DELTAPORT THIRD BERTH
ADAPTIVE MANAGEMENT STRATEGY
2009 ANNUAL REPORT

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September 10, 2010
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Vancouver Fraser Port Authority
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Attn: Carolina Eliasson, Environmental Specialist

Dear Ms. Eliasson,

Re: FINAL – Adaptive Management Strategy 2009 Annual Report, Deltaport Third Berth, Delta, BC

Hemmera is pleased to provide you with the Final- Adaptive Management Strategy, 2009 Annual Report, completed as part of the Deltaport Third Berth construction project.

We appreciate the opportunity to work with you on this project and trust that this report is satisfactory to your requirements. Please feel free to contact the undersigned at 604.669.0424 regarding any questions or further information that you may require.

Regards,
Hemmera

Geoff Wickstrom, M.A.Sc., R.P.Bio.
Project Director

EXECUTIVE SUMMARY

At the request of the Vancouver Fraser Port Authority (VFPA), Hemmera Envirochem Inc. (Hemmera), Northwest Hydraulics Consultants (NHC) and Precision Identification (Precision) are pleased to provide the Adaptive Management Strategy (AMS) 2009 Annual Report for the Deltaport Third Berth (DP3) project. The objectives of the AMS project are to undertake a science-based systematic approach to monitoring the Roberts Bank inter-causeway ecosystem to reduce uncertainty and assess the potential for negative trends in the ecosystem from marine eutrophication and dendritic channelization linked to DP3 construction and operation. This report summarizes and interprets the findings of the third year (2009) of the AMS program, and provides recommendations for adapting the program for the fourth year of monitoring.

The main components of the AMS monitoring program include monitoring of coastal geomorphology, surface water and sediment quality, eelgrass distribution, benthic community structure, and coastal seabird/shorebird composition. It is challenging to resolve specific effects related to DP3 construction and operation versus natural environmental variability. However, through monitoring a variety of factors such as physical conditions as well as biological conditions at various levels (primary producers, secondary and tertiary consumers), it is believed that the overall results will provide an early indication of impending negative effects that would warrant proactive response.

If eutrophication were occurring, one would first expect to see an increase in nutrient concentrations, followed by an increase in chlorophyll *α* and decrease in dissolved oxygen and water clarity, as primary productivity increased. No such increase has been observed at Deltaport. In cases of severe eutrophication, nuisance algal blooms have decreased the amount of light penetrating the water column, which in turn affected periphyton growth and sediment chemistry. Hypoxia, reduced water transparency, an increase organic matter deposition, and a decline in eelgrass and benthic invertebrates are also associated with severe eutrophication.

The AMS is designed to provide an early warning system, so that steps can be taken to mitigate risks well before valued ecosystem components are affected. To date, the overall findings of the program do not suggest emerging negative trends within the inter-causeway area related to DP3 construction or operation.

COASTAL GEOMORPHOLOGY

The coastal geomorphology portion of the AMS included the following activities:

- Monitoring of the area around the Crest Protection Structure (Q1- March 5 and Q3-July 20)
- Continuous automated monitoring of turbidity in the water column on the tidal flats (Q1-March 5, installed new sensor; Q2-April 27, data download, May 26 installed replacement sensor; Q3-July 20, data download and Q4-November 3, data download)

- Monitoring of erosion and deposition on the tidal flats in the immediate vicinity of the new terminal (Q1-February 7, Q2-April 27, Q3-July 20 and Q4-November 3)
- Collection and analysis of sediment samples for changes in grain size and organic carbon content (Q2-April 27 and Q4-November 3)
- Interpretation of orthophotographs for the purpose of detecting large-scale geomorphic adjustments to the study area

The results of the third year of coastal geomorphology monitoring continue to suggest that the magnitude of change on the tidal flats is not large. Net bed level changes, due to sedimentation and erosion, within the study area were typically less than 5 cm and were within the expected range. Similarly, turbidity levels were generally very low. Turbidity was influenced by waves during certain tide conditions, but there was no evidence that turbidity levels were affected by DP3.

Construction-related activities in 2007 led to the formation of 'new' drainage channels on the mud flats adjacent to the DP3 perimeter dike. Field observations from the past year indicated that only very small amounts of sediment were transported within the channels. Mapping from the orthophotos showed that the position of the channels had not changed between the time that the 2007 and 2009 photos were taken, and the depth of disturbance (DoD) rod data indicated a low level of erosion and deposition in this area.

Measurements of tidal current velocity collected in 2009 generally confirmed the model predictions presented in the Coastal Geomorphology Report that the DP3 terminal would not have a significant or adverse effect on tidal currents. Velocities at the northeast tip of the DP3 terminal did not increase appreciably and have remained low.

Recommendations based on the results to date for the coastal geomorphology program are that no further tidal current monitoring be carried out and that the turbidity monitoring program be discontinued in July, 2010.

SURFACE WATER AND SEDIMENT QUALITY

The AMS program includes nine surface water and sediment quality monitoring stations: one in the ditch that drains into the inter-causeway area near the base of the BC Ferries Causeway (DP01); six inter-causeway stations (DP02, DP03, DP04, DP05, DP08, and DP09); and two distant reference stations (DP06 and DP07). Stations DP05 and DP07 are closest to the Georgia Strait and are both subtidal. At DP05 and DP07, water samples were collected at two depths: A Level (1 metre below the water surface) and the B Level (2 metres above the sediment). The DP09 station was added in 2009 in the vicinity of the new drainage channels west of the tug basin. Stations DP08 and DP09 were only monitored for surface water and sediment quality during Q1 2009 in association with the benthic community sampling program. The quarterly monitoring events took place on the following dates:

- Q1-2009: February 23 to 24, 2009
- Q2-2009: May 20, 2009
- Q3-2009: September 14 and 15, 2009
- Q4-2009: December 3, 2009

Surface water and sediment samples were analyzed for metals and nutrients. Data evaluation included screening against applicable regulatory guidelines and standards, as well as a review of temporal and spatial trends.

Overall, metal and nutrient concentrations in surface water and sediment were in the same range as in previous years.

Total chromium, copper, and zinc concentrations were sporadically found to exceed the BC Water Quality Guidelines in surface water. The chromium concentrations, noted at DP02, DP03, DP04, and DP07, were only marginally above the guideline. The copper and zinc exceedances noted at DP07 in Q2-2009 and Q3-2009, and the zinc exceedance noted at DP04 in Q1-2009 were less than two times their respective guidelines. Other metals (boron and iron) exceedances noted in surface water are typical of local marine surface waters and have been noted consistently during each quarter. As in 2008, the highest metal concentrations in surface water were observed at reference stations DP06 and DP07, while the lowest concentrations were observed at stations DP02, DP03, and DP08 in the inter-causeway area. Metal concentrations at stations DP06 and DP07A showed similar temporal trends, likely as a function of influence from the Fraser River, a major contributor to regional water quality in the Georgia Basin. In contrast, temporal trends at DP07B (the deep water sample) showed greatest resemblance to trends at DP05A and DP05B, suggesting a greater influence from the waters of Georgia Strait.

The highest nutrient concentrations were measured at station DP01, likely as a result of upland agricultural inputs. Nutrient concentrations at the inter-causeway stations were similar to those at the reference stations.

There were no metal exceedances of applicable regulatory criteria in sediment in 2009. The lowest metal concentrations were measured at DP01 (closest to the ditch) and DP08 (in the inter-causeway area) and the highest at DP05 (closest to the turning basin). However, the application of a lithium geonormalizing technique suggested that metal concentrations measured in 2009 were representative of background. Metal concentrations did not exhibit a temporal trend.

As with surface water, nutrient concentrations were higher in sediments in the inter-causeway than at the reference stations. This is likely a function of the higher level of biological activity in the sheltered environment of the inter-causeway area as opposed to being specifically related to DP3 construction. Neither nutrients nor other eutrophication-related parameters exhibited a clear temporal trend in sediment.

Continued monitoring of the eutrophication-related parameters and metals concentrations in surface water and sediments is recommended for 2010 to document the first year of port operations, but if no change is noted, it would be recommended that metals be dropped for 2011 while monitoring of eutrophication-related parameters continued. Discussions with VFPA and SAC on the suitability of developing site-specific nutrient criteria, as used in other jurisdictions is also recommended for evaluating eutrophication based on the first three years of nutrient data.

EELGRASS

The eelgrass monitoring survey was completed between July 19 and 23, 2009. The base map produced for the distribution study was ground-truthed between September 14 and 16, 2009. The Seabed Imaging and Mapping System (SIMS) survey was conducted on August 25, 2009.

The *Zostera marina* and *Z. japonica* density and distribution in the area adjacent to the DP3 footprint have increased over the last year.

The eelgrass was healthy and productive at all the inter-causeway reference stations except Site 1. Site 1 was located in an area of dense, continuous *Z. marina* in 2003. The density and size of eelgrass in the vicinity of Site 1 and the adjacent transition habitat has converted from continuous to patchy since that time. A sand lobe has evolved from a series of dendritic channels in the inter-causeway that originally developed during the 1980s. The sand lobe complex is characterized by highly mobile sand surface sediments that are exposed more frequently than the eelgrass beds that previously occupied this area. The sand lobe continues to expand and convert *Z. marina* habitat to sand flat. It is likely that the evolution of the sand lobe contributed to the declines observed at Site 1.

A Seabed Imaging Mapping System determined that the lower limit of eelgrass distribution in the inter-causeway was very similar to that mapped using this method 2003.

The assessment of epiphyte load and absence of *Beggiatoa* sp. indicate that the eelgrass habitat was healthy and functioning well. Based on the data collected to date, there are no indications that the development of DP3 has negatively affected the inter-causeway eelgrass habitat.

There are no changes recommended to the eelgrass program.

BENTHIC INVERTEBRATE COMMUNITY

The benthic invertebrate sampling was completed during Q1-2009 from February 23 to 24, 2009. At the request of the SAC, an eighth benthic community sampling station in the intertidal zone (DP09) was added in 2009 to evaluate the impact of drainage channels in the vicinity of the tug basin.

The greatest abundance of benthic invertebrates was observed at station DP04 and the lowest abundance of benthic invertebrates was observed at reference stations DP06 and DP07. Differences in abundance, richness, evenness, and diversity between years were not statistically significant; however, an increase in abundance and richness was noted from 2007 to 2008, and again from 2008 to 2009. Regression analysis did not find a statistically significant correlation between variation in abundance, richness, evenness, and diversity and any of the abiotic factors tested (sediment grain size, total organic carbon, sulphide, nitrogen, phosphorus). Neither polychaete-amphipod nor *Polychaeta sedentaria-Polychaeta errantia* ratios showed an increase which, if observed, could signal a trend towards eutrophication. Overall, the results indicated that the benthic invertebrate populations in both the inter-causeway area and the reference area are diverse, healthy and well established. The data did not suggest a trend towards eutrophication or direct DP3 construction or operation impacts. Continued monitoring of benthic invertebrates on a biennial basis is recommended, with surveys taking place in 2010 and 2012.

COASTAL SEABIRDS / SHOREBIRD COMPOSITION

Coastal seabirds/shorebird composition, relative abundance, and use of the inter-causeway area were very similar in 2009 to that documented during 2008.

Impacts to coastal seabirds and waterfowl appear limited to direct habitat loss associated with the DP3 footprint as predicted by the environmental assessment. Observations during the 2009 survey period indicate that, in response, birds used alternative habitat available within the inter-causeway area.

The third year of the AMS bird monitoring program found consistent seasonal patterns and expected natural variability in the abundance and distribution of birds in the inter-causeway area. As part of the adaptive and evolving design of the AMS, Hemmera recommends that the monitoring program be modified to focus specifically on windshield surveys of great blue heron and brant, two species at risk that use the inter-causeway as foraging, over-wintering, and migratory stopover habitat.

RECOMMENDATIONS

To date, the AMS monitoring program has not shown compelling evidence to suggest that the DP3 construction activities have resulted in widespread adverse effects within the inter-causeway area.

Based on the findings to date, the following adaptations to the AMS program are recommended:

- Discontinue turbidity and wave monitoring in Q3-2010
- Continue metals sampling in 2010 to document the first year of port operations, but if no changes are noted, discontinue metals sampling/analysis for 2011
- Develop site-specific nutrient criteria for evaluating eutrophication based on the first three years of nutrient data
- Replace bird point count surveys with focal species windshield surveys.

