE Mean (bias corrected)	0.377	MLE Sd (bias corrected)	0.379
940			Adjusted Level of Significance (β)	0.0431
941	Approximate Chi Square Value (73.41, α)	54.68	Adjusted Chi Square Value (73.41, β)	53.98
942	95% Gamma Approximate UCL (use when n>=50)	0.507	95% Gamma Adjusted UCL (use when n<50)	0.513
943				
944	**Lognormal GOF Test on Detected Observations Only**			
945	Shapiro Wilk Test Statistic	0.971	**Shapiro Wilk GOF Test**	
946	5% Shapiro Wilk Critical Value	0.933	Detected Data appear Lognormal at 5% Significance Level	
947	Lilliefors Test Statistic	0.111	**Lilliefors GOF Test**	
948	5% Lilliefors Critical Value	0.152	Detected Data appear Lognormal at 5% Significance Level	
949	**Detected Data appear Lognormal at 5% Significance Level**			
950				
951	**Lognormal ROS Statistics Using Imputed Non-Detects**			
952	Mean in Original Scale	0.38	Mean in Log Scale	-1.393
953	SD in Original Scale	0.462	SD in Log Scale	0.921
954	95% t UCL (assumes normality of ROS data)	0.508	95% Percentile Bootstrap UCL	0.516
955	95% BCA Bootstrap UCL	0.565	95% Bootstrap t UCL	0.624
956	95% H-UCL (Log ROS)	0.54		
957				
958	**UCLs using Lognormal Distribution and KM Estimates when Detected data are Lognormally Distributed**			
959	KM Mean (logged)	-1.516	95% H-UCL (KM -Log)	0.747
960	KM SD (logged)	1.188	95% Critical H Value (KM-Log)	2.613
961	KM Standard Error of Mean (logged)	0.198		
962				
963	**DL/2 Statistics**			
964	**DL/2 Normal**		**DL/2 Log-Transformed**	
965	Mean in Original Scale	0.378	Mean in Log Scale	-1.485
966	SD in Original Scale	0.464	SD in Log Scale	1.147
967	95% t UCL (Assumes normality)	0.507	95% H-Stat UCL	0.713
968	**DL/2 is not a recommended method, provided for comparisons and historical reasons**			
969				
970	**Nonparametric Distribution Free UCL Statistics**			
971	**Detected Data appear Approximate Gamma Distributed at 5% Significance Level**			
972				
973	**Suggested UCL to Use**			
974	95% KM (Chebyshev) UCL	0.71	95% GROS Adjusted Gamma UCL	0.513
975	95% Adjusted Gamma KM-UCL	0.551		
976				
977	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.			
978	Recommendations are based upon data size, data distribution, and skewness.			
979	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).			
980	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.			

	A	B	C	D	E	F	G	H	I	J	K	L
981												
982												
983	Total PAHs											
984												
985	**General Statistics**											
986					Total Number of Observations	31					Number of Distinct Observations	22
987											Number of Missing Observations	0
988					Minimum	2.1					Mean	14.89
989					Maximum	79					Median	13
990					SD	14.41					Std. Error of Mean	2.589
991					Coefficient of Variation	0.968					Skewness	3.334
992												
993	**Normal GOF Test**											
994					Shapiro Wilk Test Statistic	0.631	**Shapiro Wilk GOF Test**					
995					5% Shapiro Wilk Critical Value	0.929	Data Not Normal at 5% Significance Level					
996					Lilliefors Test Statistic	0.318	**Lilliefors GOF Test**					
997					5% Lilliefors Critical Value	0.159	Data Not Normal at 5% Significance Level					
998	**Data Not Normal at 5% Significance Level**											
999												
1000	**Assuming Normal Distribution**											
1001	**95% Normal UCL**						**95% UCLs (Adjusted for Skewness)**					
1002					95% Student's-t UCL	19.29					95% Adjusted-CLT UCL (Chen-1995)	20.81
1003											95% Modified-t UCL (Johnson-1978)	19.55
1004												
1005	**Gamma GOF Test**											
1006					A-D Test Statistic	1.087	**Anderson-Darling Gamma GOF Test**					
1007					5% A-D Critical Value	0.759	Data Not Gamma Distributed at 5% Significance Level					
1008					K-S Test Statistic	0.208	**Kolmogrov-Smirnoff Gamma GOF Test**					
1009					5% K-S Critical Value	0.16	Data Not Gamma Distributed at 5% Significance Level					
1010	**Data Not Gamma Distributed at 5% Significance Level**											
1011												
1012	**Gamma Statistics**											
1013					k hat (MLE)	1.985					k star (bias corrected MLE)	1.814
1014					Theta hat (MLE)	7.503					Theta star (bias corrected MLE)	8.208
1015					nu hat (MLE)	123.1					nu star (bias corrected)	112.5
1016					MLE Mean (bias corrected)	14.89					MLE Sd (bias corrected)	11.06
1017											Approximate Chi Square Value (0.05)	89.01
1018					Adjusted Level of Significance	0.0413					Adjusted Chi Square Value	87.85
1019												

	A	B	C	D	E	F	G	H	I	J	K	L
1020	**Assuming Gamma Distribution**											
1021	95% Approximate Gamma UCL (use when n>=50))					18.82	95% Adjusted Gamma UCL (use when n<50)					19.07
1022												
1023	**Lognormal GOF Test**											
1024	Shapiro Wilk Test Statistic					0.955	**Shapiro Wilk Lognormal GOF Test**					
1025	5% Shapiro Wilk Critical Value					0.929	Data appear Lognormal at 5% Significance Level					
1026	Lilliefors Test Statistic					0.164	**Lilliefors Lognormal GOF Test**					
1027	5% Lilliefors Critical Value					0.159	Data Not Lognormal at 5% Significance Level					
1028	**Data appear Approximate Lognormal at 5% Significance Level**											
1029												
1030	**Lognormal Statistics**											
1031	Minimum of Logged Data					0.742	Mean of logged Data					2.428
1032	Maximum of Logged Data					4.369	SD of logged Data					0.721
1033												
1034	**Assuming Lognormal Distribution**											
1035	95% H-UCL					19.44	90% Chebyshev (MVUE) UCL					20.7
1036	95% Chebyshev (MVUE) UCL					23.48	97.5% Chebyshev (MVUE) UCL					27.34
1037	99% Chebyshev (MVUE) UCL					34.93						
1038												
1039	**Nonparametric Distribution Free UCL Statistics**											
1040	**Data appear to follow a Discernible Distribution at 5% Significance Level**											
1041												
1042	**Nonparametric Distribution Free UCLs**											
1043	95% CLT UCL					19.15	95% Jackknife UCL					19.29
1044	95% Standard Bootstrap UCL					19.13	95% Bootstrap-t UCL					23.6
1045	95% Hall's Bootstrap UCL					38.63	95% Percentile Bootstrap UCL					19.64
1046	95% BCA Bootstrap UCL					21.89						
1047	90% Chebyshev(Mean, Sd) UCL					22.66	95% Chebyshev(Mean, Sd) UCL					26.18
1048	97.5% Chebyshev(Mean, Sd) UCL					31.06	99% Chebyshev(Mean, Sd) UCL					40.65
1049												
1050	**Suggested UCL to Use**											
1051	95% Chebyshev (Mean, Sd) UCL					26.18						
1052												
1053	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
1054	These recommendations are based upon the results of the simulation studies summarized in Singh, Singh, and Iaci (2002)											
1055	and Singh and Singh (2003). However, simulations results will not cover all Real World data sets.											
1056	For additional insight the user may want to consult a statistician.											
1057												

APPENDIX D
DIVE SURVEY RESULTS

Tetra Tech EBA

Subtidal Habitat Report for Nanaimio Port 1 Drive

Nanaimo, B.C.

Prepared for:

Kristy Gabelhouse
Tetra Tech EBA

Unit 1 – 4376 Boban Dr.

Nanaimo, B.C.

V9T 6A7

May 11, 2015

Prepared by:

Shane Servant
Subtidal Surveying & Environmental Assessors (SSEA)
1479 The Outrigger
Nanoose, BC
V9P 9B6

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1.0 Disclaimer

This report is limited to observations made on April 20-23, 2015 during a SCUBA survey of the area. All efforts were made to place transects in the area to get a representation of the fish and fish habitat in the area. The transects were also placed in importance to questionable areas and limited in some areas due to manmade structures on site. The focus of the survey was to collect video and habitat information of the subtidal in areas where sediment is being tested for contamination and compared to other areas in the area.

2.0 Summary

Eelgrass was present in the shallows on transects 1 and 2. This habitat is limited and generally protected due to its fish habitat value.

Food, social or ceremonial important fish in the area are:
Red rock crab, Dungeness crab, Giant sea cucumber, Rock scallop, Swimming scallop, Nuttalls cockle, Pacific gaper clam, Fat gaper clam and Rock sole.

There was manmade debris on most transects during the survey ranging from tires to toilets.

All transects were surveyed with using video and underwater scribing. There were some issues with vessel travel and scheduling but with good communication with the SEASPAN terminal we were able to get short windows to cover the area fully.

3.0 Introduction

Subtidal Surveying and Environmental Assessors (SSEA) has been contacted to complete a subtidal fish and fish habitat survey of the marine area around the SEASPAN terminal at Nanaimo Port 1 drive.

The goals of the survey are:

1. Provide a description of the physical and biological characteristics of the surveyed habitats.
2. Find suitable shellfish and vegetation to collect for tissue analysis.
3. Provide video and photos of the survey.
4. Provide a habitat profile of the transects.
5. Provide written summary of fish and fish habitat observed during the survey.

4.0 Methods

Prior to the fieldwork, transects were plotted to represent coverage of the area, ensure coverage of areas of concern and limitations due to manmade structures.

In most cases the lead transect line was laid from the shore out to the deep end of the tenure for the divers to follow. In some cases where the vessel could not get to the shore the divers would swim the line into the shore. The SCUBA divers would go down the deep end and start the survey. One diver collected video and the other scribed the fish habitat data. The transect line is marked every 1m, 5m and 10m. The numbers on the transect line are used as a measuring device and do not correspond to the data sheets.

5.0 Results from Underwater Survey

Transect 1

The substrate is a soft sediment characterized by mud and wood debris in the deep and turns to sand with wood debris until you get close to the intertidal. The common animals in the area are: Dungeness crab, red rock crab, leather stars, tubeworms and flatfish. Other macrofauna included; unknown snails, nudibranchs, horseclams, hermit crabs, gunnel, giant anemones, and barnacles. Eelgrass was present close to the intertidal with very little other macroflaura. A low percentage of leafy algae and flat kelp was recorded. Other debris such as tires, electrical wire, metal wire and chain was also observed.

Transect 2

The substrate is soft sediment characterized by mud and sand with woody debris found along the majority of the transect. The common animals in the area are: Dungeness crab, red rock crab, tubeworms, hermit crab, and snails. Other macrofauna included; plumose anemone, leather star, pacific gaper, *Beggiatoa*, pipefish, and decorator crab. Eelgrass was observed at the intertidal/subtidal zone along with *Sargassum*, small amounts of fine red algae, and some small leafy algae.

.

Transect 3

The substrate is soft sediment of mud, sand and shell in the subtidal turning to bolders in the intertidal. The common animals in the area are: tubeworms, horse clams, and cockles. Other macrofauna included; giant plumose anemone, Dungeness crab, snails, heath's dorid, leather star, nudibranchs, red rock crab, hermit crab, rock sole, giant pink star, white spotted greenling, barnacles, shiner perch and northern spearnose poacher. The macroflora was mostly found in the first 2m of water close to the intertidal was mostly leafy algae and stringy algae. There was flat kelp present in the deep in one quadrat.

.**Transect 4**

The substrate is soft sediment in the deep until you get into 4.5m of water where it turns to boulders with some cobble and gravel. The common animals in the area are: tubeworms. Other macrofauna included; cockle, rock sole, Dungeness crab, chiton, snails, heaths dorid, barnacles, leather star, decorator crab, shiner perch and kelp crab. Flat kelp started in 6 m of water with leafy algae and stringy algae also being present. Rockweed was found up to 1.87 m above datum.

Transect 5

The substrate is a mix of soft sediment with shell and gravel. There is woody debris also found in the area. The common animals in the area are: tubeworms, snails, rock sole, piddock clam, barnacles and perch. Other macrofauna observed are; orange finger sponge, kelp greenling, swimming scallop, sea peach, purple sea star, blackeye goby and copper rockfish. A toilet and metal pipe was observed on this transect. Leafy algae was found along the transect. Flat kelp and leafy algae were also found at 6.43 m below datum.

Transect 6

The substrate in the area was mixed with mud in the deep turning to cobble then a mix of shell and boulder closer to the shore. The common animals found in the area are: tubeworms, piddock clam, and barnacles. Other macrofauna found include; Dungeness crab, heaths dorid, hermit crab, bryozoans, leather star, stalked vase sponge, rock sole, horse clam, cockle and pile perch. A low amount of macroflora was observed for most of the transect. Leafy algae and flat kelp were present. Old pilings were observed under the dock close to the shore.

Transect 7

The substrate in the area is mud in the deep and turns to primarily boulders in the intertidal. The common animals in the area are: tubeworms, horse clam, cockle, barnacles, and snails. Other macrofauna found include; heaths dorid, rock sole, giant sea anemone, giant sea cucumber, brittle star, red rock crab, white spotted greenling and limpets. An old crab trap was observed on this transect. A mix of stringy algae, leafy algae and flat kelp were found in the intertidal area on this transect.

Transect 8

The substrate in the area is primarily mud with some woody debris. The substrate changes to cobble and boulder in the intertidal. The common animals found are: tubeworms, snails, cockles, giant sea anemone, and barnacles. Other macrofauna include; rock sole, red rock crab, Dungeness crab, white spotted greenling, leather star, purple sea star and striped sea perch. The vegetation was limited to the intertidal and included; stringy algae, leafy algae, flat kelp and rockweed.

Transect 9

The substrate is primarily mud until you get into the intertidal where it turns to boulder. The common animals observed include: tubeworms, snails and barnacles. Other macrofauna include; cockle, English sole, white lined nudibranch, giant sea anemone, feather duster worm, Dungeness crab, horse clam, pile perch, purple sea star, blackeye goby, broad based tunicate, leather star and rock scallop. Leafy algae was the dominate form of vegetation and mostly in the intertidal. There was bubbling sand close to the intertidal which looked like a liquid seeping through as there were no bubbles.

Transect 10

The dominant substrate was mud then became boulders in the intertidal. The common animals found were: tubeworms, snails, giant sea anemone, and barnacles. Other macrofauna were;

gray brittle star, pipefish, hermit crab, and sand star. There was a mixture of vegetation found along the transect with most of it found in the intertidal. The dominant vegetation was leafy and stringy algae. Wooden piling were observed along the transect.

6.0 Discussion

The primary substrate in the area is a soft bottom of either mud or sand. There is areas of shell and gravel in the subtidal with the primary substrate becoming boulder in the intertidal. The common animals in the area are; tubeworms, snails, Dungeness crab, red rock crab, horse clams, cockles, rock sole, leather star, giant sea anemone, purple star, sand star, heath's dorid, shiner perch, striped sea perch and pile perch. The common seaweed in the area are: sea lettuce, rockweed, sugar wrack kelp and Japanese weed. The leafy algae in either green (sea lettuce) or red (varies), stringy algae is mostly red algae hard to determine with the short time allocated. The stringy algae may also be green or brown. Flat kelp is brown seaweed and primarily *Laminaria saccharina* but may consist of other species.

Figures

Figure 1. Nanaimo British Columbia, Canada.

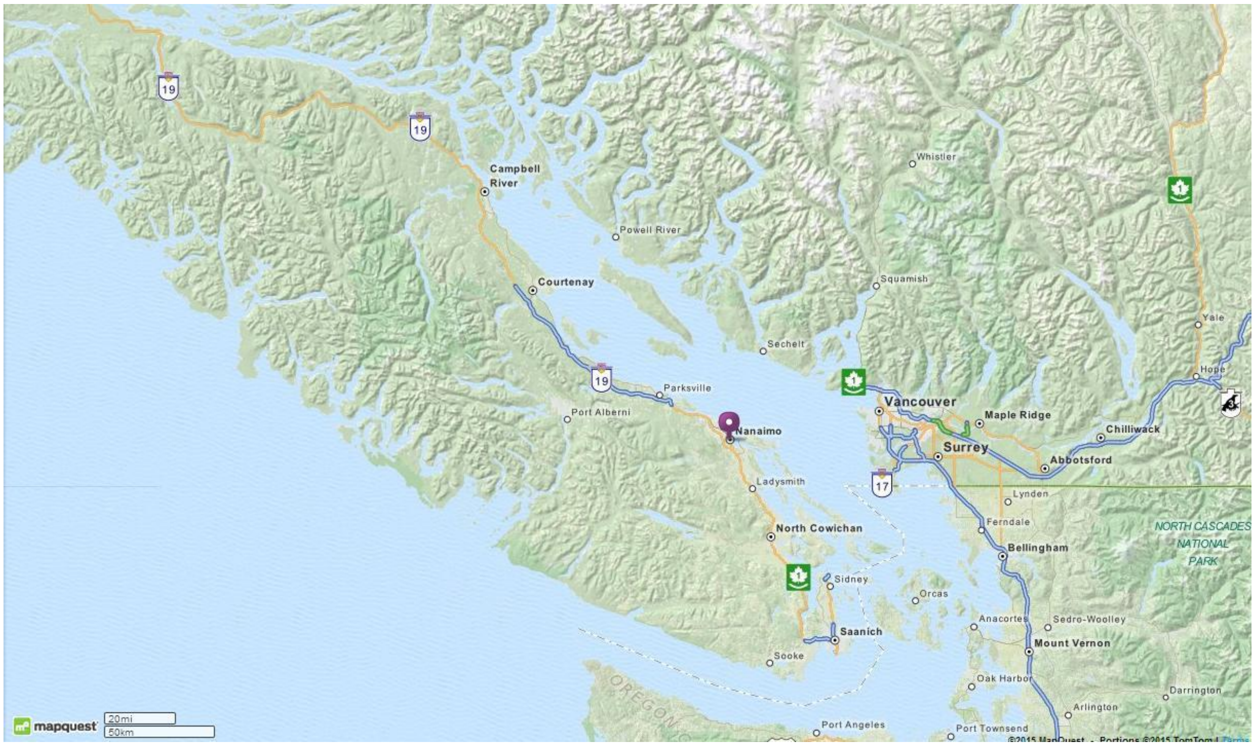


Figure 2. Area of interest.

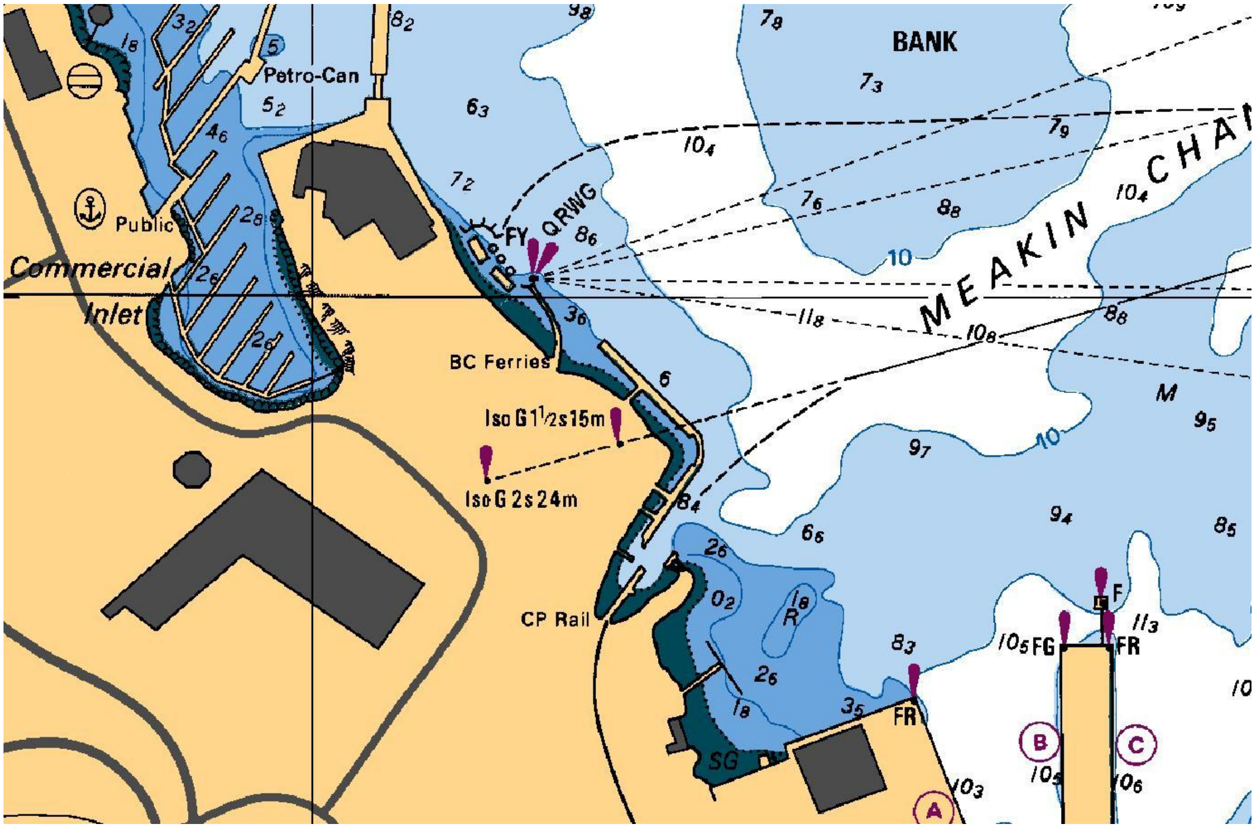
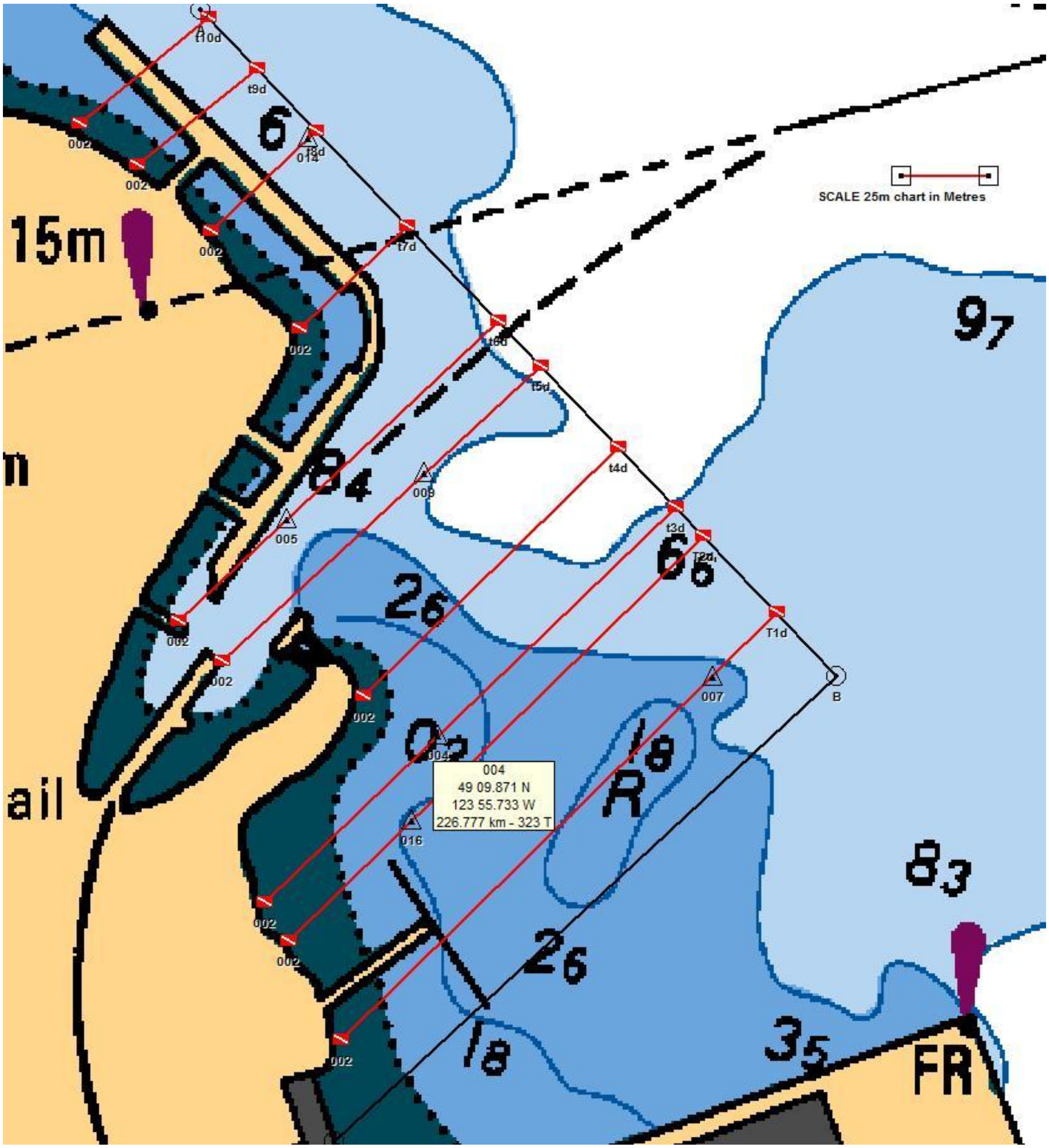


Figure 3. Transect lines



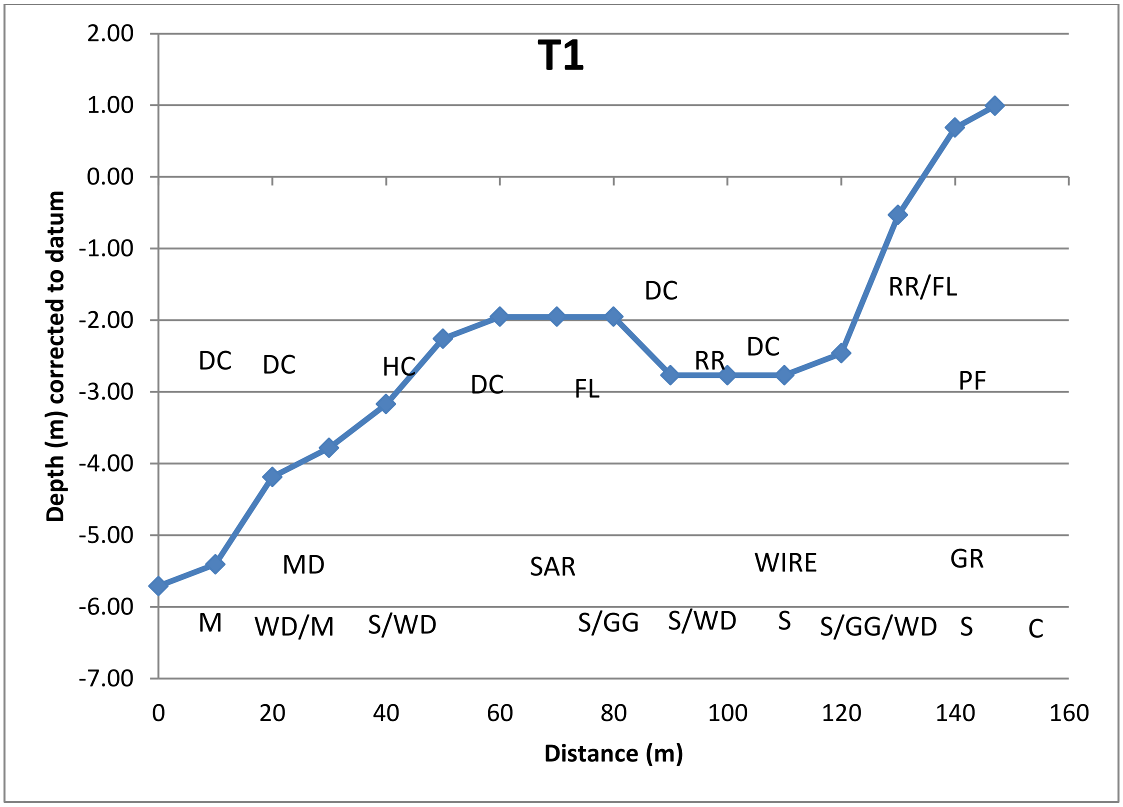
Photos

Photo 1 Nuttall's cockle.- Clinocardium nuttallii

Photo 2 Dungeness crab - *Cancer magister*

Photo 3 Rock weed – Fucus gardneri

Appendix 1 Habitat Profiles.



<u>Flora and Fauna</u>

U - Ulva

HC - Horse clam

RR - Red rock crab

DC - Dungeness crab

WD - Woody Debris

FL - Flounder

GR - eel grass

CS - clam siphon

PF - pipefish

<u>Substrate</u>

M - Mud

C - Cobble

G - Gravel

S - Sand

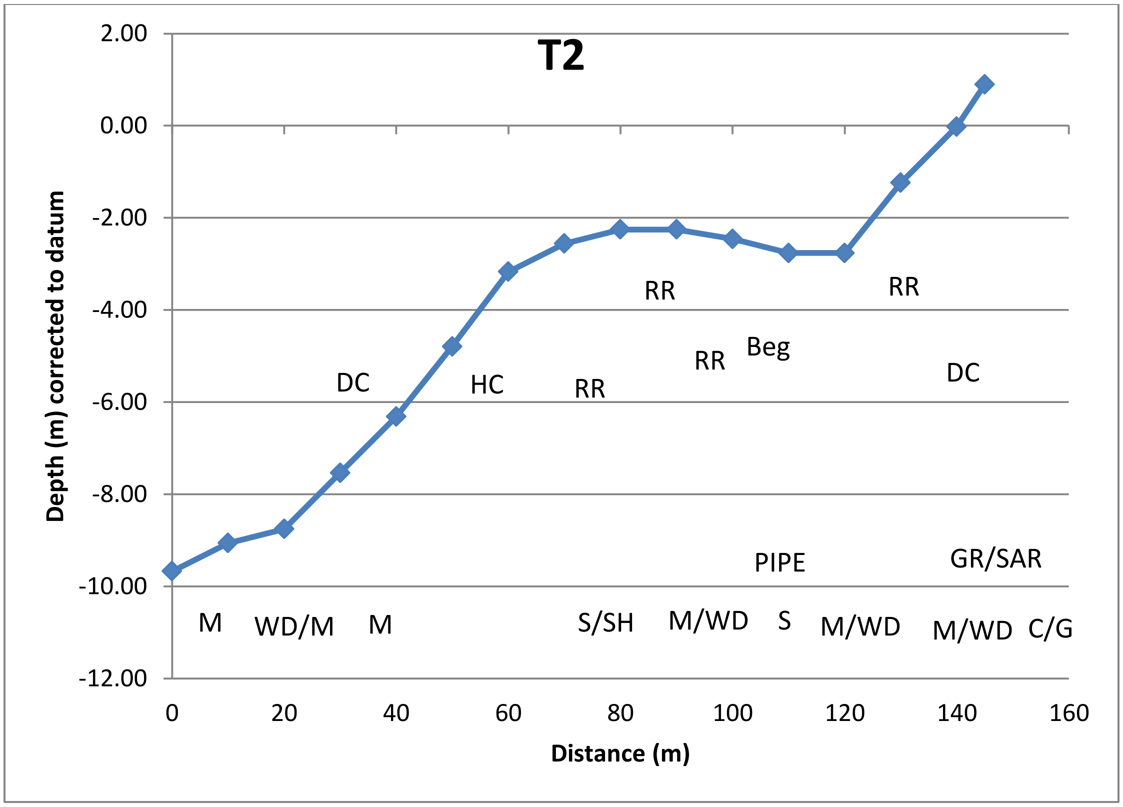
ST - steel cable

L - Log

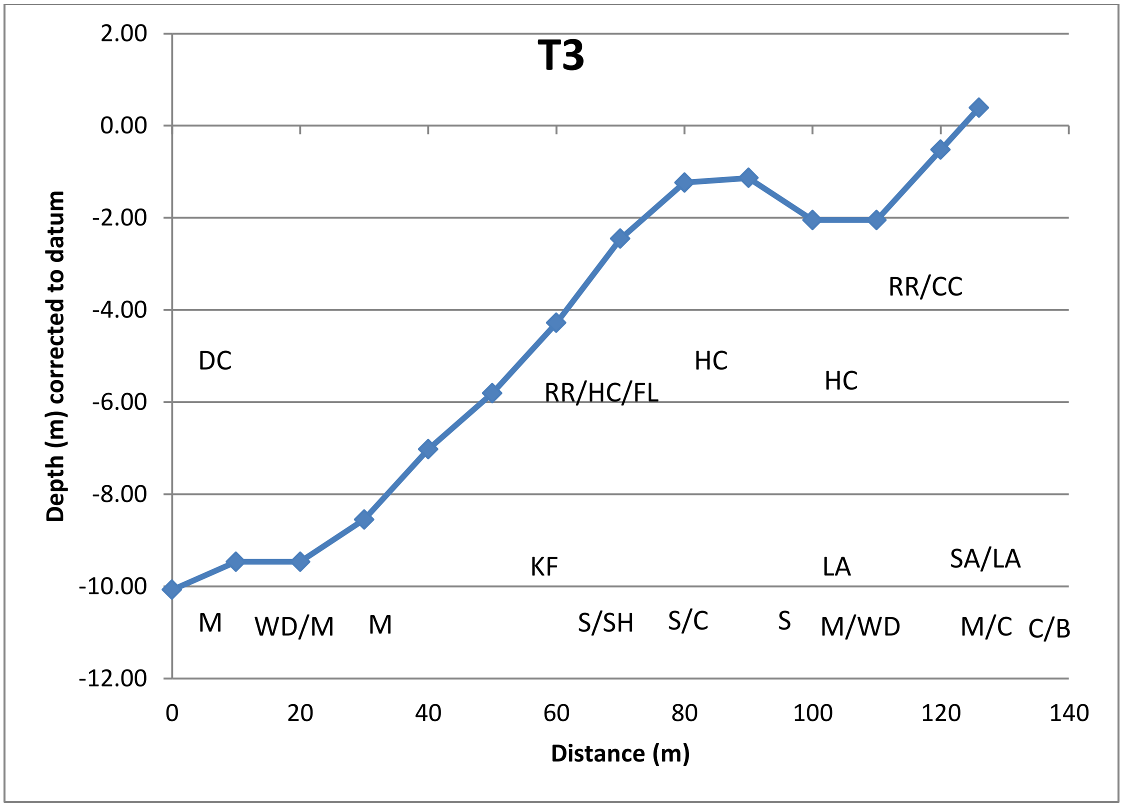
WD - Woody debris

SAR- Sargassum

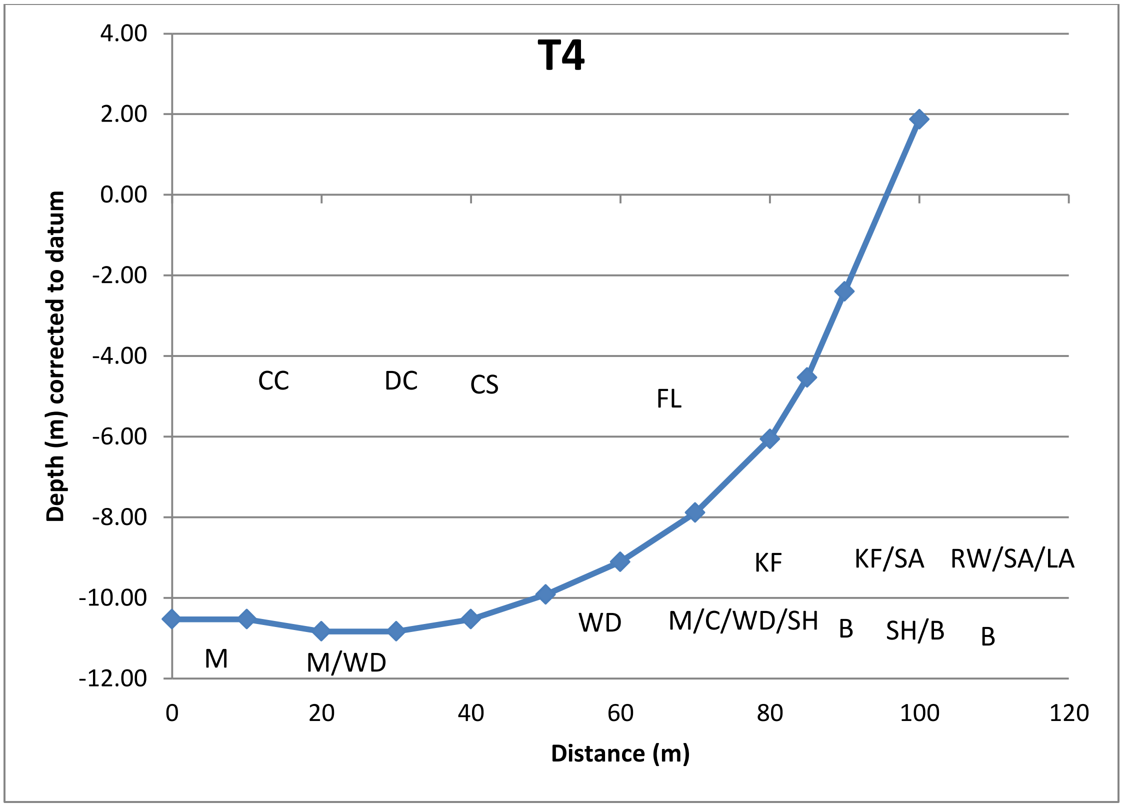
WIRE - steel wire



Flora and Fauna	Substrate
U - Ulva	M - Mud
HC - Horse clam	C - Cobble
RR - Red rock crab	G - Gravel
DC - Dungeness crab	S - Sand
WD - Woody Debris	ST - steel cable
FL - Flounder	L - Log
GR - eel grass	WD - Woody debris
CS - clam siphon	SAR- Sargassum
PF - pipefish	WIRE - steel wire



Flora and Fauna	Substrate
U - Ulva	M - Mud
HC - Horse clam	C - Cobble
RR - Red rock crab	G - Gravel
DC - Dungeness crab	S - Sand
WD - Woody Debris	ST - steel cable
FL - Flounder	L - Log
GR - eel grass	WD - Woody debris
CS - clam siphon	SAR- Sargassum
PF - pipefish	WIRE - steel wire
CC - cockle	



Flora and Fauna	Substrate
U - Ulva	M - Mud
HC - Horse clam	C - Cobble
RR - Red rock crab	G - Gravel
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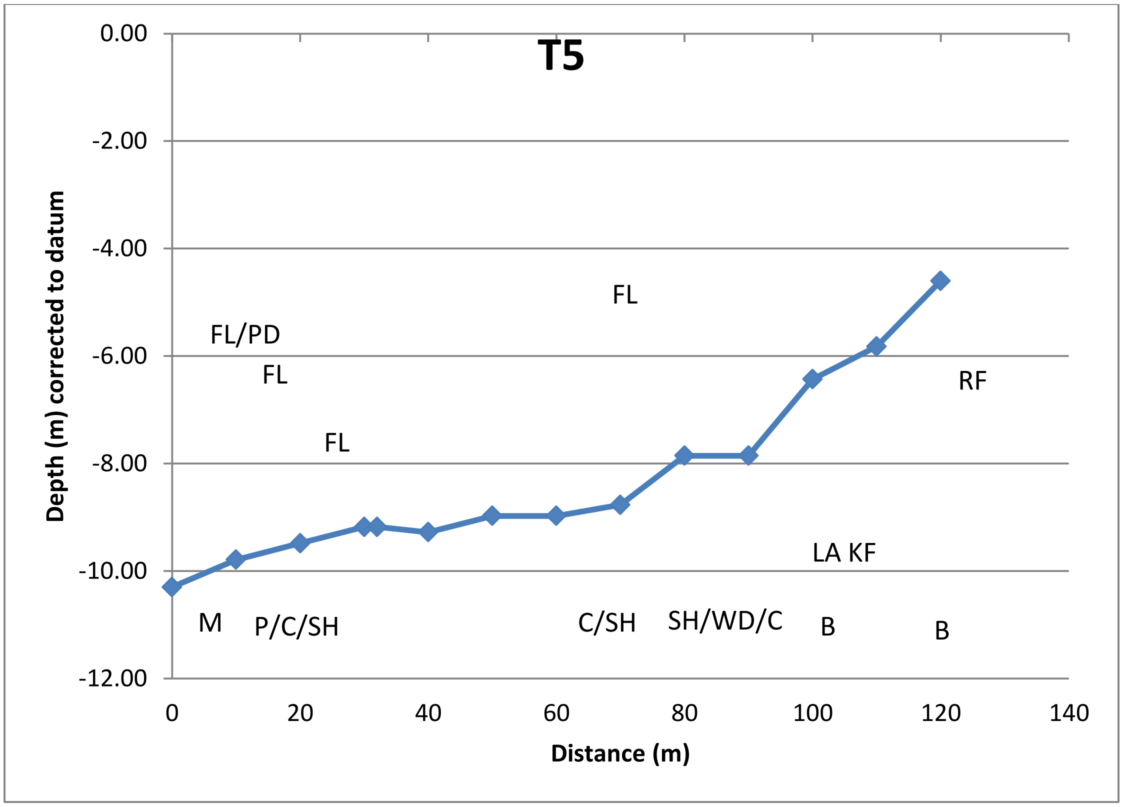
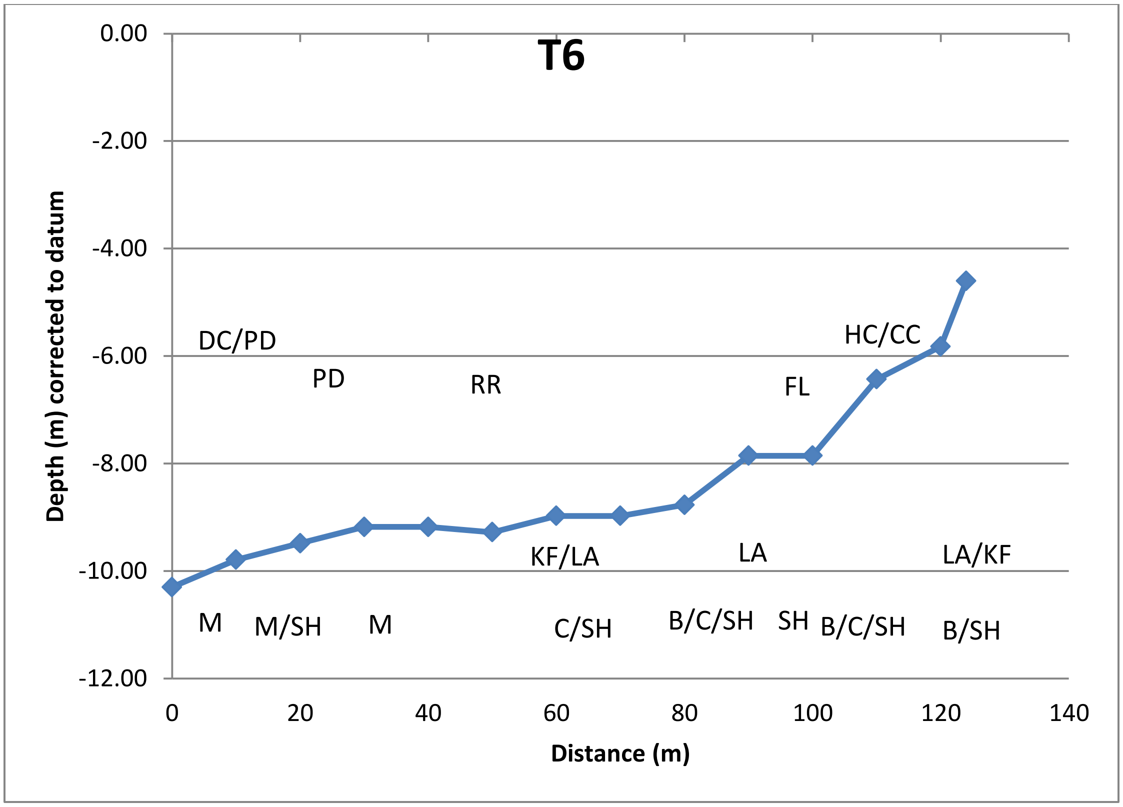
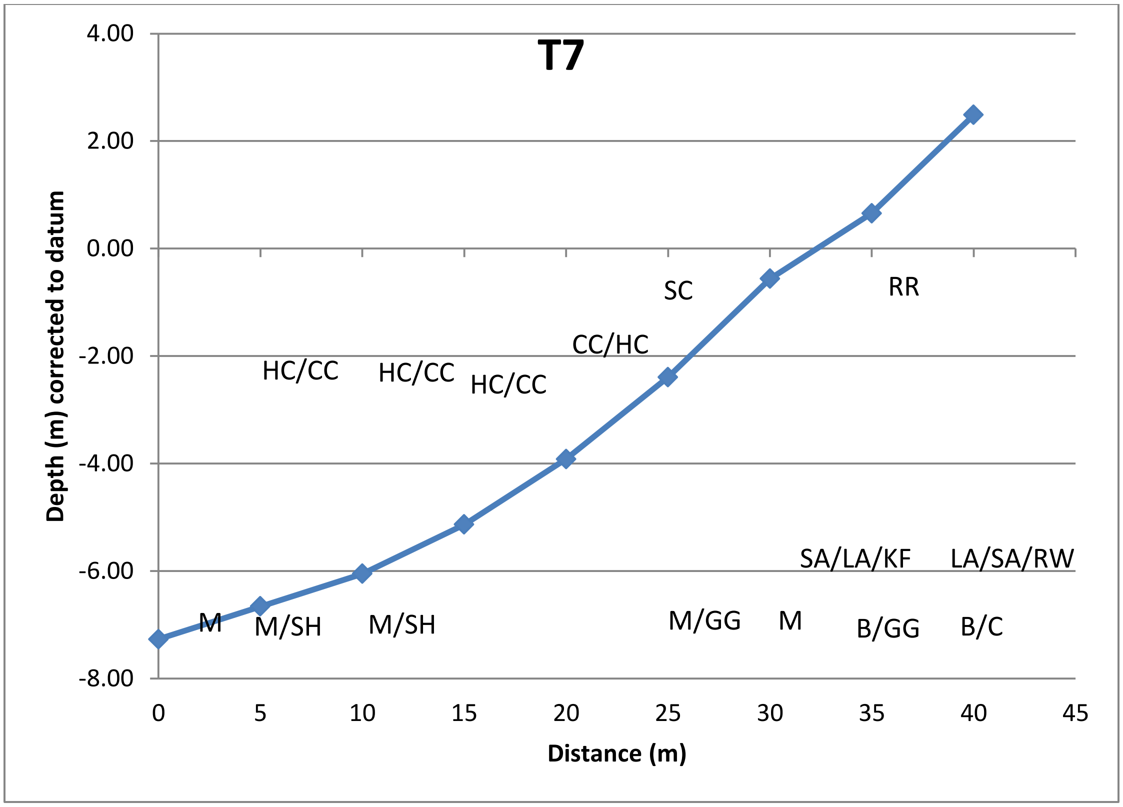
FL - Flounder	L - Log
GR - eel grass	WD - Woody debris
CS - clam siphon	SAR- Sargassum
PF - pipefish	WIRE - steel wire



