Technical Data Report

Marine Fish and Fish Habitat

ENBRIDGE NORTHERN GATEWAY PROJECT

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PREFACE

This TDR presents the results of data collected between 2005 and 2009. These data are used in Volume 6B, Sections 7, 8 and 9 of the environmental and socio-economic assessment (ESA) for the Project.

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Abbreviations

BC MAL .... British Columbia Ministry of Agriculture and Lands
BTEX .... benzene, toluene, ethylbenzene and xylenes
CCAA .... confined channel assessment area
CCME .... Canadian Council of the Ministers of the Environment
CD .... chart datum
CEPA .... Canadian Environmental Protection Agency
CISTI .... Canadian Institute of Scientific and Technical Information
COCIRM-SED .... (3-D) coastal circulation and sediment model
COSEWIC .... Committee on the Status of Endangered Wildlife in Canada
CRIMS .... Coastal Resource Information Management System
DFO .... Fisheries and Oceans Canada
DGPS .... Differential Global Positioning System
DOM .... dissolved organic matter
DL .... detection limit
ESA .... environmental and socio-economic assessment
FDEP .... Florida Department of Environmental Protection
FMA .... Fisheries Management Area
HHWLT .... higher high water, large tide
HMW .... high molecular weight
ISQG .... interim sediment and quality guidelines
LLWLT .... lower low water, large tide
LMW .... low molecular weight
LNT .... lowest normal tides
LRDW .... Land and Resource Data Warehouse
LUCO .... Land Use Coordination Office (British Columbia)
MDL .... method detection limit
MLLW .... mean lower low water
NH_3 .... ammonia
NOAA .... National Oceanic and Atmospheric Administration
NTIS .... National Technical Information Service
PAH .... polycyclic aromatic hydrocarbon
PCB .... polychlorinated biphenyl
PDA .... project development area
PEAA .... project environmental assessment area
PEL .... probable effects level
PNCIMA .... Pacific North Coast Integrated Management Area
ppt .... parts per thousand
SARA .... *Species at Risk Act*
SL .... standard length
TDR .... technical data report

the Project .... Enbridge Northern Gateway Project
TSS .... total suspended solids

Glossary

algae	A large and diverse group of simple, typically autotrophic organisms that are photosynthetic, like terrestrial plants. The largest and most complex marine forms are seaweed.
backshore zone	The area inland from the shore or beach.
bathymetry	Seafloor terrain as measured by depth sounding or radar.
beach seine	When two people drag a seine net along the bottom of a water body close to shore from the beach, usually in the intertidal or subtidal zone.
benthic	Refers to a region at or near the bottom of a body of water, or to organisms living there.
benthic invertebrates	Animals without a vertebral column that live at or near the bottom of a body of water.
biota	Collection of organisms of a geographic region or a time period.
bioturbation	The displacement and mixing of sediment particles by benthic flora or fauna.
bivalves	A marine or freshwater mollusc belonging to the taxonomic class *Bivalvia*. It has a soft body with plate-like gills enclosed within two shells hinged together.
boulder and cobble	Boulder is defined by Williams (1993) to be rocky substrate greater than 256 mm in diameter. Cobble is defined to be rocky substrate 64 to 256 mm in diameter.
boulder beach	A shoreline with predominantly rocky substrate greater than 256 mm in diameter.
dissolved metals	An element or compound that has passed into solution.
epibiota	Organisms living on the surface of other organisms.
estuarine	Relating to, or formed in, an estuary.
gillnet	A monofilament netting that is either weighted to the ocean floor or set adrift. Fish are caught as they try to swim through the webbing, entangling their gills.
herbivory	The consumption of living plant tissue by organisms.
inclinometer	An instrument used for measuring slope or angles.
infauna	Animals that live within bottom sediments.

intertidal (zone)	The area of the shoreline exposed and submerged by the tide cycle.
invertebrates	Animals without a vertebral column.
longline	Fishing gear consisting of a series of baited hooks attached to a longline. The line can be weighted, for fishing on the ocean bottom, or be suspended on floats in the water column. This is a type of fixed gear. (See also hookline.)
Lyngbye-associated wetland	Wetland habitat that is associated strongly with Lyngbye's sedge (*Carex Lyngbyei*).
macrophytes	Aquatic plants that grow in or near water.
mean lower low water	The average of the lowest tide recorded at a tide station each day during the recording period.
monoecious	Having male and female reproductive organs in the same organism.
outcrossing	Introducing unrelated genetic material into a breeding line.
pelagic	Inhabiting the open sea over or beyond the continental shelf and returning to shore only to breed.
pH	The common measure of the acidity or alkalinity of a liquid.
quadrat	A measured and marked square used to isolate a sample area.
ramp	Steep, rocky shoreline that has a slope greater than 30 degrees.
redox potential	The tendency of an ion, atom or molecule to acquire electrons.
rock wall	Shoreline type composed of near-vertical bedrock substrate.
salinity	The saltiness or dissolved salt content of a body of water.
secchi disk	A circular disk used to measure water transparency in oceans.
shore normal	At right-angles to the contours in the surf zone.
silt veneer	A thin layer or sheet of soil or rock derived granular material of a grain size between sand and clay.
substrate	A surface on which an organism grows or to which it is attached.
subtidal	The ocean environment below low tide that is always covered by water.
taxa	Groups of biological organisms.
total organic carbon	The amount of carbon bound in an organic substance.

total suspended solids	The total particulate matter (i.e., total suspended sediments) suspended in a unit of liquid. Particles can include microscopic biota, clay, or silt with attached organic and inorganic nutrients, mixed in the water column by currents or waves. Primary sources include river runoff, biological production and atmospheric fallout, with anthropogenic contributions from waste water effluent and substrate disturbances.
transect	A path or line along which surveys are conducted.
Veliger larvae	The larval stage of a shelled organism/bivalve mollusc where it has ciliated membranes for swimming and feeding.

1 Introduction

1.1 Objectives

The purpose of this document is to describe the baseline characteristics of the biophysical elements of marine fish and fish habitat that will be assessed in the environmental and socio-economic assessment (ESA) for the Enbridge Northern Gateway Project (the Project). Characteristics of the underwater acoustic environment are described in a separate report (see the Marine Acoustics (2006) Technical Data Report [JASCO 2006]). Information from the technical data report (TDR) will be used to identify construction and operational measures required to limit or avoid adverse effects on marine fish and fish habitat. Information has been generated and synthesized from existing literature sources and field surveys for the following key data categories:

- intertidal survey methodology and results
- subtidal survey methodology and results
- fish survey methodology and results
- crab survey methodology and results
- benthic invertebrate survey methodology and results
- sediment and water sampling methodology and results
- sediment dispersion modeling results

2 Methods

2.1 Study Area Boundaries

The marine environment encompasses three study areas (see Figures 2-1 and 2-2). For consistency with Sections 7, 8 and 9 of Volume 6B of the environmental and socio-economic assessment (ESA), the study areas are referred to throughout this TDR as:

- the confined channel assessment area (CCAA)
- the project environmental assessment area (PEAA)
- the project development area (PDA)

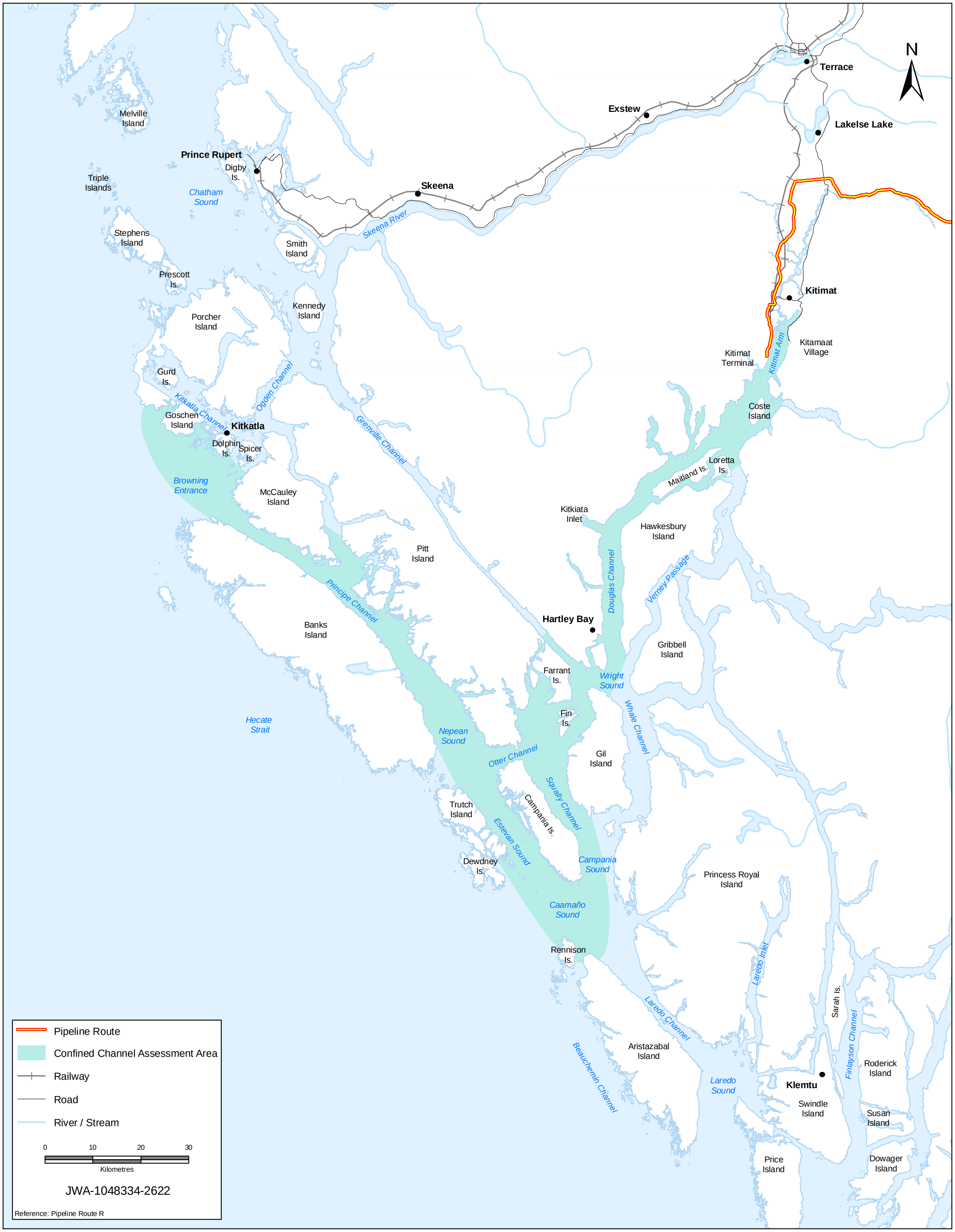
2.1.1 Study Area for Existing Data Review

Whenever possible, existing data focusing on the CCAA were used to describe the marine fish and fish habitat. Broader searches for data were also completed within the Pacific North Coast Integrated Management Area (PNCIMA), also known as the Queen Charlotte Basin. This area covers 88,000 km^2, stretching from the northwest coast of Vancouver Island to the Canada–Alaska border.

Existing information on marine fish in British Columbia is generally restricted to species that have economic or fisheries value. The TDR focuses on representative species that were chosen based on these values as well as species that play an ecologically or culturally important role in the region. The literature search focused on existing relevant data available for fish species in the CCAA. The CCAA includes most of Fisheries and Oceans Canada (DFO) Fisheries Management Area (FMA) 6 (see Figure 2-3) – which includes all of Douglas Channel and extends out to the middle of Hecate Strait between the southern tip of Banks Island to the southern tip of Aristazabal Island—and Principe Channel in FMA 5 (see Figure 2-3). In the absence of data specific to this area, the study area was further expanded to include the North Coast, Hecate Strait and the Pacific Northwest.

2.1.2 Study Area for Field Surveys

Field surveys were conducted on the north coast of Kitimat Arm, between Kitimat Estuary and Bish Cove (within the PEAA and generally the PDA) as this was identified as the most likely location for the proposed Kitimat Terminal.



REFERENCES: NTDB Topographic Mapsheets provided by the Majesty the Queen in Right of Canada, Department of Natural Resources. All rights reserved.

CONTRACTOR: Jacques Whitford AXYS Ltd.	ENBRIDGE NORTHERN GATEWAY PROJECT	FIGURE NUMBER: 2-1	DATE: 20090914
PREPARED BY: gem / PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES	Confined Channel Assessment Area	SCALE: 1:1,100,000	AUTHOR: NP / APPROVED BY: CM
		PROJECTION: UTM 9	DATUM: NAD 83

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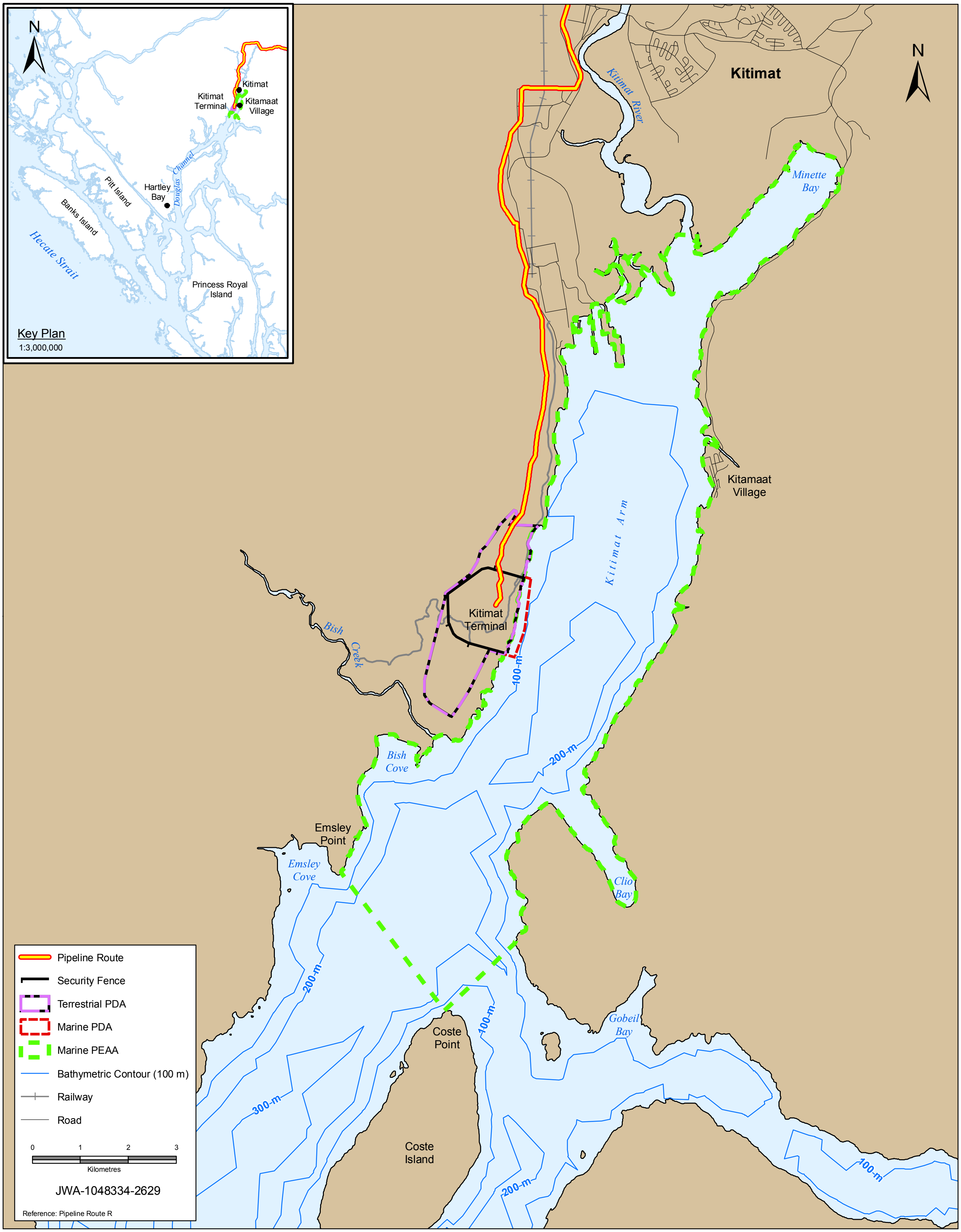

CONTRACTOR: Jacques Whitford AXYS Ltd.

PREPARED BY: gem Gateway Environmental Management Team

PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES

ENBRIDGE NORTHERN GATEWAY PROJECT

Marine Fish & Fish Habitat PEAA and PDA

FIGURE NUMBER:	DATE:
2-2	20100129

SCALE:	AUTHOR:	APPROVED BY:
1:110,000	SS	CM

PROJECTION:	DATUM:
UTM 9	NAD 83

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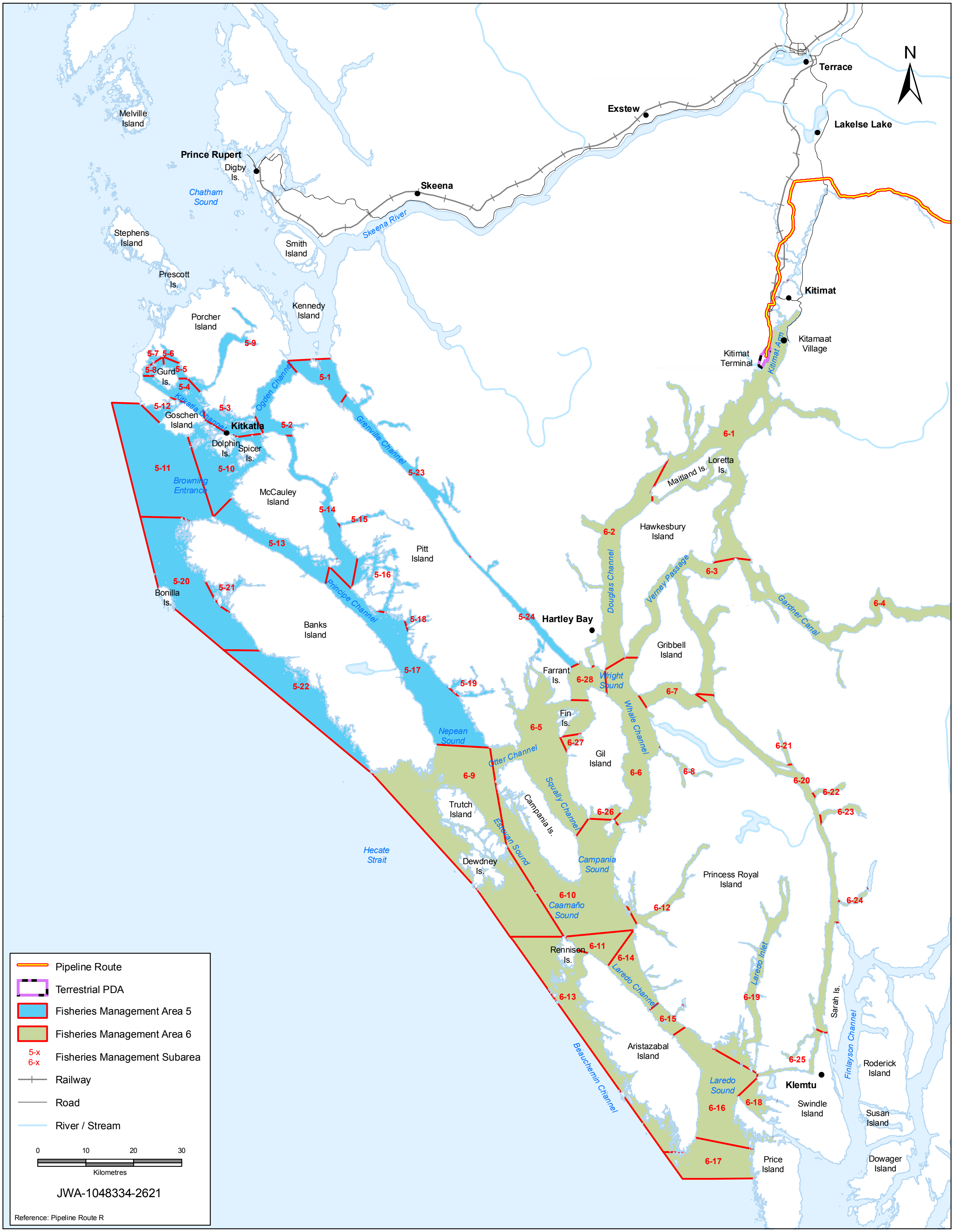

CONTRACTOR:	ENBRIDGE NORTHERN GATEWAY PROJECT	FIGURE NUMBER:	DATE:
Jacques Whitford AXYS Ltd.		2-3	20090914
PREPARED BY: gem Gateway Environmental Management Team / PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES	DFO Fisheries Management Areas 5 and 6 and Subareas	SCALE: 1:1,100,000	AUTHOR: NP / APPROVED BY: CM
		PROJECTION: UTM 9	DATUM: NAD 83

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2.2 Review of Existing Data Sources

The data review included searches for publications pertaining to marine flora and fauna within the CCAA and the PNCIMA. Existing data and information were accessed from peer reviewed scientific publications, electronic resources, agency literature and personal communication with government and academic professionals. The following databases were searched for relevant information:

- Canadian Institute of Scientific and Technical Information (CISTI)
- Fisheries and Oceans Canada WAVES catalogue
- Aquatic Sciences and Fisheries Abstracts
- Oceanic Abstracts
- Science Citation Index (Web of Science)
- BIOSIS (Biological Abstracts)
- British Columbia provincial publications
- National Technical Information Service (NTIS)
- National Oceanic and Atmospheric Administration (NOAA)
- Environment Canada publications

The Coastal Resource Information Management System (CRIMS) is maintained by the British Columbia Ministry of Agriculture and Lands (MAL) and provides access to all data currently held by the Ministry of Land and Resource Data Warehouse (LRDW). It contains a wide variety of data related to marine resources, such as aquaculture, shoreline classification and selected fisheries information. This database was searched for relevant information and data downloaded from the government FTP site (British Columbia Ministry of Agriculture and Lands 2006, Internet site).

2.3 Field Surveys

The purpose of the field surveys was to compile a species inventory and characterize baseline conditions at representative intertidal and subtidal habitats within the PEAA. The field surveys involved the following key components:

- completion of a reconnaissance survey of the PEAA by boat to identify habitat types along the shoreline
- identification of the most common and representative shoreline habitat types within the PEAA (e.g., estuary and rocky beach)
- characterization of the marine communities present in the PDA within each shoreline type in terms of species aggregation and distribution
- biophysical characterization of subtidal marine communities in the PDA
- sediment and water quality analysis in the PDA
- preparation of a list of locally abundant species

Twelve surveys were undertaken between July 2005 and August 2009 to collect biophysical data in the PEAA. Details on survey type, task, date and coverage are provided in Table 2-1.

Table 2-1 Marine-related Field Studies, Personnel and Dates Undertaken in the PEAA

Survey Type	Task completed	Date	Coverage	Biologists
Intertidal Habitat Characterization	Reconnaissance survey	July 2005	PEAA	Ben Wheeler, M.Sc. Jason Thompson, M.Sc. Owen McHugh, B.Sc.
	Transect survey	June 2006	PDA	Jason Thompson, M.Sc. Janine Beckett, M.Sc. Owen McHugh, B.Sc.
	Transect survey	July 2008	PDA	Janine Beckett, M.Sc. Todd Goodsell, B.Sc. Brock Ramshaw, B.Sc.
	Transect survey	August 2009	PDA	Colin Bates, Ph.D. Craig Losos M.Sc. Marine Winterbottom, M.Sc.
Subtidal Habitat Characterization	Qualitative subtidal survey	September 2005	PEAA	Foreshore Technologies Inc.
	Sediment and Water sampling	February 2006	PDA	Janine Beckett, M.Sc. Jason Thompson, M.Sc. Colin Bailey
	Benthic invertebrate sampling	February 2006	PDA	Janine Beckett, M.Sc. Jason Thompson, M.Sc. Colin Bailey Val McDonald, Ph.D. (Biologica Environmental) Trish Tomliens (Biologica Environmental)
	Quantitative subtidal video survey	June 2006	PDA	Barb Faggater, Ph.D. (Ocean Ecology) Ken Hall (Ocean Ecology)
	Quantitative subtidal video survey	June 2007	PDA	Barb Faggater, Ph.D (Ocean Ecology) Ken Hall (Ocean Ecology)
Nearshore Fish Survey	Beach seine	July 2005	PEAA	Jason Thompson, M.Sc Owen McHugh, B.Sc
	gillnet and longline	September 2005	PEAA	Jason Thompson, M.Sc Owen McHugh, B.Sc
Nearshore Crab Survey	Crab traps	September 2005	PDA	Jason Thompson, M.Sc Owen McHugh, B.Sc

All depths are measured in metres from chart datum. In Canadian tidal waters, chart datum refers to the lower low water, large tide (LLWLT; 0 m). Depths recorded from depth sounders on vessels have been adjusted to chart datum of 0 m. Water levels are measured from tide and water level regional station 9354 (Prince Rupert, British Columbia).

2.3.1 Intertidal Habitat Characterization

Intertidal surveys were completed during the best available low tide sequence in mid to late summer to ensure adequate coverage of all intertidal zones, and to capture a period of high productivity when seaweeds are most easily identifiable.

2.3.1.1 Reconnaissance Survey

An initial reconnaissance survey was designed to provide a qualitative overview of intertidal habitat types and to quantitatively identify general species composition (including rare or sensitive species), populations, and habitats in the PEAA. It was completed from a vessel travelling parallel to the shoreline at a slow rate of speed. An observer with a video camera filmed the shoreline as two other observers recorded GPS locations and the condition of the backshore.

2.3.1.2 Intertidal Transect Survey

Transect surveys provide quantitative information on species abundance and distribution within and adjacent to the intertidal habitat of the PDA. Transect survey methods were based on the Marine Foreshore Environmental Assessment Procedure established by DFO (DFO 2008a, Internet site).

Transect surveys were conducted every 50 to 100 m along the length of the shoreline within the PDA (the total length of coastal shoreline in PDA is approximately 2000 m). Transects were distributed along the shoreline to ensure adequate coverage of all habitat types identified in the qualitative intertidal evaluation.

At each transect location, a head stake was established at the highest high water mark (HHWM). A tape measure was deployed from the head stake directly seaward (perpendicular to shoreline) to the mean lower low water (MLLW) mark. In circumstances where tide levels were above the MLLW, the lowest point on the shoreline was selected. General physical and biological conditions were noted and photographed. The head stake was photographed both looking seaward and landward and its position recorded by GPS. The backshore zone was qualitatively documented and photographed.

Low, mid, and high intertidal zones were identified based on differences in animal and plant communities along each transect. The start and finish points of each zone were recorded from the transect tape and a clinometer was used to record the slope of each zone. The general substrate classification of each transect followed standard guidelines from Coastal/Estuarine Fish Habitat Description and Assessment Manual (Williams 1993):

- bedrock
- boulder (greater than 256 mm)
- cobble (64 to 256 mm)
- pebble (2 to 64 mm)
- sand (0.0625 to 2 mm)
- mud (mixed fine sand, silt, clay) (less than 0.0625 mm)

Physical data from each transect location was compiled to produce a cross-sectional shoreline profile showing substrate type, grade and dominant epibiota.

At each transect, three additional 25-m transect lines were placed (depending on the substrate gradient) parallel to the water line in the approximate middle of each intertidal zone. The midpoint of the three shore-parallel transects were placed on the shore-perpendicular transect, at the corresponding low, mid and high intertidal areas. Five sample positions were selected along each transect using random number tables (Figure 2-4). At each position, a 0.25 by 0.25 m quadrat was placed adjacent to the parallel transect line. At least one representative quadrat along each transect line was photographed. Observations were recorded for each quadrat and included data on:

- substrate type – substrate type is identified based on Williams (1993) and recorded as percent cover per quadrat. Substrate types are cumulative and recorded as percentages out of a total of 100%.
- Marine plants – marine plants are identified to genus or species level and abundance is recorded as percent coverage estimates per quadrat.
- Sessile animals – non-motile animals (barnacles, mussels, sponges, etc.) are identified to species level and abundance is recorded as percent coverage estimates per quadrat.
- Motile animals – individuals in each quadrat are identified to species level and counted; if numbers are too large to count (e.g., mites, amphipods), abundance is estimated per quadrat.

2.3.2 Subtidal Habitat Characterization

2.3.2.1 Qualitative Subtidal Survey

Surveys were completed in the PEAA at three sites: estuarine (Site 1), boulder beach (Site 2), and rock wall and bench (Site 3) (see Figure 2-5).

Substrate and biota information were collected visually by towing a diver on a sled just above the seabed. The sled was designed to allow the diver to work in a variety of conditions including low light, fast moving currents and poor visibility. A depth gauge and a set of dive planes allowed the diver to control the elevation at which the sled moved above the bottom. As the diver was towed along, the biophysical features were recorded using a two-way communication system. A surface technician recorded the diver’s observations onto a Trimble data logger and simultaneously collected the UTM coordinates through a Differential Global Positioning System (DGPS).

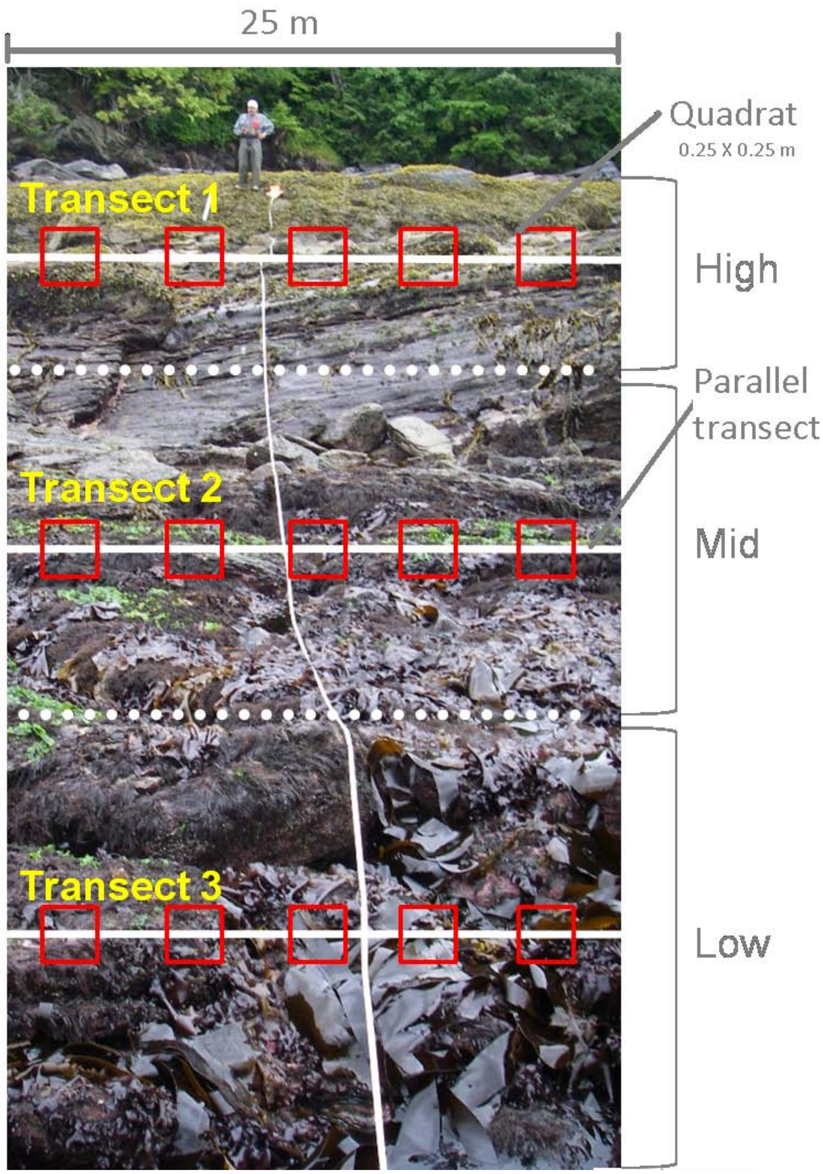
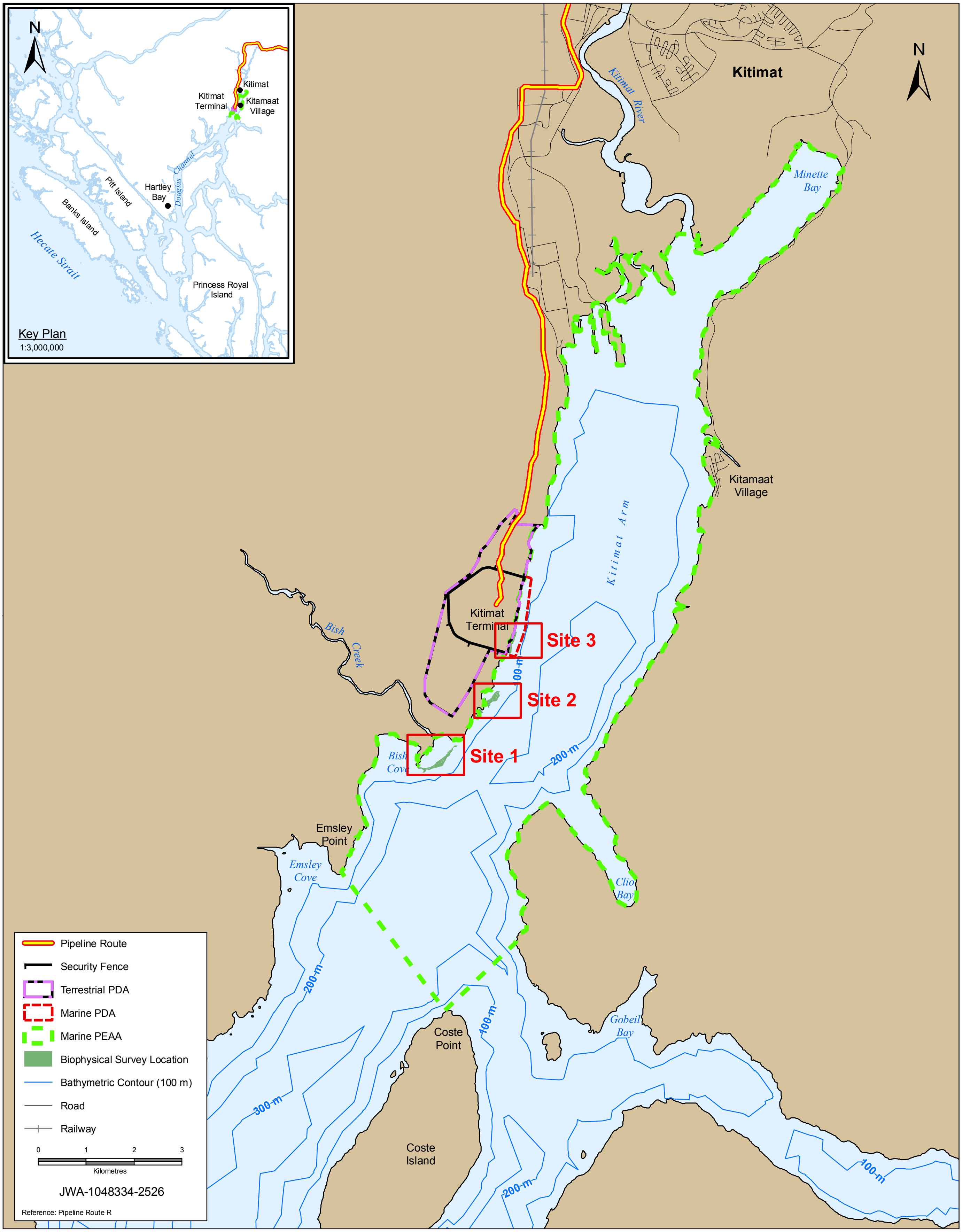


Figure 2-4 Quantitative Intertidal Survey Methodology



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CONTRACTOR: Jacques Whitford AXYS Ltd.		ENBRIDGE NORTHERN GATEWAY PROJECT	FIGURE NUMBER: 2-5		DATE: 20100129
PREPARED BY:	PREPARED FOR:	Qualitative Subtidal Survey Site Locations	SCALE: 1:110,000	AUTHOR: BA	APPROVED BY: CM
			PROJECTION: UTM 9		DATUM: NAD 83

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2.3.2.2 Quantitative Subtidal Video Survey

Subtidal video surveys were carried out in the PDA by Ocean Ecology. The southern section of the PDA was surveyed in June 2006 and the northern section of the PDA was surveyed in June 2007.

A DGPS-positioned video camera was towed along transect lines (see Figure 2-6) to collect imagery of the seabed. Typical tow speed was between one and two knots. The camera provided a composite video signal to an overlay unit that stamped the DGPS position data (latitude and longitude), together with date and time, on each video frame. The video signal was also displayed in real-time on the vessel, where it was used to adapt the survey to particular features that were seen while underway. A daylight, colour-balanced underwater light was mounted on the camera to provide additional illumination when required.

The altitude of the underwater camera was controlled using a hydraulic winch. The winch was operated from the bridge, as was monitoring of the real-time video feed from the camera. Typically, the camera was towed about 1 to 3 m above the seabed in depths up to 119 m.

Sounding data (corrected for draft) were recorded every second and logged on a laptop computer. These data, combined with line angle measured at the block, were used to correct for positioning of the camera relative to the boat.

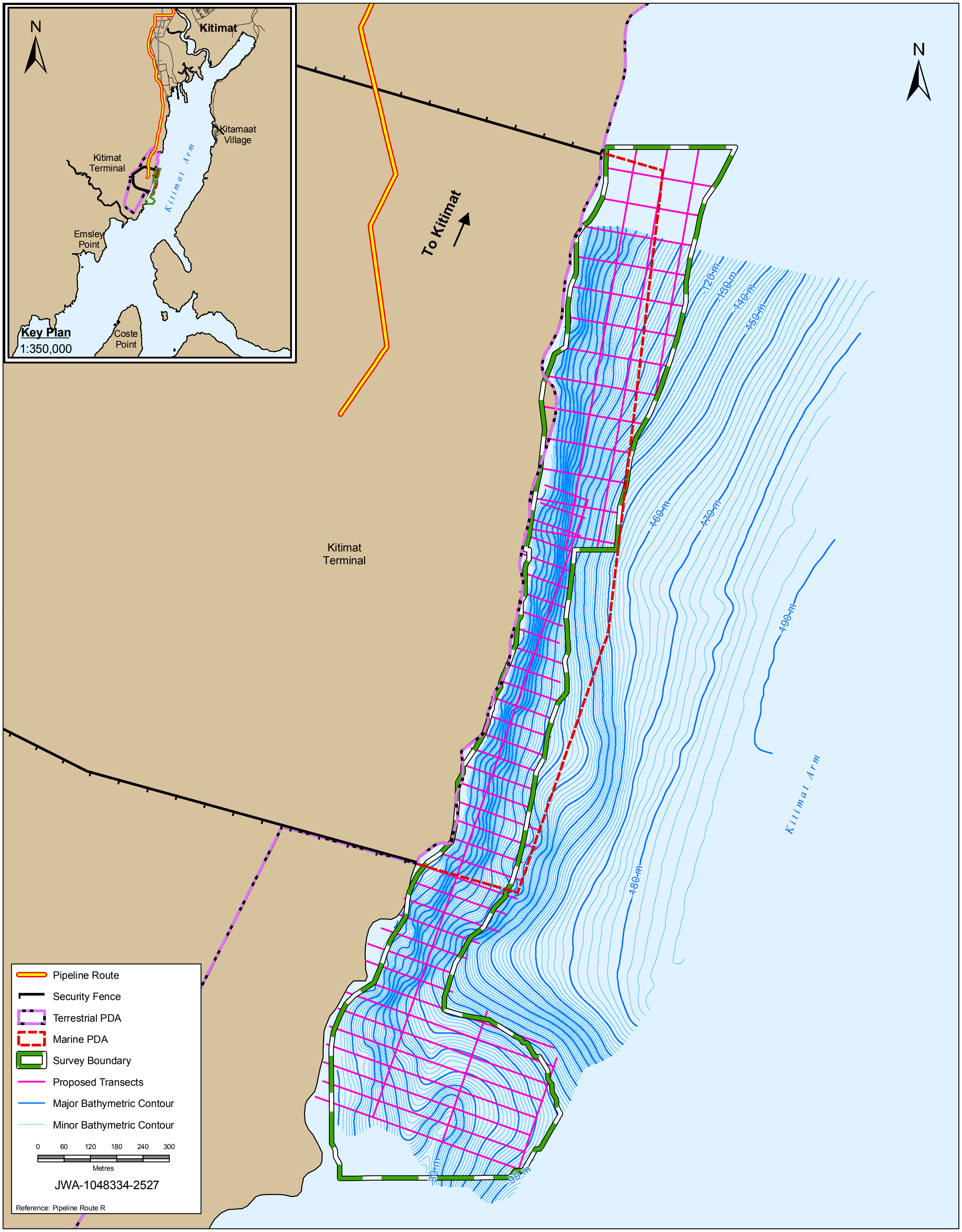
Nominal shore-perpendicular transect line spacing was 70 m. All shore-perpendicular survey track lines were continued inshore to a water depth of 3 to 5 m or to the limit of safe navigation. Several shore-parallel lines at different water depths were surveyed to provide multiple intersects or crossover points with shore-perpendicular lines. These were used to determine the confidence levels in the interpretation of the image data.

Classification and Mapping Methodology

Still images were captured from the raw video at one-second intervals. Data records for each image were produced including a classification by substrate and biota based on a method similar to that used by the British Columbia Land Use Coordination Office (LUCO).

Data were organized into geological and biological databases. The geological database contains information on substrate type and percentage cover. Anthropogenic features were mapped as part of the geological inventory. The biological database captured detail on seabed biota within two general categories, vegetation and fauna. Primary, secondary and tertiary faunal and floral types were evaluated for each image and given distribution codes. Vegetation coverage classes and faunal distribution classes were also recorded.

All data were entered into a relational database. Maps of species abundance and distribution were produced using ArcGIS software. Representative video images were captured in digital image files to illustrate seabed substrates and biota. These images were georeferenced to the ArcGIS biophysical maps on an interactive CD-ROM.



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CONTRACTOR: Jacques Whitford AXYS Ltd.		ENBRIDGE NORTHERN GATEWAY PROJECT	FIGURE NUMBER: 2-6		DATE: 20100129
PREPARED BY: gem Gateway Environmental Management Team	PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES	Proposed Transects for Quantitative Subtidal Video Survey	SCALE: 1:12,000	AUTHOR: BA	APPROVED BY: JB
			PROJECTION: UTM 9	DATUM: NAD 83	

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Survey Confidence Levels

Transect cross-over points were used to determine confidence levels in the interpretation of the image data. Each cross-over point consisted of a pair of data records, one from a shore-perpendicular transect and one from a shore-parallel transect. The number of times that both data records had the same values for each classification category (e.g., substrate, vegetation, and fauna) was recorded for each cross-over point and used to generate percentage confidence.

Bathymetry and Bottom Hardness Survey Methodology

Water depth and bottom hardness were recorded using a towed mapping sounder. Depth values from the sounder were corrected for transducer depth and tidal height, but not for changes in sound velocity due to depth-related changes in water temperature and salinity. This data set was imported into Surfer (contouring software) and contour plots were generated. The datum for the depth plot is lowest normal tides (LNT), consistent with Canadian hydrographic charts.

Substrate Maps

Substrate observations were mapped as a series of points in ArcMap. A hexagonal grid composed of hexagonal polygons with widths of 20 m was overlaid on the observation points. Each polygon was assigned a substrate code based on the code of the majority of the data points within that polygon. Polygons which contained no data points were assigned the code of the nearest neighbouring polygon.

Local Range Maps

Range maps for flora and fauna within the survey area were generated using the fixed kernel density estimation procedure. Flora observations were weighted by abundance (Table 2-2) and fauna observations were weighted by distribution (Table 2-3). In order to allow overlap of polygons between transects, the search radius (i.e., the smoothing factor) was set as the distance between transects (i.e., 80 m). For each organism, a 95% volume contour was generated. This contour enclosed the geographical area in which 95% of the estimated population was expected to be found.

Table 2-2 Vegetation abundance classes

Code	Class	Abundance
0	None	No visible vegetation
1	Sparse	Less than 5% cover
2	Low	5 to 25% cover
3	Moderate	26 to 75% cover
4	Dense	>75% cover

Table 2-3 Faunal distribution classes

Code	Class	Abundance
1	Few	Rare (single) or a few sporadic individuals
2	Patchy	A single patch, several individuals or a few patches
3	Uniform	Continuous uniform occurrence
4	Continuous	Continuous occurrence with a few gaps
5	Dense	Continuous dense occurrence
6		Code specific for school of fish

Diversity Analysis Using Range Maps

Calculations of Shannon's diversity index, Shannon's evenness, and Simpson's dominance index were carried out in ArcMap using the range map polygons.

Species Richness Maps

A hexagonal grid (composed of hexagonal polygons with widths of 20 m) was overlaid on a shape file containing all the range map polygons for a particular category (e.g., flora or fauna). Using polygon-in-polygon analysis, each hexagonal polygon was assigned a number equal to the number of range map polygons with which it overlapped. This assigned number was equal to the species richness in a given hexagonal polygon, since each range map polygon represented a different species. The coded hexagonal polygons were used to generate a species richness map.

2.3.2.3 Sediment and Water Quality Survey

Baseline studies were carried out on sediment and overlying seawater near the marine terminal in February 2006. Ten sample sites and two reference sites in the PEAA were sampled (Table 2-4). Three sediment samples per site were collected using an 11 L Van Veen Grab designed to mechanically take an undisturbed sediment sample to a maximum depth of 60 cm over approximately 0.1 m^2 of seabed. Overlying water was collected from the top of each grab sample for chemical analysis and the top 7.5 cm of sediment was collected for chemical and particle size analysis and toxicity testing. Overlying water and sediment from the three grab samples were combined to produce one composite sample for water and one composite sample for sediment. Sediment samples were stored in 8-L buckets in the dark at 4°C and shipped directly to the laboratory for analysis. Water was separated into pre-labelled sample containers, stored at 4°C in the dark and immediately shipped for analysis.

The physical parameters analyzed in sediment samples included redox (oxidation-reduction reaction) potential, particle size, moisture content, total organic carbon and sediment thickness. Water samples were analyzed for temperature, pH, salinity and sulphide content.

The chemical parameters analyzed in sediment and water samples included ammonia, sulphide, metals, dioxins and furans, porewater, total polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs) and benzene, toluene, ethylbenzene and xylenes (BTEX).

Results were compared to British Columbia, Canadian Council of the Ministers of the Environment (CCME) and Canadian Environmental Protection Agency (CEPA) guidelines where available. National Oceanic and Atmospheric Administration (NOAA) and Florida Department of Environmental Protection (FDEP) criteria were referenced when British Columbia or Canadian regulatory guidelines were not available.

Table 2-4 Seawater Sample Handling Information

Water Sample	Date of Collection	Date of Arrival at Laboratory	Notes
SWQ-06-01	February 7, 2006	February 9, 2006	WC, salinity, pH, S^-
SWQ-06-02	February 7, 2006	February 9, 2006	WC, salinity, pH, S^-
SWQ-06-03	February 3, 2006	February 9, 2006	WC, salinity, pH, S^-
SWQ-06-04	February 7, 2006	February 9, 2006	WC, salinity, pH, S^-
SWQ-06-05	February 4, 2006	February 9, 2006	WC, salinity, pH, S^-
SWQ-06-06	February 4, 2006	February 9, 2006	WC, salinity, pH, S^-
SWQ-06-07	February 4, 2006	February 9, 2006	WC, salinity, pH, S^-
SWQ-06-08	February 4, 2006	February 9, 2006	pH, salinity, S^-
SWQ-06-09	February 7, 2006	February 9, 2006	WC, salinity, pH, S^-
SWQ-06-10	February 7, 2006	February 9, 2006	WC, salinity, pH, S^-
SWQ-06-11	February 7, 2006	February 9, 2006	pH, salinity, S^-
SWQ-06-12	February 7, 2006	February 9, 2006	WC, salinity, pH, S^-

NOTES:
WC – dissolved metals, polycyclic aromatic hydrocarbons (PAHs), benzene, toluene, ethylbenzene and xylenes (BTEX), ammonia (NH_3)
S – Sulphide

2.3.2.4 Benthic Invertebrate Survey

Sediment samples for benthic invertebrate analysis were collected in February 2006 in conjunction with the sediment and water quality sampling program (Section 2.4.2.3). Benthic invertebrate samples were collected at six sites in the PEAA. Five replicate grab samples were collected at each site using an 11 L Van Veen Grab designed to mechanically take an undisturbed sediment sample to a maximum depth of 60 cm over approximately 0.1 m^2 of seabed. The top 15 cm of sediment from each grab sample was removed and gently washed through a 1 mm screen to remove silts and clays and to separate the sediment from the benthic organisms. All organisms and material remaining after washing was preserved in buffered 10% formaldehyde solution. Preserved samples were shipped to Biologica Environmental Consulting Ltd. for identification and quantification analysis.

2.3.3 Nearshore Fish Survey

Nearshore fish surveys were conducted in late summer 2005. Surveys involved the use of beach seines, gillnets and longlines to determine the fish species present in nearshore environments of the PEAA.

Fish sampling at Bish Cove was conducted under DFO licence number 2005-054 in August and September 2005. Intertidal and shallow subtidal areas were sampled using a sinking 14-m beach seine (10 mm mesh width). The net was deployed using a vessel transferring one end to a shore-based technician for each haul. Each site was seined one to eight times. All fish sampled were identified and then live-released at the collection point.

Subtidal fish habitat was sampled with 1-inch mesh gillnets. Samples were taken at two depths per site: benthic (just above bottom) and pelagic (25 m off bottom). Gillnets were set with floating buoys to facilitate easy location and checked after two hours to minimize fish mortality. All fish sampled were identified and standard length (SL) measured before being live-released at the collection point.

A 100-m longline, set with baited 35 circle hooks ranging in size from 6 to 7/0, was used to sample the deepwater habitat at three sites. The longline was set perpendicular to shore to sample varying depths at two sites and checked after two hours. Hooks were attached to a halibut clip with approximately 50 cm of 15 lb test monofilament line. Clips were attached to the longline at 3-m intervals. All fish sampled were identified and SL measured before being live-released at the collection point.

2.3.4 Nearshore Crab Survey

A crab trapping survey was completed in the PDA in late summer 2005. It was completed over a one-week period during the intertidal sampling survey. Collapsible, mesh, 1-m diameter recreational traps were baited with combinations of canned sardines and cat food and left to soak for four to six hours. The location of each trap was recorded with a handheld GPS unit. Upon retrieval, crabs were removed from the traps and species, sex, weight and carapace width were recorded. Crabs were live-released once data collection was completed.

2.4 Modelling

2.4.1 Sediment Plume and Dispersion Modelling Methodology

ASL Environmental Sciences Ltd. was contracted to use a 3-D coastal circulation and sediment model (COCIRM-SED) to compute the total suspended sediment (TSS) and sediment deposition in Kitimat Arm that would result from dredging operations at the Kitimat Terminal.

The COCIRM 3-D numerical circulation model has been widely used in coastal ocean and river applications over the past several years. A realistic numerical model domain was created for the full area of Kitimat Arm as well as Kildala Inlet. The model domain has a total length of 29.8 km and a width of 11.8 km. In the horizontal, the model has 100-m by 100-m grids over the full domain and, within 2 km of the Kitimat Terminal area, a high-resolution nested grid of 20 m by 20 m. The model has 20 layers in the vertical which span water depths from the surface to 360 m.

The model was used to compute the currents with forcing at the open boundary using tidal heights measured in March 2006 as well as with measured winds and river runoff. The release of sediments to the ocean during dredging operations is taken to be 1% of the total dredged sediments which is expected to require about 14.7 days of continuous operations. The distribution of the released sediments is taken from laboratory analyses of bottom sediment samples collected for the Project. The 3-D model was calibrated and validated using measurements collected from January to April 2006. Detailed methodology is included in the ASL report (see Appendix A).

3 Results of Baseline Investigations

3.1 Results from Data Review

3.1.1 General Review

Kitimat Arm and Douglas Channel are part of the Inner Pacific Marine Shelf ecoregion. These deep narrow fjords, with high coastal relief, are typical of the North Coast Fjord ecosection and contain protected waters with restricted water circulation. This causes low species diversity and low productivity due to poor water exchange and nutrient depletion. The water column is strongly stratified with respect to temperature and salinity. However, the combination of these factors can result in unique species assemblages in both the benthic and plankton communities (Government of British Columbia 2002). The tides in the region are semidiurnal, with large tides being approximately 7 m and the mean tide approximately 4 m. Douglas Channel receives an appreciable amount of freshwater runoff from melting snow at high altitudes. Peak discharge occurs between May and June. From late spring to fall, the Kitimat River creates a surface layer of freshwater in Kitimat Arm (DFO 1983).

Rocky shores dominate the intertidal habitat, accounting for 39% of the total shoreline of the PEAA and 76% of the CCAA shoreline. These include rock habitats with overlaying gravel, sand and boulders beaches. Estuarine shorelines with mud flats and marsh habitats compose 15% of total shoreline in the PEAA and 4% of the CCAA shoreline. The subtidal areas are dominated by sand and mud habitats, but predominantly mud (silt and clay).

Rockweed and sea lettuce (*Fucus* spp., *Ulva* spp.) are the dominant macrophytes in the intertidal zone. The dominant fauna found in this zone include barnacles, mussels, periwinkles and limpets. Species that can be found in the benthic community include sea urchins, moon snails, sea stars and the California sea cucumber. Estuaries may contain the marine vascular plant Eelgrass (*Zostera marina*). This species provides important habitat for juvenile fish, forage fish and a variety of invertebrates such as Dungeness crab. These soft bottom areas also contain commercially harvested bivalves such as butter clams and heart cockles.

A recent report on the state of knowledge of marine and shoreline areas in the Queen Charlotte Basin (LGL Limited Environmental Research Associates 2004) placed value on all the habitats in the PNCIMA. Resource and habitat themes were given relative values based on a number of sources including scientific and local knowledge. Douglas Channel and the outer islands have low-valued offshore benthic habitat when compared to the high-value area of Hecate strait (based on rockfish, groundfish and crab habitat) (LGL Limited Environmental Research Associates 2004), however, the nearshore subtidal habitats in these areas are high-valued (based on kelp, rockfish habitat, herring spawn, geoducks, urchins abalone, sea cucumber). All nearshore intertidal habitat (based on mud flats, sand flats, estuaries, eelgrass beds, intertidal bivalve habitat, salmon rivers and eulachon rivers) are also high value (as are all nearshore areas of the Queen Charlotte Basin) with the exception of the northwest portion of Graham Island due to its lack of sand, mud flats and estuaries. Intertidal diversity on a regional scale can be explained with abiotic variables such as salinity, temperature and fetch. Zacharias and Roff (2001) proposed that the outer coasts have higher diversity and would benefit more from conservation initiatives than the lower diversity inner coast environments.

Fish

Kitimat Arm and Douglas Channel support a fish assemblage typical of the North Coast Fjords and provide numerous economic opportunities for sports fishing operations. Fish habitat in the larger Queen Charlotte Basin is estimated to hold medium to high ecological value (LGL Limited Environmental Research Associates 2004). Salmon, eulachon, herring, rockfish, groundfish and their associated habitats are considered valued ecological components in the region (LGL Limited Environmental Research Associates 2004).

Approximately 300 species of fish live off the coast of British Columbia (Hart 1973). At least 42 of these species are known to occur in Douglas Channel near Bish Cove (Bell and Kallman 1976). Valued habitats for marine fish include spawning rivers, eelgrass beds, estuaries and pelagic habitat. Numerous rivers and associated channels branching off from Douglas Channel and Gardner Channel provide spawning habitat for salmon and eulachon (MacDonald 1983; Stoffels 2001; LGL Limited Environmental Research Associates 2004). Estuaries provide a rearing area for larval and juvenile fish, as well as an important transition zone and holding area for anadromous fish traveling in and out of the rivers. All six salmonid species are common in the area (sockeye, chum, coho, chinook, pink and steelhead) as are eulachon. These fish travel through Douglas Channel en route to freshwater spawning channels in Kitimat River, Gardner Channel and Kildala Arm.

Marine fish species and habitat in British Columbia are regulated by federal and provincial legislation including the *Fisheries Act*, *Species at Risk Act* and *Wildlife Act*. Legislation provides regulations and guidance for the sustainable use of fish resources and the protection of important marine habitat.

3.1.2 *Fisheries Act*

The *Fisheries Act* defines “fish” as fish, shellfish, crustaceans and marine animals. It prohibits harmful alteration, disruption or destruction of fish habitat including spawning grounds, nursery, rearing, food supply and migration areas on which fish depend directly or indirectly. The *Fisheries Act* operates under the principle of No Net Loss, which assures that unavoidable habitat loss is balanced with avoidance, mitigation and habitat replacement.

3.1.3 *Species at Risk Act (SARA)*

The Canadian *Species at Risk Act (SARA)* was established to provide for the recovery of species at risk due to human activity and to ensure that wildlife species of special concern do not become endangered or threatened (Government of Canada 2003). *SARA* prohibits killing, harming, harassing, capturing or taking species at risk. In addition, it makes it an offence to possess, collect, buy, sell or trade a listed species or to damage or destroy the residence of an extirpated, endangered or threatened species. DFO is responsible for all aquatic Species at Risk, including marine fish. For the marine species of concern that may be present in the CCAA, see Table 3-1.

Table 3-1 Marine Fish and Invertebrate Species of Special Concern in the CCAA

Common Name	G Rank[a]	Federal		British Columbia		Abundance in CCAA
		SARA Status[b]	COSEWIC Status[c]	S Rank[d]	Provincial Status[e]	
Northern Abalone	GNR	✓	T	S2	R	Medium
Bocaccio	G4	+	T	NR	NS	Unknown or low
Green Sturgeon	G3	✓	SC	S1	R	Unknown or low

NOTES:
[a]G Rank – global rank:
G1 – critically imperilled
G2 – imperilled
G3 – vulnerable to extirpation or extinction
G4 – apparently secure
G5 – demonstrably widespread, abundant and secure.
NR – unranked - Global Rank not yet assessed.
[b]*SARA* status:
✓ – listed in *SARA* Schedule 1
+ – no status; under review
[c]COSEWIC status:
E – endangered – facing imminent extirpation or extinction
T – threatened – likely to become endangered if limiting factors are not reversed
SC – special concern – characteristics make it particularly sensitive to human activities and natural events
[d]S Rank – subnational rank:
B – indicates breeding status for a migratory species
N – indicates non-breeding status for a migratory species
NA – conservation status rank is not applicable because the species is not a suitable target for conservation activities
NR – not ranked
S1 – Critically imperilled
S2 – Imperilled
S3 – Vulnerable
S4 – Apparently Secure
S5 – Secure
[e]British Columbia status:
R – red
B – blue
Y – yellow
NS – no status

Candidate *SARA* species are initially evaluated by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). COSEWIC assesses and classifies each species and ranks them according to their level of risk (extinct, extirpated, endangered, threatened, special concern, data deficient, not at risk). This initial assessment is given to the minister in charge who has 90 days to respond to the assessment. It is then up to the Governor in Council to decide if the species will be added to the species at risk list and receive federal protection. After an aquatic species is designated, it receives immediate protection and a recovery strategy is prepared that includes the identification of critical habitat (Government of Canada 2003).

Before the *SARA* was given royal assent in 2003, three lists of species had already been compiled by COSEWIC. All species on Schedule 1 were given immediate protection under *SARA* and this became the initial list of Wildlife Species at Risk (Government of Canada 2003). Before being considered for protection under *SARA*, species on Schedule 2 and Schedule 3 require reassessment by COSEWIC, based on a set of revised criteria. COSEWIC has since reassessed all of the species on Schedule 2 and 87 of the 103 species on Schedule 3. Once reassessed, species on Schedule 2 and 3 that are found to be at risk will undergo the *SARA* listing process.

3.1.4 *Wildlife Act*

Provincially designated species at risk are protected under the British Columbia *Wildlife Act*. This Act gives authority to the minister responsible to designate endangered and threatened species as well as wildlife management areas, critical wildlife areas and wildlife sanctuaries. Species are designated according to a ranking system developed by NatureServe, an international organization that tracks global biodiversity. The Red list contains species that have been legally designated as endangered or threatened in British Columbia under the authority of the *Wildlife Act*. Blue-listed species are not considered immediately threatened but are of concern because of factors rendering them vulnerable to human or natural disturbance (Vennesland et al. 2002). Yellow-listed species are generally not at risk and may be considered uncommon, common, declining or increasing, depending on the designated status.

3.1.5 Species-Specific Information

3.1.5.1 Salmonids, *Oncorhynchus* spp.

Introduction

Of the six salmon species indigenous to the Pacific Ocean, five are found in British Columbia’s waters:

- chum salmon (*Oncorhynchus keta*)
- chinook salmon (*Oncorhynchus tshawytscha*)
- pink salmon (*Oncorhynchus gorbuscha*)
- sockeye salmon (*Oncorhynchus nerka*)

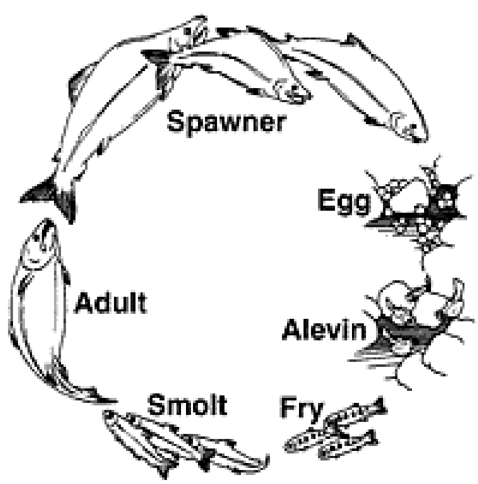
These five species comprise the mainstay of Canada’s west coast salmon fisheries (recreational, commercial and food, social and ceremonial [FSC]). The commercial fishery for steelhead trout (*Oncorhynchus mykiss*) in the CCAA is closed. In addition to providing economic and social value to fishers, salmonids are an important food resource for terrestrial vertebrate predators and scavengers, thereby forming a critical link between terrestrial and aquatic systems (Willson and Halupka 1995).

General Salmonid Lifecycle

During the summer and fall months salmonids return to their natal streams to spawn. Once they have reached their spawning grounds, adult salmonids deposit thousands of eggs into gravel nests called redds. A single redd is dug by a female using her tail. As the female releases her eggs, they are fertilized by a waiting male that releases a cloud of milt. The female then covers up the nest with gravel to protect it from predators and then begins preparations for a second nest. This process is repeated several times until the female has expended herself of eggs. After having spawned, both males and females die; however, steelhead trout may in some instances survive to go back to sea.

After several weeks of incubation, the eggs begin to develop an eye. Over the period of a couple of months the embryo develops and hatches as an alevin. The alevin carries a yolk sac upon which it feeds for 2 to 3 months. During this time, the alevin remains hidden in the gravel where it benefits from protection from predators. When the nutrients in the yolk sac have been absorbed, the young must move into the water column to feed. At this stage they are considered to be fry. Salmonid fry either live in freshwater for a few months to a few years or migrate directly to the ocean; the exact behaviour is species-dependent. It is during the smolt stage that salmonids will migrate towards the ocean if they have not already done so during the fry stage.

Upon reaching the ocean, young salmonids stay close to the coastline where the coastal environment offers a rich food source and protection from predators. After an initial winter in coastal waters, the young salmonid adults move out into the open ocean where they will spend one to six years before returning to their natal streams to spawn. The duration of time spent at sea is species-dependent (see Figure 3-1 for an illustration of the typical life cycle of a Pacific salmon).



SOURCE: (DFO 2002)

Figure 3-1 General Overview of the Pacific Salmon Lifecycle

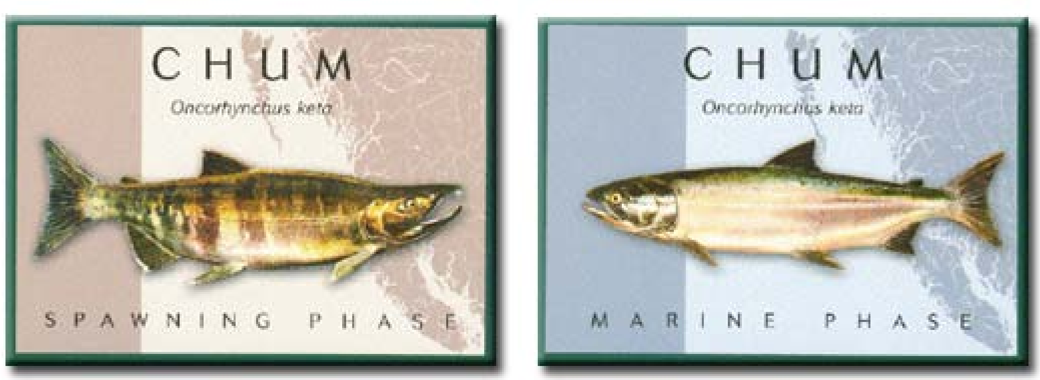
The primary salmonid species found within FMAs 5 and 6 are chum, pink, coho, chinook, sockeye, steelhead and cutthroat. A summary of each species is provided below, with particular emphasis on the characteristics and distributions that are unique to a given FMA.

Chum Salmon (Oncorhynchus keta)

Chum salmon, also known as dog salmon, have the broadest distribution of all salmon species, ranging from northern California to Alaska, as well as the Yukon and Mackenzie Rivers in the Arctic. In British Columbia, chum spawn in more than 880 streams and coastal rivers and are usually the last of the Pacific salmon to enter fresh water, generally spawning in winter. Spawning grounds for chum are generally restricted to the lower tributaries along the coast and they are rarely found more than 100 miles (160 km) inland (Hart 1973).

Adult chum salmon are distinguished from other Pacific salmon by their lack of distinct black spots on the dorsal side and caudal fin. In addition, they have 19 to 20 short gill rakers on the first arch. Adult chum average 3.5 to 4.5 kg and can measure more than 100 cm in length at maturity (DFO 2001).

Chum fry migrate immediately to marine waters upon emerging from the gravel spawning beds in the spring, 18 to 20 weeks after spawning (DFO 2008b, Internet site; Shared Strategy Development Committee 2009). As the fry migrate out of the streams and rivers they prey on insect larvae. This evolved life history reduces the mortality associated with freshwater environments; however, it does make chum more reliant on estuarine and marine habitats where the fry tend to aggregate close to shore in discrete schools during the first few weeks. During the initial weeks in salt water the fry continue to prey on copepods and *Oikopleura*. As adults, chum salmon principally eat euphausiids, squid, crab larvae and amphipods. The marine life history of chum is similar to other salmon species, with juveniles spending three to five years in the north Pacific before returning to spawn in their natal streams (Alaska Department of Fish and Game 1998; Shared Strategy Development Committee 2009). See Figure 3-2 for an illustration of chum in both the marine and spawning phases.



SOURCE: (DFO 2008b, Internet site)

Figure 3-2 Chum Salmon in Marine and Spawning Phases

The pale flesh and low fat content of chum salmon has rendered them the least commercially desirable salmon species found in British Columbia waters. However, because chum smokes well it is a favoured salmon for use by coastal Aboriginal people. The 2007 Salmon Stock Status Outlook (DFO 2007, Internet site) reported that a long-term, broadly based decline is evident among small and medium wild chum stocks in FMAs 5 and 6. In addition, brood year escapements have been relatively poor (DFO 2007, Internet site).

Pink Salmon (Oncorhynchus gorbuscha)

Of those salmon species found in the Pacific, pink salmon are the most abundant (DFO 2001). Pinks are the smallest of the salmon species, with adults averaging 1 to 2.5 kg in weight and 45.7 to 61 cm in length (Hart 1973). Despite their relatively small size, the migrations of pink salmon are extensive, ranging from California to the mouth of the Mackenzie River in the Northwest Territories, with primary spawning grounds between Puget Sound, Washington and Bristol Bay, Alaska (DFO 2001). Spawning occurs in a large percentage of coastal streams in British Columbia and in all the major rivers, with the exception of those along the south-eastern part of Vancouver Island (Hart 1973).

The lifecycle of pink salmon is relatively simple as all individuals have a fixed life span of 2 years (DFO 2001). Pinks return to their natal stream from July to October and while some travel a considerable distance upstream, the majority spawn in waters close to the ocean (DFO 2008c, Internet site). Favoured spawning areas include shallow riffles where flowing water breaks over coarse gravel or cobble-size rock and the downstream ends of pools (Alaska Department of Fish and Game 1994, Internet site). Deposited eggs hatch in late February and mature fry emerge from the gravel in April or May, depending on the water temperature (Hart 1973). Smolts then quickly migrate downstream to the open ocean where they undergo rapid growth. After 18 months at sea, adult pinks return to their natal streams to spawn and die. See Figure 3-3 for an illustration of pinks in both the marine and spawning phases.

SOURCE: DFO 2008a, Internet Site

Figure 3-3 Pink Salmon in Marine and Spawning Phases

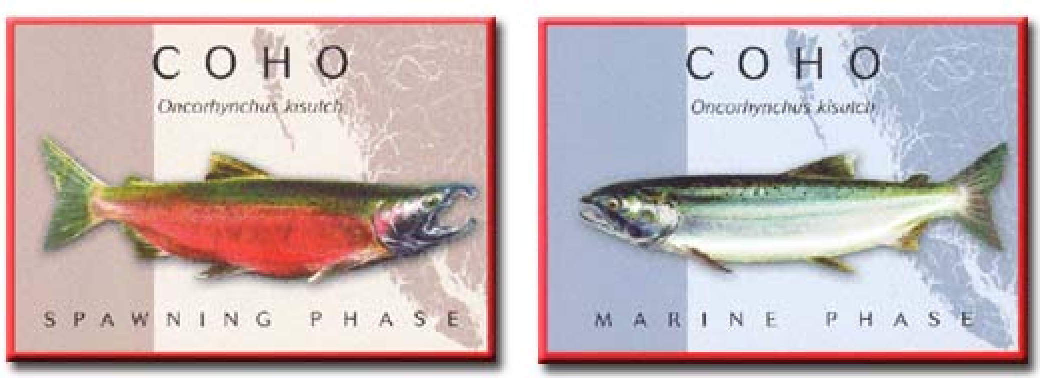
Because of the fixed 2-year life cycle, odd- and even-year stocks are reproductively isolated and genetically distinct, even if they are spawning in the same stream. Frequently, in a given stream either the odd- or the even-year cycle will be dominant with respect to productivity (Alaska Department of Fish and Game 1994, Internet site).

The commercial fishery for pink salmon primarily consists of fleets of purse seines and gillnets, that operate in channels, bays and offshore. According to the 2007 Salmon Stock Status Outlook pink stocks in FMAs 5 and 6 have been strong, but variable over the last 10 years (DFO 2007, Internet site).

Coho Salmon (Oncorhynchus kisutch)

Coho salmon, also known as silver salmon, are distributed along the coasts of the North Pacific, originating in streams from California and the Sea of Japan north to the Bering Strait. These salmon are found in more than half of coastal streams in British Columbia and as a result there are more distinct coho populations than any other Pacific salmon species in British Columbia (DFO 2008d, Internet site).

Adult coho typically range from 45 to 60 cm in length and weigh from 2.7 to 5.4 kg (Hart 1973). With the exception of pink salmon, coho have the simplest life history of the west coast salmon species. From central British Columbia south, the general coho lifecycle consists of a 3-year cycle with approximately 18 months spent in fresh water and 18 months spent in salt water. The primary exception to this trend are "jacks", sexually mature males that return to spawn after only 5 to 7 months at sea. From central British Columbia north, although the exact transition zone is unknown, the majority of coho adults are 4 years old, having spent an additional year in fresh water before going to sea. It is during their last year of life that coho become sexually mature and ready to spawn. River entry and spawn timing show considerable temporal and spatial variability. Despite this variability, some regional patterns are observed (e.g., the farther north and the larger the river, the earlier in the season coho return to their natal stream). Most coho salmon in FMAs 5 and 6 enter rivers from summer to fall when water temperatures are most favourable and spawn during October to December. Spawning occurs in areas that have gravel deposits and low water velocity. Migration of coho smolts to sea generally occurs in the spring (DFO 2001). See Figure 3-4 for an illustration of coho in the marine and spawning phases.



SOURCE: (DFO 2008d, Internet site)

Figure 3-4 Coho Salmon in Marine and Spawning Phases

Juvenile coho are aggressive, vibrantly coloured fish that tend to favour small streams, sloughs and ponds, but can also be found in lakes and large rivers. A consequence of the territoriality for feeding grounds exhibited by coho fry is that a stream tends to produce the same number of smolts each year regardless of the number of eggs deposited in it (DFO 2008d, Internet site). In fresh water, juvenile coho feed on aquatic and aerial insects, plankton and occasionally small fish. In the ocean, coho first feed on euphausiids and other plankton and later move to squid, herring, sand lance and small fish (DFO 2001).

Adult coho salmon remain in surface coastal waters throughout their lives, although some have been recorded up to 1,600 km offshore (Hart 1973). The willingness of coho to take lures, coupled with their tendency to jump and dodge, makes them a favourite among sport fishermen. In addition, coho are caught in the Aboriginal food fisheries using traditional weirs, nets and gaffs. At present there is no directed commercial net fishery for coho; however, a substantial by catch occurs in gillnet and seine fisheries for sockeye, pink and chum salmon (DFO 2001).

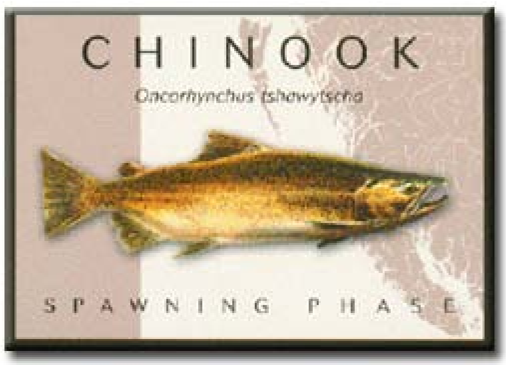
According to the Salmon Stock Status Outlook for 2007 (DFO 2007, Internet site), some coastal mainland inlets in FMAs 5 and 6 remain sensitive because of poor marine survival. In 1997, the escapement shortfall was greatest in FMA 6 and detectable throughout the central coast. This event was thought to be due to abnormally poor marine survival of smolts entering the ocean in 1996. Escapement in FMA 5 has remained relatively stable since 1969; however the quality of the data for this area is considered poor (DFO 2001). Coho escapement to streams in the Kitimat area appears to have steadily decreased since the 1960s, which has led to conservation concerns for the area (DFO 2001). Currently, coho stocks in FMA 6 appear to be rebuilding as a result of conservation efforts; FMA 5 has not been reviewed (DFO 2007, Internet site).

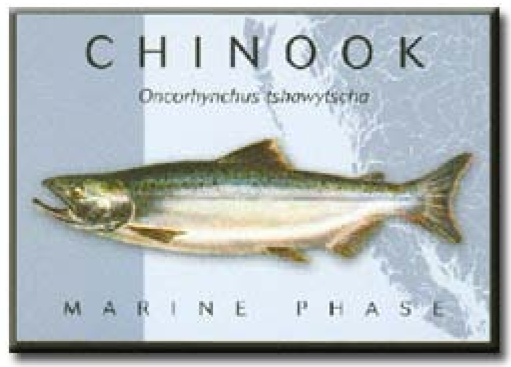
Chinook Salmon (Oncorhynchus tshawytscha)

The largest of the Pacific salmon species, Chinook, can weigh up to 57 kg with a length of 147 cm (Hart 1973), but average about 6.75 to 25 kg. Chinook are found in a small number of British Columbia streams as the majority of the population originates from major river systems, the most important being the Fraser River (DFO 2008e, Internet site). Chinook are known to migrate across large distances and are found anywhere from 41˚N to 60˚N in the Pacific Ocean (DFO 2001). Due to the fact that chinook return to their natal streams earlier than other salmon species, they are frequently referred to as spring salmon.

Chinook are piscivorous with young feeding on small fishes such as sand lance, eulachon, herring, rockfish and smooth tongue. During later years, some chinook partake in lengthy feeding migrations where herring, sand lance, pilchard and rockfish are consumed (Hart 1973).

Of all Pacific salmon species, chinook has one of the most complex and diverse lifecycles (DFO 2001). The increased complexity is the result of the existence of two major lifecycle types: “ocean” and “stream”. Many rivers have more than one stock of chinook, as spring, fall and winter runs take place (DFO 2008e, Internet site). Spawning of chinook generally occurs from August to December in the Fraser River, August to September along the south coast, October on Vancouver Island and in September along the north coast. After emerging from the gravel sometime between March and May, ocean-type fry will typically spend no more than 90 days in fresh water before migrating to the ocean. Between April and September, ocean fry congregate in shallow waters (estuaries, tidal flats and eel grass beds) where they mature to the smolt stage (Hart 1973). Stream-type fry spend their first 1 to 2 years in fresh water before migrating to the sea. This freshwater residency is spent in either the natal stream or main stream of a tributary system (DFO 2001). Upon reaching the ocean, chinook salmon spend 1 to 6 years in the ocean before returning to spawn. The majority of returning spawners are 4 to 5 years old; however some can be as old as 7 years (DFO 2001). See Figure 3-5 for an illustration of chinook in the marine and spawning phases place.





SOURCE: (DFO 2008e, Internet site)

Figure 3-5 Chinook Salmon in Marine and Spawning Phases

Chinook stocks along the North Coast are primarily stream type; however, ocean types are present to a smaller degree (DFO 2001). Apart from the Skeena and Nass Rivers, the Kitimat River is the only river that supports a major chinook stock along the North Coast (DFO 2001). Generally, north coast chinook stocks are considered to be healthy; however, as of 1998 the Kitimat River was the only major stock to show a large decline in chinook escapement (DFO 2001). The 2007 Salmon Stock Outlook (DFO 2007, Internet site) classified chinook populations in FMAs 5 and 6 to be sensitive (DFO 2007, Internet site).

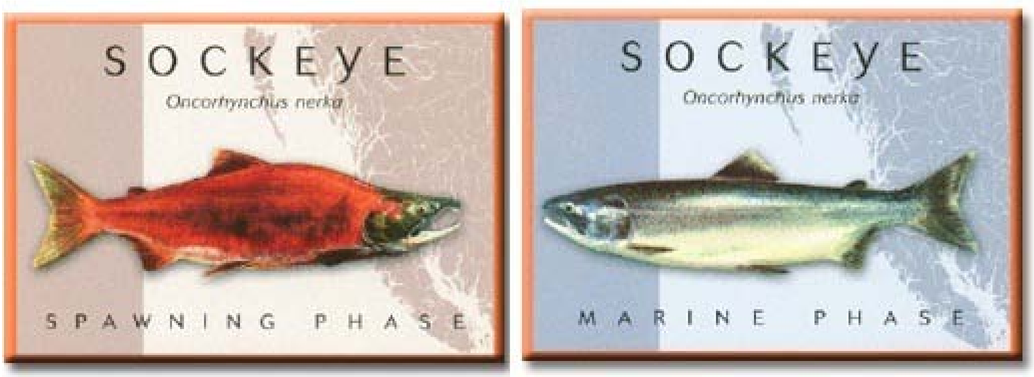
North coast chinook is harvested by commercial, sport and Aboriginal fishers in both Canada and Alaska (DFO 2001).

Chinook salmon, due to their large size, are particularly important to the sport fishery and are an important food source for Orca whales (DFO 2008e, Internet site).

Sockeye Salmon (Oncorhynchus nerka)

Sockeye salmon are found throughout the temperate North Pacific Ocean with primary spawning grounds extending from the Fraser River up to Bristol Bay, Alaska (DFO 2008f, Internet site). Sockeye vary in size depending on their age, with 4 year old fish averaging 3 kg and older fish running up to 5.5 kg (Wilderness Committee 1998, Internet site).

The majority of sockeye spawn in rivers that feed into lakes or in the outlets and spring fed beaches of lakes (DFO 2001). Some sockeye are known to spawn as far as 1,600 km from the ocean. In British Columbia, major spawning runs occur in the Fraser, Skeena and Nass Rivers, as well as in Rivers and Smith Inlets. The life history of sockeye can vary substantially depending on the run; however, in general, sockeye fry emerge from their gravel nests in the spring, spend 1 or 2 years in a freshwater nursery lake, where they then migrate to the ocean and spend 2 or 3 years before returning to their natal streams to spawn (DFO 2001). As such, spawning sockeye is generally 5 and 6 years old; however, in some northern streams returning sockeye can be as old as 8 years. See Figure 3-6 for an illustration of sockeye in the marine and spawning phases.



SOURCE: (DFO 2008f, Internet site)

Figure 3-6 Sockeye Salmon in Marine and Spawning Phases

Sockeye salmon are unique among salmonids in so far that they exhibit cyclic dominance, a phenomenon that refers to cyclic fluctuations in abundance. Sockeye can mature at ages between 2 and 6 years old, but in most systems, one age group (usually 4-year-old fish) dominates (DFO 2008f, Internet site). As a result, the majority of offspring produced in any one brood year will return to spawn 4 years later. Approximately half of sockeye runs are known to have persistent 4-year cycles with a predictable dominant year cycle line every 4 years. During the dominant year, the run size is considerably larger than the other cycle lines (DFO 2001). To date, the exact nature of the physical and biological process that maintain these population cycles are poorly understood.

The Skeena River, of which the Kitimat River is a tributary, is second only to the Fraser River in its capacity to produce sockeye. A minimum of 70 distinct spawning sites and 27 lakes are currently in use by sockeye within the Skeena watershed. Skeena River sockeye smolts migrate to the ocean in late April through June, where they then move northward along the coast and offshore into the North Pacific (DFO 2001). Most Skeena sockeye mature at age four and five, although jacks commonly return at age three (DFO 2001). Returning sockeye enter Kitimat Arm from late June through to mid August, with a typical run peak around July 23. Spawning occurs in the area from late July to October; however, the exact time of the spawn in each spawning location is largely dependent of local water temperature regimes (DFO 2001).

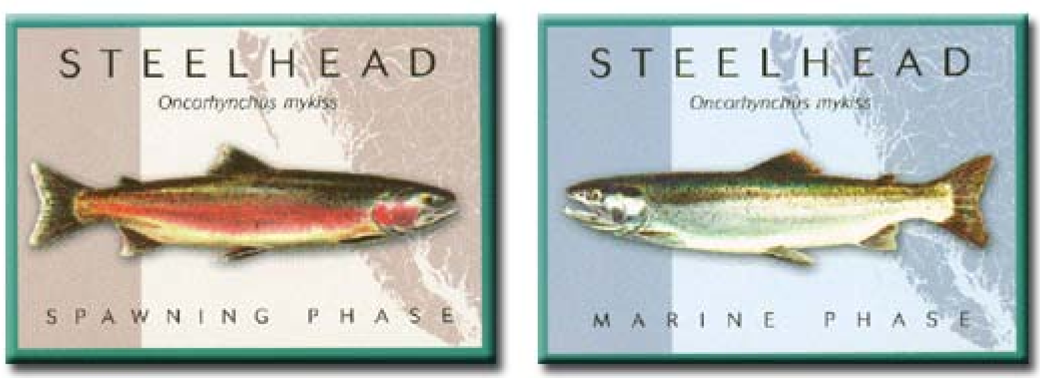
Sockeye salmon is the most targeted salmon species; sought after by sport, commercial and Aboriginal fisheries due to its quality, high oil content and deep red flesh. The commercial sockeye fishery is the longest running commercial salmon fishery in the Pacific region dating back to the beginning of the 1870s (DFO 2008f, Internet site). Presently, the commercial fishery uses purse seine, gillnets and trolling gear. Aboriginal subsistence fishers' use traditional nets, weirs and gaffs, while sport fishermen use spoons or bait (DFO 2008g, Internet site). According to the 2007 Salmon Stock Outlook, the forecast for returning sockeye to FMAs 5 and 6 is uncertain due to limited baseline assessments and evaluations (DFO 2007, Internet site).

Steelhead Trout (Oncorhynchus mykiss)

Steelhead were at one time considered a trout species, but have since been identified by biologists to be more closely related to Pacific salmon than to other trout (DFO 2008h, Internet site). Steelhead trout range from southern California to the Alaska panhandle, with major spawning grounds in coastal rivers, streams, tributaries and major river systems between Oregon and northern British Columbia.

As steelhead mature, they begin to resemble Atlantic salmon in structure and appearance (DFO 2008h, Internet site). Steelhead can reach up to 114 cm in length and approximately 19.5 kg in weight, but generally average 3.6 kg (Hart 1973).

Steelhead can live up to nine years. They spend between 1 and 3 years in fresh water before becoming smolts. As smolts, they quickly migrate to the ocean in the spring, where they continue to develop in estuarine habitats. Generally, steelhead spend two or more summers at sea before returning to their spawning streams at the age of four or five. Steelheads return to fresh water in either the summer (summer runs) or winter (winter runs). Unlike other salmonid species, steelhead may return to sea after spawning (up to 20% of fish, most of which are female) (DFO 2008h, Internet site) and later return to freshwater to spawn for a second time. These repeat spawners are commonly referred to as kelts (DFO 2008h, Internet site). See Figure 3-7 for an illustration of steelhead in the marine and spawning phases.



SOURCE: (DFO 2008h, Internet site)

Figure 3-7 Steelhead Trout in Marine and Spawning Phases

While at sea, adult steelhead mainly feed on fish and various crustaceans. Young steelhead tend to feed on insects, euphausiid, copepods, amphipods, sand lance, eulachon, red devil, searcher, herring and smooth tongue.

Due to their threatened status, no commercial fishery for steelhead exists at present; however, a catch and release sport fishery is in effect. During the past decade steelhead abundance has declined to low levels as a result of poor marine survival and habitat degradation in freshwater systems. Steelhead stocks are depleted throughout British Columbia and as a result several recovery programs have been initiated by both provincial government departments and non-governmental organizations (British Columbia Conservation Foundation 2006, Internet site).

Cutthroat Trout (Oncorhynchus clarkii)

Cutthroat trout can be found in streams and lakes along the coast ranging from northern California to Prince William Sound off the Gulf of Alaska (Hart 1973). Two subspecies of coastal cutthroat trout are native to British Columbia, a coastal form (*Oncorhynchus clarkii clarkii*) and an interior land locked form (*Oncorhynchus clarkii lewisi*), also known as westslope cutthroat. The distribution of coastal cutthroat trout does not extend very far inland, usually less than 150 km (British Columbia Ministry of Fisheries and Habitat Conservation Trust Fund 1999, Internet site). Coastal cutthroat can be further classified into two subgroups, resident and sea-run. Resident fish remain in fresh water for the duration of their life, while sea-run cutthroat are anadromous, migrating to the ocean as smolts but returning regularly to fresh water as adults to feed, overwinter and spawn. This section focuses on the sea-run coastal cutthroat subspecies.

Sea-run cutthroat generally inhabit estuaries, tidal sloughs, marshes, or near shore waters, moving in and out with the tides as they feed. However, some sea-run have been observed to undertake extensive migrations up to 100 km from the mouth of their natal streams in search of food (British Columbia Ministry of Fisheries and Habitat Conservation Trust Fund 1999, Internet site). Adult sea-run fish can reach a maximum length of 68 cm and weight of 3.6 kg (British Columbia Conservation Data Centre [BC CDC] 2005, Internet site). See Figure 3-8 for a view of a sea-run cutthroat trout.

SOURCE: (University of Washington 2009, Internet site)

Figure 3-8 Sea-Run Cutthroat Trout

At the age of three to four, coastal cutthroat become sexually mature, at which point they are ready to spawn in their natal stream. Spawning occurs from February to May in small streams where the fertilized eggs are deposited in redds. Incubation of eggs lasts six to seven weeks and the fry then emerge from the gravel one week after they have hatched (BC CDC 2005, Internet site). Sea-run cutthroat generally migrate into saltwater in the late summer after having spent 2 to 3 years in fresh water (BC CDC 2005, Internet site). The exact timing of migrations, age at migrations, length of time spent at sea and spawning time vary among stocks and geographical areas. After spawning, adults return to the ocean where they remain until the succeeding spawning season. Cutthroat can live up to a maximum of 10 years, but few survive long enough to spawn multiple times due to pressure from anglers and natural predators (British Columbia Ministry of Fisheries and Habitat Conservation Trust Fund 1999, Internet site).

Coastal cutthroat are a predatory fish that feed on other fish such as coho, sticklebacks, rockfish, sculpins and flatfish (Hart 1973). During the salmon spawning season, adults are also known to eat loose salmon eggs (British Columbia Ministry of Fisheries and Habitat Conservation Trust Fund 1999, Internet site). While in the ocean cutthroat feed on small fish as well as crustaceans. Juvenile cutthroat feed primarily on insects (Hart 1973).

The life history of coastal cutthroat negates the possibility of a commercial fishery, as they do not venture far from shore. The recreational fishery on the other hand, is large and important. The present recreational catch limit is two trout (includes steelhead, Dolly Varden, cutthroat trout, brown trout and bull trout) per day. Although recreational fishing is permitted, the British Columbia government has blue-listed the costal cutthroat, indicating that the species is considered vulnerable in British Columbia (BC CDC 2005, Internet site). In an effort to help the cutthroat population in FMA 6, the Kitimat hatchery released approximately 10,000 fish in 2005 (DFO 2006, Internet site).

3.1.5.2 Eulachon, *Thaleichthys pacificus*

Eulachon are anadromous fish that range from the Southern Bering Sea to Northern California. They grow to approximately 22.9 cm and live to be 5 or more years old (Hart 1973) (see Figure 3-9). They were historically abundant in Douglas Channel and provided a source of food for local Aboriginal communities. They are provincially listed as a Blue species of concern due to localized rarity and recent sporadic spawning failures throughout British Columbia (BC CDC 2008a, Internet site).

SOURCE: (Alaska Fisheries Science Center 2008, Internet site)

Figure 3-9 Eulachon

Of the 30 to 40 spawning rivers known in British Columbia, only half of these support regular spawning events (Hay and McCarter 2000). Suitable spawning habitat is generally characterized by pronounced spring runoff from large snowpacks or glaciers into the rivers (Hay and McCarter 2000; Beacham et al. 2005). Spawning location is variable from year to year, but four rivers in the Kitimat area are known to receive some level of eulachon spawning. Rivers in the area that support consistent Eulachon spawning are Kildala River, Kitimat River and possibly other small channels off Gardner Channel (Hay and McCarter 2000). Gilttoyees Inlet and Foch Lagoon are also used on a more irregular basis (Hay and McCarter 2000). Limited spawning habitat combined with a low understanding of reasons for decline make the eulachon a species of concern.

Eulachon generally reach maturity at the end of their third year and migrate into the lower reaches of rivers and channels to spawn in early spring (Hay and McCarter 2000). Fecundity is related to the size of the female, but averages 25,000 eggs (Hart 1973). The eggs are sticky and adhere to sand grains on the river bottom. After three to five weeks, the eggs hatch and larvae are immediately swept out to sea with the current. Larvae feed on copepod larvae and eggs, phytoplankton, mysids, copepods, ostracods and barnacle larvae. Juveniles and adults eat euphausiids and copepods. Concentrations of eulachon during spawning runs attract dogfish, sturgeon, halibut, cod, porpoise, finback whales, killer whales, sea lions and gulls that sometimes follow the eulachon migration (Hart 1973).

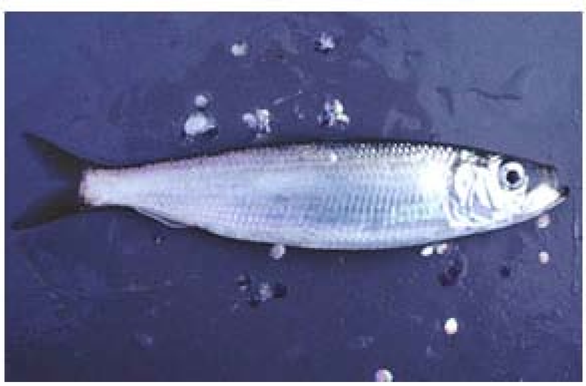
No commercial fishery for eulachon exists in British Columbia outside the Fraser River and harvest in the Kitimat area is limited to local Aboriginal communities. The eulachon has a high oil content that remains solid at room temperature. They are eaten fresh, smoked, dried or rendered down to grease that is used for food and bartering between Aboriginal communities.

Estimates of eulachon biomass are based on larval surveys and the offshore eulachon index in the Queen Charlotte Sound (McCarter and Hay 1999; DFO 2005). Population decline of eulachon across most of British Columbia in the 1990s was followed by non-existent runs in Douglas Channel from 1998 to 2000 (Hay and McCarter 2000). Biomass has since increased steadily with the largest abundance estimate recorded in 2003 (4,366 tonnes) and subsequent declines in 2004 (1,176 tonnes) (DFO 2005).

3.1.5.3 Pacific Herring, *Clupea harengus pallasi*

Pacific herring are small, schooling fish that are found in inshore and offshore waters ranging from California to the Beaufort Sea (Hart 1973). In British Columbia, herring are common to most areas and support several modest commercial fisheries. These fisheries include a food and bait fishery, spawn on kelp fishery and a herring roe fishery (DFO 2001).

Pacific herring grow to approximately 25 cm and can live up to 15 years (see Figure 3-10).



SOURCE: (Washington State Department of Fish and Wildlife 2001, Internet site)

Figure 3-10 Pacific Herring

Herring become mature between the ages of two to five, at which point they recruit to the spawning stock, which form annual spawning aggregations along the coast (Hart 1973). Fecundity, the reproductive capacity of a female fish, is correlated with size; however, females generally lay between 9,000 and 38,000 eggs. The eggs form sticky mats, which adhere to seaweed and substrate between the high tide level and 11 m depth. Large aggregations of spawners ensure a high rate of fertilization success.

Mature herring partake in annual feeding cycles that coincide with spawning events. As the spawning condition approaches in the fall, herring begin to fast and concentrate energy into the production of eggs. Once spawning is complete, they begin feeding again to replenish fat and stored oil. Large schools of herring provide a valuable food source for salmon, seals, sea lions, dogfish, lingcod and whales (Hart 1973).

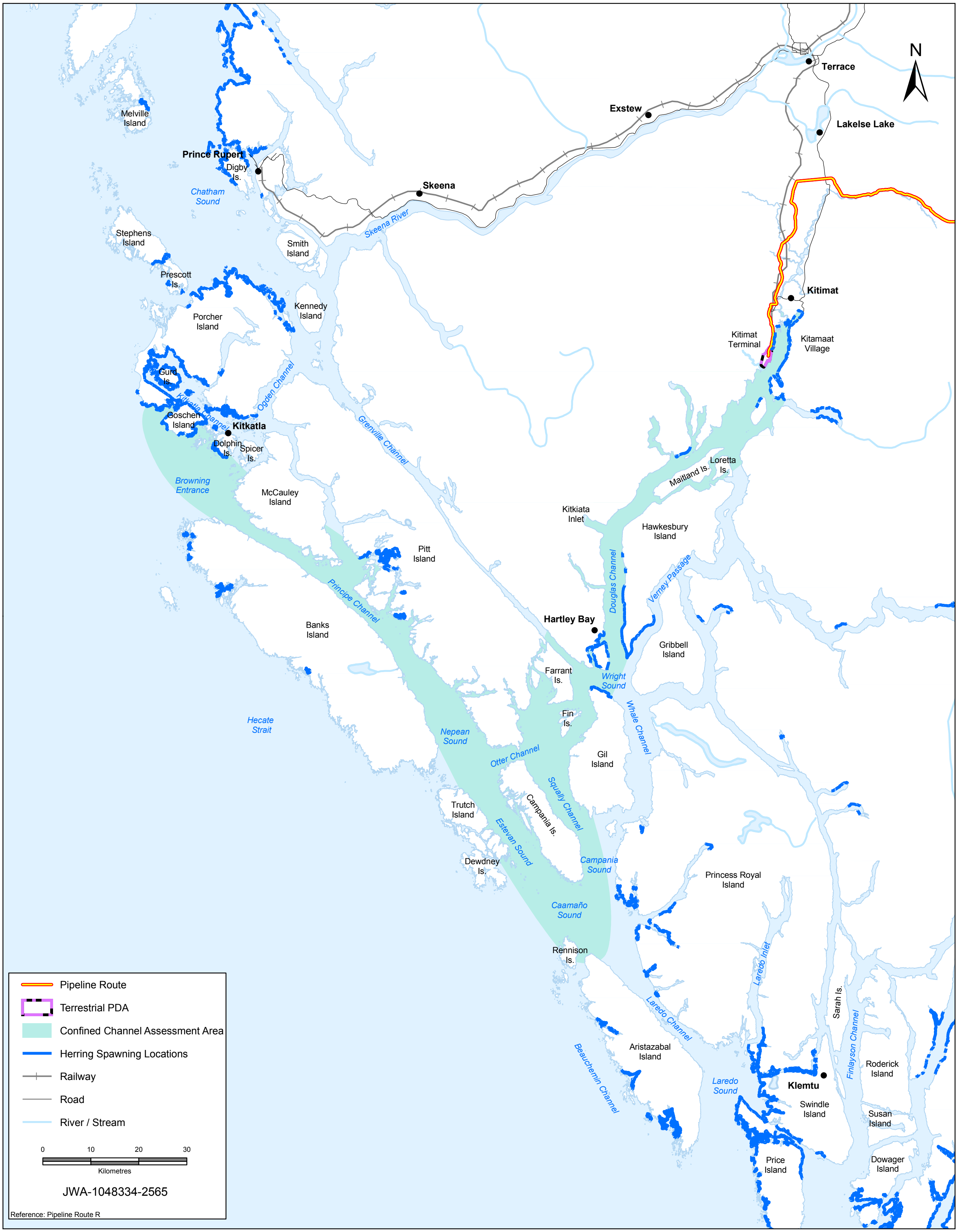
Herring eggs are subject to high rates of mortality from predation and turbulent weather that can dislodge them from their protective substrate. Eggs hatch after 10 days and recently emerged larvae immediately begin to feed on invertebrate eggs, copepods and diatoms. After two to three months, herring larvae begin to form schools and display a diurnal vertical migration where they generally move to deeper waters during the day and rise to the surface at dusk to feed. In the fall, larval schools migrate to deeper water, where they will remain until the age of two or three. During this interim period there is little evidence of any juvenile activity in inshore waters.

The Kitimat Arm supports a resident population of herring that do not contribute to the larger, migratory stocks of Hecate Strait and coastal British Columbia. The herring population in the upper reaches of Kitimat Arm is small and relatively slow growing. Although in general the herring of Kitimat Arm are resident and do not emigrate from the area, evidence suggests that they undertake a post-spawning migration to the mouth of the inlet (Triton 1993). Information on known spawning areas for herring is available from the British Columbia Coastal Resource Information System (ILMB 2007, Internet site) and shown in Figure 3-11.

Spawning locations in Douglas Channel vary from year to year, but generally include Kitimat Arm, the Southwest side of Hawkesbury Island and Hartley Bay where high concentrations of herring gather in the spring to spawn. Spawning occurs locally along the foreshore between Kitamaat Village and Minette Bay, in Clio Bay, Kildala Arm and on Coste Island. Within the Kitimat fjord complex, spawning beds are on both sides of Douglas Channel, on the west side of Ursula Channel and on the south side of Coste Island. Adult Pacific herring are also found in Kitkatla Inlet, just north of Browning Entrance and in Kitasu and Weeteean Bay south of Caamaño Sound. The average spawning period is 4 days. The Kitimat Arm Pacific herring population spawns in Minette Bay, south of Kitamaat Village where eggs attach to rockweed, the dominant cover (Triton 1993). This population spawns in March through April, between the high tide watermark and 11 m depth with a mean spawning date of March 25 (Hay et al. 1989). Juvenile Pacific herring are known to rear in the upper end of Kitimat Arm, including Minette Bay.

There are five major herring stocks in British Columbia’s coastal waters: Prince Rupert District, Central Coast, Queen Charlotte Islands[1], west coast of Vancouver Island and the Strait of Georgia. Herring in the PEAA within Douglas Channel are assumed to belong to the Central Coast stock that extends from the southern tip of Banks Island south to Johnstone Strait (DFO 2001). Herring stocks are known to fluctuate rapidly, but due to strong recruitment of the 1994 and 1995 age-classes, Central Coast stocks are currently considered to be at healthy levels (DFO 2001).

[1] In December 2009, the Queen Charlotte Islands were renamed Haida Gwaii. The previos name is retained for consistency with reviewed literature.



REFERENCES: NTDB Topographic Mapsheets provided by the Majesty the Queen in Right of Canada, Department of Natural Resources. All rights reserved.

CONTRACTOR:	ENBRIDGE NORTHERN GATEWAY PROJECT	FIGURE NUMBER:	DATE:
Jacques Whitford AXYS Ltd.		3-11	20100129
PREPARED BY: gem Gateway Environmental Management Team	PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES	SCALE: 1:1,100,000	AUTHOR: BA / APPROVED BY: CM
	Herring Spawning Areas	PROJECTION: UTM 9	DATUM: NAD 83

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3.1.5.4 Rockfish, *Sebastes* spp.

Rockfish are generally limited to the west coast of North America with the exception of a few species that live in the North Atlantic, South Pacific and South Atlantic. There are 35 species of rockfish that live in British Columbia coastal waters (Love et al. 2002). Rockfish most likely to occur in the PEAA include species collectively referred to as the inshore rockfish assemblage: copper, quillback, china, tiger and yelloweye rockfish (see Figure 3-12). Other species may be present in the PEAA, but at lower numbers and densities. Inshore waters provide suitable habitat for juvenile rockfish including the threatened Bocaccio. Numerous other species of rockfish are likely to occur in the larger CCAA, depending on depth and substrate.

SOURCE: (Alaska Fisheries Science Center 2008, Internet site)

Figure 3-12 Inshore Rockfish Species – Copper and Tiger Rockfish

Rockfish mature between 1 and 20 years and can live between 20 and 118 years, depending on species. Eggs are fertilized internally and females bear live young after 1 to 2 months gestation. Fecundity is positively correlated with size. Larvae are released between February and June and spend 3 to 6 months in the pelagic phase feeding on copepods and invertebrate eggs. Larval rockfish are generally found in the mixed layer and thermocline. Pelagic larvae are the most sensitive phase of the rockfish life cycle, and their survival is critical to overall reproductive success (Love et al. 2002). Variable oceanic conditions (upwelling intensity, food supply and water temperature) result in naturally fluctuating survival rates of rockfish larvae from year to year. Juveniles settle to the bottom where they begin feeding on bottom dwelling shrimp, crab, small fish and amphipods. Adults feed on crab, shrimp, invertebrates and other fish. Most of the inshore species actively feed at dusk and dawn and often take cover at night.

Preferred rockfish habitat includes rocky outcrops that provide complex substrate and cover in crevices, caves and rock ledges, in addition to vertical structure such as kelp forests and macroinvertebrates. Yelloweye and Tiger rockfish are often associated with boulder fields. Various life stages of rockfish species can be found in nearshore habitat both subtidally and intertidally.

All species of rockfish are of some concern in British Columbia because of their status as a popular recreational sport fish and life history characteristics that make them vulnerable to population decline and difficult recovery. Rockfish populations are in decline in some areas of the province where recreational fishing pressure and bycatch mortality are high. There is no evidence that rockfish populations in Douglas Channel are in decline (Reagan 2006, pers. comm).

Bocaccio (Sebastes paucispinis)

The bocaccio is one of 35 species of rockfish that live in British Columbia coastal waters. It is a large fish that can reach lengths of up to 90 cm and has an average weight of 7 kg (see Figure 3-13). Its range extends along the west coast of North America from Baja California to Alaska, but very little is known about its distribution in the northern and central coast of British Columbia. Projected habitat models identify Caamaño Sound as potential habitat based on known depth preferences of bocaccio (Stanley et al. 2004). Recreational catch statistics indicate records of bocaccio caught in DFO FMA 6, but not within the PEAA (encompassed by Subarea 6-1; Marine Fisheries Technical Data Report [Triton 2010]). Records of bocaccio caught in inlets in the Strait of Georgia indicate that there may be suitable habitat in the fjords of the northern coast, especially for juveniles that tend to reside in nearshore areas until they reach maturity at four to five years of age. Like most rockfish, bocaccio suffer high mortality when caught as bycatch due to overexpansion of the swim bladder. Estimates report that bocaccio stocks in Canada have declined 90% in the past 10 years (Stanley et al. 2004).

Due to apparent major declines over the past two decades and a lack of biological information specific to the Canadian population, this species is currently under review to be designated as threatened under Schedule 1 of *SARA*.

Adults are semi-pelagic and can be found in depths of 60 to 340 m. Most of the biological and abundance data were collected from work done in California and from bycatch statistics from the commercial fishery in Canada. They are commonly recorded as bycatch in association with Pacific ocean perch, yellowtail rockfish and canary rockfish (Stanley et al. 2004).

SOURCE: (NOAA 2009, Internet site)

Figure 3-13 Bocaccio

Age estimates based on otoliths suggest that bocaccio can reach 40 years of age. Sexual maturity is reached at 4 to 5 years. Copulation occurs in early fall but fertilization is delayed. Fecundity is based on female size but ranges from 20,000 to 2,300,000 eggs. Embryonic development takes approximately 1 month. Larvae hatch within the female body and are retained until the larvae are partially developed. In British Columbia, young are released in the winter. Larval and juvenile bocaccio are pelagic and often occur near the surface of nearshore waters. Between 3 and 5 months, juveniles settle to the bottom and begin to school. Larvae metamorphose over several months and settle to littoral and demersal habitat in late spring to summer. As they grow older, they continually move into deeper water and become more sedentary. The largest and oldest bocaccio are sedentary and live in deep crevices or caves.

The diet of juvenile bocaccio includes invertebrate larvae, pelagic shrimp, young rockfish, surfperch, mackerel and other small inshore fish (COSEWIC 2002). Adults feed on other rockfish, sablefish, anchovies, lantern fish and squid.

3.1.5.5 Surf Perch

There are four species of surf perch that potentially live in the CCAA — shiner perch, pile perch, striped sea perch and kelp perch. They belong to the family *embiotocidae* whose distribution in North America extends from Alaska to Baja California (Lane et al. 2002). None of the four species in the area is considered rare or threatened. The kelp perch is restricted to kelp forest habitat that occurs on the exposed sides of the Estevan Group Islands and Caamaño Sound. The shiner and pile perch are commonly found in piling habitat around wharves as they are attracted to prey that is concentrated on marine infrastructure (Lane et al. 2002). Striped seaperch can also be found in piling habitat but are usually associated with rocky bottoms or rack faces (Lane et al. 2002). They feed primarily by grazing on pilings or benthic habitat for amphipods, isopods, shrimp, mussels, barnacles and fish eggs (Lane et al. 2002).

Surf perch are viviparous fish with delayed fertilization to ensure optimal habitat requirements for broods of live young. Due to the increased energy expenditure on development of their young, surf perch have low fecundity and are slow to recover after a decrease in population (Lane et al. 2002).

Surf perch are an important part of nearshore fish assemblages and provide a small recreational fishery throughout British Columbia. Fishing records from the Kitimat area indicate that surf perch form a very small proportion of the total recreational catch (Lane et al. 2002). Common predators include sea birds, river otters, seals, sea lions and large fish (rockfish and lingcod) (Hart 1973).

Shiner Perch

Shiner perch are common in marine and estuarine waters and are able to tolerate salinity ranges of 0 ppt to 35 ppt. They reach an average size of 10 to 11 cm and live up to 6 years (Lane et al. 2002). In the summer, schools of shiner perch are attracted to eelgrass beds, wharves and pilings where they feed on small invertebrates, copepods, tunicates and fish eggs. They often disperse into deeper water in the winter and have been recorded at depths up to 146 m (Lane et al. 2002).

Sexual maturation occurs at age 1, and after mating in April to July, females store sperm until fertilization occurs in the winter (Hart 1973; Lane et al. 2002). After 5 months gestation, 4 to 20 live young are born in May to August (Hart 1973) (see Figure 3-14).

SOURCE: (NOAA and US Department of Commerce 2001, Internet site)

Figure 3-14 Shiner Perch

Pile Perch

Pile perch are the largest and longest-living surf perch sub-species in British Columbia (Lane et al. 2002). They aggregate all year and are often found near the bottom (less than 74 m) where they feed on gastropods, mussels and decapod crustaceans (Lane et al. 2002). Females mature at 4 to 10 years. Fecundity is related to female size and they generally produce 18 to 52 young. In British Columbia, live young are usually released in August after a 5-month gestation period (Hart 1973) (see Figure 3-15).

SOURCE: (DFO 2009, Internet site)

Figure 3-15 Pile Perch

Striped Seaperch

Striped seaperch reach an average length of 13 to 22 cm and live an average of 7 years. They are generally solitary, but are often found in loose aggregations, especially during breeding season in the late fall and early winter (Lane et al. 2002). They require high salinity water which restricts them to marine habitat, but they are sometimes found in the lower reaches of estuaries. Females mature at 2 to 3 years of age and release an average of 18 to 22 live young in June and July (Lane et al. 2002) (see Figure 3-16).

SOURCE: (Alaska Fisheries Science Center 2008, Internet site)

Figure 3-16 Seaperch

3.1.5.6 Threespine Stickleback, *Gasterosteus aculeatus*

Threespine stickleback are a small (less than 10 cm) fish that have a large range throughout the Pacific and Atlantic oceans. In the Pacific Ocean, they are found from Baja California to the Aleutian Islands and from Kamchatka to Korea (Hart 1973). They are found in freshwater lakes and streams as well as nearshore and offshore marine environments. They are distributed throughout British Columbia and show great variation in body form and ecology (Hart 1973) (see Figure 3-17).

SOURCE: Photo by Noel M. Burkhead (USGS 2009, Internet site)

Figure 3-17 Threespine Stickleback

They are characterized by a first dorsal fin that is modified into three serrated spines, and a first pelvic fin that is also a modified spine. A variable number of bony plates form armour on each side; populations in marine environments generally have the highest number of plates (Hart 1973). Colour is variable depending on habitat and ranges from silvery green to deep bluish-black. Several specific populations in British Columbia are designated as endangered by the Federal *Species at Risk Act* due to independent evolution into limnetic and benthic populations, however, the stickleback populations in Douglas Channel and associated marine waters are not federally listed (Government of Canada 2005, Internet site). The province of British Columbia lists stickleback populations in the province with a yellow designation (not at risk) (BC CDC 2008b, Internet site).

In marine and estuarine habitat, stickleback generally school in eelgrass and around wharves and pilings, but can also be found further out to sea (Hart 1973). They mature at one to two years old and generally migrate to freshwater to spawn in spring and early summer. Males build nests on the substrate out of plant material where one to several females deposit eggs. The male guards the eggs until they hatch approximately seven days later (BC CDC 2008b, Internet site). It is presumed that stickleback can live to four years of age and die after they breed. They feed on copepods, euphausiids, crustacean larvae and small fish (Hart 1973).

3.1.5.7 Pacific Halibut, *Hippoglossus stenolepis*

Halibut are an important sport and commercial fishery on the northern coast of British Columbia. They are laterally compressed, bottom dwelling flatfish that grow up to 267 cm and can weigh upwards of 56 kg (Hart 1973) (see Figure 3-18). According to interviews with local fishermen and historical records (Bell and Kallman 1976), halibut are a common food fishery in the CCAA and have been found in Douglas Channel, Gardner Channel, Sue Channel and Ursula Channel (Bell and Kallman 1976).

SOURCE: (Alaska Sealife Centre 2009, Internet site)

Figure 3-18 Pacific Halibut

Females are generally larger than males and mature later (Hart 1973). Mature adults migrate up to 1,600 km from shallow summer feeding grounds to deeper spawning grounds in the winter (Hart 1973). Spawning usually occurs from November to January at 275 to 412 m depth. Large females lay 2 to 3 million eggs between 40 to 935 m deep. Newly hatched larvae are usually found below 200 m. They remain pelagic for 4 to 5 months, feeding on plankton. At 3 to 5 months, they are carried inshore by surface currents and settle to the bottom as juveniles. Before settling, the bilaterally symmetrical young transform into the adult, laterally compressed form and one eye migrates to the other side of the head (Hart 1973). Juveniles remain in nearshore habitat where they feed on krill and small fish. At 5 to 7 years, juveniles move offshore to deeper waters where they become opportunistic feeders on cod, sablefish, Pollock, other flatfish, herring and octopus (Hart 1973).

Douglas Channel falls within statistical area 2b under the management of the International Pacific Halibut Commission. Stocks in this area are reasonably healthy with good average recruitment (DFO 2009).

3.1.5.8 Mussels, *Mytilus* spp.

The dominant intertidal species seen in this region is the bay mussel (*Mytilus trossulus*) or foolish mussel, which is part of the *M. edulis* complex that includes blue mussels (*M. edulis*) and Mediterranean mussels (*M. galloprovincialis*). The bay mussel is native to the Pacific Northwest and dominates the hard shoreline of the sheltered coasts of British Columbia (Gosling 1992).

Mussels occur in a diverse group of habitats including hard rocky shores, gravel and cobble substrata, and soft sediment shores in protected habitats. The grouping behaviour of mussels results in the formation of a complex network of structures that allow many other organisms the opportunity for settlement and protection.

The vertical distribution of mussels in the intertidal is controlled through both abiotic and biotic factors. Mussels are primarily found in the upper midlittoral into the lower midlittoral zone but can be found down to 40 m on docks and pilings. Temperature is known to adversely affect mussels and act in combination with desiccation to set the upper limits of mussel distribution. The lower limit is principally determined by biological factors such as predation and competition from other sessile organisms (Connell 1972; Paine 1974). Crabs, seastars, birds and otters are the organisms most commonly responsible for crab disturbance. However, due to the low diversity in this system, abiotic disturbance is likely more important, such as logs impacting the shore and creating gaps. This is probably also an important process in the CCAA as there are large amounts of woody debris in the system. Mussel beds are known to be resilient to the effects of physical and biological disturbances and full recovery usually occurs. *M. trossulus* is found far into the estuary as it can tolerate both full oceanic salinity of 35 parts per thousand (ppt), as well as very low salinity conditions of 6 to 7 ppt (Gosling 1992).

Mussels are active suspension feeders consuming bacteria, phytoplankton, detritus and dissolved organic matter (DOM). Particles are sorted across the gills and unwanted particles are expelled as pseudofaeces. Bivalves generate turnover of nutrients and organic carbon in estuarine and coastal environments by transferring phytoplanktonic primary producers to secondary production.

These bivalves are broadcast spawners and release sperm and eggs into the water simultaneously over a prolonged period, from summer to fall. The veliger larvae will live as plankton for several weeks after fertilization. They will then metamorphose to a pediveliger, develop a foot and settle to hard substrate on the bottom. These larvae then metamorphose again into a juvenile and start to develop a shell. At this stage they are still mobile and able to search for primary attachment substrate. A mature mussel can move after settlement by using its foot and byssal attachments to pull itself to new locations.

Mytilus edulis larvae will preferentially settle on filamentous algae (Seed 1969) and onto byssal threads that would settle them directly into adult mussel beds (Eyster and Pechenik 1987). The bay mussel will quickly colonize open patches in intertidal areas (Dayton 1971) and is considered a pioneer species. The competitively superior *M. californianus* eventually displaces *M. edulis* from areas where both species are found together (Paine 1974).

3.1.5.9 Dungeness Crab, *Cancer magister*

Dungeness crab (Figure 3-19) are found from San Francisco to the Aleutian Islands in Alaska. They are widely distributed in the subtidal environment and prefer a sandy or muddy bottom in salt water. However, they are tolerant of salinity changes and can be found in estuarine environments, which are often used as nursery grounds. The crabs are generally in waters shallower than 15 fathoms (27 m), but they have been found in depths down to 100 fathoms (183 m) (Alaska Department of Fish and Game 1985).

SOURCE: Janine Beckett, Stantec

Figure 3-19 Dungeness Crab

Mature female crabs typically moult between May and July. Mating occurs during May to August between hard-shelled males and soft-shelled newly molted females. This mating occurs outside of estuaries in nearshore environments. In October and November the eggs become fully developed and are extruded and fertilized. Between January and March, the larval crabs hatch and become planktonic. The female is often buried in substrate between the time of fertilization and release of larvae, which is about 2 to 3 months. In comparison to other crab species such as King Crabs, which brood their eggs for approximately a year and are vulnerable during this time, Dungeness crabs are vulnerable for a relatively short period of time. Approximately 1 year after hatching, around May and June, the larvae metamorphose and settle to the bottom. Juveniles reside in shallow coastal waters, tidal flats and estuaries, living in beds of eelgrass and other aquatic vegetation. These juvenile crabs do not move from their settlement area for several months at which point they move into deeper water as they grow larger. They reach sexual maturation after a further two years, and legal harvest limits (165 mm) typically a year following that. Studies suggest that growth is greater in estuaries than in other nearshore habitats. This may be due to higher temperatures and more abundant food sources.

Dungeness crab can recruit in very large events and the larvae are an important food source for Pacific herring, Pacific sardines, rockfish and chinook salmon. Dungeness crabs feed primarily on fish, shrimp, molluscs and crustaceans.

Abundance fluctuates greatly from year to year due to changes in oceanic conditions. This makes management difficult and is not based on population assessments. The fishery is managed by the "3-S" system, which refers to size, sex and season. The primary management tools used for this fishery are a minimum size limit (165 mm), limited entry and gear and fishery closures. The minimum size limit helps to limit mortality of the undersized female in order to safeguard reproductive potential.

There is no source information regarding specific crab habitat. Therefore, fisheries data are used to determine areas of primary crab habitat. There are areas of high valued crab habitat in Douglas Channel (LGL Limited Environmental Research Associates 2004). This does not include Kitimat arm.

3.1.5.10 Sea Cucumber, *Parastichopus californicusc*

The California sea cucumber is distributed between the Gulf of Alaska to Baja California, Mexico. It is found in the low intertidal zone down to 90 m. Previous studies have shown that 70% are found above the 20-m-depth mark (Woodby et al. 2000). The species is most common on bedrock in areas with little current where detritus accumulates. They also live on gravel, shell, sand or mud and often in eelgrass beds. Densities are highest on shell and gravel and lowest in mud and silt (larger individuals are found in mud and silt) (Woodby et al. 2000). This species is an epifaunal deposit feeder, acting as a bioturbator that reworks and redistributes sediment in the process of feeding. The impact of sea cucumbers on sediments is a function of their specific feeding activities and lifestyles. Aspidochirotids (including *P. californicaus*) decrease the stability of the sediment surface. This would be compared to, for example, dendrochirotids that facilitate the accumulation of bound organic matter on the sediment surface (Gebruk et al. 2000).

At approximately 4 years of age they reach sexual maturity and migrate to shallow waters. Sea cucumbers cease feeding and become dormant from September to early March. Sexes are separate and spawning usually occurs from late April to August, but this timing varies with location. Spawning events usually occur in waters less than 16 m in depth and fertilization occurs in the water column (Cameron and Fankboner 1989). Larvae drift as plankton for 2 to 4 months, then settle and develop into juveniles. These juveniles usually find refuge in macroalgae holdfasts, dense mats of filamentous red algae, under rocks or in rock crevices (DFO 2001). Adults may reach 500 mm and may live to over 8 years. Adults are reported to undergo seasonal migrations, although no notable data have been put forward to support this hypothesis (Campagna and Hand 2004). Sea cucumbers cannot be aged and as a result, growth rates, age at sexual maturity, longevity are often difficult to determine.

There are limited data on sea cucumber specific habitat as the fishery is still developing. Biomass estimates for the British Columbia coast have historically been based on surveys from Alaska (Campagna and Hand 2004). A recent paper compiled all surveys in British Columbia and attempted to create baseline density estimates. The suggested density that is used for areas with favourable conditions for cucumbers is 5.08 c/m-s (cucumbers per metre of shoreline). For areas where habitat is marginal the old density of 2.54 c/m-s is used.

The CRIMS database shows no fisheries resources in the CCAA. However, the commercial and recreational fisheries surveys found that there are fisheries for sea cucumber in the CCAA.

3.1.5.11 Cockles, *Clinocardium nutalli*

Cockles (also known as Nutall's Cockle) are distributed from California to the Bering Sea. They are found ranging from the intertidal zone to deep water. Cockles are common on many of the beaches of the north coast (Gillespie and Bourne 2000). They typically are found on beaches with sand and mud substrate fringed by eelgrass beds.

Cockles are often buried to very shallow depths because of their short siphons and therefore are easily harvested by sport diggers at low tide. Cockles on the British Columbia coastline spawn between July and August and the larvae are planktonic. Cockles are rapid burrowers using both the hydrostatic pressure in the foot and the valves of the shell to dig. The muscular foot can also be used to move on the surface with a lunging motion.

Commercial landings are incidental to landings of the four major commercial species: Butter clams, littleneck clams, manila clams and razor clams (Gillespie and Bourne 2000). Cockles are in important traditional food for the Aboriginal groups in the region. The value of commercial bivalve resources in the Douglas Channel system is low and Kitimat arm has no commercial bivalve resources, most likely due to water and sediment pollution (LGL Limited Environmental Research Associates 2004).

3.1.5.12 Periwinkle, *Littorina sitkana*

The periwinkle (also known as the Sitka periwinkle) is a common gastropod on sheltered shores ranging from Alaska to Puget Sound, Washington (Harbo 1999). This small grazer is often associated with rockweed beds but can have an unpredictable distribution. Some shores find this species distributed throughout the intertidal zone, while on other shores it is found limited to damp crevice refuges within the high intertidal zone. The distribution of most intertidal animals is a balance between the biotic and abiotic factors at play. Researchers have suggested that periwinkle distribution is linked to variability in predator abundance (Behrens Yamada et al. 1998). This would imply a trade-off between the increased risk of predation at lower levels and the reduced fecundity higher on the shore (due to lower nutrition). The dominant predators in this system would be crab and starfish, which are limited in their vertical distribution by desiccation stress (Behrens Yamada et al. 1998).

3.1.5.13 Marine Riparian Vegetation

Marine riparian systems are areas on land bordering tidewater and constitute the interface between terrestrial and aquatic ecosystems (Brennan and Culverwell 2004). These systems may include vegetated or non-vegetated areas shoreward of the higher high water, large tide (HHWLT). They are distinguished by gradients in biophysical conditions, ecological processes and biota (National Research Council 2002). They include those portions of terrestrial ecosystems that significantly influence exchanges of energy and matter with aquatic ecosystems.

Most riparian research has been done on freshwater systems and information available on marine riparian vegetation and associated biota is limited. However, evidence suggests that marine riparian vegetation plays a major role in fish health by providing habitat for feeding and spawning. It also likely plays a key role in stabilizing the upper shore by minimizing and filtering freshwater runoff into the nearshore marine ecosystem (Levings and Jamieson 2001).

3.1.5.14 Rockweed, *Fucus distichus* ssp. *edentatus*

Fucus distichus, commonly called rockweed, is found from the mid- to high-intertidal regions from Point Conception, California to Alaska. It is one of the most conspicuous species in temperate and subarctic systems and are the dominant intertidal algae on the west coast. For example, *Fucus distichus* comprises up to 90% of the biomass in the intertidal zone of Prince William Sound, Alaska (Stekoll and Deysher 1996). Due to this varied distribution and high biomass the species is often affected by shoreline and nearshore development.

The upper limit of rockweed is determined by desiccation stress. It can tolerate high levels of desiccation and actually photosynthesizes at a more efficient rate when under desiccation stress. The lower limit is determined by interspecific competition. Other seaweeds such as Lamanarians, will out-compete rockweed for space in the lower intertidal. Due to the limited quantity of Lamanarians in the CCAA, rockweed grows down to the low mid intertidal. The red seaweed (*Ahnefeltiopsis* spp.), found in the more exposed rock shelves, probably controls the lower limit in these habitats.

The canopy that rockweed creates in the intertidal community is a very important structuring component in the intertidal. It provides invertebrates with a food source and shelter from waves, desiccation, freezing and predators. Important grazers on rockweed include amphipods, isopods, littorines and other snails, chitons and limpets.

Rockweed has a development process more similar to that of animals than to most other algae. It produces eggs and sperm in small structures at the ends of the blades. Eggs are fertilized and settle to the substrate to form new plants, usually creating dense beds. Several life history stages have been defined for these benthic algae: spores or zygotes, germlings, juveniles and adults (Vadas et al. 1992). Important factors affecting settlement of algal spores include substrate type, sediment, silt, scouring effects, water motion, desiccation, temperature, nutrients, canopy effects, presence of turf, adult plants and presence of invertebrate grazers (Vadas et al. 1992). *F. distichus* in Prince William Sound lives for at least four years (Driskell et al. 2001).

Field measurements of growth in a related species on the Atlantic coast, spiral wrack (*Fucus spiralis*) showed season-dependant variation, with maximal growth in the summer attributed to an increase in water temperature, light intensity and day length. *F. distichus* on the Pacific coast showed higher growth rates in spring and summer with rates of 0.24 cm to 1.17 cm per month compared to growth in the winter of 0.5 to 0.4 cm per month (Ang 1991).

Disturbance experiments have attempted to address the recovery of rockweed and its contribution to successional patterns. Edelstein and McLachlan (1975) did not see recovery of *F. distichus* to its original status even after 4 years following removal and burning. Another clearing in an intertidal strip required over 10 years for recovery of algal species (Lodge 1948).

The rockweed population in western Canada is maintained primarily by periodic large recruitment pulses (Ang and De Wreede 1992).

3.1.5.15 Kelp

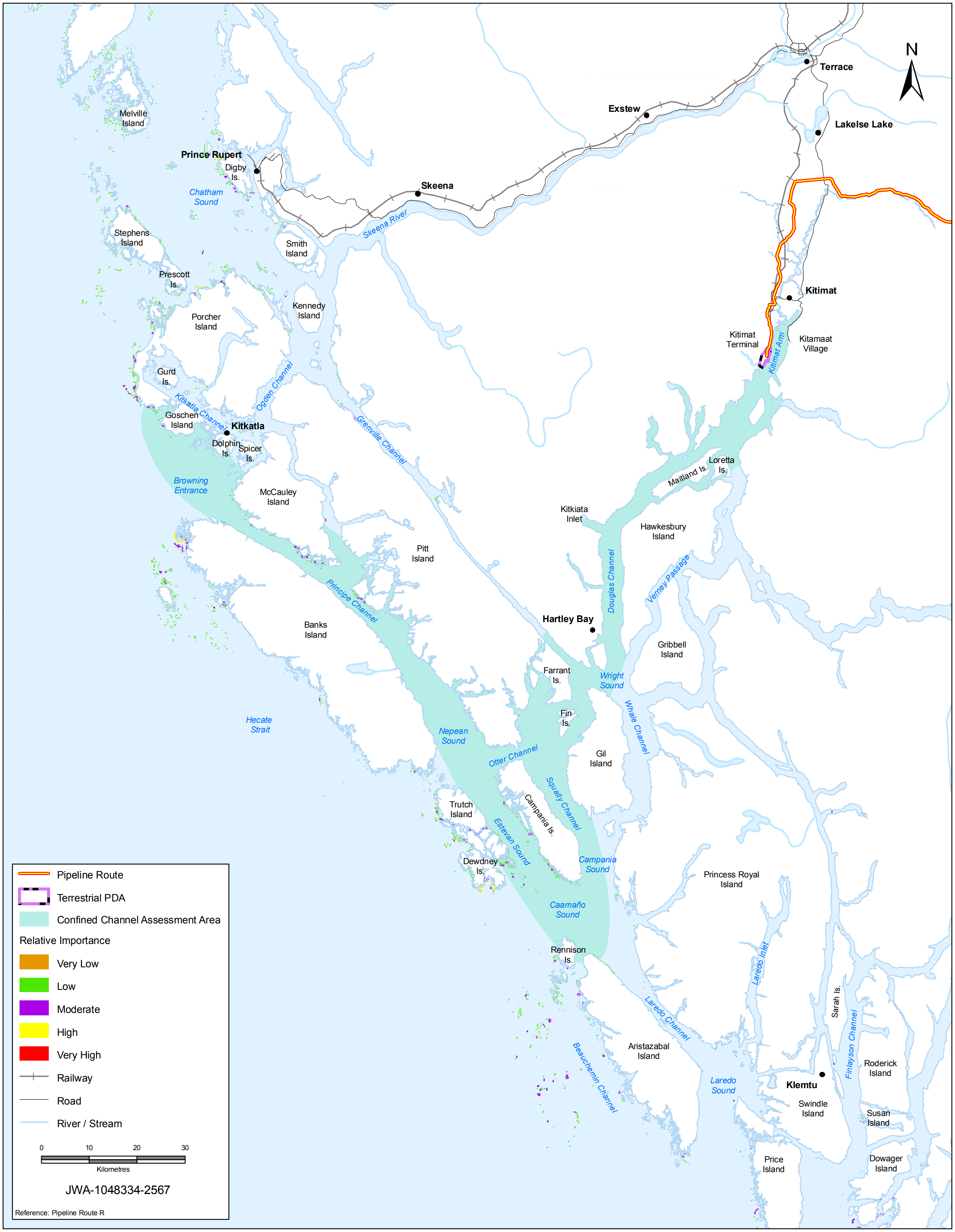
Kelps are not a taxonomically diverse group but provide some of the most productive habitat on the Pacific Coast. There are three groups of kelps that are defined by their canopy structure. The largest canopy kelps, such as *Macrocystis* spp. and *Nereocystis* spp., form the large kelp forests that grow to and float on the surface. The stipitate kelps forming the second group are small kelps held above the surface with small rigid stipes at intermediate depths. These include *Alaria*, *Laminaria* and *Pterogophora,* which form large subtidal forests on the west coast. The third group comprises the prostrate kelps that grow close to the benthos including *Hedophyllum* and other species of *Laminaria*.

Some of the dominant large kelps seen in the study area include *Laminaria* spp., *Alaria* spp., *Egregia* sp., *Nereocystis* sp., *Macrocystis* spp. and *Agarum* sp. (Druehl 2000). This is not an exhaustive list.

Marine kelps are important as modifiers of the abiotic environment. They have been shown to baffle currents and slow down horizontal water flow. This creates areas where water chemistry profiles become altered, in terms of factors such as increased sedimentation, water temperatures and dissolved oxygen concentrations. This creates a highly structured three-dimensional habitat for a number of species. There are epiphytic species that use the kelp surface as substratum on which to live. The kelp also provides shelter, spawning and nursery grounds and refuge from predators for a myriad of species. There are numerous taxa that are associated with kelps such as mammals, fish, molluscs, crabs and other algae (Steneck et al. 2002).

Kelp is sensitive to factors similar to those affecting eelgrass, with the exception of increased turbidity, increased eutrophication and increased epiphyte loads (Vandermeulen 2005). One of the dominant factors that appear to control kelp distribution and abundance is predation by grazers. The primary grazers on kelp are sea urchins. These grazers can clear a kelp bed, leaving only the coralline species remaining. Kelp will not recolonize an area when urchins are above a certain threshold. Once urchins are removed, the kelp will return. Snails and limpets are important grazers of kelp sporophytes and will control distribution (Vandermeulen 2005). In British Columbia, *Macrocystis* occurs in moderately wave-exposed areas with temperature between 6°C and 18°C and salinity greater than 23 ppt (Druehl 1978).

The large beds of *Nereocystis* and *Macrocystis* are found on the outer coasts (ILMB 2004, Internet site; see Figure 3-20). This is due to the presence of higher currents and upwelling nutrients. The CRIMS dataset shows the largest beds on the outside of Campania Island and the Estevan group.



REFERENCES: NTDB Topographic Mapsheets provided by the Majesty the Queen in Right of Canada, Department of Natural Resources. All rights reserved.

CONTRACTOR:		ENBRIDGE NORTHERN GATEWAY PROJECT	FIGURE NUMBER:		DATE:
Jacques Whitford AXYS Ltd.			3-20		20090914
PREPARED BY:	PREPARED FOR:	Kelp Bed Locations along the Outer Coast	SCALE: 1:1,100,000	AUTHOR: BA	APPROVED BY: CM
gem Gateway Environmental Management Team	ENBRIDGE NORTHERN GATEWAY PIPELINES		PROJECTION: UTM 9		DATUM: NAD 83

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3.1.5.16 Eelgrass, *Zostera* spp.

Eelgrass is a marine vascular plant that is found in sandy and muddy substrates on the Pacific coast. There are two dominant species of eelgrass in British Columbia. *Zostera marina* is the native species, while *Zostera japonica* was introduced from Japan, most likely through aquaculture material (Druehl 2000). Although this introduced species is often found growing with native species, it is not considered a threat to the distribution of the native species.

Eelgrass is energetically and ecologically important and provides vital habitat and refuge for a number of nearshore species at various life history stages, including epiphytic, epibenthic and infaunal animals. Regionally, eelgrass beds are considered very important as rearing habitats for juvenile salmon and many other commercially and culturally important species. Pacific herring use eelgrass as substrate on which to spawn. Juvenile Dungeness crabs use eelgrass beds for refuge from predation during both the juvenile phase as well as when the females are hardening their shells after mating (Sewell et al. 2001). Eelgrass is a primary source of detritus. As with most macrophytes, it baffles currents and reduces water velocity, which in turn promotes sedimentation.

The distribution of eelgrass in coastal ecosystems is controlled by a combination of biotic and abiotic factors, such as desiccation, temperature, salinity and water motion. The upper limit is often determined by exposure during low tide. The lower seaward limit is thought to be controlled by light availability. Eelgrass occurs in both intertidal and subtidal areas in the CCAA, typically between 2 and 5 m depth (chart datum [CD]).

Eelgrass can be found growing in both muddy and sandy substrates. Large eelgrass beds are often associated with estuarine conditions but are not exclusive to this habitat. Due to its preference for soft substrates, it is susceptible to scour and therefore is more successful in quiet waters. Optimal conditions are in currents of approximately 1.5 m/s. Eelgrass is also sensitive to wave action; eelgrass beds in shallow waters will alter shape and position when exposure to wave action is increased (Frederiksen et al. 2004). Optimum temperature for growth is between 10°C and 20°C (Adams and Whyte 1990) and optimum salinity is between 20 and 32 ppt (Phillips 1984). Light availability may be the most important factor affecting eelgrass distribution. Alterations in light attenuation and epiphyte loads have negative effects on eelgrass growth. Typical light regimes would be between 3 and 20 m secchi disk depths (Adams and Whyte 1990). Epiphyte loads, along with abundance and diversity of macrophytes in eelgrass beds, may be altered by the abundance and diversity of grazers present in the system (Duffy et al. 2001; Duffy et al. 2003).

Eelgrass reproduces both sexually and asexually. Asexual reproduction is through growth of the rhizome and formation of turions. On the northern coast of British Columbia, asexual reproduction occurs between late March and June. Studies in British Columbia have shown that in the appropriate environmental conditions a single eelgrass shoot may produce 10 branches per year (Durance 2002). Sexual reproduction is through seed formation and begins with flowering in May and June. Eelgrass is monoecious and fertilization occurs by drifting pollen. Release of pollen and stigmatic capture occur at separate times to promote outcrossing (Wyllie-Esheverria and Ackerman 2003). After fertilization, flowers develop into seed-bearing generative shoots that break off, float to the surface and release seeds. Very few of these seeds successfully mature into plants (Phillips 1984).

Eelgrass is sensitive to alterations within its environment. Eutrophication can have both direct and indirect negative effects on eelgrass populations. High nitrate levels will have adverse effects on eelgrass growth. It will also increase epiphyte loads that will have an effect on eelgrass growth via light limitation. High nutrient levels may also cause changes in the composition of the seaweed community, shifting to seaweeds that may shade eelgrass (Vandermeulen 2005). Other biological processes, such as herbivory and bioturbation, when altered may have negative effects on eelgrass growth.

3.1.5.17 Species at Risk

Green Sturgeon, Acipenser medirostris

The Green sturgeon is listed as a species of special concern because of a lack of knowledge and apparent absence of spawning habitat in Canada. The Green sturgeon is easily distinguished from the White sturgeon by a dark mark resembling an arrow that runs along the ventral side. Despite this unique characteristic, it is believed that Green sturgeon were often mistaken for White sturgeon until recently and as a result, historical records are largely unavailable and likely inaccurate where extant. Catch statistics for Green sturgeon have been collected since 1996 when DFO implemented 100% observer statistics.

Green sturgeon range from Mexico to Southeast Alaska but their greatest abundance appears to occur between the 40^{th} and 60^{th} parallels. There are only three spawning rivers identified, all of which are in the United States (Rogue, Klamath and Sacramento Rivers). Green sturgeons prefer estuaries and marine environments except when they return to rivers to spawn.

Sexually mature green sturgeon return to the rivers to spawn in the spring (March to July). Like most anadromous fish, they are oviparous broadcast spawners. Spawning occurs in the main stem of large rivers with fast water flow. Fecundity is positively correlated with size and age of females, but they generally release between 51,000 and 224,000 eggs. They have the largest eggs of any of the sturgeons, which most likely accounts for the lower fecundity. The high oxygen demands of the developing embryo may require cold, clean water for spawning. Larvae hatch after seven to 9 days and begin to feed after 10 days. Complete metamorphosis into juveniles occurs at approximately 45 days and these stay in the river for 1 to 4 years, gradually shifting further towards the ocean and adjusting to higher salinity. It is believed that the British Columbia population of green sturgeon comes from the three U.S. spawning aggregations. There is no evidence to suggest that its spawning habitat has ever existed in Canada. Adults travel long distances and spend 15 to 17 years in the ocean before they begin to return to the rivers to spawn, which they will then do every 3 to 5 years, spending the rest of the time in marine waters.

There is currently no recreational or commercial target fishery for Green sturgeon as they are generally considered unpalatable. Fishery statistics are gathered from bycatch records and incidental catches during White sturgeon tagging programs.

Leatherback Turtle, Dermochelys coriacea

The leather back turtle is one of seven marine turtles in the world and the only one that lives in Canadian Pacific waters. It is federally listed as endangered (*SARA*) and provincially red-listed (British Columbia *Wildlife Act*).

Leatherbacks have the most extensive geographic range of any reptile and have been recorded migrating 5,000 km in 128 days on the Atlantic coast. Leatherbacks inhabit the Pacific Ocean from 70°15’N to 27°S and migrate seasonally between feeding grounds in the North Pacific and nesting grounds in the tropical waters of the south.

Females from the Pacific population nest every 2 to 3 years on three known beaches in Central America and Mexico. They lay an average of six nests per year with 50 to 166 eggs in each nest and often place a number of unfertilized eggs on top of fertile eggs. After 60 to 65 days, hatchlings emerge from the nest. Nests are subject to high mortality due to predation, inclement weather, waves, tidal inundation and beach erosion. Hatchlings also suffer high mortality from predation. Hatchling and juvenile distribution is unknown, but it is fairly certain that they are restricted to warmer tropical waters until they reach a size large enough to tolerate colder temperatures.

Leatherbacks are commonly observed in British Columbia along the continental shelf in the open ocean between June and November, but will follow abundant planktonic food sources anywhere along the coast. Leatherbacks mainly prey upon jellyfish and other soft-bodied invertebrates. Due to the high water content and low energy value of their prey, they must consume large daily quantities to maintain a normal metabolic rate. Carapace lengths can reach up to 2 m, and individuals typically weigh up to 500 kg. Because of their large size and a layer of subcutaneous blubber, they are able to maintain core body temperatures up to 18° above ambient water temperature and can tolerate near-freezing conditions.

The overall abundance of Leatherback turtles in Canadian Pacific waters is uncertain. They are rarely seen in Douglas Channel. Key threats include incidental capture in fishing gear, high hatchling mortality and pollution that increases the ingestion of garbage in the ocean. Population estimates based on nesting females have indicated a 70% decline between 1980 to 1995 (COSEWIC 2001).

Northern Abalone, Haliotis kamtschatkana

Northern Abalone occur from Alaska to Baja California and are the only species of abalone found in British Columbia. They are listed as threatened under *SARA* (Government of Canada 2005, Internet site) and all fishing for abalone has been prohibited in British Columbia waters since 1990 (Jamieson 1999).

Northern abalone are single-shelled molluscs that grow to a diameter of 12 cm (Kozloff 1993) and have been estimated to live as long as 50 years (Jamieson 1999). They are patchily distributed on rock substrate in exposed or semi-exposed coasts throughout their range. As a primary prey species for the sea otter (also threatened under *SARA*), recovery of the northern abalone is highly associated with the recovery strategy for the sea otter (Fisheries and Oceans Canada and the Abalone Recovery Team 2004).

Abalone reproduce via broadcast spawning. As a result, adults often congregate during spawning events that can occur at any time of the year. Fertilization occurs when males and females simultaneously release gametes into the water column. Spawning by one individual usually triggers other individuals in the area to spawn, thus maximizing the potential for fertilization. Larvae reside in the water column for approximately 10 days, when they settle and begin to feed on bacterial epibiota. Estimates suggest that they mature at approximately 55 mm shell length, although this may be highly variable throughout their range. They are motile, but lifetime dispersal is estimated to be within a 10 to 100 m radius of their initial settling location. Adults feed on drifting algae that they capture with special extensions of their body called epipodia (Jamieson 1999).

The major cause of decline in northern abalone stocks in British Columbia is suspected to be consistent over-harvesting in the 1970s to 1990s. Although there is a complete moratorium on harvesting abalone in British Columbia, poaching continues to threaten remaining stocks of large, marketable abalone (Jamieson 1999). Because fecundity is correlated with size, the removal of large abalone decreases fertilization success and lowers juvenile recruitment into the breeding stock. Ample habitat is available throughout British Columbia and therefore is not thought to be a limiting factor in the recovery of this species.