ACKNOWLEDGEMENTS

Hemmera gratefully acknowledges the contributions of our additional project team members:

Coastal Geomorphology:	Northwest Hydraulic Consultants Ltd. 30 Gostick Place North Vancouver, BC V7M 3G2
Eelgrass Assessment:	Precision Identification 3622 West 3rd Avenue Vancouver, BC V6R 1L9
Vessel Services:	Ross Wetzel 18341 72nd Avenue Surrey, BC V4N 3G6
Analytical Laboratory:	ALS Environmental 1988 Triumph Street Vancouver, BC V5L 1K5
Biological Laboratory:	Biologica Environmental Services Ltd. Suite H50 Nootka Ct. 634 Humboldt Street Victoria, BC V8W 1A4

In addition, Hemmera would also like to acknowledge the effort and contributions of the following individuals:

Vancouver Fraser Port Authority:	Darrell Desjardin, Director of Environment Carolina Eliasson, Environmental Specialist Carrie Brown, Environmental Specialist
Scientific Advisory Committee:	Rowland Atkins, M.Sc., P.Geo. Senior Geomorphologist, Golder Associates Ltd. Terri Sutherland, PhD Research Scientist, Science Branch, Department of Fisheries and Oceans Ron Ydenberg, PhD Department of Biological Sciences, Simon Fraser University

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GLOSSARY OF TERMS

ADCP	Acoustic Doppler Current Profiler
AWAC	Acoustic Wave and Current Meter
AMS	Adaptive Management Strategy
BC	British Columbia
BCF	BC Ferries
CCME	Canadian Council of Ministers of the Environment
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CSR	Contaminated Sites Regulation
CWS	Canadian Wildlife Service
DF	Difference Factor
DP3	Deltaport Third Berth
DFO	Department of Fisheries and Oceans
DO	Dissolved Oxygen
DoD	Depth of Disturbance
DQO	Data Quality Objectives
EC	Environment Canada
Hs	Significant Wave Height
LAI	Leaf Area Index
MAL	Marine Aquatic Life
MEDS	Marine Environmental Data Service
NHC	Northwest Hydraulic Consultants
NTU	Nephalometric Turbidity Units
PC	Point Count
PDA	Personal Digital Assistant
PDO	Pacific Decadal Oscillation
QA/QC	Quality Assurance/Quality Control
RDL	Reported Dection Limit
RPD	Relative Percent Difference
RTK GPS	Real-Time Kinematic Global Positioning System
SAC	Scientific Advisory Committee
SARA	Species at Risk Act
$SedQC_{ss}$	Sediment Criteria for Sensitive Marine and Estuarine Sediments
SEM	Standard Error of the Mean
SIMS	Seabed Imaging and Mapping System
TFN	Tsawwassen First Nation
TKN	Total Kjeldahl Nitrogen
Tp	Wave Period
TSS	Total Suspended Solids
VFPA	Vancouver Fraser Port Authority
WHSRN	Western Hemispheric Shorebird Reserve Network
WQG	Water Quality Guidelines

1.0 INTRODUCTION

At the request of the Vancouver Fraser Port Authority (VFPA), Hemmera Envirochem Inc. (Hemmera), Northwest Hydraulics (NHC) and Precision Identification (Precision) are pleased to provide 2009 Annual Report for the Adaptive Management Strategy (AMS) for the Deltaport Third Berth (DP3) project. This report summarizes and interprets the findings of the third year (2009) of the AMS program, and provides recommendations for adapting the program for the fourth year of monitoring.

1.1 BACKGROUND

1.1.1 DP3 Project Description

Deltaport is a marine container terminal located on Roberts Bank in Delta, BC (**Figure 1**). The DP3 project involved the construction to accommodate an additional ship berth along with approximately twenty hectares of land for an expanded container storage yard and dredging to deepen the existing ship channel and creation of an adjacent tug moorage area.

The DP3 project was subject to both the provincial *British Columbia Environmental Assessment Act* and the federal *Canadian Environmental Assessment Act*. The environmental assessment involved a large number of studies including coastal geomorphology, water quality, sediment quality, marine resources, coastal seabirds and waterfowl, vegetation and wildlife, archaeology, socio-economics, noise, visual and lighting, air quality, and road, rail and ship traffic. This report is available from the BC Environmental Assessment Office website (http://www.eao.gov.bc.ca/). As part of the acceptance of the environmental assessment by the BC Environmental Assessment Office were recommendations by Environment Canada – Canadian Wildlife Service (CWS) that an AMS be developed to provide practical advance warning of potential emerging negative ecosystem trends during project construction and operation.

A complete timeline of construction activities in presented in **Table 1.1-1**.

Table 1.1-1 Timeline of Construction Activities

Site Activities	Time Period 2009			
	Q1	Q2	Q3	Q4
Caisson 26 Sheetpile Wall	Sheetpile wall construction and toe protection			
Caisson Ballast Rock Addition	Ballast addition Part 2 completed in January 2009			
Berm Rock Placement	Berm rock placement completed in January 2009			
Land-based Densification	Completed Feb 2009			
POD 4 Perimeter Drain Pumping Station	Construction Continued	Construction completed in April 2009		
Scour Protection	Ongoing	Completed May 2009		
Subtidal Reef Construction	Riprap placement started in February 2009	Riprap placement completed in April 2009		
Stage 2 Preload Movement – Part 1	Part 1 completed Feb 2009			
Stage 2 Preload Movement – Part 2	Part 2 commenced March 2009	Part 2 completed April 2009		
Tied Bulkhead Fill Complete	Top up tied bulkhead fill done in March 2009			
Toe Protection Concrete Pours	Initiated in March 2009	Completed in May 2009		
Cope Wall and Crane Wall Concrete Pours	Initiated in March 2009	Completed in May 2009		
Fenders and Bollards		Installed May to June 2009		
Install Granular Material (caisson area)	Ongoing	Completed in June 2009		
DCL Paving works (caisson area)	Ongoing	Completed in June 2009		
DCL Site Cleanup		DCL completed site cleanup work in June 2009		
Marine Construction Demobilization			DCL demobilized from site in July 2009	
TSI Terminal Finishing Works (land based) including electrical, paving, drainage	Ongoing	Ongoing	Ongoing	Completed December 2009

1.1.2 AMS Project Objectives

The objectives of the AMS project are to undertake a science-based systematic approach to the monitoring of the Roberts Bank inter-causeway ecosystem to reduce uncertainty and assess the potential for negative trends in the ecosystem from marine eutrophication and dendritic channelization. This approach should:

1. Provide practical advance warning of potential emerging negative ecosystem trends during DP3 construction and operation, and
2. Establish actions that VFPA would undertake to prevent or mitigate negative trends that exceed applicable thresholds and may be linked to the DP3 project.

The AMS includes monitoring methods to specifically identify and mitigate potential environmental effects in the following areas of concern (the AMS project team member completing the work is shown in brackets):

- Coastal geomorphology (NHC)
- Surface water quality (Hemmera)
- Sediment quality (Hemmera)
- Eelgrass distribution (Precision)
- Benthic community structure (Hemmera)
- Coastal seabird / shorebird composition (Hemmera)

1.2 Scope of Work

The AMS support program has been implemented to address concerns and meet requirements of stakeholders such as Environment Canada (EC), the Department of Fisheries and Oceans (DFO) and the CWS as well as other legislation, guidelines, and best management practices applicable to the work. The AMS involves the identification, management, prevention, and mitigation of environmental effects that may result from DP3 construction. The AMS program also undergoes an independent peer review by a Scientific Advisory Committee (SAC), comprised of scientists with expertise in the various study areas of the AMS, appointed by VFPA and EC.

The scope-of-work for the annual report involved completion of the following tasks:

- Analysis of quarterly data from coastal geomorphology/oceanography monitoring and crest protection monitoring.
- Analysis of quarterly data from surface water quality monitoring.
- Analysis of quarterly data from sediment quality monitoring.
- Analysis of eelgrass data collected in July, August, and September 2009.

- Analysis of benthic invertebrate community data collected in February 2009.
- Analysis of quarterly data from bi-weekly coastal seabird / shorebird composition surveys to monitor brant geese, great blue heron, coastal seabirds, waterfowl, and other birds.
- Evaluating the data relative to the objectives of the AMS program. Data evaluation included looking at both temporal and spatial trends in the data observed during the year as well as comparison to data collected from previous years, where applicable.
- Providing recommendations based on the findings to date, for adaptations to the AMS program and/or mitigation measures that may be required if adverse impacts are observed.

A detailed list of monitoring activities completed in 2007, 2008, and 2009 is presented in **Table 1**. A chronology of key adaptations to the AMS program implemented during 2007, 2008, and 2009 is presented in **Table 2**. A summary of the rationale for the adaptations is presented in **Table 3**.

1.2.1 Coastal Geomorphology

The physical environment of the study area for the AMS monitoring program provides the basis for the ecological features and functions that define Roberts Bank. NHC has responsibility for the Coastal Geomorphology portion of the AMS monitoring program for the area defined as the inter-causeway portion of the Roberts Bank tidal flats, extending shoreward to the dikes and seaward to the delta foreslope and includes the deeper waters in the vicinity of the new terminal. The tidal flats represent the sub-aqueous top-set beds of the Fraser River Delta and at Roberts Bank the zone is generally featureless except for the development of tidal channels. Prior to the construction of the BC Ferries and Deltaport causeways, this area would have been swept by the Fraser River plume, depositing sediments and nutrients. The environment was also shaped by wind-generated waves and tidal currents from the Strait of Georgia. With the construction of the causeways, beginning in the early 1950s, the processes affecting the inter-causeway area have been modified, primarily through diversion of the Fraser plume, a reduction in wave energy, and the expansion of eelgrass beds on the tidal flats.

A comprehensive Coastal Geomorphology Study of the Roberts Bank area was completed by NHC as part of the environmental impact assessment phase of the project (NHC 2004). This document provides background and rationale that have informed the design of the present monitoring program. In particular, the Coastal Geomorphology Study provides a very detailed description of the history of the natural and human-influenced evolution of the study area, with particular emphasis on providing greater detail for the proximal portions of the study area and less detail for the distal regions. The approach taken by the Coastal Geomorphology Study was to view the inter-causeway portion of Roberts Bank as a relatively isolated zone, cut off from significant inputs of sediment but also partially protected from the higher energy waves and currents that continue to shape the rest of the delta front.

The Coastal Geomorphology portion of the AMS monitoring program includes six primary activities:

- Monitoring of the physical conditions in the area around the Crest Protection Structure;
- Automated monitoring of turbidity in the water column on the tidal flats;
- Automated monitoring of erosion and deposition on the tidal flats in the immediate vicinity of the new terminal;
- Collection and analysis of sediment samples for analysis of grain size;
- Interpretation of orthophotographs for the purpose of detecting large-scale geomorphic adjustments to the study area;
- Coastal geomorphology mapping, consisting of hydrographic and topographic surveys; and
- Wave monitoring.

1.2.2 Surface Water Quality

Changes in surface water chemistry are one of the first indicators of emerging ecosystem trends. The objectives of the surface water study are to identify any early trends suggesting that eutrophication is occurring or that metal concentrations are increasing as a result of DP3 construction or operation.

In the context of the AMS, marine eutrophication has been defined as an enrichment of nutrients in the inter-causeway area surface water and sediment that affects, or has the potential to affect, the health and stability of the marine ecosystem at Roberts Bank. The primary source of nutrients from Deltaport is primarily treated sewage effluent. The sewage treatment plant was constructed as part of the initial Deltaport container terminal development in 1997 and provides secondary treatment of sewage prior to discharge. The sewage treatment plant is permitted under a Ministry of Water Land and Air Protection (MWLAP) effluent permit PE-14865 to discharge treated effluent into the Deltaport ship berth at a depth of 12 metres below mean low water. The projected increase in sewage output from the DP3 project was considered to be minimal. Other sources of nutrients to the DP3 area include agricultural inputs from the surrounding area and from the Fraser River, municipal waste discharges, upwelling from Georgia Straight, and bird and wildlife excreta.

Historical water quality data for Roberts Bank and the surrounding data were available from data compilations conducted by Triton (2001) and Swain et al. (1998).

It should be noted that the potential for eutrophication in the vicinity of Deltaport is considered low for two reasons. First, total primary productivity is insensitive to moderate increases or decreases in nitrogen concentrations because nitrogen concentrations in the Georgia Strait are naturally elevated (2-20 μM) (Mackas and Harrison 1997). Second, the inter-causeway area is subject to regular flushing, which removes excess nutrients.

If eutrophication were occurring, one would first expect to see an increase in nutrient concentrations, followed by an increase in chlorophyll *α* and a decrease in dissolved oxygen and clarity, as primary productivity increased. Nuisance algal blooms would decrease the amount of light penetrating the water column, affecting eelgrass growth and sediment chemistry. Seasonal hypoxia in summer months, resulting from increased plant growth due longer days and warmer water temperatures, would precede more widespread hypoxia and reduced water transparency. The table below describes the progression of eutrophication.