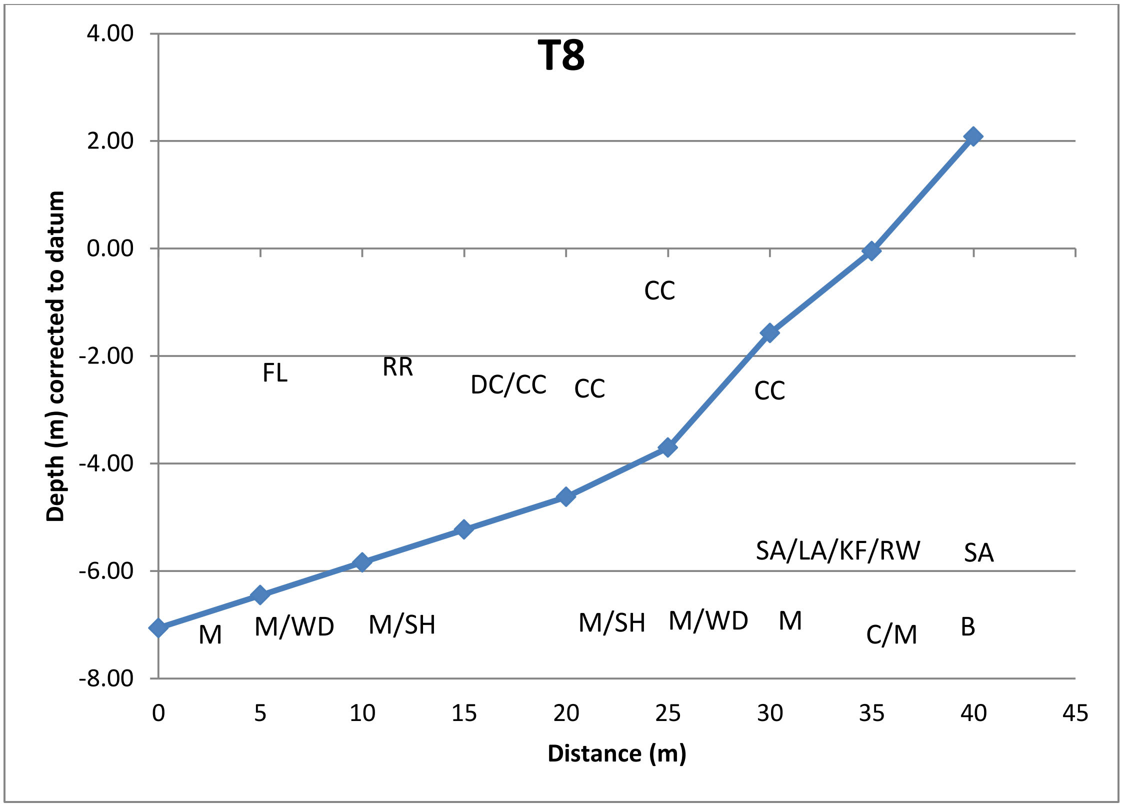
Flora and Fauna	Substrate
U - Ulva	M - Mud
HC - Horse clam	C - Cobble
RR - Red rock crab	G - Gravel
DC - Dungeness crab	S - Sand
WD - Woody Debris	ST - steel cable
FL - Flounder	L - Log
GR - eel grass	WD - Woody debris
CS - clam siphon	SAR- Sargassum
PF - pipefish	WIRE - steel wire
PD - piddock	
RF - rockfish	



<u>Flora and Fauna</u>	<u>Substrate</u>
U - Ulva	M - Mud
HC - Horse clam	C - Cobble
RR - Red rock crab	G - Gravel
DC - Dungeness crab	S - Sand
WD - Woody Debris	ST - steel cable
FL - Flounder	L - Log
GR - eel grass	WD - Woody debris
CS - clam siphon	SAR- Sargassum
PF - pipefish	WIRE - steel wire



Flora and Fauna	Substrate
U - Ulva	M - Mud
HC - Horse clam	C - Cobble
RR - Red rock crab	G - Gravel
DC - Dungeness crab	S - Sand
WD - Woody Debris	ST - steel cable
FL - Flounder	L - Log
GR - eel grass	WD - Woody debris
CS - clam siphon	SAR- Sargassum
PF - pipefish	WIRE - steel wire
SC - sea cucumber	



Flora and Fauna	Substrate
U - Ulva	M - Mud
HC - Horse clam	C - Cobble
RR - Red rock crab	G - Gravel
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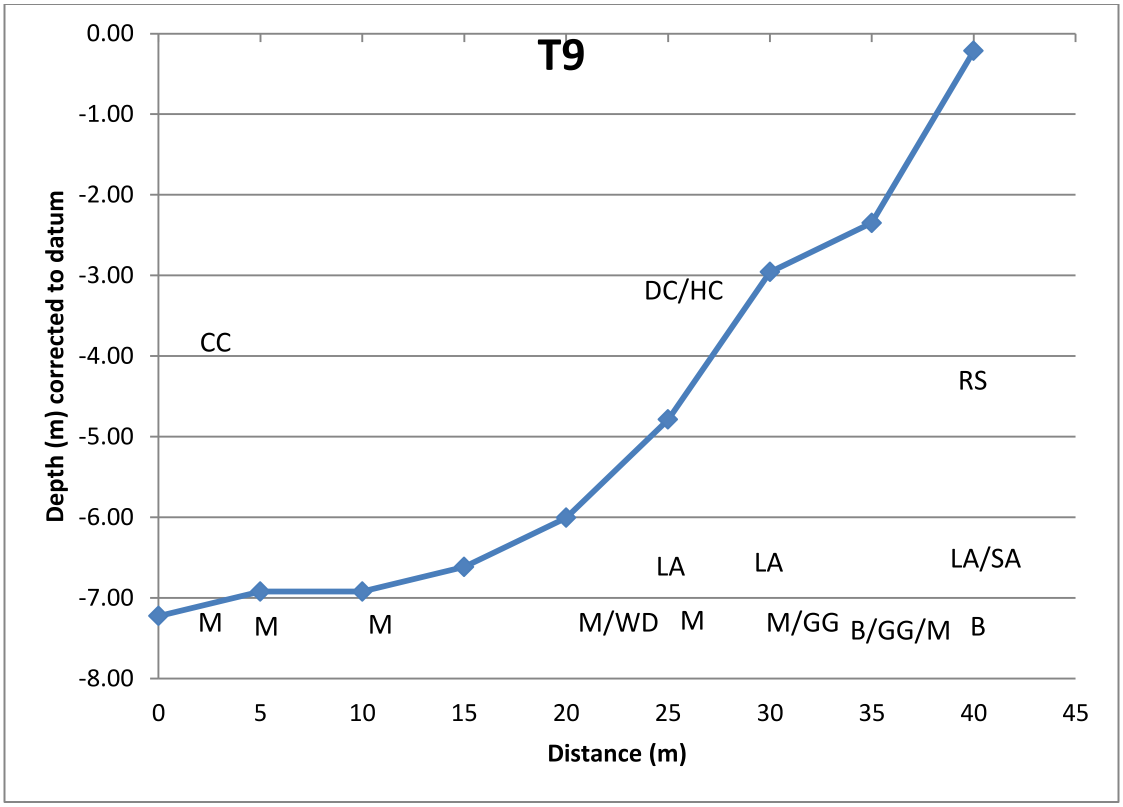
FL - Flounder	L - Log
GR - eel grass	WD - Woody debris
CS - clam siphon	SAR- Sargassum
PF - pipefish	WIRE - steel wire

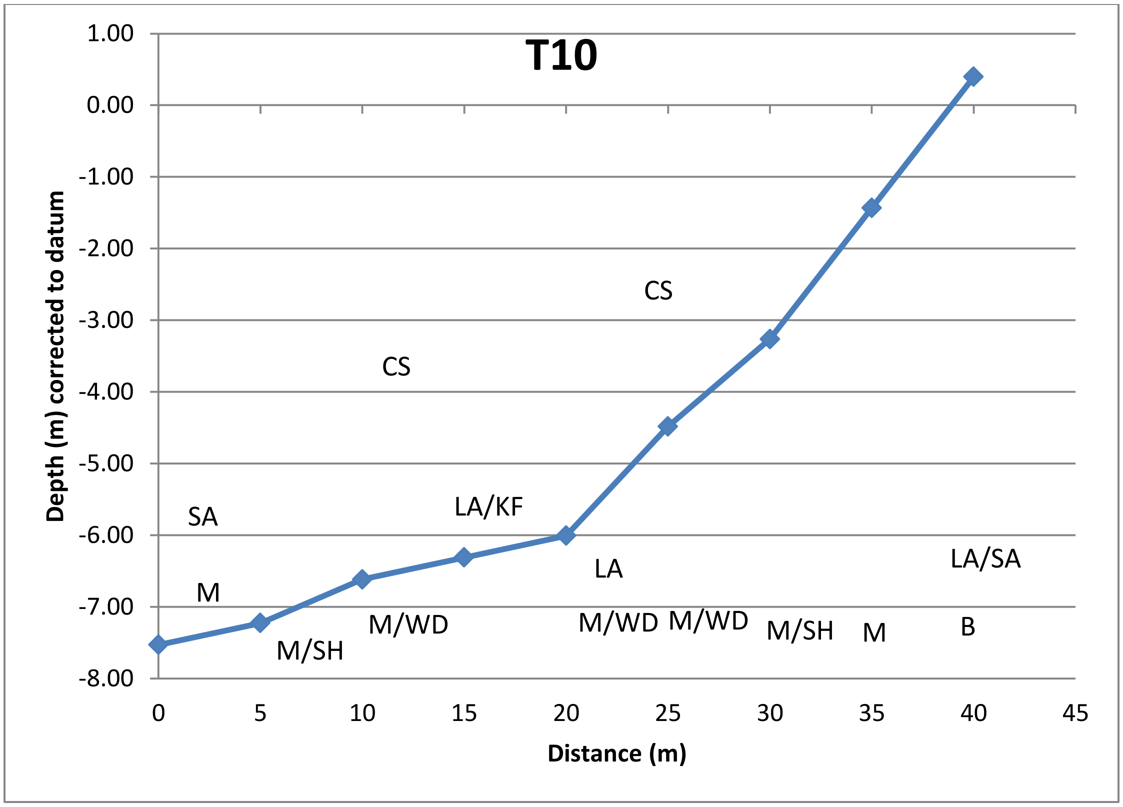


<u>Flora and Fauna</u>

U - Ulva
HC - Horse clam
RR - Red rock crab
DC - Dungeness crab
WD - Woody Debris
FL - Flounder
GR - eel grass
CS - clam siphon
PF - pipefish
RS - rock scallop

<u>Substrate</u>

M - Mud
C - Cobble
G - Gravel
S - Sand
ST - steel cable
L - Log
WD - Woody debris
SAR- Sargassum
WIRE - steel wire



Flora and Fauna	Substrate
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FL - Flounder	L - Log
GR - eel grass	WD - Woody debris
CS - clam siphon	SAR- Sargassum
PF - pipefish	WIRE - steel wire

Appendix 2 Species List

Species List for April 20-23, 2015
Subtidal Biological Survey

Percent cover of survey area: + = <5%, 1 = 6-25%, 2 = 26-50%, 3 = 51-75%, 4 = 76-100%

Biota	Substrate	Species Name	Common Name	Presence
Diatoms		*Bacillariophyta*	Brown grunge	+
Bacteria		*Beggiatoa ssp*	Beggiatoa	+
Seaweeds/Seagrasses				
		Ulva fenestrata	Sea lettuce	1
		Laminaria saccharina	Sugar wrack kelp	1
		Fucus gardneri	Rockweed	1
		Sargassum muticum	Japanese weed	1
		Zostera marina	Eelgrass	+
Invertebrates				
	Planktonic	*Mitrocoma cellularia*	Cross jellyfish	+
	Hard bottom	*Metridium farcimen*	Giant plumose anemone	1
		Pisaster ochraceus	Ochre star	1
		Evasterias troschelii	Mottled star	+
		Pisaster brevispinus	Giant pink star	+
		Crassadoma gigantea	Rock scallop	
		Dirona albolineata	Frosted nudibranch	+
		Geitodoris heathi	Heath's dorid	+
		Leucilla nuttingi	Stalked Vase sponge	
		Neoesperiopsis rigida	Orange finger sponge	+
		Eudistylia vancouveri	Feather duster worm	+
		Telmessus cheiragonus	Helmet crab	+
		Oregonia gracilis	Graceful decorator crab	+
	Soft bottom	*Cancer producta*	Red rock crab	+
		Cancer magister	Dungeness crab	1
		Luidia foliolata	Sand star	+
		Dermasterias	Leather star	1

	imbricata		
	Parastichopus californicus	Giant sea cucumber	+
	Zirfaea pilsbryi	Rough piddock	+
	Chlamys rubida	Swimming scallop	+
	Clinocardium nuttallii	Nuttall's cockle	1
	Myxicola infundibuluma	Slime tube feather duster	+
	Cucumaria miniata	Red sea cucumber	+
	Tresus nuttallii	Pacific gaper	1
	Tresus capax	Fat gaper	1
	Peltodoris nobilis	Noble sea lemon	+
	Ophiura lutkeni	Gray brittle star	+
Fish	*Cymatogaster aggregata*	Shiner perch	1
	Embiotoca lateralis	Striped sea perch	1
	Rhacochilus vacca	Pile perch	1
	Coryphopterus nicholsi	Blackeyed Goby	+
	Sygnathus leptorhynchus	Bay pipefish	+
	Lepidopsetta bilineata	Rock sole	1
	Agonopsis vulsa	Northern spearnose poacher	+
	Hexagrammos stelleri	Whitespotted greenling	+
Mammal	*Phoca vitulina*	Harbor seal	+

Location Site and Transect T1 - Dive #3 - Date April 20th , 2015 Field Data Sheet

Deep | Time start ______ | Time end ______
Shallow | Video start ______ | Video end ______
Length (m) _147______ | Picture # deep ______ | Picture # shallow ______
Max depth (ft) 23_______ | Visibility (ft) ______ | Total Time ______

Distance (m)	Depth (m)	Time (PDT)	Substrate	Seaweeds/Seagrasses	Animals
0	-9.67	1516	m90wd10		rock sole, tube worms
10	-9.06	1518	wd55m45	metal debris	red rock crab, Dungeness crab
20	-8.75	1521	m95wd5		unknown snail c, tube worms c
30	-7.53	1523	s95wd5		Dungeness crab f, tube worms c
40	-6.32	1525	s95wd5		lemon dorid nudibranch
50	-4.79	1527	s100		Dungeness crab f, horse clam f
60	-3.17	1531	s90wd10	Sargassum 5	hermit crab f, tube worms c
70	-2.56	1534	s80wd20	drift LA 5	leather stars f, barnacles
80	-2.25	1536	s70gg30	chain links LA 5	gunnel f, flatfish f
90	-2.25	1538	s70wd30	LA drift 10	Dungeness crab f, nudibranch f
100	-2.46	1541	s80wd10gg10	electrical wire	giant anemone f, red rock crab f
110	-2.76	1544	s90wd5gg5		leather star f, red rock crab f
120	-2.76	1547	s50gg25wd25	KF 5 LA 10	giant anemone f, lemon dorid f, barnacles f, leather star f
130	-1.24	1550	s75c25	metal wire and chain	red rock crab f, rock sole
140	-0.02	1553	s100	GR 10, KF 5	pipefish f, barnacle f
147	0.90	1554	c90gg10		barnacle f, leather star f

% cover: + = <5%, 1 = 6-25%, 2 = 26-50%, 3 = 51-75%, 4 = 76-100%

Abundance: 1-10 **f**ew, 11-20 **c**ommon, 21- 50 **a**bundant, 51-100 **d**ominant

Substrate: Bed**R**ock **B**oulder **C**obble **G**ravel **S**and **SH**ell Silt/**M**ud/Clay **W**oody **D**ebris in % covered.

Vegetation: **R**ock**W**eed, **K**elp**F**lat, **K**elp**S**tanding, Eel**GR**ass, Leafy**A**lgae, **S**tringy **A**lgae, **G**run**G**e

Comments:

- Wind , sky
- Depth corrected by 1.2-1.6m 1510 1.2, 1520 1.3, 1530 1.4, 1540 1.5 1550 1.6 m for datum
- Water Temperature °C

Location Site and Transect Nanaimo port 1 T2 - Dive #1 - Date April 21st , 2015 Field Data Sheet

Deep Time start ______ Time end ______

Shallow Video start ______ Video end ______

Length (m) _145______ Picture # deep ______ Picture # shallow ______

Max depth (ft) 35_______ Visibility (ft) _20_____ Total Time ______

Distance (m)	Depth (m)	Time (PDT)	Substrate	Seaweeds/Seagrasses	Animals
0	-9.67	1527	m75wd25		hermit crab f, snails f, tube worms f
10	-9.06	1529	m50wd50		tube worms c
20	-8.75	1531	m75wd25		plumose anemone, tubeworms c
30	-7.53	1534	m50wd50		Dungeness crab f, tubeworms f, hermit
40	-6.32	1537	m80wd10sh5gg5		hermit crab f, tubeworms f
50	-4.79	1539	m100		leather star, tubeworms f, pacific gaper
60	-3.17	1541	m90wd5sh5		burrowing shrimp hole
70	-2.56	1543	s50sh50		barnacles a, snails f
80	-2.25	1545	s90sh10		red rock crab
90	-2.25	1547	s90sh10	eelgrass 5, sa +	red rock crab, rock sole, leather star, tube worms f
100	-2.46	1549	s90wd5sh5	sa 5, la +	snails f, Beggiatoa present
110	-2.76	1553	m85gg10w5	metal pipe, la 5	clam siphon, snails f, barnacles a
120	-2.76	1556	m75wd20c5	la 10 drift	pipefish f, red rock crab f, barnacles a
130	-1.24	1555	gg50m50	sa20, la 10, Sargassum 5	Dungeness crab, decorator crab, barnacles d
140	-0.02	1600	m50wd50	eelgrass 5, Sargassum 20, rockweed drift	barnacles f, rock sole
145	0.90	1602	p50c50	sa 5, Sargassum 5	barnacles a

% cover: + = <5%, 1 = 6-25%, 2 = 26-50%, 3 = 51-75%, 4 = 76-100%

Abundance: 1-10 **f**ew, 11-20 **c**ommon, 21- 50 **a**bundant, 51-100 **d**ominant

Substrate: Bed**R**ock **B**oulder **C**obble **G**ravel **S**and **SH**ell Silt/**M**ud/Clay **W**oody **D**ebris in % covered.

Vegetation: **R**ock**W**eed, **K**elp**F**lat, **K**elp**S**tanding, Eel**GR**ass, **L**eafy**A**lgae, **S**tringy **A**lgae, **G**run**G**e

Comments:

- Wind light , sky sunny
- Depth corrected by 0.8-1.1m 1500 .8 1515 .9 1530 1.0 1545 1.1m for datum
- Water Temperature °C

White spotted greenling

Location Site and Transect Nanaimo port 1 T3 - Dive #1 - Date April 22nd , 2015 Field Data Sheet

Deep

Shallow

Length (m) _126______

Max depth (ft) 36_______

Time start ______ Time end ______

Video start ______ Video end ______

Picture # deep ______ Picture # shallow ______

Visibility (ft) _____ Total Time ______

Distance (m)	Depth (m)	Time (PDT)	Substrate	Seaweeds/Seagrasses	Animals
0	-10.07	1523	M60WD40	SA 5	Dungeness crab, giant plumose anemone f, tube worms f
10	-9.46	1526	M60WD35GG5		
20	-9.46	1528	M60WD30SH10		
30	-8.55	1530	M85WD10SH5		snails f, heath's dorid
40	-7.02	1535	WD90M10		leather star, nudibranch, tube worms f
50	-5.81	1537	WD50M45GG5		barnacles c, leather star
60	-4.28	1539	S60SH30WD10	KF 60	red rock crab
70	-2.45	1542	S95WD5		hermit crab f, snails f, barnacles f, cockles f, horse clam, rock sole
80	-1.23	1545	S95C5		horse clam f, snails f, barnacles f, tubeworms f
90	-1.13	1547	S95SH5		giant pink star
100	-2.05	1549	M95WD5	LA 5	horse clam
110	-2.05	1551	M80WD20	LA10	red rock crab f, cockle
120	-0.52	1554	M90C10	SA 5	white spotted greenling, barnacle f
126	0.39	1556	C60B40	SA 30 LA 20	shiner perch f, barnacle f, northern spearnose poacher

% cover: + = <5%, 1 = 6-25%, 2 = 26-50%, 3 = 51-75%, 4 = 76-100%

Abundance: 1-10 **f**ew, 11-20 **c**ommon, 21- 50 **a**bundant, 51-100 **d**ominant

Substrate: Bed**R**ock **B**oulder **C**obble **G**ravel **S**and **SH**ell Silt/**M**ud/Clay **W**oody **D**ebris in % covered.

Vegetation: **R**ock**W**eed, **K**elp**F**lat, **K**elp**S**tanding, Eel**GR**ass, **L**eafy**A**lgae, **S**tringy **A**lgae, **G**run**G**e

Comments:

- Wind 10N , sky partly cloudy
- Depth corrected by 1530 .9 1600 1.0m for datum
- Water Temperature °C

Location Site and Transect Nanaimo port 1 T4 - Dive #2 - Date April 23rd , 2015 Field Data Sheet

Deep Time start ______ Time end ______

Shallow Video start ______ Video end ______

Length (m) _100______ Picture # deep ______ Picture # shallow ______

Max depth (ft) 47_______ Visibility (ft) _____ Total Time ______

Distance (m)	Depth (m)	Time (PDT)	Substrate	Seaweeds/Seagrasses	Animals
0	-10.53	936	M95SH5		
10	-10.53	937	M85SH10WD5		tubeworms f, cockle
20	-10.83	939	M75SH5WD20		rock sole
30	-10.83	941	M75SH5WD20		Dungeness crab
40	-10.53	944	M70WD20GG10		tubeworms f, chiton, clam shows
50	-9.92	946	M70WD30		snails f, tubeworms f
60	-9.10	948	WD90GG10		heaths dorid
70	-7.88	950	M25C25WD25SH25		squid eggs, rock sole
80	-6.05	952	SH40S40C20	KF 25	barnacles a
85	-4.53	954	B100	LA 15 KF 30 SA 5	leather star, barnacles d
90	-2.40	957	B20C15G15SH50	SA 15 KF 20	leather star, decorator crab, barnacles d, tubeworms f
100	1.87	959	B100	LA 20 RW30 SA 10	shiner perch f, barnacles d, kelp crab

% cover: + = <5%, 1 = 6-25%, 2 = 26-50%, 3 = 51-75%, 4 = 76-100%

Abundance: 1-10 **f**ew, 11-20 **c**ommon, 21- 50 **a**bundant, 51-100 **d**ominant

Substrate: Bed**R**ock **B**oulder **C**obble **G**ravel **S**and **SH**ell Silt/**M**ud/Clay **W**oody **D**ebris in % covered.

Vegetation: **R**ock**W**eed, **K**elp**F**lat, **K**elp**S**tanding, Eel**GR**ass, **L**eafy**A**lgae, **S**tringy **A**lgae, **G**run**G**e

Comments:

- Wind , sky
- Depth corrected by 930 3.8 1000 3.7m for datum
- Water Temperature °C

Location Site and Transect Nanaimo port 1 T5 - Dive #1 - Date April 22nd , 2015 Field Data Sheet

Deep		Time start ______	Time end ______
Shallow		Video start ______	Video end ______
Length (m)	_120______	Picture # deep ______	Picture # shallow ______
Max depth (ft)	41______	Visibility (ft) __15___	Total Time ______

Distance (m)	Depth (m)	Time (PDT)	Substrate	Seaweeds/Seagrasses	Animals
0	-10.30	1212	M90C10	LA +	rock sole, piddock clam, tubeworms c, snails c
10	-9.79	1215	M75WD10SH10C5		piddock clam f, sponge f, hermit crab, rock sole
20	-9.48	1218	G80C10SH10		rock sole, snail f, tubeworms f
30	-9.18	1221	G50M35SH10	LA +	tubeworms f, sponge on woody debris
32	-9.18	1224		toilet bowl	tubeworms f, sponge on cobble
40	-9.28	1224	M50C20SH20GG10		
50	-8.97	1226	WD40C30M5SH20GG5	KF 5	tubeworms f
60	-8.97	1229	C75SH25		sea star, tubeworms f
70	-8.77	1232	SH85C15	metal pipe, GG5, LA 5	tubeworms c, rock sole
80	-7.85	1234	SH75WD10C10GG5		barnacles d, tubeworms c
90	-7.85	1236	SH90C10		barnacles a, male kelp greenling
100	-6.43	1238	B70SH30	LA 30, KF10	swimming scallop, sea peach, barnacles d, orange finger sponge, purple sea star
110	-5.82	1243	SH65WD20C15GG5		pile perch c, barnacles a, purple rock sponge
120	-4.60	1246	B95GG5		shrimp, barnacles d
					shiner perch, pile perch a, male kelp greenling, blackeye goby, sea peach, purple sea star, rockfish

% cover: + = <5%, 1 = 6-25%, 2 = 26-50%, 3 = 51-75%, 4 = 76-100%

Abundance: 1-10 **f**ew, 11-20 **c**ommon, 21- 50 **a**bundant, 51-100 **d**ominant

Substrate: Bed**R**ock **B**oulder **C**obble **G**ravel **S**and **SH**ell Silt/**M**ud/Clay **W**oody **D**ebris in % covered.

Vegetation: **R**ock**W**eed, **K**elp**F**lat, **K**elp**S**tanding, Eel**GR**ass, **L**eafy**A**lgae, **S**tringy **A**lgae, **G**run**G**e

Comments:

- Wind 5NW , sky partly cloudy
- Depth corrected by 1200 2.3 1300 1.6m for datum
- Water Temperature 50 °F

Location Site and Transect Nanaimo port 1 T6 - Dive #1 - Date April 23rd , 2015 Field Data Sheet

Deep | Time start ______ | Time end ______
Shallow | Video start ______ | Video end ______
Length (m) _124______ | Picture # deep ______ | Picture # shallow ______
Max depth (ft) 49_______ | Visibility (ft) _____ | Total Time ______

Distance (m)	Depth (m)	Time (PDT)	Substrate	Seaweeds/Seagrasses	Animals
0	-10.30	841	M85SH10GG5		tubeworms f, Dungeness crab, piddock clam f
10	-9.79	845	M40SH10C45GG5	LA +	piddock clam, tubeworms f
20	-9.48	847	M80SH15C5		tubeworms f
30	-9.18	849	M65SH20WD10C5		piddock clam f, heaths dorid
40	-9.18	851	C75R5SH10GG10		piddock clam, hermit crab, bryozoan
50	-9.28	854	C50M30SH20		tubeworms f, bryozoans, red rock crab
60	-8.97	855	C70SH20WD10	KF 5, LA 5	leather star, barnacles a, stalked vase sponge
70	-8.97	858	SH70GG15B10WD5	SA 5	barnacles a
80	-8.77	900	B30C30SH20GG20	LA+	barnacles a, tubeworms f
90	-7.85	903	SH90C10	LA 5	barnacles c
100	-7.85	904	B40C30SH30		rock sole, tubeworms c, barnacles d
110	-6.43	907	SH85C10GG5		horse clam, cockle
120	-5.82	910	B60SH30GG10	LA 5, KF 5	barnacles d, tubeworms c, pink bryozoan
124	-4.60	912	B90SH10	pilings under dock	pile perch f

% cover: + = <5%, 1 = 6-25%, 2 = 26-50%, 3 = 51-75%, 4 = 76-100%

Abundance: 1-10 **f**ew, 11-20 **c**ommon, 21- 50 **a**bundant, 51-100 **d**ominant

Substrate: Bed**R**ock **B**oulder **C**obble **G**ravel **S**and **SH**ell Silt/**M**ud/Clay **W**oody **D**ebris in % covered.

Vegetation: **R**ock**W**eed, **K**elp**F**lat, **K**elp**S**tanding, Eel**GR**ass, **L**eafy**A**lgae, **S**tringy **A**lgae, **G**run**G**e

Comments:

- Wind , sky partly cloudy,rain
- Depth corrected by 3.9m for datum
- Water Temperature 50 °F

Location Site and Transect Nanaimo port 1 T7 - Dive #3 - Date April 23rd , 2015 Field Data Sheet

Deep Time start ______ Time end ______

Shallow Video start ______ Video end ______

Length (m) _40______ Picture # deep ______ Picture # shallow ______

Max depth (ft) 35_______ Visibility (ft) _____ Total Time ______

Distance (m)	Depth (m)	Time (PDT)	Substrate	Seaweeds/Seagrasses	Animals
0	-7.27	1037	M90		heaths dorid, snails c, tubeworms c
5	-6.66	1039	M90SH10		snails c, tubeworms f, horse clam, cockle, giant sea anemone
10	-6.05	1040	M90SH10		horse clam, cockle, barnacles a, snails c, rock sole
15	-5.13	1043	M85SH10C5	SA 5	horse clam f, cockle, red rock crab, barnacles a
20	-3.92	1045	M75SH15WD5GG5		cockles f, horse clam, snails c, tubeworms f, barnacles a
25	-2.39	1048	M70GG30	old crab trap	giant sea anemones c, giant sea cucumber f
30	-0.56	1050	M95C5	SA 5	barnacles a, snails c, brittle star
35	0.66	1052	B90GG10	SA30 LA15 KF 10	barnacles d, red rock crab, white spotted greenling
40	2.49	1054	B70C30	LA 30 SA 30 RW10	limpets f, barnacles a

% cover: + = <5%, 1 = 6-25%, 2 = 26-50%, 3 = 51-75%, 4 = 76-100%

Abundance: 1-10 **f**ew, 11-20 **c**ommon, 21- 50 **a**bundant, 51-100 **d**ominant

Substrate: Bed**R**ock **B**oulder **C**obble **G**ravel **S**and **SH**ell Silt/**M**ud/Clay **W**oody **D**ebris in % covered.

Vegetation: **R**ock**W**eed, **K**elp**F**lat, **K**elp**S**tanding, Eel**GR**ass, **L**eafy**A**lgae, **S**tringy **A**lgae, **G**run**G**e

Comments:

- Wind , sky partly cloudy,rain
- Depth corrected by 3.4m for datum
- Water Temperature 50 °F

Location Site and Transect Nanaimo port 1 T8 - Dive #4 - Date April 23rd , 2015 Field Data Sheet

Deep Time start ______ Time end ______

Shallow Video start ______ Video end ______

Length (m) _40______ Picture # deep ______ Picture # shallow ______

Max depth (ft) 33_______ Visibility (ft) _____ Total Time ______

Distance (m)	Depth (m)	Time (PDT)	Substrate	Seaweeds/Seagrasses	Animals
0	-7.06	1112	M80SH10WD5GG5		tubeworms a, giant sea anemone
5	-6.45	1114	M95WD5		rock sole, tubeworms a, snails f
10	-5.84	1116	M90SH5C5		red rock crab, snails f, tubeworms f
15	-5.23	1118	M85WD10GG5		giant sea anemone, cockle, tubeworms c, Dungeness crab
20	-4.62	1121	M85SH10C5		giant sea anemone, cockles f, snails f
25	-3.71	1123	M65WD30C5		giant sea anemone, tubeworms c, barnacles a, cockle
30	-1.57	1126	M90WD10		tubeworms c, cockle
35	-0.05	1128	C60M30GG10	SA 20 LA10 KF10 RW5	white spotted greenling, barnacles d, leather stars f, purple star
40	2.09	1131	B100	SA70	striped sea perch f, barnacles d

% cover: + = <5%, 1 = 6-25%, 2 = 26-50%, 3 = 51-75%, 4 = 76-100%

Abundance: 1-10 **f**ew, 11-20 **c**ommon, 21- 50 **a**bundant, 51-100 **d**ominant

Substrate: Bed**R**ock **B**oulder **C**obble **G**ravel **S**and **SH**ell Silt/**M**ud/Clay **W**oody **D**ebris in % covered.

Vegetation: **R**ock**W**eed, **K**elp**F**lat, **K**elp**S**tanding, Eel**GR**ass, **L**eafy**A**lgae, **S**tringy **A**lgae, **G**run**G**e

Comments:

- Wind , sky partly cloudy,rain
- Depth corrected by 3.0m for datum
- Water Temperature 50 °F

Location Site and Transect Nanaimo port 1 T9 - Dive #2 - Date April 20th , 2015 Field Data Sheet

Deep | Time start ______ | Time end ______

Shallow | Video start ______ | Video end ______

Length (m) _40______ | Picture # deep ______ | Picture # shallow ______

Max depth (ft) 26_______ | Visibility (ft) _____ | Total Time ______

Distance (m)	Depth (m)	Time (PDT)	Substrate	Seaweeds/Seagrasses	Animals
0	-7.22	1330	M95WD5		tubeworms c, snails f, cockle, english sole
5	-6.92	1332	M100	SA +	white lined nudibranchs f, tubeworms c, snails +
10	-6.92	1335	M100		tubeworms f, snails +
15	-6.62	1337	M80WD20		giant sea anemone f, feather duster worms f
20	-6.01	1339	M90WD10		snails f, tubeworms +
25	-4.79	1340	M100	LA 5 pilings start	Dungeness crab, horse clam
30	-2.96	1343	M60GG40	LA 25	Pile perch a, giant sea anemone, ochre star c, barnacles d
35	-2.35	1346	B40GG40M20	bubbling sand (water vent)? LA 10	blackeye gobies f, barnacles a, broad based tunicate
40	-0.21	1350	B100	LA 40 SA10	barnacles d, leather star, rock scallop

% cover: + = <5%, 1 = 6-25%, 2 = 26-50%, 3 = 51-75%, 4 = 76-100%

Abundance: 1-10 **f**ew, 11-20 **c**ommon, 21- 50 **a**bundant, 51-100 **d**ominant

Substrate: Bed**R**ock **B**oulder **C**obble **G**ravel **S**and **SH**ell Silt/**M**ud/Clay **W**oody **D**ebris in % covered.

Vegetation: **R**ock**W**eed, **K**elp**F**lat, **K**elp**S**tanding, Eel**GR**ass, **L**eafy**A**lgae, **S**tringy **A**lgae, **G**run**G**e

Comments:

- Wind , sky partly cloudy,rain
- Depth corrected by 0.7m for datum
- Water Temperature 50 °F

Location Site and Transect Nanaimo port 1 T10 - Dive #1 - Date April 20th , 2015 Field Data Sheet

Deep		Time start	______	Time end	______
Shallow		Video start	______	Video end	______
Length (m)	_40______	Picture # deep	______	Picture # shallow	______
Max depth (ft)	27_______	Visibility (ft)	_____	Total Time	______

Distance (m)	Depth (m)	Time (PDT)	Substrate	Seaweeds/Seagrasses	Animals
0	-7.53	1247	M95SH5	SA 5	snails f, tubeworms f
5	-7.22	1250	M90SH5WD5	LA+	tubeworms f, snails f, gray brittle star c
10	-6.62	1253	M75SH5WD15GG5		clam/shrimp holes f, nudibranch, brittle star f, tubeworms f, pipefish f
15	-6.31	1247	M85WD10GG5	LA 10 SA +, KF 10	snails f, giant sea anemone f, hermit crabs f
20	-6.01	1301	M95WD5	LA 5	snails f, sand star
25	-4.48	1305	M90WD10	wooden pilings begin	giant sea anemone f, clam shows
30	-3.26	1307	M60SH35C5		barnacles a
35	-1.43	1309	M100		
40	0.40	1310	B100	LA40SA40	barnacles a

% cover: + = <5%, 1 = 6-25%, 2 = 26-50%, 3 = 51-75%, 4 = 76-100%

Abundance: 1-10 **f**ew, 11-20 **c**ommon, 21- 50 **a**bundant, 51-100 **d**ominant

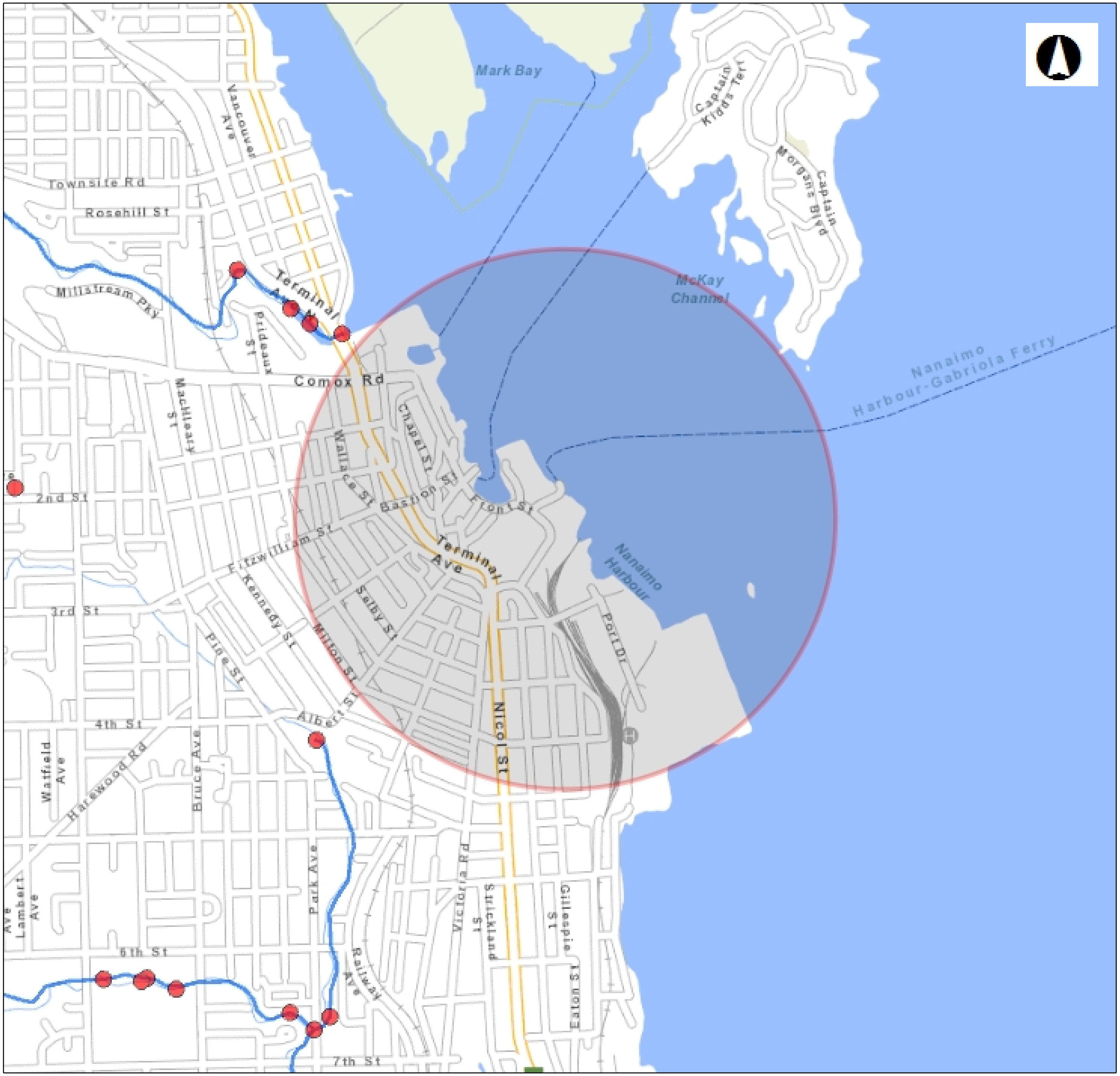
Substrate: Bed**R**ock **B**oulder **C**obble **G**ravel **S**and **SH**ell Silt/**M**ud/Clay **W**oody **D**ebris in % covered.

Vegetation: **R**ock**W**eed, **K**elp**F**lat, **K**elp**S**tanding, Eel**GR**ass, **L**eafy**A**lgae, **S**tringy **A**lgae, **G**run**G**e

Comments:

- Wind , sky partly cloudy,rain
- Depth corrected by 0.7m for datum
- Water Temperature 50 °F

APPENDIX E
ECOLOGICAL INFORMATION



BRITISH COLUMBIA

1 km Fish Search

Legend

All Fish points

POINT_TYPE_CODE

- Observation
- Summary

Stream Centre Line Network

WDIC_SPFTP_CODE

- 100 - Coastline
- 1000 - Single-line blueline, main
- 1050 - Single-line blueline, throu
- 1100 - Single-line blueline, seco
- 1150 - Single-line blueline, seco
- 1200 - Construction line, main fl
- 1250 - Construction line, double
- 1300 - Construction line, seconc

0 0.43 0.86 km

1: 21,057

Copyright/Disclaimer

Datum: NAD83

Projection: NAD_1983_BC_Environment_Albers

Key Map of British Columbia

BC Species and Ecosystems Explorer Search Results

		Status					
Scientific Name	**English Name**	**Provincial**	**BC List**	**COSEWIC**	**SARA**	**Global**	**CF Priority**
Ardea herodias fannini	Great Blue Heron, *fannini* subspecies	S2S3B,S4N (2009)	Blue	SC (2008)	1-SC (2010)	G5T4 (1997)	1
Brachyramphus marmoratus	Marbled Murrelet	S3B,S3N (2010)	Blue	T (2012)	1-T (2003)	G3 (2013)	1
Branta bernicla	Brant	S3M (2009)	Blue			G5 (1996)	2
Chrysemys picta pop. 1	Painted Turtle - Pacific Coast Population	S2 (2012)	Red	E (2006)	1-E (2007)	G5T2 (2007)	2
Corynorhinus townsendii	Townsend's Big-eared Bat	S3 (2013)	Blue			G3G4 (2014)	2
Eumetopias jubatus	Steller Sea Lion	S3B,S4N (2013)	Blue	SC (2013)	1-SC (2005)	G3 (2011)	2
Falco peregrinus pealei	Peregrine Falcon, *pealei* subspecies	S3B (2010)	Blue	SC (2007)	1-SC (2003)	G4T3 (1997)	1
Haliotis kamtschatkana	Northern Abalone	S2 (2002)	Red	T (2000)	1-T (2003)	G3G4 (2010)	2
Hirundo rustica	Barn Swallow	S3S4B (2009)	Blue	T (2011)		G5 (1996)	2
Juncus oxymeris	pointed rush	S2S3 (2000)	Blue			G5 (1993)	3
Myotis keenii	Keen's Myotis	S2S3 (2013)	Blue	DD (2003)	3 (2005)	G2G3 (2012)	1
Phalacrocorax auritus	Double-crested Cormorant	S3S4B (2013)	Blue	NAR (1978)		G5 (1999)	2
Progne subis	Purple Martin	S2S3B (2005)	Blue			G5 (1996)	3
Speyeria zerene bremnerii	Zerene Fritillary, *bremnerii* subspecies	S2 (2013)	Red			G5T3T4 (1998)	2
Uria aalge	Common Murre	S2B,S4N (2005)	Red			G5 (2003)	2

Search Summary

Time Performed Wed Jun 03 10:48:17 PDT 2015

Results 15 records.

Search Criteria
Search Type: Plants & Animals
AND BC Conservation Status:Red (Extirpated, Endangered, or Threatened) OR Blue (Special Concern)
AND Forest Districts:South Island Forest District (DSI) (Restricted to Red, Blue, and Legally designated species)
AND MOE Regions:1- Vancouver Island (Restricted to Red, Blue, and Legally designated species)
AND Regional Districts: Nanaimo (RDN) (Restricted to Red, Blue, and Legally designated species)
AND Habitat Subtypes: Industrial,Intertidal Marine,Sheltered Waters - Marine,Subtidal Marine (Restricted to Red, Blue, and Legally designated species)
AND BGC Zone:CDF
Sort Order:Scientific Name Ascending

Notes
1. Citation: B.C. Conservation Data Centre. 2015. BC Species and Ecosystems Explorer. B.C. Minist. of Environ. Victoria, B.C. Available: http://a100.gov.bc.ca/pub/eswp/ (accessed Jun 3, 2015).

2. Forest District, MoE Region, Regional District and habitat lists are restricted to species that breed in the Forest

District, MoE Region, Regional District or habitat (i.e., species will not be placed on lists where they occur only as migrants).

Modify Search | New Search | Results

APPENDIX F
LOE ATTRIBUTE SCORES AND RATIONALE

TABLE F1: LOE Weighting Factors: Aquatic Macrophyte Community - Tissue Chemistry Compared to TRVs (LOE 1a)

LOE Attribute	Factors to Consider in Ranking	Attribute Scores (check one box in each row)					Rationale
		1	2	3	4	5	
a: Strength of Association	Site-specificity and relevance of LOE to assessment endpoint; linkage based on known biological processes; similarity of effect, mechanism of action, target organ, and level of ecological organization			✓			Tissue chemistry is directly related to uptake of PAHs from sediment and effects on health of plant community, and linkage is based on known biological processes however levels of ecological receptors differ.
a: Strength of Association	Note: The scores for this attribute are entered twice to double-weight this attribute because of its importance			✓			
b: Sensitivity and Specificity	The degree to which the LOE can detect change above baseline or reference conditions; the degree to which the LOE is specific to certain stressors; the potential for confounding factors to affect interpretation		✓				Concentration of PAHs in tissue is related to the amount that the Site area sediments are impacted by PAHs however area surrounding the Site is also impacted by PAHs so no baseline available.
c. Data Quality and Study Design	Extent to which data quality objectives are met; quality of data; use of standard methods				✓		Data is representative of the Site and determination of tissue chemistry uses established lab procedures.
d. Representativeness	Spatial and temporal overlap among measurements or samples, stressors, and ecological receptors			✓			Samples were collected on-Site through a single sampling event.
e. Correlation/Causation/Consistency	Ability of LOE to demonstrate effects from exposure to stressor and to correlate effects with degree of exposure				✓		Use of TRVs to correlate effects with exposure.
Average LOE Rank			2	9	8		= 19/6 = 3.2

TABLE F2: LOE Weighting Factors: Aquatic Macrophyte Community - Apparent Health (LOE 1b)

LOE Attribute	Factors to Consider in Ranking	Attribute Scores (check one box in each row)					Rationale
		1	2	3	4	5	
a: Strength of Association	Site-specificity and relevance of LOE to assessment endpoint; linkage based on known biological processes; similarity of effect, mechanism of action, target organ, and level of ecological organization		✓				Observed health of the community can be linked to PAH impacts, but not directly linked to target organism parts or behaviour.
a: Strength of Association	Note: The scores for this attribute are entered twice to double-weight this attribute because of its importance		✓				
b: Sensitivity and Specificity	The degree to which the LOE can detect change above baseline or reference conditions; the degree to which the LOE is specific to certain stressors; the potential for confounding factors to affect interpretation	✓					Area surrounding the Site is also impacted by PAHs therefore difficult to detect differences by observations.
c. Data Quality and Study Design	Extent to which data quality objectives are met; quality of data; use of standard methods	✓					Not based on data collection; observations only.
d. Representativeness	Spatial and temporal overlap among measurements or samples, stressors, and ecological receptors		✓				Observations of the Site during a single site visit and no real temporal influences applied.
e. Correlation/Causation/Consistency	Ability of LOE to demonstrate effects from exposure to stressor and to correlate effects with degree of exposure		✓				Observed health of the community can be linked to PAH impacts but not correlated with magnitude of exposure.
Average LOE Rank		2	8				= 10/6 =1.7

TABLE F3: LOE Weighting Factors: Benthic Invertebrate Community - Sediment Chemistry Compared to TRVs (LOE 2a)

LOE Attribute	Factors to Consider in Ranking	Attribute Scores (check one box in each row)					Rationale
		1	2	3	4	5	
a: Strength of Association	Site-specificity and relevance of LOE to assessment endpoint; linkage based on known biological processes; similarity of effect, mechanism of action, target organ, and level of ecological organization	✓					The sediment chemistry is not directly related to health of the benthic community (PAH uptake limitations).
a: Strength of Association	Note: The scores for this attribute are entered twice to double-weight this attribute because of its importance	✓					
b: Sensitivity and Specificity	The degree to which the LOE can detect change above baseline or reference conditions; the degree to which the LOE is specific to certain stressors; the potential for confounding factors to affect interpretation		✓				As most of the area surrounding the Site is impacted by PAHs there is no benchmark indicator available.
c. Data Quality and Study Design	Extent to which data quality objectives are met; quality of data; use of standard methods					✓	Data is representative of the Site and established lab procedures.
d. Representativeness	Spatial and temporal overlap among measurements or samples, stressors, and ecological receptors			✓			Samples were collected on-Site through a single sampling event.
e. Correlation/Causation/Consistency	Ability of LOE to demonstrate effects from exposure to stressor and to correlate effects with degree of exposure			✓			Use of TRVs to correlated effects with exposure.
Average LOE Rank		2	2	6		5	=15/6 = 2.5

TABLE F4: LOE Weighting Factors: Benthic Invertebrate Community - Toxicity Test Results (LOE 2b)

LOE Attribute	Factors to Consider in Ranking	Attribute Scores (check one box in each row)					Rationale
		1	2	3	4	5	
a: Strength of Association	Site-specificity and relevance of LOE to assessment endpoint; linkage based on known biological processes; similarity of effect, mechanism of action, target organ, and level of ecological organization				✓		Toxicity test results are directly related to health of the community: sediment used was collected on-Site, linkages to known biological processes. However, only one sampling event was used for toxicity testing.
a: Strength of Association	Note: The scores for this attribute are entered twice to double-weight this attribute because of its importance				✓		
b: Sensitivity and Specificity	The degree to which the LOE can detect change above baseline or reference conditions; the degree to which the LOE is specific to certain stressors; the potential for confounding factors to affect interpretation				✓		A negative control sediment was used as reference condition and directly compared to on-Site toxicity test results.
c. Data Quality and Study Design	Extent to which data quality objectives are met; quality of data; use of standard methods					✓	Established laboratory method.
d. Representativeness	Spatial and temporal overlap among measurements or samples, stressors, and ecological receptors				✓		Toxicity test results are directly related to health of the community (directly aligned with ecological receptors) : sediment used was collected on-Site, linkages to known biological processes. However, only one sampling event was used for toxicity testing.
e. Correlation/Causation/Consistency	Ability of LOE to demonstrate effects from exposure to stressor and to correlate effects with degree of exposure				✓		Directly aligned with ecological receptors and response is quantitatively correlated with magnitude of exposure.
Average LOE Rank					20	5	= 25/6 = 4.2

TABLE F5: LOE Weighting Factors: Benthic Invertebrate Community - Tissue Chemistry Compared to TRVs (LOE 2c)

LOE Attribute	Factors to Consider in Ranking	Attribute Scores (check one box in each row)					Rationale
		1	2	3	4	5	
a: Strength of Association	Site-specificity and relevance of LOE to assessment endpoint; linkage based on known biological processes; similarity of effect, mechanism of action, target organ, and level of ecological organization			✓			Directly related to uptake of PAHs from sediment on target organs and health of community however levels of ecological receptors differ.
a: Strength of Association	Note: The scores for this attribute are entered twice to double-weight this attribute because of its importance			✓			
b: Sensitivity and Specificity	The degree to which the LOE can detect change above baseline or reference conditions; the degree to which the LOE is specific to certain stressors; the potential for confounding factors to affect interpretation		✓				As most of the area surrounding the Site is impacted by PAHs there is no benchmark indicator available.
c. Data Quality and Study Design	Extent to which data quality objectives are met; quality of data; use of standard methods				✓		Data is representative of the Site and established lab procedures.
d. Representativeness	Spatial and temporal overlap among measurements or samples, stressors, and ecological receptors			✓			Samples were collected on-Site through a single sampling event.
e. Correlation/Causation/Consistency	Ability of LOE to demonstrate effects from exposure to stressor and to correlate effects with degree of exposure				✓		Use of TRVs to correlated effects with exposure.
Average LOE Rank			2	9	8		= 19/6 = 3.2

APPENDIX G

MAXXAM ANALYTICAL RESULTS – TOXICITY TESTING REPORT

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MARINE SEDIMENT TOXICITY TESTING FOR TETRA TECH EBA PROJECT: CITY OF NANAIMO DRA – FINAL REPORT

Prepared for:
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Maxxam Analytics

Ecotoxicology Group Project No.: 2-11-15007
Consultant Project No.: ENVIN003511-02
Maxxam Job #: B542802 and B542517
July 2015

EXECUTIVE SUMMARY

A total of 12 marine sediment samples were collected by Tetra Tech EBA staff on May 21 and 22, 2015. The samples arrived at the Maxxam Canada Way Laboratory, in good condition, on May 22 and 23, 2015.