Surveys of northern abalone around South Banks Island, Estevan Group Islands and two sites on Aristazabal Island indicate continued population decline (Campbell et al. 1998). These areas fall within the CCAA.

Yellow-Listed Species

Some fish species in the study area are provincially listed with a yellow designation. Species with status rank S5 are considered “common to very common” and are not susceptible to extirpation or extinction under present conditions (Vennesland et al. 2002). S5 yellow-listed species in the area may include longfin smelt, threespine stickleback, Pacific staghorn sculpin, pink salmon and chum salmon. Species with status rank S4 are considered “apparently secure” and may have a small range or low abundance in the province. Species in this category are actively monitored for indications of long-term threats or declines (Vennesland et al. 2002). S4 species that may occur in the area include Pacific lamprey, coho salmon, sockeye salmon and chinook salmon.

3.1.6 Shoreline Classification

The Coastal Resource Information Management System (CRIMS), a key initiative of the Integrated Land Management Bureau, is an interactive mapping system that contains information on British Columbia shoreline habitat classification. This information was used to determine shoreline classification and composition of the PEAA (see Table 3-2) and CCAA (see Table 3-3).

Table 3-2 Shoreline Classification and Sum Length for the PEAA

Shore Zone Type	Sum Length (m)	Percentage (%)
Estuary, marsh or lagoon	3,981.3	5.68
Gravel beach	491.4	0.70
Gravel flat	2,807.8	4.01
Mud flat	6,561.8	9.36
Rock cliff	6,755.0	9.64
Rock with gravel beach	15,253.9	21.77
Rock with sand beach	1,863.1	2.66
Rock, sand and gravel beach	3,189.8	4.55
Sand beach	3,697.5	5.28
Sand flat	23,551.7	33.61
Sand and gravel flat	1,919.0	2.74
Total length of shore zone	**70,072.1**	**100.00**

Table 3-3 Shoreline Classification and Sum length for the CCAA

Shore Zone type	Sum Length (m)	Percentage (%)
Unclassified	94,032.2	3.78
Channel	10,849.6	0.44
Estuary, marsh or lagoon	92,840.6	3.73
Gravel beach	63,623.6	2.56
Gravel flat	43,198.7	1.74
Man-made	3,081.9	0.12
Mud flat	7,794.0	0.31
Rock cliff	659,858.0	26.53
Rock platform	12,703.6	0.51
Rock with gravel beach	718,926.2	28.90
Rock with sand beach	17,382.0	0.70
Rock, sand and gravel beach	471,066.0	18.94
Sand beach	191,980.7	7.72
Sand flat	85,671.1	3.44
Sand and gravel beach	11,753.6	0.47
Sand and gravel flat	2,907.8	0.12
Total length of shore zone	**2,487,669.7**	**100.00**

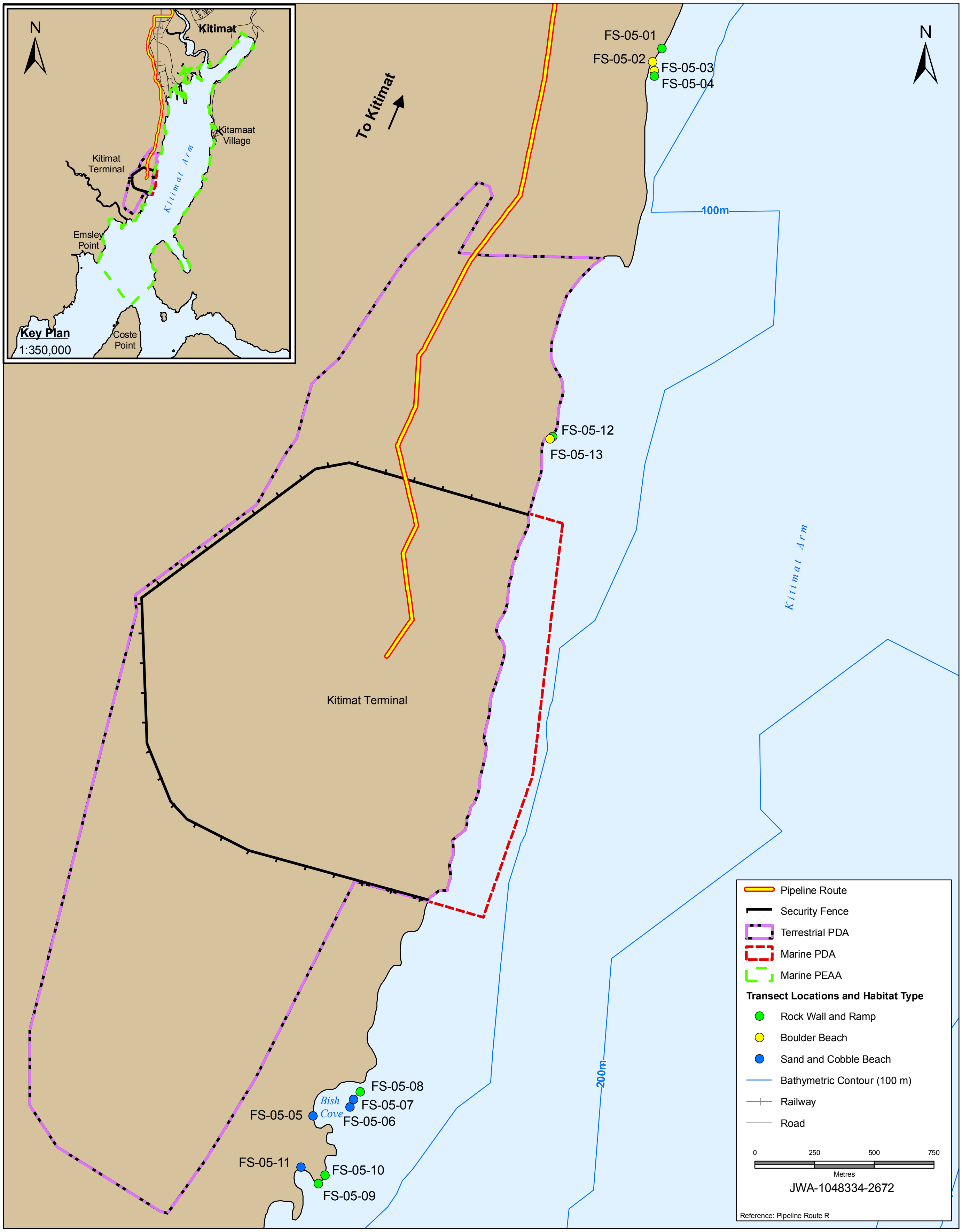
3.2 Field Survey Results

3.2.1 Intertidal Habitat Characterization Results

3.2.1.1 Reconnaissance Survey Results

In 2005, 2006, 2008 and 2009, reconnaissance surveys were completed in the PEAA that focused on the western shoreline of Kitimat Arm. Qualitative transect surveys were completed at 13 sites (Figure 3-21), identifying general substrate and species composition. Over the four surveys, 42 intertidal species of flora and fauna were identified (see Appendix B, Table B-1). Five main foreshore habitat types that are typical in the PEAA were identified based on the species list and substrate observations:

- rock wall and ramp
- boulder beach
- sand and cobble beach
- estuarine (no transect surveys completed)
- marine riparian vegetation (no transect surveys completed)



REFERENCES: NTDB Topographic Mapsheets provided by the Majesty the Queen in Right of Canada, Department of Natural Resources.

CONTRACTOR: Jacques Whitford AXYS Ltd.	ENBRIGE NORTHERN GATEWAY PROJECT	FIGURE NUMBER: 3-21	DATE: 20100129
PREPARED BY: gem Gateway Environmental Management Team / PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES	2005 Intertidal Reconnaissance Survey Transect Locations	SCALE: 1:22,000	AUTHOR: SS / APPROVED BY: CM
		PROJECTION: UTM 9	DATUM: NAD 83

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Rock Wall and Ramp

Rock wall and ramp is the dominant habitat type in the PEAA (approximately 32%). This habitat comprises rock walls, steep rock ramps and shallower rock platforms (25° to 35° slopes). Two sets of exposures (sheltered and exposed) with differing suites of organisms were recorded.

The high subtidal zone of sheltered areas is dominated by sea brush (*Ondonthalia floccossa*) with *Colpomenia* spp. epiphytes. Very few invertebrates were observed within this macrophyte cover; only limpets (*Tectura* spp.) were present. The low to mid intertidal (0 to 2 m above CD) zone is typical of the Pacific Northwest with bay mussels (*Mytilus trossulus*), Mastocarpus crust and limpets dominating the zone. The mid to high intertidal zone (1.5 to 4 m above CD) is dominated by rockweed (*Fucus distichus*), barnacles (*Balanus glandula*) and periwinkles (*Littorina* spp.) (see Photo 3-1).

Photo 3-1 Rock Wall and Ramp, Sheltered

Compared with sheltered areas, more exposed areas have a differing suite of macrophytes in the lower intertidal and high subtidal zones (see Photo 3-2). These areas are dominated by the red algae *Ahnfeltiopsis gigartenoides*, which forms a very dense, intertwined mat that appears to limit the presence of invertebrates. Deadman's fingers (*Halosaccion glandiforme*) commonly grow within this complex.

Photo 3-2 Exposed Rock Wall and Ramp

Boulder Beach

Rock platforms with boulder beach are predominantly covered with boulder and some cobble (see Photo 3-3). These areas have discontinuous patches of rockweed and mussels on the high points of the larger boulders. Mobile invertebrates such as green shore crab (*Hemigrapsus oregonensis*) are common in crevices and under rocks.

Photo 3-3 Boulder Beach

Sand and Cobble Beach

Sand and cobble beaches are often in pocket bays or more sheltered areas of the shoreline (see Photo 3-4). Sand beaches made up 4 of the 13 sites surveyed. The substrate is variable with sand, gravel and cobble dominating different areas of the beach. In these habitats limited small eelgrass beds were recorded. For example, in transect five there was an eelgrass bed that was approximately 20 m by 2 m in size. Rockweed and bay mussels are found on the larger cobble substrate. Green shore crabs are common beneath cobble. In addition, limpets, periwinkles, hermit crabs (*Pagurus* spp.) and kelp isopods (*Idotea wosesenski*) were recorded. In areas of freshwater seep, green string lettuces (*Ulva Intestinalis*) are present.

Photo 3-4 Sand and Cobble Beach

Estuarine

The PEAA also includes estuarine habitat, associated with rivers that discharge into Kitimat Arm. The closest estuary to the Kitimat Terminal site is Bish Cove Estuary (see Photo 3-5). The intertidal area of this estuary consists of extensive sand and shell debris, gravel and cobble. A qualitative assessment of Bish Cove revealed a typical suite of organisms including mussels, with associated periwinkles and limpets, and infaunal species such as clams and mud shrimp. The dominant marine macrophyte at this site is rockweed and the backshore is primarily a Lyngbye-associated wetland.

A small intertidal eelgrass bed is located at the southern end of Bish Cove. However most of the eelgrass in this cove is subtidal and was surveyed by SCUBA (see Section 1.7.2.1). Incidental records of observed species include Dungeness crab (*Cancer magister)*, mud shrimp (*Crangon septemspinosa*), green shore crab, beach hoppers (*Traskorchestia traskiana*) and starry flounder (*Platichthys stellatus)*.

Photo 3-5 Estuarine Habitat in Bish Cove

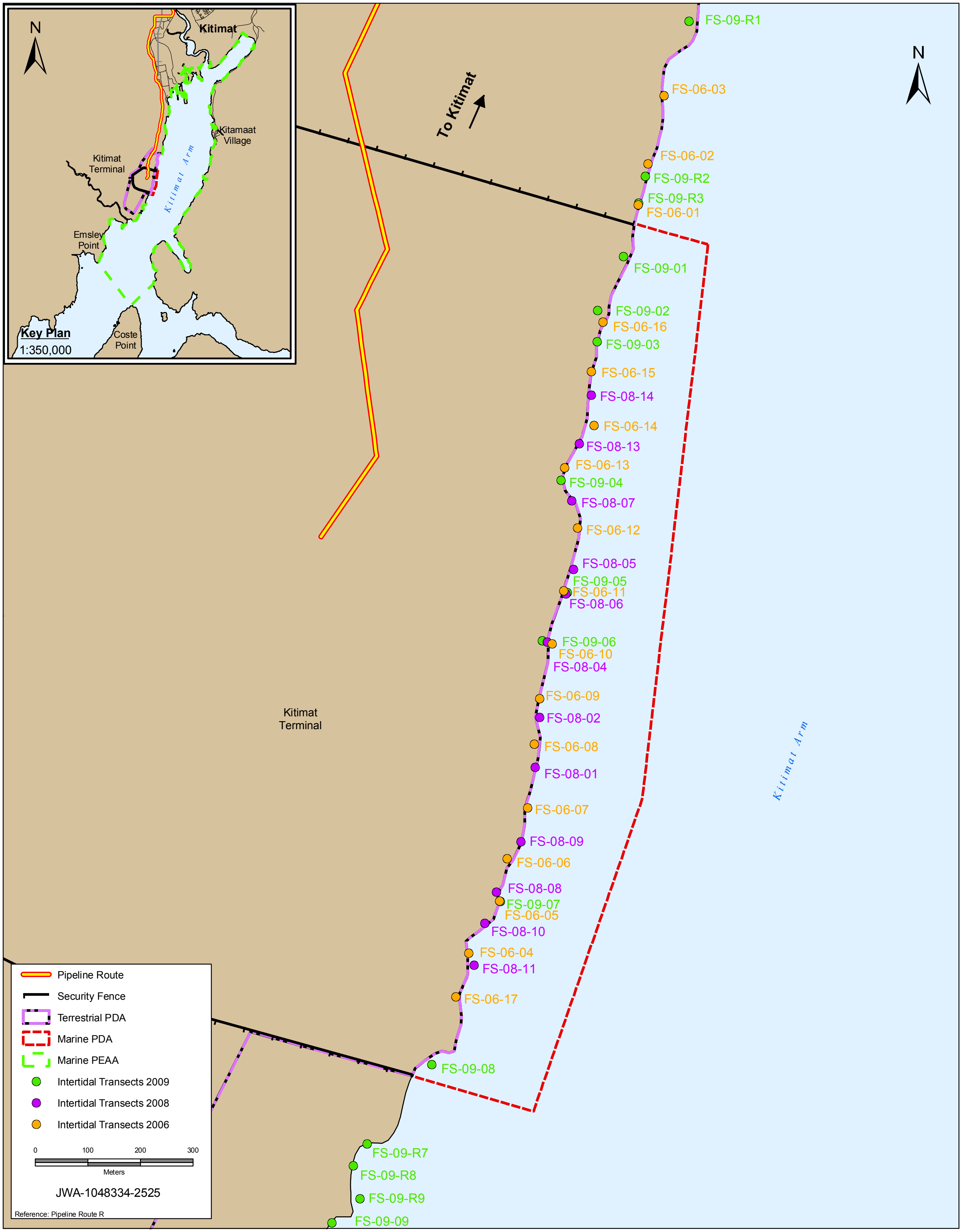
Marine Riparian Vegetation

Unaltered marine riparian habitat runs continuously along shorelines in the PEAA and PDA. It generally grows on a steep, rocky shoreline well above the high water mark, although it may receive saltwater spray during storms (Photo 3-6). The marine riparian zone in the PDA is densely populated with western hemlock, western red cedar, Amabilis fir, Sitka spruce and some Douglas-fir. Small shrubs occupy the shoreward limits of the zone, and mature forest stands extend inland from the shoreline, except for recently harvested areas (i.e., cutblocks) that support early successional vegetation.

Photo 3-6 Typical marine Riparian vegetation in the PDA

3.2.1.2 Intertidal Transect Survey Results

Intertidal transect surveys were completed in 2006, 2008, and 2009. These surveys were more systematic than the reconnaissance survey and involved quadrat sampling at 36 sites in 3 intertidal zones that span an approximately 2.5 km stretch of the shoreline surrounding the Kitimat Terminal (see Figure 3-22). Three of these sites were sampled in all three years. Transect surveys only covered the two dominant habitat types along the shoreline in the PDA: boulder and cobble, and rock wall and ramp.



REFERENCES: NTDB Topographic Mapsheets provided by the Majesty the Queen in Right of Canada, Department of Natural Resources. All rights reserved.

CONTRACTOR: Jacques Whitford AXYS Ltd.	ENBRIDGE NORTHERN GATEWAY PROJECT	FIGURE NUMBER: 3-22	DATE: 20100129
PREPARED BY: gem	PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES	SCALE: 1:10,000	AUTHOR: SS / APPROVED BY: CM
	Intertidal Survey Transect Locations	PROJECTION: UTM 9	DATUM: NAD 83

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Intertidal habitat in the PDA shows typical patterns of intertidal zonation attributed to a high abundance of brown seaweeds (mostly *Fucus sp.)* in the high intertidal zone and brown seaweeds and barnacles in the mid intertidal zone. Mussel beds are found predominantly in rock wall habitat at the mid to low intertidal zone, but are not abundant in the more gently sloping boulder and cobble habitat. The low intertidal zone is generally characterized by a relatively low diversity of red and green seaweeds mixed with brown seaweeds (mostly simple kelps). Evidence of siltation from the Kitimat River plume is found throughout the shoreline of the PDA, most predominantly affecting the filamentous red and green seaweeds in the mid to low intertidal zone. Intertidal invertebrate diversity and abundance is generally low. Species present in the PDA include periwinkles, limpets, barnacles, mussels, isopods, and shore crabs.

3.2.2 Subtidal Habitat Characterization Results

3.2.2.1 Qualitative Subtidal Survey Results

Site 1: Estuarine

Site 1 is a typical north coast fjord estuarine habitat (Appendix D, Figures D-1 and D-2). The substrate is dominated by sand with pockets of pebble, pebble and cobble, cobble and sand, and mud. The subtidal survey revealed a fringing eelgrass bed that extends from the southern point to the mouth of the creek. On the east side of the estuary the fringing eelgrass bed extends from the subtidal into the lower intertidal area, this is the largest area of eelgrass in the surveyed area. Other macrophytes that dominate this site are small red seaweeds and the kelp complex *Agarum* sp. and *Laminaria* spp. There were a number of animals seen along the transects, including Dungeness crab, flatfish (English sole, yellowfin sole and starry flounder), sea cucumber (*Parastichopus californicus*) and seastars (*Pycnopodia helianthoides*).

Site 2: Sand and cobble beach

The substrate in this habitat is dominated by sand with pockets of mud, cobble and pebble, and cobble (Appendix D, Figure D-3). There is a very small fringing eelgrass bed in this bay recorded in the intertidal survey; it is only about 20 m long and 2 m wide. There are small amounts of red algae and stipate kelp (*Laminaria* spp.). The animals recorded at this location were dominated by Dungeness crab, sea cucumbers and sea pens (*Ptilosarchus* sp.).

Site 3: Rock Wall, Kitimat Terminal

The substrate at this site is predominantly bedrock with overlying surface sediments such as mud, pebbles, cobbles and boulders (Appendix D, Figures D-4 and D-5). The predominant macrophytes are small filamentous red algae. The animals that cover most of this community are small sessile invertebrates such as tunicates (e.g., *Halocynthia* spp., *Ascidia* spp.) and tubeworms (*Serpula* spp.). There were also a number of seastars and sea cucumbers. Analyses of particle-size distribution in sediment samples taken at the PDA in February 2006 suggest that the subtidal habitat is a combination of gravel, silt and clay, with sand and clay being dominant. Complete results of particle-size distribution are presented in Appendix C.

3.2.2.2 Quantitative Subtidal Survey Results

Subtidal video survey transect locations are presented in Figure 3-23. Coverage of the site was good; however, the following factors increased the difficulty of the survey and resulted in changes to the survey design:

- strong winds and spring tides producing strong tidal currents – wind and tidal currents made course holding very difficult on several of the survey days, often resulting in a camera towing speed in excess of 2 knots. Under these conditions, the transect was aborted because of poor video quality.
- very turbid water – reduced visibility due to turbid water required the use of an underwater video light on all transects and reduced video quality in several runs
- mixing between water layers – mixing between an upper less-saline layer and a lower more-saline layer occurred frequently in shallow water, resulting in "lensing" and reduced video quality
- steep topography – steep topography inhibited visual contact with the sea floor
- intermittent DGPS signal – an intermittent DGPS signal increased positioning error

As a result of the steep topography, Transect 38 was divided into four separate diagonal runs. This avoided the difficulty of trying to tow the video camera along the edge of a cliff and also provided greater bio-zone coverage (e.g., traversing from shallow bio-zones to deep bio-zones, rather than staying at the same depth).

Transect 40 was moved inshore to shallower depths, as it was problematic to tow the camera at the limit of its tether (300 m).

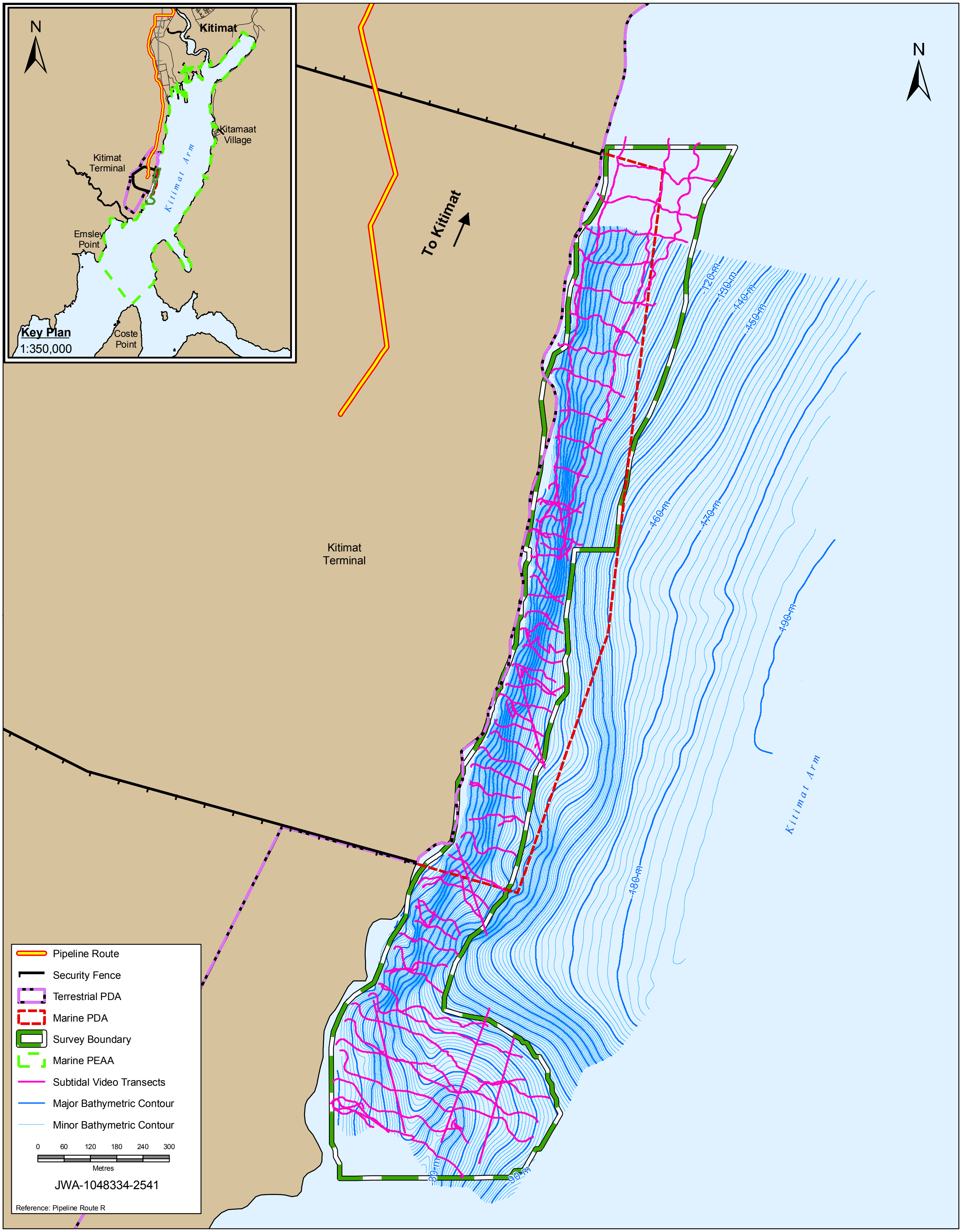
The following sections summarize the confidence levels and results from the video surveys. For a detailed review, see Appendix D.

Confidence Levels

All transect crossover points were examined and, where sufficiently high-quality data existed for both transect lines, were used to determine confidence levels in data interpretation. A total of 35 crossover points (for the south survey) and 64 crossover points (for the north survey) were selected. Each crossover point consisted of a pair of data records which were compared for:

- bottom hardness (not included in the north survey)
- substrate
- primary flora
- primary fauna

The number of times that both data records had the same values for each category were recorded and used to generate percentage confidence (see Table 3-4 and 3-5 for the results).



CONTRACTOR:		ENBRIDGE NORTHERN GATEWAY PROJECT	FIGURE NUMBER:		DATE:
Jacques Whitford AXYS Ltd.			3-23		20100129
PREPARED BY:	PREPARED FOR:	Subtidal Video Survey Transect Locations	SCALE: 1:12,000	AUTHOR: BA	APPROVED BY: JB
gem Gateway Environmental Management Team	ENBRIDGE NORTHERN GATEWAY PIPELINES		PROJECTION: UTM 9		DATUM: NAD 83

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Table 3-4 Confidence Levels in Data Interpretation (June 2006 survey of south marine PDA)

Category	Number of Points Compared	Number of Points in Agreement	Confidence (%)
Bottom hardness	19	17	89
Substrate	35	24	69
Primary flora	35	32	91
Primary fauna	35	25	71
Overall	124	98	79

Table 3-5 Confidence Levels in Data Interpretation (June 2007 survey of north marine PDA)

Category	Number of Points Compared	Number of Points in Agreement	Confidence (%)
Substrate	64	42	66
Primary flora	64	60	94
Primary fauna	64	38	60
Overall	192	140	73

The main factor believed to reduce confidence was the intermittent DGPS signal. During most of the survey the DGPS signal was received and position (in degrees decimal minutes) was accurate to four decimal places. However, during the day on which the shore-parallel transect lines were carried out, only a GPS signal was received (high mountains in the region prevented a DGPS signal from being received) and positions were accurate to two decimal places (positioning of satellites reduced GPS accuracy). Thus, the locations of the crossover points may have decreased accuracy.

Poor visibility made substrate interpretation more subjective, resulting in lower confidence levels in assignment of substrate type.

Lower confidence levels in assignment of primary fauna are expected, as fauna are mobile and may have moved out of the crossover area between transects.

Bathymetry and Bottom Hardness

The bathymetry survey area was located along the PDA shoreline and was divided into the following two sections (Appendix D, Figure D-6):

- the southern section (approximately one-third of the measured area’s length) is shallower and slopes more gently towards depth
- the northern section (approximately two-thirds of the measured area’s length) consists of a narrow shelf along the coast which abruptly drops off to deep water in a series of cliffs and ledges

The bottom hardness contour plot (Appendix D, Figure D-7) indicates that the site consists mainly of rock with some areas in deep water along the eastern edge of the surveyed region. Additionally, there are a few regions along the shore where the substrate is sand or gravel. The surveyed areas represent depositional environments, generally on seafloor with lower slope, where terrestrial sediments are accumulating.

Bottom Substrate

Based on video observations, the site substrate consists largely of silt veneer over bedrock (Appendix D, Figure D-8). The depth of veneer varies from less than 1 cm in steeper areas to depths great enough to support a number of burrowing infauna. The depth of the veneer was very difficult to estimate from the video footage except in regions where it became very shallow and bedrock was exposed. In areas where the bottom hardness recordings from the mapping sounder indicated that the silt layer was the bottom was classified as silt-mud.

Exposed bedrock was observed in the northern section as steep cliffs alternating with ledges covered with silt. These shifts between cliffs and ledges form a large set of “steps” leading to deeper water.

Cobble and pebble substrates (Appendix D, Figure D-9) were found near the shoreline. This is consistent with the bottom hardness results.

Notable amounts of woody debris (Appendix D, Figure D-10), ranging from bark to large logs, were found at the site, indicating that some type of booming operation probably took place at or near the site. Several anthropogenic objects were also observed (e.g., cables, bottles, cans).

The shallow shelf area close to shore frequently had shell debris (Appendix D, Figure D-11), suggesting bivalve populations (many infauna holes were observed, but no siphons were identified).

Flora

Algae at the site are present on the narrow, shallow shelf close to shore. Foliose and filamentous greens dominate (Appendix D, Figure D-12). Some brown algae (*Laminaria* and *Fucus*; see Appendix D, Figure D-13) and small amounts of red algae (mostly foliose reds, with some coralline and encrusting reds; see Appendix D, Figure D-14) are also present. Red seaweeds were not observed during the survey of the northern part of the PDA. It is likely that some species of red seaweeds were present; however the heavy siltation made it impossible to observe the smaller seaweed species. Algal abundance declines rapidly with distance from the shoreline as a result of the rapid increase in depth and associated decrease in light.

Invertebrates

Overall, invertebrate diversity at the site is relatively low, but the abundance of certain species, particularly silt-dwelling infauna, is high (Appendix D, Figure D-15). A number of organisms are evenly distributed throughout the site at low abundances, including sea anemones (particularly the snakelock anemone; see Appendix D, Figure D-16), sea cucumbers (Appendix D, Figure D-17) and parchment tubeworms (Appendix D, Figure D-18).

The steep rock faces in the northern section provide good habitats for tubeworms, particularly calcareous tubeworms, brachiopods (Appendix D, Figure D-19) and green sea urchins (Appendix D, Figure D-20). These organisms occurred in dense patches wherever exposed and silt-free bedrock was present.

Two species of sponges, cloud sponges and an unidentified species, were present at the site, generally associated with steep, rugged bedrock substrate. Sponges were particularly abundant at the southern end of the survey areas, just outside the marine PDA (Appendix D, Figure D-21). Less than 25% of sponge aggregations in the southern region of the PDA showed evidence of active growth and much of the remaining sponges were completely or partially buried in silt. The high levels of siltation were probably responsible for the high mortality. However, it still represented a region of higher biological diversity compared with regions in the PDA, with increased populations of rockfish and seastars (Appendix D, Figure D-22). Cloud sponge was also present, although in much lower abundance, on the cliff faces in the northern section of the PDA.

Several commercially harvested invertebrate species were also observed. Crabs (Dungeness crab in shallower water and tanner crab in deeper water; see Appendix D, Figure D-23) are fairly abundant in the southern section. Shrimp and prawn are abundant in deeper water (Appendix D, Figure D-24). Crabs and prawns were more abundant in the northern region of the survey area where flat terrain with fine-grained sediments provides a more preferred habitat.

Fish

Fish were observed to be in relatively low to moderate abundance throughout the site. Those observed (gobies, sculpin, ratfish and flatfish) were generally evenly distributed throughout the site (Appendix D, Figure D-25). Exceptions include northern ronquil, which were found predominantly in deeper water (Appendix D, Figure D-26) and rockfish, which were observed in greatest abundance in the region of the sponge aggregations (Appendix D, Figure D-27). Eelpouts were abundant in the northern region of the PDA, associated with soft substrates.

Diversity Analysis Results

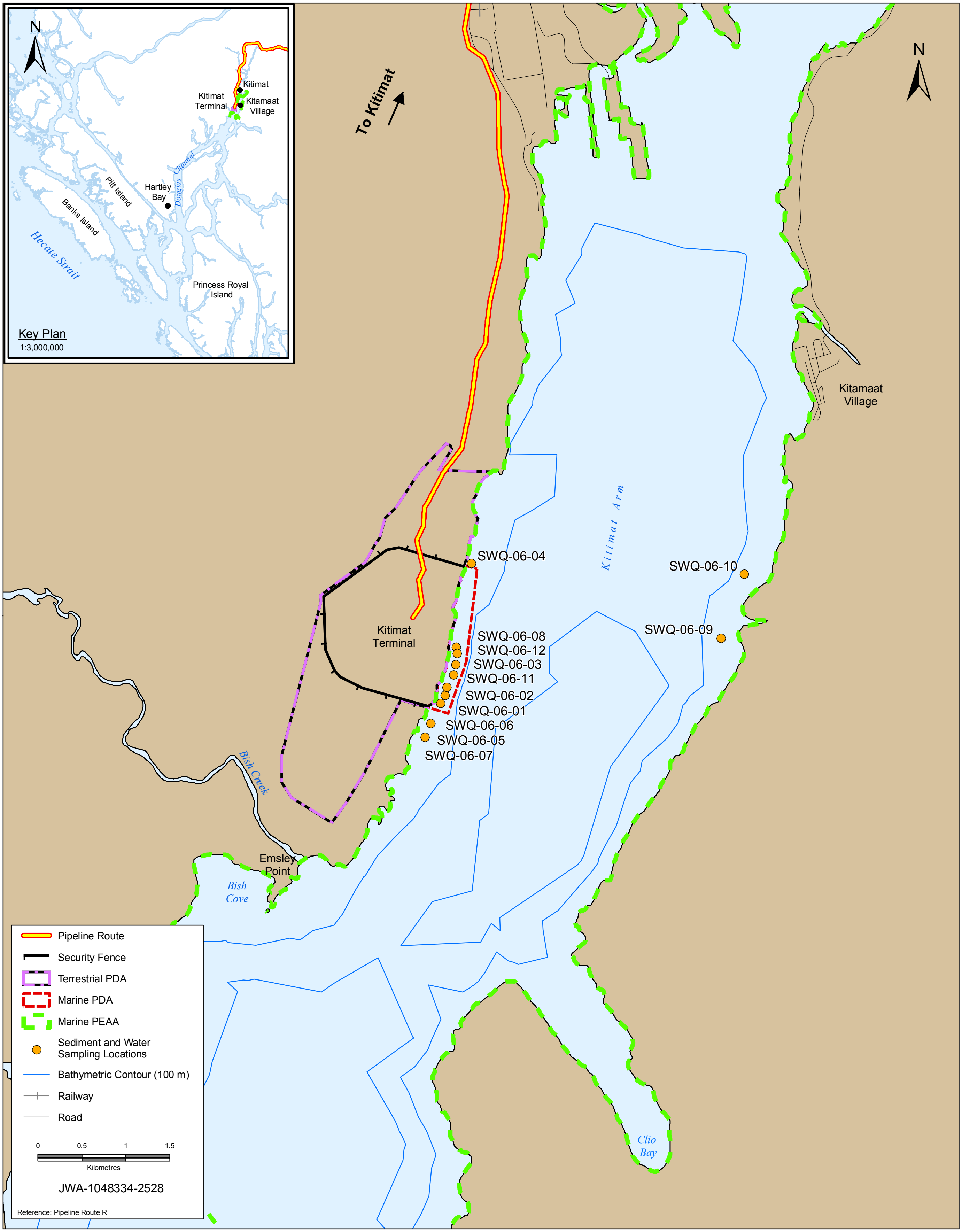
A diversity analysis of the survey site was carried out based on overlap between the distribution maps of various organisms observed at the site. Regions where the greatest number of species were observed (i.e., which had the greatest species richness) were mapped (Appendix D, Figure D-28). From this analysis, there were two regions in the site that had notably higher diversity than others:

- the southern portion of the survey area around the sponges occupying the knoll
- the steep rocky cliffs in the northern section

The cloud sponges provide habitat for fish species (e.g., rockfish) and a number of invertebrates (e.g., starfish). The cliff region provides silt-free rocky substrate for those organisms that require hard surfaces for attachment (e.g., calcareous tubeworms and brachiopods).

3.2.2.3 Sediment and Water Quality Survey Results

Ten sites were identified as sample locations within the 1.5 km area of the Kitimat Terminal. Two reference sites on the eastern side of Kitimat Arm, away from the PDA, were also surveyed (see Figure 3-24). For the analytical results of the sediment and water quality surveys, see Table 3-6, Appendix C.1 and Appendix C.2. BTEX, dioxins and furans were not analyzed in reference Samples 9 and 10, and only PCB, dioxin and furan analyses were conducted for Samples 8 and 11.



REFERENCES: NTDB Topographic Mapsheets provided by the Majesty the Queen in Right of Canada, Department of Natural Resources. All rights reserved.

CONTRACTOR: Jacques Whitford AXYS Ltd.	**ENBRIDGE NORTHERN GATEWAY PROJECT**	FIGURE NUMBER: 3-24	DATE: 20100129
PREPARED BY: gem / PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES	Sediment and Water Quality Sampling Locations	SCALE: 1:60,000 / AUTHOR: SS	APPROVED BY: CM
		PROJECTION: UTM 9	DATUM: NAD 83

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Table 3-6 Summary of Exceedances of Sediment Quality Guidelines

Sampling Locations	Parameter	Guidelines Exceeded	Notes
SWQ-06- (01, 02, 03, 04, 06, 07, 10,12	Chromium	CCME ISQG (52.3 mg/kg)	NA
All locations	Copper	CCME ISQG (18.7 mg/kg)	NA
All locations	Barium (a), cobalt (n), manganese (n), vanadium (n)	NOAA AETs (barium 48 mg/kg, cobalt 10 mg/kg, manganese 260 mg/kg, vanadium 57 mg/kg)	Canadian guidelines not available
SWQ-06- (02, 03)	Total PAHs	CEPA screening limit for ocean disposal (2.5 mg/kg)	NA
SWQ-06- (01, 02, 03, 04, 05, 06, 07,12)	Phenanthrene	CCME ISQG (0.087 mg/kg)	NA
SWQ-06- (01, 02, 03, 04, 05, 06, 07,12)	Benzo(a)anthracene	CCME ISQG (0.075 mg/kg)	NA
SWQ-06- (01, 02, 03, 04, 05, 06, 07,12)	Pyrene	CCME ISQG (0.15 mg/kg)	NA
SWQ-06- (02,03)	Total PAHs	CEPA screening limit for ocean disposal (2.5 mg/kg)	NA
SWQ-06- (01, 02, 03, 04, 05, 06, 07, 12)	Phenanthrene	CCME ISQG (0.087 mg/kg)	NA
SWQ-06- (01, 02, 03, 04, 05, 06, 07, 12)	Benzo(a)anthracene	CCME ISQG (0.075 mg/kg)	NA
SWQ-06- (01, 02, 03, 04, 05, 06, 07, 12)	Pyrene	CCME ISQG (0.15 mg/kg)	NA
SWQ-06- (01, 02, 03, 04, 05, 06, 07, 10, 12)	Chromium	CCME ISQG (52.3 mg/kg)	NA
All locations	Copper	CCME ISQG (18.7 mg/kg)	NA
All locations	Barium (a), cobalt (n), manganese (n), vanadium (n)	NOAA AETs (barium 48 mg/kg, cobalt 10 mg/kg, manganese 260 mg/kg, vanadium 57 mg/kg)	Canadian guidelines not available.

NOTES:
AETs (Apparent Effects Thresholds) based on toxicity to (a) amphipod; (n) *Neanthes* polychaete.
AET values relate chemical concentrations in sediments to biological indicators of injury and represent the concentration above which adverse biological impacts would always be expected by a specific biological indicator due to exposure to a specific contaminant (NOAA 1999, Internet site).
CCME – Canadian Council of the Ministers of the Environment
ISQG – interim sediment quality guideline
NA – Not Available
NOAA – National Oceanic and Atmospheric Administration
PAH – polycyclic aromatic hydrocarbons

For the analytical results for water chemistry, see Tables C-1 to C-4. See Table 3-7 for parameters that exceeded applicable regulatory guidelines or threshold values in water.

Table 3-7 Water Quality Guideline Exceedances for Seawater

Sampling Locations	Parameter	Guidelines Exceeded	Notes
SWQ-06- (03, 04, 05, 09, 12)	Chrysene	BC marine water quality (0.1 µg/L)	
SWQ-06- (01, 02, 03, 04, 12)	Benzo(a)pyrene	BC marine water quality (0.01 µg/L)	
SWQ-06- (01, 02, 07, 12)	Dissolved cadmium	CCME marine water quality (0.00012 mg/L)	Guideline is for total cadmium
SWQ-06-07	Dissolved zinc	BC marine maximum (0.01 mg/L)	Guideline is for total zinc

NOTES:
BC – British Columbia
CCME – Canadian Council of Ministers of the Environment

PAHs

For PAH concentrations in sediment, see Appendix C, Table C-8. Marine sediment guidelines were available for all PAH compounds.

Phenanthrene, benzo(a)anthracene and pyrene concentrations exceeded their respective CCME interim sediment quality guidelines (ISQGs) (0.087 mg/kg, 0.075 mg/kg and 0.15 mg/kg, respectively) in seven of ten samples, but did not exceed PEL. Total high molecular weight (HMW) PAH concentrations were not higher than the British Columbia No Adverse Effect level (9.6 mg/kg). Total PAH concentrations were greater than the CEPA screening limit for ocean disposal (2.5 mg/kg) in two sediment samples (SWQ 02 and SWQ 03).

Sediment concentrations of naphthalene, 2-methylnaphthalene, acenaphthylene, acenaphthene, fluorene, anthracene and benzo(k)fluoranthene were all below their respective method detection limits (MDL). However, the MDLs for these compounds were greater than their respective CCME ISQG concentrations; therefore, sediment concentrations could not be fully evaluated with respect to CCME guidelines.

Concentrations of phenanthrene, fluoranthene, pyrene, benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(a)pyrene, indeno(1,2,3-cd)pyrene, benzo(g,h,i)perylene, total low molecular weight (LMW) PAHs, total HMW PAHs and total PAH concentrations were higher in sediment samples collected near the Kitimat Terminal than in reference samples (SWQ 09 and SWQ 10). For a comparison of the average PAH concentrations, see Table 3-8.

Table 3-8 Sediment Polycyclic Aromatic Hydrocarbon Levels near the Kitimat Terminal and Reference Areas

PAH	Mean Concentrations (mg/kg)	
	Kitimat Terminal Samples	Reference Samples
Phenanthrene	0.14 ± 0.03	<0.05
Total LMW-PAHs	0.14 ± 0.03	<0.05
Fluoranthene	0.30 ± 0.06	0.04[a]
Pyrene	0.30 ± 0.06	0.04[a]
Benzo(a)athracene	0.20 ± 0.05	<0.05
Chrysene	0.23 ± 0.05	<0.05
Benzo(b)fluoranthene	0.53 ± 0.10	0.075
Benxo(a)pyrene	0.27 ± 0.07	<0.05
Indeno(1,2,3-cd)pyrene	0.20 ± 0.05	<0.05
Benzo(g,h,I)perylene	0.20 ± 0.04	<0.05
Total HMW-PAHs	2.22 ± 0.5	0.135
Total PAHs	2.36 ± 0.5	0.135

NOTES:
[a] Used half MDL to calculate the mean for less than values (0.05 and 0.06).
HMW – high molecular weight
LMW – low molecular weight
PAH – polycyclic aromatic hydrocarbon
± – mean standard deviation

For the PAH concentrations in seawater, see Appendix C, Table C-3. There are no marine water quality guidelines for quinoline or acridine.

Benzo(a)pyrene concentrations were greater than the British Columbia marine water quality guideline (0.01 µg/L) in five samples (JW1, JW 2, JW 3, JW 4, JW 12). The method detection limits (MDLs) for benzo(a)pyrene assays were greater than the guideline concentration; therefore, samples with concentrations below the MDL could not be evaluated. Chrysene concentrations exceeded the British Columbia marine water quality guideline (0.1 µg/L) in five samples (JW 3, JW 4, JW 5, JW 9, JW 12). Acenaphthene, anthracene, acridine and benzo(k)fluoranthene concentrations were below the respective MDLs in all samples.

There were some differences in PAH concentrations in seawater between samples collected near the Kitimat Terminal and samples collected at reference locations.

BTEX and Styrene

BTEX concentrations in seawater and sediment samples were below the respective method detection limits for all samples (see Appendix C, Tables C-2 and C-6).

Metals

See Table C-5 for the metal chemistry results for ten sediment samples. Sediment guidelines were not available for aluminum, boron, beryllium, bismuth, calcium, iron, potassium, lithium, magnesium, molybdenum, sodium, phosphorus, sulphur, silicon, strontium, titanium or thallium.

Chromium concentrations exceeded the CCME ISQG (52.3 mg/kg) in eight of ten samples, and copper exceeded the CCME ISQG (48.7 mg/kg) in all samples. Barium, cobalt, manganese and vanadium concentrations exceeded their respective NOAA apparent effects threshold (AET)[2] values in all sediment samples (48 mg/kg, 10 mg/kg, 260 mg/kg and 57 mg/kg, respectively).

Silver, beryllium, bismuth, antimony, selenium, tin and thallium were not detected in sediment samples. Cadmium was not detected in eight out of ten samples, and molybdenum was detected in only one sample.

There was little variation in metal concentrations between sediment samples collected near the Kitimat Terminal and samples collected at reference locations.

See Table C-1 for the dissolved metal concentrations in seawater collected in the benthic grabs. Marine water quality guidelines were not available for aluminum, beryllium, boron, calcium, cobalt, iron, lithium, magnesium, molybdenum, potassium, silicon, sodium, strontium, tin or titanium.

CCME and British Columbia guidelines represented total metal concentrations; whereas NOAA guidelines, with the exception of those for antimony and thallium, represented dissolved metal concentrations. Cadmium concentrations exceeded the CCME marine aquatic life guideline (0.00012 mg/L) in four seawater samples (SWQ01, SWQ02, SWQ07, SWQ12; see Table 3-4). The zinc concentration in sample SWQ07 exceeded the British Columbia maximum guideline concentration (0.01 mg/L). Aluminum, antimony, beryllium, bismuth, chromium, lead, lithium, mercury, silver, thallium, tin, titanium and vanadium concentrations were below their respective method detection limits in all seawater samples. Selenium was detected in only two samples, and iron was detected in only one sample.

There was little variation in metal concentrations in seawater between samples collected near the Kitimat Terminal and samples collected at reference locations.

Dioxins and Furans

See Appendix C, Table C-7 for the dioxin and furan sediment concentrations. Marine sediment guidelines were not available for individual dioxins or furans, with the exception of an NOAA AET value (3.6 pg/g) for 2, 3, 7, 8-TCDD.

TEQs ranged from 1.24 to 2.34 using toxic equivalent factors for fish described in CCME (2004) and up to 4.35 using various conventions for calculation (Van den Berg et al. 1998). These values were higher than the CCME ISQG of 0.85 pg/g but well below the probable effects level (PEL) of 21.5 pg/g (CCME 2004).

---

[2] AET values relate chemical concentrations in sediments to biological indicators of injury and represent the concentration above which adverse biological impacts would always be expected by a specific biological indicator due to exposure to a specific contaminant (NOAA 1999, Internet site).

Sediment samples from the two reference locations (SWQ09 and SWQ10) were not analyzed for dioxins and furans.

PCBs

See Appendix C, Table C-9 for the PCB concentrations in the sediment samples. Total PCB levels were below detection (0.03 µg/g) in all samples except JW11, which had a value at the detection limit. Hence, they were below CCME and British Columbia sediment quality guidelines and CEPA screening limits for ocean disposal in all samples and were also below British Columbia sediment quality criteria and CEPA screening limits for ocean disposal. Samples from the two reference locations (SWQ09 and SWQ 10) were not analyzed for PCBs.

Other Parameters

See Appendix C, Table C-4 for the salinity, pH, ammonia and sulphide concentrations in seawater, and see Appendix C, Table C-10 for the total organic carbon and percent moisture data. Particle size distribution results are presented in Appendix C.3. Sediment is dominated by fine to medium silts and clay.

Invertebrate Toxicity Testing

For a summary of the invertebrate toxicity test results, see Table 3-9. For the amphipod survival test, sediment was judged to have failed the toxicity test if the mean 10-day survival rate was more than 20% lower than that in the reference sediment and was notably different. For the polychaete test, toxicity was determined by statistical comparison of test sediments with reference sediments.

Sediment samples were not found to be toxic to either of the invertebrate test organisms.

Table 3-9 Survival and Growth Results for Marine Invertebrates

Sediment Sample	Marine Amphipod		Polychaete		
	Survival (%)	Notes	Survival (%)	Mean Growth Rate (mg/worm/day)	Notes
SWQ-06-09	97 ± 4	Reference	100 ± 0	1.00 ± 0.07	NSD[b]
SWQ-06-10	90 ± 8	Reference	100 ± 0	0.98 ± 0.15	NSD[b]
SWQ-06-01	88 ± 8	Passed	100 ± 0	1.00 ± 0.07	NSD[b]
SWQ-06-02	88 ± 8	Passed	100 ± 0	1.04 ± 0.09	NSD[b]
SWQ-06-03	80 ± 12	Passed[a]	100 ± 0	0.99 ± 0.08	NSD[b]
SWQ-06-04	87 ± 4	Passed	100 ± 0	0.95 ± 0.21	NSD[b]
SWQ-06-05	85 ± 12	Passed[a]	100 ± 0	0.97 ± 0.13	NSD[b]
SWQ-06-06	82 ± 6	Passed[a]	100 ± 0	0.99 ± 0.13	NSD[b]

Table 3-9 Survival and Growth Results for Marine Invertebrates (cont'd)

Sediment Sample	Marine Amphipod		Polychaete		
	Survival (%)	Notes	Survival (%)	Mean Growth Rate (mg/worm/day)	Notes
SWQ-06-07	84 ± 8	Passed[a]	100 ± 0	0.97 ± 0.10	NSD[b]
SWQ-06-12	81 ± 11	Passed[a]	100 ± 0	1.02 ± 0.11	NSD[b]

NOTES:
Values are ± SD.
[a] Amphipod survival measurably different from reference sediment SWQ09.
[b] NSD = not measurably different from laboratory control.

3.2.2.4 Benthic Survey Results

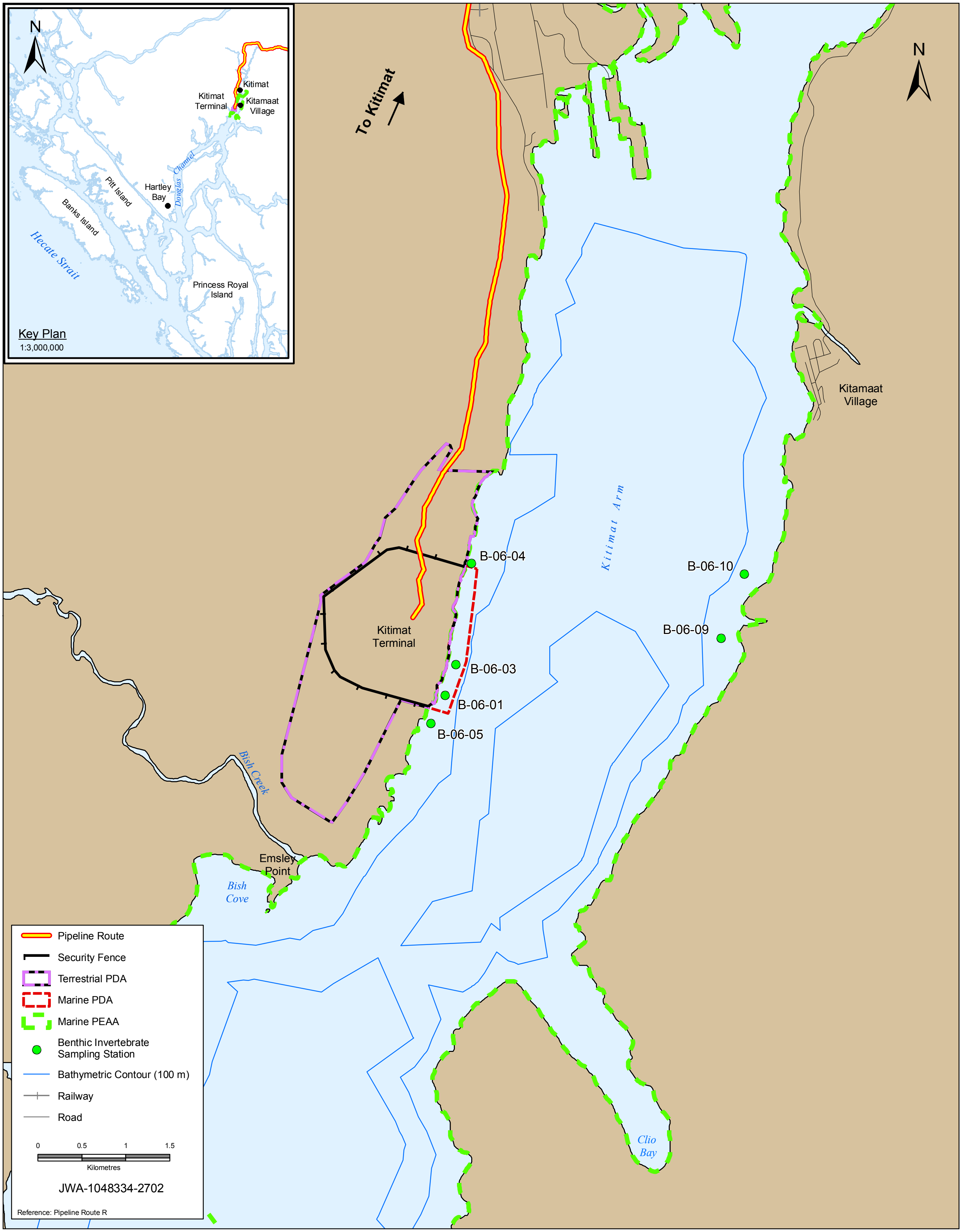
Benthic samples were collected from six sampling stations (Figure 3-25). In total 14,884 individual organisms were counted. These organisms fell into a total of 1,662 taxa. For the most dominant taxa at each of the stations, see Table 3-10. For the most common species within those taxa, see Table 3-11.

3.2.3 Nearshore Fish Survey

Beach seine, pelagic gillnetting and longlining surveys in the PDA (Figure 3-26) confirmed the presence of 13 species of benthic and pelagic fish (see Table 3-12).

Twenty-five beach seines were conducted over a 5.5 km long shoreline segment. Seven of the beach seines contained no fish. In all, seven species were found in the beach seine surveys (see Table 3-13). Shiner perch was the most common species found, followed by threespine stickleback. Other species present include tidepool sculpin, high cockscomb, buffalo sculpin, great sculpin and manacled sculpin.

Nine gillnet surveys and three longline surveys were also completed in which seven species of fish were found, as well as Dungeness crab (see Tables 3-14 and 3-15). One of the gillnet surveys and one of the longline surveys did not capture any fish, either due to a low fish population or to gear failures. Five additional species caught by gillnet but not in the beach seines were dogfish, yellowfin sole, kelp greenling, sand sole and English sole.



CONTRACTOR: Jacques Whitford AXYS Ltd.		ENBRIDGE NORTHERN GATEWAY PROJECT	FIGURE NUMBER: 3-25		DATE: 20100129
PREPARED BY: gem	PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES	Benthic Invertebrate Sampling Locations	SCALE: 1:60,000	AUTHOR: SS	APPROVED BY: CM
			PROJECTION: UTM 9		DATUM: NAD 83

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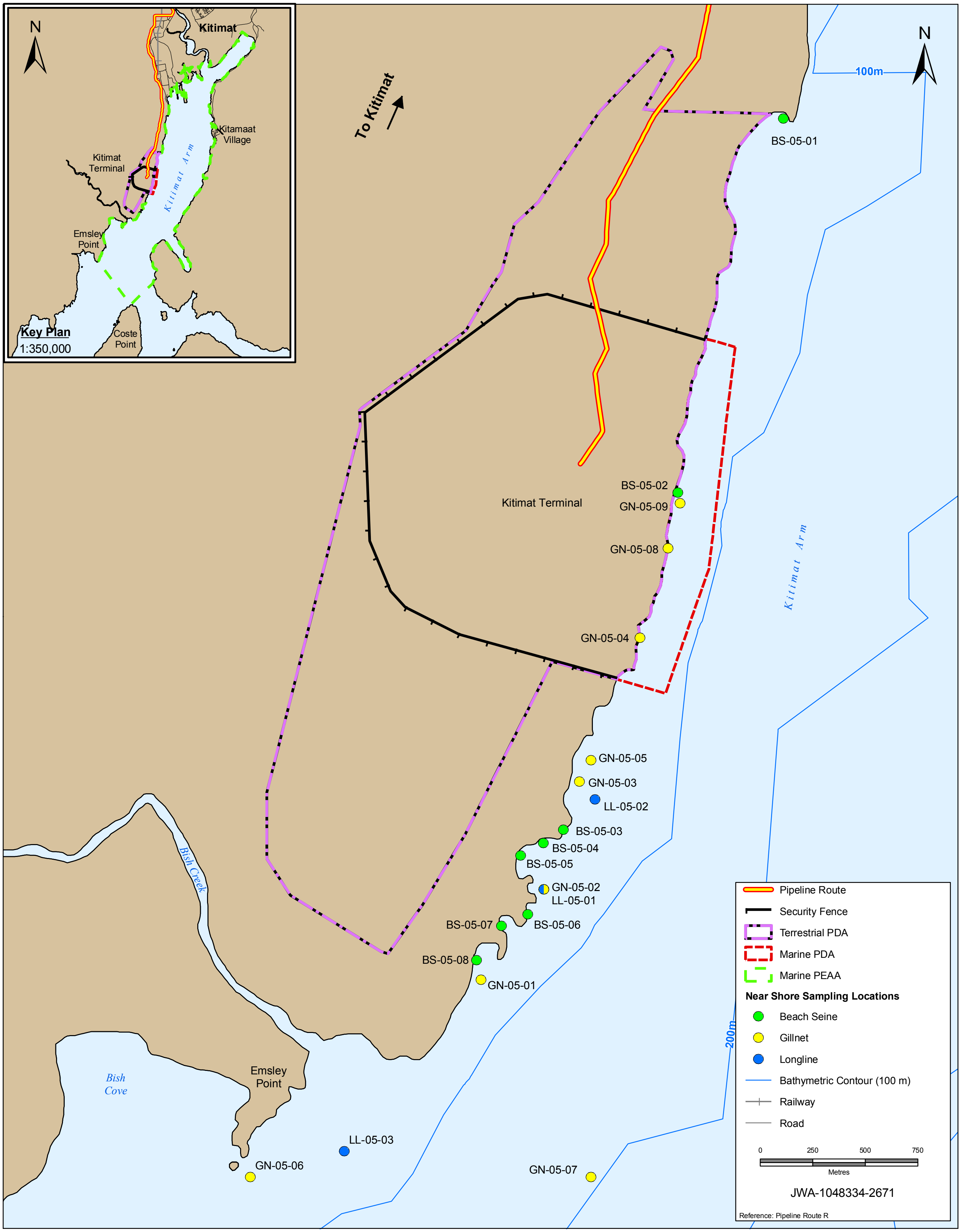
Table 3-10 Most Dominant Taxa at Each Station

Station	Most Dominant	Second Most Dominant	Third Most Dominant	Total Abundance
B-06-01	Polychaeta (937)	Bivalvia (93)	Cumacea (26)	1,136
B-06-03	Polychaeta (1,357)	Amphipoda (88)	Bivalvia (83)	1,628
B-06-04	Polychaeta (2,509)	Bivalvia (330)	Amphipoda (41)	3,026
B-06-05	Polychaeta (1,454)	Bivalvia (103)	Amphipoda (29)	1,697
B-06-09	Polychaeta (2,827)	Bivalvia (967)	Gastropoda (62)	4,174
B-06-10	Polychaeta (2,317)	Bivalvia (641)	Amphipoda (55)	3,223

Table 3-11 Most Common Species at Each Station

Station	Common Species	Station	Common Species
B-06-01	*Nephtys cornuta* *Aricidea ramosa* *Aricidea lopezi* *Galathowenia oculata*	B-06-05	Aricidea lopezi Aricidea ramose *Galathowenia oculata* *Microclymene* nr. *caudata* *Chaetozone* spp. *Axinopsida serricata*
B-06-03	*Nephtys cornuta* *Scoletoma luti* *Aricidea ramose* *Aricidea lopezi* *Galathowenia oculata*	B-06-09	*Typosyllis heterochaeta* *Aricidea ramosa* *Decamastus* nr. *gracilis* *Galathowenia oculata* *Leitoscoloplos pugettensis* *Levinsenia gracilis* *Adontorhina cyclia* *Axinopsida serricata* *Macoma carlottensis* *Macoma* spp. *Ophiura* sp. *Scleroconcha trituberculata* *Macoma elimata*
B-06-04	*Aricidea lopezi* *Aricidea ramosa* *Galathowenia oculata* *Melinna* nr. *heterodonta* *Microclymene* nr. *caudata* *Sternaspis* nr. *fossor* *Adontorhina cyclia* *Axinopsida serricata*	B-06-10	*Ninoe gemmea* *Scoletoma luti* *Aricidea ramosa* *Galathowenia oculata* *Leitoscoloplos pugettensis* *Levinsenia gracilis* *Adontorhina cyclia* *Axinopsida serricata* *Macoma carlottensis* *Ophiura* sp. *Nephasoma diaphanes* *Acila castrensis*



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CONTRACTOR: Jacques Whitford AXYS Ltd.	ENBRIGE NORTHERN GATEWAY PROJECT	FIGURE NUMBER: 3-26	DATE: 20100129
PREPARED BY: gem / PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES	Nearshore Fish Survey Stations	SCALE: 1:25,000 / PROJECTION: UTM 9	AUTHOR: SS / APPROVED BY: CM / DATUM: NAD 83

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Table 3-12 Benthic and Pelagic Fish Recorded during Fish Surveys

Species	Survey Type		
	Beach Seine (BS)	Gillnet (GN)	Longline (LL)
shiner perch (*Cymatogaster aggregatus*)	✓	✓	
English sole *(Parophrys vetulus)*		✓	
sand sole *(Psettichthys melanostictus)*		✓	✓
yellowfin sole *(Limanda aspera)*		✓	
tidepool sculpin (*Oligocottus maculosus*)	✓		
cabezon *(Scorpaenichthys marmoratus)*		✓	✓
great sculpin (*Myoxocephalus polyacanthocephalus*)	✓		
manacled sculpin (*Synchirus gilli*)	✓		
buffalo sculpin (*Enophrys bison*)	✓		
kelp greenling *(Hexagrammos decagrammus)*		✓	
threespine stickleback (*Gasterosteus aculeatus*)	✓		
high cockscomb (*Anoplarchus purpurescens*)	✓		
dogfish *(Squalus acanthias)*		✓	✓

Table 3-13 Beach Seine Catches in Douglas Channel, July 2005

Station	shiner perch	tidepool sculpin	threespine stickleback	great sculpin	buffalo sculpin	manacled sculpin	high cockscomb
BS-05-01 A		1					
BS-05-01 B	2					1	
BS-05-01 C							
BS-05-01 D		1					
BS-05-01 E	1	1					
BS-05-01 F							
BS-05-01 G		1					
BS-05-01 H							
BS-05-02 A	2		2				
BS-05-02 B							
BS-05-02 C							
BS-05-03 A							
BS-05-04 A	80						
BS-05-04 B	152		1				
BS-05-05 A	16						
BS-06-06 A	7			3			
BS-06-06 B	12		100	3			1
BS-06-06 C	65		1	1	1		4
BS-06-06 D	11			1			
BS-05-07 A	10						
BS-05-07 B	1						
BS-05-07 C							
BS-05-07 D	13						
BS-05-08 A			25				
BS-05-08 B	300						

Table 3-14 Gillnet Catches in Douglas Channel, September 2005

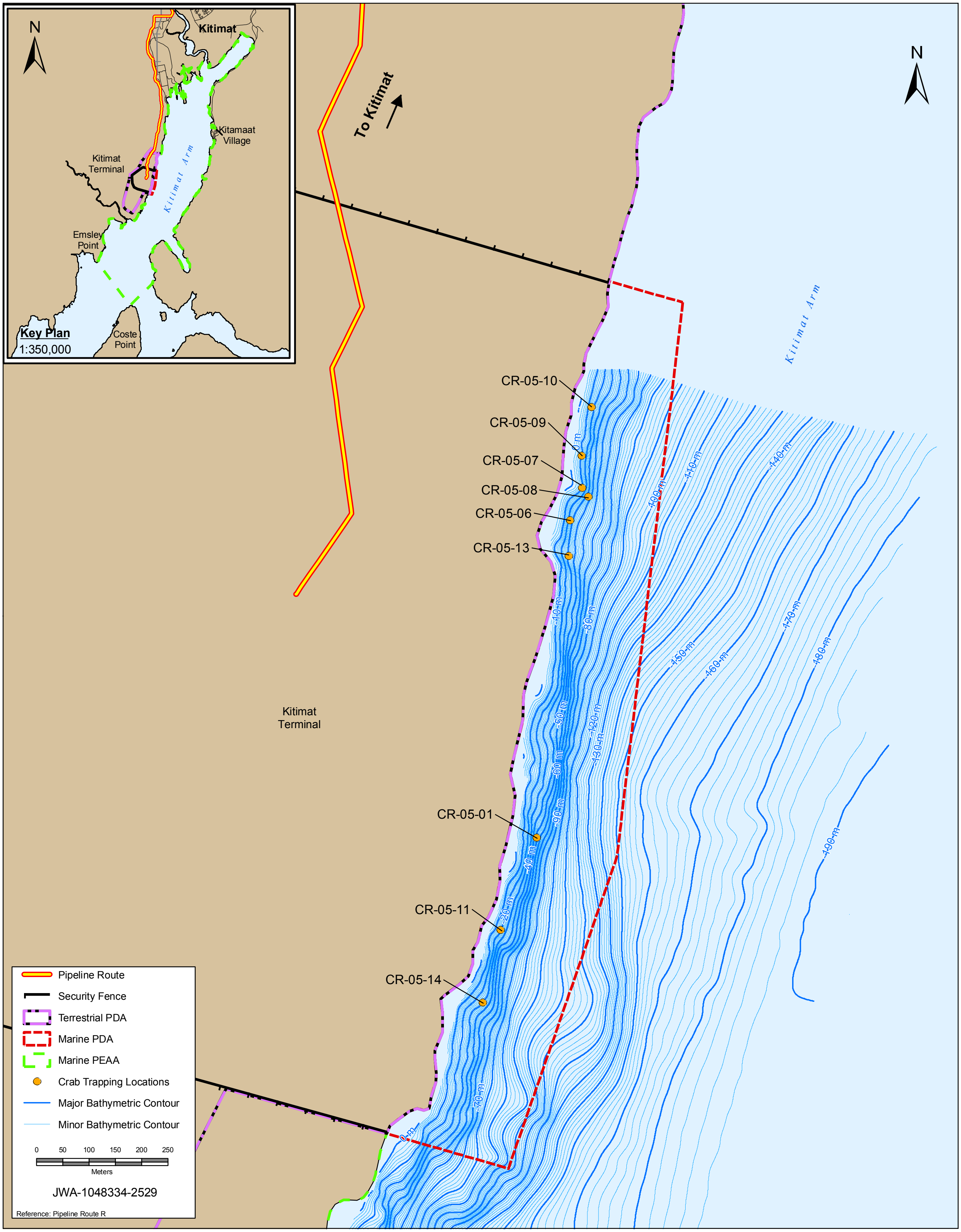
Station	Tide (m)	shiner perch	English sole	Cabezon	kelp greenling	sand sole	yellowfin sole	Dungeness crab
GN-05-01	1.92							
GN-05-02	2.50		14					1
GN-05-03	5.24	1	3	5				1
GN-05-04	0.48		1					
GN-05-05	0.49		1	5	1	2		7
GN-05-06	0.92		1			2	2	5
GN-05-07	1.23		1					
GN-05-08	4.94							
GN-05-09	5.17							

Table 3-15 Longline Catches in Douglas Channel, September 2005

Station	Effort	Tide (m)	Giant Sculpin	Dogfish	Sand Sole
LL-05-01	19 hooks/3 hours	5.20	1		
LL-05-02	24 hooks/22 hours	2.65	1	4	2
LL-05-03	24 hooks/5 hours	3.53			

3.2.4 Nearshore Crab Survey

Nine crap traps were deployed over a one week period in the PDA (Figure 3-27). There were concerns about the effectiveness of the traps; as a result, confidence in the results of this survey is moderate. There were no crabs caught in any of the traps during the survey.



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CONTRACTOR: Jacques Whitford AXYS Ltd.		**ENBRIDGE NORTHERN GATEWAY PROJECT**	FIGURE NUMBER: 3-27		DATE: 20100129
PREPARED BY: gem	PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES	Crab Trapping Locations	SCALE: 1:10,000	AUTHOR: SS	APPROVED BY: CM
			PROJECTION: UTM 9		DATUM: NAD 83

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3.3 Modelling Results

3.3.1 Sediment Plume and Dispersion Modelling Results

The model was used to compute TSS concentrations and the total deposition of sediment released during dredging operations. The model simulations of TSS concentrations from the dredging operations indicates that TSS values are low at the surface, being generally less than 0.25 mg/L, except in the immediate vicinity of the dredging barge where there is a maximum TSS value of 2.7 mg/L. Naturally occurring TSS concentrations fall in this same range of values or are higher during major river freshet events. At depths of 10 to 20 m, the area with TSS values exceeding 2.5 mg/L are confined to areas within 200 m of the dredging location, with peak values at the dredging barge of up to 58 mg/L. A very diffuse sediment plume having TSS values of 0.25 to 2.5 mg/L occurs as a band approximately 300-m wide extending up to 3 km along the coastline. This diffuse band of sediments would be difficult to detect, as the naturally occurring TSS concentrations are comparable in magnitude. The TSS values are generally reduced at greater depths. However after seven days of dredging operations, TSS concentrations of 0.25 to 2.5 mg/L are computed for depths of 50 to 70 m as the finer silt and clay particles slowly descend to the bottom. The area of this diffuse plume extends over distances of 2 km along the coast and up to 1 km from the coast.

The maximum thickness of deposited sediments is 1.1 cm but generally much less than this. The area of sediment deposition exceeding 0.1 cm is largely confined to the immediate zone of dredging activities. Outside this disturbed area, there is less than 0.1 cm of sediment deposition and typically only 0.0025 to 0.05 cm. For results, see Appendix A.

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Appendix A ASL Sediment Dispersion Model

3-D Numerical Modeling of Sediment Dispersion and Transport For Marine Dredging and Terrestrial Disposal Activities of the Enbridge Gateway Project

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EXECUTIVE SUMMARY

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1.0 INTRODUCTION

An integrated ocean circulation and sediment transport model was adapted and implemented for Kitimat Arm to provide information on the fate and dispersal of sediments discharged from the Enbridge Gateway project. The Gateway project involves two potential types of sediment releases from project activities: (a) sediments released during dredging operations for construction of the marine terminal site along the coastline of northwestern Kitimat Arm and (b) disposal of terrestrial sediments along with dredged sediments at an ocean disposal site. The mass and timing of the released sediments released, are consistent with the Project Description for the Marine Terminal (Enbridge Gateway Environment Assessment Volume 6).

1.1 COCIRM-SED Circulation and Sediment Transport Model

The model used was ASL's COCIRM-SED model, a fully three dimensional integrated model based on a circulation model (COCIRM), a coastal wave model (SWAN) a sediment transport module and geomorphological module. For this modeling application, the coastal wave model was not applied as waves are generally small in this area and the steep terrain of the region results in only very small areas where the water depths are sufficiently small that waves would be important in resuspension of sediments. Also, the geomorphological module was not applied for this application, since the very large water depths of typically 100 to > 350 m combined with the small currents limit the potential for changes in the seabed. However, the direct deposition resulting from settling of suspended sediments is explicitly modeled through the sediment module.

1.2 STFATE Near Field Model

STFATE is a numerical modeling package prepared by the U.S. Army Corps of Engineers for simulating the short term fate of material from open water barge disposals (US EPA and USACE, 1991). The model proceeds through three stages: The convective descent of the material through the water column, the dynamic collapse once the bottom has been reached, and finally the long term diffusion. STFATE assumes a steady time-independent flow, so results from STFATE were limited to concentration profiles taken soon after the disposal.

STFATE was run with a 100 m grid resolution, allowing it to match the horizontal resolution used by COCIRM-SED. Each of the 5 dumping sites were simulated individually with their own representative water depth, and assuming a flat bottom. The maximum allowable 5 points were used to represent the density structure of the water column. Because STFATE was being used primarily to model the dumping phase rather than the long term diffusion, zero-current speeds were imposed. This assumption prevented the shear actually known to be in the water column from advecting the near-surface material from the deeper material. Given the STFATE runs were only the first 20 minutes after dumping, and the total simulation extended over at least 7 days, this simplification had a negligible impact on the final outcome.

The barge was assumed to carry 4800 cubic yards of material, with 26.4% of the material being silt, 21.6% being clay, and the remaining 52% being rock. The net density of the material was about 130 lb/ft^3 (2.09 x10^3 kg/m^3). STFATE allowed for the floculation of the silt and clay by recalculating a settling velocity which was proportional to the concentration raised to the 4/3 power for concentrations between 25 mg/L and 3 g/L. The model also allowed the clay and silt to be stripped from the sediment cloud during descent.

The disposal operation was assumed to take place from a stationary barge. At the start of the operation, the draft of the barge was 22 feet, and over 2 minutes the contents were emptied. The process of emptying was simulated by 4 discreet discharges of material of 1000, 1400, 1400, and 1000 cubic yards respectively. Upon completion of the discharge, the barge draft was 5 feet.

Modeling of the disposal was done for up to 20 minutes, because over most of the water column, it took this long for the material to spread out to fill the 100 m grid. For these depths, a single concentration could be entered into COCIRM-SED. For the near-bottom, though, spreading had occurred, and a 5x5 grid of concentrations were entered. STFATE has no explicit vertical resolution, but allows sediment concentrations to be extracted for user selected depths. Concentrations were extracted for depths coincident with the centre of COCIRM-SED bins. Part of the reason for extracting concentrations at a higher vertical resolution at the near-bottom was the rapid increase in concentrations (Figure 1). For each disposal site, the concentration at the peak was extracted. This concentration was scaled back by a factor of 0.679 to account for the peak being distributed over a much smaller vertical span that the peak itself, and an additional factor of 1.022 was included to account for the spreading of material beyond the 5x5 grid for this single depth. As a final check, COCIRM-SED inputs were used to calculate the total suspended sediment. Consistency was found with STFATE, except for the deepest site where the peak silt concentrations needed to be scaled up by an additional 25-30% to conserve mass. It should be noted that only the silt, and not the clay, needed this additional empirical scaling factor.

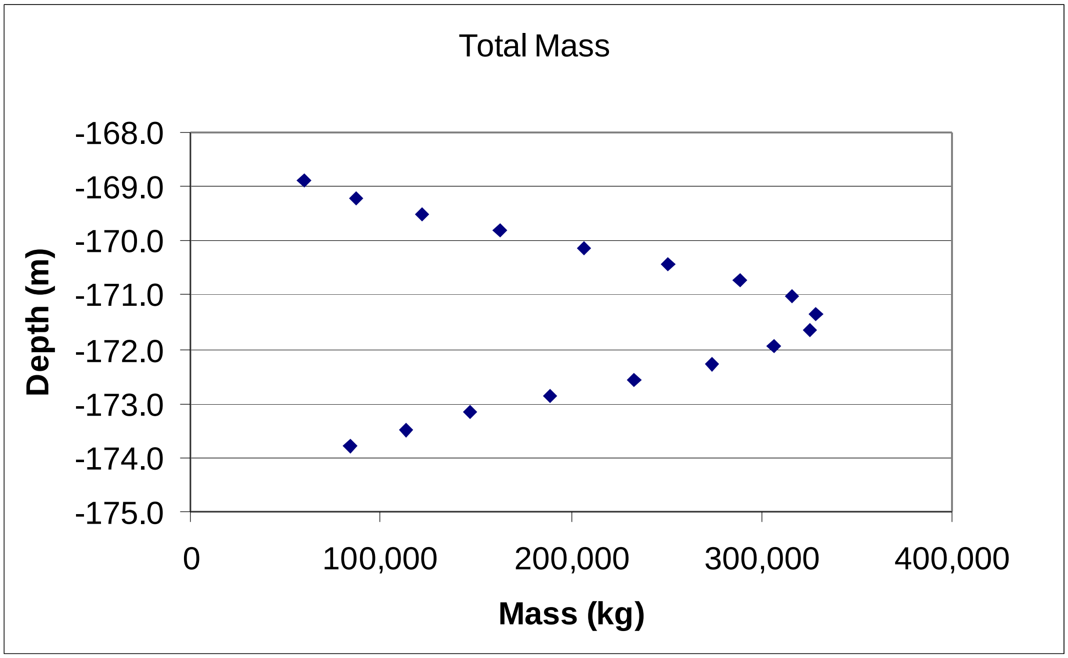

Figure 1: Mass of sediment as a function of depth in about 174 m of water.

2.0 MODEL DOMAIN AND BATHYMETRY

2.1 Model Domain and Grid Resolution

A realistic numerical model domain was created for the full area of Kitimat Arm as well as Kildala Inlet. The model domain has a total length of 29.8 km and a width of 11.8 km. In the horizontal, the model has grids of size 100 m by 100 m over the full domain, and within 2 km of the marine terminal area, a high resolution nested grid of 20 m by 20 m is used. In the vertical, the model represents the water column as

Vertical Grid: The 20 vertical z-coordinate layers before chart datum (Table 2) are unevenly distributed in order to allow more realistic representation of depths in the marine dredging area and the upper layer where velocities have larger vertical gradients. There is also one layer above chart datum which is used to represent the variability of water levels due to the tides and other forcing conditions.

Table 1: The vertical layer depths (at bottom of layer) and thickness of each layer for the dredging and calibration/verification models, and for the disposal models.
.

Cal/Ver (m)	Thickness (m)	Disposal Case (m)	Thickness (m)
2	2	2	2
4	2	4	2
7	3	7	3
10	3	10	3
13	3	13	3
16	3	16	3
20	4	20	4
25	5	25	5
30	5	30	5
40	10	40	10
50	10	50	10
70	20	70	20
100	30	100	30
140	40	140	40
180	40	144.7	4.7
220	40	149.7	5
260	40	158.7	9
310	50	163.7	5
360	50	168.7	5
		172	3.3

2.2 Bathymetry

Water depths are represented in the model on the scale of the horizontal grid dimensions. The water depths were obtained from digital versions of the Canadian Hydrographic Service Nautical chart numbers 3736 and 3743.

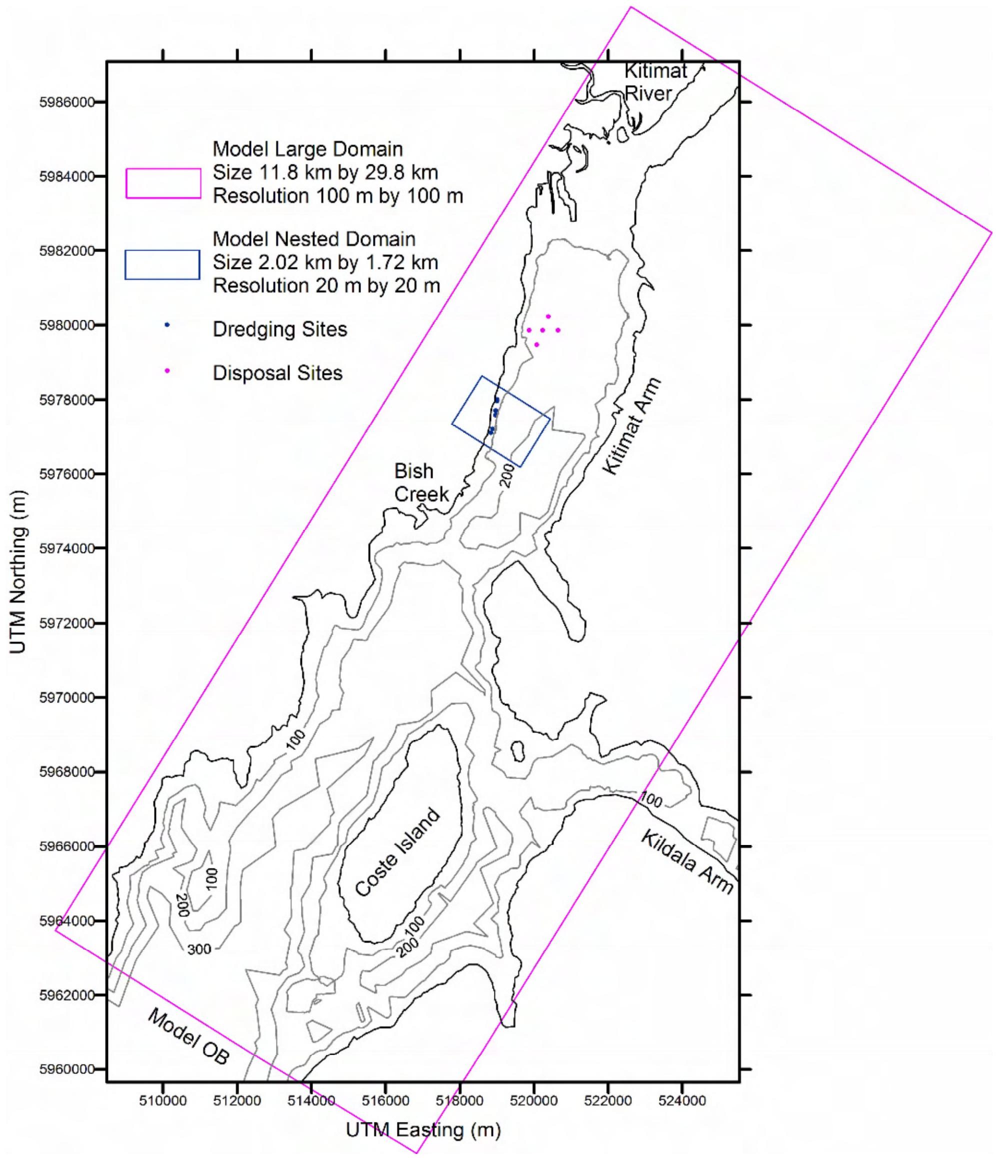

Figure 2: The bathymetry, reduced to the lowest normal tide (chart datum, used by the model.

2.3 Model Time Step and Stability

The model is operated on computation time step corresponding to 15 s in real-world time. For this purposes of modeling simulations of the fate of the transport and deposition of sediments, the 3-D numerical model was operated for a period of 7 full days in most cases, with one model simulation extending over 14 days. The total computer time to run the model on a very fast PC Windows computer is approximately 3 days.

2.4 Initial and Boundary Conditions

The model is forced by water level elevations at the open southern boundary as well as by River discharges at the north boundary (Kitimat River) as well as representing river inputs through Bish Creek, Jesse Lake and Kildala Inlet. The water levels at the southern boundary were based on tidal elevations measured offshore of the terminal area in a water depth of 179 m in the September 2005, and in a water depth of 30 m in January and April 2006 (Appendices A.7 and A.8 in GEM, 2006). The tidal heights are referenced to the lowest normal mean water level or chart datum. The Bish Creek, Jesse Lake, and Kildala river inputs were taken to be linearly proportional to the Kitimat River discharge (which is gauged) based on the relative basin areas. Wind forcing was spatially uniform across the model domain, and was taken from the Nanakwa shoal buoy, located just south of Coste Island.

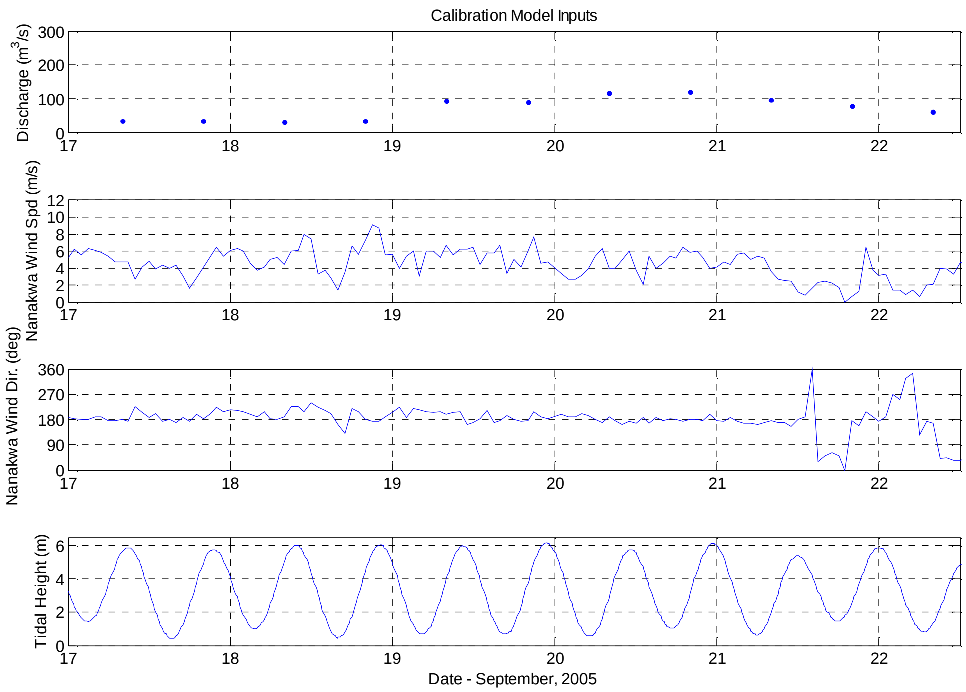

Figure 3: Kitimat River discharge, Nanakwa wind speed, wind direction, and tidal height forcing in September for the calibration run.

The freshwater discharge forcing in September was relatively low, peaking at just over 100 m^3/s. The wind speeds were generally at 4 ± 2 m/s, though a wind speed of up to 9 m/s was measured in the calibration period. The winds were almost always from the south. The tidal heights showed a strong semi-diurnal variation, and had a magnitude of about 5 m.

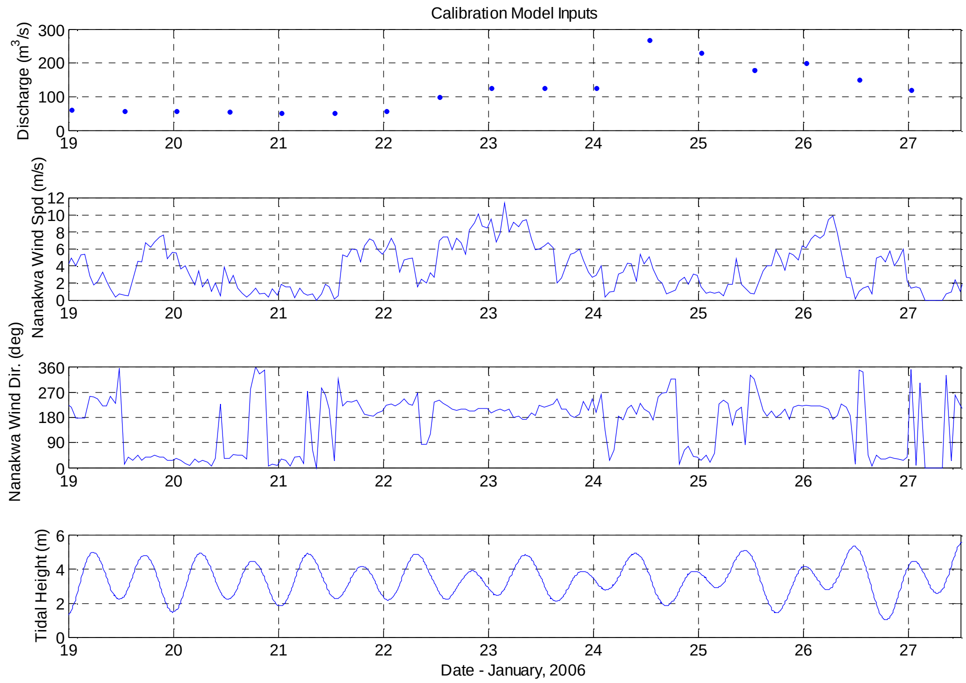

Figure 4: Kitimat River discharge, Nanakwa wind speed, wind direction, and tidal height forcing in January for the verification run.

The freshwater forcing in January was much stronger than in September, peaking at over 250 m^3/s. In the second half of the model run, after January 22, all of the discharge values exceeded 100 m^3/s. The wind speeds were much more variable, often with speeds under 2 m/s, but also reaching peaks of 8-11 m/s every day to four days. The winds were along channel, usually from the south, but with several events from the north. One of the longer northerly events started around mid-day on the 19th, and persisted for almost a day. The wind speeds nearly reached 8 m/s during this event.

The temperature, salinity, and density profiles for the calibration model, in September, are shown in the left panel of Figure 5. The model domain was initialized with a spatially uniform field, illustrated by the magenta curve, and the salinity and temperature properties (blue curve) were advected across the open boundary. The riverine input was reflected in the somewhat fresher and less dense surface waters encountered in the initial conditions than the boundary conditions. These trends were also maintained in the initial and boundary conditions for the verification model in January; however, the boundary salinity and density at depth were significantly larger than the initial model conditions.

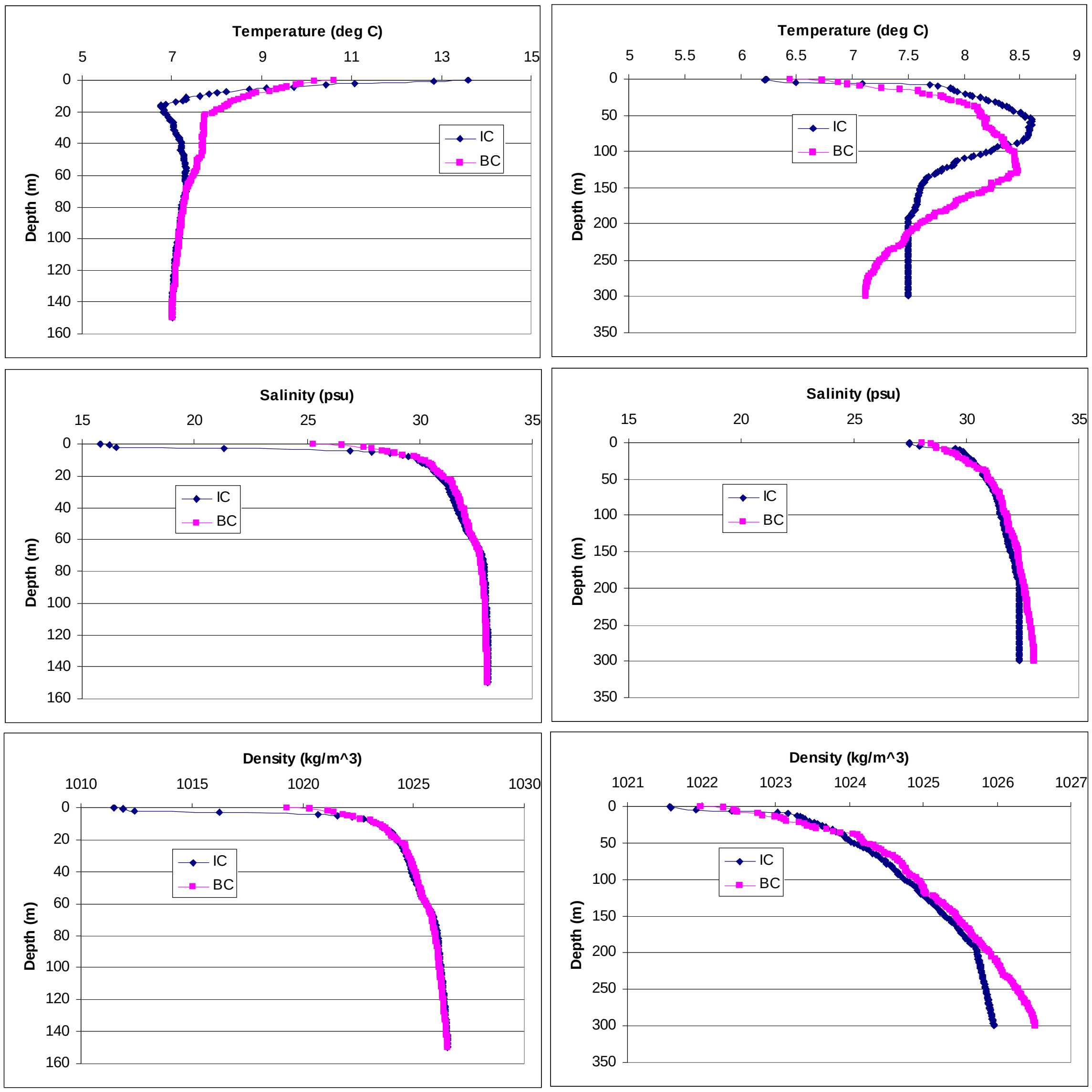

Figure 5: Initial temperature, salinity, and density profiles are shown in blue, and the southern boundary temperature, salinity, and density profiles are given in purple. The profiles on the left are for the calibration model run in September, 2005, and the profiles on the right are for the verification model run in January, 2006.

3.0 MODEL CALIBRATION

Model calibration was carried out for Sept 15 to Sept. 22, 2005 using data collected in this period, and analyzed in GEM technical report ASL-TR-007.

3.1 Initial Conditions and Stabilization

The initial conditions for model calibration and verification runs were as follows:

(1) All velocities were set equal to zero.

(2) Water elevation at each grid point was set to a constant value, which was equal to the initial water elevation at the downstream open boundary. The boundary conditions used in the model runs are described in Section 2.4.

Starting from initial conditions, the modeled flows gradually converge to a stable state. Here, we deemed that the model results were stable when maximum velocity fluctuations were less than 0.005 m/s. This process takes about 3 days of real time and consumes computer time of about 12 hrs of computer time.

3.2 Calibration Model Results

3.2.1 Flows

The flow fields within the model are illustrated starting 6.5 days into the model run, and every 3 hours thereafter for a near-surface, mid-depth, and near-bottom level. At the near-surface, there is a general down-channel flow at all of the times sampled. It is at the head of the inlet where the flow direction show large magnitude flow reversals. Between 19:00 and 22:00, the flood tide diminishes in magnitude (Figure 6). At 01:00 on 22 September, the tide has turned to ebb, and by 04:00 the ebb flow is large (Figure 7). By 07:00, the currents flood tide has returned (Figure 8). At 9 m, and 14 m, the strong flows associated with the river are no longer evident in the vector flow plots (Figure 9 through Figure 14). Examination of the time series plots of current speed and direction indicate that at 9 and 15 m depth, there is a flow reversal from northward to southward flow near midnight. These time series are taken from a point offshore of the terminal site, and indicate that even though the strongest flows are to the south, there are reversals and weak flood currents.

In Figure 15, the blue curve indicates the modeled currents, and the red dots indicate the measured currents. Both the model and measurements reflect a predominant southerly flow, with episode of northerly currents. Examination of the speed panel indicates that there are several events where the surface currents reach speeds of 20 cm/s or more. These higher speed events almost always correspond to southerly flow, both in the model and in the measurements, even though there is not always consistency in when these events occur.

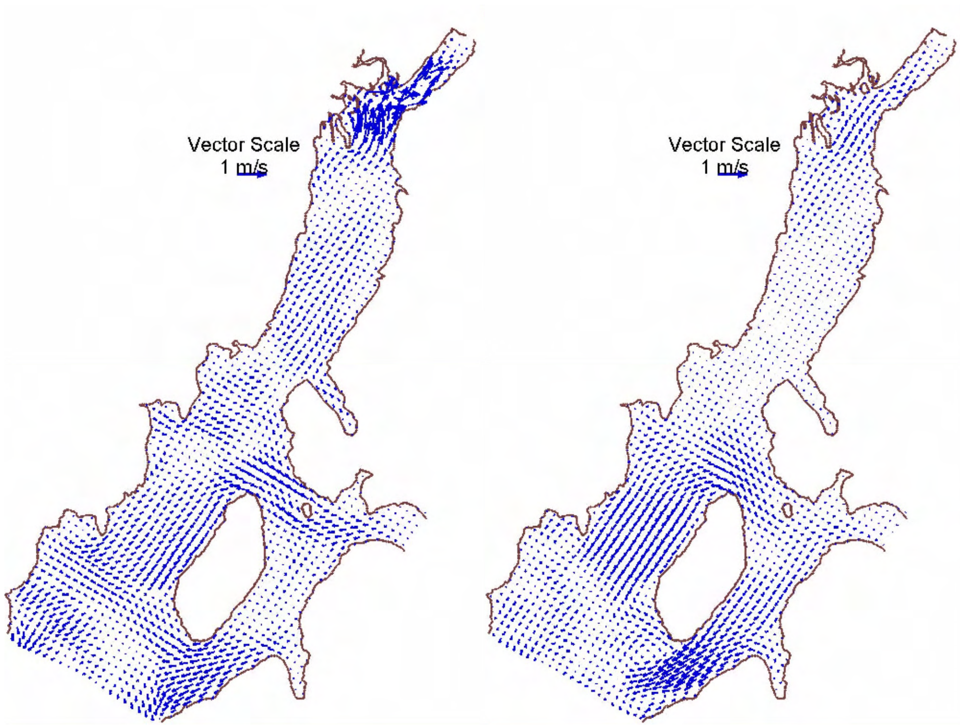

Figure 6: Surface velocities at 19:00 and 22:00 on September 21, 2005.

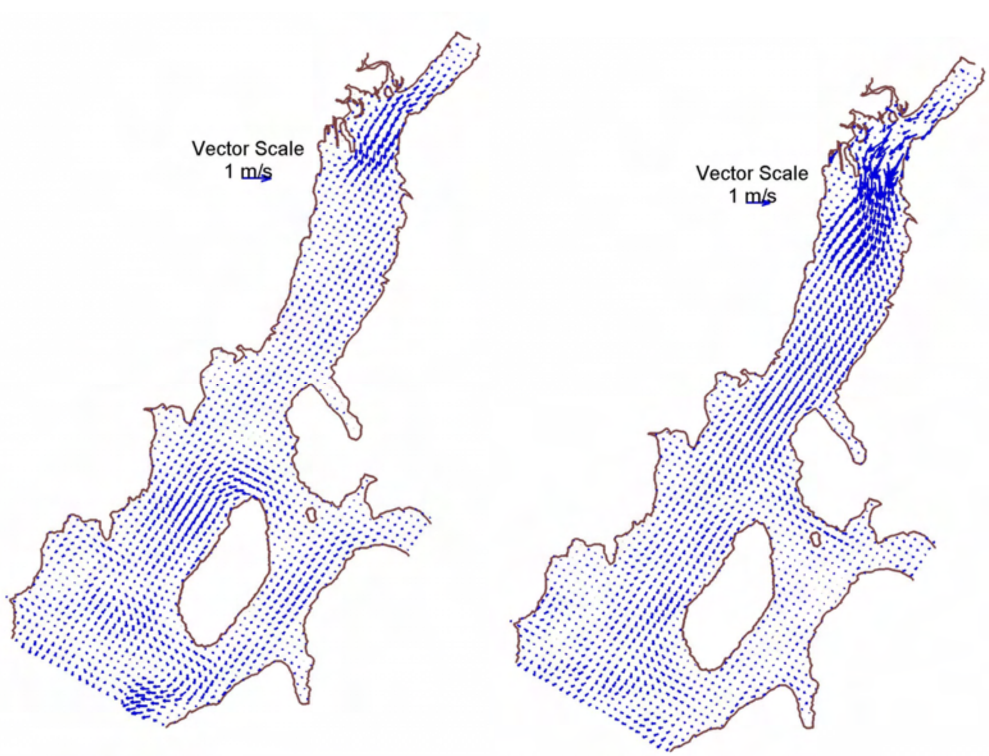

Figure 7: Surface velocities at 1:00 and 4:00 on September 22, 2005..

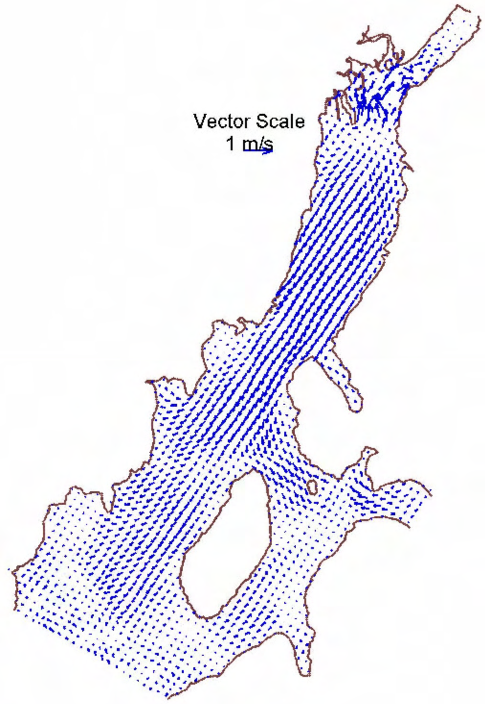

Figure 8: Surface velocities at 7:00 on September 22, 2005.

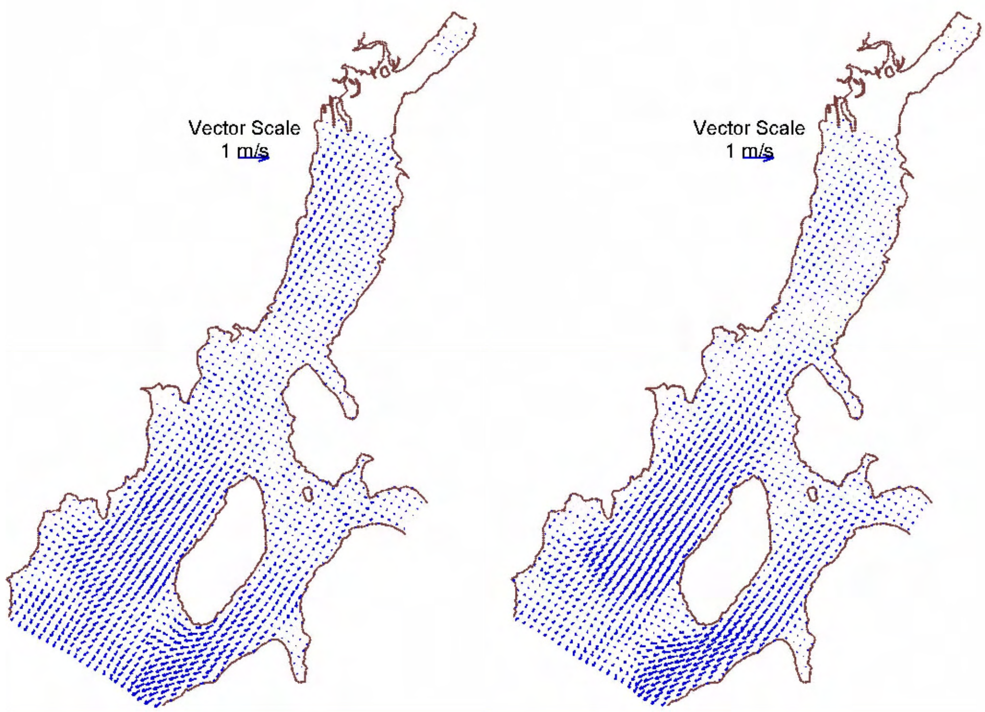

Figure 9: Velocities at 9 m depth at 19:00 and 21:00 on September 21, 2005.

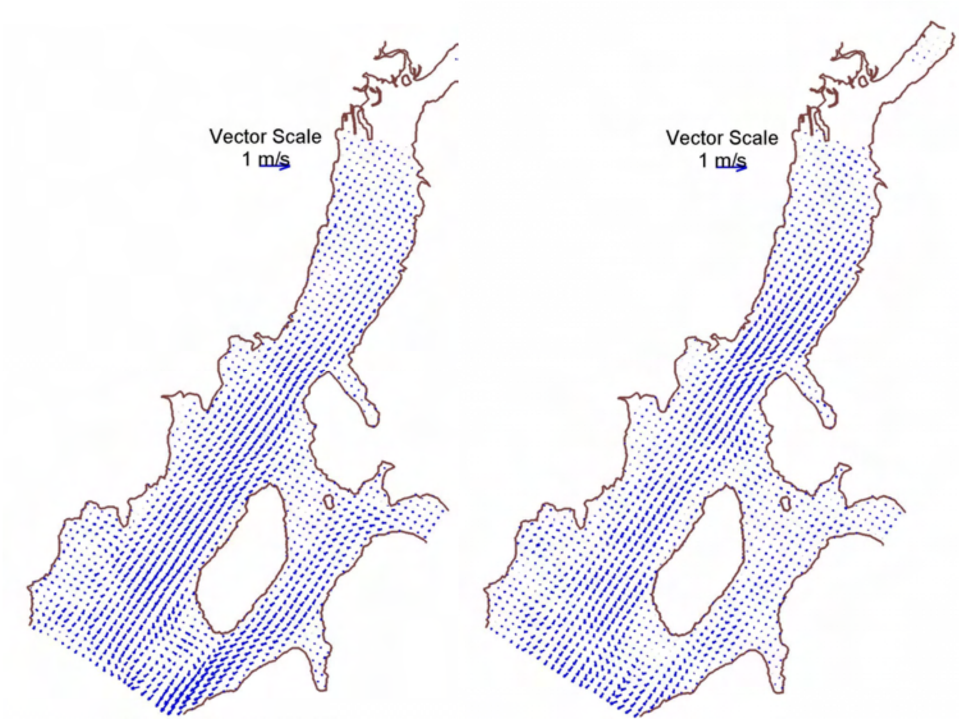

Figure 10: Velocities at 9 m depth at 1:00 and 4:00 on September 22, 2005..

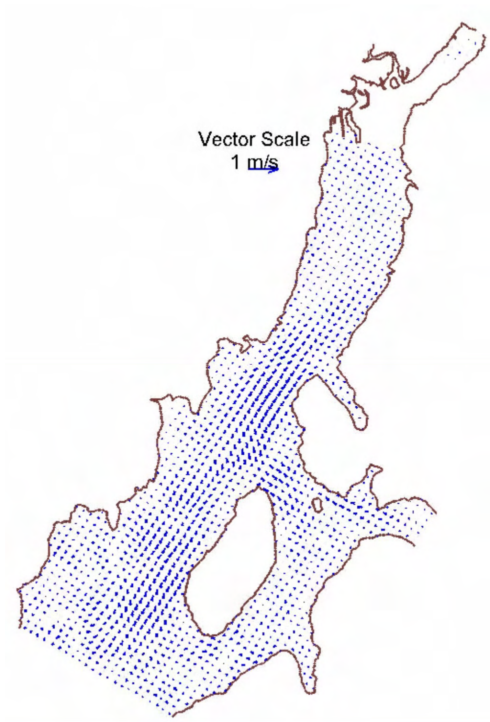

Figure 11:   Velocities at 9 m depth at 7:00 on September 22, 2005.

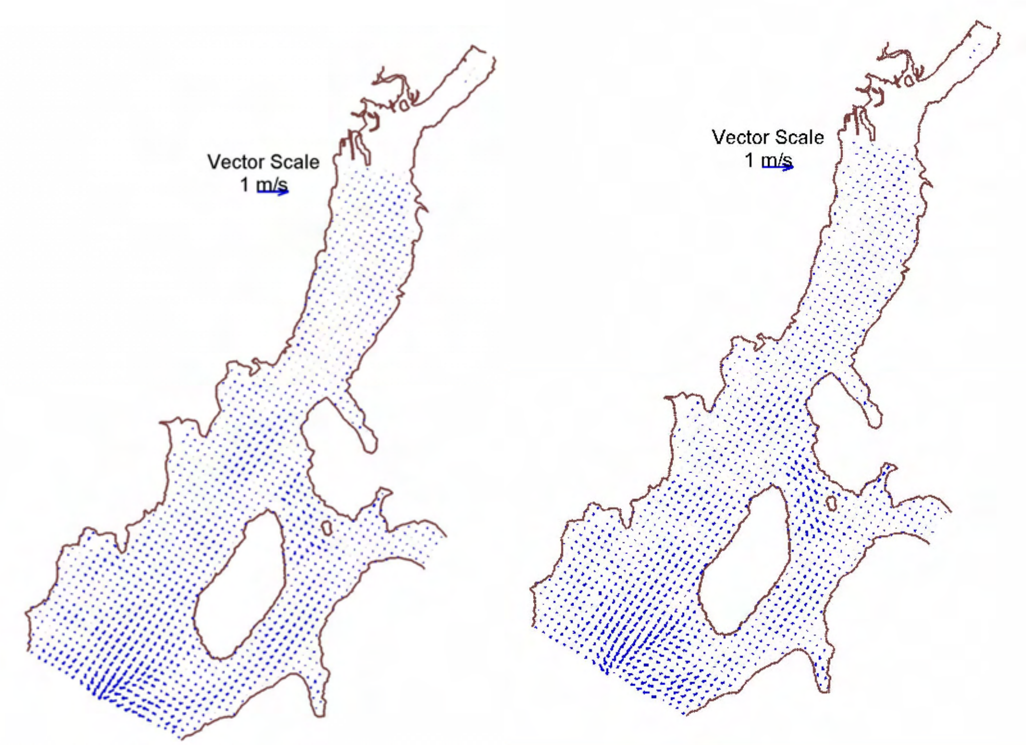

Figure 12: Velocities at 41 m depth at 19:00 and 21:00 on September 21, 2005.

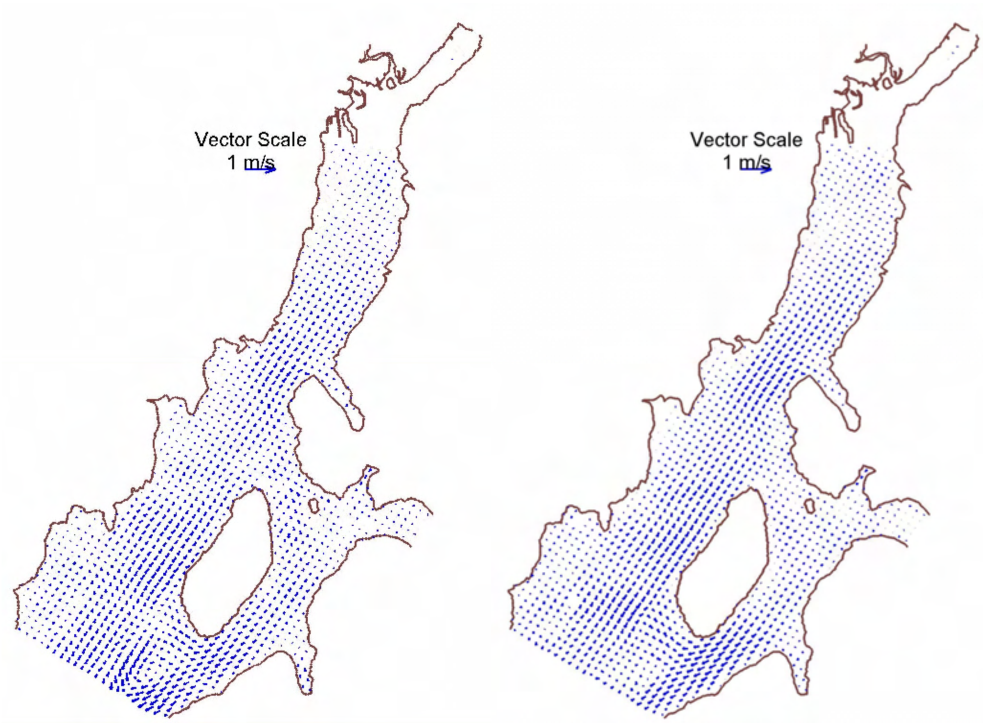

Figure 13: Velocities at 41 m depth at 1:00 and 4:00 on September 22, 2005.

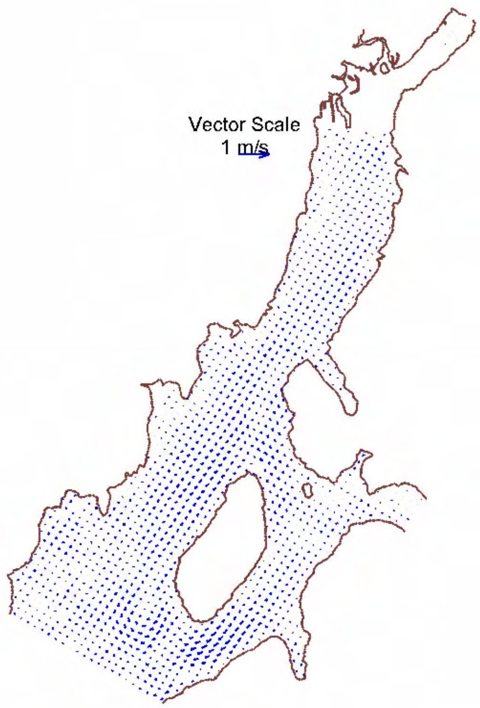

Figure 14: Velocities at 41 m depth at 7:00 on September 22, 2005.

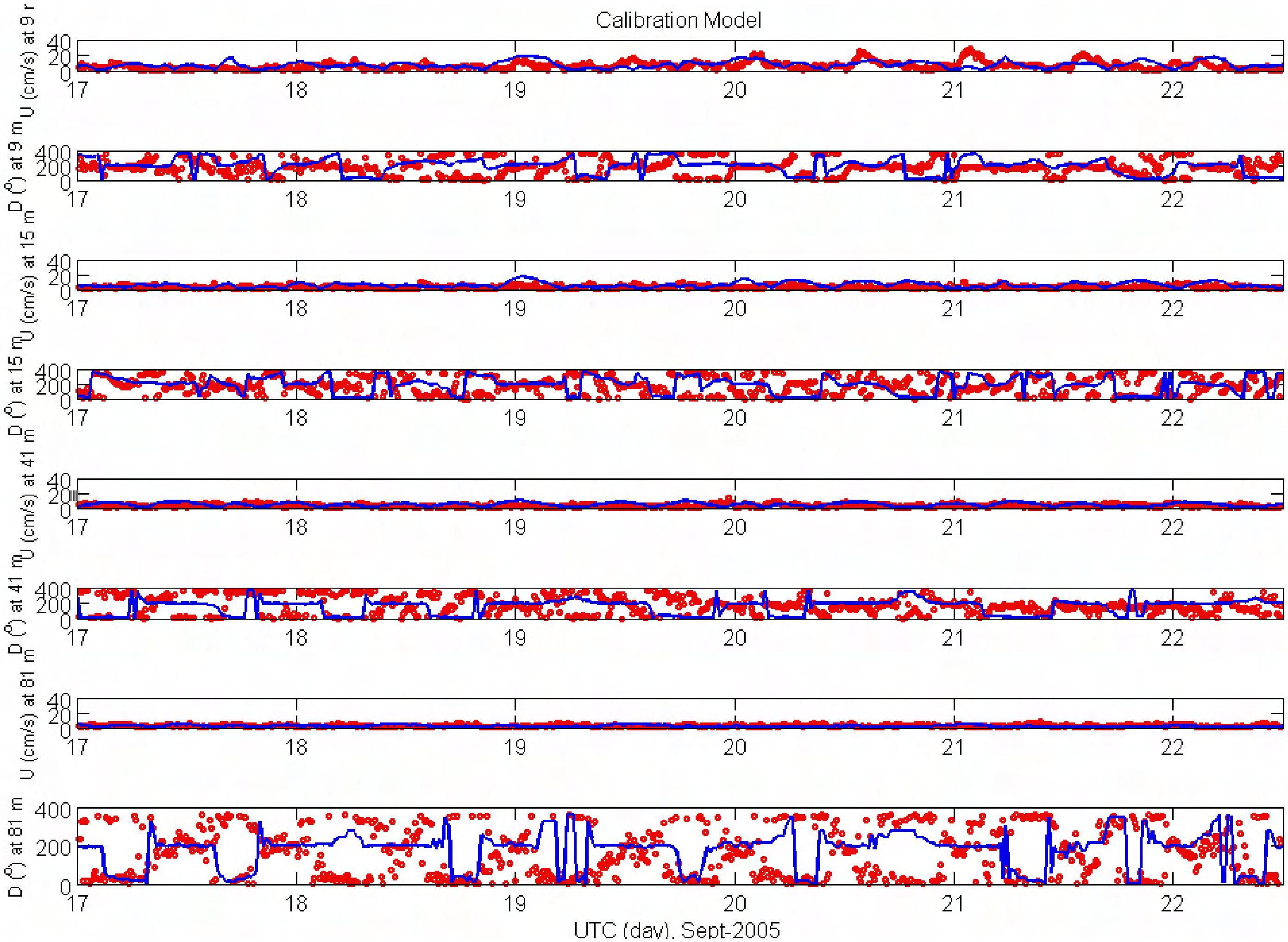

Figure 15: Along-channel flow speeds and directions for 9, 15, and 81 m depth. The red dots denote measurements, and the blue lines denote model results.

3.2.2 Summary Statistics

The mean and maximum current speeds are calculated for the calibration model run, both for the model (solid lines), and measurements (open circles) in Figure 16. Overall, there is good agreement with the mean speeds agreeing to within 3 cm/s, and the maximum speeds usually agreeing to within 5-10 cm/s. There may be a tendency for the model to underestimate the maximum, but there is no clear bias in the mean current speed.

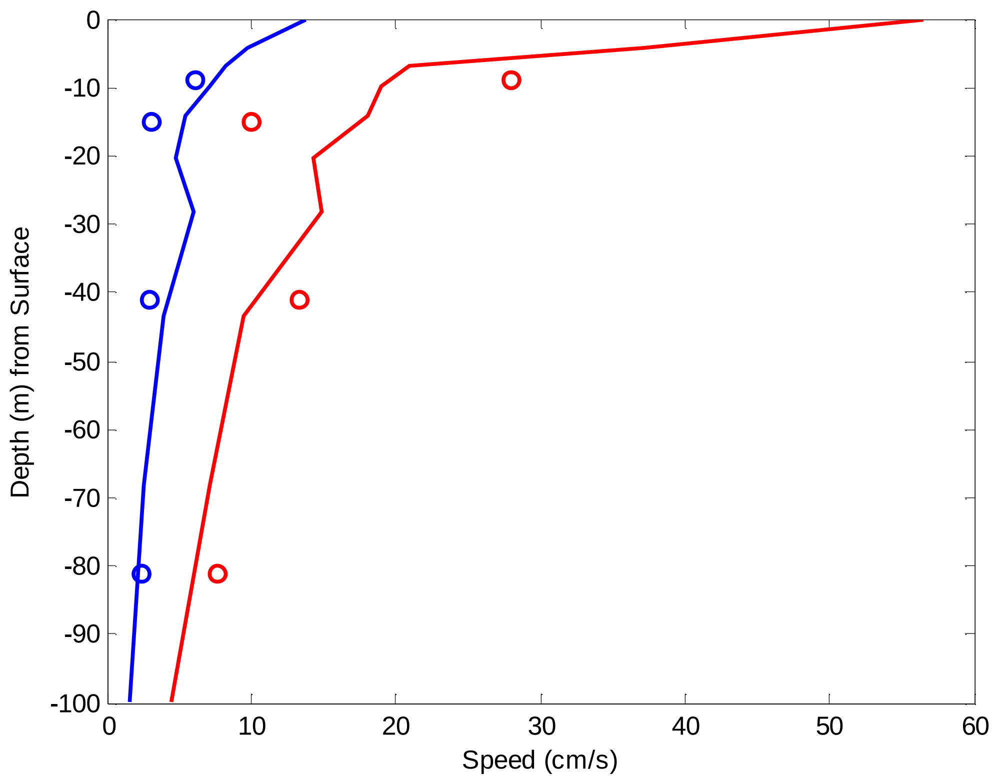

Figure 16: Mean speed (blue), and max speed (red) profiles for the model (lines) and measurements (open circles).

The vector mean current components are illustrated in Figure 17. The east component (blue) tends to be small, and the agreement tends to be limited. The sign of the north component (red) agrees at the near-surface and near-bottom, and the magnitude agrees to within 1-2 cm/s.

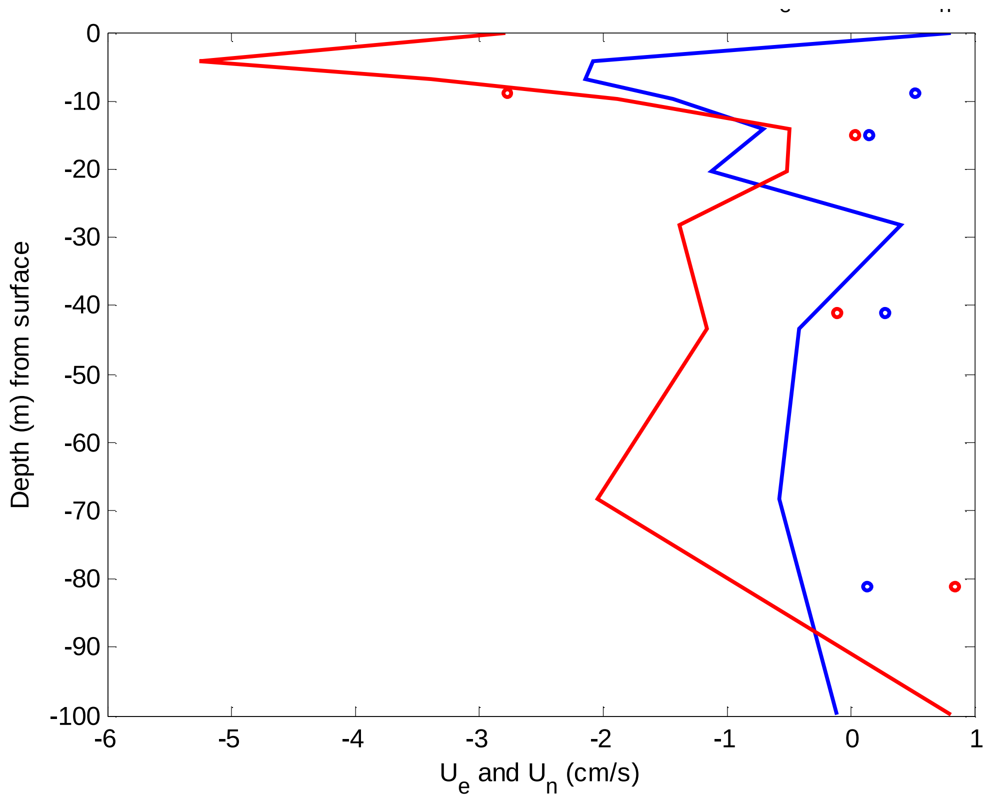

Figure 17: Vector average north velocity component (red) and east velocity component (blue) for the model (lines) and measurements (open circles).

4.0 MODEL VERIFICATION

Model calibration was carried out for January 17 to January. 27, 2006 using data collected in this period, and analyzed in GEM technical report ASL-TR-008.

4.1 Verification Model Results

4.1.1 Flows

As was the case for the calibration case, the dominant flow direction is to the south. Between the 08:00 and 11:00 measurement on January 24, a flow reversal from a flood to ebb is evident in the area of the terminal site at all depths (Figure 18, Figure 21, and Figure 24). It isn't until 20:00 (Figure 20), that the same characteristically large ebb flows which were found in the calibration model run are found again in the verification model run.

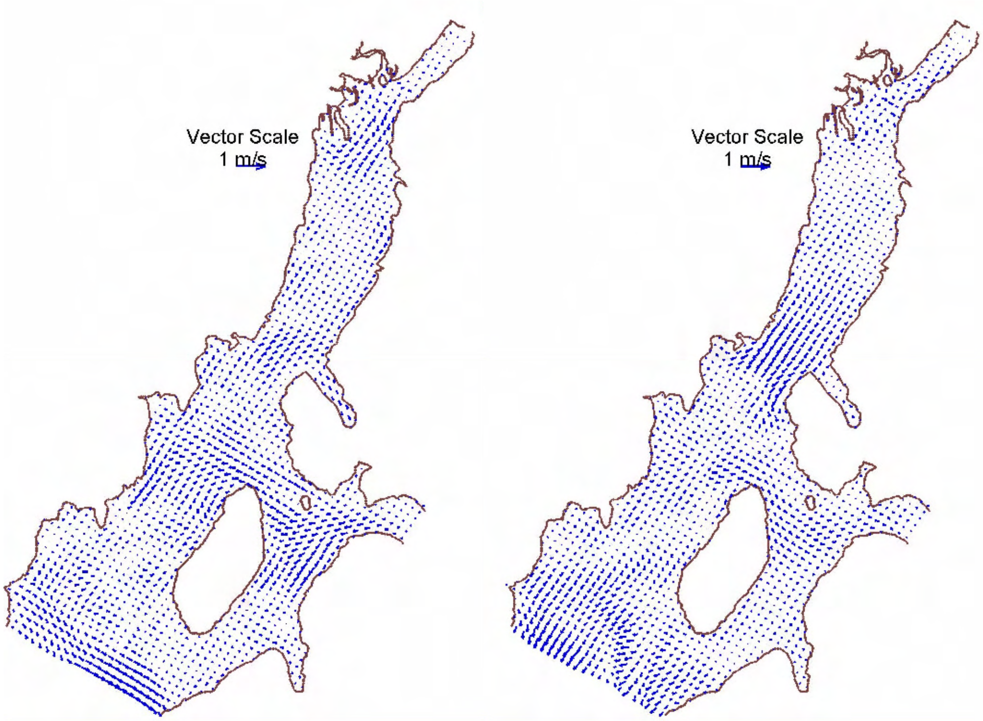

Figure 18: Surface velocities at 08:00 and 11:00 on January 24, 2006.

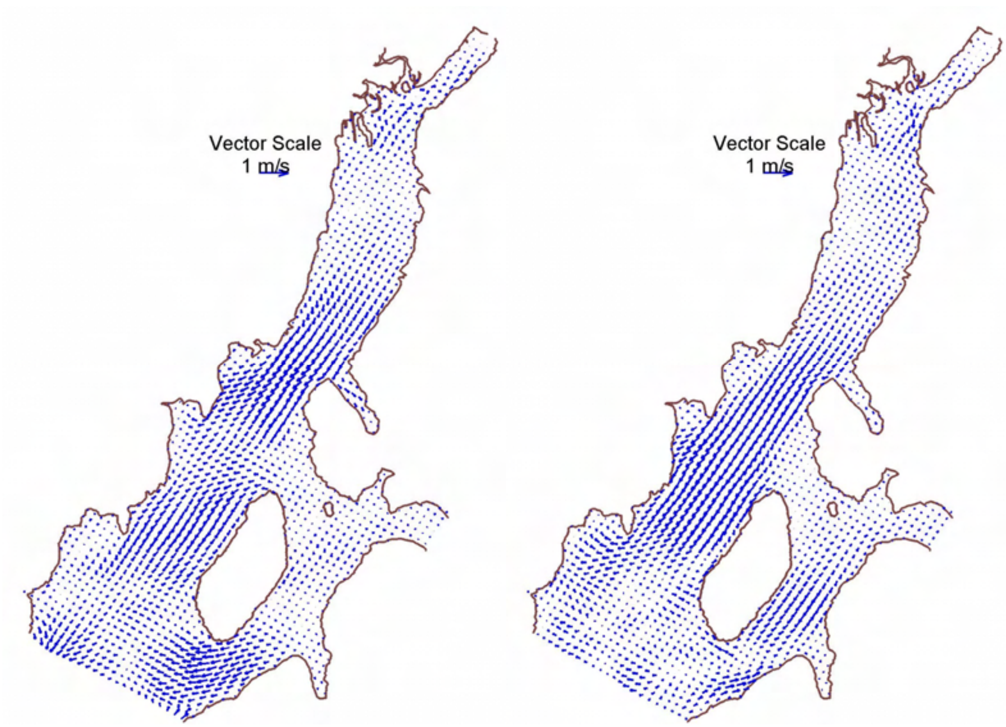

Figure 19: Surface velocities at 14:00 and 17:00 on January 24, 2006.

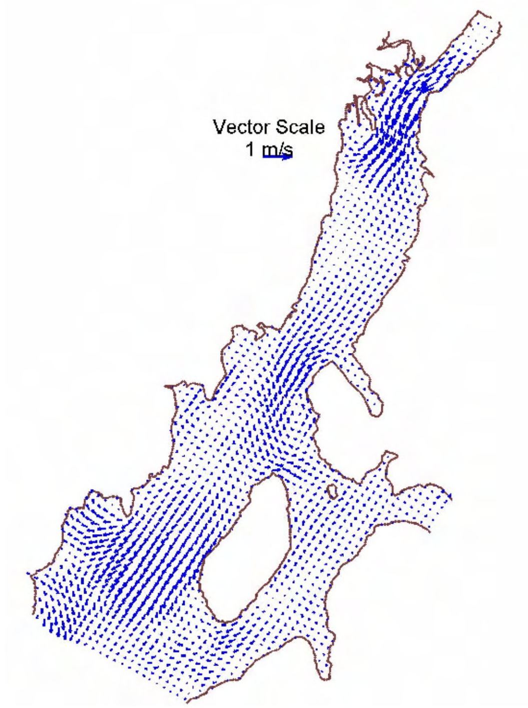

Figure 20: Surface velocities at 20:00 on January 24, 2006.

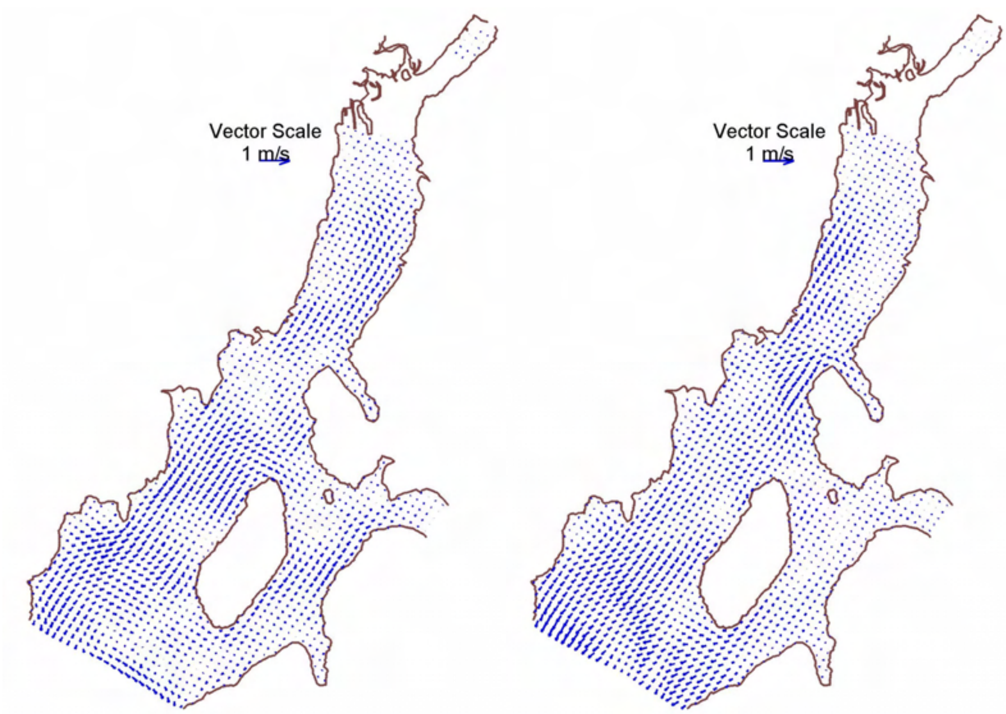

Figure 21: Velocities at 6 m depth at 08:00 and 11:00 on January 24, 2006.

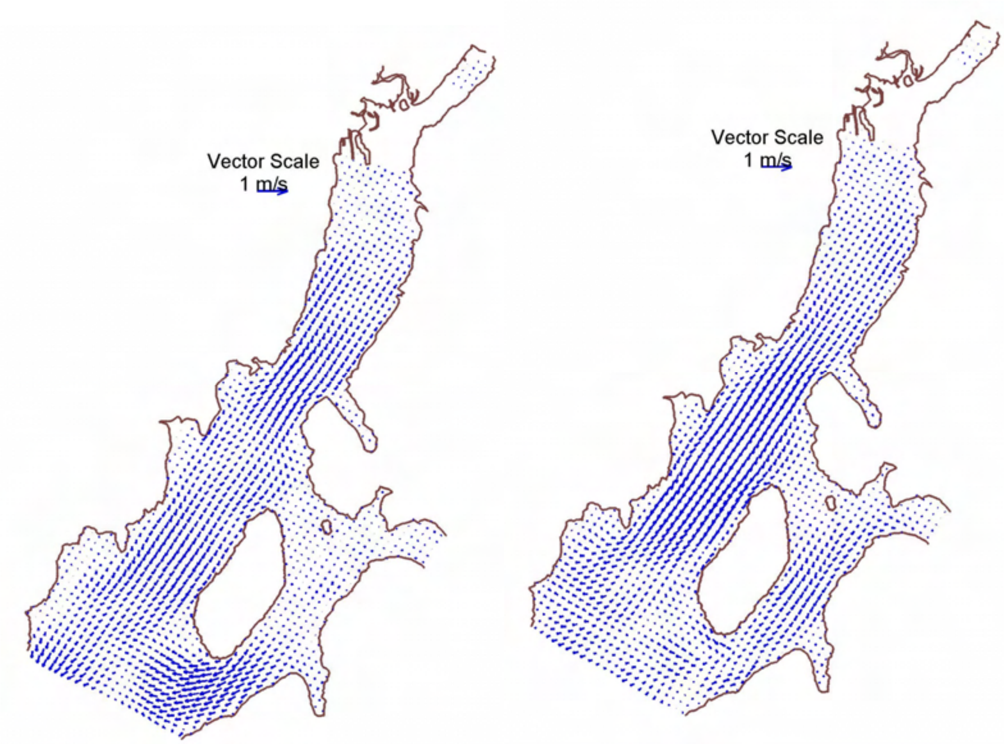

Figure 22: Velocities at 6 m depth at 14:00 and 17:00 on January 24, 2006.

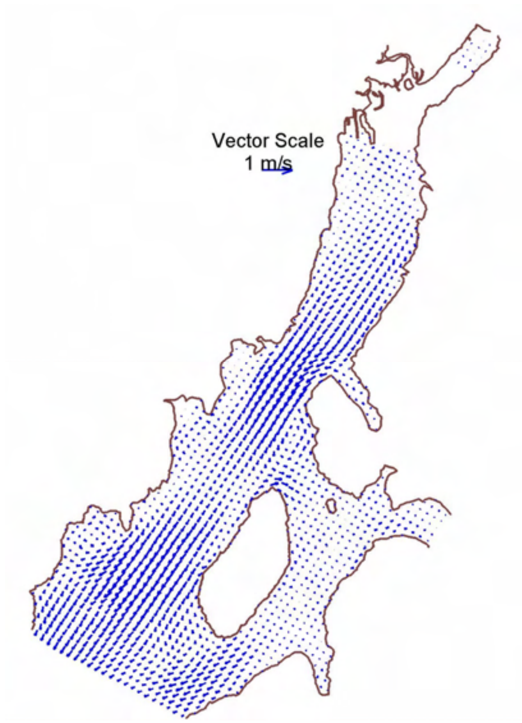

Figure 23: Velocities at 6 m depth at 20:00 on January 24, 2006.

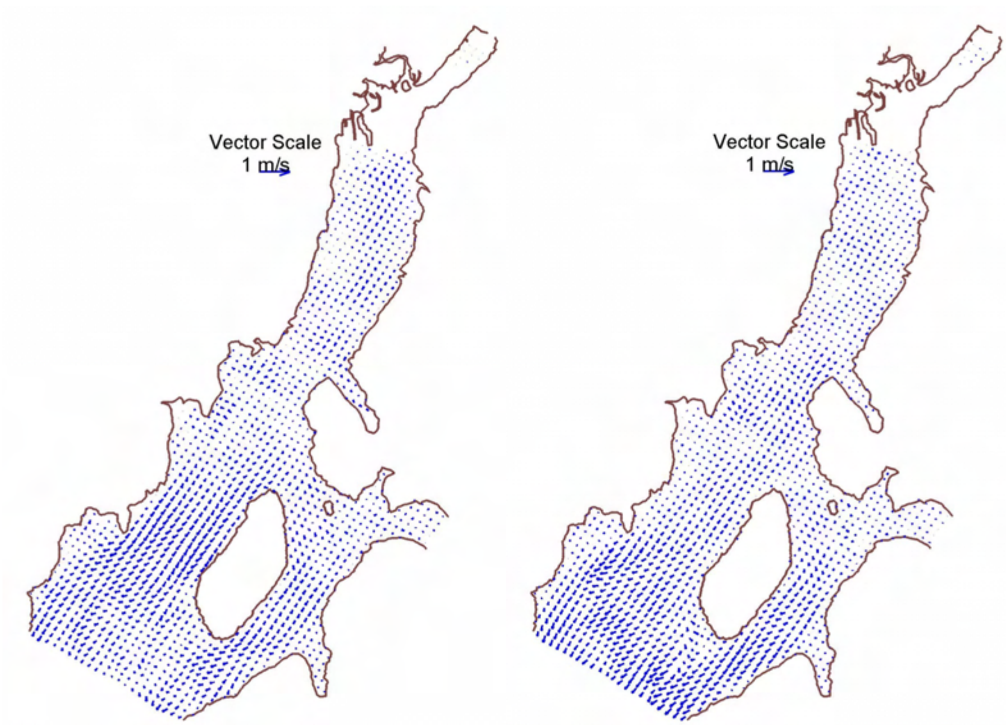

Figure 24: Velocities at 29 m depth at 08:00 and 11:00 on January 24, 2006.

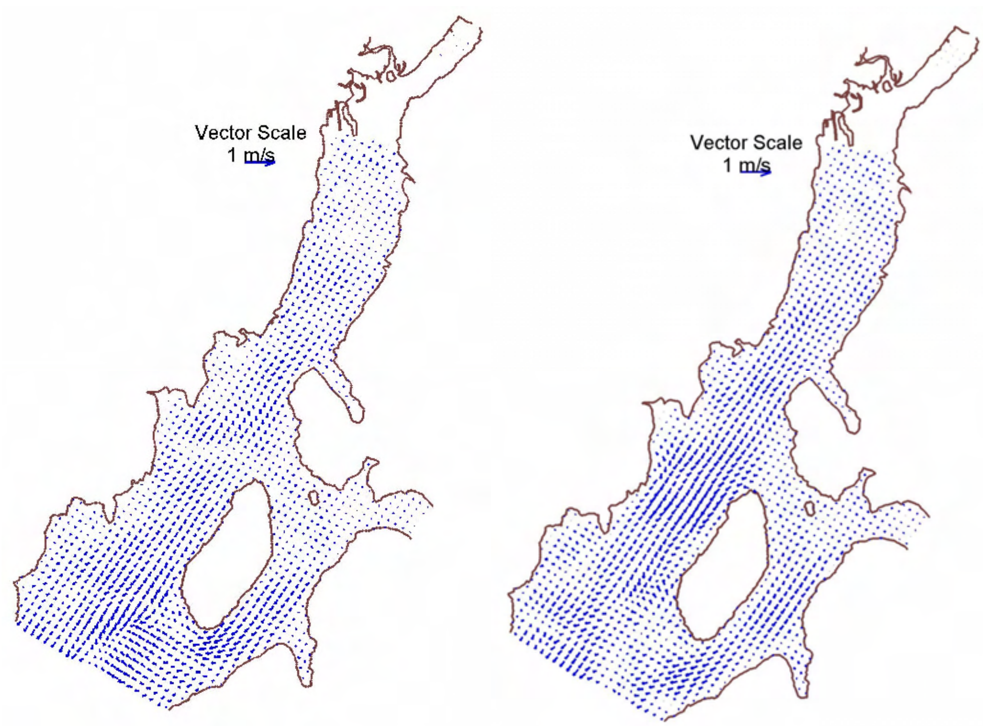

Figure 25: Velocities at 29 m depth at 14:00 and 17:00 on January 24, 2006.

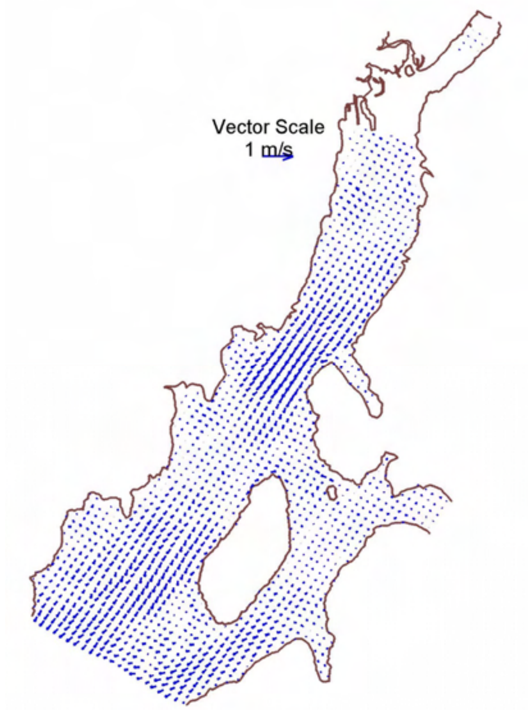

Figure 26: Velocities at 29 m depth at 20:00 on January 24, 2006.

Examination of the time series plots in Figure 27 indicates the same pattern of episodes of high speed events directed to the south. Once more the model predicts their existence, and is able to predict the timing of some of them, such as the event of January 23, but there are also examples such as the 3 large peaks starting on January 22 which the model is unable to predict.