Table 1.2-1 Progression of Eutrophication

Nutrient Enrichment	Primary Symptoms	Secondary Symptoms
• Increased concentrations of nitrogen and phosphorus • Changes in nutrient ratios	• Increased phytoplankton primary production and biomass • Changed phytoplankton community structure • Harmful algal blooms • Increased growth of short-lived nuisance macroalgae • Increased sedimentation of organic matter	• Reduced water transparency • Altered distribution of long-lived submerged vegetation • Altered benthic invertebrate communities • Reduced bottom water oxygen concentrations • Kills of bottom-dwelling fish and invertebrates

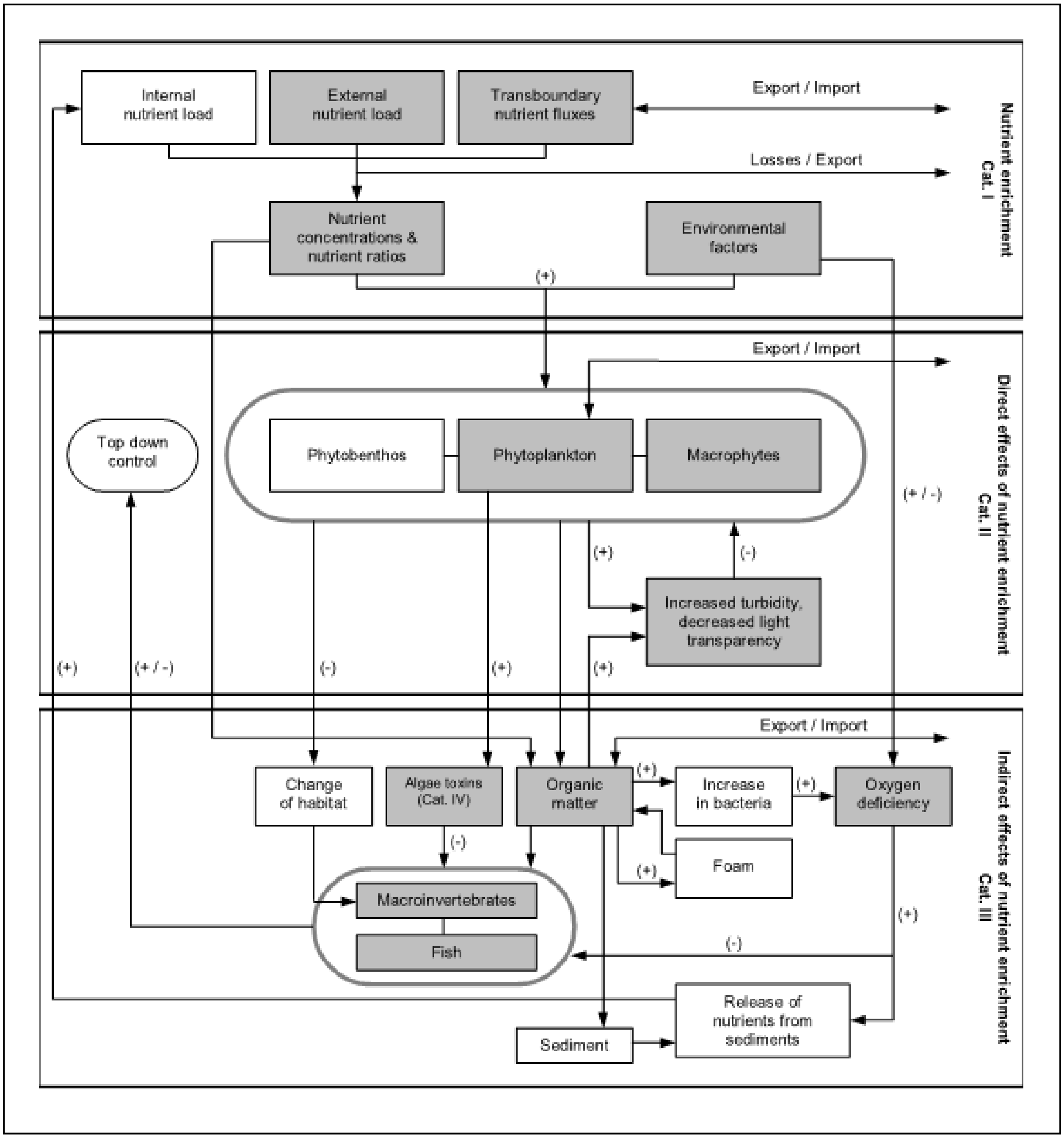
Figure 1.2-1 provides a more detailed illustration of the feedback loops involved in the eutrophication process.

As noted above, surface water chemistry is used as a first tier indicator of potential eutrophication in the inter-causeway area at Roberts Bank.

Surface water samples were collected by Hemmera at seven fixed surface water and sediment monitoring stations. In Q1-2009, surface water samples were collected at two additional sampling stations in the inter-causeway area, added to enhance the benthic invertebrate sampling program as per recommendations from the SAC.

In addition to the quarterly monitoring, the waters of the upper end of the DP3 turning basin (near DP04) were also monitored continuously (every 15 minutes) for pH, temperature, and dissolved oxygen using a YSI 6600V2 buoy-mounted sonde. The sonde was damaged twice by storms during continuous deployment in 2007 and 2008 so, in 2009, to avoid damage due to storm events, the sonde was no longer deployed continuously but rather for approximately one week each quarter.

Figure 1.2-1 Generic Conceptual Framework to Assess Eutrophication (OSPAR 2005)



1.2.3 Sediment Quality

Changes in sediment chemistry are also an indicator of emerging ecosystem trends. The objectives of the sediment chemistry study are the same as for surface water: to identify any trends suggesting that eutrophication is occurring or that metal concentrations are increasing as a result of DP3 construction or operation.

An extensive sediment sampling program concentrations was conducted to the east and west of the Deltaport causeway prior to DP3 construction (Hemmera 2004). Sediment data for the reference area are presented in Stancil (1980).

Changes in sediment chemistry would be expected to occur after trends signalling eutrophication were noted in surface water. The decomposition of algae would lead to an increase in nutrient concentrations in sediment, a decrease in redox values, and an increase in sulphide concentrations. Metal concentrations in sediment could potentially increase as a result of co-deposition with sulphides. Sediment chemistry is also used as a first tier indicator of potential eutrophication in the intercauseway area at Roberts Bank as changes in sediment chemistry would be expected to affect the composition of the benthic invertebrate community and the health of the eelgrass community.

1.2.4 Eelgrass

Eelgrass (*Zostera* spp.) meadows provide a variety of ecological services that assist in the maintenance of healthy estuarine and marine habitats. Eelgrass habitat is considered essential habitat because it is the basis of primary production that supports both economically and ecologically important finfish and shellfish populations (Duarte et al. 2008). Native eelgrass (*Z. marina*) meadows support numerous commercially important finfish and shellfish species (Orth and Heck 1980, Phillips 1984, Heck et al. 1989, 1995, 2003, Fredette et al. 1990, Short et al. 1993, Dean and Haldorson 2000, Beck et al. 2001).

Ducks, swans, and geese are known to forage on *Z. marina* during migration. Black brant geese are dependant of *Z. marina* as their primary food source; their migration route follows *Z. marina* meadows from Alaska to Mexico and back (Wyllie-Echeverria and Ackerman 2003). Herons are known to forage for prey extensively in *Z. marina* meadows (Essinger 2007). Baldwin and Lovvorn reported that waterfowl distribution in Boundary Bay, British Columbia was related to the presence of *Zostera* spp. (1994a), and that the expansion of *Z. japonica* habitat at that location resulted in a local increase in the abundance of dabbling ducks and brant (1994b).

Zostera species sequester large amounts of carbon and the productivity of healthy eelgrass meadow rivals exceeds that of most oceanic and terrestrial ecosystems (Mateo et al. 2007). The eelgrass provides a substrate and habitat for numerous species epiphytes, epibenthos, and benthos which add to the overall productivity of the habitat (Fredette et al. 1990).

Eelgrass produces oxygen through photosynthesis and releases it into the water and sediment (Constanza et al. 1997, Marba et al. 2007).

Zostera species increase decomposition rates in sediments, regulate nutrient cycles, and accelerate nutrient regeneration (Short 1987, Hansen et al. 2000).

Zostera meadows act as a filter trapping and binding sediments (Fonseca 1992, Heiss et al. 2000) and removing contaminants (Lyngby and Brix 1982, Francoise et al. 1989, Hoven et al. 1999). The *Zostera* leaves baffle currents and waves reducing coastal erosion (Koch and Verduin 2001).

Roberts Bank supports the largest native eelgrass (*Zostera marina*) meadow in southern British Columbia. Dramatic increases in the area colonized by native eelgrass occurred between 1967 and 2003 (Durance 2004a and 2004b, Harrison 2004).

The large increases in *Z. marina* habitat at this location are likely the result of several factors:

- The flow of water on ebb tides is impeded by the BC Ferry causeway, and reduces the extent of the area that is completely drained at low tide and therefore the amount of time that eelgrass is exposed to air and desiccation stress.
- The Deltaport causeway deflects the plume of the Fraser River, hence the turbidity of the water over the inter-causeway eelgrass bed has decreased since the causeway was developed. The reduction in turbidity results in increased photoperiod duration and intensity for the eelgrass, which may have stimulated growth and reproduction.
- The BC Ferry causeway may protect the eelgrass bed from severe south easterly winter storms. Eelgrass beds along the Washington and Oregon coast are often partially removed by winter storms. Although this has never been formally documented in British Columbia there is evidence that it occurs in Boundary Bay.
- The introduction and rapid mudflat colonization by *Z. japonica* may have resulted in ponding of water at higher elevations during low tide (Tarbotton and Harrison 1996). This may have enabled *Z. marina*, which is more susceptible to desiccation, to colonize areas higher than previously possible. Once established *Z. marina* could out compete (shade) the smaller *Z. japonica*.
- Studies conducted during the 1970s and 1980s along the Pacific coast determined that the successful establishment of *Z. marina* from seedlings was very rare. However, in the last decade researchers have noted the successful establishment of many seedlings in eelgrass beds from California to British Columbia (S. Wyllie-Escherverria, pers. comm.; C. Durance, pers. obs.). It is possible that the increased amount of available light accelerates seedling development, enhancing seedling survival. Billions of *Zostera* seeds are produced in the inter-causeway annually, hence even a small increase in survivorship could lead to a dramatic increase in density and distribution.

Z. japonica, an introduced species of eelgrass, was first identified in the inter-causeway area in 1976 (Harrison and Bigley 1982). The area colonized *by Z. japonica* rapidly increased to 317 hectares by 2003 (FREMP). *Z. japonica* colonized areas that were above the optimal range for *Z. marina.*

Zostera populations are declining globally; primarily due to anthropogenic stresses (Short and Wyllie-Escheverria, 1996, 2000). The specific factors responsible for declines include: increased nutrient inputs resulting in decreased light availability (Kemp et al. 1983, Moore et al 1997); increased nitrogen loading leading to increased algal abundance (den Hartog 1994, Short and Burdick, 1996, Bowen and Valiela

2001); organic enrichment resulting in sediment reducing conditions and anoxia (De Casabianca et al. 1997, Flindt et al. 1997, Terrados et al. 1999); elevated sulphide levels impacting root metabolism (Smith et al, 1988), nutrient uptake (Pregnall et al. 1984), and photosynthetic processes (Goodman et al. 1995); physical disturbance though fishing practices; and shoreline development including dredging, filling, and shoreline hardening (Moore and Short 2007).

Z. marina is often used as an indicator species to monitor and/or assess ecosystem health since changes in light availability or water quality conditions affect the distribution, abundance, and growth of the species (Dennison et al. 1993, Short et al. 1993). Therefore, the AMS program monitors the health and vigour of *Z. marina* and the distribution of *Z. marina* and *Z. japonica* in the inter causeway area of Roberts Bank. Changes in surface water and sediment chemistry would be expected to affect the composition of the benthic invertebrate community and the health of the eelgrass community, eelgrass health and vigour are, used as a second tier indicator.

1.2.4.1 Eelgrass Survey Objectives and Rationale

The eelgrass survey was designed to detect changes in the eelgrass habitat of the inter-causeway area and to determine whether any changes were caused directly or indirectly by the development of DP3. The specific objectives of the eelgrass monitoring plan are:

- To map the distribution of eelgrass (*Z. marina and Z. japonica*) the inter causeway annually via remote sensing.
- To monitor the vigour and species composition of eelgrass at the nine reference stations that were established for the Deltaport Third Berth EA, and to record the presence of epiphytes and *Beggiatoa* sp. at each of these stations annually.
- To map the lower limit of eelgrass of eelgrass distribution within the inter-causeway area using the Seabed Imaging and Mapping System (SIMS) every three years.