The following 3 sediment toxicity tests were subsequently requested for 7 of the 12 samples; a 10 day survival test with the marine amphipod *Eohaustorius estuarius*, a 48 hour larval development test with the bivalve *Mytilus galloprovincialis*, and a 20 day survival and growth test, with the marine polychaete *Neanthes arenaceodentata*.

All tests were initiated between June 10 and 12, 2015. The amphipod, bivalve and polychaete tests were completed between June 12 and 30, 2015.

The results for each sample were statistically assessed against those of the control(s), and the reference sediment, 15SED11, for all applicable endpoints. The endpoint of survival was assessed for all species tested. Sub-lethal effects, such as growth or normal development, were examined in the marine polychaete and bivalve tests. No statistically significant differences were detected between the control(s), the reference sediment, and the samples for any of the assessed endpoints.

Details regarding the test methods, test conditions, organism acclimation, and quality control measures are summarised within the report. Each test was considered valid as survival in the laboratory control(s) met the validity criteria outlined in the associated reference methods.

All tabulated data, raw data, and associated supporting documents are located within the report appendices.

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SECTION 1 SEDIMENT DESCRIPTION

1.1 Sample Information

A total of 12 marine sediment samples were collected by Tetra Tech EBA staff, May 21 and 22, 2015. The samples arrived at the Maxxam Canada Way Laboratory, on May 22 and 23, 2015.

Of the 12 sediment samples, 7 were selected for toxicity testing. All tests were initiated within their respective hold times. Sample information, including sediment descriptions, porewater ammonia and sulphides analyses, water quality data, and the chain of custody forms, are located in Appendix A.

All samples arrived at the laboratory in good condition, and there were no apparent events during shipping and handling which appeared to have compromised the quality of the samples. The samples varied in colour, texture, grain size and content. Upon opening the containers, a description of each sample was recorded ("Sediment Sample Descriptions" in Appendix A). Prior to use in the tests, each sample was thoroughly homogenised in a clean stainless steel bowl using a stainless steel spoon. Any headspace in the sample container was purged with nitrogen gas prior to re-sealing it to prevent oxidation of the sediment during storage. When not in use, the samples were stored in the dark at 4 ± 2°C.

1.2 Negative Control Sediment

The negative control sediment used for all toxicity tests was collected from Yaquina Bay, Newport, Oregon, by Northwestern Aquatic Sciences. This beach sand has been used as a negative control in previous studies conducted in the Maxxam Ecotoxicology Laboratory, and has proved to be non-toxic to a variety of organisms. It was wet sieved with control water through 500 µm stainless steel mesh before use in the tests.

Table 1-1 Physiochemical Characterisation of Yaquina Bay Beach Sand

Total Organic Carbon (g/kg)	Moisture Content (%)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
0.34	7.0	<0.10	99	0.15	0.55

1.3 Porewater Characterisation

After sample homogenization, aliquots of sediment were distributed into 500 mL polycarbonate centrifuge bottles and nitrogen gas was placed over the sediments. They were centrifuged for 20 minutes at 5000 rpm. The resulting porewater was carefully decanted and analysed for ammonia, pH, temperature, and salinity.

Analysis of ammonia and sulphides in porewater was performed at the Maxxam Environmental Inorganic Water Laboratory. Colorimetric methods were used to determine aqueous concentrations of ammonia.

The total ammonia concentrations as N (mg/L) in the samples, was measured under basic conditions using the Berthelot reaction in the presence of EDTA. A sample was treated sequentially until a blue indophenol complex formed, which could then be measured photometrically at 660nm.

Total sulphide in the samples was first preserved as a precipitate, and then was re-suspended and dissolved prior to analysis. The dissolved sulphide was reacted quantitatively with 2 molecules of N,N-dimethyl-p-phenylenediamine oxalate under acidic conditions, in the presence of ferric chloride, to form methylene blue. Diammonium hydrogen phosphate was added after colour formation to remove the colour associated with ferric chloride. The intense blue colour of methylene blue was then measured at 664 nm using a UV visible spectrometer.

Total ammonia and sulphides in porewater are available in Appendix A.

SECTION

2 10 DAY MARINE AMPHIPOD TEST

2.1 Test Methods

The survival of *Eohaustorius estuarius,* when exposed to solid-phase sediment samples for 10 days, was assessed according to the Environment Canada Biological Test Method "Reference Method for Determining Acute Lethality of Sediment to Marine or Estuarine Amphipods", and the Maxxam SOP "Marine or Estuarine Amphipod 10 Day Survival and Reburial Test (BBY2SOP-00012).

One day prior to test initiation, the sediment samples were individually homogenized, and 175mL aliquots were distributed into 1L test vessels. Overlying seawater was then slowly added by pouring a stream of water onto a Plexiglas baffle without disturbing the sediment layer. The test vessels were then randomized on the bench top, and airlines and lids were fitted to each test vessel.

The following day, on June 12, 2015, samples of overlying water were removed from the test vessels for initial water quality analysis. Amphipods were removed from their holding containers and seeded into the test vessels.

During the test, any observed sediment avoidance by the amphipods was recorded. Daily observations and aeration checks were performed, and the temperature and dissolved oxygen was measured three times per week in a test vessel designated for water quality measurements.

At test termination, the contents of each test vessel were sieved and the live amphipods enumerated. Missing amphipods were presumed to have died and decomposed during the test.

2.2 Organism Information

2.2.1 Organism Acclimation and Holding Information

One batch of *Eohaustorius estuarius* were field collected by Northwestern Aquatic Science staff on June 05, 2015, and were shipped to Maxxam on June 8, 2015. The amphipods arrived June 09, 2015, in small plastic containers filled with site sand and a 1mm layer of overlying seawater.

Upon arrival at Maxxam, the containers were carefully placed a 40L aquaria, filled with clean 28ppt seawater. There was insufficient overlying water within the amphipod containers to perform water quality on the shipping water. The water quality information provided by the supplier at the time of shipping was used to ensure the salinity or temperature adjustments to the holding water did not exceed 5 ppt or 3°C per day. Any moribund or deceased amphipods were removed and recorded on the acclimation sheet (Appendix B).

The amphipods were not fed during the holding period. The amphipods were held at Maxxam for 4 days prior to test initiation. See Appendix B for all bench sheets and raw data associated with the acclimation and holding of the amphipods.

2.2.2 Organism Health

The mortality rate during the holding period did not exceed 20% overall, or 5% in the 48 hours preceding the test. Bench sheets of daily water quality with observations of number dead or inactive amphipods during the holding period are available in Appendix B.

2.2.3 Organism Age

Twenty representative amphipods were euthanized and measured lengthwise to the nearest mm. The average length of the organism batch was determined to be within 3-5mm, which indicated they were the correct age (see Table 2-1).

2.3 Test Conditions

See Table 2-1 for a detailed list of the test conditions. All bench sheets used to record raw data are available in Appendix B.

Table 2-1 Test Conditions and Methods for the 10-day *Eohaustorius estuarius* Test

Parameter	Conditions and Methods
Test Type and Duration	10 Day, Static (non-renewal)
Temperature	15 ± 2°C
Salinity	28 ± 2 ppt
Photoperiod and Light Intensity	24 hours light: 0 hours dark. Wide spectrum cool white fluorescent lights used to provide: 602-681lux during light cycle.
Aeration	< 100 bubbles/ minute. Clean oil-free air supplied to each test vessel via micro-bore plastic tubing
Test Chamber	1 L Jars with plastic lids containing small opening for airline tubing.
Sediment Volume	175 ml of homogenized sediment (2-3cm depth)

Parameter	Conditions and Methods
Overlying Water Source and Volume	750mL; UV sterilized Vancouver Aquarium Seawater filtered through 5 µm, and aerated before use.
Overlying Water Quality	Temperature, pH, salinity, dissolved oxygen, total ammonia measurements on Day 0 and Day 10 of test. Temperature and dissolved oxygen were also measured three times weekly during the test.
Replicates	5 per sample, plus an additional replicate for water quality measurements.
Control Sediment	Yaquina Bay Sand, rinsed with clean, natural seawater and sieved through a 500 µm stainless steel mesh
Reference Sediment	15SED11
Organisms/ replicate	20
Organism Source and age	Field collected by Northwestern Aquatic Sciences, Newport, Oregon. Juvenile to pre-reproductive adult
Percent mortality of organisms during acclimation	0.3%
Organism length	3.5 ± 0.5mm
Feeding	None
Endpoints	Mean Survival
Test Validity Criteria	≥90% mean survival in the negative controls.
Statistical Software	CETIS™ version 1.8.7.16. Tidepool Scientific Software (Copyright 2000-2013).

2.4 Quality Assurance/Quality Control

2.4.1 Reference Toxicant Results

A 96 hour reference toxicant test was performed alongside the test. The water-only reference toxicant test, using cadmium chloride ($CdCl_2 \cdot 2.5H_20$), was performed on June 12, 2015, to assess the sensitivity of the test organisms and the precision of the results. The resulting reference toxicant test LC50 was compared in a control chart with the results of previous tests. Table 2-2 summarises the result of the reference toxicant test.

The calculated LC50 for the reference toxicant test was within the two standard deviation (95%) range of the historic mean LC50. The method used in preparing the control charts was taken from “Control Charting of Reference Toxicant Tests” (BBY2 WI-00007).

Table 2-2 Reference Toxicant Test Results for *Eohaustorius estuarius*

Organism Batch	Test Date	LC50 with 95% Confidence Limits (mg/L Cd^{2+})	Previous Mean with 2SD (mg/L Cd^{2+})
NA150609	2015 June 12	5.8 (4.6, 7.1)	6.8 (3.3, 14.0)

2.4.2 Test Validity Criteria

Survival data in the laboratory controls were considered be acceptable if the mean percent survival in the negative control was greater than or equal to 90%. The mean percent survival of the control was 99%.

2.5 Results

Total survival in each replicate and the mean ± SD in the control and test sediments are listed in the “10-day *Eohaustorius estuarius* Survival Test- Summary of Survival” sheets. Survival in the samples ranged from 95 to 100%. No statistically significant decreases in mean survival were detected in any sample when compared against the negative control or the reference sediment (15SED11). A summary of the survival results is located in Table 2-3.

Total ammonia concentrations, pH, temperature, and salinity in overlying and porewater water at test initiation (Day 0) and completion (Day 10), as well as other daily water quality measurements, are available in Appendix B.

Amphipod avoidance of the sediment was observed in the reference sediment, 15SED11, on Day 3 through Day 8 of the test. By Day 10, all of the amphipods were buried in all replicates of 15SED11.

2.5.1 Data Analysis

The survival data for all samples and the negative control was entered into the statistical program “Comprehensive Environmental Toxicity Information System” (CETIS, 2000-2013). When determining the appropriate comparison tests to use, the Environment Canada “Guidance Document on Statistical Methods for Environmental Toxicity Tests” (EPS 1/RM/46, 2005) was followed.

See the CETIS Analytical Reports for information on the specific tests used for the mean survival comparisons. All analyses were conducted as one-tailed comparisons with the decision level for determining statistical significance set to 0.05 (p value <0.05).

Table 2-3 Results for Mean Amphipod Survival

Sample ID	Mean Survival ± SD (%)
Negative Control	99 ± 2
15SED11	97 ± 7
15SED02	99 ± 2
15SED03	95 ± 4
15SED05	98 ± 3
15SED06	97 ± 3
15SED07	99 ± 2
15SED08	98 ± 3

SD = Standard Deviation

SECTION

3 20 DAY POLYCHAETE SURVIVAL AND GROWTH TEST

3.1 Test Methods

The survival and growth of the marine polychaete, *Neanthes arenaceodentata*, when exposed to solid-phase sediment samples for 20 days, were assessed according to the methods outlined in the Puget Sound Estuarine Program "Juvenile Polychaete Bioassay" (1995) and the Maxxam SOP "*Neanthes arenaceodentata* Survival and Growth Test (BBY2SOP-00030).

One day prior to test initiation, the sediment samples were individually homogenized, and 175ml aliquots were distributed into 1L test vessels. Overlying seawater was then slowly added by pouring a stream of water onto a Plexiglas baffle without disturbing the sediment layer. The test vessels were then randomized on the bench top, and airlines and lids were fitted to each test vessel.

The following day, on June 10, 2015, samples of overlying water were removed from the test vessels for initial water quality analysis. Juvenile polychaetes were removed from their culture dishes and seeded into the test vessels.

Daily observations and aeration checks were performed. The temperature, pH, salinity and dissolved oxygen were measured every 3rd day, directly before ~30% of the overlying seawater was renewed in each vessel. Every 2nd day, a suspension of finely ground fish flakes and seawater was added to the test vessels.

At test termination, the contents of each test vessel were sieved and the recovered live polychaetes were placed into pre-weighed aluminum boats, which were then placed in a drying oven for >24hours.

Dry weights were measured to 0.1 mg using an analytical balance. Missing polychaetes were presumed to have died and decomposed during the test.

3.2 Organism Information

3.2.1 Acclimation and Holding Information

One batch of *Neanthes arenaceodentata* was received from Aquatic Toxicology Support, Bremerton, Washington, USA, on June 09, 2015. The laboratory-reared polychaetes are identified as originating from the California State University strain (Smith, 1964). Juveniles, aged

2-3 weeks post emergence, were packed in small twist-tie bags filled with seawater and a small quantity of fresh seaweed. They were shipped directly for overnight delivery to Maxxam and arrived without incident.

Upon arrival at Maxxam, the twist tie bag contents were carefully poured into glass culture dishes, filled with a small amount of Vancouver Aquarium seawater, and gentle aeration was supplied to each culture pan. An aliquot of shipping water from each container was set aside for water quality. It was then ensured that salinity or temperature adjustments to the holding water of the polychaetes did not exceed 5 ppt or 3°C per day.

The organisms were held at Maxxam for 1 day before the test was initiated. The polychaetes were fed a small amount of ground Tetramin™ flakes daily during the holding period. Datasheets of daily water quality with observations of number dead or inactive polychaetes during the holding period are available in Appendix C.

3.2.2 Organism Health

The average mortality rate during the 48 hours prior to testing did not exceed 10% in any of the given cultures.

3.2.3 Organism Size

At test initiation, 3 groups of 5 polychaetes, representative of the organisms seeded into the test vessels, were placed into pre-weighed aluminum boats. After drying in 60°C oven for >24 hours, the contents of each weigh boat was measured to 0.01mg using an analytical balance. The average individual weight per worm was determined to be within the required range of 0.25-1.0 mg/worm, indicating that the organism batch was of the correct size (See Table 3-1).

3.3 Test Conditions

See Table 3-1 for a detailed list of the test conditions. All bench sheets and raw data are available in Appendix C.

Table 3-1 Test Conditions for the 20-day *Neanthes arenaceodentata* Test

Parameter	**Conditions and Methods**
Test Type and Duration	20 Day, Static - renewal
Temperature	20 ± 1°C
Salinity	28 ± 2 ppt
Photoperiod and Light Intensity	24 hours light. Wide spectrum cool white fluorescent lights used to provide: 462-533 lux during the light cycle.
Aeration	< 100 bubbles/ minute. Clean oil-free air supplied to each test vessel via micro-bore plastic tubing
Test Chamber	1 L Jars with plastic lids containing small opening for airline tubing.
Sediment Volume	175 ml of homogenized sediment (2-3cm depth)
Overlying Water Volume and Source	750 mL; Vancouver Aquarium seawater U.V sterilized, filtered through 5 µm, and aerated before use.
Overlying Water Quality	Every 3rd day: temperature, pH, salinity, and dissolved oxygen measurements recorded. Total ammonia and sulphides measured on Day 0 of test. Total ammonia on Day 20.
Water Renewal	30% of the overlying water was siphoned and replaced with clean seawater every 3rd day, directly after water quality measurements were taken.
Feeding	Every 2nd day; 1mL per replicate of a ground Tetramin™ flake-seawater slurry (40mg dry solids/mL).
Replicates	5 per sample, plus an additional replicate for water quality measurements.
Control Sediment	Yaquina Bay Sand. Rinsed with clean seawater and sieved through a 500 µm stainless steel mesh
Reference Sediment	15SED11
Organisms/ Replicate	5
Organism Source and age	Aquatic Toxicology Support; juvenile worms aged 16 days post emergence.
Average Initial Dry Weight	0.40 mg/worm
Endpoints	Mean Survival, Mean Dry weight, Total Dry Weight, and Growth Rate.
Test Validity Criteria	≥ 90% mean survival in the controls. ≥0.38mg/day/worm.
Statistical Software	CETIS™ version 1.8.7 Tidepool Scientific Software (Copyright 2000-2013).

3.4 Quality Assurance/Quality Control

3.4.1 Reference Toxicant Results

A 96 hour reference toxicant test was performed on the batch of organisms. The LC50 of the reference toxicant test was calculated and compared in a control chart with those of previous tests. Table 3-2 summarises the result of the reference toxicant test. The reference toxicant test had an LC50 that was within the two standard deviation (95%) range of the historic mean LC50.

The method used in preparing the control charts was taken from "Control Charting of Reference Toxicant Tests" (BBY2 WI-00007).

Table 3-2 Reference Toxicant Test Results for *Neanthes arenaceodentata*

Organism Batch	Test Date	LC50 with 95% Confidence Limits (mg/L Cd^{2+})	Previous Mean with 2SD (mg/L Cd^{2+})
AT150609	2015 Jun 10	7.5 (5.6, 10)	8.1 (5.0, 13.3)

3.4.2 Test Validity Criteria

Survival data in the laboratory controls are considered be acceptable if the mean percent survival in the negative control was ≥ 90%, and the mean growth rate in the controls exceeded ≥0.38 mg/worm/day. The mean percent survival of the control was 92%. The mean growth rate in the control was 0.80 mg/worm/day.

3.5 Results

The survival and dry weight, in each replicate, and the mean ± SD in the control and test sediments, for every test batch, are available in Appendix C. The data are summarized in the "20-day *Neanthes arenaceodentata* Survival and Growth Test Summary of Survival" and the "*Neanthes* Weights" pages.

Overall, mean organism survival in the samples ranged from 92 to 100%, mean dry weight from 12.5 to 14.9 mg/worm, total dry weight from 58.1 to 74.3 mg per replicate, and mean growth rate from 0.61 to 0.73 mg/worm/day. No statistically significant decreases were detected in any of the sediment samples when compared against the negative control or the reference sediment (15SED11). A summary of the survival and growth results is located in Table 3-3.

Total ammonia concentrations, pH, temperature, and salinity in overlying water at test initiation (Day 0), completion (Day 20), and all other water quality data are located in Appendix C.

3.5.1 Data Analysis

The survival and dry weight data for all samples and their respective controls was entered into the statistical program "Comprehensive Environmental Toxicity Information System" (CETIS, 2000-2013). When determining the appropriate comparison tests to use, the Environment Canada "Guidance Document on Statistical Methods for Environmental Toxicity Tests" (EPS 1/RM/46, 2005) was followed.

See the CETIS Analytical Reports for information on the specific tests used for the comparison testing, as well as supporting auxiliary tests, if applicable. All analyses were conducted as one-tailed comparisons with the decision level for determining statistical significance set to 0.05 (p value <0.05).

Table 3-3 Results for Mean Polychaete Survival and Growth

Sample ID	Mean Survival ± SD (%)	Mean Total Dry Weight ± SD (mg/replicate)	Mean Dry Weight ± SD (mg/worm)	Mean Growth Rate ± SD (mg/day/worm)
Negative Control	92 ± 11	75.7 ± 15.2	16.4 ± 2.5	0.80± 0.12
15SED11	100 ± 0	67.0 ± 12.4	13.4 ± 2.5	0.65 ± 0.12
15SED02	100 ± 0	70.9 ± 7.0	14.2 ± 1.4	0.69 ± 0.07
15SED03	92 ± 18	66.9 ± 5.2	14.9 ± 2.5	0.73 ± 0.13
15SED05	100 ± 0	70.7 ± 20.1	14.1 ± 4.0	0.69 ± 0.20
15SED06	92 ± 11	58.1 ± 14.5	12.5 ± 2.1	0.61 ± 0.10
15SED07	100 ± 0	74.3 ± 18.4	14.9 ± 3.7	0.72 ± 0.18
15SED08	96 ± 9	65.9 ± 14.6	13.7 ± 2.3	0.66 ± 0.12

SD: Standard Deviation

SECTION

4 48 HOUR BIVALVE SEDIMENT TEST

4.1 Test Methods

The normal development and survival of the Blue mussel, *Mytilus galloprovincialis*, when exposed to sediment elutriate samples for 48 hours, was assessed according to the Puget Sound Estuary Program Method “Bivalve Larvae Sediment Bioassay” (PSEP, 1995), and the Maxxam SOP “Bivalve Larval Development Sediment Test (BBY2SOP-00032).

One day prior to test initiation, the sediment samples were individually homogenized, and 18g aliquots were distributed into 1L test vessels. To create the elutriate suspension, 900mL of overlying seawater was then added to each vessel and the contents were vigorously agitated for 10 seconds. The test vessels were then randomized on the bench top, and the elutriate preparations were allowed to settle overnight.

Two controls, a seawater control and a sediment control, were prepared.

The following day, on Jun 10, 2015, samples of overlying water were removed from a water quality vessel for initial water quality analysis.

After spawning, collecting, and fertilizing the bivalve gametes, approximately 20000 embryos were added to each test vessel. At 48 hours, the larvae were monitored to see if 95% of the larvae had reached the development prodissoconch I stage. As they had not, the test duration was extended. Once it was determined that a developmental plateau had been reached, where the monitoring counts of developed larvae no longer continued to rise, the test was ended at hour 56.

The overlying water from each test vessel was decanted into a clean vessel. 10mL aliquots were then pipetted into 30mL test tubes, and preserved with buffered formalin.

The contents of each test tube were enumerated and scored as normally or abnormally developed. The seawater control was used to determine if the test met all applicable test validity criteria. The sediment control acted as a method control for the decantation step, as it is common to not capture all larvae that were originally seeded into the test. This is in part due to entrainment of the larvae on the surface of the sediment.

4.2 Organism Information

Male and female gravid mussels, collected from Mission Bay California, arrived at Maxxam on June 09, 2015. The mussels were held 1 day prior to use.

The mussels were gently scrubbed before they were placed into a 16±1°C seawater bath outfitted with a recirculating pump. Any organisms with obvious injuries or abnormalities were discarded. The temperature of the water bath was slowly increased to induce the mussels to spawn. After 1 hour, the water bath and any non responsive organisms were discarded.

Once an individual had begun to spawn, they were rinsed and isolated in a beaker of 16±1°C seawater. Male and female gametes were quality checked by microscopic examination before they were pooled and concentrated.

After determining and adjusting their relative densities, the suspensions of eggs and sperm were combined; the resulting embryos were allowed to develop for 1 hour before they were seeded into the test vessels.

4.3 Test Conditions

See Table 4-1 for a detailed list of the test conditions. All bench sheets used to record raw data are available in Appendix D.

Table 4-1 Test Conditions and Methods for the 48-h Bivalve Sediment Test

Parameter	**Conditions and Methods**
Test Type and Duration	48-h extended to 56-h, Static (non-renewal)
Temperature	16 ± 1°C
Salinity	28 ± 2 ppt
Photoperiod and Light Intensity	16 hours light: 8 hours dark. Wide spectrum cool white fluorescent lights used to provide: 50-100 foot candles during light cycle.
Aeration	No aeration or pre-aeration required during test.
Test Vessel	1L glass jars
Seawater Volume	900 mL
Sediment Mass	18.0 ± 0.5g
Replication	5 per sample, plus an additional replicate for water quality measurements.
Negative Control	Vancouver Aquarium Seawater

Parameter	Conditions and Methods
Sediment Control	Yaquina Beach Sand
Reference Sediment	15SED11
Organism	*Mytilus galloprovincialis*
Organism Source and Age	Marine Research and Educational Products; Gravid Adults
Average Initial Density	202 embryo per test vessel; CV = 16%
Feeding	None
Endpoints	Survival and Normal Development, Combined Survived and Normally Developed: Mean ± standard deviation (SD) per sample
Test Validity Criteria	≥70% mean normal development in the seawater controls
Statistical Software	CETIS™ version 1.8.7.16 Tidepool Scientific Software (Copyright 2000-2013).

4.4 Quality Assurance/Quality Control

4.4.1 Reference Toxicant Results

A 48 hour reference toxicant test was conducted alongside the tests. The reference toxicant test, using copper chloride ($CuCl_2 \cdot 2H_20$), was performed to assess the sensitivity of the test organisms and the precision of the results. The LC50 of the reference toxicant test was calculated and compared in a control chart with those of previous tests. Table 3-2 summarises the results of the reference toxicant test.

The reference toxicant test had an LC50 that was within the two standard deviation (95%) range of the historic mean LC50. The method used in preparing the control charts was taken from “Control Charting of Reference Toxicant Tests” (BBY2 WI-00007).

Table 4-2 Reference Toxicant Test Results for 48-h Bivalve Normal Development

Organism Batch	Test Date	EC50 with 95% Confidence Limits (µg/L Cu^{2+})	Previous Mean with 2SD (µg/L Cu^{2+})
MR150609	2015 Jun 10	8.1 (7.5, 8.8)	10.1 (7.9, 12.9)

4.4.2 Test Validity Criteria

The Larval Development data in the controls were considered be acceptable as the mean percent normal development was ≥70%. The mean percent normal development in the seawater control was 86.

4.5 Results

The total survival, proportion normally developed, and combined proportion survived normally developed, in each replicate, are listed in the “Bivalve Embryo-Larval Development Test- Embryo Microscopic Examination” sheets, located in Appendix D. A summary of the point estimates and statistical comparisons for mean survival and normal development, between the sediment control and each sample, are located in Table 4-3.

Overall, mean normal development in the samples ranged from 80 to 88%, mean survival from 52 to 70%, and mean combined proportion survived normally developed from 43 to 61%. A summary of statistically significant differences between the sediment control and each sample is located in Table 4-3.

Total dissolved oxygen, pH, temperature, and salinity in all sample concentrations, at test initiation and completion, as well as other daily water quality measurements, are located in the raw data (Appendix D).

4.5.1 Data Analysis

The data for all samples and their respective controls was entered into the statistical program “Comprehensive Environmental Toxicity Information System” (CETIS, 2000-2013). When determining the appropriate tests to use, the Environment Canada “Guidance Document on Statistical Methods for Environmental Toxicity Tests” (EPS 1/RM/46, 2005) was followed.

The seawater and sediment control were compared using Equal Variance t Two-Sample tests. When they were determined to be not significantly different for a given endpoint, the control data were pooled prior to comparison testing. For endpoints where the two controls were statistically different, the sediment control, or method control, was used for the comparisons analyses.

All comparison tests were conducted one-tailed, using Dunnetts Multiple Comparison Test, with the decision level for determining statistical significance set to 0.05 (p value <0.05). Table 4-3 contains a summary of the results for mean survival and development. There were no statistically significant decreases detected in any of the samples when compared against the control(s), or the reference sediment (15SED11).

Grubbs Test detected two outliers; 15SED11, replicate A, and 15SED08, replicate E. Upon examining the raw data, it was determined that the two data points were good candidates for exclusion and they were removed from the statistical comparisons.

Table 4-3 Results for Mean Bivalve Larval Development

Sample ID	Bivalve Larval Development Test		
	Mean Proportion Normal ±SD (%)	**Mean Survival ± SD (%)**	**Mean Combined Survival-Proportion Normal ± SD (%)**
Seawater Control	86 ± 2	81 ± 10	70 ± 9
Sediment Control	80 ± 7	52 ± 10	42 ± 11
15SED11	83 ± 7	52 ± 9	43 ± 9
15SED02	88 ± 4	67 ± 4	58 ± 4
15SED03	86 ± 3	56 ± 5	48 ± 4
15SED05	80 ± 12	55 ± 13	45 ± 16
15SED06	88 ± 4	69 ± 7	61 ± 8
15SED07	83 ± 6	70 ± 7	59 ± 10
15SED08	87 ± 3	68 ± 4	59 ± 4

SD: Standard Deviation

SECTION 5 REFERENCES

Comprehensive Environmental Toxicity Information System (CETIS). 2000-2013. Tidepool Scientific. LLC. Version 1.8.7.16

Environment Canada. 1992. Biological Test method: Acute Test for Sediment Toxicity Using Marine or Estuarine Amphipods. Environmental Protection Publications, Conservation and Protection. Ottawa, Ontario. EPS 1/RM/26.

Environment Canada. 1998. Biological Test method: Reference Method for Determining Acute Lethality of Sediment to Marine or Estuarine Amphipods. Environmental Protection Publications, Conservation and Protection. Ottawa, Ontario. EPS 1/RM/35.

Environment Canada. 2005. Guidance Document on Statistical Methods for Environmental Toxicity Tests. Environmental Protection Publications. Conservation and Protection. Ottawa, Ontario. EPS 1/RM/46.

Maxxam WI for Standard Operating Procedure for the Control Charting of Reference Toxicant Tests. BBY2 WI-00007.

Maxxam SOP Test Method for the Marine or Estuarine Amphipod 10 day Survival and Re-burial Test. BBY2 SOP-00012.

Maxxam SOP Test Method for the *Neanthes arenaceodentata* Survival and Growth Test. BBY2 SOP-00030.

Maxxam SOP Test Method for the Bivalve Larval Sediment Test. BBY2 SOP-00032.

Puget Sound Estuarine Program. 1995. Recommended Guidelines for Conducting Laboratory Bioassays on Puget Sound Sediments. Juvenile Polychaete Sediment Bioassay. U.S. Environmental Protection Agency, Region 10, Office of Puget Sound, Seattle, WA.

Puget Sound Estuarine Program. 1995. Recommended Guidelines for Conducting Laboratory Bioassays on Puget Sound Sediments. Bivalve Larvae Sediment Bioassay. U.S. Environmental Protection Agency, Region 10, Office of Puget Sound, Seattle, WA.

APPENDICES

APPENDIX

A SAMPLE INFORMATION AND CHAIN OF CUSTODY RECORDS

Maxxam

4606 Canada Way, Burnaby, BC Canada V5G 1K5 Ph: 604 734 7276 Toll Free: 1 800 665 8566 Fax: 604 731 2386

Maxxam Job#: B542517

CHAIN OF CUSTODY RECORD

Page: 1 of 1

G 089222

Invoice To: Require Report? Yes ☒ No ☐

Company Name: Tetra Tech EBA
Contact Name: Lora Paul
Address: #1-4376 Boban Dr, Nanaimo BC PC: V9T 6A7
Phone / Fax#: 250 756 2256
E-mail: lora.paul@tetratech.com

Report To:

Company Name: Tetra Tech EBA
Contact Name: Kristy Gabelhouse
Address: same ←
PC:
Phone / Fax#: Ph: Fax:
E-mail: kristy.gabelhouse@tetratech.com

PO #:
Quotation #:
Project #: ENVIN03511-02
Proj. Name:
Location: 1 Port Drive, Nanaimo
Sampled By: Shawneen Walker

REGULATORY REQUIREMENTS SERVICE REQUESTED:

- ☒ CSR
- ☐ CCME
- ☐ BC Water Quality
- ☐ Other
- ☐ DRINKING WATER

- ☒ Regular Turn Around Time (TAT) (5 days for most tests)
- ☐ RUSH (Please contact the lab) ☐ 1 Day ☐ 2 Day ☐ 3 Day
- Date Required:

Special Instructions:

Return Cooler ☐ Ship Sample Bottles (please specify) ☐

ANALYSIS REQUESTED: BTEX/VPH, MTBE, VOC/VPH, EPH, TEH, PAH ☒ LEPH/HEPH, CCME-PHC (Fractions 1-4 Plus BTEX), CCME-PHC (Fractions 2-4), CCME BTEX (Fraction 1 Plus BTEX), PCB, Phenols by 4AAP, Phenols by GCMS, TOG, MOG, SWOG, Dissolved Metals (Field Filtered? Y N; Field Acidified? Y N), Totals Metals (Field Acidified? Y N), Nitrate, Nitrite, Ammonia, Chloride, Fluoride, Sulphate, Total Suspended Solids-TSS, TDS, pH, Conductivity, Alkalinity, BOD, COD, Coliform, Total & E.coli, Fecal, Asbestos, TOC, grain size, ☒ HOLD [illegible]

	Sample Identification	Lab Identification	Sample Type	Date/Time Sampled	PAH / LEPH/HEPH	TOC	grain size	HOLD
1	15Sed01		Sed	2015/5/21	X	X	X	X
2	15 Sed02	MH3566	↓	↓	X	X	X	X
3	15 Sed03	MH3567			X	X	X	X
4	15 Sed04	MH3568			X	X	X	X
5	15 Sed05	MH3569			X	X	X	X
6	15 Sed06	MH3570			X	X	X	X
7	15 Sed07	MH3571			X	X	X	X
8	15 Sed08	MH3572			X	X	X	X
9	15 Sed09	MH3573			X	X	X	X
10	15Sed10				X	X	X	X
11	15Sed11				X	X	X	X
12	15Sed12				X	X	X	X

B542517

Samples are from a Drinking Water Source? YES NO
Does source supply multiple households? YES NO

Relinquished by:	Date (YY/MM/DD):	Time:	Received by:	Date (YY/MM/DD):	Time:
[signature]	15/05/21	15:51	[signature]	2015/05/22	15:50

Laboratory Use Only

Time Sensitive ☐

Temperature on Receipt (°C): 5,4,3 / 3,5,6

Custody Seal Intact on Cooler? N/A Yes ☐ No ☐

*IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORD. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.

White: Maxxam Yellow: Client

COC-1030 (09/10)

Maxxam International Corporation o/a Maxxam Analytics

4,4,7 / 4,6,6 / 4,7,6 / 6,4,5 / 6,7,6 / 5,6,5

Maxxam

4606 Canada Way, Burnaby, BC Canada V5G 1K5 Ph: 604 734 7276 Toll Free: 1 800 665 8566 Fax: 604 731 2386

CHAIN OF CUSTODY RECORD

Page: 1 of 1

Maxxam Job#: B542802

G 079957

Invoice To: Require Report? Yes ☐ No ☐

Company Name: Tetra Tech EBA
Contact Name: Lora Paul
Address: #1-4376 Boban Dr
Nanaimo BC PC: V9T 6A7
Phone / Fax#: 250 756 2256
E-mail: lora.paul@tetratech.com

Report To:

Company Name: Tetra Tech EBA
Contact Name: Kristy Gabelhause
Address:
PC:
Phone / Fax#: Ph: Fax:
kristy.gabelhause@tetratech.com

PO #:
Quotation #:
Project #: ENVIND03511-02
Proj. Name: City of Nanaimo
Location: 1 Port Drive, Nanaimo
Sampled By: Shawneen Walker

REGULATORY REQUIREMENTS

- [x] CSR
- [ ] CCME
- [ ] BC Water Quality
- [ ] Other
- [ ] DRINKING WATER

SERVICE REQUESTED:

- [x] Regular Turn Around Time (TAT) (5 days for most tests)
- [ ] RUSH (Please contact the lab)
- [ ] 1 Day ☐ 2 Day ☐ 3 Day

Date Required:

Special Instructions:

Return Cooler ☐ Ship Sample Bottles (please specify) ☐

ANALYSIS REQUESTED

	Sample Identification	Lab Identification	Sample Type	Date/Time Sampled	BTEX/VPH	VOC/VPH	EPH / TEH	PAH / LEPH/HEPH	CCME-PHC (Fractions 1-4 Plus BTEX)	CCME-PHC (Fractions 2-4)	CCME BTEX (Fraction 1 Plus BTEX)	FOG	Phenols by 4AAP / Phenols by GCMS	TOG / MOG / SWOG	Dissolved Metals (Field Filtered Y/N)	(Field Acidified Y/N)	Total Metals Field Acidified? Y/N	Nitrate / Nitrite / Ammonia	Chloride / Fluoride / Sulphate	Total Suspended Solids-TSS / TDS	pH / Conductivity / Alkalinity	BOD	COD	Coliform, Total & E.coli / Fecal	Asbestos	TOC	Grain Size					HOLD / Toxicity
1	15 Sed 01	MH4918	Sed	15/5/22				X																		X	X					X
2	15 Sed 10	MH4919		"				X																		X	X					X
3	15 Sed 11	MH4920		"				X																		X	X					X
4	15 Sed 12	MH4921						X																		X	X					X
5																																
6																																
7																																
8																																
9																																
10																																
11																																
12																																

B542802

Samples are from a Drinking Water Source? YES / NO
Does source supply multiple households? YES / NO

Relinquished by:	Date (YY/MM/DD):	Time:	Received by:	Date (YY/MM/DD):	Time:
S Walker	15/5/22		Nahid Amer	2015/05/23	10:15

Laboratory Use Only

Time Sensitive ☐

Temperature on Receipt (°C): 3,4,4 / 9,6,4 / 4,4,4 / 5,6,4

Custody Seal Intact on Cooler? Yes / No

N/A

IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORD. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.

White: Maxxam Yellow: Client

COC-1003 (05/10)

Maxxam International Corporation o/a Maxxam Analytics

ECOTOXICOLOGY
SEDIMENT SAMPLE DESCRIPTIONS

Client # / Name: 11478 tetra tech   Job #: B542517

Maxxam Sample Name	Sample #	Client Sample Name	Date Homogenised / Subsampled	Grain Size & Colour	Type of Debris Removed (e.g. rock, wood, plant, etc...)	Endemic Animals Removed	Odour	Additional Comments/Observations	Analyst
Sed 11	MH 4920	15SED 11	2015 Jun 09 / 2015 JUN 11	Greyish black, Sand with stones	~~none~~ (A) Yes	none	Sewage Rotten eggs	~~Sheared~~ NB 2015 June 09	CS NB MT
Sed 02	MH3566	15 SED 02	2015 June 9 / 2015 JUN 11	Greyish black, clay	wood debris	none	Sewage and Rotten eggs	oil like sheen on surface of sediment	CS NB MT
Sed 03	MH3567	15SED 03	2015 June 9 / 2015 JUN 11	Greyish black, Sandy loam	wood	none	Sewage	oil like sheen on the surface	CS NB [illegible]
Sed 05	MH3569	15SED 05	2015 Jun 09 / 2015 JUN 11	Grayish black, clay loam	none	none	Organic		CS MO
Sed 06	MH3570	15SED06	2015 Jun 09 / 2015 JUN 11	Dark Gray, clay loam	none	none	Organic	little oil like sheen on surface	CS [illegible]
Sed 07	MH3571	15SED07	2015 June 09 / 2015 JUN 11	Dark grey clay	none	none	organic	n/a	NB MO
Sed 08	MH3572	15SED 08	2015 Jun 09 / 2015 JUN 11	Dark grey Clay	none wood pieces (2 large)	Removed 3 dead worms 1 bivalve	Organic Sewage	n/a	CS MO

DML 2015 Jun 23

(A) Removed large stones by sieving with 12.5 mm sieve, C.S 2015 Jun 09

Maxxam Job #: B548553
Report Date: 2015/06/17

Maxxam Analytics (TOX Internal)
Client Project #: 2-11-15007 NEANTHES PW
Site Location: TOX
Sampler Initials: GM

RESULTS OF CHEMICAL ANALYSES OF SEA WATER

Maxxam ID		MK5957		MK5958		MK5959		MK5960	MK5961	
Sampling Date		2015/06/09		2015/06/09		2015/06/09		2015/06/09	2015/06/09	
COC Number		G094761		G094761		G094761		G094761	G094761	
	Units	15 SED 11 PORE WATER	RDL	15 SED 02 PW	RDL	15 SED 03 PW	RDL	15 SED 05 PW	15 SED 06 PW	RDL
Nutrients										
Total Ammonia (N)	mg/L	67	0.50	8.6	0.050	13	0.10	6.0	6.5	0.050
RDL = Reportable Detection Limit										

Maxxam ID		MK5962		MK5963	
Sampling Date		2015/06/09		2015/06/09	
COC Number		G094761		G094761	
	Units	15 SED 07 PW	RDL	15 SED 08 PW	RDL
Nutrients					
Total Ammonia (N)	mg/L	5.0	0.050	12	0.10
RDL = Reportable Detection Limit					

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Maxxam Job #: B548553
Report Date: 2015/06/17

Maxxam Analytics (TOX Internal)
Client Project #: 2-11-15007 NEANTHES PW
Site Location: TOX
Sampler Initials: GM

MISCELLANEOUS (SEA WATER)

Maxxam ID		MK5957	MK5958	MK5959	MK5960	MK5961	MK5962	
Sampling Date		2015/06/09	2015/06/09	2015/06/09	2015/06/09	2015/06/09	2015/06/09	
COC Number		G094761	G094761	G094761	G094761	G094761	G094761	
	Units	15 SED 11 PORE WATER	15 SED 02 PW	15 SED 03 PW	15 SED 05 PW	15 SED 06 PW	15 SED 07 PW	RDL
MISCELLANEOUS								
Sulphide	mg/L	0.253 (1)	0.205 (1)	0.284 (1)	0.454 (1)	0.295 (1)	0.141 (1)	0.010

RDL = Reportable Detection Limit
(1) RDL raised due to limited initial sample amount.

Maxxam ID		MK5963	
Sampling Date		2015/06/09	
COC Number		G094761	
	Units	15 SED 08 PW	RDL
MISCELLANEOUS			
Sulphide	mg/L	10.1	0.50

RDL = Reportable Detection Limit

Maxxam Analytics International Corporation o/a Maxxam Analytics Burnaby: 4606 Canada Way V5G 1K5 Telephone(604) 734-7276 Fax(604) 731-2386

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Maxxam Job #: B549196
Report Date: 2015/06/17

Maxxam Analytics (TOX Internal)
Client Project #: 2-11-15008
Site Location: AMPHIPAD DAY-1 PORE WATER ECOTOX
Sampler Initials: MT

RESULTS OF CHEMICAL ANALYSES OF SEA WATER

Maxxam ID		MK9568		MK9569	MK9570		MK9571	MK9572	MK9573		MK9574	
Sampling Date		2015/06/11		2015/06/11	2015/06/11		2015/06/11	2015/06/11	2015/06/11		2015/06/11	
COC Number		G094765		G094765	G094765		G094765	G094765	G094765		G094765	
	Units	**15SED11**	**RDL**	**15SED02**	**15SED03**	**RDL**	**15SED05**	**15SED06**	**15SED07**	**RDL**	**15SED08**	**RDL**
Nutrients												
Total Ammonia (N)	mg/L	78	0.50	11	15	0.10	6.9	6.6	7.8	0.050	15	0.10

RDL = Reportable Detection Limit

Maxxam Analytics International Corporation o/a Maxxam Analytics Burnaby: 4606 Canada Way V5G 1K5 Telephone(604) 734-7276 Fax(604) 731-2386

ECOTOXICOLOGY
MARINE SEDIMENT TEST – POREWATER MEASUREMENTS

Client # & Name: 11478 Tetra Tech

Date Measured: 2015 Jun 09

Porewater Collection Method: Did centrifugation of samples using BBY2-0317 centrifuge @ 2500 rpm for 20 min. @ 4°C.

Sample ID	Salinity (‰)	Temperature (°C)	pH	Ammonia (mg/L)	Sulphide (mg/L)
15SED11	25	19.6	7.7	67	0.253
15SED02	26	18.6	7.5	8.6	0.205
15SED03	24	19.5	7.6	13	0.284
15SED05	23	19.6	7.5	6.0	0.454
15SED06	24	19.7	7.7	6.5	0.295
15SED07	24	20.4	7.6	5.0	0.141
15SED08	25	19.0	7.5	12	10.1
Analyst	C.S	CS	CS	mt	mt
Date	2015 Jun 09	2015 Jun 09	2015 Jun 09	2015 Jul 03	2015 Jul 03

mt 2015 Jul 03

Comments

mt 2015 Jul 03

ECOTOXICOLOGY

MARINE SEDIMENT TEST – POREWATER MEASUREMENTS

Client # & Name: 11478 Tetra Tech

Date Measured: 2015 Jun 11

Porewater Collection Method: centrifuged sediments for 20 min @ 4°C @ 5000 RPM using table-top centrifuge BBY2-0317.