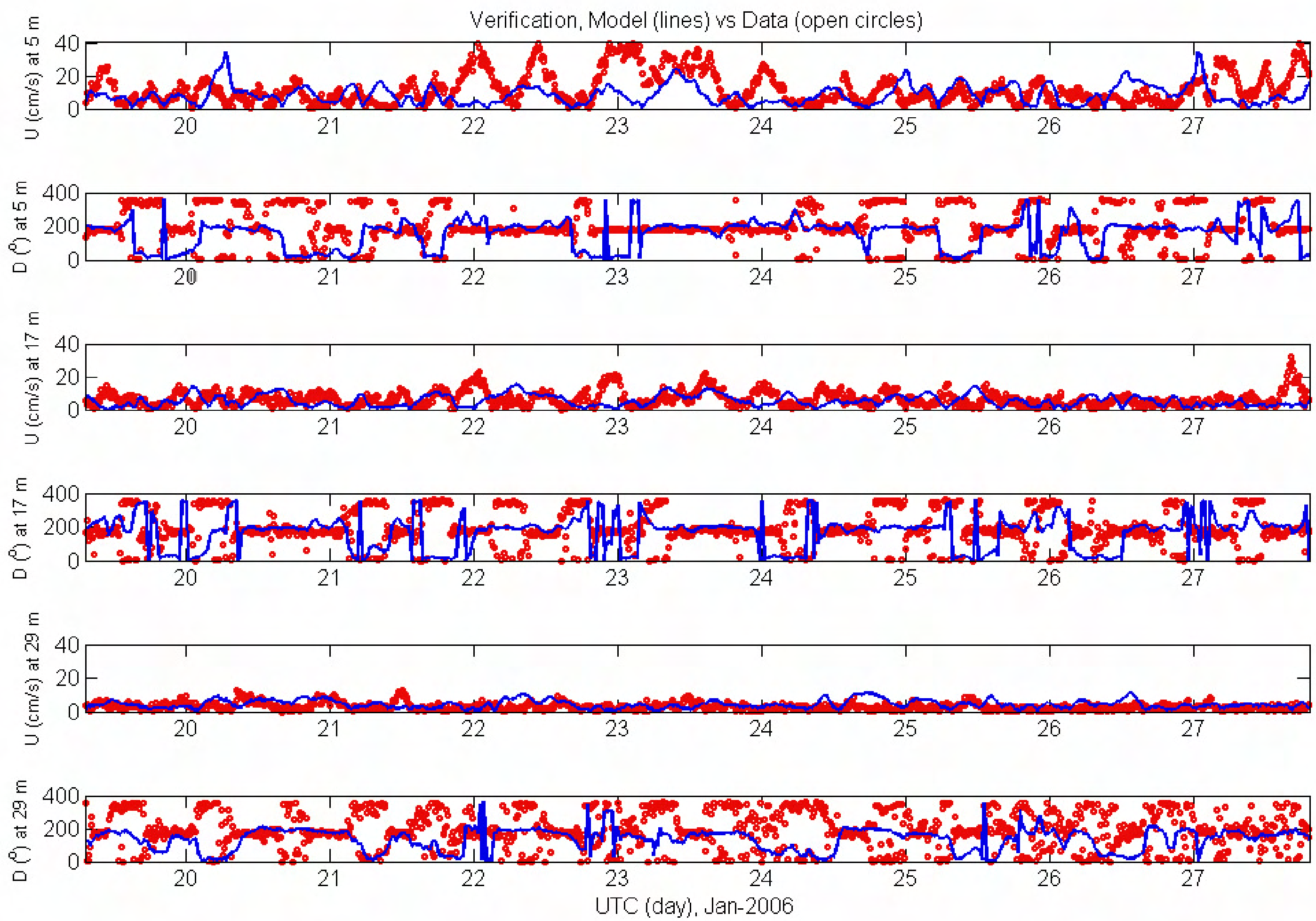

Figure 27: Along-channel flow speeds and directions for 5, 17, and 29 m depth. The red dots denote measurements, and the blue lines denote model results.

4.1.2 Summary Statistics

The mean and maximum current speeds are calculated for the validation model run, both for the model (solid lines), and measurements (open circles) in Figure 28. Overall, there is good agreement with the mean speeds agreeing to within 3 cm/s, and the maximum speeds agreeing to within 5-10 cm/s. There may be a tendency for the model to overestimate the mean, but underestimate the maximum.

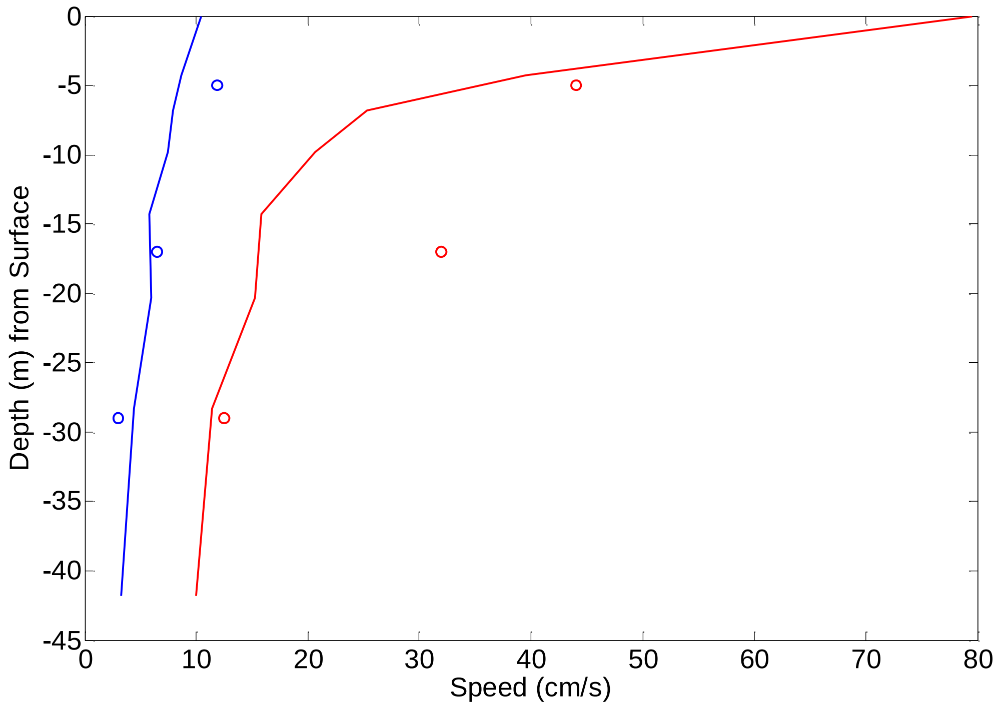

Figure 28: Mean speed (blue), and max speed (red) profiles for the model (lines) and measurements (open circles) in the verification model case.

The vector mean current components are illustrated in Figure 29. The east component (blue), tends to be small, in both the measurements and the model; however the sign of the model component is sometimes wrong. The north component (red) reflects the trend from large negative (southward) flows at the surface to small southward flows at the near-bottom. Except for the 5 m depth, the north component magnitude tends to agree to within 1-2 cm/s.

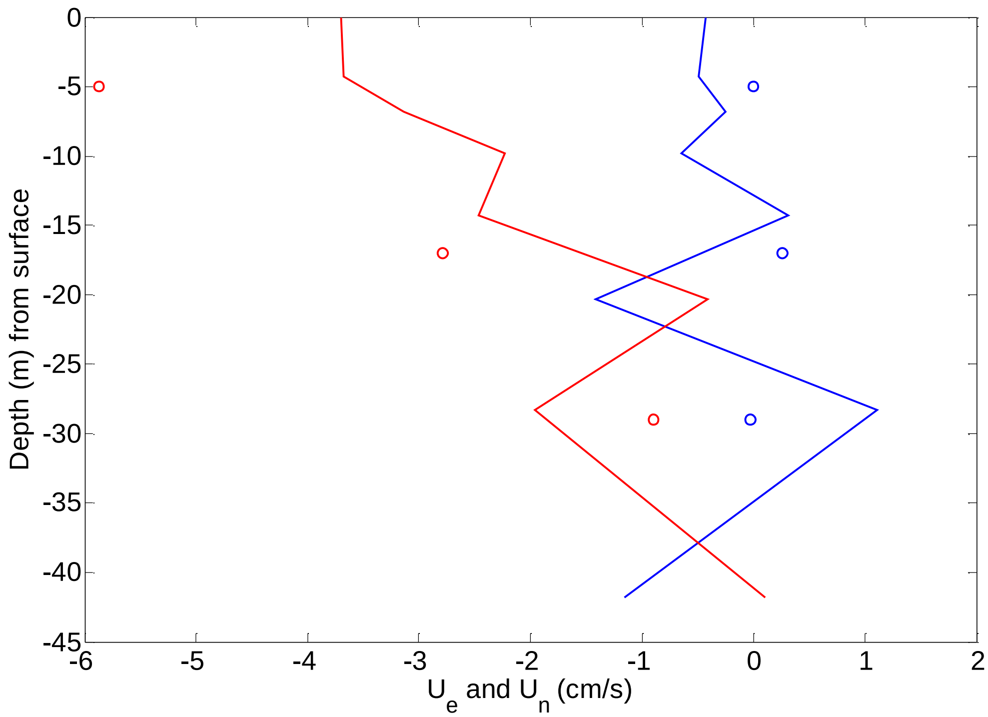

Figure 29: Vector average north velocity component (red) and east velocity component (blue) for the model (lines) and measurements (open circles) in the verification model case.

5.0 SUMMARY

6.0 LITERATURE CITED

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APPENDIX A: DETAILED DESCRIPTION OF THE COCIRM-SED MODEL

(from Jiang and Fissel, 2006)

COCIRM-SED consists of four integrated modules (Figure 1): circulation, wave, sediment transport and morphodynamics. The circulation module (COCIRM), developed over the past several years (Jiang, 1999; Fissel, et al., 2002; Jiang, et al., 2003; Jiang and Fissel, 2004), represents a computational fluid dynamics approach to the study of river, estuarine and coastal circulation regimes. The wave module is an adaptation of the third generation, nearshore transformation spectral wave model, SWAN, developed by the Delft University of Technology. The sediment transport model involves the dynamics of cohesive and non-cohesive sediment based on multiple size classes. The morphological module solves the bottom elevation variations due to sediment deposition and erosion over different periods. The model explicitly simulates such natural forces as pressure heads, buoyancy or density difference due to salinity, temperature and suspended sediment, river inflow, meteorological forcing, and bottom and shoreline drag. The model applies the fully three-dimensional basic equations of shallow water hydrodynamics and conservative mass transport combined with a second order turbulence closure model (Mellor and Yamada, 1982), where the pressure is simply assumed hydrostatic, then solves for time-dependent, three-dimensional velocities, salinity, temperature, suspended sediment concentrations and coarse sediment bed-loads by size category, turbulence kinetic energy and mixing length, horizontal and vertical diffusivities, water surface elevation, 2D wave spectra, wave forces, and bottom elevation variations.

A semi-implicit finite difference method is applied in COCIRM-SED. This numerical solution has the advantage of good stability. The stable time step, *dt*, is only restricted by horizontal diffusivity as follows (Casulli and Cheng, 1992)

$$dt \le \mathrm{MIN}\left[2(A_x,\quad A_y)\left(\frac{1}{dx^2}+\frac{1}{dy^2}\right)\right]^{-1} \qquad (1)$$

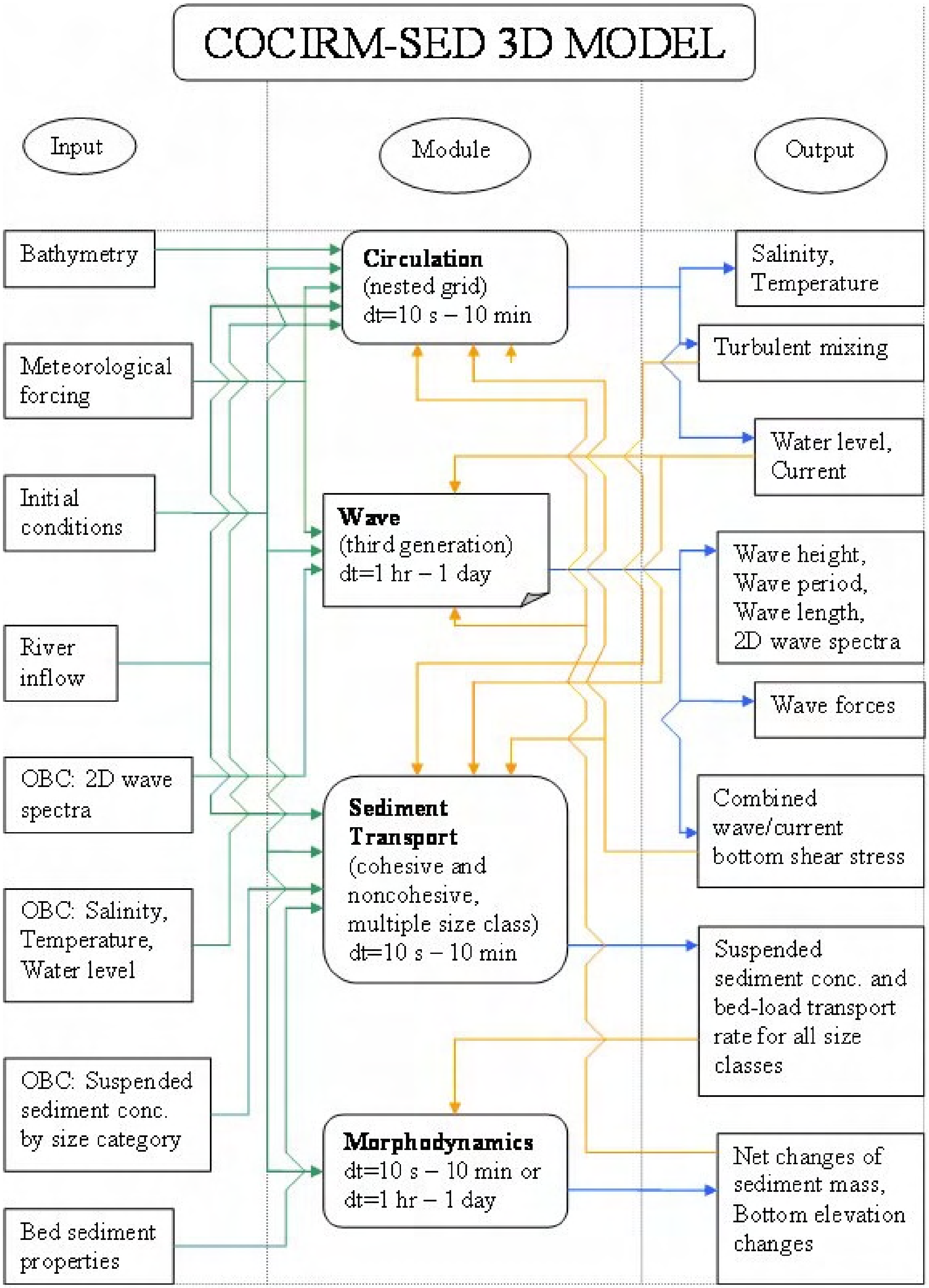

Figure 30: Schematic Diagram of COCIRM-SED system.

where A_x and A_y are respectively horizontal diffusion coefficients in x- and y-directions, and *dx* and *dy* are spatial grid sizes in x- and y-directions, respectively. Evidently, when $A_x = A_y = 0$, this scheme becomes unconditionally stable. The model is incorporated with a drying/wetting scheme and is capable of modeling circulation, wave and sediment dynamics over intertidal zones. By using a fully dynamic and two-way connection nested grid approach (Jiang, et al., 2003), the model also allows a high grid resolution refinement, up to a factor of 1/20, in particular area of interest to coastal engineering project and having high resolution demand. The horizontal grid sizes are typically in the range of 5 m to 1,000 m. The vertical sigma-grid may be distributed evenly or with log-resolution near surface and bottom and linear in between, with typically 10 – 20 layers.

To activate the sediment transport and morphological modules, one need only input the grain size (d_k) and percentage fraction (f_k) for each sediment category, with a typical total number of categories 5 – 20. COCIRM-SED readily simulates settling velocities (w_k), suspended sediment concentration (c_k), bed-load rates ($S_{b,k}$), and bottom elevation changes by size category. For fine-grained sediments with particle size less than 32 – 62 μm (clay – silt range), modeling of cohesive sediment transport will be involved, while for coarse sediments with particle size greater than 32 – 62 μm (sand, granule and fine pebble), modeling of non-cohesive sediment transport will be activated.

For cohesive sediments, bottom deposition, D_k (Krone, 1962), erosion, E_k (Parchure and Mehta, 1985), and settling velocity, w_k (Mehta and Li, 1997) are given by

$$D_k = w_{s,k} c_k H\left[1 - \frac{\tau_{cw}}{\tau_d}\right]\left(1 - \frac{\tau_{cw}}{\tau_d}\right) \qquad (2)$$

$$E_k = f_k M_{\max} \exp(-\chi \tau_e{}^{\lambda}) H[\tau_{cw} - \tau_e](\tau_{cw} - \tau_e) \qquad (3)$$

$$w_{s,k} = \left[\frac{a c_k{}^{\alpha}}{(c_k{}^2 + b^2)^{\beta}}\right]\left[\frac{\rho_{s,k} / \rho(\theta, s, c) - 1}{1.65}\right]\left[\frac{10^{-6}}{\upsilon(\theta, c)}\right] F(\theta) \qquad (4)$$

where *H*[-] is a heavyside function which becomes zero if the quantity inside the square brackets becomes negative, otherwise is equal to one, τ_{cw} is the bottom shear stress due to current and wave (Grant and Madsen, 1979), τ_d is the critical shear stress for deposition, which is taken as 0.1 N/m^2 (Krone, 1962), τ_e is the critical shear stress for erosion, $M_{\max}$ is the maximum erosion constant at $\tau_{cw} = 2\tau_e$, χ, λ, a, b, α and β are the sediment-dependent empirical coefficients, θ is the temperature, $\rho_{s,k}$ is the sediment granular density of kth sediment, ρ(θ,s,c) is the temperature, salinity and sediment dependent fluid density, $\upsilon(\theta, c)$ is the temperature and sediment dependent fluid viscosity, and $F(\theta)$ is the temperature effect function on flocculation, $F(\theta)$=1.777-0.0518θ, for θ=0–30 °C (Jiang, 1999). Two types of cohesive sediment beds are classified, namely newly-deposited and fully-consolidated beds. The newly-deposited bed goes through consolidation process (Toorman and Berlamont, 1993), while the dry weight for the fully-consolidated bed is simply computed using empirical profile formula. The shear strength of the bottom cohesive sediments is then calculated in terms of solid weight fraction as follows (Mehta, 1991).

$$\tau_e = \tau_{e0} + \alpha_1(\phi - \phi_c)^{\beta_1} \qquad (5)$$

where τ_{e0} is the shear strength for newly deposited sediment, α_1 and β_1 are sediment-dependent coefficients, ϕ is the solid weight fraction ($= c_k / \rho_{s,k}$), ϕ_c is the critical solid weight fraction below which mud has a fluid-like consistency.

For non-cohesive sediments, the effect of particle interaction on settling velocities is considered as follows

$$w_k = \left(1 - \frac{c}{\rho_{s,k}}\right)^4 w_{k0} \qquad (6)$$

where c is the total suspended sediment concentration, and w_{k0} is the free settling velocity. By assuming spherical particles, the Stokes law is a fairly good approximation of free settling velocity with Reynolds number Re < 0.5 ($\mathrm{Re} = w_{k0} d_k / \upsilon$). For higher Reynolds number, the effects of inertia and virtual mass have to be accounted for. Due to the effect of flow separation behind the falling particle, the value of the drag coefficient depends strongly on the level of free stream turbulence, apart from turbulence caused by the particle itself. In this case, the formulas reported in van Rijn (1984a) are applied. Two separated parts are involved in coarse sediment transport, namely suspended-load and bed-load. The formulas introduced in van Rijn (2000) are used for calculating the bed-load transport rates. For suspended-load transport, the bottom sediment re-suspension and deposition are given by

$$E_k = c_{a,k}\left(\frac{K_v}{\Delta z}\right)$$
$$D_k = c_{1,k}\left(\frac{K_v}{\Delta z} + w_k\right) \qquad (7)$$

where K_v is the vertical diffusion coefficient at the bottom of the lowest σ-layer, which is derived from the second order turbulence closure model, Δz is the vertical distance from the reference level a to the center of the lowest σ-layer, $c_{1,k}$ is the kth sediment concentration at lowest σ-layer, and $c_{a,k}$ is the sediment reference concentration at the reference level *a*, which is determined from (van Rijn, 1984b)

$$c_{a,k} = 0.015 f_k \eta_k \rho_{s,k} \frac{d_k^{0.7}}{a} \frac{\left[(u_* / u_{*,k})^2 - 1\right]^{1.5}}{\left[(\rho_{s,k} / \rho - 1) g / \upsilon^2\right]^{0.1}} \tag{8}$$

where η_k is the user-specified calibration parameter for k^th^ sediment, u_* is the shear velocity due to current and wave, g is the gravitational acceleration, and $u_{*,k}$ is the critical shear velocity for incipient motion of k^th^ sediment. In determining $u_{*,k}$, the hiding and exposure factor of non-uniform coarse sediment bed is taken into account due to the work by Wu, et al. (2000) as follows

$$u_{*,k} = \left[\left(\frac{\rho_{s,k}}{\rho} - 1\right) g d_k \vartheta_c \left(\frac{p_{h,k}}{p_{e,k}}\right)^m\right]^{0.5} \tag{9}$$

where ϑ_c is the non-dimensional critical shear velocity corresponding uniform sediment or the mean size of bed materials, m is the empirical constant (≅0.6), and $p_{h,k}$ and $p_{e,k}$ are respectively the total hidden and exposed probabilities of k^th^ non-cohesive sediment.

In the morphological module, an acceleration factor, f_m (≥1.0), is introduced in dealing with time scale difference between hydrodynamics and morphodynamics. The bottom elevation changes at any model grid cell (i,j) is given by

$$\Delta h_{i,j} = \sum \left[(\Delta S_{bed})_{i,j} + (\Delta S_{sus})_{i,j}\right] f_m dt \tag{10}$$

where $(\Delta S_{bed})_{i,j}$ is the ratio of bed-load rate net change into or out off the model grid cell (i,j) to the dry weight of bottom sediment, $\rho_{d,k}$, and $(\Delta S_{sus})_{i,j}$ is the ratio of net bottom erosion and deposition to the dry weight of bottom sediment, and is determined by

$$(\Delta S_{sus})_{i,j} = \sum_{k=1}^{K} \frac{(D_k - E_k)_{i,j}}{\rho_{d,k}} \tag{11}$$

where *K* is the total number of sediment fractions.

Module Integration and Coupling

COCIRM-SED was developed in a fashion that carefully integrates and couples sub-modules together within the same computational framework, except the wave module SWAN, which runs externally (Figure 1). Changes in wave conditions occur over time scales of hour to days while circulation and sediment dynamics can have shorter time scales, and moreover, modeling spectral wave transformations has a very high demand on computer physical memory. It is hence more economic and efficient to run the wave model SWAN externally and input the simulated wave parameters (e.g., wave forces, significant wave height, wave period, wave length and wave direction) into COCIRM-SED. At every time step, COCIRM-SED interpolates wave parameters from the output of SWAN, and inputs them to other modules. The buoyancy effects due to salinity, temperature and suspended sediments on the circulations are all taken into account, and the state function of the bulk density of water is read as follows

$$\rho(\theta, s, c) = \rho_0(\theta, s) + \sum_{k=1}^{K}\left(1 - \frac{\rho_0(\theta, s)}{\rho_{s,k}}\right)c_k \qquad (12)$$

where $\rho_0(\theta, s)$ is water density under the effect of salinity and temperature. The feedback of morphodynamics to other physical processes is made possible by changing the bottom elevation derived from Eq. (10) at every time step.

APPENDIX B: DETAILS OF STFATE PARAMETERS USED

A brief description of the methods used in STFATE is presented in section C2 of US EPA and USACE (1991). In this appendix, the parameter values which were used are tabulated.

Table 2: List of STFATE material parameters.

	specific. gravity	volume fraction	Fall vel (ft/s)	Deposit void ratio	Critical Shear Stress (lb/ft^2)	Cohesive (Y/N)	Stripped during Descent (Y/N)
silt	2.65	0.264	0.010	4.5	0.0085	Y	Y
clay	2.65	0.216	0.002	7.5	0.0038	Y	Y
clumps	1.60	0.520	3.000	0.4	0.0200	N	N

Table 3: List of additional STFATE parameters. All default values were used.

Coefficient	Value
Settling Coefficient	0.000
Apparent Mass Coefficient	1.000
Drag Coefficient for a Sphere	0.500
Form Drag for Collapsing Cloud	1.000
Skin Friction for Collapsing Cloud	0.010
Drag for an Ellipsoidal Wedge	0.100
Drag for a Plate	1.000
Friction Between Cloud and Bottom	0.010
4/3 Law Horiz. Diff. Dissip. Factor	0.001
Unstratified Water Vert. Diff. Coeff.	0.025
Ratio – Cloud/Ambient Density Gradients	0.250
Turbulent Thermal Entrainment	0.235
Entrainment in Collapse	0.100
Stripping Factor	0.003

Spatial Distributions of Suspended Sediment Concentrations and Sediment Deposition From Marine Terminal Dredging Operations

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Executive Summary

As part of the Enbridge Gateway Project, a major marine terminal is proposed for the northwest coastline of Kitimat Arm (Figure 1). As an input to the assessment of potential environmental effects of the project, the 3D coastal circulation and sediment model, COCIRM-SED, was used for computing suspended sediment concentrations (TSS) and deposition of sediments in Kitimat Arm resulting from dredging operations at the Enbridge Gateway Marine Terminal.

The COCIRM 3-D numerical circulation model has been widely used in coastal ocean and river applications over the past several years. A realistic numerical model domain was created for the full area of Kitimat Arm as well as Kildala Inlet. The model domain has a total length of 29.8 km and a width of 11.8 km. In the horizontal, the model has grids of size 100 m by 100 m over the full domain, and within 2 km of the marine terminal area, a high resolution nested grid of 20 m by 20 m is used. The model has 20 layers in the vertical spanning water depths to from the surface to 360 m. The model was used to compute the currents with forcing at the open boundary using tidal heights measured in March 2006 as well as with measured winds and river runoff. The release of sediments to the ocean during dredging operations is taken to be 1% of the total dredged sediments which is expected to require about 14.7 days of continuous operations. The distribution of the released sediments is taken from laboratory analyses of bottom sediment samples collected for the Gateway project. The 3-D model was calibrated and validated using Gateway measurements made from January to April 2006.

The model simulations of total suspended sediment (TSS) concentrations from the dredging operation indicates that TSS values are low at the surface being generally less than 0.25 mg/l except in the immediate vicinity of the dredging barge with a maximum TSS value is 2.7 mg/l. Naturally occurring TSS values fall in this same range of values or are higher during major river freshet events. At depths of 10 to 20 m, the area with TSS values exceeding 2.5 mg/l are confined to areas within 200 m of the dredging location, with peak values at the dredging barge of up to 58 mg/l. A very diffuse sediment plume having TSS values of 0.25 to 2.5 mg/l occurs as a band of approximately 300 m width extending up to 3 km along the coastline. This diffuse band of sediments would be difficult to detect as the naturally occurring TSS values are comparable in magnitude. The TSS values are generally reduced at greater depths, although TSS concentrations of 0.25 to 2.5 mg/l are computed for depths of 50-70 m after 7 days of dredging operations as the finer silt and clay particles slowly descend to the bottom. The area of this diffuse plume extends over distances of 2 km along the coast and up to 1 km from the coast.

The model was used to compute the total deposition of the sediment released during dredging operations. The maximum thickness of deposited sediments is 1.1 cm and generally much less than this. The area of sediment deposition with a thickness exceeding 0.1 cm is largely confined to the immediate zone of dredging activities. Outside of this disturbed area, the amount of deposition is less than 0.1 cm and typically much less at 0.0025 to 0.05 cm.

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1. Project Overview and Objectives

1.1 Project Overview and Background

As part of the Enbridge Gateway Project, a major marine terminal will be constructed along the northwest coastline of Kitimat Arm (Figure 1). As an input to the assessment of potential environmental effects of the project, the 3D coastal circulation and sediment model, COCIRM-SED, was used for computing suspended sediment concentrations (TSS) and deposition of sediments in Kitimat Arm resulting from dredging operations at the Enbridge Gateway Marine Terminal.

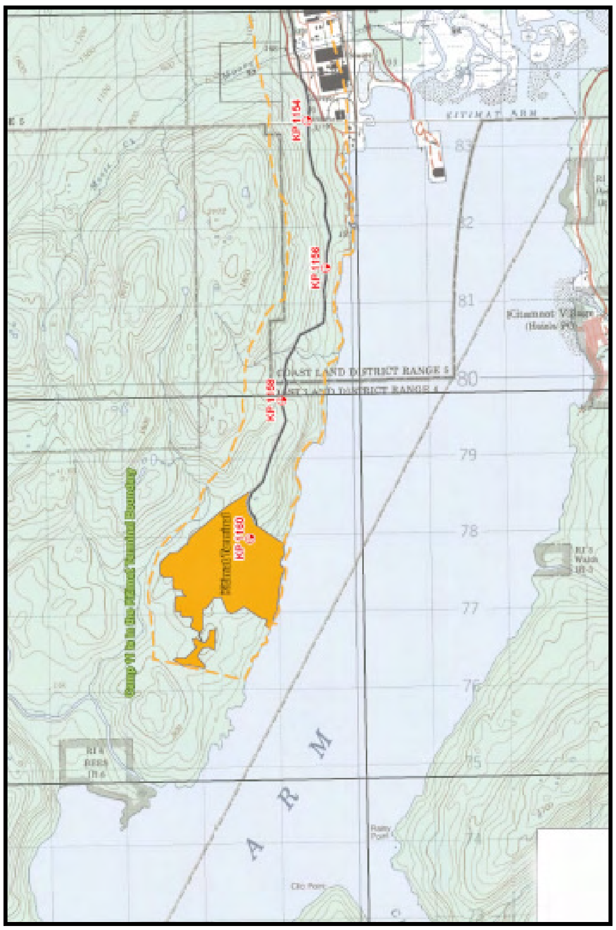

Figure 1: Map of Kitimat Arm showing the area of the Marine Terminal Area and Tank Farm (in orange).

In this report, we present the results of the numerical modeling simulations of suspended sediment concentrations as well as the estimated levels of deposition of the sediments back to the seabed. The report also describes the COCIRM-SED numerical model itself and the manner in which project activities were represented in the numerical modeling simulations.

2. Numerical Modeling Methods

2.1 ASL-COCIRM-SED Basic Description and Previous Applications

ASL COCIRM-SED integrated modeling approach involves application of ASL's fully 3-D coastal circulation model (COCRIM), combined with Delft Hydraulic's SWAN model for waves and ASL's own sediment transport and morphodynamics modules (Jiang and Fissel, 2006). ASL-COCIRM uses σ-transform, and second order turbulence closure. It solves for the time-dependent, three-dimensional velocities (u, v, w), temperature (T), salinity (s), suspended sediment concentration (TSS), contaminant concentration (C) as well as water surface elevation (ζ) (Jiang, 1999). It also includes the use of multiple particle sizes for sediment dispersal and deposition processes, wetting/drying and nested sub-grid schemes, capable of incorporating tidal flats, jet-like flows and relatively small interested areas. Grid sizes can range from <10 m to kilometers in size. The sediment transport and morphodynamics modules within COCIRM-SED follow the accepted practices and understandings of sediment dynamics as derived from the current scientific and engineering publications. These modules operate as subroutines and functions within the COCIRM model. The basis of the COCIRM application to sediment transport is based on extensive previous work in this application area (Jiang et al, 2004; Jiang and Mehta, 2000).

The COCIRM 3-D numerical circulation model has been widely used in coastal ocean and river applications over the past several years, including recent projects involving environmental assessment issues:

- numerical modeling of cooling water recirculation at Burrard Thermal Generating Station for BC Hydro, which involved modeling of the extensive tidal flats at the eastern end of the Arm (Jiang et al., 2003; Jiang and Fissel, 2004);
- high resolution model of three dimensional flows, water levels and temperatures at the confluence of the Columbia and Pend d'Oreille Rivers, for the Waneta Expansion Project presently under review by the BC EAO (Fissel and Jiang, 2002);
- numerical modeling of tidal currents and water properties in Canoe Pass and Discovery Passage off Northern Vancouver Island (2005) (Jiang and Fissel, 2005);
- high resolution modeling of currents and suspended sediment concentrations and depositions at four landing sites for underwater electrical cables to be installed by the British Columbia Transmission Corp. across the southern Strait of Georgia and Trincomli Channel (in progress).

2.2 ASL-COCIRM-SED Implementation for VITR Landing Sites Modeling

A realistic numerical model domain was created for the full area of Kitimat Arm as well as Kildala Inlet (Figure 2). The model domain has a total length of 29.8 km and a width of 11.8 km. In the horizontal, the model has grids of size 100 m by 100 m over the full domain, and within 2 km of the marine terminal area, a high resolution nested grid of 20 m by 20 m is used

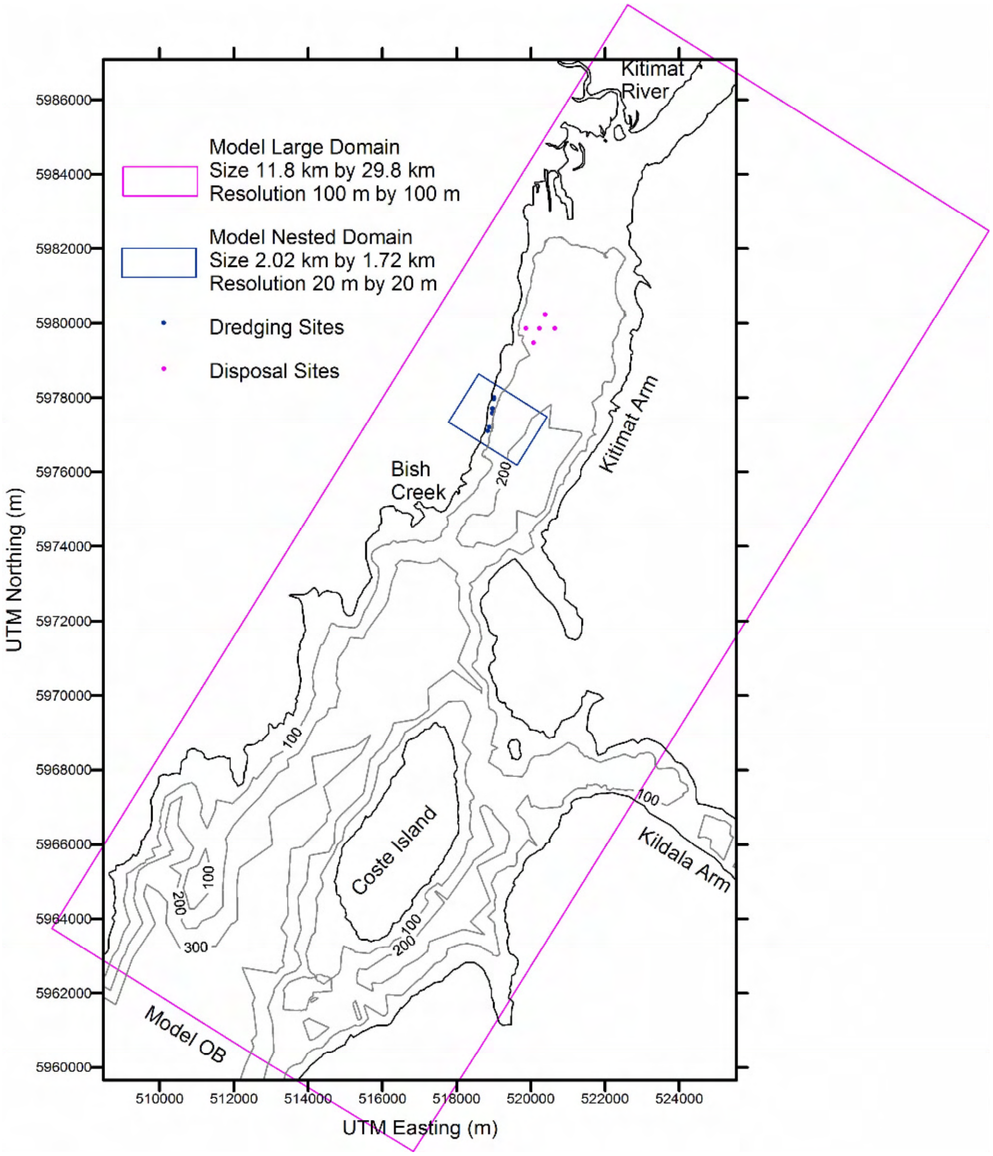

Figure 2: The model domain for Kitimat Arm. Also show is the bathymetry, reduced to the lowest normal tide (chart datum, used by the model.

In the vertical, the model represents the water column is represented as 20 vertical z-coordinate layers before chart datum (Table 1) are unevenly distributed in order to allow more realistic representation of depths in the marine dredging area and the upper layer where velocities have larger vertical gradients. There is also one layer above chart datum which is used to represent the variability of water levels due to the tides and other forcing conditions.

Table 1: The vertical layer depths (at bottom of layer) and thickness of each layer for the dredging and calibration/verification models, and for the disposal models.

Cal/Ver (m)	Thickness (m)
2	2
4	2
7	3
10	3
13	3
16	3
20	4
25	5
30	5
40	10
50	10
70	20
100	30
140	40
180	40
220	40
260	40
310	50
360	50

Water depths are represented in the model on the scale of the horizontal grid dimensions. The water depths were obtained from digital versions of the Canadian Hydrographic Service Nautical chart numbers 3736 and 3743.

<u>Model Forcing, Calibration and Validation</u>

The model circulation results from (a) the tidal and other forcing through time varying water levels on the open southern boundary of the model domain, derived from measurements made for the Enbridge Gateway project (see appendices A.7 and A.8 in GEM ,2006) (b) wind measurements from Environment Canada's Nanakwa Shoal buoy and from river runoff through the Kitimat River at the northern open boundary of the model domain and through discharges representing outflows through Bish Creek, Jesse Lake and Kildala Arm. Initial temperature, salinity and density distributions within the model domain and along its open southern boundary are derived from oceanographic data collected for this project in April 2006 (Appendix A.8 in GEM, 2006).

Measurements of ocean currents made near the terminal site were used to calibrate and validate the 3-D numerical simulations of circulation made by the model. For more details on the 3-D numerical model and its calibration and verification, please see the companion report (Fissel et al., 2006).

The model is operated on computation time step corresponding to 15 s in real-world time. For this purposes of modeling simulations of the fate of the sediments released in dredging, the 3-D numerical model was operated for a period of 7 full days, for the period of March 10 to 16, 2006. Dredging model activities were simulated at six individual locations for one-half of the total duration at the planned dredging activity as summarized in Table 3. The total computer time to run the model on a very fast PC Windows computer is approximately 3 days.

3. Project Information As Represented in the Model

3.1 Dredging Activities at Enbridge Gateway Marine Terminal

The model based simulations of TSS are derived from Marine Terminal Project Description in Volume 6. Dredging will be conducted within the 8 week period from Feb. 11 to Apr. 4, 2008. The dredging will take place at each of the two tankers berths (oil berth and condensate berth) in the amount of 7,200 m3 per berth as well as a smaller volume of 725 m3 at the construction berth (see Figure 1). The area of the dredging at each of the major berths is approximately 32 m by 150 m to a depth of 1.5 m. The dredging operations will be conducted in water depths ranging from 10 to 30 m.

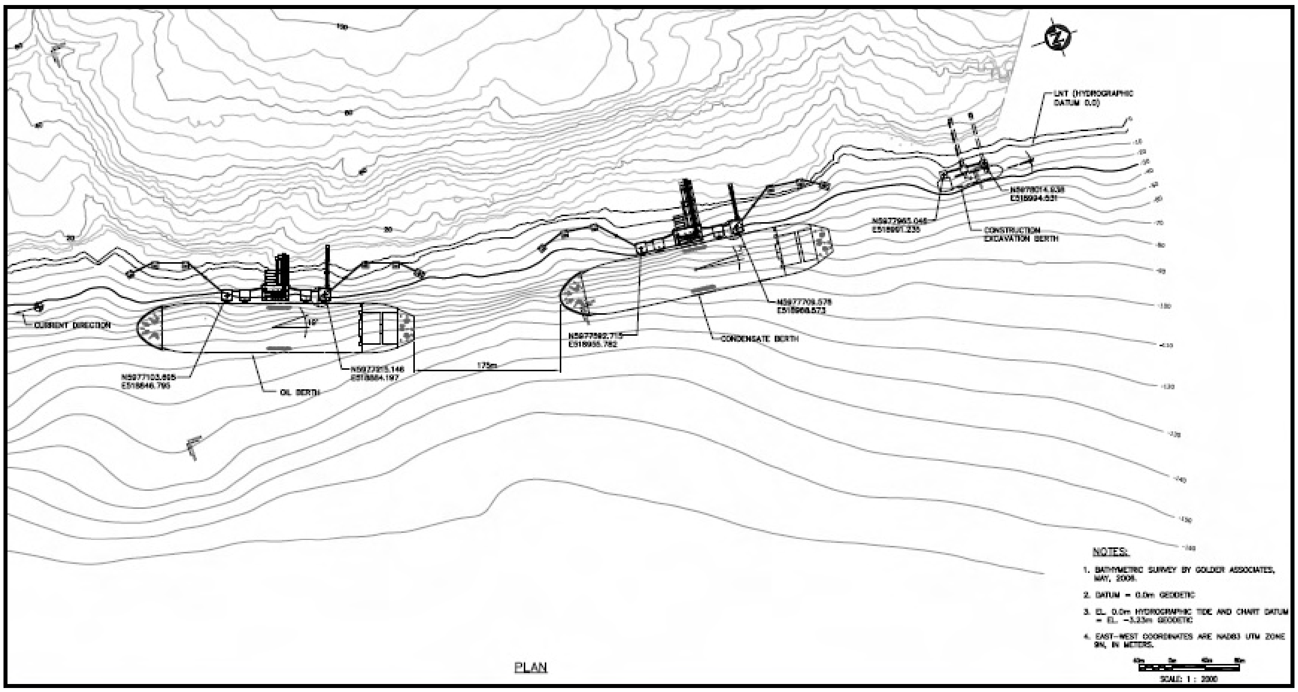

Figure 3: Map of the planned locations of the marine terminals where dredging activities will occur.

Based on a historical regional study of bottom sediments (Bornhold, 1983), the bottom sediments are predominantly muds, with a vertical gradation of silts on the surface and clays at greater depths. Detailed measurements of the grain size analysis were made in a laboratory study using bottom grab samples collected for this project in March of 2006, at 12 sites in total. The sediments have been analyzed at several sites in the area of the proposed dredging area (Figure 4). The closest location is site 1. An overlay of the cumulative size distributions shows negligible differences compared to adjacent sites 2 and 6.

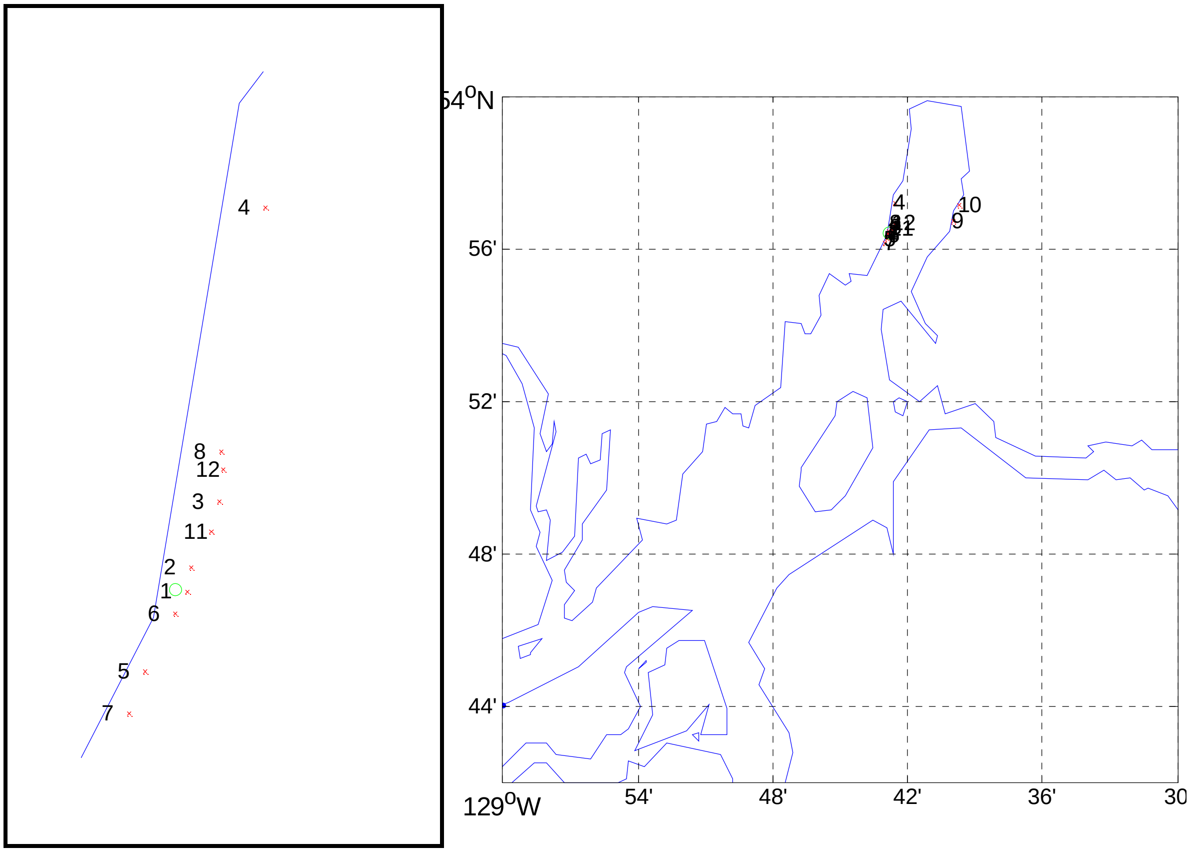

Figure 4: A map of the sediment size sampling locations (red dots), and the dredging site (green circle).

Based on the site 1 sediment size distribution, the proportion of sediments within 5 size classes was identified (Table 1). Median diameters are also calculated in preparation for the calculation of suitable settling velocities.

Table 2: Defining the 5 sediment size classes, based on sediment sample JW1, the proportion and the median diameter within each category.

Start Diameter (mm)	Category Name	Stop Diameter (mm)	Proportion (%)	Median Diameter (mm)
0.000	clay	< 0.002	13.30	0.001
0.002	fine silt	0.016	53.86	0.007
0.016	med silt	0.031	17.63	0.022
0.031	coarse silt	0.063	9.81	0.043
0.063	sand	2.000	5.40	0.098

For clay and fine silts, the process of flocculation can be important. Flocculation results from the cohesive attraction of very small particles into larger clumps or flocs, consisting of many very small particles plus water, if the concentrations are sufficiently large. Flocculation typically occurs when the suspended sediment concentrations are in the range of 100 to 1000 mg/L or larger.   Such concentrations are possible due to episodic release of sediments off the bottom and while being raised through the water column which occurs at time scales of a minute or so out of a total time sale of a few minutes to complete one full sediment removal step. In considering the episodic nature of the sediment releases, the initial Total Suspended Sediment (TSS) concentrations are calculated to be over 100 mg/L for short periods of time which will likely trigger flocculation. For the clay, fine silt, and medium silt categories, particles which better represent the flocs actual settling velocity, were introduced into the model.

The duration of the dredging operations is estimated to be 7 days, on a 24 hour per day operation, to complete the requirements at each of the major marine terminals. Dredging at the construction and excavation berth will be completed in less than one day.

The dredging will be conducted with clamshell buckets that capture the dredged materials from the bottom, raising the closed bucket through the water column and then depositing the materials into a dredge barge for disposal at an approved location elsewhere. The disposal of the dredged materials is not dealt with in this analysis.

3.2 Dredging Activities - Assumptions

Dredging will be carried out to minimize the release of sediments to the water column. The potential release processes include (Schroeder and Ziegler, 2004): the bottom wake arising from capturing the sediment in the clamshell bucket and expulsion during closing, stripping of sediments from the shovel while rising through the water column, draining during slewing and washing from descent through the water column. Also it is possible that loads can be lost due to debris.

Based on a historical review of dredging operations, Schroeder and Ziegler (2004) provide a range of loss rates of 0.2 to 3% for closed mechanical dredges. In this simulation, the loss rate was taken to be 1%. We further assume that one-half of the total loss will occur within 5 m of the bottom due to a combination of: capturing the sediment; expulsion of sediments when closing the bucket; and during the initial raising of the bucket through the water column. The remaining 50% of the losses are assumed to be evenly distributed through the upper 20 m of the water column.

The release rate is computed as 1% of 7500 m^3 for a total release volume of 75 m^3 which occurs over a 7 day period for a rate of 10.714 m^3/day or 0.000124 m^3/s. Taking the sediment density as 2650 kg/m^3, the mass release rate is 0.3286 kg/s. Since the computations are made over a duration of several days, the release rate is taken to be continuous in time, rather than episodic over periods of minutes.

The model is operated on computation time step corresponding to 15 s in real-world time. For this purposes of modeling simulations of the fate of the sediments released in dredging, the 3-D numerical model was operated for a period of 7 full days, for the period of March 10 to 16, 2006. Dredging model activities were simulated at six individual locations for one-half of the total duration at the planned dredging activity as summarized in Table 3. The total computer time to run the model on a very fast PC Windows computer is approximately 3 days.

Table 3: Model simulation times by location and water depth used in the numerical model runs.

Oil Berth	East	North	Water Depth (m)	Notes	Separation (m)	Dredged Volume (m^3)	simulation time (hours)
1	518,836.80	5,977,103.70	21.7	moved 10 m to west	118	7500	40.00
2	518,874.20	5,977,215.12	18	moved 10 m to west			40.00
Condensate Berth							
1	518,955.70	5,977,592.70	20.4		117	7500	40.00
2	518,963.60	5,977,709.60	30	moved 5 m to west			40.00
Excavation Berth							
1	519,001.20	5,977,965.00	14	moved 210 to east	50	725	4.00
2	519,004.50	5,978,014.90	20	moved 10 m to east			4.00
Total							168.00

3.3 Initial Dilution of Sediments Discharged from Dredging Operations

The dilution of the sediments into the water zone is estimated to be over an initial mixing zone scale size of 4 m^2 centred on the dredge bucket (Schroeder and Ziegler, 2004). Based on the instantaneous sediment release rates (with the bucket being raised at an average speed of 0.5 m/s through the water column once every 2 minutes), the initial suspended sediment concentrations are computed as having maximum instantaneous values of up to: 800 mg/L in the lower 5 m of the water column for the combined three categories of silt, 130 mg/l for clay and 50 mg/L for silt. In the upper portion of the water column the maximum instantaneous concentrations are reduced by a factors ranging from 2 to 5 depending on the actual water depths in which the dredging is taking place. From these initial concentrations, flocculation of sediments occurs for clays and silts in the bottom 5 m of the water column and silts only in the upper parts of the water column, as the concentrations of clays are too low in this upper zone. The time scale for these comparatively large (see below) TSS values are limited to periods of several minutes and to horizontal distance scales of < 100 m.

Due to ocean currents and other causes of ocean turbulence, these initial TSS concentrations arising from a single raising of the dredge bucket will be reduced to values of up to 10 mg/L in the lower part of the water column and smaller values in the upper portions of the ocean. These mixed values are represented by the numerical model on the 20 m by 20 m horizontal grid size. The transport of the sediments away from the dredging operation depends primarily on the ocean currents as computed by the numerical model. Over the 2 minute (120 s) time frame between raising the dredging bucket, the TSS values vary according to the rate at which ocean currents move the sediments away from the dredging location over the 2 minute time scales. When currents are small, say < 0.05 m/s, the water and sediments move a distance of < 6 m, so the TSS values will tend to increase above the diluted levels from a single dredging operation.

3.4 Suspended Sediment Background Values

The ambient (background) surface values of TSS within Bush Cove and in the portion of Kitimat adjacent to Bish Cove are between 3 and 25 mg/l in winter (Hatfield Consultants Ltd., 1982 and JWL, 1997). The higher ranges of surface TSS values are likely due to runoff from local rivers and creeks that contain sediments of terrestrial origin (JWL, 1997). TSS levels are markedly reduced at depths below the river plume levels and at locations in Kitimat Arm that further away from local rivers. McDonald (1983) reports TSS values of 0.3 to 1.02 mg/l at water depths of 1 and 5 m at three sites in Kitimat Arm with a surface value of 5.9 mg/l at a site near the Kitimat River (McDonald, 1983). During the time of the major freshet on the Kitimat River in May-July and possible during a secondary freshet in October, surface values of TSS in Kitimat Arm could be larger (McDonald, 1983). Overall, naturally occurring TSS values are expected to be in the range of 0.5 to 2.5 mg/l except during major freshet events when surface value can exceed 20 mg/l. In the immediate vicinity of small rivers and creeks, surface values can also exceed 20 mg/l.

4. Model Results

4.1 Suspended Sediments from Dredging

The first sets of SSC model results represent the suspended sediments after 80 hours or 3 1/3 days, of dredging activities at the oil tanker terminal berth. The results are presented at for horizontal layers at water depths of 0-2 m, 10-13 m (Figure 5), 16-20 m, 50-70 m (Figure 6) and 140-180 m (Figure 7).

The increased levels of TSS (TSS > 0.5 mg/l) at the surface resulting from dredging are distributed as a narrow along shore band with a width of < 100 m extending approximately 2 km to the north. Very low concentrations (0.05-0.25) are also present in the form of a narrow band to the south of the terminal and an extension of this band, situated offshore of Elmsley Cove, each with a length of 3-4 km and a width of 200 – 300 meters. The TSS values are always less than 0.25 mg/L except immediately adjacent to the active dredging location (up to 2.7 mg/L). In the surface layer, naturally occurring TSS values can be 2.5 mg/L or greater.

At intermediate water depths of 10-13 m and 16-20 m, the dredging sediment plume has somewhat higher values associated with larger area of TSS values exceeding the range of background levels of 0.3 to 2.5 m. The maximum values are 4.6 mg/l at depths of 10-13 m and 58.4 mg/l at 16-20 m, although TSS values exceeding 2.5 mg/l are limited to areas within of less than 200 m of the instantaneous dredging activity. A larger, lower concentration plume extends to the northwest. The portion of this plume with marginally detectable TSS values (0.25 to 2.5 mg/l) extends as band of up to a few hundred metres width up to 3 km from the dredging activity at 10-13 m and 16-20 m depth.

At deeper depths of 50-70 m and 140-180 m, the SSC values are even lower, with maximum values of 0.45 and 0.1 mg/l, respectively. At these greater depths, the TSS values resulting from dredging would be nearly undetectable.

The second set of displayed model results for TSS represent the suspended sediments after 168 hours, or 7 days, of dredging operation with the dredge having worked at all three terminal sites (see Table 3 for details). The distribution of TSS values at the same selected layers (as used for 80 hour runs) are presented in Figure 8 (0-2 m and 10-13 m depth), Figure 9 (16-20 m and 50-70 m depth) and Figure 10 (140-180 m depth).

After 7 days, the continuing advection of the cumulative discharge of suspended sediments has come into an approximate balance with the losses of suspended sediments due to dilution and deposition to the seabed, as can be seen by comparable size of the sediment plumes with those computed for 80 hours of dredging. At the surface level of 0-2 m (Figure 8), the TSS levels after 7 days are actually lower than after 80 hours (maximum value of 1.1 mg/l vs. 2.7 mg/l) and the area of TSS values > 0.25 mg/l is smaller. The changes results from stronger currents after 7 days which results in greater dispersal of sediments and lower TSS values.

The TSS distributions after 7 days of dredging at depths of 10-13 and 16-20 m (Figure 8 and Figure 9) have somewhat reduced maximum values of 3.8 mg/l and 6.7 mg/l, respectively, from the distributions after 80 hours. However, similar patterns of enhanced TSS values extend alongshore to the north-northeast for distances of up to 2.5 km.

At depths of 50-70 m (Figure 9) the TSS values are somewhat larger (peak values of 3.3mg/l) than after 80 hours with TSS values exceeding 0.25 mg/l, which extends up to 2 km to the north-northwest and up to 1 km in width. These somewhat larger values at greater depths result from the settling of the finer sediment particulates, particularly silts and clays, which take several days to settle to the bottom in water depths of 100 m or more.

At depths of 140-180 m (Figure 10), TSS values are always less than 0.05 mg/l, well below measurable levels.

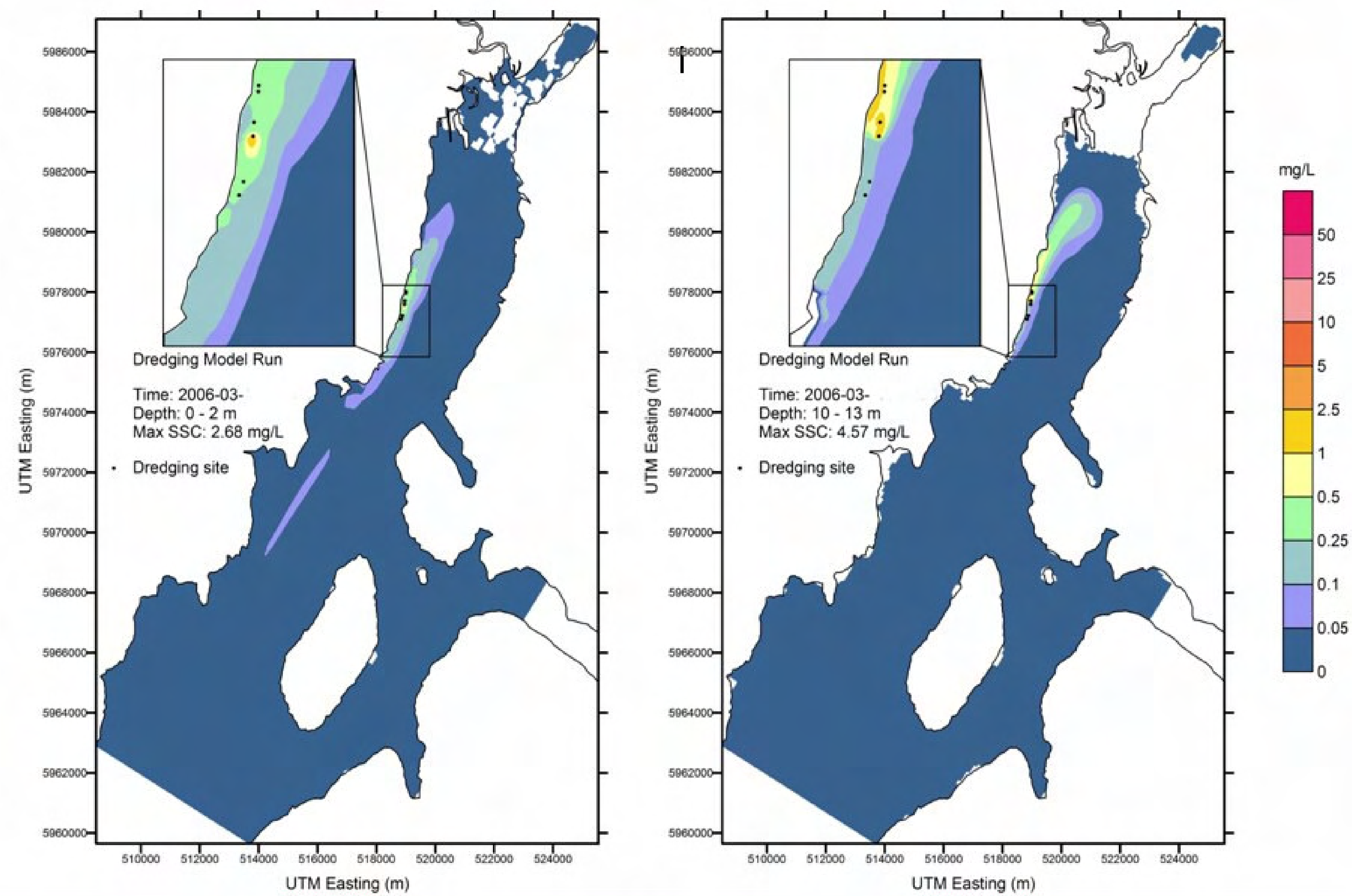

Figure 5: Model Derived TSS values (mg/l) after 80 hours of dredging for the surface layer (left) and for 10-13 m depth (right). The details of the TSS distribution in the immediate vicinity of the marine terminal are shown in the inset in the upper left of each panel.

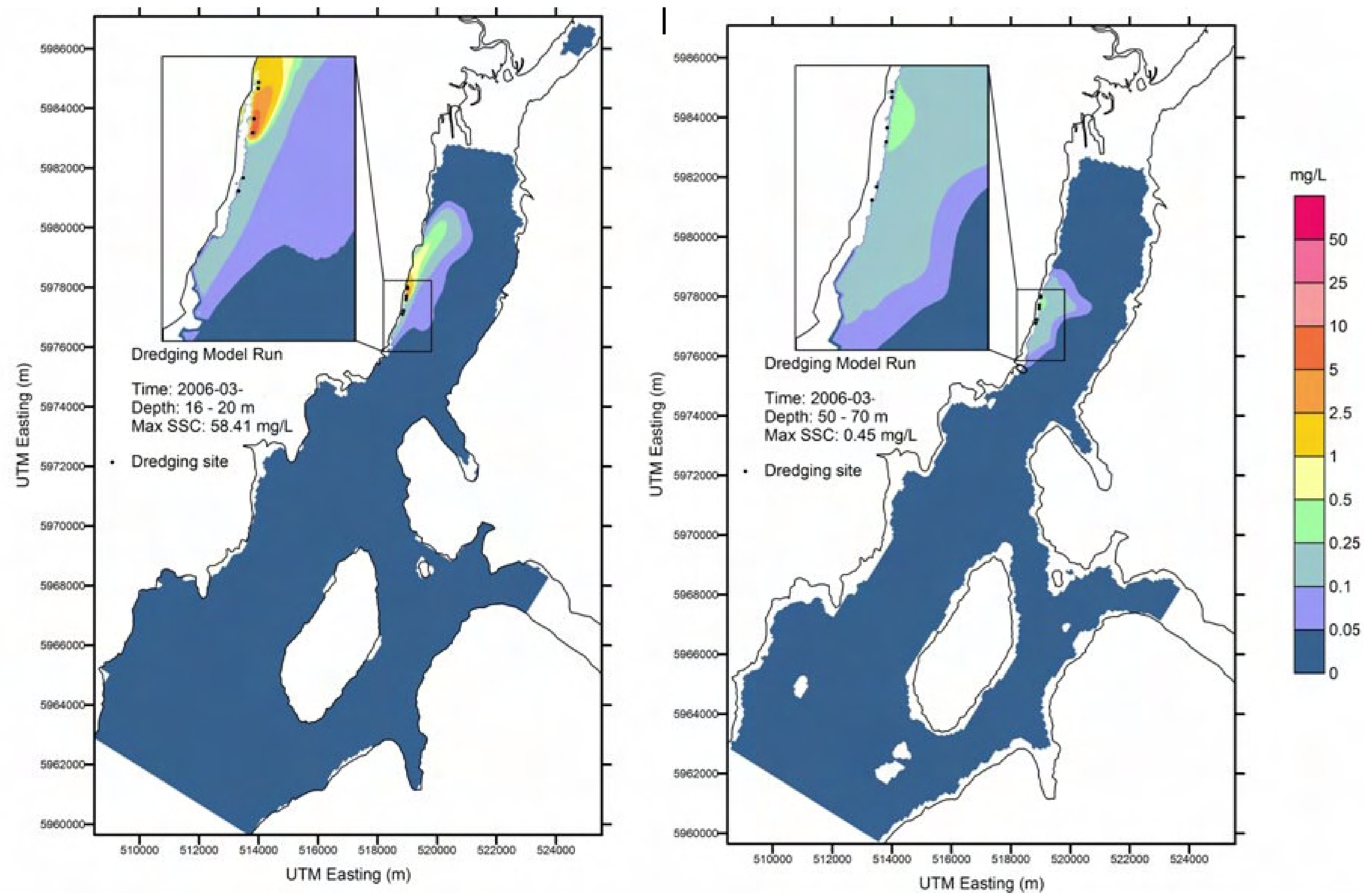

Figure 6: : Model-derived TSS values (mg/l) after 80 hours of dredging for 16-20 m depth (left) and for 50-70 m depth (right). The details of the TSS distribution in the immediate vicinity of the marine terminal are shown in the inset in the upper left of each panel.

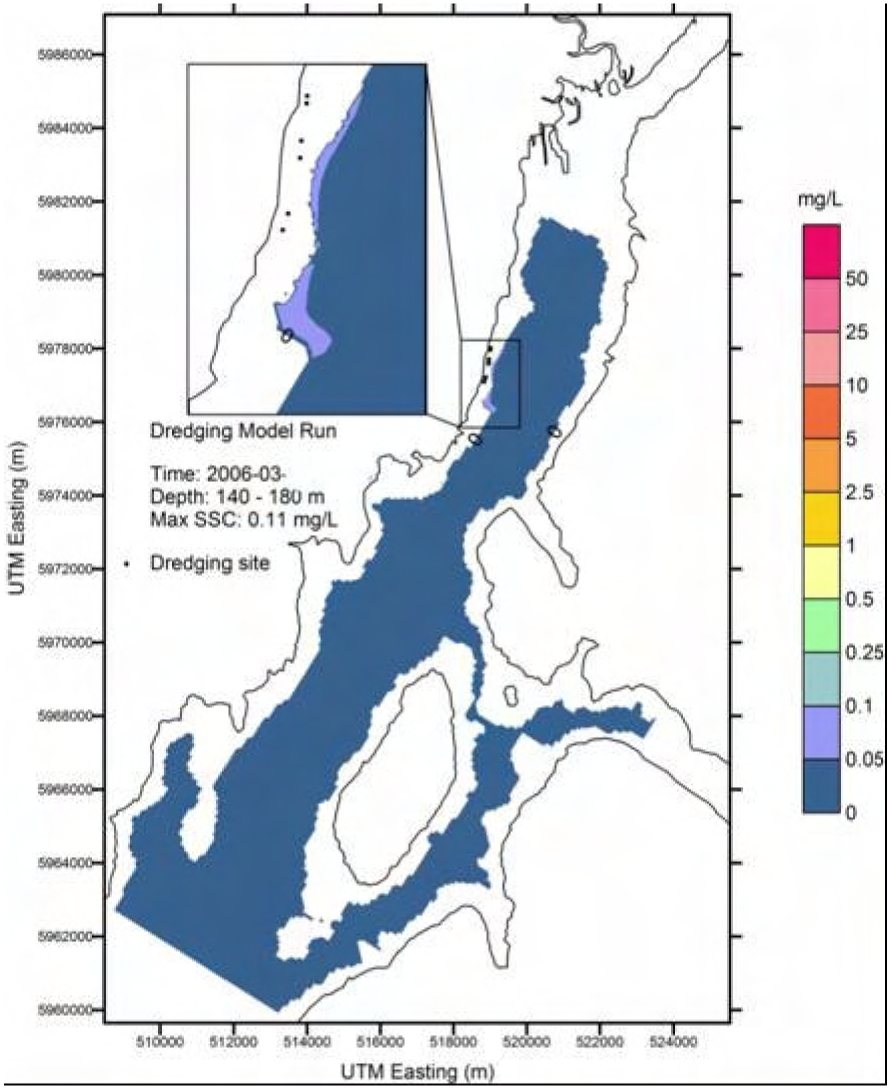

Figure 7: Model-derived TSS Concentrations after 80 hours at 140 - 180 m water depth.

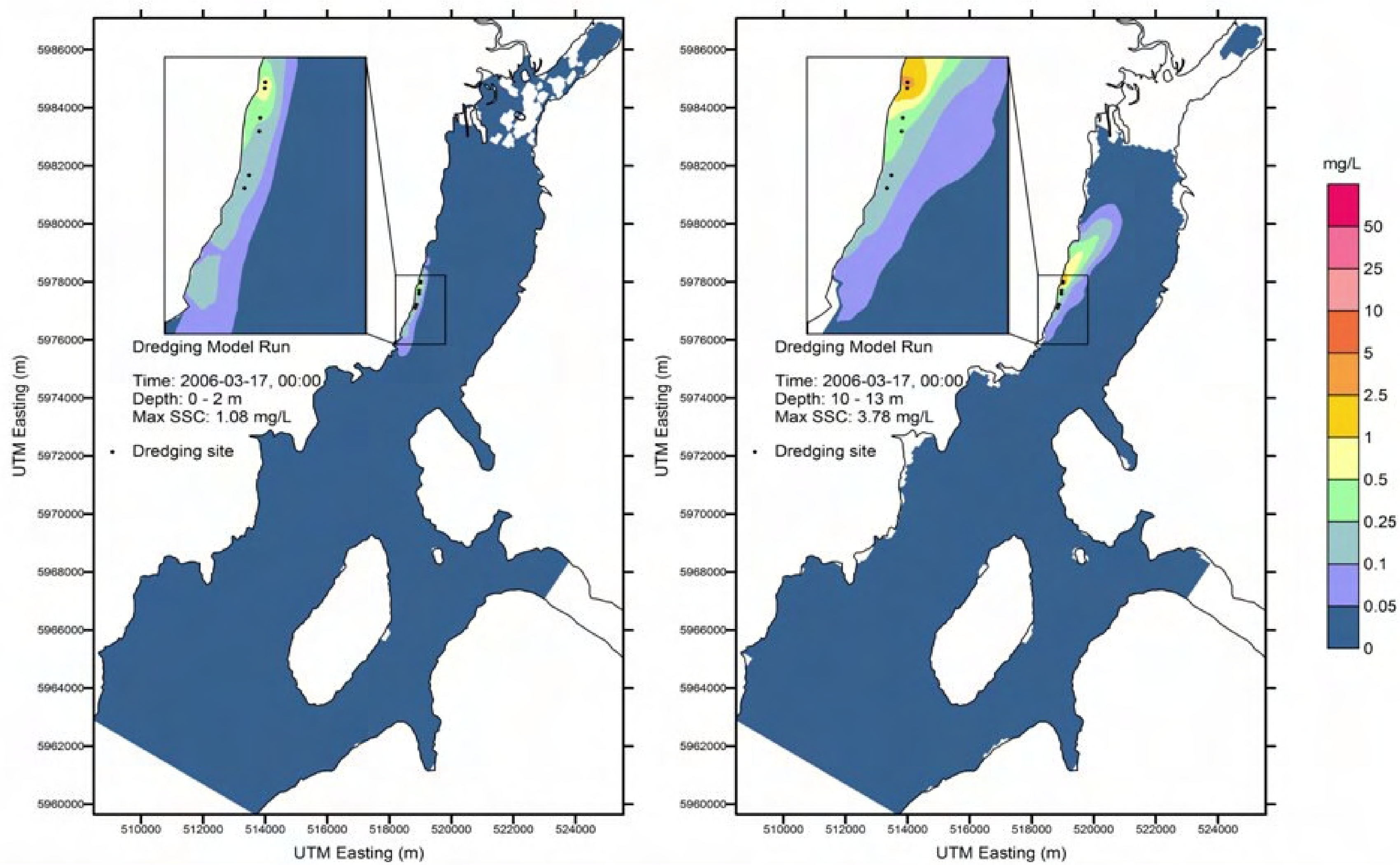

Figure 8: Model Derived TSS values (mg/l) after 7 days of dredging for the surface layer (left) and for 10-13 m depth (right). The details of the TSS distribution in the immediate vicinity of the marine terminal are shown in the inset in the upper left of each panel.

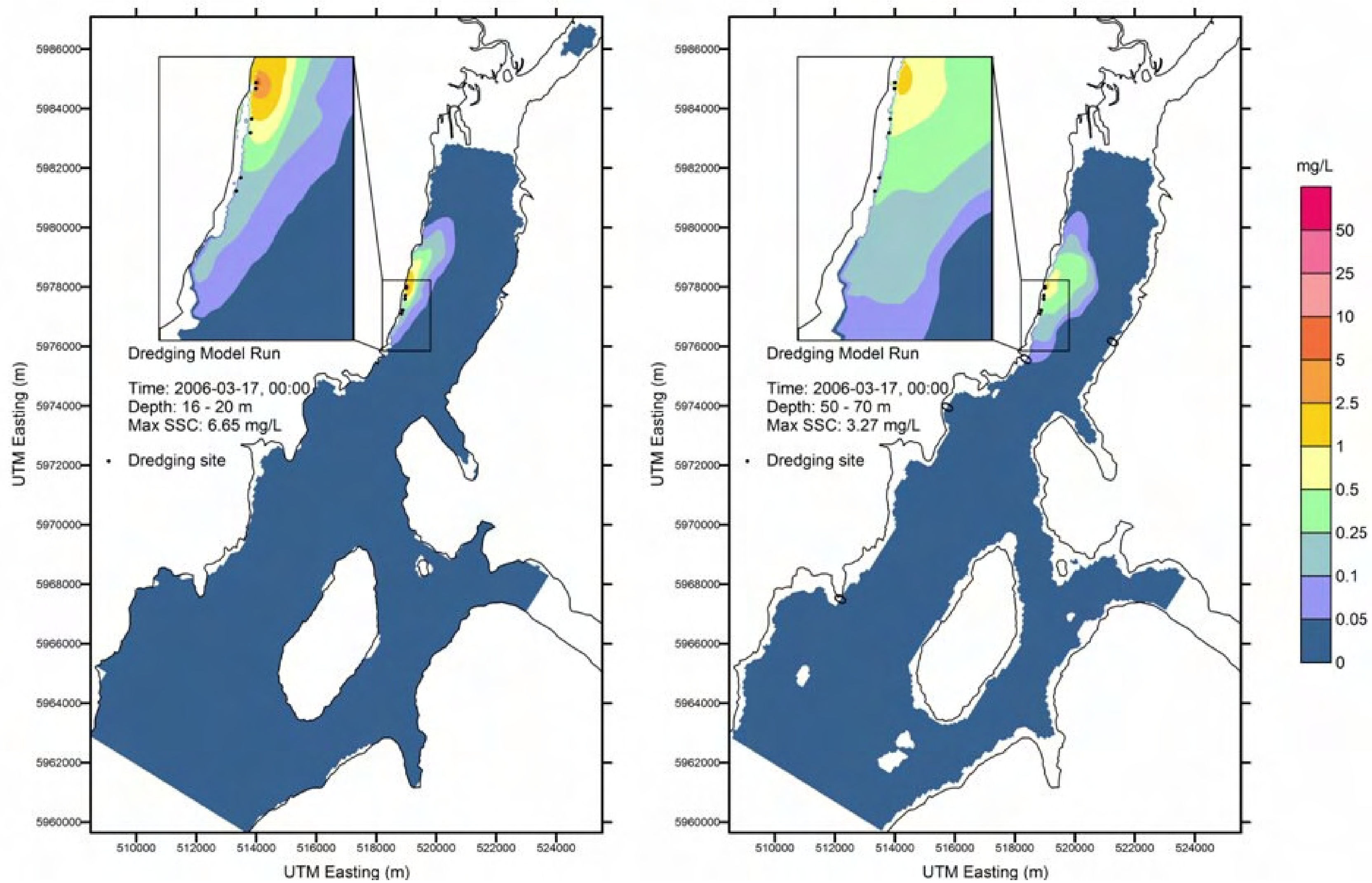

Figure 9: Model-derived TSS values (mg/l) after 7 days of dredging for 16-20 m depth (left) and for 50-70 m depth (right). The details of the TSS distribution in the immediate vicinity of the marine terminal are shown in the inset in the upper left of each panel.

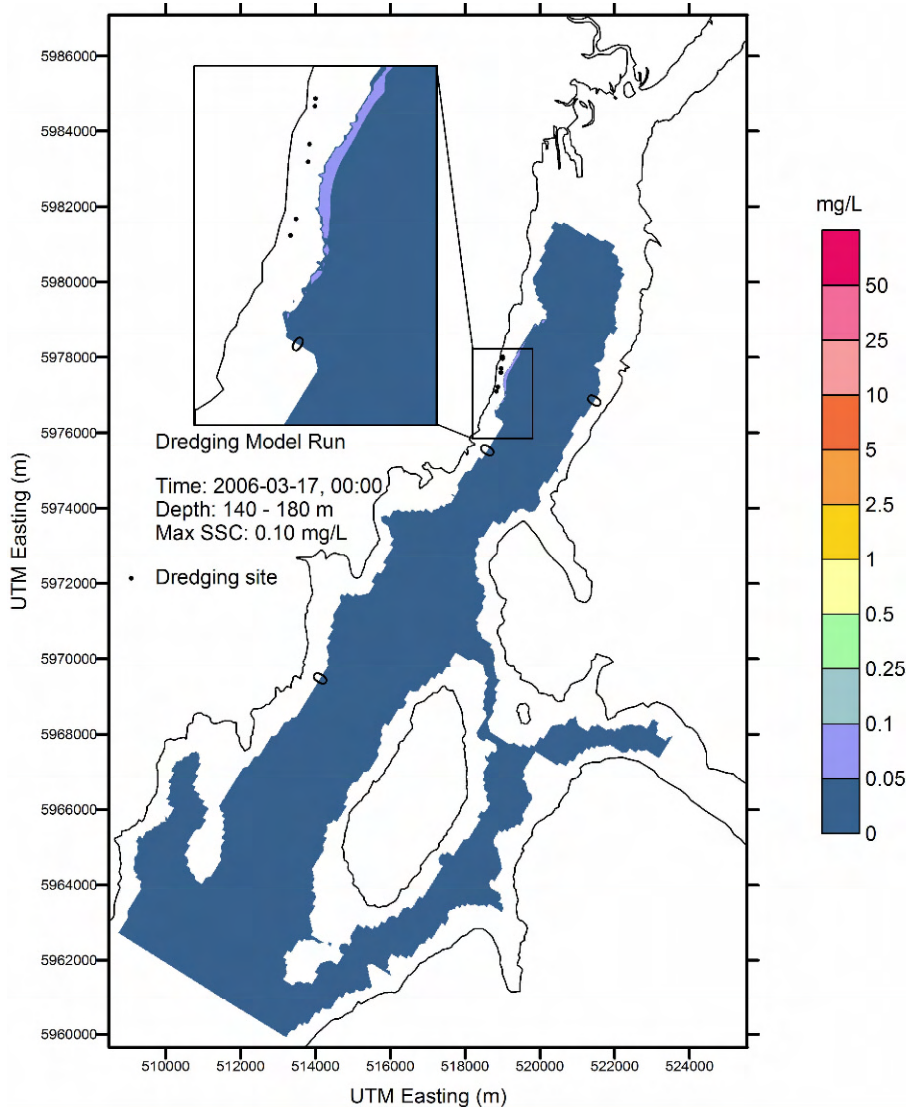

Figure 10: Model-derived TSS Concentrations after 7 days at 140 - 180 m water depth.

4.2 Deposited Sediments from Dredging

The total deposition of the sediment released during dredging operations is presented in Figure 11 for Kitimat Arm and in Figure 12 for the Marine Terminal area. The maximum thickness of deposited sediments is 1.1 cm and generally much less than this. The area of sediment deposition with a thickness exceeding 0.1 cm is largely confined to the immediate zone of dredging activities. Outside of this disturbed area, the amount of deposition is < 0.1 cm and typically much less at 0.025 to 0.05 cm.

The area where deposition exceeds 1.0 cm is limited to 400 m^2, in the one grid cell that had 1.1 cm. The area with depositions exceeding 0. 5 cm, is limited to small zones within the two main terminal sites, covering a total area of 1,600 m^2. Within the immediate area of the two main marine terminals (Figure 12), the total deposition > 0.1 cm extends over an area of 150 along the shore m by 40 m across.

Most of the sediment is widely dispersed over an extended alongshore band of approximately 4 km length and 400 m width. Typical sediment deposition levels in this area are very low, in the range of 0.001 to 0.1 cm.

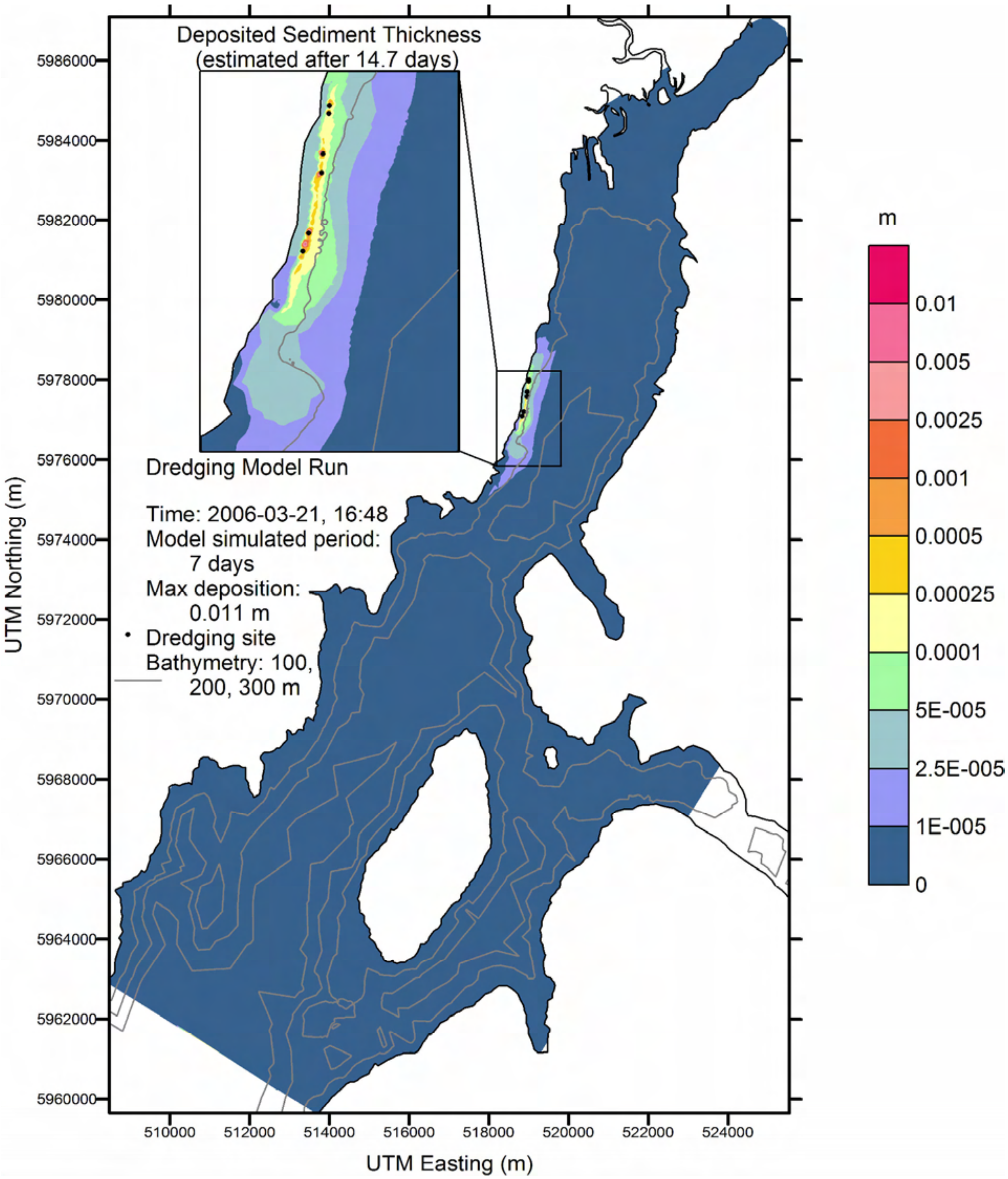

Figure 11: The estimated total deposition after 14.7 days of dredging activity based on scaling up the model derived deposition after 7 days by a factor of 2.1

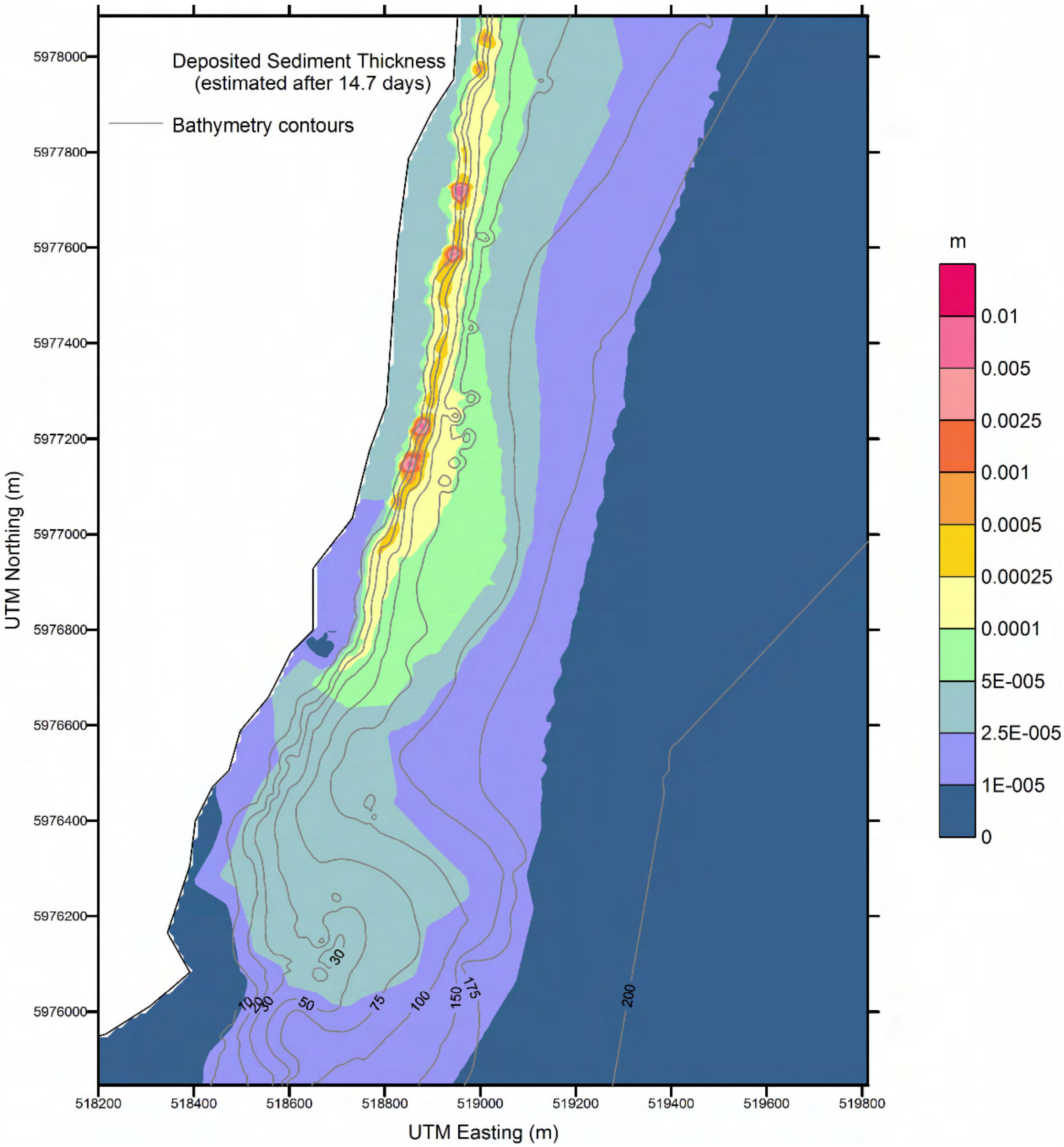

Figure 12: The estimated total deposition in the immediate area of the terminal after 14.7 days of dredging activity based on scaling up the model derived deposition after 7 days by a factor of 2.1.

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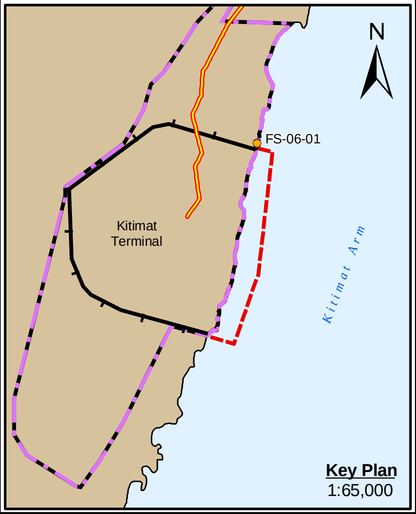
Appendix B Marine Foreshore Survey Species Summary

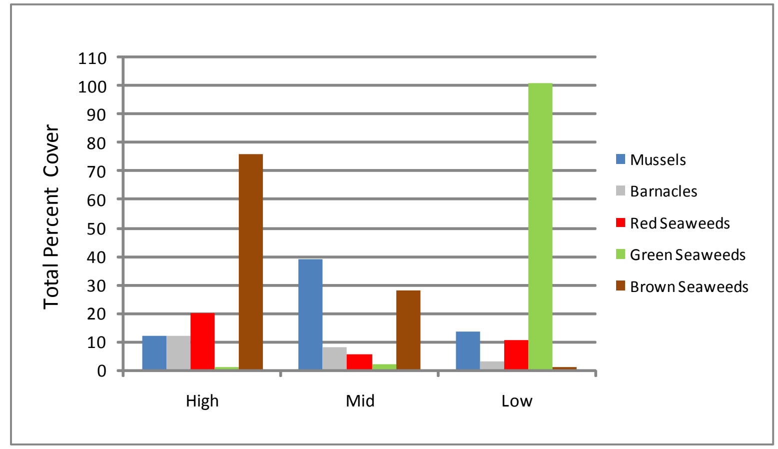
Table B-1 Summary of species found in PDA intertidal surveys

Group	Species	Common name	Presence											
			Low intertidal zone				Mid intertidal zone				High intertidal zone			
			2005	2006	2008	2009	2005	2006	2008	2009	2005	2006	2008	2009
Molluscs	*Littorina scutulata*	Checkered periwinkle	✓	✓										
	Littorina sitkana	Sitka periwinkle	✓	✓		✓	✓	✓						
	Lottia spp	Limpet spp.						✓	✓		✓	✓		
	Mytilus spp/spp complex	Mussel spp.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Tectura spp	Limpet spp.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
Crustaceans	*Balanus glandula*	Common acorn barnacle	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Cthalamus dalli	Small acorn barnacle	✓	✓	✓		✓	✓	✓		✓	✓		
	Hemigrapsus oregonensis	Green shore crab				✓				✓			✓	
	Hemigrapsus nudus	Purple shore crab	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Idotea resecata	Isopod spp.	✓	✓			✓	✓			✓	✓		
	Idotea wosesenki	Isopod spp.					✓				✓			
	Pagurus spp.	Hermit crab				✓								
	Unknown isopod	Unknown isopod			✓				✓					
Red Seaweeds	*Ahnfeltia fastigiata*	Wiry forked seaweed			✓									
	Ahnfeltiopsis spp	Forked seaweed	✓		✓					✓				
	Ahnfeltiopsis gigartenoides		✓											
	Cladophora	Sea moss	✓	✓			✓	✓			✓	✓		
	Halosaccion glandiforme	Sea sacs or deadman's fingers	✓	✓	✓					✓				
	Hildenbrandia spp	Red rock crust				✓			✓				✓	
	Mastocarpus spp.	Turkish washcloth	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓
	Neorhodomela spp	Black pine			✓				✓	✓				
	Odonthalia spp.	Toothed-twig seaweed	✓	✓	✓			✓						
	Palmaria spp.	Dulse			✓					✓				
	Pteroiphonia app.	Black tassel	✓											
	Polysiphonia spp.	Polly	✓											
		Pink coralline algae	✓	✓	✓	✓								
	Unknown branching Red #1	Unknown red seaweed	✓	✓	✓		✓	✓	✓	✓				✓
	Unknown branching Red #2	Unknown red seaweed	✓	✓						✓				
	Unknown branching Red #3	Unknown red seaweed			✓					✓				
	Unknown branching Red #10	Unknown red seaweed	✓	✓										

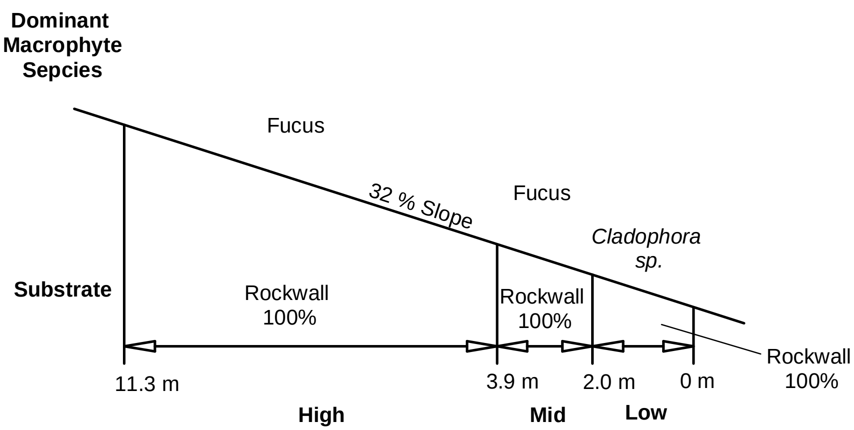
Table B-1 Summary of species found in PDA intertidal surveys (cont'd)

Group	Species	Common name	Presence											
			Low intertidal zone				Mid intertidal zone				High intertidal zone			
			2005	2006	2008	2009	2005	2006	2008	2009	2005	2006	2008	2009
Green Seaweeds	*Acrosiphonia coalita*	Green rope	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	
	Ulva spp.	Sea lettuce	✓	✓			✓	✓		✓	✓	✓		✓
	Ulva intestinalis	Sea hair	✓	✓	✓		✓	✓	✓		✓	✓	✓	
		Green Crust		✓				✓						
		Unknown Green 1	✓	✓			✓	✓						
Brown Seaweeds	*Fucus gardneri*	Rockweed	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓
	Laminaria spp	Various large brown kelps			✓					✓				✓
	Laminaria setchellii	Split kelp	✓	✓										
	Ralfsia fungiformis	Fungiform tar spot alga	✓	✓			✓	✓			✓		✓	
	Sargassum muticum	Wireweed	✓	✓			✓	✓						
		Unknown Brown 1	✓	✓			✓	✓						
		Unknown Brown 2	✓	✓										



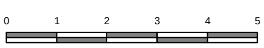


Relative Abundance & Distribution of Flora & Fauna in Transect FS-06-01



Profile of Intertidal Transect FS-06-01

Transect FS-06-01 Looking Upward from Low Water Mark



JWA-1048334-2630

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CONTRACTOR: Jacques Whitford AXYS Ltd.		**ENBRIDGE NORTHERN GATEWAY PROJECT**	FIGURE NUMBER: B-1	DATE: 20100210
PREPARED BY: gem	PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES	2006 Intertidal Transect Survey - Transect FS-06-01	SCALE: 1:150	AUTHOR: NP / APPROVED BY: CM
			PROJECTION: UTM 9	DATUM: NAD 83

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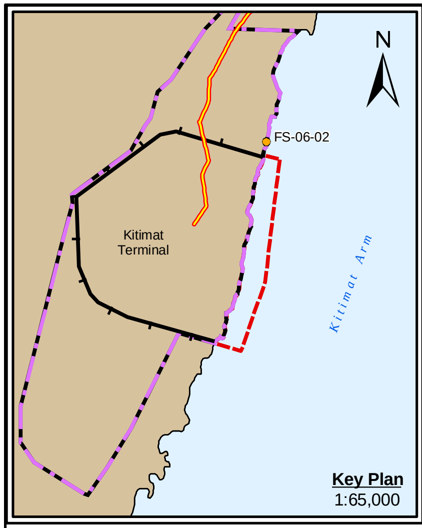
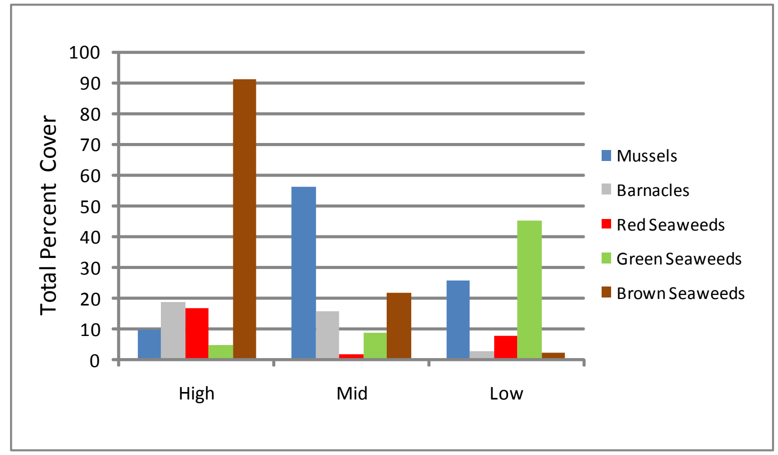
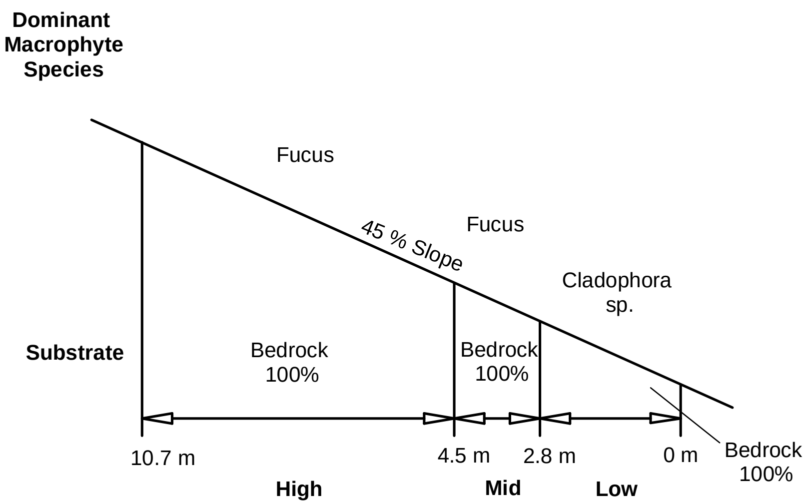




Relative Abundance & Distribution of Flora & Fauna in Transect FS-06-02



Profile of Intertidal Transect FS-06-02

Transect FS-06-02 Looking Upward from Low Water Mark

0 1 2 3 4 5
Meters

JWA-1048334-2631

CONTRACTOR: Jacques Whitford AXYS Ltd.	**ENBRIDGE NORTHERN GATEWAY PROJECT**	FIGURE NUMBER: B-2	DATE: 20100210
PREPARED BY: gem / PREPARED FOR: Enbridge Northern Gateway Pipelines	2006 Intertidal Transect Survey - Transect FS-06-02	SCALE: 1:150	AUTHOR: NP / APPROVED BY: CM
		PROJECTION: UTM 9	DATUM: NAD 83

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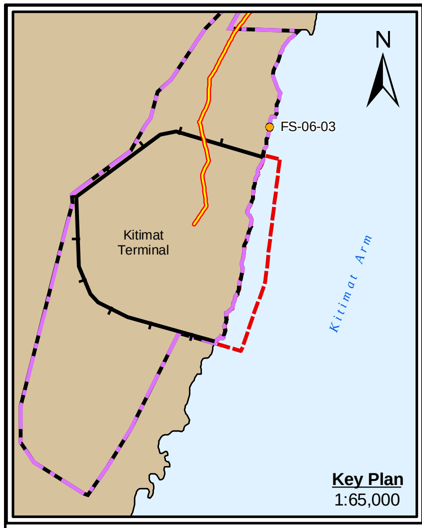
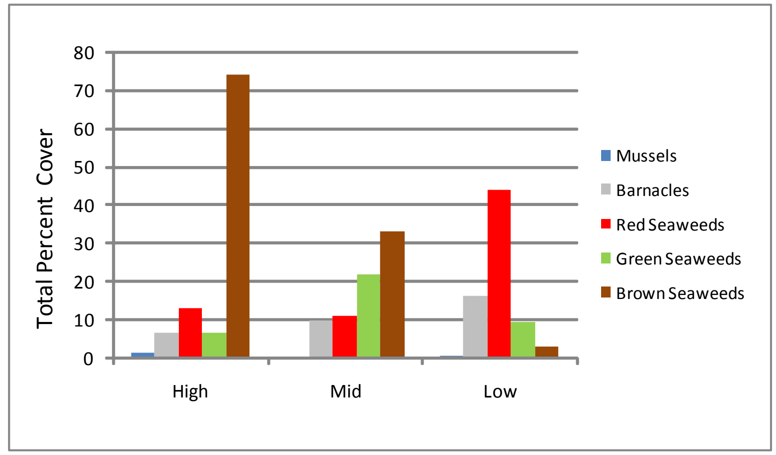
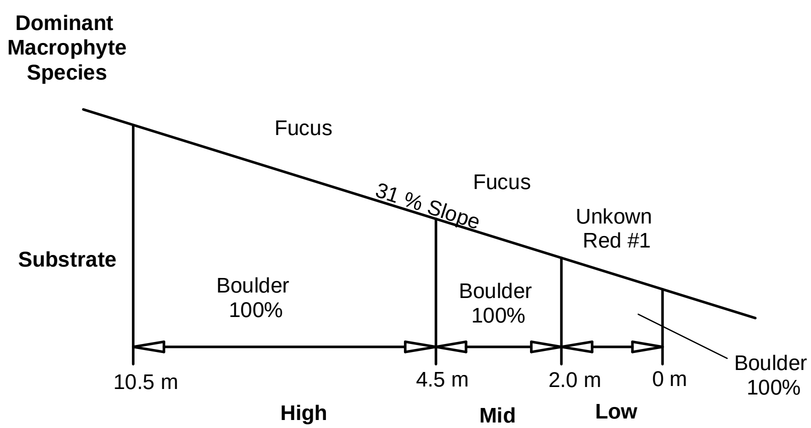




Relative Abundance & Distribution of Flora & Fauna in Transect FS-06-03

Transect FS-06-03 Looking Upward from Low Water Mark



Profile of Intertidal Transect FS-06-03

0 1 2 3 4 5
Meters

JWA-1048334-2632

REFERENCES: NTDB Topographic Mapsheets provided by the Majesty the Queen in Right of Canada, Department of Natural Resources. All rights reserved.

CONTRACTOR: Jacques Whitford AXYS Ltd.	ENBRIDGE NORTHERN GATEWAY PROJECT	FIGURE NUMBER: B-3	DATE: 20100210
PREPARED BY: gem / PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES	2006 Intertidal Transect Survey - Transect FS-06-03	SCALE: 1:150	AUTHOR: NP / APPROVED BY: CM
		PROJECTION: UTM 9	DATUM: NAD 83

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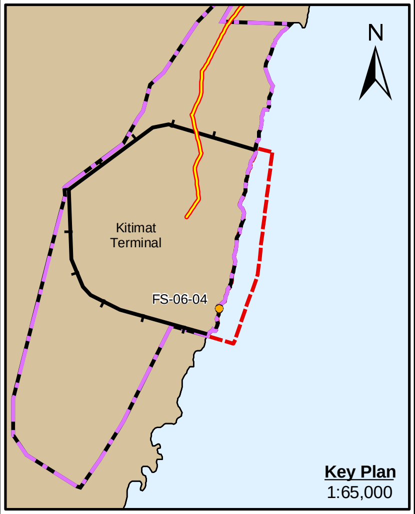
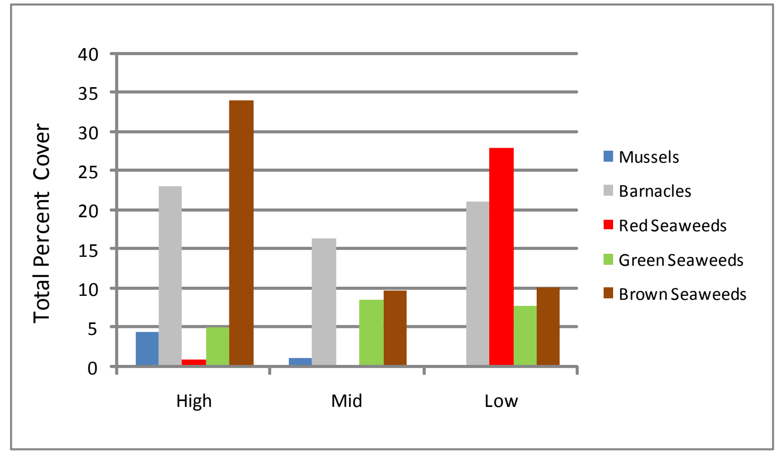
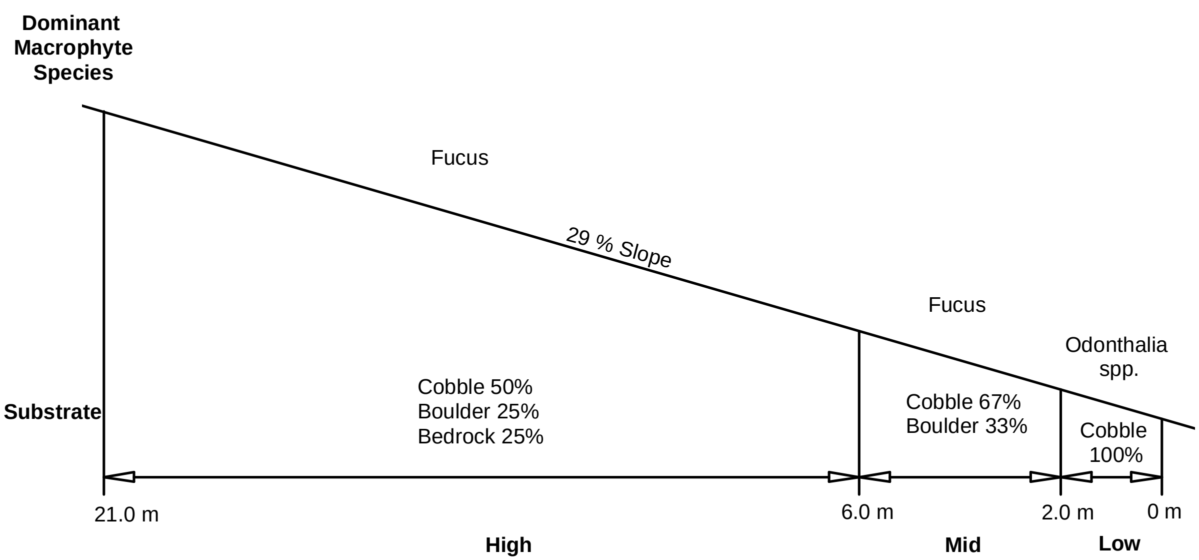




Relative Abundance & Distribution of Flora & Fauna in Transect FS-06-04



Profile of Intertidal Transect FS-06-04

Transect FS-06-04 Looking Upward from Low Water Mark

0 1 2 3 4 5

Meters

JWA-1048334-2633

REFERENCES: NTDB Topographic Mapsheets provided by the Majesty the Queen in Right of Canada, Department of Natural Resources. All rights reserved.

CONTRACTOR: Jacques Whitford AXYS Ltd.		ENBRIDGE NORTHERN GATEWAY PROJECT	FIGURE NUMBER: B-4		DATE: 20100210
PREPARED BY: gem	PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES	2006 Intertidal Transect Survey - Transect FS-06-04	SCALE: 1:150	AUTHOR: NP	APPROVED BY: CM
			PROJECTION: UTM 9	DATUM: NAD 83	

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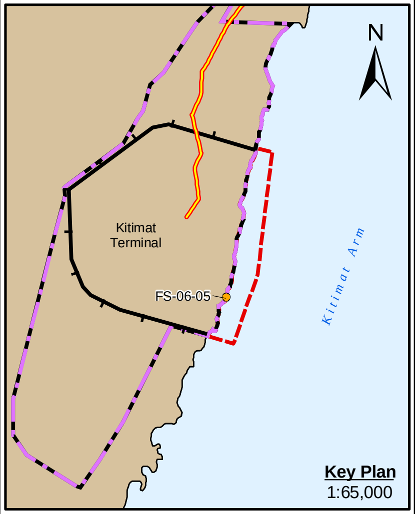
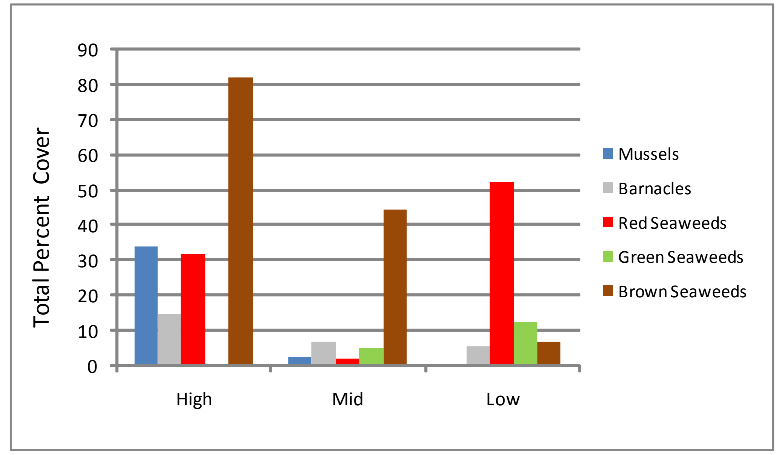
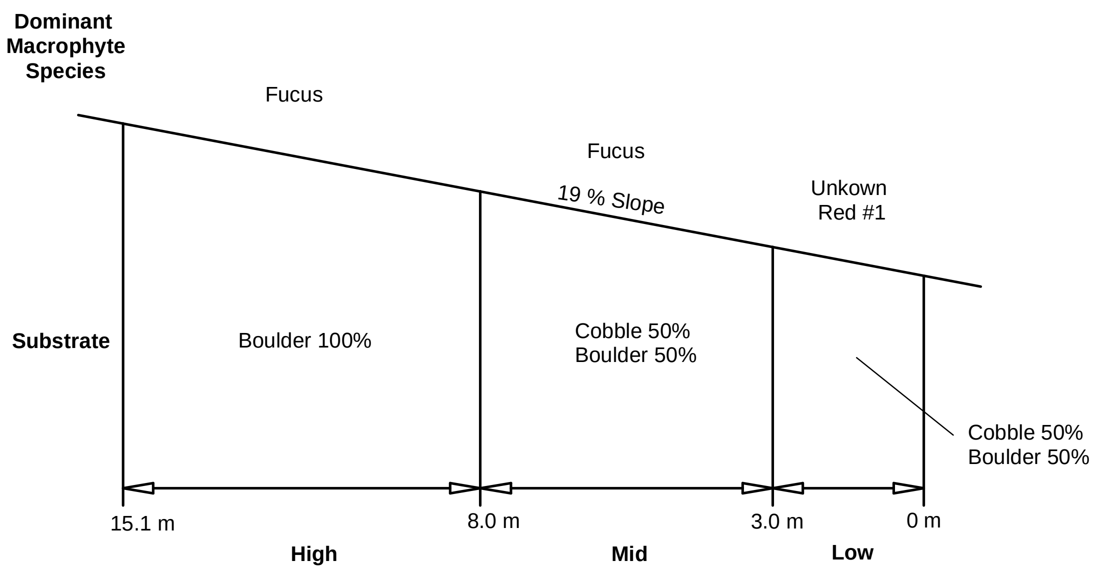


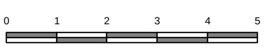


Relative Abundance & Distribution of Flora & Fauna in Transect FS-06-05



Profile of Intertidal Transect FS-06-05

Transect FS-06-05 Looking Upward from Low Water Mark



JWA-1048334-2634

REFERENCES: NTDB Topographic Mapsheets provided by the Majesty the Queen in Right of Canada, Department of Natural Resources.

CONTRACTOR: Jacques Whitford AXYS Ltd.

PREPARED BY: gem

PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES

ENBRIDGE NORTHERN GATEWAY PROJECT

2006 Intertidal Transect Survey - Transect FS-06-05

FIGURE NUMBER: B-5		DATE: 20100210
SCALE: 1:150	AUTHOR: NP	APPROVED BY: CM
PROJECTION: UTM 9	DATUM: NAD 83	

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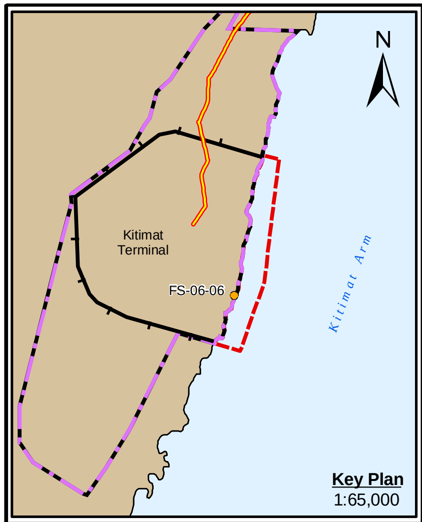
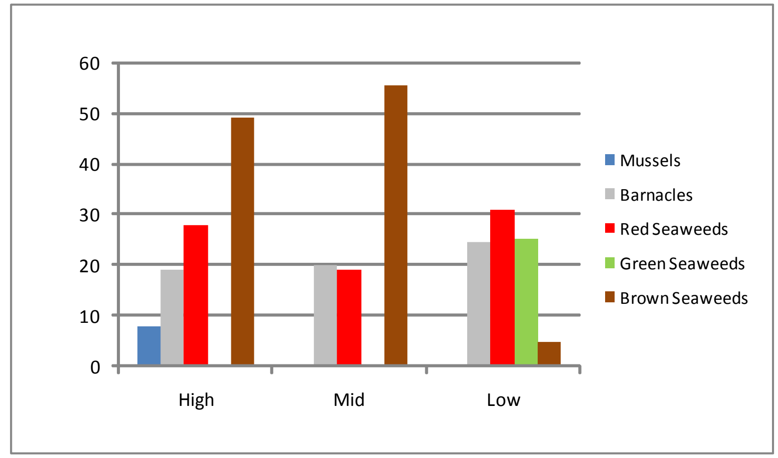
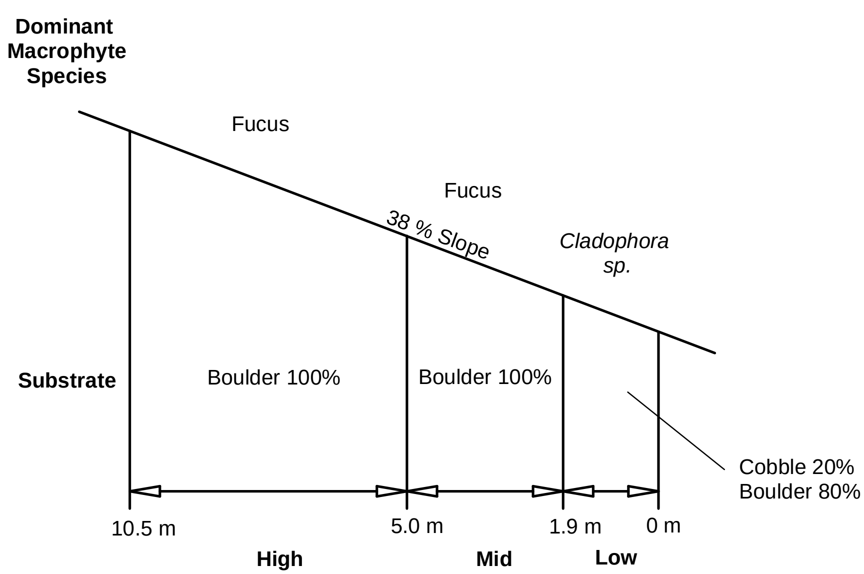




Relative Abundance & Distribution of Flora & Fauna in Transect FS-06-06



Profile of Intertidal Transect FS-06-06

Transect FS-06-06 Looking Upward from Low Water Mark

0 1 2 3 4 5
Meters

JWA-1048334-2635

CONTRACTOR: Jacques Whitford AXYS Ltd.

PREPARED BY: gem

PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES

ENBRIDGE NORTHERN GATEWAY PROJECT

2006 Intertidal Transect Survey - Transect FS-06-06

FIGURE NUMBER:		DATE:
B-6		20100210
SCALE: 1:150	AUTHOR: NP	APPROVED BY: CM
PROJECTION: UTM 9	DATUM: NAD 83	

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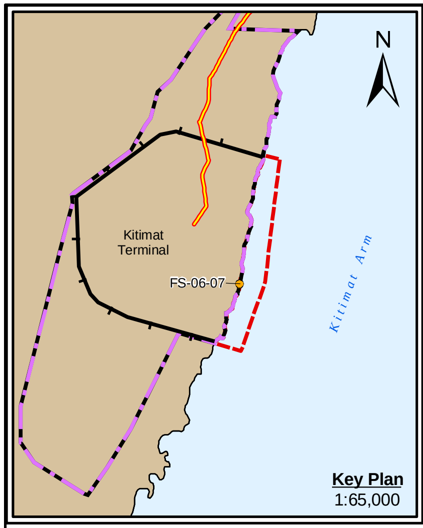
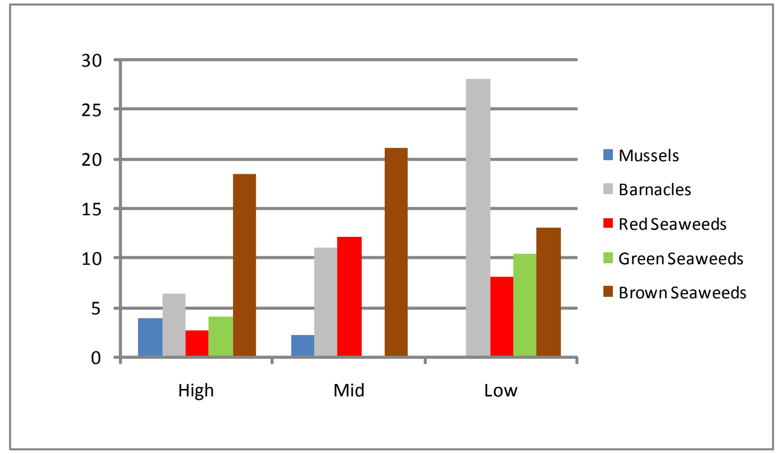
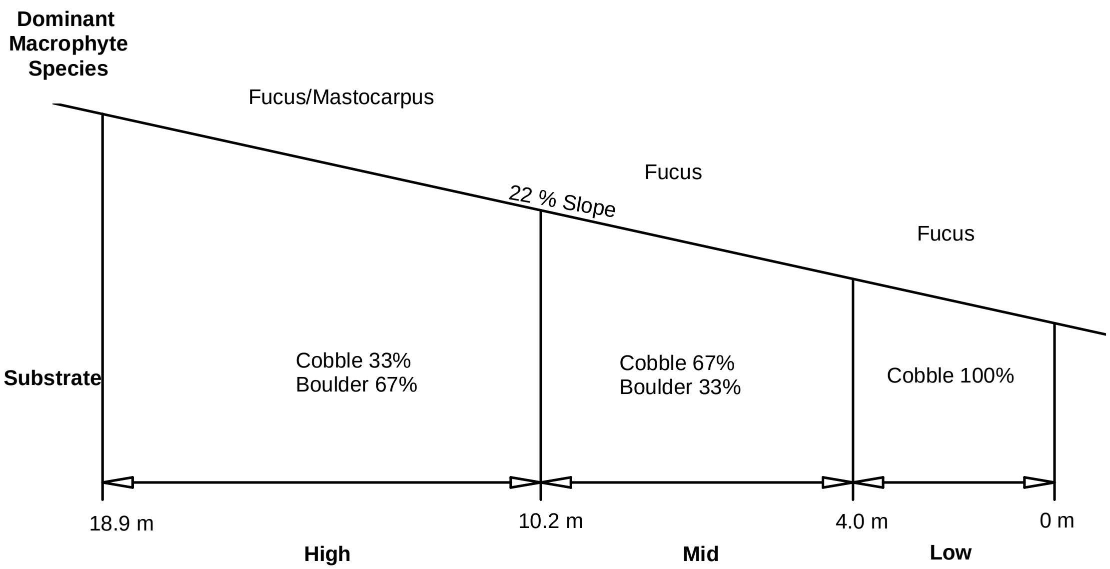




Relative Abundance & Distribution of Flora & Fauna in Transect FS-06-07



Profile of Intertidal Transect FS-06-07

Transect FS-06-07 Looking Downward from High Water Mark

0 1 2 3 4 5
Meters

JWA-1048334-2636

REFERENCES: NTDB Topographic Mapsheets provided by the Majesty the Queen in Right of Canada, Department of Natural Resources. All rights reserved.

CONTRACTOR: Jacques Whitford AXYS Ltd.

PREPARED BY: gem

PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES

ENBRIDGE NORTHERN GATEWAY PROJECT

2006 Intertidal Transect Survey - Transect FS-06-07

FIGURE NUMBER: B-7	DATE: 20100210	
SCALE: 1:150	AUTHOR: NP	APPROVED BY: CM
PROJECTION: UTM 9	DATUM: NAD 83	

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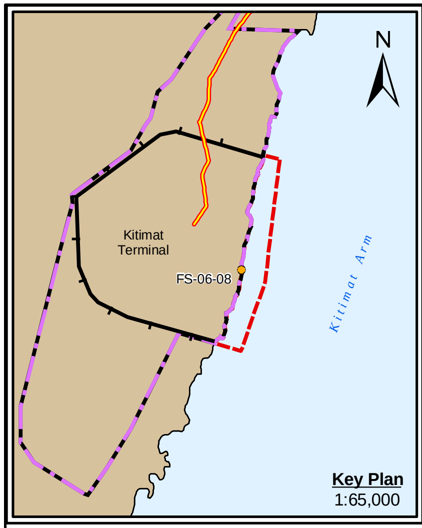
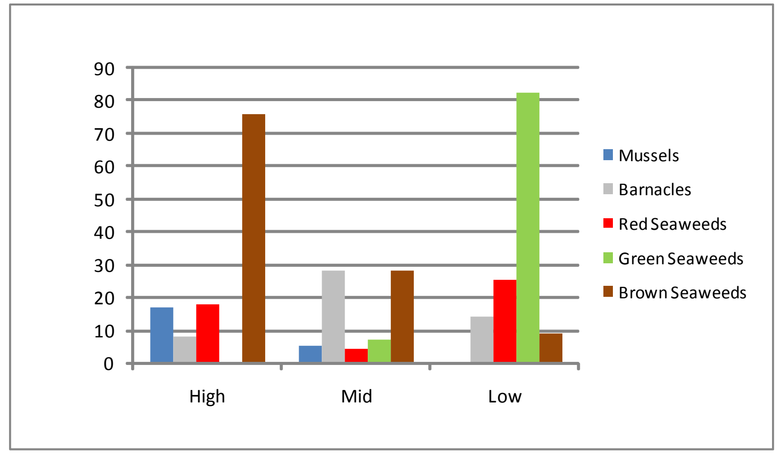
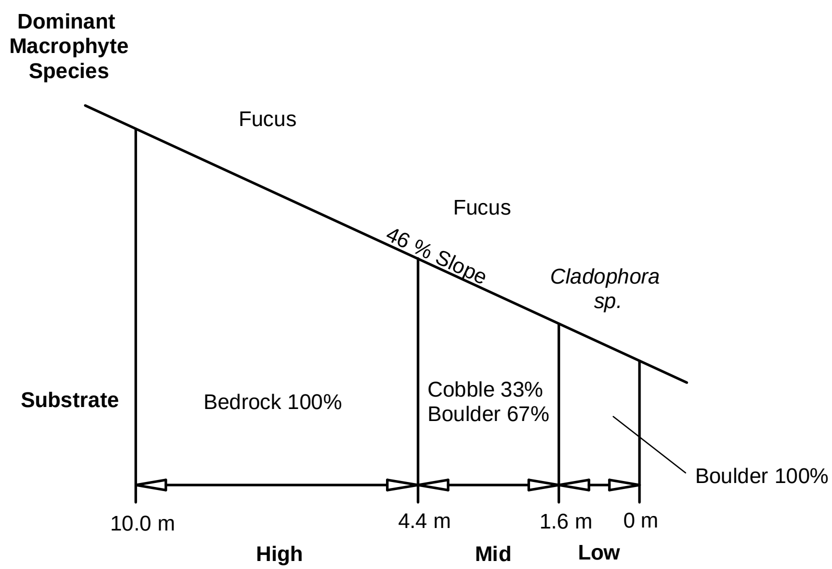


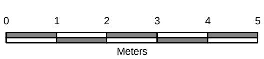


Relative Abundance & Distribution of Flora & Fauna in Transect FS-06-08



Profile of Intertidal Transect FS-06-08

Transect FS-06-08 Looking Upward from Low Water Mark



JWA-1048334-2637

CONTRACTOR: Jacques Whitford AXYS Ltd.		ENBRIDGE NORTHERN GATEWAY PROJECT	FIGURE NUMBER: B-8		DATE: 20100210
PREPARED BY: gem	PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES	2006 Intertidal Transect Survey - Transect FS-06-08	SCALE: 1:150	AUTHOR: NP	APPROVED BY: CM
			PROJECTION: UTM 9	DATUM: NAD 83	

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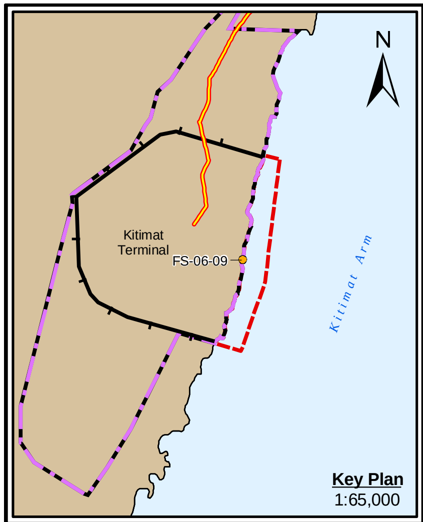
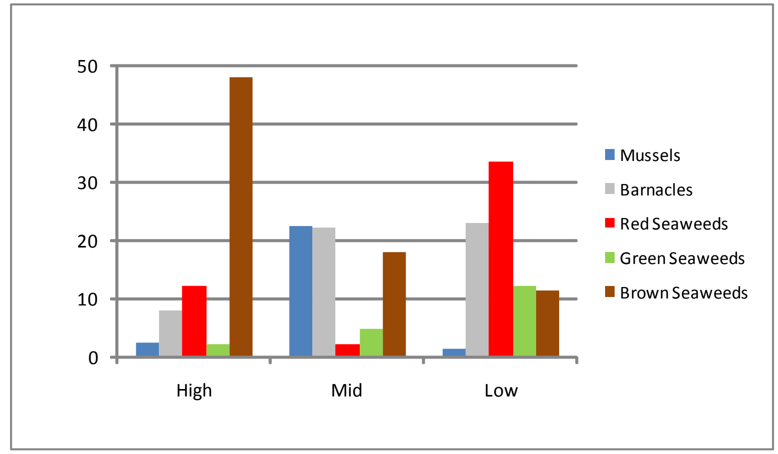
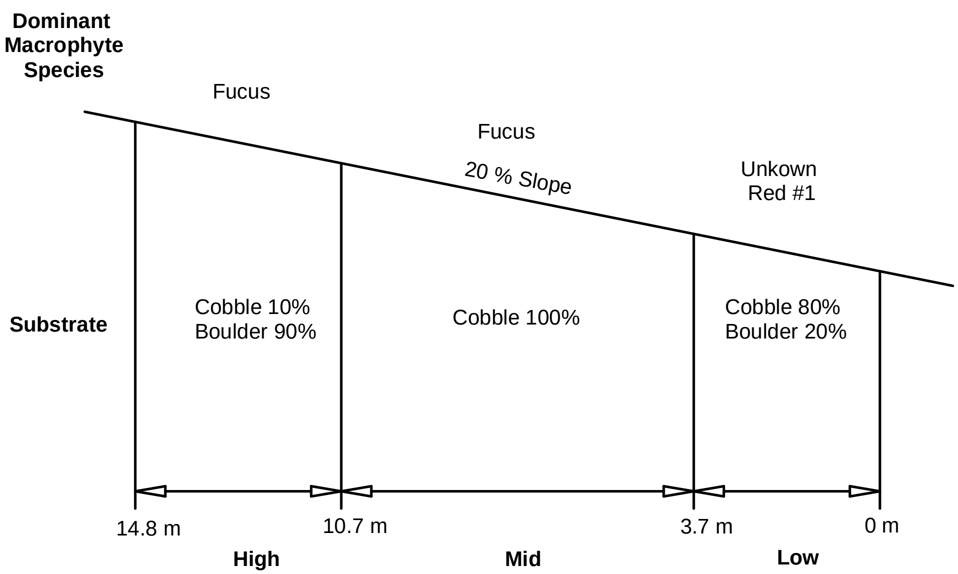




Relative Abundance & Distribution of Flora & Fauna in Transect FS-06-09



Profile of Intertidal Transect FS-06-09

Transect FS-06-09 Looking Upward from Low Water Mark

0 1 2 3 4 5
Meters

JWA-1048334-2638

REFERENCES: NTDB Topographic Mapsheets provided by the Majesty the Queen in Right of Canada, Department of Natural Resources. All rights reserved.

CONTRACTOR: Jacques Whitford AXYS Ltd.		ENBRIDGE NORTHERN GATEWAY PROJECT	FIGURE NUMBER: B-9		DATE: 20100210
PREPARED BY: gem	PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES	2006 Intertidal Transect Survey - Transect FS-06-09	SCALE: 1:150	AUTHOR: NP	APPROVED BY: CM
			PROJECTION: UTM 9	DATUM: NAD 83	

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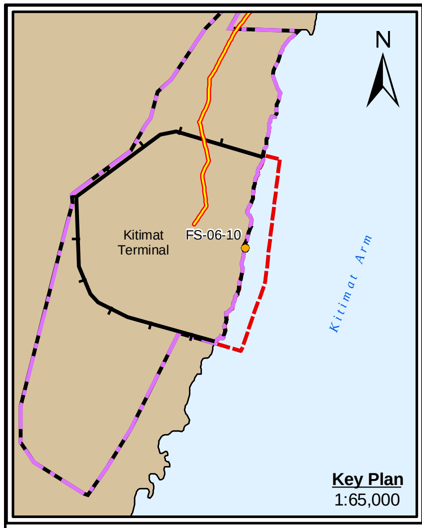
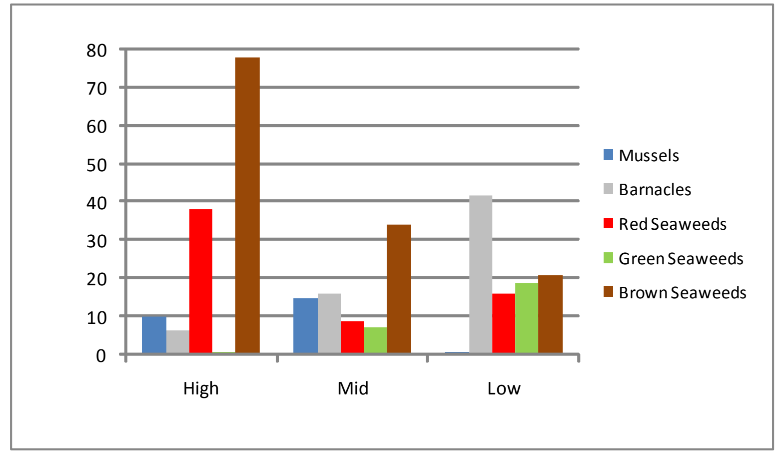
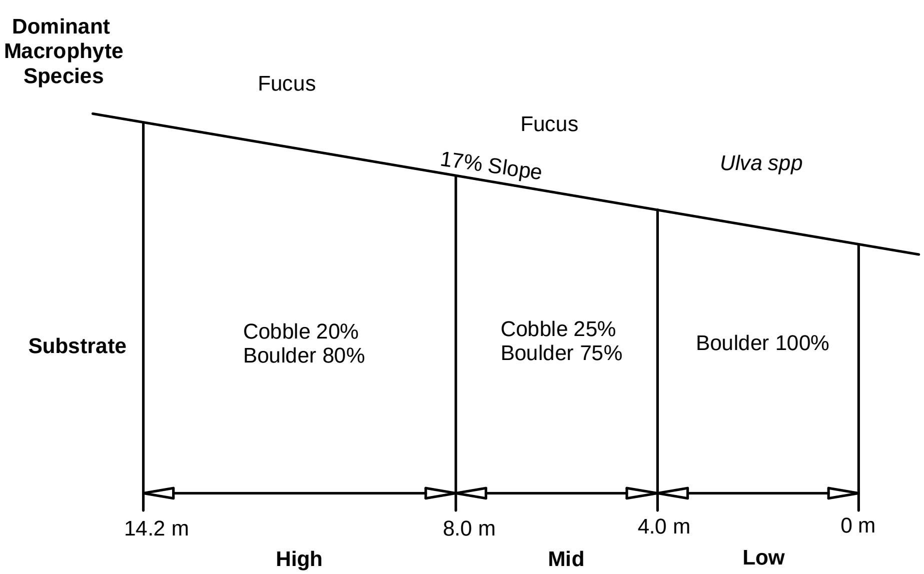




Relative Abundance & Distribution of Flora & Fauna in Transect FS-06-10



Profile of Intertidal Transect FS-06-10

Transect FS-06-10 Looking Downward from High Water Mark

0 1 2 3 4 5

Meters

JWA-1048334-2639

CONTRACTOR: Jacques Whitford AXYS Ltd.	ENBRIDGE NORTHERN GATEWAY PROJECT	FIGURE NUMBER: B-10	DATE: 20100210	
PREPARED BY: gem	PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES	2006 Intertidal Transect Survey - Transect FS-06-10	SCALE: 1:150	AUTHOR: NP	APPROVED BY: CM
			PROJECTION: UTM 9	DATUM: NAD 83

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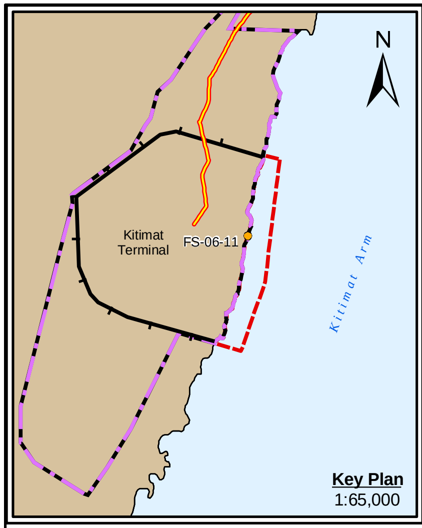
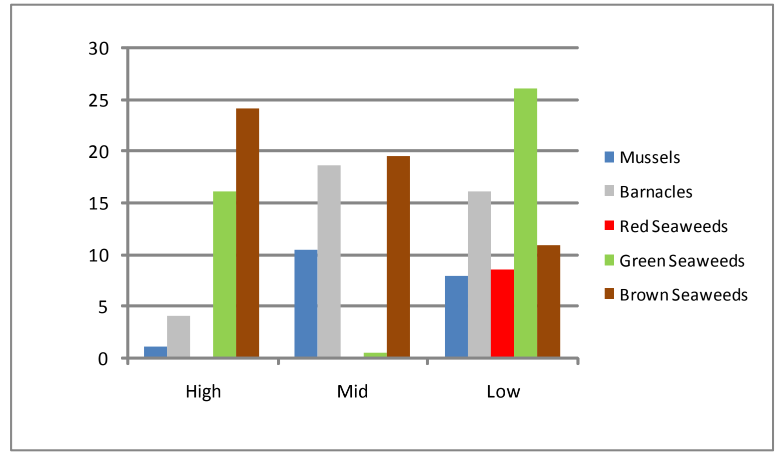
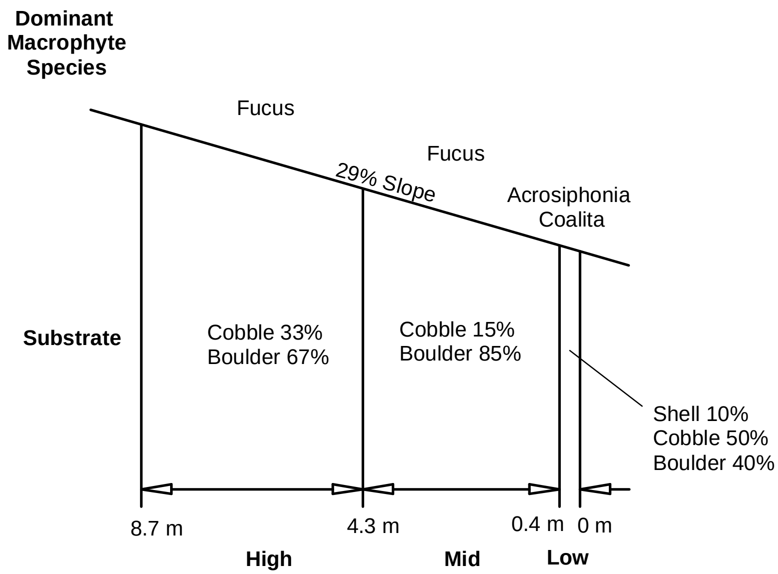




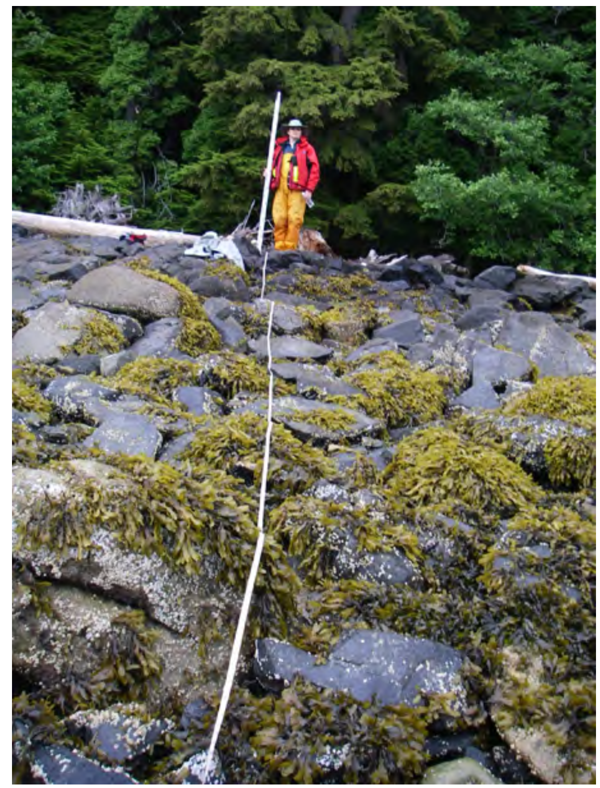
Relative Abundance & Distribution of Flora & Fauna in Transect FS-06-11



Profile of Intertidal Transect FS-06-11

0 1 2 3 4 5
Meters

JWA-1048334-2640



Transect FS-06-11 Looking Upward from Low Water Mark

REFERENCES: NTDB Topographic Mapsheets provided by the Majesty the Queen in Right of Canada, Department of Natural Resources.

CONTRACTOR: Jacques Whitford AXYS Ltd.	ENBRIDGE NORTHERN GATEWAY PROJECT	FIGURE NUMBER: B-11	DATE: 20100210
PREPARED BY: gem / PREPARED FOR: Enbridge Northern Gateway Pipelines	2006 Intertidal Transect Survey - Transect FS-06-11	SCALE: 1:150	AUTHOR: NP / APPROVED BY: CM
		PROJECTION: UTM 9	DATUM: NAD 83

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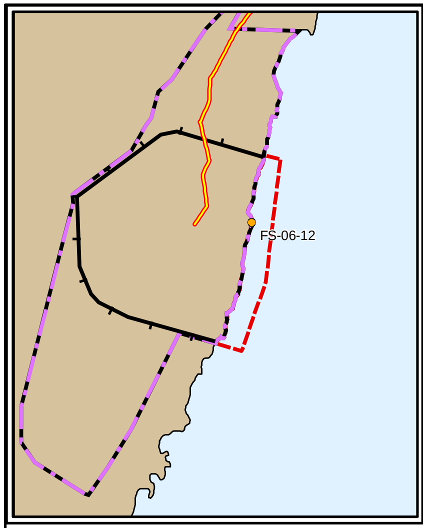
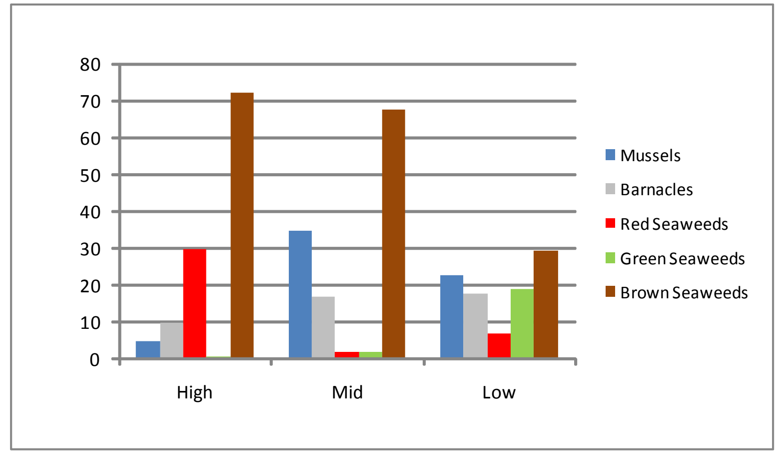
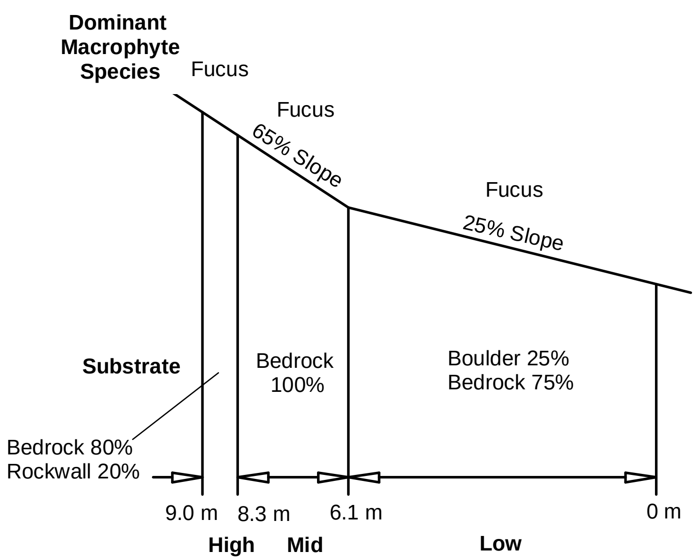




Relative Abundance & Distribution of Flora & Fauna in Transect FS-06-12



Profile of Intertidal Transect FS-06-12

Transect FS-06-12 Looking Upward from Low Water Mark

0 1 2 3 4 5
Meters

JWA-1048334-2641

REFERENCES: NTDB Topographic Mapsheets provided by the Majesty the Queen in Right of Canada, Department of Natural Resources.