The objectives were based on rationale provided in the literature by numerous seagrass scientists and by decades of experience studying the Roberts Bank eelgrass meadows. The rationale behind each of the objectives is explained in the following sections.

1.2.4.2 Distribution Map

The distribution of *Z. marina* and *Z. japonica* may vary inter annually due to natural factors that include: climate; mean sea level; and the timing, duration, and amplitude of low and high tides. Anthropogenic impacts that cause changes in light availability, water quality conditions, or sedimentation / erosion rates could also alter the distribution of the two *Zostera* species.

A baseline map of the eelgrass distribution was prepared in 2003 for the Deltaport Third Berth Project Marine Resources Impact Assessment (Triton 2004). The annual AMS eelgrass surveys map the current distribution of both species and use the maps to detect changes that have occurred relative to 2003 and previous AMS study years.

1.2.4.3 Eelgrass Health and Vigour

Slight changes in light availability or water quality conditions can affect the productivity of *Z. marina*. The relative productivity of *Z. marina* was estimated at eleven reference stations as part of the Deltaport Third Berth Project Marine Resources Impact Assessment (Triton 2004). Nine of the original reference stations were selected for the AMS. These stations are monitored annually to detect changes in eelgrass productivity. The stations that were selected included all those located in the inter-causeway, two west of the Deltaport Causeway, and three in Boundary Bay. Changes in the inter-causeway eelgrass productivity could be related to influences other than the development of DP3, the data from stations west of the Deltaport Causeway could assist in differentiating between changes caused by the development of DP3 and other local sources such as the Fraser River plume. The Boundary Bay stations were selected to provide data on larger scale of environmental change such as climate.

The eelgrass habitat at Site 1 was very similar to that at Site 2 in 2003. Site 2 was selected due to its proximity to DP3. Site 1 was selected as a reference by which to assess changes in the eelgrass habitat adjacent to DP3 should they occur. Due to a shift from dense native eelgrass to patchy mixed eelgrass, Site 1 was no longer suitable for comparison to Site 2, therefore a new station, Site 1B was established. The eelgrass habitat at Site 1B is very similar to that at Site 2. Site 1 was renamed Site 1A, monitoring will continue at this site as the data may provide insight into the evolution of the sand lobe.

The three reference stations in Boundary Bay were selected in 2003 to represent eelgrass habitat within a range similar to the sites included in the 2003 Roberts Bank study area. Reference site WR1 is located near the upper limit of the eelgrass bed; the *Z. marina* at this location is similar in stature and density to *Z. japonica*. The 2003 Roberts Bank study area included a site west of the Deltaport Causeway that provided habitat similar to WR1 in Boundary Bay; this site was not included in the AMS surveys due to the absence of this habitat type within the inter-causeway area. The reference site WR1 was surveyed each year while waiting for the tide to ebb providing access to WR2 and WR3. Reference site WR2 is slightly lower than site WR1 and therefore supports larger plants. Site WR3 is the deepest and supports the largest plants of the three reference sites in Boundary Bay.

The productivity of eelgrass varies seasonally, thus the annual sampling is conducted at a date comparable, within a few weeks, to the date when the 2003 data was collected.

A variety of epiphytes colonize eelgrass; these are an important food source for many organisms and add to the overall productivity of the habitat. However, there have been several instances where epiphyte populations have surpassed natural levels and smothered eelgrass to the extent the habitat was severely impacted or destroyed. Two causes for these extensive epiphyte increases have been identified; eutrophication and over fishing. Eutrophication has occurred in poorly flushed estuaries when the nutrient load, usually from upland sources, increases. The added nutrients encouraged the growth of epiphytes that smothered the eelgrass. The epiphytes comprise a lower level on many food webs. The epiphytes are consumed by small grazers (amphipods, copepods, etc.) that are then consumed by small fish. The small fish are eventually consumed by larger fish. The extensive removal of large fish via commercial fishing unbalances the system. The abundance of small fish increases because fewer are consumed by large fish. The increase in small fish abundance leads to a decrease in grazer population that would have otherwise kept the epiphytes in balance.

The AMS monitors the relative abundance of epiphytes at each of the reference stations annually as an early indicator of potential degradation within the eelgrass habitat.

Beggiatoa sp. is frequently used as an indicator species to identify degraded marine habitats. The filamentous preteobacteria forms visible whitish mats in many polluted marine environments, especially those with eutrophic sediments rich in hydrogen sulphide and low in oxygen. *Beggiatoa* sp. has not been observed at Roberts Bank however the eelgrass survey team searches for evidence of it during the other field surveys, as it would indicate a decline in the health of the ecosystem. The VFPA would be notified immediately if *Beggiatoa* sp. was discovered in the inter-causeway area. A monitoring program would be immediately developed and implemented.

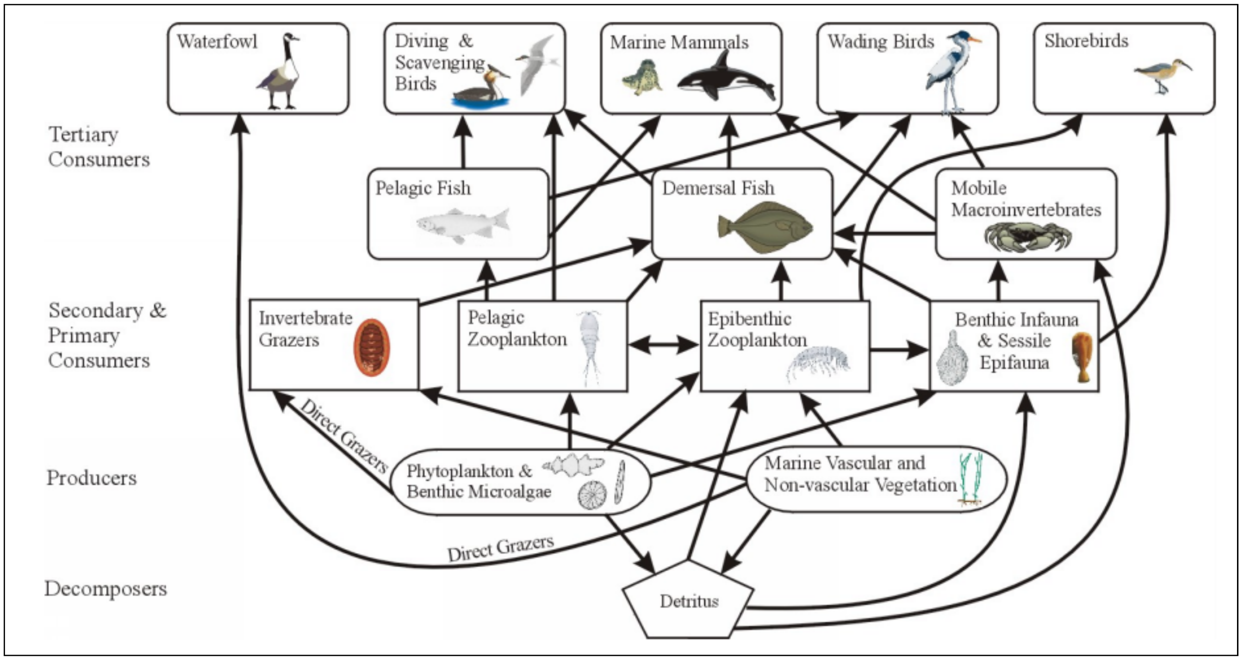
1.2.4.4 Lower Limit of Eelgrass Distribution

The lower limit of eelgrass distribution is dependent on many factors including; light penetration (turbidity), current, and substrate type. The lower limit of an established eelgrass meadow may be decreased by anthropogenic impacts that increase turbidity (eg. suspended sediments, nutrients) or increase currents (eg. bow thrusters, vessel traffic). The maximum depth of eelgrass distribution along highly developed portions of the eastern coast of the United States is less than one metre, while in the clear waters off of Alaska it has been recorded at depths greater than 30 metres. The lower limit of the inter-causeway eelgrass meadow is not usually visible on orthophotos due to the influence of the turbid Fraser River. The extent that is visible on the photographs is dependant not only on the turbidity at the time of filming but also on the tide height. The annual remote sensing mapping is not capable of determining the depth limit of eelgrass in the inter causeway. In order to assess whether the depth distribution of eelgrass has changed over time the lower limit of the eelgrass meadow is mapped triennially using an integrated remotely operated towed video camera and GPS system.

1.2.5 Benthic Community

Benthic invertebrates play a critical role in maintaining ecosystem health, as a food source for birds, fish, and macroinvertebrates (Peterson et al. 2000) (**Figure 1.2-2**).

Figure 1.2-2 Conceptual Marine Food Web for Roberts Bank (Triton 2004)



Subtidal habitats tend to be physically predictable. In contrast, intertidal habitats are characterized by greater variability in physical factors, including waves, tidal currents, erosion, slope, light, air exposure, temperature, salinity, and sediment stability. Burd et al. (1998) note that the influence of these factors, as well as biological factors, can lead to spatial heterogeneity of intertidal assemblages in what appear to be similar habitats. An earlier study by Burd et al. (1987) in the intertidal zone in Boundary Bay found that not only sediment grain size, but also the presence of eelgrass affected the species assemblage, with benthic communities in eelgrass beds structurally different and more diverse than those in nearby bare sediments.

Changes in the benthic invertebrate community linked to eutrophication would only be expected to occur after changes in surface water chemistry and/or sediment chemistry were noted. In the initial stages, benthic invertebrate abundance would be expected to increase as a result of increased nutrient availability. Benthic invertebrates can cope with oxygen depletion to varying degrees (days to month). As the amount of oxygen available in sediment decreased, the structure of the benthic invertebrate community would be expected to change, with more tolerant suspension and burrowing detritus feeders increasing in abundance. Signs of such change, would include an increase in the ratio of polychaetes to amphipods and an increase in the ratio of *polychaeta sedentaria* to *polychaeta errantia*.

In cases of severe eutrophication, overall benthic invertebrate abundance would be expected to decrease significantly, with only the most tolerant species surviving. This would result from a combination of factors including excessive organic matter deposition, oxygen depletion, and hydrogen sulphide release. For benthic habitats, much of the increased primary production is delivered directly to microbial loops (Baird et al. 2004). Higher rates of microbial decomposition can deplete dissolved oxygen near the sediment–water interface and produce hydrogen sulphide that enters pore water, and eventually the water column (Diaz & Rosenberg 1995). Organic matter deposition can also directly smother benthic invertebrates. Therefore, benthic community, like eelgrass health and vigour, is also a second tier indicator.

The objective of the benthic invertebrate community sampling and analysis is to determine if changes in eutrophication-linked parameters are causing changes in the benthic invertebrate community. It should be noted that natural variability in benthic invertebrate communities can make it difficult to determine if subtle changes are linked to eutrophication or other causes. Site-specific factors will affect the composition of the benthic invertebrate community and its sensitivity to increased nutrient loading.

1.2.6 Birds

The Fraser River Delta provides habitat that is international in its significance for a wide variety of birds including waterfowl, shorebirds, coastal seabirds, great blue herons, and raptors. Annually, approximately half a million birds depend on this delta with approximately 1.4 million birds utilizing the delta during the peak of migration (Butler and Campbell 1987). The Fraser River Estuary, which includes Roberts Bank and the inter-causeway area between the Deltaport Causeway and the BC Ferries Causeway, provide critical habitat for the largest wintering concentrations of waterbirds and raptors in Canada (BC Waterfowl Society 2006). In addition, the Fraser Delta has been designated part of the Western Hemispheric Shorebird Reserve Network (WHSRN) due to its status as a key stopover point used by shorebirds during migration. The entire worldwide population of western sandpipers (estimated 3.6 million birds) are believed to migrate along the coast of British Columbia. Of these birds, between 500,000 – 1,000,000 stop and stage along the Fraser River Delta during peak spring migration to forage along tidal mudflats where they build up energy reserves needed to reach breeding grounds in the Yukon-Kuskokwim Delta (Butler et al. 2002). Peak spring migration numbers have declined steadily between 1994 (1,125,000) and 2001 (126,000) as indicated by Butler and Lemon (2001).