Sample ID	Salinity (‰)	Temperature (°C)	pH	Ammonia (mg/L)	Sulphide (mg/L)
SED 11	25	17.4	7.7	✓ 78	
SED 02	26	16.8	7.5	✓ 11	
SED 03	25	17.5	7.7	✓ 15	mt 2015 Jun 11
SED 05	23	17.6	7.9	✓ 6.9	
SED 06	24	16.4	7.8	✓ 6.6	
SED 07	24	16.6	7.6	✓ 7.8	
SED 08	25	16.6	7.6	✓ 15	
		mt 2015 Jun 11			
Analyst	mt	mt	mt	mt / DML	n/a
Date	2015Jun11	2015 Jun11	2015Jun11	2015 Jun11	n/a

Comments

DML 2015 Jun 23

APPENDIX

B 10-DAY MARINE AMPHIPOD TEST

CETIS Analytical Report

Eohaustorius 10-d Survival and Reburial Sediment Test — **Maxxam Analytics**

Analysis ID:	05-3272-2821	**Endpoint:**	Survival Rate	**CETIS Version:**	CETISv1.8.7
Analyzed:	06 Jul-15 11:24	**Analysis:**	STP 2x2 Contingency Tables	**Official Results:**	Yes

Batch ID:	17-8400-6913	**Test Type:**	Survival-Reburial	**Analyst:**	
Start Date:	12 Jun-15 13:10	**Protocol:**	EC/EPS 1/RM/35	**Diluent:**	Natural Seawater (Van. Aquarium)
Ending Date:	22 Jun-15 12:00	**Species:**	Eohaustorius estuarius	**Brine:**	Not Applicable
Duration:	9d 23h	**Source:**	Northwestern Aquatic Science, OR	**Age:**	

Sample Code	Sample ID	Sample Date	Receive Date	Sample Age	Client Name	Project
Control	18-5837-4942	12 Jun-15	12 Jun-15	13h	Tetra Tech	2-11-15007
15SED11	15-6240-9376	22 May-15	23 May-15	21d 13h		
15SED02	12-8649-8243	21 May-15	22 May-15	22d 13h		
15SED03	18-5588-3709	21 May-15	22 May-15	22d 13h		
15SED05	10-5366-6000	21 May-15	22 May-15	22d 13h		
16SED06	19-5992-9006	21 May-15	22 May-15	22d 13h		
15SED07	09-4217-4404	21 May-15	22 May-15	22d 13h		
15SED08	21-3716-2985	21 May-15	22 May-15	22d 13h		

Sample Code	Material Type	Sample Source	Station Location	Latitude	Longitude
Control	Marine/Estuarine Se	Tetra Tech	Control		
15SED11	Marine/Estuarine Se	Tetra Tech	15SED11		
15SED02	Marine/Estuarine Se	Tetra Tech	15SED02		
15SED03	Marine/Estuarine Se	Tetra Tech	15SED03		
15SED05	Marine/Estuarine Se	Tetra Tech	15SED05		
16SED06	Marine/Estuarine Se	Tetra Tech	16SED06		
15SED07	Marine/Estuarine Se	Tetra Tech	15SED07		
15SED08	Marine/Estuarine Se	Tetra Tech	15SED08		

Data Transform	Zeta	Alt Hyp	Trials	Seed	Test Result
Untransformed		C > T	NA	NA	

Fisher Exact/Bonferroni-Holm Test

Sample	vs	Sample	Test Stat	P-Value	P-Type	Decision(α:5%)
Control		15SED11	0.3144	1.0000	Exact	Non-Significant Effect
Control		15SED02	0.7513	1.0000	Exact	Non-Significant Effect
Control		15SED03	0.1058	0.7408	Exact	Non-Significant Effect
Control		15SED05	0.5	1.0000	Exact	Non-Significant Effect
Control		16SED06	0.3106	1.0000	Exact	Non-Significant Effect
Control		15SED07	0.7513	1.0000	Exact	Non-Significant Effect
Control		15SED08	0.5	1.0000	Exact	Non-Significant Effect

Data Summary

Group	NR	R	NR + R	Prop NR	Prop R	%Effect
Control	99	1	100	0.99	0.01	0.0%
15SED11	98	3	101	0.9703	0.0297	1.99%
15SED02	99	1	100	0.99	0.01	0.0%
15SED03	95	5	100	0.95	0.05	4.04%
15SED05	98	2	100	0.98	0.02	1.01%
16SED06	97	3	100	0.97	0.03	2.02%
15SED07	99	1	100	0.99	0.01	0.0%
15SED08	98	2	100	0.98	0.02	1.01%

05 Jul 06 2015 Jul 10

Analyst: H.G QA: JP

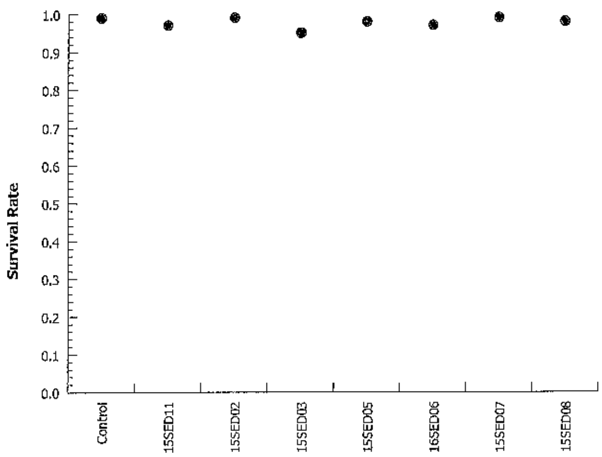
Eohaustorius 10-d Survival and Reburial Sediment Test **Maxxam Analytics**

Analysis ID:	05-3272-2821	**Endpoint:**	Survival Rate	**CETIS Version:**	CETISv1.8.7
Analyzed:	06 Jul-15 11:24	**Analysis:**	STP 2x2 Contingency Tables	**Official Results:**	Yes

Survival Rate Detail

Group	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
Control	1	0.95	1	1	1
15SED11	1	0.85	1	1	1
15SED02	1	0.95	1	1	1
15SED03	1	0.95	0.95	0.95	0.9
15SED05	1	1	1	0.95	0.95
16SED06	0.95	1	1	0.95	0.95
15SED07	1	1	1	1	0.95
15SED08	1	0.95	1	0.95	1

Graphics



Eohaustorius 10-d Survival and Reburial Sediment Test — **Maxxam Analytics**

Analysis ID:	06-2995-3516	**Endpoint:**	Survival Rate	**CETIS Version:**	CETISv1.8.7
Analyzed:	06 Jul-15 11:24	**Analysis:**	STP 2x2 Contingency Tables	**Official Results:**	Yes

Batch ID:	17-8400-6913	**Test Type:**	Survival-Reburial	**Analyst:**	
Start Date:	12 Jun-15 13:10	**Protocol:**	EC/EPS 1/RM/35	**Diluent:**	Natural Seawater (Van. Aquarium)
Ending Date:	22 Jun-15 12:00	**Species:**	Eohaustorius estuarius	**Brine:**	Not Applicable
Duration:	9d 23h	**Source:**	Northwestern Aquatic Science, OR	**Age:**	

Sample Code	Sample ID	Sample Date	Receive Date	Sample Age	Client Name	Project
15SED11	15-6240-9376	22 May-15	23 May-15	21d 13h	Tetra Tech	2-11-15007
15SED02	12-8649-8243	21 May-15	22 May-15	22d 13h		
15SED03	18-5588-3709	21 May-15	22 May-15	22d 13h		
15SED05	10-5366-6000	21 May-15	22 May-15	22d 13h		
16SED06	19-5992-9006	21 May-15	22 May-15	22d 13h		
15SED07	09-4217-4404	21 May-15	22 May-15	22d 13h		
15SED08	21-3716-2985	21 May-15	22 May-15	22d 13h		

Sample Code	Material Type	Sample Source	Station Location	Latitude	Longitude
15SED11	Marine/Estuarine Se	Tetra Tech	15SED11		
15SED02	Marine/Estuarine Se	Tetra Tech	15SED02		
15SED03	Marine/Estuarine Se	Tetra Tech	15SED03		
15SED05	Marine/Estuarine Se	Tetra Tech	15SED05		
16SED06	Marine/Estuarine Se	Tetra Tech	16SED06		
15SED07	Marine/Estuarine Se	Tetra Tech	15SED07		
15SED08	Marine/Estuarine Se	Tetra Tech	15SED08		

Data Transform	Zeta	Alt Hyp	Trials	Seed	Test Result
Untransformed		C > T	NA	NA	

Fisher Exact/Bonferroni-Holm Test

Sample	vs	Sample	Test Stat	P-Value	P-Type	Decision(α:5%)
15SED11		15SED02	1	1.0000	Exact	Non-Significant Effect
15SED11		15SED03	0.355	1.0000	Exact	Non-Significant Effect
15SED11		15SED05	1	1.0000	Exact	Non-Significant Effect
15SED11		16SED06	0.6539	1.0000	Exact	Non-Significant Effect
15SED11		15SED07	1	1.0000	Exact	Non-Significant Effect
15SED11		15SED08	1	1.0000	Exact	Non-Significant Effect

Data Summary

Group	NR	R	NR + R	Prop NR	Prop R	%Effect
15SED11	98	3	101	0.9703	0.0297	0.0%
15SED02	99	1	100	0.99	0.01	-2.03%
15SED03	95	5	100	0.95	0.05	2.09%
15SED05	98	2	100	0.98	0.02	-1.0%
16SED06	97	3	100	0.97	0.03	0.03%
15SED07	99	1	100	0.99	0.01	-2.03%
15SED08	98	2	100	0.98	0.02	-1.0%

Survival Rate Detail

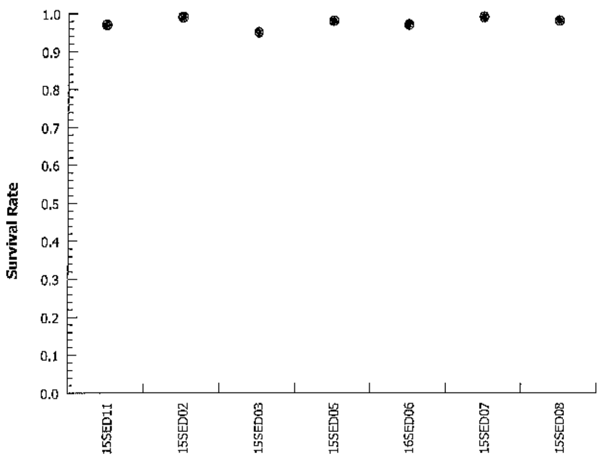
Group	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
15SED11	1	0.85	1	1	1
15SED02	1	0.95	1	1	1
15SED03	1	0.95	0.95	0.95	0.9
15SED05	1	1	1	0.95	0.95
16SED06	0.95	1	1	0.95	0.95
15SED07	1	1	1	1	0.95
15SED08	1	0.95	1	0.95	1

2015 Jul 06 Analyst: MG 2015 Jul 10 QA: JP

Eohaustorius 10-d Survival and Reburial Sediment Test — **Maxxam Analytics**

Analysis ID:	06-2995-3516	**Endpoint:**	Survival Rate	**CETIS Version:**	CETISv1.8.7
Analyzed:	06 Jul-15 11:24	**Analysis:**	STP 2x2 Contingency Tables	**Official Results:**	Yes

Graphics



Analyst: M.G. 2015 Jul 06 QA: 2015 Jul 10

Maxxam Analytics

10-day *Eohaustorius estuarius* Survival Test
Summary of Survival

Client Name and #: Tetra Tech # 11478
Job #: B542517, B542802

Start Date: 2015 Jun 12
End Date: 2015 Jun 22

Sample ID	Sample #	Replicate	# Exposed	# Surviving	Survival (%)	Mean Survival (%)	SD
Control	-	A	20	20	100	99	2
		B	20	19	95		
		C	20	20	100		
		D	20	20	100		
		E	20	20	100		
15 SED 11	MH4920	A	20	20	100	97	7
		B	20	17	85		
		C	20	20	100		
		D	20	20	100		
		E	21	21	100		
15 SED 02	MH3566	A	20	20	100	99	2
		B	20	19	95		
		C	20	20	100		
		D	20	20	100		
		E	20	20	100		
15 SED 03	MH3567	A	20	20	100	95	4
		B	20	19	95		
		C	20	19	95		
		D	20	19	95		
		E	20	18	90		
15 SED 05	MH3569	A	20	20	100	98	3
		B	20	20	100		
		C	20	20	100		
		D	20	19	95		
		E	20	19	95		
15 SED 06	MH3570	A	20	19	95	97	3
		B	20	20	100		
		C	20	20	100		
		D	20	19	95		
		E	20	19	95		
15 SED 07	MH3571	A	20	20	100	99	2
		B	20	20	100		
		C	20	20	100		
		D	20	20	100		
		E	20	19	95		
15 SED 08	MH3572	A	20	20	100	98	3
		B	20	19	95		
		C	20	20	100		
		D	20	19	95		
		E	20	20	100		

JP 2015 Jul 10

ECOTOXICOLOGY

Maxxam

BBY2FCD-00221/2

ENVIRO. CANADA MARINE AMPHIPOD 10 DAY SEDIMENT TEST - TEST CONDITIONS AND SURVIVAL DATA

Client # & Name: 11478 Tetra Tech
Start Date & Time: 2015 Jun 12, 1310
Sample Date: 2015 May 21-22
End Date: 2015 Jun 22
Sample Received: 2015 May 22-23
Species: Eohaustorius estuarius
Maxxam Project #: ~~B542517~~ 2-11-15007(A)
Organism Lot #: NA150609
Job #: B542517, B542802
Analyst(s): D.Lai C.Tang, Amsfoy, K.Tamaki D.Lai

Sample ID: Control

	Day 0	3	5	7	10
Day	Friday	Monday	Wednesday	Friday	Monday
Date	2015 Jun 12	2015 Jun 15	2015 Jun 17	2015 Jun 19	2015 Jun 22
Temperature(°C)	14.0	15.0	15.3	14.6	14.5
D.O. (mg/L)	8.8	8.3	8.3	8.6	8.6
pH	8.0				8.0
Salinity (‰)	28				28
Analyst	DML	CT	CT	Ay	Kt

	# Alive				
Replicate	A	B	C	D	E
	20	19	20	20	20
Analyst	Kt	Kt	Kt	Kt	Kt

Ammonia Sample (mg/L)

Initial	Final
✓ 0.016	✓ <0.0050

Sample ID: Sed 11

	Day 0	3	5	7	10
Day	Friday	Monday	Wednesday	Friday	Monday
Date	2015 Jun 12	2015 Jun 15	2015 Jun 17	2015 Jun 19	2015 Jun 22
Temperature(°C)	13.6	14.8	15.0	14.4	14.4
D.O. (mg/L)	8.5	8.3	8.4	8.6	8.6
pH	7.9				8.2
Salinity (‰)	28				28
Analyst	DML	CT	CT	Ay	Kt

	# Alive				
Replicate	A	B	C	D	E
	20	17	20	20	21
Analyst	Kt	DML	Kt	Kt	Kt

Ammonia Sample (mg/L)

Initial	Final
✓ ~~12~~ 29	✓ 12

WE DML 2015 Jun 23

(A) WE DML 2015 Jun 10

ENVIRO. CANADA MARINE AMPHIPOD 10 DAY SEDIMENT TEST - TEST CONDITIONS AND SURVIVAL DATA

Sample ID: Sed 02

	Day 0	3	5	7	10
Day	Friday	Monday	Wednesday	Friday	Monday
Date	2015Jun12	2015Jun15	2015Jun17	2015JUN19	2015Jun22
Temperature(°C)	13.6	14.7	14.9	14.5	14.4
D.O. (mg/L)	8.7	8.3	8.4	8.6	8.6
pH	8.0				8.4
Salinity (‰)	28				28
Analyst	DML	CT	CT	wj	KT

	# Alive				
Replicate	A	B	C	D	E
	20	19	20	20	20
Analyst	KT	KT	DML	KT	~~K~~ DML

WE DML 2015 Jun22

Ammonia Sample (mg/L)

Initial	Final
✓ ~~1.7~~ 1.2	✓ 0.91

WE DML 2015Jun23

Sample ID: Sed 03

	Day 0	3	5	7	10
Day	Friday	Monday	Wednesday	Friday	Monday
Date	2015Jun12	2015 Jun 15	2015Jun17	2015JUN19	2015JUN22
Temperature(°C)	13.4	14.4	14.6	14.3	21.2 (A)
D.O. (mg/L)	8.8	8.4	8.4	8.6	8.9
pH	8.0				8.1
Salinity (‰)	27				28
Analyst	DML	CT	CT	wj	wj

	# Alive				
Replicate	A	B	C	D	E
	20	19	19	19	18
Analyst	DML	KT	DML	KT	DML

Ammonia Sample (mg/L)

Initial	Final
✓ 1.7	✓ 0.42

(A) WQ done later in the day in the Dephnia room ∴ greater temp. increase.

ENVIRO. CANADA MARINE AMPHIPOD 10 DAY SEDIMENT TEST - TEST CONDITIONS AND SURVIVAL DATA

Sample ID: Sed 05

	Day 0	3	5	7	10
Day	Friday	Monday	Wednesday	Friday	Monday
Date	2015 Jun 12	2015 Jun 15	2015 Jun 17	2015 JUN 19	2015 Jun 22
Temperature(°C)	13.3	14.4	14.5	14.4	14.2
D.O. (mg/L)	8.7	8.5	8.5	8.4	8.7
pH	8.0				8.2
Salinity (‰)	28				28
Analyst	DML	CT	CT	wy	KT

	# Alive				
Replicate	A	B	C	D	E
	20	20	20	18+1	19
Analyst	KT	CS	DML	DML	KT

Ammonia Sample (mg/L)

Initial	Final
✓ 0.92	✓ 2.2

Sample ID: Sed 06

	Day 0	3	5	7	10
Day	Friday	Monday	Wednesday	Friday	Monday
Date	2015 Jun 12	2015 Jun 15	2015 Jun 17	2015 JUN 19	2015 Jun 22
Temperature(°C)	13.9	14.5	14.6	14.6	14.5
D.O. (mg/L)	(A) ~~28~~ 8.7	8.5	8.5	8.5	8.7
pH	7.9				8.2
Salinity (‰)	28				28
Analyst	DML	CT	CT	wy	KT

	# Alive				
Replicate	A	B	C	D	E
	19	20	20	19	19
Analyst	CS	KT	DML	KT	KT

Ammonia Sample (mg/L)

Initial	Final
✓ 0.86	✓ 0.34

(A) WE DML 2015 Jun 12

ECOTOXICOLGY

ENVIRO. CANADA MARINE AMPHIPOD 10 DAY SEDIMENT TEST - TEST CONDITIONS AND SURVIVAL DATA

Sample ID: Sed 07

	Day 0	3	5	7	10
Day	Friday	Monday	Wednesday	Friday	Monday
Date	2015 Jun 12	2015 Jun 15	2015 Jun 17	2015 JUN 19	2015 Jun 22
Temperature(°C)	Ⓐ ~~8.8~~ 13.3	14.2	14.3	14.4	14.2
D.O. (mg/L)	8.8	8.5	8.5	8.6	8.7
pH	8.0				8.1
Salinity (‰)	27				28
Analyst	DML	CT	CT	wj	KT

	# Alive				
Replicate	A	B	C	D	E
	20	20	20	20	19
Analyst	CS	DML	KT	DML	KT

Ammonia Sample (mg/L)

Initial	Final
✓ 0.88	✓ 1.0

Sample ID: Sed 08

	Day 0	3	5	7	10
Day	Friday	Monday	Wednesday	Friday	Monday
Date	2015 Jun 12	2015 Jun 15	2015 Jun 17	2015 JUN 19	2015 Jun 22
Temperature(°C)	13.3	14.2	14.3	14.4	14.2
D.O. (mg/L)	8.7	8.5	8.5	8.6	8.6
pH	8.0				8.2
Salinity (‰)	28				28
Analyst	DML	CT	CT	wj	KT

	# Alive				
Replicate	A	B	C	D	E
	20	19	20	19	20
Analyst	DML	CS	CS	KT	KT

Ammonia Sample (mg/L)

Initial	Final
✓ 1.1	✓ 4.1

Ⓐ WE DML 2015 Jun 12

ECOTOXICOLOGY
MARINE AMPHIPOD 10 DAY SEDIMENT TEST - AERATION CHECKS

Client # & Name: 11478 Tetra Tech

Start Date & Time: 2015 JUN 12 @ 13:10

Initial when aeration is checked. If air is off record DO and note which replicate(s) in comments section.

Day	-1	0	1	2	3	4	5	6	7	8	9	10
Date	2015 Jun 11	~~DML~~ (A)	2015 Jun 13	2015 Jun 14	2015 Jun 15	2015 Jun 16	2015 Jun 17	2015 Jun 18	2015 Jun 19	2015 Jun 20	2015 Jun 21	2015 Jun 22
Early AM		DML	mt	WB	OT	OT	OT	mo	wy	TW	mo	Kt
Mid-day		DML	Mt	WB	OT	OT	OT	mo	wy	TW	mo	~~DML~~
Late PM	mt	wy	Mt	OT	OT	OT	OT	mo	wy	TW	mo	~~DML 2015 Jun 23~~

Comments:

2015 Jun 11 – Set aeration @ 11:57 -mt

2015 Jun 12 – all pods appear buried in sediment @ time zero, DML

2015 JUN 12 – all pods are buried within the sediments at late check wy

2015 Jun 15 – all pods burried in sediments except 15 SED 11, in which some pods are floating/swimming around in overlying water OT

2015 Jun 16 – all pods burried in sediments except 15SED11, in which some pods are floating/swimming around in overlying water OT

2015 Jun 17 – all pods burried in sediments except 15SED ~~0~~ 11 (C), in which some pods are swimming around in overlying water OT

2015 Jun 18 – appear only 1 pod in rep E still swimming DML

2015 Jun 18 – ~~Aeration~~ Aeration (A) stopped in 15 SED02 A, ~~[illegible]~~ (B) DO = 8.1 mg/L (95.1% sat). Restarted aeration @ ~~16~~ 18 (B):09. ~~mo~~ One amphipod was swimming. mo

(A) WE DML 2015 Jun 12

2015 Jun 18 – Aeration stopped in 15SED03C, DO = 8.4 mg/L (98.6% sat). Restarted aeration @ 18:13. mo

(B) WE mo 2015 Jun 18

(C) WE OT 2015 JUL 09

ECOTOXICOLOGY
TEST OBSERVATIONS

Page 1 of 1

Test Initiation Date:	2015Jun12	Test Item:	n/a
Sponsor:	Tetra Tech	Study Number:	n/a
Test Method:	Amphipod	Project Number:	2-1145007

2015 Jun 19 – All test vessels were aerating normally at AM aeration check: ug

2015 Jun21 - Aeration stopped in 15 SED07 C when checked in early AM. DO = 8.2 (96.4 % sat). Restarted aeration @ 09:01. mo

2015Jun22 - Control Rep B - 1 dead amphipod found kt.

2015 Jun 22 - all pods buried in 15sell during take down DML

DML
2015
Jun23

Form approved by: J. Pickard   Date: June 30, 2011

Randomization Chart for Amphipod Test
Use the coloured dots to find appropriate concentrations
Position Map

	Back Wall	
6	12	
5	11	
4	10	
3	9	
2	8	
1	7	etc...
	Front of Counter	

Client # 11478 Date: 2015 Jun 12

Position #	Treatment	Replicate	Colour
11	Control	A	Red
24		B	Red
9		C	Red
18		D	Red
33		E	Red
3		Measure	Red
23	15 sed 11	A	Green
13		B	Green
43		C	Green
46		D	Green
16		E	Green
4		Measure	Green
19	15 sed 02	A	Yellow
29		B	Yellow
34		C	Yellow
36		D	Yellow
39		E	Yellow
17		Measure	Yellow
22	15 sed 03	A	White
37		B	White
38		C	White
40		D	White
2		E	White
45		Measure	White
20	15 sed 05	A	Lt blue
30		B	Lt blue
26		C	Lt blue
10		D	Lt blue
48		E	Lt blue
27		Measure	Lt blue
32	15 sed 06	A	Pink
31		B	Pink
15		C	Pink
5		D	Pink
47		E	Pink
1		Measure	Pink

Position #	Treatment	Replicate	Colour
21	15 sed 07	A	Orange
44		B	Orange
25		C	Orange
41		D	Orange
8		E	Orange
42		Measure	Orange
12	15 sed 08	A	Lt green
7		B	Lt green
6		C	Lt green
28		D	Lt green
14		E	Lt green
35		Measure	Lt green

ECOTOXICOLOGY

MARINE AMPHIPOD 10 DAY SEDIMENT TEST - SEAWATER

Instructions:

Add 175 mL sediment to each test vessel.
Add 900 mL control seawater to each test vessel by pouring the seawater over a diffuser held just above the water level. Use a separate diffuser for each sediment.

Randomize the test vessels, add a lid, insert airline

Client # & Name: 11478 Tetra Tech

Source of Seawater: Van Aqua

Seawater Batch: 2015 Jun01

Date Used: 2015 Jun11

Sample IDs: Various

Water Quality Before Use:

D.O. (mg/L): 9.3 pH: 8.0

Temperature (°C): 14.5 Salinity (‰) : 28

Analyst: M. O'Toole

ECOTOXICOLOGY

ORGANISMS - ACCLIMATION AND HOLDING CONDITIONS

Maxxam

BBY2FCD-00070/2

Client #'s : 11458

Date & Time of Arrival: 2015 Jun 09 @ 14:30

Organism Lot #: NA150609

~~Age~~ Size upon Arrival: 3-5 mm Ⓐ

Water (L) per Shipping Bag: n/a

Organism: Eohaustorius estuarius

Number of Shipping Bags: 15

#of Organisms Ordered: 1440 ± 10%

Arrival Conditions

Bag ID	# Dead	% Dead	Cond (µS/cm)/ Salinity (ppt)	Temp (°C)	DO (mg/L)	pH	Feeding	Analyst

mt 2015 Jun 09

Ⓐ Not enough overlying H2O to do arrival WQ - mt 2015 Jun 09.

Daily Conditions During Holding/Acclimation

	Mortalities		Water Quality					
Date	# Dead	% Dead	Cond (µS/cm)/ Salinity (ppt)	Temp (°C)	DO (mg/L)	pH	Feeding	Analyst
2015 Jun 10	1	n/a	28	15.3	8.1	7.6	n/a	mt
2015 Jun 11	3	n/a	28	16.8	8.0	7.8	n/a	mt
2015 Jun 12	0	n/a	28	13.8	8.7	8.0	n/a	Dmc
Total Mortalities	4	0.3						

Dmc 2015 Jun 23

Comments (e.g. feeding times and quantities; fish behaviour, acclimation conditions): Analyst

2015 Jun 09 - one dead amphipod upon arrival mt
- Placed shipping containers into a large aquarium with mt
Van. Aqua. seawater (batch 2015 May 07, re-filtered 2015 Jun 08) mt
and air line. ~~Van~~ Ⓐ WQ of seawater ⇒ Temp (°C) = 16.2 pH = 7.9 mt
DO (mg/L) = 8.4 salinity (ppt) = 28 mt

M.G 2015 July 06

Ⓐ WE mt 2015 Jun 09

Rec'd 2015 Jun09
@ 14:30
MT

Northwestern Aquatic Sciences
3814 Yaquina Bay Rd., P.O. Box 1437, Newport, OR 97365
Tel: 541-265-7225, Fax: 541-265-2799, www.nwaquatic.com

SUBJECT: Animal Collection Data Sheet (shipping)

SOLD TO: Maxxam Analytics
4606 Canada Way
Burnaby, BC Canada V5G 1K5

Attn: Marriah Grey/Janet Pickard
604-726-7276 ex. 2302/ 800-665-8566
FAX: 604-731-2386

FedEx account number: 353748343

DATE OF SHIPMENT: 6-8-15

ANIMAL HISTORY

Species	**Age/Size**	**Number Shipped**
Eohaustorius estuarius	3-5 mm	1440 + 10%

WATER QUALITY AT TIME OF SHIPMENT

Temperature (° C): 15.2	PH: 8.2	Salinity (ppt): 28.0	DO (mg/L): 7.9
Other:			

PACKAGED BY: Yves Nakahara **DATE:** 6-8-15

FIELD COLLECTION/CULTURE NOTES:

Collected on 6-5-15 at Lower Yaquina Bay, OR.
Collection site data: Temp: 8.0°C, Salinity 33.0 ppt; salinity adjusted down ~5 ppt.
Held at 15°C in aerated water.

ADDITIONAL COMMENTS:

20 L 0.5 mm sieved home sediment included.

PLEASE RETURN ALL SHIPPING MATERIALS thank you!
If you have any questions, please call Gary Buhler or Gerald Irissarri at (541) 265-7225.
Thank You.

Marine Amphipod 10 Day Acute Survival Sediment Test
Length Measurements

Client # & Name: 11478 Tetra Tech

Species: *Eohaustorius estuarius*

Start Date: 2015 Jun 12

Organism Lot #: NA150609

Sample IDs: Various

Job #: B542517, B542802

Lengths at Beginning of Test

Marine Amphipod #	Length (mm)
1	3.0
2	3.0
3	3.0
4	4.0
5	4.0
6	4.0
7	3.0
8	3.0
9	4.0
10	4.0
11	3.0
12	3.0
13	4.0
14	3.0
15	3.0
16	3.0
17	4.0
18	3.0
19	4.0
20	4.0
Average	3.5
SD	0.5
Analyst	DML

Average must be 3-5 mm (Environment Canada 1992, ASTM 2003, PSEP 1995)

MARINE AMPHIPOD 10 DAY ACUTE SURVIVAL SEDIMENT TEST - LENGTH MEASUREMENTS

Client # & Name: 11478 Tetra Tech

Species: *Eohaustorius estuarius*

Start Date: ~~2015 Jun 09~~ 12 WEDM 2015 Jun 12

Organism Lot #: NA150609

Sample IDs: Various

Job #: B542517, B542802

Lengths at Beginning of Test

Marine Amphipod #	Length (mm)
1	3
2	3
3	3
4	4
5	4
6	4
7	3
8	3
9	4
10	4
11	3
12	3
13	4
14	3
15	3
16	3
17	4
18	3
19	4
20	4
Average	#DIV/0!
SD	#DIV/0!
Analyst	DMC

Average must be 3-5 mm (Environment Canada 1992, ASTM 2003, PSEP 1995)

Maxxam
A Bureau Veritas Group Company

Maxxam Job #: B549792
Report Date: 2015/06/19

Maxxam Analytics (TOX Internal)
Client Project #: 2-11-15007
Site Location: AMPHIPOD IVERLAY DAY 0 - POD
Sampler Initials: MA

RESULTS OF CHEMICAL ANALYSES OF SEA WATER

Maxxam ID		ML2374	ML2375	ML2376	ML2377	ML2378	
Sampling Date		2015/06/12	2015/06/12	2015/06/12	2015/06/12	2015/06/12	
COC Number		G094767	g094767	g094767	g094767	g094767	
	Units	CTRL0 DO POD	ISSED02 DO POD	ISSED03 DO POD	ISSED05 DO POD	ISSED06 DO POD	RDL
Nutrients							
Total Ammonia (N)	mg/L	0.016	1.2	1.7	0.92	0.86	0.0050
RDL = Reportable Detection Limit							

Maxxam ID		ML2379	ML2380	ML2381	
Sampling Date		2015/06/12	2015/06/12	2015/06/12	
COC Number		g094767	g094767	g094767	
	Units	ISSED07 DO POD	ISSED08 DO POD	ISSED11 DO POD	RDL
Nutrients					
Total Ammonia (N)	mg/L	0.88	1.1	2.9	0.0050
RDL = Reportable Detection Limit					

Maxxam Analytics International Corporation o/a Maxxam Analytics Burnaby: 4606 Canada Way V5G 1K5 Telephone(604) 734-7276 Fax(604) 731-2386

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Success Through Science®

Maxxam Job #: B552697
Report Date: 2015/06/24

Maxxam Analytics (TOX Internal)
Client Project #: 2-11-15007 DAY 10 OVERLY
Site Location: TOX
Sampler Initials: DML

RESULTS OF CHEMICAL ANALYSES OF SEA WATER

Maxxam ID		MM8151	MM8152	MM8153	MM8154	
Sampling Date		2015/06/22	2015/06/22	2015/06/22	2015/06/22	
COC Number		G094777	G094777	G094777	G094777	
	Units	**CTRL OVERLY DAY 10 POD**	**15SED02 DAY 10 POD**	**15SED03 DAY 10 POD**	**15SED05 DAY 10 POD**	**RDL**
Nutrients						
Total Ammonia (N)	mg/L	<0.0050	0.91	0.42	2.2	0.0050
RDL = Reportable Detection Limit						

Maxxam ID		MM8155	MM8156	MM8157		MM8158	
Sampling Date		2015/06/22	2015/06/22	2015/06/22		2015/06/22	
COC Number		G094777	G094777	G094777		G094777	
	Units	**15SED06 DAY 10 POD**	**15SED07 DAY 10 POD**	**15SED08 DAY 10 POD**	**RDL**	**15SED11 DAY 10 POD**	**RDL**
Nutrients							
Total Ammonia (N)	mg/L	0.34	1.0	4.1	0.0050	12	0.10
RDL = Reportable Detection Limit							

Maxxam Analytics International Corporation o/a Maxxam Analytics Burnaby: 4606 Canada Way V5G 1K5 Telephone(604) 734-7276 Fax(604) 731-2386

APPENDIX

C 20-DAY MARINE POLYCHAETE GROWTH AND SURVIVAL TEST

Neanthes 20-d Survival and Growth Sediment Test — **Maxxam Analytics**

Analysis ID:	06-2486-3002	**Endpoint:**	Growth Rate-mg/day	**CETIS Version:**	CETISv1.8.7
Analyzed:	06 Jul-15 11:55	**Analysis:**	Parametric-Control vs Treatments	**Official Results:**	Yes

Batch ID:	04-3672-6765	**Test Type:**	Survival-Growth	**Analyst:**	
Start Date:	10 Jun-15 11:58	**Protocol:**	PSEP (1995)	**Diluent:**	Natural Seawater (Van. Aquarium)
Ending Date:	30 Jun-15 12:00	**Species:**	Neanthes arenaceodentata	**Brine:**	Not Applicable
Duration:	20d 0h	**Source:**	Aquatic Toxicology Support	**Age:**	

Sample Code	Sample ID	Sample Date	Receive Date	Sample Age	Client Name	Project
Control	07-3743-5224	10 Jun-15	10 Jun-15	12h	Tetra Tech	2-11-15007
15SED11	15-6240-9376	22 May-15	23 May-15	19d 12h		
15SED02	12-8649-8243	21 May-15	22 May-15	20d 12h		
15SED03	18-5588-3709	21 May-15	22 May-15	20d 12h		
15SED05	10-5366-6000	21 May-15	22 May-15	20d 12h		
16SED06	19-5992-9006	21 May-15	22 May-15	20d 12h		
15SED07	09-4217-4404	21 May-15	22 May-15	20d 12h		
15SED08	21-3716-2985	21 May-15	22 May-15	20d 12h		

Sample Code	Material Type	Sample Source	Station Location	Latitude	Longitude
Control	Marine/Estuarine Se	Tetra Tech	Control		
15SED11	Marine/Estuarine Se	Tetra Tech	15SED11		
15SED02	Marine/Estuarine Se	Tetra Tech	15SED02		
15SED03	Marine/Estuarine Se	Tetra Tech	15SED03		
15SED05	Marine/Estuarine Se	Tetra Tech	15SED05		
16SED06	Marine/Estuarine Se	Tetra Tech	16SED06		
15SED07	Marine/Estuarine Se	Tetra Tech	15SED07		
15SED08	Marine/Estuarine Se	Tetra Tech	15SED08		

Data Transform	Zeta	Alt Hyp	Trials	Seed	PMSD	Test Result
Untransformed	NA	C > T	NA	NA	26.5%	

Dunnett Multiple Comparison Test

Sample Code	vs	Sample Code	Test Stat	Critical	MSD	DF	P-Value	P-Type	Decision(α:5%)
Control		15SED11	1.736	2.445	0.212	8	0.1861	CDF	Non-Significant Effect
		15SED02	1.283	2.445	0.212	8	0.3517	CDF	Non-Significant Effect
		15SED03	0.848	2.445	0.212	8	0.5510	CDF	Non-Significant Effect
		15SED05	1.301	2.445	0.212	8	0.3439	CDF	Non-Significant Effect
		16SED06	2.245	2.445	0.212	8	0.0751	CDF	Non-Significant Effect
		15SED07	0.8916	2.445	0.212	8	0.5305	CDF	Non-Significant Effect
		15SED08	1.575	2.445	0.212	8	0.2378	CDF	Non-Significant Effect

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Between	0.119948	0.01713542	7	0.9107	0.5108	Non-Significant Effect
Error	0.6020939	0.01881543	32			
Total	0.7220418		39			

Distributional Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:1%)
Variances	Bartlett Equality of Variance	5.145	18.48	0.6422	Equal Variances
Distribution	Shapiro-Wilk W Normality	0.9739	0.9236	0.4728	Normal Distribution

2015 July 06 2015 Jul 10

Analyst: M.G. QA: JP

Neanthes 20-d Survival and Growth Sediment Test — **Maxxam Analytics**

Analysis ID:	06-2486-3002	**Endpoint:**	Growth Rate-mg/day	**CETIS Version:**	CETISv1.8.7
Analyzed:	06 Jul-15 11:55	**Analysis:**	Parametric-Control vs Treatments	**Official Results:**	Yes

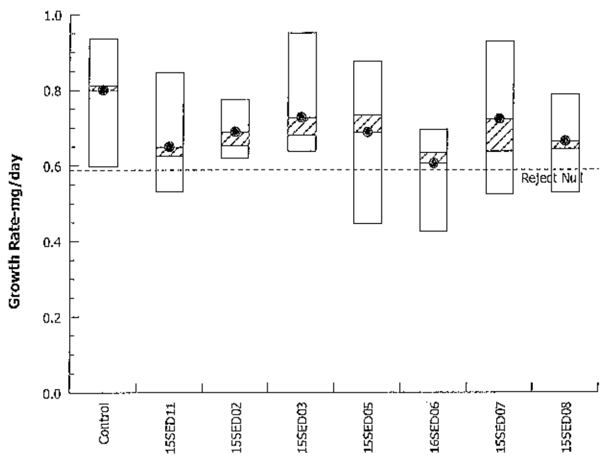
Growth Rate-mg/day Summary

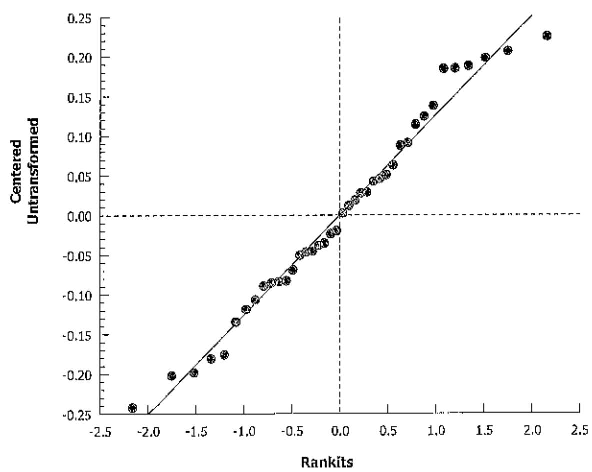
Sample Code	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
Control	5	0.8001	0.6448	0.9553	0.812	0.5978	0.9375	0.05592	15.63%	0.0%
15SED11	5	0.6495	0.4956	0.8033	0.6257	0.5307	0.8472	0.05542	19.08%	18.82%
15SED02	5	0.6888	0.6016	0.776	0.6532	0.6196	0.7764	0.03142	10.2%	13.91%
15SED03	5	0.7265	0.5684	0.8846	0.6801	0.6372	0.9515	0.05693	17.52%	9.2%
15SED05	5	0.6872	0.438	0.9363	0.7329	0.4447	0.8751	0.08973	29.2%	14.11%
16SED06	5	0.6053	0.4753	0.7352	0.634	0.4248	0.6962	0.04681	17.29%	24.35%
15SED07	5	0.7227	0.4948	0.9507	0.6371	0.5243	0.9291	0.0821	25.4%	9.67%
15SED08	5	0.6634	0.5192	0.8076	0.6437	0.5289	0.7876	0.05192	17.5%	17.08%

Growth Rate-mg/day Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
Control	0.812	0.9375	0.5978	0.8023	0.8508
15SED11	0.6772	0.8472	0.6257	0.5307	0.5665
15SED02	0.6532	0.7764	0.6432	0.7515	0.6196
15SED03	0.9515	0.6758	0.6879	0.6801	0.6372
15SED05	0.4447	0.5116	0.8751	0.7329	0.8716
16SED06	0.6962	0.634	0.6478	0.4248	0.6236
15SED07	0.9291	0.5243	0.6371	0.9073	0.6158
15SED08	0.5795	0.5289	0.6437	0.7773	0.7876

Graphics





2015 Jul 06 Analyst: M.G. 2015 Jul 10 QA: JP

Neanthes 20-d Survival and Growth Sediment Test — **Maxxam Analytics**

Analysis ID:	15-2362-4004	**Endpoint:**	Growth Rate-mg/day	**CETIS Version:**	CETISv1.8.7
Analyzed:	06 Jul-15 11:55	**Analysis:**	Parametric-Control vs Treatments	**Official Results:**	Yes

Batch ID:	04-3672-6765	**Test Type:**	Survival-Growth	**Analyst:**	
Start Date:	10 Jun-15 11:58	**Protocol:**	PSEP (1995)	**Diluent:**	Natural Seawater (Van. Aquarium)
Ending Date:	30 Jun-15 12:00	**Species:**	Neanthes arenaceodentata	**Brine:**	Not Applicable
Duration:	20d 0h	**Source:**	Aquatic Toxicology Support	**Age:**	

Sample Code	Sample ID	Sample Date	Receive Date	Sample Age	Client Name	Project
15SED11	15-6240-9376	22 May-15	23 May-15	19d 12h	Tetra Tech	2-11-15007
15SED02	12-8649-8243	21 May-15	22 May-15	20d 12h		
15SED03	18-5588-3709	21 May-15	22 May-15	20d 12h		
15SED05	10-5366-6000	21 May-15	22 May-15	20d 12h		
16SED06	19-5992-9006	21 May-15	22 May-15	20d 12h		
15SED07	09-4217-4404	21 May-15	22 May-15	20d 12h		
15SED08	21-3716-2985	21 May-15	22 May-15	20d 12h		

Sample Code	Material Type	Sample Source	Station Location	Latitude	Longitude
15SED11	Marine/Estuarine Se	Tetra Tech	15SED11		
15SED02	Marine/Estuarine Se	Tetra Tech	15SED02		
15SED03	Marine/Estuarine Se	Tetra Tech	15SED03		
15SED05	Marine/Estuarine Se	Tetra Tech	15SED05		
16SED06	Marine/Estuarine Se	Tetra Tech	16SED06		
15SED07	Marine/Estuarine Se	Tetra Tech	15SED07		
15SED08	Marine/Estuarine Se	Tetra Tech	15SED08		

Data Transform	Zeta	Alt Hyp	Trials	Seed	PMSD	Test Result
Untransformed	NA	C > T	NA	NA	32.5%	

Dunnett Multiple Comparison Test

Sample Code	vs	Sample Code	Test Stat	Critical	MSD	DF	P-Value	P-Type	Decision(α:5%)
15SED11		15SED02	-0.4479	2.407	0.211	8	0.9455	CDF	Non-Significant Effect
		15SED03	-0.8775	2.407	0.211	8	0.9824	CDF	Non-Significant Effect
		15SED05	-0.4296	2.407	0.211	8	0.9431	CDF	Non-Significant Effect
		16SED06	0.5033	2.407	0.211	8	0.6789	CDF	Non-Significant Effect
		15SED07	-0.8344	2.407	0.211	8	0.9801	CDF	Non-Significant Effect
		15SED08	-0.1588	2.407	0.211	8	0.8958	CDF	Non-Significant Effect

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Between	0.05434461	0.009057435	6	0.47	0.8246	Non-Significant Effect
Error	0.5395527	0.01926974	28			
Total	0.5938973		34			

Distributional Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:1%)
Variances	Bartlett Equality of Variance	5.072	16.81	0.5346	Equal Variances
Distribution	Shapiro-Wilk W Normality	0.966	0.9146	0.3431	Normal Distribution

Growth Rate-mg/day Summary

Sample Code	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
15SED11	5	0.6495	0.4956	0.8033	0.6257	0.5307	0.8472	0.05542	19.08%	0.0%
15SED02	5	0.6888	0.6016	0.776	0.6532	0.6196	0.7764	0.03142	10.2%	-6.05%
15SED03	5	0.7265	0.5684	0.8846	0.6801	0.6372	0.9515	0.05693	17.52%	-11.86%
15SED05	5	0.6872	0.438	0.9363	0.7329	0.4447	0.8751	0.08973	29.2%	-5.81%
16SED06	5	0.6053	0.4753	0.7352	0.634	0.4248	0.6962	0.04681	17.29%	6.8%
15SED07	5	0.7227	0.4948	0.9507	0.6371	0.5243	0.9291	0.0821	25.4%	-11.28%
15SED08	5	0.6634	0.5192	0.8076	0.6437	0.5289	0.7876	0.05192	17.5%	-2.15%

2015Jul06 2015Jul10

Analyst: M.G. QA: JP

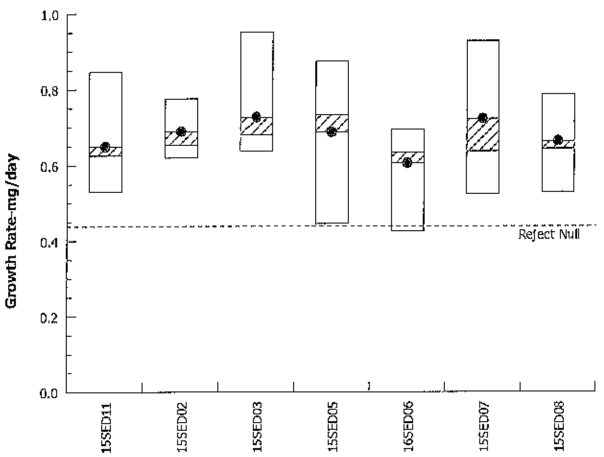
Neanthes 20-d Survival and Growth Sediment Test — Maxxam Analytics

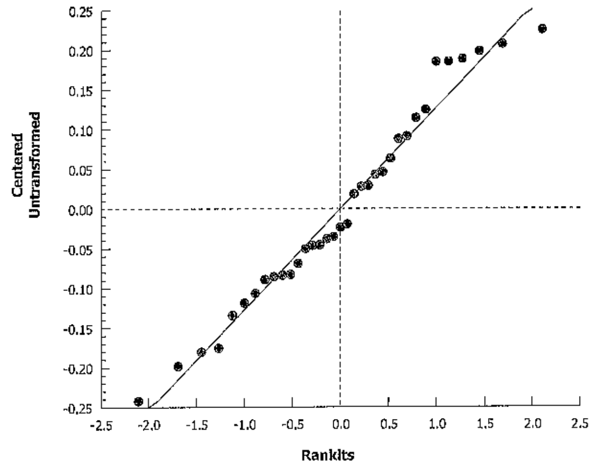
Analysis ID:	15-2362-4004	**Endpoint:**	Growth Rate-mg/day	**CETIS Version:**	CETISv1.8.7
Analyzed:	06 Jul-15 11:55	**Analysis:**	Parametric-Control vs Treatments	**Official Results:**	Yes

Growth Rate-mg/day Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
15SED11	0.6772	0.8472	0.6257	0.5307	0.5665
15SED02	0.6532	0.7764	0.6432	0.7515	0.6196
15SED03	0.9515	0.6758	0.6879	0.6801	0.6372
15SED05	0.4447	0.5116	0.8751	0.7329	0.8716
16SED06	0.6962	0.634	0.6478	0.4248	0.6236
15SED07	0.9291	0.5243	0.6371	0.9073	0.6158
15SED08	0.5795	0.5289	0.6437	0.7773	0.7876

Graphics





2015Jul06 Analyst: M.G 2015Jul10 QA: JP

Neanthes 20-d Survival and Growth Sediment Test — **Maxxam Analytics**

Analysis ID:	11-4025-3075	**Endpoint:**	Mean Dry Weight-mg	**CETIS Version:**	CETISv1.8.7
Analyzed:	06 Jul-15 11:57	**Analysis:**	Parametric-Control vs Treatments	**Official Results:**	Yes