CONTRACTOR: Jacques Whitford AXYS Ltd.		ENBRIDGE NORTHERN GATEWAY PROJECT	FIGURE NUMBER: B-12		DATE: 20100210
PREPARED BY: gem	PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES	2006 Intertidal Transect Survey - Transect FS-06-12	SCALE: 1:150	AUTHOR: NP	APPROVED BY: CM
			PROJECTION: UTM 9	DATUM: NAD 83	

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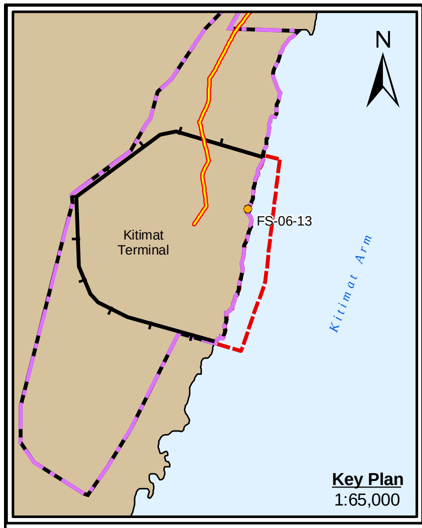
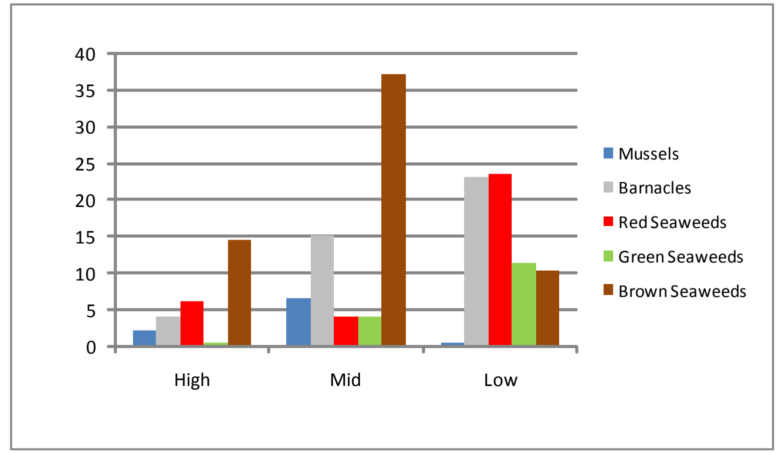
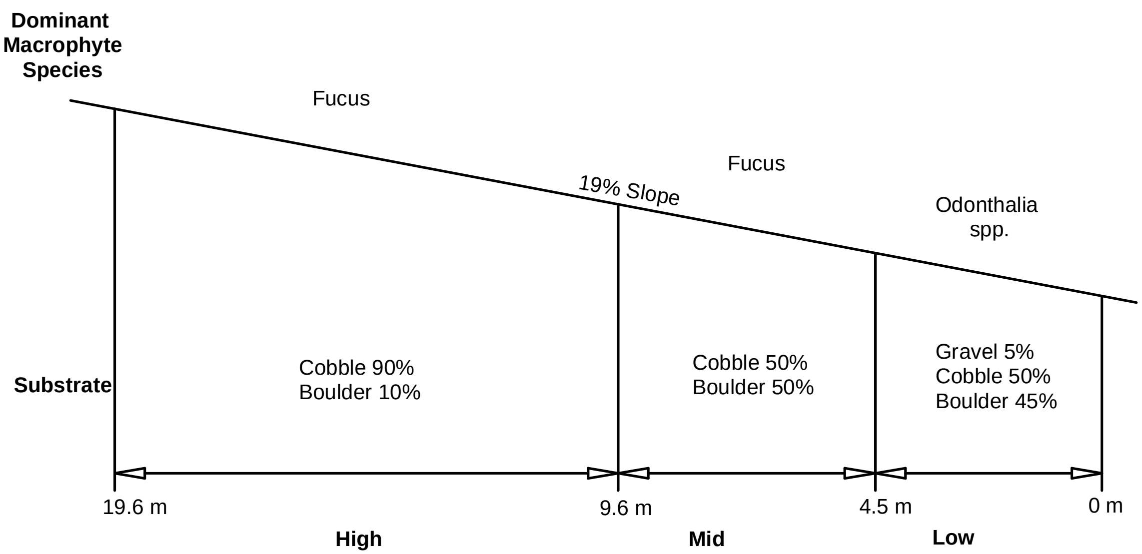




Relative Abundance & Distribution of Flora & Fauna in Transect FS-06-13



Profile of Intertidal Transect FS-06-13

0 1 2 3 4 5
Meters

JWA-1048334-2642

Transect FS-06-13 Looking Upward from Low Water Mark

REFERENCES: NTDB Topographic Mapsheets provided by the Majesty the Queen in Right of Canada, Department of Natural Resources.

CONTRACTOR: Jacques Whitford AXYS Ltd.		ENBRIDGE NORTHERN GATEWAY PROJECT	FIGURE NUMBER: B-13		DATE: 20100210
PREPARED BY: gem	PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES	2006 Intertidal Transect Survey - Transect FS-06-13	SCALE: 1:150	AUTHOR: NP	APPROVED BY: CM
			PROJECTION: UTM 9	DATUM: NAD 83	

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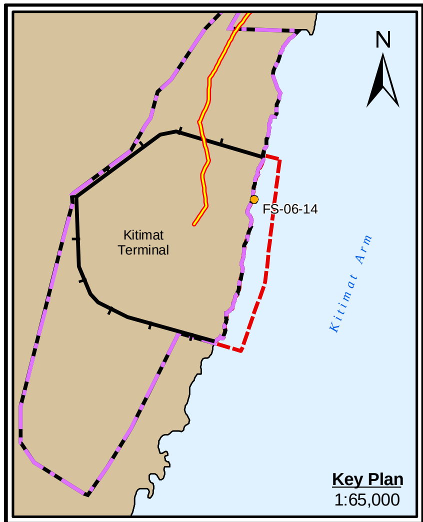
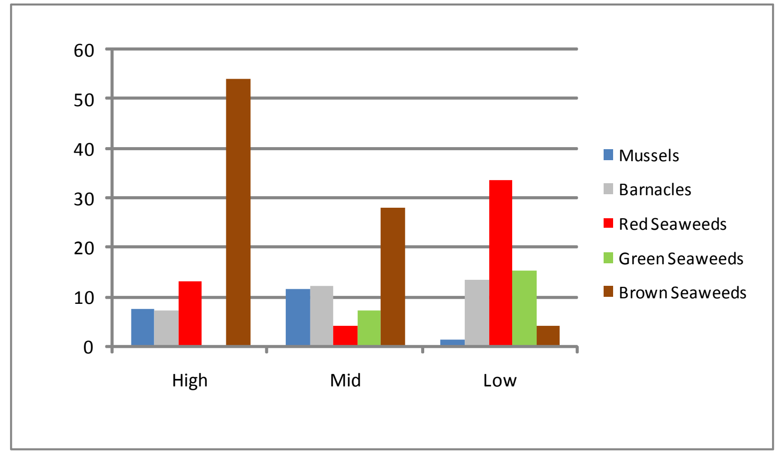
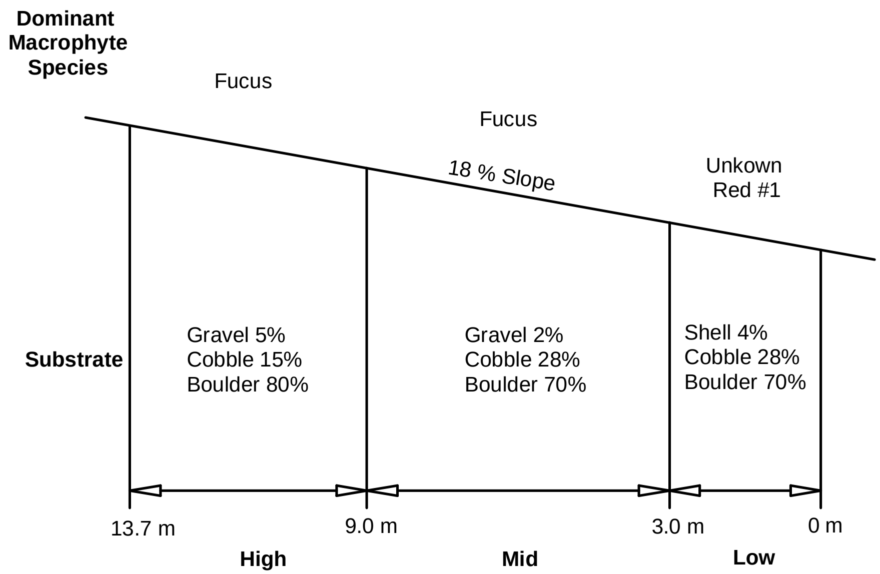




Relative Abundance & Distribution of Flora & Fauna in Transect FS-06-14



Profile of Intertidal Transect FS-06-14

Transect FS-06-14 Looking Upward from Low Water Mark

0 1 2 3 4 5
Meters

JWA-1048334-2643

CONTRACTOR: Jacques Whitford AXYS Ltd.	ENBRIDGE NORTHERN GATEWAY PROJECT	FIGURE NUMBER: B-14	DATE: 20100210
PREPARED BY: gem / PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES	2006 Intertidal Transect Survey - Transect FS-06-14	SCALE: 1:150	AUTHOR: NP / APPROVED BY: CM
		PROJECTION: UTM 9	DATUM: NAD 83

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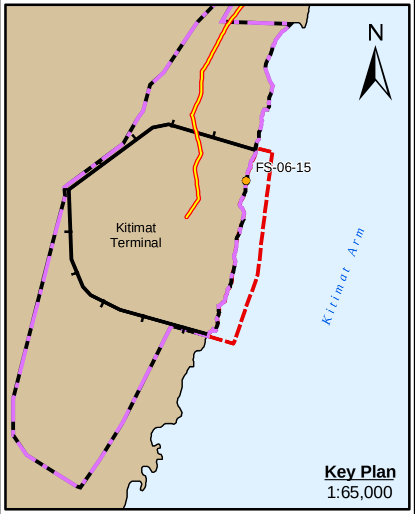
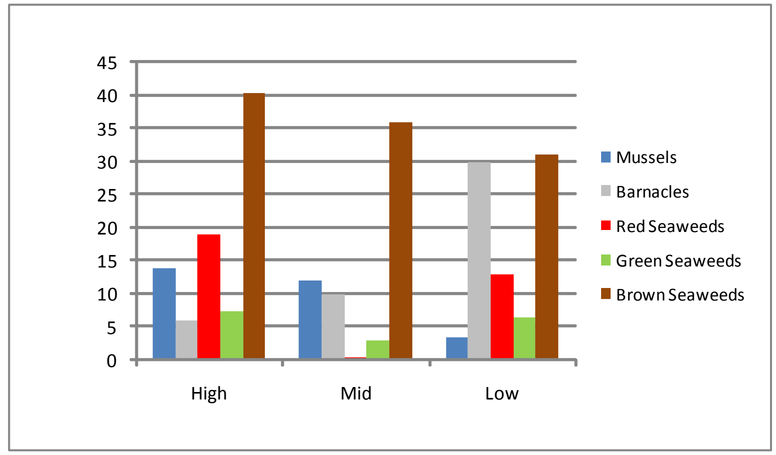
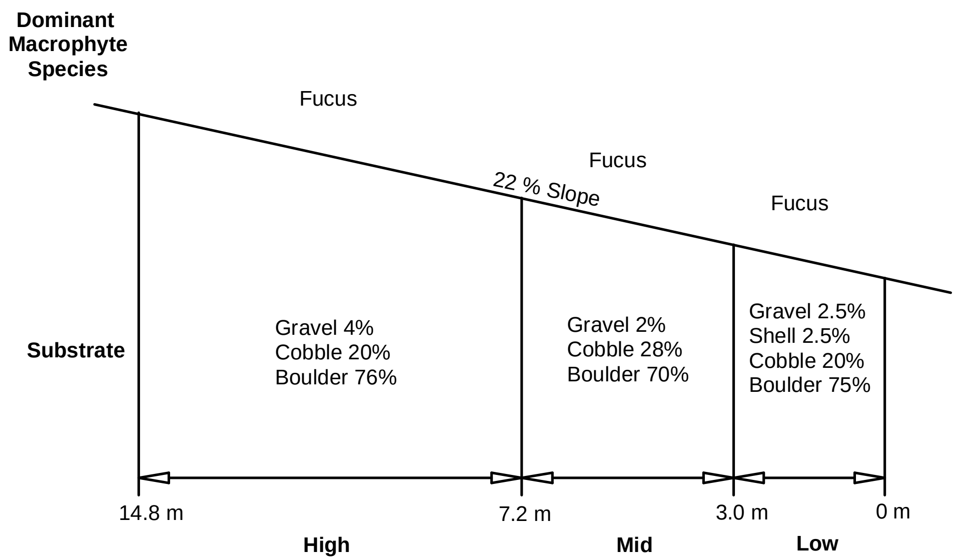




Relative Abundance & Distribution of Flora & Fauna in Transect FS-06-15



Profile of Intertidal Transect FS-06-15

Transect FS-06-15 Looking Upward from Low Water Mark

0 1 2 3 4 5
Meters

JWA-148334-2644

REFERENCES: NTDB Topographic Mapsheets provided by the Majesty the Queen in Right of Canada, Department of Natural Resources. All rights reserved.

CONTRACTOR: Jacques Whitford AXYS Ltd.		**ENBRIDGE NORTHERN GATEWAY PROJECT**
PREPARED BY: gem	PREPARED FOR: ENBRIDGE NORTHERN	2006 Intertidal Transect Survey - Transect FS-06-15

FIGURE NUMBER: B-15		DATE: 20100210
SCALE: 1:150	AUTHOR: NP	APPROVED BY: CM
PROJECTION: UTM 9	DATUM: NAD 83	

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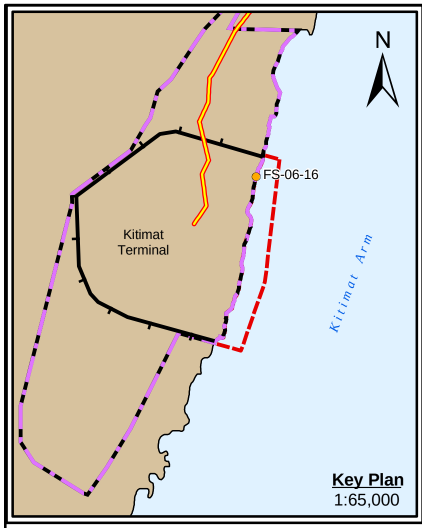
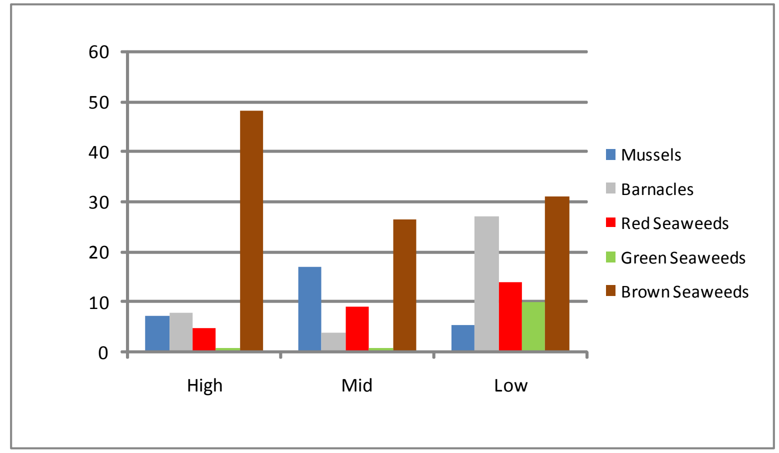
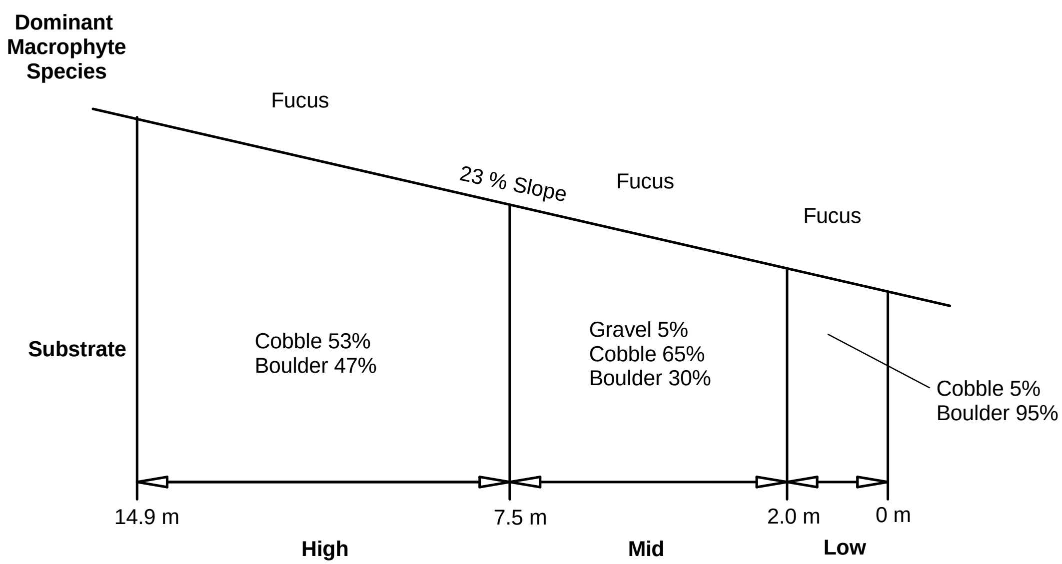




Relative Abundance & Distribution of Flora & Fauna in Transect FS-06-16



Profile of Intertidal Transect FS-06-16

Transect FS-06-16 Looking Upward from Low Water Mark

0 1 2 3 4 5
Meters

JWA-1048334-2645

REFERENCES: NTDB Topographic Mapsheets provided by the Majesty the Queen in Right of Canada, Department of Natural Resources. All rights reserved.

CONTRACTOR: Jacques Whitford AXYS Ltd.		**ENBRIDGE NORTHERN GATEWAY PROJECT**	FIGURE NUMBER: B-16	DATE: 20100210
PREPARED BY: gem	PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES	2006 Intertidal Transect Survey - Transect FS-06-16	SCALE: 1:150	AUTHOR: NP / APPROVED BY: CM
			PROJECTION: UTM 9	DATUM: NAD 83

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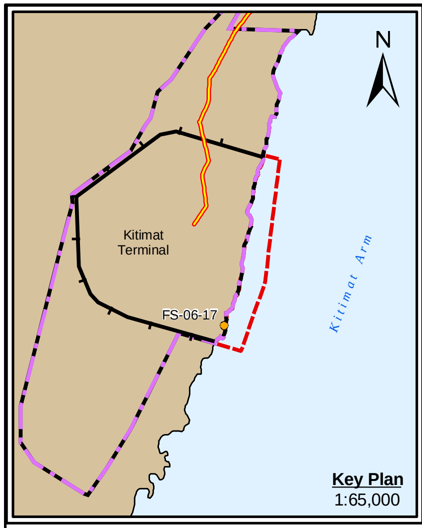
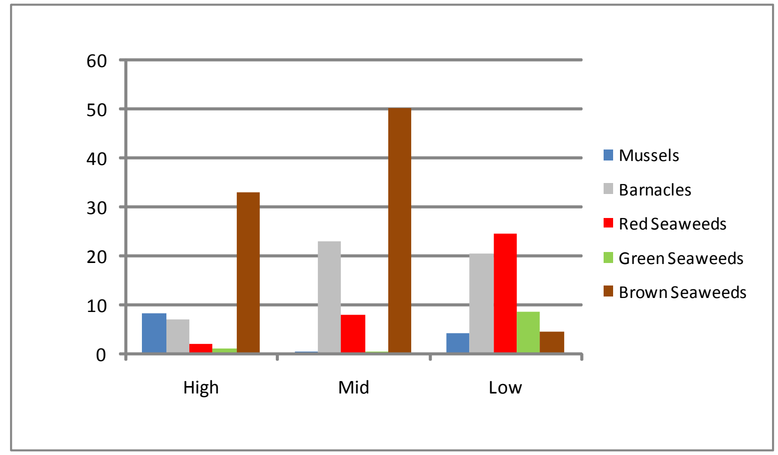
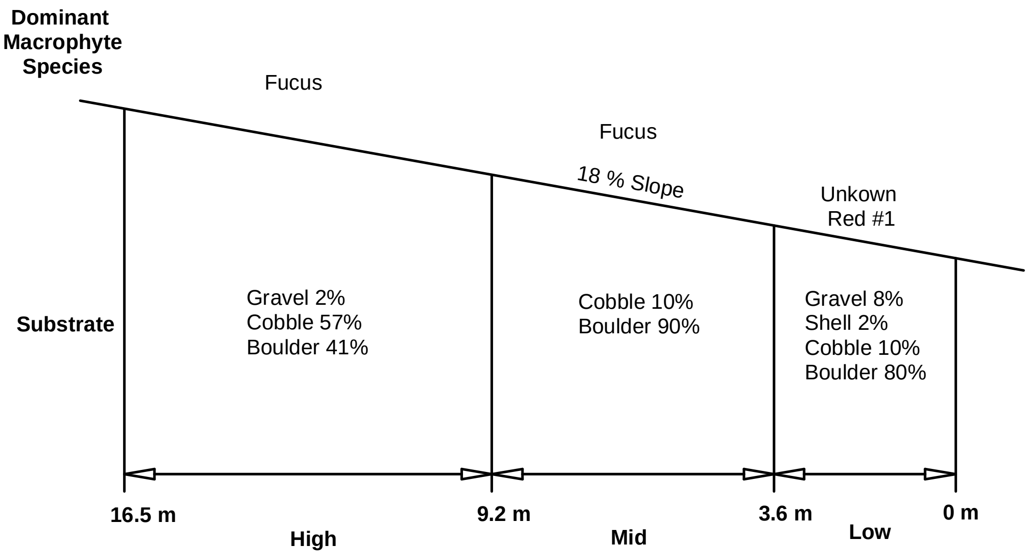




Relative Abundance & Distribution of Flora & Fauna in Transect FS-06-17



Profile of Intertidal Transect FS-06-17

Transect FS-06-17 Looking Upward from Low Water Mark

0 1 2 3 4 5
Meters

JWA-1048334-2646

CONTRACTOR: Jacques Whitford AXYS Ltd.

PREPARED BY: gem

PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES

ENBRIDGE NORTHERN GATEWAY PROJECT

2006 Intertidal Transect Survey - Transect FS-06-17

FIGURE NUMBER:		DATE:
B-17		20100210
SCALE: 1:150	AUTHOR: NP	APPROVED BY: CM
PROJECTION: UTM 9	DATUM: NAD 83	

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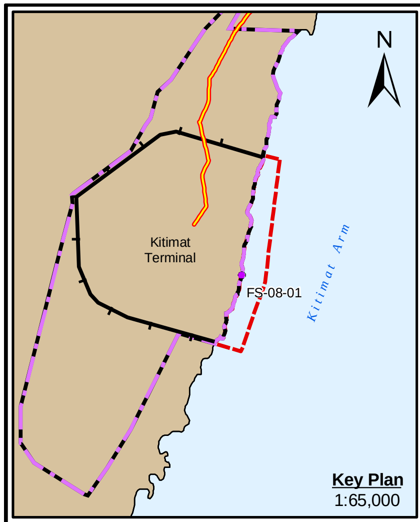
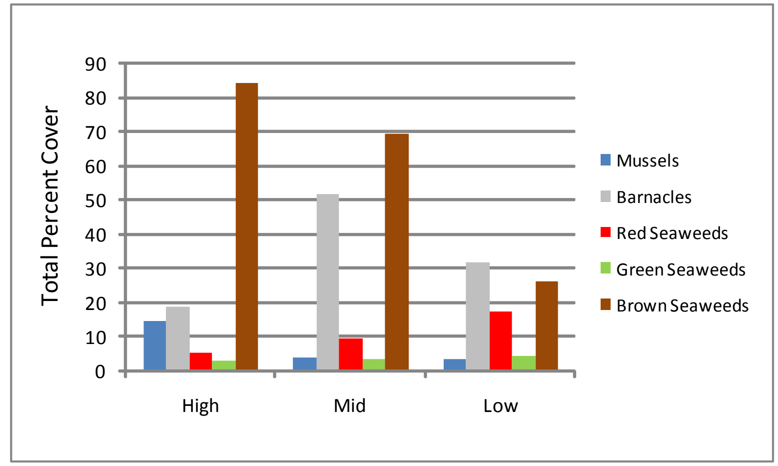
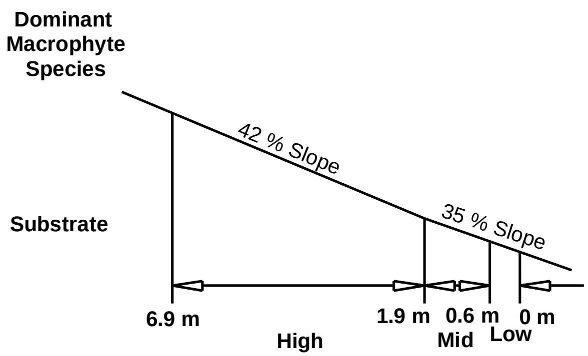


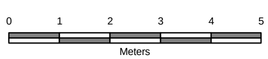


Relative Abundance & Distribution of Flora & Fauna in Transect FS-08-01



Profile of Intertidal Transect FS-08-01

Transect FS-08-01 Looking Upward from Low Water Mark



JWA-1048334-2713

CONTRACTOR: Jacques Whitford AXYS Ltd.		**ENBRIDGE NORTHERN GATEWAY PROJECT**	FIGURE NUMBER: B-18	DATE: 20100210
PREPARED BY:	PREPARED FOR:	2008 Intertidal Transect Survey - Transect FS-08-01	SCALE: 1:150	AUTHOR: SS / APPROVED BY: CM
			PROJECTION: UTM 9	DATUM: NAD 83

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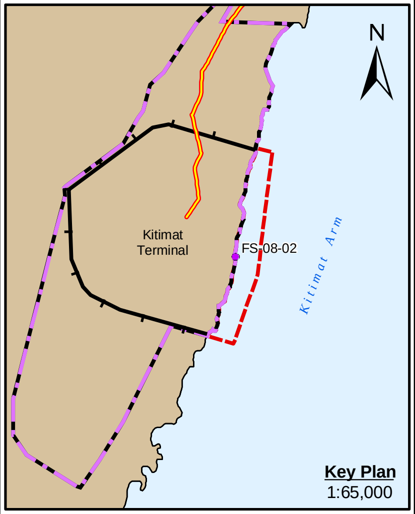

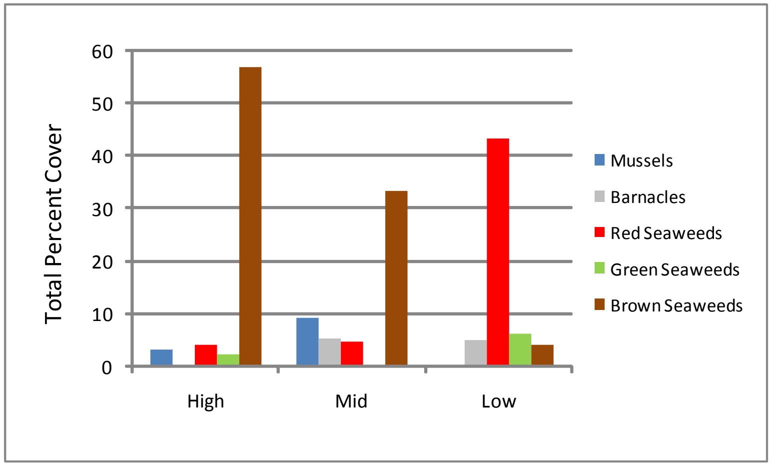

Relative Abundance & Distribution of Flora & Fauna in Transect FS-08-02

Profile of Intertidal Transect FS-08-02

0 2 4 6 8 10

Meters

Transect FS-08-02 Looking Upward from Low Water Mark

JWA-1048334-2714

CONTRACTOR: Jacques Whitford AXYS Ltd.

PREPARED BY: gem

PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES

ENBRIDGE NORTHERN GATEWAY PROJECT

2008 Intertidal Transect Survey - Transect FS-08-02

FIGURE NUMBER: B-19

DATE: 20100210

SCALE: 1:300

AUTHOR: SS

APPROVED BY: CM

PROJECTION: UTM 9

DATUM: NAD 83

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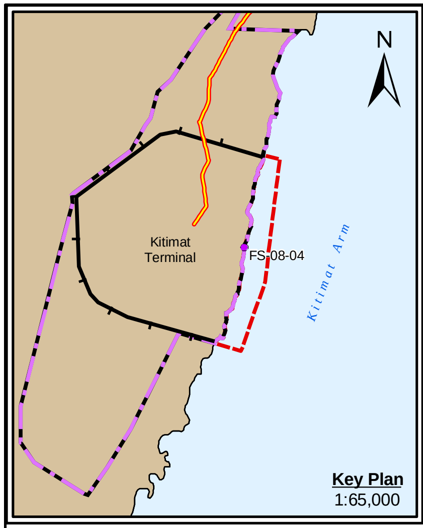
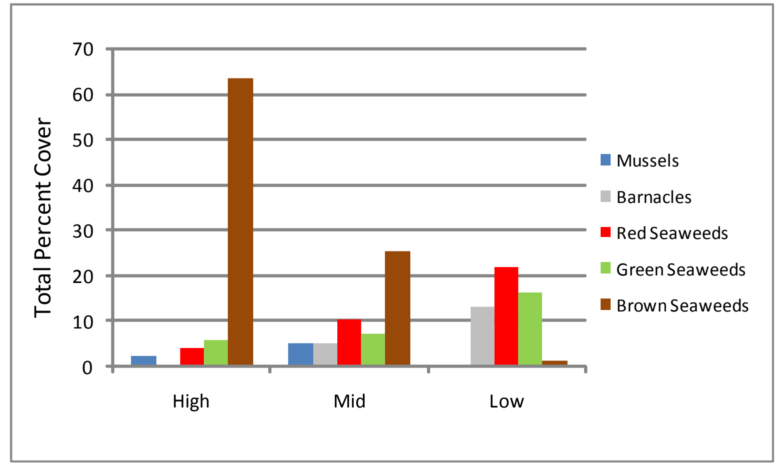
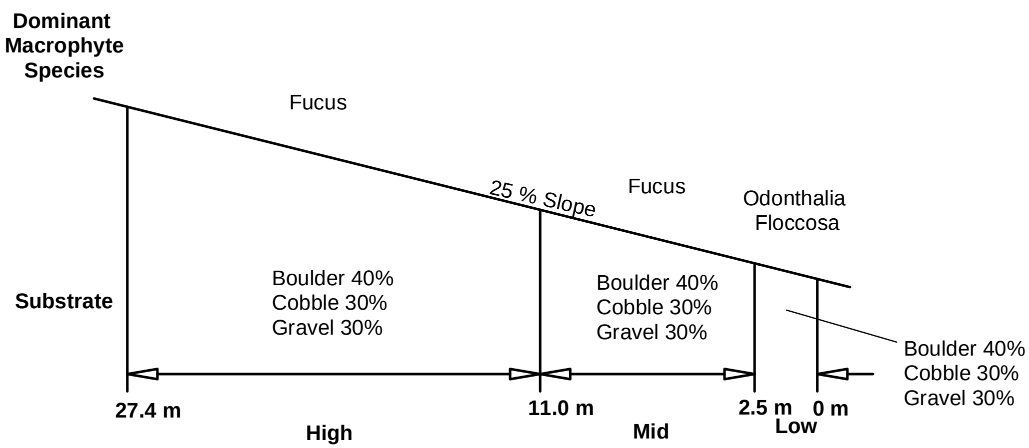




Relative Abundance & Distribution of Flora & Fauna in Transect FS-08-04



Profile of Intertidal Transect FS-08-04

Transect FS-08-04 Looking Upward from Low Water Mark

JWA-1048334-2664

REFERENCES: NTDB Topographic Mapsheets provided by the Majesty the Queen in Right of Canada, Department of Natural Resources.

CONTRACTOR: Jacques Whitford AXYS Ltd.		ENBRIDGE NORTHERN GATEWAY PROJECT	FIGURE NUMBER: B-20		DATE: 20100210
PREPARED BY: gem	PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES	2008 Intertidal Transect Survey - Transect FS-08-04	SCALE: 1:300	AUTHOR: SS	APPROVED BY: CM
			PROJECTION: UTM 9		DATUM: NAD 83

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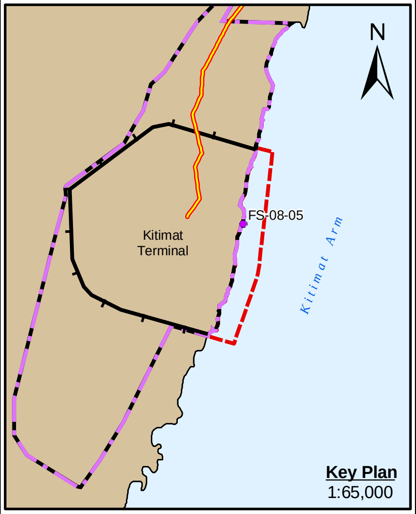
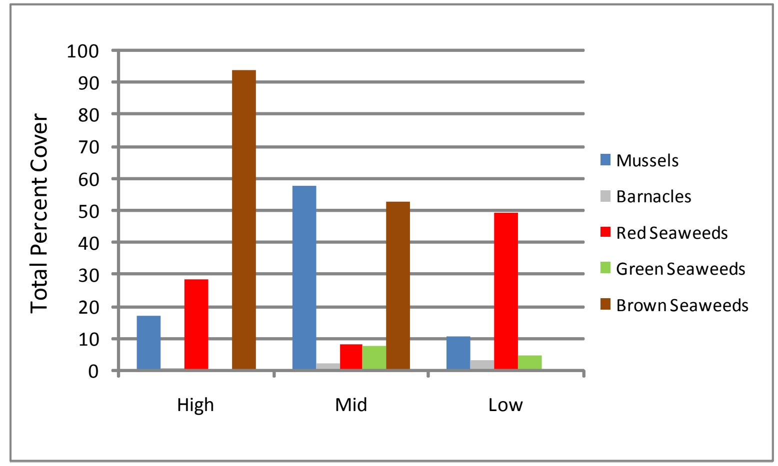
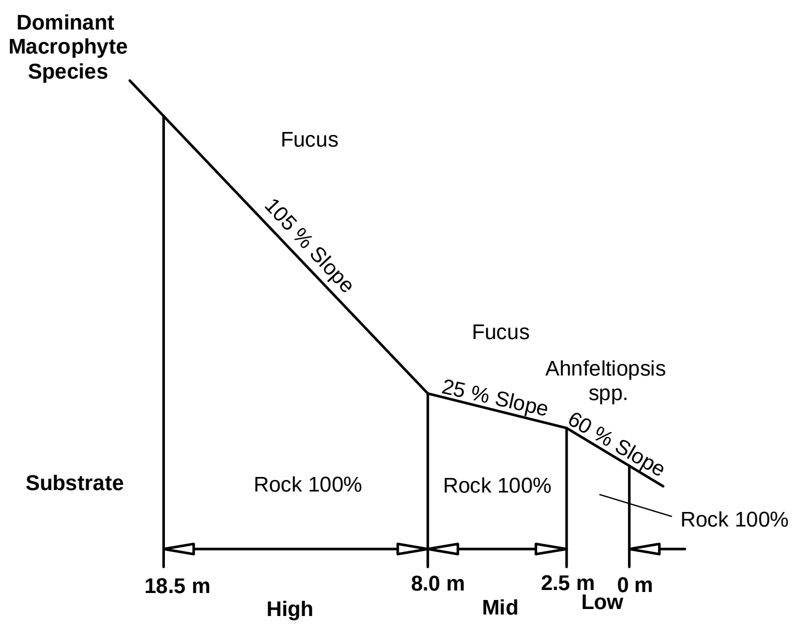




Relative Abundance & Distribution of Flora & Fauna in Transect FS-08-05



Profile of Intertidal Transect FS-08-05

Transect FS-08-05 Looking Upward from Low Water Mark

0 2 4 6 8 10
Meters

JWA-1048334-2665

REFERENCES: NTDB Topographic Mapsheets provided by the Majesty the Queen in Right of Canada, Department of Natural Resources. All rights reserved.

CONTRACTOR: Jacques Whitford AXYS Ltd.

PREPARED BY: gem

PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES

ENBRIDGE NORTHERN GATEWAY PROJECT

2008 Intertidal Transect Survey - Transect FS-08-05

FIGURE NUMBER:	B-21
DATE:	20100210
SCALE:	1:300
AUTHOR:	SS
APPROVED BY:	CM
PROJECTION:	UTM 9
DATUM:	NAD 83

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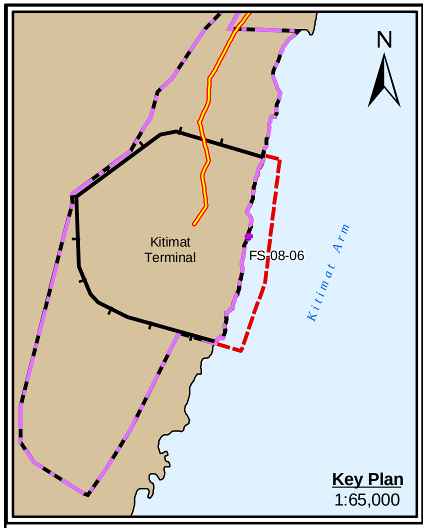
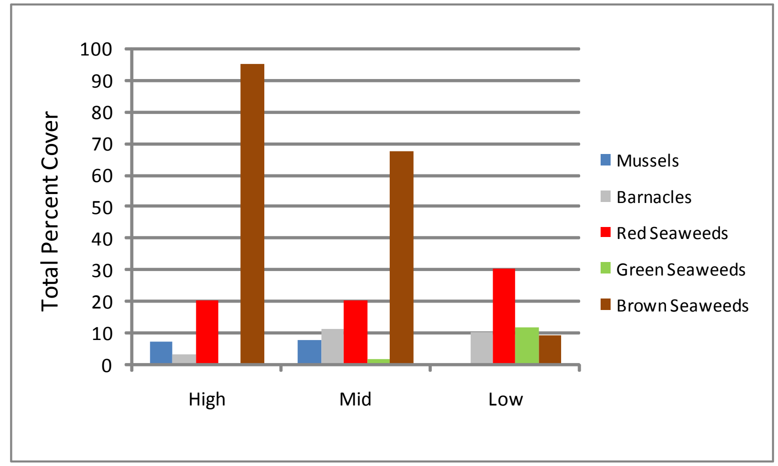
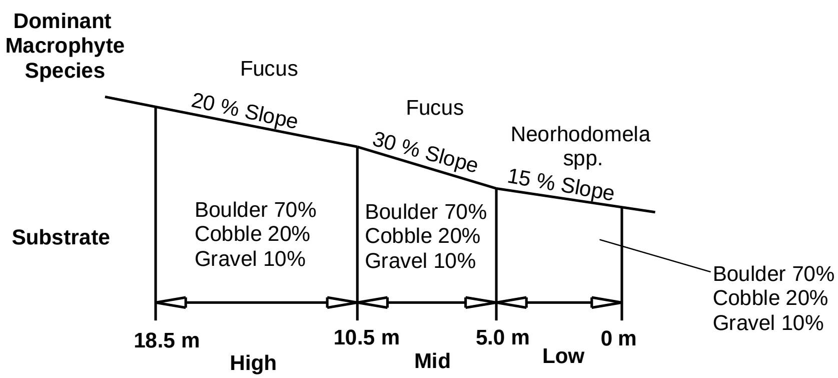




Relative Abundance & Distribution of Flora & Fauna in Transect FS-08-06



Profile of Intertidal Transect FS-08-06

Transect FS-08-06 Looking Upward from Low Water Mark

0 2 4 6 8 10
Meters

JWA-1048334-2715

REFERENCES: NTDB Topographic Mapsheets provided by the Majesty the Queen in Right of Canada, Department of Natural Resources.

CONTRACTOR: Jacques Whitford AXYS Ltd.	ENBRIDGE NORTHERN GATEWAY PROJECT	FIGURE NUMBER: B-22	DATE: 20100210
PREPARED BY: / PREPARED FOR:	2008 Intertidal Transect Survey - Transect FS-08-06	SCALE: 1:300	AUTHOR: SS / APPROVED BY: CM
		PROJECTION: UTM 9	DATUM: NAD 83

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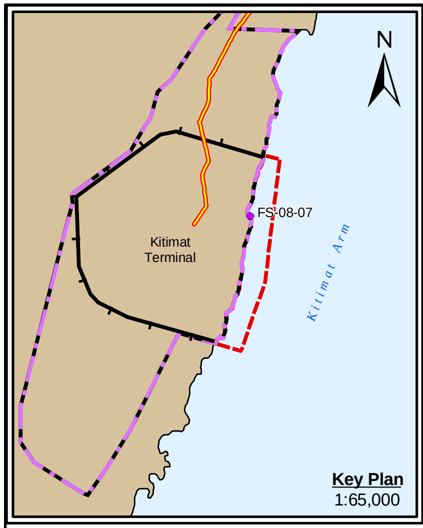
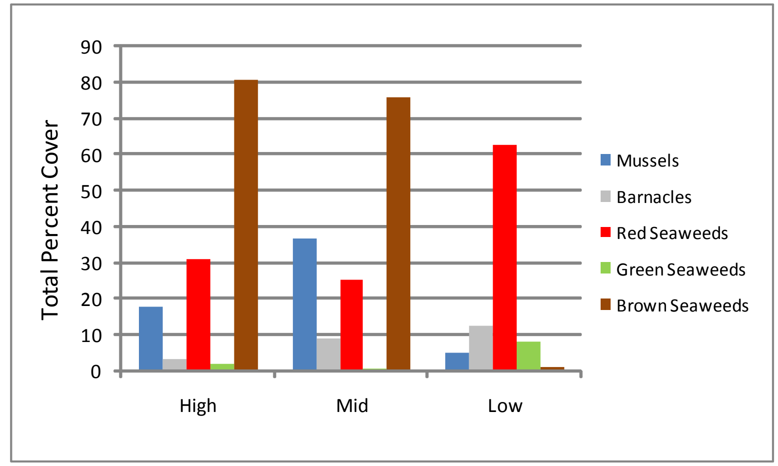
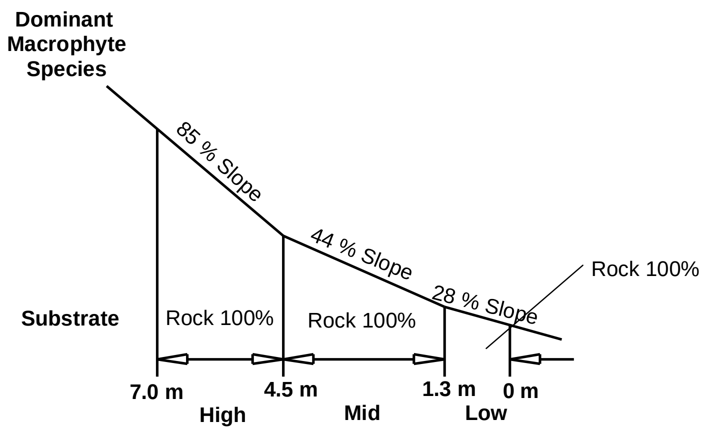


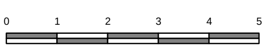


Relative Abundance & Distribution of Flora & Fauna in Transect FS-08-07



Profile of Intertidal Transect FS-08-07

Transect FS-08-07 Looking Upward from Low Water Mark



JWA-1048334-2716

REFERENCES: NTDB Topographic Mapsheets provided by the Majesty the Queen in Right of Canada, Department of Natural Resources. All rights reserved.

CONTRACTOR: Jacques Whitford AXYS Ltd.

PREPARED BY: gem

PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES

ENBRIDGE NORTHERN GATEWAY PROJECT

2008 Intertidal Transect Survey - Transect FS-08-07

FIGURE NUMBER: B-23

DATE: 20100210

SCALE: 1:150

AUTHOR: SS

APPROVED BY: CM

PROJECTION: UTM 9

DATUM: NAD 83

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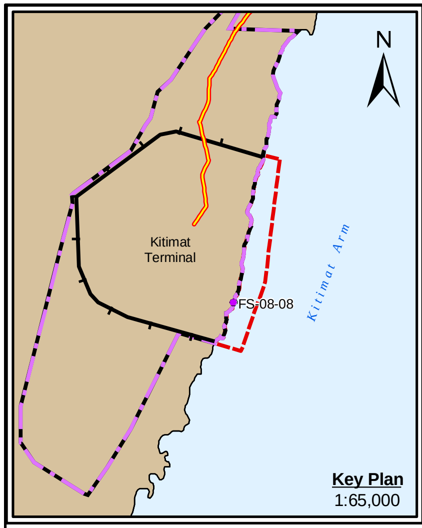
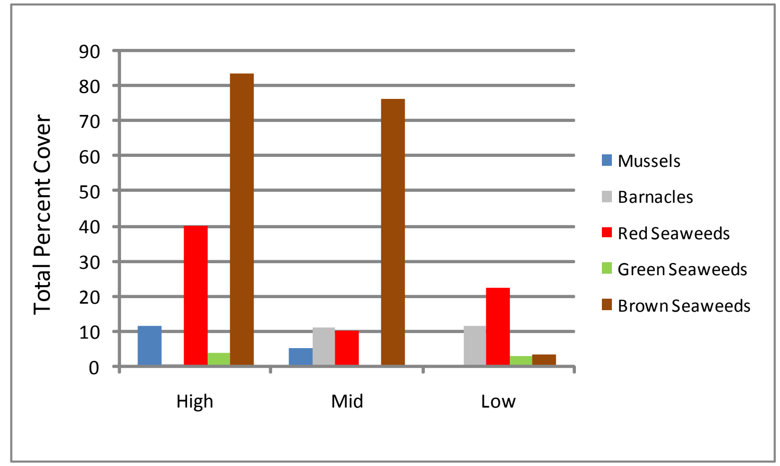
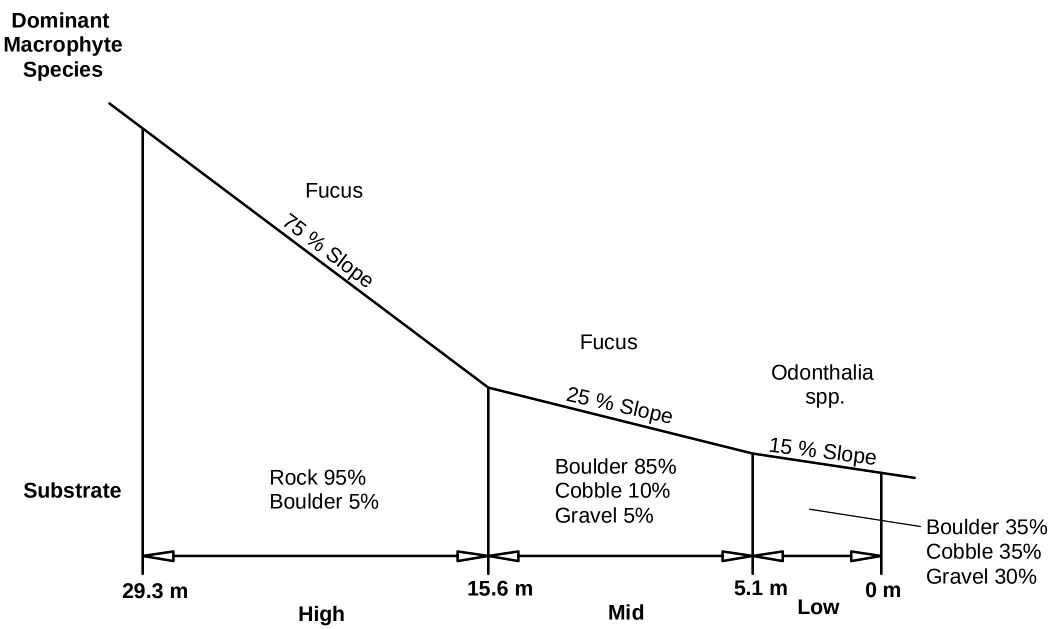




Relative Abundance & Distribution of Flora & Fauna in Transect FS-08-08



Profile of Intertidal Transect FS-08-08

Transect FS-08-08 Looking Upward from Low Water Mark

0 2 4 6 8 10
Meters

JWA-1048334-2666

REFERENCES: NTDB Topographic Mapsheets provided by the Majesty the Queen in Right of Canada, Department of Natural Resources. All rights reserved.

CONTRACTOR: Jacques Whitford AXYS Ltd.		ENBRIDGE NORTHERN GATEWAY PROJECT	FIGURE NUMBER: B-24		DATE: 20100210
PREPARED BY: gem	PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES	2008 Intertidal Transect Survey - Transect FS-08-08	SCALE: 1:300	AUTHOR: SS	APPROVED BY: CM
			PROJECTION: UTM 9	DATUM: NAD 83	

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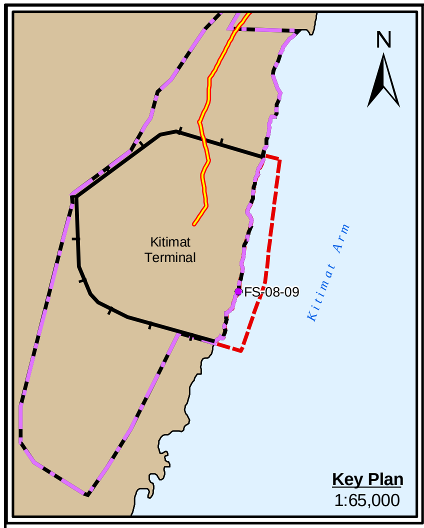
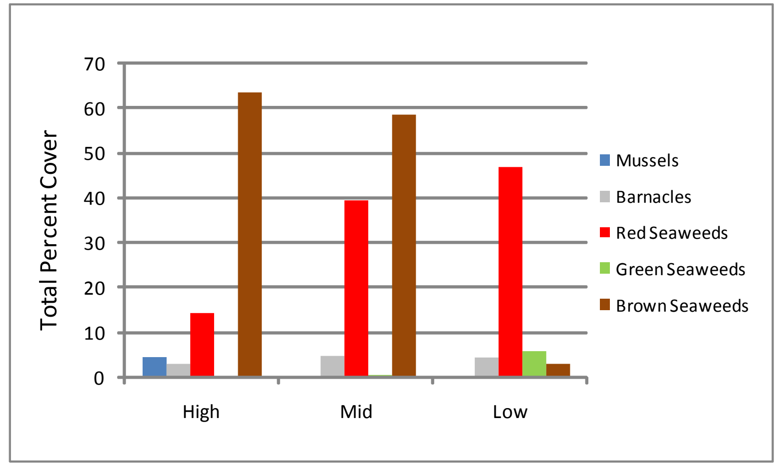
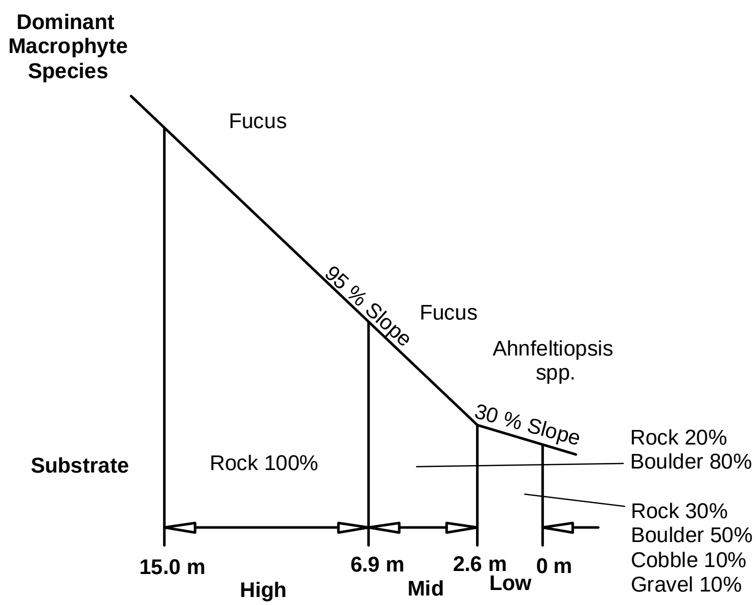




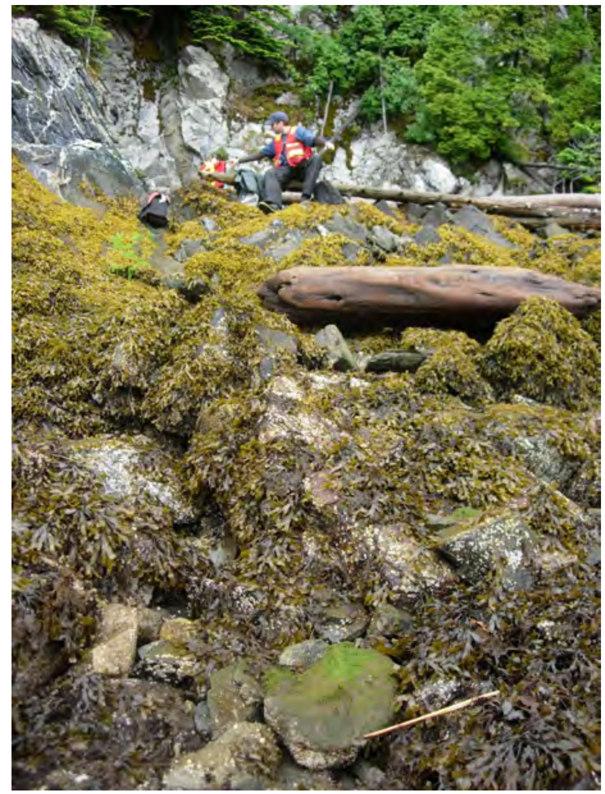
Relative Abundance & Distribution of Flora & Fauna in Transect FS-08-09



Profile of Intertidal Transect FS-08-09

0 2 4 6 8 10
Meters

JWA-1048334-2667



Transect FS-08-09 Looking Upward from Low Water Mark

REFERENCES: NTDB Topographic Mapsheets provided by the Majesty the Queen in Right of Canada, Department of Natural Resources.

CONTRACTOR: Jacques Whitford AXYS Ltd.		ENBRIDGE NORTHERN GATEWAY PROJECT	FIGURE NUMBER: B-25		DATE: 20100210
PREPARED BY: gem	PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES	2008 Intertidal Transect Survey - Transect FS-08-09	SCALE: 1:300	AUTHOR: SS	APPROVED BY: CM
			PROJECTION: UTM 9	DATUM: NAD 83	

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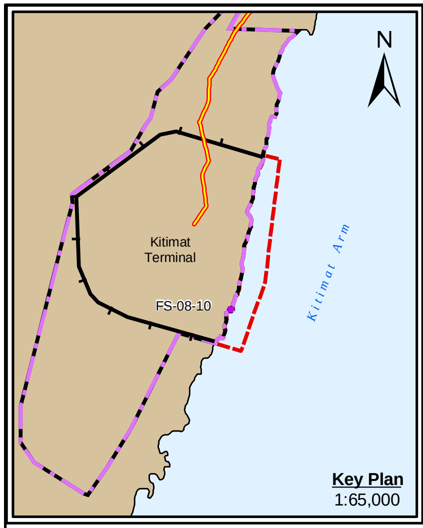
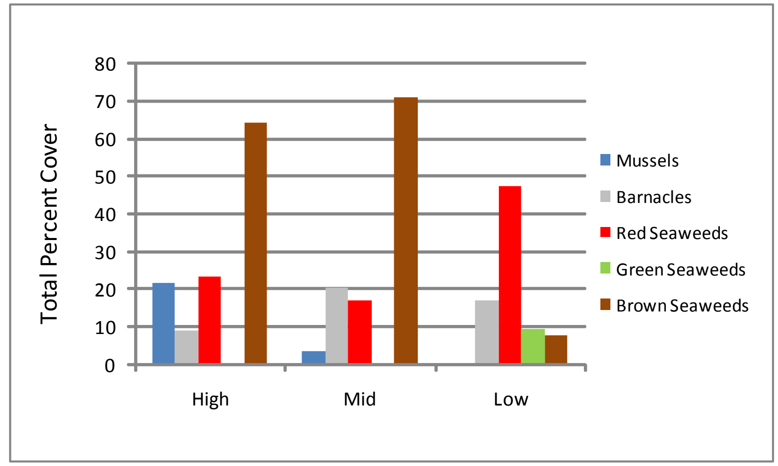
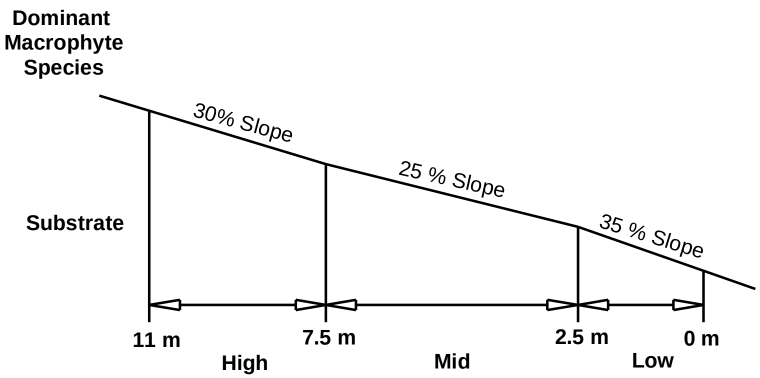




Relative Abundance & Distribution of Flora & Fauna in Transect FS-08-10



Profile of Intertidal Transect FS-08-10

Transect FS-08-10 Looking Upward from Low Water Mark

0 1 2 3 4 5

Meters

JWA-1048334-2717

REFERENCES: NTDB Topographic Mapsheets provided by the Majesty the Queen in Right of Canada, Department of Natural Resources. All rights reserved.

CONTRACTOR: Jacques Whitford AXYS Ltd.

PREPARED BY: gem

PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES

ENBRIDGE NORTHERN GATEWAY PROJECT

2008 Intertidal Transect Survey - Transect FS-08-10

FIGURE NUMBER: B-26		DATE: 20100210
SCALE: 1:150	AUTHOR: SS	APPROVED BY: CM
PROJECTION: UTM 9	DATUM: NAD 83	

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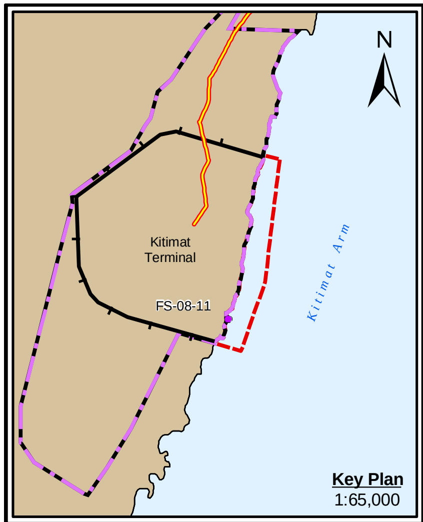
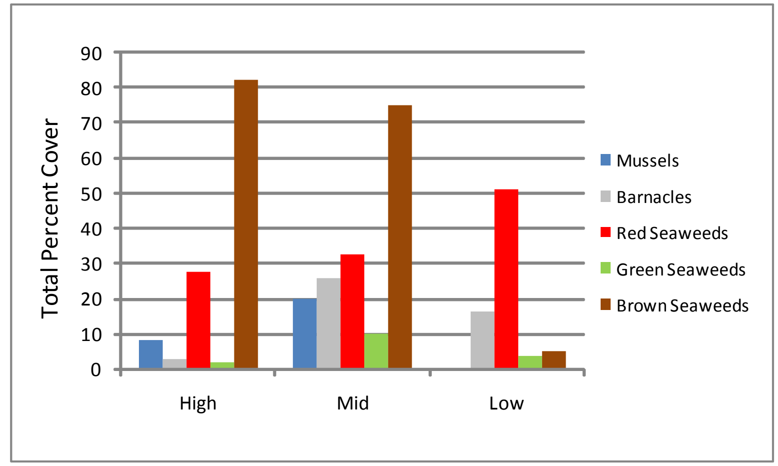
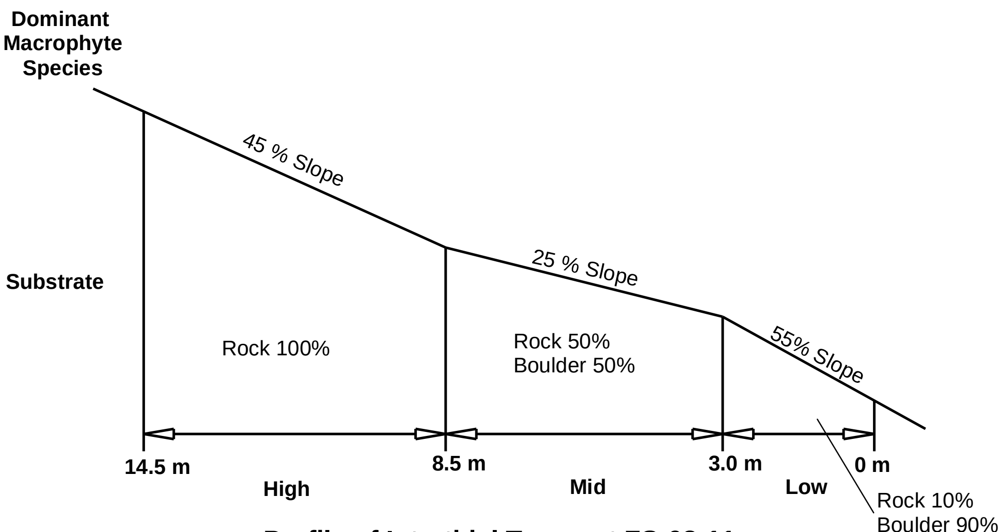


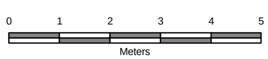


Relative Abundance & Distribution of Flora & Fauna in Transect FS-08-11



Profile of Intertidal Transect FS-08-11

Transect FS-08-11 Looking Upward from Low Water Mark



JWA-1048334-2718

CONTRACTOR: Jacques Whitford AXYS Ltd.	ENBRIDGE NORTHERN GATEWAY PROJECT	FIGURE NUMBER: B-27		DATE: 20100210
PREPARED BY: gem / PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES	2008 Intertidal Transect Survey - Transect FS-08-11	SCALE: 1:150	AUTHOR: SS	APPROVED BY: CM
		PROJECTION: UTM 9		DATUM: NAD 83

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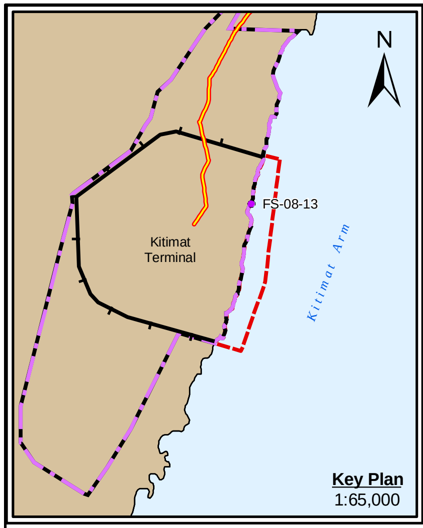
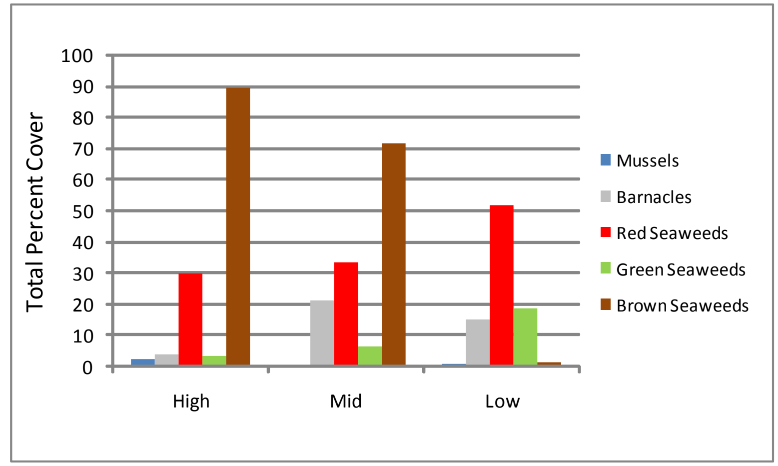
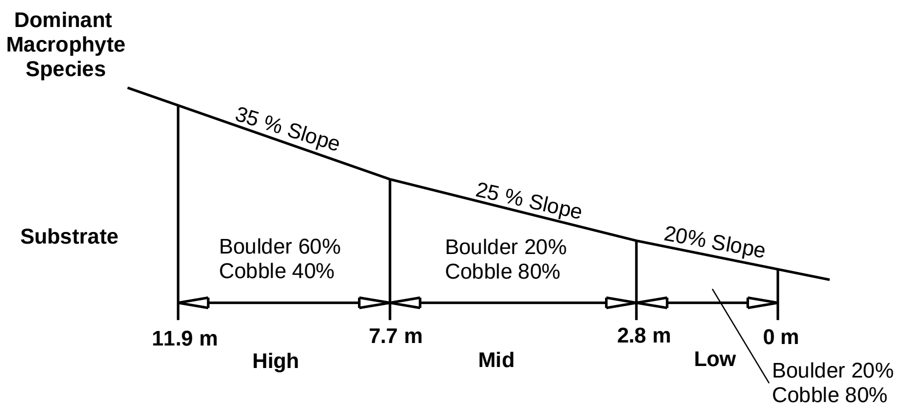




Relative Abundance & Distribution of Flora & Fauna in Transect FS-08-13



Profile of Intertidal Transect FS-08-13

Transect FS-08-13 Looking Upward from Low Water Mark

0 1 2 3 4 5
Meters

JWA-1048334-2719

REFERENCES: NTDB Topographic Mapsheets provided by the Majesty the Queen in Right of Canada, Department of Natural Resources. All rights reserved.

CONTRACTOR: Jacques Whitford AXYS Ltd.		ENBRIDGE NORTHERN GATEWAY PROJECT	FIGURE NUMBER: B-28		DATE: 20100210
PREPARED BY: gem	PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES	2008 Intertidal Transect Survey - Transect FS-08-13	SCALE: 1:150	AUTHOR: SS	APPROVED BY: CM
			PROJECTION: UTM 9	DATUM: NAD 83	

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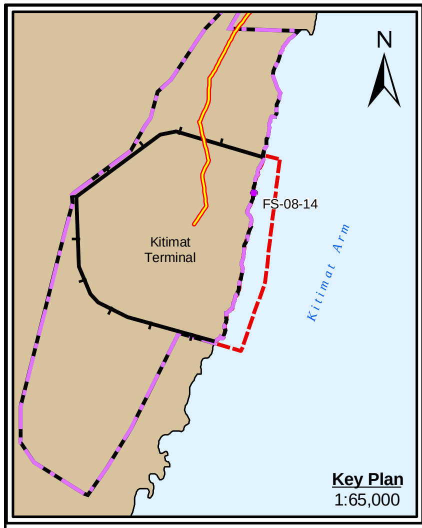
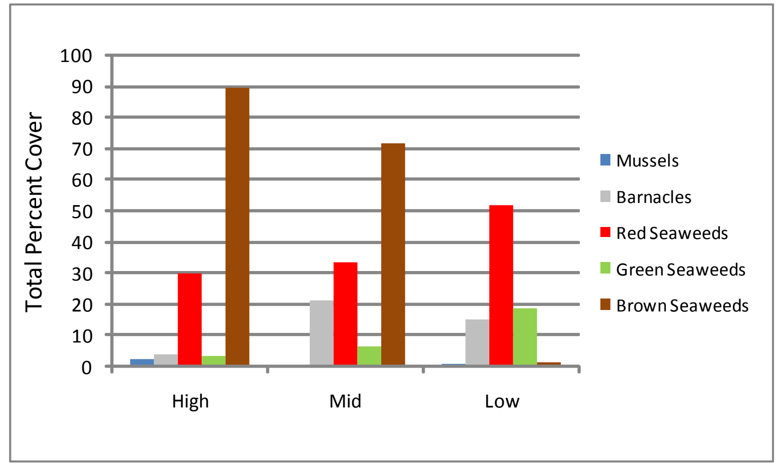
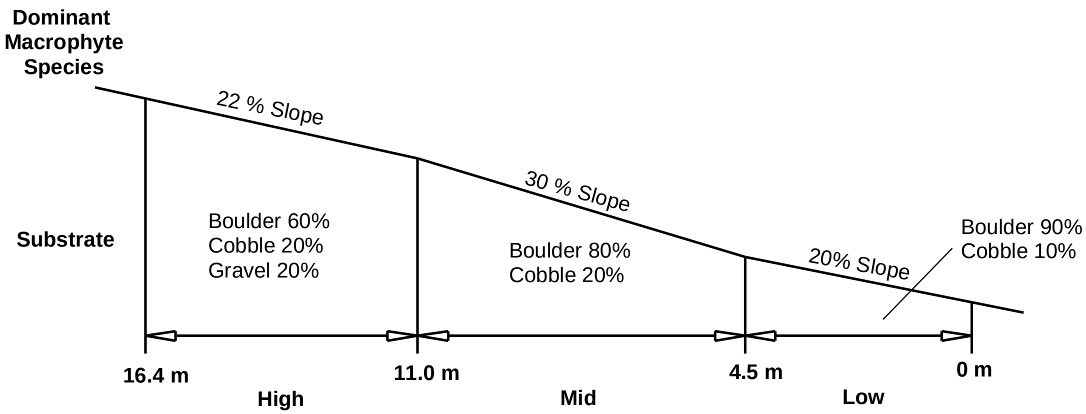




Relative Abundance & Distribution of Flora & Fauna in Transect FS-08-14



Profile of Intertidal Transect FS-08-14

Transect FS-08-14 Looking Upward from Low Water Mark

0 1 2 3 4 5

Meters

JWA-1048334-2720

REFERENCES: NTDB Topographic Mapsheets provided by the Majesty the Queen in Right of Canada, Department of Natural Resources. All rights reserved.

CONTRACTOR: Jacques Whitford AXYS Ltd.		**ENBRIDGE NORTHERN GATEWAY PROJECT**	FIGURE NUMBER: B-29		DATE: 20100210
PREPARED BY: gem	PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES	2008 Intertidal Transect Survey - Transect FS-08-14	SCALE: 1:150	AUTHOR: SS	APPROVED BY: CM
			PROJECTION: UTM 9	DATUM: NAD 83	

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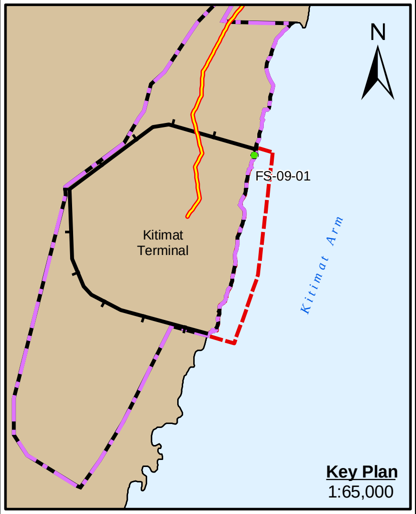
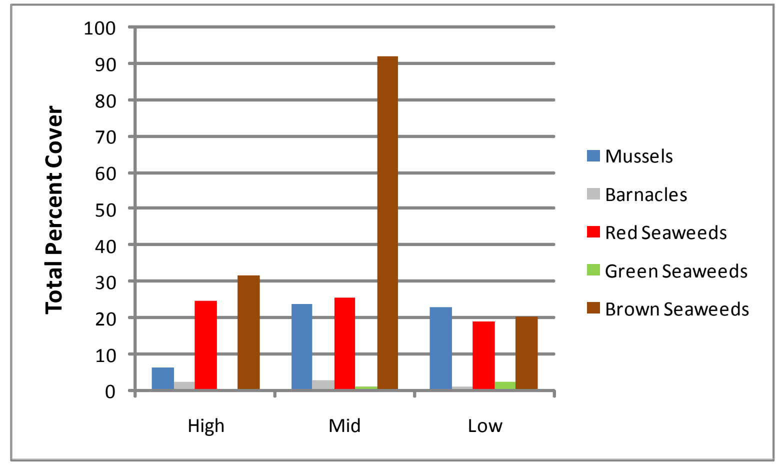
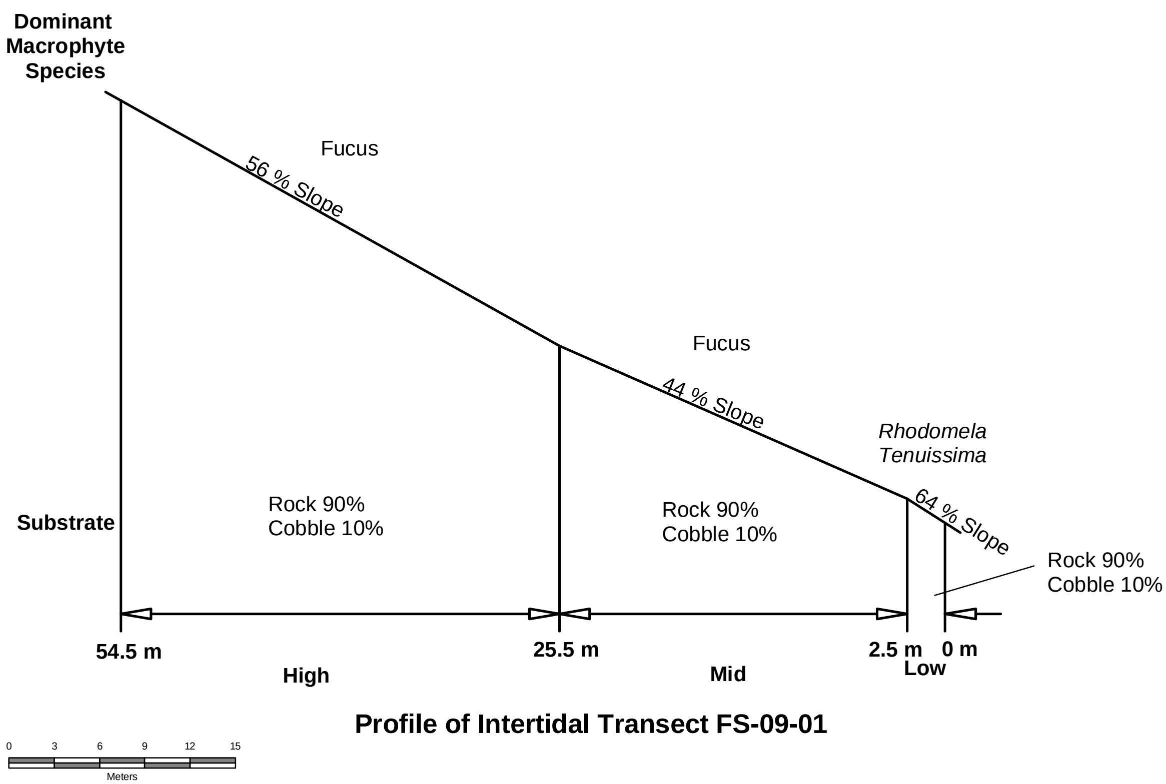




Relative Abundance & Distribution of Flora & Fauna in Transect FS-09-01



Profile of Intertidal Transect FS-09-01

JWA-1048334-2649

Transect FS-09-01 Looking Downward from High Water Mark

REFERENCES: NTDB Topographic Mapsheets provided by the Majesty the Queen in Right of Canada, Department of Natural Resources. All rights reserved.

CONTRACTOR: Jacques Whitford AXYS Ltd.		ENBRIDGE NORTHERN GATEWAY PROJECT	FIGURE NUMBER: B-30		DATE: 20100210
PREPARED BY: gem	PREPARED FOR: ENBRIDGE NORTHERN	2009 Intertidal Transect Survey - Transect FS-09-01	SCALE: 1:500	AUTHOR: SS	APPROVED BY: CM
			PROJECTION: UTM 9	DATUM: NAD 83	

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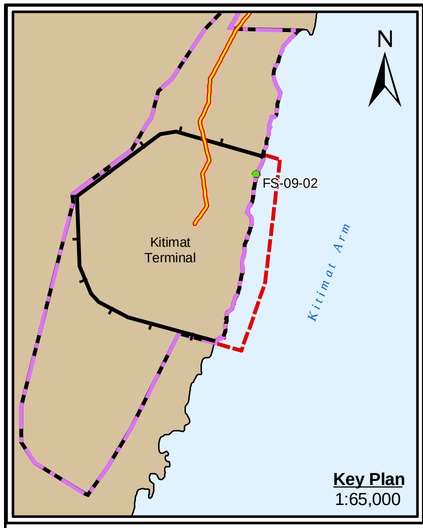
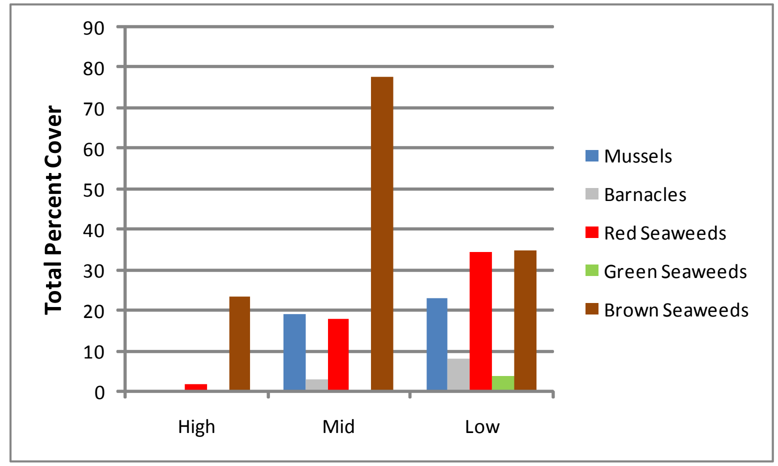
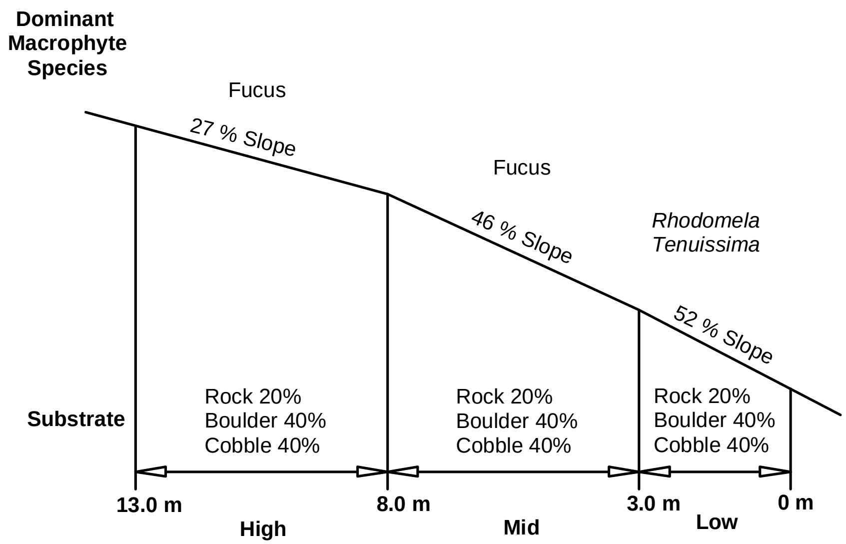




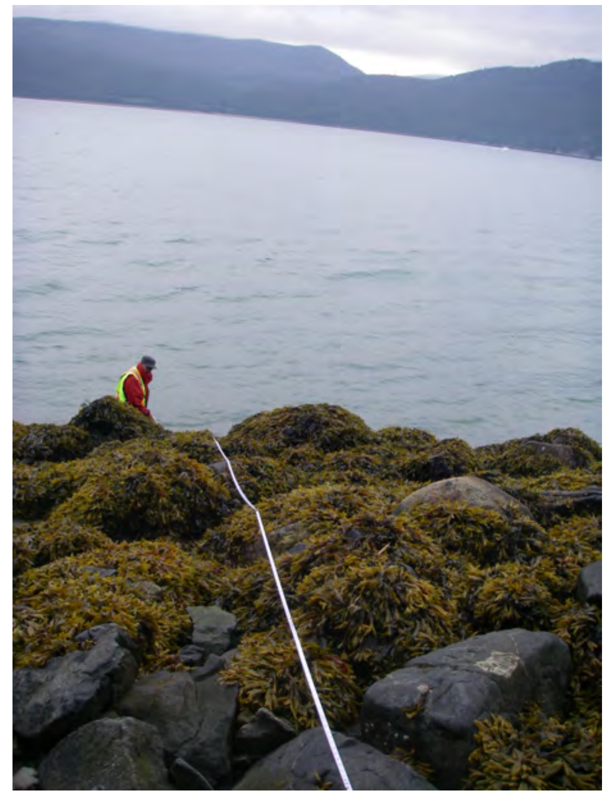
Relative Abundance & Distribution of Flora & Fauna in Transect FS-09-02



Profile of Intertidal Transect FS-09-02

0 1 2 3 4 5
Meters

JWA-1048334-2650



Transect FS-09-02 Looking Downward from High Water Mark

REFERENCES: NTDB Topographic Mapsheets provided by the Majesty the Queen in Right of Canada, Department of Natural Resources. All rights reserved.

CONTRACTOR: Jacques Whitford AXYS Ltd.

PREPARED BY: gem

PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES

ENBRIDGE NORTHERN GATEWAY PROJECT

2009 Intertidal Transect Survey - Transect FS-09-02

FIGURE NUMBER:	DATE:	
B-31	20100210	
SCALE: 1:150	AUTHOR: SS	APPROVED BY: CM
PROJECTION: UTM 9	DATUM: NAD 83	

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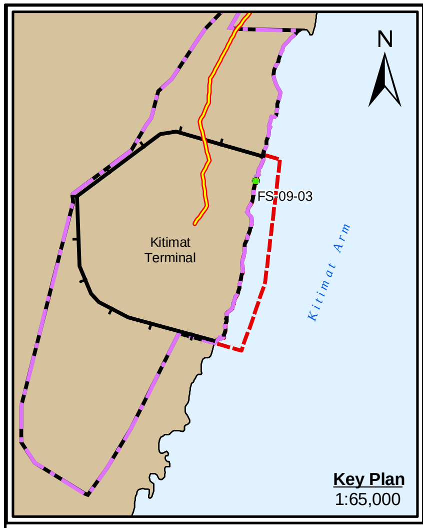
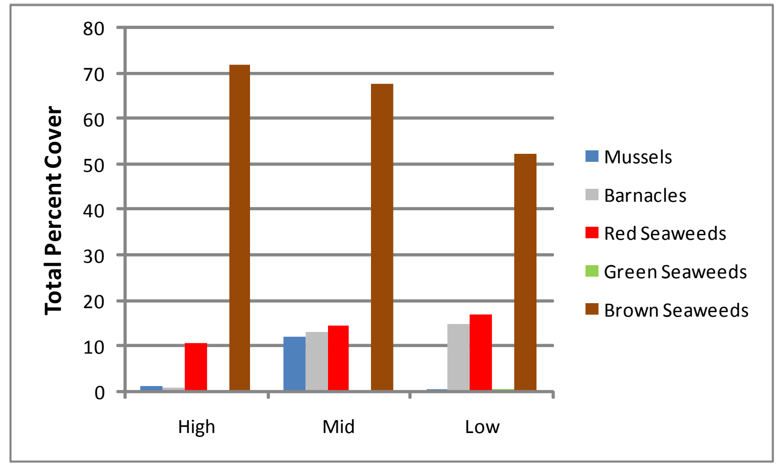
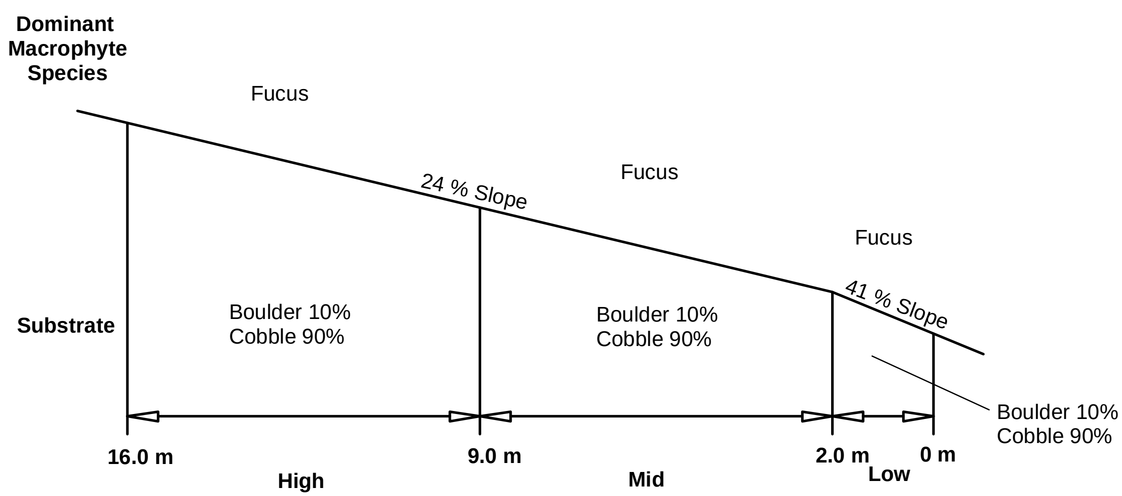
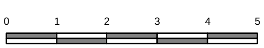




Relative Abundance & Distribution of Flora & Fauna in Transect FS-09-03



Profile of Intertidal Transect FS-09-03



JWA-1048334-2651

Transect FS-09-03 Looking Upward from Low Water Mark

REFERENCES: NTDB Topographic Mapsheets provided by the Majesty the Queen in Right of Canada, Department of Natural Resources. All rights reserved.

CONTRACTOR: Jacques Whitford AXYS Ltd.	**ENBRIDGE NORTHERN GATEWAY PROJECT**	FIGURE NUMBER: B-32	DATE: 20100210
PREPARED BY: gem / PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES	2009 Intertidal Transect Survey - Transect FS-09-03	SCALE: 1:150	AUTHOR: SS / APPROVED BY: CM
		PROJECTION: UTM 9	DATUM: NAD 83

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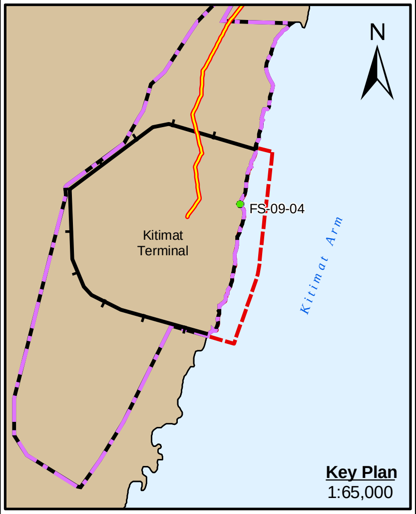
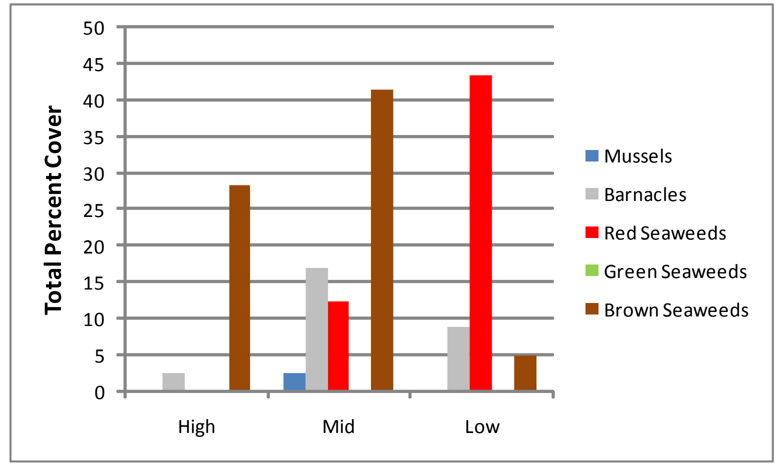
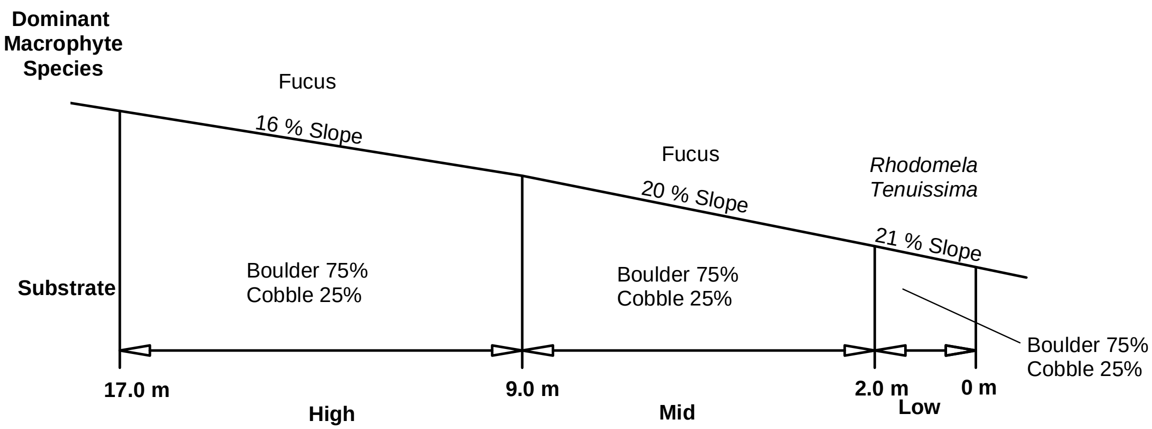




Relative Abundance & Distribution of Flora & Fauna in Transect FS-09-04



Profile of Intertidal Transect FS-09-04

Transect FS-09-04 Looking Upward from Low Water Mark

0 1 2 3 4 5
Meters

JWA-1048334-2652

CONTRACTOR: Jacques Whitford AXYS Ltd.

PREPARED BY: gem

PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES

ENBRIDGE NORTHERN GATEWAY PROJECT

2009 Intertidal Transect Survey - Transect FS-09-04

FIGURE NUMBER: B-33		DATE: 20100210
SCALE: 1:150	AUTHOR: SS	APPROVED BY: CM
PROJECTION: UTM 9	DATUM: NAD 83	

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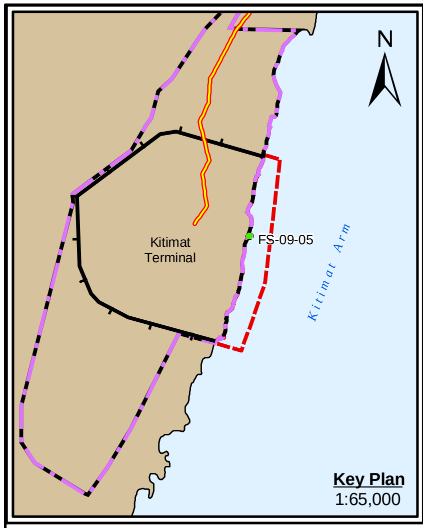
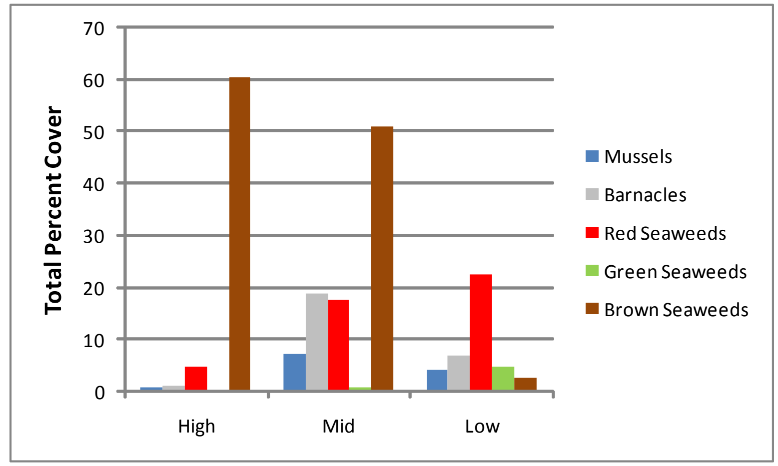
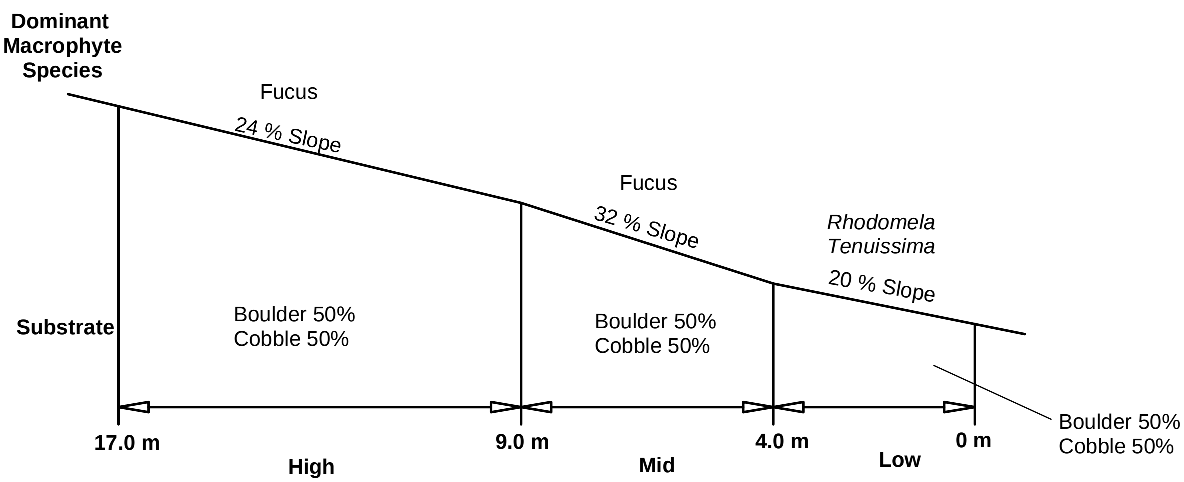
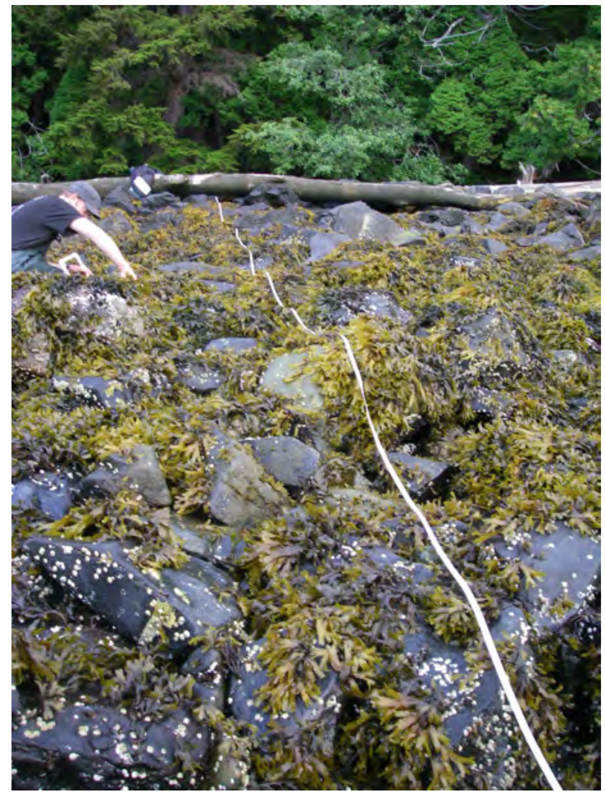




Relative Abundance & Distribution of Flora & Fauna in Transect FS-09-05



Profile of Intertidal Transect FS-09-05



Transect FS-09-05 Looking Upward from Low Water Mark

0 1 2 3 4 5
Meters

JWA-1048334-2653

CONTRACTOR: Jacques Whitford AXYS Ltd.		ENBRIDGE NORTHERN GATEWAY PROJECT	FIGURE NUMBER: B-34	DATE: 20100210
PREPARED BY: gem	PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES	2009 Intertidal Transect Survey - Transect FS-09-05	SCALE: 1:150	AUTHOR: SS / APPROVED BY: CM
			PROJECTION: UTM 9	DATUM: NAD 83

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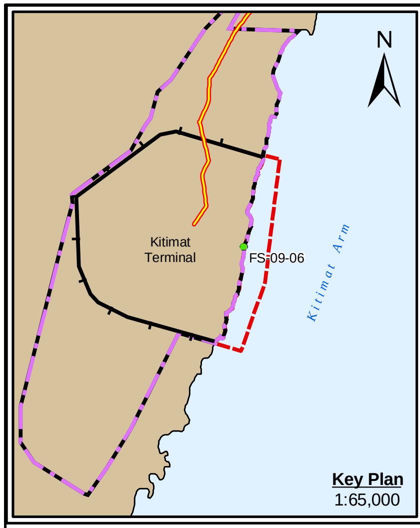
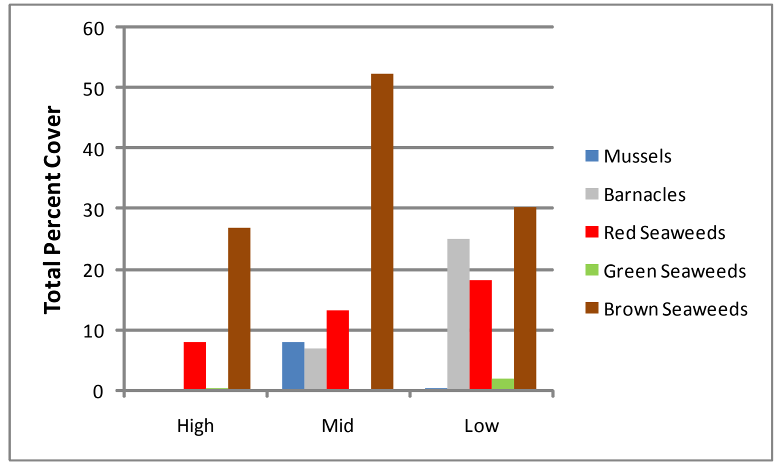
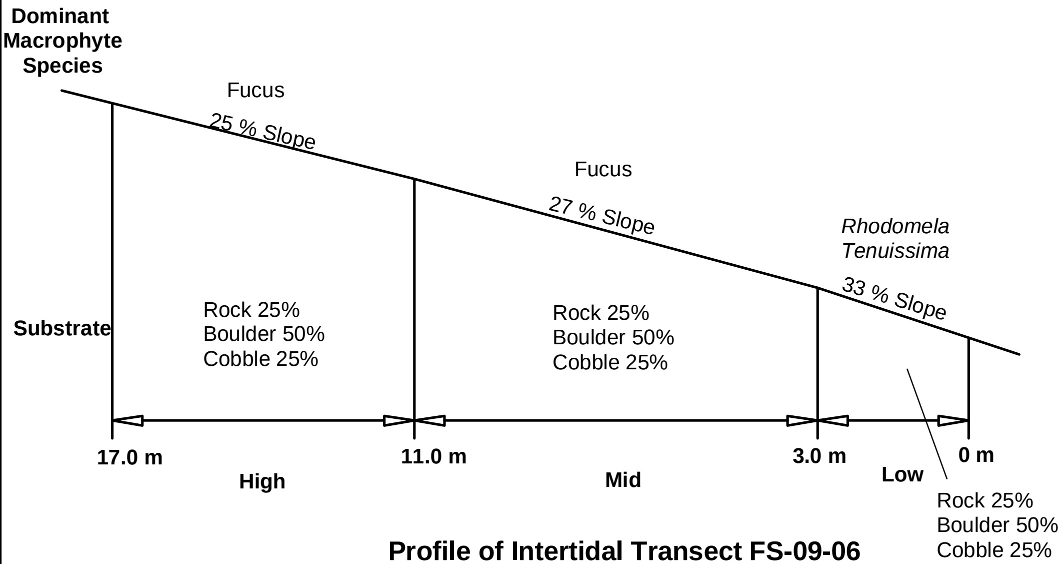




Relative Abundance & Distribution of Flora & Fauna in Transect FS-09-06



Profile of Intertidal Transect FS-09-06

Transect FS-09-06 Looking Upward from Low Water Mark

0 1 2 3 4 5
Meters

JWA-1048334-2654

REFERENCES: NTDB Topographic Mapsheets provided by the Majesty the Queen in Right of Canada, Department of Natural Resources. All rights reserved.

CONTRACTOR: Jacques Whitford AXYS Ltd.		ENBRIDGE NORTHERN GATEWAY PROJECT	FIGURE NUMBER: B-35		DATE: 20100210
PREPARED BY: gem	PREPARED FOR: Enbridge Northern Gateway Pipelines	2009 Intertidal Transect Survey - Transect FS-09-06	SCALE: 1:150	AUTHOR: SS	APPROVED BY: CM
			PROJECTION: UTM 9	DATUM: NAD 83	

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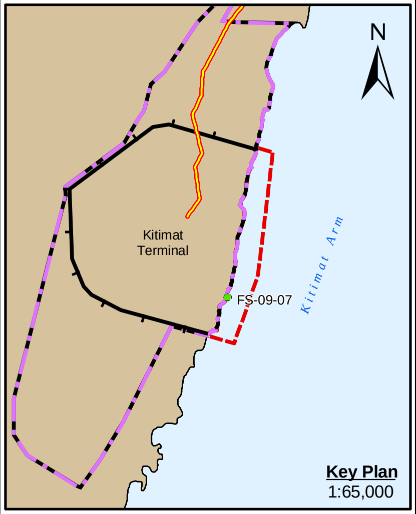
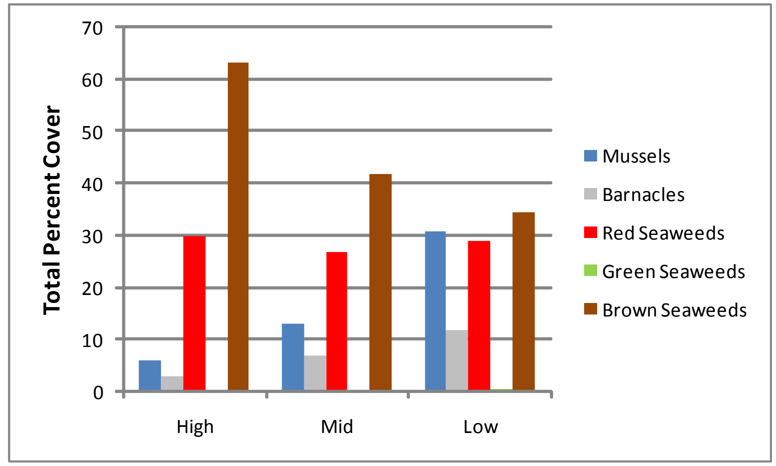
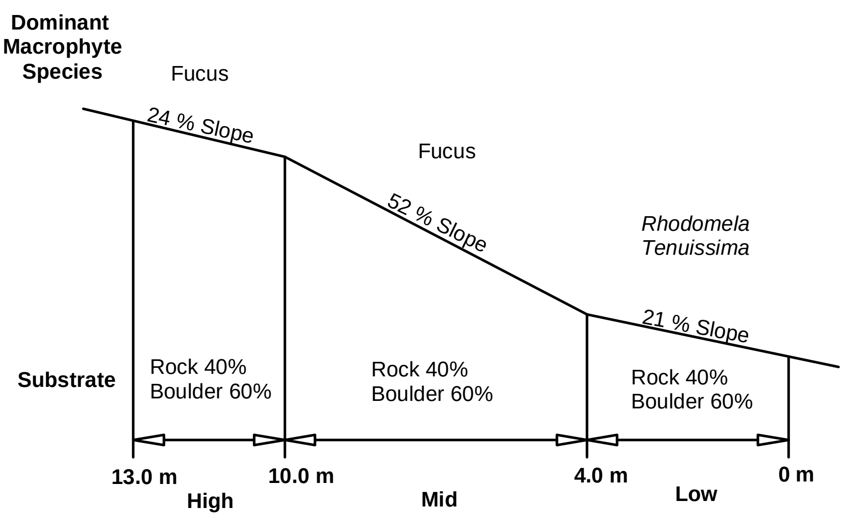




Relative Abundance & Distribution of Flora & Fauna in Transect FS-09-07



Profile of Intertidal Transect FS-09-07

Transect FS-09-07 Looking Upward from Low Water Mark

0 1 2 3 4 5
Meters

JWA-1048334-2655

REFERENCES: NTDB Topographic Mapsheets provided by the Majesty the Queen in Right of Canada, Department of Natural Resources.

CONTRACTOR: Jacques Whitford AXYS Ltd.		**ENBRIDGE NORTHERN GATEWAY PROJECT**	FIGURE NUMBER: B-36		DATE: 20100210
PREPARED BY: gem	PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES	2009 Intertidal Transect Survey - Transect FS-09-07	SCALE: 1:150	AUTHOR: SS	APPROVED BY: CM
			PROJECTION: UTM 9	DATUM: NAD 83	

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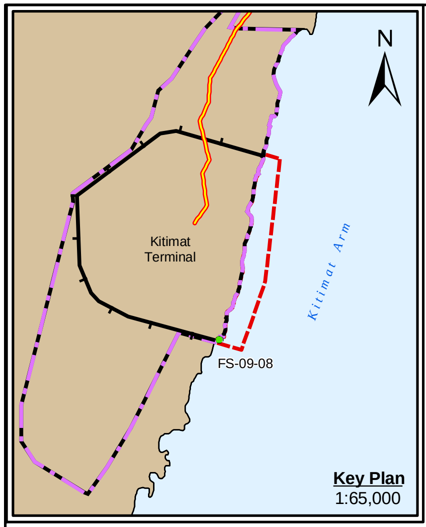
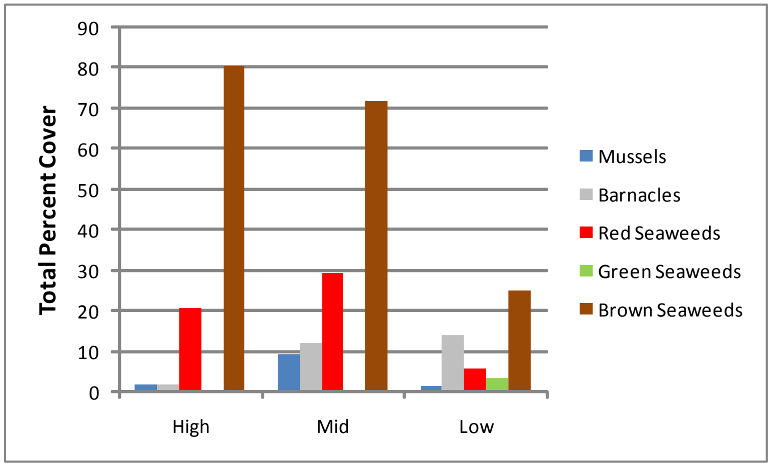
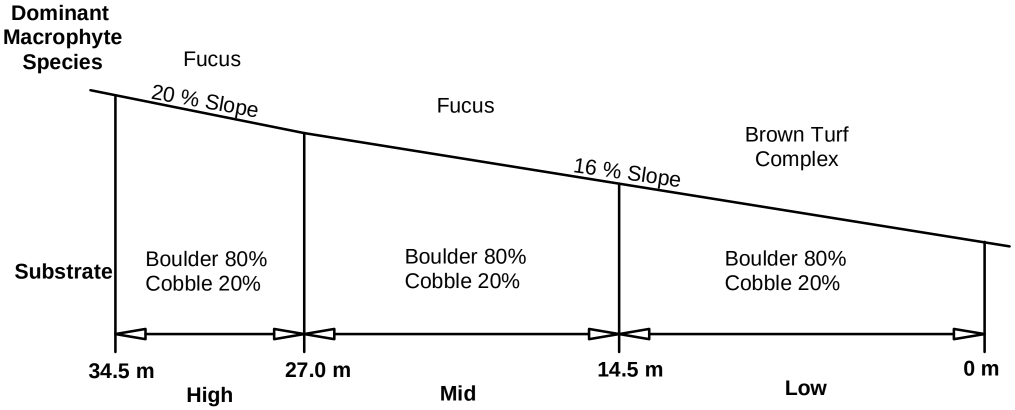




Relative Abundance & Distribution of Flora & Fauna in Transect FS-09-08



Profile of Intertidal Transect FS-09-08

Transect FS-09-08 Looking Upward from Low Water Mark

0 2 4 6 8 10
Meters

JWA-1048334-2656

REFERENCES: NTDB Topographic Mapsheets provided by the Majesty the Queen in Right of Canada, Department of Natural Resources. All rights reserved.

CONTRACTOR: Jacques Whitford AXYS Ltd.	**ENBRIDGE NORTHERN GATEWAY PROJECT**	FIGURE NUMBER: B-37	DATE: 20100210
PREPARED BY: gem / PREPARED FOR: Enbridge Northern Gateway Pipelines	2009 Intertidal Transect Survey - Transect FS-09-08	SCALE: 1:300	AUTHOR: SS / APPROVED BY: CM
		PROJECTION: UTM 9	DATUM: NAD 83

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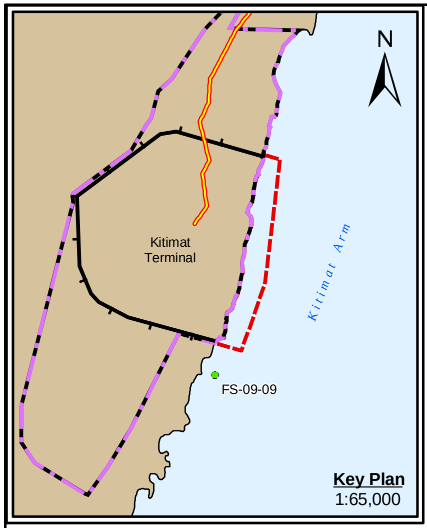
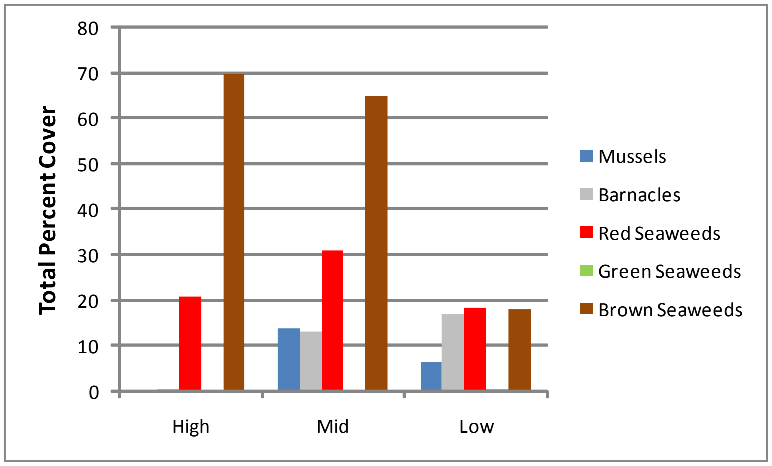
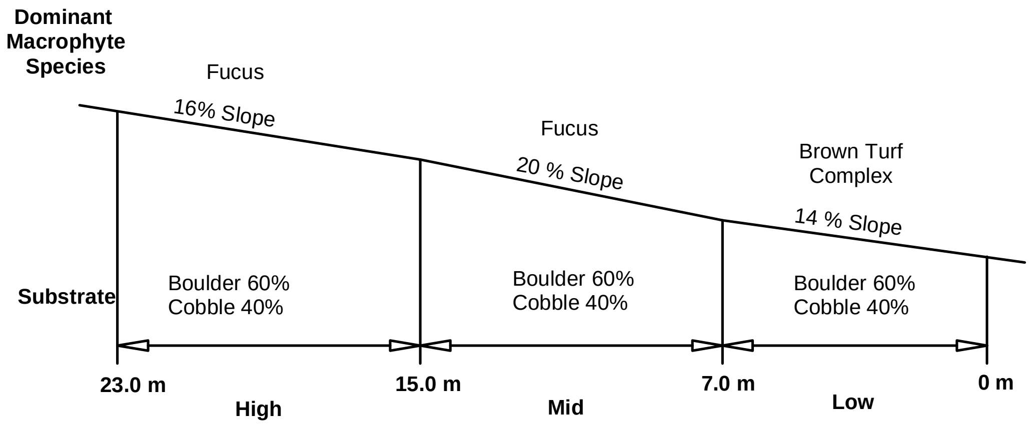




Relative Abundance & Distribution of Flora & Fauna in Transect FS-09-09



Profile of Intertidal Transect FS-09-09

Transect FS-09-09 Looking Upward from Low Water Mark

0 1 2 3 4 5
Meters

JWA-1048334-2657

CONTRACTOR: Jacques Whitford AXYS Ltd.		**ENBRIDGE NORTHERN GATEWAY PROJECT**
PREPARED BY: gem	PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES	2009 Intertidal Transect Survey - Transect FS-09-09

FIGURE NUMBER: B-38		DATE: 20100210
SCALE: 1:200	AUTHOR: SS	APPROVED BY: CM
PROJECTION: UTM 9	DATUM: NAD 83	

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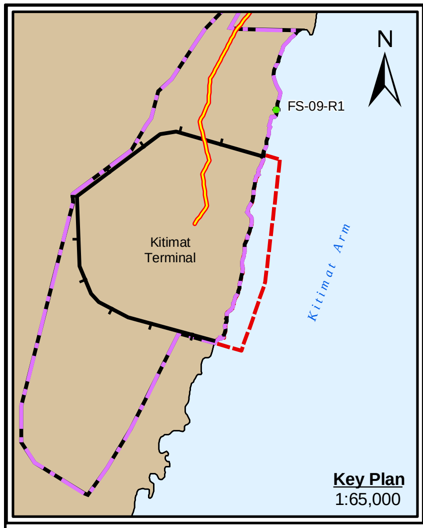
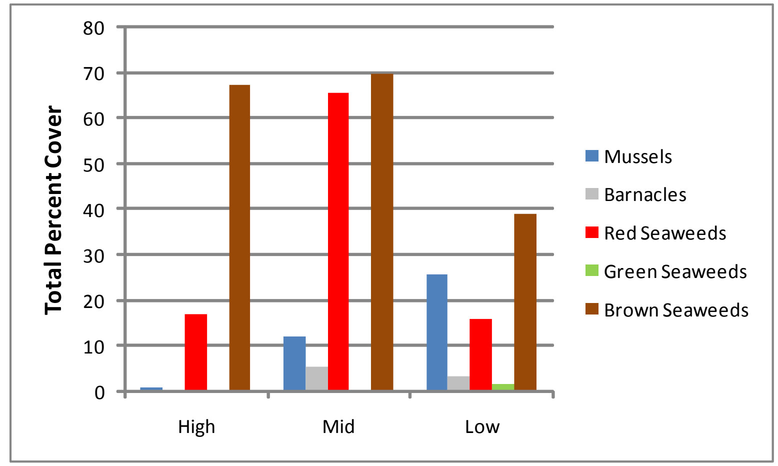
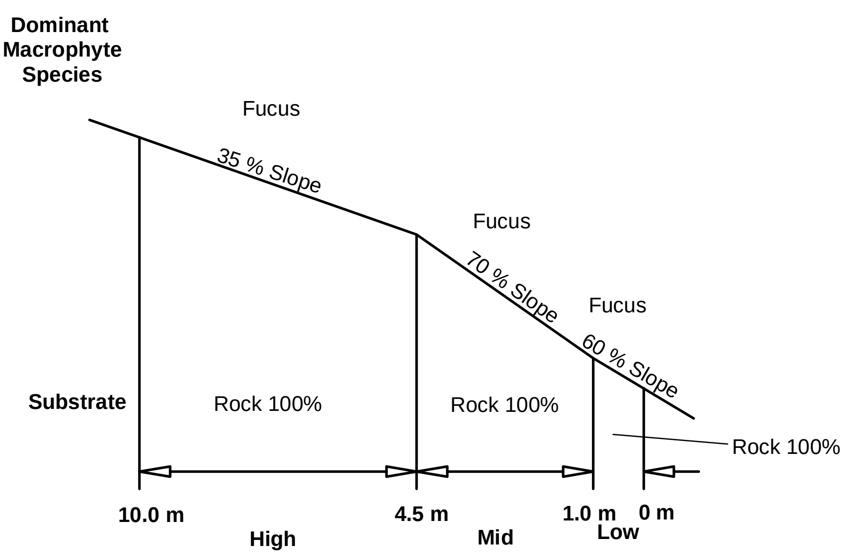


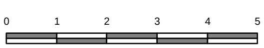


Relative Abundance & Distribution of Flora & Fauna in Transect FS-09-R1



Profile of Intertidal Transect FS-09-R1

Transect FS-09-R1 Looking Downward from High Water Mark



JWA-1048334-2658

REFERENCES: NTDB Topographic Mapsheets provided by the Majesty the Queen in Right of Canada, Department of Natural Resources.

CONTRACTOR: Jacques Whitford AXYS Ltd.		**ENBRIDGE NORTHERN GATEWAY PROJECT**
PREPARED BY: gem	PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES	2009 Intertidal Transect Survey - Transect FS-09-R1

FIGURE NUMBER: B-39		DATE: 20100210	
SCALE: 1:150	AUTHOR: SS	APPROVED BY: CM	
PROJECTION: UTM 9	DATUM: NAD 83		

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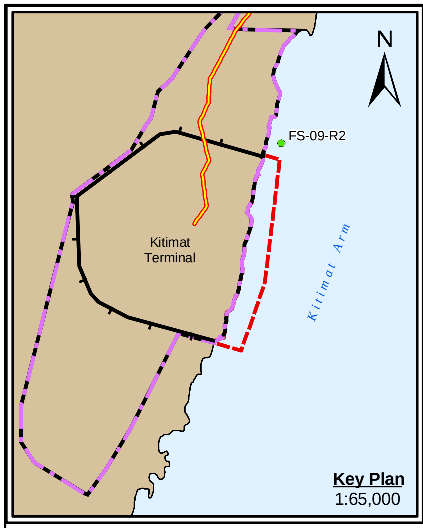
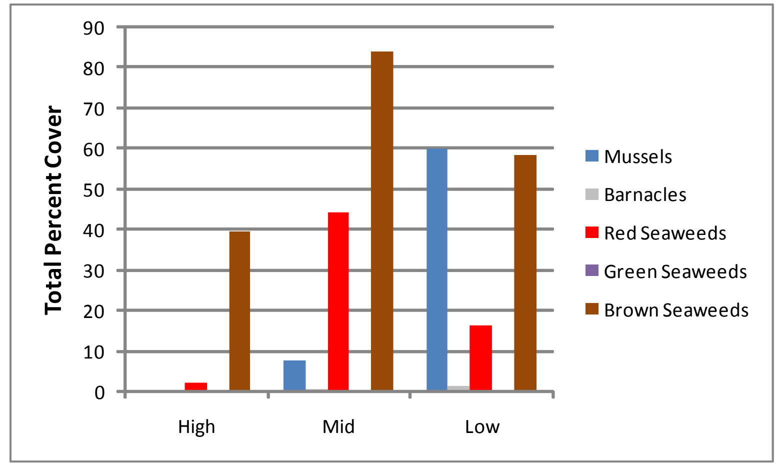
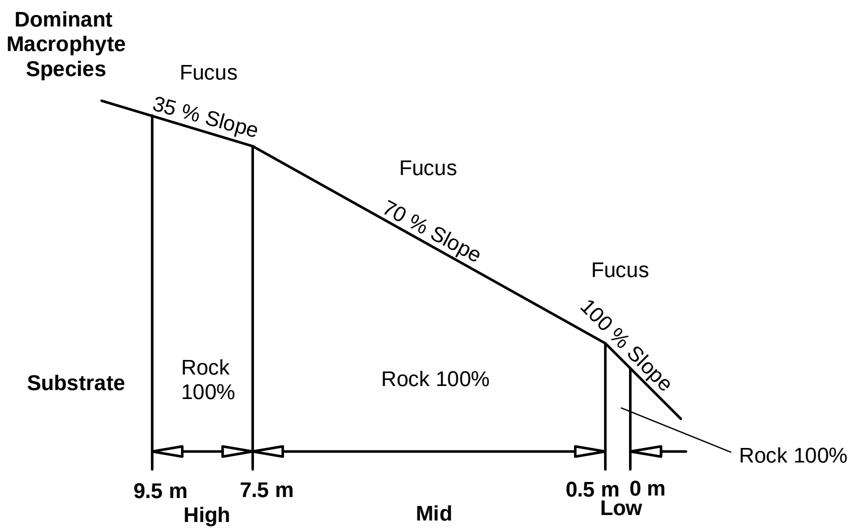




Relative Abundance & Distribution of Flora & Fauna in Transect FS-09-R2



Profile of Intertidal Transect FS-09-R2

0 1 2 3 4 5

Meters

JWA-1048334-2659

Transect FS-09-R2 Looking Downward from High Water Mark

REFERENCES: NTDB Topographic Mapsheets provided by the Majesty the Queen in Right of Canada, Department of Natural Resources. All rights reserved.

CONTRACTOR: Jacques Whitford AXYS Ltd.		ENBRIDGE NORTHERN GATEWAY PROJECT	FIGURE NUMBER: B-40		DATE: 20100210
PREPARED BY: gem	PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES	2009 Intertidal Transect Survey - Transect FS-09-R2	SCALE: 1:150	AUTHOR: SS	APPROVED BY: CM
			PROJECTION: UTM 9	DATUM: NAD 83	

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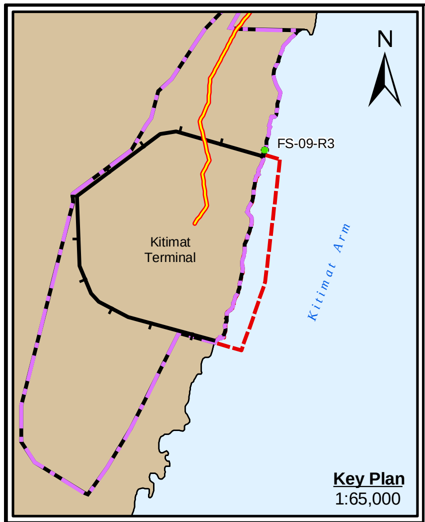
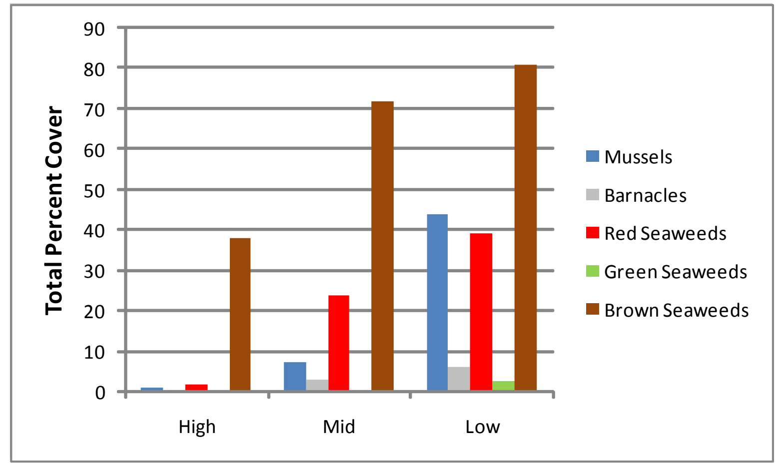
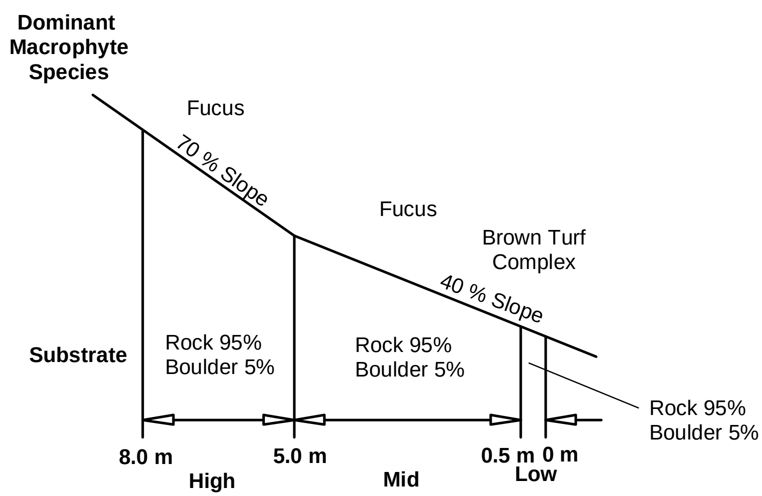
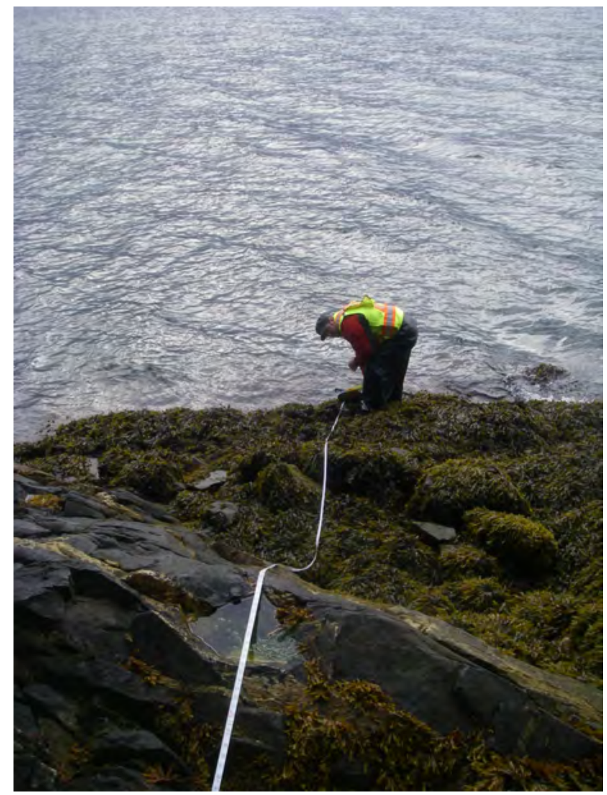




Relative Abundance & Distribution of Flora & Fauna in Transect FS-09-R3



Profile of Intertidal Transect FS-09-R3



Transect FS-09-R3 Looking Downward from High Water Mark

0 1 2 3 4 5
Meters

JWA-1048334-2660

REFERENCES: NTDB Topographic Mapsheets provided by the Majesty the Queen in Right of Canada, Department of Natural Resources. All rights reserved.

CONTRACTOR: Jacques Whitford AXYS Ltd.		**ENBRIDGE NORTHERN GATEWAY PROJECT**	FIGURE NUMBER: B-41	DATE: 20100210
PREPARED BY: gem	PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES	2009 Intertidal Transect Survey - Transect FS-09-R3	SCALE: 1:150	AUTHOR: SS / APPROVED BY: CM
			PROJECTION: UTM 9	DATUM: NAD 83

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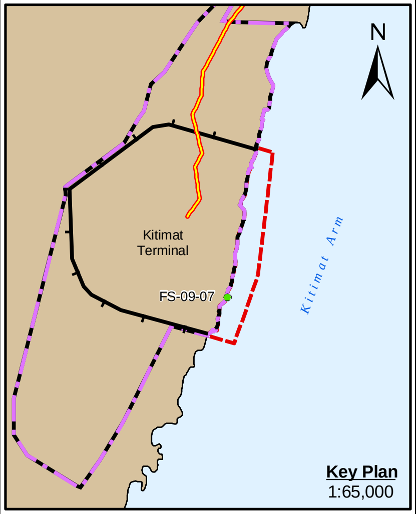
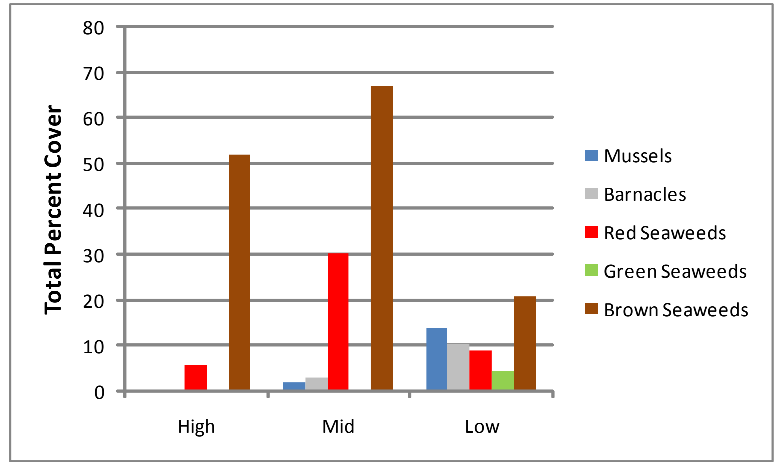
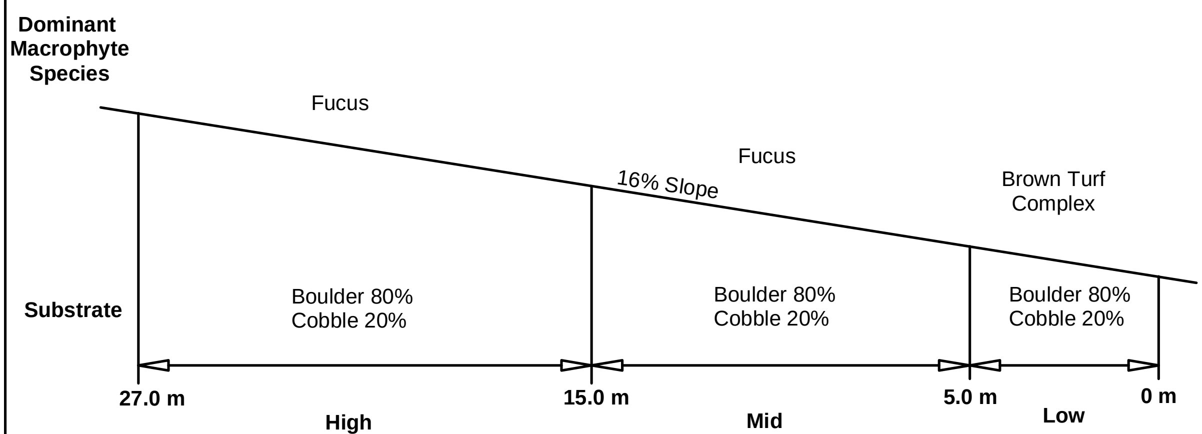




Relative Abundance & Distribution of Flora & Fauna in Transect FS-09-R7



Profile of Intertidal Transect FS-09-R7

Transect FS-09-R7 Looking Downward from High Water Mark

0 1 2 3 4 5
Meters

JWA-1048334-2661

REFERENCES: NTDB Topographic Mapsheets provided by the Majesty the Queen in Right of Canada, Department of Natural Resources.

CONTRACTOR: Jacques Whitford AXYS Ltd.		ENBRIDGE NORTHERN GATEWAY PROJECT	FIGURE NUMBER: B-42		DATE: 20100210
PREPARED BY: gem	PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES	2009 Intertidal Transect Survey - Transect FS-09-R7	SCALE: 1:200	AUTHOR: SS	APPROVED BY: CM
			PROJECTION: UTM 9	DATUM: NAD 83	

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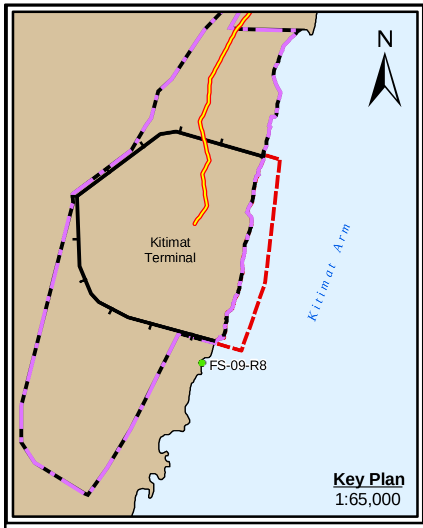
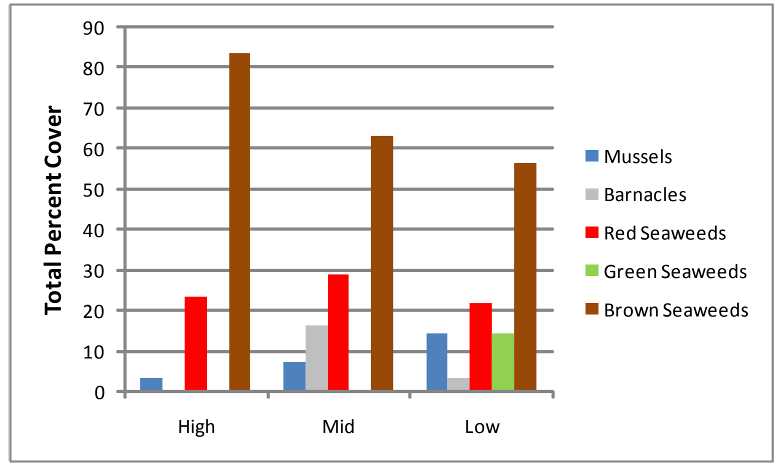
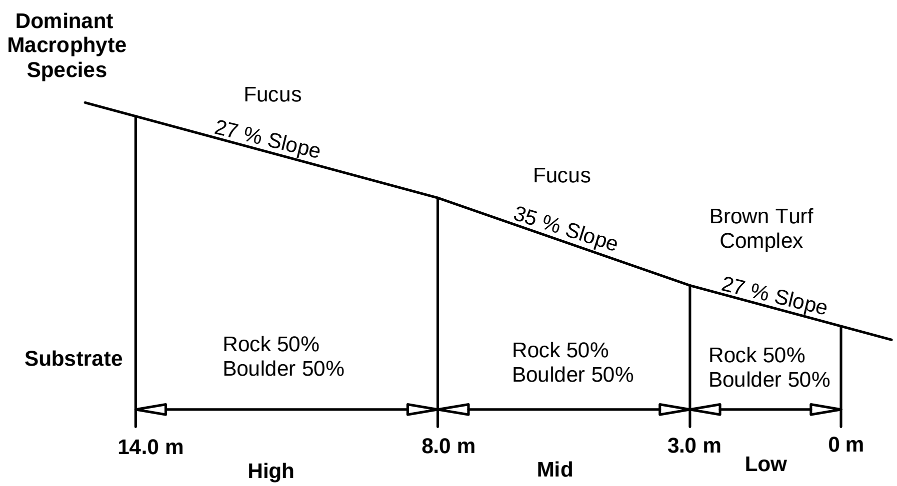




Relative Abundance & Distribution of Flora & Fauna in Transect FS-09-R8



Profile of Intertidal Transect FS-09-R8

Transect FS-09-R8 Looking Downward from High Water Mark

0 1 2 3 4 5
Meters

JWA-1048334-2662

REFERENCES: NTDB Topographic Mapsheets provided by the Majesty the Queen in Right of Canada, Department of Natural Resources. All rights reserved.