Two listed species that use the region include the great blue heron and brant. Great blue heron are listed federally by the Committee on the Status of Endangered Wildlife (COSEWIC) under the Species at Risk Act (SARA, Schedule 3) as a species of ‘Special Concern’, meaning that it is particularly sensitive to human disturbance. Provincially, the coastal *fannini* subspecies is blue-listed due to declining populations attributed primarily to human development and in part to increasing disturbance from eagle populations (Gebauer and Moul, 2001). Blue-listed organisms are indigenous species or subspecies considered to be of Special Concern in British Columbia, but whose populations are not so imperilled as to be considered threatened with, or in danger of, extirpation (i.e., red-listed). In addition, the area is an important wintering and migration stopover area for brant, which are also blue-listed provincially.

Due to the potential for disturbance to this habitat, Hemmera conducted a detailed study of waterfowl and coastal seabirds as part of the Deltaport Third Berth environmental assessment (Hemmera 2005). This document indicated the following potential impacts to waterfowl and coastal seabirds:

- Approximately 6% of the resting/roosting and/or foraging habitat available to waterfowl and coastal seabirds would be lost under the project footprint. Compensation has been planned for this loss of habitat.
- Temporary displacement of resting/roosting and/or foraging habitat for birds using the inter-causeway area during construction. These impacts were not deemed significant given the availability of alternative habitat throughout the remainder of the study area.
- Dredging operations may cause a reduction in prey items for foraging birds near the dredge areas and increased turbidity associated with dredging could affect visibility for foraging birds.
- No significant auditory impacts from construction were expected to waterfowl and coastal seabirds due to acclimation to existing noise levels and the expectation that noise levels resulting from construction would not exceed those already present at the site resulting from normal activities at the Port.
- No significant impacts from additional lighting were expected as birds have become acclimated to existing lighting at the port facility.

The main objectives of this bird study are to provide complimentary data towards answering the concern regarding potential marine eutrophication and changes to coastal erosion processes and the distribution and composition of local biota, including shorebirds and coastal seabirds in the inter-causeway area. The bird study data are considered one indicator of ecosystem structure and function on a relatively broad spatial-temporal scale. Ecosystem changes leading to adverse ecosystem effects (e.g., eutrophication and erosion) that may be attributable to DP3 construction activity would likely be first detected through monitoring at a finer scale (e.g., water quality, benthic community, and eelgrass monitoring). Therefore, bird monitoring is considered a third tier indicator of potential eutrophication.

However, construction activities can potentially alter bird feeding and/or resting behaviours and bioenergetics, and as such, monitoring bird relative abundance and behaviours in the context of the DP3 construction activity is an important indicator of construction-related effects to a valued ecosystem component. Due to the possibility that changes to the ecosystem over time can be linked to key species such as great blue heron, brant, western sandpiper, and dunlin, monitoring bird usage within the inter-causeway area was part of the overall strategy to monitor ecosystem structure and function in the inter-causeway area.

To this end, the following bird study objectives were identified:

1. Determine whether there are impacts to brant geese and great blue heron usage of the inter-causeway area during critical periods of construction and operation.
2. Determine whether there are impacts on coastal seabird and shorebird usage of the inter-causeway area during construction.

1.3 FIELD METHODOLOGIES

The detailed field methodologies for the various survey and sampling methods are included in the Detailed Workplan document prepared for the VFPA by Hemmera (2007a) and a summary is also attached in **Appendix A**. The following sections provide some of the basic methodology along with any methodological variations that were necessary for completion of the work.

1.3.1 Coastal Geomorphology

Monitoring for the AMS program began in April 2007 and has continued through 2009. The following sub-sections provide a summary of the methodology and timing for each monitoring activity. A detailed description of the methodology is presented in **Appendix A**.

1.3.1.1 Crest Protection Structure Monitoring

Historically, the initial construction of the BC Ferries terminal and causeway, and the subsequent development of the Roberts Bank port facilities, starting with the port causeway and coal terminal, altered the coastal geomorphology processes at Roberts Bank. In assessing the potential coastal impacts to Roberts Bank as the result of the DP3 project, the formation, and ongoing development, of dendritic channels within the inter-causeway area was identified as a major concern.

Monitoring of the Crest Protection Structure was initially proposed to assess its ongoing effectiveness and to detect channel incision, headcutting or dendritic channel formation around the perimeter of the structure, as well as the stability of the structure itself. This task, in combination with orthophotography mapping, is used to track the continued growth of the existing dendritic channels as well as to monitor for the potential development of new channels. The proposed monitoring covers the entire perimeter of the Crest Protection Structure, with particular attention paid to the portion in the vicinity of the tug basin and DP3 structures. Repeated photo documentation and terrestrial surveys are conducted at known locations, using high precision Real Time Kinematic (RTK) GPS to measure the dimensions of channels that are present or subsequently form, as well as to navigate to the photo monitoring locations and monitoring cross sections.

Inspections were conducted by NHC in 2009 during very low tide conditions within the Q1 and Q3 periods and involved the collection of repeat cross-section surveys, as well as photographs that were taken at previously established sites during Q3 period only. Monitoring of the Crest Protection Structure was initially proposed to be a quarterly activity but following recommendations included in the AMS 2007 Annual Report (Hemmera, 2008d) the monitoring frequency was reduced to twice a year. Photo documentation occurs only once per year because the low tides during the Q1 period occur only during the night and effective photography is not possible. **Figure 2** shows the locations of the monitoring cross-sections as well as the monitoring points on the Crest Protection Structure and **Table 4** shows the coordinates of the monitoring points.

The topographic survey data is processed and plotted into the cross-section graphs according to a method established in 2008 which was adopted in order to eliminate small reporting inconsistencies that were previously discovered. Distance along the cross-section is now calculated relative to a fixed mid-point on the Crest Protection Structure and RTK GPS elevation data is corrected using the elevation measured at a known benchmark.

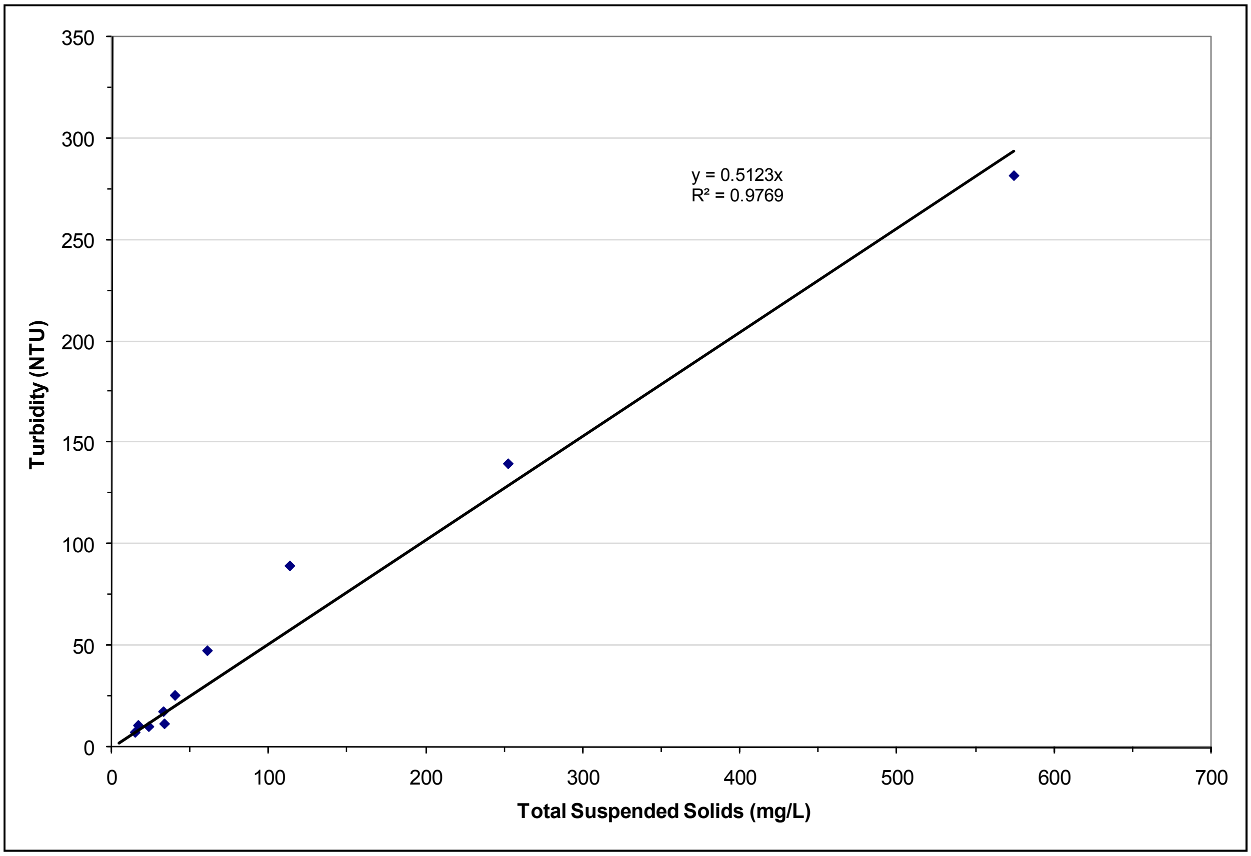
1.3.1.2 Automated Turbidity Monitoring

Sediment dynamics are one of the primary features of the geomorphic system at Roberts Bank. The movement of sediment is expected to occur as a result of tidal flow and waves. Sediment dynamics are monitored indirectly through the system of depth of disturbance (DoD) rods (see Section 1.3.1.3) which measure medium-term changes to the elevation of the tidal flats on a quarterly basis over a wide area. Measurement of turbidity in the water column provides a proxy record of sediment movement at a much finer temporal resolution but at one location only.

Turbidity is a measure of the passage of light through water and is only a proxy for sediment concentrations because it is affected by a number of factors such as grain size, material type, and organic content. A location-specific curve must be developed based on empirical data in order to relate the measured turbidity to the concentration of total suspended solids (TSS). This was originally addressed in the DP3 Project AMS Detailed Workplan, which is based in part on NHC’s project proposal, by inclusion of a work task for the periodic collection of water samples during a tidal cycle. However, preliminary field data showed that this method would not be successful, mainly due to the generally very low turbidity levels in the inter-causeway portion of Roberts Bank, and the difficulty of capturing the relatively rare occurrence of higher turbidity levels, which would have required extensive field time. In the absence of measurements of these higher turbidity levels, extension of the curve would not be valid.

NHC's memo of November 2007 presented a rationale for revising the originally proposed methodology. The collection of water samples was discontinued as an AMS monitoring activity in mid-2007 with the development of a TSS-Turbidity relationship that used laboratory measurements of sediments collected in the vicinity of the monitoring station. The turbidity monitoring station provides a continuous record of measured turbidity from which TSS is computed using the expression $x=y/0.5123$ (where x=TSS and y=turbidity) as shown in **Figure 1.3-1**.

Figure 1.3-1 Plot of TSS versus Mean Turbidity (from NHC memo dated November 5, 2007)



Two Analite NEP495 Turbidity Logging Probes were installed at the inception of the AMS monitoring program and began collecting data on July 12, 2007 (locations shown in **Figure 3**). Due to recurring issues and damage, one of the sensors was removed from the site on April 21, 2008. The remaining instrument (Sensor 2) is located at a ground elevation of approximately 0.5 m (Chart Datum) with the sensor resting 20 cm above the bed level in order to document near-bed sediment transport characteristics. Although the elevation of the bed would suggest that the site dries at tides lower than 0.5 m (Chart Datum), the presence of the Crest Protection Structure creates a ponding effect and the instrument generally remains wetted. However, during very low-tide conditions (approximately 4 to 6 times per year), the sensor is occasionally left above water, and the timing of these events is noted.

Turbidity values, expressed in Nephelometric Turbidity Units (NTU), are recorded at 15 minute intervals with 100 samples per measurement that are averaged to provide a single record. The Analite NEP495 has a self-wiping mechanism that is employed every two hours to prevent the gradual fouling of the lens that would result in steadily increasing readings. Marine organisms, such as starfish and barnacles, have been observed living within the instrument housing and the turbidity record displays numerous anomalously high values that are thought to be caused by particles or organisms passing close to the lens. The sampling interval was selected to capture the effects of storms and other weather events with durations of several hours or more and is not designed to capture the effect on turbidity of individual waves. Maintenance of the equipment is carried out on a quarterly basis to change batteries and wiper pads, and generally clean the instrument. Data download is carried out at this time as well.

Tidal fluctuations in the Strait of Georgia are thought to be one of the most important processes affecting the physical environment at Roberts Bank. It drives tidal flow across Roberts Bank and has a significant effect on the behaviour and effect of waves within the study area. A local tide gauge was installed on a caisson at the Deltaport site on June 14, 2007 to provide information to supplement interpretation of the turbidity data. Due to recurring damage associated in part with construction activities, the tide gauge was removed from the site during the Q4-2008 monitoring visit on October 17, 2008. Observed tide levels at Point Atkinson were shown in the 2008 Annual Report (Hemmera 2009) to be a reasonable proxy for local tide height, based on the record that was successfully collected. Tide level data from Point Atkinson has been used to help analyze the turbidity data included in the present annual report. The tide gauge will be re-installed at a new, less exposed location in the spring of 2010.