Batch ID:	04-3672-6765	**Test Type:**	Survival-Growth	**Analyst:**	
Start Date:	10 Jun-15 11:58	**Protocol:**	PSEP (1995)	**Diluent:**	Natural Seawater (Van. Aquarium)
Ending Date:	30 Jun-15 12:00	**Species:**	Neanthes arenaceodentata	**Brine:**	Not Applicable
Duration:	20d 0h	**Source:**	Aquatic Toxicology Support	**Age:**	

Sample Code	Sample ID	Sample Date	Receive Date	Sample Age	Client Name	Project
Control	07-3743-5224	10 Jun-15	10 Jun-15	12h	Tetra Tech	2-11-15007
15SED11	15-6240-9376	22 May-15	23 May-15	19d 12h		
15SED02	12-8649-8243	21 May-15	22 May-15	20d 12h		
15SED03	18-5588-3709	21 May-15	22 May-15	20d 12h		
15SED05	10-5366-6000	21 May-15	22 May-15	20d 12h		
16SED06	19-5992-9006	21 May-15	22 May-15	20d 12h		
15SED07	09-4217-4404	21 May-15	22 May-15	20d 12h		
15SED08	21-3716-2985	21 May-15	22 May-15	20d 12h		

Sample Code	Material Type	Sample Source	Station Location	Latitude	Longitude
Control	Marine/Estuarine Se	Tetra Tech	Control		
15SED11	Marine/Estuarine Se	Tetra Tech	15SED11		
15SED02	Marine/Estuarine Se	Tetra Tech	15SED02		
15SED03	Marine/Estuarine Se	Tetra Tech	15SED03		
15SED05	Marine/Estuarine Se	Tetra Tech	15SED05		
16SED06	Marine/Estuarine Se	Tetra Tech	16SED06		
15SED07	Marine/Estuarine Se	Tetra Tech	15SED07		
15SED08	Marine/Estuarine Se	Tetra Tech	15SED08		

Data Transform	Zeta	Alt Hyp	Trials	Seed	PMSD	Test Result
Untransformed	NA	C > T	NA	NA	25.9%	

Dunnett Multiple Comparison Test

Sample Code	vs	Sample Code	Test Stat	Critical	MSD	DF	P-Value	P-Type	Decision(α:5%)
Control		15SED11	1.736	2.445	4.243	8	0.1861	CDF	Non-Significant Effect
		15SED02	1.283	2.445	4.243	8	0.3517	CDF	Non-Significant Effect
		15SED03	0.848	2.445	4.243	8	0.5510	CDF	Non-Significant Effect
		15SED05	1.301	2.445	4.243	8	0.3439	CDF	Non-Significant Effect
		16SED06	2.245	2.445	4.243	8	0.0751	CDF	Non-Significant Effect
		15SED07	0.8916	2.445	4.243	8	0.5305	CDF	Non-Significant Effect
		15SED08	1.575	2.445	4.243	8	0.2378	CDF	Non-Significant Effect

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Between	47.97918	6.854169	7	0.9107	0.5108	Non-Significant Effect
Error	240.8376	7.526174	32			
Total	288.8167		39			

Distributional Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:1%)
Variances	Bartlett Equality of Variance	5.145	18.48	0.6422	Equal Variances
Distribution	Shapiro-Wilk W Normality	0.9739	0.9236	0.4728	Normal Distribution

2015 July 06 2015 Jul 10

Neanthes 20-d Survival and Growth Sediment Test — **Maxxam Analytics**

Analysis ID:	11-4025-3075	**Endpoint:**	Mean Dry Weight-mg	**CETIS Version:**	CETISv1.8.7
Analyzed:	06 Jul-15 11:57	**Analysis:**	Parametric-Control vs Treatments	**Official Results:**	Yes

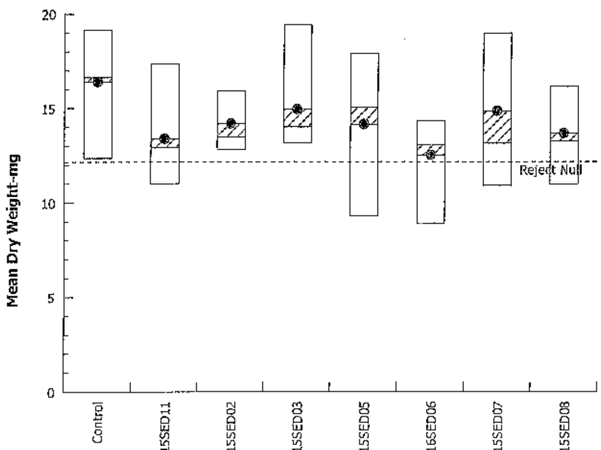
Mean Dry Weight-mg Summary

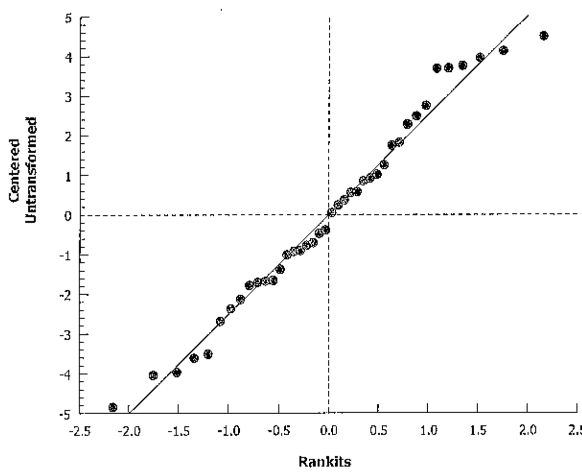
Sample Code	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
Control	5	16.4	13.3	19.51	16.64	12.35	19.15	1.118	15.25%	0.0%
15SED11	5	13.39	10.31	16.47	12.91	11.01	17.34	1.108	18.51%	18.37%
15SED02	5	14.18	12.43	15.92	13.46	12.79	15.93	0.6283	9.91%	13.57%
15SED03	5	14.93	11.77	18.09	14	13.14	19.43	1.139	17.05%	8.97%
15SED05	5	14.14	9.161	19.13	15.06	9.294	17.9	1.795	28.37%	13.77%
16SED06	5	12.51	9.906	15.1	13.08	8.895	14.32	0.9362	16.74%	23.75%
15SED07	5	14.85	10.3	19.41	13.14	10.89	18.98	1.642	24.72%	9.43%
15SED08	5	13.67	10.78	16.55	13.27	10.98	16.15	1.038	16.99%	16.67%

Mean Dry Weight-mg Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
Control	16.64	19.15	12.35	16.45	17.42
15SED11	13.94	17.34	12.91	11.01	11.73
15SED02	13.46	15.93	13.26	15.43	12.79
15SED03	19.43	13.92	14.16	14	13.14
15SED05	9.294	10.63	17.9	15.06	17.83
16SED06	14.32	13.08	13.36	8.895	12.87
15SED07	18.98	10.89	13.14	18.55	12.72
15SED08	11.99	10.98	13.27	15.95	16.15

Graphics





Neanthes 20-d Survival and Growth Sediment Test — **Maxxam Analytics**

Analysis ID:	15-4171-6572	**Endpoint:**	Mean Dry Weight-mg	**CETIS Version:**	CETISv1.8.7
Analyzed:	06 Jul-15 11:57	**Analysis:**	Parametric-Control vs Treatments	**Official Results:**	Yes

Batch ID:	04-3672-6765	**Test Type:**	Survival-Growth	**Analyst:**	
Start Date:	10 Jun-15 11:58	**Protocol:**	PSEP (1995)	**Diluent:**	Natural Seawater (Van. Aquarium)
Ending Date:	30 Jun-15 12:00	**Species:**	Neanthes arenaceodentata	**Brine:**	Not Applicable
Duration:	20d 0h	**Source:**	Aquatic Toxicology Support	**Age:**	

Sample Code	Sample ID	Sample Date	Receive Date	Sample Age	Client Name	Project
15SED11	15-6240-9376	22 May-15	23 May-15	19d 12h	Tetra Tech	2-11-15007
15SED02	12-8649-8243	21 May-15	22 May-15	20d 12h		
15SED03	18-5588-3709	21 May-15	22 May-15	20d 12h		
15SED05	10-5366-6000	21 May-15	22 May-15	20d 12h		
16SED06	19-5992-9006	21 May-15	22 May-15	20d 12h		
15SED07	09-4217-4404	21 May-15	22 May-15	20d 12h		
15SED08	21-3716-2985	21 May-15	22 May-15	20d 12h		

Sample Code	Material Type	Sample Source	Station Location	Latitude	Longitude
15SED11	Marine/Estuarine Se	Tetra Tech	15SED11		
15SED02	Marine/Estuarine Se	Tetra Tech	15SED02		
15SED03	Marine/Estuarine Se	Tetra Tech	15SED03		
15SED05	Marine/Estuarine Se	Tetra Tech	15SED05		
16SED06	Marine/Estuarine Se	Tetra Tech	16SED06		
15SED07	Marine/Estuarine Se	Tetra Tech	15SED07		
15SED08	Marine/Estuarine Se	Tetra Tech	15SED08		

Data Transform	Zeta	Alt Hyp	Trials	Seed	PMSD	Test Result
Untransformed	NA	C > T	NA	NA	31.6%	

Dunnett Multiple Comparison Test

Sample Code	vs	Sample Code	Test Stat	Critical	MSD	DF	P-Value	P-Type	Decision(α:5%)
15SED11		15SED02	-0.4479	2.407	4.227	8	0.9455	CDF	Non-Significant Effect
		15SED03	-0.8775	2.407	4.227	8	0.9824	CDF	Non-Significant Effect
		15SED05	-0.4296	2.407	4.227	8	0.9431	CDF	Non-Significant Effect
		16SED06	0.5033	2.407	4.227	8	0.6789	CDF	Non-Significant Effect
		15SED07	-0.8344	2.407	4.227	8	0.9801	CDF	Non-Significant Effect
		15SED08	-0.1588	2.407	4.227	8	0.8958	CDF	Non-Significant Effect

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Between	21.73785	3.622974	6	0.47	0.8246	Non-Significant Effect
Error	215.8211	7.707895	28			
Total	237.5589		34			

Distributional Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:1%)
Variances	Bartlett Equality of Variance	5.072	16.81	0.5346	Equal Variances
Distribution	Shapiro-Wilk W Normality	0.966	0.9146	0.3431	Normal Distribution

Mean Dry Weight-mg Summary

Sample Code	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
15SED11	5	13.39	10.31	16.47	12.91	11.01	17.34	1.108	18.51%	0.0%
15SED02	5	14.18	12.43	15.92	13.46	12.79	15.93	0.6283	9.91%	-5.87%
15SED03	5	14.93	11.77	18.09	14	13.14	19.43	1.139	17.05%	-11.51%
15SED05	5	14.14	9.161	19.13	15.06	9.294	17.9	1.795	28.37%	-5.63%
16SED06	5	12.51	9.906	15.1	13.08	8.895	14.32	0.9362	16.74%	6.6%
15SED07	5	14.85	10.3	19.41	13.14	10.89	18.98	1.642	24.72%	-10.94%
15SED08	5	13.67	10.78	16.55	13.27	10.98	16.15	1.038	16.99%	-2.08%

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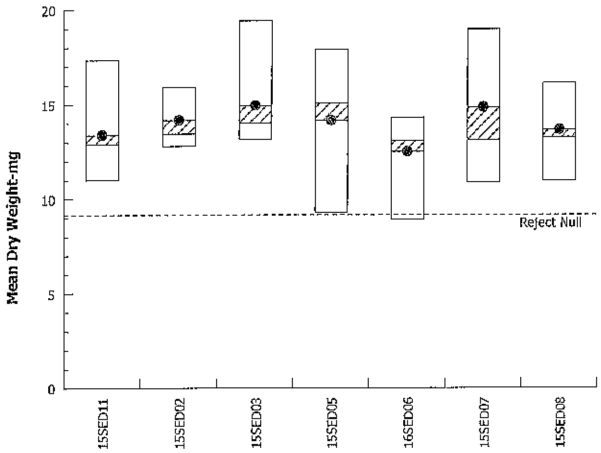
Neanthes 20-d Survival and Growth Sediment Test — Maxxam Analytics

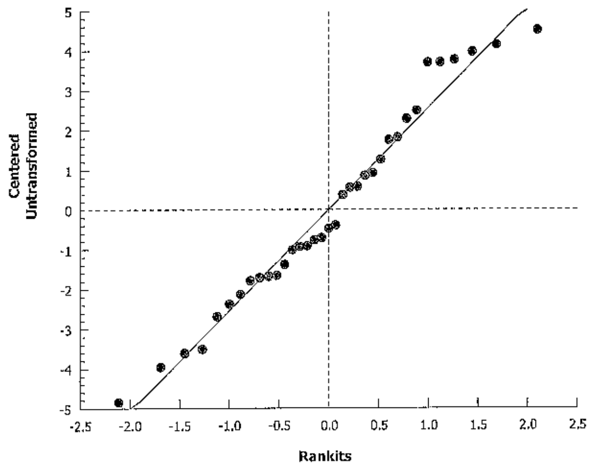
Analysis ID:	15-4171-6572	**Endpoint:**	Mean Dry Weight-mg	**CETIS Version:**	CETISv1.8.7
Analyzed:	06 Jul-15 11:57	**Analysis:**	Parametric-Control vs Treatments	**Official Results:**	Yes

Mean Dry Weight-mg Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
15SED11	13.94	17.34	12.91	11.01	11.73
15SED02	13.46	15.93	13.26	15.43	12.79
15SED03	19.43	13.92	14.16	14	13.14
15SED05	9.294	10.63	17.9	15.06	17.83
16SED06	14.32	13.08	13.36	8.895	12.87
15SED07	18.98	10.89	13.14	18.55	12.72
15SED08	11.99	10.98	13.27	15.95	16.15

Graphics





Analyst: M. G 2015 Jul 06 QA: 2015 Jul 10

Neanthes 20-d Survival and Growth Sediment Test — **Maxxam Analytics**

Analysis ID:	02-2877-5567	**Endpoint:**	Total Dry Weight (mg)	**CETIS Version:**	CETISv1.8.7
Analyzed:	06 Jul-15 11:57	**Analysis:**	Parametric-Control vs Treatments	**Official Results:**	Yes

Batch ID:	04-3672-6765	**Test Type:**	Survival-Growth	**Analyst:**	
Start Date:	10 Jun-15 11:58	**Protocol:**	PSEP (1995)	**Diluent:**	Natural Seawater (Van. Aquarium)
Ending Date:	30 Jun-15 12:00	**Species:**	Neanthes arenaceodentata	**Brine:**	Not Applicable
Duration:	20d 0h	**Source:**	Aquatic Toxicology Support	**Age:**	

Sample Code	Sample ID	Sample Date	Receive Date	Sample Age	Client Name	Project
15SED11	15-6240-9376	22 May-15	23 May-15	19d 12h	Tetra Tech	2-11-15007
15SED02	12-8649-8243	21 May-15	22 May-15	20d 12h		
15SED03	18-5588-3709	21 May-15	22 May-15	20d 12h		
15SED05	10-5366-6000	21 May-15	22 May-15	20d 12h		
16SED06	19-5992-9006	21 May-15	22 May-15	20d 12h		
15SED07	09-4217-4404	21 May-15	22 May-15	20d 12h		
15SED08	21-3716-2985	21 May-15	22 May-15	20d 12h		

Sample Code	Material Type	Sample Source	Station Location	Latitude	Longitude
15SED11	Marine/Estuarine Se	Tetra Tech	15SED11		
15SED02	Marine/Estuarine Se	Tetra Tech	15SED02		
15SED03	Marine/Estuarine Se	Tetra Tech	15SED03		
15SED05	Marine/Estuarine Se	Tetra Tech	15SED05		
16SED06	Marine/Estuarine Se	Tetra Tech	16SED06		
15SED07	Marine/Estuarine Se	Tetra Tech	15SED07		
15SED08	Marine/Estuarine Se	Tetra Tech	15SED08		

Data Transform	Zeta	Alt Hyp	Trials	Seed	PMSD	Test Result
Untransformed	NA	C > T	NA	NA	32.1%	

Dunnett Multiple Comparison Test

Sample Code	vs	Sample Code	Test Stat	Critical	MSD	DF	P-Value	P-Type	Decision(α:5%)
15SED11		15SED02	-0.4408	2.407	21.48	8	0.9446	CDF	Non-Significant Effect
		15SED03	0.007623	2.407	21.48	8	0.8551	CDF	Non-Significant Effect
		15SED05	-0.4228	2.407	21.48	8	0.9421	CDF	Non-Significant Effect
		16SED06	0.988	2.407	21.48	8	0.4577	CDF	Non-Significant Effect
		15SED07	-0.8212	2.407	21.48	8	0.9794	CDF	Non-Significant Effect
		15SED08	0.1125	2.407	21.48	8	0.8245	CDF	Non-Significant Effect

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Between	791.3901	131.8983	6	0.663	0.6799	Non-Significant Effect
Error	5570.722	198.9543	28			
Total	6362.112		34			

Distributional Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:1%)
Variances	Bartlett Equality of Variance	8.398	16.81	0.2104	Equal Variances
Distribution	Shapiro-Wilk W Normality	0.9658	0.9146	0.3396	Normal Distribution

Total Dry Weight (mg) Summary

Sample Code	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
15SED11	5	66.95	51.56	82.33	64.57	55.07	86.72	5.542	18.51%	0.0%
15SED02	5	70.88	62.16	79.6	67.32	63.96	79.64	3.142	9.91%	-5.87%
15SED03	5	66.88	60.44	73.32	69.58	58.29	70.79	2.318	7.75%	0.1%
15SED05	5	70.72	45.8	95.63	75.29	46.47	89.51	8.973	28.37%	-5.63%
16SED06	5	58.13	40.16	76.1	64.36	35.58	71.62	6.473	24.9%	13.17%
15SED07	5	74.27	51.48	97.07	65.71	54.43	94.91	8.21	24.72%	-10.94%
15SED08	5	65.94	47.78	84.1	66.37	47.96	80.76	6.54	22.18%	1.5%

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Analyst: M.G QA: JP

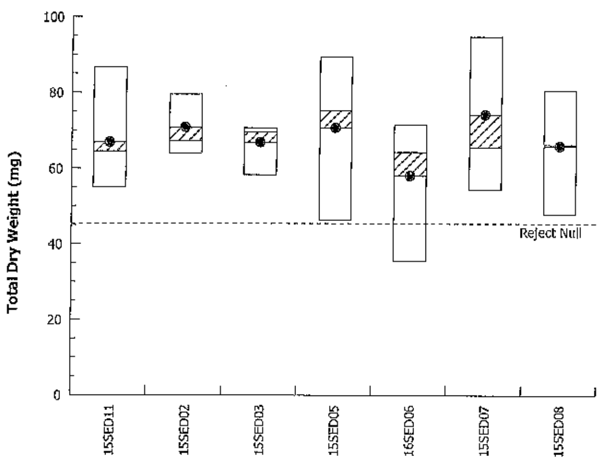
Neanthes 20-d Survival and Growth Sediment Test — Maxxam Analytics

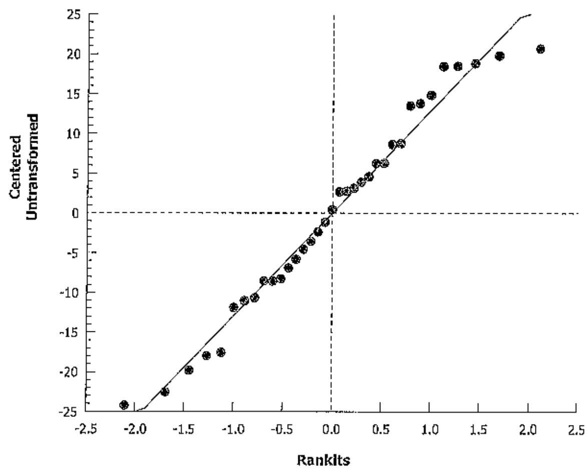
Analysis ID:	02-2877-5567	**Endpoint:**	Total Dry Weight (mg)	**CETIS Version:**	CETISv1.8.7
Analyzed:	06 Jul-15 11:57	**Analysis:**	Parametric-Control vs Treatments	**Official Results:**	Yes

Total Dry Weight (mg) Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
15SED11	69.72	86.72	64.57	55.07	58.65
15SED02	67.32	79.64	66.32	77.15	63.96
15SED03	58.29	69.58	70.79	70.01	65.72
15SED05	46.47	53.16	89.51	75.29	89.16
16SED06	71.62	52.32	66.78	35.58	64.36
15SED07	94.91	54.43	65.71	92.73	63.58
15SED08	47.96	54.89	66.37	79.73	80.76

Graphics





Neanthes 20-d Survival and Growth Sediment Test — **Maxxam Analytics**

Analysis ID:	05-1351-7822	**Endpoint:**	Total Dry Weight (mg)	**CETIS Version:**	CETISv1.8.7
Analyzed:	06 Jul-15 11:57	**Analysis:**	Parametric-Control vs Treatments	**Official Results:**	Yes

Batch ID:	04-3672-6765	**Test Type:**	Survival-Growth	**Analyst:**	
Start Date:	10 Jun-15 11:58	**Protocol:**	PSEP (1995)	**Diluent:**	Natural Seawater (Van. Aquarium)
Ending Date:	30 Jun-15 12:00	**Species:**	Neanthes arenaceodentata	**Brine:**	Not Applicable
Duration:	20d 0h	**Source:**	Aquatic Toxicology Support	**Age:**	

Sample Code	Sample ID	Sample Date	Receive Date	Sample Age	Client Name	Project
Control	07-3743-5224	10 Jun-15	10 Jun-15	12h	Tetra Tech	2-11-15007
15SED11	15-6240-9376	22 May-15	23 May-15	19d 12h		
15SED02	12-8649-8243	21 May-15	22 May-15	20d 12h		
15SED03	18-5588-3709	21 May-15	22 May-15	20d 12h		
15SED05	10-5366-6000	21 May-15	22 May-15	20d 12h		
16SED06	19-5992-9006	21 May-15	22 May-15	20d 12h		
15SED07	09-4217-4404	21 May-15	22 May-15	20d 12h		
15SED08	21-3716-2985	21 May-15	22 May-15	20d 12h		

Sample Code	Material Type	Sample Source	Station Location	Latitude	Longitude
Control	Marine/Estuarine Se	Tetra Tech	Control		
15SED11	Marine/Estuarine Se	Tetra Tech	15SED11		
15SED02	Marine/Estuarine Se	Tetra Tech	15SED02		
15SED03	Marine/Estuarine Se	Tetra Tech	15SED03		
15SED05	Marine/Estuarine Se	Tetra Tech	15SED05		
16SED06	Marine/Estuarine Se	Tetra Tech	16SED06		
15SED07	Marine/Estuarine Se	Tetra Tech	15SED07		
15SED08	Marine/Estuarine Se	Tetra Tech	15SED08		

Data Transform	Zeta	Alt Hyp	Trials	Seed	PMSD	Test Result
Untransformed	NA	C > T	NA	NA	29.1%	

Dunnett Multiple Comparison Test

Sample Code	vs	Sample Code	Test Stat	Critical	MSD	DF	P-Value	P-Type	Decision(α:5%)
Control		15SED11	0.9725	2.445	22.03	8	0.4924	CDF	Non-Significant Effect
		15SED02	0.536	2.445	22.03	8	0.6920	CDF	Non-Significant Effect
		15SED03	0.9801	2.445	22.03	8	0.4889	CDF	Non-Significant Effect
		15SED05	0.5538	2.445	22.03	8	0.6844	CDF	Non-Significant Effect
		16SED06	1.951	2.445	22.03	8	0.1299	CDF	Non-Significant Effect
		15SED07	0.1592	2.445	22.03	8	0.8308	CDF	Non-Significant Effect
		15SED08	1.084	2.445	22.03	8	0.4405	CDF	Non-Significant Effect

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Between	1073.153	153.3075	7	0.7558	0.6276	Non-Significant Effect
Error	6490.565	202.8302	32			
Total	7563.718		39			

Distributional Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:1%)
Variances	Bartlett Equality of Variance	8.444	18.48	0.2951	Equal Variances
Distribution	Shapiro-Wilk W Normality	0.9682	0.9236	0.3158	Normal Distribution

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Neanthes 20-d Survival and Growth Sediment Test — **Maxxam Analytics**

Analysis ID:	05-1351-7822	**Endpoint:**	Total Dry Weight (mg)	**CETIS Version:**	CETISv1.8.7
Analyzed:	06 Jul-15 11:57	**Analysis:**	Parametric-Control vs Treatments	**Official Results:**	Yes

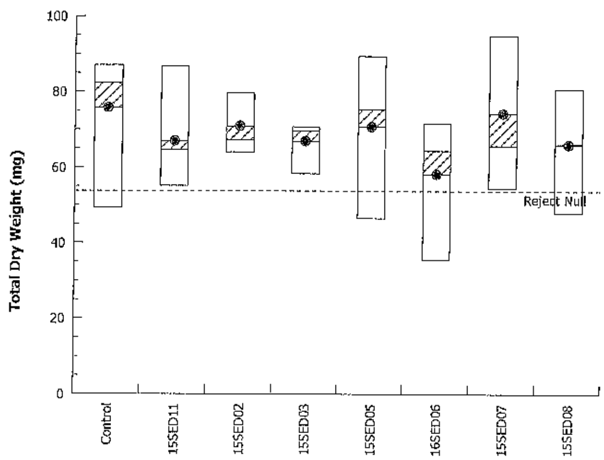
Total Dry Weight (mg) Summary

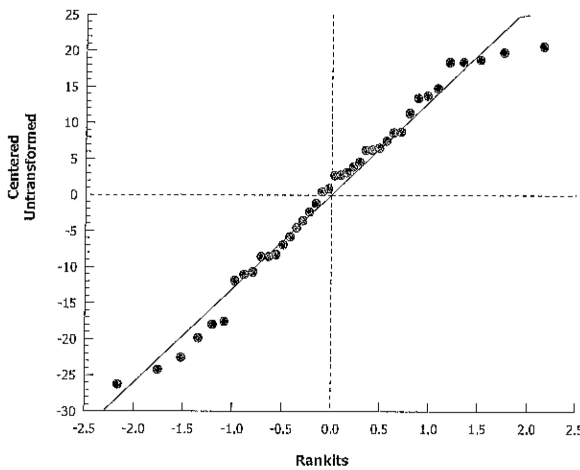
Sample Code	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
Control	5	75.71	56.88	94.54	82.23	49.42	87.08	6.782	20.03%	0.0%
15SED11	5	66.95	51.56	82.33	64.57	55.07	86.72	5.542	18.51%	11.57%
15SED02	5	70.88	62.16	79.6	67.32	63.96	79.64	3.142	9.91%	6.38%
15SED03	5	66.88	60.44	73.32	69.58	58.29	70.79	2.318	7.75%	11.66%
15SED05	5	70.72	45.8	95.63	75.29	46.47	89.51	8.973	28.37%	6.59%
16SED06	5	58.13	40.16	76.1	64.36	35.58	71.62	6.473	24.9%	23.21%
15SED07	5	74.27	51.48	97.07	65.71	54.43	94.91	8.21	24.72%	1.89%
15SED08	5	65.94	47.78	84.1	66.37	47.96	80.76	6.54	22.18%	12.9%

Total Dry Weight (mg) Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
Control	83.2	76.6	49.42	82.23	87.08
15SED11	69.72	86.72	64.57	55.07	58.65
15SED02	67.32	79.64	66.32	77.15	63.96
15SED03	58.29	69.58	70.79	70.01	65.72
15SED05	46.47	53.16	89.51	75.29	89.16
16SED06	71.62	52.32	66.78	35.58	64.36
15SED07	94.91	54.43	65.71	92.73	63.58
15SED08	47.96	54.89	66.37	79.73	80.76

Graphics





2015 July 06 2015 Jul 16

CETIS Analytical Report

Neanthes 20-d Survival and Growth Sediment Test — **Maxxam Analytics**

Analysis ID:	01-3867-3823	**Endpoint:**	Survival Rate	**CETIS Version:**	CETISv1.8.7
Analyzed:	06 Jul-15 11:53	**Analysis:**	STP 2x2 Contingency Tables	**Official Results:**	Yes

Batch ID:	04-3672-6765	**Test Type:**	Survival-Growth	**Analyst:**	
Start Date:	10 Jun-15 11:58	**Protocol:**	PSEP (1995)	**Diluent:**	Natural Seawater (Van. Aquarium)
Ending Date:	30 Jun-15 12:00	**Species:**	Neanthes arenaceodentata	**Brine:**	Not Applicable
Duration:	20d 0h	**Source:**	Aquatic Toxicology Support	**Age:**	

Sample Code	Sample ID	Sample Date	Receive Date	Sample Age	Client Name	Project
Control	07-3743-5224	10 Jun-15	10 Jun-15	12h	Tetra Tech	2-11-15007
15SED11	15-6240-9376	22 May-15	23 May-15	19d 12h		
15SED02	12-8649-8243	21 May-15	22 May-15	20d 12h		
15SED03	18-5588-3709	21 May-15	22 May-15	20d 12h		
15SED05	10-5366-6000	21 May-15	22 May-15	20d 12h		
16SED06	19-5992-9006	21 May-15	22 May-15	20d 12h		
15SED07	09-4217-4404	21 May-15	22 May-15	20d 12h		
15SED08	21-3716-2985	21 May-15	22 May-15	20d 12h		

Sample Code	Material Type	Sample Source	Station Location	Latitude	Longitude
Control	Marine/Estuarine Se	Tetra Tech	Control		
15SED11	Marine/Estuarine Se	Tetra Tech	15SED11		
15SED02	Marine/Estuarine Se	Tetra Tech	15SED02		
15SED03	Marine/Estuarine Se	Tetra Tech	15SED03		
15SED05	Marine/Estuarine Se	Tetra Tech	15SED05		
16SED06	Marine/Estuarine Se	Tetra Tech	16SED06		
15SED07	Marine/Estuarine Se	Tetra Tech	15SED07		
15SED08	Marine/Estuarine Se	Tetra Tech	15SED08		

Data Transform	Zeta	Alt Hyp	Trials	Seed	Test Result
Untransformed		C > T	NA	NA	

Fisher Exact/Bonferroni-Holm Test

Sample	vs	Sample	Test Stat	P-Value	P-Type	Decision(α:5%)
Control		15SED11	1	1.0000	Exact	Non-Significant Effect
Control		15SED02	1	1.0000	Exact	Non-Significant Effect
Control		15SED03	0.6954	1.0000	Exact	Non-Significant Effect
Control		15SED05	1	1.0000	Exact	Non-Significant Effect
Control		16SED06	0.6954	1.0000	Exact	Non-Significant Effect
Control		15SED07	1	1.0000	Exact	Non-Significant Effect
Control		15SED08	1	1.0000	Exact	Non-Significant Effect

Data Summary

Sample Code	NR	R	NR + R	Prop NR	Prop R	%Effect
Control	23	2	25	0.92	0.08	0.0%
15SED11	25	0	25	1	0	-8.7%
15SED02	25	0	25	1	0	-8.7%
15SED03	23	2	25	0.92	0.08	0.0%
15SED05	25	0	25	1	0	-8.7%
16SED06	23	2	25	0.92	0.08	0.0%
15SED07	25	0	25	1	0	-8.7%
15SED08	24	1	25	0.96	0.04	-4.35%

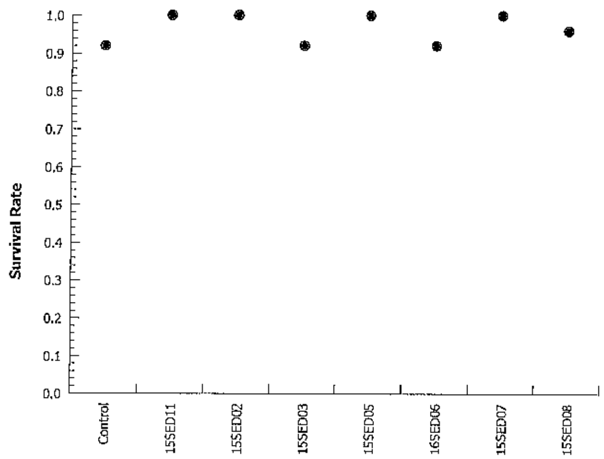
Neanthes 20-d Survival and Growth Sediment Test — Maxxam Analytics

Analysis ID:	01-3867-3823	**Endpoint:**	Survival Rate	**CETIS Version:**	CETISv1.8.7
Analyzed:	06 Jul-15 11:53	**Analysis:**	STP 2x2 Contingency Tables	**Official Results:**	Yes

Survival Rate Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
Control	1	0.8	0.8	1	1
15SED11	1	1	1	1	1
15SED02	1	1	1	1	1
15SED03	0.6	1	1	1	1
15SED05	1	1	1	1	1
16SED06	1	0.8	1	0.8	1
15SED07	1	1	1	1	1
15SED08	0.8	1	1	1	1

Graphics



2015Jul06 2015Jul10
Analyst: M.G. QA: JP

Neanthes 20-d Survival and Growth Sediment Test | **Maxxam Analytics**

Analysis ID:	16-4366-3719	**Endpoint:**	Survival Rate	**CETIS Version:**	CETISv1.8.7
Analyzed:	06 Jul-15 11:53	**Analysis:**	STP 2x2 Contingency Tables	**Official Results:**	Yes

Batch ID:	04-3672-6765	**Test Type:**	Survival-Growth	**Analyst:**	
Start Date:	10 Jun-15 11:58	**Protocol:**	PSEP (1995)	**Diluent:**	Natural Seawater (Van. Aquarium)
Ending Date:	30 Jun-15 12:00	**Species:**	Neanthes arenaceodentata	**Brine:**	Not Applicable
Duration:	20d 0h	**Source:**	Aquatic Toxicology Support	**Age:**	

Sample Code	Sample ID	Sample Date	Receive Date	Sample Age	Client Name	Project
15SED11	15-6240-9376	22 May-15	23 May-15	19d 12h	Tetra Tech	2-11-15007
15SED02	12-8649-8243	21 May-15	22 May-15	20d 12h		
15SED03	18-5588-3709	21 May-15	22 May-15	20d 12h		
15SED05	10-5366-6000	21 May-15	22 May-15	20d 12h		
16SED06	19-5992-9006	21 May-15	22 May-15	20d 12h		
15SED07	09-4217-4404	21 May-15	22 May-15	20d 12h		
15SED08	21-3716-2985	21 May-15	22 May-15	20d 12h		

Sample Code	Material Type	Sample Source	Station Location	Latitude	Longitude
15SED11	Marine/Estuarine Se	Tetra Tech	15SED11		
15SED02	Marine/Estuarine Se	Tetra Tech	15SED02		
15SED03	Marine/Estuarine Se	Tetra Tech	15SED03		
15SED05	Marine/Estuarine Se	Tetra Tech	15SED05		
16SED06	Marine/Estuarine Se	Tetra Tech	16SED06		
15SED07	Marine/Estuarine Se	Tetra Tech	15SED07		
15SED08	Marine/Estuarine Se	Tetra Tech	15SED08		

Data Transform	Zeta	Alt Hyp	Trials	Seed	Test Result
Untransformed		C > T	NA	NA	

Fisher Exact/Bonferroni-Holm Test

Sample	vs	Sample	Test Stat	P-Value	P-Type	Decision(α:5%)
15SED11		15SED02	1	1.0000	Exact	Non-Significant Effect
15SED11		15SED03	0.2449	1.0000	Exact	Non-Significant Effect
15SED11		15SED05	1	1.0000	Exact	Non-Significant Effect
15SED11		16SED06	0.2449	1.0000	Exact	Non-Significant Effect
15SED11		15SED07	1	1.0000	Exact	Non-Significant Effect
15SED11		15SED08	0.5	1.0000	Exact	Non-Significant Effect

Data Summary

Sample Code	NR	R	NR + R	Prop NR	Prop R	%Effect
15SED11	25	0	25	1	0	0.0%
15SED02	25	0	25	1	0	0.0%
15SED03	23	2	25	0.92	0.08	8.0%
15SED05	25	0	25	1	0	0.0%
16SED06	23	2	25	0.92	0.08	8.0%
15SED07	25	0	25	1	0	0.0%
15SED08	24	1	25	0.96	0.04	4.0%

Survival Rate Detail

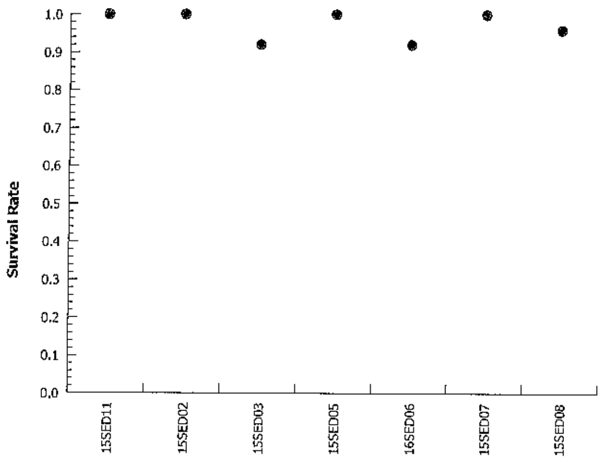
Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
15SED11	1	1	1	1	1
15SED02	1	1	1	1	1
15SED03	0.6	1	1	1	1
15SED05	1	1	1	1	1
16SED06	1	0.8	1	0.8	1
15SED07	1	1	1	1	1
15SED08	0.8	1	1	1	1

2015 Jul 06 Analyst: M. G 2015 Jul 10 QA: JP

Neanthes 20-d Survival and Growth Sediment Test — **Maxxam Analytics**

Analysis ID:	16-4366-3719	**Endpoint:**	Survival Rate	**CETIS Version:**	CETISv1.8.7
Analyzed:	06 Jul-15 11:53	**Analysis:**	STP 2x2 Contingency Tables	**Official Results:**	Yes

Graphics



2015 Jul 06 2015 Jul 10
Analyst: M.G. QA: JP

Maxxam Analytics

20-d *Neanthes arenaceodentata* Survival and Growth Test
Summary of Survival

Client Name and #: 11478 Tetra Tech
Job #: B542517/B542802

Start Date: 2015 Jun 10
End Date: 2015 Jun 30

Sample ID	Sample #	Replicate	# Exposed	# Surviving	Survival (%)	Mean Survival (%)	SD
Control	-	A	5	5	100	92	11
		B	5	4	80		
		C	5	4	80		
		D	5	5	100		
		E	5	5	100		
15 SED 11	MH4920	A	5	5	100	100	0
		B	5	5	100		
		C	5	5	100		
		D	5	5	100		
		E	5	5	100		
15 SED 02	MH3566	A	5	5	100	100	0
		B	5	5	100		
		C	5	5	100		
		D	5	5	100		
		E	5	5	100		
15 SED 03	MH3567	A	5	3	60	92	18
		B	5	5	100		
		C	5	5	100		
		D	5	5	100		
		E	5	5	100		
15 SED 05	MH3569	A	5	5	100	100	0
		B	5	5	100		
		C	5	5	100		
		D	5	5	100		
		E	5	5	100		
15 SED 06	MH3570	A	5	5	100	92	11
		B	5	4	80		
		C	5	5	100		
		D	5	4	80		
		E	5	5	100		
15 SED 07	MH3571	A	5	5	100	100	0
		B	5	5	100		
		C	5	5	100		
		D	5	5	100		
		E	5	5	100		
15 SED 08	MH3572	A	5	4	80	96	9
		B	5	5	100		
		C	5	5	100		
		D	5	5	100		
		E	5	5	100		

JP 2015 July 10

ECOTOXICOLOGY

Neanthes Weights

Maxxam

BBY2FCD-00274/1

Client # & Name: 11478 Tetra Tech

Start Date and Time: 2015 Jun 10

Sample #/ID: Various

End Date: 2015 Jun 30

Job # B542517/B542802

Weighing Dates: 2015 Jun 23, 2015 Jul 02

Balance ID: BBY2-0260

Stats File ID: NA-11478-0115

Analyst(s): T.Wollelo, M. O'Toole

Boat #	Sample ID	Replicate	# Worms	Boat Wt. (g)	Boat & Worms Wt. (g)	Wt. of Worms (mg)	Mean Wt./Worm (mg)	Mean Wt./Conc. (mg)	SD
1	Control	A	5	1.1250	1.2082	83.2	16.6	16.4	2.5
2		B	4	1.1027	1.1793	76.6	19.2		
3		C	4	1.0991	1.1485	49.4	12.4		
4		D	5	1.0949	1.1771	82.2	16.4		
5		E	5	1.1111	1.1982	87.1	17.4		
6	15 SED 11	A	5	1.1076	1.1773	69.7	13.9	13.4	2.5
7		B	5	1.1003	1.1870	86.7	17.3		
8		C	5	1.1060	1.1706	64.6	12.9		
9		D	5	1.1041	1.1592	55.1	11.0		
10		E	5	1.1122	1.1709	58.6	11.7		
11	15 SED 02	A	5	1.1018	1.1691	67.3	13.5	14.2	1.4
12		B	5	1.1083	1.1879	79.6	15.9		
13		C	5	1.1102	1.1765	66.3	13.3		
14		D	5	1.1208	1.1980	77.2	15.4		
15		E	5	1.1111	1.1751	64.0	12.8		
16	15 SED 03	A	3	1.1124	1.1707	58.3	19.4	14.9	2.5
17		B	5	1.0992	1.1688	69.6	13.9		
18		C	5	1.1052	1.1760	70.8	14.2		
19		D	5	1.0931	1.1631	70.0	14.0		
20		E	5	1.1016	1.1673	65.7	13.1		
21	15 SED 05	A	5	1.1072	1.1537	46.5	9.3	14.1	4.0
22		B	5	1.1232	1.1764	53.2	10.6		
23		C	5	1.1106	1.2001	89.5	17.9		
24		D	5	1.1085	1.1838	75.3	15.1		
25		E	5	1.1044	1.1936	89.2	17.8		
26	15 SED 06	A	5	1.1085	1.1801	71.6	14.3	12.5	2.1
27		B	4	1.0911	1.1434	52.3	13.1		
28		C	5	1.1014	1.1682	66.8	13.4		
29		D	4	1.0996	1.1352	35.6	8.9		
30		E	5	1.1080	1.1724	64.4	12.9		
31	15 SED 07	A	5	1.0817	1.1766	94.9	19.0	14.9	3.7
32		B	5	1.0899	1.1443	54.4	10.9		
33		C	5	1.0957	1.1614	65.7	13.1		
34		D	5	1.0943	1.1870	92.7	18.5		
35		E	5	1.0852	1.1488	63.6	12.7		
36	15 SED 08	A	4	1.0919	1.1399	48.0	12.0	13.7	2.3
37		B	5	1.0876	1.1425	54.9	11.0		
38		C	5	1.0867	1.1531	66.4	13.3		
39		D	5	1.1129	1.1926	79.7	15.9		
40		E	5	1.0885	1.1693	80.8	16.2		
41	QA/QC	QA/QC	0	1.0987	1.0989	0.18	-	-	-
42	QA/QC	QA/QC	0	1.1187	1.1189	0.17	-	-	-
1		A	5	1.1250	1.2082	83.2	-	-	-
Analyst				TW	MO				

20-d *Neanthes arenaceodentata* Survival and Growth Test Mean Growth Rate

Client Name and #: 11478 Tetra Tech
Job #: B542517/B542802
Analyst: T. Wollelo, M. O'Toole
Start Date: 2015 Jun 10
End Date: 2015 Jun 30

Sample ID	Sample #	Replicate	Initial Weight (mg)	Ind. Dry Weight (mg)	Growth rate (mg/day)	Mean Growth Rate (mg/day)	SD
Control	N/A	A	0.4	16.6	0.81	0.80	0.12
		B	0.4	19.2	0.94		
		C	0.4	12.4	0.60		
		D	0.4	16.5	0.80		
		E	0.4	17.4	0.85		
15 SED 11	MH4920	A	0.4	13.9	0.68	0.65	0.12
		B	0.4	17.3	0.85		
		C	0.4	12.9	0.63		
		D	0.4	11.0	0.53		
		E	0.4	11.7	0.57		
15 SED 02	MH3566	A	0.4	13.5	0.65	0.69	0.07
		B	0.4	15.9	0.78		
		C	0.4	13.3	0.64		
		D	0.4	15.4	0.75		
		E	0.4	12.8	0.62		
15 SED 03	MH 3567	A	0.4	19.4	0.95	0.73	0.13
		B	0.4	13.9	0.68		
		C	0.4	14.2	0.69		
		D	0.4	14.0	0.68		
		E	0.4	13.1	0.64		
15 SED 05	MH 3570	A	0.4	9.3	0.44	0.69	0.20
		B	0.4	10.6	0.51		
		C	0.4	17.9	0.88		
		D	0.4	15.1	0.73		
		E	0.4	17.8	0.87		
15 SED 06	MH 3571	A	0.4	14.3	0.70	0.61	0.10
		B	0.4	13.1	0.63		
		C	0.4	13.4	0.65		
		D	0.4	8.9	0.43		
		E	0.4	12.9	0.62		
15 SED 07	MH 3572	A	0.4	19.0	0.93	0.72	0.18
		B	0.4	10.9	0.52		
		C	0.4	13.1	0.64		
		D	0.4	18.6	0.91		
		E	0.4	12.7	0.62		
15 SED 08		A	0.4	12.0	0.58	0.66	0.12
		B	0.4	11.0	0.53		
		C	0.4	13.3	0.64		
		D	0.4	16.0	0.78		
		E	0.4	16.2	0.79		

ECOTOXICOLOGY

Maxxam

20 DAY *NEANTHES ARENACEODENTATA* SURVIVAL AND GROWTH - TEST CONDITION AND SURVIVAL

Client # & Name: 11478 Tetra Tech

Start Date and Time: 2015 Jun10 @1158

Client Project #: 2-11-15007

End Date: 2015 Jun 30

Maxxam Job #: B542517/B542802

Wt. at Start of Test (g): 0.40mg/worm MG2015July06

Organism Lot #: AT150609

Statistics File: NA-11478-0115

Analyst(s): T. Wollelo K.Tamaki M.Thompson C.Tang D.Lai, Armstrong M.O'Toole N.Blassnitz

Sample ID: Control

Date	2015 Jun10	2015 Jun13	2015 Jun16	2015 Jun 19	2015 Jun24 22 (D)	2015 Jun 25	2015 Jun28	2015 Jun30
	Day 0	Day 3	Day 6	Day 9	Day 12	Day 15	Day 18	Day 20
Temp. (ºC)	19.5	19.9	19.5	19.6	19.8	19.8	19.7	19.8
D.O. (mg/L)	7.8	6.6	7.2	7.2	7.3	7.4	7.2	7.4
pH	8.0	7.7	7.8	7.8	(C) ~~8.1~~ 7.8	7.8	7.9	7.9
Salinity (‰)	28	28	28	28	29	28	29	29
Analyst	KT	MT	CT	wy	MT	wy	AC	TW

Replicate	A	B	C	D	E	Total Ammonia (N) mg/L	
# Surviving	5	4	4	5	5	Initial	Final
Analyst	TW	TW	TW	TW	TW	0.026	5.1

Sample ID: Sed11

Sample #: MH4920

Date	2015 Jun10	2015 Jun 13 (A)	2015 Jun16	2015 Jun 19	2015 Jun24 (D) 22	2015 Jun 25	2015 Jun28	2015 Jun30
	Day 0	Day 3	Day 6	Day 9	Day 12	Day 15	Day 18	Day 20
Temp. (ºC)	19.6	19.9	19.7	19.5	19.3	19.7	19.7	19.8
D.O. (mg/L)	7.3	0.3 (B)	7.3	7.5	7.6	7.5	7.4	7.5
pH	8.0	7.4	8.0	8.1	8.2	8.1	8.2	8.2
Salinity (‰)	28	28	28	28	28	28	29	29
Analyst	KT	MT	CT	wy	MT	wy	AC	TW