CONTRACTOR: Jacques Whitford AXYS Ltd.		**ENBRIDGE NORTHERN GATEWAY PROJECT**	FIGURE NUMBER: B-43		DATE: 20100210
PREPARED BY: gem	PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES	2009 Intertidal Transect Survey - Transect FS-09-R8	SCALE: 1:150	AUTHOR: SS	APPROVED BY: CM
			PROJECTION: UTM 9	DATUM: NAD 83	

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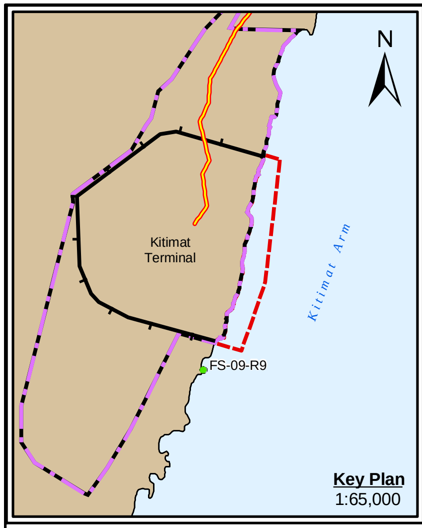
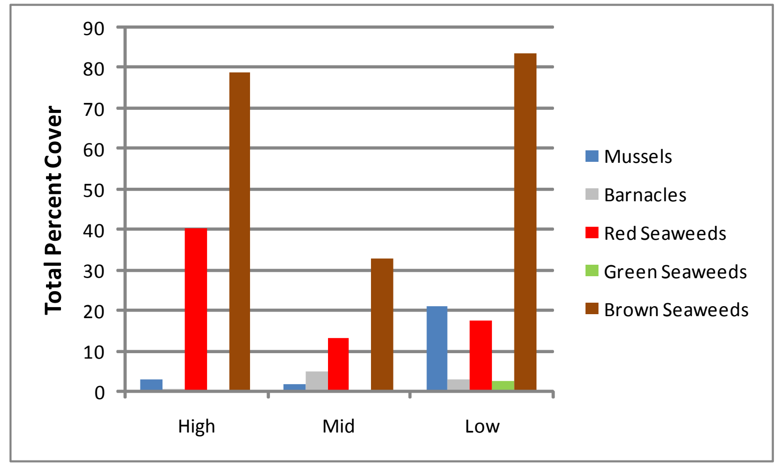
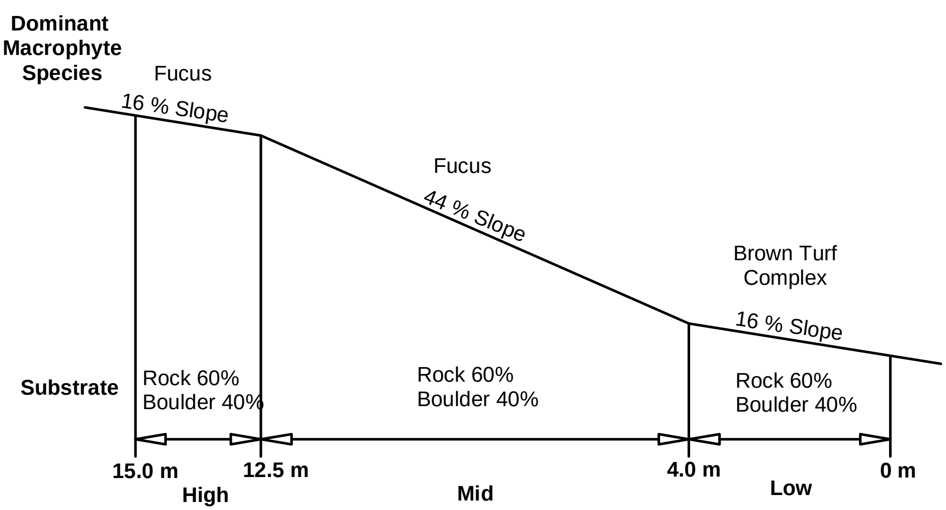




Relative Abundance & Distribution of Flora & Fauna in Transect FS-09-R9



Profile of Intertidal Transect FS-09-R9

Transect FS-09-R9 Looking Downward from High Water Mark

0 1 2 3 4 5
Meters

JWA-1048334-2663

CONTRACTOR: Jacques Whitford AXYS Ltd.	**ENBRIDGE NORTHERN GATEWAY PROJECT**	FIGURE NUMBER: B-44 / DATE: 20100210
PREPARED BY: gem / PREPARED FOR: Enbridge Northern Gateway Pipelines	2009 Intertidal Transect Survey - Transect FS-09-R9	SCALE: 1:150 / AUTHOR: SS / APPROVED BY: CM
		PROJECTION: UTM 9 / DATUM: NAD 83

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Appendix C Sediment and Seawater Chemistry Testing

C.1 Sediment and Seawater Chemistry Testing from Vizon Scitec

Table C-1 Dissolved Metal Concentrations in Seawater

Dissolved Metals	Seawater Samples												Marine Guidelines				
	1	2	2	2	3	4	5	6	7	12	9	10	BC (marine)[1]		CCME (marine)[1]	NOAA[5]	
			(replicates)								(reference)		30-Day average	Maximum		CMC	CCC
	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)
Aluminum	<0.10	<0.10	<0.10	<0.10	<0.4	<0.10	<0.10	<0.30	<0.10	<0.10	<0.8	<0.10	-	-	-	-	
Antimony	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	-	-	-	1.5[1]	0.5[1]
Arsenic	<0.00020	0.0012	0.0012	0.0012	0.0013	0.0011	0.0019	0.0011	0.0016	0.0010	0.00079	0.0010	-	-	0.0125	-	-
Barium	0.0082	0.0093	0.0093	0.0091	0.014	0.0083	0.0076	0.0068	0.0074	0.017	0.0076	0.0074	-	-	-	-	-
Beryllium	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	-	-	-	-	-
Bismuth	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	-	-	-	-	-
Boron	3.9	3.9	3.9	3.8	3.7	3.5	3.6	3.4	3.7	3.5	3.7	3.6	-	-	-	-	-
Cadmium	0.00013	0.00015	0.00015	0.00016	0.00010	0.00012	0.000090	0.00011	0.00013	0.00017	0.00011	0.00011	-	-	0.00012	-	-
Calcium	326	342	342	340	307	310	324	301	318	317	321	319	-	-	-		-
Chromium	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	-	-	0.056[3]; 0.0015[4]	-	-
Cobalt	0.00015	0.000061	0.000061	0.000060	0.00027	0.000061	0.00013	0.000062	0.00010	0.0021	0.000056	<0.000050	-	-	-	-	-
Copper	0.00082	0.00096	0.00096	0.00098	0.00120	0.00092	0.00107	0.00097	0.00117	0.00070	0.00094	0.00079	0.002	0.003	-	-	-
Iron	<0.010	<0.010	<0.010	0.03	<0.010	<0.010	<0.010	<0.010	<0.010	0.043	<0.010	<0.010	-	-	-	-	-
Lead	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	0.002	0.14	-	-	-
Lithium	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	-	-	-	-	-
Magnesium	1130	1190	1190	1180	1050	1070	1120	1040	1120	1080	1110	1140	-	-	-	-	-
Manganese	0.014	0.0070	0.0070	0.0068	0.054	0.0016	0.0095	0.0051	0.011	1.48	0.0020	0.0029	-	-	-	-	-
Mercury	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	0.00002	0.002	0.000016	-	-
Molybdenum	0.0092	0.0096	0.0096	0.0094	0.0095	0.0089	0.0095	0.0091	0.0087	0.0091	0.0095	0.0081	-	-	-	-	-
Nickel	0.00074	0.00075	0.00075	0.00073	0.00088	0.00071	0.00073	0.00070	0.00076	0.00085	0.00069	0.00061	-	-	-	0.074[2]	0.0082[2]
Phosphorus	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	-	-	-	-	0.0001[1]
Potassium	347	362	362	356	324	326	341	315	336	332	338	336	-	-	-	-	-
Selenium	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	0.00057	<0.00050	<0.00050	<0.00050	0.00099	<0.00050	<0.00050	0.002		-	-	-
Silicon	1.3	1.5	1.5	1.4	1.7	1.3	1.3	1.2	1.3	2.5	1.1	1.1	-	-	-	-	-
Silver	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.0015	0.003	-	-	-
Sodium	8460	8820	8820	8640	7860	7960	8290	7680	8180	8050	8280	8210	-	-	-	-	-
Strontium	5.8	5.6	5.6	5.6	5.7	5.2	5.3	5.0	5.5	5.1	5.7	5.4	-	-	-	-	-

Table C-1 Dissolved Metal Concentrations in Seawater (cont'd)

Dissolved Metals	Seawater Samples												Marine Guidelines				
	1	2	2	2	3	4	5	6	7	12	9	10	BC (marine)[1]		CCME (marine)[1]	NOAA[5]	
			(replicates)								(reference)		30-Day average	Maximum		CMC	CCC
	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)
Thallium	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	-	-	-	2.13[1]	-
Tin	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	-	-	-	-	-
Titanium	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	-	-	-	-	-
Uranium	0.0018	0.0026	0.0026	0.0027	0.0020	0.0019	0.0023	0.0018	0.0022	0.0022	0.0020	0.0013	-	-	-	-	-
Vanadium	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	-	-	-	-	-
Zinc	0.0034	0.0017	0.0017	0.0014	0.0012	0.0011	0.0097	0.0070	0.021	0.0097	0.0050	0.0058	-	0.01	-	-	-

NOTES:
Highlighted cells indicate concentrations that exceed applicable guideline and criteria values.
Mercury guidelines and criteria are for inorganic mercury.
[1] Total metal values
[2] Dissolved metals
[3] Chromium 3+
[4] Chromium 6+
[5] NOAA criteria were only included if British Columbia or CCME guidelines were not available.
'<' indicates value less than method detection limit
'-' indicates guidelines and criteria not available or not applicable
CCME – Canadian Council of Ministers of the Environment
CMC – criteria maximum concentration is the highest level for a 1-hour average exposure not to be exceeded more than once every 3 years (acute).
CCC – criteria continuous concentration is the highest level for a 4-day average exposure not to be exceeded more than once every 3 years (chronic).
CMC and CCCs are proposed criteria
NOAA – National Oceanic and Atmospheric Administration

Table C-2 Non-Halogenated Volatile Concentrations in Seawater

Non-Halogenated Volatiles	Seawater Sample										Marine Guidelines	
	1	2	3	4	5	6	7	12	9	10	BC	CCME
									(reference)		Marine	Marine
	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)
Benzene	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	110
Ethylbenzene	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	250	215
Toluene	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	330	25
Xylenes	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-

NOTES:
'-' indicates guidelines and criteria not available or not applicable.
'<' indicates value less than method detection limit
CCME – Canadian Council of Ministers of the Environment

Table C-3 Polycyclic Aromatic Hydrocarbon Concentrations in Seawater

PAHs	MDL	Seawater Sample										BC	CCME	NOAA[1]	
		#1	#2	#3	#4	#5	#6	#7	#12	#9	#10				
										(reference)		Marine	Marine	CMC	CCC
	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)
Naphthalene	0.05	<0.05	0.11	<0.06	0.11	<0.08	<0.07	<0.08	<0.05	<0.05	<0.05	1	1.4	-	-
Quinoline	0.10	<0.1	<0.1	<0.12	<0.1	<0.16	<0.14	<0.16	0.61	<0.1	0.31	-	-	-	-
2-Methylnapthalene	0.05	<0.05	<0.05	<0.06	<0.05	<0.08	<0.07	<0.08	0.21	<0.05	<0.05	1	-	-	-
Acenaphthylene	0.05	<0.05	<0.05	<0.06	<0.05	<0.08	<0.07	<0.08	<0.05	0.08	<0.05	-	-	300	-
Acenaphthene	0.05	<0.05	<0.05	<0.06	<0.05	<0.08	<0.07	<0.08	<0.05	<0.05	<0.05	6	-	-	-
Fluorene	0.05	<0.05	<0.05	<0.06	0.12	<0.08	<0.07	<0.08	<0.05	<0.05	<0.05	12.0	-	-	-
Phenanthrene	0.05	<0.05	<0.05	0.15	0.31	0.16	<0.07	<0.08	0.35	0.14	0.11	-	-	7.7	4.6
Anthracene	0.05	<0.05	<0.05	<0.06	<0.05	<0.08	<0.07	<0.08	<0.05	<0.05	<0.05	-	-	300	-
Acridine	0.10	<0.1	<0.1	<0.12	<0.1	<0.16	<0.14	<0.16	<0.1	<0.1	<0.1	-	-	-	-
Total LMW-PAHs		N/A	0.11	0.15	0.54	0.16	N/A	N/A	1.17	0.22	0.42	-	-	300	-
Fluoranthene	0.05	0.30	0.41	0.22	1.07	0.10	<0.07	<0.08	1.01	0.13	0.47	-	-	40	16
Pyrene	0.05	0.27	0.39	0.20	0.96	0.09	<0.07	<0.08	0.89	0.09	0.04	-	-	300	-
Benzo(a)anthracene	0.05	0.46	0.76	0.48	1.47	0.18	<0.07	<0.08	1.05	0.05	<0.05	-	-	300	-
Chrysene	0.05	<0.05	<0.05	0.44	1.65	0.25	<0.07	<0.08	1.98	0.10	0.09	0.1	-	-	-
Benzo(b)fluoranthene	0.05	1.48	1.86	1.34	4.69	0.53	<0.07	<0.08	3.94	0.27	0.19	-	-	300	-
Benzo(k)fluoranthene	0.05	<0.05	<0.05	<0.06	<0.05	<0.08	<0.07	<0.08	<0.05	<0.05	<0.05	-	-	300	-
Benzo(a)pyrene	0.05	0.23	0.36	0.13	0.06	<0.08	<0.07	<0.08	0.87	<0.05	<0.05	0.01	-	-	-
Indeno(1,2,3-cd)pyrene	0.05	0.16	0.28	0.15	0.06	<0.08	<0.07	<0.08	0.48	<0.05	<0.05	-	-	300	-
Dibenz(a,h)anthracene	0.05	<0.05	<0.05	<0.06	<0.05	<0.08	<0.07	<0.08	0.08	<0.05	<0.05	-	-	300	-
Benzo(g,h,i)perylene	0.05	0.14	0.25	0.08	0.06	<0.08	<0.07	<0.08	0.05	0.14	0.11	-	-	300	-

Table C-3 Polycyclic Aromatic Hydrocarbon Concentrations in Seawater (cont'd)

PAHs	MDL	Seawater Sample										BC	CCME	NOAA[1]	
		#1	#2	#3	#4	#5	#6	#7	#12	#9	#10				
										(reference)		Marine	Marine	CMC	CCC
	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)
Total HMW-PAHs		3.04	4.31	3.04	10.0	1.15	N/A	N/A	10.4	0.78	0.90	-	-	300	-
Total PAHs		3.04	4.42	3.19	10.6	1.31	N/A	N/A	11.5	1.00	1.32	-	-	300	-

NOTES:
Highlighted cells indicate concentrations that exceed applicable guideline and criteria values.
[1] NOAA criteria were only included if British Columbia or CCME guidelines were not available.
'<' indicates value less than method detection limit
'-' indicates guidelines and criteria not available or not applicable
CCME – Canadian Council of Ministers of the Environment
NOAA – National Oceanic and Atmospheric Administration
CMC – criteria maximum concentration is the highest level for a 1-hour average exposure not to be exceeded more than once every 3 years (acute).
CCC – criteria continuous concentration is the highest level for a 4-day average exposure not to be exceeded more than once every 3 years (chronic).
CMC and CCCs are proposed criteria
MDL – method detection limit
N/A – not applicable

Table C-4 Other Seawater Parameters

Seawater Sample	Parameter NH₃	pH	Salinity	S⁻
	(mg N/L)		(%)	(mg/L)
#1	0.023	7.53	28.7	0.366
#2	0.087	7.72	29.5	0.366
#8	-	7.12	29.4	0.427
#9	0.016	7.61	27.6	0.274
#10	0.015	7.77	27.7	0.32
#11	-	7.12	27.1	0.305
#12	0.117	7.26	26.9	0.442
#3	0.094	7.63	26.5	0.259
#4	0.107	7.94	26.9	0.686
#5	0.036	7.98	28.0	0.213
#6	0.017	7.83	26.2	0.168
#7	0.024	7.94	27.9	0.289

NOTE:
'-' indicates not measured

Table C-5 Metal Concentrations in Sediment

Metal	MDL	Sediment Sample															Marine Sediment Criteria/Guidelines											
		1	2	3	3	4	5	6	7	7	7	7	7	12	9	10	BC Generic Sediment Quality Criteria		CCME Sediment Quality Guidelines for Marine Aquatic Life		CEPA	NOAA[2]			FDEP[3]		Washington State Sediment Quality Standard	
					(duplicate)					(replicates)					(reference)		SedQC$_{SCS}$	SedQC$_{TCS}$	ISQG	PEL		ERL	ERM	AET	TEL	PEL	Level[4]	Effects Level[5]
	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
Silver	0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	-	-	-	-	-	1	3.7	3.1 (b)	0.733	1.77	6.1	6.1
Aluminium	10	35,800	35,900	35,300	36,900	35,600	32,500	35,000	37,300	38,400	39,700	38,200	37,200	35,500	25,400	32800	-	-	-	-	-	-	-	-	-	-	-	-
Arsenic	1	2	2	5	6	3	2	4	6	4	5	4	6	2	3	3	26	50[1]	7.24	41.6	-	-	-	-	-	-	-	-
Boron	3	42	42	55	57	57	53	58	57	54	68	57	59	53	33	46	-	-	-	-	-	-	-	-	-	-	-	-
Barium	0.05	147	146	145	145	145	130	147	152	167	170	162	154	150	121	135	-	-	-	-	-	-	-	48 (a)	-	-	-	-
Beryllium	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	-	-	-	-	-	-	-	-	-
Bismuth	5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	-	-	-	-	-	-	-	-	-	-	-	-
Calcium	10	15,000	16,100	14,800	15,000	15,100	16,200	14,800	16,000	16,900	17,500	17,000	16,700	15,600	11,100	15,200	-	-	-	-	-	-	-	-	-	-	-	-
Cadmium	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.09	<0.05	0.09	0.08	0.11	0.06	<0.05	<0.05	2.6	5	0.7	4.2	0.6	-	-	-	-	-	-	-
Cobalt	0.3	14.7	14.2	14.4	15.3	13.4	12.8	13.5	14.4	14.8	15.2	15.2	14.9	14.1	14.2	14.3	-	-	-	-	-	-	-	10 (n)	-	-	-	-
Chromium	0.3	52.5	53.5	52.6	56.8	53.2	48.2	52.3	55.5	56.7	58.9	57.6	56.3	52.7	43.3	54.4	99	190	52.3	160	-	-	-	-	-	-	-	-
Copper	0.5	48.4	47.0	47.4	52.0	45.1	43.1	44.1	51.1	49.7	51.5	51.4	51.3	46.7	34.3	40.8	67	130	18.7	108	-	-	-	-	-	-	-	-
Iron	5	39,400	37,200	39,000	40,900	36,900	34,000	36,400	40,400	39,500	40,900	40,100	40,300	38,000	37,300	38,200	-	-	-	-	-	-	-	-	-	-	-	-
Mercury	0.0005	0.0221	0.0162	0.0180	0.0127	0.0182	0.0168	0.0185	0.0137	0.0141	0.0136	0.0147	0.0114	0.0167	0.0121	0.0115	0.43	0.84	0.13	0.7	0.75	-	-	-	-	-	-	-
Potassium	3	9,940	10,100	9,830	10,200	9,630	8,880	9,830	10,700	11,100	11,500	10,900	10,700	10,100	6,860	8,670	-	-	-	-	-	-	-	-	-	-	-	-
Lithium	1	54	54	52	58	50	50	48	55	53	56	55	54	50	54	52	-	-	-	-	-	-	-	-	-	-	-	-
Magnesium	10	16,600	16,200	16,500	17,400	15,900	15,100	15,840	17,300	17,200	17,800	17,400	17,400	16,300	15,500	16,400	-	-	-	-	-	-	-	-	-	-	-	-
Manganese	0.05	677	634	659	701	626	566	625	669	671	695	680	672	646	513	596	-	-	-	-	-	-	-	260 (n)	-	-	-	-
Molybdenum	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	1.2	0.7	<0.5	<0.5	<0.5	-	-	-	-	-	-	-	-	-	-	-	-
Sodium	10	16,100	16,000	16,900	16,100	15,300	15,800	15,600	18,000	17,800	18,400	18,300	18,300	16,500	11,500	12,800	-	-	-	-	-	-	-	-	-	-	-	-
Nickel	0.3	23	24	24	24	23	21.8	22.2	23.7	23.7	24.4	24.0	23.6	22.6	18.0	24.6	-	-	-	-	-	20.9	51.6	110 (e,l)	15.9	42.8	-	-
Phosphorus	2	1,060	799	992	1,350	762	718	1,040	1,370	1,000	1,300	1,160	1,280	686	1,390	1,190	-	-	-	-	-	-	-	-	-	-	-	-
Lead	1	5	4	4	4	4	5	4	5	5	5	4	5	4	2	3	69	130	30.2	112	-	-	-	-	-	-	-	-
Sulphur	10	2,090	2,230	2,100	2,060	1,900	3,787	2,136	3,300	3,120	3,310	3,170	3,630	2,730	1,707	1,919	-	-	-	-	-	-	-	-	-	-	-	-
Antimony	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	-	-	-	-	-	-	-	9.3 (e)	-	-	-	-
Selenium	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	-	-	-	-	-	-	-	1 (a)	-	-	-	-
Silicon	3	321	203	252	324	145	202	632	368	314	369	301	310	189	304	253	-	-	-	-	-	-	-	-	-	-	-	-
Tin	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	-	-	-	-	-	-	-	< 3.4 (n)	-	-	-	-
Strontium	0.5	140	142	138	141	142	135	135	150	154	157	153	149	144	92	125	-	-	-	-	-	-	-	-	-	-	-	-

Table C-5 Metal Concentrations in Sediment (cont'd)

Metal	MDL	Sediment Sample															Marine Sediment Criteria/Guidelines											
		1	2	3	3	4	5	6	7	7	7	7	7	12	9	10	BC Generic Sediment Quality Criteria		CCME Sediment Quality Guidelines for Marine Aquatic Life		CEPA	NOAA[2]			FDEP[3]		Washington State Sediment Quality Standard	
					(duplicate)					(replicates)					(reference)		$SedQC_{SCS}$	$SedQC_{TCS}$	ISQG	PEL		ERL	ERM	AET	TEL	PEL	Level[4]	Effects Level[5]
	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
Titanium	0.5	484	1,490	1,630	2,110	682	627	1,750	2,240	1,770	2,230	1,960	2,210	1,060	1,480	1,830	-	-	-	-	-	-	-	-	-	-	-	-
Thallium	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	-	-	-	-	-	-	-	-	-	-	-	-
Vanadium	0.5	86	135	136	142	107	94.4	130	144	144	149	145	144	136	117	134	-	-	-	-	-	-	-	57 (n)	-	-	-	-
Zinc	0.3	84.2	79.1	81.1	85.9	75.9	73.6	76.2	84.9	84.6	87.5	86.3	87.3	79.9	80.2	79.1	170	330	124	271	-	-	-	-	-	-	-	-

NOTES:
Highlighted indicates value exceeds applicable regulatory guideline and criteria
AET values represent the concentration above which adverse biological effects would always be expected by that biological indicator. Adverse effects are known to occur below the AET. AET values were developed for use in Puget Sound, Washington.
[1] Less reliable value that could not be fully evaluated
[2] National Oceanic and Atmospheric Administration
[3] Florida Department of Environmental Protection
[4] sediment quality goal
[5] upper regulatory level for source control and clean-up decision making
[6] AET = Apparent effects threshold (entry is the lowest value among AET values for: a - amphipod; b - bivalve; e - echinoderm larvae; l - larval max; n - *Neanthes* (polychaete) bioassay
'-' indicates guideline and criteria not available or not applicable
CEPA – Canadian Environmental Protection Agency (Screening Limits for Ocean Disposal)
MDL – method detection limit
$SedQC_{SCS}$ – sediment quality criteria for sensitive contaminated sites
$SedQC_{TCS}$ – sediment quality criteria for typical contaminated sites

Table C-6 Non-Halogenated Volatile Concentrations in Sediment

Non-Halogenated Volatiles	MDL	Sediment Sample										Marine Sediment Guidelines
		1	2	3	4	5	6	7	12	9	10	NOAA
										(reference)		AET
	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
Benzene	0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.080	<0.040	<0.040	-
Ethylbenzene	0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.050	<0.050	0.004[e,l]
Styrene	0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.050	<0.050	-
Toluene	0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.050	<0.050	-
meta- and para-Xylene	0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.050	<0.050	-
ortho-Xylene	0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.050	<0.050	-
Total Xylenes	0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.10	<0.10	0.004[b,l]

NOTES:
'-' indicates no guideline and criteria available
e – echinoderm larvae; l – larval (max); b – bivalve
MDL – method detection limit
NOAA – National Oceanic and Atmospheric Administration
AET – apparent effects threshold
NOAA criteria were used, as no Canadian guidelines and criteria were available.

Table C-7 Dioxin and Furan Concentrations in Sediment

Dioxin/Furan	Sediment Sample												Marine Sediment Guidelines		
	1	2	3	4	4 (duplicate)	5	6	7	8	11	12	Lab Blank	CCME		NOAA
													ISQG	PEL	AET
	(pg/g)	(pg/g)	(pg/g)	(pg/g)	(pg/g)	(pg/g)	(pg/g)	(pg/g)	(pg/g)	(pg/g)	(pg/g)	(pg/g)			pg/g
2,3,7,8-TCDD	0.15	0.17	0.15	0.14	NDR 0.11	0.21	NDR 0.13	0.17	0.2	NDR 0.12	NDR 0.17	NDR 0.03	-	-	3.6
1,2,3,7,8-PeCDD	1.32	1.7	1.28	1.03	0.95	1.63	0.95	1.4	1.73	1.14	1.25	0.06	-	-	-
1,2,3,4,7,8-HxCDD	< 0.08	< 0.16	0.2	< 0.12	< 0.15	< 0.12	0.13	0.19	0.23	0.17	0.19	0.07	-	-	-
1,2,3,6,7,8-HxCDD	11.5	14.6	12.3	9.27	9.14	13.1	8.05	12.7	15	10.7	11.8	NDR 0.05	-	-	-
1,2,3,7,8,9-HxCDD	5.25	6.46	5.44	4.37	4.33	5.98	3.82	5.42	6.7	4.76	5.28	NDR 0.10	-	-	-
1,2,3,4,6,7,8-HpCDD	14.8	15.4	14.2	12	12.5	14.2	10.1	16.5	18.1	13.3	12.9	NDR 0.19	-	-	-
OCDD	63.3	51.8	53.8	48.9	51.6	43	37.2	82.4	60.7	49.7	45.5	0.51	-	-	-
2,3,7,8-TCDF	0.38	0.35	0.32	0.32	0.3	0.37	0.25	0.32	0.3	0.29	0.3	0.03	-	-	-
1,2,3,7,8-PeCDF	0.09	0.08	0.08	NDR 0.06	0.1	NDR 0.12	NDR 0.06	NDR 0.08	NDR 0.08	0.07	NDR 0.08	0.05	-	-	-
2,3,4,7,8-PeCDF	0.14	0.13	NDR 0.18	NDR 0.13	0.09	0.15	0.12	0.15	NDR 0.11	0.12	NDR 0.11	0.07	-	-	-
1,2,3,4,7,8-HxCDF	0.18	0.13	NDR 0.15	0.19	NDR 0.06	NDR 0.15	NDR 0.12	NDR 0.17	NDR 0.11	0.1	NDR 0.13	NDR 0.05	-	-	-
1,2,3,6,7,8-HxCDF	0.14	NDR 0.08	0.09	0.11	0.11	NDR 0.09	0.09	NDR 0.10	0.1	NDR 0.09	NDR 0.08	0.06	-	-	-
1,2,3,7,8,9-HxCDF	0.04	< 0.03	< 0.03	< 0.03	< 0.02	< 0.03	NDR 0.02	NDR 0.02	< 0.02	< 0.02	< 0.02	NDR 0.08	-	-	-
2,3,4,6,7,8-HxCDF	0.1	NDR 0.11	0.12	0.08	0.1	0.1	NDR 0.08	0.09	0.1	NDR 0.09	NDR 0.11	NDR 0.06	-	-	-
1,2,3,4,6,7,8-HpCDF	1.54	1.35	1.35	1.37	1.41	1.37	0.98	1.33	1.32	1.18	1.22	0.1	-	-	-
1,2,3,4,7,8,9-HpCDF	0.14	0.15	0.14	NDR 0.11	0.11	0.1	NDR 0.09	NDR 0.08	NDR 0.10	0.08	NDR 0.09	NDR 0.05	-	-	-
OCDF	3.87	2.43	2.76	2.92	3.13	2.57	1.81	2.77	2.8	2.5	2.49	NDR 0.16	-	-	-
Total Tetra-Dioxins	2.06	2.19	1.78	1.33	1.17	2.28	0.53	1.69	2.18	1.11	1.91	< 0.02	-	-	-
Total Penta-Dioxins	9.52	13.2	10.6	8.46	8.29	13.3	8.23	12	14.3	8.88	10.6	0.06	-	-	-
Total Hexa-Dioxins	82.9	103	87.7	68.7	67	95.3	58.7	87.1	111	75.8	85.6	0.07	-	-	-
Total Hepta-Dioxins	38.3	35.1	34.5	30	30.6	33.6	23.3	47.6	45.6	33.2	29.5	0.11	-	-	-
Total Tetra-Furans	2.72	2.98	2.82	2.52	2.3	2.58	1.87	2.56	2.29	2.4	2.82	0.03	-	-	-
Total Penta-Furans	1.79	1.71	1.61	1.36	1.11	1.58	1.27	1.28	0.72	1.21	1.3	0.18	-	-	-
1,2,3,7,8,9-HxCDF	2.05	1.7	1.79	2.01	1.62	1.08	1.44	1.51	1.92	1.75	0.54	0.06	-	-	-
Total Hepta-Furans	4.59	3.69	3.59	3.68	3.89	3.62	2.64	3.8	3.59	3.35	3.13	0.1	-	-	-
% Moisture	52.6	53.4	53.8	49.7	52.5	50.9	51.6	55	52.9	53.5	55.1		-	-	-

Table C-7 Dioxin and Furan Concentrations in Sediment (cont'd)

Dioxin/Furan	Sediment Sample												Marine Sediment Guidelines		
	1	2	3	4	4 (duplicate)	5	6	7	8	11	12	Lab Blank	CCME ISQG	CCME PEL	NOAA AET
	(pg/g)	(pg/g)	(pg/g)	(pg/g)	(pg/g)	(pg/g)	(pg/g)	(pg/g)	(pg/g)	(pg/g)	(pg/g)	(pg/g)			pg/g
2,3,7,8-TCDF (C)[1]	NDR 0.17	0.15	0.2	0.14	0.11	0.12	NDR 0.10	NDR 0.11	0.11	NDR 0.13	0.14	0.02	-	-	-
TEQ (ND=1/2 MDL)[2]	1.84	2.26	1.78	1.42	1.24	2.20	1.24	1.98	2.34	1.50	1.56	0.14	0.85	21.5	

NOTES:

AET values represent the concentration above which adverse biological effects would always be expected by that biological indicator. Adverse effects are known to occur below the AET. AET values were developed for use in Puget Sound, Washington.

Highlighted indicates value exceeds applicable regulatory guideline and criteria.

'-' indicates no guideline and criteria available

'<' indicates less than the detection limit

AET = Apparent effects threshold (entry is the lowest value among AET values for: a - amphipod; b - bivalve; o - oyster larvae; e - echinoderm larvae; i - infaunal community effects; l - larval max; m - Microtox bioassay; n - *Neanthes* (polychaete) bioassay

ID = insufficient data

MDL = method detection limit

NDR = peak detected but did not meet quantification criteria; value not included in TEQ calculations

NOAA = National Oceanic and Atmospheric Administration

PEL = probably effects level

[1] Duplicate 2,3,7,8-TCDF value not included in TEQ calculation (analysis conducted in a different column from rest of samples for confirmatory purposes).

[2] TEQ calculated using TEFs for fish (CCME, 2004); 1/2 MDL value used for non-detects in TEQ calculations

Table C-8 Polycyclic Aromatic Hydrocarbon Concentrations in Sediment

PAH	MDL	Sediment Sample												Marine Sediment Guidelines									
		1	2	2	3	4	5	5	6	7	12	9	10	BC		CCME		CEPA	NOAA			FDEP	
				(replicate)				(replicate)				(reference)		$SedQC_{SCS}$	$SedQC_{TCS}$	ISQG	PEL		ERL	ERM	AET	TEL	PEL
	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)
Naphthalene	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.24	0.47	0.035	0.39	-					
2-Methylnapthalene	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.12	0.24	0.020	0.20	-					
Acenaphthylene	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.079	0.15	0.006	0.13	-					
Acenaphthene	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.055	0.11	0.007	0.0089	-					
Fluorene	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.089	0.17	0.021	0.14	-					
Phenanthrene	0.05	0.15	0.15	0.17	0.18	0.15	0.13	0.11	0.14	0.15	0.09	<0.05	<0.05	0.34	0.65	0.087	0.54	-					
Anthracene	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.15	0.29	0.047	0.25	-					
Total LMW-PAHs		0.15	0.15	0.17	0.18	0.15	0.13	0.11	0.14	0.15	0.09	NA	NA	-	-	-	-	-	0.552	3.2	1.2[e]	0.312	1.442
Fluoranthene	0.05	0.33	0.32	0.37	0.39	0.29	0.26	0.22	0.28	0.3	0.22	<0.05	0.06	0.93	1.8	0.11	1.49	-					
Pyrene	0.05	0.33	0.32	0.38	0.4	0.29	0.26	0.22	0.28	0.3	0.24	<0.05	0.06	0.87	1.7	0.15	1.4	-					
Benzo(a)anthracene	0.05	0.23	0.24	0.26	0.27	0.19	0.16	0.13	0.17	0.18	0.13	<0.05	<0.05	0.43	0.83	0.075	0.69	-					
Chrysene	0.05	<0.05	0.28	0.3	0.32	0.23	0.2	0.16	0.21	0.22	0.16	<0.05	<0.05	0.52	1	0.108	0.85	-					
Benzo(b)fluoranthene	0.05	0.61	0.6	0.7	0.7	0.54	0.42	0.36	0.43	0.46	0.49	0.06	0.09	-	-	-	-	-	-	-	1.8[e,i]	-	-
Benzo(k)fluoranthene	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	-	-	-	-	-	-	1.8[e,i]	-	-
Benzo(a)pyrene	0.05	0.32	0.32	0.39	0.36	0.27	0.22	0.19	0.24	0.24	0.17	<0.05	<0.05	0.47	0.92	0.089	0.76	-					
Indeno(1,2,3-cd)pyrene	0.05	0.24	0.23	0.27	0.25	0.22	0.16	0.14	0.17	0.17	0.11	<0.05	<0.05	-	-	-	-	-	-	-	0.6[m]	-	-
Dibenz(a,h)anthracene	0.05	0.05	0.05	0.06	0.06	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.084	0.16	0.0062	0.14	-					
Benzo(g,h,i)perylene	0.05	0.23	0.22	0.25	0.23	0.24	0.16	0.15	0.18	0.17	0.12	<0.05	<0.05	-	-	-	-	-	-	-	0.67[m]	-	-

Table C-8 Polycyclic Aromatic Hydrocarbon Concentrations in Sediment (cont'd)

PAH	MDL	Sediment Sample												Marine Sediment Guidelines									
		1	2	2	3	4	5	5	6	7	12	9	10	BC		CCME		CEPA	NOAA			FDEP	
				(replicate)				(replicate)				(reference)		$SedQC_{SCS}$	$SedQC_{TCS}$	ISQG	PEL		ERL	ERM	AET	TEL	PEL
	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)
Total HMW-PAHs		2.3	2.6	3.0	3.0	2.3	1.8	1.6	2.0	2.0	1.6	0.06	0.21	-	-	-	-	-	1.7	9.6	7.9[e]	0.655	6.676
Total PAHs		2.5	2.7	3.2	3.2	2.4	2.0	1.7	2.1	2.2	1.7	0.06	0.21	-	-	-	-	2.5					

NOTES:
AET values represent the concentration above which adverse biological effects would always be expected by that biological indicator. Adverse effects are known to occur below the AET. AET values were developed for use in Puget Sound, Washington.
Highlighted cells indicate value is above applicable guideline and criteria.
NOAA and FDEP guidelines and criteria were only included if Canadian guidelines were not available.
'-' indicates guideline and criteria not available or not applicable
AET – Apparent effects threshold (entry is the lowest value among AET values for: e - echinoderm larvae; i - infaunal community effects; m - Microtox bioassay.
CCME – Canadian Council of Ministers of the Environment
CEPA – Canadian Environmental Protection Agency; Screening Limits for Ocean Disposal
ERL – effects range low
ERM = effects range median
FDEP – Florida Department of Environmental Protection (source document is Macdonald 1994)
ISQG – Interim sediment quality guideline
MDL – method detection limit
NA – not applicable
NOAA – National Oceanic and Atmospheric Administration
PAH – polycyclic aromatic hydrocarbon
PEL – Probable effects level
$SedQC_{SCS}$ – sediment quality criteria for sensitive contaminated sites
$SedQC_{TCS}$ – sediment quality criteria for typical contaminated sites
TEL = threshold effects level

Table C-9 Polychlorinated Biphenyl Concentrations in Sediment

Sediment Sample	MDL	Total PCBs (as Aroclor 1254)	Marine Sediment Guidelines				
			BC Generic Sediment Quality Criteria[1]		CCME[2]		CEPA
			$SedQC_{SCS}$	$SedQC_{TCS}$	ISQG	PEL	
	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)	(ug/g)
1	0.03	<0.03	0.12	0.23	0.0633	0.709	0.1
2	0.03	<0.03	0.12	0.23	0.0633	0.709	0.1
3	0.03	<0.03	0.12	0.23	0.0633	0.709	0.1
3 (replicate)	0.03	<0.03	0.12	0.23	0.0633	0.709	0.1
4	0.03	<0.03	0.12	0.23	0.0633	0.709	0.1
5	0.03	<0.03	0.12	0.23	0.0633	0.709	0.1
6	0.03	<0.03	0.12	0.23	0.0633	0.709	0.1
7	0.03	<0.03	0.12	0.23	0.0633	0.709	0.1
8	0.03	<0.03	0.12	0.23	0.0633	0.709	0.1
11	0.03	0.03	0.12	0.23	0.0633	0.709	0.1
11 (replicate)	0.03	0.03	0.12	0.23	0.0633	0.709	0.1
12	0.03	<0.03	0.12	0.23	0.0633	0.709	0.1

NOTES:

Samples were quantified against an Aroclor 1254 standard because the PCB pattern was closest to this particular Aroclor.

[1] The sum of four to seven Aroclor mixtures, not including Aroclor 1254

[2] Aroclor 1254

CCME – Canadian Council of Ministers of the Environment

CEPA – Canadian Environmental Protection Agency (Screening Limits for Ocean Disposal)

ISQG – interim sediment quality guideline

MDL – method detection limit

PCB – polychlorinated biphenyl

PEL – probable effects level

SedQCSCS – sediment quality criteria for sensitive contaminated sites

SedQCTCS – sediment quality criteria for typical contaminated sites

Table C-10 Other Sediment Parameters

Sediment Sample	Moisture	Total Organic Carbon
	(%)	(% dry wt.)
1	54.3	1.28
3	55	1.29
4	56.7	0.99
5	53.4	1.08
5 (rep)	55.1	1.82
6	53.2	1.17
7	58.6	0.75
9	57.1	1.63
10	49.9	0.78
12	54.4	1.25

C.2 Vizon Scitec Report

C.3 Particle Size Distribution Results – Vizon Scitec

VIZON SCITEC

TOXICITY AND CHEMICAL TESTING ON MARINE SEAWATER AND SEDIMENT SAMPLES FOR THE GATEWAY ENVIRONMENTAL MANAGEMENT (GEM) MARINE PROJECT SAMPLING PERIOD: FEBRUARY 2006

Prepared for:

Jacques Whitford Ltd.
4370 Dominion Street, 5th Floor
Burnaby, BC
Canada V5G 4L7

Prepared by:

Toxicology Group

Project No.: 2-11-0965B Jacques Whitford
April 2006

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SUMMARY

Seawater and marine sediment samples were collected by Jacques Whitford staff and shipped to Vizon for arrival on 9 February 2006. Seawater samples were analysed for dissolved metals, PAHs, BTEX, ammonia, pH, salinity, and sulphide. The sediment samples tested using the 10-d marine amphipod survival (*Eohaustorius estuarius*) test and 20-d polychaete survival and growth (*Neanthes arenaceodentata*) test. In addition, the sediment was also characterised for total metals, PAHs, BTEX, moisture content, total organic carbon, particle size distribution, total PCBs, dioxins and furans, and AVS/SEM; and porewater ammonia, pH, and sulphide.

The analytical reports for the seawater and sediment characterisation are located in the appropriate sections of this report. Table 1 summarises the results of the toxicity tests as per the guidance provided in the appropriate test methods. The values are mean ± SD unless otherwise indicated.

Table 1 Summary of Survival and Growth Results for Marine Amphipod and Polychaete Tests

JW Sample Name	Vizon Sample Name	Marine Amphipod		Polychaete			
		Survival (%)	Notes[a]	Survival (%)	Mean Dry Weight (mg/worm)	Mean Growth Rate (mg/worm/day)	Notes
Site 9	JW9	97 ± 4	N/A	100 ± 0	20.64 ± 1.40	1.00 ± 0.07	NSD[c]
Site 10	JW10	90 ± 8	N/A	100 ± 0	20.25 ± 3.10	0.98 ± 0.15	NSD[c]
Site 1	JW1	88 ± 8	Passed	100 ± 0	20.61 ± 1.32	1.00 ± 0.07	NSD[d]
Site 2	JW2	88 ± 8	Passed	100 ± 0	21.45 ± 1.85	1.04 ± 0.09	NSD[d]
Site 3	JW3	80 ± 12	Passed[b]	100 ± 0	20.54 ± 1.66	0.99 ± 0.08	NSD[d]
Site 4	JW4	87 ± 4	Passed	100 ± 0	19.71 ± 4.20	0.95 ± 0.21	NSD[d]
Site 5	JW5	85 ± 12	Passed[b]	100 ± 0	20.15 ± 2.64	0.97 ± 0.13	NSD[d]
Site 6	JW6	82 ± 6	Passed[b]	100 ± 0	20.52 ± 2.65	0.99 ± 0.13	NSD[d]
Site 7	JW7	84 ± 8	Passed[b]	100 ± 0	19.98 ± 2.07	0.97 ± 0.10	NSD[d]
Site 12	JW12	81 ± 11	Passed[b]	100 ± 0	21.02 ± 2.17	1.02 ± 0.11	NSD[d]

[a] As per EPS 1/RM/35, the test sediment is judged to have failed this sediment toxicity test if the mean 10-d survival rate is more than 20% lower than that in the reference sediment and is significantly different. The reference sediments were identified by the client to be Site 9 (JW9) and Site 10 (JW10).

[b] Amphipod survival in test sediments JW3, JW5, JW6, JW7, and JW12 were significantly different from reference sediment JW9. Maximum difference = 17%.

[c] NSD = Not significantly different from laboratory control. PSEP states that the bioassay response measured for sediments from each reference station should be less than the mean response that can be determined as toxic in statistical comparisons with the control sediment.

[d] NSD = Not significantly different from either reference sediment (Site 9 or Site 10).

SAMPLE INFORMATION

This section of the report contains the Toxicity Test Request Sheet(s) for the test samples, and any applicable sample information. For the sediment samples, sample identification was confirmed by the recorded information on water-proof labels located in the samples. All samples arrived on 9 February 2006. From receipt to test initiation, samples were stored in a cold room that was at 4 ± 2°C.

The seawater samples were collected in separate bottles appropriate to the requested analyses: dissolved metals, PAHs, BTEX, ammonia, pH, salinity, and sulphide. As per the client's request, only seawater samples from Site 1 to 7, 9, 10, and 12 were analysed. For the dates of sample collection and associated information, see the Chain of Custody forms.

The sediment samples were stored until use in the toxicity tests: 10-d marine amphipod survival (*Eohaustorius estuarius*) and 20-d polychaete survival and growth (*Neanthes arenaceodentata*). Aliquots were also collected for sediment characterisation: total metals, PAHs, BTEX, moisture content, total organic carbon, particle size distribution, total PCBs, dioxins and furans, and AVS/SEM; and porewater ammonia, pH, and sulphide. After the first opening, any headspace in the sample pails was replaced with nitrogen gas during storage. As per the client's request, only selected sediment samples were analysed for toxicity testing or particular sediment characterisation (Table 2).

Table 2 Sample Information for Sediment Samples

JW Sample Name	Vizon Sample Name	Vizon Login Number	Date of Collection	Date of Sample Arrival	Arrival Temperature (°C)	Notes[a]
Site 1	JW1	060210J-01	3 Feb 2006	9 Feb 2006	12.2	T, PW, SC, D/F, PCBs
Site 2	JW2	060210J-02	3 Feb 2006	9 Feb 2006	11.8	T, PW, SC, D/F, PCBs
Site 3	JW3	060210J-03	3 Feb 2006	9 Feb 2006	13.6	T, PW, SC, D/F, PCBs
Site 4	JW4	060210J-04	4 Feb 2006	9 Feb 2006	13.4	T, PW, SC, D/F, PCBs
Site 5	JW5	060210J-05	4 Feb 2006	9 Feb 2006	13.6	T, PW, SC, D/F, PCBs
Site 6	JW6	060210J-06	4 Feb 2006	9 Feb 2006	12.4	T, PW, SC, D/F, PCBs
Site 7	JW7	060210J-07	4 Feb 2006	9 Feb 2006	15.2	T, PW, SC, D/F, PCBs
Site 8	JW8	060210J-08	4 Feb 2006	9 Feb 2006	15.6	D/F, PCBs
Site 9	JW9	060210J-09	7 Feb 2006	9 Feb 2006	8.8	T, PW, SC
Site 10	JW10	060210J-10	7 Feb 2006	9 Feb 2006	8.4	T, PW, SC
Site 11	JW11	060210J-11	N/A	9 Feb 2006	13.8	D/F, PCBs
Site 12	JW12	060210J-12	N/A	9 Feb 2006	13.0	T, PW, SC, D/F, PCBs

[a] T = toxicity testing; PW = porewater chemistry; SC = all sediment characterisation except dioxins/furans and total PCBs; D/F = Dioxins/Furans; PCBs = Total PCBs.

TOXICITY TEST REQUEST SHEET

VIZON SCITEC

FOR LAB USE ONLY	PROJECT NUMBER	DATE FEB 10/06
	CLIENT	SAMPLE NUMBER 060210J-01

REPORTING AND BILLING INFORMATION

RESULTS TO:		INVOICE TO (IF DIFFERENT):	
NAME Janine Beckett		NAME	
COMPANY Jacques Whitford		COMPANY	
ADDRESS 4370 Dominion Rd.		ADDRESS	
5th floor			
Burnaby	BC		
CITY	PROVINCE	CITY	PROVINCE
COUNTRY Canada	POSTAL CODE V5G 4L7	COUNTRY	POSTAL CODE
TELEPHONE 604-436-3014	FAX 604-436-3752	TELEPHONE	FAX

SAMPLE INFORMATION

12.2

SAMPLE NAME #1 Kitimat/Douglas Channel	
SAMPLING METHOD 11L. Van Veen grab	SPECIAL INSTRUCTIONS
SAMPLED BY J. Beckett / J. Thompson	
DATE Feb.3/06 TIME	
CONTAINER TYPE AND NUMBER 8L bucket #1	

TOXICITY TESTS REQUIRED

PROTOCOL		100% SCREEN (PASS/FAIL)	CONCENTRATION RANGE	COMMENTS
ACUTE	DAPHNIA MAGNA 48H STATIC ACUTE			
	RAINBOW TROUT 96H STATIC ACUTE			
	MICROTOX			
CHRONIC	SALMONID 7D EMBRYO VIABILITY			
	FATHEAD MINNOW 7D SURVIVAL AND GROWTH			
	CERIODAPHNIA DUBIA 7D SURVIVAL AND REPRODUCTION			
	SELENASTRUM GROWTH 72H INHIBITION			
	TOPSMELT 7D SURVIVAL AND GROWTH			
	ECHINODERM FERTILIZATION TEST (SEA URCHINS/SAND DOLLARS)			
	CHAMPIA PARVULA REPRODUCTION			
OTHER	10d amphipod survival 20 d Polychaete survival			

CHAIN OF CUSTODY RECORD

RELINQUISHED BY: Janine Beckett

RECEIVED BY:

NAME	DATE	TIME	NAME	DATE	TIME
			S. Bigham	Feb 9/06	1514
				Feb 10/06	1247

L:QAU/Forms/Requisition- Chain of Custody Forms/Current/Templates/Toxicity Tests Request Form v4.dot

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Tel: (360) 738-0958
Fax: (360) 733-3590

TOXICITY TEST REQUEST SHEET

VIZON SCITEC

FOR LAB USE ONLY	PROJECT NUMBER	DATE FEB10/06
	CLIENT	SAMPLE NUMBER 060210J-02

REPORTING AND BILLING INFORMATION

RESULTS TO:		INVOICE TO (IF DIFFERENT):	
NAME Janine Beckett		NAME	
COMPANY Jacques Whitford		COMPANY	
ADDRESS 4370 Dominion Rd.		ADDRESS	
5th floor			
Burnaby	BC		
CITY Canada	PROVINCE V5G 4L7	CITY	PROVINCE
COUNTRY 604-436-3014	POSTAL CODE 604-436-3752	COUNTRY	POSTAL CODE
TELEPHONE	FAX	TELEPHONE	FAX

SAMPLE INFORMATION

SAMPLE NAME #2 Kitimat/Douglas Channel		
SAMPLING METHOD 11L Van Veen grab		SPECIAL INSTRUCTIONS
SAMPLED BY J. Beckett / J. Thompson		
DATE Feb. 3/06	TIME	
CONTAINER TYPE AND NUMBER 8L bucket #2		

11.8

TOXICITY TESTS REQUIRED

PROTOCOL		100% SCREEN (PASS/FAIL)	CONCENTRATION RANGE	COMMENTS
ACUTE	DAPHNIA MAGNA 48H STATIC ACUTE			
	RAINBOW TROUT 96H STATIC ACUTE			
	MICROTOX			
CHRONIC	SALMONID 7D EMBRYO VIABILITY			
	FATHEAD MINNOW 7D SURVIVAL AND GROWTH			
	CERIODAPHNIA DUBIA 7D SURVIVAL AND REPRODUCTION			
	SELENASTRUM GROWTH 72H INHIBITION			
	TOPSMELT 7D SURVIVAL AND GROWTH			
	ECHINODERM FERTILIZATION TEST (SEA URCHINS/SAND DOLLARS)			
	CHAMPIA PARVULA REPRODUCTION			
OTHER	10d. amphipod survival 20d. Polychaete survival			

CHAIN OF CUSTODY RECORD

RELINQUISHED BY: Janine Beckett			RECEIVED BY:		
NAME	DATE	TIME	NAME	DATE	TIME
			S. Bingham	FEB9/06	1514
				FEB10/06	1247

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TOXICITY TEST REQUEST SHEET

VIZON SCITEC

FOR LAB USE ONLY	PROJECT NUMBER	DATE Feb 10/06
	CLIENT	SAMPLE NUMBER 060210J-03

REPORTING AND BILLING INFORMATION

RESULTS TO:		INVOICE TO (IF DIFFERENT):	
NAME Janine Beckett		NAME	
COMPANY Jacques Whitford		COMPANY	
ADDRESS 4370 Dominion Rd. 5th floor		ADDRESS	
Burnaby	BC		
CITY Canada	PROVINCE V5G 4L7	CITY	PROVINCE
COUNTRY 604-436-3014	POSTAL CODE 604-436-3752	COUNTRY	POSTAL CODE
TELEPHONE	FAX	TELEPHONE	FAX

SAMPLE INFORMATION

SAMPLE NAME #3 Kitimat / Douglas Channel	
SAMPLING METHOD 11 L Van Veen Grab	SPECIAL INSTRUCTIONS
SAMPLED BY J. Beckett / J. Thompson	
DATE Feb 3/06 TIME	
CONTAINER TYPE AND NUMBER 8L bucket #3	

136

TOXICITY TESTS REQUIRED

PROTOCOL		100% SCREEN (PASS/FAIL)	CONCENTRATION RANGE	COMMENTS
ACUTE	DAPHNIA MAGNA 48H STATIC ACUTE			
	RAINBOW TROUT 96H STATIC ACUTE			
	MICROTOX			
CHRONIC	SALMONID 7D EMBRYO VIABILITY			
	FATHEAD MINNOW 7D SURVIVAL AND GROWTH			
	CERIODAPHNIA DUBIA 7D SURVIVAL AND REPRODUCTION			
	SELENASTRUM GROWTH 72H INHIBITION			
	TOPSMELT 7D SURVIVAL AND GROWTH			
	ECHINODERM FERTILIZATION TEST (SEA URCHINS/SAND DOLLARS)			
	CHAMPIA PARVULA REPRODUCTION			
OTHER	10 d amphipod survival 20 d. Polychaete survival			

CHAIN OF CUSTODY RECORD

RELINQUISHED BY: Janine Beckett

RECEIVED BY:

NAME	DATE	TIME	NAME	DATE	TIME
			SB	Feb 9/06	1514
				Feb 10/06	1247

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TOXICITY TEST REQUEST SHEET

VIZON SCITEC

FOR LAB USE ONLY	PROJECT NUMBER	DATE Feb10/06
	CLIENT	SAMPLE NUMBER 060210J-04

REPORTING AND BILLING INFORMATION

RESULTS TO:		INVOICE TO (IF DIFFERENT):	
NAME Janine Beckett		NAME	
COMPANY Jacques Whitford		COMPANY	
ADDRESS 4370 Dominion Rd.		ADDRESS	
5th floor			
Burnaby	BC		
CITY Canada	PROVINCE V5G 4L7	CITY	PROVINCE
COUNTRY 604-436-3014	POSTAL CODE 604-436-3752	COUNTRY	POSTAL CODE
TELEPHONE	FAX	TELEPHONE	FAX

SAMPLE INFORMATION

SAMPLE NAME #4 Kitimat/Douglas Channel		
SAMPLING METHOD 11 L Van Veen grab		SPECIAL INSTRUCTIONS
SAMPLED BY J. Beckett/J. Thompson		
DATE Feb. 4/06	TIME	
CONTAINER TYPE AND NUMBER 8L bucket #4		

TOXICITY TESTS REQUIRED

PROTOCOL		100% SCREEN (PASS/FAIL)	CONCENTRATION RANGE	COMMENTS
ACUTE	DAPHNIA MAGNA 48H STATIC ACUTE			
	RAINBOW TROUT 96H STATIC ACUTE			
	MICROTOX			
CHRONIC	SALMONID 7D EMBRYO VIABILITY			
	FATHEAD MINNOW 7D SURVIVAL AND GROWTH			
	CERIODAPHNIA DUBIA 7D SURVIVAL AND REPRODUCTION			
	SELENASTRUM GROWTH 72H INHIBITION			
	TOPSMELT 7D SURVIVAL AND GROWTH			
	ECHINODERM FERTILIZATION TEST (SEA URCHINS/SAND DOLLARS)			
	CHAMPIA PARVULA REPRODUCTION			
OTHER	10 d amphipod survival 20 d. Polychaete survival			

B.4

CHAIN OF CUSTODY RECORD

RELINQUISHED BY: Janine Beckett			RECEIVED BY:		
NAME	DATE	TIME	NAME	DATE	TIME
			SB	Feb9/06	1514
				Feb10/06	1247

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TOXICITY TEST REQUEST SHEET

VIZON SCITEC

FOR LAB USE ONLY	PROJECT NUMBER	DATE FEB10/06
	CLIENT	SAMPLE NUMBER 060210J-05

REPORTING AND BILLING INFORMATION

RESULTS TO:		INVOICE TO (IF DIFFERENT):	
NAME Janine Beckett		NAME	
COMPANY Jacques Whitford		COMPANY	
ADDRESS 4370 Dominion Rd. 5th floor		ADDRESS	
CITY Burnaby	PROVINCE BC	CITY	PROVINCE
COUNTRY Canada	POSTAL CODE V5G 4L7	COUNTRY	POSTAL CODE
TELEPHONE 604-436	FAX 604 4363752	TELEPHONE	FAX

SAMPLE INFORMATION

SAMPLE NAME #5 Kitimat/Douglas Channel	
SAMPLING METHOD 1L Van Veen	SPECIAL INSTRUCTIONS
SAMPLED BY J. Beckett / J. Thompson	
DATE Feb 4/06 TIME	
CONTAINER TYPE AND NUMBER 8L bucket #5	

13.6

TOXICITY TESTS REQUIRED

PROTOCOL		100% SCREEN (PASS/FAIL)	CONCENTRATION RANGE	COMMENTS
ACUTE	DAPHNIA MAGNA 48H STATIC ACUTE			
	RAINBOW TROUT 96H STATIC ACUTE			
	MICROTOX			
CHRONIC	SALMONID 7D EMBRYO VIABILITY			
	FATHEAD MINNOW 7D SURVIVAL AND GROWTH			
	CERIODAPHNIA DUBIA 7D SURVIVAL AND REPRODUCTION			
	SELENASTRUM GROWTH 72H INHIBITION			
	TOPSMELT 7D SURVIVAL AND GROWTH			
	ECHINODERM FERTILIZATION TEST (SEA URCHINS/SAND DOLLARS)			
	CHAMPIA PARVULA REPRODUCTION			
OTHER	10 d Amphipod 20 d Polycheate survival			

CHAIN OF CUSTODY RECORD

RELINQUISHED BY: Janine Beckett

RECEIVED BY:

NAME	DATE	TIME	NAME	DATE	TIME
			SB	FEB 9/06	1514
				FEB10/06	1247

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TOXICITY TEST REQUEST SHEET

VIZON SCITEC

FOR LAB USE ONLY	PROJECT NUMBER	DATE FEB10/06
	CLIENT	SAMPLE NUMBER 06021O1-06

REPORTING AND BILLING INFORMATION

RESULTS TO:		INVOICE TO (IF DIFFERENT):	
NAME Janine Beckett		NAME	
COMPANY Jacques Whitford		COMPANY	
ADDRESS 4370 Dominion Rd.		ADDRESS	
5th floor			
Burnaby	BC		
CITY Canada	PROVINCE V5G 4L7	CITY	PROVINCE
COUNTRY 604-436-3014	POSTAL CODE 604-436-3752	COUNTRY	POSTAL CODE
TELEPHONE	FAX	TELEPHONE	FAX

SAMPLE INFORMATION

SAMPLE NAME #6 Kitimat/Douglas Channel		
SAMPLING METHOD 11 L Van Veen Grab		SPECIAL INSTRUCTIONS
SAMPLED BY J Beckett/J. Thompson		
DATE Feb.4/06	TIME 10:30	
CONTAINER TYPE AND NUMBER 8L bucket #6		

TOXICITY TESTS REQUIRED

PROTOCOL		100% SCREEN (PASS/FAIL)	CONCENTRATION RANGE	COMMENTS
ACUTE	DAPHNIA MAGNA 48H STATIC ACUTE			
	RAINBOW TROUT 96H STATIC ACUTE			
	MICROTOX			
CHRONIC	SALMONID 7D EMBRYO VIABILITY			
	FATHEAD MINNOW 7D SURVIVAL AND GROWTH			
	CERIODAPHNIA DUBIA 7D SURVIVAL AND REPRODUCTION			
	SELENASTRUM GROWTH 72H INHIBITION			
	TOPSMELT 7D SURVIVAL AND GROWTH			
	ECHINODERM FERTILIZATION TEST (SEA URCHINS/SAND DOLLARS)			
	CHAMPIA PARVULA REPRODUCTION			
OTHER	10 d amphipod survival 20 d Polychaete survival			

CHAIN OF CUSTODY RECORD

RELINQUISHED BY: Janine Beckett			RECEIVED BY:		
NAME	DATE	TIME	NAME	DATE	TIME
			SB	FEB9/06	1514
				FEB10/06	1247

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TOXICITY TEST REQUEST SHEET

VIZON SCITEC

FOR LAB USE ONLY	PROJECT NUMBER	DATE Feb 10/06
	CLIENT	SAMPLE NUMBER 060210.1-07

REPORTING AND BILLING INFORMATION

RESULTS TO:		INVOICE TO (IF DIFFERENT):	
NAME Janine Beckett		NAME	
COMPANY Jacques Whitford		COMPANY	
ADDRESS 4370 Dominion Rd.		ADDRESS	
5th Floor			
Burnaby	BC		
CITY Canada	PROVINCE V5G 4L7	CITY	PROVINCE
COUNTRY 604 436 3014	POSTAL CODE 604 436 3752	COUNTRY	POSTAL CODE
TELEPHONE	FAX	TELEPHONE	FAX

SAMPLE INFORMATION

SAMPLE NAME #7 Kitimat/Douglas Channel	
SAMPLING METHOD 11L Van Veen grab	SPECIAL INSTRUCTIONS
SAMPLED BY J. Beckett/J. Thompson	
DATE Feb 4/06 — TIME	
CONTAINER TYPE AND NUMBER 8L bucket #7	

15.2

TOXICITY TESTS REQUIRED

PROTOCOL		100% SCREEN (PASS/FAIL)	CONCENTRATION RANGE	COMMENTS
ACUTE	DAPHNIA MAGNA 48H STATIC ACUTE			
	RAINBOW TROUT 96H STATIC ACUTE			
	MICROTOX			
CHRONIC	SALMONID 7D EMBRYO VIABILITY			
	FATHEAD MINNOW 7D SURVIVAL AND GROWTH			
	CERIODAPHNIA DUBIA 7D SURVIVAL AND REPRODUCTION			
	SELENASTRUM GROWTH 72H INHIBITION			
	TOPSMELT 7D SURVIVAL AND GROWTH			
	ECHINODERM FERTILIZATION TEST (SEA URCHINS/SAND DOLLARS)			
	CHAMPIA PARVULA REPRODUCTION			
OTHER	10d. amphipod survival 20 d. Polychaete survival			

CHAIN OF CUSTODY RECORD

RELINQUISHED BY: Janine Beckett			RECEIVED BY:		
NAME	DATE	TIME	NAME	DATE	TIME
			SB	Feb 9/06	1514
				Feb 10/06	1247

Vizon SciTec Inc.
3650 Wesbrook Mall
Vancouver, BC
Canada V6S 2L2
Canada
Tel: (604) 224-4331
Fax: (604) 224-0540
USA
Tel: (360) 738-0958
Fax: (360) 733-3590

TOXICITY TEST REQUEST SHEET

VIZON SCITEC

FOR LAB USE ONLY	PROJECT NUMBER	DATE Feb 10/06
	CLIENT	SAMPLE NUMBER 060210T-08

REPORTING AND BILLING INFORMATION

RESULTS TO:		INVOICE TO (IF DIFFERENT):	
NAME Janine Beckett		NAME	
COMPANY Jacques Whitford		COMPANY	
ADDRESS 4370 Dominion Rd.		ADDRESS	
5th floor			
Burnaby	BC		
CITY Canada	PROVINCE V5G 4L7	CITY	PROVINCE
COUNTRY 604 436 3014	POSTAL CODE 604 436 3752	COUNTRY	POSTAL CODE
TELEPHONE	FAX	TELEPHONE	FAX

SAMPLE INFORMATION

SAMPLE NAME #8 Kitimat/Douglas Channel		
SAMPLING METHOD 11L Van Veen grab		SPECIAL INSTRUCTIONS
SAMPLED BY J. Beckett / J. Thompson		
DATE Feb 4 ~~8~~/06	TIME	
CONTAINER TYPE AND NUMBER 8L bucket #8		

156

TOXICITY TESTS REQUIRED

PROTOCOL		100% SCREEN (PASS/FAIL)	CONCENTRATION RANGE	COMMENTS
ACUTE	DAPHNIA MAGNA 48H STATIC ACUTE			
	RAINBOW TROUT 96H STATIC ACUTE			
	MICROTOX			
CHRONIC	SALMONID 7D EMBRYO VIABILITY			
	FATHEAD MINNOW 7D SURVIVAL AND GROWTH			
	CERIODAPHNIA DUBIA 7D SURVIVAL AND REPRODUCTION			
	SELENASTRUM GROWTH 72H INHIBITION			
	TOPSMELT 7D SURVIVAL AND GROWTH			
	ECHINODERM FERTILIZATION TEST (SEA URCHINS/SAND DOLLARS)			
	CHAMPIA PARVULA REPRODUCTION			
OTHER	10d. amphipod survival 20d. Polychaete Survival			

CHAIN OF CUSTODY RECORD

RELINQUISHED BY: Janine Beckett			RECEIVED BY:		
NAME	DATE	TIME	NAME	DATE	TIME
			S. Bigham	Feb 9/06	1514
				Feb 10/06	1247

Vizon SciTec Inc.
3650 Wesbrook Mall
Vancouver, BC
Canada V6S 2L2
Canada
Tel: (604) 224-4331
Fax: (604) 224-0540
USA
Tel: (360) 738-0958
Fax: (360) 733-3590

TOXICITY TEST REQUEST SHEET

VIZON SCITEC

FOR LAB USE ONLY	PROJECT NUMBER	DATE Feb 10/06
	CLIENT	SAMPLE NUMBER 060210T-09

REPORTING AND BILLING INFORMATION

RESULTS TO:		INVOICE TO (IF DIFFERENT):	
NAME Janine Beckett		NAME	
COMPANY Jacques Whitford		COMPANY	
ADDRESS 4370 Dominion St.		ADDRESS	
5th floor			
Burnaby	B.C.		
CITY Canada	PROVINCE V5G 4L7	CITY	PROVINCE
COUNTRY 604 436 3014	POSTAL CODE 604 436 3752	COUNTRY	POSTAL CODE
TELEPHONE	FAX	TELEPHONE	FAX

9 or 10 ?

SAMPLE INFORMATION

SAMPLE NAME #9 Kitimat/Douglas Channel	
SAMPLING METHOD 11L Van Veen grab	SPECIAL INSTRUCTIONS
SAMPLED BY J. Beckett / J. Thompson	
DATE Feb 7/06 TIME	
CONTAINER TYPE AND NUMBER 8L bucket #9	

8.8/8.4

TOXICITY TESTS REQUIRED

PROTOCOL		100% SCREEN (PASS/FAIL)	CONCENTRATION RANGE	COMMENTS
ACUTE	DAPHNIA MAGNA 48H STATIC ACUTE			
	RAINBOW TROUT 96H STATIC ACUTE			
	MICROTOX			
CHRONIC	SALMONID 7D EMBRYO VIABILITY			
	FATHEAD MINNOW 7D SURVIVAL AND GROWTH			
	CERIODAPHNIA DUBIA 7D SURVIVAL AND REPRODUCTION			
	SELENASTRUM GROWTH 72H INHIBITION			
	TOPSMELT 7D SURVIVAL AND GROWTH			
	ECHINODERM FERTILIZATION TEST (SEA URCHINS/SAND DOLLARS)			
	CHAMPIA PARVULA REPRODUCTION			
OTHER	10 d. amphipod survival 20 d. Polychaete survival			

CHAIN OF CUSTODY RECORD

RELINQUISHED BY: Janine Beckett			RECEIVED BY:		
NAME	DATE	TIME	NAME	DATE	TIME
			SB	Feb 9/06	1514
				Feb 10/06	1247

Vizon SciTec Inc.
3650 Wesbrook Mall
Vancouver, BC
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Canada
Tel: (604) 224-4331
Fax: (604) 224-0540
USA
Tel: (360) 738-0958
Fax: (360) 733-3590

TOXICITY TEST REQUEST SHEET

VIZON SCITEC

FOR LAB USE ONLY	PROJECT NUMBER	DATE FEB10/06
	CLIENT	SAMPLE NUMBER 060210Q1-10

REPORTING AND BILLING INFORMATION

RESULTS TO:		INVOICE TO (IF DIFFERENT):	
NAME Janine Beckett		NAME	
COMPANY Jacques Whitford		COMPANY	
ADDRESS 4370 Dominion St.		ADDRESS	
5th floor			
Burnaby BC			
CITY Canada	PROVINCE V5G 4L7	CITY	PROVINCE
COUNTRY 604 436 3014	POSTAL CODE 604 436 3752	COUNTRY	POSTAL CODE
TELEPHONE	FAX	TELEPHONE	FAX

9 or 10?

SAMPLE INFORMATION

SAMPLE NAME #10 Kitimat/Douglas Channel	
SAMPLING METHOD 11L Van Veen grab	SPECIAL INSTRUCTIONS
SAMPLED BY J. Beckett / J. Thompson	
DATE Feb 7/06 — TIME	
CONTAINER TYPE AND NUMBER 8L bucket #10	

7.8/8.4

TOXICITY TESTS REQUIRED

PROTOCOL		100% SCREEN (PASS/FAIL)	CONCENTRATION RANGE	COMMENTS
ACUTE	DAPHNIA MAGNA 48H STATIC ACUTE			
	RAINBOW TROUT 96H STATIC ACUTE			
	MICROTOX			
CHRONIC	SALMONID 7D EMBRYO VIABILITY			
	FATHEAD MINNOW 7D SURVIVAL AND GROWTH			
	CERIODAPHNIA DUBIA 7D SURVIVAL AND REPRODUCTION			
	SELENASTRUM GROWTH 72H INHIBITION			
	TOPSMELT 7D SURVIVAL AND GROWTH			
	ECHINODERM FERTILIZATION TEST (SEA URCHINS/SAND DOLLARS)			
	CHAMPIA PARVULA REPRODUCTION			
OTHER	10d. amphipod survival 20 d. Polychaete survival			

CHAIN OF CUSTODY RECORD

RELINQUISHED BY: NAME	DATE	TIME	RECEIVED BY: NAME	DATE	TIME
Janine Beckett			S. Brigham	FEB9/06	1514
				FEB10/06	1247

L:QAU/Forms/Requisition- Chain of Custody Forms/Current/Templates/Toxicity Tests Request Form v4.dot

Vizon SciTec Inc.
3650 Wesbrook Mall
Vancouver, BC
Canada V6S 2L2
Canada
Tel: (604) 224-4331
Fax: (604) 224-0540
USA
Tel: (360) 738-0958
Fax: (360) 733-3590

VIZON SCITEC

SAMPLE REQUISITION and CHAIN OF CUSTODY FORM

Company Name: Jacques Whitford
Address: 4370 Dominion
City: Burnaby Province: BC PC: V5G-4L7
Telephone: 604-436-3014 FAX #: 604-436-3752
Report To: J. Beckett Sampled by: J. Beckett / J. Thompson

Billing Address (If different):
Purchase Order #:
Project #: ABC 50656.12
Manager: Ben Wheeler.

VIZON SCITEC
3650 Wesbrook Mall
Vancouver, B.C.
V6S 2L2
TEL: (604) 224-4331
FAX: (604) 224-0540
Website: vizonscitec.com

Turnaround time:

15 working days	☐	2 working days	☐
10 working days	☐	24 hours	☐
5 working days	☐	Same day	☐

Sample type:

Potable Water	☐	Vegetation	☐
Waste Water	☐	Air	☐
Soil/Sediment	☒	Other	☐

Analysis Requested

	Client Sample ID	Date/Time Sampled	Matrix Type	# of Cont.	Cont. Size/Type	Sample Log #	Sediment BL bucket	Sulphide	total Metals						Comments
1	#11			* 060210J-11			✓	✓	✓	060210J					-70, -71
2	#2							✓	✓						-72, -73
3	#8							✓	✓						-74, -75
4	#12							✓	✓						-76, -77
5	#10							✓	✓						-78, -79
6	#4							✓							-80
7	#1							✓	✓						-81, -82
8	#9							✓	✓						-83, -84
9															
10															

Relinquished by: J. Beckett	Date: Feb 8	Time:	Received by: S.B	Date: Feb 9/06	Time: 1514
Relinquished by:	Date:	Time:	Received by:	Date: Feb 10/06	Time: 1247
Relinquished by:	Date:	Time:	Received by:	Date:	Time:
Relinquished by:	Date:	Time:	Received by:	Date:	Time:

Sample conditions upon receipt:

Frozen: ☐
Cold: ☒
Ambient: ☐
N/A: ☐

Method of Shipment:
Shipment condition: (e.g. breakage, leakage): Good

Other Information: (e.g. sample pre-treatment, holding time, storage, safety, deficiencies, etc)
* NO Toxicity CofC for #11 (SB)

Page ___ of ___

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SAMPLE REQUISITION and CHAIN OF CUSTODY FORM

VIZON SCITEC

Company Name: Jacques Whitford
Address: 4370 Dominion
City: Burnaby Province: BC PC: V5G-4L7
Telephone: 604-436-3014 FAX #: 604-436-3752
Report To: J. Beckett Sampled by: J. Beckett / S. Thompson

Billing Address (If different):
Purchase Order #:
Project #: ABC 50655.12
Manager:

VIZON SCITEC
3650 Wesbrook Mall
Vancouver, B.C.
V6S 2L2
TEL: (604) 224-4331
FAX: (604) 224-0540
Website: vizonscitec.com

Turnaround time:

- ☐ 15 working days
- ☐ 10 working days
- ☐ 5 working days
- ☐ 2 working days
- ☐ 24 hours
- ☐ Same day

Sample type:

- ☐ Potable Water
- ☐ Waste Water
- ☐ Soil/Sediment
- ☐ Vegetation
- ☐ Air
- ☑ Other

	Client Sample ID	Date/Time Sampled	Matrix Type	# of Cont.	Cont. Size/Type	Sample Log #	Analysis Requested: Sediment 8L bucket								Comments
1	#8				⊛ 060210T-12		✓								15.6°C
2	#12				↙		✓								13.0°C
3															
4															
5															
6															
7															
8															
9															
10															

Relinquished by	Date	Time	Received by	Date	Time
J. Beckett	Feb 8		SB	Feb 9/06	1514
				Feb 10/06	1247

Sample conditions upon receipt:

- Frozen: ☐
- Cold: ☑
- Ambient: ☐
- N/A: ☐

Method of Shipment:

Shipment condition: (e.g. breakage, leakage): Good

Other Information: (e.g. sample pre-treatment, holding time, storage, safety, deficiencies, etc)

⊛ No toxicity C of C for #12 (SB)

VIZON SCITEC

SAMPLE REQUISITION and CHAIN OF CUSTODY FORM

Company Name: Jacques Whitford
Address: 4370 Dominion
City: Burnaby Province: BC PC:
Telephone: 604-436-3014 FAX #: 604-436-3752
Report To: Janine Beckett Sampled by: J. Beckett / J. Thompson

Billing Address (If different):
Purchase Order #:
Project #: ABC 50655.12
Manager:

VIZON SCITEC
3650 Wesbrook Mall
Vancouver, B.C.
V6S 2L2
TEL: (604) 224-4331
FAX: (604) 224-0540
Website: vizonscitec.com

Turnaround time:
- ☐ 15 working days
- ☐ 10 working days
- ☐ 5 working days
- ☐ 2 working days
- ☐ 24 hours
- ☐ Same day

Sample type:
- ☐ Potable Water
- ☐ Waste Water
- ☐ Soil/Sediment
- ☐ Vegetation
- ☐ Air
- ☒ Other

	Client Sample ID	Date/Time Sampled	Matrix Type	# of Cont.	Cont. Size/Type	Sample Log #	Analysis Requested: Total Metals								Comments
1	5	Feb 4		1	8L	5									
2	6	Feb 4		1	8L	6									
3															
4															
5															
6															
7															
8															
9															
10															

Relinquished by: J. Beckett Date: Feb 6 Time: 13:30 Received by: Date: Time:
Relinquished by: Date: Time: Received by: Date: Time:
Relinquished by: Date: Time: Received by: Date: Time:
Relinquished by: Date: Time: Received by: Date: Time:

Sample conditions upon receipt:
- Frozen: ☐
- Cold: ☐
- Ambient: ☐
- N/A ☐

Method of Shipment:
Shipment condition:(e.g. breakage, leakage):

Other Information: (e.g. sample pre-treatment, holding time, storage, safety, deficiencies, etc)

VIZON SCITEC

SAMPLE REQUISITION and CHAIN OF CUSTODY FORM

Company Name: Jacques Whitford
Address: 4370 Dominion
City: Burnaby Province: BC PC:
Telephone: 604-436-3014 FAX #: 604-436-3752
Report To: Janine Beckett Sampled by: J. Beckett / J. Thompson

Billing Address (If different):
Purchase Order #:
Project #: ABC 50655.12
Manager:

VIZON SCITEC
3650 Wesbrook Mall
Vancouver, B.C.
V6S 2L2
TEL: (604) 224-4331
FAX: (604) 224-0540
Website: vizonscitec.com

Turnaround time:
15 working days ☐ 2 working days ☐
10 working days ☐ 24 hours ☐
5 working days ☐ Same day ☐

Sample type:
Potable Water ☐ Vegetation ☐
Waste Water ☐ Air ☐
Soil/Sediment ☒ Other ☐

	Client Sample ID	Date/Time Sampled	Matrix Type	# of Cont.	Cont. Size/Type	Sample Log #	Total Metals	PAH	BTEX	Moisture	Particle	Toc			Comments
1	#3	Feb 3		1	8L	3	✓	✓	✓	✓	✓	✓			porewater
2	#4	Feb 4		1	8L	4	✓	✓	✓	✓	✓	✓			"
3															
4															
5															
6															
7															
8															
9															
10															

Relinquished by: J. Beckett Date: Feb 6 Time: 13:30 Received by: Date: Time:
Relinquished by: Date: Time: Received by: Date: Time:
Relinquished by: Date: Time: Received by: Date: Time:
Relinquished by: Date: Time: Received by: Date: Time:

Sample conditions upon receipt:
Frozen: ☐ Method of Shipment:
Cold: ☐
Ambient: ☐ Shipment condition:(e.g. breakage, leakage):
N/A ☐

Other Information: (e.g. sample pre-treatment, holding time, storage, safety, deficiencies, etc)

VIZON SCITEC

SAMPLE REQUISITION and CHAIN OF CUSTODY FORM

Company Name: Jacques Whitford
Address: 4370 Dominion Rd.
City: Burnaby Province: BC PC:
Telephone: 604-436-3014 FAX #: 604-436-3752
Report To: Janine Beckett Sampled by: J. Beckett/J. Thompson

Billing Address (If different):

Purchase Order #:
Project #: ABL50655.12
Manager:

VIZON SCITEC
3650 Wesbrook Mall
Vancouver, B.C.
V6S 2L2
TEL: (604) 224-4331
FAX: (604) 224-0540
Website: vizonscitec.com

Turnaround time:

15 working days	☐	2 working days	☐
10 working days	☐	24 hours	☐
5 working days	☐	Same day	☐

Sample type:

Potable Water	☐	Vegetation	☐
Waste Water	☐	Air	☐
Soil/Sediment	☒	Other	☐

	Client Sample ID	Date/Time Sampled	Matrix Type	# of Cont.	Cont. Size/Type	Sample Log #	Total metals	PAH	BTEX	Moisture	Particle	TOC			Comments
1	#1	Feb 3		1	8L	1	Total metals	PAH	BTEX						* Porewater
2	#2	Feb 3		1	8L	2									"
3															
4															
5															
6															
7															
8															
9															
10															

(Analysis Requested: Total metals, PAH, BTEX, Moisture, Particle, TOC)

Relinquished by: J. Beckett Date: Feb 6 Time: 13:30 Received by: Date: Time:
Relinquished by: Date: Time: Received by: Date: Time:
Relinquished by: Date: Time: Received by: Date: Time:
Relinquished by: Date: Time: Received by: Date: Time:

Sample conditions upon receipt:

Frozen: ☐
Cold: ☒
Ambient: ☐
N/A ☐

Method of Shipment:
Shipment condition:(e.g. breakage, leakage):

Other Information: (e.g. sample pre-treatment, holding time, storage, safety, deficiencies, etc)

VIZON SCITEC

SAMPLE REQUISITION and CHAIN OF CUSTODY FORM

Company Name: Jacques Whitford
Address: 4370 Dominion
City: Burnaby Province: BC PC:
Telephone: 604-436-3014 FAX #: 604-436-3752
Report To: J. Beckett Sampled by: J. Beckett/J. Thompson

Billing Address (If different):
Purchase Order #:
Project #: ABC 50655.12
Manager:

VIZON SCITEC
3650 Wesbrook Mall
Vancouver, B.C.
V6S 2L2
TEL: (604) 224-4331
FAX: (604) 224-0540
Website: vizonscitec.com

Turnaround time:

- 15 working days ☐ 2 working days ☐
- 10 working days ☐ 24 hours ☐
- 5 working days ☐ Same day ☐

Sample type:

- Potable Water ☐ Vegetation ☐
- Waste Water ☐ Air ☐
- Soil/Sediment ☐ Other ☐

Analysis Requested

	Client Sample ID	Date/Time Sampled	Matrix Type	# of Cont.	Cont. Size/Type	Sample Log #									Comments
1	7	Feb 4		1	8L	7									
2															
3															
4															
5															
6															
7															
8															
9															
10															

Relinquished by: J. Beckett Date: Feb 6 Time: 13:30 Received by: Date: Time:
Relinquished by: Date: Time: Received by: Date: Time:
Relinquished by: Date: Time: Received by: Date: Time:
Relinquished by: Date: Time: Received by: Date: Time:

Sample conditions upon receipt:

- Frozen: ☐
- Cold: ☐
- Ambient: ☐
- N/A ☐

Method of Shipment:

Shipment condition:(e.g. breakage, leakage):

Other Information: (e.g. sample pre-treatment, holding time, storage, safety, deficiencies, etc)

VIZON SCITEC

SAMPLE REQUISITION and CHAIN OF CUSTODY FORM

Company Name: Jacques Whitford
Address: 4370 Dominion
City: Burnaby Province: BC PC: V5G 4L7
Telephone: 604-436-3014 FAX #: 604 436 3752
Report To: Janine Beckett Sampled by: J. Beckett/J. Thompson

Billing Address (If different):
Purchase Order #:
Project #: ABC 50655.12
Manager:

VIZON SCITEC
3850 Wesbrook Mall
Vancouver, B.C.
V6S 2L2
TEL: (604) 224-4331
FAX: (604) 224-0540
Website: vizonscitec.com

Turnaround time:
- 15 working days ☐ 2 working days ☐
- 10 working days ☐ 24 hours ☐
- 5 working days ☐ Same day ☐

Sample type:
- Potable Water ☐ Vegetation ☐
- Waste Water ☐ Air ☐
- Soil/Sediment ☒ Other ☐

Analysis Requested: Sediment 8L bucket

	Client Sample ID	Date/Time Sampled	Matrix Type	# of Cont.	Cont. Size/Type	Sample Log #	Sediment 8L bucket							Comments
1	#9	Feb.7/06					✓							
2	#10	"					✓							
3														
4														
5														
6														
7														
8														
9														
10														

Relinquished by: J. Beckett Date: Feb 8 Time: Received by: Date: Time:
Relinquished by: Date: Time: Received by: Date: Time:
Relinquished by: Date: Time: Received by: Date: Time:
Relinquished by: Date: Time: Received by: Date: Time:

Sample conditions upon receipt:
Frozen: ☐ Method of Shipment:
Cold: ☐
Ambient: ☐ Shipment condition:(e.g. breakage, leakage):
N/A ☐

Other information: (e.g. sample pre-treatment, holding time, storage, safety, deficiencies, etc)

8.8/8.4.

ALS Environmental
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www.alsenviro.com

Vancouver, BC 1988 Triumph Street V5L 1X5 Tel: 604-253-4188 Toll Free: 1-800-665-0243 Fax: 604-253-6700
Fort St. John, BC #2 - 8820 100th Street V1J 3W9 Tel: 250-785-8281 Fax: 250-785-8286
Calgary, AB #2 - 21 Highfield Circle SE T2G 5N6 Tel: 403-214-5431 Toll Free: 1-866-722-6231 Fax: 403-214-5430
Burlington, ON 5420 Mainway Drive, Unit 5 L7L 6A4 Tel: 905-331-3111 Toll Free: 1-888-257-3684 Fax: 905-331-4567

CHAIN OF CUSTODY FORM

PAGE ____ OF ____

SEND REPORT TO:

CLIENT: Jacques Whitford ATTN.: J Beckett
ADDRESS: 4370 Dominion
CITY: Burnaby PROV.: BC POSTAL CODE: V5G 4L7
TELEPHONE: 604-436-3014 FAX: 604-436-
SAMPLER: J. Beckett
PROJECT NAME & NO.: ABC 50655.12 QUOTE NO.:
PO NO.: ALS CONTACT:

REPORT FORMAT: ☐ HARDCOPY ☐ EMAIL - ADDRESS:
☐ FAX ☐ EXCEL ☐ PDF ☐ OTHER:

ANALYSIS REQUESTED:

FOR LAB USE ONLY	SAMPLE IDENTIFICATION	DATE (YYYY-MM-DD)	TIME	MATRIX	1 pH/salinity	2 Ammonia	3 BTEX	4 PAH	NOTES (sample specific comments, due dates, etc.)
	#1	2006/02/07			✓	✓	✓	✓	060210 J-13, J-14, J-15, J-16
	#2	"			✓	✓	✓	✓	J-17, J-18, J-19, J-20
	#4	"						✓	J-21, ~~[illegible]~~
	#8	"			✓	✓	✓	✓	J-22, J-23, J-24, J-25
	#9	"			✓	✓	✓	✓	J-26, J-27, J-28, J-29
	#10	"			✓	✓	✓	✓	J-30, J-31, J-32, J-33
	#11	"			✓	✓	✓	✓	J-34, J-35, J-36, J-37
	#12	"			✓	✓	✓	✓	J-38, J-39, J-40, J-41

TURN AROUND REQUIRED: ☐ ROUTINE ☐ RUSH - SPECIFY DATE: ______ (surcharge may apply)

SEND INVOICE TO: ☐ SAME AS REPORT ☐ DIFFERENT FROM REPORT (provide details below)
INVOICE FORMAT: ☐ HARDCOPY ☐ PDF ☐ FAX

SPECIAL INSTRUCTIONS:

RELINQUISHED BY:	DATE / TIME	RECEIVED BY:	DATE / TIME
J. Beckett	DATE Feb. 8/06; TIME	SB	DATE Feb 9/06; TIME 1514
	DATE; TIME	8B	DATE Feb 10/06; TIME 1247

FOR LAB USE ONLY

COOLER SEAL INTACT? ☐ YES ☐ NO ☐ N/A
SAMPLE TEMPERATURE 12.2 °C
FROZEN? ☐ YES ☐ NO
COOLING METHOD? ☐ ICEPACKS ☐ ICE ☐ NONE

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Fort St. John, BC #2 - 8820 100th Street V1J 3W9 Tel: 250-785-8281 Fax: 250-785-8286
Calgary, AB #2 - 21 Highfield Circle SE T2G 5N6 Tel: 403-214-5431 Toll Free: 1-866-722-6231 Fax: 403-214-5430
Burlington, ON 5420 Mainway Drive, Unit 5 L7L 6A4 Tel: 905-331-3111 Toll Free: 1-888-257-3684 Fax: 905-331-4567

+4823

CHAIN OF CUSTODY FORM

PAGE ______ OF ______

SEND REPORT TO:

CLIENT: Jacques Whitford ATTN.: ______
ADDRESS: 4370 Dominion
CITY: Burnaby PROV.: BC POSTAL CODE: V5G 4L7
TELEPHONE: 604 436 3014 FAX: 604 436 3752 SAMPLER: J. Beckett
PROJECT NAME & NO.: ABC 50655.12 QUOTE NO.: ______
PO NO.: ______ ALS CONTACT: ______

REPORT FORMAT: ☐ HARDCOPY ☐ EMAIL - ADDRESS: ______
☐ FAX ☐ EXCEL ☐ PDF ☐ OTHER: ______

ANALYSIS REQUESTED: 1 PAH, 2 Sulphide, 3 Ammonia, 4 Salinity/pH, 5 Total Metals, 6 BTEX

FOR LAB USE ONLY	SAMPLE IDENTIFICATION	DATE (YYYY-MM-DD)	TIME	MATRIX	1 PAH	2 Sulphide	3 Ammonia	4 Salinity/pH	5 Total Metals	6 BTEX		1	2	3	4	5	6 NOTES (sample specific comments, due dates, etc.)
	#3	2006/02/03	1700		✓	✓	✓	✓	✓	✓	060210J	-42	-43	-44	-45	-46	-47
	#4	2006/02/04	900				✓	✓	✓	✓			~~-48~~	-48	-49	-50	-51
	#5	2006/02/04	1400		✓	✓	✓	✓	✓	✓		-52	-53	-54	-55	-56	-57
	#6	2006/02/04	1000		✓	✓	✓	✓	✓	✓		-58	-59	-60	-61	-62	-63
	#7	2006/02/04	1530		✓	✓	✓	✓	✓	✓		-64	-65	-66	-67	-68	-69

TURN AROUND REQUIRED: ☒ ROUTINE ☐ RUSH - SPECIFY DATE: ______ (surcharge may apply)

SEND INVOICE TO: ☐ SAME AS REPORT ☐ DIFFERENT FROM REPORT (provide details below)
INVOICE FORMAT: ☐ HARDCOPY ☐ PDF ☐ FAX

SPECIAL INSTRUCTIONS:

RELINQUISHED BY:	DATE / TIME	RECEIVED BY:	DATE / TIME
	DATE: TIME:	XB	DATE: Feb 9/06 TIME: 1514
	DATE: TIME:	XB	DATE: Feb 10/06 TIME: 1247

FOR LAB USE ONLY

COOLER SEAL INTACT? ☐ YES ☐ NO ☐ N/A
SAMPLE TEMPERATURE 2°C
FROZEN? ☐ YES ☐ NO
COOLING METHOD? ☐ ICEPACKS ☐ ICE ☐ NONE

ALS COPY

SEE WHITEPAPER FOR SOURCE VERSIONR_08

VIZON SCITEC

SAMPLE REQUISITION and CHAIN OF CUSTODY FORM

Company Name: Jacques Whitford
Address: 4370 Dominion
City: Burnaby Province: BC PC: V5G-4L7
Telephone: 604-436-3014 FAX #: 604-436-3752
Report To: J. Beckett Sampled by: J. Beckett/S. Thompson

Billing Address (If different):
Purchase Order #:
Project #: ABC 50655.12
Manager: Ben Wheeler.

VIZON SCITEC
3650 Wesbrook Mall
Vancouver, B.C.
V6S 2L2
TEL: (604) 224-4331
FAX: (604) 224-0540
Website: vizonscitec.com

Turnaround time: ☐ 15 working days ☐ 10 working days ☐ 5 working days ☐ 2 working days ☐ 24 hours ☐ Same day

Sample type: ☐ Potable Water ☐ Waste Water ☒ Soil/Sediment ☐ Vegetation ☐ Air ☐ Other

	Client Sample ID	Date/Time Sampled	Matrix Type	# of Cont.	Cont. Size/Type	Sample Log #	Sediment 8L bucket	Sulphide	total Metals						Comments
1	#11			*060210J-11			✓	✓	✓			060210J			-70, -71
2	#2							✓	✓						-72, -73
3	#8							✓	✓						-74, -75
4	#12							✓	✓						-76, -77
5	#10							✓	✓						-78, -79
6	#4							✓							-80
7	#1							✓	✓						-81, -82
8	#9							✓	✓						-83, -84
9															
10															

Relinquished by:	Date:	Time:	Received by:	Date:	Time:
J. Beckett	Feb 8		S.B	Feb 9/06	1514
				Feb 10/06	1247

Sample conditions upon receipt:
☐ Frozen
☑ Cold
☐ Ambient
☐ N/A

Method of Shipment:
Shipment condition: (e.g. breakage, leakage): Good

Other Information: (e.g. sample pre-treatment, holding time, storage, safety, deficiencies, etc)
* NO Toxicity Cof C for #11 (SB)

Page ___ of ___

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Sediment Sample Descriptions

Project # 2-11-0965B

Sample Name	Vizon Sample # / Name	Date Homogenised / Subsampled	Grain Size	Type of Debris Removed	Endemic Animals Removed	Odor	N Applied & Stored in Cold Rm	Analyst
JW1	060210J-01	06 Feb 23	Fine	1 small branch	None	None	YES	TVO
JW2	060210J-02	06 Feb 23	fine	few small pebbles & a few twigs	none	None	Yes	JD
JW3	060210J-03	06 Feb 23	Fine	many wood debris	None	None	YES	T.VO
JW4	060210J-04	06 Feb ~~14~~ 23 JD ee	Fine	many small twigs	2 small worms	None	Yes	JD
JW5	060210J-05	06 Feb-23	Fine w/ small lots KS ee grains	lots of rocks & wood debris	none	None	YES	JD.
JW6	060210J-06	06 Feb 23	Fine	Small chunks of wood	none	none	Yes	KS
JW7	060210J-07	06 Feb 23	Fine ~~lots of water~~ KS ee	~~small chunks of~~ KS ee ~~wood~~ lots of wood debris	NONE	none	YES	TVO
JW9	060210J-09	06 Feb 23	Fine	small amount of rocks & shells	none	none	YES	JP
JW10	060210J-10	06 Feb 23	Fine	small number of small twigs	none	none	yes	JD
JW12	060210J-12	feb 23/06	FINE	LOTS OF WOOD DEBRIS	NONE	NONE	YES	TVO

Sediment Sample Descriptions

Project # 2-11-0965B

Sample Name	Vizon Sample # / Name	Date Homogenised / Subsampled	Grain Size	Type of Debris Removed	Endemic Animals Removed	Odor	N Applied & Stored in Cold Rm	Analyst
JW12	060210J-12	06Mar07	Fine	n/a	n/a	n/a	✓	CM
JW6	060210J-06	06Mar07	Fine	n/a	n/a	n/a	✓	CM
JW9	060210J-09	06Mar07	grey-brown Fine	n/a	n/a	n/a	✓	KS
~~J0W7~~ KS JW7	060210J-07	06Mar07	lighter brown Fine easier to mix	n/a	n/a	n/a	✓	KS
JW10	060210J-10	06Mar07	Fine light brown	n/a	n/a	n/a	✓	CM
JW2	060210J-02	06Mar07	grey/brown	n/a	n/a	n/a	✓	CM
JW4	060210J-04	06Mar07	Fine clumped.	n/a	n/a	n/a	✓	KS
JW1	060210J-01	06-Mar-07	fine chocolate brown	n/a	n/a	n/a	✓	KS
JW5	060210J-05	06-Mar-07	coarse grey-brown	n/a is debris in it	n/a	slight	✓	CM
JW3	060210J-03	06Mar07	~~chocolate~~ grey brown fine	n/a	n/a	n/a	✓	CM
JW8	060210J-08	06Mar07	dark brown black fine ē small	none large rocks/wood chunks	n/a	rotten eggs	✓	KS
JW11	060210J-11	06Mar07	Grey fine	large rock & wood bits none removed	n/a	coal	✓	CM

SEAWATER CHARACTERISATION

This section of the report contains the analytical chemistry reports for analysis of the seawater samples. The reports are presented in the following order:

- Dissolved Metals
- PAHs
- BTEX
- Ammonia, pH, and Sulphide
- Salinity and pH

METHODS:

Dissolved Metals Concentrations in Seawater:

Analysis conducted using procedures adapted from US EPA and Puget Sound Water Quality Authority, 1995, "Recommended Guidelines for Measuring Metals in Puget Sound Marine Water, Sediment, and Tissue Samples". Select trace metals were extracted by SPR-IDA chelation prior to analysis. See analytical report from subcontractor for more details.

PAH Concentrations:

Analysis was conducted using guidelines from EPA Methods 3510C and 8270 (SW-846), which including using a liquid-liquid extraction with dichloromethane, and analyzing the extracts using GC/MS (SIM).

BTEX (Benzene, Toluene, Ethyl Benzene, Xylene) Concentrations:

Analysis was conducted using procedures based on EPA Methods 624/8240.8260, which involving sparging with a Purge and Trap apparatus using GC/MS. Analyses were conducted by a subcontractor.

Ammonia Concentrations:

Vizon SOP 5330 (Colorimetric Analysis of Ammonia Nitrogen in Water and Wastewater). Current Version. Adapted from: Sheiner D. 1976. Determination of Ammonia and Kjeldahl Nitrogen by Indophenol Method. *Water Research*. Vol. 10:31-36. Pergammon Press. Similar in principle to: Standard Methods for the Examination of Water and Wastewater, APHA, AWWA, WEF, 20th Edition, 1998. Method 4500 – NH3 F .

Sulfide Concentrations:

SM 4500 S^{2-} F (Iodometric Method) in Standard Methods for the Examination of Water and Wastewater, 20th ed., 1998.

Salinity and pH:

Calibrated conductivity meter and pH meter.

ALS Environmental

CERTIFICATE OF ANALYSIS

Date: March 14, 2006

ALS File No. X2210

Report On: 2-11-0965B Seawater Analysis

Report To: **Vizon SciTec Inc.**
3650 Wesbrook Mall
Vancouver, BC
V6S 2L2

Received: February 17, 2006

ALS ENVIRONMENTAL
per:

Sime Buric, B.Sc. - Client Services
Can Dang, B.Sc. - Project Chemist

ALS CANADA LTD.
1988 Triumph Street, Vancouver, BC Canada V5L 1K5
Phone: 604-253-4188 Fax: 604-253-6700 Website: www.alsenviro.com

REMARKS

Please note that the metals detection limits have been increased due to the elevated concentration of Sodium in the samples.

Also note that some of the results for some samples for Aluminum have been reported as less than detection limits due to contamination.

File No. X2210

RESULTS OF ANALYSIS - Seawater

Sample ID		SITE 4 060210 J-50	SITE 5 060210 J-56	SITE 6 060210 J-62	SITE 7 060210 J-68	SITE 2 060210 J-73
Sample Date		06-02-04	06-02-04	06-02-04	06-02-04	06-02-07
ALS ID		*1*	*2*	*3*	*4*	*5*
Dissolved Metals						
Aluminum	D-Al	<0.10	<0.10	<0.30	<0.10	<0.10
Antimony	D-Sb	<0.010	<0.010	<0.010	<0.010	<0.010
Arsenic	D-As	0.00107	0.00185	0.00108	0.00157	0.00116
Barium	D-Ba	0.0083	0.0076	0.0068	0.0074	0.0093
Beryllium	D-Be	<0.050	<0.050	<0.050	<0.050	<0.050
Bismuth	D-Bi	<0.050	<0.050	<0.050	<0.050	<0.050
Boron	D-B	3.5	3.6	3.4	3.7	3.9
Cadmium	D-Cd	0.000117	0.000090	0.000109	0.000125	0.000154
Calcium	D-Ca	310	324	301	318	342
Chromium	D-Cr	<0.050	<0.050	<0.050	<0.050	<0.050
Cobalt	D-Co	0.000061	0.000132	0.000062	0.000104	0.000061
Copper	D-Cu	0.000924	0.00107	0.000971	0.00117	0.000961
Iron	D-Fe	<0.010	<0.010	<0.010	<0.010	<0.010
Lead	D-Pb	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Lithium	D-Li	<0.50	<0.50	<0.50	<0.50	<0.50
Magnesium	D-Mg	1070	1120	1040	1120	1190
Manganese	D-Mn	0.00161	0.00954	0.00509	0.0111	0.00699
Mercury	D-Hg	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Molybdenum	D-Mo	0.0089	0.0095	0.0091	0.0087	0.0096
Nickel	D-Ni	0.000714	0.000732	0.000701	0.000764	0.000747
Phosphorus	D-P	<3.0	<3.0	<3.0	<3.0	<3.0
Potassium	D-K	326	341	315	336	362
Selenium	D-Se	0.00057	<0.00050	<0.00050	<0.00050	<0.00050
Silicon	D-Si	1.32	1.26	1.20	1.27	1.50
Silver	D-Ag	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Sodium	D-Na	7960	8290	7680	8180	8820
Strontium	D-Sr	5.17	5.29	5.00	5.49	5.63
Thallium	D-Tl	<0.010	<0.010	<0.010	<0.010	<0.010
Tin	D-Sn	<0.010	<0.010	<0.010	<0.010	<0.010
Titanium	D-Ti	<0.10	<0.10	<0.10	<0.10	<0.10
Uranium	D-U	0.00189	0.00234	0.00183	0.00224	0.00258
Vanadium	D-V	<0.10	<0.10	<0.10	<0.10	<0.10
Zinc	D-Zn	0.00114	0.00966	0.00702	0.0212	0.00165

Remarks regarding the analyses appear at the beginning of this report.
Results are expressed as milligrams per litre except where noted.
< = Less than the detection limit indicated.

File No. X2210

RESULTS OF ANALYSIS - Seawater

Sample ID		SITE 12 060210 J-77	SITE 10 060210 J-79	SITE 1 060210 J-92	SITE 9 060210 J-84	SITE 3 060210 J-46
Sample Date		06-02-07	06-02-07	06-02-07	06-02-07	06-02-03
ALS ID		*6*	*7*	*8*	*9*	*10*
Dissolved Metals						
Aluminum	D-Al	<0.10	<0.10	<0.10	<0.80	<0.40
Antimony	D-Sb	<0.010	<0.010	<0.010	<0.010	<0.010
Arsenic	D-As	0.00102	0.00102	<0.00020	0.00079	0.00131
Barium	D-Ba	0.0168	0.0074	0.0082	0.0076	0.0135
Beryllium	D-Be	<0.050	<0.050	<0.050	<0.050	<0.050
Bismuth	D-Bi	<0.050	<0.050	<0.050	<0.050	<0.050
Boron	D-B	3.5	3.6	3.9	3.7	3.7
Cadmium	D-Cd	0.000174	0.000107	0.000127	0.000114	0.000101
Calcium	D-Ca	317	319	326	321	307
Chromium	D-Cr	<0.050	<0.050	<0.050	<0.050	<0.050
Cobalt	D-Co	0.00213	<0.000050	0.000145	0.000056	0.000273
Copper	D-Cu	0.000703	0.000786	0.000822	0.000942	0.00120
Iron	D-Fe	0.043	<0.010	<0.010	<0.010	<0.010
Lead	D-Pb	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Lithium	D-Li	<0.50	<0.50	<0.50	<0.50	<0.50
Magnesium	D-Mg	1080	1140	1130	1110	1050
Manganese	D-Mn	1.48	0.00287	0.0137	0.00204	0.0538
Mercury	D-Hg	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Molybdenum	D-Mo	0.0091	0.0081	0.0092	0.0095	0.0095
Nickel	D-Ni	0.000845	0.000614	0.000736	0.000694	0.000877
Phosphorus	D-P	<3.0	<3.0	<3.0	<3.0	<3.0
Potassium	D-K	332	336	347	338	324
Selenium	D-Se	0.00099	<0.00050	<0.00050	<0.00050	<0.00050
Silicon	D-Si	2.51	1.11	1.29	1.12	1.74
Silver	D-Ag	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Sodium	D-Na	8050	8210	8460	8280	7860
Strontium	D-Sr	5.14	5.42	5.83	5.72	5.69
Thallium	D-Tl	<0.010	<0.010	<0.010	<0.010	<0.010
Tin	D-Sn	<0.010	<0.010	<0.010	<0.010	<0.010
Titanium	D-Ti	<0.10	<0.10	<0.10	<0.10	<0.10
Uranium	D-U	0.00216	0.00131	0.00177	0.00200	0.00197
Vanadium	D-V	<0.10	<0.10	<0.10	<0.10	<0.10
Zinc	D-Zn	0.00970	0.00576	0.00341	0.00498	0.00119

Remarks regarding the analyses appear at the beginning of this report.
Results are expressed as milligrams per litre except where noted.
< = Less than the detection limit indicated.

File No. X2210

Appendix 1 - QUALITY CONTROL - Replicates

Seawater		SITE 2 060210 J-73 06-02-07	SITE 2 060210 J-73 QC # 488487
Dissolved Metals			
Aluminum	D-Al	<0.10	<0.10
Antimony	D-Sb	<0.010	<0.010
Arsenic	D-As	0.00116	0.00116
Barium	D-Ba	0.0093	0.0091
Beryllium	D-Be	<0.050	<0.050
Bismuth	D-Bi	<0.050	<0.050
Boron	D-B	3.9	3.8
Cadmium	D-Cd	0.000154	0.000158
Calcium	D-Ca	342	340
Chromium	D-Cr	<0.050	<0.050
Cobalt	D-Co	0.000061	0.000060
Copper	D-Cu	0.000961	0.000979
Iron	D-Fe	<0.010	0.030
Lead	D-Pb	<0.000050	<0.000050
Lithium	D-Li	<0.50	<0.50
Magnesium	D-Mg	1190	1180
Manganese	D-Mn	0.00699	0.00681
Mercury	D-Hg	<0.000010	<0.000010
Molybdenum	D-Mo	0.0096	0.0094
Nickel	D-Ni	0.000747	0.000732
Phosphorus	D-P	<3.0	<3.0
Potassium	D-K	362	356
Selenium	D-Se	<0.00050	<0.00050
Silicon	D-Si	1.50	1.39
Silver	D-Ag	<0.0010	<0.0010
Sodium	D-Na	8820	8640
Strontium	D-Sr	5.63	5.64
Thallium	D-Tl	<0.010	<0.010
Tin	D-Sn	<0.010	<0.010
Titanium	D-Ti	<0.10	<0.10
Uranium	D-U	0.00258	0.00265
Vanadium	D-V	<0.10	<0.10
Zinc	D-Zn	0.00165	0.00137

Remarks regarding the analyses appear at the beginning of this report.
Results are expressed as milligrams per litre except where noted.
< = Less than the detection limit indicated.

Appendix 2 - METHODOLOGY

Outlines of the methodologies utilized for the analysis of the samples submitted are as follows

Metals in Water

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" 20th Edition 1998 published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using either hotplate or microwave oven, or filtration (EPA Method 3005A). Instrumental analysis is by atomic absorption/emission spectrophotometry (EPA Method 7000 series), inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B), and/or inductively coupled plasma - mass spectrometry (EPA Method 6020).

Recommended Holding Time:
Sample: 6 months
Reference: EPA

Laboratory Location: ALS Environmental, Vancouver

Metals in Seawater

This analysis is carried out using procedures adapted from "Recommended Guidelines for Measuring Metals in Puget Sound Marine Water, Sediment, and Tissue Samples" prepared for the United States Environmental Protection Agency and the Puget Sound Water Quality Authority, 1995. The procedures may involve preliminary sample treatment by acid digestion or filtration (EPA Method 3005A). Instrumental analysis of the seawater is by atomic absorption/emission spectrophotometry (EPA Method 7000 series), inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B), and/or inductively coupled plasma - mass spectrometry (EPA Method 6020).

Recommended Holding Time:
Sample: 6 months
Reference: Puget

Laboratory Location: ALS Environmental, Vancouver

Trace Metals in Seawater by SPR-IDA Chelation

This analysis is carried out using procedures adapted from "Recommended Guidelines for Measuring Metals in Puget Sound Marine Water, Sediment, and Tissue Samples" prepared for the United States Environmental Protection Agency and the Puget Sound Water Quality Authority, 1995, and with procedures adapted from Cetac Technologies Incorporated. A suspended particulate resin (SPR), consisting of immobilized iminodiacetate (IDA) on a divinylbenzene polymer, is used to chelate and preconcentrate metals in seawater. Instrumental analysis is by inductively coupled plasma mass spectrometry (ICPMS) and/or routine atomic absorption spectrophotometry techniques (EPA 7000 series).

Recommended Holding Time:
Sample/Extract: 6 months
Reference: Puget

Laboratory Location: ALS Environmental, Vancouver

Mercury in Seawater

This analysis is carried out using procedures adapted from "Recommended Guidelines for Measuring Metals in Puget Sound Marine Water, Sediment, and Tissue Samples" prepared for the United States Environmental Protection Agency and the Puget Sound Water Quality Authority, 1995. The procedure involves a cold-oxidation of the acidified seawater sample using bromine monochloride prior to reduction of the sample with stannous chloride. Instrumental analysis is by cold vapour atomic fluorescence spectrophotometry (EPA Method 245.7).

Recommended Holding Time:
Sample: 28 days
Reference: Puget

Laboratory Location: ALS Environmental, Vancouver

Results contained within this certificate relate only to the samples as submitted.

This Certificate Of Analysis shall only be reproduced in full, except with the written approval of ALS Environmental.

End of Report

POLYNUCLEAR AROMATIC HYDR .RBONS (PAHs) ANALYSIS REPORT

VIZON SCITEC
3650 Wesbrook Mall
Vancouver, B.C.
Canada
V6S 2L2
TEL: (604) 224-4331
FAX: (604) 224-0540

Date: April 11, 2006
Project No: 2-11-0965B

Client: Jacques Whitford

ATTENTION:Kerrie Serber

VIZON CONTACT: Rosemary Scot

Comments:

The analysis was carried out using guidelines from EPA Methods 3510C and 8270 (SW-846). This method used a liquid-liquid extraction with dichloromethane . The extracts were analysed by GC/MS (SIM).

Vizon No: / **Description** / **SAMPLE DATED:**	ICWQG	Detection Limit	Method Blank	060210J-16 #1 water Feb. 07/06	060210J-20 #2 water Feb. 07/06	060210J-21 #4 water Feb. 07/06	060210J-29 #9 water Feb. 07/06	060210J-33 #10 water Feb. 07/06	060210J-41 #12 water Feb. 07/06	060210J-42 #3 water Feb. 03/06	060210J-52 #5 water Feb. 04/06	060210J-58 #6 water Feb. 04/06	060210J-64 #7 water Feb. 04/06
Naphthalene	1.1	0.05	<0.05	<0.05	0.11	0.11	<0.05	<0.05	<0.05	<0.06	<0.08	<0.07	<0.08
Quinoline	3.4	0.10	<0.1	<0.1	<0.1	<0.1	<0.1	0.31	0.61	<0.12	<0.16	<0.14	<0.16
2-Methylnapthalene		0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.21	<0.06	<0.08	<0.07	<0.08
Acenapthylene		0.05	<0.05	<0.05	<0.05	<0.05	0.08	<0.05	<0.05	<0.06	<0.08	<0.07	<0.08
Acenaphthene	5.8	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.06	<0.08	<0.07	<0.08
Fluorene	3.0	0.05	<0.05	<0.05	<0.05	0.12	<0.05	<0.05	<0.05	<0.06	<0.08	<0.07	<0.08
Phenanthrene	0.4	0.05	<0.05	<0.05	<0.05	0.31	0.14	0.11	0.35	0.15	0.16	<0.07	<0.08
Anthracene	0.012	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.06	<0.08	<0.07	<0.08
Acridine	4.4	0.10	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.12	<0.16	<0.14	<0.16
Total LMW-PAHs			**0.00**	**0.00**	**0.11**	**0.54**	**0.22**	**0.42**	**1.17**	**0.15**	**0.16**	**0.00**	**0.00**
Fluoranthene	0.04	0.05	<0.05	0.30	0.41	1.07	0.13	0.47	1.01	0.22	0.10	<0.07	<0.08
Pyrene	0.025	0.05	<0.05	0.27	0.39	0.96	0.09	0.04	0.89	0.20	0.09	<0.07	<0.08
Benzo(a) anthracene	0.018	0.05	<0.05	0.46	0.76	1.47	0.05	<0.05	1.05	0.48	0.18	<0.07	<0.08
Chrysene	ISD	0.05	<0.05	<0.05	<0.05	1.65	0.10	0.09	1.98	0.44	0.25	<0.07	<0.08
Benzo(b) fluoranthene		0.05	<0.05	1.48	1.86	4.69	0.27	0.19	3.94	1.34	0.53	<0.07	<0.08
Benzo(k) fluoranthene		0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.06	<0.08	<0.07	<0.08
Benzo(a) pyrene	0.015	0.05	<0.05	0.23	0.36	0.06	<0.05	<0.05	0.87	0.13	<0.08	<0.07	<0.08
Indeno(1,2,3-cd)pyrene		0.05	<0.05	0.16	0.28	0.06	<0.05	<0.05	0.48	0.15	<0.08	<0.07	<0.08
Dibenz(a,h)anthracene		0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.08	<0.06	<0.08	<0.07	<0.08
Benzo(g,h,i)perylene		0.05	<0.05	0.14	0.25	0.06	0.14	0.11	0.05	0.08	<0.08	<0.07	<0.08
Total HMW-PAHs				**3.04**	**4.31**	**10.0**	**0.78**	**0.90**	**10.4**	**3.04**	**1.15**	**0.00**	**0.00**
Total PAHs				**3.04**	**4.42**	**10.6**	**1.00**	**1.32**	**11.5**	**3.19**	**1.31**	**0.00**	**0.00**

Results are reported in micrograms per liter (ug/L)
ICWQG Interim Canadian Water Quality Guidelines
ISD : Insufficient Data
Note: Benzo(b)fluoranthene and Benzo(k)fluoranthene reported as total. Detection Limits for sample #'s 3, 5, 6 & 7 are higher due to less than 1.0L sample volume used for analysis.

Approved by: ____________________

BENZENE TOLUENE ETHYLBENZENE XYLENES (BTEX) ANALYSIS REPORT

Date: 12 April 2006
Project No: 2-11-0965B

Client: Jacques Whitford

VIZON SCITEC
3650 Wesbrook Mall
Vancouver, B.C.
Canada
V6S 2L2
TEL: (604) 224-4331
FAX: (604) 224-0540

ATTENTION:Kerrie Serben

VIZON CONTACT: Rosemary Scot

Comments:

The analysis was performed using procedures based on US EPA Methods 624/8240.8260, involving sparging with a Purge and Trap apparatus using GC/MS.

Vizon No:	060210J-15	060210J-19	060210J-28	060210J-32	060210J-40	060210J-47	060210J-51	060210J-57	060210J-63	060210J-69
Description	#1	#2	#9	#10	#12	#3	#4	#5	#6	#7
	water	water	water	water	water	water	water	water	water	water
SAMPLE DATED:	Feb. 07/06	Feb. 07/06	Feb. 07/06	Feb. 07/06	Feb. 07/06	Feb. 03/06	Feb. 04/06	Feb. 04/06	Feb. 04/06	Feb. 04/06
Benzene	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Ethyl Benzene	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Toluene	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Xylenes	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

Results are reported in micrograms per liter (ug/L)
Surrogate Recoveries ranges from 90 - 100 %

Project #: 2-11-0965B
Company: Jacques Whitford
Contact: Janine Beckett

BCR #	Sample	Sample Date	NH_3 mg N/L	pH ph Units	S^- mg/L
060210J-13	#1	7-Feb-2006	—	7.53	—
060210J-14	#1	7-Feb-2006	0.023	—	—
060210J-17	#2	7-Feb-2006	—	7.72	—
060210J-18	#2	7-Feb-2006	0.087	—	—
060210J-22	#8	7-Feb-2006	—	7.12	—
060210J-23	#8	7-Feb-2006	~~0.216~~ N.R.	—	—
060210J-26	#9	7-Feb-2006	—	7.61	—
060210J-27	#9	7-Feb-2006	0.016	—	—
060210J-30	#10	7-Feb-2006	—	7.77	—
060210J-31	#10	7-Feb-2006	0.015	—	—
060210J-34	#11	7-Feb-2006	—	7.12	—
060210J-35	#11	7-Feb-2006	N.R.	—	—
060210J-38	#12	7-Feb-2006	—	7.26	—
060210J-39	#12	7-Feb-2006	0.117	—	—
060210J-43	#3	3-Feb-2006	—	—	0.259
060210J-44	#3	3-Feb-2006	0.094	—	—
060210J-45	#3	3-Feb-2006	—	7.63	—
060210J-48	#4	4-Feb-2006	0.107	—	—
060210J-49	#4	4-Feb-2006	—	7.94/7.97	—
060210J-53	#5	4-Feb-2006	—	—	0.213
060210J-54	#5	4-Feb-2006	0.036	—	—
060210J-55	#5	4-Feb-2006	—	7.98	—
060210J-59	#6	4-Feb-2006	—	—	0.168
060210J-60	#6	4-Feb-2006	0.017	—	—
060210J-61	#6	4-Feb-2006	—	7.83	—
060210J-65	#7	4-Feb-2006	—	—	0.289
060210J-66	#7	4-Feb-2006	0.024	—	—
060210J-67	#7	4-Feb-2006	—	7.94	—
060210J-70	#11	7-Feb-2006	—	—	0.305
060210J-72	#2	7-Feb-2006	—	—	0.366
060210J-74	#8	7-Feb-2006	—	—	0.427
060210J-76	#12	7-Feb-2006	—	—	0.442
060210J-78	#10	7-Feb-2006	—	—	0.320
060210J-80	#4	7-Feb-2006	—	—	0.686
060210J-81	#1	7-Feb-2006	—	—	0.366
060210J-83	#9	7-Feb-2006	—	—	0.274
Date Analyzed:			Feb 15/06	Feb 27/06	Feb 20/06
QC					
TRUE			0.103	6.21	–
Found			0.111	6.40	–
Initials			HL	YL	LC
Test Methods:			5330 / 5331	5325	

N.R. = analysis not required

Vizon SciTec
Vancouver, BC

Marine Sediment Tests
~~Porewater~~ KSee Measurements

Client # & Name: #128 Jacques Whitford   Start Date: N/A

Date Measured: Site Seawater 06-Feb-28   Start Time: N/A

Sample ID	Temperature (°C)	pH	Salinity	Analyst
#1	~~17.8~~ 18.7 KSee	~~7.1~~ 7.2 KSee	28.7‰	KS
#2	16.7	~~7.1~~ 7.3 KSee	29.5‰	KS
#3	19.2	7.4	26.5‰	KS
#4	17.6	7.5	26.9‰	KS
#5	17.7	7.5	28.0‰	KS
#6	18.4	7.6	26.2‰	KS
#7	17.1	7.5	27.9‰	KS
#8	18.2	7.0	29.4‰	KS
#9	16.8	7.4	27.6‰	KS
#10	18.9	7.5	27.7‰	KS
#11	16.7	7.0	27.1‰	KS
#12	17.0	7.3	26.9%	KS

Comments

Allowed samples to come up to room temp over ≈ 3-4 hrs KS
Salinity measured with WTW Conductivity meter (#3) Model COND 330i
~~Cond~~ KSee pH/temp measured c̄ Fisher Scientific pH meter (#3)
Model Accumet Basic AB15 (Cerio meter)

SEDIMENT CHARACTERISATION

This section of the report contains the analytical chemistry reports for analysis of the sediment samples. The reports are presented in the following order:

- Total metals
- PAHs
- BTEX
- Total Organic Carbon and Moisture Content
- Particle Size Distribution
- Total PCBs
- Dioxins and Furans
- AVS/SEM
- Porewater Ammonia and Sulphide
- Porewater Salinity and pH

At the time of this report, only the preliminary AVS/SEM results were available. The final results will be submitted at a later date.

For the final analytical report for the dioxins and furans analyses, a full data package was supplied on CD ROM by the subcontractor. This CD ROM will be sent with the Vizon report.

METHODS:

Total Metals Concentrations in Sediment:

Sediment samples for total metals analysis were prepared based on Strong Acids Leachable Metals (SALM) in Soil – CSR Analytical Method 8 procedure (BCMELP 2001) and analysed by Inductively Coupled Plasma/Mass Spectroscopy (ICP/MS) and Cold Vapour Atomic Fluorescence Spectroscopy (CVAFS). The analytical batch consisted of 10 sediment samples one of which was digested and analyzed in 5 replicates as per Ocean Disposal Permit Guidlines and four QA/QC samples (two digestion blanks and two Certified Reference Material samples). Subsamples equivalent of 2g of dry sample were digested with 1:1 mixture of Hydrochloric and Nitric Acid at 90°C following overnight cold digestion. Each extract was brought to volume (50 mL) with deionised water. The extracts were analysed using Inductively Coupled Plasma Optical Emission Spectroscopy (ICP-OES) and Cold Vapour Atomic Fluorescence Spectroscopy (CVAFS), for mercury. The samples were prepared and analyzed for Total Metals at Vizon. The Mercury analysis was conducted by a subcontractor.

PAH Concentrations:

The analysis was conducted using guidelines from EPA Methods 3520C and 8270 (SW-846), which involves a liquid-liquid extraction with dichloromethane. The extracts were analysed by a subcontractor by GC/MS (SIM).

BTEX (Benzene, Toluene, Ethyl Benzene, Xylene) Concentrations:

Volatile organic compounds were extracted with methanol following a procedure from the BC Ministry of Water Land and Air Protection Analytical Method for Contaminated Sites, 1999, "Volatile Hydrocarbons in Solids by GC/FID". Extracts were analysed by direct injection capillary column gas chromatography with mass spectrometric detection (GC/MS). See analytical report from subcontractor for more details.

Total Organic Carbon:

Samples were digested in acid, then analysed using a Leco Induction Furnace combustion/volumetric analysis technique. Analyses were conducted by a subcontractor.

Moisture content was analysed gravimetrically by heating a separate sample portion at 105 °C and measuring the weight loss. Analyses were conducted by a subcontractor.

Particle Size Distribution:

Samples were sieved for particle size distribution according to ASTM C136-84A (Standard Method for Sieve Analysis of Fine and Coarse Aggregates). Select samples were analysed on a Malvern Mastersizer 2000 by a subcontractor.

Total PCB Concentrations:

Samples were soxhlet extracted with acetone/hexane at a 50:50 ratio, concentrated, cleaned up on Florisil, and analysed by GC/ECD.

Dioxins and Furans Concentrations:

Analyses were conducted in general accordance with US EPA Method 1613 Revision B. For further details, see the subcontractor's analytical report (on CD ROM).

Ammonia Concentrations:

Vizon SOP 5330 (Colorimetric Analysis of Ammonia Nitrogen in Water and Wastewater). Current Version. Adapted from: Sheiner D. 1976. Determination of Ammonia and Kjeldahl Nitrogen by Indophenol Method. *Water Research*. Vol. 10:31-36. Pergammon Press. Similar in principle to: Standard Methods for the Examination of Water and Wastewater, APHA, AWWA, WEF, 20th Edition, 1998. Method 4500 – NH3 F .

Sulfide Concentrations:

SM 4500 S^{2-} F (Iodometric Method) in Standard Methods for the Examination of Water and Wastewater, 20th ed., 1998.

Salinity and pH:

Calibrated conductivity meter and pH meter.

ANALYSIS REPORT

Date of Analysis: 9-Mar-06
DATE of Report: 15-Mar-06
PROJECT No: 2-11-965B

APPROVED BY: _______ Anna Becalska

CLIENT: **Jacques Whitford**
4370 Dominion Street, 5th Floor
Burnaby, BC
Canada V5G 4L7

CONTACT: **Janine Beckett**

VIZON SCITEC
3650 Wesbrook Mall
Vancouver, B.C.
Canada
TEL: (604) 224-4331
FAX: (604) 224-0540

COMMENTS: Total Metals analysis of sediment samples.
METHODS: ICP-AES Analysis of Total & Dissolved Metals in Water and Wastewater, 5240/5245 v.3.1

Login ID:	DL	060223J-01	060223J-02	060223J-03	060223J-03	060223J-04
Client ID:		JW1	JW2	JW3	Duplicate	JW4
		23-Feb-06	23-Feb-06	23-Feb-06	23-Feb-06	23-Feb-06
	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
Ag Silver	0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Al Aluminium	10	35800	35900	35300	36900	35600
As Arsenic	1	2	2	5	6	3
B Boron	3	42	42	55	57	57
Ba Barium	0.05	147	146	145	145	145
Be Beryllium	0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Bi Bismuth	5	<5	<5	<5	<5	<5
Ca Calcium	10	15000	16100	14800	15000	15100
Cd Cadmium	0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Co Cobalt	0.3	14.7	14.2	14.4	15.3	13.4
Cr Chromium	0.3	52.5	53.5	52.6	56.8	53.2
Cu Copper	0.5	48.4	47.0	47.4	52.0	45.1
Fe Iron	5	39400	37200	39000	40900	36900
Hg Mercury	0.0005	0.0221	0.0162	0.0180	0.0127	0.0182
K Potassium	3	9940	10100	9830	10200	9630
Li Lithium	1	54	54	52	58	50
Mg Magnesium	10	16600	16200	16500	17400	15900
Mn Manganese	0.05	677	634	659	701	626
Mo Molybdenum	0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Na Sodium	10	16100	16000	16900	16100	15300
Ni Nickel	0.3	23	24	24	24	23
P Phosphorus	2	1060	799	992	1350	762
Pb Lead	1	5	4	4	4	4
S Sulfur	10	2090	2230	2100	2060	1900
Sb Antimony	1	<1	<1	<1	<1	<1
Se Selenium	1	<1	<1	<1	<1	<1
Si Silicon	3	321	203	252	324	145
Sn Tin	2	<2	<2	<2	<2	<2
Sr Strontium	0.5	140	142	138	141	142
Ti Titanium	0.5	484	1490	1630	2110	682
Tl Thallium	1	<1	<1	<1	<1	<1
V Vanadium	0.5	86	135	136	142	107
Zn Zinc	0.3	84.2	79.1	81.1	85.9	75.9

ANALYSIS REPORT

Date of Analysis: 9-Mar-06
DATE of Report: 15-Mar-06
PROJECT No: 2-11-965B

APPROVED BY: _______ Anna Becalska

CLIENT: Jacques Whitford
4370 Dominion Street, 5th Floor
Burnaby, BC
Canada V5G 4L7

CONTACT: Janine Beckett

VIZON SCITEC
3650 Wesbrook Mall
Vancouver, B.C.
Canada
TEL: (604) 224-4331
FAX: (604) 224-0540

COMMENTS: Total Metals analysis of sediment samples.
METHODS: ICP-AES Analysis of Total & Dissolved Metals in Water and Wastewater, 5240/5245 v.3.1

Login ID:	DL	060223J-05	060223J-06	060223J-08	060223J-09	060223J-10
Client ID:		JW5	JW6	JW9	JW10	JW12
		23-Feb-06	23-Feb-06	23-Feb-06	23-Feb-06	23-Feb-06
	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
Ag Silver	0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Al Aluminium	10	32500	35000	25400	32800	35500
As Arsenic	1	2	4	3	3	2
B Boron	3	53	58	33	46	53
Ba Barium	0.05	130	147	121	135	150
Be Beryllium	0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Bi Bismuth	5	<5	<5	<5	<5	<5
Ca Calcium	10	16200	14800	11100	15200	15600
Cd Cadmium	0.05	<0.05	<0.05	<0.05	<0.05	0.06
Co Cobalt	0.3	12.8	13.5	14.2	14.3	14.1
Cr Chromium	0.3	48.2	52.3	43.3	54.4	52.7
Cu Copper	0.5	43.1	44.1	34.3	40.8	46.7
Fe Iron	5	34000	36400	37300	38200	38000
Hg Mercury	0.0005	0.0168	0.0185	0.0121	0.0115	0.0167
K Potassium	3	8880	9830	6860	8670	10100
Li Lithium	1	50	48	54	52	50
Mg Magnesium	10	15100	15840	15500	16400	16300
Mn Manganese	0.05	566	625	513	596	646
Mo Molybdenum	0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Na Sodium	3	15800	15600	11500	12800	16500
Ni Nickel	0.3	21.8	22.2	18.0	24.6	22.6
P Phosphorus	2	718	1040	1390	1190	686
Pb Lead	1	5	4	2	3	4
S Sulfur	10	3787	2136	1707	1919	2730
Sb Antimony	1	<1	<1	<1	<1	<1
Se Selenium	1	<1	<1	<1	<1	<1
Si Silicon	3	202	632	304	253	189
Sn Tin	2	<2	<2	<2	<2	<2
Sr Strontium	0.5	135	135	92	125	144
Ti Titanium	0.5	627	1750	1480	1830	1060
Tl Thallium	1	<1	<1	<1	<1	<1
V Vanadium	0.5	94.4	130	117	134	136
Zn Zinc	0.3	73.6	76.2	80.2	79.1	79.9

ANALYSIS REPORT

Date of Analysis: 9-Mar-06
DATE of Report: 15-Mar-06
PROJECT No: 2-11-965B

APPROVED BY: _______ Anna Becalska

CLIENT: Jacques Whitford
4370 Dominion Street, 5th Floor
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CONTACT: Janine Beckett

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TEL: (604) 224-4331
FAX: (604) 224-0540

COMMENTS: Total Metals analysis of sediment samples.
METHODS: ICP-AES Analysis of Total & Dissolved Metals in Water and Wastewater, 5240/5245 v.3.1

Login ID:	DL	060223J-07	060223J-07	060223J-07	060223J-07	060223J-07
Client ID:		JW7	Rep-1	Rep-2	Rep-3	Rep-4
		23-Feb-06				
	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
Ag Silver	0.3	<0.3	<0.3	<0.3	<0.3	<0.3
Al Aluminium	10	37300	38400	39700	38200	37200
As Arsenic	1	6	4	5	4	6
B Boron	3	57	54	68	57	59
Ba Barium	0.05	152	167	170	162	154
Be Beryllium	0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Bi Bismuth	5	<5	<5	<5	<5	<5
Ca Calcium	10	16000	16900	17500	17000	16700
Cd Cadmium	0.05	0.09	<0.05	0.09	0.08	0.11
Co Cobalt	0.3	14.4	14.8	15.2	15.2	14.9
Cr Chromium	0.3	55.5	56.7	58.9	57.6	56.3
Cu Copper	0.5	51.1	49.7	51.5	51.4	51.3
Fe Iron	5	40400	39500	40900	40100	40300
Hg Mercury	0.0005	0.0137	0.0141	0.0136	0.0147	0.0114
K Potassium	3	10700	11100	11500	10900	10700
Li Lithium	1	55	53	56	55	54
Mg Magnesium	10	17300	17200	17800	17400	17400
Mn Manganese	0.05	669	671	695	680	672
Mo Molybdenum	0.5	<0.5	<0.5	<0.5	1.2	0.7
Na Sodium	3	18000	17800	18400	18300	18300
Ni Nickel	0.3	23.7	23.7	24.4	24.0	23.6
P Phosphorus	2	1370	1000	1300	1160	1280
Pb Lead	1	5	5	5	4	5
S Sulfur	10	3300	3120	3310	3170	3630
Sb Antimony	1	<1	<1	<1	<1	<1
Se Selenium	1	<1	<1	<1	<1	<1
Si Silicon	3	368	314	369	301	310
Sn Tin	2	<2	<2	<2	<2	<2
Sr Strontium	0.5	150	154	157	153	149
Ti Titanium	0.5	2240	1770	2230	1960	2210
Tl Thallium	1	<1	<1	<1	<1	<1
V Vanadium	0.5	144	144	149	145	144
Zn Zinc	0.3	84.9	84.6	87.5	86.3	87.3

POLYNUCLEAR AROMATIC HYDRO... RBONS (PAHs) ANALYSIS REPORT

Date: April 10, 2006
Project No: 2-11-0965B

Client: Jacques Whitford

VIZON SCITEC
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Vancouver, B.C.
Canada
V6S 2L2
TEL: (604) 224-4331
FAX: (604) 224-0540

ATTENTION: Kerrie Serb

VIZON CONTACT: Rosemary Scot

Comments:

The analysis was carried out using guidelines from EPA Methods 3520C and 8270 (SW-846). This method used a liquid-liquid extraction with dichloromethane . The extracts were analysed by GC/MS (SIM).

Vizon No: / Description / SAMPLE DATED:	ISQG ug/g	Detection Limit	Certified Material Reference Value ug/g	Expected Concentration Range ug/g	060223J-01 JW1 Sediment Feb.23/06	060223J-02 JW2 Trial 1 Sediment Feb.23/06	060223J-02 JW2 Trial 2 Sediment Feb.23/06	060223J-03 JW3 Sediment Feb.23/06	060223J-04 JW4 Sediment Feb.23/06	060223J-05 JW5 Trial 1 Sediment Feb.23/06	060223J-05 JW5 Trial 2 Sediment Feb.23/06	060223J-06 JW6 Sediment Feb.23/06	060223J-07 JW7 Sediment Feb.23/06	060223J-08 JW9 Sediment Feb.23/06	060223J-09 JW10 Sediment Feb.23/06	060223J-10 JW12 Sediment Feb.23/06
Napthalene	0.0346	0.05	0.25	0.18 - 0.32	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
2-Methylnapthalene	0.0202	0.05			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Acenapthylene	0.0059	0.05	0.15(a)		<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Acenaphthene	0.0067	0.05			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Fluorene	0.0212	0.05			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Phenanthrene	0.0867	0.05	5.20	4.20 - 6.20	0.15	0.15	0.17	0.18	<0.05	0.13	0.11	0.14	0.15	<0.05	<0.05	0.09
Anthracene	0.0469	0.05	0.38	0.23 - 0.53	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Total LMW-PAHs					0.15	0.15	0.17	0.18	0.00	0.13	0.11	0.14	0.15	0.0	0.0	0.09
Fluoranthene	0.1130	0.05	8.40	5.80 - 11.0	0.33	0.32	0.37	0.39	<0.05	0.26	0.22	0.28	0.30	<0.05	0.06	0.22
Pyrene	0.1530	0.05	5.80	4.00 - 7.60	0.33	0.32	0.38	0.40	<0.05	0.26	0.22	0.28	0.30	<0.05	0.06	0.24
Benzo(a) anthracene	0.0748	0.05			0.23	0.24	0.26	0.27	<0.05	0.16	0.13	0.17	0.18	<0.05	<0.05	0.13
Chrysene	0.1080	0.05	2.80	1.90 - 2.40	<0.05	0.28	0.30	0.32	<0.05	0.20	0.16	0.21	0.22	<0.05	<0.05	0.16
Benzo(b) fluoranthene		0.05			0.61	0.60	0.70	0.70	<0.05	0.42	0.36	0.43	0.46	0.06	0.09	0.49
Benzo(k) fluoranthene		0.05			<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Benzo(a) pyrene	0.0888	0.05			0.32	0.32	0.39	0.36	<0.05	0.22	0.19	0.24	0.24	<0.05	<0.05	0.17
Indeno(1,2,3-cd)pyrene		0.05	1.30	0.60 - 2.00	0.24	0.23	0.27	0.25	<0.05	0.16	0.14	0.17	0.17	<0.05	<0.05	0.11
Dibenz(a,h)anthracene	0.0062	0.05	0.20	0.10 - 0.30	0.05	0.05	0.06	0.06	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Benzo(g,h,i)perylene		0.05			0.23	0.22	0.25	0.23	<0.05	0.16	0.15	0.18	0.17	<0.05	<0.05	0.12
Total HMW-PAHs					2.34	2.58	2.98	2.98	0.00	1.84	1.57	1.96	2.04	0.06	0.21	1.64
Total PAHs					2.49	2.73	3.15	3.16	0.00	1.97	1.68	2.10	2.19	0.06	0.21	1.73

(a) Upper limit amount present is not greater than 0.15 ug/g

Results are reported in micrograms per liter (ug/g) on a dry weight basis
ISQG Interim Marine Sediment Quality Guidelines
Note: Benzo(b fluoranthene and Benzo(k)fluoranthene reported as total

Approved by: ____________________

ALS Environmental

CERTIFICATE OF ANALYSIS

Date: March 20, 2006

ALS File No. X3044

Report On: 2-11-0965B Soil Analysis

Report To: **Vizon SciTec Inc.**
3650 Wesbrook Mall
Vancouver, BC
V6S 2L2

Received: March 10, 2006

ALS ENVIRONMENTAL
per:

Andre Langlais, M.Sc. - Project Chemist
Sime Buric, B.Sc. - Client Services

ALS CANADA LTD.
1988 Triumph Street, Vancouver, BC Canada V5L 1K5
Phone: 604-253-4188 Fax: 604-253-6700 Website: www.alsenviro.com

File No. X3044

REMARKS

Please note that the Detection limits were increased for some of the samples due to low sample volume.

File No. X3044

RESULTS OF ANALYSIS - Sediment/Soil

Sample ID	JW1	JW2	JW3	JW4	JW5
Sample Date	06-02-23	06-02-23	06-02-23	06-02-23	06-02-23
ALS ID	*1*	*2*	*3*	*4*	*5*
Physical Tests					
Moisture %	59.4	65.4	59.7	54.2	57.6
Non-Halogenated Volatiles					
Benzene	<0.080	<0.080	<0.080	<0.080	<0.080
Ethylbenzene	<0.10	<0.10	<0.10	<0.10	<0.10
Styrene	<0.10	<0.10	<0.10	<0.10	<0.10
Toluene	<0.10	<0.10	<0.10	<0.10	<0.10
meta- & para-Xylene	<0.10	<0.10	<0.10	<0.10	<0.10
ortho-Xylene	<0.10	<0.10	<0.10	<0.10	<0.10
Total Xylenes	<0.20	<0.20	<0.20	<0.20	<0.20

Remarks regarding the analyses appear at the beginning of this report.
Results are expressed as milligrams per dry kilogram except where noted.
< = Less than the detection limit indicated.
VPH = Volatile Petroleum Hydrocarbons.

File No. X3044

RESULTS OF ANALYSIS - Sediment/Soil

Sample ID	JW6	JW7	JW9	JW10	JW12
Sample Date	06-02-23	06-02-23	06-02-23	06-02-23	06-02-23
ALS ID	*6*	*7*	*8*	*9*	*10*
Physical Tests					
Moisture %	61.9	60.5	50.2	52.3	62.7
Non-Halogenated Volatiles					
Benzene	<0.080	<0.080	<0.040	<0.040	<0.080
Ethylbenzene	<0.10	<0.10	<0.050	<0.050	<0.10
Styrene	<0.10	<0.10	<0.050	<0.050	<0.10
Toluene	<0.10	<0.10	<0.050	<0.050	<0.10
meta- & para-Xylene	<0.10	<0.10	<0.050	<0.050	<0.10
ortho-Xylene	<0.10	<0.10	<0.050	<0.050	<0.10
Total Xylenes	<0.20	<0.20	<0.10	<0.10	<0.20

Remarks regarding the analyses appear at the beginning of this report.
Results are expressed as milligrams per dry kilogram except where noted.
< = Less than the detection limit indicated.
VPH = Volatile Petroleum Hydrocarbons.

File No. X3044

Appendix 1 - QUALITY CONTROL - Replicates

Sediment/Soil	JW4	JW4
	06-02-23	QC # 491459
Physical Tests		
Moisture %	54.2	54.1
Non-Halogenated Volatiles		
Benzene	<0.080	<0.080
Ethylbenzene	<0.10	<0.10
Styrene	<0.10	<0.10
Toluene	<0.10	<0.10
meta- & para-Xylene	<0.10	<0.10
ortho-Xylene	<0.10	<0.10
Total Xylenes	<0.20	<0.20

Remarks regarding the analyses appear at the beginning of this report.
Results are expressed as milligrams per dry kilogram except where noted.
< = Less than the detection limit indicated.
VPH = Volatile Petroleum Hydrocarbons.

Appendix 2 - METHODOLOGY

Outlines of the methodologies utilized for the analysis of the samples submitted are as follows

Moisture in Sediment/Soil

This analysis is carried out gravimetrically by drying the sample at 103 C for a minimum of six hours.

Recommended Holding Time:
Sample: 14 days
Reference: Puget

Laboratory Location: ALS Environmental, Vancouver

Volatile Organic Compounds in Sediment/Soil

Volatile Organic Compounds (VOC) are extracted from sediment or soil with methanol, following a procedure from the British Columbia Ministry of Water Land and Air Protection (BCWLAP) Analytical Method for Contaminated Sites "Volatile Hydrocarbons in Solids by GC/FID" (Version 2.1 July 1999). Aliquots of the extract are analyzed by direct injection capillary column gas chromatography with mass spectrometric detection (GC/MS), using procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846, Method 8260B, published by the United States Environmental Protection Agency (EPA).

Recommended Holding Time:
Sample: 14 days   Extract: 40 days
Reference: EPA

Laboratory Location: ALS Environmental, Vancouver

Calculation of Total Xylenes

Total Xylenes is the sum of the concentrations of the ortho, meta, and para Xylene isomers. Results below detection limit (DL) are treated as zero. The DL for Total Xylenes is set to a value no less than the sum of the DLs of the individual Xylenes.

Laboratory Location: ALS Environmental, Vancouver

Results contained within this certificate relate only to the samples as submitted.

End of Report

Analysis Report

CANTEST LTD.
Professional
Analytical
Services

4606 Canada Way
Burnaby, B.C.
V5G 1K5

Fax: 604 731 2386

Tel: 604 734 7276

1 800 665 8566

REPORT ON: Analysis of Soil Samples

REPORTED TO: Vizon SciTec Inc.
(FKA BC Research Inc.)
3650 Wesbrook Mall
Vancouver, BC
V6S 2L2

Att'n: K. Serben

CHAIN OF CUSTODY: 187279
PROJECT NAME: Sediments
PROJECT NUMBER: 2-11-0965B
P.O. NUMBER: R69046

NUMBER OF SAMPLES: 12

REPORT DATE: March 3, 2006

DATE SUBMITTED: February 24, 2006

GROUP NUMBER: 70225007

SAMPLE TYPE: Soil

NOTE: Results contained in this report refer only to the testing of samples as submitted. Other information is available on request.

TEST METHODS:

Moisture in Soil - analysis was performed gravimetrically by heating a separate sample portion at 105 C and measuring the weight loss.

Total Organic Carbon - samples were digested in acid then analyzed using a Leco Induction Furnace combustion/volumetric analysis technique.

TEST RESULTS:

(See following page)

CANTEST LTD.

Richard S. Jornitz
Supervisor, Inorganic Testing

REPORTED TO: Vizon SciTec Inc.

REPORT DATE: March 3, 2006

GROUP NUMBER: 70225007

Conventional Parameters in Soil

CLIENT SAMPLE IDENTIFICATION:	SAMPLE DATE	CANTEST ID	Moisture	Total Organic Carbon C
JW1	Feb 23/06	602250054	54.3	1.28
JW2	Feb 23/06	602250055	55.0	1.29
JW3	Feb 23/06	602250056	56.7	0.99
JW4	Feb 23/06	602250057	53.4	1.08
JW5	Feb 23/06	602250058	55.1	1.82
JW6	Feb 23/06	602250059	53.2	1.17
JW7	Feb 23/06	602250060	58.6	0.75
JW9	Feb 23/06	602250061	57.1	1.63
JW10	Feb 23/06	602250062	49.9	0.78
JW12	Feb 23/06	602250063	54.4	1.25
Control D	Feb 23/06	602250064	23.6	<
Control M	Feb 23/06	602250065	23.5	<
DETECTION LIMIT			0.1	0.5
UNITS			%	% dry wt.