1.3.1.3 Monitoring of Erosion and Deposition

One of the objectives of the AMS is to monitor for potential changes to the elevation of the tidal flats in the vicinity of DP3. Deployment of a photo-electronic erosion pin (PEEP) was initially included in the work program to meet this objective. A PEEP contains a vertical array of light-sensing diodes, which generate a voltage proportional to the length of the exposed length of the array. Although the instrument has been used on river floodplains, there are no reports of its use for long-term monitoring in a marine setting, and given the experimental nature of this equipment, this device was not considered suitable for use at Deltaport. Deployment of a series of depth of disturbance (DoD) rods provides a simpler, less expensive method to obtain the relevant data using a proven technique. Furthermore, the significant cost savings of a DoD rod as compared to a single PEEP has allowed for a more extensive area to be measured and presently covers a portion of Roberts Bank adjacent to the DP3 terminal.

The DoD rods consist of a smooth rod with a washer placed over the rod resting at the sediment surface. The rods were installed by hand in the sediment by pushing to the point of refusal such that on average a 2.4 m length of rod is placed below the sediment surface, well below the expected maximum depth of disturbance. Burial or scour of the washer is measured relative to the top of the rod each quarter. The rods are inspected on a quarterly basis to clear any accumulated vegetation and repair any damage.

Twenty-six DoD rods were installed in April 2007, and eight extra rods were added to the array as per recommendations made in the AMS 2007 Annual Report (**Figure 4**). Six of these rods were added on April 9, 2008 to provide increased resolution in the area of new drainage channels and an additional two were added to the pond area on July 3, 2008. A handheld GPS is used to navigate to the DoD rods during low tides. Monitoring consists of measuring the depth of scour or burial relative to the top of the rod using a steel tape. For consistency, heights are always measured along the southeast side of the rod for to reduce any random error associated with a rod that may not be perfectly plumb to the sediment surface. At locations where the washer is buried, the surrounding sediment is excavated by hand to expose the washer and then subsequently re-graded to the level of the surrounding surface to reset the washer height. A photograph is taken at each installation site to record the general site conditions as well as the specific condition of the DoD rod.

Figure 5 illustrates the sequential measurements that are made to calculate maximum scour and net deposition. The initial condition was established by resetting the washer at the new ground surface in the previous quarterly monitoring and measuring the distance to the top of the rod. The final condition is measured at the beginning of the subsequent quarterly monitoring. The depth of the washer marks the maximum scour depth, while the elevation of the sediment surface marks the net deposition. These data provide values of maximum scour but not values of deposition for the quarter as it is not possible to detect if sediment was deposited at a higher elevation and subsequently partially eroded. After collecting the measurements, any disturbed sediment around the base of the rod is re-graded and the washer placed on the new sediment surface.

Vegetation accumulation on the DoD rod has in the past occurred on a seasonal basis and is related to growth and die off of the various plant species found in the vicinity of Roberts Bank. The presence of vegetation on the rod is noted and photo-documented and the height/quantity of accumulated weed is recorded as it may influence bed elevation change at the rod site. Accumulated seaweed is carefully removed to expose the bare sediments underneath and allow measurement of washer burial or scour as described above.

Periodic damage to the rods has been observed over the course of the AMS, primarily in the form of rods discovered to be leaning or bent. In these cases, the damage was noted in the field notes, typically along with an angle of inclination, and photos were taken of the damaged rod condition. Wherever possible, such rods were straightened by hand and measured. If the strength of rod was compromised because of severe bending, it was replaced during a subsequent monitoring visit and re-surveyed. Rod elevations are periodically surveyed using an RTK GPS to monitor the stability of the height of the rods as a point of reference for the measurements over time.

1.3.1.4 Sediment Samples

Collection of sediment samples was included as part of the AMS geomorphology monitoring to characterize the grain size of near-surface sediment and monitor for potential changes in sediment size distribution. Samples are collected twice a year at each of the original twenty-six DoD rod sites, once in the early spring during Q2 monitoring and again in the fall during Q4 monitoring to capture conditions following the post-Fraser River freshet season. The 2009 sampling was conducted in April and then in

November in conjunction with monitoring of the DoD rods. The first set of samples was collected at a distance of 5 m to the north of the DoD rods, while the second sampling took place at a distance of 5 m to the south of each rod. To avoid re-sampling in the same hole, the sampling location is rotated around the rod location.

Samples are collected at each DoD Rod site using a shallow hand corer that is pushed into the sediment to a depth of at least 15 cm. When the core is removed, any water resting on top of the sample core within the corer tube is carefully decanted and the top 10 cm of the sample is separated and stored in a freezer until it is sent to the lab for analysis. Freezing ensures that ongoing biological activity does not alter the grain size distribution. A sampling depth of 10 cm was chosen to ensure that there is sufficient sediment to perform a robust grain size analysis and that the sample captures undisturbed sediment at depth as well as newly deposited sediment. Preliminary monitoring of the DoD rods has demonstrated that a 10 cm sampling depth is appropriate at a majority of the sites. During collection, samples are photographed, stored in bags, and brief sedimentological descriptions are made. They are then sent to a commercial lab to be analyzed for particle size distribution as well as organic content.

The primary purpose of the laboratory analysis is to determine the particle size distribution of the samples, with particular emphasis on the percentage of the finest fraction. Results are compared with those of previous years to determine if a fining or coarsening trend is occurring.

The remaining sample is then put through a series of sieves and a hydrometer to provide a graph of percent finer by weight down to 0.5 mm.

1.3.1.5 Interpretation of Orthophotographs

Orthophotographic mapping was proposed in the AMS Plan for the purpose of tracking the dendritic channelization process as well as other geomorphic features within the study area. Aerial photographs of the study area are scheduled to be taken on a yearly basis during summer low tides in July. The 2009 photos were flown on July 24 during a low-tide of 0.7 m Chart Datum. Aerial photos were evaluated to assess trends and patterns of erosion and/or accretion on the tidal flats as well as changes to any other significant features such as tidal channels. This evaluation is conducted annually and covers the entire inter-causeway tidal flat area. The methodology consists of overlaying successive orthorectified photographs using GIS mapping techniques to delineate and identify morphological changes on the tidal flats. A set of systematic mapping protocols was developed to map geomorphic features and allow comparison between photos taken in successive years. Mapping was completed by a geomorphologist who is familiar with the physical environment of Roberts Bank. The resulting maps show the location of tidal channels, areas of erosion or sand accretion, significant geomorphic features, and changes in vegetation between successive surveys.

1.3.1.6 Coastal Geomorphology Mapping

Coastal geomorphology mapping was included as part of the AMS geomorphology monitoring to assess topographic changes due to long-term erosion or accretion of the inter-causeway tidal flats in the general vicinity of DP3. A combined bathymetric and topographic survey of the tidal flats using Real Time Kinematic (RTK) GPS positioning was carried out in 2007, and the next survey is scheduled for 2010.

1.3.1.7 Wave and Current Monitoring

Wind-generated waves and tidal currents are the primary geomorphic drivers at Roberts Bank. Potential changes to the waves and currents were assessed within the Coastal Geomorphology Study (NHC 2006) using numerical modeling techniques, as well as field measurements using an Acoustic Doppler Current Profiler (ADCP) and a hand-held Swoffer instrument. The modeling results and the field measurements also provide an assessment of baseline conditions predating the construction of DP3.

Wave and tidal currents were initially measured by an upward-looking acoustic wave and current meter (AWAC) that was deployed in the vicinity of DP3 in January, 2007 by ASL Environmental Sciences Inc. The instrument was subsequently dragged laterally across the ship turning basin by construction equipment but was found and re-deployed, only to be later buried by dredgeate and destroyed. No data could be recovered following this incident.

An alternate strategy for monitoring waves and currents was outlined in a memo prepared by NHC dated January 30, 2008 (NHC 2008). This strategy, which was adopted in the spring of 2008, consists of recording wave height using three non-directional wave sensors distributed within the study area. Measurements of ocean currents using a boat-mounted ADCP have also been made to verify the results of the numerical modeling studies that were included in the Coastal Geomorphology Study (NHC 2004). As the model runs predicted only a very small increase in the magnitude of tidal currents at the end of the DP3 footprint, ongoing measurements of tidal currents should not be required if the model results can be verified.

Three wave sensors were installed at various locations within the study area on April 10, 2008 (**Figure 3**). Sensor #1 was installed on the tidal flats opposite the DP3 facility in an area that is quite well protected from most waves that may enter the turning basin. Sensor #2 is potentially fully exposed to waves entering the turning basin but is located on the shoreward side of the Crest Protection Structure so wave energy would be reduced or eliminated depending on tidal stage. Sensor #3 is located on the seaward side of the Crest Protection Structure so is exposed to all waves that enter the turning basin. Sensor #3 therefore represents a control condition, while Sensor #2 and #1 represent zones of declining wave energy through attenuation or periodic high tide levels.

The RBR Ltd. TWR-2050 sensor is a tide and wave recorder equipped with both a temperature sensor and a pressure sensor. The sensor measures the pressure of the water above it and by transforming the pressure to depth, tides are seen as slow changes in depth while waves are seen as higher frequency depth modulation. For the AMS monitoring, the sensors are programmed to record wave height in data bursts of 1024 samples at 4 Hz for a short period each hour. This sampling scheme provides a measure of the full spectrum of wave conditions while prolonging battery life and data storage capacity to allow for quarterly data downloads. Because the calculation of wave height from changes in water pressure is sensitive to water depth, the initial water depth must be carefully determined. If the instrument is moved to deeper or shallower water without adjusting the sensor settings the results are not valid. As discussed in the Results section below, dragging of the instrument has occurred during the 2009 monitoring period.

Field measurements of current velocities were made on June 23, 2009 using a boat-mounted ADCP following completion of the caisson installation. Measurements were made periodically throughout the day during a large tide swing in reasonably calm weather conditions. During the course of the ADCP measurements, the tide level ranged from 1.5 m (Chart Datum) at 09:30 h to 0.1 m at 12:30 h and then rising to 4.0 m at 18:30 h.

Figure 6 shows the location where the ADCP measurements were made along a line extending from the end of the wharf extension to the edge of the turning basin. The bathymetry along a typical section is also shown. The bed elevation is relatively level immediately seaward of the wharf and rises along the slope at the edge of the turning basin. This gradual slope profile is interrupted towards the center of the transect by a four-metre high topographic feature extending over a distance of 50 m. Conditions on the water were calm on the day of the survey, except for an episode of relatively small waves that occurred early in the measurement period. The transect was surveyed three times each hour to provide increased confidence in the dataset.

The instrument used to collect the velocity measurements is a 1200 kHz RDI RioGrande ADCP mounted on a river cat raft (**Appendix B – Photo 1**) that was towed behind a flat-bottomed herring skiff. The three-dimensional velocity vector is measured every second at 15 cm vertical increments within the water column as the instrument is towed along the transect line. The collected velocity data was processed using the ADCPXP software developed at the University of Iowa, which permits extraction of mean velocities for each one-second measurement, as well as discharge along each section. A spatial depth-averaging function was applied to average velocities at approximately 3 m horizontal (10 ft) intervals along each section. In addition, velocities collected over three consecutive sections were averaged to give a value representative of the hourly sampling.

1.3.2 Surface Water Quality

Surface water samples were collected by Hemmera at the seven fixed surface water and sediment monitoring stations illustrated on **Figure 7** (DP01, DP02, DP03, DP04, DP05, DP06, and DP07). In Q1 only, surface water samples were collected at DP08 and DP09, as per the recommendations from the SAC. The surface water samples were added to provide co-located surface water samples to enhance the interpretation benthic invertebrate sampling program results. A representative surface water sample was collected one metre below the surface at each intertidal sampling station using a Van Dorn sampler. At subtidal sampling stations DP05 and DP07, water samples were collected at two depths: the A level (1.0 metres below the water surface) and the B level (2.0 metres above the sediment). At DP01, located in a tidally influenced drainage ditch discharging to the inter-causeway area, samples were collected from 0.5 m below surface from under the dyke bridge (**Figure 8**). Surface water sampling dates are presented in **Table 1**. The detailed methodology and the field and laboratory quality assurance and quality control (QA/QC) measures are as outlined in **Appendix A**.