Replicate	A	B	C	D	E	Total Ammonia (N) mg/L	
# Surviving	5	5	5	5	5	Initial	Final
Analyst	MO	NB	MO	MT	NB	3.8	10

Additional Comments: (A) Neanthes crawling up the sides of test vessels (near top of water) in measure rep (but in other reps, neanthes appear to be burrowed) - mt 2015 Jun 13
(B) Increased aeration rate (see aeration form for note) - mt 2015 Jun 13
(C) WE mt 2015 Jun 22 (D) WE CE mt 2015 Jun 24

20 DAY *NEANTHES ARENACEODENTATA* SURVIVAL AND GROWTH - TEST CONDITIONS AND SURVIVAL

Sample ID: Sed 02 Maxxam #: MH3566

Date	2015 JUN10	2015 JUN13	2015 JUN16	2015JUN19	Ⓐ 22 ~~2015JUN24~~	2015JUN25	2015JUN28	2015 JUN ~~28~~ 30 Ⓑ
	Day 0	Day 3	Day 6	Day 9	Day 12	Day 15	Day 18	Day 20
Temp. (ºC)	19.7	20.1	19.9	19.7	19.6	19.7	19.7	19.8
D.O. (mg/L)	7.7	6.9	7.3	7.1	7.2	7.2	7.0	Ⓑ ~~7~~ 6.9
pH	8.1	7.9	8.4	8.3	8.3	8.2	8.2	8.2
Salinity (‰)	28	28	28	28	29	28	29	29
Analyst	Kt	Mt	OT	wy	Mt	wy	AC	TW

Replicate	A	B	C	D	E	Total Ammonia (N) mg/L	
# Surviving	5	5	5	5	5	Initial	Final
Analyst	CS	CS	TW	CS	mo	1.4	1.7

Sample ID: Sed 03 Maxxam #: MH3567

Date	2015 JUN10	2015 JUN13	2015 JUN16	2015JUN19	Ⓐ 22 ~~2015JUN24~~	2015JUN25	2015 JUN28	2015 JUN30
	Day 0	Day 3	Day 6	Day 9	Day 12	Day 15	Day 18	Day 20
Temp. (ºC)	19.8	20.0	19.8	19.7	19.4	19.6	19.7	20.0
D.O. (mg/L)	7.7	6.5	7.3	7.2	7.3	7.4	7.3	7.1
pH	8.1	7.7	8.0	8.1	8.3	8.3	8.3	8.2
Salinity (‰)	28	28	28	28	29	28	29	29
Analyst	Kt	Mt	OT	wy	Mt	wy	AC	TW

Replicate	A	B	C	D	E	Total Ammonia (N) mg/L	
# Surviving	3	5	5	5	5	Initial	Final
Analyst	CS	TW	NB	Mt	Mt	2.0	1.7

Additional Comments: Ⓐ WE Mt 2015 Jun 24 LE

Mt 2015 Jul 03

Ⓑ WE TW 2015 Jun 30

20 DAY *NEANTHES ARENACEODENTATA* SURVIVAL AND GROWTH - TEST CONDITIONS AND SURVIVAL

Sample ID: Sed05 ⓒ 22 Maxxam #: MH3569

Date	2015 Jun10	2015 Jun13	2015 Jun 16	2015 Jun19	2015 Jun21	2015 Jun25	2015 Jun28	2015 Jun30
	Day 0	Day 3	Day 6	Day 9	Day 12	Day 15	Day 18	Day 20
Temp. (ºC)	19.9	19.9	19.5	19.5	19.4	19.5	19.7	19.8
D.O. (mg/L)	7.8	7.0	7.6	7.4	7.5	7.6	7.3	7.2
pH	8.1	7.9	8.1	8.1	8.2	8.1	8.1	8.2
Salinity (‰)	28	28	29	28	28	28	28	28
Analyst	kt	mt	OP	wj	mt	wj	AC	TW

Replicate	A	B	C	D	E	Total Ammonia (N) mg/L	
# Surviving	5	5	5	5	5	Initial	Final
Analyst	mo	NB	CS	NB	mo	0.97	6.3

Sample ID: Sed06 22 ⓒ Maxxam #: MH3570

Date	2015 Jun10	2015 Jun13	2015 Jun 16	2015 Jun19	2015 Jun21	2015 Jun25	2015 Jun28	2015 Jun30
	Day 0	Day 3	Day 6	Day 9	Day 12	Day 15	Day 18	Day 20
Temp. (ºC)	19.5	19.8	19.8	19.4	Ⓑ ~~19.6~~ 19.2	19.6	20.0	19.8
D.O. (mg/L)	7.9	1.6 Ⓐ	7.2	7.7	Ⓑ ~~7.3~~ 7.7	7.5	7.4	7.5
pH	8.0	7.4	8.1	8.2	Ⓑ ~~8.2~~ 8.3	8.2	8.2	8.3
Salinity (‰)	28	28	28	28	Ⓑ ~~28~~ 29	28	29	29
Analyst	kt	mt	OP	wj	mt	wj	AC	TW

Replicate	A	B	C	D	E	Total Ammonia (N) mg/L	
# Surviving	5	4	5	4	5	Initial	Final
Analyst	CS	TW	mt	mo	TW	0.87	0.75

Additional Comments: Ⓐ See note on aeration data sheet (BBY2FCD-00172) - mt 2015 Jun 13

Ⓑ WE mt 2015 Jun 22 mt 2015 Jul 03

ⓒ WE mt 2015 Jun 24 LE

mt 2015 Jul 03

20 DAY *NEANTHES ARENACEODENTATA* SURVIVAL AND GROWTH - TEST CONDITIONS AND SURVIVAL

Sample ID: Sed 07

Maxxam #: MH3571

Date	2015 JUN10	2015 JUN13	2015 JUN16	2015 JUN19	2015 JUN21 Ⓑ 22	2015 JUN25	2015 JUN28	2015 JUN30
	Day 0	Day 3	Day 6	Day 9	Day 12	Day 15	Day 18	Day 20
Temp. (ºC)	19.7	19.9	19.7	19.8	19.6	19.6	19.7	19.7
D.O. (mg/L)	7.8	6.9	7.5	7.7	7.3	7.5	7.4	7.2
pH	8.1	7.8	8.1	8.2	8.2	8.0	8.1	8.1
Salinity (‰)	28	28	28	28	28	28	28	29
Analyst	Kt	Mt	OT	wj	Mt	wj	AC	TW

Replicate	A	B	C	D	E	Total Ammonia (N) mg/L	
# Surviving	5	5	5	5	5	Initial	Final
Analyst	CJ	NB	Mt	NB	NB	0.99	0.30

Sample ID: Sed08

Maxxam #: MH3572

Date	2015 JUN10	2015 JUN13	2015 JUN16	2015 JUN19	2015 JUN21 Ⓑ 22	2015 JUN25	2015 JUN28	2015 JUN30
	Day 0	Day 3	Day 6	Day 9	Day 12	Day 15	Day 18	Day 20
Temp. (ºC)	19.6	20.0	19.8	19.4	Ⓐ ~~19.2~~ 19.4	19.6	19.7	19.8
D.O. (mg/L)	7.4	6.7	7.1	7.0	Ⓐ ~~7.7~~ 7.1	7.3	7.1	7.3
pH	7.9	7.8	8.1	8.2	Ⓐ ~~8.3~~ 8.2	8.2	8.3	8.3
Salinity (‰)	28	28	28	28	Ⓐ ~~29~~ 28	28	29	29
Analyst	Kt	Mt	OT	wj	Mt	wj	AC	TW

Replicate	A	B	C	D	E	Total Ammonia (N) mg/L	
# Surviving	4	5	5	5	5	Initial	Final
Analyst	mo	NB	mo	Mt	mo	1.3	5.2

Additional Comments: Ⓐ WE Mt 2015 JUN 22 Ⓑ LE WE Mt 2015 JUN24

Mt 2015 JUL 03

Client # & Name: 11478 Tetra Tech

Start Date & Time: 2015 Jun10 @ 1158

Initial when aeration is checked. If air is off record DO and note which replicate(s) in comments section.

Day	-1	0	1	2	3	4	5	6	7	8	9
Date	2015 Jun09	2015 Jun10	2015 Jun11	2015 Jun12	2015 Jun13	2015 June14	2015 Jun15	2015 Jun16	2015 Jun17	2015 Jun18	2015 Jun19
Early AM		Kt	mo	cs	mt	cB	Cf	Cf	Cf	mo	wj
Mid-day		Kt	mo	cs	mt	cB	Cf	Cf	Cf	mo	wj
Late PM	TW	mo	mo	mt 2015 Jun13	mt	Cf	Cf	Cf	Cf	DMC	wj

Day	10	11	12	13	14	15	16	17	18	19	Day 20
Date	2015 Jun20	2015 Jun21	2015 Jun22	2015 Jun23	2015 Jun24	2015 Jun25	2015 Jun26	2015 Jun27	2015 Jun28	2015 Jun29	2015 Jun30
Early AM	TW	mo	mt	wj	wj	wj	wj	SR	Cf	TW	TW
Mid-day	cs	mo	mt	wj	wj	wj	wj	SR	Cf	TW	2015 Jun30 TW
Late PM	TW	mo	mt	wj	wj	wj	wj	SR	Cf	TW	

Comments:

Aeration started @ 15:55 TW

2015 Jun10 - All sediment appears to be light gray colour. All neanthes appear to burrowed. All airlines are 1-2cm above sediment surface. -mo

2015 Jun13 - 15SED06 measure jar not aerating at Am aeration check. Measured DO (0.4 mg/L @19.9°C) and fixed airline - mt

2015 Jun13 - Increased aeration rate slightly for all reps of all samples due to some low DO readings when doing Day 3 water quality - mt

mt 2015 Jul 03

ECOTOXICOLOGY

Neanthes arenaceodentata 20 Day Survival and Growth Test Feeding Record

Client # & Name: 11478 Tetra Tech

Start Date & Time: 2015Jun10@11:58

# of replicates: 48

Total Wt. Fish Flakes (g): 2.40

Volume of seawater (ml): 60.0

Day	Date	Analyst	Conc'n of Feed (mg/mL)	1 mL Feed (√)
0	2015Jun10	KT	40	✓
2	2015 June12	CS	40	✓
4	2015 Jun 14	UB	40	✓
6	2015 Jun 16 ~~2015 Jun14~~	CT ~~UB~~ (A)	40	✓
8	2015 Jun18	DMC	40	✓
10	2015 Jun 20	CS	40	✓
12	2015Jun22	MT	40	✓
14	2015 JUN 24	WY	40	✓
16	2015 Jun 26	WY	40	✓
18	2015Jun28	CT	40	✓

Add one vial of ground fish flakes to the volume of seawater indicated above. Place slurry on stirplate and let spin for at least 5 minutes. Feed each replicate 1 mL of slurry.

Comments: (A) WE UB 2015 June 16

MT 2015 Jul 03

Client # & Name: 11478 Tetra Tech Test Initiation Date: 2015Jun10

Seawater Arrival Date: 2015Jun01 Type of Seawater: Van Aqua

Date	Day	Temperature (°C)	D.O. (mg/L)	pH	Salinity (‰)	30% Water Renewal (✓)	Analyst
2015Jun09	Day -1	18.2	8.7	8.1	28		mo
2015Jun10	Day 0	19.5	8.0	8.0	28		Kt
2015Jun13	Day 3	19.3	7.8	8.1	28	✓	mt
2015Jun16	Day 6	19.5	7.6	8.1	29	✓	Cl
2015JUN19	Day 9	19.5	8.0	8.1	28	✓	y
2015JUN22	Day 12	19.2	7.9	8.1	28	✓	mt
2015JUN25	Day 15	19.5	8.2	8.2	28	✓	y
2015Jun26	Day 18	19.6	8.0	8.1	29	✓	Cl

Note: Seawater should be filtered, U.V. sterilized and aerated ≥ 24 hours prior to use.

Comments:

~~mt 2015 Jul 03~~

Randomization Chart for Neanthes Test
Use the coloured dots to find appropriate concentrations
Position Map

	Back Wall	
6	12	
5	11	
4	10	
3	9	
2	8	
1	7	etc...
	Front of Counter	

Client # 11478 Date: 2015 Jun 10

Position #	Treatment	Replicate	Colour
37	Control	A	Red
46		B	Red
17		C	Red
24		D	Red
42		E	Red
18		Measure	Red
44	15 sed 11	A	Green
47		B	Green
7		C	Green
4		D	Green
27		E	Green
16		Measure	Green
1	15 sed 02	A	Yellow
11		B	Yellow
29		C	Yellow
31		D	Yellow
10		E	Yellow
48		Measure	Yellow
15	15 sed 03	A	Purple
25		B	Purple
36		C	Purple
8		D	Purple
28		E	Purple
23		Measure	Purple
32	15 sed 05	A	Lt blue
13		B	Lt blue
12		C	Lt blue
39		D	Lt blue
41		E	Lt blue
30		Measure	Lt blue
5	15 sed 06	A	Pink
21		B	Pink
34		C	Pink
20		D	Pink
40		E	Pink
3		Measure	Pink

Position #	Treatment	Replicate	Colour
26	15 sed 07	A	Orange
19		B	Orange
9		C	Orange
33		D	Orange
38		E	Orange
35		Measure	Orange
22	15 sed 08	A	Lt green
6		B	Lt green
45		C	Lt green
2		D	Lt green
43		E	Lt green
14		Measure	Lt green

ECOTOXICOLOGY

ORGANISMS - ACCLIMATION AND HOLDING CONDITIONS

MaxXam

BBY2FCD-00070/2

Client #'s : #11478

Date & Time of Arrival: 2015 Jun 09 @ 1120

Organism Lot #: ~~M~~ (A) AT150609

Age upon Arrival: 15 days

Water (L) per Shipping Bag: ~250 mL

Organism: Neanthes arenaceodentata

Number of Shipping Bags: 10

#of Organisms Ordered: 460

Arrival Conditions

	Bag ID	# Dead	% Dead	Cond (µS/cm)/ Salinity (ppt)	Temp (°C)	DO (mg/L)	pH	Feeding	Analyst
Pan A	1	0	0	30	21.5	6.3	7.2	✓	Mt
	2	0	0	31	21.8	6.1	7.2	✓	Mt
	3	0	0	30	21.9	5.8	7.2	✓	Mt
Pan B	4	0	0	30	21.9	5.9	7.2	✓	Mt
	5	0	0	30	21.9	6.1	7.2	✓	Mt
	6	0	0	30	21.9	5.9	7.2	✓	Mt
Pan C	7	0	0	30	21.9	5.7	7.1	✓	Mt
	8	0	0	30	21.8	5.8	7.2	✓	Mt
	9	0	0	30	22.0	5.8	7.2	✓	Mt
	10	0	0	30	22.0	5.9	7.2	✓	Mt

Daily Conditions During Holding/Acclimation

Date	Mortalities # Dead	Mortalities % Dead	Water Quality Cond ~~(µS/cm)~~/ Salinity (ppt)	Temp (°C)	DO (mg/L)	pH	Feeding	Analyst
2015 Jun10 - A	0	0	30	19.8	7.1	7.8	n/a (C)	mo
(B) 2015 Jun10 - B	0	0	n/a	n/a	n/a	n/a	n/a (C)	mo
2015 Jun10 - C	0	0	30	20.0	6.4	7.6	n/a (C)	mo
			Mt	2015	Jul 03			
Total Mortalities								

Comments (e.g. feeding times and quantities; fish behaviour, acclimation conditions): Analyst

2015 Jun 09 - Van Aqua SW (batch 2015 Jun 01, re-filtered 2015 Jun 08) WQ: Mt
Temp (°C) = 20.3 pH = 7.9 DO (mg/L) = 7.6 Salinity (ppt) = 28 Mt
- Placed neanthes in glass pans, did arrival WQ, added airlines Mt
- Added ~200 mL (A) ~~to~~ of seawater to each pan and fed each Mt
pan a sprinkle of tetramin (250um seived, lot # 206321) Mt

(B) 2015 Jun 10 - Used culture pan B to seed and poured it out before WQ was done. Neanthes appeared healthy, and culture water looked the same as pans B and ~~&~~ C (some debris present). mo

(A) WE Mt 2015 Jun 09

(C) 2015 Jun 10 - Fed test vessels before seeding. mo

AT150609

Rec'd 2015 Jun 09 @ 11:20 MT

Aquatic Toxicology Support
1849 Charleston Beach Road West
Bremerton, Washington 98312
(360) 813-1202

Order Summary

Species: *Neanthes arenaceodentata**	Emerge Date: 25 May '15
Number Ordered: 460	Number Shipped: 460 +10%
Date Shipped: 8 June '15	Salinity (ppt): 30

*Smith 1964. CSU Long Beach strain. Feed upon arrival.

Neanthes Weights

Client # & Name: 11478 Tetra Tech

Start Date and Time: 2015 Jun 10 @ 11:58

Organism Lot: AT150609

End Date: 2015 Jun 30

Organism Age: 16 days

Stats File ID: n/a

Weighing Dates: 2015 Jun 10, 2015 Jun 11

Avg weight (Day 0) (mg): 0.40

Job # / Sample #: B542517 + B542802/ Various

Balance ID: BBY2-0260

Analyst(s): M. O'Toole, D.Lai

Boat #	# Worms	Boat Weight (g)	Worms + Boat weight (g)	Total Worm weight (g)	Individual worm weight (mg)
9N	5	1.01100	1.01290	0.00190	0.38
10N	5	1.00844	1.01042	0.00198	0.40
11N	5	1.00365	1.00573	0.00208	0.42
Analyst		MO	DML		

Comments:

MT 2015 Jul 03

Maxxam Job #: B548867
Report Date: 2015/06/17

Maxxam Analytics (TOX Internal)
Client Project #: 2-11-15007
Site Location: NEANTHES #11478
Sampler Initials: MOT

RESULTS OF CHEMICAL ANALYSES OF WATER

Maxxam ID		MK7948	MK7949	MK7950	MK7951	
Sampling Date		2015/06/10	2015/06/10	2015/06/10	2015/06/10	
COC Number		G094763	G094763	G094763	G094763	
	Units	15SED07 NEA OVERLY	15SED02 NEA OVERLY	15SED08 NEA OVERLY	15SED06 NEA OVERLY	RDL
Nutrients						
Total Ammonia (N)	mg/L	0.99	1.4	1.3	0.87	0.0050

RDL = Reportable Detection Limit

Maxxam ID		MK7952	MK7953	MK7954	MK7955	
Sampling Date		2015/06/10	2015/06/10	2015/06/10	2015/06/10	
COC Number		G094763	G094763	G094763	G094763	
	Units	CTRL NEA OVERLY	15SED03 NEA OVERLY	15SED05 NEA OVERLY	15SED11 NEA OVERLY	RDL
Nutrients						
Total Ammonia (N)	mg/L	0.026	2.0	0.97	3.8	0.0050

RDL = Reportable Detection Limit

Maxxam Analytics International Corporation o/a Maxxam Analytics Burnaby: 4606 Canada Way V5G 1K5 Telephone(604) 734-7276 Fax(604) 731-2386

Maxxam Job #: B555337
Report Date: 2015/07/06

Maxxam Analytics (TOX Internal)
Client Project #: 2-11-15007 NEANTHES # 11478
Sampler Initials: TW

RESULTS OF CHEMICAL ANALYSES OF SEA WATER

Maxxam ID		MO4529		MO4530		MO4531	
Sampling Date		2015/06/30		2015/06/30		2015/06/30	
COC Number		G098571		G098571		G098571	
	Units	**15 SED11 NEA OVERLY**	**RDL**	**15 SED07 NEAN OVERLY**	**RDL**	**15 SED08 NEAN OVERLY**	**RDL**
Nutrients							
Total Ammonia (N)	mg/L	10	0.10	0.30	0.0050	5.2	0.050
RDL = Reportable Detection Limit							

Maxxam ID		MO4532	MO4533	MO4534	
Sampling Date		2015/06/30	2015/06/30	2015/06/30	
COC Number		G098571	G098571	G098571	
	Units	**15 SED06 NEA OVERLYING**	**15 SED03 NEA OVERLYING**	**15 SED02 NEA OVERLYING**	**RDL**
Nutrients					
Total Ammonia (N)	mg/L	0.75	1.7	1.7	0.0050
RDL = Reportable Detection Limit					

Maxxam ID		MO4535	MO4536	
Sampling Date		2015/06/30	2015/06/30	
COC Number		G098571	G098571	
	Units	**15 SED05 NEA OVERLY**	**CONTROL OVERLYING**	**RDL**
Nutrients				
Total Ammonia (N)	mg/L	6.3	5.1	0.050
RDL = Reportable Detection Limit				

Maxxam Analytics International Corporation o/a Maxxam Analytics Burnaby: 4606 Canada Way V5G 1K5 Telephone(604) 734-7276 Fax(604) 731-2386

APPENDIX

D 48 HOUR BIVALVE LARVAL DEVELOPMENT SEDIMENT TEST

CETIS Analytical Report

Report Date:	08 Jul-15 13:36 (p 1 of 6)		
Test Code:	MG-11478-0115 | 14-7319-1653		

Bivalve Larval Survival and Development Test — **Maxxam Analytics**

Analysis ID:	14-5322-7153	**Endpoint:**	Combined Proportion Normal	**CETIS Version:**	CETISv1.8.7
Analyzed:	08 Jul-15 13:26	**Analysis:**	Parametric-Two Sample	**Official Results:**	Yes

Batch ID:	14-3686-3261	**Test Type:**	Development-Survival	**Analyst:**	
Start Date:	10 Jun-15 13:45	**Protocol:**	PSEP (1995)	**Diluent:**	Natural Seawater (Van. Aquarium)
Ending Date:	12 Jun-15 21:16	**Species:**	Mytilus galloprovincialis	**Brine:**	Not Applicable
Duration:	56h	**Source:**	Marine Research and Educational Products	**Age:**	

Data Transform	Zeta	Alt Hyp	Trials	Seed	PMSD	Test Result
Angular (Corrected)	NA	C > T	NA	NA	16.6%	

Equal Variance t Two-Sample Test

Sample Code	vs	Sample Code	Test Stat	Critical	MSD	DF	P-Value	P-Type	Decision(α:5%)
SW Control		SED Control	4.262	1.86	0.125	8	0.0014	CDF	Significant Effect

Auxiliary Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:5%)
Extreme Value	Grubbs Extreme Value	1.474	2.29	1.0000	No Outliers Detected

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Between	0.2064813	0.2064813	1	18.17	0.0028	Significant Effect
Error	0.09092174	0.01136522	8			
Total	0.2974031		9			

Distributional Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:1%)
Variances	Variance Ratio F	1.36	23.15	0.7729	Equal Variances
Distribution	Shapiro-Wilk W Normality	0.9368	0.7411	0.5175	Normal Distribution

Combined Proportion Normal Summary

Sample Code	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
SW Control	5	0.701	0.5901	0.8119	0.6832	0.5743	0.8069	0.03993	12.74%	0.0%
SED Control	5	0.4248	0.286	0.5635	0.4109	0.2822	0.5594	0.04996	26.3%	39.41%

Angular (Corrected) Transformed Summary

Sample Code	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
SW Control	5	0.9956	0.8737	1.117	0.9729	0.8599	1.116	0.04389	9.86%	0.0%
SED Control	5	0.7082	0.5661	0.8503	0.6958	0.56	0.8449	0.05118	16.16%	28.87%

Combined Proportion Normal Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
SW Control	0.5743	0.6832	0.8069	0.6782	0.7624
SED Control	0.2822	0.5099	0.3614	0.4109	0.5594

Angular (Corrected) Transformed Detail

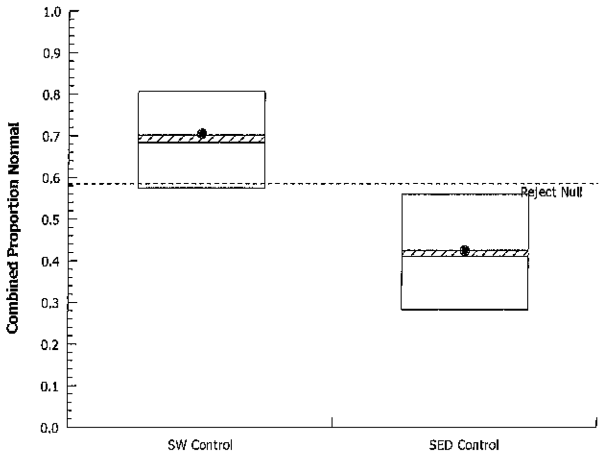
Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
SW Control	0.8599	0.9729	1.116	0.9676	1.062
SED Control	0.56	0.7953	0.6449	0.6958	0.8449

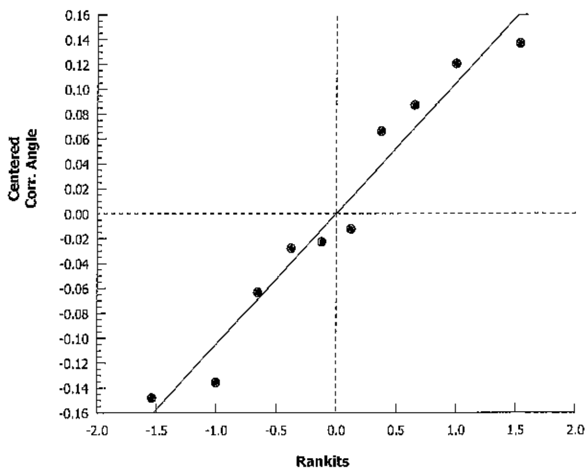
2015 Jul 08 2015 Jul 10

Bivalve Larval Survival and Development Test — **Maxxam Analytics**

Analysis ID:	14-5322-7153	**Endpoint:**	Combined Proportion Normal	**CETIS Version:**	CETISv1.8.7
Analyzed:	08 Jul-15 13:26	**Analysis:**	Parametric-Two Sample	**Official Results:**	Yes

Graphics





Bivalve Larval Survival and Development Test — **Maxxam Analytics**

Analysis ID:	01-3853-0630	**Endpoint:**	Proportion Normal	**CETIS Version:**	CETISv1.8.7
Analyzed:	08 Jul-15 13:26	**Analysis:**	Parametric-Two Sample	**Official Results:**	Yes

Batch ID:	14-3686-3261	**Test Type:**	Development-Survival	**Analyst:**	
Start Date:	10 Jun-15 13:45	**Protocol:**	PSEP (1995)	**Diluent:**	Natural Seawater (Van. Aquarium)
Ending Date:	12 Jun-15 21:16	**Species:**	Mytilus galloprovincialis	**Brine:**	Not Applicable
Duration:	56h	**Source:**	Marine Research and Educational Products	**Age:**	

Data Transform	Zeta	Alt Hyp	Trials	Seed	PMSD	Test Result
Angular (Corrected)	NA	C > T	NA	NA	6.57%	

Equal Variance t Two-Sample Test

Sample Code	vs	Sample Code	Test Stat	Critical	MSD	DF	P-Value	P-Type	Decision(α:5%)
SW Control		SED Control	1.753	1.86	0.076	8	0.0588	CDF	Non-Significant Effect

Auxiliary Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:5%)
Extreme Value	Grubbs Extreme Value	1.723	2.29	0.6358	No Outliers Detected

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Between	0.01300021	0.01300021	1	3.074	0.1176	Non-Significant Effect
Error	0.03382896	0.00422862	8			
Total	0.04682916		9			

Distributional Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:1%)
Variances	Variance Ratio F	8.704	23.15	0.0593	Equal Variances
Distribution	Shapiro-Wilk W Normality	0.9602	0.7411	0.7884	Normal Distribution

Proportion Normal Summary

Sample Code	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
SW Control	5	0.8599	0.8348	0.885	0.849	0.8406	0.8851	0.009048	2.35%	0.0%
SED Control	5	0.803	0.7196	0.8865	0.7757	0.7308	0.8828	0.03005	8.37%	6.61%

Angular (Corrected) Transformed Summary

Sample Code	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
SW Control	5	1.188	1.151	1.225	1.172	1.16	1.225	0.0132	2.49%	0.0%
SED Control	5	1.116	1.008	1.224	1.077	1.025	1.221	0.03895	7.81%	6.07%

Proportion Normal Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
SW Control	0.8406	0.8466	0.849	0.8782	0.8851
SED Control	0.7308	0.8655	0.7604	0.7757	0.8828

Angular (Corrected) Transformed Detail

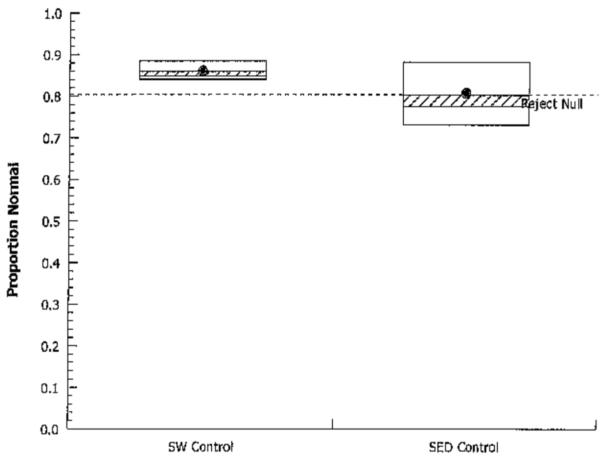
Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
SW Control	1.16	1.168	1.172	1.214	1.225
SED Control	1.025	1.195	1.059	1.077	1.221

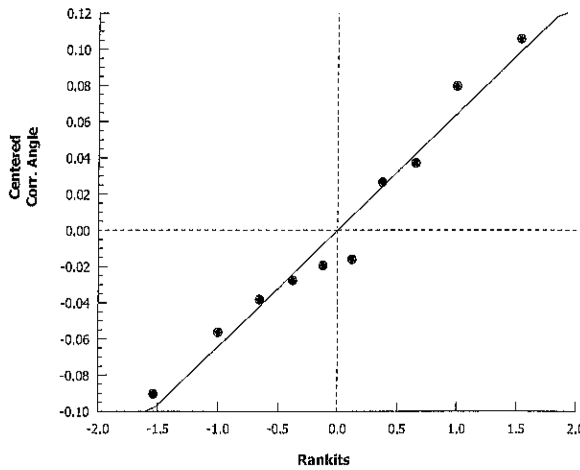
2015 Jul 08
Analyst: M.G
2015 Jul 10
QA: [illegible]

Bivalve Larval Survival and Development Test | **Maxxam Analytics**

Analysis ID:	01-3853-0630	**Endpoint:**	Proportion Normal	**CETIS Version:**	CETISv1.8.7
Analyzed:	08 Jul-15 13:26	**Analysis:**	Parametric-Two Sample	**Official Results:**	Yes

Graphics





Bivalve Larval Survival and Development Test — **Maxxam Analytics**

Analysis ID:	02-6615-1244	**Endpoint:**	Survival Rate	**CETIS Version:**	CETISv1.8.7
Analyzed:	08 Jul-15 13:26	**Analysis:**	Parametric-Two Sample	**Official Results:**	Yes
Batch ID:	14-3686-3261	**Test Type:**	Development-Survival	**Analyst:**	
Start Date:	10 Jun-15 13:45	**Protocol:**	PSEP (1995)	**Diluent:**	Natural Seawater (Van. Aquarium)
Ending Date:	12 Jun-15 21:16	**Species:**	Mytilus galloprovincialis	**Brine:**	Not Applicable
Duration:	56h	**Source:**	Marine Research and Educational Products	**Age:**	

Data Transform	Zeta	Alt Hyp	Trials	Seed	PMSD	Test Result
Angular (Corrected)	NA	C > T	NA	NA	13.4%	

Equal Variance t Two-Sample Test

Sample Code	vs	Sample Code	Test Stat	Critical	MSD	DF	P-Value	P-Type	Decision(α:5%)
SW Control		SED Control	4.342	1.86	0.142	8	0.0012	CDF	Significant Effect

Auxiliary Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:5%)
Extreme Value	Grubbs Extreme Value	1.819	2.29	0.4662	No Outliers Detected

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Between	0.2741924	0.2741924	1	18.85	0.0025	Significant Effect
Error	0.11636	0.014545	8			
Total	0.3905524		9			

Distributional Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:1%)
Variances	Variance Ratio F	2.032	23.15	0.5093	Equal Variances
Distribution	Shapiro-Wilk W Normality	0.9832	0.7411	0.9800	Normal Distribution

Survival Rate Summary

Sample Code	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
SW Control	5	0.8149	0.691	0.9387	0.8069	0.6832	0.9505	0.0446	12.24%	0.0%
SED Control	5	0.5228	0.4023	0.6433	0.5297	0.3861	0.6337	0.0434	18.56%	35.84%

Angular (Corrected) Transformed Summary

Sample Code	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
SW Control	5	1.14	0.9662	1.313	1.116	0.9729	1.346	0.06244	12.25%	0.0%
SED Control	5	0.8084	0.6868	0.93	0.8151	0.6705	0.9207	0.04381	12.12%	29.06%

Survival Rate Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
SW Control	0.6832	0.8069	0.9505	0.7723	0.8614
SED Control	0.3861	0.5891	0.4752	0.5297	0.6337

Angular (Corrected) Transformed Detail

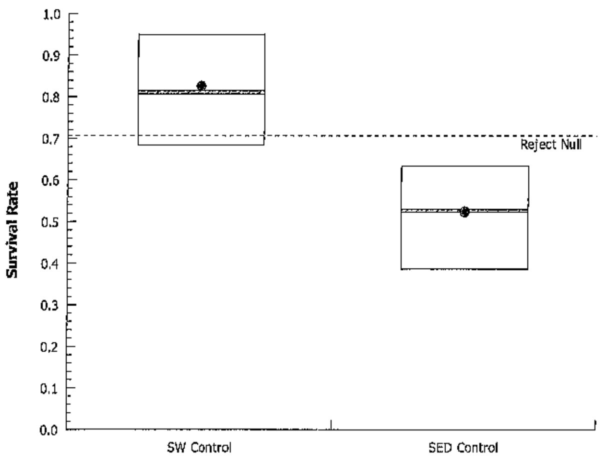
Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
SW Control	0.9729	1.116	1.346	1.073	1.189
SED Control	0.6705	0.875	0.7606	0.8151	0.9207

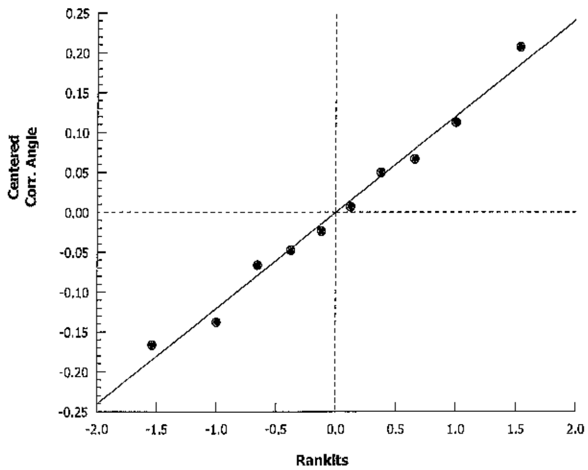
2015 Jul 08 2015 Jul 10

Bivalve Larval Survival and Development Test — **Maxxam Analytics**

Analysis ID:	02-6615-1244	**Endpoint:**	Survival Rate	**CETIS Version:**	CETISv1.8.7
Analyzed:	08 Jul-15 13:26	**Analysis:**	Parametric-Two Sample	**Official Results:**	Yes

Graphics





CETIS Analytical Report

Report Date:	08 Jul-15 13:43 (p 1 of 4)
Test Code:	MG-11478-0115 | 14-7319-1653

Bivalve Larval Survival and Development Test — **Maxxam Analytics**

Analysis ID:	12-8664-6886	**Endpoint:**	Proportion Normal	**CETIS Version:**	CETISv1.8.7
Analyzed:	08 Jul-15 13:27	**Analysis:**	Parametric-Control vs Treatments	**Official Results:**	Yes

Batch ID:	14-3686-3261	**Test Type:**	Development-Survival	**Analyst:**	
Start Date:	10 Jun-15 13:45	**Protocol:**	PSEP (1995)	**Diluent:**	Natural Seawater (Van. Aquarium)
Ending Date:	12 Jun-15 21:16	**Species:**	Mytilus galloprovincialis	**Brine:**	Not Applicable
Duration:	56h	**Source:**	Marine Research and Educational Products	**Age:**	

Data Transform	Zeta	Alt Hyp	Trials	Seed	PMSD	Test Result
Angular (Corrected)	NA	C > T	NA	NA	11.0%	

Dunnett Multiple Comparison Test

Sample Code	vs	Sample Code	Test Stat	Critical	MSD	DF	P-Value	P-Type	Decision(α:5%)
SED Control		15SED11	0.1395	2.503	0.116	12	0.9017	CDF	Non-Significant Effect
		15SED02	-1.444	2.503	0.108	13	0.9996	CDF	Non-Significant Effect
		15SED03	-0.814	2.503	0.108	13	0.9951	CDF	Non-Significant Effect
		15SED05	0.885	2.503	0.108	13	0.6149	CDF	Non-Significant Effect
		16SED06	-1.467	2.503	0.108	13	0.9997	CDF	Non-Significant Effect
		15SED07	0.03025	2.503	0.108	13	0.9251	CDF	Non-Significant Effect
		15SED08	-0.9772	2.503	0.116	12	0.9974	CDF	Non-Significant Effect

Auxiliary Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:5%)
Extreme Value	Grubbs Extreme Value	2.9	3.067	0.0990	No Outliers Detected

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Between	0.04745454	0.006779221	7	1.102	0.3837	Non-Significant Effect
Error	0.2153838	0.006153823	35			
Total	0.2628384		42			

Distributional Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:1%)
Variances	Bartlett Equality of Variance	8.948	18.48	0.2564	Equal Variances
Distribution	Shapiro-Wilk W Normality	0.9691	0.9281	0.2952	Normal Distribution

Proportion Normal Summary

Sample Code	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
SED Control	10	0.8315	0.7917	0.8712	0.8478	0.7308	0.8851	0.01757	6.68%	0.0%
15SED11	4	0.8255	0.7162	0.9348	0.8299	0.7375	0.9048	0.03433	8.32%	0.72%
15SED02	5	0.8759	0.8274	0.9245	0.8865	0.812	0.9174	0.01747	4.46%	-5.35%
15SED03	5	0.8584	0.8189	0.8979	0.8571	0.8148	0.9029	0.01424	3.71%	-3.24%
15SED05	5	0.7962	0.6518	0.9405	0.8396	0.6196	0.8978	0.05199	14.6%	4.24%
16SED06	5	0.8767	0.8301	0.9232	0.8947	0.8295	0.9085	0.01677	4.28%	-5.44%
15SED07	5	0.8302	0.7584	0.902	0.8231	0.7692	0.8902	0.02587	6.97%	0.15%
15SED08	4	0.866	0.8261	0.906	0.8704	0.8321	0.8913	0.01256	2.9%	-4.16%

Angular (Corrected) Transformed Summary

Sample Code	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
SED Control	10	1.152	1.1	1.203	1.17	1.025	1.225	0.02281	6.26%	0.0%
15SED11	4	1.145	0.9993	1.291	1.146	1.033	1.257	0.04589	8.01%	0.56%
15SED02	5	1.214	1.143	1.285	1.227	1.122	1.279	0.02568	4.73%	-5.39%
15SED03	5	1.187	1.129	1.244	1.183	1.126	1.254	0.02072	3.91%	-3.04%
15SED05	5	1.114	0.938	1.29	1.159	0.9061	1.245	0.0633	12.71%	3.3%
16SED06	5	1.215	1.145	1.285	1.24	1.145	1.263	0.02517	4.63%	-5.47%
15SED07	5	1.151	1.053	1.248	1.137	1.07	1.233	0.03515	6.83%	0.11%
15SED08	4	1.197	1.139	1.255	1.203	1.149	1.235	0.0182	3.04%	-3.94%

2015 Jul 08 Analyst: MG 2015 Jul 10 QA: [illegible]

Bivalve Larval Survival and Development Test — **Maxxam Analytics**

Analysis ID:	12-8664-6886	**Endpoint:**	Proportion Normal	**CETIS Version:**	CETISv1.8.7
Analyzed:	08 Jul-15 13:27	**Analysis:**	Parametric-Control vs Treatments	**Official Results:**	Yes

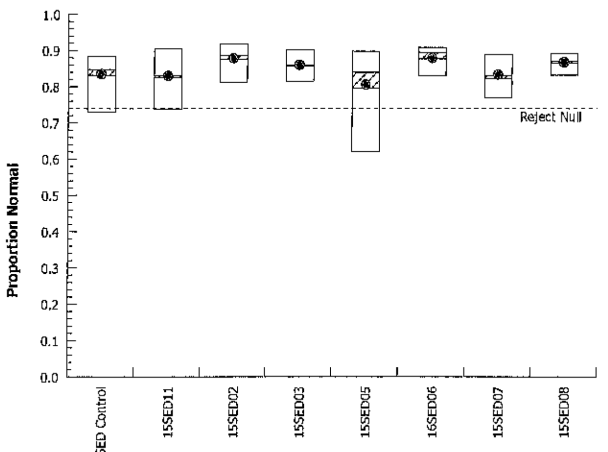
Proportion Normal Detail

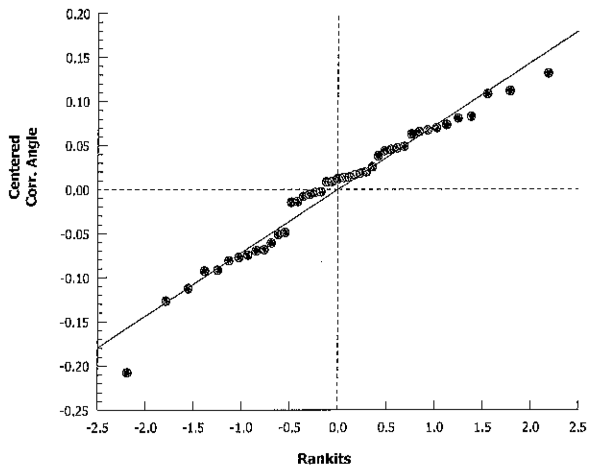
Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
SED Control	0.8406	0.8466	0.849	0.8782	0.8851	0.7308	0.8655	0.7604	0.7757	0.8828
15SED11	0.8362	0.8235	0.9048	0.7375						
15SED02	0.8897	0.8741	0.812	0.9174	0.8865					
15SED03	0.8148	0.8492	0.8571	0.8679	0.9029					
15SED05	0.8832	0.8396	0.7407	0.6196	0.8978					
16SED06	0.8947	0.9074	0.8295	0.9085	0.8433					
15SED07	0.7692	0.7795	0.8889	0.8231	0.8902					
15SED08	0.8649	0.8913	0.876	0.8321						

Angular (Corrected) Transformed Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
SED Control	1.16	1.168	1.172	1.214	1.225	1.025	1.195	1.059	1.077	1.221
15SED11	1.154	1.137	1.257	1.033						
15SED02	1.232	1.208	1.122	1.279	1.227					
15SED03	1.126	1.172	1.183	1.199	1.254					
15SED05	1.222	1.159	1.037	0.9061	1.245					
16SED06	1.24	1.262	1.145	1.263	1.164					
15SED07	1.07	1.082	1.231	1.137	1.233					
15SED08	1.194	1.235	1.211	1.149						

Graphics





Analyst: M.G. 2015 Jul 08 QA: 2015 Jul 10

Bivalve Larval Survival and Development Test — **Maxxam Analytics**

Analysis ID:	08-9095-4020	**Endpoint:**	Proportion Normal	**CETIS Version:**	CETISv1.8.7
Analyzed:	08 Jul-15 13:42	**Analysis:**	Parametric-Control vs Treatments	**Official Results:**	Yes
Batch ID:	14-3686-3261	**Test Type:**	Development-Survival	**Analyst:**	
Start Date:	10 Jun-15 13:45	**Protocol:**	PSEP (1995)	**Diluent:**	Natural Seawater (Van. Aquarium)
Ending Date:	12 Jun-15 21:16	**Species:**	Mytilus galloprovincialis	**Brine:**	Not Applicable
Duration:	56h	**Source:**	Marine Research and Educational Products	**Age:**	

Data Transform	Zeta	Alt Hyp	Trials	Seed	PMSD	Test Result
Angular (Corrected)	NA	C > T	NA	NA	13.2%	

Dunnett Multiple Comparison Test

Sample Code	vs	Sample Code	Test Stat	Critical	MSD	DF	P-Value	P-Type	Decision(α:5%)
15SED11		15SED02	-1.268	2.395	0.129	7	0.9927	CDF	Non-Significant Effect
		15SED03	-0.7674	2.395	0.129	7	0.9704	CDF	Non-Significant Effect
		15SED05	0.5842	2.395	0.129	7	0.6232	CDF	Non-Significant Effect
		16SED06	-1.287	2.395	0.129	7	0.9931	CDF	Non-Significant Effect
		15SED07	-0.09578	2.395	0.129	7	0.8664	CDF	Non-Significant Effect
		15SED08	-0.9103	2.395	0.136	6	0.9797	CDF	Non-Significant Effect

Auxiliary Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:5%)
Extreme Value	Grubbs Extreme Value	2.861	2.952	0.0737	No Outliers Detected

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Between	0.04339382	0.007232303	6	1.116	0.3805	Non-Significant Effect
Error	0.1685546	0.006482871	26			
Total	0.2119485		32			

Distributional Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:1%)
Variances	Bartlett Equality of Variance	8.733	16.81	0.1892	Equal Variances
Distribution	Shapiro-Wilk W Normality	0.9723	0.9104	0.5456	Normal Distribution

Proportion Normal Summary

Sample Code	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
15SED11	4	0.8255	0.7162	0.9348	0.8299	0.7375	0.9048	0.03433	8.32%	0.0%
15SED02	5	0.8759	0.8274	0.9245	0.8865	0.812	0.9174	0.01747	4.46%	-6.11%
15SED03	5	0.8584	0.8189	0.8979	0.8571	0.8148	0.9029	0.01424	3.71%	-3.99%
15SED05	5	0.7962	0.6518	0.9405	0.8396	0.6196	0.8978	0.05199	14.6%	3.55%
16SED06	5	0.8767	0.8301	0.9232	0.8947	0.8295	0.9085	0.01677	4.28%	-6.2%
15SED07	5	0.8302	0.7584	0.902	0.8231	0.7692	0.8902	0.02587	6.97%	-0.57%
15SED08	4	0.866	0.8261	0.906	0.8704	0.8321	0.8913	0.01256	2.9%	-4.91%

Angular (Corrected) Transformed Summary

Sample Code	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
15SED11	4	1.145	0.9993	1.291	1.146	1.033	1.257	0.04589	8.01%	0.0%
15SED02	5	1.214	1.143	1.285	1.227	1.122	1.279	0.02568	4.73%	-5.98%
15SED03	5	1.187	1.129	1.244	1.183	1.126	1.254	0.02072	3.91%	-3.62%
15SED05	5	1.114	0.938	1.29	1.159	0.9061	1.245	0.0633	12.71%	2.76%
16SED06	5	1.215	1.145	1.285	1.24	1.145	1.263	0.02517	4.63%	-6.07%
15SED07	5	1.151	1.053	1.248	1.137	1.07	1.233	0.03515	6.83%	-0.45%
15SED08	4	1.197	1.139	1.255	1.203	1.149	1.235	0.0182	3.04%	-4.53%

2015 Jul 08 Analyst: M.G 2015 Jul 10 QA: JP

Bivalve Larval Survival and Development Test — **Maxxam Analytics**

Analysis ID:	08-9095-4020	**Endpoint:**	Proportion Normal	**CETIS Version:**	CETISv1.8.7
Analyzed:	08 Jul-15 13:42	**Analysis:**	Parametric-Control vs Treatments	**Official Results:**	Yes