% = percent

< = Less than detection limit

% dry wt. = percent, dry weight basis

Screen Assay of Jacques Whitford Samples 2-11-0965B

JW1				
Screen (mm)	Mass (g)	% Retained		% Passing
		Interval	Cumulative	
2.000	0.78	0.5	0.5	99.5
1.000	0.62	0.4	0.8	99.2
0.500	0.99	0.6	1.4	98.6
0.250	1.94	1.1	2.5	97.5
0.150	2.68	1.6	4.1	95.9
0.063	6.78	4.0	8.1	91.9
0.053	2.11	1.2	9.3	90.7
0.038	3.64	2.1	11.4	88.6
<0.038	151.55	88.6	100.0	0.0
Total	171.09	100.0		

JW2				
Screen (mm)	Mass (g)	% Retained		% Passing
		Interval	Cumulative	
2.000	0.50	0.3	0.3	99.7
1.000	0.95	0.6	0.9	99.1
0.500	1.44	0.9	1.8	98.2
0.250	2.23	1.4	3.2	96.8
0.150	2.22	1.4	4.6	95.4
0.063	6.05	3.8	8.5	91.5
0.053	1.72	1.1	9.6	90.4
0.038	3.46	2.2	11.7	88.3
<0.038	139.55	88.3	100.0	0.0
Total	158.12	100.0		

JW3				
Screen (mm)	Mass (g)	% Retained		% Passing
		Interval	Cumulative	
2.000	0.02	0.0	0.0	100.0
1.000	0.50	0.3	0.3	99.7
0.500	0.52	0.3	0.7	99.3
0.250	0.81	0.5	1.2	98.8
0.150	0.95	0.6	1.8	98.2
0.063	3.24	2.1	3.9	96.1
0.053	1.23	0.8	4.8	95.2
0.038	2.50	1.6	6.4	93.6
<0.038	143.17	93.6	100.0	0.0
Total	152.94	100.0		

JW4				
Screen (mm)	Mass (g)	% Retained		% Passing
		Interval	Cumulative	
2.000	0.03	0.0	0.0	100.0
1.000	0.38	0.2	0.2	99.8
0.500	0.6	0.3	0.5	99.5
0.250	1.17	0.6	1.1	98.9
0.150	1.49	0.8	1.9	98.1
0.063	4.44	2.2	4.1	95.9
0.053	1.57	0.8	4.9	95.1
0.038	4.09	2.1	7.0	93.0
<0.038	183.57	93.0	100.0	0.0
Total	197.34	100.0		

JW5				
Screen (mm)	Mass (g)	% Retained		% Passing
		Interval	Cumulative	
2.000	4.94	2.5	2.5	97.5
1.000	6.13	3.1	5.6	94.4
0.500	7.44	3.8	9.3	90.7
0.250	7.19	3.6	13.0	87.0
0.150	5.54	2.8	15.8	84.2
0.063	11.73	5.9	21.7	78.3
0.053	3.10	1.6	23.2	76.8
0.038	4.46	2.3	25.5	74.5
<0.038	147.64	74.5	100.0	0.0
Total	198.17	100.0		

JW6				
Screen (mm)	Mass (g)	% Retained		% Passing
		Interval	Cumulative	
2.000	0.01	0.0	0.0	100.0
1.000	0.52	0.2	0.2	99.8
0.500	0.61	0.3	0.5	99.5
0.250	1.28	0.6	1.1	98.9
0.150	1.65	0.8	1.9	98.1
0.063	7.08	3.3	5.2	94.8
0.053	3.32	1.5	6.7	93.3
0.038	5.13	2.4	9.1	90.9
<0.038	194.83	90.9	100.0	0.0
Total	214.43	100.0		

JW7				
Screen (mm)	Mass (g)	% Retained		% Passing
		Interval	Cumulative	
2.000	0.82	0.5	0.5	99.5
1.000	2.12	1.3	1.8	98.2
0.500	2.40	1.5	3.3	96.7
0.250	2.61	1.6	4.9	95.1
0.150	1.85	1.1	6.0	94.0
0.063	6.23	3.8	9.8	90.2
0.053	2.50	1.5	11.4	88.6
0.038	3.85	2.4	13.7	86.3
<0.038	140.85	86.3	100.0	0.0
Total	163.23	100.0		

JW9				
Screen (mm)	Mass (g)	% Retained		% Passing
		Interval	Cumulative	
2.000	0.45	0.3	0.3	99.7
1.000	1.95	1.3	1.6	98.4
0.500	2.06	1.4	3.0	97.0
0.250	2.16	1.5	4.5	95.5
0.150	1.53	1.0	5.5	94.5
0.063	5.63	3.8	9.3	90.7
0.053	2.49	1.7	10.9	89.1
0.038	3.50	2.4	13.3	86.7
<0.038	128.87	86.7	100.0	0.0
Total	148.64	100.0		

JW10				
Screen (mm)	Mass (g)	% Retained		% Passing
		Interval	Cumulative	
2.000	0.01	0.0	0.0	100.0
1.000	0.48	0.2	0.2	99.8
0.500	1.25	0.5	0.7	99.3
0.250	4.55	1.9	2.6	97.4
0.150	13.77	5.6	8.2	91.8
0.063	66.71	27.3	35.5	64.5
0.053	12.17	5.0	40.5	59.5
0.038	10.23	4.2	44.7	55.3
<0.038	135.09	55.3	100.0	0.0
Total	244.26	100.0		

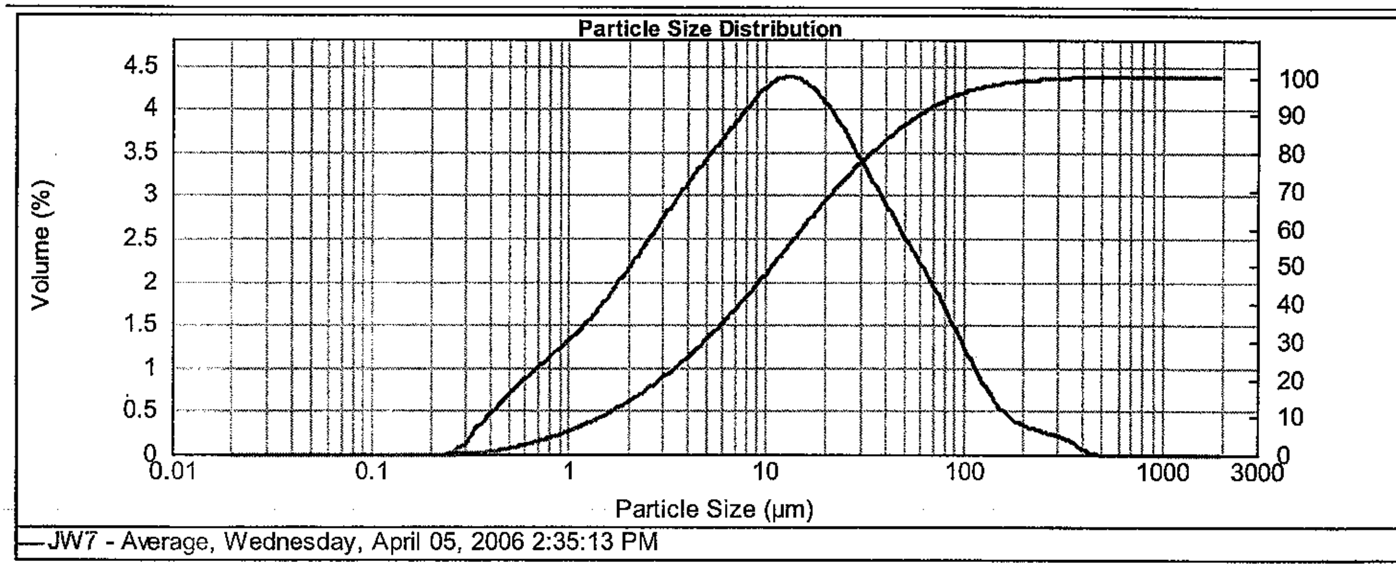
JW12				
Screen (mm)	Mass (g)	% Retained		% Passing
		Interval	Cumulative	
2.000	0.28	0.2	0.2	99.8
1.000	1.63	1.0	1.2	98.8
0.500	1.57	1.0	2.2	97.8
0.250	2.2	1.4	3.6	96.4
0.150	1.69	1.1	4.7	95.3
0.063	3.35	2.1	6.9	93.1
0.053	1.21	0.8	7.6	92.4
0.038	2.72	1.7	9.4	90.6
<0.038	141.77	90.6	100.0	0.0
Total	156.42	100.0		

MASTERSIZER 2000

Result Analysis Report

Sample Name: JW7 - Average	**SOP Name:**	**Measured:** Wednesday, April 05, 2006 2:35:13 PM	
Sample Source & type: Works = Vizon Scitec Inc- Kerrie Serben	**Measured by:** Vivian	**Analysed:** Wednesday, April 05, 2006 2:35:15 PM	
Particle Name: Soil	**Accessory Name:** Hydro 2000S (A)	**Analysis model:** General purpose	**Sensitivity:** Normal
Particle RI: 1.230	**Absorption:** 0.5	**Size range:** 0.020 to 2000.000 um	**Obscuration:** 16.80 %
Dispersant Name: Water	**Dispersant RI:** 1.330	**Weighted Residual:** 0.664 %	**Result Emulation:** Off
Concentration: 0.0105 %Vol	**Span :** 5.419	**Uniformity:** 1.81	**Result units:** Volume
Specific Surface Area: 1.52 m²/g	**Surface Weighted Mean D[3,2]:** 3.947 um	**Vol. Weighted Mean D[4,3]:** 24.219 um	

d(0.1): 1.500 um **d(0.5):** 10.889 um **d(0.9):** 60.513 um



Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %
0.020	0.00	0.112	0.00	0.626	2.64	3.499	22.86	19.572	66.47	109.466	96.50
0.022	0.00	0.124	0.00	0.692	3.26	3.872	24.85	21.658	69.15	121.132	97.15
0.024	0.00	0.137	0.00	0.766	3.94	4.285	26.93	23.966	71.73	134.041	97.69
0.027	0.00	0.152	0.00	0.848	4.68	4.742	29.10	26.520	74.21	148.326	98.12
0.030	0.00	0.168	0.00	0.938	5.47	5.247	31.35	29.346	76.57	164.133	98.47
0.033	0.00	0.186	0.00	1.038	6.32	5.806	33.69	32.473	78.82	181.625	98.75
0.037	0.00	0.205	0.00	1.149	7.24	6.425	36.10	35.934	80.94	200.981	98.99
0.041	0.00	0.227	0.00	1.271	8.23	7.109	38.60	39.764	82.94	222.400	99.20
0.045	0.00	0.251	0.00	1.407	9.29	7.867	41.19	44.001	84.82	246.101	99.39
0.050	0.00	0.278	0.02	1.556	10.43	8.706	43.85	48.690	86.58	272.329	99.55
0.055	0.00	0.308	0.09	1.722	11.66	9.633	46.59	53.879	88.24	301.351	99.71
0.061	0.00	0.341	0.23	1.906	12.97	10.660	49.40	59.621	89.78	333.467	99.83
0.067	0.00	0.377	0.46	2.109	14.38	11.796	52.26	65.975	91.22	369.005	99.93
0.075	0.00	0.417	0.76	2.334	15.88	13.053	55.14	73.006	92.53	408.330	99.99
0.083	0.00	0.462	1.13	2.583	17.48	14.444	58.03	80.787	93.72	451.846	100.00
0.091	0.00	0.511	1.57	2.858	19.18	15.983	60.89	89.396	94.78	500.000	100.00
0.101	0.00	0.565	2.07	3.162	20.97	17.687	63.71	98.924	95.71		

MALVERN INSTRUMENTS

MASTERSIZER 2000

Result Analysis Report

Sample Name: JW3 - Average

SOP Name:

Measured: Wednesday, April 05, 2006 2:07:30 PM

Sample Source & type: Works = Vizon Scitec Inc- Kerrie Serben

Measured by: Vivian

Analysed: Wednesday, April 05, 2006 2:07:31 PM

Particle Name: Soil

Accessory Name: Hydro 2000S (A)

Analysis model: General purpose

Sensitivity: Normal

Particle RI: 1.230

Absorption: 0.5

Size range: 0.020 to 2000.000 um

Obscuration: 14.36 %

Dispersant Name: Water

Dispersant RI: 1.330

Weighted Residual: 0.632 %

Result Emulation: Off

Concentration: 0.0089 %Vol

Span : 4.655

Uniformity: 1.65

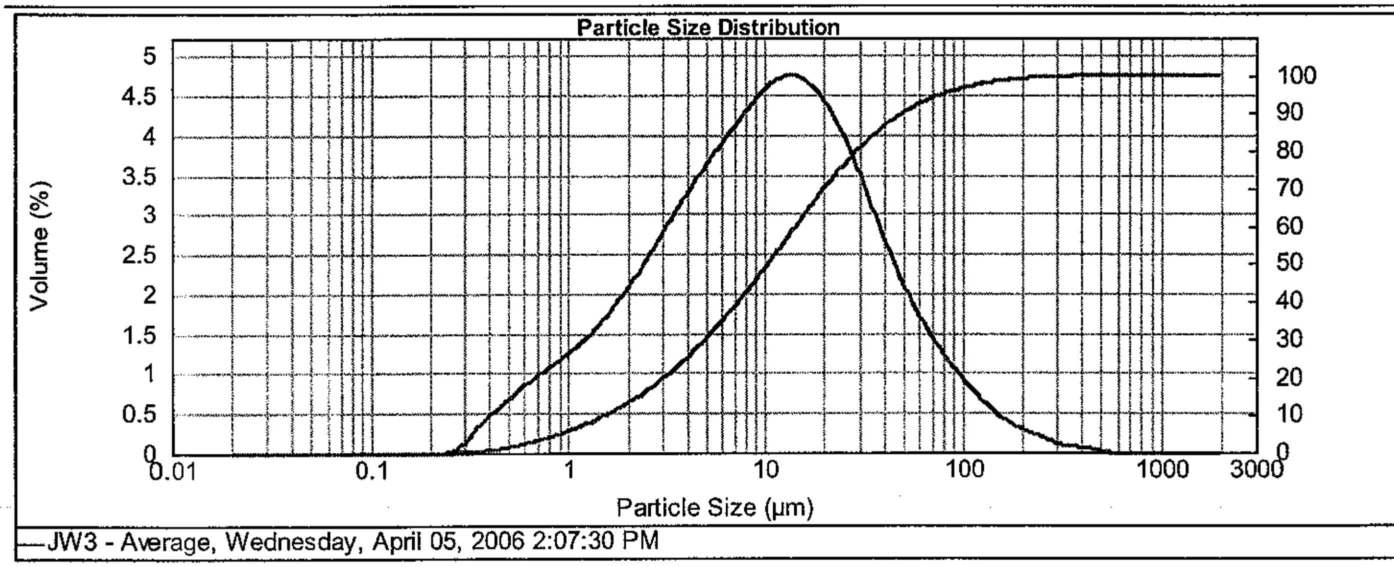
Result units: Volume

Specific Surface Area: 1.51 m²/g

Surface Weighted Mean D[3,2]: 3.973 um

Vol. Weighted Mean D[4,3]: 21.616 um

d(0.1): 1.554 um **d(0.5):** 10.417 um **d(0.9):** 50.046 um



Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %
0.020	0.00	0.112	0.00	0.626	2.58	3.499	22.36	19.572	69.27	109.466	97.17
0.022	0.00	0.124	0.00	0.692	3.18	3.872	24.42	21.658	72.18	121.132	97.67
0.024	0.00	0.137	0.00	0.766	3.84	4.285	26.60	23.966	74.96	134.041	98.10
0.027	0.00	0.152	0.00	0.848	4.54	4.742	28.89	26.520	77.59	148.326	98.46
0.030	0.00	0.168	0.00	0.938	5.30	5.247	31.29	29.346	80.06	164.133	98.76
0.033	0.00	0.186	0.00	1.038	6.12	5.806	33.78	32.473	82.35	181.625	99.01
0.037	0.00	0.205	0.00	1.149	6.99	6.425	36.37	35.934	84.44	200.981	99.22
0.041	0.00	0.227	0.00	1.271	7.92	7.109	39.05	39.764	86.35	222.400	99.40
0.045	0.00	0.251	0.00	1.407	8.93	7.867	41.83	44.001	88.07	246.101	99.55
0.050	0.00	0.278	0.02	1.556	10.02	8.706	44.70	48.690	89.61	272.329	99.68
0.055	0.00	0.308	0.08	1.722	11.19	9.633	47.66	53.879	90.99	301.351	99.77
0.061	0.00	0.341	0.22	1.906	12.46	10.660	50.70	59.621	92.22	333.467	99.83
0.067	0.00	0.377	0.45	2.109	13.83	11.796	53.79	65.975	93.31	369.005	99.89
0.075	0.00	0.417	0.75	2.334	15.30	13.053	56.92	73.006	94.29	408.330	99.94
0.083	0.00	0.462	1.11	2.583	16.88	14.444	60.07	80.787	95.15	451.846	99.97
0.091	0.00	0.511	1.54	2.858	18.59	15.983	63.19	89.396	95.92	500.000	100.00
0.101	0.00	0.565	2.03	3.162	20.41	17.687	66.27	98.924	96.59		

MASTERSIZER 2000

MALVERN INSTRUMENTS

Result Analysis Report

Sample Name: JW2 - Average
SOP Name:
Measured: Wednesday, April 05, 2006 2:00:38 PM

Sample Source & type: Works = Vizon Scitec Inc- Kerrie Serben
Measured by: Vivian
Analysed: Wednesday, April 05, 2006 2:00:39 PM

Particle Name: Soil
Accessory Name: Hydro 2000S (A)
Analysis model: General purpose
Sensitivity: Normal

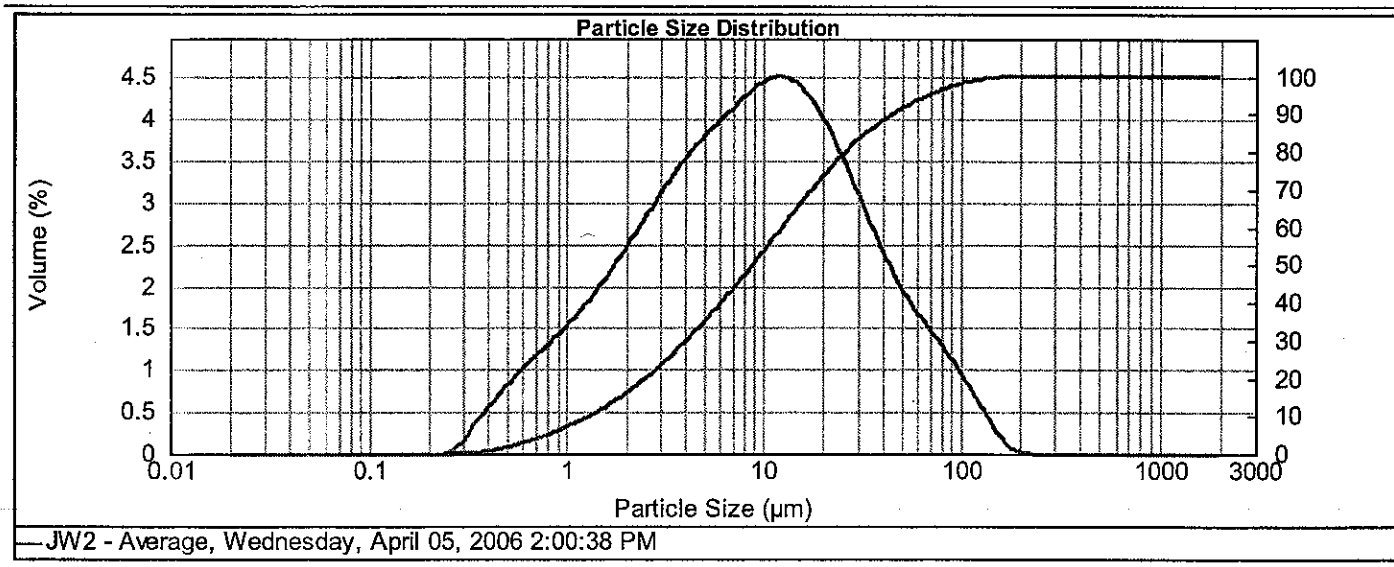
Particle RI: 1.230
Absorption: 0.5
Size range: 0.020 to 2000.000 um
Obscuration: 16.96 %

Dispersant Name: Water
Dispersant RI: 1.330
Weighted Residual: 0.634 %
Result Emulation: Off

Concentration: 0.0093 %Vol
Span : 4.956
Uniformity: 1.58
Result units: Volume

Specific Surface Area: 1.73 m²/g
Surface Weighted Mean D[3,2]: 3.459 um
Vol. Weighted Mean D[4,3]: 17.616 um

d(0.1): 1.307 um **d(0.5):** 8.826 um **d(0.9):** 45.046 um



Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %
0.020	0.00	0.112	0.00	0.626	3.13	3.499	26.53	19.572	72.90	109.466	98.62
0.022	0.00	0.124	0.00	0.692	3.86	3.872	28.78	21.658	75.52	121.132	99.11
0.024	0.00	0.137	0.00	0.766	4.66	4.285	31.13	23.966	78.01	134.041	99.48
0.027	0.00	0.152	0.00	0.848	5.52	4.742	33.55	26.520	80.36	148.326	99.74
0.030	0.00	0.168	0.00	0.938	6.45	5.247	36.06	29.346	82.54	164.133	99.90
0.033	0.00	0.186	0.00	1.038	7.45	5.806	38.63	32.473	84.56	181.625	99.97
0.037	0.00	0.205	0.00	1.149	8.52	6.425	41.28	35.934	86.42	200.981	100.00
0.041	0.00	0.227	0.00	1.271	9.67	7.109	43.99	39.764	88.11	222.400	100.00
0.045	0.00	0.251	0.00	1.407	10.90	7.867	46.77	44.001	89.66	246.101	100.00
0.050	0.00	0.278	0.03	1.556	12.23	8.706	49.61	48.690	91.07	272.329	100.00
0.055	0.00	0.308	0.11	1.722	13.65	9.633	52.51	53.879	92.36	301.351	100.00
0.061	0.00	0.341	0.28	1.906	15.17	10.660	55.46	59.621	93.54	333.467	100.00
0.067	0.00	0.377	0.56	2.109	16.80	11.796	58.44	65.975	94.62	369.005	100.00
0.075	0.00	0.417	0.91	2.334	18.53	13.053	61.43	73.006	95.61	408.330	100.00
0.083	0.00	0.462	1.35	2.583	20.37	14.444	64.40	80.787	96.51	451.846	100.00
0.091	0.00	0.511	1.87	2.858	22.32	15.983	67.31	89.396	97.32	500.000	100.00
0.101	0.00	0.565	2.46	3.162	24.37	17.687	70.15	98.924	98.02		

MASTERSIZER 2000

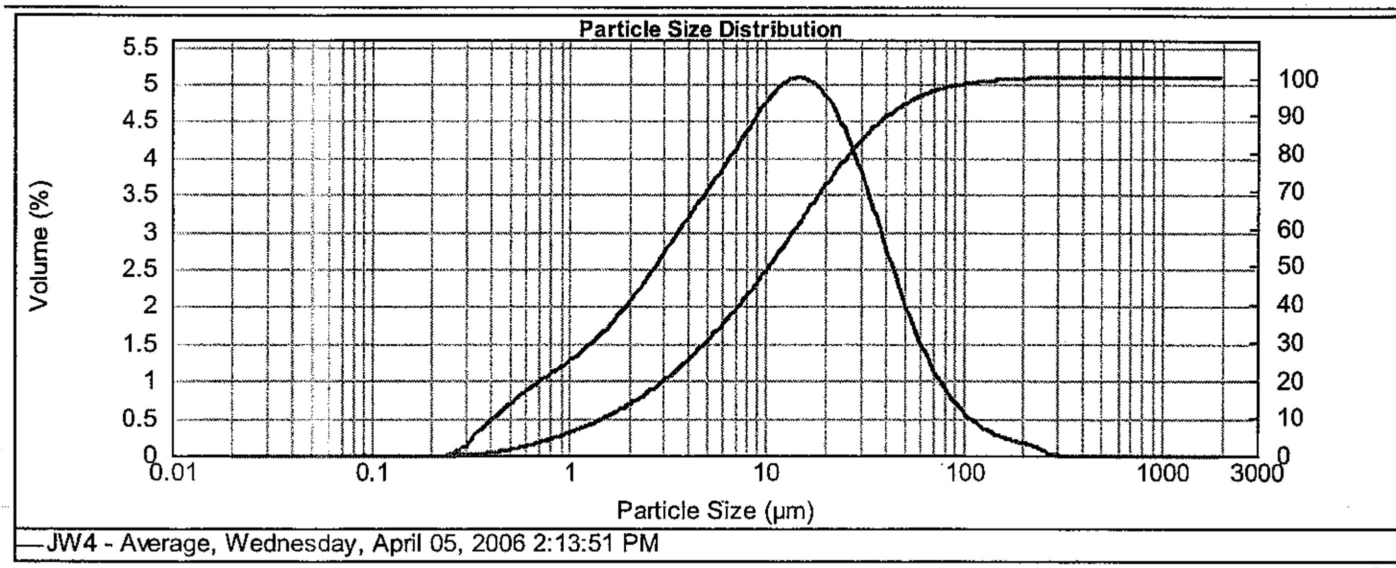
Result Analysis Report

Sample Name:	SOP Name:	Measured:
JW4 - Average		Wednesday, April 05, 2006 2:13:51 PM
Sample Source & type:	**Measured by:**	**Analysed:**
Works = Vizon Scitec Inc- Kerrie Serben	Vivian	Wednesday, April 05, 2006 2:13:52 PM

Particle Name:	Accessory Name:	Analysis model:	Sensitivity:
Soil	Hydro 2000S (A)	General purpose	Normal
Particle RI:	**Absorption:**	**Size range:**	**Obscuration:**
1.230	0.5	0.020 to 2000.000 um	15.67 %
Dispersant Name:	**Dispersant RI:**	**Weighted Residual:**	**Result Emulation:**
Water	1.330	0.625 %	Off

Concentration:	Span :	Uniformity:	Result units:
0.0096 %Vol	3.845	1.31	Volume
Specific Surface Area:	**Surface Weighted Mean D[3,2]:**	**Vol. Weighted Mean D[4,3]:**	
1.53 m^2/g	3.921 um	18.136 um	

d(0.1): 1.526 um **d(0.5): 10.439 um** **d(0.9): 41.660 um**



Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %
0.020	0.00	0.112	0.00	0.626	2.66	3.499	22.35	19.572	70.56	109.466	98.64
0.022	0.00	0.124	0.00	0.692	3.28	3.872	24.36	21.658	73.74	121.132	98.93
0.024	0.00	0.137	0.00	0.766	3.95	4.285	26.48	23.966	76.80	134.041	99.17
0.027	0.00	0.152	0.00	0.848	4.68	4.742	28.71	26.520	79.69	148.326	99.36
0.030	0.00	0.168	0.00	0.938	5.45	5.247	31.05	29.346	82.39	164.133	99.53
0.033	0.00	0.186	0.00	1.038	6.28	5.806	33.50	32.473	84.88	181.625	99.67
0.037	0.00	0.205	0.00	1.149	7.17	6.425	36.06	35.934	87.13	200.981	99.79
0.041	0.00	0.227	0.00	1.271	8.11	7.109	38.74	39.764	89.15	222.400	99.89
0.045	0.00	0.251	0.00	1.407	9.13	7.867	41.54	44.001	90.93	246.101	99.96
0.050	0.00	0.278	0.02	1.556	10.22	8.706	44.46	48.690	92.47	272.329	100.00
0.055	0.00	0.308	0.09	1.722	11.39	9.633	47.51	53.879	93.80	301.351	100.00
0.061	0.00	0.341	0.24	1.906	12.65	10.660	50.66	59.621	94.92	333.467	100.00
0.067	0.00	0.377	0.48	2.109	14.00	11.796	53.91	65.975	95.87	369.005	100.00
0.075	0.00	0.417	0.78	2.334	15.46	13.053	57.23	73.006	96.66	408.330	100.00
0.083	0.00	0.462	1.15	2.583	17.01	14.444	60.59	80.787	97.31	451.846	100.00
0.091	0.00	0.511	1.59	2.858	18.68	15.983	63.95	89.396	97.84	500.000	100.00
0.101	0.00	0.565	2.10	3.162	20.45	17.687	67.29	98.924	98.28		

MALVERN INSTRUMENTS

MASTERSIZER 2000

Result Analysis Report

Sample Name:
JW6 - Average

SOP Name:

Measured:
Wednesday, April 05, 2006 2:28:07 PM

Sample Source & type:
Works = Vizon Scitec Inc- Kerrie Serben

Measured by:
Vivian

Analysed:
Wednesday, April 05, 2006 2:28:09 PM

Particle Name:
Soil

Accessory Name:
Hydro 2000S (A)

Analysis model:
General purpose

Sensitivity:
Normal

Particle RI:
1.230

Absorption:
0.5

Size range:
0.020 to 2000.000 um

Obscuration:
14.17 %

Dispersant Name:
Water

Dispersant RI:
1.330

Weighted Residual:
0.670 %

Result Emulation:
Off

Concentration:
0.0084 %Vol

Span :
4.658

Uniformity:
1.52

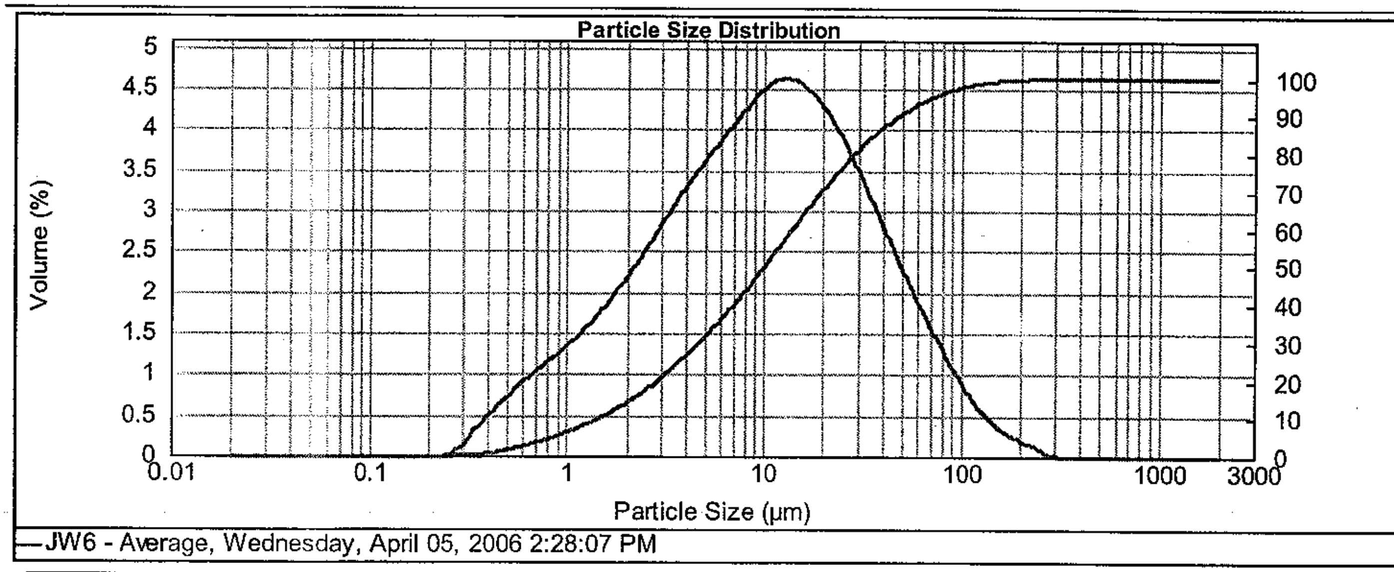
Result units:
Volume

Specific Surface Area:
1.58 m²/g

Surface Weighted Mean D[3,2]:
3.794 um

Vol. Weighted Mean D[4,3]:
19.564 um

d(0.1): **1.452** um **d(0.5):** **10.068** um **d(0.9):** **48.345** um



Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %
0.020	0.00	0.112	0.00	0.626	2.78	3.499	23.60	19.572	69.74	109.466	98.14
0.022	0.00	0.124	0.00	0.692	3.43	3.872	25.69	21.658	72.55	121.132	98.59
0.024	0.00	0.137	0.00	0.766	4.14	4.285	27.87	23.966	75.26	134.041	98.95
0.027	0.00	0.152	0.00	0.848	4.91	4.742	30.16	26.520	77.84	148.326	99.23
0.030	0.00	0.168	0.00	0.938	5.73	5.247	32.54	29.346	80.27	164.133	99.46
0.033	0.00	0.186	0.00	1.038	6.61	5.806	35.01	32.473	82.56	181.625	99.63
0.037	0.00	0.205	0.00	1.149	7.55	6.425	37.58	35.934	84.69	200.981	99.77
0.041	0.00	0.227	0.00	1.271	8.56	7.109	40.23	39.764	86.66	222.400	99.88
0.045	0.00	0.251	0.00	1.407	9.64	7.867	42.97	44.001	88.46	246.101	99.96
0.050	0.00	0.278	0.02	1.556	10.80	8.706	45.80	48.690	90.11	272.329	100.00
0.055	0.00	0.308	0.09	1.722	12.05	9.633	48.71	53.879	91.60	301.351	100.00
0.061	0.00	0.341	0.25	1.906	13.40	10.660	51.69	59.621	92.94	333.467	100.00
0.067	0.00	0.377	0.49	2.109	14.83	11.796	54.72	65.975	94.14	369.005	100.00
0.075	0.00	0.417	0.81	2.334	16.37	13.053	57.77	73.006	95.20	408.330	100.00
0.083	0.00	0.462	1.20	2.583	18.02	14.444	60.82	80.787	96.13	451.846	100.00
0.091	0.00	0.511	1.66	2.858	19.77	15.983	63.85	89.396	96.92	500.000	100.00
0.101	0.00	0.565	2.19	3.162	21.63	17.687	66.83	98.924	97.59		

MALVERN INSTRUMENTS

MASTERSIZER 2000

Result Analysis Report

Sample Name:
JW12 - Average

SOP Name:

Measured:
Wednesday, April 05, 2006 2:44:47 PM

Sample Source & type:
Works = Vizon Scitec Inc- Kerrie Serben

Measured by:
Vivian

Analysed:
Wednesday, April 05, 2006 2:44:48 PM

Particle Name:
Soil

Accessory Name:
Hydro 2000S (A)

Analysis model:
General purpose

Sensitivity:
Normal

Particle RI:
1.230

Absorption:
0.5

Size range:
0.020 to 2000.000 um

Obscuration:
14.35 %

Dispersant Name:
Water

Dispersant RI:
1.330

Weighted Residual:
0.649 %

Result Emulation:
Off

Concentration:
0.0074 %Vol

Span :
4.180

Uniformity:
1.61

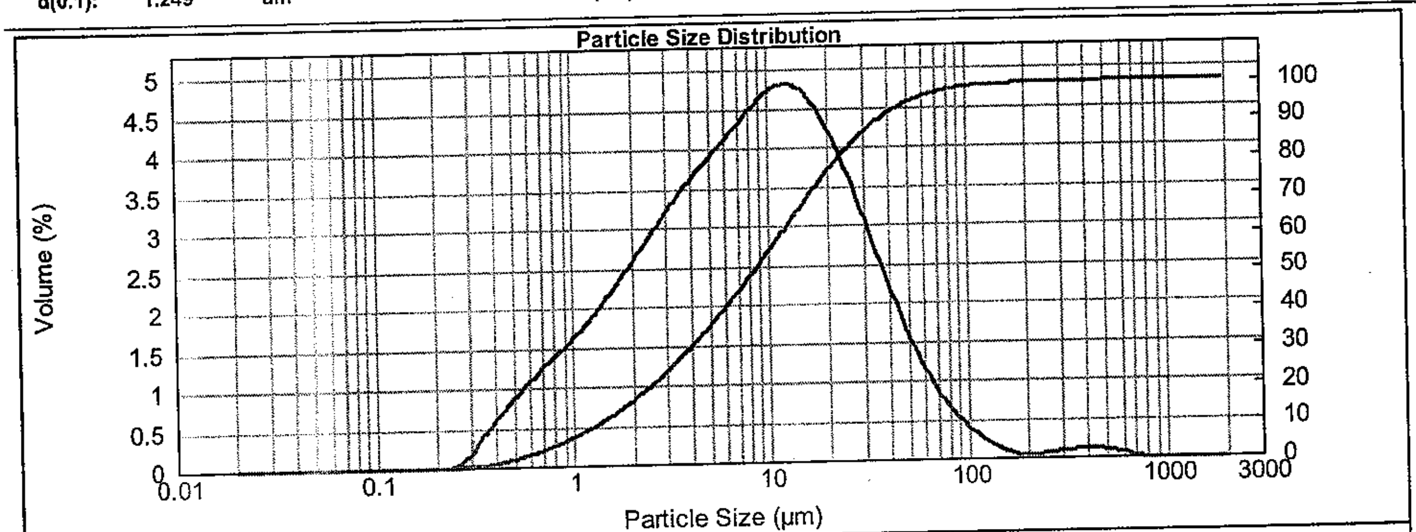
Result units:
Volume

Specific Surface Area:
1.81 m^2/g

Surface Weighted Mean D[3,2]:
3.308 um

Vol. Weighted Mean D[4,3]:
16.799 um

d(0.1): 1.249 um **d(0.5):** 8.261 um **d(0.9):** 35.777 um



—JW12 - Average, Wednesday, April 05, 2006 2:44:47 PM

Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %
0.020	0.00	0.112	0.00	0.626	3.31	3.499	27.70	19.572	76.31	109.466	98.86
0.022	0.00	0.124	0.00	0.692	4.08	3.872	30.01	21.658	79.07	121.132	99.05
0.024	0.00	0.137	0.00	0.766	4.93	4.285	32.41	23.966	81.66	134.041	99.18
0.027	0.00	0.152	0.00	0.848	5.84	4.742	34.90	26.520	84.06	148.326	99.27
0.030	0.00	0.168	0.00	0.938	6.82	5.247	37.47	29.346	86.27	164.133	99.34
0.033	0.00	0.186	0.00	1.038	7.87	5.806	40.12	32.473	88.28	181.625	99.37
0.037	0.00	0.205	0.00	1.149	9.00	6.425	42.85	35.934	90.07	200.981	99.39
0.041	0.00	0.227	0.00	1.271	10.21	7.109	45.67	39.764	91.66	222.400	99.42
0.045	0.00	0.251	0.00	1.407	11.51	7.867	48.57	44.001	93.05	246.101	99.45
0.050	0.00	0.278	0.03	1.556	12.90	8.706	51.56	48.690	94.24	272.329	99.49
0.055	0.00	0.308	0.11	1.722	14.39	9.633	54.62	53.879	95.26	301.351	99.54
0.061	0.00	0.341	0.30	1.906	15.97	10.660	57.75	59.621	96.12	333.467	99.60
0.067	0.00	0.377	0.59	2.109	17.67	11.796	60.93	65.975	96.84	369.005	99.66
0.075	0.00	0.417	0.97	2.334	19.46	13.053	64.11	73.006	97.43	408.330	99.73
0.083	0.00	0.462	1.43	2.583	21.36	14.444	67.28	80.787	97.91	451.846	99.80
0.091	0.00	0.511	1.98	2.858	23.37	15.983	70.39	89.396	98.31	500.000	99.87
0.101	0.00	0.565	2.61	3.162	25.48	17.687	73.41	98.924	98.62		

MALVERN INSTRUMENTS

MASTERSIZER 2000

Result Analysis Report

Sample Name:
JW1 - Average

SOP Name:

Measured:
Wednesday, April 05, 2006 1:49:53 PM

Sample Source & type:
Works = Vizon Scitec Inc- Kerrie Serben

Measured by:
Vivian

Analysed:
Wednesday, April 05, 2006 1:49:54 PM

Particle Name:
Soil

Accessory Name:
Hydro 2000S (A)

Analysis model:
General purpose

Sensitivity:
Normal

Particle RI:
1.230

Absorption:
0.5

Size range:
0.020 to 2000.000 um

Obscuration:
17.50 %

Dispersant Name:
Water

Dispersant RI:
1.330

Weighted Residual:
0.720 %

Result Emulation:
Off

Concentration:
0.0104 %Vol

Span :
4.675

Uniformity:
1.63

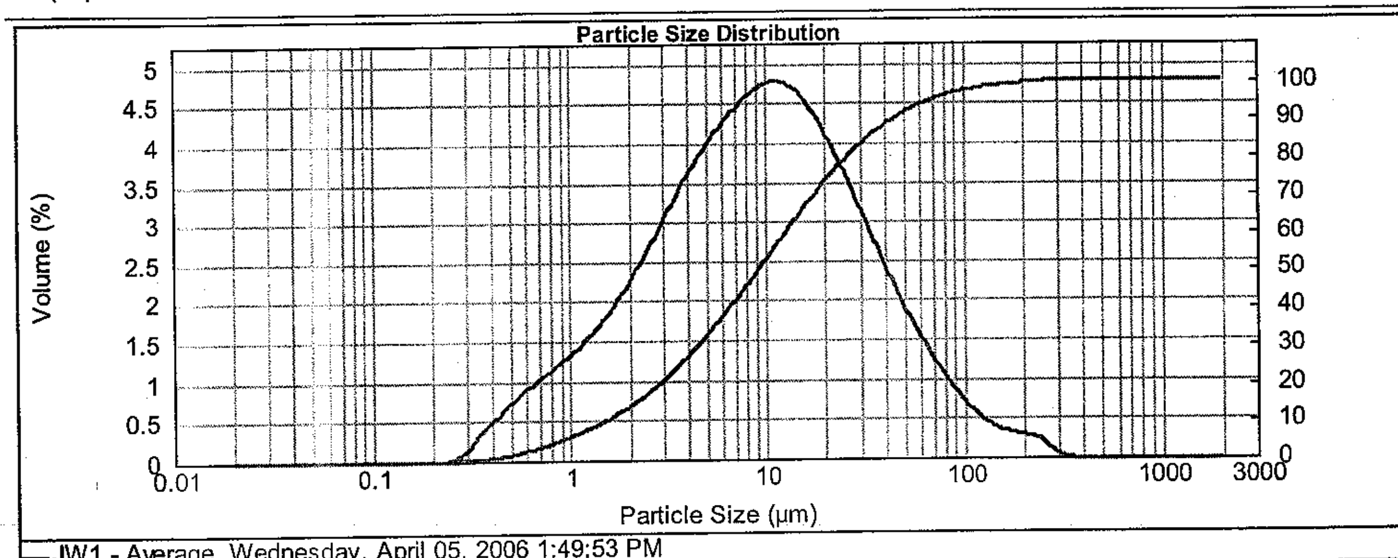
Result units:
Volume

Specific Surface Area:
1.61 m²/g

Surface Weighted Mean D[3,2]:
3.735 um

Vol. Weighted Mean D[4,3]:
18.918 um

d(0.1): **1.469** um **d(0.5):** **9.155** um **d(0.9):** **44.268** um



Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %
0.020	0.00	0.112	0.00	0.626	2.74	3.499	24.10	19.572	72.91	109.466	97.81
0.022	0.00	0.124	0.00	0.692	3.38	3.872	26.37	21.658	75.60	121.132	98.19
0.024	0.00	0.137	0.00	0.766	4.08	4.285	28.77	23.966	78.14	134.041	98.50
0.027	0.00	0.152	0.00	0.848	4.83	4.742	31.30	26.520	80.52	148.326	98.78
0.030	0.00	0.168	0.00	0.938	5.64	5.247	33.93	29.346	82.74	164.133	99.02
0.033	0.00	0.186	0.00	1.038	6.50	5.806	36.67	32.473	84.79	181.625	99.23
0.037	0.00	0.205	0.00	1.149	7.44	6.425	39.49	35.934	86.66	200.981	99.44
0.041	0.00	0.227	0.00	1.271	8.44	7.109	42.41	39.764	88.37	222.400	99.63
0.045	0.00	0.251	0.00	1.407	9.51	7.867	45.40	44.001	89.91	246.101	99.80
0.050	0.00	0.278	0.02	1.556	10.68	8.706	48.46	48.690	91.30	272.329	99.93
0.055	0.00	0.308	0.09	1.722	11.94	9.633	51.57	53.879	92.53	301.351	99.98
0.061	0.00	0.341	0.24	1.906	13.30	10.660	54.72	59.621	93.63	333.467	100.00
0.067	0.00	0.377	0.49	2.109	14.78	11.796	57.88	65.975	94.60	369.005	100.00
0.075	0.00	0.417	0.80	2.334	16.38	13.053	61.03	73.006	95.45	408.330	100.00
0.083	0.00	0.462	1.18	2.583	18.10	14.444	64.13	80.787	96.19	451.846	100.00
0.091	0.00	0.511	1.64	2.858	19.96	15.983	67.16	89.396	96.82	500.000	100.00
0.101	0.00	0.565	2.16	3.162	21.96	17.687	70.10	98.924	97.36		

MASTERSIZER 2000

Result Analysis Report

Sample Name:
JW5 - Average

SOP Name:

Measured:
Wednesday, April 05, 2006 2:22:13 PM

Sample Source & type:
Works = Vizon Scitec Inc- Kerrie Serben

Measured by:
Vivian

Analysed:
Wednesday, April 05, 2006 2:22:15 PM

Particle Name:
Soil

Accessory Name:
Hydro 2000S (A)

Analysis model:
General purpose

Sensitivity:
Normal

Particle RI:
1.230

Absorption:
0.5

Size range:
0.020 to 2000.000 um

Obscuration:
16.51 %

Dispersant Name:
Water

Dispersant RI:
1.330

Weighted Residual:
0.718 %

Result Emulation:
Off

Concentration:
0.0095 %Vol

Span :
6.405

Uniformity:
2.59

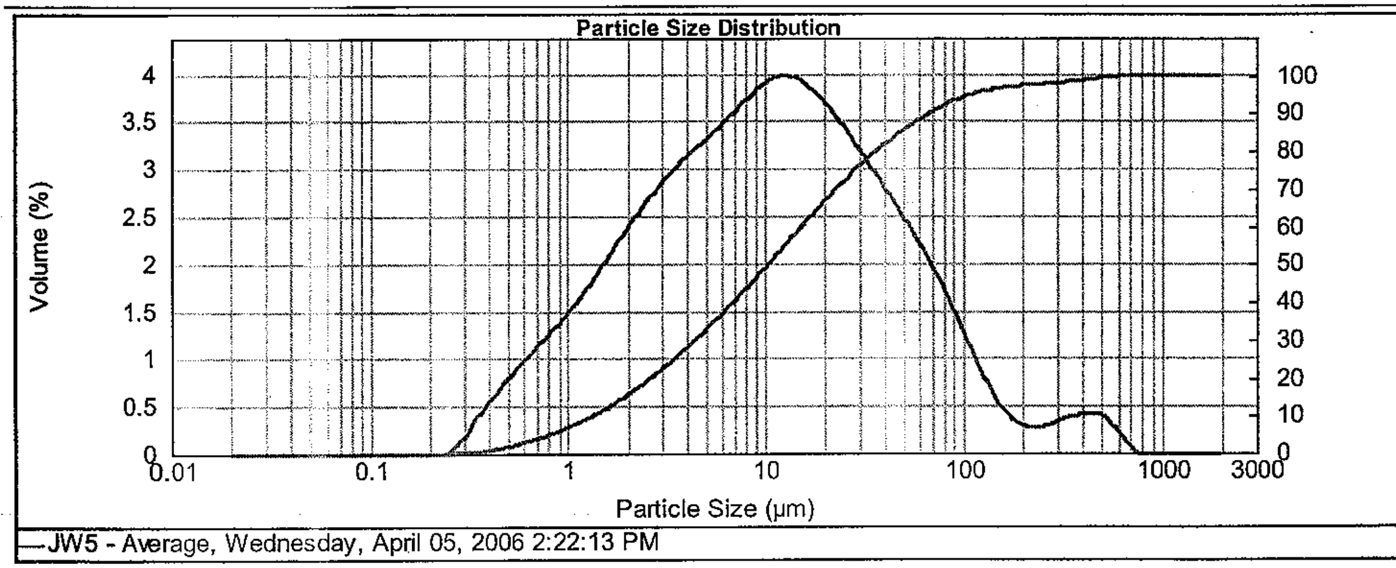
Result units:
Volume

Specific Surface Area:
1.65 m²/g

Surface Weighted Mean D[3,2]:
3.634 um

Vol. Weighted Mean D[4,3]:
30.894 um

d(0.1): 1.341 um **d(0.5):** 10.372 um **d(0.9):** 67.775 um



Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %
0.020	0.00	0.112	0.00	0.626	3.08	3.499	25.33	19.572	66.23	109.466	94.98
0.022	0.00	0.124	0.00	0.692	3.78	3.872	27.35	21.658	68.65	121.132	95.64
0.024	0.00	0.137	0.00	0.766	4.54	4.285	29.43	23.966	71.01	134.041	96.18
0.027	0.00	0.152	0.00	0.848	5.37	4.742	31.57	26.520	73.28	148.326	96.60
0.030	0.00	0.168	0.00	0.938	6.26	5.247	33.76	29.346	75.47	164.133	96.92
0.033	0.00	0.186	0.00	1.038	7.23	5.806	36.00	32.473	77.57	181.625	97.17
0.037	0.00	0.205	0.00	1.149	8.26	6.425	38.31	35.934	79.57	200.981	97.38
0.041	0.00	0.227	0.00	1.271	9.38	7.109	40.67	39.764	81.49	222.400	97.56
0.045	0.00	0.251	0.00	1.407	10.58	7.867	43.09	44.001	83.31	246.101	97.74
0.050	0.00	0.278	0.03	1.556	11.87	8.706	45.57	48.690	85.04	272.329	97.93
0.055	0.00	0.308	0.12	1.722	13.25	9.633	48.11	53.879	86.67	301.351	98.14
0.061	0.00	0.341	0.30	1.906	14.72	10.660	50.70	59.621	88.20	333.467	98.38
0.067	0.00	0.377	0.58	2.109	16.29	11.796	53.32	65.975	89.64	369.005	98.64
0.075	0.00	0.417	0.93	2.334	17.94	13.053	55.95	73.006	90.96	408.330	98.91
0.083	0.00	0.462	1.36	2.583	19.68	14.444	58.58	80.787	92.16	451.846	99.17
0.091	0.00	0.511	1.86	2.858	21.49	15.983	61.18	89.396	93.24	500.000	99.44
0.101	0.00	0.565	2.44	3.162	23.38	17.687	63.73	98.924	94.18		

ANALYSIS REPORT

DATE: 11-Apr-06
PROJECT No: 2-11-0965b

APPROVED BY: H.P. Meier

CLIENT: Jacques Whitford

CONTACT: Janine Beckett

VIZON SCITEC
3650 Wesbrook Mall
Vancouver, B.C.
Canada
TEL: (604) 224-4331
FAX: (604) 224-0540

COMMENTS: Total PCB's in soils and sediments.

METHODS: Soxhlet extraction with acetone/hexane 50:50. Concentration, solvent exchange to hexane. Elemental sulfur removal using mercury and clean up on Florisil. Analysis by GC/ECD.

Sample	Date	Vizon #	Total PCB's as Aroclor 1254 ug/g drywt.
JW-1	Feb. 23/06	060223J-01	<0.03
JW-2	Feb. 23/06	060223J-02	<0.03
JW-3 (1)	Feb. 23/06	060223J-03	<0.03
JW-3 (2)	Feb. 23/06	060223J-03	<0.03
JW-4	Feb. 23/06	060223J-04	<0.03
JW-5	Feb. 23/06	060223J-05	<0.03
JW-6	Feb. 23/06	060223J-06	<0.03
JW-7	Feb. 23/06	060223J-07	<0.03
JW-8	Mar. 07/06	060307K-11	<0.03
JW-11 (1)	Mar. 07/06	060307K-12	0.03
JW-11 (2)	Mar. 07/06	060307K-12	0.03
JW-12	Feb. 23/06	060223J-10	<0.03
Reference Mat.			
HS-2			113.2 ug/kg
Target			111.8+/-2.5 ug/kg

Samples were quantified against an Aroclor 1254 standard since the PCB pattern was closest to this particular Aroclor.

VIZON SCITEC INC.

SOLID SAMPLES

DIOXIN/FURAN ANALYSIS

AXYS METHOD: MLA-017

Contract: 2733
Data Package Identification: DPWG18861
Analysis WG18545

Prepared for:
Kerri Serben
3650 Westbrook Mall
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Prepared by:
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P.O. Box 2219, 2045 Mills Rd West
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CANADA

Contact: Kalai Pillay
Project Manager

6 April 2006

VIZON SCITEC INC.
SOLID SAMPLES

DIOXIN AND FURAN ANALYSIS
AXYS METHOD: MLA-017
2733: L8721-1 to -10

06 April 2006

NARRATIVE

This narrative describes the analysis of ten solid samples for the determination of polychlorinated dioxins and furans using High Resolution Gas Chromatography / High Resolution Mass Spectrometry (HRGC / HRMS).

SAMPLE RECEIPT AND STORAGE

Samples were received on 8th March 2006. Details of sample conditions upon receipt are provided on the Sample Receiving Record form included in this Data Package. The samples were stored at -20°C prior to extraction and analysis.

SAMPLE PREPARATION

Samples were prepared prior to analysis, as detailed on the Sample Preparation Record forms included in this data package

ANALYSIS

Analysis procedures were in general accordance with **USEPA Method 1613, Revision B** as documented in AXYS document MLA-017 Rev 09. A list of modifications of USEPA method 1613B is provided following this narrative.

Samples and QC samples (a procedural blank, a known sample called an Ongoing Precision and Recovery (OPR), and a duplicate) were analyzed in analysis batch DXWG18545. The composition of the batch is shown on the Cover Page and the Batch List forms included in this Data Package.

An accurately weighed aliquot of each sample was spiked with ^{13}C-labeled Dioxin/Furan surrogates and soxhlet extracted with 80:20 toluene/acetone. The sample extracts were spiked with ^{37}Cl-labeled 2,3,7,8-TCDD cleanup standard prior to chromatographic column cleanup procedures. Cleanup procedures were performed on Fluid Management Systems, Inc *'Power-Prep™ System'* using standard chromatographic clean up columns. All final extracts were reduced in volume and spiked with ^{13}C-labeled recovery (internal) standards prior to instrumental analysis. Ten grams of clean sand (L6796-4 REF) was used as the matrix for the Lab Blank and OPR samples.

CALCULATION

Target analyte concentrations were determined by isotope dilution or internal standard quantification procedures using Micromass OPUSQuan software. Formulae used in the conversion of the raw chromatograms to concentration are provided in the method summary document.

Sample specific detection limits (SDL) were determined from the analysis data following the same procedures used to convert target peak responses to concentrations. In cases when the software selects unrepresentative area for detection limit calculations, the data interpretation chemist or the QA chemists made corrections; these corrections are hand noted on the quantification report pages.

Toxic Equivalency (TEQ) calculations were performed using WHO 1998 toxic equivalency factors. Target analytes that did not meet the method ion abundance ration criteria, flagged with a 'NDR', were not included in the TEQ calculations.

REPORTING CONVENTIONS

The AXYS contract number assigned for internal tracking was 2733. Samples were assigned a unique laboratory identifier L8721-XX, where X = numeral; all data reports reference this unique AXYS ID plus the client sample identifier. To assist with locating data a table correlating AXYS ID with the client sample number is included in this Data Package.

The laboratory qualifiers used are as follows:

NDR	=	identifies a target that could not be confirmed by virtue of not satisfying all method required criteria, the reported value may be interpreted as an estimated maximum analyte concentration
ND	=	identifies a compound that was not detected
*	=	identifies a compound that has been confirmed on another column

Final results are reported in concentration units of picograms per gram (pg/g) on a dry weight basis.

QA/QC NOTES

Samples and QC samples were analyzed in a single analysis batch carried intact through the entire analytical process. The sample data were reviewed and evaluated in relation to the batch QC samples.

- Sample analyte concentrations are not blank corrected and should be compared to the blank levels for significance.
- All linearity, calibration verification, OPR and labeled compound recovery specifications were met.

ANALYTICAL DISCUSSION

The analyst noted on the laboratory extraction log that a portion of the extract of the samples, JW11 & JW 12 (AXYS IDs: L8721-9 & -10) was lost during transfer. Given that all the QC parameters met the method and contract criteria, which indicated that the analysis was in a status of control, the data are not considered impacted by this variance.

Data Package

This data package is assigned a unique identifier DPWG18861, shown on the front page of this Data Package. This data package is provided in CD-ROM format. Included in this data package is the following documentation:

Sample Cover Page and Correlation Table
Sample Receiving Documentation
Sample Preparation Records
Laboratory extraction logs for each sample
Sample data reports (in order of AXYS Sample ID)
Laboratory QC data reports
Instrumental QC data reports (organized by analysis date)
Sample raw data (in order of AXYS Sample ID)
Laboratory QC raw data (Lab Blank and OPR)
Instrumental QC raw data (organized by analysis date)

I certify that this data package is in compliance with the terms and conditions of the contract, both technically and for completeness, except for the conditions detailed above. In addition, I certify, that to the best of my knowledge and belief, the data as reported are true and accurate. The following signature, on behalf of AXYS Analytical Services Ltd, authorizes the release of the data contained in this data package.

Signed: Kalai Pillay, B.Sc.; Project Manager

6 April 2006

Date Signed

ANALYSIS OF POLYCHLORINATED DIOXINS AND FURANS BY EPA METHOD 1613B

Samples are spiked with a suite of isotopically labelled surrogate standards prior to analysis, solvent extracted, and cleaned up through a series of chromatographic columns that may include gel permeation, silica, Florisil, carbon/Celite, and alumina columns. The extract is concentrated and spiked with an isotopically labelled recovery (internal) standard. Analysis is performed using a high-resolution mass spectrometer coupled to a high-resolution gas chromatograph equipped with a DB-5 capillary chromatography column (60 m, 0.25 mm i.d., 0.1 µm film thickness). A second column, DB-225 (30 m, 0.25 mm i.d., 0.15 µm film thickness), is used for confirmation of 2,3,7,8-TCDF identification. All procedures are carried out according to protocols as described in EPA Method 1613B, with the significant modifications summarized below. The data are evaluated against QC criteria presented in Tables 1 and 2.

Method Modifications:

Section 2.1.2

Non-aqueous liquid from multiphase sample is combined with the solid phase and extracted by Dean Stark soxhlet.

Section 7.2.1

Anhydrous sodium sulphate (Na_2SO_4) is purchased in powder form (not granular) and is baked overnight prior to use. There is no solvent rinse with dichloromethane.

Section 7.10

The concentration of the labelled compound spiking solution is 100 ng/mL (except for OCDD which is 200 ng/mL) and the sample spiking volume is 20 µL. The resulting concentrations in the final extracts are as specified in the method.

Section 7.11

The concentration of the clean-up standard spiking solution is 10 ng/mL and the sample spiking volume is 20 µL. The resulting concentration in the final extracts are as specified in the method.

Sections 7.13, 14.0, 15.0

An additional lower level calibration solution, 0.2 times the concentration of CS1, is prepared and included in the initial calibration series. Initial calibration is based on a six-point series.

Section 7.14

The concentration of the PAR spiking solutions is 0.2/1.0/2.0 ng/mL for tetra/penta, hexa, hepta, hexa/octas respectively and the spiking volume is 1 mL. The resulting final concentration in the extracts are as specified in the method.

Section 9.3.3, Table 7

Acceptance criteria for the percent recovery of surrogate standards in samples have been revised. Criteria that are higher than 130% have been lowered to 130%, as presented in Table 1.

Section 11.5

Aqueous samples containing >1% visible solids are prepared and extracted using the same procedure as samples containing ≤1% visible solids. This involves extracting the solids by soxhlet and the filtrate by separatory funnel extraction and combining the extract from the two phases.

Section 12.0

Samples with sufficiently low moisture content may be mixed with Na_2SO_4 and extracted using regular soxhlet apparatus in 80:20 toluene:acetone.

Section 12.4

The equilibration time for the sodium sulphate drying step is that required to produce a dry, free flowing powder (minimum thirty minutes). This may be less than the 12-hour minimum specified in EPA 1613B.

Section 12.5.1

Samples are spiked with cleanup standard right after extraction and before reduction; not spiked into the separatory funnels containing the extracts prior to the acid/base wash.

Section 12.6.1.1

Rotary evaporator baths are maintained at 35°C. Mimic proofs are collected instead of collecting proofs each day and archiving.

Section 13.0

Extracts may be cleaned up on silica, alumina and carbon chromatographic columns using a Fluid Management System (FMS) automated cleanup system.

Section 13.7

Gravimetric lipid analysis is carried out on two subsamples of the extract.

Sections 14.0, 15.0, 16.0, Table 8, Table 9

M/Z channels 354/356 and 366/368 are used to confirm and quantify the native and surrogate penta-substituted dioxins, respectively; this change from the method's specification is made in the instrument method in order to avoid a persistent interference in the 356/358 and 368/370 M/Z channels. The theoretical ratio for the P5CDD M/M+2 ions is 0.61; therefore, the acceptance range is 0.52 - 0.70.

Section 15.3.5, Table 6

Acceptance criteria for calibration verification concentrations have been modified, as presented in Table 1, so that ranges do not exceed 70-130% of the test concentration.

Section 15.5.3 Table 6

Acceptance specifications for OPR concentrations have been modified, as presented in Table 1, so that ranges do not exceed 70-130%.

Section 17.0

$Conc_i$ - the concentrations of target analytes, and the labelled compound concentrations and recoveries, are calculated using the equations below. These procedures are equivalent to those described in the method but are more direct.

$$Conc_i = \frac{A_i}{A_{si}} \times \frac{M_{si}}{RRF_{i,si}} \times \frac{1}{M_x}$$

where A_i = summed areas of the primary and secondary m/z's for the analyte peak of interest (compound i)

A_{si} = summed areas of the primary and secondary m/z's for the labelled surrogate peak used to quantify i)

M_x = mass of sample taken for analysis

M_{si} = mass of labelled surrogate (compound si) added to sample as calculated by the concentration of standard spiked (pg/mL) multiplied by the volume spiked (mL)

$RRF_{i,si}$ = mean relative response factor of i to si from the five-point calibration range and defined individually as:

$$\frac{A_i}{A_{si}} \times \frac{M_{si}}{M_i}$$

Calculation of Surrogate Standard Concentrations and Percent Recoveries:

Concentrations of surrogate standards are calculated using the following equation:

$$Conc_{si} = \frac{A_{si}}{A_{rs}} \times \frac{M_{rs}}{RRF_{si,rs}}$$

and, the percent recoveries of the surrogate standards are calculated using the following equation:

$$\%Recovery = \frac{A_{si}}{A_{rs}} \times \frac{M_{rs}}{RRF_{si,rs}} \times \frac{1}{M_{si}} \times 100$$

where A_{rs} and A_{si} are the summed peak areas (from the primary and secondary m/z channels) of recovery standard and labelled surrogate added to the sample;
M_{rs} and M_{si} are the masses of recovery standard and labelled surrogate added to the sample, and;
$RRF_{si,rs}$ is the mean relative response factor of the labelled surrogate to the recovery standard as determined by the five-point calibration range and defined individually as:

$$\frac{A_{si}}{A_{rs}} \times \frac{M_{rs}}{M_{si}}$$

Section 17.5

Extracts may be diluted with solvent and re-analyzed by GC/MS isotope-dilution to bring the instrumental response to within the linear range of the instrument. For very high-level samples where a smaller sample aliquot may not be representative, extracts may be diluted and re-spiked with labelled quantification standards and re-analyzed by GC/MS to bring the instrumental response analytes within range. Final results may be recovery corrected using the mean recovery of labelled quantification standards.

Table 1. QC Acceptance Criteria for PCDD/F in CAL/VER, IPR, OPR and Test Samples[1]

	Test Conc ng/mL	IPR[2]		OPR[3] (%)	I-CAL %	CAL/VER[4] (%)	Labelled Cmpd %Rec. in Sample	
		RSD (%)	X(%)				Warning Limit	Control Limit
Native Compound								
2,3,7,8-TCDD	10	28	83-129	70-130	20	78-129	-	-
2,3,7,8-TCDF	10	20	87-137	75-130	20	84-120	-	-
1,2,3,7,8-PeCDD	50	15	76-132	70-130	20	78-130	-	-
1,2,3,7,8-PeCDF	50	15	86-124	80-130	20	82-120	-	-
2,3,4,7,8-PeCDF	50	17	72-150	70-130	20	82-122	-	-
1,2,3,4,7,8-HxCDD	50	19	78-152	70-130	20	78-128	-	-
1,2,3,6,7,8-HxCDD	50	15	84-124	76-130	20	78-128	-	-
1,2,3,7,8,9-HXCDD	50	22	74-142	70-130	35	82-122	-	-
1,2,3,4,7,8-HxCDF	50	17	82-108	72-130	20	90-112	-	-
1,2,3,6,7,8-HxCDF	50	13	92-120	84-130	20	88-114	-	-
1,2,3,7,8,9-HxCDF	50	13	84-122	78-130	20	90-112	-	-
2,3,4,6,7,8-HxCDF	50	15	74-158	70-130	20	88-114	-	-
1,2,3,4,6,7,8-HpCDD	50	15	76-130	70-130	20	86-116	-	-
1,2,3,4,6,7,8-HpCDF	50	13	90-112	82-122	20	90-110	-	-
1,2,3,4,7,8,9-HpCDF	50	16	86-126	78-130	20	86-116	-	-
OCDD	100	19	86-126	78-130	20	79-126	-	-
OCDF	100	27	74-146	70-130	35	70-130	-	-
Surrogate Standards								
$^{13}C_{12}$-2,3,7,8-TCDD	100	37	28-134	25-130	35	82-121	40-120	25-130
$^{13}C_{12}$-2,3,7,8-TCDF	100	35	31-113	25-130	35	71-130	40-120	24-130
$^{13}C_{12}$-1,2,3,7,8-PeCDD	100	39	27-184	25-150	35	70-130	40-120	25-130
$^{13}C_{12}$-1,2,3,7,8-PeCDF	100	34	27-156	25-130	35	76-130	40-120	24-130
$^{13}C_{12}$-2,3,4,7,8-PeCDF	100	38	16-279	25-130	35	77-130	40-120	21-130
$^{13}C_{12}$-1,2,3,4,7,8-HxCDD	100	41	29-147	25-130	35	85-117	40-120	32-130
$^{13}C_{12}$-1,2,3,6,7,8-HxCDD	100	38	34-122	25-130	35	85-118	40-120	28-130
$^{13}C_{12}$-1,2,3,4,7,8-HxCDF	100	43	27-152	25-130	35	76-130	40-120	26-130
$^{13}C_{12}$-1,2,3,6,7,8-HxCDF	100	35	30-122	25-130	35	70-130	40-120	26-123
$^{13}C_{12}$-1,2,3,7,8,9-HxCDF	100	40	24-157	25-130	35	74-130	40-120	29-130
$^{13}C_{12}$-2,3,4,6,7,8-HxCDF	100	37	29-136	25-130	35	73-130	40-120	28-130
$^{13}C_{12}$-1,2,3,4,6,7,8-HpCDD	100	35	34-129	25-130	35	72-130	40-120	23-130
$^{13}C_{12}$-1,2,3,4,6,7,8-HpCDF	100	41	32-110	25-130	35	78-129	40-120	28-130
$^{13}C_{12}$-1,2,3,4,7,8,9-HpCDF	100	40	28-141	25-130	35	77-129	40-120	26-130
$^{13}C_{12}$-OCDD	200	48	20-138	25-130	35	70-130	25-120	17-130
Cleanup Standard								
$^{37}Cl_4$-2,3,7,8-TCDD	10	36	39-154	31-130	35	79-127	40-120	35-130

[1] QC acceptance criteria for IPR, OPR, and samples based on a 20 µL extract final volume
[2] IPR: Initial Precision and Recovery demonstration
[3] OPR: Ongoing Precision and Recovery test run with every batch of samples.
[4] CAL VER: Calibration Verification test run at least every 12 hours

Table 2. QC Specifications for QC Samples, Instrumental Analysis, and Analyte Quantification

QC Parameter	Specification
Analysis Duplicate	Must agree to within ±20% of the mean (applicable to concentrations >10 times the DL)[1]
Procedural Blank	**Blood:** TCDD/F <0.2 pg/sample, PeCDD/F <0.5 pg/sample, HxCDD/F and HpCDD/F <1.0 pg/ sample, OCDD/F<5 pg/sample **Other Matrices:** TCDD/F <0.5 pg/sample, PeCDD/F, HxCDD/F, HpCDD/F <1.0 pg/sample, OCDD/F <5 pg/sample Higher levels acceptable where all sample concentrations a >10X the blank
Detection Limit	SDL Requirements **Blood:** Tetra-penta-CDD/F 0.2 pg/sample Hexa-octa-CDD/F 0.5 pg/sample **Other Matrices:** 1 pg/sample
Instrument Carryover: **Toluene Blank** **Samples**	A. 1st toluene blank following CAL-VER must have <0.6 pg TCDD and <19 pg OCDD B. 2nd toluene blank following CAL-VER must have <0.2 pg TCDD and <3 pg OCDD <10% contribution from preceding sample (based on observed instrument carryover rate)
Analyte/Surrogate Ratios	Response must be within the calibrated range of the instrument. Coders may use data from more than one chromatogram to get the responses in the calibrated range.
Ion Ratios	Must be within ±15% of theoretical
Sensitivity	S:N≥10:1 for all compounds for 0.1 pg/µL (CS-0.2), plus For bloods: S:N≥3:1 for 0.025 pg/µL 2,3,7,8-T4CDD

[1] Duplicate criterion is a guideline; final assessment depends upon sample characteristics, overall batch QC and on-going lab performance.

VIZON SCITEC INC.

COVER PAGE AND CORRELATION TABLE

DIOXIN/FURAN ANALYSIS

Lab Name: AXYS Analytical Services Ltd.	**Contract No: 2733**
Project No: N/A	**AXYS Method: MLA-017**
Data Package Identification: DPWG18861	**Program: Solid Samples**
Client Sample No.	**Lab Sample ID**
LAB BLANK	WG18545-101
OPR	WG18545-102
JW1	L8721-1
JW2	L8721-2
JW3	L8721-3
JW4	L8721-4 WG18545-103 Duplicate
JW5	L8721-5
JW6	L8721-6
JW7	L8721-7
JW8	L8721-8
JW11	L8721-9
JW12	L8721-10

Dioxins and Furans Analysis of Marine Sediment

CLIENT ID	JW1	JW12	JW2	JW3	JW4	JW5
AXYS ID	L8721-1	L8721-10	L8721-2	L8721-3	L8721-4 (A)	L8721-5
WORKGROUP	WG18545	WG18545	WG18545	WG18545	WG18545	WG18545
Sample Size	10.7 g (dry)	10.4 g (dry)	10.7 g (dry)	10.4 g (dry)	10.9 g (dry)	10.9 g (dry)
UNITS	pg/g (dry weight basis)	pg/g (dry weight basis)	pg/g (dry weight basis)	pg/g (dry weight basis)	pg/g (dry weight basis)	pg/g (dry weight basis)
2,3,7,8-TCDD	0.15	NDR 0.17	0.17	0.15	0.14	0.21
1,2,3,7,8-PeCDD	1.32	1.25	1.7	1.28	1.03	1.63
1,2,3,4,7,8-HxCDD	< 0.08	0.19	< 0.16	0.2	< 0.12	< 0.12
1,2,3,6,7,8-HxCDD	11.5	11.8	14.6	12.3	9.27	13.1
1,2,3,7,8,9-HxCDD	5.25	5.28	6.46	5.44	4.37	5.98
1,2,3,4,6,7,8-HpCDD	14.8	12.9	15.4	14.2	12	14.2
OCDD	63.3	45.5	51.8	53.8	48.9	43
2,3,7,8-TCDF	0.38	0.3	0.35	0.32	0.32	0.37
1,2,3,7,8-PeCDF	0.09	NDR 0.08	0.08	0.08	NDR 0.06	NDR 0.12
2,3,4,7,8-PeCDF	0.14	NDR 0.11	0.13	NDR 0.18	NDR 0.13	0.15
1,2,3,4,7,8-HxCDF	0.18	NDR 0.13	0.13	NDR 0.15	0.19	NDR 0.15
1,2,3,6,7,8-HxCDF	0.14	NDR 0.08	NDR 0.08	0.09	0.11	NDR 0.09
1,2,3,7,8,9-HxCDF	0.04	< 0.02	< 0.03	< 0.03	< 0.03	< 0.03
2,3,4,6,7,8-HxCDF	0.1	NDR 0.11	NDR 0.11	0.12	0.08	0.1
1,2,3,4,6,7,8-HpCDF	1.54	1.22	1.35	1.35	1.37	1.37
1,2,3,4,7,8,9-HpCDF	0.14	NDR 0.09	0.15	0.14	NDR 0.11	0.1
OCDF	3.87	2.49	2.43	2.76	2.92	2.57
Total Tetra-Dioxins	2.06	1.91	2.19	1.78	1.33	2.28
Total Penta-Dioxins	9.52	10.6	13.2	10.6	8.46	13.3
Total Hexa-Dioxins	82.9	85.6	103	87.7	68.7	95.3
Total Hepta-Dioxins	38.3	29.5	35.1	34.5	30	33.6
Total Tetra-Furans	2.72	2.82	2.98	2.82	2.52	2.58
Total Penta-Furans	1.79	1.3	1.71	1.61	1.36	1.58
Total Hexa-Furans	2.05	0.54	1.7	1.79	2.01	1.08
Total Hepta-Furans	4.59	3.13	3.69	3.59	3.68	3.62
% Moisture	52.6	55.1	53.4	53.8	49.7	50.9
2,3,7,8-TCDF (C)	NDR 0.17	0.14	0.15	0.2	0.14	0.12
TEQ (WHO 1998) ND=0	3.44	3.14	4.25	3.43	2.72	4.01
TEQ (WHO 1998) ND=1/2DL	3.44	3.16	4.26	3.44	2.74	4.02

Dioxins and Furans Analysis of Marine Sediment

JW6	JW7	JW8	JW11	Lab Blank	Spiked Matrix	JW4 (Duplicate)
L8721-6	L8721-7	L8721-8	L8721-9	WG18545-101	WG18545-102	WG18545-103 (DUP L8721-4)
WG18545	WG18545	WG18545	WG18545	WG18545	WG18545	WG18545
10.9 g (dry)	10.6 g (dry)	11.3 g (dry)	10.7 g (dry)	10.0 g		10.2 g (dry)
pg/g (dry weight basis)	pg/g (dry weight basis)	pg/g (dry weight basis)	pg/g (dry weight basis)	pg/g	% Recov	pg/g (dry weight basis)
NDR 0.13	0.17	0.2	NDR 0.12	NDR 0.03	95.5	NDR 0.11
0.95	1.4	1.73	1.14	0.06	95.7	0.95
0.13	0.19	0.23	0.17	0.07	94.4	< 0.15
8.05	12.7	15	10.7	NDR 0.05	96.3	9.14
3.82	5.42	6.7	4.76	NDR 0.10	100	4.33
10.1	16.5	18.1	13.3	NDR 0.19	92.5	12.5
37.2	82.4	60.7	49.7	0.51	96.8	51.6
0.25	0.32	0.3	0.29	0.03	98.6	0.3
NDR 0.06	NDR 0.08	NDR 0.08	0.07	0.05	96.1	0.1
0.12	0.15	NDR 0.11	0.12	0.07	95.3	0.09
NDR 0.12	NDR 0.17	NDR 0.11	0.1	NDR 0.05	94.4	NDR 0.06
0.09	NDR 0.10	0.1	NDR 0.09	0.06	96.7	0.11
NDR 0.02	NDR 0.02	< 0.02	< 0.02	NDR 0.08	97.4	< 0.02
NDR 0.08	0.09	0.1	NDR 0.09	NDR 0.06	95.2	0.1
0.98	1.33	1.32	1.18	0.1	99.1	1.41
NDR 0.09	NDR 0.08	NDR 0.10	0.08	NDR 0.05	94.5	0.11
1.81	2.77	2.8	2.5	NDR 0.16	85.6	3.13
0.53	1.69	2.18	1.11	< 0.02		1.17
8.23	12	14.3	8.88	0.06		8.29
58.7	87.1	111	75.8	0.07		67
23.3	47.6	45.6	33.2	0.11		30.6
1.87	2.56	2.29	2.4	0.03		2.3
1.27	1.28	0.72	1.21	0.18		1.11
1.44	1.51	1.92	1.75	0.06		1.62
2.64	3.8	3.59	3.35	0.1		3.89
51.6	55	52.9	53.5			52.5
NDR 0.10	NDR 0.11	0.11	NDR 0.13	0.02		0.11
2.33	3.67	4.35	2.93	0.114		2.52
2.35	3.68	4.36	2.94	0.129		2.54

Dioxins and Furans Analysis in Marine Sediment

See below for definitions of possible flags and labels in the database (sheet tab 'GenericEDD')

NDR	=	peak detected but did not meet quantification criteria number following this flag represents an unconfirmed concentration
<	=	less than the detection limit number following this symbol represents the detection limit For homologue totals sums, please see the individual congener data for the detection limit.
OLR	=	exceeds calibrated linear range, see dilution data

AUTOFAX
COVER SHEET

CANTEST
A Member of the CANAM Group

CanTest Ltd.

Professional Analytical Services

4606 Canada Way
Burnaby, BC
V5G 1K5

Fax: 604 731 2386

Tel: 604 734 7276

1 800 665 8566

Date: April 18, 2006
To: Vizon SciTec Inc.
Att'n: K. Serben
From: LINKS Automatic Fax
Subject: Analytical results for Group# 70329082

MESSAGE:

The analytical results on these pages are being sent to you via the CANTEST Laboratory Information News and Knowledge System (LINKS) "AutoFax" service. This transmission includes data submitted under the following project information:

CANTEST Group# 70329082
Project Name: JW
Project Number: 2-11-0965B
Submission Date: March 28, 2006
Matrix: Soil

This is a final report. A signed report and invoice will be sent by courier or mail.

Thank you for considering CANTEST for your analytical needs. Please feel free to contact a Technical Service Representative at (604) 734-7276 (1-800-665-8566) should you have any questions about the LINKS "AutoFax" or any other CANTEST services.

REPORTED TO: Vizon SciTec Inc.

REPORT DATE: April 18, 2006

GROUP NUMBER: 70329082

CANTEST

Conventional Parameters in Soil

CLIENT SAMPLE IDENTIFICATION:	SAMPLE DATE	CANTEST ID	Moisture
JW1 060307K-01	Mar 7/06	603290296	50.6
JW2 060307K-02	Mar 7/06	603290297	44.0
JW3 060307K-03	Mar 7/06	603290298	49.3
JW4 060307K-04	Mar 7/06	603290299	48.4
JW5 060307K-05	Mar 7/06	603290300	54.9
JW6 060307K-06	Mar 7/06	603290301	51.7
JW7 060307K-07	Mar 7/06	603290302	53.4
JW9 060307K-08	Mar 7/06	603290303	30.9
JW10 060307K-09	Mar 7/06	603290304	46.3
JW12 060307K-10	Mar 7/06	603290305	43.6
DETECTION LIMIT			0.1
UNITS			%

% = percent

REPORTED TO: Vizon SciTec Inc.

REPORT DATE: April 18, 2006

GROUP NUMBER: 70329082

CANTEST

Simultaneously Extracted Metals-reported in micromoles- in Soil

CLIENT SAMPLE IDENTIFICATION:		JW1 060307K-01	JW2 060307K-02	JW3 060307K-03	JW4 060307K-04	
DATE SAMPLED:		Mar 7/06	Mar 7/06	Mar 7/06	Mar 7/06	
CANTEST ID:		603290296	603290297	603290298	603290299	DETECTION LIMIT
Acid Volatile Sulphide		1.3	0.4	0.3	0.3	0.2
Cadmium	Cd	<	<	<	<	0.0009
Copper	Cu	0.10	<	<	<	0.006
Lead	Pb	<	<	<	<	0.005
Mercury	Hg	<	<	<	<	0.000005
Nickel	Ni	0.045	0.010	0.010	0.012	0.009
Zinc	Zn	0.21	0.045	0.049	0.049	0.006

Results expressed as micromoles per gram (dry wt.) (umoles/gram)
< = Less than detection limit

REPORTED TO: Vizon SciTec Inc.

REPORT DATE: April 18, 2006

GROUP NUMBER: 70329082

CANTEST

Simultaneously Extracted Metals-reported in micromoles- in Soil

CLIENT SAMPLE IDENTIFICATION:		JW5 060307K-05	JW6 060307K-06	JW7 060307K-07	JW9 060307K-08	
DATE SAMPLED:		Mar 7/06	Mar 7/06	Mar 7/06	Mar 7/06	
CANTEST ID:		603290300	603290301	603290302	603290303	DETECTION LIMIT
Acid Volatile Sulphide		1.8	0.7	0.4	<	0.2
Cadmium	Cd	<	<	<	<	0.0009
Copper	Cu	<	<	<	<	0.006
Lead	Pb	<	<	0.005	<	0.005
Mercury	Hg	0.000009	<	<	<	0.000005
Nickel	Ni	0.014	<	0.010	0.024	0.009
Zinc	Zn	0.050	0.030	0.078	0.091	0.006

Results expressed as micromoles per gram (dry wt.) (umoles/gram)
< = Less than detection limit

REPORTED TO: Vizon SciTec Inc.

REPORT DATE: April 18, 2006

GROUP NUMBER: 70329082

CANTEST

Simultaneously Extracted Metals-reported in micromoles- in Soil

CLIENT SAMPLE IDENTIFICATION:		JW10 060307K-09	JW12 060307K-10	
DATE SAMPLED:		Mar 7/06	Mar 7/06	
CANTEST ID:		603290304	603290305	DETECTION LIMIT
Acid Volatile Sulphide		0.7	0.9	0.2
Cadmium	Cd	<	<	0.0009
Copper	Cu	0.009	<	0.006
Lead	Pb	<	<	0.005
Mercury	Hg	<	<	0.000005
Nickel	Ni	0.029	0.020	0.009
Zinc	Zn	0.11	0.092	0.006

Results expressed as micromoles per gram (dry wt.) (umoles/gram)
< = Less than detection limit

Analysis Report

CANTEST LTD.
Professional Analytical Services
4606 Canada Way
Burnaby, B.C.
V5G 1K5
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TEL: 604 734 7276
1 800 665 8566

REPORT ON:	Analysis of Soil Samples
REPORTED TO:	Vizon SciTec Inc. (FKA BC Research Inc.) 3650 Wesbrook Mall Vancouver, BC V6S 2L2
	Att'n: K. Serben
CHAIN OF CUSTODY:	101048
PROJECT NAME:	JW
PROJECT NUMBER:	2-11-0965B
P.O. NUMBER:	V2339

NUMBER OF SAMPLES: 10

REPORT DATE: April 18, 2006

DATE SUBMITTED: March 28, 2006

GROUP NUMBER: 70329082

SAMPLE TYPE: Soil

NOTE: Results contained in this report refer only to the testing of samples as submitted. Other information is available on request.

TEST METHODS:

Simultaneously Extractable Metals - analysis was performed using Inductively Coupled Plasma Spectroscopy (ICP), Inductively Coupled Plasma Mass Spectroscopy (ICP/MS) or by other techniques as described.

Acid Volatile Sulphide/Simultaneously Extractable Metals - analysis was performed using procedures based on "Determination of Acid Volatile Sulfide and Selected Simultaneously Extractable Metals in Sediment", U.S. EPA Draft Analytical Method, December 1991. Sulphides in the sample are volatilized by acidification, then trapped in aqueous solution, and measured using gravimetric analysis. The Simultaneously Extractable Metals, liberated from the sample during acidification, are determined using the analysis techniques described.

Mercury - analysis was performed using Cold Vapour Atomic Absorption Spectrophotometry.

Arsenic, antimony, cadmium, lead, selenium - analysis was performed using Inductively Coupled Plasma/Mass Spectroscopy (ICP/MS).

Moisture in Soil - analysis was performed gravimetrically by heating a separate sample portion at 105 C and measuring the weight loss.

TEST RESULTS:

(See following pages)

CANTEST LTD.

Greg Sparrow, B.Sc.
Senior Analyst

Project #: 2-11-0965B
Company: Jacques Whitford
Contact: Janine Beckett

BCR #	Sample	Sample Date	NH_3 mg N/L	S^- mg/L
060223J-43	Porewater JW1	23-Feb-2006	1.25	—
060223J-44	Porewater JW2	23-Feb-2006	2.17	—
060223J-45	Porewater JW3	23-Feb-2006	1.88	—
060223J-46	Porewater JW4	23-Feb-2006	1.18/1.19	—
060223J-47	Porewater JW5	23-Feb-2006	0.964	—
060223J-48	Porewater JW6	23-Feb-2006	0.946	—
060223J-49	Porewater JW7	23-Feb-2006	1.87	—
060223J-50	Porewater JW9	23-Feb-2006	0.632	—
060223J-51	Porewater JW10	23-Feb-2006	1.43	—
060223J-52	Porewater JW12	23-Feb-2006	1.06	—
060223J-53	Porewater Control D	23-Feb-2006	0.027	—
060223J-54	Porewater Control M	23-Feb-2006	<0.01	—
060223J-55	Porewater JW1	23-Feb-2006	—	0.253
060223J-56	Porewater JW2	23-Feb-2006	—	<0.2
060223J-57	Porewater JW3	23-Feb-2006	—	0.500
060223J-58	Porewater JW4	23-Feb-2006	—	<0.2
060223J-59	Porewater JW5	23-Feb-2006	—	<0.2
060223J-60	Porewater JW6	23-Feb-2006	—	<0.2
060223J-61	Porewater JW7	23-Feb-2006	—	<0.2
060223J-62	Porewater JW9	23-Feb-2006	—	0.258
060223J-63	Porewater JW10	23-Feb-2006	—	<0.2
060223J-64	Porewater JW12	23-Feb-2006	—	<0.2
060223J-65	Porewater Control D	23-Feb-2006	—	<0.2
060223J-66	Porewater Control M	23-Feb-2006	—	<0.2
Date Analyzed:			Feb. 24/06	Mar. 9/06
QC				
TRUE			0.103	
Found			0.098	
Initials			HL	AS
Test Methods:			5330 / 5331	

Vizon SciTec
Vancouver, BC

***Neanthes* Sediment Test**
Porewater Measurements

Client # & Name: #128 Jacques Whitford Start Date: 06-Feb-24

Date Measured: 06Feb 23 /24 Start Time: 14:30

Sample ID	Salinity (‰)	Temperature (°C)	pH	NH_3 & Sulfide Sample Taken	Analyst
JW1	27	20.0	7.6	✓	LS
JW2	25	20.2	7.7	✓	LS
JW3	27	20.2	7.7	✓	LS
JW4	25	20.2	7.7	✓	LS
JW5	26	20.4	7.6	✓	LS
JW6	25	20.0	7.6	✓	LS
JW7	25	20.0	7.5	✓	LS
JW9	26	20.0	7.5	✓	LS
JW10	25	19.8	7.3	✓	LS
JW12	25	19.9	7.3	✓	LS
Control M	25	18.5	7.9	✓	KS
Control D	25	18.5	7.8	✓	KS

Comments

used Daphnia meters

Vizon SciTec, Inc.
Vancouver, BC

Total and Unionized Ammonia Results for Jacques Whitford Marine Sediment Tests - Porewater

Sample Name	Salinity (‰)	pH	Temperature (°C)	Total Ammonia (mg N/L)	% Unionized Ammonia[ab]	Unionized Ammonia (mg N/L)
JW1	27	7.6	20.0	1.25	1.30	0.016
JW2	25	7.7	20.2	2.17	1.63	0.035
JW3	27	7.7	20.2	1.88	1.63	0.031
JW4	25	7.7	20.2	1.19	1.63	0.019
JW5	26	7.6	20.4	0.96	1.30	0.013
JW6	25	7.6	20.0	0.95	1.30	0.012
JW7	25	7.5	20.0	1.87	1.03	0.019
JW9	26	7.5	20.0	0.63	1.03	0.007
JW10	25	7.3	19.8	1.43	1.03	0.015
JW12	25	7.3	19.9	1.06	1.03	0.011

[a] Values from Bower CE and Bidwell, JP. 1978. Ionization of Ammonia in Seawater: Effects of Temperature, pH and Salinity. Journal of Fisheries Research Board of Canada 35:1012-1016

[b] When a %unionized ammonia value is not available for a certain pH (e.g., pH<7.5) or salinity, the value closest to the pH or salinity is used.

10-D SURVIVAL TEST WITH *EOHAUSTORIUS ESTUARIUS*

This section of the report contains a summary table of the test conditions (Table 3). Copies of the benchsheets (raw data) are inserted after the above table.

Table 3 Test Summary Checklist – 10-d Survival Test with *Eohaustorius estuarius*

Client Name/Location	Jacques Whitford Ltd. / Burnaby, BC
Testing Lab/Location	Vizon SciTec Inc. / Vancouver, BC
Sample Information	
Sample Names	JW1 to JW7, JW9, JW10, and JW12
Type of Sample	Field collected sediments
Method of Collection	See "Toxicity Test Request" sheet or "Chain of Custody" form
Sample Collector	See "Toxicity Test Request" sheet or "Chain of Custody" form
Sample Volume	8 L
Sample Containers	8-L white food grade plastic buckets
Information on Labelling/Coding	See "Toxicity Test Request" sheet or "Chain of Custody" form
Sample Collection Date (dd-mm-yr)	3-Feb-06 to 7-Feb-06
Sample Temperature upon Arrival	8.4 – 15.6°C
Date (dd-mm-yr) & Time of Sample Receipt at Lab	9-Feb-06 @ 15:14 PM
Date Test Started and Ended (dd-mm-yr)	24-Feb-06 and 06-Mar-06
Storage Conditions	From receipt to test initiation, the samples were stored in a cold room that was at 4 ± 2°C
Sediment and Pore Water Characterisation	See "Sediment Sample Descriptions" in **Sample Information** section and analytical reports, benchsheets in **Sediment Characterisation** section
Sample Preparation	
Homogenisation	Samples (including the separated liquid) were individually mixed until homogenised at ambient laboratory temperature; if necessary, debris and indigenous macro-organisms were removed during homogenisation (see "Sediment Sample Descriptions" sheet)
Date of Homogenisation	23-Feb-06
Characterisation	In **Sediment Characterisation** section
Test Organisms	
Species	*Eohaustorius estuarius*
Source	Mackenzie Beach, Tofino, BC from same population; as collected by Doug Swanston, Seacology, North Vancouver, BC.
Date of Collection (dd-mm-yr)	20-Feb-06
Method of Organism Collection	All containers, sieves, pipettes and items that contacted the amphipods were cleaned by scrubbing with sand and rinsing with seawater prior to use. Seawater used in the sieving and storage of amphipods was collected adjacent to the amphipod collection site. The seawater was sieved to removed debris and unwanted organisms. A refractometer was used to determine the salinity of the seawater (30‰). Large debris and

	undesired amphipod species and other visible organisms were removed as observed during sieving. Approximately 100 mL of sieved seawater (28‰) was added to each container. Amphipods were drawn into a pipette and counted into clean containers (110/container) from the sieve. Each container was inspected for debris and unwanted organisms. Approximately 200 mL of clean sieved sand was then added to each container. A clean lid was loosely fitted and the container was placed in a cooler. Amphipods were stored in a locked vehicle or in the possession of a Seacology employee at all times prior to delivery at Vizon.
Age at Start of Test	3 to 5 mm juveniles
Date of Organism Arrival (dd-mm-yr)	22-Feb-06
Holding and Acclimation Conditions	See "Acclimation and Holding Conditions" sheets.
% Emerged during Holding Period	See "Acclimation and Holding Conditions" sheets.
Average Total Body Length (mean ± SD, sample size)	3.5 ± 0.5; 20 amphipods were measured. See "Length Measurements" sheet.
Test Conditions & Apparatus	
Personnel	Pam Sinclair, Kerrie Serben, Glenn Lunty, Jackie Danisek, Jeremy Keating, Leslie-Anne Stavroff, Nigel May, Tam Vo, Janet Pickard
Description of Lighting and Temperature Regulation Systems	24 hour light with incandescent lighting; heating / air-conditioning units operating to provide appropriate temperature.
Test Vessels and Lids	1 L glass jars with ~ 8 cm inner diameter; covered.
Cleaning and Rinsing Procedures	All glassware was washed with detergent, rinsed with deionised water, soaked in an acid bath for a minimum of three hours and rinsed with deionised water prior to use.
Aeration System	Filtered air through 0.5 mm (ID) / 1.5 mm (OD) Tygon flexible microbore airline tubing
Control Sediment and Test Water	
Control Sediment Source	Mackenzie Beach, Tofino, BC; as collected by Doug Swanston, Seacology, North Vancouver, BC.
Control Sediment Collection Procedure	Sediment was sieved (1 mm) before use with control/dilution seawater.
Control Sediment Storage	From receipt to test initiation, the samples were stored in a cold room that was at 4 ± 2°C
Overlying Water	Uncontaminated sand-filtered seawater obtained from the Vancouver Aquarium, Vancouver, BC. The seawater was pumped from Burrard Inlet from a depth of 40-45 feet and filtered through a gravity sand filter, with sand mesh size 22. After filtration, the seawater was held in a concrete reservoir (retention time approximately 4 h) before passing through a UV steriliser. The seawater was stored at 15°C prior to use in the tests.
Type and Quantity of Chemicals Added to Water	No chemicals were added to the water.

Pre-treatment of Overlying Water	The seawater was continuously aerated prior to use.
Test Methods	
Test Method	Environment Canada (1992 and 1998 amendments). Biological Test Method: Acute Test for Sediment Toxicity Using Marine or Estuarine Amphipods, EPS 1/RM/26 and Environment Canada (1998). Biological Test Method: Reference Method for Determining Acute Lethality of Sediment to Marine or Estuarine Amphipods, EPS 1/RM/35.
Test Type / Duration	10-d whole sediment toxicity test with no water renewal
Test Temperature	Water temperature ranged from 13.3°C to 15.2°C over the exposure period. See "Test Conditions and Survival Data" sheets.
Lighting	Overhead full spectrum (fluorescent or equivalent); 500 – 1000 lux, 24 h light
Aeration	Continuous and minimal in each test vessel; checked 2-3 times daily
Date/Time for Test Start	24-Feb-06 @ 14:50
Date for Test Completion	06-Mar-06
Volume / Depth of Wet Sediment	175 mL; 4 cm
Volume / Depth Test Water	775 mL; 9 cm
Water Renewal	None; there was no need to replace water due losses from evaporation.
# Organisms / Vessel	Twenty (20) amphipods were randomly assigned to each test chamber
Lab Replicates	There were five (5) laboratory replicates for each field replicate. There was also one (1) measurement beaker for each sediment sample.
Feeding Regime	None
Observations & Measurements	
Dissolved Oxygen Concentrations (DO) and Temperature	In overlying water, at the start of the test and 3 times/week (MWF) in the measurement beakers. See "Test Conditions and Survival Data" sheets.
pH, Conductivity, and Ammonia Concentrations	pH, conductivity, and ammonia concentrations were measured in sub-samples taken from all replicates at the start and end of the test. Probes were rinsed with clean water between sample measurements. See "Test Conditions and Survival Data" sheets.
Sediment Appearance and Observations During Test	See "Aeration Checks" sheet.
Survival	All live amphipods recovered from the overlying water or sediment in a single test chamber were counted.
Analytical Methods	**Ammonia:** Vizon SOP 5330 (Colorimetric Analysis of Ammonia Nitrogen in Water and Wastewater). Current Version. Adapted from: Sheiner D. 1976. Determination of Ammonia and Kjeldahl Nitrogen by Indophenol Method. *Water Research.* Vol. 10:31-36. Pergammon Press. Similar in principle to: Standard Methods for the Examination of Water and Wastewater, APHA, AWWA, WEF, 20th Edition, 1998. Method 4500 – NH3 F .

	Sulfide: SM 4500 S^{2-} F (Iodometric Method) in Standard Methods for the Examination of Water and Wastewater, 20th ed., 1998.
Sampling, Sample Preparation and Storage prior to Analysis	Ammonia and sulfide samples were collected by removing 10-20 mL from each replicate and placing in a 125-mL plastic bottle; samples were stored at 4 ± 2°C prior to analysis.
Anything Unusual about the Test, Deviation from Test Method, Problems	• There were no water quality measurements taken in the controls on Day 3, but measurements were taken in all test sediments. • Water temperature was below 14°C (13.3-13.9°C) on Day 7 but was between 14.0 and 15.2°C on the other sampling days. • Ammonia was not measured on Day 10 in JW1.
Results	
Endpoints	Mean (± SD) % of amphipods that survived the 10-day exposure. See "10-d *Eohaustorius estuarius* Survival Test" sheet.
Endpoint Results	**Comparison with Laboratory Control** There was no difference in survival between the test sediments and the laboratory control ($p > 0.05$). **Comparison with Reference Sediments (JW9 and JW10)** There was no significant difference in survival between JW10 and the test sediments ($p > 0.05$). There was a significant difference between JW9 and test sediments JW3, JW5, JW6, JW7, and JW12. However, the maximum difference was 17% (between JW9 and JW3). Statistical analyses were conducted using ToxCalc Ver. 5.0.23j
QA/QC	
Test Validity Criteria	Control survival was >90% (mean pooled control survival was 100%).
Ref Tox Test LC50 (95% CL) (mg Cd^{2+}/L) and Duration of Test	7.0 (5.7 – 8.6) Test duration was 96 hours.
Invalid Ref Tox Test? If YES state initiation and/or findings of a test system review	No; the control survival was 100%. For the test to be valid the control survival should be ≥90%. See "Control Chart" sheet.
Ref Tox Test Historic Geometric Mean (±SD) and 2SD Range (mg Cd^{2+}/L)	9.8 ± 3.2; 2SD range: (3.4 – 16.1)
Date of Ref Tox Test (dd-mm-yr)	24-Feb-06
Organisms Batch and Condition of Ref Tox Test	Same batch of organisms used in the tests as for the reference toxicant; static, 96-h water-only test

Marine Amphipods-10 Day Survival

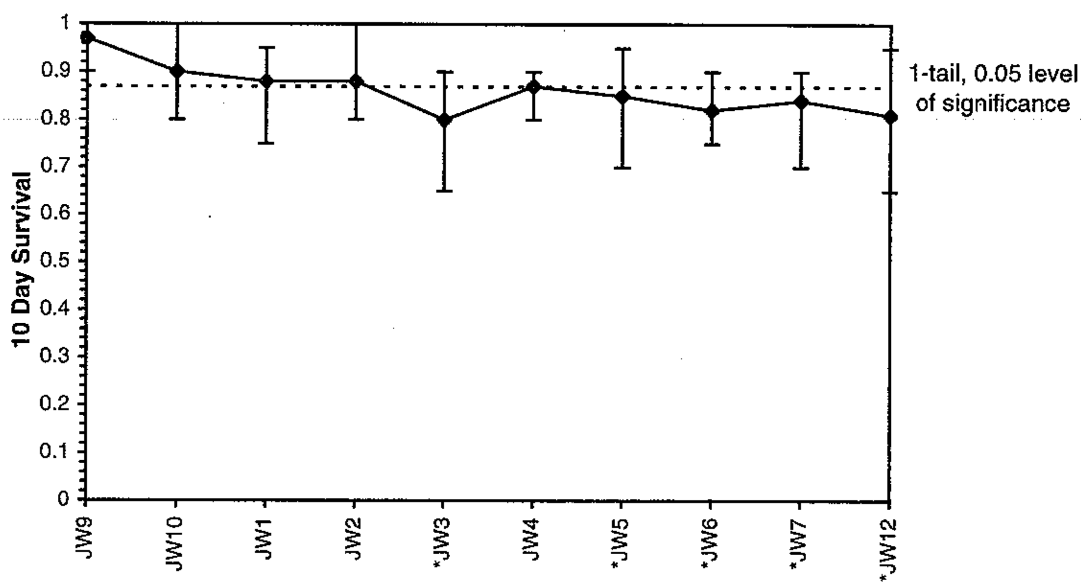
Start Date:	2/24/2006	Test ID:	EE128-0205	Sample ID:	128-Jacques Whitford
End Date:	3/6/2006	Lab ID:	VIZ-Vizon SciTec Toxicology	Sample Type:	SM-Sediment
Sample Date:		Protocol:	EPS1/RM/26-Amphipods	Test Species:	EE-Eohaustorius estuarius
Comments:	Test Sediments Compared to Reference Sediments only				

Conc-%	1	2	3	4	5
JW9	1.0000	1.0000	0.9000	0.9500	1.0000
JW10	0.9000	0.8500	0.8000	1.0000	0.9500
JW1	0.9500	0.7500	0.8500	0.9500	0.9000
JW2	0.9000	0.8000	1.0000	0.8500	0.8500
JW3	0.6500	0.7000	0.8500	0.9000	0.9000
JW4	0.8500	0.9000	0.9000	0.8000	0.9000
JW5	0.7000	0.9500	0.9500	0.7500	0.9000
JW6	0.8000	0.7500	0.9000	0.8000	0.8500
JW7	0.9000	0.8500	0.7000	0.8500	0.9000
JW12	0.9500	0.8500	0.8500	0.7500	0.6500

			Transform: Arcsin Square Root						1-Tailed	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
JW9	0.9700	1.0778	1.3941	1.2490	1.4588	6.802	5	*		
JW10	0.9000	1.0000	1.2667	1.1071	1.4588	10.996	5			
JW1	0.8800	0.9778	1.2320	1.0472	1.3453	10.233	5	2.075	2.480	0.1938
JW2	0.8800	0.9778	1.2322	1.1071	1.4588	11.056	5	2.072	2.480	0.1938
*JW3	0.8000	0.8889	1.1200	0.9377	1.2490	13.087	5	3.508	2.480	0.1938
JW4	0.8700	0.9667	1.2055	1.1071	1.2490	5.314	5	2.414	2.480	0.1938
*JW5	0.8500	0.9444	1.1956	0.9912	1.3453	13.964	5	2.541	2.480	0.1938
*JW6	0.8200	0.9111	1.1367	1.0472	1.2490	6.772	5	3.294	2.480	0.1938
*JW7	0.8400	0.9333	1.1671	0.9912	1.2490	9.033	5	2.905	2.480	0.1938
*JW12	0.8100	0.9000	1.1353	0.9377	1.3453	13.484	5	3.312	2.480	0.1938

Auxiliary Tests	Statistic		Critical		Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.9607		0.926		-0.1501	-0.7093
Bartlett's Test indicates equal variances (p = 0.70)	5.48445		20.0902			
The control means are not significantly different (p = 0.13)	1.69146		2.306			
Hypothesis Test (1-tail, 0.05)	**MSDu**	**MSDp**	**MSB**	**MSE**	**F-Prob**	**df**
Dunnett's Test indicates significant differences	0.10019	0.10338	0.03464	0.01526	0.04446	8, 36
Treatments vs JW9						

Dose-Response Plot



ToxCalc v5.0

Reviewed by: KK
6 Apr 13

Marine Amphipods-10 Day Survival

Start Date:	2/24/2006	Test ID:	EE128-0205	Sample ID:	128-Jacques Whitford
End Date:	3/6/2006	Lab ID:	VIZ-Vizon SciTec Toxicology	Sample Type:	SM-Sediment
Sample Date:		Protocol:	EPS1/RM/26-Amphipods	Test Species:	EE-Eohaustorius estuarius

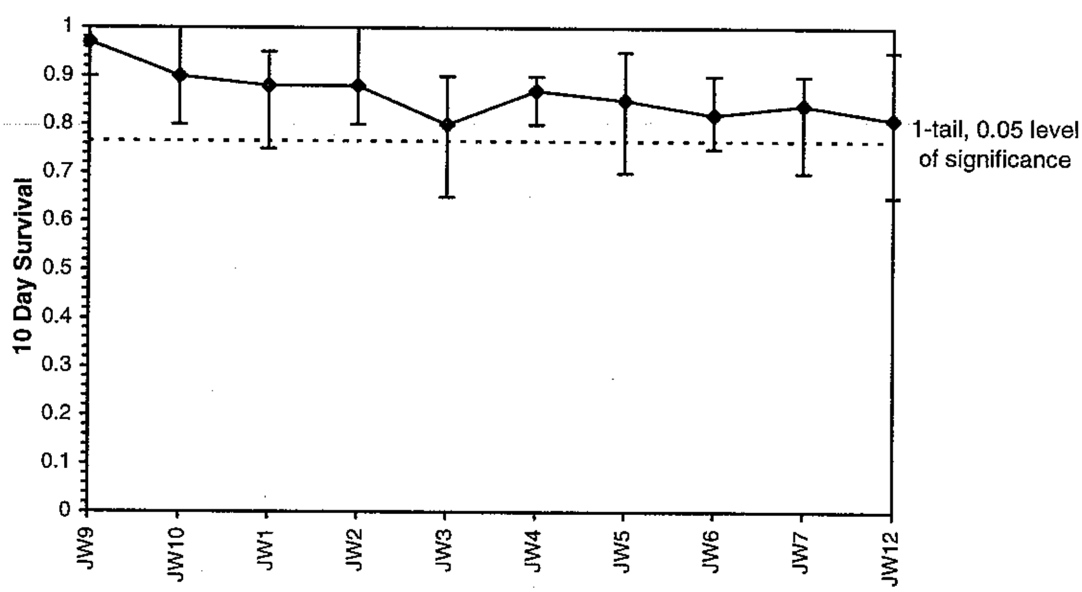
Comments: Test Sediments Compared to Reference Sediments only

Conc-%	1	2	3	4	5
JW9	1.0000	1.0000	0.9000	0.9500	1.0000
JW10	0.9000	0.8500	0.8000	1.0000	0.9500
JW1	0.9500	0.7500	0.8500	0.9500	0.9000
JW2	0.9000	0.8000	1.0000	0.8500	0.8500
JW3	0.6500	0.7000	0.8500	0.9000	0.9000
JW4	0.8500	0.9000	0.9000	0.8000	0.9000
JW5	0.7000	0.9500	0.9500	0.7500	0.9000
JW6	0.8000	0.7500	0.9000	0.8000	0.8500
JW7	0.9000	0.8500	0.7000	0.8500	0.9000
JW12	0.9500	0.8500	0.8500	0.7500	0.6500

			Transform: Arcsin Square Root						1-Tailed	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
JW9	0.9700	1.0778	1.3941	1.2490	1.4588	6.802	5			
JW10	0.9000	1.0000	1.2667	1.1071	1.4588	10.996	5	*		
JW1	0.8800	0.9778	1.2320	1.0472	1.3453	10.233	5	0.428	2.480	0.2010
JW2	0.8800	0.9778	1.2322	1.1071	1.4588	11.056	5	0.425	2.480	0.2010
JW3	0.8000	0.8889	1.1200	0.9377	1.2490	13.087	5	1.809	2.480	0.2010
JW4	0.8700	0.9667	1.2055	1.1071	1.2490	5.314	5	0.755	2.480	0.2010
JW5	0.8500	0.9444	1.1956	0.9912	1.3453	13.964	5	0.877	2.480	0.2010
JW6	0.8200	0.9111	1.1367	1.0472	1.2490	6.772	5	1.603	2.480	0.2010
JW7	0.8400	0.9333	1.1671	0.9912	1.2490	9.033	5	1.229	2.480	0.2010
JW12	0.8100	0.9000	1.1353	0.9377	1.3453	13.484	5	1.621	2.480	0.2010

Auxiliary Tests	Statistic		Critical		Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.96207		0.926		-0.0574	-0.8157
Bartlett's Test indicates equal variances (p = 0.75)	5.07539		20.0902			
The control means are not significantly different (p = 0.13)	1.69146		2.306			
Hypothesis Test (1-tail, 0.05)	**MSDu**	**MSDp**	**MSB**	**MSE**	**F-Prob**	**df**
Dunnett's Test indicates no significant differences	0.14449	0.15873	0.01307	0.01642	0.60991	8, 36
Treatments vs JW10						

Dose-Response Plot



ToxCalc v5.0

Reviewed by: KK 06Apr13

Marine Amphipods-10 Day Survival

Start Date:	2/24/2006	Test ID:	EE128-0105	Sample ID:	128-Jacques Whitford
End Date:	3/6/2006	Lab ID:	VIZ-Vizon SciTec Toxicology	Sample Type:	SM-Sediment
Sample Date:		Protocol:	EPS1/RM/26-Amphipods	Test Species:	EE-Eohaustorius estuarius
Comments:					

Conc-%	1	2	3	4	5
Control-1	1.0000	1.0000	1.0000	1.0000	0.9500
Control-2	1.0000	1.0000	1.0000	1.0000	1.0000
JW1	0.9500	0.7500	0.8500	0.9500	0.9000
JW2	0.9000	0.8000	1.0000	0.8500	0.8500
JW3	0.6500	0.7000	0.8500	0.9000	0.9000
JW4	0.8500	0.9000	0.9000	0.8000	0.9000
JW5	0.7000	0.9500	0.9500	0.7500	0.9000
JW6	0.8000	0.7500	0.9000	0.8000	0.8500
JW7	0.9000	0.8500	0.7000	0.8500	0.9000
JW9	1.0000	1.0000	0.9000	0.9500	1.0000
JW10	0.9000	0.8500	0.8000	1.0000	0.9500
JW12	0.9500	0.8500	0.8500	0.7500	0.6500

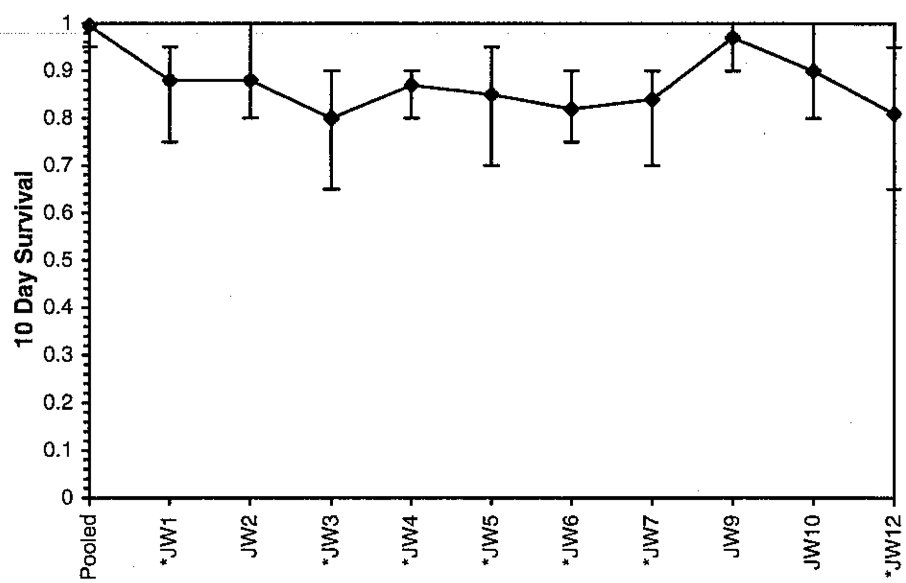
			Transform: Arcsin Square Root					Rank	1-Tailed
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical
Pooled	0.9950	1.0000	1.4474	1.3453	1.4588	2.479	10		
*JW1	0.8800	0.8844	1.2320	1.0472	1.3453	10.233	5	16.00	19.00
JW2	0.8800	0.8844	1.2322	1.1071	1.4588	11.056	5	20.50	19.00
*JW3	0.8000	0.8040	1.1200	0.9377	1.2490	13.087	5	15.00	19.00
*JW4	0.8700	0.8744	1.2055	1.1071	1.2490	5.314	5	15.00	19.00
*JW5	0.8500	0.8543	1.1956	0.9912	1.3453	13.964	5	16.00	19.00
*JW6	0.8200	0.8241	1.1367	1.0472	1.2490	6.772	5	15.00	19.00
*JW7	0.8400	0.8442	1.1671	0.9912	1.2490	9.033	5	15.00	19.00
JW9	0.9700	0.9749	1.3941	1.2490	1.4588	6.802	5	32.00	19.00
JW10	0.9000	0.9045	1.2667	1.1071	1.4588	10.996	5	21.00	19.00
*JW12	0.8100	0.8141	1.1353	0.9377	1.3453	13.484	5	15.50	19.00

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Kolmogorov D Test indicates non-normal distribution (p <= 0.01)	1.09598	1.035	-0.1116	-0.3981
Bartlett's Test indicates equal variances (p = 0.06)	17.9962	23.2093		
The control means are not significantly different (p = 0.35)	1	2.306		

Hypothesis Test (1-tail, 0.05)

Wilcoxon Rank Sum Test indicates significant differences
Treatments vs Pooled Controls

Dose-Response Plot



 ToxCalc v5.0 Reviewed by: KS

Vizon SciTec Inc.
Vancouver, BC

10-d *Eohaustorius estuarius* Survival Test

Sample ID	Log In ID	# Surviving	Sample Survival (%)	Mean Survival (%)	SD
Control-1M	-	20	100	99	2
Control-1M	-	20	100	**Pooled**	**Pooled**
Control-1M	-	20	100	100	2
Control-1M	-	20	100		
Control-1M	-	19	95		
Control-2M	-	20	100	100	0
Control-2M	-	20	100		
Control-2M	-	20	100		
Control-2M	-	20	100		
Control-2M	-	20	100		
JW1	060210J-01	19	95	88	8
JW1	060210J-01	15	75		
JW1	060210J-01	17	85		
JW1	060210J-01	19	95		
JW1	060210J-01	18	90		
JW2	060210J-02	18	90	88	8
JW2	060210J-02	16	80		
JW2	060210J-02	20	100		
JW2	060210J-02	17	85		
JW2	060210J-02	17	85		
JW3	060210J-03	13	65	80	12
JW3	060210J-03	14	70		
JW3	060210J-03	17	85		
JW3	060210J-03	18	90		
JW3	060210J-03	18	90		
JW4	060210J-04	17	85	87	4
JW4	060210J-04	18	90		
JW4	060210J-04	18	90		
JW4	060210J-04	16	80		
JW4	060210J-04	18	90		
JW5	060210J-05	14	70	85	12
JW5	060210J-05	19	95		
JW5	060210J-05	19	95		
JW5	060210J-05	15	75		
JW5	060210J-05	18	90		
JW6	060210J-06	16	80	82	6
JW6	060210J-06	15	75		
JW6	060210J-06	18	90		
JW6	060210J-06	16	80		
JW6	060210J-06	17	85		
JW7	060210J-07	18	90	84	8
JW7	060210J-07	17	85		
JW7	060210J-07	14	70		
JW7	060210J-07	17	85		
JW7	060210J-07	18	90		
JW9	060210J-09	20	100	97	4
JW9	060210J-09	20	100		
JW9	060210J-09	18	90		
JW9	060210J-09	19	95		
JW9	060210J-09	20	100		

KK 06Apr13

10-d *Eohaustorius estuarius* Survival Test

Sample ID	Log In ID	# Surviving	Sample Survival (%)	Mean Survival (%)	SD
JW10	060210J-10	18	90	90	8
JW10	060210J-10	17	85		
JW10	060210J-10	16	80		
JW10	060210J-10	20	100		
JW10	060210J-10	19	95		
JW12	060210J-12	19	95	81	11
JW12	060210J-12	17	85		
JW12	060210J-12	17	85		
JW12	060210J-12	15	75		
JW12	060210J-12	13	65		

KK 06Apr13

Vizon SciTec **Marine Amphipod 10 Day Acute Survival Sediment Test**
Test Conditions and Survival Data

Client # & Name: 128 - Jacques Whitford **Start Date & Time:** 06 Feb 24 @ 14:50

Sample Date: N/A **End Date:** 06 Mar 06

Sample Received: N/A **Species:** Eohaustorius estuarius

Vizon Project #: 2-11-0965B **Organism Lot #:** SE060222

Analyst(s): P Sinclair, J. Keating, K Saben

Sample ID: Control 1M **Vizon #:** n/a

	Day 1	3	5	7	10
Day	Friday	Monday	Wednesday	Friday	Monday
Date	06 Feb 24		06 ~~Feb~~ Mar 01	06 Mar 03	06 Mar 06
Temperature(°C)	14.8		14.2	13.7	14.2
D.O. (mg/L)	8.5		8.3	8.2	8.5
pH	8.1				8.1
Salinity (‰)	27				28
Analyst	PS		PS	PS	JK PS

	# Alive				
Replicate	A	B	C	D	E
	~~19~~ 20	20	20	20	19
Analyst	PS	PS	PS	PS	PS

Ammonia Sample Taken

Initial	Final
✓ KS	✓

Sample ID: Control 2M **Vizon #:** n/a

	Day 1	3	5	7	10
Day	Friday	Monday	Wednesday	Friday	Monday
Date	06 Feb 24		06 Mar 01	06 Mar 03	06 Mar 06
Temperature(°C)	14.8		14.2	13.6	14.0
D.O. (mg/L)	8.5		8.3	8.3	8.6
pH	8.1				8.1
Salinity (‰)	28				28
Analyst	PS		PS	PS	JK PS

	# Alive				
Replicate	A	B	C	D	E
	20	20	20	20	20
Analyst	JK	JK	JK	JK	JK

Ammonia Sample Taken

Initial	Final
✓ KS	✓

Vizon SciTec

Marine Amphipod 10 Day Acute Survival Sediment Test
Test Conditions and Survival Data

Client # & Name: 128-Jacques Whitford Start Date & Time: 06Feb24@14:50

Sample Date: 06 Feb 03 End Date: 06 Mar 06

Sample Received: 06 Feb 10 Species: Eohaustorius estuarius

Vizon Project #: 2-11-0965B Organism Lot #: SE060222

Analyst(s): P Sinclair K Seeben, J. Danisek, G. Lowty, J. Keating, Tam VO

Sample ID: JW1 Vizon #: 060210J-01

	Day 1	3	5	7	10
Day	Friday	Monday	Wednesday	Friday	Monday
Date	06 Feb 24	06 Feb 27	06 MAR 01	06 MAR 03	06 Mar 06
Temperature(°C)	15.2	14.6	14.7	13.6	14.4
D.O. (mg/L)	8.2	8.3	8.5	8.0	8.6
pH	8.0				8.0
Salinity (‰)	28				29
Analyst	PS KS JD	JD	GL	GL	JK PS

	# Alive				
Replicate	A	B	C	D	E
	19	15	17	19	18
Analyst	JK	JK	JK	JK	JK

128 JW1 Measure A: 17 TV +2 deads

Ammonia Sample Taken

Initial	Final
✓KS	✓

Sample ID: JW2 Vizon #: 060210J-02

	Day 1	3	5	7	10
Day	Friday	Monday	Wednesday	Friday	Monday
Date	06 Feb 24	06 ~~Mar~~ Feb 27	06 MAR 01	06 MAR 03	06 Mar 06
Temperature(°C)	15.1	14.7	14.4	13.3	14.0°C
D.O. (mg/L)	8.2	8.3	8.6	8.2	8.6
pH	8.0				8.0
Salinity (‰)	27				29
Analyst	JD PS KS	JD	GL	GL	PS

	# Alive				
Replicate	A	B	C	D	E
	18	16 (1 dead)	20	17	17
Analyst	PS	PS	PS	PS	PS

Ammonia Sample Taken

Initial	Final
✓KS	✓

Vizon SciTec

Marine Amphipod 10 Day Acute Survival Sediment Test
Test Conditions and Survival Data

Client # & Name: 128 - Jacques Whitford **Start Date & Time:** 06 Feb 24 @ 14:50

Sample Date: 06 Feb ~~03~~ 04 **End Date:** 06 Mar 06

Sample Received: 06 Feb 10 **Species:** Eohaustorius estuarius

Vizon Project #: 2-11-0965 B **Organism Lot #:** SE060222

Analyst(s): P. Sinclair K Seber, J. Danisek, G Lusty, J. Keating Tam VD, L Stavro

Sample ID: JW3 **Vizon #:** 060210J-03

	Day 1	3	5	7	10
Day	Friday	Monday	Wednesday	Friday	Monday
Date	06 Feb 24	06 Feb 27	06 Mar 01	06 MAR 03	06 Mar 06
Temperature(°C)	14.9	14.7	14.4	13.6	14.2
D.O. (mg/L)	8.3	8.4	8.7	8.1	~~8~~ 8.6
pH	8.0				8.0
Salinity (‰)	28				29
Analyst	JD PS KS	JD	GL	GL	JK PS

	# Alive				
Replicate	A	B	C	D	E
	13	14	17	18	18
Analyst	JK	TV	TV	TV	TV

JW3 Measure (128) 16 TV

Ammonia Sample Taken

Initial	Final
✓KS	✓

Sample ID: JW4 **Vizon #:** 060210J-04

	Day 1	3	5	7	10
Day	Friday	Monday	Wednesday	Friday	Monday
Date	06 Feb 24	06 Feb 27	06 ~~Feb~~ Mar 01	06 MAR 03	06 Mar 06
Temperature(°C)	15.1	14.7	14.4	13.4	14.0
D.O. (mg/L)	8.3	8.4	8.7	8.1	8.5
pH	8.0				8.0
Salinity (‰)	28				29
Analyst	JD PS KS	JD	GL/LS	GL	JK PS

	# Alive				
Replicate	A	B	C	D	E
	17 (+1 dead)	18	18	16 (+4 dead)	18 (+1 dead)
Analyst	PS	PS	PS	PS	PS

Ammonia Sample Taken

Initial	Final
✓KS	✓

Vizon SciTec **Marine Amphipod 10 Day Acute Survival Sediment Test**
Test Conditions and Survival Data

Client # & Name: 128 - Jacques Whitford **Start Date & Time:** 06 Feb 24 @ 14:50

Sample Date: 06 Feb ~~03~~ 04 **End Date:** 06 Mar 06

Sample Received: 06 Feb 10 **Species:** Eohaustorius estuarius

Vizon Project #: 2-11-0965B **Organism Lot #:** SE060222

Analyst(s): P. Sinclair, J. Danisek, G Lenty, J. Keating, L Stavroff, K Suban

Sample ID: JW5 **Vizon #:** 060210J-05

	Day 1	3	5	7	10
Day	Friday	Monday	Wednesday	Friday	Monday
Date	06 Feb 24	06 Feb 27	06 Mar 01	06 MAR 03	06 Mar 06
Temperature(°C)	15.0	14.7	14.7	13.9	14.6
D.O. (mg/L)	8.3	8.5	8.9	8.0	8.6
pH	8.0				8.1
Salinity (‰)	27				29
Analyst	PS JD	JD	GL/LS	GL	JK PS

	# Alive				
Replicate	A	B	C	D	E
	19	19	19	15	18
Analyst	JK	JK	JK	JK	JK

Ammonia Sample Taken

Initial	Final
✓KS	✓

Sample ID: JW6 **Vizon #:** 060210J-06

	Day 1	3	5	7	10
Day	Friday	Monday	Wednesday	Friday	Monday
Date	06 Feb 24	06 Feb 27	06 Mar 01	06 MAR 03	06 Mar 06
Temperature(°C)	15.0	14.6	14.6	13.~~7~~8 GL	14.4
D.O. (mg/L)	7.7	8.2	9.0	8.0	8.5
pH	8.1				8.0
Salinity (‰)	27				29
Analyst	PS JD	JD	GL/LS	GL	JK PS

	# Alive				
Replicate	A	B	C	D	E
	16	15	18	16	17
Analyst	LS	LS	LS	LS	LS

Ammonia Sample Taken

Initial	Final
✓KS	✓

Vizon SciTec

Marine Amphipod 10 Day Acute Survival Sediment Test
Test Conditions and Survival Data

Client # & Name: 128 - Jacques Whitford Start Date & Time: 06 Feb 24 @ 14:50

Sample Date: 06 Feb ~~03~~04 + 06 Feb 07 End Date: 06 Mar 06

Sample Received: 06 Feb 10 Species: Eohaustorius estuarius

Vizon Project #: 2-11-0965B Organism Lot #: SE060222

Analyst(s): P. Sinclair, K Suber, J. Danisek, G. Lusty, J Keating, Tam Vo, L Stovrol

Sample ID: JW7 Vizon #: 060210J-07

	Day 1	3	5	7	10
Day	Friday	Monday	Wednesday	Friday	Monday
Date	06 Feb 24	06 Feb 27	06 Mar 01	06 MAR 03	06 Mar 06
Temperature(°C)	14.9	14.8	14.4	13.6	14.1
D.O. (mg/L)	7.9	8.6	9.0	8.2	8.7
pH	8.0				8.0
Salinity (‰)	27				29
Analyst	PS JD	JD	GL / LS	GL	JK PS

	# Alive				
Replicate	A	B	C	D	E
	18	17	14	17	18
Analyst	GL	GL	TV	TV	GL

Ammonia Sample Taken

Initial	Final
✓ KS	✓

Sample ID: JW9 Vizon #: 060210J-09

	Day 1	3	5	7	10
Day	Friday	Monday	Wednesday	Friday	Monday
Date	06 Feb 24	06 Feb 27	06 Mar 01	06 MAR 03	06 Mar 06
Temperature(°C)	15.0	14.5	14.3	13.3	14.1
D.O. (mg/L)	8.3	8.4	9.0	8.3	8.6
pH	8.0				8.1
Salinity (‰)	27				29
Analyst	PS JD	JD	GL / LS	GL	JK PS

	# Alive				
Replicate	A	B	C	D	E
	20	20	(18) 18	19	20
Analyst	PS	PS	TV	JK	TV

Ammonia Sample Taken

Initial	Final
✓ KS	✓

Vizon SciTec **Marine Amphipod 10 Day Acute Survival Sediment Test**
Test Conditions and Survival Data

Client # & Name: 128-Jacques Whitford **Start Date & Time:** 06 Feb 24 @ 14:50

Sample Date: 06 Feb ~~03~~ 07 **End Date:** 06 Mar 06

Sample Received: 06 Feb 10 **Species:** Eohaustorius estuarius

Vizon Project #: 2-11-0965B **Organism Lot #:** SE060222

Analyst(s): P. Sinclair, KSuben, J. Danisek, G. Lowty, J. Keating, KSuben, L Stavrof

Sample ID: JW10 **Vizon #:** 060210J-10

	Day 1	3	5	7	10
Day	Friday	Monday	Wednesday	Friday	Monday
Date	06 Feb 24	06 Feb 27	06 Mar 01	06 MAR 03	06 Mar 06
Temperature(°C)	15.2	14.6	14.5	13.4	14.1
D.O. (mg/L)	8.3	8.4	8.8	8.3	8.5
pH	8.0				8.1
Salinity (‰)	28				29
Analyst	PS JD	JD	GL LS	GL	JK PS

	# Alive				
Replicate	A	B	C	D	E
	18	17	~~15~~ 16	20	19
Analyst	LS	KS	KS	KS	LS

Ammonia Sample Taken

Initial	Final
✓ KS	✓

Sample ID: JW12 **Vizon #:** 060210J-12

	Day 1	3	5	7	10
Day	Friday	Monday	Wednesday	Friday	Monday
Date	06 Feb 24	06 Feb 27	06 Mar 01	06 MAR 03	06 Mar 06
Temperature(°C)	15.0	14.7	14.4	13.4	14.0
D.O. (mg/L)	8.3	8.4	8.9	8.2	8.5
pH	8.0				8.0
Salinity (‰)	28				29
Analyst	PS JD	JD	GL LS	GL	JK PS

	# Alive				
Replicate	A	B	C	D	E
	19	17 + ~~17~~ 1 dead	17	15	13
Analyst	KS	KS	JK	LS	GL

Ammonia Sample Taken

Initial	Final
✓ KS	✓

Vizon SciTec, Inc.
Vancouver, BC

Total and Unionized Ammonia Results for Marine Amphipod Tests

	Day 0						Day 10					
Sample Name	Salinity (‰)	pH	Temperature (°C)	Total Ammonia (mg N/L)	% Unionized Ammonia	Unionized Ammonia (mg N/L)	Salinity (‰)	pH	Temperature (°C)	Total Ammonia (mg N/L)	% Unionized Ammonia	Unionized Ammonia (mg N/L)
JW1	28	8.0	15.2	0.224	2.17	0.0049	29	8.0	14.4	N/A	2.02	N/A
JW2	27	8.0	15.1	0.235	2.22	0.0052	29	8.0	14.0	0.224	2.02	0.0045
JW3	28	8.0	14.9	0.212	2.17	0.0046	29	8.0	14.2	0.167	2.02	0.0034
JW4	28	8.0	15.1	0.257	2.17	0.0056	29	8.0	14.0	0.070	2.02	0.0014
JW5	27	8.0	15.0	0.198	2.22	0.0044	29	8.1	14.6	0.104	2.72	0.0028
JW6	27	8.1	15.0	0.157	2.78	0.0044	29	8.0	14.4	0.082	2.02	0.0017
JW7	27	8.0	14.9	0.160	2.22	0.0036	29	8.0	14.1	0.100	2.02	0.0020
JW9	27	8.0	15.0	0.308	2.22	0.0068	29	8.1	14.1	0.464	2.53	0.0117
JW10	28	8.0	15.2	0.209	2.17	0.0045	29	8.1	14.1	0.240	2.53	0.0061
JW12	28	8.0	15.0	0.161	2.17	0.0035	29	8.0	14.0	0.228	2.02	0.0046

[a] Values from Bower CE and Bidwell, JP. 1978. Ionization of Ammonia in Seawater: Effects of Temperature, pH and Salinity. Journal of Fisheries Research Board of Canada 35:1012-1016.

[b] When a %unionized ammonia value is not available for a certain pH or salinity, the value closest to the pH or salinity is used.

VIZON SCITEC LABORATORY RECORD BOOK

INVESTIGATOR: PROJECT NUMBER: DATE: PAGE NUMBER: 5981

Project #: 2-11-0965B
Company: Jacques Whitford
Contact: Janine Beckett

BCR #	Sample	Sample Date	NH_3 mg N/L	S^- mg/L
060224L-01	Amphipods Day 0 Control M	24-Feb-2006	0.023	—
060224L-02	Amphipods Day 0 JW1	24-Feb-2006	0.224	—
060224L-03	Amphipods Day 0 JW2	24-Feb-2006	0.235	—
060224L-04	Amphipods Day 0 JW3	24-Feb-2006	0.212	—
060224L-05	Amphipods Day 0 JW4	24-Feb-2006	0.257	—
060224L-06	Amphipods Day 0 JW5	24-Feb-2006	0.198	—
060224L-07	Amphipods Day 0 JW6	24-Feb-2006	0.157	—
060224L-08	Amphipods Day 0 JW7	24-Feb-2006	0.160	—
060224L-09	Amphipods Day 0 JW9	24-Feb-2006	0.308	—
060224L-10	Amphipods Day 0 JW10	24-Feb-2006	0.209	—
060224L-11	Amphipods Day 0 JW12	24-Feb-2006	0.161/0.161	—
060224L-12	Amphipods Day 0 Control M	24-Feb-2006	—	<0.20
060224L-13	Amphipods Day 0 ~~Control M~~ JW1	24-Feb-2006	—	<0.20
060224L-14	Amphipods Day 0 JW2	24-Feb-2006	—	<0.20
060224L-15	Amphipods Day 0 JW3	24-Feb-2006	—	<0.20
060224L-16	Amphipods Day 0 JW4	24-Feb-2006	—	0.20
060224L-17	Amphipods Day 0 JW5	24-Feb-2006	—	<0.20
060224L-18	Amphipods Day 0 JW6	24-Feb-2006	—	<0.20
060224L-19	Amphipods Day 0 JW7	24-Feb-2006	—	<0.20
060224L-20	Amphipods Day 0 JW9	24-Feb-2006	—	<0.20
060224L-21	Amphipods Day 0 JW10	24-Feb-2006	—	<0.20
060224L-22	Amphipods Day 0 JW12	24-Feb-2006	—	<0.20
Date Analyzed:			FEB. 24/06	March 8/06
QC				
TRUE			0.103	
Found			0.098	
Initials			HZ	YL
Test Methods:			5330 / 5331	

BCRL LABORATORY RECORD BOOK

NUMBER: 211

Project #: 2-11-0965B
Company: Jacques Whitford
Contact: Janine Beckett

BCR #	Sample	Sample Date	NH_3 mg N/L	S^- mg/L
060306C-01	Amphipods Day 10 Control M1	6-Mar-2006	<0.01	—
060306C-02	Amphipods Day 10 Control M1	6-Mar-2006	—	0.500
060306C-03	Amphipods Day 10 Control M2	6-Mar-2006	<0.01	—
060306C-04	Amphipods Day 10 Control M2	6-Mar-2006	—	0.246
060306C-05	Amphipods Day 10 JW1	6-Mar-2006	—	—
060306C-06	Amphipods Day 10 ~~Control M1~~ JW1	6-Mar-2006	—	0.254
060306C-07	Amphipods Day 10 JW2	6-Mar-2006	0.224	—
060306C-08	Amphipods Day 10 JW2	6-Mar-2006	—	0.533
060306C-09	Amphipods Day 10 JW3	6-Mar-2006	0.167	—
060306C-10	Amphipods Day 10 JW3	6-Mar-2006	—	0.393
060306C-11	Amphipods Day 10 JW4	6-Mar-2006	0.070	—
060306C-12	Amphipods Day 10 JW4	6-Mar-2006	—	0.375
060306C-13	Amphipods Day 10 JW5	6-Mar-2006	0.104	—
060306C-14	Amphipods Day 10 JW5	6-Mar-2006	—	0.242
060306C-15	Amphipods Day 10 JW6	6-Mar-2006	0.082	—
060306C-16	Amphipods Day 10 JW6	6-Mar-2006	—	0.375
060306C-17	Amphipods Day 10 JW7	6-Mar-2006	0.100	—
060306C-18	Amphipods Day 10 JW7	6-Mar-2006	—	0.375
060306C-19	Amphipods Day 10 JW9	6-Mar-2006	0.464	—
060306C-20	Amphipods Day 10 JW9	6-Mar-2006	—	0.381
060306C-21	Amphipods Day 10 JW10	6-Mar-2006	0.240	—
060306C-22	Amphipods Day 10 JW10	6-Mar-2006	—	<0.2
060306C-23	Amphipods Day 10 JW12	6-Mar-2006	0.228	—
060306C-24	Amphipods Day 10 JW12	6-Mar-2006	—	0.393
Date Analyzed:			MAR.6/06	06Mar07
QC				
TRUE			0.103	
Found			0.103	
Initials			HL	AS
Test Methods:			5330 / 5331	

Vizon SciTec

Marine Amphipod 10 Day Acute Survival Sediment Test
Aeration Checks

Client # & Name: 128 Jacques Whitford   Start Date & Time: 06 Feb 24 @ 14:50

Initial when aeration is checked. If air is off record DO and note which replicate(s) in comments section.

	Day -1	Day 0	1	2	3	4	5	6	7	8	9	10
Date	06 Feb 23	06 Feb 24	06 Feb 25	06 Feb 26	06 Feb 27	06 Feb 28	06 ~~Feb 28~~ Mar 1	06 Mar 02	06 MAR 03	06 Mar 04	06 Mar 05	06 Mar 06
Early AM		✓	✓	✓	✓	✓	✓	✓	✓	MM	✓	✓
Mid-day		✓	✓✓	✓	✓	✓	LS ✓	✓	✓	MM	✓	
Late PM	✓	✓	✓	✓	✓	✓	✓	✓ GL	✓ GL	MM	✓	

Comments:

06-Feb-27 Airline blocked on replicate JW 7 E. DO: 8.4 @ ~~21.1~~ 15.1°c Time: 8:37 JD
& JW 6 A also airline blocked. DO: 8.3 @ 14.9°C Time: 8:37 JD
06 ~~Feb~~ Mar 1 Airline blocked on replicate JW 2 A @ 8:19. DO: 8.6 @ 14.2°c JD
Airline blocked on replicate JW 4 E @ 8:20. DO: 8.5 @ 14.1°c JD
06 Mar 02 Airline blocked on replicate JW 5 Measure @ 8:24. DO: 8.0 @ 14.1°C JD
Airline blocked on replicate JW 9 Measure @ 8:24 DO: 8.1 @ 13.6°C JD
Airline blocked on replicate JW 9 B @ 12:00 DO: 8.2 @ 13.9°C JD
06 MAR 03 AIRLINE BLOCK ON JW 4 D @ 12:00 DO 8.4 @ 13.9°C GL
AIRLINE BLOCK CTL 1M-B @ 14:15 DO 8.0 @ 13.5°C GL

Vizon SciTec
Vancouver, BC

Marine Amphipod 10 Day Acute Survival Sediment Test
Record of Aeration and Test Observations

Client # & Name: 128 Jacques Whitford   Start Date and Time: 06 Feb 24 @ 14:50

Sample ID: JW 1-12   Vizon #: 060210J

Sediment Description
(e.g. colour, texture, homogeneity, presence of plants, animals & tracks or burrows of animals):

Date	Rep.	Comments (e.g. not aerating, DO levels (if not aerating), daily airline checks etc.)	Analyst
06 Mar 06	JW 2B	3 worm (neanthes like) found in Sample.	PS
06-Mar-06	JW 3A	1 amphipod swimming in overlying water	

Vizon SciTec Inc. **Marine Amphipod 10 Day Acute Survival Sediment Test**
Vancouver, BC **Length Measurements**

Client # & Name: #128 Jacques Whitford

Vizon #: Various

Sample ID: Various

Species: Eohaustorius estuarius

Start Date and Time: 2006-Feb-24

Organism Lot #: SE060222

End Date: 2006-Mar-6

Lengths at Beginning of Test

Marine Amphipod #	Length (mm)
1	3.00
2	4.00
3	3.50
4	3.00
5	3.00
6	4.00
7	4.00
8	4.00
9	3.00
10	3.00
11	4.00
12	4.00
13	4.00
14	4.00
15	3.00
16	3.00
17	3.00
18	3.00
19	4.00
20	3.50
Average	3.50
SD	0.49
Analyst	K Serben

Average must be 3-5 mm (Environment Canada 1992, ASTM 2003, PSEP 1995)

Vizon SciTec Inc. **Marine Amphipod 10 Day Acute Survival Sediment Test**
Vancouver, BC **Length Measurements**

Client # & Name: 128 JacquesWhitford Vizon #: ——

Sample ID: —— Species: E. estuarius

Start Date and Time: 06-Feb-24 Organism Lot #: ~~DR060221~~ SE060222

End Date: 06 Mar-16

Lengths at Beginning of Test

Marine Amphipod #	Length (mm)
1	3
2	4
3	3.5
4	3
5	3
6	4
7	4
8	4
9	3
10	3
11	4
12	4
13	4
14	4
15	3
16	3
17	3
18	3
19	4
20	3.5
Average	#DIV/0!
SD	#DIV/0!
Analyst	K Salem

Average must be 3-5 mm (Environment Canada 1992, ASTM 2003, PSEP 1995)

Randomization Chart for Amphipod Tests

Use the coloured dots to find appropriate concentrations

Client # 128

Position #	Treatment	Replicate	Colour	Position #	Treatment	Replicate	Colour
31	Cntrl-1M	A	Glo Yellow	40	Cntrl-2M	A	yellow
50	Cntrl-1M	B	Glo Yellow	63	Cntrl-2M	B	Yellow
9	Cntrl-1M	C	Glo Yellow	66	Cntrl-2M	C	Yellow
5	Cntrl-1M	D	Glo Yellow	38	Cntrl-2M	D	Yellow
45	Cntrl-1M	E	Glo Yellow	18	Cntrl-2M	E	Yellow
8	Cntrl-1M	Measure	Glo Yellow	59	Cntrl-2M	Measure	Yellow
71	JW1	A	Red	46	JW6	A	Dk. Green
54	JW1	B	Red	10	JW6	B	Dk. Green
62	JW1	C	Red	11	JW6	C	Dk. Green
61	JW1	D	Red	2	JW6	D	Dk. Green
4	JW1	E	Red	20	JW6	E	Dk. Green
67	JW1	Measure	Red	1	JW6	Measure	Dk. Green
49	JW2	A	Dk. Blue	17	JW7	A	Glo Green
16	JW2	B	Dk. Blue	6	JW7	B	Glo Green
43	JW2	C	Dk. Blue	72	JW7	C	Glo Green
41	JW2	D	Dk. Blue	36	JW7	D	Glo Green
24	JW2	E	Dk. Blue	65	JW7	E	Glo Green
47	JW2	Measure	Dk. Blue	3	JW7	Measure	Glo Green
21	JW3	A	Orange	57	JW9	A	Leaf
39	JW3	B	Orange	22	JW9	B	Leaf
48	JW3	C	Orange	27	JW9	C	Leaf
33	JW3	D	Orange	58	JW9	D	Leaf
19	JW3	E	Orange	34	JW9	E	Leaf
32	JW3	Measure	Orange	56	JW9	Measure	Leaf
7	JW4	A	White	60	JW10	A	Beige
68	JW4	B	White	13	JW10	B	Beige
51	JW4	C	White	37	JW10	C	Beige
30	JW4	D	White	12	JW10	D	Beige
23	JW4	E	White	28	JW10	E	Beige
42	JW4	Measure	White	69	JW10	Measure	Beige
35	JW5	A	Red-Orange	15	JW12	A	Blue
44	JW5	B	Red-Orange	14	JW12	B	Blue
26	JW5	C	Red-Orange	70	JW12	C	Blue
53	JW5	D	Red-Orange	29	JW12	D	Blue
25	JW5	E	Red-Orange	64	JW12	E	Blue
55	JW5	Measure	Red-Orange	52	JW12	Measure	Blue

Client # Ref Tox

Position #	Treatment	Replicate	Colour
10	Control	A	White
11	Control	B	White
2	1	A	White
12	1	B	White
8	2.5	A	White
1	2.5	B	White
3	6.5	A	White
4	6.5	B	White
5	16	A	White
9	16	B	White
6	40	A	White
7	40	B	White

Vizon SciTec
Vancouver, BC

Marine Amphipod 10 Day Acute Survival Sediment Test
Acclimation and Holding Conditions

Species: *Eohaustorius estuarius*

Organism Lot #: SE060222

Date Collected: 06 Feb 20

# of Organisms: 1890

Date Arrived: 06 Feb 22

Upon Arrival: Temperature (°C): 13.0 D.O. (mg/L): 9.1 pH: 7.7 Salinity (‰) : 26

Acclimation/Holding Conditions ✱

Parameter	Day 0	Day 0	Day 1	Day 1	Day 2	Day 2	Day 3	Day 3	Day 4	Day 4	Day 5	Day 5
Date	Initial	Final	Initial	Final	Initial	Final	Initial	Final	Initial	Final	Initial	Final
pH		8.0				8.1						
Temperature (°C)		14.8				14.7						
D.O. (mg/L)		8.6				8.5						
Salinity (‰)		28										
Dead	6											
Inactive	0											
Emerged	0											
Analyst	[illegible]	[illegible]				[illegible]						

Parameter	Day 6	Day 6	Day 7	Day 7	Day 8	Day 8	Day 9	Day 9	Day 10	Day 10	Total	% Effected
Date	Initial	Final	Initial	Final	Initial	Final	Initial	Final	Initial	Final		
pH												
Temperature (°C)												
D.O. (mg/L)												
Salinity (‰)												
Dead												
Inactive												
Emerged												
Analyst												

50% H_2O Change ✱ Added 9L to each of 3 containers of pods (7 aquaria)

	Day 0	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10
Date	Feb 22									
Analyst	[illegible] ✱									

Janet Pickard/BC Research/CA

03/30/2006 11:11 AM

To Kerrie Serben/BC Research/CA@BC Research

cc

bcc

Subject Fw: Eohaustorius estuarius, collected Feb. 20, 2006

Regards,

Janet Pickard
Vizon SciTec Inc.
Bioassay Manager
3650 Wesbrook Mall
Vancouver, B.C. V6S 2L2

ph: (604) 224-4331 ext. 260
fax: (604) 224-0540
jpickard@vizonscitec.com
http://vizonscitec.com

----- Forwarded by Janet Pickard/BC Research/CA on 03/30/2006 11:10 AM -----

"Douglas Swanston" <seacology@telus.net>

03/30/2006 11:09 AM

To "Janet Pickard" <jpickard@vizonscitec.com>

cc

Subject Eohaustorius estuarius, collected Feb. 20, 2006

Hello Janet,

Here is a summary of the collection activities for the first round of collections.

Collect amphipods Feb. 20, 2006

Amphipods collected per container = 110 amphipods each

Average collection mortalities per container = 3 amphipods per container

Salinity of water in containers = 28 ppt

Temperature of containers = 10 C.