The parameters analyzed for each surface water sample included:

- Temperature
- pH
- Hardness
- Salinity
- Metals
- Chlorine[1]
- Turbidity and total suspended solids (TSS)
- Nutrients (Phosphate, Phosphorus, Ortho-phosphorus, Total Kjeldahl Nitrogen (TKN), Total Nitrogen, Ammonia, Nitrate, Nitrite and Organic Nitrogen)
- Clarity (via secchi disc)
- Chlorophyll *α*

The detailed methodology and the field and laboratory quality assurance and quality control (QA/QC) measures are as outlined in **Appendix A**.

The station nearest the DP3 construction area (DP04), was also monitored continuously for a number of water quality parameters (pH, temperature, conductivity, and dissolved oxygen) using a YSI 6600V2 buoy-mounted sonde operated in conjunction with the DP3 construction environmental monitoring program. In 2009, the sonde was deployed on an intermittent basis to avoid damage due to storm events.

1 Chlorine was analyzed only in the sample collected at station DP01. The purpose of this parameter relates to the presence of an immediately up-gradient recreational water park and concerns of discharge to the inter-causeway area.

A 20% difference between the measured parameter inter-causeway and reference station results was initially proposed to gauge the potential for impacts; however, AMS results from 2007 suggested that baseline conditions at the inter-causeway and reference stations differed by more than 20%. As such, an alternate approach to evaluating the data was adopted in 2008.

The minimum and maximum concentrations recorded during each quarterly sampling event in 2009 for each parameter of interest were noted and three categories of approximately equal range were created. The average concentration for the parameter over the four quarters was then calculated at each station and the value categorized as low, intermediate, or high, with low average values represented by small dots and high average values represented by large dots. This method facilitated the identification of spatial trends in metal and nutrient concentrations and the comparison of spatial trends in sediment and surface water data. Temporal trends for select parameters were also graphed.

1.3.3 Sediment Quality

Quarterly sediment sampling was completed by Hemmera at the same time as the surface water sampling at the stations illustrated on **Figure 7**. A representative sediment grab sample was collected from each of the nine stations using a Ponar sampler. Sediment samples were analyzed for the following parameters:

- Metals
- Total nitrogen
- Ammonia
- Nutrients
- Redox (Eh)
- Hydrogen sulphide (H_2S)

The detailed methodology and the field and laboratory QA/QC measures are as outlined in **Appendix A**. The sediment data was analyzed following the same procedure as the surface water data.

1.3.4 Eelgrass

1.3.4.1 Distribution and Mapping

Digital orthophotographs (2009) were interpreted to develop a base layer for mapping the current distribution of eelgrass in the inter-causeway area. The criterion for minimum polygon size was 50 m by 50 m.

The 2009 orthophotos and base layer were downloaded into a personal data assistant with GPS capabilities (PDA/GPS). The study team ground-truthed the polygon boundaries of the base layer using the PDA/GPS. A mobile Geographic Information System (GIS) mapping program on the PDA enabled the team to confirm and/or determine the boundaries and species composition of polygons in the field.

A Seabed Imaging and Mapping System (SIMS) was used to determine the lower edge of eelgrass distribution in the inter-causeway area. The SIMS system uses a towed underwater video camera and is positioned with a real time differential GPS. The camera, towed from a boat, follows predetermined track lines perpendicular to the deep edge of the inter-causeway eelgrass bed. The film is analyzed noting the presence, absence, and relative density of eelgrass along each track. A SIMS survey is completed triennelly (first survey in 2009, next survey scheduled for 2012).

The data from the orthophoto interpretation, field surveys, and the SIMS survey were combined with the GIS layer developed for the Coastal Geomorpholgy component of this study that delineated channels in the study area to produce a map detailing the 2009 distribution of eelgrass within the study area.

1.3.4.2 Monitoring Eelgrass Vigour & Health at the Established Stations

The survey assesses the health and growth of eelgrass at nine of the eelgrass monitoring stations that were established for the DP3 Environmental Assessment, including four stations in the inter-causeway area, two stations west of the Deltaport Causeway **(Figure 9)**, and three reference stations in Boundary Bay (**Figure 10)**.

The parameters that were quantified at each of the stations included total shoot density, reproductive shoot density, shoot length, and shoot width[2]. Means were calculated from 20 replicate samples at each station.

The relative productivity at each station was calculated using a Leaf Area Index (LAI) formula. The LAI is calculated as follows:

$$\text{LAI} = \text{mean density } (\#/m^2) \times \text{mean shoot length (m)} \times \text{mean shoot width (m)}$$

The data for each parameter at each station from 2009, 2008, 2007, and 2003 was used to create histograms to demonstrate the trends over time.

T-tests using the Bonferroni correction adjustment were used to test for significant differences between years for each parameter, except in cases where there was no variation within a data set. A standard paired two-sample, 2-tailed t-test was used in cases where the Bonferroni correction adjustment could not be applied.

The presence or absence of *Beggiatoa sp.* and relative density of epiphytes and was recorded at each of the stations. Photographs were taken at each site to document the epiphytic cover for future reference.

2 Quadrat sampling along transects as described in *Methods for Mapping and Monitoring Eelgrass Habitat in British Columbia* (Precision 2002).

1.3.5 Benthic Community

Hemmera collected and prepared sediment samples for benthic community analysis at eight of the nine sampling stations from March 3 to 5, 2008 (**Figure 7**). Benthic invertebrate sediment samples were not collected from station DP01 (**Figure 8**), a tidally influenced freshwater drainage ditch distinct from the other sampling stations. To capture inherent variability potentially present at the stations, three replicates were collected per station for the benthic community sampling. Sediment samples were screened using a 0.5 mm sieve. Benthic invertebrate samples were shipped to Biologica Environmental Services (Biologica) for taxonomic identification. The detailed methodology for the benthic invertebrate sampling is included in **Appendix A**.

The benthic invertebrate data were tested for normality, log transformed if normalization was required, and analyzed using analysis of variance (ANOVA) and General Linear Modeling Regression.

ANOVA was used to test for differences in richness, Shannon Wiener diversity, evenness, and overall benthic invertebrate abundance between years (2007, 2008, and 2009). For the statistical analysis, richness was defined as the number of different species present. Shannon Wiener diversity and evenness are defined below:

$$\text{Shannon Wiener diversity} = \sum P_i (\ln P_i)$$

Where P_i = proportion of each species in the sample

$$\text{Evenness} = \text{Shannon Wiener diversity} / \text{Maximum Diversity}$$

Where: Maximum Diversity = ln (Number of Species)

General Linear Modeling Regression was completed to determine if there was a significant correlation between key eutrophication-linked parameters in sediment and the benthic invertebrate variables listed above. Data was pooled across years when conducting regression analyses i.e. year was not used as a factor in models. Both backward-stepping and forward-stepping regression was completed.

1.3.6 Birds

A number of changes to the bird monitoring program have been implemented since 2008 and are described below.

1. Distance categories for all point counts were changed to 0 – 250 m, 250 – 500 m, and 500 m – 1 km as used by the Canadian Wildlife Service during surveys conducted in 2004.
2. Point counts along the BC Ferries (BCF) Transect (except as outlined in recommendation #6) were discontinued as no evidence of impacts from the Deltaport construction work has been documented or was expected.

3. The number of point counts along the Tsawwassen First Nation (TFN) Transect was reduced from five to three by merging PC 113 with PC 115, and merging PC 105 with PC 107. This was implemented after assessing the value of data collection along the TFN Transect to determine whether continued TFN surveys were necessary to achieve the goals outlined in the AMS.
4. The frequency of survey events was reduced from bi-weekly to once every four weeks beginning the week of June 23, 2008 (survey event 31) with the exception of a six-week period during spring western sandpiper migration (April – May).
5. The frequency of winter surveys was reduced to one tidal event per survey for a period of three months (December – February) due to minimal fluctuations between high and low tide levels, during winter surveys.
6. Seasonal species-specific “windshield” surveys were implemented in conjunction with regularly scheduled (monthly) survey events to provide absolute abundance counts of brant (i.e., November – May) and great blue heron (i.e., May – August) when these species are most abundant. These surveys ensure that focal species of the AMS (brant and great blue heron), are represented along the BC Ferries Causeway (which had been otherwise removed from the survey scope) and would provide an improved estimate (absolute abundance) of the total number of brant and great blue heron using the study area. No time limit exists for these windshield surveys; rather, the objective of the survey is to count all the brant and great blue heron using the inter-causeway area at a given time. These windshield surveys would be included as part of the existing monthly survey events.

The above recommendations were reviewed and accepted by the Scientific Advisory Committee (SAC) and implemented in June 2008.

Hemmera conducted 13 surveys for waterfowl and coastal seabirds between January and December 2009 on the dates listed in **Table 5**. Each survey consisted of point counts (PCs) of 20 minutes in duration along the Deltaport Transect and TFN Transect. Additional windshield surveys were conducted for great blue heron (March - September) and brant (January - May, and November - December). **Figure 11** outlines the study area and PC stations. Both high and low tide surveys were conducted at each PC from February through October 2009. Only high tide level surveys were conducted in January, February, November, and December due to the absence of significant daytime low tides. Surveys were conducted over a one to three-day period, and data was summarized consistent with the detailed methodology presented in **Appendix A**.

To make data from multiple study years comparable, data from previous study years in which bi-monthly surveys were conducted was filtered to select one survey from each month. Survey events within a month were chosen systematically by selecting the event conducted closest to the 15th day of the month. When surveys were conducted over multiple days, to ensure adequate coverage of the project area, all surveys within that “event” were included in the data analyses. To meet recommendations accepted by SAC associated with western sandpiper both April and the first May survey event were selected for all years.

Analyses of changes in abundance and use of the inter-causeway area for all species and functional groups, except great blue heron and brant, were derived from point count data collected from the Deltaport Transect and TFN Transects. For great blue heron and brant, overall abundance estimates were derived from data collected from the Deltaport, TFN, and BCF Transects and analyzed for changes between years. For these analyses, point count data was used for the Deltaport and TFN Transects, and BCF Transect data was compiled from point count data (prior to June 2008) and windshield survey data (post June 2008).

To evaluate potential patterns in bird use of the study area relative to DP3 construction activities, several sources were consulted to develop a Disturbance Severity Rating Scale. Data sources used were: 1) notes taken concerning construction activities and perceived noise levels during surveys while in the vicinity of DP3 construction, 2) environmental monitoring logs (compiled by Hemmera for VFPA), and 3) daily engineer's reports summarizing daily site activity (compiled by Klohn Crippen Berger for VFPA). Due to the completion of DP3 construction activities requiring environmental monitoring, environmental monitoring logs and engineer's reports were discontinued in July 2009. As a result, surveyor notes and environmental monitoring reports for construction on the East Causeway were used for documenting disturbance from August to December, 2009. Based on analysis of these sources, a rating scheme (**Table 1.3-1**) was developed to categorize and rank disturbance severity from DP3 construction activity.

Table 1.3-1 Disturbance Severity Ratings

Rating	Description
0	No disturbance
1	Low: minimal noise being generated, and/or minimal in water (or near water) activities that would disturb birds
2	Moderate: some construction noise generated and/or activities in project area that may disturb birds
3	High: activities producing loud noises (e.g., pile driving), and/or many activities going on in water.

The severity ratings scale was then used to assess patterns in bird abundance and distribution relative to noise levels and construction activities. General linear modeling was also used to evaluate whether a relationship existed between the severity of impacts and great blue heron and brant use of areas closest to DP3 construction.

2.0 RESULTS

The following sections provide a summary of key findings for the AMS quarterly monitoring events during 2009.

2.1 BACKGROUND INFORMATION

2.1.1 Weather, Tides and Fraser River

Winds, waves, tidal currents and Fraser River discharges provide the main driving forces for the physical processes occurring at Roberts Bank. This chapter provides a brief overview of these parameters for the duration of the 2009 monitoring period. Comparisons to historical conditions were made using statistical techniques to provide an assessment of the overall frequency and magnitude of these driving forces. Reference stations for environmental data collected outside of the AMS program were chosen based on proximity to the site, quality of data, and length of historical record. It is recognised that conditions within the AMS Monitoring Area may differ somewhat from those measured at the external stations, both in terms of magnitude as well as timing but an in-depth analysis of these variations is outside the scope of the AMS. The primary purpose of presenting these data is to provide an independent evaluation of the relative wind and wave conditions compared to historical conditions in order to put the data collected for the AMS Monitoring Program into context. The wind and wave analysis based on the external stations provides a useful proxy measurement of the overall energy regime affecting the site.