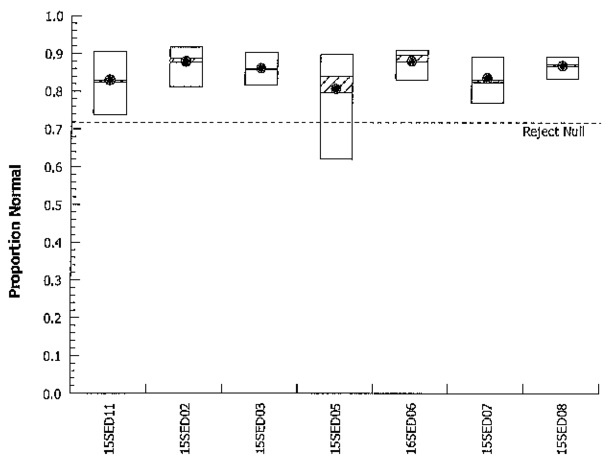
Proportion Normal Detail

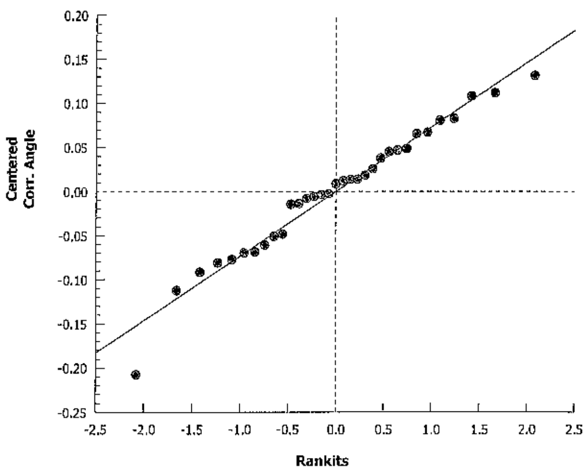
Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
15SED11	0.8362	0.8235	0.9048	0.7375	
15SED02	0.8897	0.8741	0.812	0.9174	0.8865
15SED03	0.8148	0.8492	0.8571	0.8679	0.9029
15SED05	0.8832	0.8396	0.7407	0.6196	0.8978
16SED06	0.8947	0.9074	0.8295	0.9085	0.8433
15SED07	0.7692	0.7795	0.8889	0.8231	0.8902
15SED08	0.8649	0.8913	0.876	0.8321	

Angular (Corrected) Transformed Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
15SED11	1.154	1.137	1.257	1.033	
15SED02	1.232	1.208	1.122	1.279	1.227
15SED03	1.126	1.172	1.183	1.199	1.254
15SED05	1.222	1.159	1.037	0.9061	1.245
16SED06	1.24	1.262	1.145	1.263	1.164
15SED07	1.07	1.082	1.231	1.137	1.233
15SED08	1.194	1.235	1.211	1.149	

Graphics





2015 Jul 10

Analyst: MG QA: 2015 Jul 10

CETIS Analytical Report

Bivalve Larval Survival and Development Test — **Maxxam Analytics**

Analysis ID:	14-3988-1795	**Endpoint:**	Survival Rate	**CETIS Version:**	CETISv1.8.7
Analyzed:	08 Jul-15 13:27	**Analysis:**	Parametric-Control vs Treatments	**Official Results:**	Yes
Batch ID:	14-3686-3261	**Test Type:**	Development-Survival	**Analyst:**	
Start Date:	10 Jun-15 13:45	**Protocol:**	PSEP (1995)	**Diluent:**	Natural Seawater (Van. Aquarium)
Ending Date:	12 Jun-15 21:16	**Species:**	Mytilus galloprovincialis	**Brine:**	Not Applicable
Duration:	56h	**Source:**	Marine Research and Educational Products	**Age:**	

Data Transform	Zeta	Alt Hyp	Trials	Seed	PMSD	Test Result
Angular (Corrected)	NA	C > T	NA	NA	25.7%	

Dunnett Multiple Comparison Test

Sample Code	vs	Sample Code	Test Stat	Critical	MSD	DF	P-Value	P-Type	Decision(α:5%)
SED Control		15SED11	0.05811	2.46	0.135	7	0.8659	CDF	Non-Significant Effect
		15SED02	-2.858	2.46	0.128	8	1.0000	CDF	Non-Significant Effect
		15SED03	-0.6519	2.46	0.128	8	0.9756	CDF	Non-Significant Effect
		15SED05	-0.5012	2.46	0.128	8	0.9632	CDF	Non-Significant Effect
		16SED06	-3.419	2.46	0.128	8	1.0000	CDF	Non-Significant Effect
		15SED07	-3.679	2.46	0.128	8	1.0000	CDF	Non-Significant Effect
		15SED08	-2.858	2.46	0.135	7	1.0000	CDF	Non-Significant Effect

Auxiliary Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:5%)
Extreme Value	Grubbs Extreme Value	2.014	3.014	1.0000	No Outliers Detected

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Between	0.2352099	0.03360141	7	4.999	0.0008	Significant Effect
Error	0.2016499	0.006721663	30			
Total	0.4368598		37			

Distributional Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:1%)
Variances	Bartlett Equality of Variance	6.997	18.48	0.4291	Equal Variances
Distribution	Shapiro-Wilk W Normality	0.9751	0.9202	0.5458	Normal Distribution

Survival Rate Summary

Sample Code	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
SED Control	5	0.5228	0.4023	0.6433	0.5297	0.3861	0.6337	0.0434	18.56%	0.0%
15SED11	4	0.5198	0.3802	0.6594	0.547	0.396	0.5891	0.04386	16.88%	0.57%
15SED02	5	0.6673	0.614	0.7206	0.6733	0.599	0.7079	0.0192	6.43%	-27.65%
15SED03	5	0.5564	0.4967	0.6161	0.5347	0.5099	0.6238	0.0215	8.64%	-6.44%
15SED05	5	0.5475	0.3897	0.7054	0.5248	0.401	0.6782	0.05685	23.22%	-4.74%
16SED06	5	0.6931	0.6121	0.774	0.6634	0.6386	0.802	0.02916	9.41%	-32.58%
15SED07	5	0.705	0.6137	0.7962	0.7129	0.6287	0.8119	0.03286	10.42%	-34.85%
15SED08	4	0.6757	0.6081	0.7434	0.6658	0.6386	0.7327	0.02124	6.29%	-29.26%

Angular (Corrected) Transformed Summary

Sample Code	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
SED Control	5	0.8084	0.6868	0.93	0.8151	0.6705	0.9207	0.04381	12.12%	0.0%
15SED11	4	0.8052	0.6647	0.9456	0.8326	0.6807	0.875	0.04413	10.96%	0.4%
15SED02	5	0.9566	0.9005	1.013	0.9623	0.8851	0.9998	0.02021	4.72%	-18.33%
15SED03	5	0.8422	0.7818	0.9025	0.8201	0.7953	0.9105	0.02174	5.77%	-4.18%
15SED05	5	0.8344	0.6737	0.995	0.8102	0.6857	0.9676	0.05786	15.51%	-3.22%
16SED06	5	0.9857	0.8942	1.077	0.9518	0.9259	1.11	0.03293	7.47%	-21.93%
15SED07	5	0.9992	0.8966	1.102	1.005	0.9156	1.122	0.03696	8.27%	-23.6%
15SED08	4	0.9656	0.8926	1.039	0.9546	0.9259	1.027	0.02295	4.75%	-19.45%

2015 Jul 08 2015 Jul 10

Analyst: M.G. QA: [illegible]

Bivalve Larval Survival and Development Test — **Maxxam Analytics**

Analysis ID:	14-3988-1795	**Endpoint:**	Survival Rate	**CETIS Version:**	CETISv1.8.7
Analyzed:	08 Jul-15 13:27	**Analysis:**	Parametric-Control vs Treatments	**Official Results:**	Yes

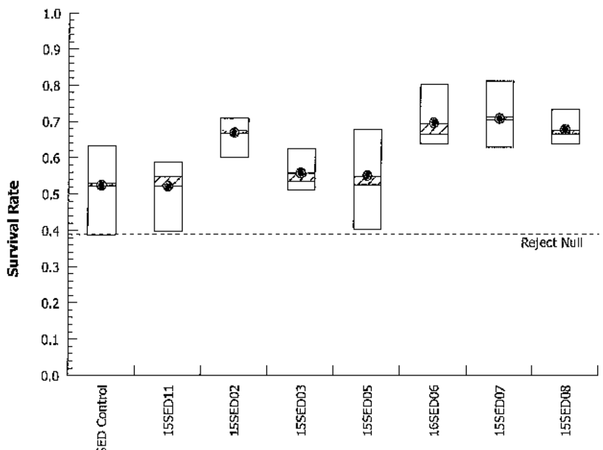
Survival Rate Detail

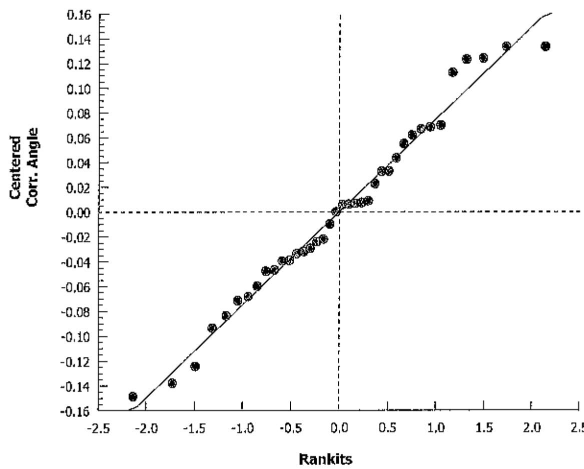
Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
SED Control	0.3861	0.5891	0.4752	0.5297	0.6337
15SED11	0.5743	0.5891	0.5198	0.396	
15SED02	0.6733	0.7079	0.6584	0.599	0.698
15SED03	0.5347	0.6238	0.5891	0.5248	0.5099
15SED05	0.6782	0.5248	0.401	0.4554	0.6782
16SED06	0.6584	0.802	0.6386	0.703	0.6634
15SED07	0.6436	0.6287	0.7129	0.7277	0.8119
15SED08	0.7327	0.6832	0.6386	0.6485	

Angular (Corrected) Transformed Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
SED Control	0.6705	0.875	0.7606	0.8151	0.9207
15SED11	0.8599	0.875	0.8052	0.6807	
15SED02	0.9623	0.9998	0.9466	0.8851	0.989
15SED03	0.8201	0.9105	0.875	0.8102	0.7953
15SED05	0.9676	0.8102	0.6857	0.7408	0.9676
16SED06	0.9466	1.11	0.9259	0.9944	0.9518
15SED07	0.931	0.9156	1.005	1.022	1.122
15SED08	1.027	0.9729	0.9259	0.9362	

Graphics





2015 July 08 2015 Jul 10

Analyst: M.G QA: [illegible]

Bivalve Larval Survival and Development Test — **Maxxam Analytics**

Analysis ID:	07-8884-0765	**Endpoint:**	Survival Rate	**CETIS Version:**	CETISv1.8.7
Analyzed:	08 Jul-15 13:28	**Analysis:**	Parametric-Control vs Treatments	**Official Results:**	Yes

Batch ID:	14-3686-3261	**Test Type:**	Development-Survival	**Analyst:**	
Start Date:	10 Jun-15 13:45	**Protocol:**	PSEP (1995)	**Diluent:**	Natural Seawater (Van. Aquarium)
Ending Date:	12 Jun-15 21:16	**Species:**	Mytilus galloprovincialis	**Brine:**	Not Applicable
Duration:	56h	**Source:**	Marine Research and Educational Products	**Age:**	

Data Transform	Zeta	Alt Hyp	Trials	Seed	PMSD	Test Result
Angular (Corrected)	NA	C > T	NA	NA	25.6%	

Dunnett Multiple Comparison Test

Sample Code	vs	Sample Code	Test Stat	Critical	MSD	DF	P-Value	P-Type	Decision(α:5%)
15SED11		15SED02	-2.847	2.395	0.127	7	1.0000	CDF	Non-Significant Effect
		15SED03	-0.696	2.395	0.127	7	0.9645	CDF	Non-Significant Effect
		15SED05	-0.549	2.395	0.127	7	0.9491	CDF	Non-Significant Effect
		16SED06	-3.395	2.395	0.127	7	1.0000	CDF	Non-Significant Effect
		15SED07	-3.649	2.395	0.127	7	1.0000	CDF	Non-Significant Effect
		15SED08	-2.863	2.395	0.134	6	1.0000	CDF	Non-Significant Effect

Auxiliary Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:5%)
Extreme Value	Grubbs Extreme Value	2.081	2.952	1.0000	No Outliers Detected

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Between	0.1864764	0.03107939	6	4.949	0.0017	Significant Effect
Error	0.1632684	0.006279553	26			
Total	0.3497447		32			

Distributional Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:1%)
Variances	Bartlett Equality of Variance	6.667	16.81	0.3527	Equal Variances
Distribution	Shapiro-Wilk W Normality	0.9754	0.9104	0.6428	Normal Distribution

Survival Rate Summary

Sample Code	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
15SED11	4	0.5198	0.3802	0.6594	0.547	0.396	0.5891	0.04386	16.88%	0.0%
15SED02	5	0.6673	0.614	0.7206	0.6733	0.599	0.7079	0.0192	6.43%	-28.38%
15SED03	5	0.5564	0.4967	0.6161	0.5347	0.5099	0.6238	0.0215	8.64%	-7.05%
15SED05	5	0.5475	0.3897	0.7054	0.5248	0.401	0.6782	0.05685	23.22%	-5.33%
16SED06	5	0.6931	0.6121	0.774	0.6634	0.6386	0.802	0.02916	9.41%	-33.33%
15SED07	5	0.705	0.6137	0.7962	0.7129	0.6287	0.8119	0.03286	10.42%	-35.62%
15SED08	4	0.6757	0.6081	0.7434	0.6658	0.6386	0.7327	0.02124	6.29%	-30.0%

Angular (Corrected) Transformed Summary

Sample Code	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
15SED11	4	0.8052	0.6647	0.9456	0.8326	0.6807	0.875	0.04413	10.96%	0.0%
15SED02	5	0.9566	0.9005	1.013	0.9623	0.8851	0.9998	0.02021	4.72%	-18.8%
15SED03	5	0.8422	0.7818	0.9025	0.8201	0.7953	0.9105	0.02174	5.77%	-4.6%
15SED05	5	0.8344	0.6737	0.995	0.8102	0.6857	0.9676	0.05786	15.51%	-3.63%
16SED06	5	0.9857	0.8942	1.077	0.9518	0.9259	1.11	0.03293	7.47%	-22.41%
15SED07	5	0.9992	0.8966	1.102	1.005	0.9156	1.122	0.03696	8.27%	-24.09%
15SED08	4	0.9656	0.8926	1.039	0.9546	0.9259	1.027	0.02295	4.75%	-19.92%

2015Jul08 2015Jul10

Bivalve Larval Survival and Development Test — **Maxxam Analytics**

Analysis ID:	07-8884-0765	**Endpoint:**	Survival Rate	**CETIS Version:**	CETISv1.8.7
Analyzed:	08 Jul-15 13:28	**Analysis:**	Parametric-Control vs Treatments	**Official Results:**	Yes

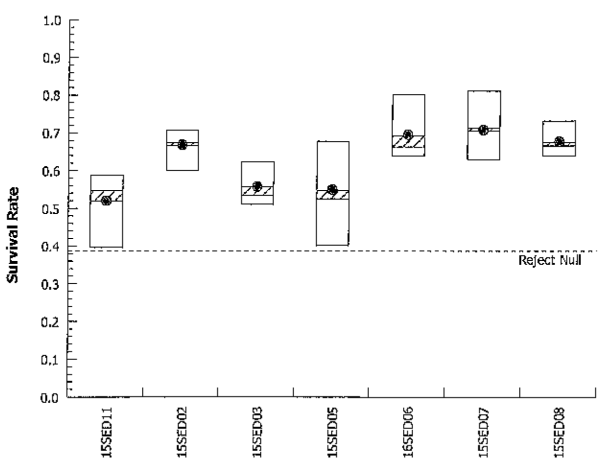
Survival Rate Detail

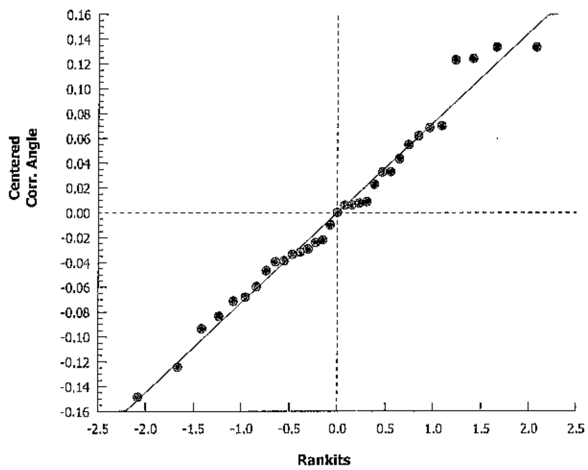
Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
15SED11	0.5743	0.5891	0.5198	0.396	
15SED02	0.6733	0.7079	0.6584	0.599	0.698
15SED03	0.5347	0.6238	0.5891	0.5248	0.5099
15SED05	0.6782	0.5248	0.401	0.4554	0.6782
16SED06	0.6584	0.802	0.6386	0.703	0.6634
15SED07	0.6436	0.6287	0.7129	0.7277	0.8119
15SED08	0.7327	0.6832	0.6386	0.6485	

Angular (Corrected) Transformed Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
15SED11	0.8599	0.875	0.8052	0.6807	
15SED02	0.9623	0.9998	0.9466	0.8851	0.989
15SED03	0.8201	0.9105	0.875	0.8102	0.7953
15SED05	0.9676	0.8102	0.6857	0.7408	0.9676
16SED06	0.9466	1.11	0.9259	0.9944	0.9518
15SED07	0.931	0.9156	1.005	1.022	1.122
15SED08	1.027	0.9729	0.9259	0.9362	

Graphics





2015Jul10 2015Jul10

Bivalve Larval Survival and Development Test — **Maxxam Analytics**

Analysis ID:	02-2342-5593	**Endpoint:**	Combined Proportion Normal	**CETIS Version:**	CETISv1.8.7
Analyzed:	08 Jul-15 13:28	**Analysis:**	Parametric-Control vs Treatments	**Official Results:**	Yes

Batch ID:	14-3686-3261	**Test Type:**	Development-Survival	**Analyst:**	
Start Date:	10 Jun-15 13:45	**Protocol:**	PSEP (1995)	**Diluent:**	Natural Seawater (Van. Aquarium)
Ending Date:	12 Jun-15 21:16	**Species:**	Mytilus galloprovincialis	**Brine:**	Not Applicable
Duration:	56h	**Source:**	Marine Research and Educational Products	**Age:**	

Data Transform	Zeta	Alt Hyp	Trials	Seed	PMSD	Test Result
Angular (Corrected)	NA	C > T	NA	NA	35.3%	

Dunnett Multiple Comparison Test

Sample Code	vs	Sample Code	Test Stat	Critical	MSD	DF	P-Value	P-Type	Decision(α:5%)
SED Control		15SED11	-0.1177	2.46	0.157	7	0.9070	CDF	Non-Significant Effect
		15SED02	-2.7	2.46	0.148	8	1.0000	CDF	Non-Significant Effect
		15SED03	-0.9063	2.46	0.148	8	0.9885	CDF	Non-Significant Effect
		15SED05	-0.3384	2.46	0.148	8	0.9443	CDF	Non-Significant Effect
		16SED06	-3.14	2.46	0.148	8	1.0000	CDF	Non-Significant Effect
		15SED07	-2.79	2.46	0.148	8	1.0000	CDF	Non-Significant Effect
		15SED08	-2.566	2.46	0.157	7	1.0000	CDF	Non-Significant Effect

Auxiliary Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:5%)
Extreme Value	Grubbs Extreme Value	1.973	3.014	1.0000	No Outliers Detected

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Between	0.2227135	0.03181621	7	3.537	0.0069	Significant Effect
Error	0.269895	0.008996502	30			
Total	0.4926085		37			

Distributional Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:1%)
Variances	Bartlett Equality of Variance	12.24	18.48	0.0928	Equal Variances
Distribution	Shapiro-Wilk W Normality	0.9731	0.9202	0.4812	Normal Distribution

Combined Proportion Normal Summary

Sample Code	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
SED Control	5	0.4248	0.286	0.5635	0.4109	0.2822	0.5594	0.04996	26.3%	0.0%
15SED11	4	0.4319	0.2832	0.5806	0.4752	0.2921	0.4851	0.04672	21.63%	-1.69%
15SED02	5	0.5842	0.535	0.6333	0.599	0.5347	0.6188	0.01771	6.78%	-37.53%
15SED03	5	0.4772	0.4291	0.5254	0.4604	0.4356	0.5297	0.01733	8.12%	-12.35%
15SED05	5	0.4455	0.2502	0.6409	0.4406	0.2822	0.6089	0.07036	35.31%	-4.9%
16SED06	5	0.6089	0.5125	0.7053	0.5891	0.5297	0.7277	0.03472	12.75%	-43.36%
15SED07	5	0.5881	0.4662	0.7101	0.599	0.4901	0.7228	0.04393	16.7%	-38.46%
15SED08	4	0.5854	0.5163	0.6545	0.5842	0.5396	0.6337	0.02171	7.42%	-37.82%

Angular (Corrected) Transformed Summary

Sample Code	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
SED Control	5	0.7082	0.5661	0.8503	0.6958	0.56	0.8449	0.05118	16.16%	0.0%
15SED11	4	0.7157	0.5618	0.8695	0.7606	0.571	0.7705	0.04834	13.51%	-1.06%
15SED02	5	0.8702	0.8203	0.92	0.8851	0.8201	0.9054	0.01795	4.61%	-22.87%
15SED03	5	0.7626	0.7144	0.8108	0.7458	0.7209	0.8151	0.01736	5.09%	-7.68%
15SED05	5	0.7285	0.5285	0.9286	0.7259	0.56	0.8952	0.07205	22.12%	-2.87%
16SED06	5	0.8965	0.7958	0.9973	0.875	0.8151	1.022	0.03627	9.05%	-26.59%
15SED07	5	0.8756	0.7499	1.001	0.8851	0.7755	1.016	0.04527	11.56%	-23.64%
15SED08	4	0.8715	0.8012	0.9417	0.8701	0.825	0.9207	0.02207	5.07%	-23.05%

CETIS Analytical Report

Report Date:	08 Jul-15 13:38 (p 2 of 4)
Test Code:	MG-11478-0115 | 14-7319-1653

Bivalve Larval Survival and Development Test — **Maxxam Analytics**

Analysis ID:	02-2342-5593	**Endpoint:**	Combined Proportion Normal	**CETIS Version:**	CETISv1.8.7
Analyzed:	08 Jul-15 13:28	**Analysis:**	Parametric-Control vs Treatments	**Official Results:**	Yes

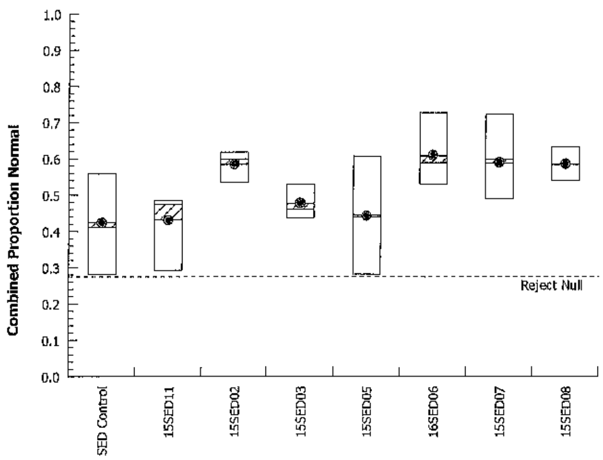
Combined Proportion Normal Detail

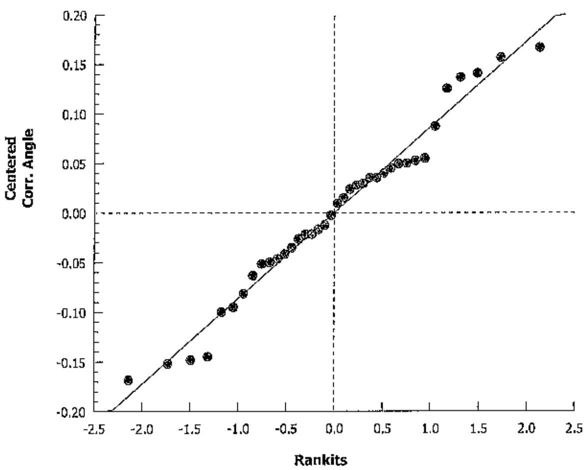
Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
SED Control	0.2822	0.5099	0.3614	0.4109	0.5594
15SED11	0.4802	0.4851	0.4703	0.2921	
15SED02	0.599	0.6188	0.5347	0.5495	0.6188
15SED03	0.4356	0.5297	0.505	0.4554	0.4604
15SED05	0.599	0.4406	0.297	0.2822	0.6089
16SED06	0.5891	0.7277	0.5297	0.6386	0.5594
15SED07	0.495	0.4901	0.6337	0.599	0.7228
15SED08	0.6337	0.6089	0.5594	0.5396	

Angular (Corrected) Transformed Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
SED Control	0.56	0.7953	0.6449	0.6958	0.8449
15SED11	0.7656	0.7705	0.7557	0.571	
15SED02	0.8851	0.9054	0.8201	0.835	0.9054
15SED03	0.7209	0.8151	0.7903	0.7408	0.7458
15SED05	0.8851	0.7259	0.5764	0.56	0.8952
16SED06	0.875	1.022	0.8151	0.9259	0.8449
15SED07	0.7804	0.7755	0.9207	0.8851	1.016
15SED08	0.9207	0.8952	0.8449	0.825	

Graphics





Bivalve Larval Survival and Development Test — **Maxxam Analytics**

Analysis ID:	12-4517-8042	**Endpoint:**	Combined Proportion Normal	**CETIS Version:**	CETISv1.8.7
Analyzed:	08 Jul-15 13:28	**Analysis:**	Parametric-Control vs Treatments	**Official Results:**	Yes

Batch ID:	14-3686-3261	**Test Type:**	Development-Survival	**Analyst:**	
Start Date:	10 Jun-15 13:45	**Protocol:**	PSEP (1995)	**Diluent:**	Natural Seawater (Van. Aquarium)
Ending Date:	12 Jun-15 21:16	**Species:**	Mytilus galloprovincialis	**Brine:**	Not Applicable
Duration:	56h	**Source:**	Marine Research and Educational Products	**Age:**	

Data Transform	Zeta	Alt Hyp	Trials	Seed	PMSD	Test Result
Angular (Corrected)	NA	C > T	NA	NA	34.5%	

Dunnett Multiple Comparison Test

Sample Code	vs	Sample Code	Test Stat	Critical	MSD	DF	P-Value	P-Type	Decision(α:5%)
15SED11		15SED02	-2.518	2.395	0.147	7	0.9999	CDF	Non-Significant Effect
		15SED03	-0.7641	2.395	0.147	7	0.9701	CDF	Non-Significant Effect
		15SED05	-0.2088	2.395	0.147	7	0.8928	CDF	Non-Significant Effect
		16SED06	-2.948	2.395	0.147	7	1.0000	CDF	Non-Significant Effect
		15SED07	-2.606	2.395	0.147	7	0.9999	CDF	Non-Significant Effect
		15SED08	-2.409	2.395	0.155	6	0.9998	CDF	Non-Significant Effect

Auxiliary Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:5%)
Extreme Value	Grubbs Extreme Value	2.044	2.952	1.0000	No Outliers Detected

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Between	0.1697418	0.0282903	6	3.382	0.0134	Significant Effect
Error	0.2174979	0.008365305	26			
Total	0.3872397		32			

Distributional Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:1%)
Variances	Bartlett Equality of Variance	11.86	16.81	0.0651	Equal Variances
Distribution	Shapiro-Wilk W Normality	0.9682	0.9104	0.4327	Normal Distribution

Combined Proportion Normal Summary

Sample Code	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
15SED11	4	0.4319	0.2832	0.5806	0.4752	0.2921	0.4851	0.04672	21.63%	0.0%
15SED02	5	0.5842	0.535	0.6333	0.599	0.5347	0.6188	0.01771	6.78%	-35.24%
15SED03	5	0.4772	0.4291	0.5254	0.4604	0.4356	0.5297	0.01733	8.12%	-10.49%
15SED05	5	0.4455	0.2502	0.6409	0.4406	0.2822	0.6089	0.07036	35.31%	-3.15%
16SED06	5	0.6089	0.5125	0.7053	0.5891	0.5297	0.7277	0.03472	12.75%	-40.97%
15SED07	5	0.5881	0.4662	0.7101	0.599	0.4901	0.7228	0.04393	16.7%	-36.16%
15SED08	4	0.5854	0.5163	0.6545	0.5842	0.5396	0.6337	0.02171	7.42%	-35.53%

Angular (Corrected) Transformed Summary

Sample Code	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
15SED11	4	0.7157	0.5618	0.8695	0.7606	0.571	0.7705	0.04834	13.51%	0.0%
15SED02	5	0.8702	0.8203	0.92	0.8851	0.8201	0.9054	0.01795	4.61%	-21.58%
15SED03	5	0.7626	0.7144	0.8108	0.7458	0.7209	0.8151	0.01736	5.09%	-6.55%
15SED05	5	0.7285	0.5285	0.9286	0.7259	0.56	0.8952	0.07205	22.12%	-1.79%
16SED06	5	0.8965	0.7958	0.9973	0.875	0.8151	1.022	0.03627	9.05%	-25.27%
15SED07	5	0.8756	0.7499	1.001	0.8851	0.7755	1.016	0.04527	11.56%	-22.34%
15SED08	4	0.8715	0.8012	0.9417	0.8701	0.825	0.9207	0.02207	5.07%	-21.77%

2015 Jul 08 Analyst: M.G. 2015 Jul 10 QA: [illegible]

Bivalve Larval Survival and Development Test — **Maxxam Analytics**

Analysis ID:	12-4517-8042	**Endpoint:**	Combined Proportion Normal	**CETIS Version:**	CETISv1.8.7
Analyzed:	08 Jul-15 13:28	**Analysis:**	Parametric-Control vs Treatments	**Official Results:**	Yes

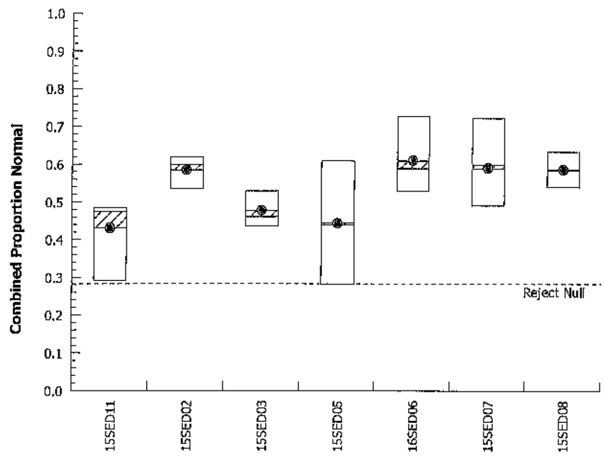
Combined Proportion Normal Detail

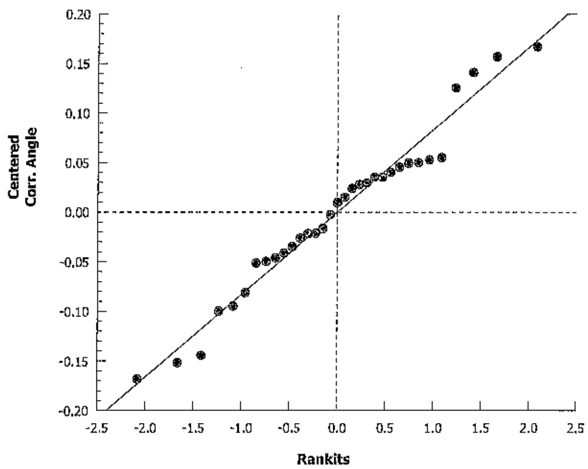
Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
15SED11	0.4802	0.4851	0.4703	0.2921	
15SED02	0.599	0.6188	0.5347	0.5495	0.6188
15SED03	0.4356	0.5297	0.505	0.4554	0.4604
15SED05	0.599	0.4406	0.297	0.2822	0.6089
16SED06	0.5891	0.7277	0.5297	0.6386	0.5594
15SED07	0.495	0.4901	0.6337	0.599	0.7228
15SED08	0.6337	0.6089	0.5594	0.5396	

Angular (Corrected) Transformed Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
15SED11	0.7656	0.7705	0.7557	0.571	
15SED02	0.8851	0.9054	0.8201	0.835	0.9054
15SED03	0.7209	0.8151	0.7903	0.7408	0.7458
15SED05	0.8851	0.7259	0.5764	0.56	0.8952
16SED06	0.875	1.022	0.8151	0.9259	0.8449
15SED07	0.7804	0.7755	0.9207	0.8851	1.016
15SED08	0.9207	0.8952	0.8449	0.825	

Graphics





Maxxam

Bivalve Embryo-Larval Test
Embryo Microscopic Examination

Species: *Mytilus galloprovincialis*
Client: 11478 Tetra Tech
Sample ID: Various
Job# / Sample #: B542517, B542802/Various

Start Date and Time: 2015 Jun 10 @ 13:45
End Date and Time: 2015 Jun 12 @ 21:16
Analyst(s): M. Thompson, M. O'Toole, N. Blassnitz

Date Counted: 2015 Jun 13 to Jun 25
Organism Lot #: MR150609

Sample ID	Replicate	Normal (#)	Abnormal (#)	Final Number	Normal (%)	Average (%)	SD (%)	# Initial Embryos	Survival (%)	Average (%)	SD (%)	Proportion Normal/Alive	Combined (%)	Average (%)	SD (%)
Control	A	116	22	138	84.06	85.99	2.02	202	68.32	81.49	9.97	0.57	57.43	70.10	8.93
	B	138	25	163	84.66			202	80.69			0.68	68.32		
	C	163	29	192	84.90			202	95.05			0.81	80.69		
	D	137	19	156	87.82			202	77.23			0.68	67.82		
	E	154	20	174	88.51			202	86.14			0.76	76.24		
Sediment	A	57	21	78	73.08	80.30	6.72	202	38.61	52.28	9.70	0.28	28.22	42.48	11.17
Control	B	103	16	119	86.55			202	58.91			0.51	50.99		
	C	73	23	96	76.04			202	47.52			0.36	36.14		
	D	83	24	107	77.57			202	52.97			0.41	41.09		
	E	113	15	128	88.28			202	63.37			0.56	55.94		
15SED11	A*	21	34	55	38.18	82.55	6.87	202	27.23	51.98	8.77	0.10	10.40	43.19	9.34
	B	97	19	116	83.62			202	57.43			0.48	48.02		
	C	98	21	119	82.35			202	58.91			0.49	48.51		
	D	95	10	105	90.48			202	51.98			0.47	47.03		
	E	59	21	80	73.75			202	39.60			0.29	29.21		
15SED02	A	121	15	136	88.97	87.59	3.91	202	67.33	66.73	4.29	0.60	59.90	58.42	3.96
	B	125	18	143	87.41			202	70.79			0.62	61.88		
	C	108	25	133	81.20			202	65.84			0.53	53.47		
	D	111	10	121	91.74			202	59.90			0.55	54.95		
	E	125	16	141	88.65			202	69.80			0.62	61.88		
15SED03	A	88	20	108	81.48	85.84	3.19	202	53.47	55.64	4.81	0.44	43.56	47.72	3.88
	B	107	19	126	84.92			202	62.38			0.53	52.97		
	C	102	17	119	85.71			202	58.91			0.50	50.50		
	D	92	14	106	86.79			202	52.48			0.46	45.54		
	E	93	10	103	90.29			202	50.99			0.46	46.04		
15SED05	A	121	16	137	88.32	79.62	11.63	202	67.82	54.75	12.71	0.60	59.90	44.55	15.73
	B	89	17	106	83.96			202	52.48			0.44	44.06		
	C	60	21	81	74.07			202	40.10			0.30	29.70		
	D	57	35	92	61.96			202	45.54			0.28	28.22		
	E	123	14	137	89.78			202	67.82			0.61	60.89		
15SED06	A	119	14	133	89.47	87.67	3.75	202	65.84	69.31	6.52	0.59	58.91	60.89	7.76
	B	147	15	162	90.74			202	80.20			0.73	72.77		
	C	107	22	129	82.95			202	63.86			0.53	52.97		
	D	129	13	142	90.85			202	70.30			0.64	63.86		
	E	113	21	134	84.33			202	66.34			0.56	55.94		

Maxxam

Bivalve Embryo-Larval Test
Embryo Microscopic Examination

Species: *Mytilus galloprovincialis*
Client: 11478 Tetra Tech
Sample ID: Various
Job# / Sample #: B542517, B542802/Various

Start Date and Time: 2015 Jun 10 @ 13:45
End Date and Time: 2015 Jun 12 @ 21:16
Analyst(s): M. Thompson, M. O'Toole, N. Blassnitz

Date Counted: 2015 Jun 13 to Jun 25
Organism Lot #: MR150609

Sample ID	Replicate	Normal (#)	Abnormal (#)	Final Number	Normal (%)	Average (%)	SD (%)	# Initial Embryos	Survival (%)	Average (%)	SD (%)	Proportion Normal/Alive	Combined (%)	Average (%)	SD (%)
15SED07	A	100	30	130	76.92	83.02	5.78	202	64.36	70.50	7.35	0.50	49.50	58.81	9.82
	B	99	28	127	77.95			202	62.87			0.49	49.01		
	C	128	16	144	88.89			202	71.29			0.63	63.37		
	D	121	26	147	82.31			202	72.77			0.60	59.90		
	E	146	18	164	89.02			202	81.19			0.72	72.28		
15SED08	A	128	20	148	86.49	86.60	2.51	202	73.27	67.57	4.25	0.63	63.37	58.54	4.34
	B	123	15	138	89.13			202	68.32			0.61	60.89		
	C	113	16	129	87.60			202	63.86			0.56	55.94		
	D	109	22	131	83.21			202	64.85			0.54	53.96		
	E*	32	55	87	36.78			202	43.07			0.16	15.84		
Analyst		MT/MO	MT/MO					MT/MO							

*Replicate excluded from statistical analysis.

ECOTOXICOLOGY

BIVALVE LARVAL DEVELOPMENT SEDIMENT TEST – TEST COUNTS

Species: M. galloprovincialis

Client # and Name: 11478-Tetra Tech

Test Method/Duration: PSEP(1995b)/55.5 hours

Test Started: 2015 Jun 10 @ 13:45

Test Ended: 2015 Jun 12 @ ~~19~~ 21:16 Ⓐ

Organism Lot #: MR150609

Ave. # of embryos/test vessel: 202

Analyst(s): M. Thompson, M. O'Toole

Test Controls

Date Counted: 2015 Jun 13, 2015 Jun 17, 2015 Jun 23

	Replicate	Ⓒ A Ⓑ	B	C	D	E
Seawater Control	Normal	116	138	163	137	154
	Abnormal	22	25	29	19	20
Sediment Control	Normal	57	103	73	83	113
	Abnormal	21	16	23	24	15
Analyst		mt	mt	mt+mo	mo	mo

Sample #: MH4920/B542802

Sample Date: 2015 May 22

Date Counted: 2015 Jun 23

Sample Name	Replicate	A Ⓓ	B	C	D	E Ⓔ
15SED11	Normal	21	97	98	95	59
	Abnormal	34	19	21	10	21
Analyst		mo	mo	mo	mo	mo

Ⓐ WE mt 2015 Jun 12

Ⓑ Counted tube A2 as well: 133 normal/25 abnormal. -mt 2015 Jun 13 ↳ (seawater control)

Ⓒ Counted tube A2 as well (sediment control): 43 normal/12 abnormal

Ⓓ Counted tube A2 as well: 21 normal/23 abnormal. -mo 2015 Jun 23

Ⓔ Counted tube E2 as well: 65 normal/10 abnormal. -mo 2015 Jun 23

Sample #: MH3566/B542517

Sample Date: 2015 May 21 Date Counted: 2015 Jun 23

Sample Name	Replicate	A	B	C	D	E
15SED02	Normal	121	125	108	111	125
	Abnormal	15	18	25	10	16
Analyst		mo	mo	mo	mo	mo

Sample #: MH3567 /B542517

Sample Date: 2015 May 21 Date Counted: 2015 Jun 23, 2015 Jun 24

Sample Name	Replicate	A	B	C	D	E
15SED03	Normal	88	107	102	92	93
	Abnormal	20	19	17	14	10
Analyst		mo	mo	mo	mo	mo

Sample #: MH3569 / B542517

Sample Date: 2015 May 21 Date Counted: 2015 Jun ~~23~~ 24
WE mo 2015 Jun 24

Sample Name	Replicate	A	B	C	D (A)	E
15SED05	Normal	121	89	60	57	123
	Abnormal	16	17	21	35	14
Analyst		mo	mo	mo	mo	mo

(A) Counted tube D2 as well: 42 normal/36 abnormal.
-mo 2015 Jun 24

ECOTOXICOLOGY

BIVALVE LARVAL DEVELOPMENT SEDIMENT TEST – TEST COUNTS

Sample #: MH3570/B542517

Sample Date: 2015 May 21

Date Counted: 2015 Jun 24

Sample Name	Replicate	A	B	C	D	E
15SED06	Normal	119	147	107	129	113
	Abnormal	14	15	22	13	Ⓐ ~~18~~ 21
Analyst		mo	mo	mo	mo	mo

Sample #: MH3571/B542517

Sample Date: 2015 May 21

Date Counted: 2015 Jun 24

Sample Name	Replicate	A	B	C	D	E
15SED07	Normal	100	99	128	121	146
	Abnormal	30	28	16	26	18
Analyst		mo	mo	mo	mo	mo

Sample #: MH3572/B542517

Sample Date: 2015 May 21

Date Counted: 2015 Jun 25

Sample Name	Replicate	A	B	C	D	E Ⓑ
15SED08	Normal	128	123	113	109	32
	Abnormal	20	15	16	22	55
Analyst		mo	mo	mo	mo	mo

Ⓐ WE mo 2015 Jun24

Ⓑ Counted tube E2 as well, 36 normal / 48 abnormal.
-mo 2015 Jun 25

BIVALVE LARVAL DEVELOPMENT SEDIMENT TEST – TEST MEASUREMENTS

Species: M. galloprovincialis

Client # and Name: 11478 - Tetra Tech EBA

Test Method: PSEP (1995B)

Organism Lot #: MR150609

Sample Date: 2015 May 21 and 22

Date Received: 2015 May 22, 23

Date & Time Started: 2015 Jun 10 @ 1345

Date & Time Ended: 2015 Jun 12 @

Test Duration/Extension:

Control Water Date: 2015 June 01 (filtered and UV sterilized on 2015 June 08)

pH 7.8 Temperature (°C) 15.9

D.O. (mg/L) 8.0 Salinity (‰) 29

Sample	Initial				24 hr				48 hr				54/60hr			
	Salinity (‰)	Temp. (°C)	pH	D.O. (mg/L)	Salinity (‰)	Temp. (°C)	pH	D.O. (mg/L)	Salinity (‰)	Temp. (°C)	pH	D.O. (mg/L)	Salinity (‰)	Temp. (°C)	pH	D.O. (mg/L)
SW Ctrl	28	15.5	8.1	8.5	28	15.1	8.1	8.2	28	15.2	8.0	8.2	28	14.8	8.0	8.3
Sed Ctrl	28	15.4	8.1	8.3	28	14.9	8.1	8.2	28	15.2	8.0	8.2	28	15.0	8.0	8.3
Analyst	MB				MT MB				MT MB				MT			
Date	2015 June 10				2015 June 11				2015 Jun 12				2015 Jun 12			

Sample ID: 15 SED11

Sample#: MH4920 / B542802

Sample	Initial				24 hr				48 hr				54/60hr			
	Salinity (‰)	Temp. (°C)	pH	D.O. (mg/L)	Salinity (‰)	Temp. (°C)	pH	D.O. (mg/L)	Salinity (‰)	Temp. (°C)	pH	D.O. (mg/L)	Salinity (‰)	Temp. (°C)	pH	D.O. (mg/L)
	28	15.3	8.0	6.4	28	15.1	8.0	6.5	28	15.0	8.0	6.6	28	14.9	7.9	6.6
Analyst	MB				MT				MT				MT			
Date	2015 June 10				2015 Jun 11				2015 Jun 12				2015 Jun 12			

Sample ID: 15SED02 Sample#: MH3566 / B542517

Sample	Initial				24 hr				48 hr				54/60hr			
	Salinity (‰)	Temp. (°C)	pH	D.O. (mg/L)	Salinity (‰)	Temp. (°C)	pH	D.O. (mg/L)	Salinity (‰)	Temp. (°C)	pH	D.O. (mg/L)	Salinity (‰)	Temp. (°C)	pH	D.O. (mg/L)
	28	15.2	8.0	7.1	28	14.8	8.0	~~7.8~~ B 6.8	28	15.2	8.0	6.8	28	15.0	7.9	6.8
Analyst	NB				Mt				Mt				Mt			
Date	2015 June 10				2015 Jun 11				2015 Jun 12				2015 Jun 12			

Sample ID: 15SED03 Sample#: MH3567 / B542517

Sample	Initial				24 hr				48 hr				54/60hr			
	Salinity (‰)	Temp. (°C)	pH	D.O. (mg/L)	Salinity (‰)	Temp. (°C)	pH	D.O. (mg/L)	Salinity (‰)	Temp. (°C)	pH	D.O. (mg/L)	Salinity (‰)	Temp. (°C)	pH	D.O. (mg/L)
	28	15.2	8.0	7.8		A	Mt 2015 Jun 11		~~28~~ C	~~15.~~ C	Mt 2015 Jun 12		28	14.9	8.0	7.5
Analyst	NB								C ~~Mt~~				Mt			
Date	2015 June 10								C ~~2015 Jun 12~~				2015 Jun 12			

Sample ID: 15SED05 Sample#: MH3569 / B542517

Sample	Initial				24 hr				48 hr				54/60hr			
	Salinity (‰)	Temp. (°C)	pH	D.O. (mg/L)	Salinity (‰)	Temp. (°C)	pH	D.O. (mg/L)	Salinity (‰)	Temp. (°C)	pH	D.O. (mg/L)	Salinity (‰)	Temp. (°C)	pH	D.O. (mg/L)
	28	15.5	8.0	7.8	28	15.1	8.0	7.8	28	15.1	8.0	7.5	28	14.9	7.9	7.1
Analyst	NB				Mt				Mt				Mt			
Date	2015 June 10				2015 Jun 11				2015 Jun 12				2015 Jun 12			

A 15SED03 Rep B compromised by fresh water. Will use measure jar as a replacement rep for this sample (will not do WQ until test end so as to not take the chance of ~~compromizing~~ B compromising the measure jar - Mt 2015 Jun 11

B WE Mt 2015 Jun 11 C WE Mt 2015 Jun 12

Sample ID: 15SED06 Sample#: MH3570/B542517

Sample	Initial				24 hr				48 hr				54/60hr			
	Salinity (‰)	Temp. (°C)	pH	D.O. (mg/L)	Salinity (‰)	Temp. (°C)	pH	D.O. (mg/L)	Salinity (‰)	Temp. (°C)	pH	D.O. (mg/L)	Salinity (‰)	Temp. (°C)	pH	D.O. (mg/L)
	28	15.4	8.0	7.4	28	15.1	8.0	7.3	28	15.1	7.9	7.2	28	15.0	7.9	~~7.8~~ (A) 6.9
Analyst	NB				MT				MT				MT			
Date	2015 June 10				2015 JUN 11				2015 JUN 12				2015 JUN 12			

Sample ID: 15SED07 Sample#: MH3571/B542517

Sample	Initial				24 hr				48 hr				54/60hr			
	Salinity (‰)	Temp. (°C)	pH	D.O. (mg/L)	Salinity (‰)	Temp. (°C)	pH	D.O. (mg/L)	Salinity (‰)	Temp. (°C)	pH	D.O. (mg/L)	Salinity (‰)	Temp. (°C)	pH	D.O. (mg/L)
	28	15.1	8.0	7.5	28	14.9	8.0	7.4	28	15.1	7.9	7.1	28	14.9	7.9	6.7
Analyst	NB				MT				MT				MT			
Date	2015 June 10				2015 JUN 11				2015 JUN 12				2015 JUN 12			