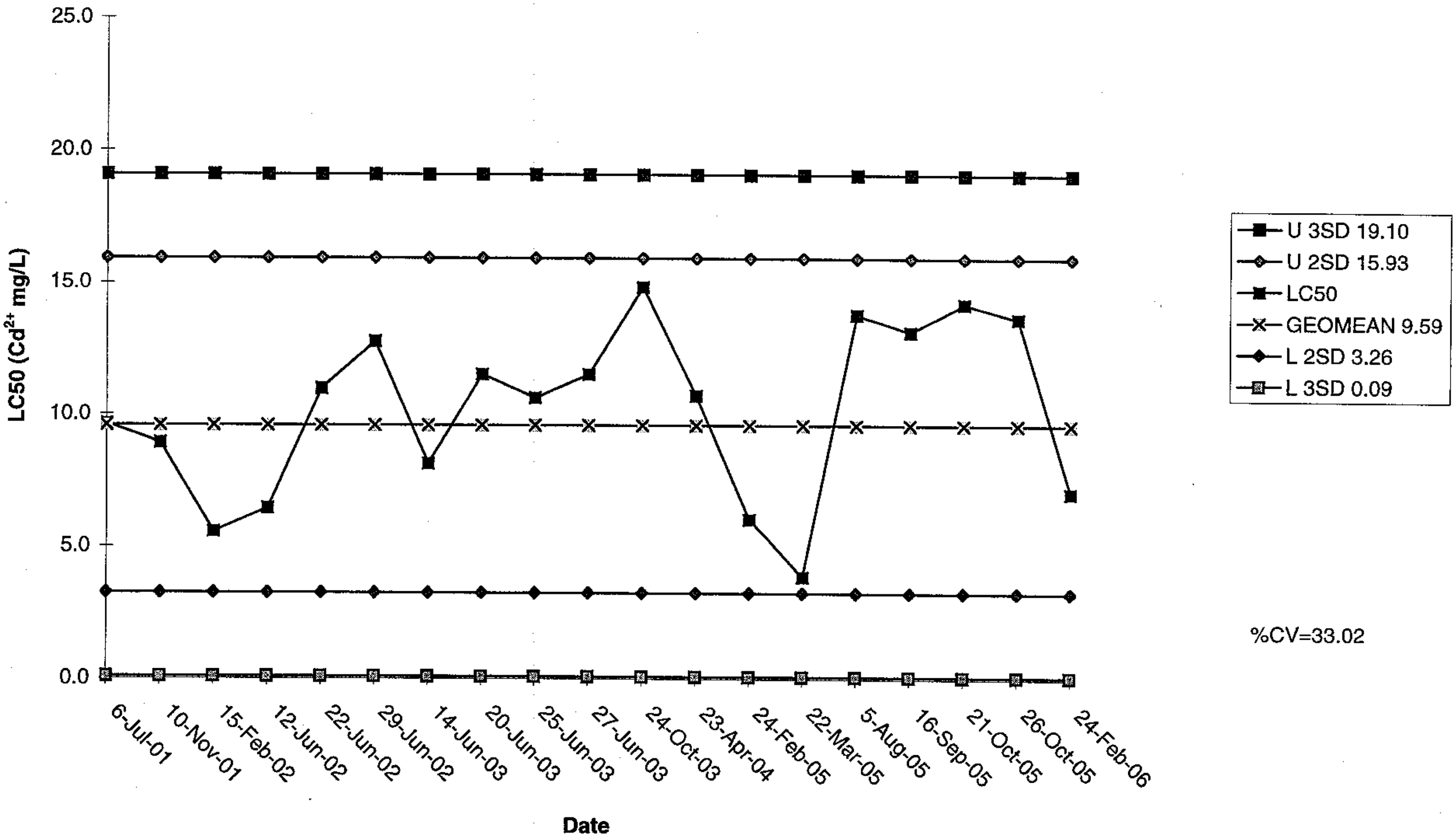
Salinity of water at collection site = 30 ppt

Temperature of water at collection site = 7 C.

Amphipods delivered to Vizon Scitec Feb. ~~21~~ 22, 2006 Douglas Swanston.vcf

Eohaustorius estuarius

96-hr Water-Only Reference Toxicant Control Chart using Cadmium (2^+)



20-D SURVIVAL & GROWTH TEST WITH *NEANTHES ARENACEODENTATA*

This section of the report contains a summary table of the test conditions (Table 4). Copies of the benchsheets (raw data) are inserted after the above table.

Table 4 Test Summary Checklist – 20-d Survival and Growth Test with *Neanthes arenaceodentata*

Client Name/Location	Jacques Whitford Ltd. / Burnaby, BC
Testing Lab/Location	Vizon SciTec Inc. / Vancouver, BC
Sediment Sample	
Sample collection date (dd-mm-yr)	3-Feb-06 to 7-Feb-06
Sample Temperature upon Arrival	8.4 - 15.6°C
Storage Conditions	From receipt to test initiation, the samples were stored in a cold room that was at 4 ± 2°C
Sediment and Pore Water Characterisation	See "Sediment Sample Descriptions" in **Sample Information** section and analytical reports, benchsheets in **Sediment Characterisation** section
Date (dd-mm-yr) & Time of Sample Receipt at Lab	9-Feb-06 @ 15:14 PM
Sample Information	
Sample Names	JW1 to JW7, JW9, JW10, and JW12
Type of Sample	Field collected sediments
Method of Collection	See "Toxicity Test Request" sheet or "Chain of Custody" form
Sample Collector	See "Toxicity Test Request" sheet or "Chain of Custody" form
Sample Volume	8 L
Sample Containers	8-L white food grade plastic buckets
Information on Labelling/Coding	See "Toxicity Test Request" sheet or "Chain of Custody" form
Date/Time for Test Start	24-Feb-06 @ 14:30
Date for Test Completion	06-Mar-16
Test Organisms Imported from External Supplier	The EC document on the importation of test organisms was been followed (September 1999)
Species & Source	*Neanthes arenaceodentata* supplied by D. Reish, California State University, Long Beach, CA
Age at start of test	Emergent juveniles (2-3 weeks post-emergence)
Unusual appearance, behaviour, or treatment of organisms by supplier before shipping or by lab immediately preceding the test	See "Acclimation and Holding Conditions" sheets
Temp. & DO of shipping water immediately upon arrival	See "Acclimation and Holding Conditions" sheets
Acclimation rate & procedure	Fresh seawater was gradually added over the three day holding period. See "Acclimation and Holding Conditions" sheets for details.
Mortality upon arrival and 24 h preceding test	See "Acclimation and Holding Conditions" sheets
Test Conditions & Facilities	
Test method	Puget Sound Estuary Program. 1995. Recommended Guidelines for Conducting Laboratory Bioassays on Puget Sound Sediments. Juvenile

	Polychaete Sediment Bioassay.
Test type	Static-renewal, 3x weekly renewal, 20-day test
Test temperature	Water temperature ranged from 19.4°C to 21.6°C over the exposure period. See "Test Conditions and Survival Data" sheets.
Photo-period	24 hours light
Test vessels	1-L glass jars
Persons performing test	Kerrie Serben, Jackie Danisek, Nigel May, Christie MacKinley, Val Comeau, Corey Steckler, Janet Pickard, Glenn Lunty
Control/dilution water	Vancouver aquarium, from Burrard Inlet, 40-45' deep inlet, gravity sand filter w/sand mesh size 22, passed through UV steriliser
Type & quantity of chemicals added to control/dilution water	No chemicals were added
Control sediment	Same sediment as used for control sediment in the marine amphipod tests.
Sediment volume and depth	175 mL & 4 cm
Overlying water volume and depth	775 mL & 9 cm depth
# of replicates per sample	5
# of organisms per test vessel	5
Manner & rate of renewal of overlying water	Three times weekly; ~30% (250 mL) of solution was removed with by pouring off water. The water was replaced with new seawater.
Water quality measurements	See "Test Conditions and Survival Data" sheets
Deviation from test method	There was nothing unusual about the test, no deviations from test method, and no problems with this test.
Results	
Initial total biomass based on dry weight (mean ± SD)	0.67 ± 0.03 mg / worm
Initial pore water salinity	See "Pore Water Measurements" sheet in **Sediment Characterisation** section.
Endpoints	20-d percent survival for each replicate and mean (± SD) for each test sediment. 20-d total and individual biomass for each replicate and mean (± SD) for each test sediment. 20-d individual growth rate for each replicate and mean (± SD) for each test sediment. See "Summary of Survival Results for *Neanthes arenaceodentata* Tests" and "Dry Weights of Polychaete Worms" sheet.
Endpoint results	**Comparison with Laboratory Control** There was no significant difference in survival, individual biomass, total biomass, or growth rate between the laboratory control and the test sediments ($p > 0.05$). **Comparison with Reference Sediments** No significant differences in survival, individual biomass, total biomass, or growth rate between either JW9 or JW10 and the test sediments ($p > 0.05$).

	Statistical analyses were conducted using ToxCalc Version 5.0.23j
QA/QC	
Test Validity Criteria	Control survival was >90% (mean pooled control survival was 100%). Control growth rate was > 0.38 mg/individual/day (mean pooled control growth rate was >1.00 mg/individual/day).
Ref tox test LC50 (95% CL) (mg Cd^{2+}/L) and duration of test	9.7 (9.0, 10.3) Test duration was 96 hours.
Invalid Ref tox test?	No; the control survival was 100%. For the test to be valid the control survival should be ≥90%. See “Control Chart” sheet.
Ref tox test historic mean & 2SD range (mgCd^{2+}/L)	8.7; 2SD range: (5.2 – 12.1)
Date of ref tox test (y/m/d)	24-Feb-06
Organisms batch and conditions of ref tox test	Same batch of organisms used in the tests as for the reference toxicant; static, 96-h water-only test

Neanthes arenaceodentata Survival and Growth Test-Individual Biomass

Start Date:	2/24/2006	Test ID:	NA128-0106	Sample ID:	128-Jacques Whitford
End Date:	3/16/2006	Lab ID:	VIZ-Vizon SciTec Toxicology	Sample Type:	SM-Sediment
Sample Date:		Protocol:	PSEP ~~1991~~ 1995-Polychaetes	Test Species:	NA-Neanthes arenaceodentata
Comments:					

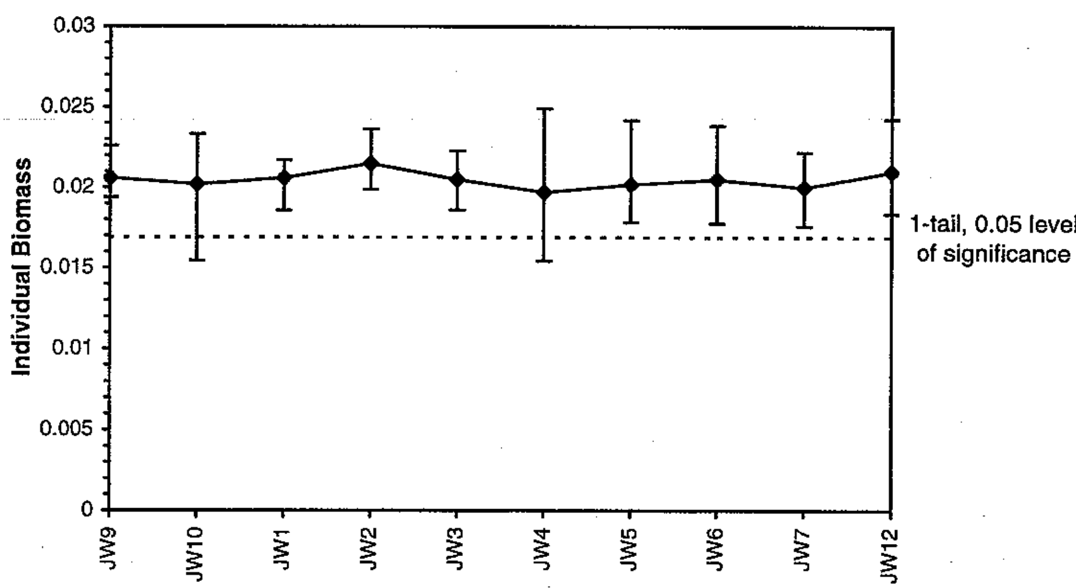
Conc-%	1	2	3	4	5
JW9	0.0194	0.0216	0.0226	0.0199	0.0196
JW10	0.0234	0.0191	0.0223	0.0209	0.0155
JW1	0.0217	0.0200	0.0186	0.0214	0.0214
JW2	0.0233	0.0207	0.0236	0.0198	0.0199
JW3	0.0223	0.0212	0.0189	0.0187	0.0216
JW4	0.0155	0.0169	0.0249	0.0234	0.0179
JW5	0.0178	0.0181	0.0214	0.0193	0.0241
JW6	0.0192	0.0190	0.0178	0.0239	0.0228
JW7	0.0176	0.0222	0.0204	0.0216	0.0181
JW12	0.0184	0.0201	0.0243	0.0208	0.0215

			Transform: Untransformed						1-Tailed	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
JW9	0.0206	1.0195	0.0206	0.0194	0.0226	6.761	5	*		
JW10	0.0202	1.0000	0.0202	0.0155	0.0234	15.307	5			
JW1	0.0206	1.0176	0.0206	0.0186	0.0217	6.394	5	0.026	2.480	0.0037
JW2	0.0215	1.0595	0.0215	0.0198	0.0236	8.624	5	-0.541	2.480	0.0037
JW3	0.0205	1.0144	0.0205	0.0187	0.0223	8.071	5	0.070	2.480	0.0037
JW4	0.0197	0.9735	0.0197	0.0155	0.0249	21.287	5	0.623	2.480	0.0037
JW5	0.0202	0.9951	0.0202	0.0178	0.0241	13.100	5	0.330	2.480	0.0037
JW6	0.0205	1.0136	0.0205	0.0178	0.0239	12.914	5	0.080	2.480	0.0037
JW7	0.0200	0.9868	0.0200	0.0176	0.0222	10.335	5	0.442	2.480	0.0037
JW12	0.0210	1.0383	0.0210	0.0184	0.0243	10.312	5	-0.254	2.480	0.0037

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.96276	0.926	0.4055	-0.4807
Bartlett's Test indicates equal variances (p = 0.40)	8.38986	20.0902		
The control means are not significantly different (p = 0.80)	0.25996	2.306		

Hypothesis Test (1-tail, 0.05)	MSDu	MSDp	MSB	MSE	F-Prob	df
Dunnett's Test indicates no significant differences	0.00371	0.17983	1.4E-06	5.6E-06	0.97804	8, 36
Treatments vs JW9						

Dose-Response Plot



ToxCalc v5.0

Reviewed by: KS

Neanthes arenaceodentata Survival and Growth Test-Individual Biomass

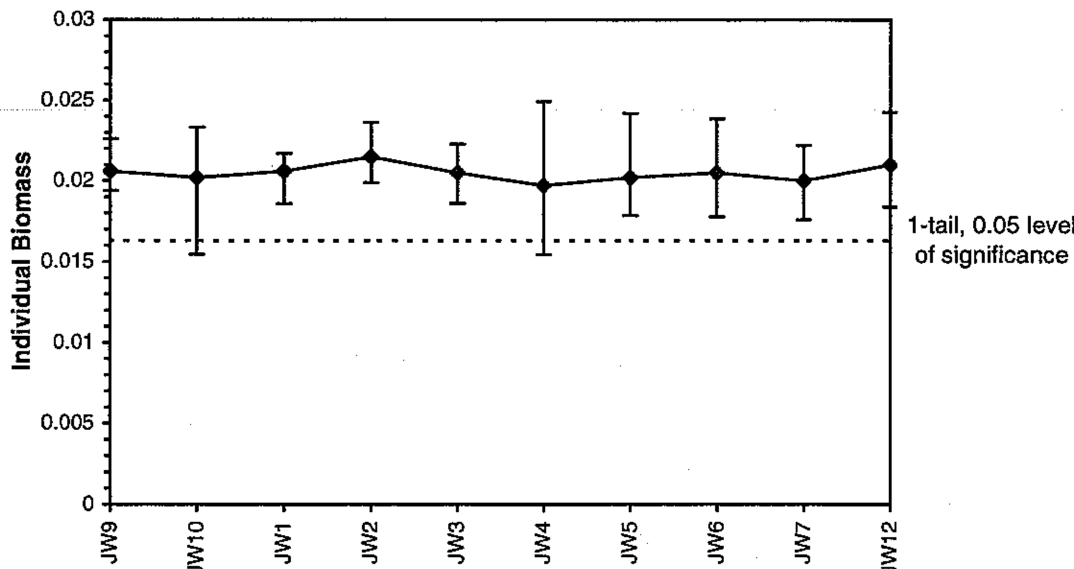
Start Date:	2/24/2006	Test ID:	NA128-0106	Sample ID:	128-Jacques Whitford
End Date:	3/16/2006	Lab ID:	VIZ-Vizon SciTec Toxicology	Sample Type:	SM-Sediment
Sample Date:		Protocol:	PSEP ~~1991~~ 1995-Polychaetes	Test Species:	NA-Neanthes arenaceodentata
Comments:					

Conc-%	1	2	3	4	5
JW9	0.0194	0.0216	0.0226	0.0199	0.0196
JW10	0.0234	0.0191	0.0223	0.0209	0.0155
JW1	0.0217	0.0200	0.0186	0.0214	0.0214
JW2	0.0233	0.0207	0.0236	0.0198	0.0199
JW3	0.0223	0.0212	0.0189	0.0187	0.0216
JW4	0.0155	0.0169	0.0249	0.0234	0.0179
JW5	0.0178	0.0181	0.0214	0.0193	0.0241
JW6	0.0192	0.0190	0.0178	0.0239	0.0228
JW7	0.0176	0.0222	0.0204	0.0216	0.0181
JW12	0.0184	0.0201	0.0243	0.0208	0.0215

			Transform: Untransformed						1-Tailed	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
JW9	0.0206	1.0195	0.0206	0.0194	0.0226	6.761	5			
JW10	0.0202	1.0000	0.0202	0.0155	0.0234	15.307	5	*		
JW1	0.0206	1.0176	0.0206	0.0186	0.0217	6.394	5	-0.222	2.480	0.0040
JW2	0.0215	1.0595	0.0215	0.0198	0.0236	8.624	5	-0.750	2.480	0.0040
JW3	0.0205	1.0144	0.0205	0.0187	0.0223	8.071	5	-0.181	2.480	0.0040
JW4	0.0197	0.9735	0.0197	0.0155	0.0249	21.287	5	0.334	2.480	0.0040
JW5	0.0202	0.9951	0.0202	0.0178	0.0241	13.100	5	0.061	2.480	0.0040
JW6	0.0205	1.0136	0.0205	0.0178	0.0239	12.914	5	-0.172	2.480	0.0040
JW7	0.0200	0.9868	0.0200	0.0176	0.0222	10.335	5	0.166	2.480	0.0040
JW12	0.0210	1.0383	0.0210	0.0184	0.0243	10.312	5	-0.482	2.480	0.0040

Auxiliary Tests	Statistic		Critical		Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.97067		0.926		0.18365	-0.5916
Bartlett's Test indicates equal variances (p = 0.51)	7.20771		20.0902			
The control means are not significantly different (p = 0.80)	0.25996		2.306			
Hypothesis Test (1-tail, 0.05)	**MSDu**	**MSDp**	**MSB**	**MSE**	**F-Prob**	**df**
Dunnett's Test indicates no significant differences	0.00398	0.19678	1.4E-06	6.5E-06	0.9852	8, 36
Treatments vs JW10						

Dose-Response Plot



 ToxCalc v5.0 Reviewed by: KS

Neanthes arenaceodentata Survival and Growth Test-Total Biomass

Start Date:	2/24/2006	Test ID:	NA128-0106	Sample ID:	128-Jacques Whitford
End Date:	3/16/2006	Lab ID:	VIZ-Vizon SciTec Toxicology	Sample Type:	SM-Sediment
Sample Date:		Protocol:	PSEP ~~1991~~ 1995-Polychaetes	Test Species:	NA-Neanthes arenaceodentata
Comments:					

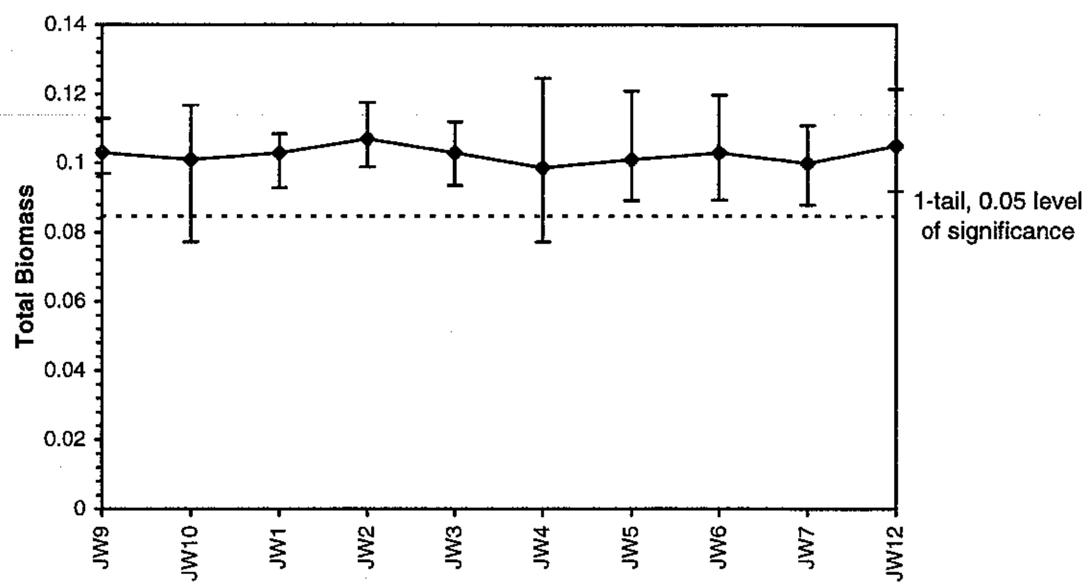
Conc-%	1	2	3	4	5
JW9	0.0972	0.1078	0.1132	0.0997	0.0982
JW10	0.1169	0.0955	0.1117	0.1047	0.0775
JW1	0.1086	0.0998	0.0930	0.1070	0.1069
JW2	0.1165	0.1035	0.1179	0.0992	0.0993
JW3	0.1117	0.1058	0.0946	0.0933	0.1081
JW4	0.0773	0.0845	0.1246	0.1172	0.0893
JW5	0.0890	0.0907	0.1070	0.0964	0.1207
JW6	0.0958	0.0949	0.0890	0.1194	0.1141
JW7	0.0879	0.1110	0.1020	0.1082	0.0905
JW12	0.0921	0.1003	0.1215	0.1041	0.1077

			Transform: Untransformed						1-Tailed	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
JW9	0.1032	1.0195	0.1032	0.0972	0.1132	6.761	5	*		
JW10	0.1012	1.0000	0.1012	0.0775	0.1169	15.307	5			
JW1	0.1030	1.0176	0.1030	0.0930	0.1086	6.394	5	0.026	2.480	0.0186
JW2	0.1073	1.0595	0.1073	0.0992	0.1179	8.624	5	-0.541	2.480	0.0186
JW3	0.1027	1.0144	0.1027	0.0933	0.1117	8.071	5	0.070	2.480	0.0186
JW4	0.0986	0.9735	0.0986	0.0773	0.1246	21.287	5	0.623	2.480	0.0186
JW5	0.1008	0.9951	0.1008	0.0890	0.1207	13.100	5	0.330	2.480	0.0186
JW6	0.1026	1.0136	0.1026	0.0890	0.1194	12.914	5	0.080	2.480	0.0186
JW7	0.0999	0.9868	0.0999	0.0879	0.1110	10.335	5	0.442	2.480	0.0186
JW12	0.1051	1.0383	0.1051	0.0921	0.1215	10.312	5	-0.254	2.480	0.0186

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.96276	0.926	0.4055	-0.4807
Bartlett's Test indicates equal variances (p = 0.40)	8.38986	20.0902		
The control means are not significantly different (p = 0.80)	0.25996	2.306		

Hypothesis Test (1-tail, 0.05)	MSDu	MSDp	MSB	MSE	F-Prob	df
Dunnett's Test indicates no significant differences	0.01856	0.17983	3.5E-05	0.00014	0.97804	8, 36
Treatments vs JW9						

Dose-Response Plot



 ToxCalc v5.0 Reviewed by: KS

Neanthes arenaceodentata Survival and Growth Test-Total Biomass

Start Date:	2/24/2006	Test ID:	NA128-0106	Sample ID:	128-Jacques Whitford
End Date:	3/16/2006	Lab ID:	VIZ-Vizon SciTec Toxicology	Sample Type:	SM-Sediment
Sample Date:		Protocol:	PSEP ~~1997~~ 1995 -Polychaetes	Test Species:	NA-Neanthes arenaceodentata
Comments:					

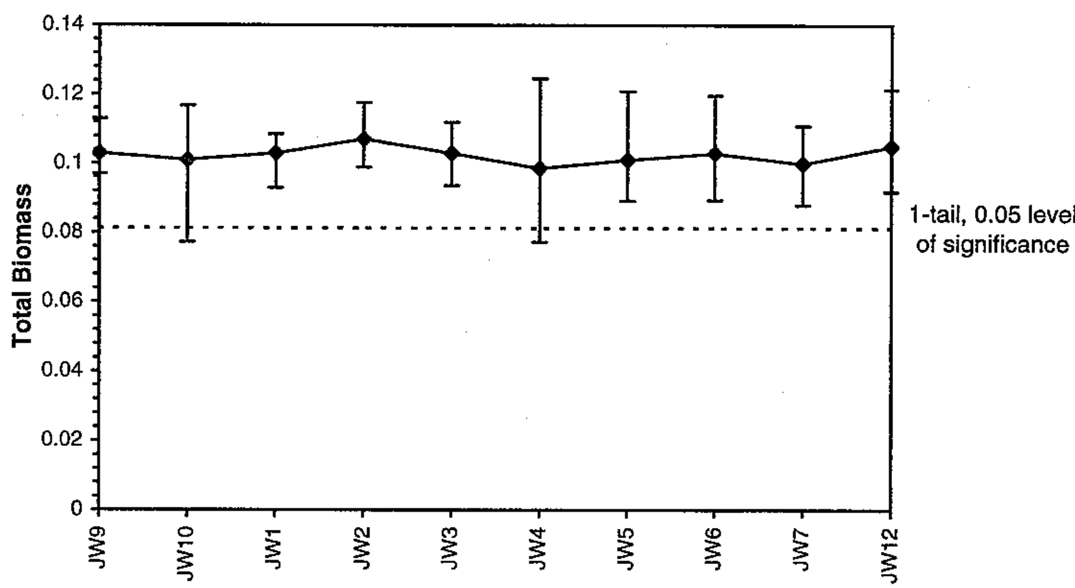
Conc-%	1	2	3	4	5
JW9	0.0972	0.1078	0.1132	0.0997	0.0982
JW10	0.1169	0.0955	0.1117	0.1047	0.0775
JW1	0.1086	0.0998	0.0930	0.1070	0.1069
JW2	0.1165	0.1035	0.1179	0.0992	0.0993
JW3	0.1117	0.1058	0.0946	0.0933	0.1081
JW4	0.0773	0.0845	0.1246	0.1172	0.0893
JW5	0.0890	0.0907	0.1070	0.0964	0.1207
JW6	0.0958	0.0949	0.0890	0.1194	0.1141
JW7	0.0879	0.1110	0.1020	0.1082	0.0905
JW12	0.0921	0.1003	0.1215	0.1041	0.1077

			Transform: Untransformed						1-Tailed	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
JW9	0.1032	1.0195	0.1032	0.0972	0.1132	6.761	5			
JW10	0.1012	1.0000	0.1012	0.0775	0.1169	15.307	5	*		
JW1	0.1030	1.0176	0.1030	0.0930	0.1086	6.394	5	-0.222	2.480	0.0199
JW2	0.1073	1.0595	0.1073	0.0992	0.1179	8.624	5	-0.750	2.480	0.0199
JW3	0.1027	1.0144	0.1027	0.0933	0.1117	8.071	5	-0.181	2.480	0.0199
JW4	0.0986	0.9735	0.0986	0.0773	0.1246	21.287	5	0.334	2.480	0.0199
JW5	0.1008	0.9951	0.1008	0.0890	0.1207	13.100	5	0.061	2.480	0.0199
JW6	0.1026	1.0136	0.1026	0.0890	0.1194	12.914	5	-0.172	2.480	0.0199
JW7	0.0999	0.9868	0.0999	0.0879	0.1110	10.335	5	0.166	2.480	0.0199
JW12	0.1051	1.0383	0.1051	0.0921	0.1215	10.312	5	-0.482	2.480	0.0199

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.97067	0.926	0.18365	-0.5916
Bartlett's Test indicates equal variances (p = 0.51)	7.20771	20.0902		
The control means are not significantly different (p = 0.80)	0.25996	2.306		

Hypothesis Test (1-tail, 0.05)	MSDu	MSDp	MSB	MSE	F-Prob	df
Dunnett's Test indicates no significant differences	0.01992	0.19678	3.5E-05	0.00016	0.9852	8, 36
Treatments vs JW10						

Dose-Response Plot



 ToxCalc v5.0 Reviewed by: KS

Neanthes arenaceodentata Survival and Growth Test-Growth Rate

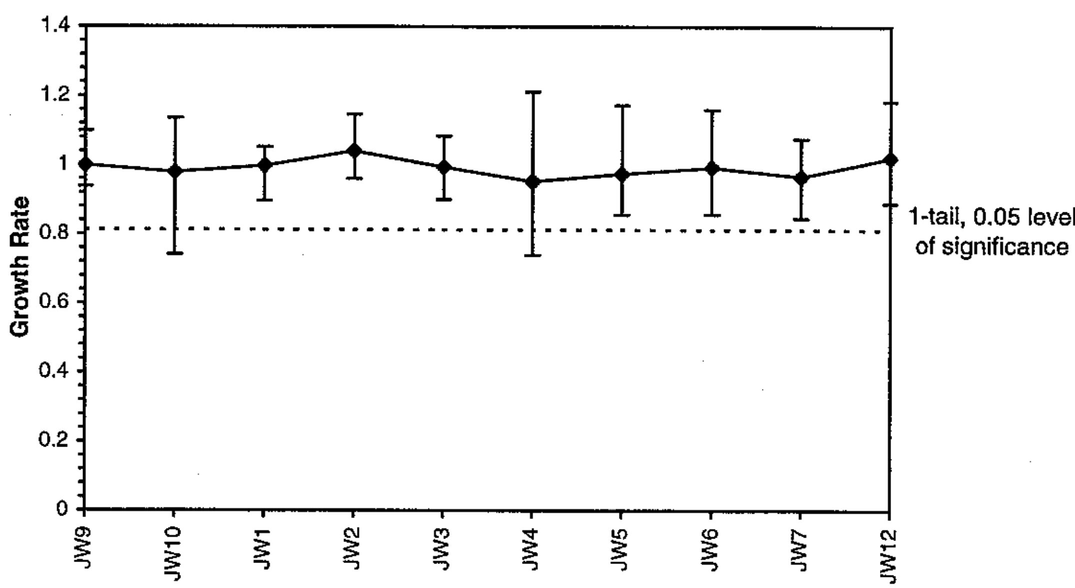
Start Date:	2/24/2006	Test ID:	NA128-0106	Sample ID:	128-Jacques Whitford
End Date:	3/16/2006	Lab ID:	VIZ-Vizon SciTec Toxicology	Sample Type:	SM-Sediment
Sample Date:		Protocol:	PSEP ~~1991~~ 1995-Polychaetes	Test Species:	NA-Neanthes arenaceodentata
Comments:					

Conc-%	1	2	3	4	5
JW9	0.9383	1.0449	1.0984	0.9635	0.9485
JW10	1.1356	0.9211	1.0830	1.0132	0.7419
JW1	1.0520	0.9640	0.8960	1.0362	1.0358
JW2	1.1319	1.0011	1.1454	0.9585	0.9592
JW3	1.0832	1.0249	0.9124	0.8991	1.0479
JW4	0.7390	0.8116	1.2124	1.1381	0.8595
JW5	0.8560	0.8731	1.0366	0.9309	1.1735
JW6	0.9242	0.9157	0.8566	1.1601	1.1071
JW7	0.8457	1.0761	0.9860	1.0485	0.8719
JW12	0.8870	0.9691	1.1813	1.0073	1.0439

			Transform: Untransformed						1-Tailed	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
JW9	0.9987	1.0202	0.9987	0.9383	1.0984	6.988	5	*		
JW10	0.9790	1.0000	0.9790	0.7419	1.1356	15.831	5			
JW1	0.9968	1.0182	0.9968	0.8960	1.0520	6.608	5	0.026	2.480	0.1856
JW2	1.0392	1.0616	1.0392	0.9585	1.1454	8.902	5	-0.541	2.480	0.1856
JW3	0.9935	1.0149	0.9935	0.8991	1.0832	8.343	5	0.070	2.480	0.1856
JW4	0.9521	0.9726	0.9521	0.7390	1.2124	22.036	5	0.623	2.480	0.1856
JW5	0.9740	0.9950	0.9740	0.8560	1.1735	13.551	5	0.330	2.480	0.1856
JW6	0.9927	1.0141	0.9927	0.8566	1.1601	13.350	5	0.080	2.480	0.1856
JW7	0.9656	0.9864	0.9656	0.8457	1.0761	10.694	5	0.442	2.480	0.1856
JW12	1.0177	1.0396	1.0177	0.8870	1.1813	10.651	5	-0.254	2.480	0.1856

Auxiliary Tests	Statistic		Critical		Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.96276		0.926		0.4055	-0.4807
Bartlett's Test indicates equal variances (p = 0.40)	8.38986		20.0902			
The control means are not significantly different (p = 0.80)	0.25996		2.306			
Hypothesis Test (1-tail, 0.05)	**MSDu**	**MSDp**	**MSB**	**MSE**	**F-Prob**	**df**
Dunnett's Test indicates no significant differences	0.18563	0.18587	0.00348	0.01401	0.97804	8, 36
Treatments vs JW9						

Dose-Response Plot



 ToxCalc v5.0 Reviewed by: KS

Neanthes arenaceodentata Survival and Growth Test-Growth Rate

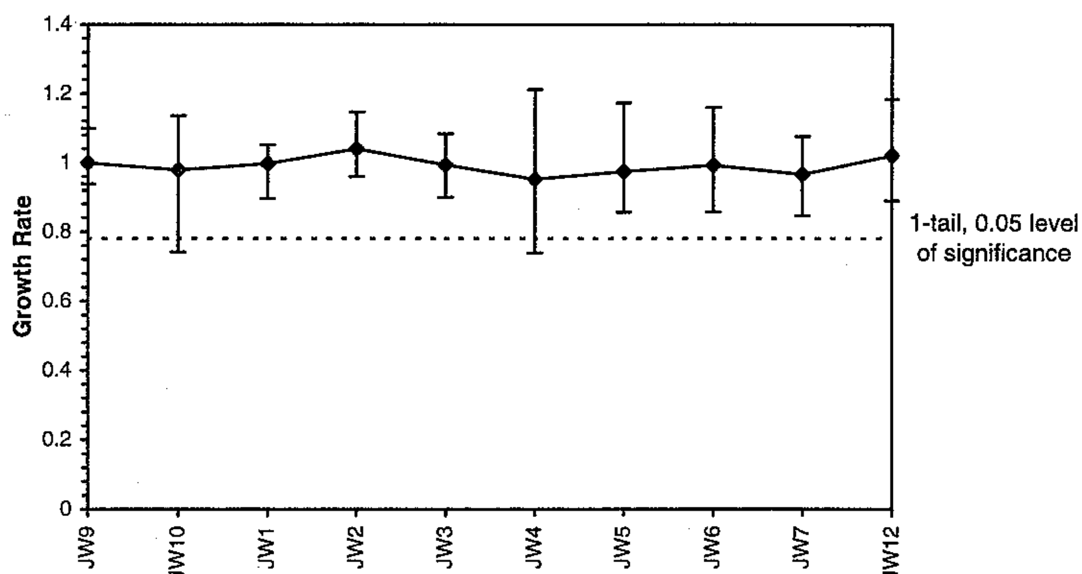
Start Date:	2/24/2006	Test ID:	NA128-0106	Sample ID:	128-Jacques Whitford
End Date:	3/16/2006	Lab ID:	VIZ-Vizon SciTec Toxicology	Sample Type:	SM-Sediment
Sample Date:		Protocol:	PSEP ~~1991~~ 1995 -Polychaetes	Test Species:	NA-Neanthes arenaceodentata
Comments:					

Conc-%	1	2	3	4	5
JW9	0.9383	1.0449	1.0984	0.9635	0.9485
JW10	1.1356	0.9211	1.0830	1.0132	0.7419
JW1	1.0520	0.9640	0.8960	1.0362	1.0358
JW2	1.1319	1.0011	1.1454	0.9585	0.9592
JW3	1.0832	1.0249	0.9124	0.8991	1.0479
JW4	0.7390	0.8116	1.2124	1.1381	0.8595
JW5	0.8560	0.8731	1.0366	0.9309	1.1735
JW6	0.9242	0.9157	0.8566	1.1601	1.1071
JW7	0.8457	1.0761	0.9860	1.0485	0.8719
JW12	0.8870	0.9691	1.1813	1.0073	1.0439

			Transform: Untransformed						1-Tailed	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD
JW9	0.9987	1.0202	0.9987	0.9383	1.0984	6.988	5			
JW10	0.9790	1.0000	0.9790	0.7419	1.1356	15.831	5	*		
JW1	0.9968	1.0182	0.9968	0.8960	1.0520	6.608	5	-0.222	2.480	0.1992
JW2	1.0392	1.0616	1.0392	0.9585	1.1454	8.902	5	-0.750	2.480	0.1992
JW3	0.9935	1.0149	0.9935	0.8991	1.0832	8.343	5	-0.181	2.480	0.1992
JW4	0.9521	0.9726	0.9521	0.7390	1.2124	22.036	5	0.334	2.480	0.1992
JW5	0.9740	0.9950	0.9740	0.8560	1.1735	13.551	5	0.061	2.480	0.1992
JW6	0.9927	1.0141	0.9927	0.8566	1.1601	13.350	5	-0.172	2.480	0.1992
JW7	0.9656	0.9864	0.9656	0.8457	1.0761	10.694	5	0.166	2.480	0.1992
JW12	1.0177	1.0396	1.0177	0.8870	1.1813	10.651	5	-0.482	2.480	0.1992

Auxiliary Tests	Statistic		Critical		Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.01)	0.97067		0.926		0.18365	-0.5916
Bartlett's Test indicates equal variances (p = 0.51)	7.20771		20.0902			
The control means are not significantly different (p = 0.80)	0.25996		2.306			
Hypothesis Test (1-tail, 0.05)	**MSDu**	**MSDp**	**MSB**	**MSE**	**F-Prob**	**df**
Dunnett's Test indicates no significant differences	0.19923	0.20351	0.00354	0.01613	0.9852	8, 36
Treatments vs JW10						

Dose-Response Plot



 ToxCalc v5.0 Reviewed by: KS

Neanthes arenaceodentata Survival and Growth Test-Individual Biomass

Start Date:	2/24/2006	Test ID:	NA128-0206	Sample ID:	128-Jacques Whitford
End Date:	3/16/2006	Lab ID:	VIZ-Vizon SciTec Toxicology	Sample Type:	SM-Sediment
Sample Date:		Protocol:	PSEP ~~1991~~ 1995 -Polychaetes	Test Species:	NA-Neanthes arenaceodentata
Comments:	Comparison with Laboratory Control				

Conc-%	1	2	3	4	5	6	7	8	9	10
Control M	0.0210	0.0303	0.0222	0.0275	0.0225	0.0198	0.0201	0.0190	0.0195	0.0190
Control D	0.0206	0.0190	0.0248	0.0188	0.0196	0.0234	0.0263	0.0186	0.0219	0.0209
JW1	0.0217	0.0200	0.0186	0.0214	0.0214					
JW2	0.0233	0.0207	0.0236	0.0198	0.0199					
JW3	0.0223	0.0212	0.0189	0.0187	0.0216					
JW4	0.0155	0.0169	0.0249	0.0234	0.0179					
JW5	0.0178	0.0181	0.0214	0.0193	0.0241					
JW6	0.0192	0.0190	0.0178	0.0239	0.0228					
JW7	0.0176	0.0222	0.0204	0.0216	0.0181					
JW9	0.0194	0.0216	0.0226	0.0199	0.0196					
JW10	0.0234	0.0191	0.0223	0.0209	0.0155					
JW12	0.0184	0.0201	0.0243	0.0208	0.0215					

			Transform: Untransformed					Rank	1-Tailed
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical
Pooled	0.0217	1.0000	0.0217	0.0186	0.0303	14.924	20		
JW1	0.0206	0.9478	0.0206	0.0186	0.0217	6.394	5	59.00	27.00
JW2	0.0215	0.9869	0.0215	0.0198	0.0236	8.624	5	72.00	27.00
JW3	0.0205	0.9448	0.0205	0.0187	0.0223	8.071	5	56.00	27.00
JW4	0.0197	0.9067	0.0197	0.0155	0.0249	21.287	5	47.00	27.00
JW5	0.0202	0.9269	0.0202	0.0178	0.0241	13.100	5	48.00	27.00
JW6	0.0205	0.9441	0.0205	0.0178	0.0239	12.914	5	54.00	27.00
JW7	0.0200	0.9192	0.0200	0.0176	0.0222	10.335	5	49.00	27.00
JW9	0.0206	0.9496	0.0206	0.0194	0.0226	6.761	5	62.00	27.00
JW10	0.0202	0.9314	0.0202	0.0155	0.0234	15.307	5	59.00	27.00
JW12	0.0210	0.9671	0.0210	0.0184	0.0243	10.312	5	61.00	27.00

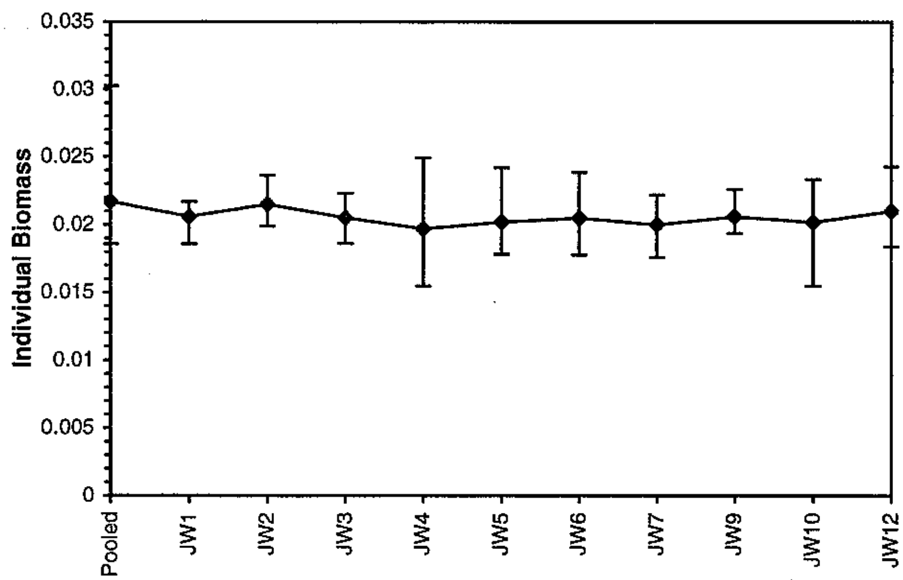
Auxiliary Tests	Statistic	Critical	Skew	Kurt
Kolmogorov D Test indicates non-normal distribution (p <= 0.01)	1.10836	1.035	0.82635	0.84647
Bartlett's Test indicates equal variances (p = 0.36)	10.9892	23.2093		
The control means are not significantly different (p = 0.64)	0.47822	2.10092		

Hypothesis Test (1-tail, 0.05)

Wilcoxon Rank Sum Test indicates no significant differences

Treatments vs Pooled Controls

Dose-Response Plot



 ToxCalc v5.0 Reviewed by: KS

Neanthes arenaceodentata Survival and Growth Test-Total Biomass

Start Date:	2/24/2006	Test ID: NA128-0206		Sample ID:	128-Jacques Whitford
End Date:	3/16/2006	Lab ID: VIZ-Vizon SciTec Toxicology		Sample Type:	SM-Sediment
Sample Date:		Protocol: PSEP ~~1991~~ 1995-Polychaetes		Test Species:	NA-Neanthes arenaceodentata
Comments:	Comparison with Laboratory Control				

Conc-%	1	2	3	4	5	6	7	8	9	10
Control M	0.1052	0.1515	0.1111	0.1376	0.1124	0.0990	0.1006	0.0951	0.0974	0.0950
Control D	0.1028	0.0948	0.1238	0.0940	0.0980	0.1172	0.1315	0.0931	0.1096	0.1047
JW1	0.1086	0.0998	0.0930	0.1070	0.1069					
JW2	0.1165	0.1035	0.1179	0.0992	0.0993					
JW3	0.1117	0.1058	0.0946	0.0933	0.1081					
JW4	0.0773	0.0845	0.1246	0.1172	0.0893					
JW5	0.0890	0.0907	0.1070	0.0964	0.1207					
JW6	0.0958	0.0949	0.0890	0.1194	0.1141					
JW7	0.0879	0.1110	0.1020	0.1082	0.0905					
JW9	0.0972	0.1078	0.1132	0.0997	0.0982					
JW10	0.1169	0.0955	0.1117	0.1047	0.0775					
JW12	0.0921	0.1003	0.1215	0.1041	0.1077					

			Transform: Untransformed					Rank	1-Tailed
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical
Pooled	0.1087	1.0000	0.1087	0.0931	0.1515	14.924	20		
JW1	0.1030	0.9478	0.1030	0.0930	0.1086	6.394	5	59.00	27.00
JW2	0.1073	0.9869	0.1073	0.0992	0.1179	8.624	5	72.00	27.00
JW3	0.1027	0.9448	0.1027	0.0933	0.1117	8.071	5	56.00	27.00
JW4	0.0986	0.9067	0.0986	0.0773	0.1246	21.287	5	47.00	27.00
JW5	0.1008	0.9269	0.1008	0.0890	0.1207	13.100	5	48.00	27.00
JW6	0.1026	0.9441	0.1026	0.0890	0.1194	12.914	5	54.00	27.00
JW7	0.0999	0.9192	0.0999	0.0879	0.1110	10.335	5	49.00	27.00
JW9	0.1032	0.9496	0.1032	0.0972	0.1132	6.761	5	62.00	27.00
JW10	0.1012	0.9314	0.1012	0.0775	0.1169	15.307	5	59.00	27.00
JW12	0.1051	0.9671	0.1051	0.0921	0.1215	10.312	5	61.00	27.00

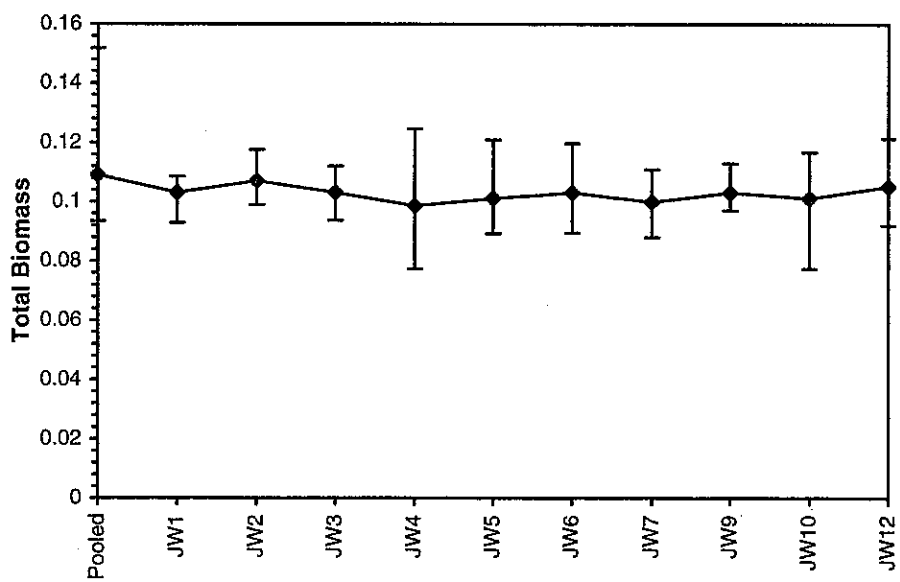
Auxiliary Tests	Statistic	Critical	Skew	Kurt
Kolmogorov D Test indicates non-normal distribution (p <= 0.01)	1.10836	1.035	0.82635	0.84647
Bartlett's Test indicates equal variances (p = 0.36)	10.9892	23.2093		
The control means are not significantly different (p = 0.64)	0.47822	2.10092		

Hypothesis Test (1-tail, 0.05)

Wilcoxon Rank Sum Test indicates no significant differences

Treatments vs Pooled Controls

Dose-Response Plot



Neanthes arenaceodentata Survival and Growth Test-Growth Rate

Start Date:	2/24/2006	Test ID:	NA128-0206	Sample ID:	128-Jacques Whitford
End Date:	3/16/2006	Lab ID:	VIZ-Vizon SciTec Toxicology	Sample Type:	SM-Sediment
Sample Date:		Protocol:	PSEP ~~1991~~ 1995 -Polychaetes	Test Species:	NA-Neanthes arenaceodentata
Comments:	Comparison with Laboratory Control				

Conc-%	1	2	3	4	5	6	7	8	9	10
Control M	1.0182	1.4815	1.0776	1.3423	1.0902	0.9563	0.9724	0.9174	0.9400	0.9162
Control D	0.9946	0.9141	1.2043	0.9060	0.9461	1.1384	1.2812	0.8977	1.0621	1.0134
JW1	1.0520	0.9640	0.8960	1.0362	1.0358					
JW2	1.1319	1.0011	1.1454	0.9585	0.9592					
JW3	1.0832	1.0249	0.9124	0.8991	1.0479					
JW4	0.7390	0.8116	1.2124	1.1381	0.8595					
JW5	0.8560	0.8731	1.0366	0.9309	1.1735					
JW6	0.9242	0.9157	0.8566	1.1601	1.1071					
JW7	0.8457	1.0761	0.9860	1.0485	0.8719					
JW9	0.9383	1.0449	1.0984	0.9635	0.9485					
JW10	1.1356	0.9211	1.0830	1.0132	0.7419					
JW12	0.8870	0.9691	1.1813	1.0073	1.0439					

			Transform: Untransformed					Rank	1-Tailed
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical
Pooled	1.0535	1.0000	1.0535	0.8977	1.4815	15.398	20		
JW1	0.9968	0.9462	0.9968	0.8960	1.0520	6.608	5	59.00	27.00
JW2	1.0392	0.9864	1.0392	0.9585	1.1454	8.902	5	72.00	27.00
JW3	0.9935	0.9430	0.9935	0.8991	1.0832	8.343	5	56.00	27.00
JW4	0.9521	0.9038	0.9521	0.7390	1.2124	22.036	5	47.00	27.00
JW5	0.9740	0.9246	0.9740	0.8560	1.1735	13.551	5	48.00	27.00
JW6	0.9927	0.9423	0.9927	0.8566	1.1601	13.350	5	54.00	27.00
JW7	0.9656	0.9166	0.9656	0.8457	1.0761	10.694	5	49.00	27.00
JW9	0.9987	0.9480	0.9987	0.9383	1.0984	6.988	5	62.00	27.00
JW10	0.9790	0.9292	0.9790	0.7419	1.1356	15.831	5	59.00	27.00
JW12	1.0177	0.9660	1.0177	0.8870	1.1813	10.651	5	61.00	27.00

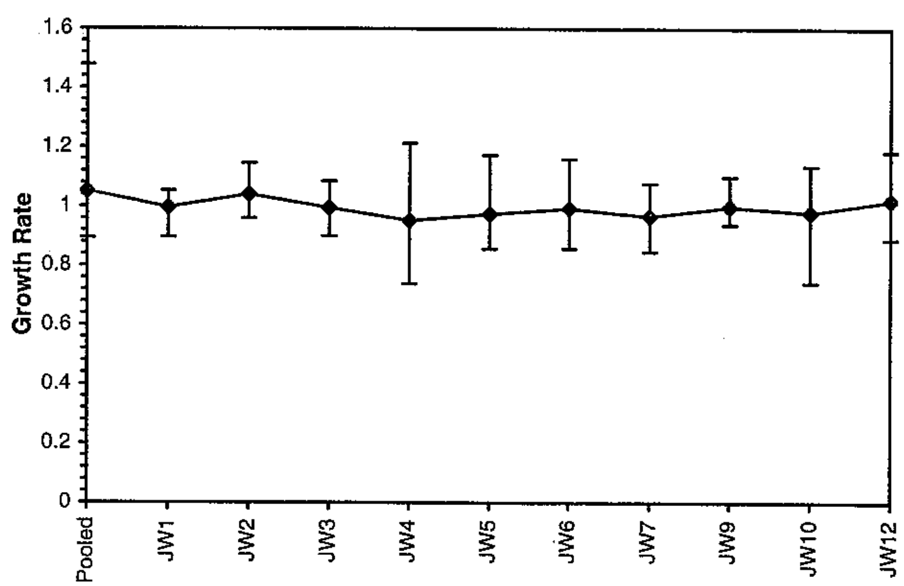
Auxiliary Tests	Statistic	Critical	Skew	Kurt
Kolmogorov D Test indicates non-normal distribution ($p <= 0.01$)	1.10836	1.035	0.82635	0.84647
Bartlett's Test indicates equal variances ($p = 0.36$)	10.9892	23.2093		
The control means are not significantly different ($p = 0.64$)	0.47822	2.10092		

Hypothesis Test (1-tail, 0.05)

Wilcoxon Rank Sum Test indicates no significant differences

Treatments vs Pooled Controls

Dose-Response Plot



 ToxCalc v5.0 Reviewed by: KS

Vizon SciTec Inc.
Vancouver, BC

Summary of Survival Results for
***Neanthes arenaceodentata* Tests**

Sample ID	Log In ID	# Surviving	Sample Survival (%)	Mean Survival (%)	SD
Control M-1	-	5	100	100	0
Control M-1	-	5	100	**Pooled**	**Pooled**
Control M-1	-	5	100	100	0
Control M-1	-	5	100		
Control M-1	-	5	100		
Control M-2	-	5	100	100	0
Control M-2	-	5	100		
Control M-2	-	5	100		
Control M-2	-	5	100		
Control M-2	-	5	100		
Control D-1	-	5	100	100	0
Control D-1	-	5	100	**Pooled**	**Pooled**
Control D-1	-	5	100	100	0
Control D-1	-	5	100		
Control D-1	-	5	100		
Control D-2	-	5	100	100	0
Control D-2	-	5	100		
Control D-2	-	5	100		
Control D-2	-	5	100		
Control D-2	-	5	100		
JW1	060210J-01	5	100	100	0
JW1	060210J-01	5	100		
JW1	060210J-01	5	100		
JW1	060210J-01	5	100		
JW1	060210J-01	5	100		
JW2	060210J-02	5	100	100	0
JW2	060210J-02	5	100		
JW2	060210J-02	5	100		
JW2	060210J-02	5	100		
JW2	060210J-02	5	100		
JW3	060210J-03	5	100	100	0
JW3	060210J-03	5	100		
JW3	060210J-03	5	100		
JW3	060210J-03	5	100		
JW3	060210J-03	5	100		
JW4	060210J-04	5	100	100	0
JW4	060210J-04	5	100		
JW4	060210J-04	5	100		
JW4	060210J-04	5	100		
JW4	060210J-04	5	100		
JW5	060210J-05	5	100	100	0
JW5	060210J-05	5	100		
JW5	060210J-05	5	100		
JW5	060210J-05	5	100		
JW5	060210J-05	5	100		
JW6	060210J-06	5	100	100	0
JW6	060210J-06	5	100		
JW6	060210J-06	5	100		
JW6	060210J-06	5	100		
JW6	060210J-06	5	100		

KK 06Apr13

Vizon SciTec Inc.
Vancouver, BC

Summary of Survival Results for
***Neanthes arenaceodentata* Tests**

Sample ID	Log In ID	# Surviving	Sample Survival (%)	Mean Survival (%)	SD
JW7	060210J-07	5	100	100	0
JW7	060210J-07	5	100		
JW7	060210J-07	5	100		
JW7	060210J-07	5	100		
JW7	060210J-07	5	100		
JW9	060210J-09	5	100	100	0
JW9	060210J-09	5	100		
JW9	060210J-09	5	100		
JW9	060210J-09	5	100		
JW9	060210J-09	5	100		
JW10	060210J-10	5	100	100	0
JW10	060210J-10	5	100		
JW10	060210J-10	5	100		
JW10	060210J-10	5	100		
JW10	060210J-10	5	100		
JW12	060210J-12	5	100	100	0
JW12	060210J-12	5	100		
JW12	060210J-12	5	100		
JW12	060210J-12	5	100		
JW12	060210J-12	5	100		

KK 06Apr13

Vizon SciTec Inc.

Dry Weights of Polychaete Worms

Client # / Name: #128 Jacques Whitford

Sample ID: JW1-JW7, JW9, JW10, JW12

Start & End Date: 24-Feb-06 & 16-Mar-06

Mean Dry Weight at Test Initiation (mg/worm): 0.67

Sample ID	Rep	# Worms	Boat Wt. (g)	Boat & Worms Wt (g)	Wt. of Worms (mg)	Mean Wt./Worm (mg)	Mean Wt./Conc. (mg)	SD	Estimated Individual Growth Rate (mg/worm/d)	Mean Growth Rate (mg/worm/d)	SD
Ctrl M-1	A	5	1.14760	1.25277	105.17	21.03	24.71	3.99	1.02	1.20	0.20
Ctrl M-1	B	5	1.13655	1.28805	151.50	30.30	**Pooled**	**Pooled**	1.48	**Pooled**	**Pooled**
Ctrl M-1	C	5	1.14331	1.25442	111.11	22.22	22.09	3.85	1.08	1.07	0.20
Ctrl M-1	D	5	1.14270	1.28028	137.58	27.52			1.34		
Ctrl M-1	E	5	1.14036	1.25273	112.37	22.47			1.09		
Ctrl M-2	A	5	1.14090	1.23988	98.98	19.80	19.48	0.49	0.96	0.94	0.02
Ctrl M-2	B	5	1.14091	1.24150	100.59	20.12			0.97		
Ctrl M-2	C	5	1.14644	1.24153	95.09	19.02			0.92		
Ctrl M-2	D	5	1.14011	1.23746	97.35	19.47			0.94		
Ctrl M-2	E	5	1.13316	1.22813	94.97	18.99			0.92		
Ctrl D-1	A	5	1.15218	1.25499	102.81	20.56	20.53	2.46	0.99	0.99	0.12
Ctrl D-1	B	5	1.14470	1.23946	94.76	18.95	**Pooled**	**Pooled**	0.91	**Pooled**	**Pooled**
Ctrl D-1	C	5	1.15017	1.27395	123.78	24.76	21.39	2.67	1.20	1.04	0.12
Ctrl D-1	D	5	1.14731	1.24126	93.95	18.79			0.91		
Ctrl D-1	E	5	1.14274	1.24070	97.96	19.59			0.95		
Ctrl D-2	A	5	1.13813	1.25532	117.19	23.44	22.24	2.86	1.14	1.08	0.14
Ctrl D-2	B	5	1.14836	1.27983	131.47	26.29			1.28		
Ctrl D-2	C	5	1.14700	1.24012	93.12	18.62			0.90		
Ctrl D-2	D	5	1.14585	1.25541	109.56	21.91			1.06		
Ctrl D-2	E	5	1.14581	1.25050	104.69	20.94			1.01		
JW1	A	5	1.14218	1.25073	108.55	21.71	20.61	1.32	1.05	1.00	0.07
JW1	B	5	1.13837	1.23812	99.75	19.95			0.96		
JW1	C	5	1.14427	1.23722	92.95	18.59			0.90		
JW1	D	5	1.14960	1.25657	106.97	21.39			1.04		
JW1	E	5	1.14522	1.25215	106.93	21.39			1.04		
JW2	A	5	1.13556	1.25210	116.54	23.31	21.45	1.85	1.13	1.04	0.09
JW2	B	5	1.14007	1.24353	103.46	20.69			1.00		
JW2	C	5	1.14473	1.26262	117.89	23.58			1.15		
JW2	D	5	1.13840	1.23760	99.20	19.84			0.96		
JW2	E	5	1.14030	1.23957	99.27	19.85			0.96		
JW3	A	5	1.13580	1.24747	111.67	22.33	20.54	1.66	1.08	0.99	0.08
JW3	B	5	1.14253	1.24837	105.84	21.17			1.02		
JW3	C	5	1.14826	1.24285	94.59	18.92			0.91		
JW3	D	5	1.13356	1.22682	93.26	18.65			0.90		
JW3	E	5	1.14436	1.25250	108.14	21.63			1.05	KK06Ap13	

Dry Weights of Polychaete Worms

Client # / Name: #128 Jacques Whitford

Sample ID: JW1-JW7, JW9, JW10, JW12

Start & End Date: 24-Feb-06 & 16-Mar-06

Mean Dry Weight at Test Initiation (mg/worm): 0.67

Sample ID	Rep	# Worms	Boat Wt. (g)	Boat & Worms Wt (g)	Wt. of Worms (mg)	Mean Wt./Worm (mg)	Mean Wt./Conc. (mg)	SD	Estimated Individual Growth Rate (mg/worm/d)	Mean Growth Rate (mg/worm/d)	SD
JW4	A	5	1.13850	1.21575	77.25	15.45	19.71	4.20	0.74	0.95	0.21
JW4	B	5	1.14165	1.22616	84.51	16.90			0.81		
JW4	C	5	1.14981	1.27440	124.59	24.92			1.21		
JW4	D	5	1.14544	1.26260	117.16	23.43			1.14		
JW4	E	5	1.14700	1.23630	89.30	17.86			0.86		
JW5	A	5	1.14191	1.23086	88.95	17.79	20.15	2.64	0.86	0.97	0.13
JW5	B	5	1.13870	1.22936	90.66	18.13			0.87		
JW5	C	5	1.14091	1.24792	107.01	21.40			1.04		
JW5	D	5	1.13453	1.23097	96.44	19.29			0.93		
JW5	E	5	1.13800	1.25870	120.70	24.14			1.17		
JW6	A	5	1.15127	1.24704	95.77	19.15	20.52	2.65	0.92	0.99	0.13
JW6	B	5	1.14913	1.24405	94.92	18.98			0.92		
JW6	C	5	1.15185	1.24086	89.01	17.80			0.86		
JW6	D	5	1.14488	1.26424	119.36	23.87			1.16		
JW6	E	5	1.15003	1.26409	114.06	22.81			1.11		
JW7	A	5	1.14578	1.23370	87.92	17.58	19.98	2.07	0.85	0.97	0.10
JW7	B	5	1.15145	1.26241	110.96	22.19			1.08		
JW7	C	5	1.14695	1.24890	101.95	20.39			0.99		
JW7	D	5	1.13970	1.24790	108.20	21.64			1.05		
JW7	E	5	1.13646	1.22700	90.54	18.11			0.87		
JW9	A	5	1.13192	1.22910	97.18	19.44	20.64	1.40	0.94	1.00	0.07
JW9	B	5	1.13995	1.24779	107.84	21.57			1.04		
JW9	C	5	1.14511	1.25830	113.19	22.64			1.10		
JW9	D	5	1.13850	1.23820	99.70	19.94			0.96		
JW9	E	5	1.15048	1.24868	98.20	19.64			0.95		
JW10	A	5	1.14604	1.26295	116.91	23.38	20.25	3.10	1.14	0.98	0.15
JW10	B	5	1.14021	1.23567	95.46	19.09			0.92		
JW10	C	5	1.14706	1.25871	111.65	22.33			1.08		
JW10	D	5	1.14750	1.25217	104.67	20.93			1.01		
JW10	E	5	1.15078	1.22832	77.54	15.51			0.74		
JW12	A	5	1.13428	1.22633	92.05	18.41	21.02	2.17	0.89	1.02	0.11
JW12	B	5	1.15014	1.25040	100.26	20.05			0.97		
JW12	C	5	1.13710	1.25858	121.48	24.30			1.18		
JW12	D	5	1.15079	1.25487	104.08	20.82			1.01		
JW12	E	5	1.13741	1.24515	107.74	21.55			1.04	KK (illegible)	

Vizon SciTec. Inc. ***Neanthes*** **Initial Weights of Polychaete Worms**

Client # & Name: #128 Jacques Whitford Start Date and Time: 06-Feb-24 @ 14:30

Organism Lot #: DR060221 Weighing Dates: 06-Feb-23 and 06-Feb-25

Analyst(s): J Pickard, N May

Boat #	Replicate	# Worms	Boat Wt. (g)	Boat & Worms Wt. (g)	Wt. of Worms (mg)	Mean Wt./Worm (mg)	Mean Wt./Sample (mg)	SD
A	A	5	1.14534	1.14854	3.20	0.64	0.67	0.03
B	B	5	1.13762	1.14107	3.45	0.69		
C	C	5	1.13654	1.13996	3.42	0.68		
Analyst			JP	NM				

Vizon SciTec. Inc. ***Neanthes* Initial Weights of Polychaete Worms**

Client # & Name: #128 Jacques Whitford Start Date and Time: 06-Feb-24 @ 14:30

Organism Lot #: DR060221 Weighing Dates: 06 Feb 23 and 06-Feb-25

Analyst(s): J. Pickard, N Mury

Boat #	Replicate	# Worms	Boat Wt. (g)	Boat & Worms Wt. (g)	Wt. of Worms (mg)	Mean Wt./Worm (mg)	Mean Wt./Sample (mg)	SD
AN1	A	5	1.14534	1.14854	0.00	0.00	0.00	0.00
BN2	B	5	1.13762	1.14107	0.00	0.00		
CN3	C	5	1.13654	1.13996	0.00	0.00		
Analyst			JP	NM				

Dried in 60°C oven

N;/Biology/Bioassay/Forms/Neanthes/Neanthes Weights

FORM: 1604F05v1
2005/08/01

Vizon SciTec Inc.
Vancouver, BC

***Neanthes arenaceodentata* 20-d Test**
Dry Weights of Polychaete Worms

Client # & Name: 128 Jacques Whitford
Sample Date: 06 Feb 03, 04 and 07
Sample Received: 06-Feb-10
Organism Lot #: DR060221
Sample ID: JW 1-12
Analyst(s): G. Lunty K Seiber

Start Date and Time: 06-Feb-24 @ 14:30
End Date: 06-Mar-16
Weighing Dates: 06 MAR 15 06 MAR 17
Vizon #: 060210 J
ToxCalc. File ID: NA128-0106

Boat #	Sample ID	Replicate	# Worms	Boat Wt. (g)	Boat & Worms Wt. (g)	Wt. of Worms (mg)	Mean Wt./Worm (mg)	Mean Wt./Sample (mg)	SD
1	Control M-1	A	5	1.14760	1.25277	0.00	#DIV/0!	#DIV/0!	#DIV/0!
2	Control M-1	B	5	1.13655	1.28805	0.00	#DIV/0!		
3	Control M-1	C	5	1.14331	1.25442	0.00	#DIV/0!		
4	Control M-1	D	5	1.14270	1.280328	0.00	#DIV/0!		
5	Control M-1	E	5	1.1404330	1.25273	0.00	#DIV/0!		
6	Control M-2	A	5	1.14090	1.23998	0.00	#DIV/0!	#DIV/0!	#DIV/0!
7	Control M-2	B	5	1.14091	1.24150	0.00	#DIV/0!		
8	Control M-2	C	5	1.14644	1.24153	0.00	#DIV/0!		
9	Control M-2	D	5	1.14011	1.23746	0.00	#DIV/0!		
10	Control M-2	E	5	1.13316	1.22813	0.00	#DIV/0!		
11	Control D-1	A	5	1.1522318	1.25499	0.00	#DIV/0!	#DIV/0!	#DIV/0!
12	Control D-1	B	5	1.14470	1.23946	0.00	#DIV/0!		
13	Control D-1	C	5	1.15017	1.27395	0.00	#DIV/0!		
14	Control D-1	D	5	1.14731	1.241286	0.00	#DIV/0!		
15	Control D-1	E	5	1.14274	1.24070	0.00	#DIV/0!		
16	Control D-2	A	5	1.13813	1.25532	0.00	#DIV/0!	#DIV/0!	#DIV/0!
17	Control D-2	B	5	1.148436	1.27983	0.00	#DIV/0!		
18	Control D-2	C	5	1.14700	1.24012	0.00	#DIV/0!		
19	Control D-2	D	5	1.14585	1.25541	0.00	#DIV/0!		
20	Control D-2	E	5	1.14581	1.25050	0.00	#DIV/0!		
21	JW9	A	5	1.132~~07~~ 192	1.22910	0.00	#DIV/0!	#DIV/0!	#DIV/0!
22	JW9	B	5	~~1.13142~~44*	1.24779	0.00	#DIV/0!		
23	JW9	C	5	1.14511	1.25830	0.00	#DIV/0!		
24	JW9	D	5	1.13850	1.23820	0.00	#DIV/0!		
25	JW9	E	5	1.15048	1.24868	0.00	#DIV/0!		
26	JW1	A	5	1.14218	1.25073	0.00	#DIV/0!	#DIV/0!	#DIV/0!
27	JW1	B	5	1.138437	1.23812	0.00	#DIV/0!		
28	JW1	C	5	1.14427	1.23722	0.00	#DIV/0!		
29	JW1	D	5	1.14960	1.25657	0.00	#DIV/0!		
30	JW1	E	5	1.14522	1.25215	0.00	#DIV/0!		
31	JW2	A	5	1.13556	1.25210	0.00	#DIV/0!	#DIV/0!	#DIV/0!
32	JW2	B	5	1.14007	1.24353	0.00	#DIV/0!		
33	JW2	C	5	1.14473	1.26262	0.00	#DIV/0!		
34	JW2	D	5	1.13840	1.23760	0.00	#DIV/0!		
35	JW2	E	5	1.14030	1.23957	0.00	#DIV/0!		
71	QA/QC	QA/QC		1.15283	1.15272	0.00	-	-	-
72	QA/QC	QA/QC		1.14840	1.14836	0.00	-	-	-
1		A		1.14760	1.25319	0.00	-	-	-
Analyst			KS	GL	GL				

* BE 22 DRY wt (g) 1.13995 GL 06MAR15

Vizon SciTec Inc.
Vancouver, BC

***Neanthes arenaceodentata* 20-d Test**
Dry Weights of Polychaete Worms

Client # & Name: 128 Jacques Whitford

Start Date and Time: 06 Feb -24 @ 14:30

Sample Date: 06 Feb 03, 04 and 07

End Date: 06-Mar-16

Sample Received: 06 Feb-10

Weighing Dates: 06MAR15

Organism Lot #: DR060221

Vizon #: 060210J

Sample ID: JW 1-12

Toxalc. File ID: NA128-0106

Analyst(s): G. Lunty

Boat #	Sample ID	Replicate	# Worms	Boat Wt. (g)	Boat & Worms Wt. (g)	Wt. of Worms (mg)	Mean Wt./Worm (mg)	Mean Wt./Sample (mg)	SD
36	JW3	A	5	1.135480	1.24747	0.00	#DIV/0!	#DIV/0!	#DIV/0!
37	JW3	B	5	1.14253	1.24837	0.00	#DIV/0!		
38	JW3	C	5	1.14826	1.24285	0.00	#DIV/0!		
39	JW3	D	5	1.13356	1.22682	0.00	#DIV/0!		
40	JW3	E	5	1.14436	1.25250	0.00	#DIV/0!		
41	JW4	A	5	1.13850	1.21575	0.00	#DIV/0!	#DIV/0!	#DIV/0!
42	JW4	B	5	1.14165	1.22616	0.00	#DIV/0!		
43	JW4	C	5	1.14981	1.27440	0.00	#DIV/0!		
44	JW4	D	5	1.14544	1.26260	0.00	#DIV/0!		
45	JW4	E	5	1.14700	1.23630	0.00	#DIV/0!		
46	JW5	A	5	1.14191	1.23086	0.00	#DIV/0!	#DIV/0!	#DIV/0!
47	JW5	B	5	1.13870	1.22936	0.00	#DIV/0!		
48	JW5	C	5	1.14061	1.24792	0.00	#DIV/0!		
49	JW5	D	5	1.13453	1.23097	0.00	#DIV/0!		
50	JW5	E	5	1.13800	1.25870	0.00	#DIV/0!		
51	JW6	A	5	1.15127	1.24704	0.00	#DIV/0!	#DIV/0!	#DIV/0!
52	JW6	B	5	1.14913	1.24405	0.00	#DIV/0!		
53	JW6	C	5	1.15185	1.24086	0.00	#DIV/0!		
54	JW6	D	5	1.14488	1.26424	0.00	#DIV/0!		
55	JW6	E	6	1.15003	1.26409	0.00	#DIV/0!		
56	JW7	A	5	1.14578	1.23370	0.00	#DIV/0!	#DIV/0!	#DIV/0!
57	JW7	B	5	1.15145	1.26241	0.00	#DIV/0!		
58	JW7	C	5	1.147695	1.24890	0.00	#DIV/0!		
59	JW7	D	5	1.13970	1.24790	0.00	#DIV/0!		
60	JW7	E	5	1.13646	1.22700	0.00	#DIV/0!		
61	JW10	A	5	1.14604	1.26295	0.00	#DIV/0!	#DIV/0!	#DIV/0!
62	JW10	B	5	1.14021	1.23567	0.00	#DIV/0!		
63	JW10	C	5	1.14706	1.25871	0.00	#DIV/0!		
64	JW10	D	5	1.14750	1.25217	0.00	#DIV/0!		
65	JW10	E	5	1.15078	1.22832	0.00	#DIV/0!		
66	JW12	A	5	1.13428	1.22633	0.00	#DIV/0!	#DIV/0!	#DIV/0!
67	JW12	B	5	1.15014	1.25040	0.00	#DIV/0!		
68	JW12	C	5	1.13710	1.25858	0.00	#DIV/0!		
69	JW12	D	5	1.15079	1.25487	0.00	#DIV/0!		
70	JW12	E	5	1.13741	1.24515	0.00	#DIV/0!		
73	QA/QC	QA/QC		1.14306	1.14299	0.00	-	-	-
74	QA/QC	QA/QC		1.14305	1.14300	0.00	-	-	-
36	JW3	A		1.13584	1.24777	0.00	-	-	-
Analyst				GL	GL				

N;/Biology/Bioassay/Forms/Neanthes/Neanthes Weights.xls

FORM: 1604F07v1
2005/08/01

Vizon SciTec

Neanthes Survival and Change in Biomass Test
Aeration and Feeding Checks

Client # & Name: 128 Jaques Whitford

Start Date & Time: 06-Feb-24 14:30

Initial when aeration is checked. If air is off record DO and note which replicate(s) in comments section.

	Day 0	1	2	3	4	5	6	7	8	9
Date	Feb 23 / 24	Feb 24 / 25	Feb 26	Feb 27	Feb 28	Mar 1	Mar 2	Mar 03	Mar 04	Mar 05
Early AM	✓	✓✓	✓	✓	✓	✓	✓	✓		✓
Mid-day	✓	✓	✓	✓	✓	✓	✓	✓	NM	✓
Late PM	✓	✓	✓	✓	✓	✓	✓	✓	NM	✓

	Day 10	11	12	13	14	15	16	17	18	19
Date	06 Mar 06	06 Mar 07	06 Mar 08	06 Mar 09	06 Mar 10	06 Mar 11	06 Mar 12	06 Mar 13	06 Mar 14	06 Mar 15
Early AM	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Mid-day	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Late PM	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

	Day 20
Date	06 Mar 16
Early AM	✓
Mid-day	
Late PM	

Comments:

06-Feb-27 Airline blocked on replicate DW 10 D : DO 6.8 @ 21.1°C. Time: 8:18 J

H_2O change done on all replicates ; water quality measurements taken from replicate A JD

06-Mar-01 H_2O Δ done on all replicates ; water quality measurements taken from replicate B JD

06-Mar-05 H_2O Δ on all replicates ; WQ measurements from replicate C JD

06 Mar 08 H_2O Δ on all replicates ; WQ measurements from replicate D for all samples JD

06 Mar 14 H_2O Δ on all replicates ; WQ from rep D for all samples JD

(5mL of 8g/L Nutra-Marine per Rep)

Feeding Check		
Day	Date	Analyst
Day 0	06-Feb-24	KS
Day 2	06-Feb-26	JD
Day 4	06-Feb 28	JD
Day 6	06 Mar 02	JD
Day 8	06 Mar 04	NM

Feeding Check		
Day	Date	Analyst
Day 10	06 Mar 06	JD
Day 12	06 Mar 08	JD
Day 14	06 Mar 10	CM
Day 16	06 Mar 12	JD
Day 18	06 Mar 14	JD

Vizon SciTec
Vancouver, BC

Neanthes arenaceodentata
Survival and Change in Biomass Test Observations

Client # & Name: 128 Jacques Whitford Start Date and Time: 06 Feb 24 @ 14:30
End Date: 06-Mar-16

Date	Sample	Replicate	Comments (e.g. floating, emerged, swimming, and/or apparently dead polychaetes, sizes of polychaetes, native organisms, food or sediment in digestive tract, inactive polychaetes)	Analyst
06-Feb-24	All	All	None emerged @ 3:54PM	KS
06-Feb-25	All	All	None emerged @ 8:50	mm
06-Feb-26	All	All	None emerged @ 8:00	JD
06 Feb 27	All	All	None emerged @ 9:00	JD
06 Feb 28	All	All	None emerged @ 8:32	JD
06 Mar 1	All	All	None emerged @ 8:22	JD
06 Mar 2	JW 5	A	1 worm emerged @ 9:59	JD
06 Mar 4	Ctrl 1M	D	1 worm emerged Ctrl 1-M	mm
06 Mar 5	ctrl 1D	B & C, E	1 worm emerged @ 9:11	JD
"	ctrl 2D	A	2 worms emerged @ 9:20	JD
"	ctrl 2D	B	1 worm emerged @ 9:20	JD
"	ctrl 1M	D & C	1 worm emerged @ 9:23	JD
"	JW 5	D	1 worm emerged @ 9:46	JD
06 Mar 6	JW 5	C	2 worms emerged @ 8:15	JD
"	Cntrl 1M	D	1 worm emerged @ 8:15	JD
"	Cntrl 1D	B	1 worm emerged @ 8:17	JD
06 Mar 07	Cntrl 1M	A	1 worm emerged @ 12:05	JD
06 Mar 08	Cntrl 1D	B, A, E	1 worm emerged @ 9:36	JD
"	Cntrl 2D	A, B, E & C	1 worm emerged @ 9:38	JD
"	Cntrl 1M	B	" " @ 9:40	JD
"	Cntrl 2M	E, C	" " @ 9:46	JD
"	JW 3	C, A	2 worms emerged @ 10:02	JD
"	JW 3	D, B	1 worm emerged @ 10:02	JD
"	JW 6	A, B	" " @ 10:14	JD
06 Mar 09	All	All	None emerged @ 8:25	JD
06 Mar 11	All	All	None emerged	mm
06 Mar 12	All	All	" "	JD
06 Mar 13	Cntrl 1M	D	1 emerged @ 13:55	JD
"	JW 7	D	" " "	JD
06 Mar 14	Cntrl 1M	D	2 emerged @ 9:14	JD
06 Mar 14	Cntrl 1D	A + C	1 emerged @ 9:21	JD
"	JW 1	B	" 9:39	JD
"	JW 2	B, D	" 9:45	JD
"	JW 3	B	" 9:54	JD

Vizon SciTec
Vancouver, BC

Neanthes arenaceodentata
Survival and Change in Biomass Test Observations

Client # & Name: 128 Jacques Whitford
Start Date and Time: 06 Feb 24 @ 14:30
End Date: 06 Mar 16

Date	Sample	Replicate	Comments (e.g. floating, emerged, swimming, and/or apparently dead polychaetes, sizes of polychaetes, native organisms, food or sediment in digestive tract, inactive polychaetes)	Analyst
06 Mar 14	JW 4	A, E	1 emerged @ 9:59	JD
"	JW 7	D	" 10:13	JD
"	JW 9	A	" 10:17	JD
"	JW 10	D	" 10:21	JD
"	All	All	H_2O Δ done	JD
"	All	A	used for final WQ	JD
06 Mar 15	Ctrl D	B, C	1 emerged @ 8:10	JD
"	Ctrl M	D	2 emerged @ 8:10	JD
"	JW9	E	1 emerged @ 8:12	JD
06 Mar 16	CM1	All	~~Some~~ Sandy, None emerged	KS
"	CM1	All	A - little ~~feces~~ gut contents B - lots gut contents, some feces in cups; C - same as B	
"	[illegible]		D - some feces, some gut contents E - similar to A; all rinsed in DI; in oven @ 9:40 AM	KS
	CD1	B	Some Smaller	CS
"	JW9	A	2 emerged,	CS
06 Mar 16	~~CD~~ CM2	All	feces + cocoons present in cups, worms rinsed in DI + put in oven @ 10:30 AM	KS
	~~CD-1~~ CM2	All	little feces present, all ~~w/~~ some gut contents → oven @ 10:30 AM	KS
	CD-2	All	similar to ~~CM-2~~ ~~CM~~ CD-1, rinsed c̄ DI → oven @ 10:40 AM	KS
	JW-2	B	1 emerged	VD
	JW2	D	3 emerged	CS
	JW9	All	In oven @ 11:07	JP
	JW1	All	In oven @ 12:00	JP
	JW2	All	In oven @ 12:15	JP
	JW4	A	2 emerged	VD
	JW3	All	In oven @ 12:40	JP
	JW4	All	In oven @ 12:53	JP
	JW5	A	1 worm emerged.	VD
	JW5	All	In oven @ 14:18	JP
	JW7	E	1 emerged	VD
JW6	~~JW5~~	All	In oven @ 14:35	JP
	JW7	All	In oven @ 14:48	JP
	JW12	D	~~2 exposed~~ CS 2 emerged	CS
	JW10	All	In oven @ 15:05	JP
	JW12	All	In oven @ 15:18	JP

Vizon SciTec *Neanthes arenaceodentata* **Survival and Change in Biomass Test**
Test Conditions and Survival Data

Client # & Name: 128 - Jacques Whitford **Start Date and Time:** 06-Feb-24 @ 14:30
Client Project #: ——— **End Date:** 06 Mar 16
Vizon Project #: 2-11-0965B **Age at Start of Test:** Juvenile
Organism Lot #: DR060221 **Statistics File:** NA128-0106
Analyst(s): K Sellen, C. MacKinlay, J. Danisek, M May, C. Steckler, V. Comeau

Sample ID: Control M-1 **Vizon #:** N/A

Date	06-Feb-24	06 Feb 27	06 Mar 02	06 Mar 05	06 Mar 08	06 Mar 11	06 Mar 14	06 Mar 16
Replicate	A	B	C	D	E	A	B	C
	Day 0	Day 3	Day 6	Day 9	Day 12	Day 15	Day 18	Day 20
Temp. (ºC)	19.5	20.8	20.1	19.5	19.9	20.4	21.2	19.9
D.O. (mg/L)	7.8	7.1	7.3	7.4	7.4	6.9	6.8	7.3
pH	8.0	7.6	7.8	7.8	7.9	7.8 (MM wo obmoll)	7.8	7.8
Salinity (‰)	~~28~~ 27 (KS)	28	28	28	28	28	28	28
Analyst	KS	JD	JD	JD	JD	MM	JD	CM

Replicate	A	B	C	D	E	Ammonia & Sulfide Samples Taken	
# Surviving	5	5	5	5	5	Initial	Final
Analyst	JD	CS	KS	VC	CS	✓KS	✓KS

Sample ID: Control M-2 **Vizon #:** N/A

Date	06-Feb-24	06 Feb 27	06 Mar 02	06 Mar 05	06 Mar 08	06 Mar 11	06 Mar 14	06 Mar 16
Replicate	A	B	C	D	E	A	B	C
	Day 0	Day 3	Day 6	Day 9	Day 12	Day 15	Day 18	Day 20
Temp. (ºC)	19.5	20.5	20.1	19.6	20.3	20.2	21.2	20.3
D.O. (mg/L)	7.6	7.3	7.6	7.4	7.2	7.2	6.8	7.4
pH	8.0	7.7	7.9	7.8	7.9	7.9	7.8	7.8
Salinity (‰)	27	28	28	28	28	28	28	29
Analyst	KS	JD	JD	JD	JD	MM	JD	CM

Replicate	A	B	C	D	E	Ammonia & Sulfide Samples Taken	
# Surviving	5	5	5	5	5	Initial	Final
Analyst	VC	JD	KQ	CS	JD	✓KS	✓B

Feeding Regime: 5 mL per Replicate of 8.0 g/L Seawater TetraMarine Slurry

Vizon SciTec *Neanthes arenaceodentata* **Survival and Change in Biomass Test**
Test Conditions and Survival Data

Client # & Name: 128-Jacques Whitford
Start Date and Time: 06 Feb24@14:30
Client Project #: —
End Date: 06 Mar 16
Vizon Project #: 2-11-0965B
Age at Start of Test: Juvenile
Organism Lot #: PR060221
Statistics File: NA128-0106
Analyst(s): K Sulven, C. MacKinlay, J. Danisek, Mmay, C. Steckler, Val Comeau

Sample ID: Control D-1 **Vizon #:** N/A

Date	06-Feb-24	06 Feb 27	06 Mar 02	06 Mar 05	06 Mar 08	06 Mar 11	06 Mar 14	06 Mar 16
Replicate	A	B	C	D	E	A	B	C
	Day 0	Day 3	Day 6	Day 9	Day 12	Day 15	Day 18	Day 20
Temp. (ºC)	19.4	20.6	~~20.0~~ 20.2 JD ce	19.5	20.0	20.1	21.3	20.4
D.O. (mg/L)	7.8	6.9	~~7.1~~ 7.6 JD ce	7.3	7.4	7.3	6.8	7.4
pH	7.9	JD ce 7.45	JD ce ~~7.4~~ 7.8	7.8	7.9	7.9	7.7	7.8
Salinity (‰)	28	28	28	28	28	28	28	~~28~~ CM 29
Analyst	KS	JD	JD	JD	JD	MM	JD	CM

Replicate	A	B	C	D	E	Ammonia & Sulfide Samples Taken	
# Surviving	5	5	5	5	5	Initial	Final
Analyst	VC	CS	JD	VC	CS	✓KS	✓

Sample ID: Control D-2 **Vizon #:** N/A

Date	06-Feb-24	06-Feb-27	06 Mar 02	06 Mar 05	06 Mar 08	06 Mar 11	06 Mar 14	06 Mar 16
Replicate	A	B	C	D	E	A	B	C
	Day 0	Day 3	Day 6	Day 9	Day 12	Day 15	Day 18	Day 20
Temp. (ºC)	19.4	20.9	20.2	19.4	19.9	20.3	21.2	20.5
D.O. (mg/L)	7.9	7.2	7.4	7.5	7.4	6.7	6.9	7.3
pH	7.9	7.7	7.9	7.9	7.9	7.8	7.7	7.8
Salinity (‰)	27	28	28	28	28	28	28	29
Analyst	KS	JD	JD	JD	JD	MM	JD	CM

Replicate	A	B	C	D	E	Ammonia & Sulfide Samples Taken	
# Surviving	5	5	5	5	5	Initial	Final
Analyst	JD	JD	VC	CS	JD	✓KS	✓

Feeding Regime: 5 mL per Replicate of 8.0 g/L Seawater TetraMarine Slurry

Vizon SciTec *Neanthes arenaceodentata* **Survival and Change in Biomass Test**
Test Conditions and Survival Data

Client # & Name: 128-Jacques Whitford
Start Date and Time: 06Feb24@14:30
Client Project #: —
End Date: 06 Mar 16
Vizon Project #: 2-11-965B
Age at Start of Test: Juvenile
Organism Lot #: DR060221
Statistics File: NA128-0106
Analyst(s): K Saben, C. MacKinlay, J. Danisek, MMay, C Steckler, V. Comeau

Sample ID: JW1
Vizon #: 060210J-01

Date	06-Feb-24	06Feb27	06Mar02	06Mar05	06Mar08	06Mar11	06Mar14	06Mar16
Replicate	A	B	C	D	E	A	B	C
	Day 0	Day 3	Day 6	Day 9	Day 12	Day 15	Day 18	Day 20
Temp. (ºC)	19.5	20.3	20.0	19.5	20.4	20.3	21.1	20.5
D.O. (mg/L)	7.5	7.3	7.4	7.5	7.6	6.6	6.9	7.2
pH	7.9	7.6	7.8	7.8	7.8	7.6	7.7	7.8
Salinity (‰)	28	29	28	28	28	28	28	29
Analyst	KS	JD	JD	JD	JD	MM	JD	CM

Replicate	A	B	C	D	E	Ammonia & Sulfide Samples Taken	
# Surviving	5	5	5	5	5	Initial	Final
Analyst	JD	CS	JD	[illegible]	VC	✓KS	✓

Sample ID: JW2
Vizon #: 060210J-02

Date	06-Feb-24	06Feb27	06Mar02	06Mar05	06Mar08	06Mar11	06Mar14	06Mar16
Replicate	A	B	C	D	E	A	B	C
	Day 0	Day 3	Day 6	Day 9	Day 12	Day 15	Day 18	Day 20
Temp. (ºC)	19.5	20.2	20.2	19.5	20.1	20.2	21.2	20.5
D.O. (mg/L)	7.8	7.1	7.3	7.4	7.5	6.5	6.9	7.1
pH	7.8	7.6	7.8	7.7	7.8	7.7	7.8	7.9
Salinity (‰)	28	29	28	28	28	28	28	29
Analyst	KS	JD	JD	JD	JD	MM	JD	CM

Replicate	A	B	C	D	E	Ammonia & Sulfide Samples Taken	
# Surviving	5	5	5	5	5	Initial	Final
Analyst	CS	VC	JD	CS	VC	✓KS	✓

Feeding Regime: 5 mL per Replicate of 8.0 g/L Seawater TetraMarine Slurry

Vizon SciTec *Neanthes arenaceodentata* **Survival and Change in Biomass Test**
Test Conditions and Survival Data

Client # & Name: #128-Jacques Whitford **Start Date and Time:** 06Feb24@14:30
Client Project #: — **End Date:** 06 Mar 16
Vizon Project #: 2-11-965B **Age at Start of Test:** Juvenile
Organism Lot #: DR060221 **Statistics File:** NA128-0106
Analyst(s): K Saben, C. MacKinlay, J. Danisek, MM, C Steckler, Val Comeau

Sample ID: JW3 **Vizon #:** 060210J-03

Date	06-Feb-24	06Feb27	06Mar02	06Mar05	06Mar08	06Mar11	06Mar14	06Mar16
Replicate	A	B	C	D	E	A	B	C
	Day 0	Day 3	Day 6	Day 9	Day 12	Day 15	Day 18	Day 20
Temp. (ºC)	19.5	20.2	20.2	19.5	20.2	20.2	21.4	20.4
D.O. (mg/L)	7.8	7.5	7.5	7.4	7.4	7.2	6.9	6.9
pH	7.8	7.7	7.8	7.8	7.8	7.9	7.8	7.8
Salinity (‰)	28	29	29	28	28	28	28	29
Analyst	KS	JD	JD	JD	JD	MM	JD	CM

Replicate	A	B	C	D	E	Ammonia & Sulfide Samples Taken	
# Surviving	5	5	5	5	5	Initial	Final
Analyst	JD	CS	VC	VC	CS	VKS	✓

Sample ID: JW4 **Vizon #:** ~~02~~ KS 060210J-04

Date	06-Feb-24	06Feb27	06Mar02	06Mar05	06Mar08	06Mar11	06Mar14	06Mar16
Replicate	A	B	C	D	E	A	B	C
	Day 0	Day 3	Day 6	Day 9	Day 12	Day 15	Day 18	Day 20
Temp. (ºC)	19.5	20.2	20.2	19.6	20.2	20.1	21.6	20.3
D.O. (mg/L)	7.7	6.9	7.4	7.2	7.4	7.2	7.0	6.9
pH	7.8	7.5	7.7	7.7	7.8	7.9	7.7	7.8
Salinity (‰)	28	29	28	28	28	28	28	29
Analyst	KS	JD	JD	JD	JD	MM	JD	CM

Replicate	A	B	C	D	E	Ammonia & Sulfide Samples Taken	
# Surviving	5	5	5	5	5	Initial	Final
Analyst	VC	JD	CS	JD	VC	VKS	✓

Feeding Regime: 5 mL per Replicate of 8.0 g/L Seawater TetraMarine Slurry

Vizon SciTec ***Neanthes arenaceodentata* Survival and Change in Biomass Test**
Test Conditions and Survival Data

Client # & Name: 128 - Jacques Whitford
Start Date and Time: 06 Feb 24 @ 14:30
Client Project #: —
End Date: 06 Mar 16
Vizon Project #: 2-11-965B
Age at Start of Test: Juvenile
Organism Lot #: DR060221
Statistics File: NA128-006
Analyst(s): C. McKinlay, J. Danisek, N May, C. Steckler, Val Comeau, J. Pickard, K Suben

Sample ID: JW5
Vizon #: 060210J-05

Date	06-Feb-24	06Feb27	06Mar02	06Mar05	06Mar08	06Mar11	06Mar14	06Mar16
Replicate	A	B	C	D	E	A	B	C
	Day 0	Day 3	Day 6	Day 9	Day 12	Day 15	Day 18	Day 20
Temp. (ºC)	19.6	20.1	20.1	19.6	20.1	20.0	~~20.0~~ 21.3	20.4
D.O. (mg/L)	7.7	7.1	7.3	7.4	7.4	7.3	~~7.2~~ 7.0	7.0
pH	7.9	7.6	7.7	7.8	7.9	8.0	~~7.8~~ 7.9	7.9
Salinity (‰)	28	29	28	28	28	28	28	29
Analyst	KS	JD	JD	JD	JD	NM	JD	CM JP

Replicate	A	B	C	D	E	Ammonia & Sulfide Samples Taken	
# Surviving	5	5	5	5	5	Initial	Final
Analyst	JD	CS	JD	CS	JD	✓	✓

Sample ID: JW6
Vizon #: 060210J-06

Date	06-Feb-24	06 Feb 27	06 Mar 02	06 Mar 05	06 Mar 08	06Mar11	06 Mar 14	06Mar16
Replicate	A	B	C	D	E	A	B	C
	Day 0	Day 3	Day 6	Day 9	Day 12	Day 15	Day 18	Day 20
Temp. (ºC)	19.6	20.2	20.1	19.6	20.3	20.0	21.4	20.4
D.O. (mg/L)	7.7	7.4	7.4	7.5	7.3	7.2	7.0	7.0
pH	7.9	7.7	7.8	7.8	7.9	7.8	7.8	7.9
Salinity (‰)	28	29	29	28	28	28	28	29
Analyst	KS	JD	JD	JD	JD	NM	JD	CM

Replicate	A	B	C	D	E	Ammonia & Sulfide Samples Taken	
# Surviving	5	5	5	5	5	Initial	Final
Analyst	CS	JD	VC	CS	JD	✓	✓

Feeding Regime: 5 mL per Replicate of 8.0 g/L Seawater TetraMarine Slurry

Vizon SciTec *Neanthes arenaceodentata* **Survival and Change in Biomass Test**
Test Conditions and Survival Data

Client # & Name: #128 - Jacques Whitford
Start Date and Time: 06 Feb 24 @ 14:30
Client Project #: ——
End Date: 06 Mar 16
Vizon Project #: 2-11-965B
Age at Start of Test: Juvenile
Organism Lot #: DR060221
Statistics File: NA128-0106
Analyst(s): K Suben, C MacKinley, J. Danisek, NMay, C Steeklen, V. Comeau

Sample ID: JW7
Vizon #: 060210J-07

Date	06-Feb-24	06 Feb 27	06 Mar 02	06 Mar 05	06 Mar 08	06 Mar 11	06 Mar 14	06 Mar 16
Replicate	A	B	C	D	E	A	B	C
	Day 0	Day 3	Day 6	Day 9	Day 12	Day 15	Day 18	Day 20
Temp. (ºC)	19.6	20.2	20.2	19.7	20.5	20.1	21.3	20.3
D.O. (mg/L)	7.8	6.9	7.6	7.3	7.2	7.3	7.1	7.1
pH	7.9	7.5	7.8	7.7	7.8	7.9	7.8	7.9
Salinity (‰)	28	29	29	28	28	28	28	29
Analyst	KS	JD	JD	JD	JD	NM	JD	CM

Replicate	A	B	C	D	E	Ammonia & Sulfide Samples Taken	
# Surviving	5	5	5	5	5	Initial	Final
Analyst	VC	JD	CS	VC	VC	✓	✓

Sample ID: JW9
Vizon #: 060210J-09

Date	06-Feb-24	06 Feb 27	06 Mar 02	06 Mar 05	06 Mar 08	06 Mar 11	06 Mar 14	06 Mar 16
Replicate	A	B	C	D	E	A	B	C
	Day 0	Day 3	Day 6	Day 9	Day 12	Day 15	Day 18	Day 20
Temp. (ºC)	19.7	20.2	20.3	19.7	20.6	20.2	21.3	20.4
D.O. (mg/L)	7.7	7.3	7.4	7.4	7.2	7.2	7.1	7.1
pH	7.9	7.6	7.8	7.8	7.8	7.9	7.8	7.9
Salinity (‰)	27	28	28	28	28	28	28	29
Analyst	KS	JD	JD	JD	JD	NM	JD	CM

Replicate	A	B	C	D	E	Ammonia & Sulfide Samples Taken	
# Surviving	5	5	5	5	5	Initial	Final
Analyst	CS	JD	CS	VC	VC	✓	✓

Feeding Regime: 5 mL per Replicate of 8.0 g/L Seawater TetraMarine Slurry

Vizon SciTec *Neanthes arenaceodentata* **Survival and Change in Biomass Test**
Test Conditions and Survival Data

Client # & Name: 128 - Jacques Whitford
Start Date and Time: 06 Feb 24 @ 14:30
Client Project #: ——
End Date: 06 Mar 16
Vizon Project #: 2-11-965B
Age at Start of Test: Juvenile
Organism Lot #: DR060221
Statistics File: NA128-0106
Analyst(s): K Suben, J. Danisek, N May, C. MacKinlay, V. Comeau, Corey Steckler

Sample ID: JW10
Vizon #: 060210J-10

Date	06-Feb-24	06 Feb 27	06 Mar 02	06 Mar 05	06 Mar 08	06 Mar 11	06 Mar 14	06 Mar 16
Replicate	A	B	C	D	E	A	B	C
	Day 0	Day 3	Day 6	Day 9	Day 12	Day 15	Day 18	Day 20
Temp. (ºC)	19.7	20.2	20.4	19.4	20.3	20.4	21.4	20.5
D.O. (mg/L)	7.6	7.4	7.5	7.5	7.3	6.7	7.1	6.9
pH	7.9	7.7	7.9	7.8	7.9	7.7	7.9	7.8
Salinity (‰)	28	29	28	28	28	28	28	29
Analyst	KS	JD	JD	JD	JD	NM	JD	CM

Replicate	A	B	C	D	E	Ammonia & Sulfide Samples Taken	
# Surviving	5	5	5	5	5	Initial	Final
Analyst	JD	CS	VC	JD	CS	✓	✓

Sample ID: JW12
Vizon #: 060210J-12

Date	06-Feb-24	06 Feb 27	06 Mar 02	06 Mar 05	06 Mar 08	06 Mar 11	06 Mar 14	06 Mar 16
Replicate	A	B	C	D	E	A	B	C
	Day 0	Day 3	Day 6	Day 9	Day 12	Day 15	Day 18	Day 20
Temp. (ºC)	19.7	20.2	20.4	19.5	20.4	20.1	21.4	20.4
D.O. (mg/L)	7.6	7.0	7.6	7.5	7.3	7.1	7.0	6.9
pH	7.9	7.6	7.9	7.8	7.8	7.8	7.9	7.9
Salinity (‰)	28	29	29	~~28~~ 29	28	28	28	29
Analyst	KS	JD	OZ	JD	JD	NM	JD	CM

Replicate	A	B	C	D	E	Ammonia & Sulfide Samples Taken	
# Surviving	5	5	5	5	5	Initial	Final
Analyst	VC	JD	CS	CS	JD	✓	✓

Feeding Regime: 5 mL per Replicate of 8.0 g/L Seawater TetraMarine Slurry

Vizon SciTec, Inc.
Vancouver, BC

Total and Unionized Ammonia Results for *Neanthes arenaceodentata* Tests

	Day 0						Day 10					
Sample Name	Salinity (‰)	pH	Temperature (°C)	Total Ammonia (mg N/L)	% Unionized Ammonia[ab]	Unionized Ammonia (mg N/L)	Salinity (‰)	pH	Temperature (°C)	Total Ammonia (mg N/L)	% Unionized Ammonia[ab]	Unionized Ammonia (mg N/L)
JW1	28	7.9	19.5	0.226	2.50	0.0057	29	7.8	20.5	0.797	2.14	0.0001
JW2	28	7.8	19.5	0.243	1.99	0.0048	29	7.9	20.5	1.80	2.68	0.0482
JW3	28	7.8	19.5	0.282	1.99	0.0056	29	7.8	20.4	0.503	1.99	0.0100
JW4	28	7.8	19.5	0.274	1.99	0.0055	29	7.8	20.3	0.663	1.99	0.0132
JW5	28	7.9	19.6	0.200	2.50	0.0050	29	7.9	20.4	0.950	2.50	0.0238
JW6	28	7.9	19.6	0.222	2.50	0.0056	29	7.9	20.4	0.735	2.50	0.0184
JW7	28	7.9	19.6	0.212	2.50	0.0053	29	7.9	20.3	0.844	2.50	0.0211
JW9	27	7.9	19.7	0.328	2.55	0.0084	29	7.9	20.4	3.49	2.50	0.0873
JW10	28	7.9	19.7	0.228	2.50	0.0057	29	7.8	20.5	2.30	2.14	0.0492
JW12	28	7.9	19.7	0.185	2.50	0.0046	29	7.9	20.4	1.66	2.50	0.0415

[a] Values from Bower CE and Bidwell, JP. 1978. Ionization of Ammonia in Seawater: Effects of Temperature, pH and Salinity. Journal of Fisheries Research Board of Canada 35:1012-1016.

[b] When a %unionized ammonia value is not available for a certain pH or salinity, the value closest to the pH or salinity is used.

ZIZON LABORATORY RECORD BOOK

INVEST

PAGE NUMBER:
145998

Project #: 2-11-0965B
Company: Jacques Whitford
Contact: Janine Beckett

BCR #	Sample	Sample Date	NH_3 mg N/L	S^- mg/L
060302A-01	Neanthes Day 0 Control D	24-Feb-2006	~~0.027~~ 0.018	—
060302A-02	Neanthes Day 0 Control D	24-Feb-2006	—	<0.20
060302A-03	Neanthes Day 0 Control M	24-Feb-2006	<0.01	—
060302A-04	Neanthes Day 0 Control M	24-Feb-2006	—	<0.20
060302A-05	Neanthes Day 0 JW1	24-Feb-2006	0.226	—
060302A-06	Neanthes Day 0 ~~Control D~~ JW1	24-Feb-2006	—	0.21
060302A-07	Neanthes Day 0 JW2	24-Feb-2006	0.243	—
060302A-08	Neanthes Day 0 JW2	24-Feb-2006	—	0.30
060302A-09	Neanthes Day 0 JW3	24-Feb-2006	0.282	—
060302A-10	Neanthes Day 0 JW3	24-Feb-2006	—	0.32
060302A-11	Neanthes Day 0 JW4	24-Feb-2006	0.274	—
060302A-12	Neanthes Day 0 JW4	24-Feb-2006	—	0.32
060302A-13	Neanthes Day 0 JW5	24-Feb-2006	0.200	—
060302A-14	Neanthes Day 0 JW5	24-Feb-2006	—	0.43
060302A-15	Neanthes Day 0 JW6	24-Feb-2006	0.222	—
060302A-16	Neanthes Day 0 JW6	24-Feb-2006	—	<0.20
060302A-17	Neanthes Day 0 JW7	24-Feb-2006	0.212	—
060302A-18	Neanthes Day 0 JW7	24-Feb-2006	—	1.28
060302A-19	Neanthes Day 0 JW9	24-Feb-2006	0.328	—
060302A-20	Neanthes Day 0 JW9	24-Feb-2006	—	0.64
060302A-21	Neanthes Day 0 JW10	24-Feb-2006	0.228	—
060302A-22	Neanthes Day 0 JW10	24-Feb-2006	—	0.43
060302A-23	Neanthes Day 0 JW12	24-Feb-2006	0.185	—
060302A-24	Neanthes Day 0 JW12	24-Feb-2006	—	0.43
Date Analyzed:			Feb. 24/06	March 7/06
QC				
TRUE			0.103	
Found			0.098	
Initials				YL
Test Methods:			5330 / 5331	

Project #: 2-11-965B
Company: Jacques Whitford
Contact: Janine Beckett

BCR #	Sample	Sample Date	NH_3 mg N/L
060317A-01	Neanthes Day 20 CD1	16/mar 23-Feb-2006	0.970
060317A-02	Neanthes Day 20 C2D	mar 16 23-Feb-2006	0.584
060317A-03	Neanthes Day 20 CM1	23-Feb-2006	6.73 / 6.21
060317A-04	Neanthes Day 20 CM2	23-Feb-2006	6.20
060317A-05	Neanthes Day 20 JW1	23-Feb-2006	0.797
060317A-06	Neanthes Day 20 JW2	23-Feb-2006	1.80
060317A-07	Neanthes Day 20 JW3	23-Feb-2006	0.485 / 0.520
060317A-08	Neanthes Day 20 JW4	23-Feb-2006	0.663
060317A-09	Neanthes Day 20 JW5	23-Feb-2006	0.950
060317A-10	Neanthes Day 20 JW6	23-Feb-2006	0.735
060317A-11	Neanthes Day 20 JW7	23-Feb-2006	0.844
060317A-12	Neanthes Day 20 JW9	23-Feb-2006	3.49
060317A-13	Neanthes Day 20 JW10	23-Feb-2006	2.30
060317A-14	Neanthes Day 20 JW12	23-Feb-2006	1.66
Date Analyzed:			Mar. 18/06
QC			
TRUE			0.128
Found			0.131
Initials			LC
Test Methods:			5330 / 5331

BCRI

LABORATORY RECORD BOOK

INVESTIGATOR:

PROJECT NUMBER:

DATE:

PAGE NUMBER: 113272

Project #: 2-11-0965B
Company: Jacques Whitford
Contact: Janine Beckett

BCR #	Sample	Sample Date	S^- mg/L
060316Y-01	Neanthes Day 20 CD1	Mar 16 23-Feb-2006	0.35
060316Y-02	Neanthes Day 20 CD2	23-Feb-2006	0.28
060316Y-03	Neanthes Day 20 CM1	23-Feb-2006	<0.20
060316Y-04	Neanthes Day 20 CM2	23-Feb-2006	<0.20
060316Y-05	Neanthes Day 20 JW1	23-Feb-2006	<0.20
060316Y-06	Neanthes Day 20 JW2	23-Feb-2006	<0.20
060316Y-07	Neanthes Day 20 JW3	23-Feb-2006	<0.20
060316Y-08	Neanthes Day 20 JW4	23-Feb-2006	0.22
060316Y-09	Neanthes Day 20 JW5	23-Feb-2006	0.22
060316Y-10	Neanthes Day 20 JW6	23-Feb-2006	0.22
060316Y-11	Neanthes Day 20 JW7	23-Feb-2006	<0.20
060316Y-12	Neanthes Day 20 JW9	23-Feb-2006	<0.20
060316Y-13	Neanthes Day 20 JW10	23-Feb-2006	0.41
060316Y-14	Neanthes Day 20 JW12	23-Feb-2006	<0.20
			0.22
Date Analyzed:			
			March 20/06
QC			
TRUE			
Found			
Initials			
			YL
Test Methods:			

Vizon SciTec **Neanthes Initial Seawater Measurements**

Client # & Name: #128 Jacques Whitford.

Control Seawater: Vancouver Aquarium

Date	Temperature	pH	D.O.	Salinity
06-Feb-23	21.1°C	8.1	7.5	27‰
06-~~Feb~~Mar-02	20.0°C	8.0	7.7	27%
06 Mar-05	20.4°C	8.0	7.7	28%
06 Mar 08	20.0°C	7.9	7.7	28%
06 Mar 11				28‰
06 Mar 13	20.3°C	7.9	7.8	28%

Randomization Chart for Neanthes Tests

Use the coloured dots to find appropriate concentrations

Client # 128

Position #	Treatment	Replicate	Colour	Position #	Treatment	Replicate	Colour
8	Cntrl-1M	A	Pink [redacted]	65	Cntrl-1D	A	Dark Blue
44	Cntrl-1M	B	[redacted]	6	Cntrl-1D	B	Dark Blue
14	Cntrl-1M	C	[redacted]	7	Cntrl-1D	C	Dark Blue
1	Cntrl-1M	D	[redacted]	63	Cntrl-1D	D	Dark Blue
5	Cntrl-1M	E	[redacted]	41	Cntrl-1D	E	Dark Blue
46	JW1	A	Beige	20	JW6	A	White
39	JW1	B	Beige	29	JW6	B	White
9	JW1	C	Beige	22	JW6	C	White
48	JW1	D	Beige	56	JW6	D	White
21	JW1	E	Beige	68	JW6	E	White
50	JW2	A	Yellow	38	JW7	A	Orange
49	JW2	B	Yellow	55	JW7	B	Orange
42	JW2	C	Yellow	35	JW7	C	Orange
47	JW2	D	Yellow	54	JW7	D	Orange
40	JW2	E	Yellow	17	JW7	E	Orange
26	JW3	A	Dark Green	66	JW9	A	Lt. Blue
32	JW3	B	Dark Green	2	JW9	B	Lt. Blue
58	JW3	C	Dark Green	4	JW9	C	Lt. Blue
57	JW3	D	Dark Green	18	JW9	D	Lt. Blue
23	JW3	E	Dark Green	64	JW9	E	Lt. Blue
52	JW4	A	Yellow Glo	10	JW10	A	Red-Orange
69	JW4	B	Yellow Glo	60	JW10	B	Red-Orange
43	JW4	C	Yellow Glo	25	JW10	C	Red-Orange
3	JW4	D	Yellow Glo	62	JW10	D	Red-Orange
12	JW4	E	Yellow Glo	67	JW10	E	Red-Orange
59	JW5	A	Leaf	70	JW12	A	Green Glo
45	JW5	B	Leaf	16	JW12	B	Green Glo
13	JW5	C	Leaf	28	JW12	C	Green Glo
15	JW5	D	Leaf	31	JW12	D	Green Glo
37	JW5	E	Leaf	30	JW12	E	Green Glo
61	Cntrl-2M	A	Red	11	Cntrl-2D	A	Neon Green
24	Cntrl-2M	B	Red	36	Cntrl-2D	B	Neon Green
34	Cntrl-2M	C	Red	53	Cntrl-2D	C	Neon Green
19	Cntrl-2M	D	Red	27	Cntrl-2D	D	Neon Green
33	Cntrl-2M	E	Red	51	Cntrl-2D	E	Neon Green

Vizon SciTec *Neanthes* **Acclimation and Holding Conditions**

Species: Neanthes arenaceodentata

Organism Lot #: DR060221

Holding Conditions									
	Before Water Addition				After Water Addition				
Date & Time	Salinity (‰)	Temperature (ºC)	pH	DO (mg/L)	Salinity (‰)	Temperature (ºC)	pH	DO (mg/L)	Analyst
06 Feb 21 @ 15:30	33	18	7.5	7.3	32	20.5	7.7	7.5	JD
06 Feb 22 @ 8:45	33	21.0	7.4	7.3	32	20.5	7.5	7.2	JD
Feb 22 @ 14:20	—	—	—	—	27	20.1	7.7		JP
Feb 23 @ 8:47	28		7.7		~~28~~		JD ~~7.7~~		
Feb 23 @ 14:10	—	—	—	—	29	20.5	7.8	7.2	JP

Feeding

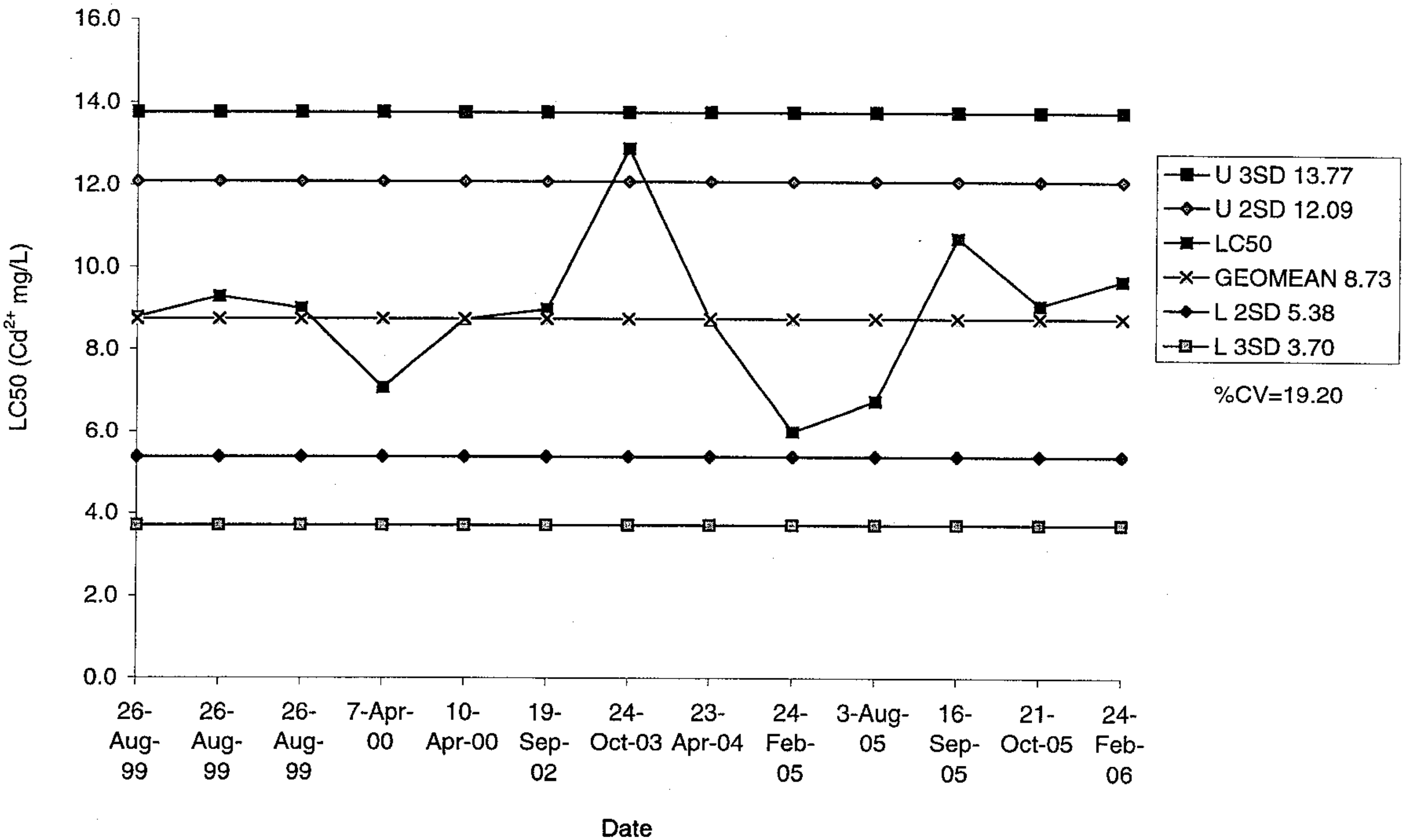
Date	06 Feb 21	06 Feb 22	06 Feb 23						
Analyst	JDanisek	J Pickard	J Pickard						

Culture Health

Date	Total Number	Deaths	Removed	% Mortality (Previous 7 days)	Comments (e.g appearance)	Analyst

VIZON SCITEC INC.
Vancouver, BC

Neanthes arenaceodentata
96-hr Reference Toxicant Control Chart for Cadmium Chloride



MASTERSIZER 2000

Result Analysis Report

Sample Name:
JW1 - Average

SOP Name:

Measured:
Wednesday, April 05, 2006 1:49:53 PM

Sample Source & type:
Works = Vizon Scitec Inc- Kerrie Serben

Measured by:
Vivian

Analysed:
Wednesday, April 05, 2006 1:49:54 PM

Particle Name:
Soil

Accessory Name:
Hydro 2000S (A)

Analysis model:
General purpose

Sensitivity:
Normal

Particle RI:
1.230

Absorption:
0.5

Size range:
0.020 to 2000.000 um

Obscuration:
17.50 %

Dispersant Name:
Water

Dispersant RI:
1.330

Weighted Residual:
0.720 %

Result Emulation:
Off

Concentration:
0.0104 %Vol

Span :
4.675

Uniformity:
1.63

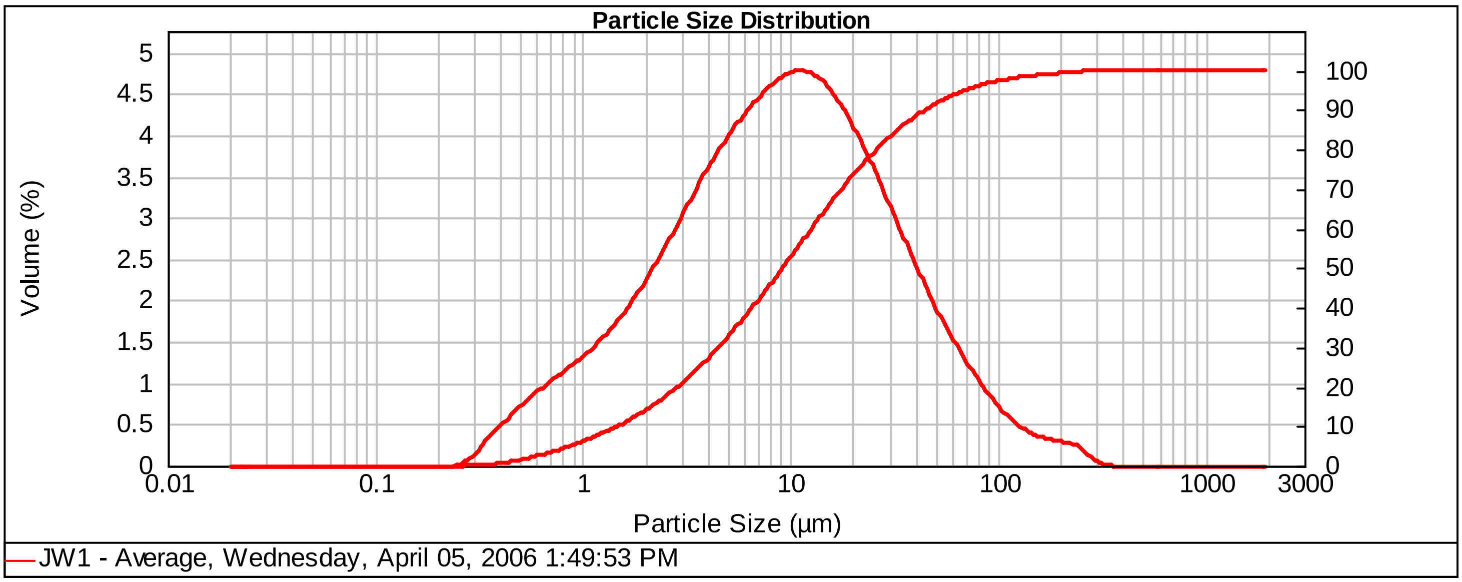
Result units:
Volume

Specific Surface Area:
1.61 m²/g

Surface Weighted Mean D[3,2]:
3.735 um

Vol. Weighted Mean D[4,3]:
18.918 um

d(0.1): 1.469 um **d(0.5): 9.155 um** **d(0.9): 44.268 um**



Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %
0.020	0.00	0.112	0.00	0.626	2.74	3.499	24.10	19.572	72.91	109.466	97.81
0.022	0.00	0.124	0.00	0.692	3.38	3.872	26.37	21.658	75.60	121.132	98.19
0.024	0.00	0.137	0.00	0.766	4.08	4.285	28.77	23.966	78.14	134.041	98.50
0.027	0.00	0.152	0.00	0.848	4.83	4.742	31.30	26.520	80.52	148.326	98.78
0.030	0.00	0.168	0.00	0.938	5.64	5.247	33.93	29.346	82.74	164.133	99.02
0.033	0.00	0.186	0.00	1.038	6.50	5.806	36.67	32.473	84.79	181.625	99.23
0.037	0.00	0.205	0.00	1.149	7.44	6.425	39.49	35.934	86.66	200.981	99.44
0.041	0.00	0.227	0.00	1.271	8.44	7.109	42.41	39.764	88.37	222.400	99.63
0.045	0.00	0.251	0.00	1.407	9.51	7.867	45.40	44.001	89.91	246.101	99.80
0.050	0.00	0.278	0.02	1.556	10.68	8.706	48.46	48.690	91.30	272.329	99.93
0.055	0.00	0.308	0.09	1.722	11.94	9.633	51.57	53.879	92.53	301.351	99.98
0.061	0.00	0.341	0.24	1.906	13.30	10.660	54.72	59.621	93.63	333.467	100.00
0.067	0.00	0.377	0.49	2.109	14.78	11.796	57.88	65.975	94.60	369.005	100.00
0.075	0.00	0.417	0.80	2.334	16.38	13.053	61.03	73.006	95.45	408.330	100.00
0.083	0.00	0.462	1.18	2.583	18.10	14.444	64.13	80.787	96.19	451.846	100.00
0.091	0.00	0.511	1.64	2.858	19.96	15.983	67.16	89.396	96.82	500.000	100.00
0.101	0.00	0.565	2.16	3.162	21.96	17.687	70.10	98.924	97.36		

MASTERSIZER 2000

Result Analysis Report

Sample Name:
JW2 - Average

SOP Name:

Measured:
Wednesday, April 05, 2006 2:00:38 PM

Sample Source & type:
Works = Vizon Scitec Inc- Kerrie Serben

Measured by:
Vivian

Analysed:
Wednesday, April 05, 2006 2:00:39 PM

Particle Name:
Soil

Accessory Name:
Hydro 2000S (A)

Analysis model:
General purpose

Sensitivity:
Normal

Particle RI:
1.230

Absorption:
0.5

Size range:
0.020 to 2000.000 um

Obscuration:
16.96 %

Dispersant Name:
Water

Dispersant RI:
1.330

Weighted Residual:
0.634 %

Result Emulation:
Off

Concentration:
0.0093 %Vol

Span :
4.956

Uniformity:
1.58

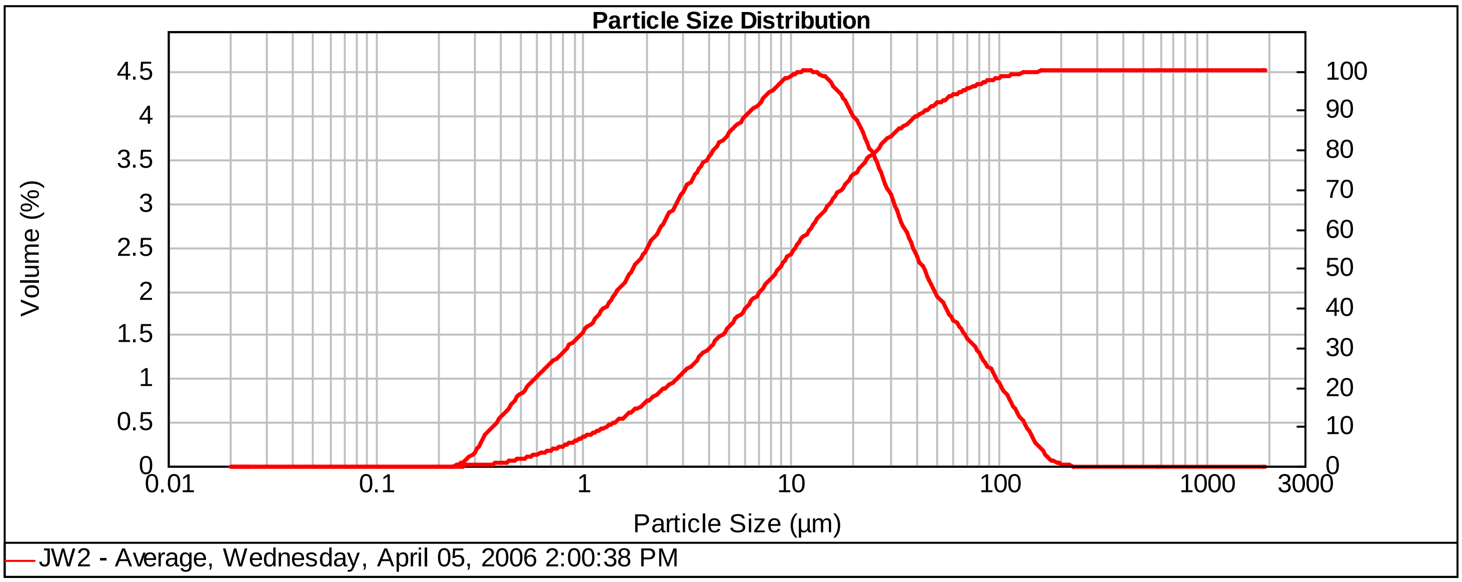
Result units:
Volume

Specific Surface Area:
1.73 m²/g

Surface Weighted Mean D[3,2]:
3.459 um

Vol. Weighted Mean D[4,3]:
17.616 um

d(0.1): 1.307 um **d(0.5): 8.826 um** **d(0.9): 45.046 um**



Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %
0.020	0.00	0.112	0.00	0.626	3.13	3.499	26.53	19.572	72.90	109.466	98.62
0.022	0.00	0.124	0.00	0.692	3.86	3.872	28.78	21.658	75.52	121.132	99.11
0.024	0.00	0.137	0.00	0.766	4.66	4.285	31.13	23.966	78.01	134.041	99.48
0.027	0.00	0.152	0.00	0.848	5.52	4.742	33.55	26.520	80.36	148.326	99.74
0.030	0.00	0.168	0.00	0.938	6.45	5.247	36.06	29.346	82.54	164.133	99.90
0.033	0.00	0.186	0.00	1.038	7.45	5.806	38.63	32.473	84.56	181.625	99.97
0.037	0.00	0.205	0.00	1.149	8.52	6.425	41.28	35.934	86.42	200.981	100.00
0.041	0.00	0.227	0.00	1.271	9.67	7.109	43.99	39.764	88.11	222.400	100.00
0.045	0.00	0.251	0.00	1.407	10.90	7.867	46.77	44.001	89.66	246.101	100.00
0.050	0.00	0.278	0.03	1.556	12.23	8.706	49.61	48.690	91.07	272.329	100.00
0.055	0.00	0.308	0.11	1.722	13.65	9.633	52.51	53.879	92.36	301.351	100.00
0.061	0.00	0.341	0.28	1.906	15.17	10.660	55.46	59.621	93.54	333.467	100.00
0.067	0.00	0.377	0.56	2.109	16.80	11.796	58.44	65.975	94.62	369.005	100.00
0.075	0.00	0.417	0.91	2.334	18.53	13.053	61.43	73.006	95.61	408.330	100.00
0.083	0.00	0.462	1.35	2.583	20.37	14.444	64.40	80.787	96.51	451.846	100.00
0.091	0.00	0.511	1.87	2.858	22.32	15.983	67.31	89.396	97.32	500.000	100.00
0.101	0.00	0.565	2.46	3.162	24.37	17.687	70.15	98.924	98.02		

MASTERSIZER 2000

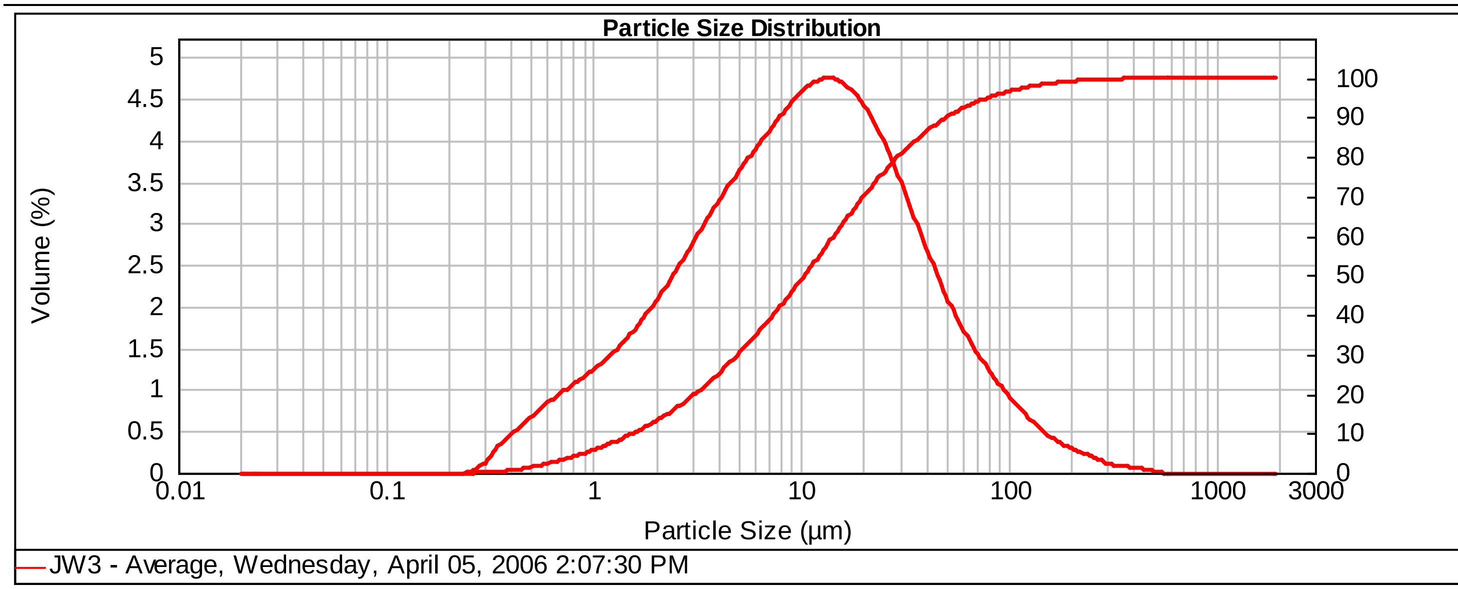
Result Analysis Report

Sample Name: JW3 - Average	**SOP Name:**	**Measured:** Wednesday, April 05, 2006 2:07:30 PM
Sample Source & type: Works = Vizon Scitec Inc- Kerrie Serben	**Measured by:** Vivian	**Analysed:** Wednesday, April 05, 2006 2:07:31 PM

Particle Name: Soil	**Accessory Name:** Hydro 2000S (A)	**Analysis model:** General purpose	**Sensitivity:** Normal
Particle RI: 1.230	**Absorption:** 0.5	**Size range:** 0.020 to 2000.000 um	**Obscuration:** 14.36 %
Dispersant Name: Water	**Dispersant RI:** 1.330	**Weighted Residual:** 0.632 %	**Result Emulation:** Off

Concentration: 0.0089 %Vol	**Span :** 4.655	**Uniformity:** 1.65	**Result units:** Volume
Specific Surface Area: 1.51 m²/g	**Surface Weighted Mean D[3,2]:** 3.973 um	**Vol. Weighted Mean D[4,3]:** 21.616 um	

d(0.1): 1.554 um **d(0.5): 10.417 um** **d(0.9): 50.046 um**



Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %
0.020	0.00	0.112	0.00	0.626	2.58	3.499	22.36	19.572	69.27	109.466	97.17
0.022	0.00	0.124	0.00	0.692	3.18	3.872	24.42	21.658	72.18	121.132	97.67
0.024	0.00	0.137	0.00	0.766	3.84	4.285	26.60	23.966	74.96	134.041	98.10
0.027	0.00	0.152	0.00	0.848	4.54	4.742	28.89	26.520	77.59	148.326	98.46
0.030	0.00	0.168	0.00	0.938	5.30	5.247	31.29	29.346	80.06	164.133	98.76
0.033	0.00	0.186	0.00	1.038	6.12	5.806	33.78	32.473	82.35	181.625	99.01
0.037	0.00	0.205	0.00	1.149	6.99	6.425	36.37	35.934	84.44	200.981	99.22
0.041	0.00	0.227	0.00	1.271	7.92	7.109	39.05	39.764	86.35	222.400	99.40
0.045	0.00	0.251	0.00	1.407	8.93	7.867	41.83	44.001	88.07	246.101	99.55
0.050	0.00	0.278	0.02	1.556	10.02	8.706	44.70	48.690	89.61	272.329	99.68
0.055	0.00	0.308	0.08	1.722	11.19	9.633	47.66	53.879	90.99	301.351	99.77
0.061	0.00	0.341	0.22	1.906	12.46	10.660	50.70	59.621	92.22	333.467	99.83
0.067	0.00	0.377	0.45	2.109	13.83	11.796	53.79	65.975	93.31	369.005	99.89
0.075	0.00	0.417	0.75	2.334	15.30	13.053	56.92	73.006	94.29	408.330	99.94
0.083	0.00	0.462	1.11	2.583	16.88	14.444	60.07	80.787	95.15	451.846	99.97
0.091	0.00	0.511	1.54	2.858	18.59	15.983	63.19	89.396	95.92	500.000	100.00
0.101	0.00	0.565	2.03	3.162	20.41	17.687	66.27	98.924	96.59		

MASTERSIZER 2000

Result Analysis Report

Sample Name:
JW4 - Average

SOP Name:

Measured:
Wednesday, April 05, 2006 2:13:51 PM

Sample Source & type:
Works = Vizon Scitec Inc- Kerrie Serben

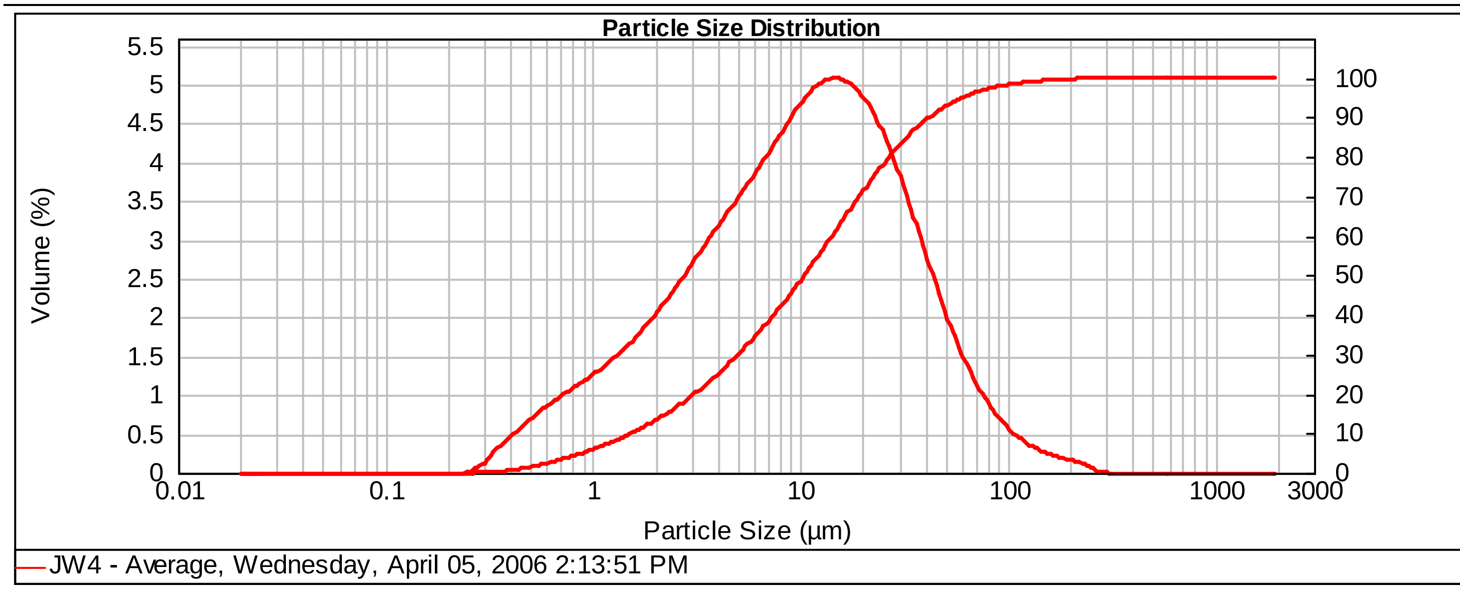
Measured by:
Vivian

Analysed:
Wednesday, April 05, 2006 2:13:52 PM

Particle Name:	Accessory Name:	Analysis model:	Sensitivity:
Soil	Hydro 2000S (A)	General purpose	Normal
Particle RI:	**Absorption:**	**Size range:**	**Obscuration:**
1.230	0.5	0.020 to 2000.000 um	15.67 %
Dispersant Name:	**Dispersant RI:**	**Weighted Residual:**	**Result Emulation:**
Water	1.330	0.625 %	Off

Concentration:	Span :	Uniformity:	Result units:
0.0096 %Vol	3.845	1.31	Volume
Specific Surface Area:	**Surface Weighted Mean D[3,2]:**	**Vol. Weighted Mean D[4,3]:**	
1.53 m²/g	3.921 um	18.136 um	

d(0.1): 1.526 um **d(0.5): 10.439 um** **d(0.9): 41.660 um**



Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %
0.020	0.00	0.112	0.00	0.626	2.66	3.499	22.35	19.572	70.56	109.466	98.64
0.022	0.00	0.124	0.00	0.692	3.28	3.872	24.36	21.658	73.74	121.132	98.93
0.024	0.00	0.137	0.00	0.766	3.95	4.285	26.48	23.966	76.80	134.041	99.17
0.027	0.00	0.152	0.00	0.848	4.68	4.742	28.71	26.520	79.69	148.326	99.36
0.030	0.00	0.168	0.00	0.938	5.45	5.247	31.05	29.346	82.39	164.133	99.53
0.033	0.00	0.186	0.00	1.038	6.28	5.806	33.50	32.473	84.88	181.625	99.67
0.037	0.00	0.205	0.00	1.149	7.17	6.425	36.06	35.934	87.13	200.981	99.79
0.041	0.00	0.227	0.00	1.271	8.11	7.109	38.74	39.764	89.15	222.400	99.89
0.045	0.00	0.251	0.00	1.407	9.13	7.867	41.54	44.001	90.93	246.101	99.96
0.050	0.00	0.278	0.02	1.556	10.22	8.706	44.46	48.690	92.47	272.329	100.00
0.055	0.00	0.308	0.09	1.722	11.39	9.633	47.51	53.879	93.80	301.351	100.00
0.061	0.00	0.341	0.24	1.906	12.65	10.660	50.66	59.621	94.92	333.467	100.00
0.067	0.00	0.377	0.48	2.109	14.00	11.796	53.91	65.975	95.87	369.005	100.00
0.075	0.00	0.417	0.78	2.334	15.46	13.053	57.23	73.006	96.66	408.330	100.00
0.083	0.00	0.462	1.15	2.583	17.01	14.444	60.59	80.787	97.31	451.846	100.00
0.091	0.00	0.511	1.59	2.858	18.68	15.983	63.95	89.396	97.84	500.000	100.00
0.101	0.00	0.565	2.10	3.162	20.45	17.687	67.29	98.924	98.28		

MASTERSIZER 2000

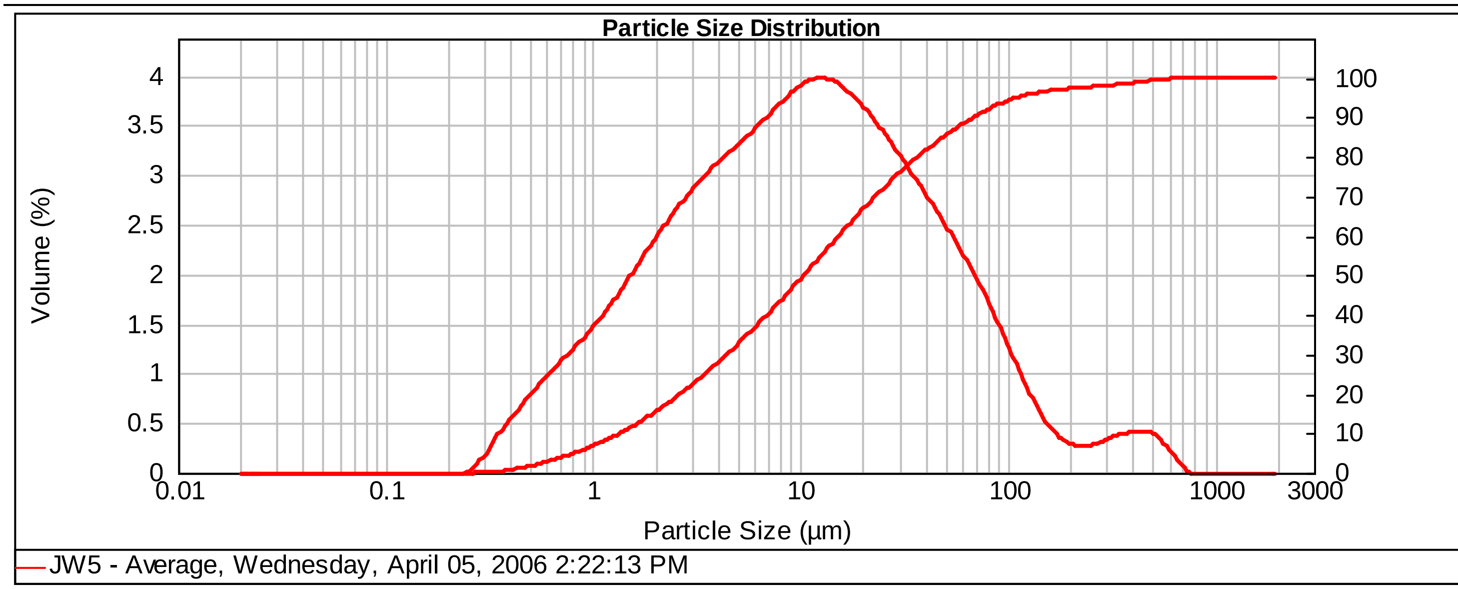
Result Analysis Report

Sample Name: JW5 - Average	**SOP Name:**	**Measured:** Wednesday, April 05, 2006 2:22:13 PM
Sample Source & type: Works = Vizon Scitec Inc- Kerrie Serben	**Measured by:** Vivian	**Analysed:** Wednesday, April 05, 2006 2:22:15 PM

Particle Name: Soil	**Accessory Name:** Hydro 2000S (A)	**Analysis model:** General purpose	**Sensitivity:** Normal
Particle RI: 1.230	**Absorption:** 0.5	**Size range:** 0.020 to 2000.000 um	**Obscuration:** 16.51 %
Dispersant Name: Water	**Dispersant RI:** 1.330	**Weighted Residual:** 0.718 %	**Result Emulation:** Off

Concentration: 0.0095 %Vol	**Span :** 6.405	**Uniformity:** 2.59	**Result units:** Volume
Specific Surface Area: 1.65 m²/g	**Surface Weighted Mean D[3,2]:** 3.634 um	**Vol. Weighted Mean D[4,3]:** 30.894 um	

d(0.1): 1.341 um **d(0.5): 10.372 um** **d(0.9): 67.775 um**



Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %
0.020	0.00	0.112	0.00	0.626	3.08	3.499	25.33	19.572	66.23	109.466	94.98
0.022	0.00	0.124	0.00	0.692	3.78	3.872	27.35	21.658	68.65	121.132	95.64
0.024	0.00	0.137	0.00	0.766	4.54	4.285	29.43	23.966	71.01	134.041	96.18
0.027	0.00	0.152	0.00	0.848	5.37	4.742	31.57	26.520	73.28	148.326	96.60
0.030	0.00	0.168	0.00	0.938	6.26	5.247	33.76	29.346	75.47	164.133	96.92
0.033	0.00	0.186	0.00	1.038	7.23	5.806	36.00	32.473	77.57	181.625	97.17
0.037	0.00	0.205	0.00	1.149	8.26	6.425	38.31	35.934	79.57	200.981	97.38
0.041	0.00	0.227	0.00	1.271	9.38	7.109	40.67	39.764	81.49	222.400	97.56
0.045	0.00	0.251	0.00	1.407	10.58	7.867	43.09	44.001	83.31	246.101	97.74
0.050	0.00	0.278	0.03	1.556	11.87	8.706	45.57	48.690	85.04	272.329	97.93
0.055	0.00	0.308	0.12	1.722	13.25	9.633	48.11	53.879	86.67	301.351	98.14
0.061	0.00	0.341	0.30	1.906	14.72	10.660	50.70	59.621	88.20	333.467	98.38
0.067	0.00	0.377	0.58	2.109	16.29	11.796	53.32	65.975	89.64	369.005	98.64
0.075	0.00	0.417	0.93	2.334	17.94	13.053	55.95	73.006	90.96	408.330	98.91
0.083	0.00	0.462	1.36	2.583	19.68	14.444	58.58	80.787	92.16	451.846	99.17
0.091	0.00	0.511	1.86	2.858	21.49	15.983	61.18	89.396	93.24	500.000	99.44
0.101	0.00	0.565	2.44	3.162	23.38	17.687	63.73	98.924	94.18		

MASTERSIZER 2000

Result Analysis Report

Sample Name:
JW6 - Average

SOP Name:

Measured:
Wednesday, April 05, 2006 2:28:07 PM

Sample Source & type:
Works = Vizon Scitec Inc- Kerrie Serben

Measured by:
Vivian

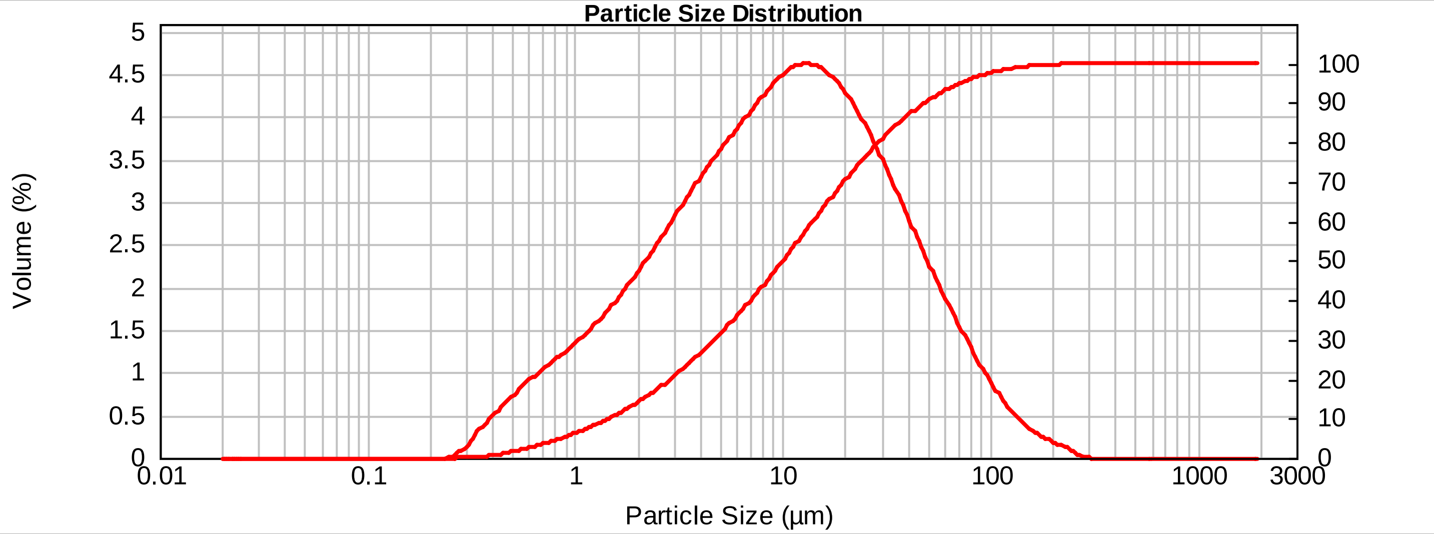
Analysed:
Wednesday, April 05, 2006 2:28:09 PM

Particle Name: Soil	**Accessory Name:** Hydro 2000S (A)	**Analysis model:** General purpose	**Sensitivity:** Normal
Particle RI: 1.230	**Absorption:** 0.5	**Size range:** 0.020 to 2000.000 um	**Obscuration:** 14.17 %
Dispersant Name: Water	**Dispersant RI:** 1.330	**Weighted Residual:** 0.670 %	**Result Emulation:** Off

Concentration: 0.0084 %Vol	**Span :** 4.658	**Uniformity:** 1.52	**Result units:** Volume
Specific Surface Area: 1.58 m²/g	**Surface Weighted Mean D[3,2]:** 3.794 um	**Vol. Weighted Mean D[4,3]:** 19.564 um	

d(0.1): 1.452 um **d(0.5): 10.068 um** **d(0.9): 48.345 um**

Particle Size Distribution



JW6 - Average, Wednesday, April 05, 2006 2:28:07 PM

Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %
0.020	0.00	0.112	0.00	0.626	2.78	3.499	23.60	19.572	69.74	109.466	98.14
0.022	0.00	0.124	0.00	0.692	3.43	3.872	25.69	21.658	72.55	121.132	98.59
0.024	0.00	0.137	0.00	0.766	4.14	4.285	27.87	23.966	75.26	134.041	98.95
0.027	0.00	0.152	0.00	0.848	4.91	4.742	30.16	26.520	77.84	148.326	99.23
0.030	0.00	0.168	0.00	0.938	5.73	5.247	32.54	29.346	80.27	164.133	99.46
0.033	0.00	0.186	0.00	1.038	6.61	5.806	35.01	32.473	82.56	181.625	99.63
0.037	0.00	0.205	0.00	1.149	7.55	6.425	37.58	35.934	84.69	200.981	99.77
0.041	0.00	0.227	0.00	1.271	8.56	7.109	40.23	39.764	86.66	222.400	99.88
0.045	0.00	0.251	0.00	1.407	9.64	7.867	42.97	44.001	88.46	246.101	99.96
0.050	0.00	0.278	0.02	1.556	10.80	8.706	45.80	48.690	90.11	272.329	100.00
0.055	0.00	0.308	0.09	1.722	12.05	9.633	48.71	53.879	91.60	301.351	100.00
0.061	0.00	0.341	0.25	1.906	13.40	10.660	51.69	59.621	92.94	333.467	100.00
0.067	0.00	0.377	0.49	2.109	14.83	11.796	54.72	65.975	94.14	369.005	100.00
0.075	0.00	0.417	0.81	2.334	16.37	13.053	57.77	73.006	95.20	408.330	100.00
0.083	0.00	0.462	1.20	2.583	18.02	14.444	60.82	80.787	96.13	451.846	100.00
0.091	0.00	0.511	1.66	2.858	19.77	15.983	63.85	89.396	96.92	500.000	100.00
0.101	0.00	0.565	2.19	3.162	21.63	17.687	66.83	98.924	97.59		

MASTERSIZER 2000

Result Analysis Report

Sample Name: JW7 - Average

SOP Name:

Measured: Wednesday, April 05, 2006 2:35:13 PM

Sample Source & type: Works = Vizon Scitec Inc- Kerrie Serben

Measured by: Vivian

Analysed: Wednesday, April 05, 2006 2:35:15 PM

Particle Name: Soil

Accessory Name: Hydro 2000S (A)

Analysis model: General purpose

Sensitivity: Normal

Particle RI: 1.230

Absorption: 0.5

Size range: 0.020 to 2000.000 um

Obscuration: 16.80 %

Dispersant Name: Water

Dispersant RI: 1.330

Weighted Residual: 0.664 %

Result Emulation: Off

Concentration: 0.0105 %Vol

Span : 5.419

Uniformity: 1.81

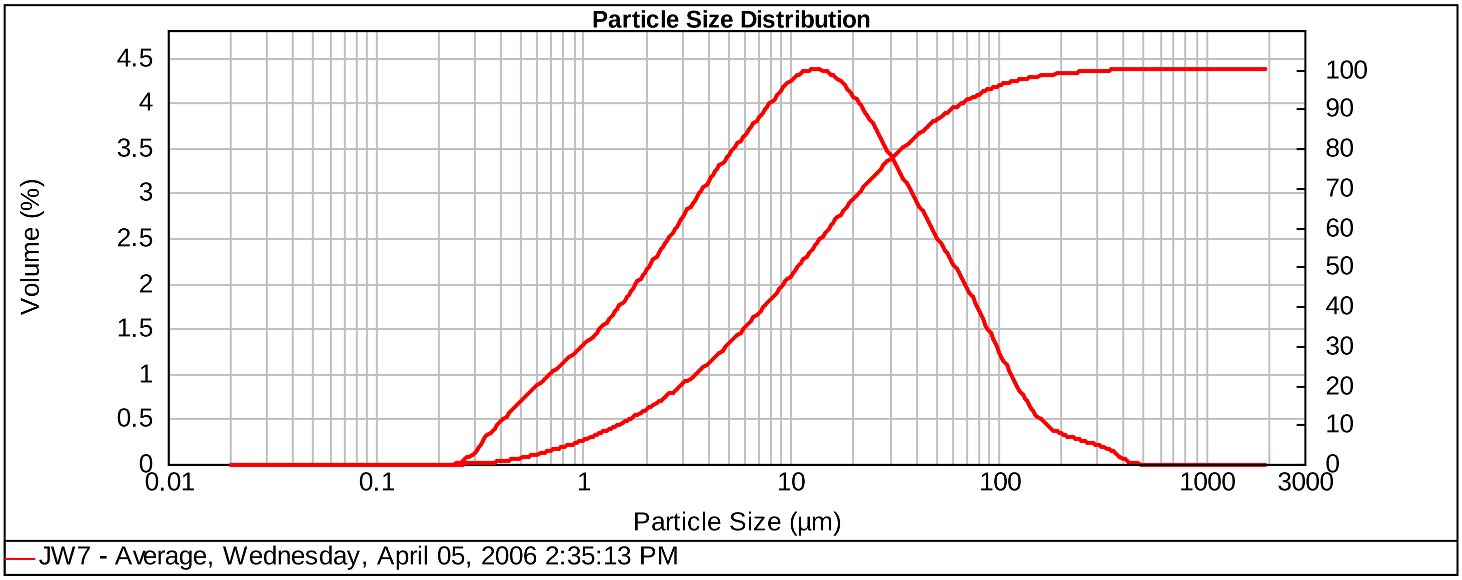
Result units: Volume

Specific Surface Area: 1.52 m²/g

Surface Weighted Mean D[3,2]: 3.947 um

Vol. Weighted Mean D[4,3]: 24.219 um

d(0.1): 1.500 um **d(0.5): 10.889 um** **d(0.9): 60.513 um**



Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %
0.020	0.00	0.112	0.00	0.626	2.64	3.499	22.86	19.572	66.47	109.466	96.50
0.022	0.00	0.124	0.00	0.692	3.26	3.872	24.85	21.658	69.15	121.132	97.15
0.024	0.00	0.137	0.00	0.766	3.94	4.285	26.93	23.966	71.73	134.041	97.69
0.027	0.00	0.152	0.00	0.848	4.68	4.742	29.10	26.520	74.21	148.326	98.12
0.030	0.00	0.168	0.00	0.938	5.47	5.247	31.35	29.346	76.57	164.133	98.47
0.033	0.00	0.186	0.00	1.038	6.32	5.806	33.69	32.473	78.82	181.625	98.75
0.037	0.00	0.205	0.00	1.149	7.24	6.425	36.10	35.934	80.94	200.981	98.99
0.041	0.00	0.227	0.00	1.271	8.23	7.109	38.60	39.764	82.94	222.400	99.20
0.045	0.00	0.251	0.00	1.407	9.29	7.867	41.19	44.001	84.82	246.101	99.39
0.050	0.00	0.278	0.02	1.556	10.43	8.706	43.85	48.690	86.58	272.329	99.55
0.055	0.00	0.308	0.09	1.722	11.66	9.633	46.59	53.879	88.24	301.351	99.71
0.061	0.00	0.341	0.23	1.906	12.97	10.660	49.40	59.621	89.78	333.467	99.83
0.067	0.00	0.377	0.46	2.109	14.38	11.796	52.26	65.975	91.22	369.005	99.93
0.075	0.00	0.417	0.76	2.334	15.88	13.053	55.14	73.006	92.53	408.330	99.99
0.083	0.00	0.462	1.13	2.583	17.48	14.444	58.03	80.787	93.72	451.846	100.00
0.091	0.00	0.511	1.57	2.858	19.18	15.983	60.89	89.396	94.78	500.000	100.00
0.101	0.00	0.565	2.07	3.162	20.97	17.687	63.71	98.924	95.71		

MASTERSIZER 2000

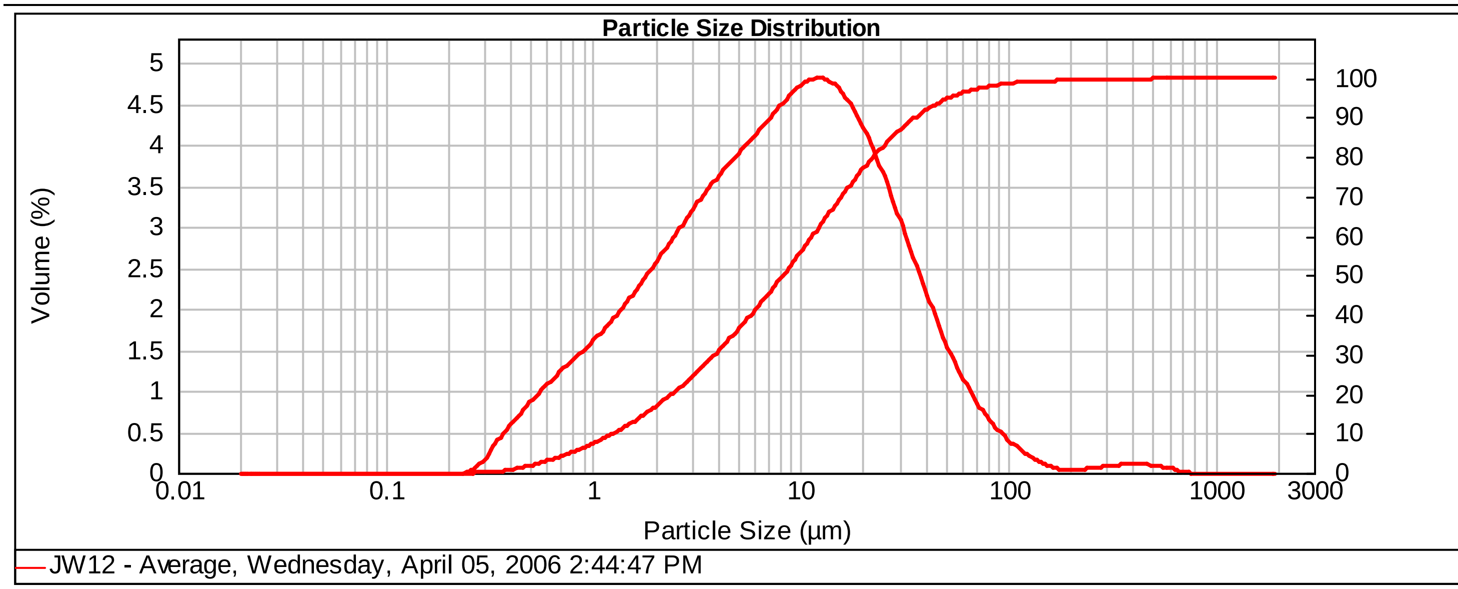
Result Analysis Report

Sample Name: JW12 - Average	**SOP Name:**	**Measured:** Wednesday, April 05, 2006 2:44:47 PM
Sample Source & type: Works = Vizon Scitec Inc- Kerrie Serben	**Measured by:** Vivian	**Analysed:** Wednesday, April 05, 2006 2:44:48 PM

Particle Name: Soil	**Accessory Name:** Hydro 2000S (A)	**Analysis model:** General purpose	**Sensitivity:** Normal
Particle RI: 1.230	**Absorption:** 0.5	**Size range:** 0.020 to 2000.000 um	**Obscuration:** 14.35 %
Dispersant Name: Water	**Dispersant RI:** 1.330	**Weighted Residual:** 0.649 %	**Result Emulation:** Off

Concentration: 0.0074 %Vol	**Span :** 4.180	**Uniformity:** 1.61	**Result units:** Volume
Specific Surface Area: 1.81 m²/g	**Surface Weighted Mean D[3,2]:** 3.308 um	**Vol. Weighted Mean D[4,3]:** 16.799 um	

d(0.1): 1.249 um **d(0.5): 8.261 um** **d(0.9): 35.777 um**



Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %
0.020	0.00	0.112	0.00	0.626	3.31	3.499	27.70	19.572	76.31	109.466	98.86
0.022	0.00	0.124	0.00	0.692	4.08	3.872	30.01	21.658	79.07	121.132	99.05
0.024	0.00	0.137	0.00	0.766	4.93	4.285	32.41	23.966	81.66	134.041	99.18
0.027	0.00	0.152	0.00	0.848	5.84	4.742	34.90	26.520	84.06	148.326	99.27
0.030	0.00	0.168	0.00	0.938	6.82	5.247	37.47	29.346	86.27	164.133	99.34
0.033	0.00	0.186	0.00	1.038	7.87	5.806	40.12	32.473	88.28	181.625	99.37
0.037	0.00	0.205	0.00	1.149	9.00	6.425	42.85	35.934	90.07	200.981	99.39
0.041	0.00	0.227	0.00	1.271	10.21	7.109	45.67	39.764	91.66	222.400	99.42
0.045	0.00	0.251	0.00	1.407	11.51	7.867	48.57	44.001	93.05	246.101	99.45
0.050	0.00	0.278	0.03	1.556	12.90	8.706	51.56	48.690	94.24	272.329	99.49
0.055	0.00	0.308	0.11	1.722	14.39	9.633	54.62	53.879	95.26	301.351	99.54
0.061	0.00	0.341	0.30	1.906	15.97	10.660	57.75	59.621	96.12	333.467	99.60
0.067	0.00	0.377	0.59	2.109	17.67	11.796	60.93	65.975	96.84	369.005	99.66
0.075	0.00	0.417	0.97	2.334	19.46	13.053	64.11	73.006	97.43	408.330	99.73
0.083	0.00	0.462	1.43	2.583	21.36	14.444	67.28	80.787	97.91	451.846	99.80
0.091	0.00	0.511	1.98	2.858	23.37	15.983	70.39	89.396	98.31	500.000	99.87
0.101	0.00	0.565	2.61	3.162	25.48	17.687	73.41	98.924	98.62		

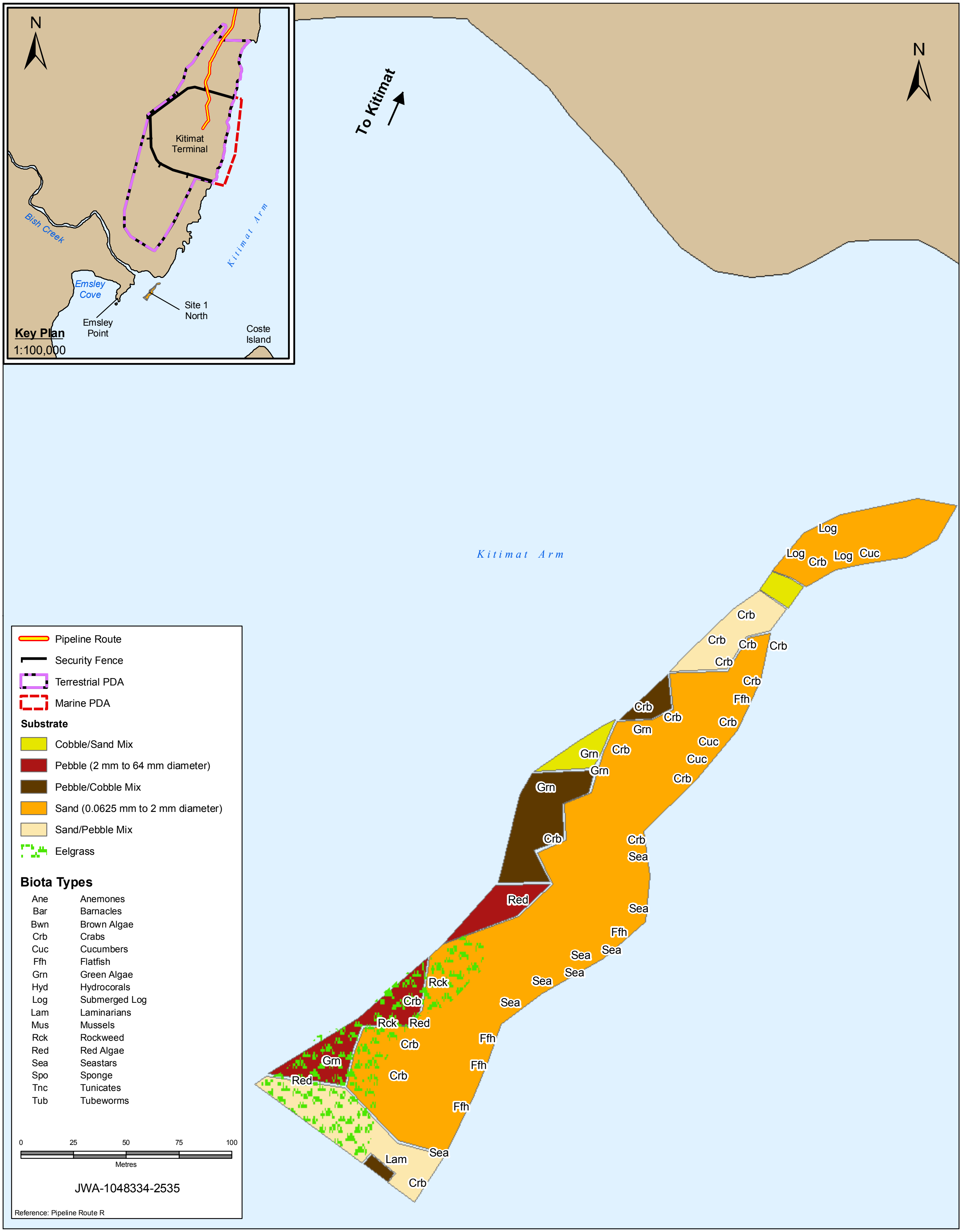
Appendix D Subtidal Video Survey

Table D-1 Transect Lengths and Positions

Transect Number	Start (Latitude/Longitude)	End (Latitude/Longitude)	Length (m)
1	53°56’2.11”/128°43’10.95”	53°55’56.73”/128°42’45.65”	832
2	53°56’3.30”/128°43’9.99”	53°55’58.03”/128°42’44.88”	822
3	53°56’4.69”/128°43’9.94”	53°55’59.28”/128°42’44.16”	847
4	53°56’5.99”/128°43’9.56”	53°56’0.49”/128°42’43.39”	859
5	53°56’7.34”/128°43’9.17”	53°56’1.77”/128°42’42.63”	871
6	53°56’8.64”/128°43’8.02”	53°56’3.04”/128°42’41.91”	863
7	53°56’9.83”/128°43’7.11”	53°56’4.28”/128°42’41.09”	857
8	53°56’10.56”/128°43’4.05”	53°56’5.69”/128°42’41.09”	753
9	53°56’12.18”/128°43’4.60”	53°56’9.81”/128°42’53.78”	355
10	53°56’13.43”/128°43’4.32”	53°56’11.22”/128°42’53.78”	344
11	53°56’14.53”/128°43’2.69”	53°56’12.27”/128°42’52.00”	350
12	53°56’15.52”/128°43’0.34”	53°56’13.40”/128°42’50.42”	327
13	53°56’16.74”/128°42’59.77”	53°56’14.19”/128°42’47.88”	389
14	53°56’18.01”/128°42’58.85”	53°56’15.55”/128°42’47.12”	386
15	53°56’19.26”/128°42’57.90”	53°56’16.66”/128°42’45.63”	401
16	53°56’20.05”/128°42’55.17”	53°56’18.08”/128°42’45.10”	328
17	53°56’21.20”/128°42’53.79”	53°56’19.39”/128°42’45.02”	289
18	53°56’22.50”/128°42’53.26”	53°56’20.38”/128°42’43.20”	330
19	53°56’23.92”/128°42’53.26”	53°56’21.74”/128°42’43.01”	336
20	53°56’25.22”/128°42’52.55”	53°56’23.30”/128°42’43.70”	287
21	53°56’26.63”/128°42’52.35”	53°56’24.71”/128°42’43.68”	283
22	53°56’27.82”/128°42’51.30”	53°56’26.04”/128°42’42.96”	274
23	53°56’28.92”/128°42’49.96”	53°56’27.22”/128°42’42.10”	260
24	53°56’30.28”/128°42’49.43”	53°56’28.61”/128°42’41.43”	261
25	53°56’31.54”/128°42’48.74”	53°56’29.93”/128°42’41.12”	249
26	53°56’32.73”/128°42’47.45”	53°56’31.26”/128°42’40.45”	230
27	53°56’34.03”/128°42’46.87”	53°56’32.61”/128°42’40.12”	221
28	53°56’35.36”/128°42’46.35”	53°56’34.00”/128°42’39.78”	216
29	53°56’36.66”/128°42’45.77”	53°56’35.50”/128°42’40.26”	177
30	53°56’38.01”/128°42’45.53”	53°56’36.80”/128°42’39.93”	188
31	53°56’39.34”/128°42’45.15”	53°56’38.15”/128°42’39.45”	187
32	53°56’40.78”/128°42’44.96”	53°56’39.45”/128°42’38.92”	198
33	53°56’42.07”/128°42’44.69”	53°56’40.88”/128°42’39.03”	189
34	53°56’43.54”/128°42’44.54”	53°56’42.21”/128°42’38.46”	200

Table D-1 Transect Lengths and Positions (cont'd)

Transect Number	Start (Latitude/Longitude)	End (Latitude/Longitude)	Length (m)
35	53°56'44.64"/128°42'43.39"	53°56'43.40"/128°42'37.50"	193
36	53°56'45.88"/128°42'42.48"	53°56'44.75"/128°42'36.97"	179
37	53°56'47.16"/128°42'41.96"	53°56'46.05"/128°42'36.64"	175
38	53°56'0.66"/128°43'3.76"	53°56'46.08"/128°42'36.64"	2,525
38	53°55'58.77"/128°42'55.23"	53°56'8.39"/128°42'49.43"	536
40	53°55'56.73"/128°42'45.65"	53°56'4.92"/128°42'40.76"	455



CONTRACTOR: Jacques Whitford AXYS Ltd.		**ENBRIDGE NORTHERN GATEWAY PROJECT**	FIGURE NUMBER: D-1	DATE: 20100129
PREPARED BY: gem	PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES	Biophysical Survey Results for Site 1 North	SCALE: 1:2,500	AUTHOR: SS	APPROVED BY: CM
			PROJECTION: UTM 9	DATUM: NAD 83

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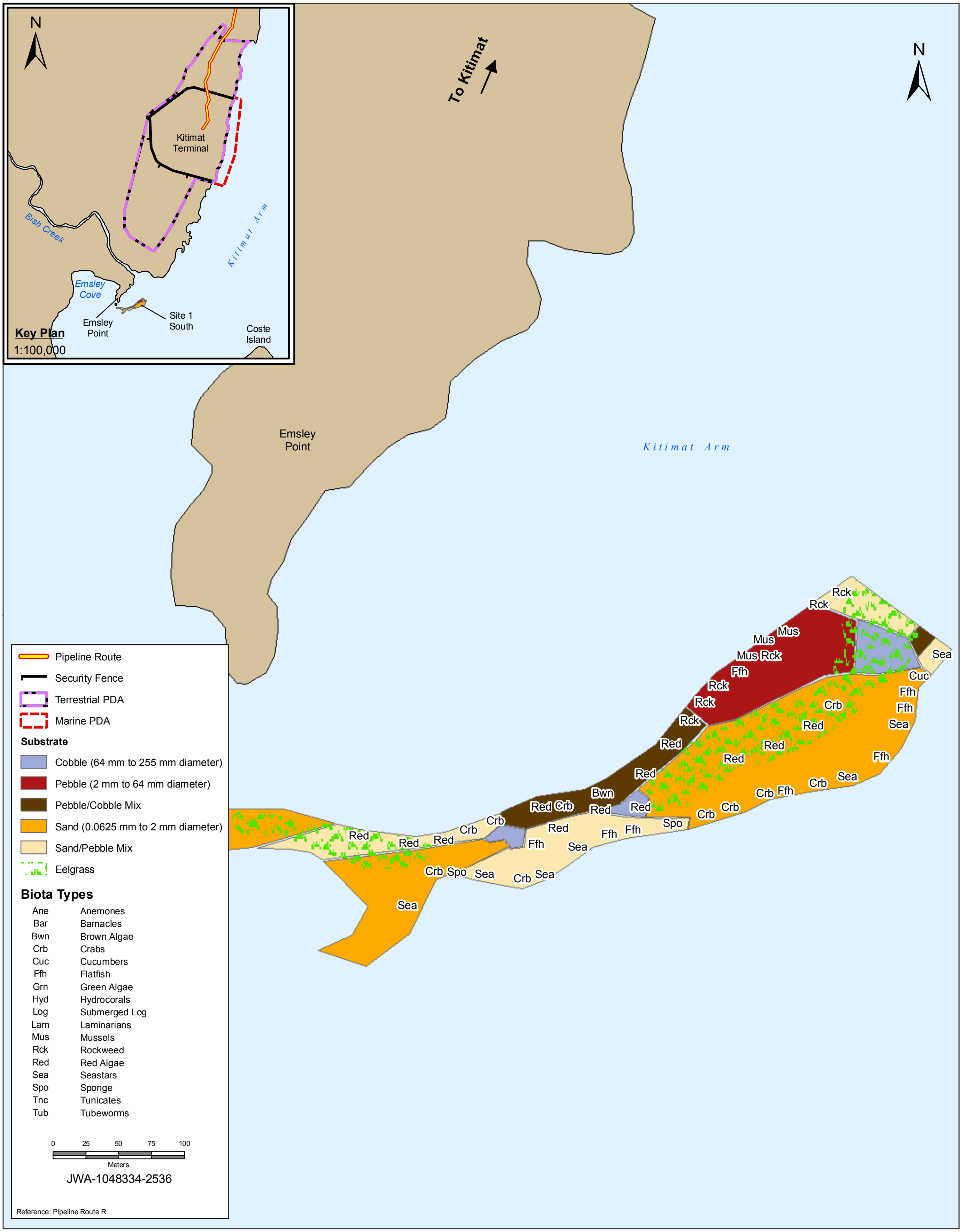

CONTRACTOR: Jacques Whitford AXYS Ltd.		**ENBRIDGE NORTHERN GATEWAY PROJECT**	FIGURE NUMBER: D-2	DATE: 20100129
PREPARED BY: gem Gateway Environmental Management Team	PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES	Biophysical Survey Results Results for Site 1 South	SCALE: 1:4,000 / PROJECTION: UTM 9	AUTHOR: SS / APPROVED BY: CM / DATUM: NAD 83

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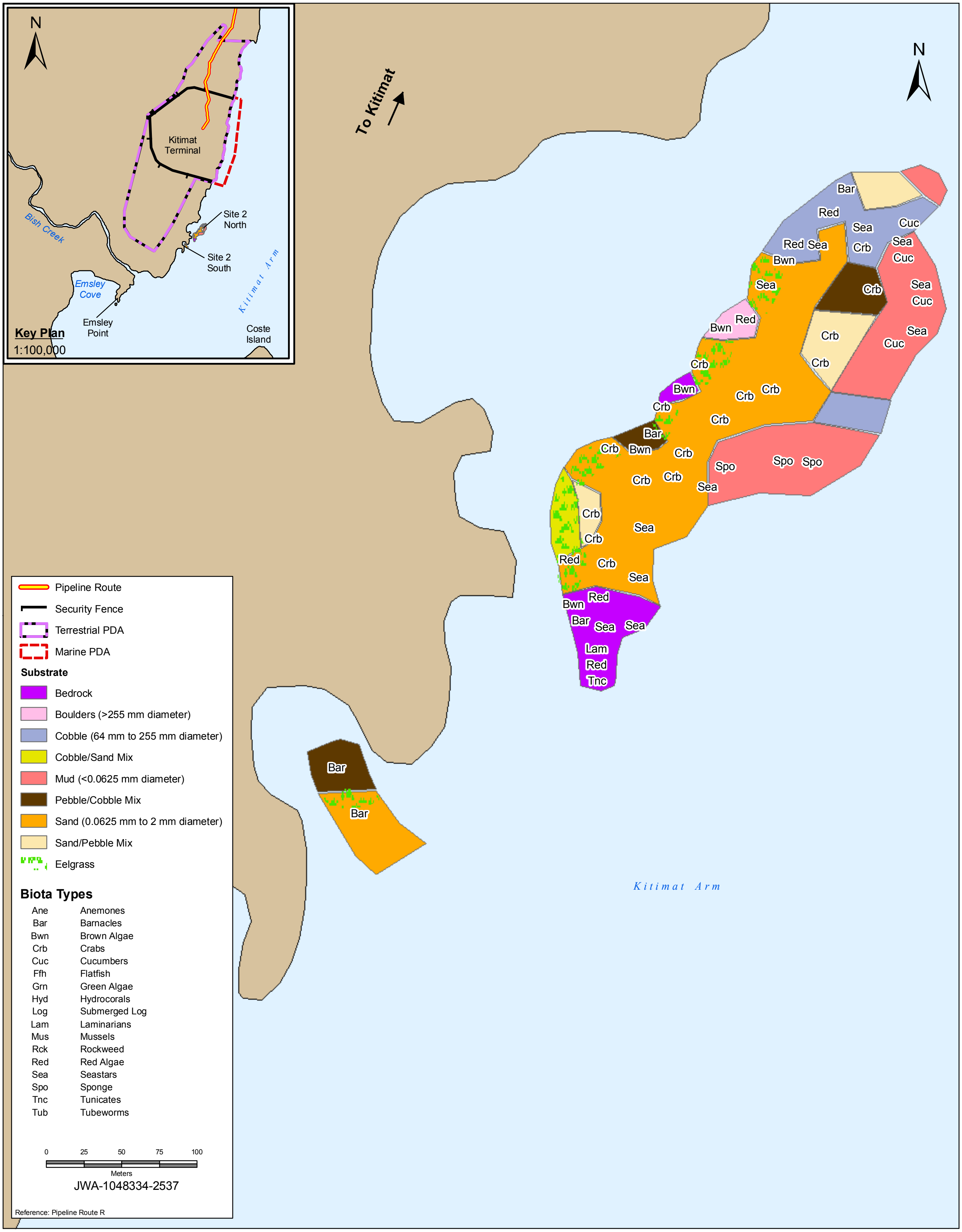

CONTRACTOR: Jacques Whitford AXYS Ltd.		ENBRIDGE NORTHERN GATEWAY PROJECT	FIGURE NUMBER: D-3		DATE: 20100129	
PREPARED BY: gem Gateway Environmental Management Team	PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES	Biophysical Survey Results for Site 2	SCALE: 1:3,500	AUTHOR: SS	APPROVED BY: CM	
			PROJECTION: UTM 9		DATUM: NAD 83	

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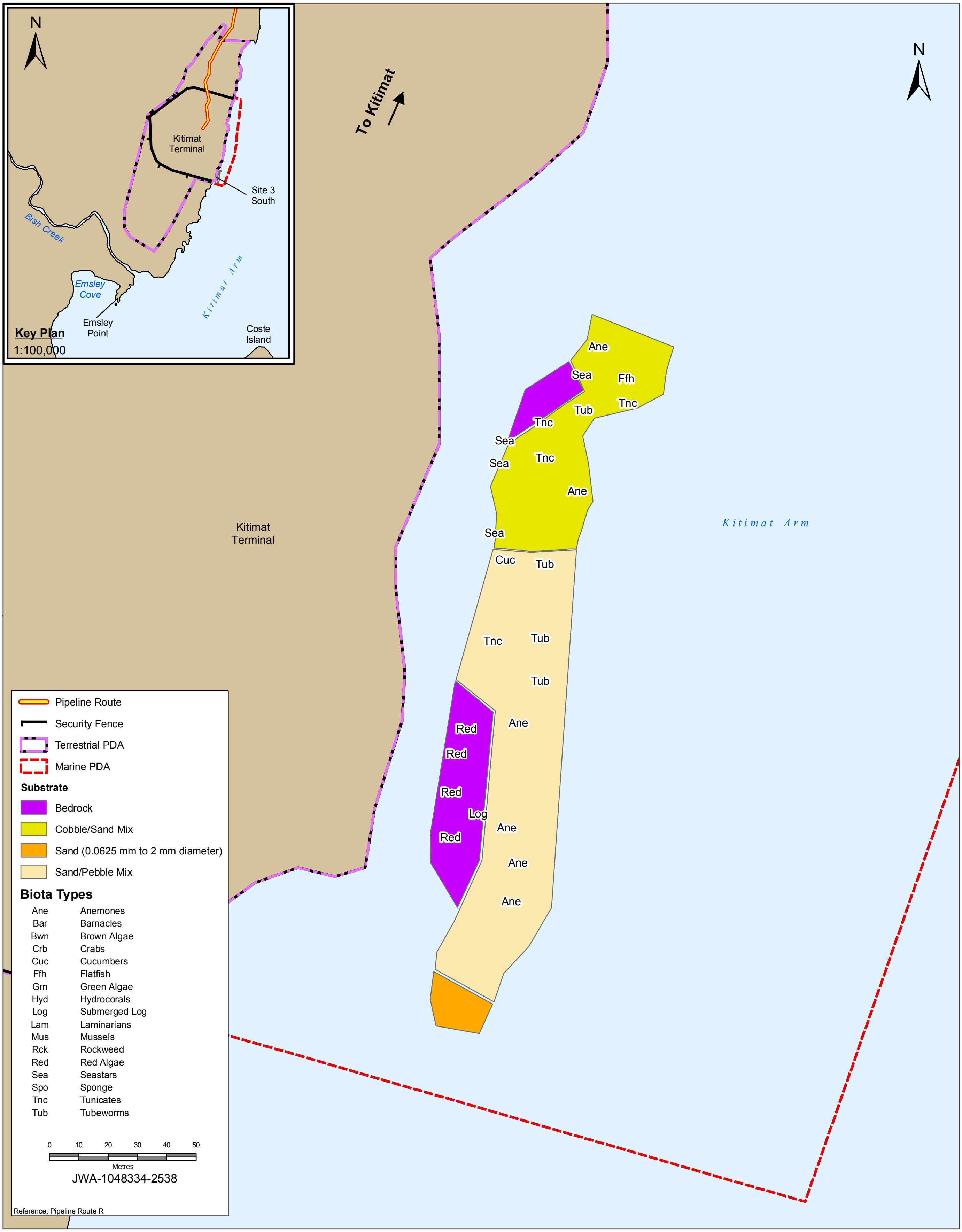

REFERENCES: NTDB Topographic Mapsheets provided by the Majesty the Queen in Right of Canada, Department of Natural Resources.

CONTRACTOR: Jacques Whitford AXYS Ltd.	**ENBRIDGE NORTHERN GATEWAY PROJECT**	FIGURE NUMBER: D-4	DATE: 20100129
PREPARED BY: gem Gateway Environmental Management Team	PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES	Biophysical Survey Results for Site 3 South	SCALE: 1:1,800	AUTHOR: SS	APPROVED BY: CM
			PROJECTION: UTM 9	DATUM: NAD 83

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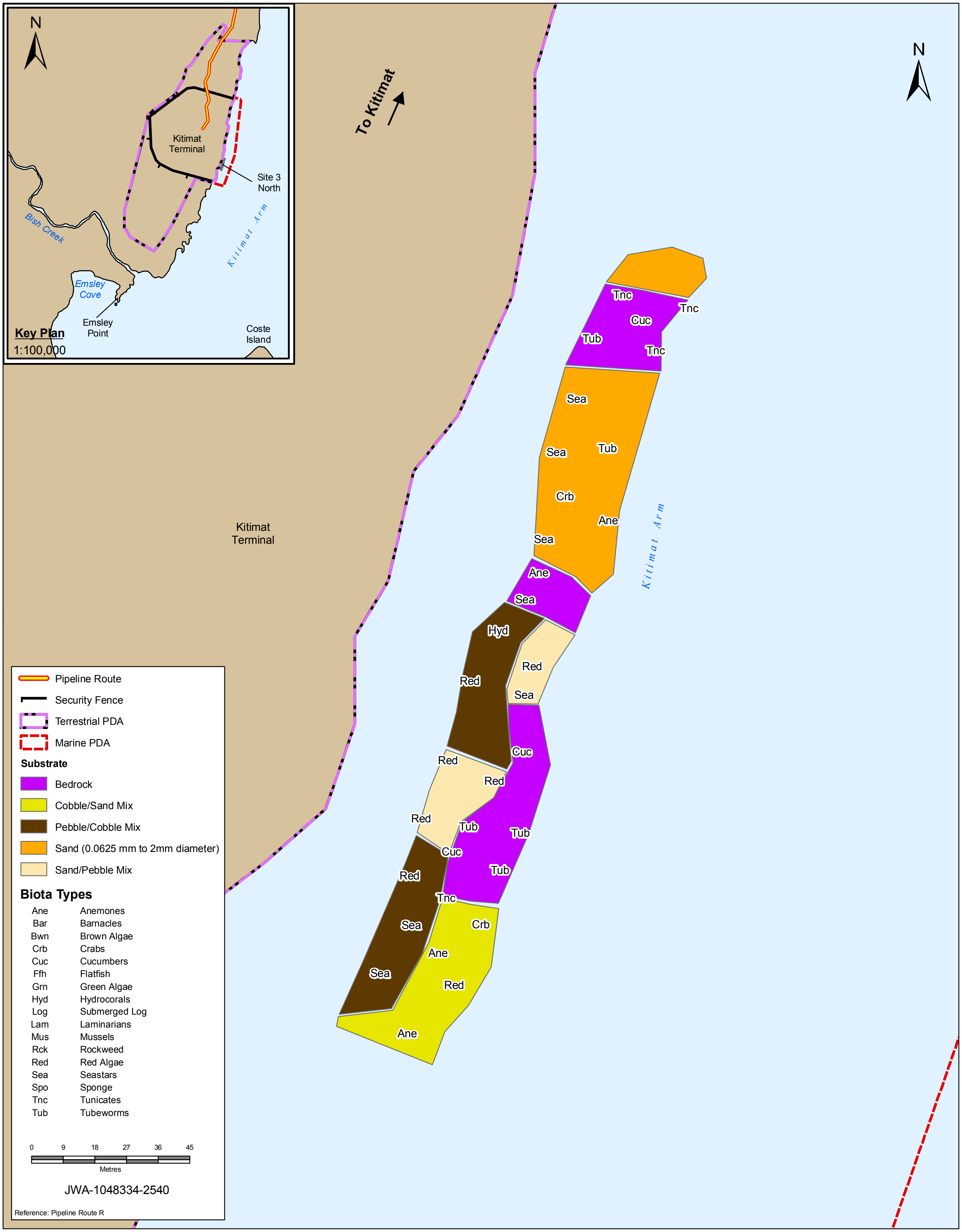

CONTRACTOR: Jacques Whitford AXYS Ltd.	ENBRIDGE NORTHERN GATEWAY PROJECT	FIGURE NUMBER: D-5	DATE: 20100129
PREPARED BY: gem	PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES	SCALE: 1:1,500	AUTHOR: SS / APPROVED BY: CM
	Biophysical Survey Results for Site 3 North	PROJECTION: UTM 9	DATUM: NAD 83

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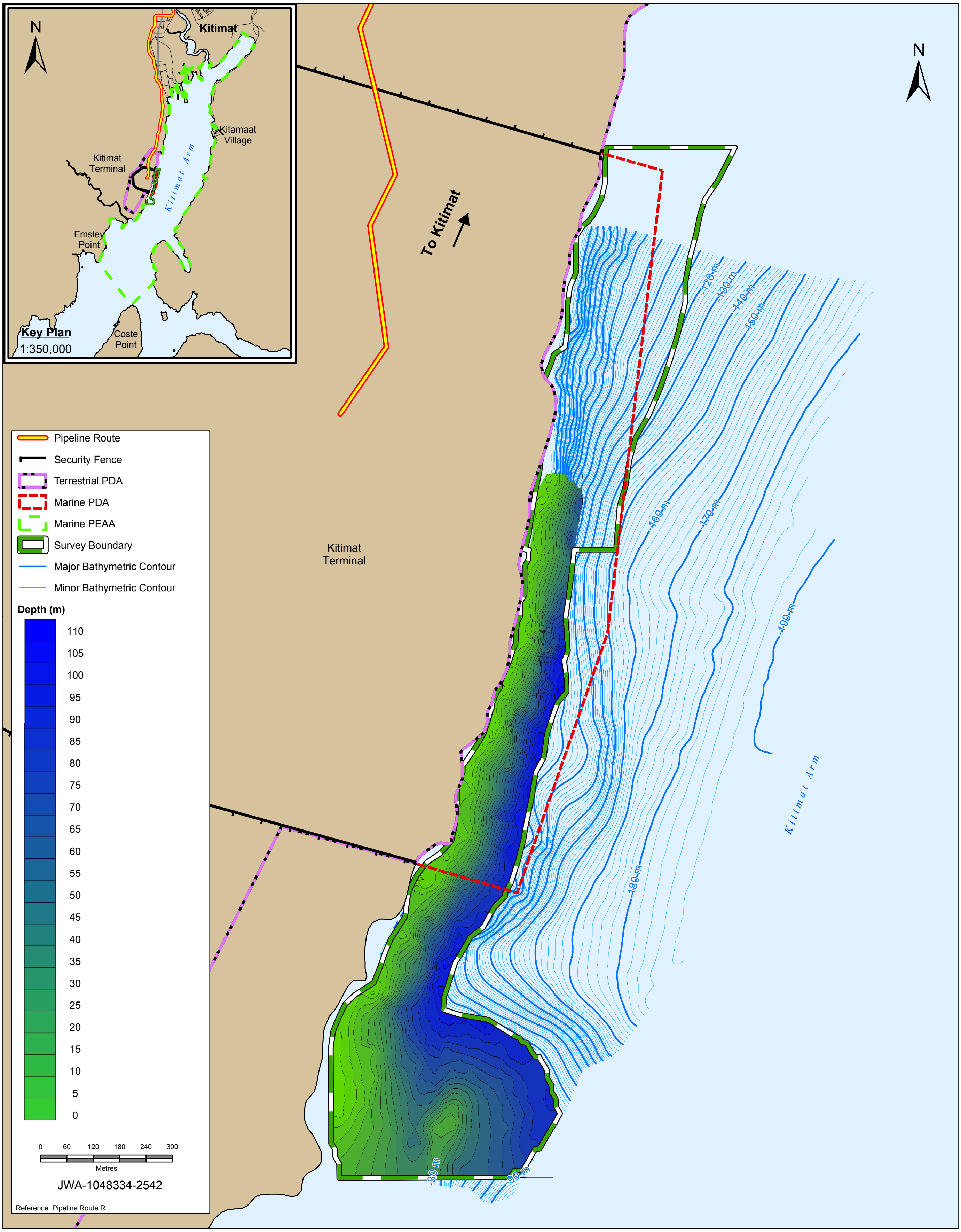

CONTRACTOR:		ENBRIDGE NORTHERN GATEWAY PROJECT	FIGURE NUMBER:		DATE:
Jacques Whitford AXYS Ltd.			D-6		20100129
PREPARED BY:	PREPARED FOR:	Site Bathymetry	SCALE: 1:12,000	AUTHOR: BA	APPROVED BY: JB
gem Gateway Environmental Management Team	ENBRIDGE NORTHERN GATEWAY PIPELINES		PROJECTION: UTM 9		DATUM: NAD 83

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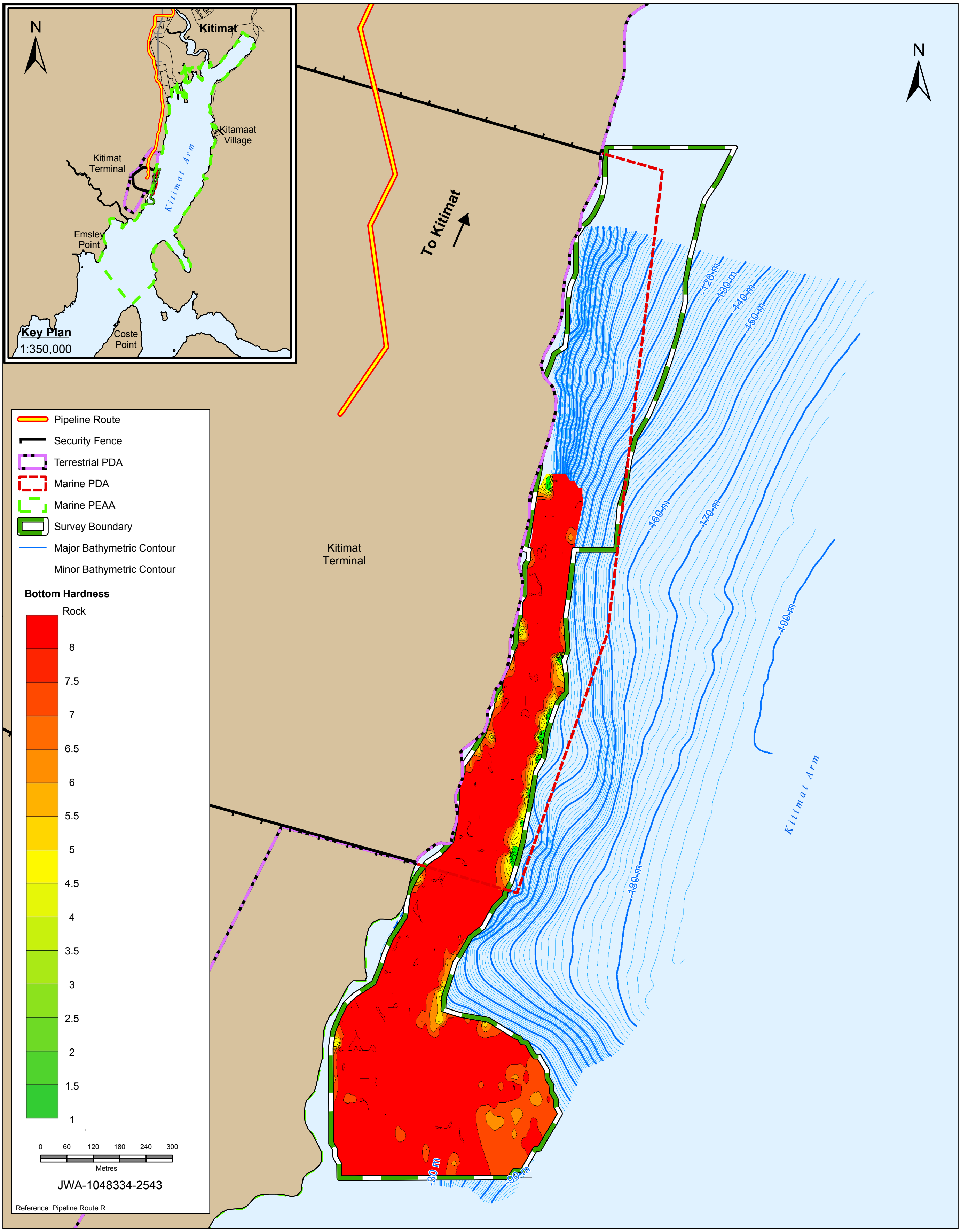

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CONTRACTOR: Jacques Whitford AXYS Ltd.		ENBRIDGE NORTHERN GATEWAY PROJECT	FIGURE NUMBER: D-7		DATE: 20100129
PREPARED BY: gem Gateway Environmental Management Team	PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES	Bottom Hardness Contours	SCALE: 1:12,000	AUTHOR: BA	APPROVED BY: JB
			PROJECTION: UTM 9	DATUM: NAD 83	

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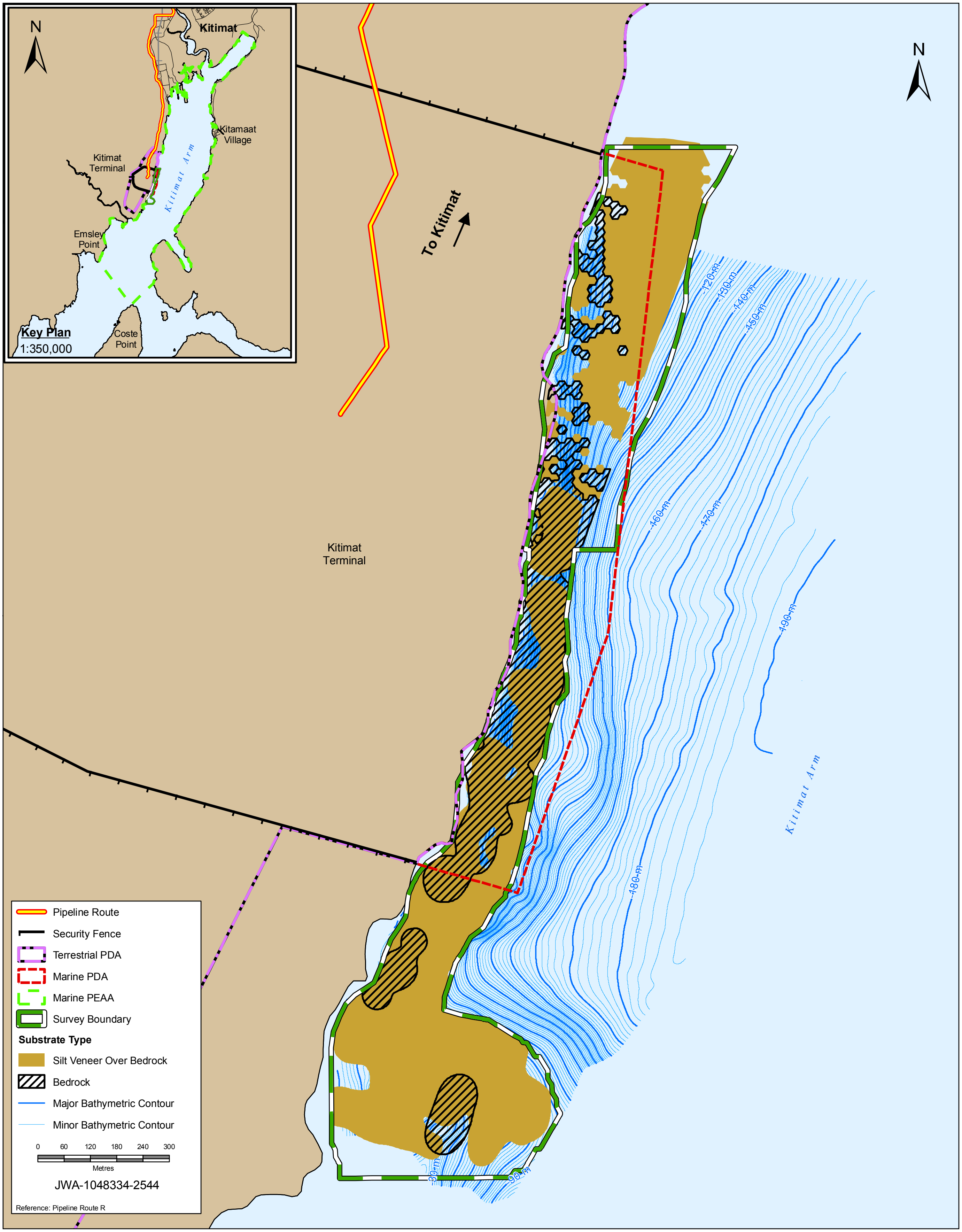

CONTRACTOR: Jacques Whitford AXYS Ltd.	ENBRIDGE NORTHERN GATEWAY PROJECT	FIGURE NUMBER: D-8	DATE: 20100129
PREPARED BY: gem	PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES	SCALE: 1:12,000	AUTHOR: BA / APPROVED BY: JB
	Bottom Substrate Distribution Bedrock and Silt Veneer	PROJECTION: UTM 9	DATUM: NAD 83

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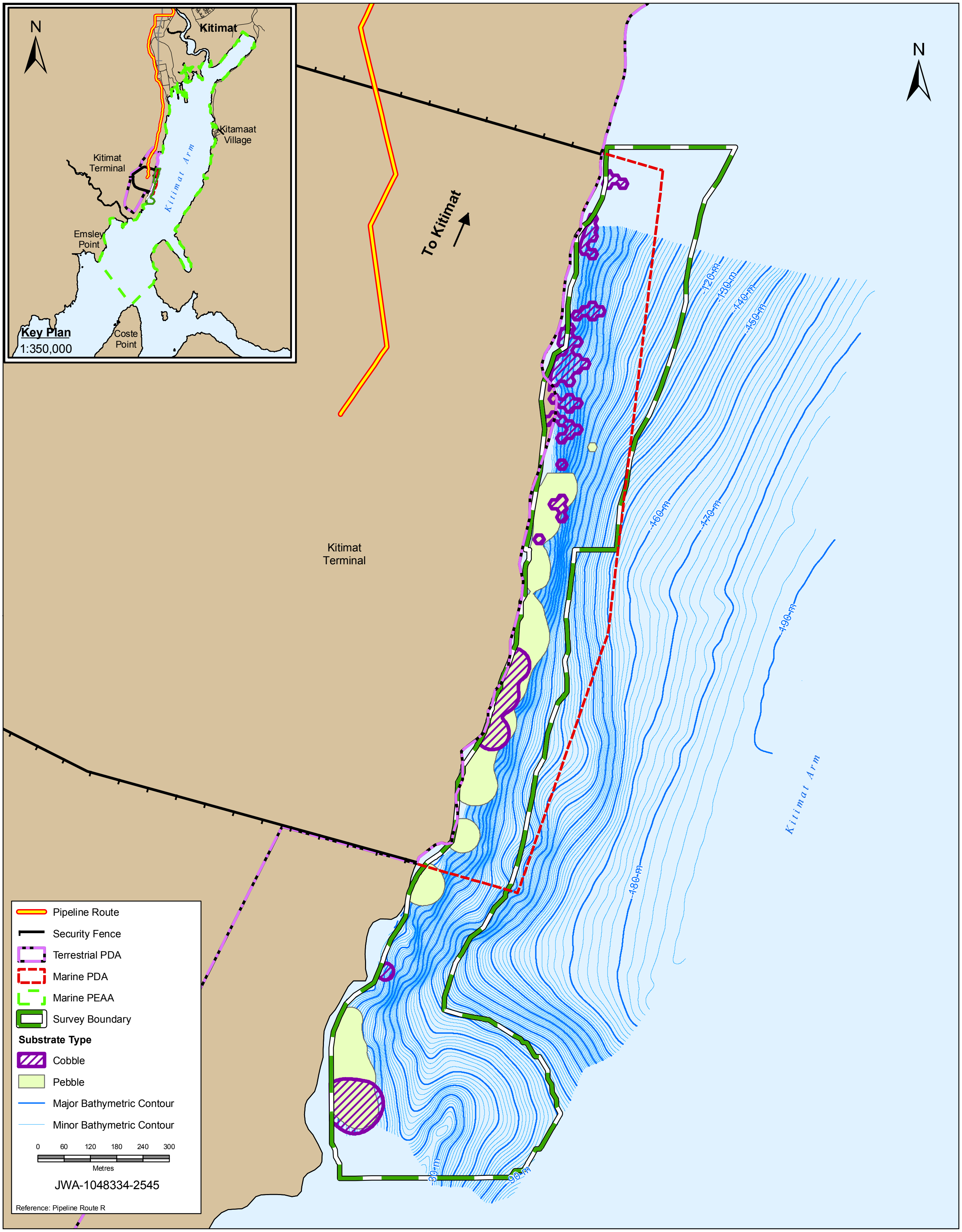

CONTRACTOR:		ENBRIDGE NORTHERN GATEWAY PROJECT	FIGURE NUMBER:		DATE:
Jacques Whitford AXYS Ltd.			D-9		20100129
PREPARED BY:	PREPARED FOR:	Bottom Substrate Distribution - Pebble and Cobble	SCALE: 1:12,000	AUTHOR: BA	APPROVED BY: JB
gem	ENBRIDGE NORTHERN GATEWAY PIPELINES		PROJECTION: UTM 9		DATUM: NAD 83

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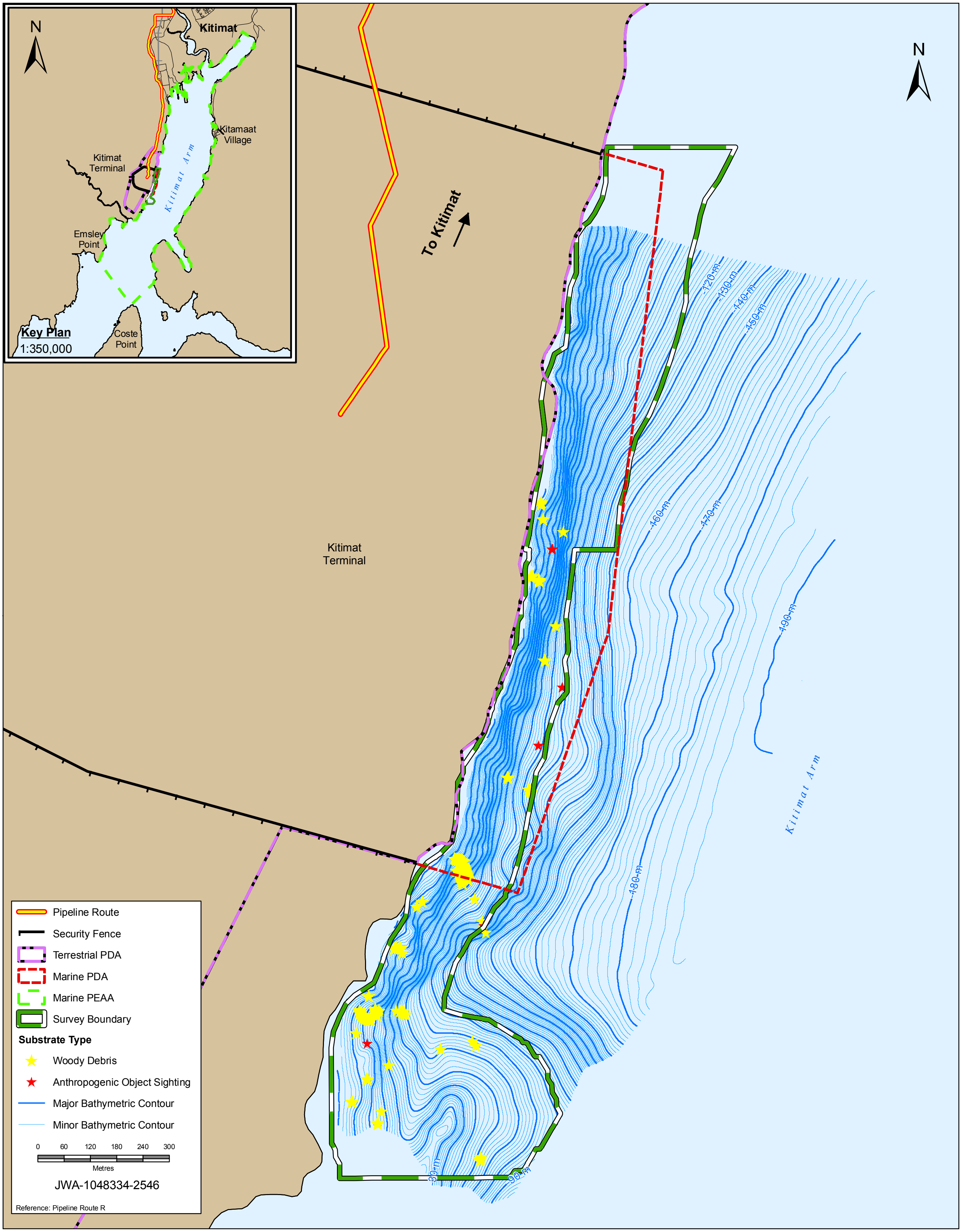

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CONTRACTOR: Jacques Whitford AXYS Ltd.		ENBRIDGE NORTHERN GATEWAY PROJECT	FIGURE NUMBER: D-10		DATE: 20100129
PREPARED BY: gem Gateway Environmental Management Team	PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES	Bottom Substrate Distribution - Woody Debris and Anthropogenic Objects	SCALE: 1:12,000	AUTHOR: BA	APPROVED BY: JB
			PROJECTION: UTM 9		DATUM: NAD 83

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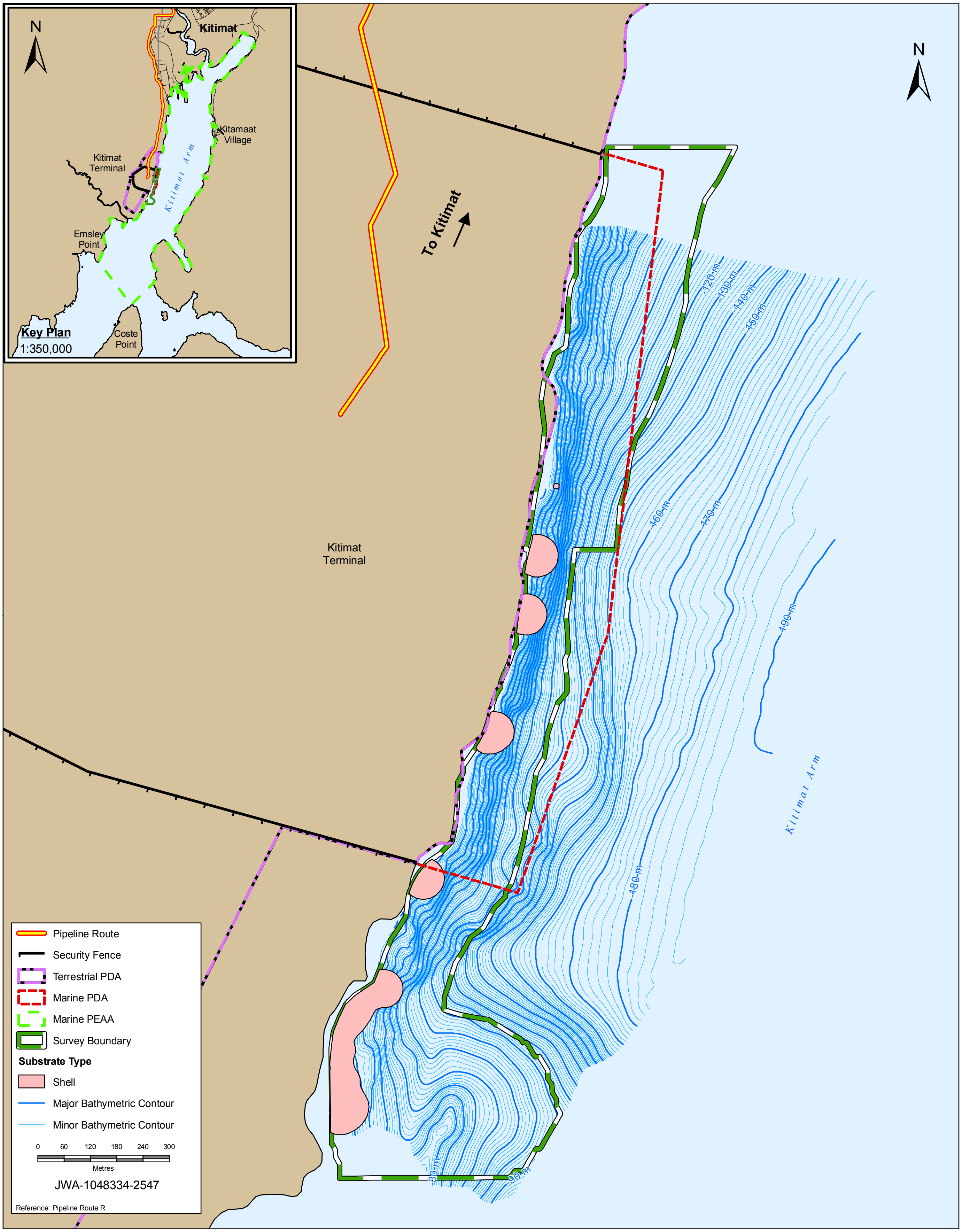

REFERENCES: NTDB Topographic Mapsheets provided by the Majesty the Queen in Right of Canada, Department of Natural Resources. All rights reserved.

CONTRACTOR:		ENBRIDGE NORTHERN GATEWAY PROJECT	FIGURE NUMBER:		DATE:
Jacques Whitford AXYS Ltd.			D-11		20100129
PREPARED BY:	PREPARED FOR:	Bottom Substrate Distribution - Shell	SCALE: 1:12,000	AUTHOR: BA	APPROVED BY: JB
gem	ENBRIDGE NORTHERN GATEWAY PIPELINES		PROJECTION: UTM 9		DATUM: NAD 83

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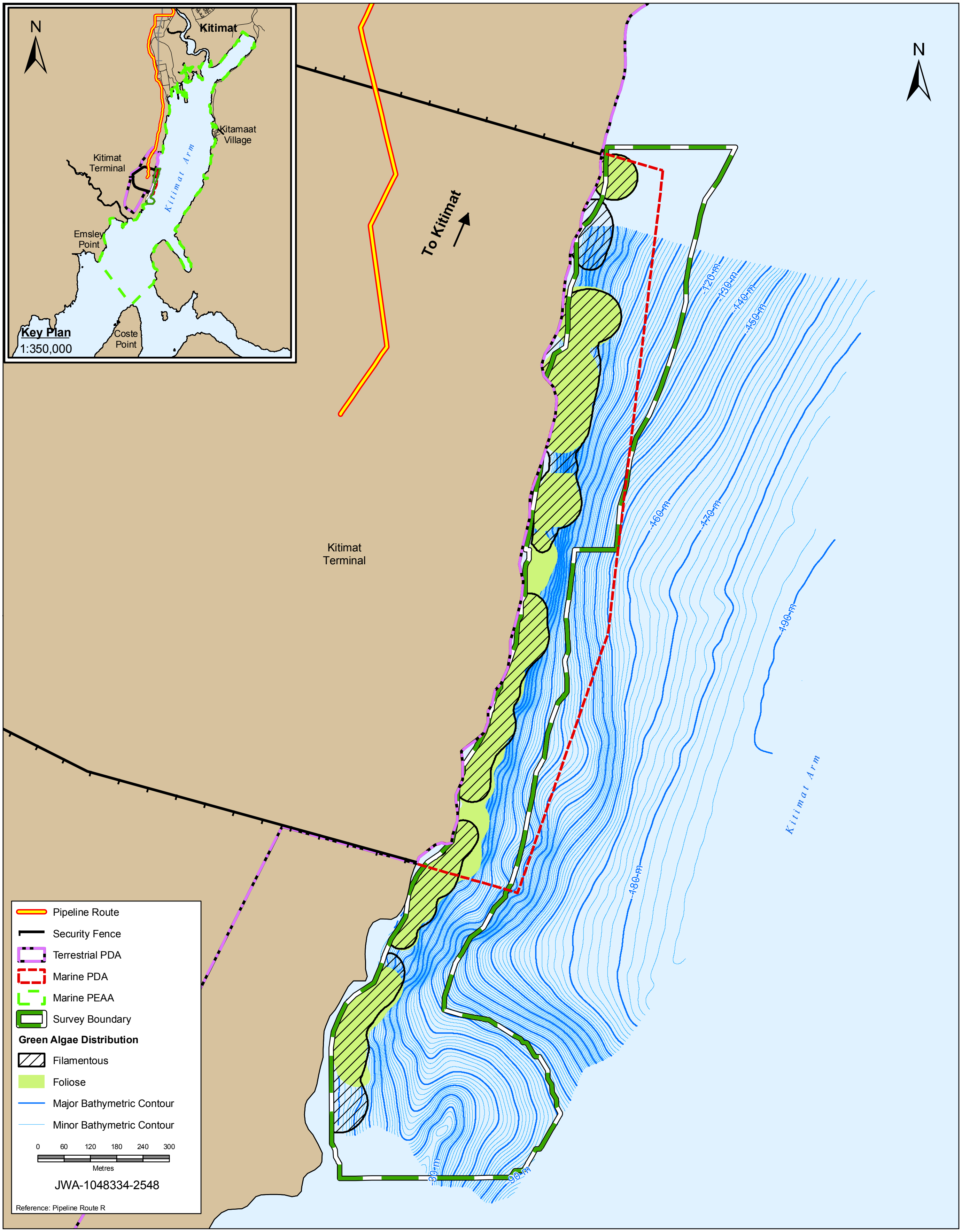

REFERENCES: NTDB Topographic Mapsheets provided by the Majesty the Queen in Right of Canada, Department of Natural Resources. All rights reserved.

CONTRACTOR:		ENBRIDGE NORTHERN GATEWAY PROJECT	FIGURE NUMBER:		DATE:
Jacques Whitford AXYS Ltd.			D-12		20100129
PREPARED BY:	PREPARED FOR:	Distribution of Green Algae	SCALE: 1:12,000	AUTHOR: BA	APPROVED BY: JB
gem Gateway Environmental Management Team	ENBRIDGE NORTHERN GATEWAY PIPELINES		PROJECTION: UTM 9		DATUM: NAD 83

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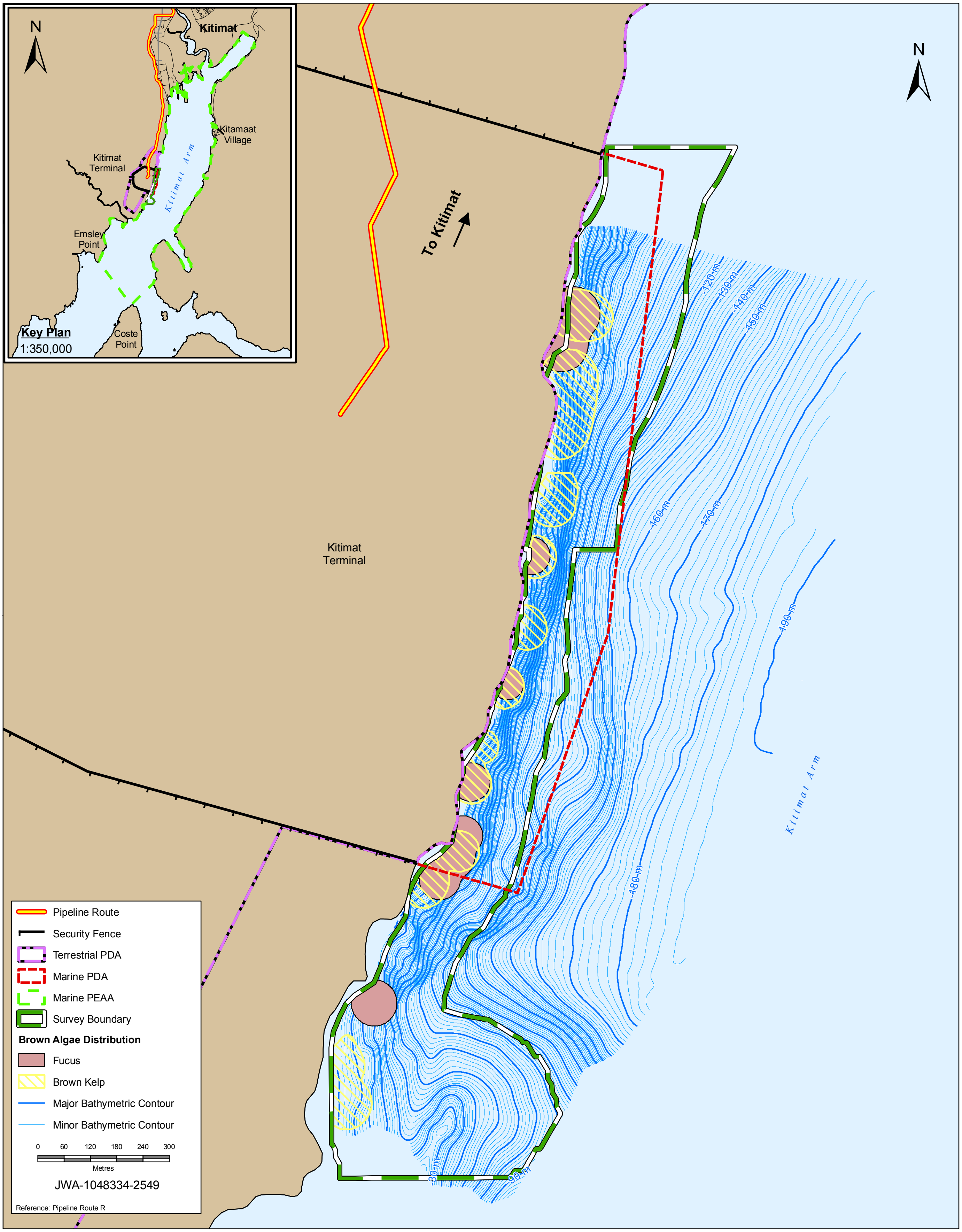

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CONTRACTOR: Jacques Whitford AXYS Ltd.		ENBRIDGE NORTHERN GATEWAY PROJECT	FIGURE NUMBER: D-13		DATE: 20100129
PREPARED BY: gem Gateway Environmental Management Team	PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES	Distribution of Brown Algae	SCALE: 1:12,000	AUTHOR: BA	APPROVED BY: JB
			PROJECTION: UTM 9	DATUM: NAD 83	

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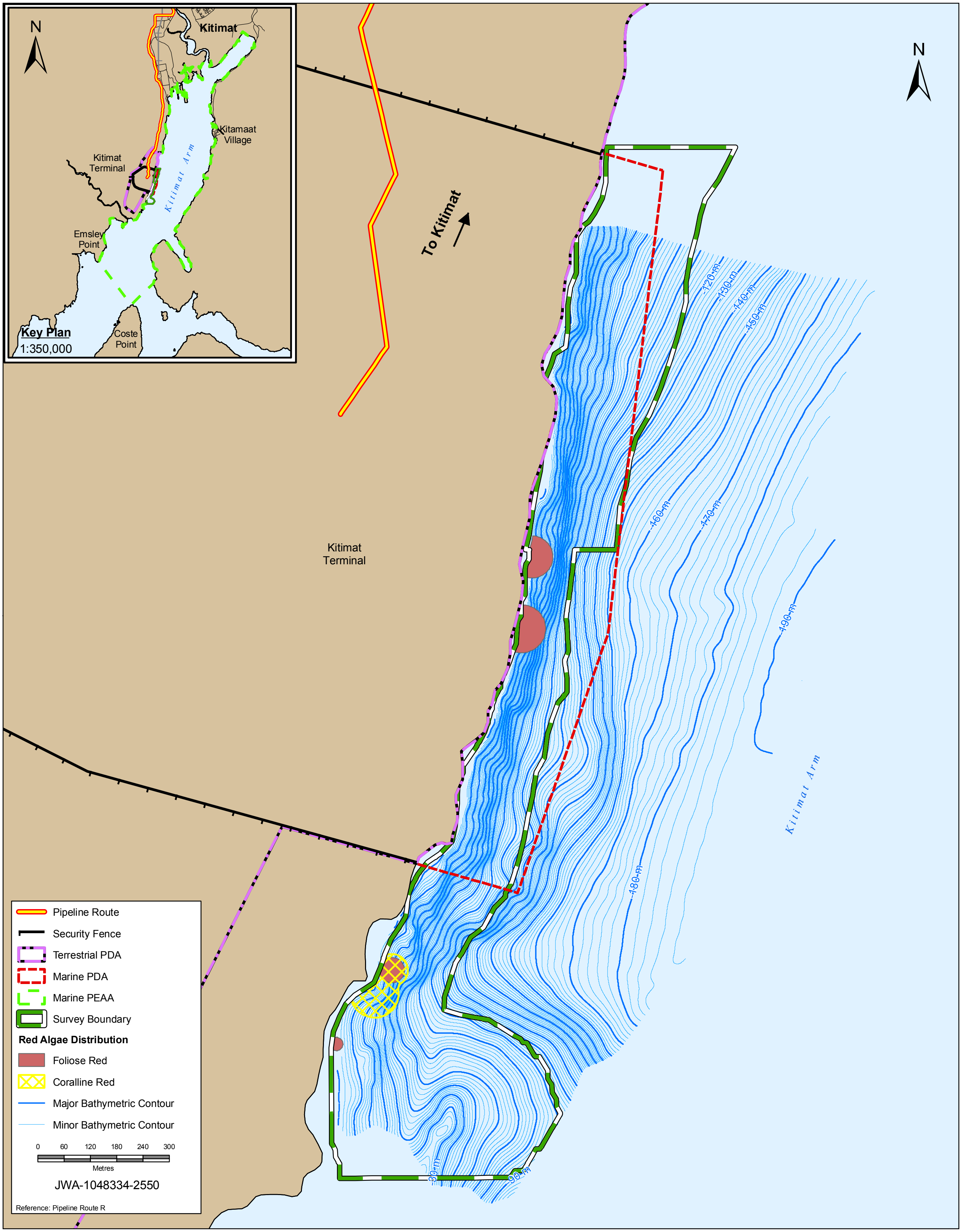

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CONTRACTOR: Jacques Whitford AXYS Ltd.

PREPARED BY: gem Gateway Environmental Management Team

PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES

ENBRIDGE NORTHERN GATEWAY PROJECT

Distribution of Red Algae

FIGURE NUMBER: D-14

DATE: 20100129

SCALE: 1:12,000

AUTHOR: BA

APPROVED BY: JB

PROJECTION: UTM 9

DATUM: NAD 83

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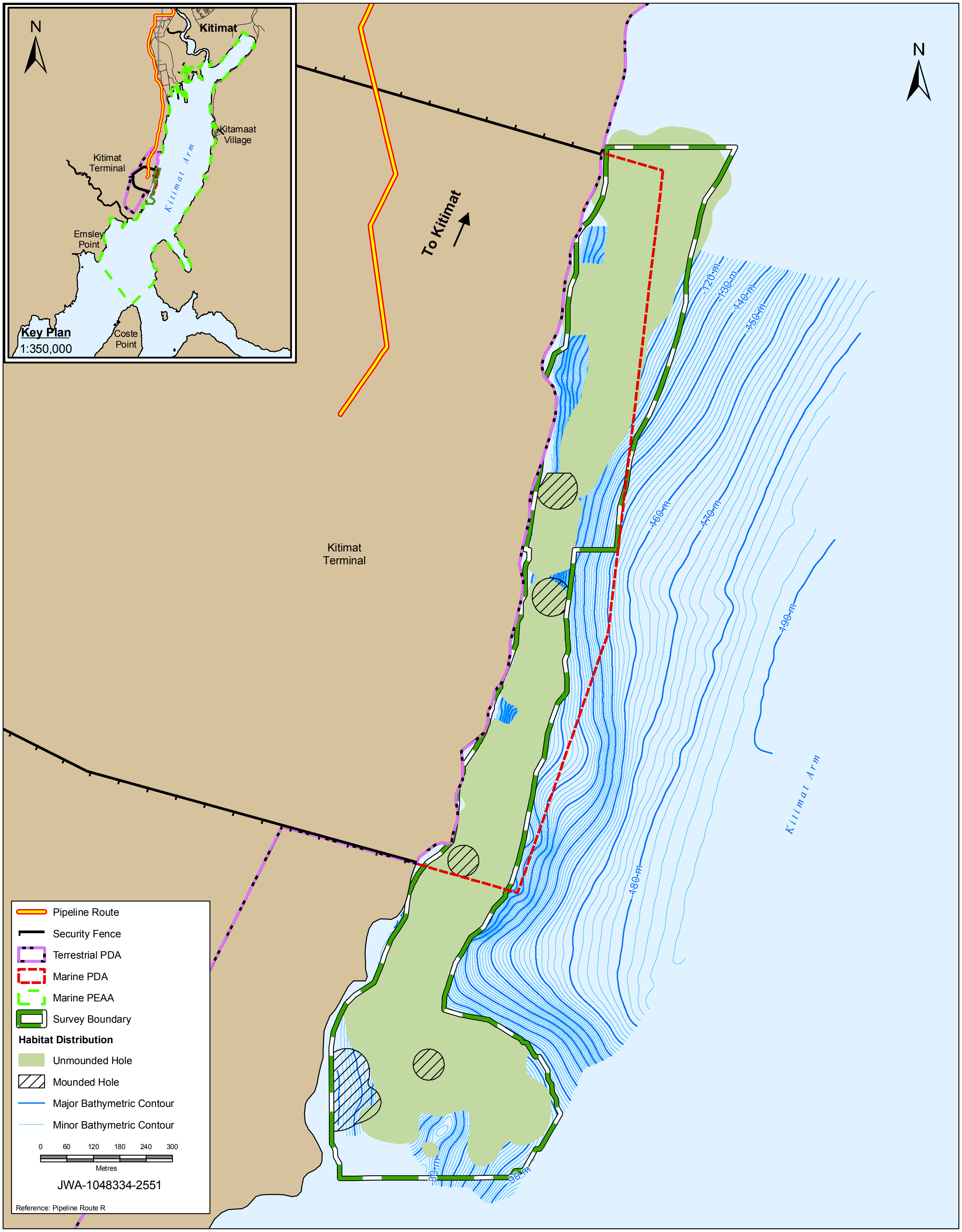

REFERENCES: NTDB Topographic Mapsheets provided by the Majesty the Queen in Right of Canada, Department of Natural Resources. All rights reserved.

CONTRACTOR:		ENBRIDGE NORTHERN GATEWAY PROJECT	FIGURE NUMBER: D-15		DATE: 20100129
Jacques Whitford AXYS Ltd.		Potential Distribution of Silt-Dwelling Organisms	SCALE: 1:12,000	AUTHOR: BA	APPROVED BY: JB
PREPARED BY: gem Gateway Environmental Management Team	PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES		PROJECTION: UTM 9	DATUM: NAD 83	

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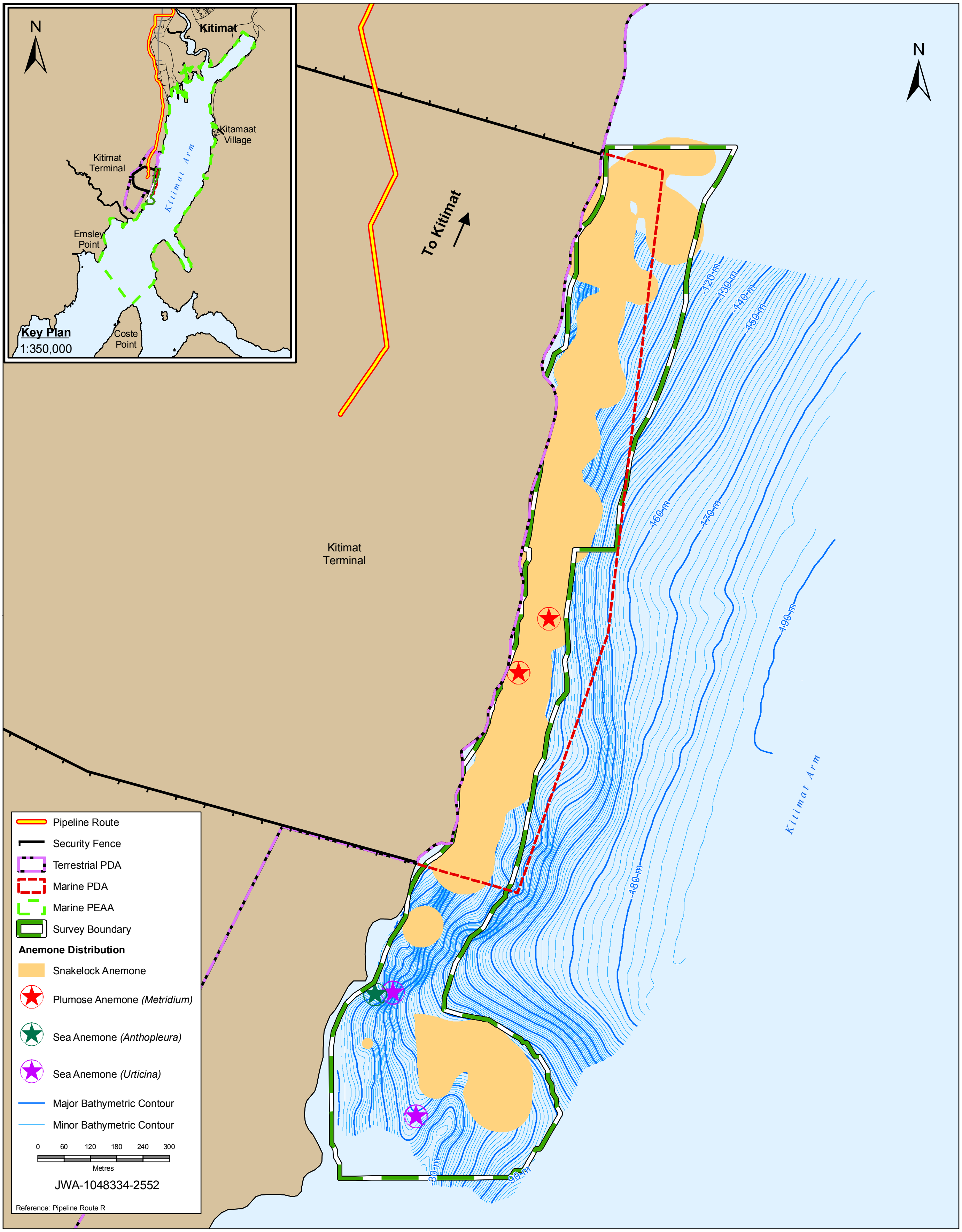

REFERENCES: NTDB Topographic Mapsheets provided by the Majesty the Queen in Right of Canada, Department of Natural Resources. All rights reserved.

CONTRACTOR: Jacques Whitford AXYS Ltd.		ENBRIDGE NORTHERN GATEWAY PROJECT	FIGURE NUMBER: D-16		DATE: 20100129
PREPARED BY: gem Gateway Environmental Management Team	PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES	Anemone Distribution	SCALE: 1:12,000	AUTHOR: BA	APPROVED BY: JB
			PROJECTION: UTM 9	DATUM: NAD 83	

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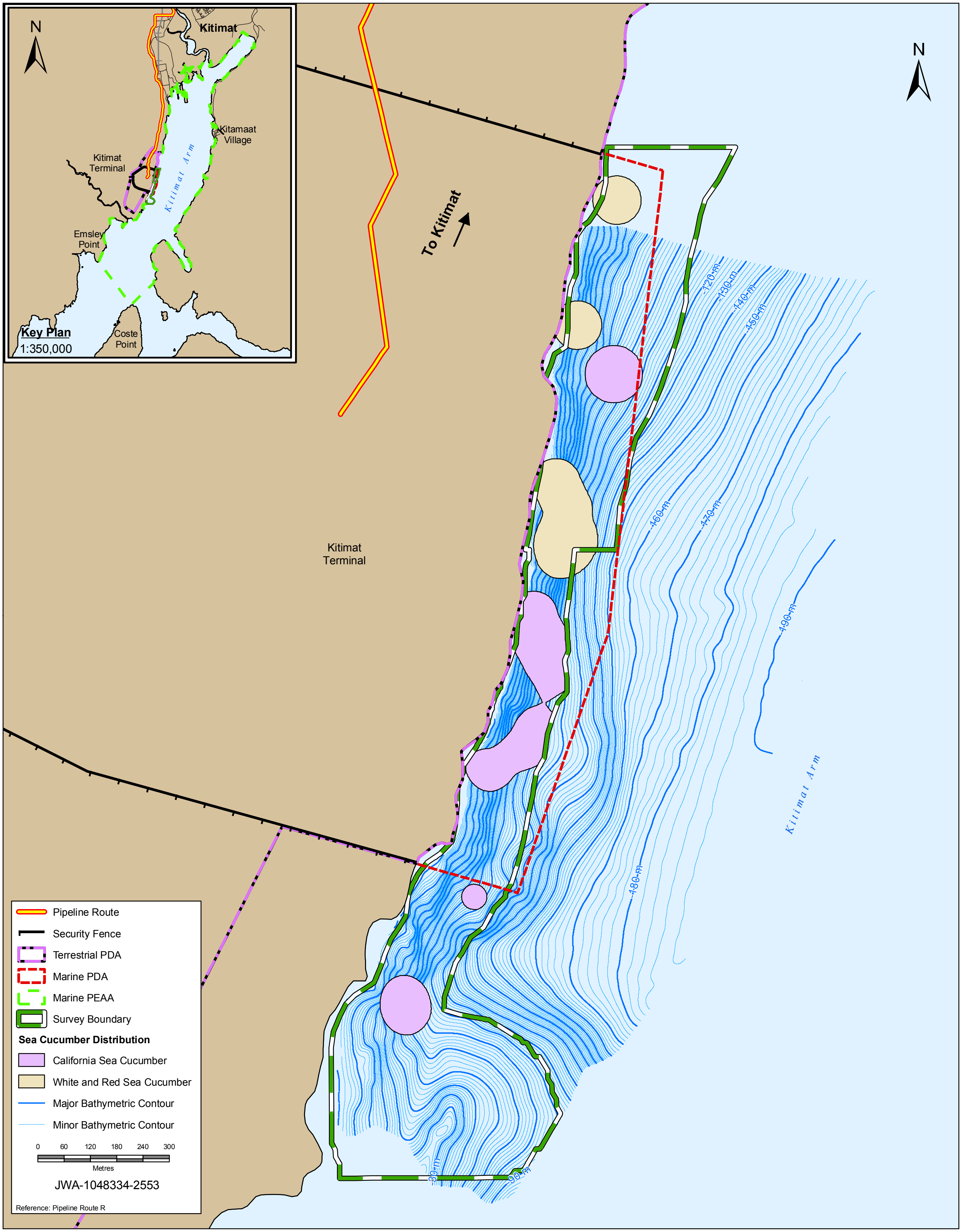

CONTRACTOR: Jacques Whitford AXYS Ltd.		ENBRIDGE NORTHERN GATEWAY PROJECT	FIGURE NUMBER: D-17	DATE: 20100129
PREPARED BY: gem	PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES	Sea Cucumber Distribution	SCALE: 1:12,000	AUTHOR: BA / APPROVED BY: JB
			PROJECTION: UTM 9	DATUM: NAD 83

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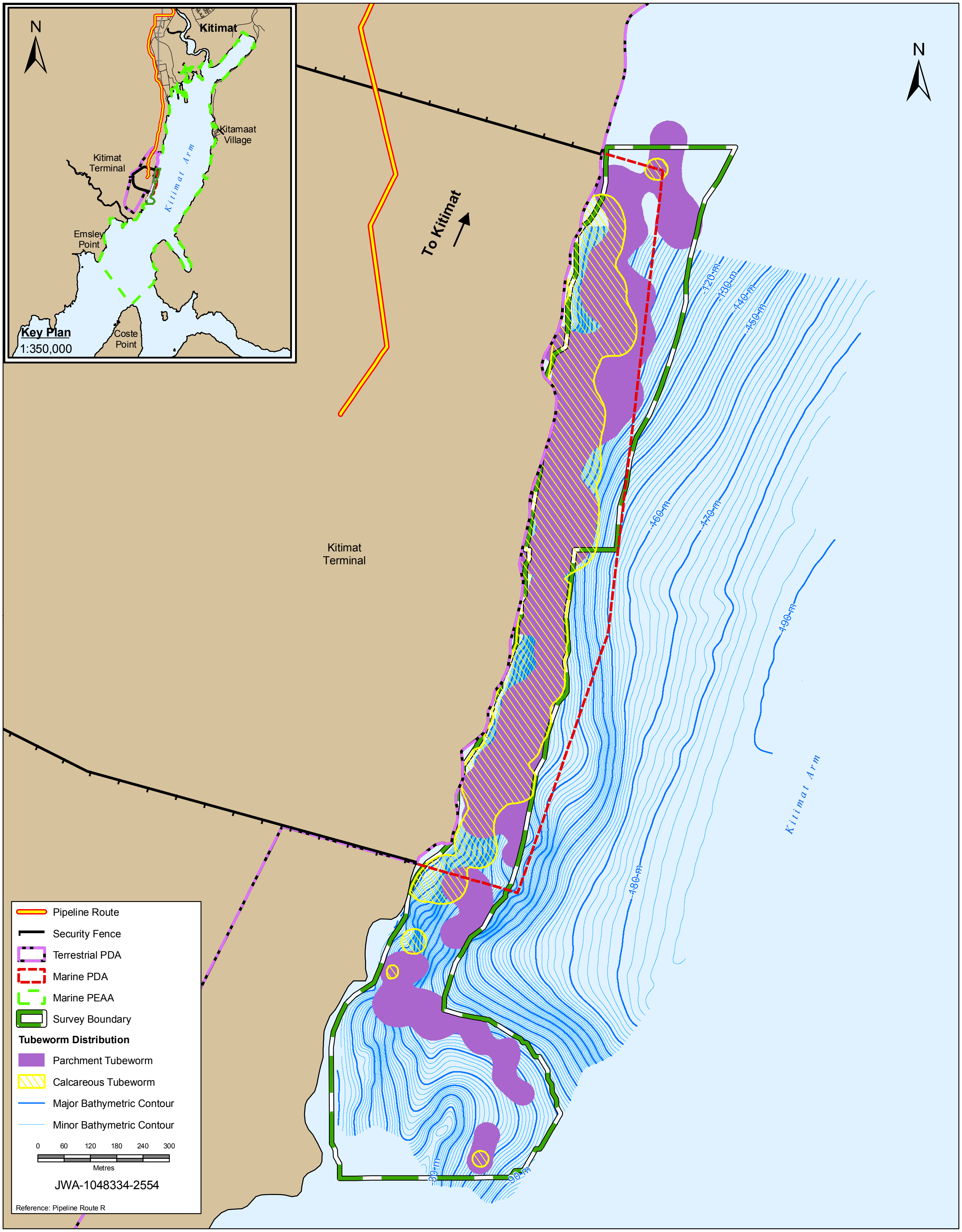

CONTRACTOR: Jacques Whitford AXYS Ltd.

PREPARED BY: gem Gateway Environmental Management Team

PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES

ENBRIDGE NORTHERN GATEWAY PROJECT

Tubeworm Distribution

FIGURE NUMBER:	DATE:
D-18	20100129

SCALE:	AUTHOR:	APPROVED BY:
1:12,000	BA	JB

PROJECTION:	DATUM:
UTM 9	NAD 83

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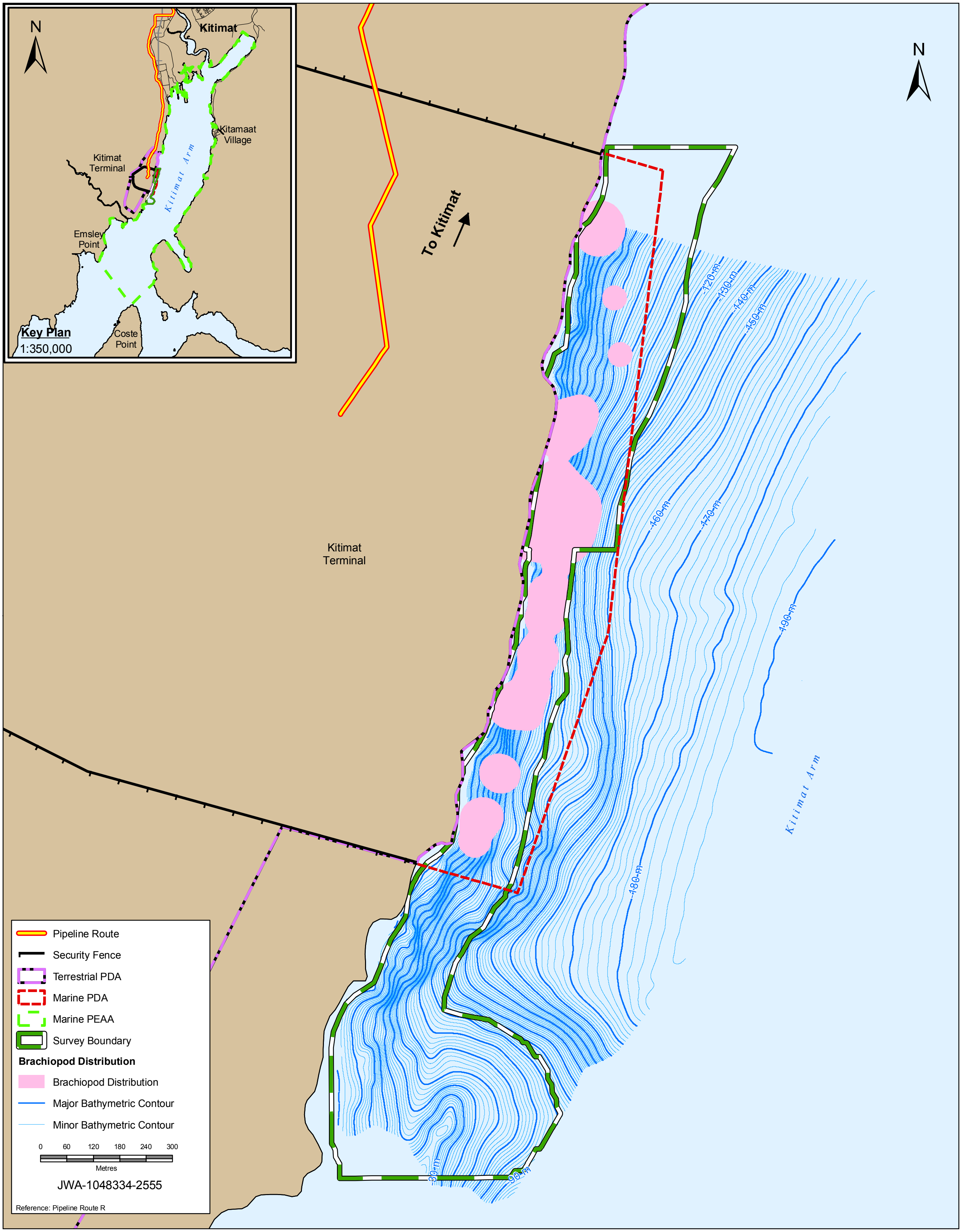

CONTRACTOR: Jacques Whitford AXYS Ltd.		ENBRIDGE NORTHERN GATEWAY PROJECT	FIGURE NUMBER: D-19		DATE: 20100129
PREPARED BY: gem	PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES	Brachiopod Distribution	SCALE: 1:12,000	AUTHOR: BA	APPROVED BY: JB
			PROJECTION: UTM 9	DATUM: NAD 83	

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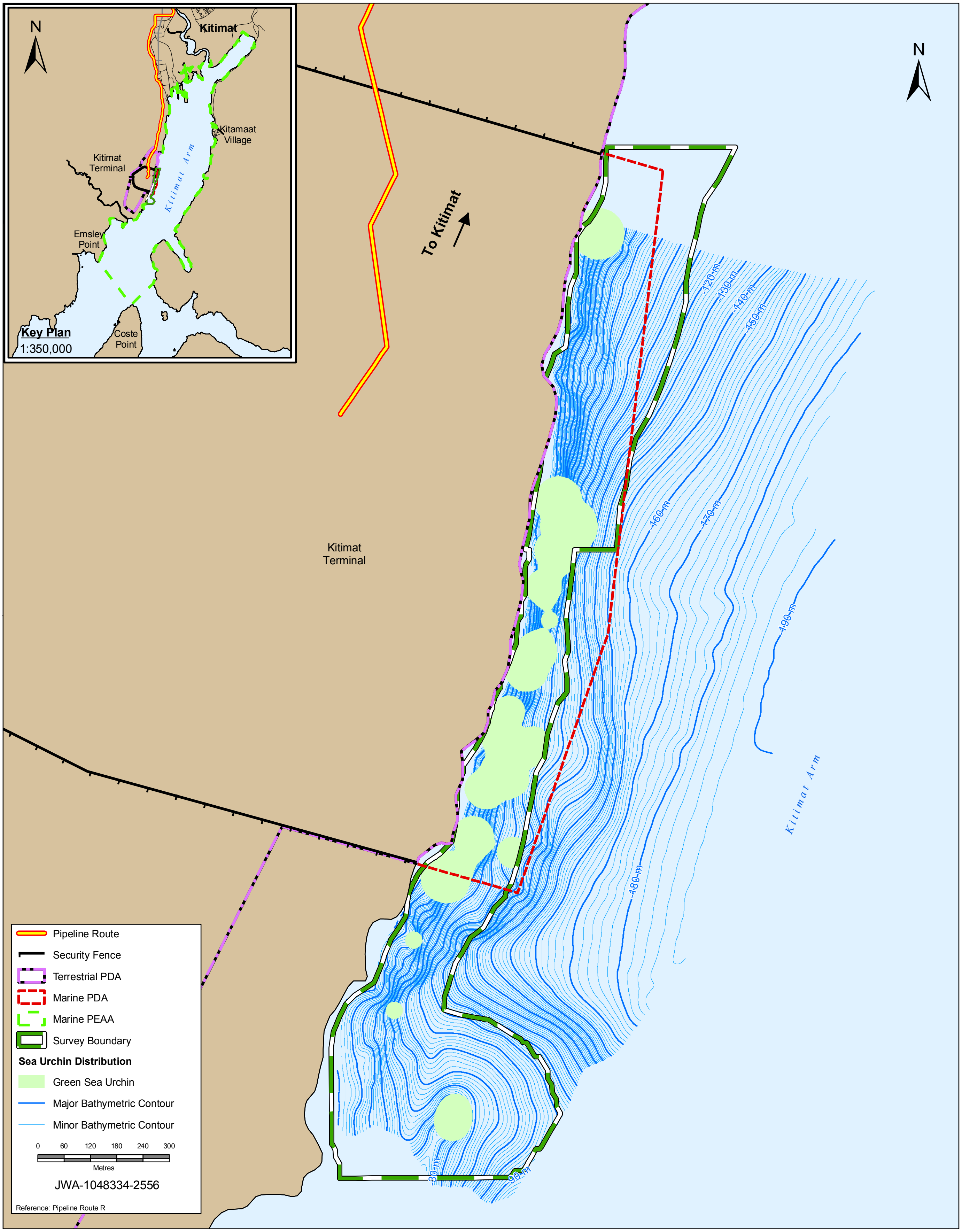

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CONTRACTOR: Jacques Whitford AXYS Ltd.	ENBRIDGE NORTHERN GATEWAY PROJECT	FIGURE NUMBER: D-20	DATE: 20100129
PREPARED BY: gem	Green Sea Urchin Distribution	SCALE: 1:12,000	AUTHOR: BA; APPROVED BY: JB
PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES		PROJECTION: UTM 9	DATUM: NAD 83

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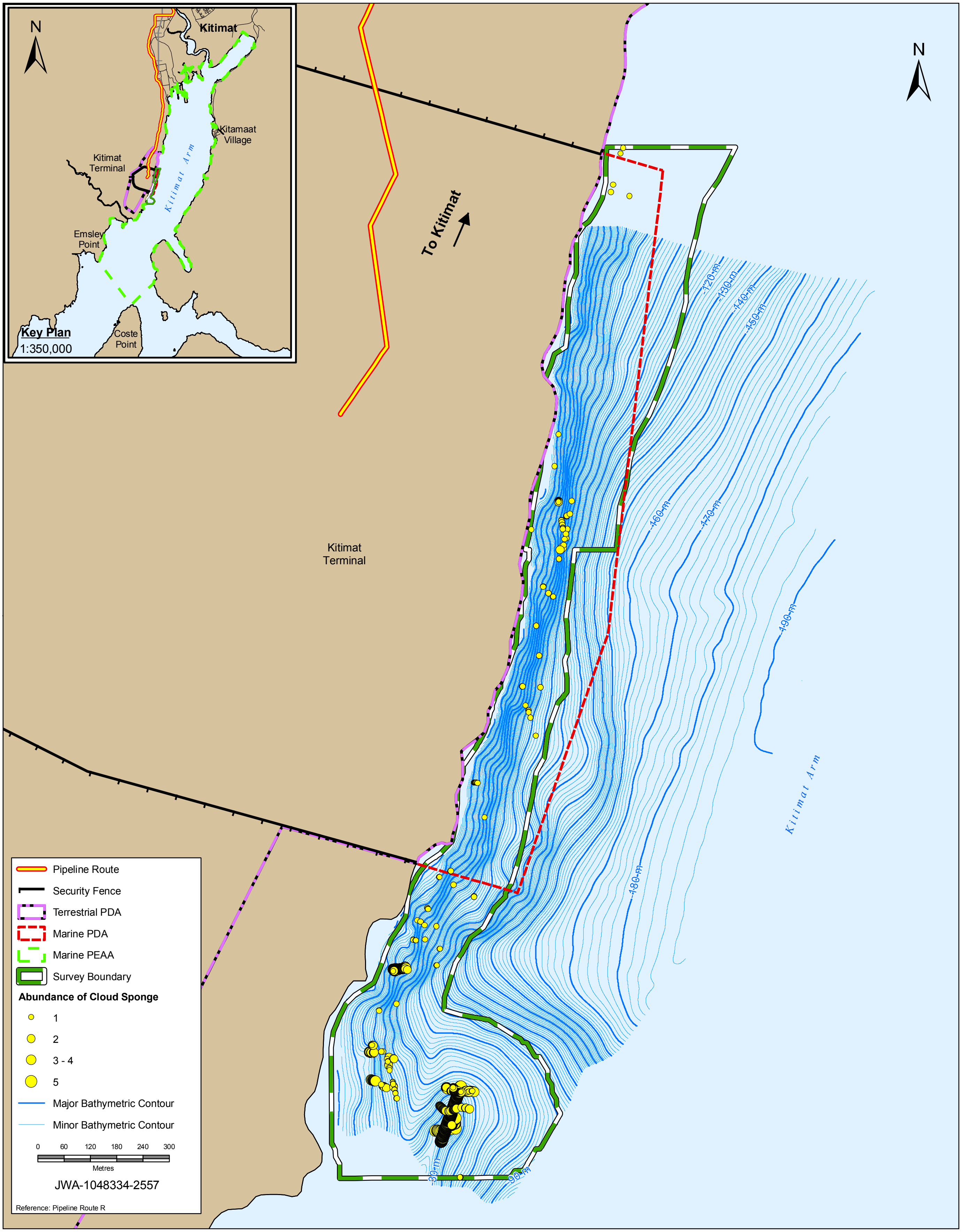

CONTRACTOR:		ENBRIDGE NORTHERN GATEWAY PROJECT	FIGURE NUMBER:		DATE:
Jacques Whitford AXYS Ltd.			D-21		20100129
PREPARED BY:	PREPARED FOR:	Cloud Sponge Distribution	SCALE: 1:12,000	AUTHOR: BA	APPROVED BY: JB
gem Gateway Environmental Management Team	ENBRIDGE NORTHERN GATEWAY PIPELINES		PROJECTION: UTM 9	DATUM: NAD 83	

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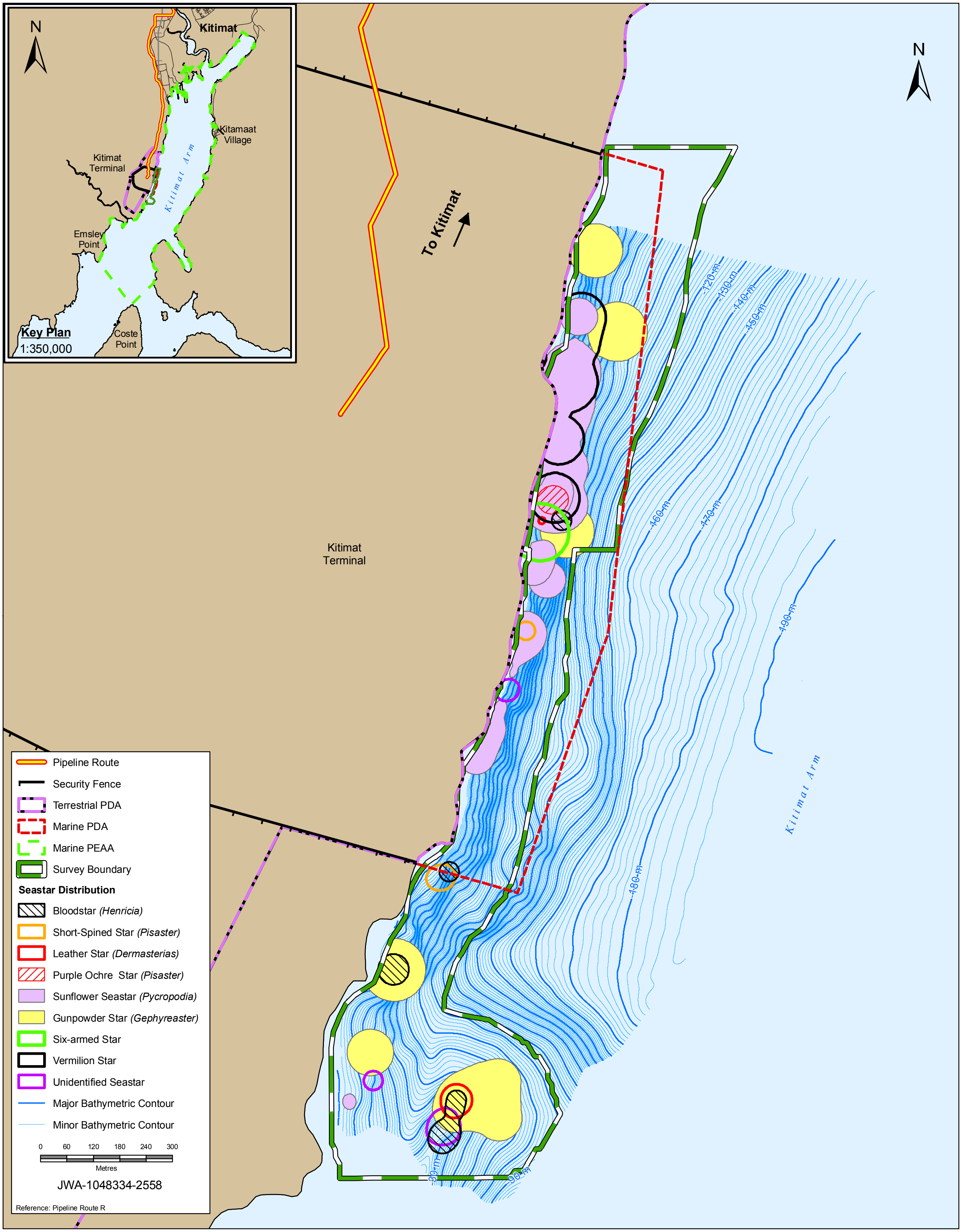

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CONTRACTOR:		ENBRIDGE NORTHERN GATEWAY PROJECT	FIGURE NUMBER:	DATE:	
Jacques Whitford AXYS Ltd.			D-22	20100129	
PREPARED BY:	PREPARED FOR:	Seastar Distribution	SCALE: 1:12,000	AUTHOR: BA	APPROVED BY: JB
gem Gateway Environmental Management Team	ENBRIDGE NORTHERN GATEWAY PIPELINES		PROJECTION: UTM 9	DATUM: NAD 83	

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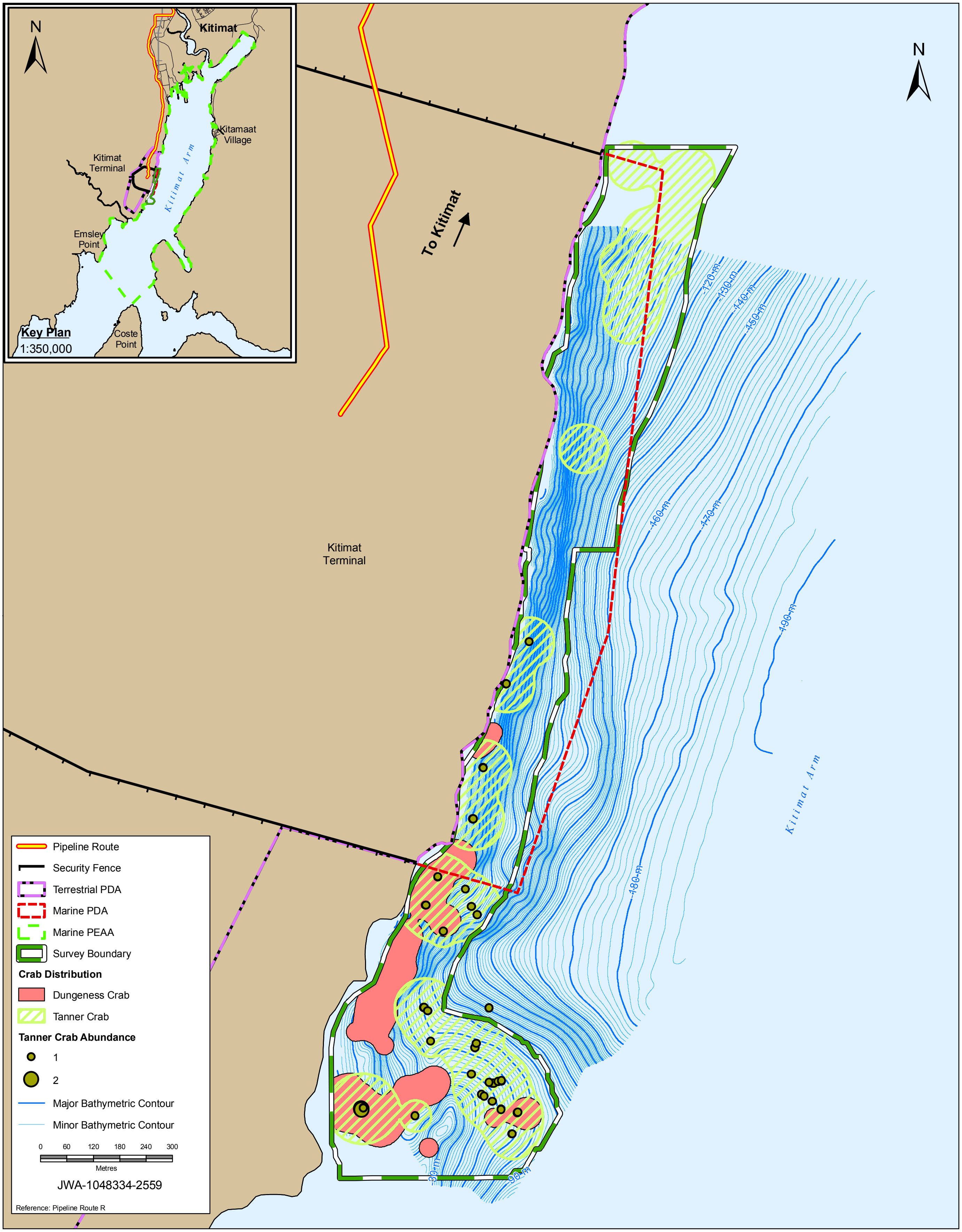

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CONTRACTOR:		ENBRIDGE NORTHERN GATEWAY PROJECT	FIGURE NUMBER:		DATE:
Jacques Whitford AXYS Ltd.			D-23		20100129
PREPARED BY:	PREPARED FOR:	Crab Distribution	SCALE: 1:12,000	AUTHOR: BA	APPROVED BY: JB
gem Gateway Environmental Management Team	ENBRIDGE NORTHERN GATEWAY PIPELINES		PROJECTION: UTM 9		DATUM: NAD 83

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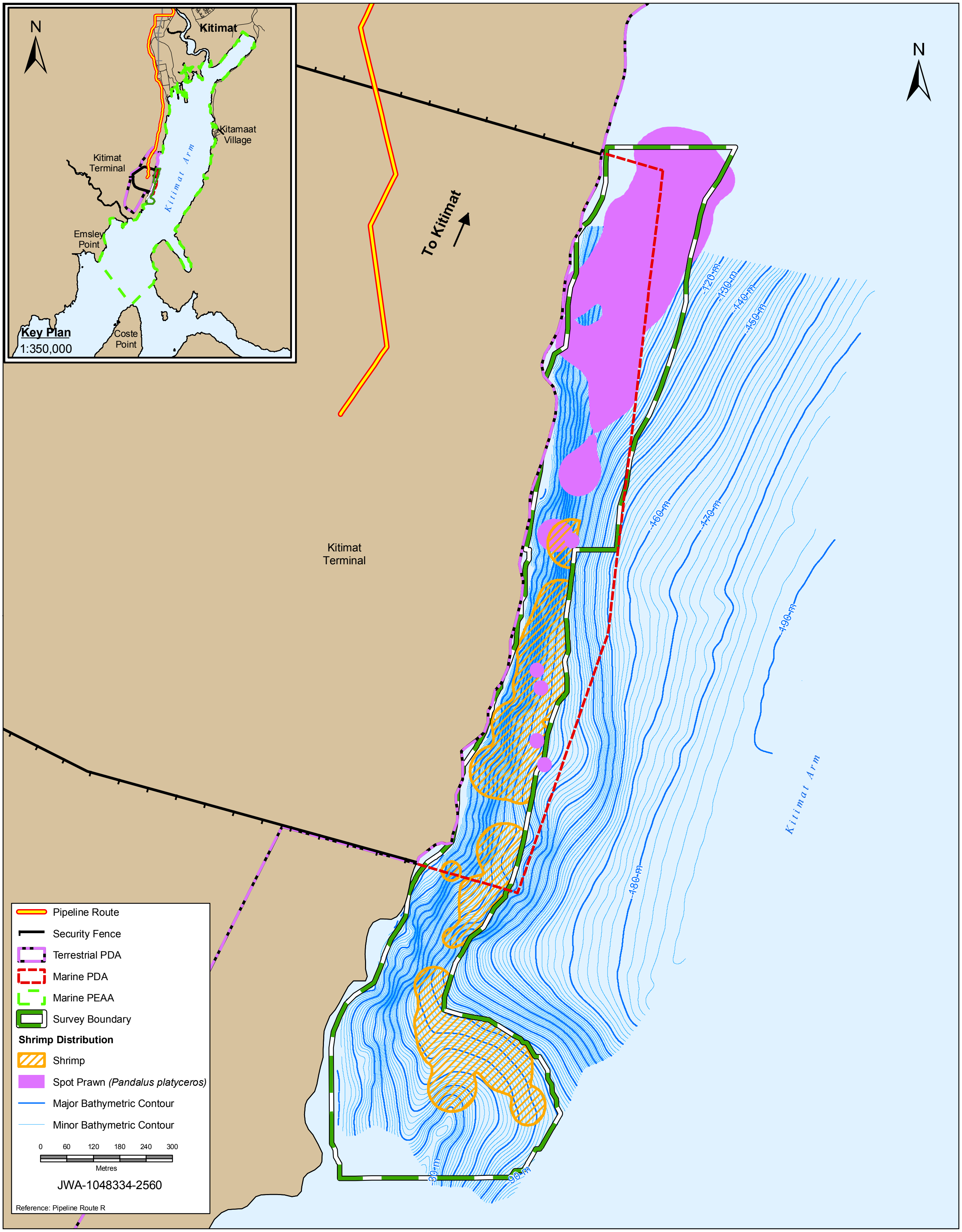

CONTRACTOR: Jacques Whitford AXYS Ltd.		ENBRIDGE NORTHERN GATEWAY PROJECT	FIGURE NUMBER: D-24		DATE: 20100129
PREPARED BY: gem Gateway Environmental Management Team	PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES	Shrimp and Prawn Distribution	SCALE: 1:12,000	AUTHOR: BA	APPROVED BY: JB
			PROJECTION: UTM 9	DATUM: NAD 83	

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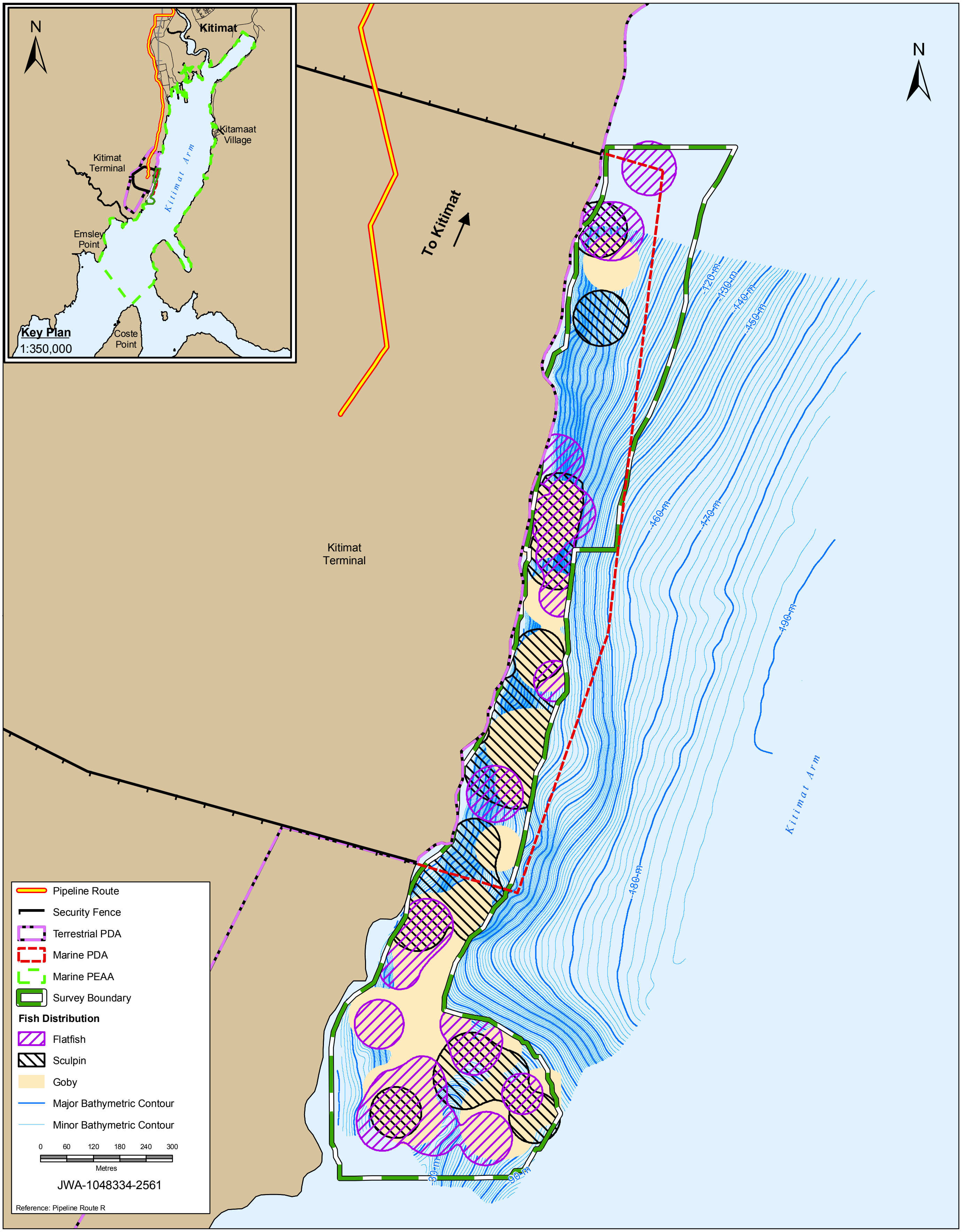

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CONTRACTOR: Jacques Whitford AXYS Ltd.		**ENBRIDGE NORTHERN GATEWAY PROJECT**	FIGURE NUMBER: D-25		DATE: 20100129
PREPARED BY: gem Gateway Environmental Management Team	PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES	Goby, Sculpin and Flatfish Distribution	SCALE: 1:12,000	AUTHOR: BA	APPROVED BY: JB
			PROJECTION: UTM 9		DATUM: NAD 83

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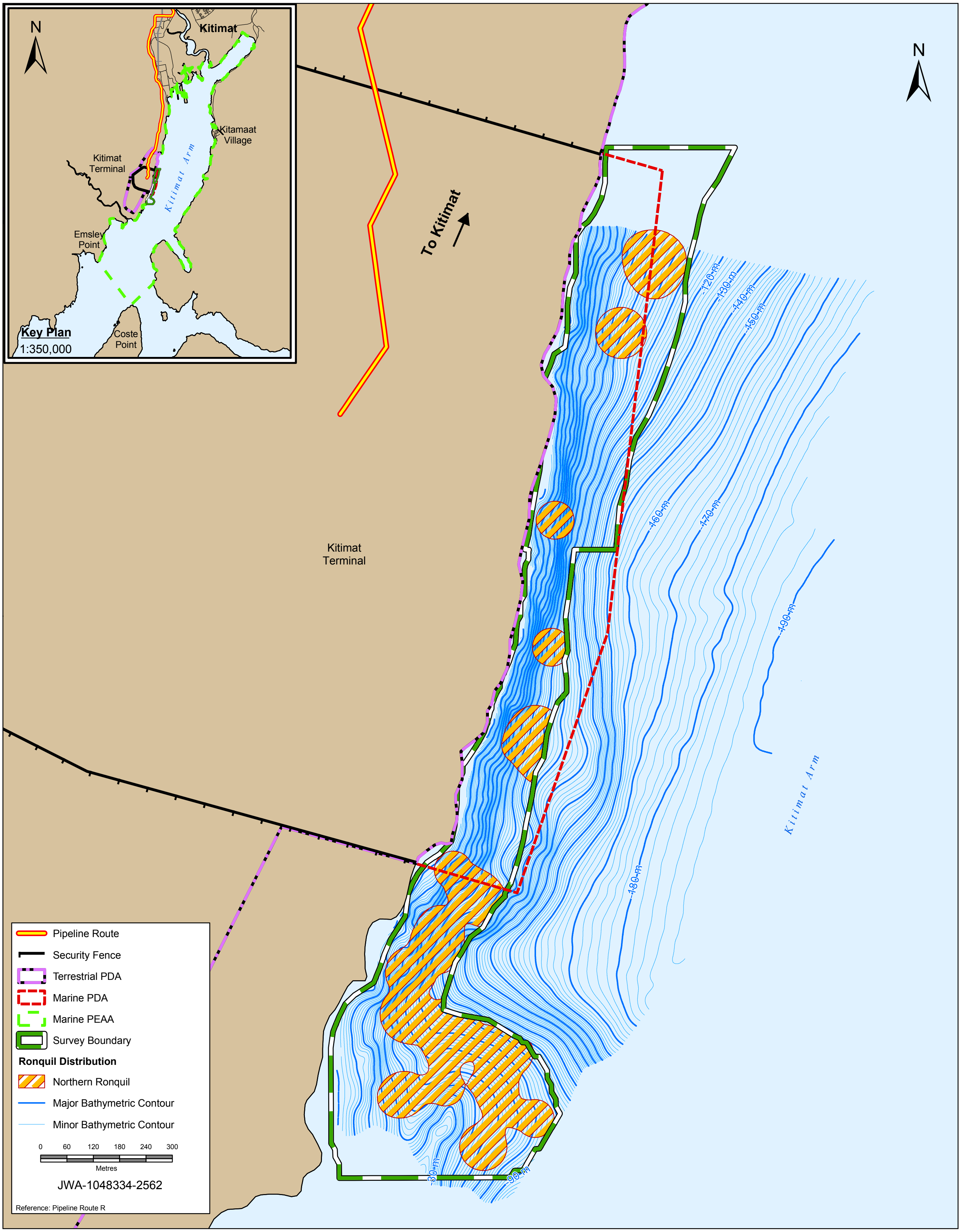

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CONTRACTOR:	ENBRIDGE NORTHERN GATEWAY PROJECT	FIGURE NUMBER:		DATE:
Jacques Whitford AXYS Ltd.		D-26		20100129
PREPARED BY: gem Gateway Environmental Management Team / PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES	Northern Ronquil Distribution	SCALE: 1:12,000	AUTHOR: BA	APPROVED BY: JB
		PROJECTION: UTM 9	DATUM: NAD 83	

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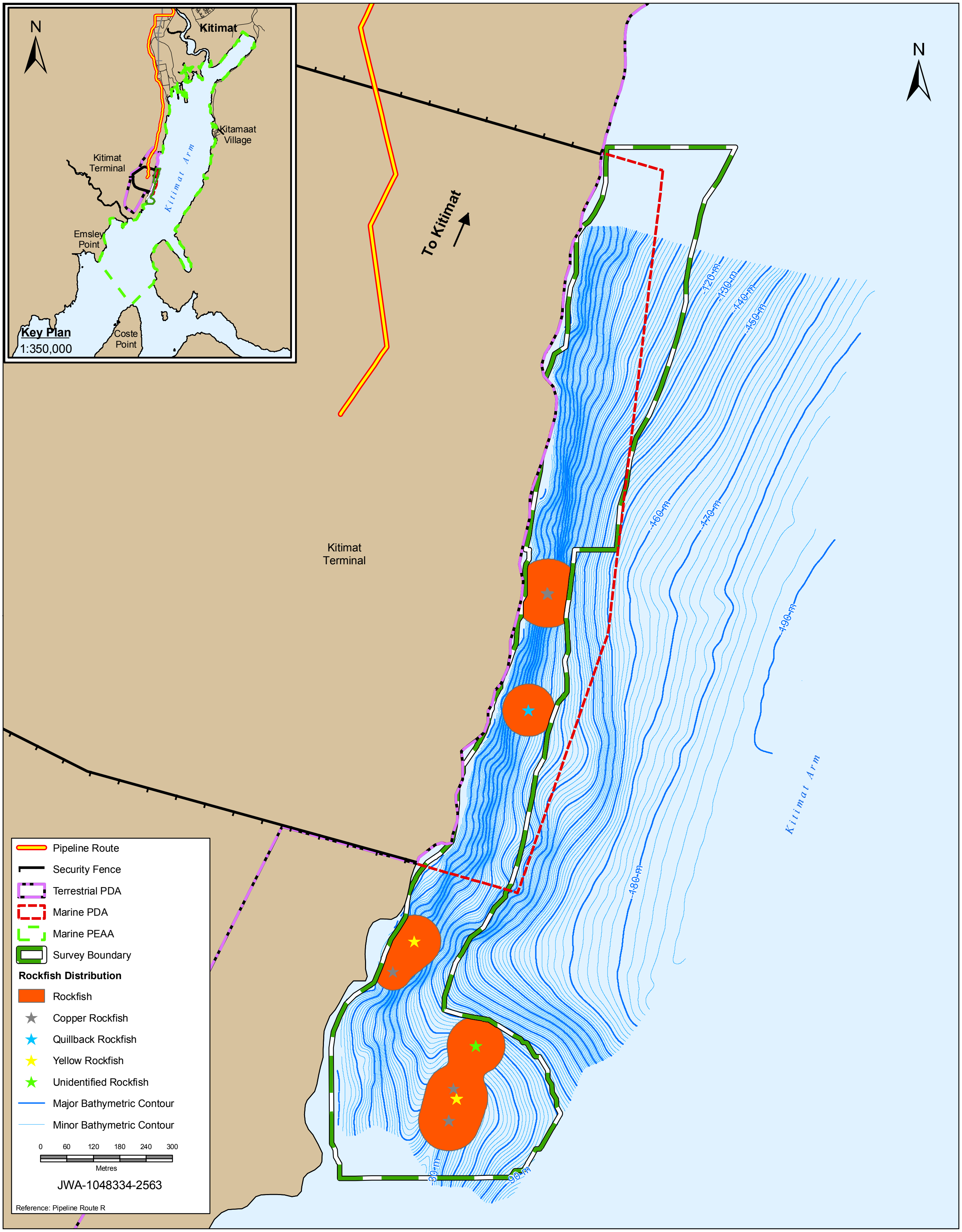

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CONTRACTOR:		ENBRIDGE NORTHERN GATEWAY PROJECT	FIGURE NUMBER:		DATE:
Jacques Whitford AXYS Ltd.			D-27		20100129
PREPARED BY: gem Gateway Environmental Management Team	PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES	Rockfish Distribution	SCALE: 1:12,000	AUTHOR: BA	APPROVED BY: JB
			PROJECTION: UTM 9		DATUM: NAD 83

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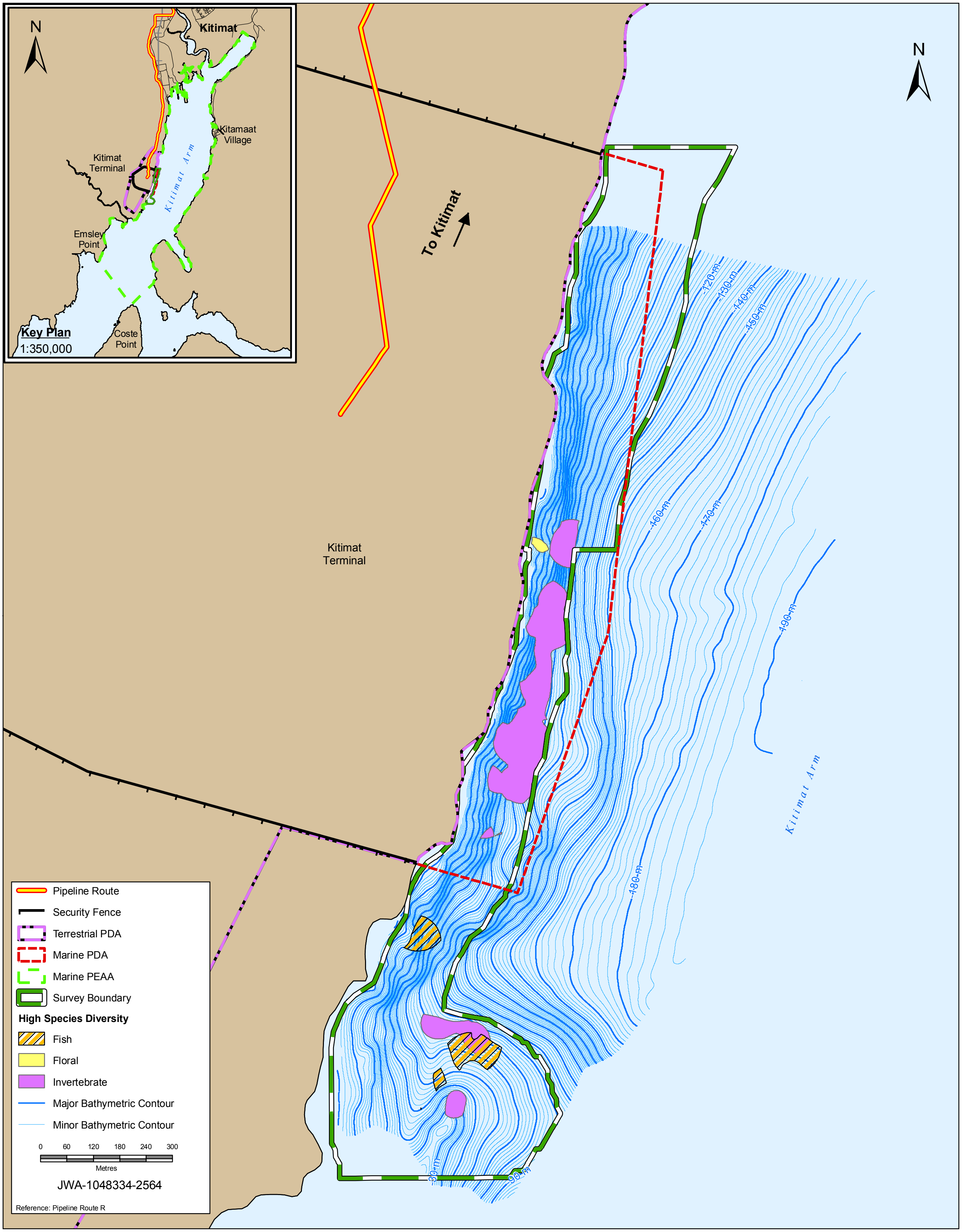

CONTRACTOR: Jacques Whitford AXYS Ltd.		ENBRIDGE NORTHERN GATEWAY PROJECT	FIGURE NUMBER: D-28	DATE: 20100129
PREPARED BY: gem Gateway Environmental Management Team	PREPARED FOR: ENBRIDGE NORTHERN GATEWAY PIPELINES	Regions of High Relative Species Diversity	SCALE: 1:12,000	AUTHOR: BA / APPROVED BY: JB
			PROJECTION: UTM 9	DATUM: NAD 83

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