Sample ID: 15SED08 Sample#: MH3572/B542517

Sample	Initial				24 hr				48 hr				54/60hr			
	Salinity (‰)	Temp. (°C)	pH	D.O. (mg/L)	Salinity (‰)	Temp. (°C)	pH	D.O. (mg/L)	Salinity (‰)	Temp. (°C)	pH	D.O. (mg/L)	Salinity (‰)	Temp. (°C)	pH	D.O. (mg/L)
	28	15.2	8.0	7.6	28	15.0	8.0	7.4	28	15.2	7.9	6.8	28	15.1	7.9	6.5
Analyst	NB				MT				MT				MT			
Date	2015 June 10				2015 JUN 11				2015 JUN 12				2015 JUN 12			

(A) WE MT 2015 JUN 12

ECOTOXICOLOGY

ORGANISMS - ACCLIMATION AND HOLDING CONDITIONS

Maxxam

BBY2FCD-00070/2

Client #'s : 11478

Date & Time of Arrival: 2015 Jun 09 @ 1130

Organism Lot #: MR150609

Age upon Arrival: gravid

Water (L) per Shipping Bag: ~300 mL

Organism: Mytilus galloprovincialis

Number of Shipping Bags: 1

#of Organisms Ordered: ~50

Arrival Conditions

Bag ID	# Dead	% Dead	Cond (µS/cm)/ Salinity (ppt)	Temp (°C)	DO (mg/L)	pH	Feeding	Analyst
1	4		31	17.3	6.2	7.3	n/a	mt

mt 2015 Jun 09

Daily Conditions During Holding/Acclimation

Date	Mortalities		Water Quality					
Date	# Dead	% Dead	Cond (µS/cm)/ Salinity (ppt)	Temp (°C)	DO (mg/L)	pH	Feeding	Analyst
Total Mortalities								

mt 2015 Jun 09

Comments (e.g. feeding times and quantities; fish behaviour, acclimation conditions): Analyst

2015 Jun 09 - scrubbed mussels, placed them in 4 L buckets with seawater (Van. Aqua. batch 2015 Jun01, re-filtered 2015 Jun 08) and placed buckets in 4°C cold room for overnight acclimation. WQ of seawater ⇒ Temp (°C) = 16.4 Ⓐ, pH = 8.0, DO = 8.2 mg/L, salinity (ppt) = 28. mt

JP 2015 July 10

Ⓐ WE mt 2015 Jun 09

Species: M. galloprovincialis

Date: 2015 Jun 10

Organism Lot#: MR150609

Analyst/s: M. Thompson

Temperature of Water	Time In/out	Length of Time	Comments	Analyst
17	0840		Added 26 mussels to	mt
			water bath; wait to	mt
			resume pumping	mt
18	0844			mt
19	0847			mt
20	0849			mt
21	0850			mt
22	0851			mt
23	0855			mt
24	0856			mt
25	0858			mt
26	0901			mt
27	0903			mt
27	0916		1 female	mt
27	0928		1 male	mt
27	Ⓐ ~~0935~~ 0935		1 male	mt
27	0936		1 male	mt
27	0940		1 male	mt
27	0943		1 female - dud	mt
27	0945		1 male	mt
27	0945		1 male	mt
27	0946		Ⓐ ~~1 male~~ 1 female - dud	mt
27	0946		1 male	mt
27	0946		1 male	mt
27	0949		1 male	mt
27	0950		1 female	mt
27	0950		1 male	mt
		JR 2015	July 10	

Ⓐ WE mt 2015 Jun 10

ECOTOXICOLOGY

BIVALVE EMBRYO LARVAL DEVELOPMENT TEST - BIVALVE SPAWNING RECORD

Maxxam

Species: M. galloprovincialis

Date: 2015 June 10

Organism Lot#: MR150609

Analyst/s: MBlassnitz

Temperature of Water	Time In/out	Length of Time	Comments	Analyst
17°C	8:44		added 29 musselstobath	MB
17°C	8:46		turned bath on due to	MB
17°C	8:46		mussels resuming pumping	MB
19°C	8:48		n/a	MB
20°C	8:49		n/a	MB
21°C	8:50		n/a	MB
22°C	8:52		n/a	MB
24°C	8:55		n/a	MB
25°C	8:55		n/a	MB
26°C	8:56		n/a	MB
27°C	9:00		n/a	MB
27°C	9:10		One female	MB
27°C	9:20		one female and One male	MB
27°C	9:22		one female	MB
27°C	9:27		One female one male	MB
27°C	9:30		one male	MB
27°C	9:50		one male	MB
27°C	9:55		stopped water bath	MB

JP 2015 July 10

Maxxam

BBY2FCD-00035/1

Page 1 of 1

ECOTOXICOLOGY
TEST OBSERVATIONS

Page 1 of 1

Test Initiation Date: 2015 Jun 10
Sponsor: NA
Test Method: NA
Test Item: NA
Study Number: NA
Project Number: NA

2015 Jun 10

# female	condition of eggs	Used?	# male	motility of sperm	Used?
1	round, good	Yes	1	good	Yes
2	round, good	Yes	2	good	Yes
3	round, good	Yes	3	good	Yes
4	round, good	Yes	4	good	Yes
5	round, good		5	good	Yes
6	some mis-shaped	NO	6	good	Yes
			7	good	Yes
			8	good	Yes
			9	good	Yes
			10	good	Yes

JP 2015 July 10

Form approved by: J. Pickard Date: June 30, 2011

ECOTOXICOLOGY

BIVALVE EMBRYO-LARVAL DEVELOPMENT TEST
Embryo Density Determination for PSEP Tests

Species: M. galloprovincialis
Organism Lot#: MR150609
Start Date: 2015 Jun 10
Analyst: M.Thompson

Egg Suspension Preparation

	Count #1	Count #2	Count #3	Average (300-400)
Initial Egg Suspension Counts (10 μL):	344	317	378	346

Pipette ID: BBY2-0273

Volume of egg suspension (100 mL) diluted with 100 mL of seawater
to obtain a final volume of 200 mL with a density of 30,000-40,000 eggs/mL
Time egg suspension prepared: 10:35

Fertilization

Volume of sperm suspension used for fertilization: 60mL
Time sperm added to egg suspension: 10:41

Embryo Preparation

	Count #1	Count #2	Count #3	Average (200-400)
Test Embryo Suspension Counts (10 μL) :	259	309	246	271

Pipette ID: BBY2-0273

Volume of embryo suspension (~~260~~ 100 mL) ~~diluted~~ removed with 20 mL of seawater
to obtain a final volume of 80 mL with a density of 20,00-40,000 eggs/mL
ME MB 2015 Jun 10
Time embryo suspension prepared: 13:50
Time embryos seeded into test: 13:55
Pipette ID (for seeding test): BBY2-0111

Control Embryo Counts

Preserve 6 replicate 10mL aliquots from monitoring jars. After settling, remove 1mL aliquots from each tube until all embryos have been found. Record total number of embryos in each of the 6 replicates below

Date(s) Counted: 2015Jun12, 2015 Jun23
Analyst(s): M.Thompson, M.O'Toole

Rep #1	Rep #2	Rep #3	Rep #4	Rep #5	Rep #6	Average
259	201	207	193	189	161	202

Observations:

2015 Jun 12 M. Thompson

12:01 (~46 hours) - 157 "D" shaped / 46 round (77%)
12:45 (47 hours) - 134 "D" / 33 round (80%)
14:15 (48.5 hours) - 153 "D" / 39 round (80%)
15:15 (49.5 hours) - 165 "D" / 20 round (89%)
16:00 (~50 hours) - 183 "D" / 15 round (92%) } Avg = 91%
- 168 "D" / 18 round (90%)

Ref tox #1 and #2 can come down (>90% "D" shells)

16:45 (51 hours) - 139 "D" / 16 round (90%)
17:45 (52 hours) - 145 "D" / 11 round (94%)
- 162 "D" / 19 round (90%) } Avg = 92%
- 188 "D" / 19 round (91%)
18:18 (~52.5 hours) - 147 "D" / 18 round (89%)
- 136 "D" / 10 round (93%) } Avg = 91%
- 163 "D" / 17 round (91%)
19:26 (~54 hours) - 116 "D" / 14 round (89%)
- 147 "D" / 20 round (88%) } Avg = 88%
- 137 "D" / 19 round (88%)

Development has appeared to have plateaued.
Will take test down @ 54 hours.
2015 Jun 12 M. Thompson

JP 2015 July 10

APPENDIX H

WILDLIFE DIET MODEL AND SAMPLE CALCULATION FOR WILDLIFE EXPOSURE

1.0 APPENDIX H1 – WILDLIFE EXPOSURE CALCULATION

1.1 Lesser Scaup Exposure to Contaminants of Concern (COCs) on the Site

The exposure estimations for wildlife were based on a modified wildlife dietary exposure model by Sample and Suter (1994) for the calculation of a total daily oral dose (TDOD). This model derives exposure for receptors using concentrations of COCs in sediment and food items as presented below.

The tissue concentrations assumed for invertebrates and plants were the maximum concentrations (in dry weight (dw)) measured in crustacean/mollusks and algal tissues on-Site, respectively. For the scaup, it was assumed that insect body burden was the same as crustacean/mollusk.

1.1.1 Total Daily Oral Dose Calculation

This section provides a sample calculation for a scaup's exposure to naphthalene in sediments (one of the Polycyclic Aromatic Hydrocarbon (PAHs) that are COCs at the Site). Wildlife total daily oral doses were estimated using the following model:

$$TDOD = (SUF)\left[\sum_{i=1}^{m}\sum_{k=1}^{n} P_{ik}\left(IR_i \times C_{ijk}\right)\right]$$

m = Total number of ingested media (e.g., food, soil) (unitless)
n = Number of types of medium (i) consumed (unitless)
IR_i = Ingestion rate for medium (i) (kg/kg BW/day or L/kg BW/day)
P_{ik} = Proportion of type (k) of medium (i) consumed (unitless)
C_{ijk} = Concentration of contaminant (j) in type (k) of medium (i) (mg/kg)
SUF = site use factor (unitless).

This model can be broken down to the following:

Total Oral Dose Daily Dose (TDOD) of COC (j) or total exposure (E_{total}):

E_{total} = SUF X (E_{food} + $E_{sediment}$)

Where:

E_{total} = total exposure from all pathways (mg/kg-day)

E_{food} = total exposure from food consumption (mg/kg-day)

$E_{sediment}$ = total exposure from sediment consumption (mg/kg-day)

SUF = site use factor (unitless). Applied a value of 1 for SUF (i.e., assumes receptor spends all its time on the Site).

Food Ingestion:

E_{food} = P x (IR_{food} X C_{food})

Where:

E_{food} = exposure from food consumption (mg/day)

P = proportion of the food type in the diet

IR_{food} = food ingestion rate (kg/kg BW/day) dw

C_{food} = COC concentration in food (mg/kg) dw

Food Ingestion Rates (IR_{food}), which are body weight normalized based on the weight of the receptor, are presented in Table H1 of the Wildlife Diet Model, in Appendix H.

Ingestion of Sediments:

$$E_{sediment} = IR_{sediment} \text{ X } C_{sediment}$$

Where:

$E_{sediment}$ = exposure from sediment ingestion (mg/day)

$IR_{sediment}$ = Incidental sediment ingestion rates was assumed to be 2% of IR_{food}

$C_{sediment}$ = COC concentration in sediment (mg/kg) dw

The sediment concentration applied was the calculated 95% UCLM concentration found for each COC.

The following are the pertinent variable values used to estimate the scaup's TDOD to naphthalene at the Site:

$C_{sediment}$ = 1.7 mg/kg (dw)
$C_{vegetation}$ = 0.015 mg/kg (algal tissue on site in dw)
$C_{invertebrates}$ = 0.017 mg/kg (crustacean/mollusks tissue on site in dw)
$IR_{sediment}$ = 0.0014 kg dw/day
IR_{food} = 0.07 kg dw food /kg BW /day
$P_{vegetation}$ = 0.90
$P_{invertebrates}$ = 0.10

1.1.2 Example Exposure Calculation

$E_{sediment}$ = (0.0014 kg dw/day) (1.7 mg/kg) = 0.0024 mg/kg-day

$E_{vegetation}$ = (0.9) (0.07 kg dw food /kg BW /day) (0.015 mg/kg) = 0.00095 mg/kg-day

$E_{invertebrates}$ = (0.1) (0.07 kg dw food /kg BW /day) (0.017 mg/kg) = 0.00012 mg/kg-day

E_{food} = 0.00095 mg/kg-day + 0.00012 mg/kg-day = 0.0011 mg/kg-day

E_{total} = (1) (0.0024 mg/kg-day + 0.0011 mg/kg-day) = 0.003 mg/kg-day

1.1.3 Example Hazard Quotient Calculation

Wildlife HQs were calculated using the following model:

$$HQ = \frac{E_{total}}{TRV}$$

Where:

HQ = Hazard Quotient (unitless)
E_{total} (or TDOD) = Total Exposure (i.e. Total Daily Oral Dose) (mg/kg-day)
TRV = Toxicity Reference Value (mg/kg-day)

The sample HQ calculation below is for the scaup's estimated daily oral exposure to naphthalene at the Site.

$$HQ = \frac{\mathrm{Etotal}}{TRV} = \frac{0.003mg / kg - day}{15mg / kg / day} = 0.0002$$

TABLE H2: EXPOSURE ASSESSMENT PARAMETERS USED IN THE WILDLIFE DIET MODEL

Species	Parameter	Parameter Abbreviation	Units	Value	Reference
Surface Area of Impacted Sediment on the Site was assumed to be the entire area of the Site = 27,087 m^2 (2.81 ha)					
River Otter	Body Weight (average)	BW	kg	7.5	EC FCSAP Module 3
(carnivorous mammal)	Foraging Range (average)		ha	900	EC FCSAP Module 3
dry weight (dw)	Ingestion sediment (2%)	$IR_{sediment}$	kg/day	0.0006	Calculated with FCSAP data
dw	Ingestion food	IR_{food}	kg food /kg BW /day	0.03	EC FCSAP Module 3
	Diet composition Used	Invertebrates	%	100	EC FCSAP Module 3
Lesser Scaup	Body Weight (average)	BW	kg	0.707	EC FCSAP Module 3
(omnivorous bird)	Foraging Range (average)		ha	10	EC FCSAP Module 3
dw	Ingestion sediment (2%)	$IR_{sediment}$	kg/day	0.0014	Calculated with FCSAP data
dw	Ingestion food	IR_{food}	kg food /kg BW /day	0.07	EC FCSAP Module 3
	Diet composition Used	Invertebrates	%	90	EC FCSAP Module 3
		Vegetation	%	10	EC FCSAP Module 3

Notes:

IRs was calcluated using assumed incidental sediment ingestion rate of 2%

TABLE H2: ECOLOGICAL DIET MODEL FOR WILDLIFE EXPOSED TO COCS

Receptor	Dry Food Ingestion Rate (IR_{food}) (kg dw food /kg BW /day)	Dry Sediment Ingestion Rate ($IR_{sediment}$) (kg dw/day)	Food Item	Diet Compostition (P) (%)	COPC	Site-Specific Media		Site-Specific Exposure (E)		Site Use Factor (SUF) (unitless)	Sum Site-Specific (SS) Exposure: E_{total} = (E_{food} + $E_{sediment}$) * SUF (mg/kg-day)
						Food Source (C_{food}) (mg/kg) dw	Sediment ($C_{sediment}$) (mg/kg) dw	Food: E_{food} = [Sum C_{food} *(IR_{food}*P)] (mg/kg-day)	Sediment: $E_{sediment}$ = ($C_{sediment}$*$IR_{sediment}$) (mg/kg-day)		
River Otter	0.03	0.0006	invertebrates	1.00	2-methylnaphthalene	-	2.4	-	0.0014	1	-
					acenaphthene	0.017	0.6	0.00051	0.0004		0.0009
					acenaphthylene	0.017	0.07	0.00051	0.0000		0.0006
					anthracene	0.039	0.9	0.00117	0.0005		0.002
					benz(a)anthracene	0.029	1	0.00087	0.0006		0.001
					chrysene	0.043	1.4	0.00129	0.0008		0.002
					fluoranthene	0.079	5.3	0.00237	0.0032		0.006
					fluorene	0.017	0.6	0.00051	0.0004		0.0009
					naphthalene	0.017	1.7	0.00051	0.0010		0.002
					phenanthrene	0.045	2.7	0.00135	0.0016		0.003
					pyrene	0.051	3.4	0.00153	0.0020		0.004
					benzo(a)pyrene	0.033	0.7	0.00099	0.0004		0.001
					total PAHs	-	26.2	-	0.0157		-
Lesser Scaup	0.07	0.0014	vegetation	0.90	2-methylnaphthalene	-	2.4	-	0.0034	1	-
					acenaphthene	0.015	0.6	0.0011	0.0008		0.002
					acenaphthylene	0.015	0.07	0.0011	0.0001		0.001
					anthracene	0.015	0.9	0.0012	0.0013		0.002
					benz(a)anthracene	0.018	1	0.0013	0.0014		0.003
					chrysene	0.033	1.4	0.0024	0.0020		0.004
					fluoranthene	0.06	5.3	0.004	0.0074		0.01
					fluorene	0.015	0.6	0.0011	0.0008		0.002
					naphthalene	0.015	1.7	0.0011	0.0024		0.003
					phenanthrene	0.02	2.7	0.0016	0.0038		0.01
					pyrene	0.042	3.4	0.003	0.0048		0.01
					benzo(a)pyrene	0.029	0.7	0.0021	0.0010		0.003
					total PAHs	-	26.2	-	0.0367		-
	0.07	0.0014	invertebrates	0.10	2-methylnaphthalene	-	2.4	* Plant and benthic invertebrates concentrations were added together to derive exposure for the Lesser Scaup.			
					acenaphthene	0.017	0.6				
					acenaphthylene	0.017	0.07				
					anthracene	0.039	0.9				
					benz(a)anthracene	0.029	1				
					chrysene	0.043	1.4				
					fluoranthene	0.079	5.3				
					fluorene	0.017	0.6				
					naphthalene	0.017	1.7				
					phenanthrene	0.045	2.7				
					pyrene	0.051	3.4				
					benzo(a)pyrene	0.033	0.7				
					total PAHs	-	26.2				

TABLE H3: SUMMARY OF TOXICITY REFERENCE VALUES FOR THE WILDLIFE DIET MODEL

Receptor	COC	TRV (mg/kg-day)
Mammal	2-methylnaphthalene	65.6
	acenaphthene	65.6
	acenaphthylene	65.6
	anthracene	65.6
	benz(a)anthracene	0.615
	chrysene	0.615
	fluoranthene	65.6
	fluorene	65.6
	naphthalene	65.6
	phenanthrene	65.6
	pyrene	0.615
	benzo(a)pyrene	0.615
	total PAHs	-
Bird	2-methylnaphthalene	15
	acenaphthene	15
	acenaphthylene	15
	anthracene	15
	benz(a)anthracene	0.107
	chrysene	0.107
	fluoranthene	15
	fluorene	15
	naphthalene	15
	phenanthrene	15
	pyrene	20.5
	benzo(a)pyrene	0.107
	total PAHs	-

TABLE H4: SUMMARY OF HAZARD QUOTIENTS FOR WILDLIFE EXPOSED TO COCS

Receptor	COC	Total Exposure (E_{total}) (mg/kg-day)	Toxicity Reference Value (TRV) (mg/kg-day)	Hazard Quotient ($HQ = E_{total} / TRV$)
River Otter	2-methylnaphthalene	-	65.6	-
	acenaphthene	0.0009	65.6	0.00001
	acenaphthylene	0.0006	65.6	0.00001
	anthracene	0.002	65.6	0.00003
	benz(a)anthracene	0.001	0.615	0.002
	chrysene	0.002	0.615	0.003
	fluoranthene	0.006	65.6	0.00008
	fluorene	0.0009	65.6	0.00001
	naphthalene	0.002	65.6	0.00002
	phenanthrene	0.003	65.6	0.00005
	pyrene	0.004	0.615	0.006
	benzo(a)pyrene	0.001	0.615	0.002
	total PAHs	-	-	-
Lesser Scaup	2-methylnaphthalene	-	15	-
	acenaphthene	0.002	15	0.0001
	acenaphthylene	0.001	15	0.00008
	anthracene	0.002	15	0.0002
	benz(a)anthracene	0.003	0.107	0.03
	chrysene	0.004	0.107	0.04
	fluoranthene	0.01	15	0.001
	fluorene	0.002	15	0.0001
	naphthalene	0.003	15	0.0002
	phenanthrene	0.01	15	0.0004
	pyrene	0.01	20.5	0.0004
	benzo(a)pyrene	0.003	0.107	0.03
	total PAHs	-	-	-

APPENDIX I
TRV DETAILS

TABLE I1 : TOXICITY REFERENCE VALUES FOR PLANTS

COC	Test Species	Test Endpoint	Measurement	CBR (mg/kg ww)	Source	Notes
2-methylnaphthalene	Not Available					
Acenaphthene	Not Available					
Acenaphthylene	Not Available					
Anthracene	***Scenedesmus vacuolatus***	**ED50**	**Reproduction**	**25.1**	**Grote et al, 2005**	modelled tissue concentration, not measured
Benzo(a)anthracene	***Scenedesmus vacuolatus***	**ED50**	**Reproduction**	**21.8**	**Grote et al, 2005**	modelled tissue concentration, not measured
Chrysene	Not Available					
Fluoranthene	***Scenedesmus vacuolatus***	**ED50**	**Reproduction**	**17.8**	**Grote et al, 2005**	modelled tissue concentration, not measured
Fluorene	Not Available					
Naphthalene	Not Available					
Phenathrene	***Scenedesmus vacuolatus***	**ED50**	**Reproduction**	**910.3**	**Grote et al, 2005**	modelled tissue concentration, not measured
Pyrene	***Scenedesmus vacuolatus***	**ED50**	**Reproduction**	**23.3**	**Grote et al, 2005**	modelled tissue concentration, not measured
Benzo(a)pyrene	Not Available					
Total PAHs	Not Available					

Notes:
ED50: Median Effective Dose that produces an effect in 50% of the population
CBR: Critical body residues
ERED: U.S. Army Corps of Engineers/U.S. Environmental Protection Agency Environmental Residue-Effects Database
Results in **Bold** are the CBRs selected as TRVs

TABLE I2: TOXICITY REFERENCE VALUES FOR BENTHIC INVERTEBRATES

COC	Receptor	Test Species	Test Endpoint	Measurement	CBR (mg/kg ww)	Source	Effect
2-Methylnaphthalene	Crab	Not Available					
	Mussels	Not Available					
Acenaphthene	Crab	Not Available					
	Mussel	***Mytilus edulis***	**ED50**	**Growth**	**29.4**	**Donkin et al, 1989**	Reduction in feeding rate
Acenaphthylene	Crab	Not Available					
	Mussels	Not Available					
Anthracene	Crab	***Rhepoxynius abronius***	**LD22**	**Mortality**	**9.09**	**Boese et al, 1999**	
	Mussels	Not Available					
Benzo[a]anthracene	Crab	***Rhepoxynius abronius***	**LD22**	**Mortality**	**8.26**	**Boese et al, 1999**	
	Mussel	***Dreissena polymorpha***	**NOED**	**Mortality**	**0.6**	**Roper et al, 1996**	
Chrysene	Crab	***Rhepoxynius abronius***	**LD22**	**Mortality**	**3.15**	**Boese et al, 1999**	
	Mussel	***Dreissena polymorpha***	**NOED**	**Mortality**	**0.93**	**Roper et al, 1996**	
Fluoranthene	Crab	***Schizopera knabeni***	**ED25**	**Reproduction**	**40.5**	**Lotufo 1998**	
		Coullana sp	ED25	Feeding	20.23	**Lotufo 1998**	
	Mussel	***Mytilus edulis***	**LOED**	**Mortality**	**1.5**	**Eertman et al 1995**	Reduced tolerance to aerial exposure.
Fluorene	Crab	***Hyalella azteca***	**ED17**	**Growth**	**85.38**	**Schuler et al, 2007**	
	Mussels	Not Available					
Naphthalene	Crab	***Diporeia* spp.**	**ED50**	**Mortality**	**346.06**	**Landrum et al, 2003**	Immobility
	Mussels	***Mytilus edulis***	**ED50**	**Growth**	**31.3**	**Donkin et al, 1989**	Reduction in feeding rate
Phenanthrene	Crab	***Diporeia* spp.**	**ED50**	**Mortality**	**303.0**	**Landrum et al, 2003**	Immobility
	Mussels	Not Available					
Pyrene	Crab	***Diporeia* spp.**	**ED50**	**Mortality**	**1233.79**	**Landrum et al, 2003**	Immobility
	Mussel	***Dreissena polymorpha***	**NOED**	**Mortality**	**1.08**	**Roper et al, 1996**	
		Dreissena polymorpha	ED50	Feeding rate	189	Donkin et al, 1989	
Benzo[a]pyrene	Crab	***Ampelisca abdita***	**LC50**	**Mortality**	**23**	**Fay et al, 2000**	
	Mussel	***Mytilus edulis***	**LOED**	**Mortality**	**3.2**	**Eertman et al 1995**	Reduced tolerance to aerial exposure.
Total PAHs	Crab	***Pandalus borealis***	**LD10**	**Mortality**	**0.096**	**Bechmann et al, 2010**	
	Mussel	***Dreissena polymorpha***	**NOED**	**Mortality**	**10.4**	**Roper et al, 1996**	
		Mytilus edulis	ED25	Cellular	0.211	Sunt et al, 2011	

Notes:
ED17: Median Effective Dose that produces an effect in 17% of the population
ED25: Median Effective Dose that produces an effect in 25% of the population
ED50: Median Effective Dose that produces an effect in 50% of the population
LD10: Lethal dose in which 10% of the population will die
LD22: Lethal dose in which 22% of the population will die
LD50: Lethal dose in which 50% of the population will die
LOED: Low observed effective dose
NOED: No observed effective dose
CBR: Critical body residues
ERED: U.S. Army Corps of Engineers/U.S. Environmental Protection Agency Environmental Residue-Effects Database
Results in **Bold** are the CBRs selected as TRVs

TABLE I3: TOXICITY REFERENCE VALUES FOR BIRDS

COC	Test Endpoint	TRV (mg/kg bw/day)	Measurement	Reference From Environment Canada, 2015
2-methylnaphthalene	Not Available			
Acenaphthene	Not Available			
Acenaphthylene	Not Available			
Anthracene	Not Available			
Benzo(a)anthracene	NOEL	0.107	Survival, reproduction and growth effects.	LANL (2014)
Chrysene	Not Available			
Fluoranthene	Not Available			
Fluorene	Not Available			
Naphthalene	NOEL	15	Mortality	LANL (2014); Eco-SSL (2007)
Phenathrene	Not Available			
Pyrene	NOEL	20.5	Mortality	LANL (2014)
Benzo(a)pyrene	Not Available			
Total PAHs	Not Available			

Notes:

NOAEL: No Observed Adverse Effect Level

Eco-SSL: USEPA Ecological Soil Screening Levels

LANL: Los Alamos National Laboratory

TABLE I4: TOXICITY REFERENCE VALUES FOR MAMMALS

COC	Test Endpoint	TRV (mg/kg bw/day)	Measurement	Reference From Environment Canada, 2015
2-methylnaphthalene	Not Available			
Acenaphthene	Not Available			
Acenaphthylene	Not Available			
Anthracene	Not Available			
Benzo(a)anthracene	Not Available			
Chrysene	Not Available			
Fluoranthene	Not Available			
Fluorene	Not Available			
Naphthalene	The highest bounded NOAEL that is lower than the lowest bounded LOAEL	65.6	Reproduction, growth and survival	Eco-SSL (2007)
Phenathrene	Not Available			
Pyrene	Not Available			
Benzo(a)pyrene	The highest bounded NOAEL that is lower than the lowest bounded LOAEL	0.615	Reproduction, growth and survival	Eco-SSL (2007)
Total PAHs	Not Available			

Notes:
NOAEL: No Observed Adverse Effect Level
LOAEL: Low Observed Adverse Effect Level
Eco-SSL: USEPA Ecological Soil Screening Levels

APPENDIX J
PROTOCOL 20 CHECKLIST

BRITISH COLUMBIA | Ministry of Environment

PROTOCOL 20

FOR CONTAMINATED SITES

Detailed Ecological Risk Assessment Requirements

Version 1.0

Prepared pursuant to Section 64 of the
Environmental Management Act

Approved: Michael W. Macfarlane — Director of Waste Management — March 13, 2013 — Date

Effective date: April 1, 2013

1.0 Definitions

The following words, acronyms and expressions used in this protocol are defined in ministry Procedure 8, "Definitions and Acronyms for Contaminated Sites":

- Approved Professional
- contaminated sites legal instrument
- Director
- conceptual model
- detailed site investigation (DSI)
- ecological risk assessment
- exposure pathway
- high risk site
- ministry
- monitoring plan
- potential contaminant of concern
- preliminary site investigation (PSI)
- receptor
- Regulation
- remediation
- risk-based standards
- screening risk assessment (SLRA)
- sediment
- Summary of Site Condition (SoSC)
- toxicity reference value (TRV)
- weight-of-evidence

In addition, under this protocol, ecological risk assessment is considered equivalent to environmental risk assessment under the Contaminated Sites Regulation.

2.0 Introduction

This protocol identifies components of, and requirements for, the completion of a detailed ecological risk assessment (DERA) as described under the Contaminated Sites Regulation (the Regulation).

Any DERA completed for regulatory purposes is expected to follow the risk assessment methodology, procedures and guidance in Technical Guidance 7, "Supplemental Guidance for Risk Assessments." In the case that Technical Guidance 7 methods, procedures or guidance is not followed, the deviation and a rationale justifying the deviation, must be fully documented in the risk assessment report.

3.0 Detailed ecological risk assessment checklist

Appendix 1 of this protocol contains a checklist listing the key elements of any DERA submitted in support of a recommendation to issue a contaminated sites legal instrument based on compliance with the Regulation's risk-based standards.

Section IV of the checklist takes the form of a four column table, which presents key DERA elements in the following subsections keyed to DERA methodology:

1) General Requirements,
2) Problem formulation,
3) Exposure assessment,
4) Effects assessment,
5) Risk characterization, and
6) Uncertainty Assessment.

For each subsection, Column I of Section IV lists the relevant DERA Checklist elements. A response to the question in Column I is required if "Mandatory" is listed beside that element in Column II. In Column III, the applicant's response to the checklist element must be recorded as either "yes" or "no." Column IV provides the applicant with an opportunity to include comments related to the answer provided in Column III.

A negative response to a mandatory checklist element may jeopardize a recommendation to issue a contaminated site legal instrument. In the case that a negative response is provided to a mandatory item in column III, a rationale justifying deviation from the mandatory element must be provided in Column IV. For example, if no operative ecological pathways exist now or in the future at a site, this lack of operative pathways would justify a "no" answer to exposure related mandatory elements in the checklist.

Checklist elements identified as "Optional" in Column I of Section IV of the checklist may or may not be answered at the discretion of the risk assessor. These optional elements involve general good DERA practice, which, while recommended, are not considered by the ministry to be critical to completion of detailed ecological risk assessments under the Regulation.

The risk assessor(s) responsible for the DERA must complete and sign Part 3 of the checklist. Note that all signatories to Part 3 are jointly and equally responsible for all risk assessment aspects of the Detailed Ecological Risk Assessment.

The checklist is designed to provide an opportunity for the risk assessor(s) to demonstrate that the risk assessment includes all required elements of a detailed ecological risk assessment. Determining if a particular required element of the risk assessment has been adequately addressed is the responsibility of the risk assessment reviewer (i.e., the ministry risk assessor or the risk assessment Approved Professional) for the site.

4.0 Reporting

A completed DERA Checklist must be provided with any DERA report submitted in support of a recommendation to issue a contaminated sites legal instrument based on compliance with the risk-based standards of the Regulation.

For sites with operable pathways, the detailed ecological risk assessment report must be structured as a formal framework of related objectives, assessment endpoints and measurement endpoints. The report must summarize the pertinent information from site investigation and ecological risk assessment performed for the site.

In particular the DERA must:

a) provide context for the source of site contamination and the environmental fate and effect of contamination on ecological receptors at the site;
b) describe and evaluate: pertinent physical, chemical and biological processes which influence the effects of contaminants on ecological receptors at the site;
c) describe the process by which contaminants of concern and critical ecological receptors were selected for the site;
d) provide a conceptual model which includes potential contaminants of concern, lists all potential contaminant exposure pathways, and identifies operative (i.e. open) pathways for the site;
e) provide sufficient methodological detail to allow risk equations and calculated risk estimates to be independently reproduced and validated;
f) provide a final conclusion on the acceptability of the level of ecological risk determined in the DERA completed for the site;
g) provide a comprehensive uncertainty analysis for all aspects of the DERA which contribute to the conclusion related to the acceptability of the level of ecological risk determined in the DERA completed for the site; and
h) in the case that weight-of-evidence based arguments or considerations are used to determine the level of ecological risk for the site, provide clear and preferably quantifiable, *a priori* weightings assigned with specific corresponding underlying rationale and an associated uncertainty assessment for all weighted aspects of the DERA which contribute to the level of ecological risk determined for the site.

For more information contact the Environmental Management Branch at site@gov.bc.ca

Appendix 1

Detailed Ecological Risk Assessment Checklist

BRITISH COLUMBIA | Ministry of Environment

DETAILED ECOLOGICAL RISK ASSESSSMENT CHECKLIST

Land Remediation Section
PO Box 9342 Stn Prov Govt
Victoria B.C. V8W 9M1
Telephone: (250) 387-4441
Fax: (250) 387-8897

Submission of this checklist is required by Protocol 20, "Detailed Ecological Risk Assessment Checklist" under the *Environmental Management Act*.

Part 1. Land, owner and risk assessor information

Section I Land Description						
Site ID Number (if known)	11687					
PID	029-036-500	or		PIN		
Legal Description	Lot A, Section 1, and Part of the Bed of the Public Harbour of Nanaimo, Nanaimo District Plan EPP27507					
Latitude	Degrees	49°	Minutes	09'	Seconds	50.3" North
Longitude	Degrees	123°	Minutes	55'	Seconds	50.7" West
Site Civic Address	Street	1 Port Drive				
	City	Nanaimo, BC			Postal Code	

Section II Property Owner and/or Operator (if applicable)				
Name	City of Nanaimo			
Address	Street	455 Wallace Street		
	City	Nanaimo	Province/State	BC
	Country	Canada	Postal/Zip Code	V9R 5J6
Phone	250-754-4251	Fax	E-Mail	

Section III Risk Assessor(s)	
Name(s)	Kristy Gabelhouse and Scott Steer
Organization(s)	Tetra Tech EBA Inc. and Steer Environmental Associates Ltd.
Address:	~~1-4376 Boban Drive~~
Street	1-4376 Boban Drive
City, Province/State	Nanaimo, BC
Country, Postal/Zip Code	Canada V9T 6A7
Phone	250-756-2256
Fax	
E-Mail	kristy.gabelhouse@tetratech.com

Part 2. Detailed Ecological Risk Assessment Checklist

Section IV Detailed Ecological Risk Assessment Checklist			
Column I	Column II	Column III	Column IV
DERA Checklist Element	Response Requirement	Response (Yes or No)	Comments
Subsection 1.0 General Requirements			
1.1 Does the DERA identify who the major participants are in the risk assessment and state their qualifications?	Mandatory	Yes	Section 7.0 Qualifications of Assessors
1.2 Does the DERA describe how the method(s) of assessment and the findings of any previous investigation(s) were used to design and carry out the current assessment?	Mandatory	Yes	Section 2.4
1.3 Does the DERA describe the extent to which any previous assessment(s) were/were not relied upon?	Mandatory	Yes	Section 2.4
1.4 If ministry preapprovals apply to the DERA, has all required preapproval documentation been provided with the risk assessment?	Mandatory	n/a	

Section IV Detailed Ecological Risk Assessment Checklist			
Column I	**Column II**	**Column III**	**Column IV**
DERA Checklist Element	**Response Requirement**	**Response (Yes or No)**	**Comments**
1.5 Does the report make it clear what conditions are required (if any) for the instrument being applied for (e.g., Schedule B conditions for a Certificate of Compliance)?	Mandatory	Not at this time	
1.6 Has field data relevant to the ecological risk assessment been provided?	Mandatory	Yes	
1.7 Has laboratory data relevant to the ecological risk assessment been provided?	Mandatory	Yes	Appendix B and Appendix H Also Appendix I

Subsection 2.0 Problem Formulation			
2.1 Have the objectives of the ecological risk assessment been documented[1]?	Mandatory	Yes	Section 1.0 - Introduction
2.2 Were assessment and measurement endpoints for operative exposure pathways warranting further assessment defined[1]?	Mandatory	Yes	Section 4.2.6
2.3 Were assessment and measurement endpoints linked to the risk assessment objectives[1]?	Mandatory	Yes	Section 4.2.6
2.4 Were all current and reasonable potential future land, water and sediment uses identified in the problem formulation and considered in screening for chemical exceedances?	Mandatory	Yes	Current was defined (Section 2.0) Future not applicable at this time
2.5 Were assumptions associated with current and future land use documented and rationale provided (e.g., development scenario)?	Mandatory	n/a	
2.6 Were potential contaminants of concern identified?	Mandatory	Yes	Section 4.2.1
2.7 Was a conceptual model included?	Mandatory	Yes	Section 4.2.5 and Figure 4
2.8 Were all relevant exposure pathways (direct and indirect) identified and considered?	Mandatory	Yes	Section 4.2.3

Section IV Detailed Ecological Risk Assessment Checklist			
Column I	**Column II**	**Column III**	**Column IV**
DERA Checklist Element	**Response Requirement**	**Response (Yes or No)**	**Comments**
2.9 If the site was previously assessed using screening level risk assessment (SLRA) and if exposure pathways excluded under the SLRA were not considered in the DERA; were the assumptions upon which the pathways were excluded in the SLRA confirmed in the DERA[2]?	Mandatory	n/a	
2.10 If statistics were used in the DERA, was a rationale provided for the statistical methods used?	Mandatory	Yes	Section 4.4.1.2
2.11 Was a rationale provided for any exclusion of contaminants that exceed applicable standards, criteria, or guidelines[3]?	Mandatory	n/a	
2.12 Did a qualified biologist visit and assess the site?	Mandatory	Yes	
2.13 Were receptors of potential concern identified based on commonly accepted risk assessment practice, including consideration of: ecological relevance, social importance, exposure potential and contaminant sensitivity[4]?	Mandatory	Yes	Section 4.2.2
2.14 Was the site assessed for likely use by red and blue listed species?	Mandatory	Yes	Section 4.2.2
2.15 Were contaminant-pathway-receptor combinations that warranted further assessment clearly identified?	Mandatory	Yes	Section 4.2.4
2.16 If contaminant-pathway-receptor combinations were excluded from further assessment, was a rationale for the exclusion provided?	Mandatory	Yes	Section 4.2.4
2.17 If bioassays were used, was detailed rationale provided for the selection of the toxicity tests used, (e.g., consideration of: sensitivity of the organism to the potential contaminants of concern; potential confounding factors; taxonomic diversity, etc.)?	Mandatory	Yes	Section 4.3.2

Section IV Detailed Ecological Risk Assessment Checklist			
Column I	Column II	Column III	Column IV
DERA Checklist Element	Response Requirement	Response (Yes or No)	Comments
2.18 If the assessment of risk was based on several lines of evidence, was the approach used to evaluate individual lines of evidence and to integrate findings across lines of evidence documented[5]?	Mandatory	Yes	Section 4.2.7
2.19 Were future contaminant concentrations and potential contaminant degradation products considered?	Optional	n/a	

Subsection 3.0 Exposure Assessment			
3.1 Was each contaminant-pathway-receptor combination identified for further assessment evaluated?	Mandatory	Yes	Section 4.6
3.2 Was each applicable land use scenario (current and future) evaluated?	Mandatory	Yes	Current only
3.3 Was supporting rationale provided for methods used to estimate exposure point contaminant concentration(s)?	Mandatory	Yes	Section 4.4.1
3.4 If a fate and transport model or other exposure model was used, were model equations provided and referenced?	Mandatory	n/a	
3.5 If an exposure model was used, were equations and the input data provided to support an independent quality assurance check for each exposure route in the risk assessment?	Mandatory	Yes	Section 4.4.1.3
3.6 Were all exposure model parameters defined and was rationale provided for all exposure model parameter values (with references where applicable)?	Mandatory	Yes	Section 4.4.1.3 and Appendix J

Section IV Detailed Ecological Risk Assessment Checklist			
Column I	Column II	Column III	Column IV
DERA Checklist Element	Response Requirement	Response (Yes or No)	Comments
3.7 If an exposure model was used, was uncertainty regarding both: (a) the structure of the exposure model and (b) the parameter values used in the exposure model, considered in any interpretation of the results of the exposure modelling?	Mandatory	Yes	Section 5.1.2
3.8 If an exposure model was used, were the model's results compared to, or calibrated to, empirical (i.e., measured data) to determine if the model adequately represents reality?	Optional	No	
3.9 For any models used, was a sensitivity analysis or a rationale for the absence of a sensitivity analysis provided?	Optional	No	
3.10 Were data quality objectives established for field parameters used in the risk assessment?	Optional	N/A	

Subsection 4.0 Effects Assessment			
4.1 If ecological surveys (e.g., plant, soil invertebrate, bird, fish, or benthic communities) were conducted, was the survey methodology used (including sampling locations and seasons) documented?	Mandatory	Yes	Desktop survey Section 4.2.2
4.2 If toxicity reference values (TRVs) were used, was a rationale for the selection and/or development of the TRVs provided?	Mandatory	Yes	Section 4.5
4.3 If TRVs were used, was the source of the TRVs referenced? If TRVs were developed *de novo*, was their derivation documented?	Mandatory	Yes	Section 4.5 and Appendix K
4.4 If TRVs were used, was the toxicity endpoint associated with each TRV identified?	Mandatory	Yes	Section 4.5 and Appendix K
4.5 Did the level of protection used in the DERA comply with the level specified in the ministry ecological risk assessment policy summary[6] for the applicable land use or media?	Mandatory	Yes	Section 4.2.6

Section IV Detailed Ecological Risk Assessment Checklist			
Column I	**Column II**	**Column III**	**Column IV**
DERA Checklist Element	**Response Requirement**	**Response (Yes or No)**	**Comments**
4.6 If risks were evaluated relative to: a reference site(s) or reference condition(s), was rationale for the selection of the reference site(s) or reference condition(s) provided? Were confounding variables (e.g., soil: texture, pH, grain size, depth etc.) addressed and considered in the evaluation?	Mandatory	n/a	
4.7 If site-specific toxicity testing was conducted, did the test method(s) used meet the quality standards of Environment Canada[7], ASTM[8] or another recognized government agency?	Mandatory	Yes	Appendix I
4.8 If site-specific toxicity tests were conducted, did the tests include samples from the most contaminated area of the site?	Mandatory	Yes	Appendix I and Figure 7
4.9 Were potential toxicological interactions (e.g., synergistic or antagonistic effects) between potential contaminants of concern discussed?	Optional	No	
4.10 Were up to date toxicity profiles provided for each potential contaminant of concern?	Optional	No	

Subsection 5.0 Risk Characterization			
5.1 Was sufficient detail provided for equations used to calculate numeric risk estimates so that it is clear how the estimates were derived?	Mandatory	Yes	Section 4.6.2
5.2 Was preference given to the use of hazard quotients in expressing numeric risk estimates?	Mandatory	Yes	Section 4.6.2
5.3 If hazard quotients were calculated, were they documented for each complete contaminant-receptor-pathway combination (as identified in the Problem Formulation)?	Mandatory	Yes	Section 4.6.2

Section IV Detailed Ecological Risk Assessment Checklist			
Column I	**Column II**	**Column III**	**Column IV**
DERA Checklist Element	**Response Requirement**	**Response (Yes or No)**	**Comments**
5.4 If hazard quotients were not calculated, was rationale provided for using a different approach (e.g., site observations or plotting exposure with dose-response data)?	Mandatory	Yes	Section 4.6.2.3 (Fish)
5.5 If an ecological hazard quotient exceeded unity, but the level of risk was considered acceptable, was a rationale provided?	Mandatory	n/a	
5.6 Were risks for all operative contaminant-receptor-pathways detailed in the problem formulation assessed and categorized as acceptable or unacceptable?	Mandatory	Yes	Section 4.6.2
5.7 Were the conclusions (i.e., risk characterization) consistent with the assessment endpoints?	Mandatory	Yes	Section 4.6.2
5.8 Does the risk assessment provide an explicit risk conclusion in regard to the significance of the ecological risk posed by the contamination at the site?	Mandatory	Yes	Section 6.0

Subsection 6.0 Uncertainty Assessment			
6.1 Were uncertainties (e.g., measurement uncertainty, random variations, conceptual uncertainty and ignorance) explicitly evaluated and stated, including their implications on risk conclusions?	Mandatory	Yes	Section 5.0
6.2 If a weight-of-evidence approach was used, was preference given to assigning quantifiable, *a priori* weightings to weighted aspects of the DERA?	Mandatory	Yes	
6.3 If a weight-of-evidence approach was used, were the weight-of-evidence conclusions determined in a manner consistent with the approach laid out in the problem formulation?	Mandatory	Yes	Section 4.6

Section IV Detailed Ecological Risk Assessment Checklist			
Column I	Column II	Column III	Column IV
DERA Checklist Element	Response Requirement	Response (Yes or No)	Comments
6.4 If a weight-of-evidence approach was used, were uncertainties associated with the use of the assigned weightings explicitly evaluated and stated, including their implications on risk conclusions?	Mandatory	Yes	Section 5.1

Footnotes

1. Ecological risk assessment objectives and assessment and measurement endpoints are described in Science Advisory Board for Contaminated Sites in British Columbia, Report on: Detailed Ecological Risk Assessment (DERA) in British Columbia Technical Guidance, September, 2008.
2. Where both SLRA and DRA are applied at a site, pathways screened using SLRA should be re-evaluated in the problem formulation stage of the DRA to confirm that the assumptions and conditions inherent in SLRA are satisfied at the site.
3. Province of British Columbia. *Environmental Management Act. BC Reg 375/96* Contaminated Sites Regulation Section 59 (2).
4. Guidance on selecting receptors of potential concern can be found in Science Advisory Board for Contaminated Sites in British Columbia, Report on: Detailed Ecological Risk Assessment (DERA) in British Columbia Technical Guidance, September, 2008.
5. Guidance on the use of weight-of-evidence evaluation under DERA can be found in Science Advisory Board for Contaminated Sites in British Columbia, Report on: Guidance for a Weight of Evidence Approach in Conducting Detailed Ecological Risk Assessments (DERA) in British Columbia, October, 2010.
6. Ministry of Environment, lands and Parks. Tier 1 Ecological Risk Assessment Policy Decision Summary. Victoria, British Columbia. 1999.
7. Environment Canada toxicity test protocols are available from the Environment Canada Biological Test Method Series website. Environment Canada. Ottawa, Ontario.
8. ASTM toxicity testing protocols can be purchased through the ASTM Committee E47 on Biological Effects and Environmental Fate website. American Society for Testing and Materials International. Technical Committee E47 on Biological Effects and Environmental Fate.

Part 3. Professional Statements and Signatures

Section V Professional Statements and Signatures – To be completed by the Risk Assessor or Risk Assessment Specialist

In accordance with Section 63 of the Contaminated Sites Regulation, I confirm that:

1) the detailed ecological risk assessment for which this checklist is submitted has been performed in accordance with Ministry of Environment approved methods, procedures, guidance and standards of professional practice;
2) the responses provided in this Detailed Ecological Risk Assessment Checklist are true and accurate based on current knowledge as of the date completed; and
3) I have demonstrable experience in conducting ecological risk assessments and in conducting investigations of the type used to prepare the detailed ecological risk assessment for which this checklist is submitted.

Print Name	Signature	Date completed (yy-mm-dd)

If multiple signatories add additional Part 3 forms as needed.

NOTE: All signatories to Part 3 are jointly and equally responsible for all risk assessment aspects of the Detailed Ecological Risk Assessment

Apply professional society stamp (if applicable)