2.1.2 Winds and Waves

Deltaport Terminal is exposed to waves from the northwest, west, south-west, south and south-east. **Figure 12** shows the fetch lengths measured at 10 degree intervals from a point near the offshore end of the terminal. The offshore (deepwater) wave conditions are governed by the fetch length, wind speed and wind duration. There are no continuous long-term wave or wind measurements at Deltaport. However, hourly wind data for the period from January to December 2009 were obtained from Vancouver International Airport, which has the longest continuous record in the area. Wave heights and wave periods have been recorded at Halibut Bank by Fisheries and Oceans Canada through the Marine Environmental Data Service (MEDS) program. The Halibut Bank station is located in the Strait of Georgia approximately mid-way between Nanaimo and Sechelt and 45 km northwest of Deltaport. The combination of wind and wave measurements provides a reasonable basis for characterizing the deepwater wave climate near Deltaport in 2008. The wind speed and direction data were used to hindcast the deepwater wave conditions at the site using a standard calculation relating fetch length, wind speed, and wind duration to wave height, while the measurements at Halibut Bank provided an independent check of the predictions. Knowledge of the deepwater wave conditions from the hindcast data provides a useful contextual comparison for evaluating the wave data that was collected at the three stations within the study area.

Wind speed and wind direction were tabulated for four periods: January-March (**Table 6**), April-June (**Table 7**), July-September (**Table 8**) and October-December (**Table 9**). The values in these tables represent the number of observations (hourly data) in each speed class and direction range. The time series of wind measurements was also reviewed to identify specific storm events over the monitoring period. In this case, a storm event was defined as having a sustained wind speed greater than 30 km/h. **Table 10** summarizes each event in terms of the time period, corresponding tide levels, and estimated significant wave height (Hs) and wave period (Tp) and includes an evaluation of the historical probability of occurrence for exceedence of this wind speed.

The strongest wind event that occurred in the January-March period was from the west with a maximum wind speed of 59 km/h and winds that remained above 30 km/h for sixteen hours. This event had the highest average wind speed of the year at 47.9 km/h and would have generated wave heights of 3.0 m, which would be the highest waves of the year. The majority of the strong wind events in this period came from the west and northwest, with seven observations exceeding 40 km/h (**Table 6**). Of the ten storm events in this period, all but one is predicted to have generated waves of greater than 1 m (Hs) according to hindcast calculations. During the April-June period, there were five observations with maximum wind speed exceeding 40 km/h (**Table 10**), which came from the west and northwest, except for one event that came from the east. The highest winds in this period occurred between April 21 and 22 and had a maximum wind speed of 56 km/h from the west and would have generated 1.9 m waves. The strongest winds in the July-September period were also from the west, northwest, and southeast, but only one observation exceeded 40 km/h that would have generated waves greater than 1.8 m in height. The strongest winds in the October-December period were from the west, northwest and south. Winds exceeded 40 km/h on nine occasions and reached a maximum value of 63 km/h on October 24th (**Table 10**), which is the highest wind speed of the year.

The highest winds occurred on October 23 (63 km/h) but the most severe storm event of the year in terms of sustained wind and maximum wave heights, occurred on March 31st with winds rising above 30 km/h from the west at 8 am and rising over 50 km/h within one hour. The storm generally came from the west but winds veered to the northwest during two separate one-hour observations, before returning to the west. After the first hour, winds remained above 50 km/h for eight hours before gradually diminishing to less than 30 km/h over the following six hours. The maximum wind speed for this storm was 59 km/h, which has a probability of exceedence of 0.09% on the basis of all peak hourly winds for the period from 1953 to 2006. An average hourly wind of 63 km/h, as reported for October 23 has a probability of exceedence of 0.05%. The highest reported significant wave height (Hs) during this period at Halibut Banks was 1.7 m with a period (Tp) of 4.8 seconds. The hindcast wave height at Deltaport was calculated to be 3.0 m. The storm was associated with a high tide of 4.1 m (Chart Datum) at 8:05 h at the beginning of the storm on March 31st that dropped to 0.8 m at 15:44 h and then rose again to 4.1 m at 23:42 h as the storm ended.

There were no other storm events in 2009 that had wind speeds over 60 km/h, though there were eight additional storm events that had maximum wind speeds of over 50 km/h. The third strongest winds of the year were associated with a storm on November 18th and 19th had average winds over 30 km/h for 18 hours and maximum winds of up to 57 km/h. The station at Halibut Bank recorded heights of over 2.3 m during this event, while hindcast wave heights at Roberts Bank were estimated to be 1.9 m. The fourth strongest storm event occurred on April 21st with winds from the west at up to 56 km/h. The significant wave height (Hs) was estimated to reach 1.9 m during this event.

A frequency analysis was carried out on the wind and wave data to assess the relative magnitude of the 2009 events versus the long-term conditions. Estimates of long-term frequency and duration of wind events and wave conditions were summarized in NHC (2004). **Figure 13** shows cumulative frequency distribution (hours exceedance) plots of wind speed for the four seasons. **Figure 14** shows similar plots for wave heights recorded at Halibut Bank. In 2009, the incidence of winds of all speeds was essentially the same as for the long-term record for the January to March period. For the other three quarterly periods, the hours exceedence curve is shifted slightly to the right of the long-term record curve, which would appear to indicate that winds of any given speed occurred more often in 2009 than on average. This is clearly not possible and the difference appears to lie primarily in the lack of calm conditions, particularly during the April to June and July to September periods.

A comparison of the 2009 wave data to the long-term average conditions is more complex than for the wind data. Between January and March, there was a much higher incidence of waves less than 1.3 m in height as compared to the long-term average. The October to December period showed a similar trend to generally smaller wave heights, but for wave heights of 0.3 m (Hs) and smaller, the trend was very similar to the average conditions. The April to June and July to September periods showed similar trends against the long-term average data. Each of these periods had fewer times when waves between 0.5 m and 1 m in height were exceeded and a slightly higher occurrence of small waves.

Overall, the wind and wave conditions in 2009 were generally less severe than the average conditions and slightly less severe than in 2008, although the comparison is somewhat qualitative. In terms of large storms, there were 32 storm events identified in 2009 as compared to only 25 events in 2008. However, the two largest storms in 2008 both had winds that exceeded the highest winds reported in 2009 but these storms would have generated slightly smaller waves.

2.1.3 Tides

Tide levels are predicted by the Canadian Hydrographic Service at Tsawwassen using observed levels at Point Atkinson as a reference station. Tide levels were also measured by NHC at Deltaport from June 14, 2007 using a pressure transducer and data logger. The record from this instrument contains a number of gaps caused by accidental damage and wilful tampering of the installation, and ends on July 3, 2008 when the instrument was permanently removed. **Figure 15** to **Figure 18** show the observed tide levels by month for 2009 at the Point Atkinson gauge. The tides are mixed, semi-diurnal in nature. Consequently, there are differences in elevation between successive high waters and successive low waters. The sequence of the tides typically follows the pattern of Higher High Water, Higher Low Water, Lower High Water and Lower Low Water, although this pattern is reversed approximately 15% of the days in a tide cycle as the tides switch from spring to neap. Lower Low Water occurs in daylight hours between April and August while during the fall and winter season Lower Low Water occurs during the night time. The tide range undergoes a bi-weekly variation due to the influence of the moon. Spring tides, having the largest range, occur 15 days apart, 26 hours after a new or full moon. The maximum tidal ranges occur near the time of the summer and winter solstice. The minimum tidal range occurs around the time of the Spring and Autumn equinoxes.

The highest tide of 2009 occurred on November 17th during one of the shorter periods of higher winds, when wind speed exceeded 30 km/h for three hours. The predicted High Water at Tsawwassen was 4.5 m (Chart Datum) at 06:39 h.

2.1.4 Fraser River Discharge and Sediment Inflow

The Fraser River hydrograph has a characteristic nival-regime, with the flow rising in late April, peaking in May and early June, then receding through the late summer and fall. The lowest annual discharge typically occurs in March.

The Fraser River adds approximately 18 million tonnes of sand, silt and clay sediment to the Strait of Georgia each year on average. Suspended sediment concentrations typically rise to between 500 mg/L to 1,000 mg/L during the May-June freshet season, then decline through the late summer and fall to between 100 to 200 mg/L. Sediment concentrations in the low flow winter season typically range between 50 to 100 mg/L (McLean and Church, 1986).

Virtually the entire sand load is deposited in the delta front off the main arm jetty near Steveston. Due to the isolated nature of the inter-causeway portion of Roberts Bank and the presence of the Deltaport Causeway, even the fine clay-sized sediment in the Fraser plume is deflected into the deep waters of the Strait of Georgia (**Figure 19**).

Information on conditions during 2009 is based on preliminary data from Water Survey of Canada and is still subject to revision. The 2009 freshet was smaller than average, reaching a maximum discharge of 7,500 m^3/s at Hope and approximately 8,800 m^3/s at Mission in mid-June. This flood had a return period of between one and two years. By the first week of July the discharge reduced to 5,000 m^3/s and by September the flow reduced further to below 2,000 m^3/s. Between October and December the discharge remained between 1,200 to 2,100 m^3/s, fluctuating in response to local rainstorms. No sediment measurements were made on the Fraser River in 2009. However, based on a comparison with previous years of observations it is likely that the total load in 2009 was lower than mean annual load of around 18 million tonnes. Based on previous years observations it is expected the highest sediment concentrations would have reached approximately 1,000 mg/L in early June, declining to a few hundred mg/L by mid-August.

2.1.5 Construction Activities

The DP3 construction activities for 2009 are summarised in **Table 1.1-1**. The majority of construction actvities were land-based and related to paving and construction of the TSI Terminal. Marine construction focused primarily on completing scour and protection works around the perimeter of the terminal and occurred within the Q1 and Q2 periods. Marine construction was completed by July 2009. As noted in the AMS 2008 Annual Report (Hemmera 2009), turbidity levels associated with construction activities were monitored by a separate project team. It was found during construction monitoring that turbidity levels generally returned to background levels within 30 m to 50 m of the active construction site. During certain activities that occurred in 2008, such as general fill of the caisson trench, turbidity levels dissipated within 300 m. To our knowledge, there were no such activities during 2009, and the turbidity sensor (Sensor 2) is located at least 300 m from any construction activities that occurred in 2009.

Construction of the East Causeway Habitat Compensation Works commenced in September 2009. This activity involves replacing the existing rock rip-rap that is currently protecting the east side of the Deltaport Causeway with structures designed to create a more complex range of habitat types. Construction started near the northern end of the causeway near the overpass and has proceeded along the causeway towards the port. The work occurs during low tides, and sediment generated from the activity is contained in trenches. This construction activity is scheduled to be completed in June 2010.

2.2 COASTAL GEOMORPHOLOGY

2.2.1 Crest Protection Structure Monitoring

As per the recommendation included in the AMS 2007 Annual Report (Hemmera 2008d) to reduce the Crest Protection Structure Monitoring from a quarterly to a bi-annual activity, the 2009 monitoring includes two repeat Cross-Section surveys and one set of monitoring photos. Surveys were collected during the Q1 and Q3 monitoring periods, and photos were taken during daylight low tides in Q3. The 2009 surveys are shown in **Figure 20** and the 2008 surveys are shown in **Figure 21**. The RTK GPS malfunctioned during the Q2-2009 monitoring visit in February, and so the Crest Protection Structure Monitoring was completed one month later during the next available low tide period. A selection of the monitoring photographs is presented in **Appendix B**.

2.2.2 Automated Turbidity Monitoring

Two Analite NEP495 Turbidity Logging Probes were installed and began collecting data on July 12, 2007 (locations shown in **Figure 3**). Sensor 1 was permanently removed from site on April 21, 2008 due to recurring water damage.

The measured turbidity record for 2009 was interrupted by technical issues at the beginning of the year. During the Q1-2009 monitoring site visit in February, 2009, Sensor 2 could not be located. The installation appears to have been disturbed during a large storm event. A replacement sensor for the missing Sensor 2 was installed shortly thereafter, but all data for the period between the Q4-2008 site visit and the Q1-2009 site visit was lost with the instrument. Data download and instrument maintenance was scheduled for April 27, 2009 during the scheduled Q2-2009 site visit, but water was found to have penetrated the temporary replacement turbidity sensor, and so no data from this period was retrieved. A new replacement sensor with an updated design was installed on May 26, 2009 and continued to operate for the duration of the year.

Figure 22 shows a time series plot of the raw 2009 turbidity data from Sensor 2 for the period from May 26 to December 31. Periods of low tide below 0.7 m are shown on the plot as well as the timing of monitoring site visits. The timing of large storms that generated significant wave heights (Hs) of greater than 2 m is also indicated. **Figure 23** shows the same time series but with the large spikes removed and a smoothing function applied to the remaining data. The time series plot shows that the recorded turbidity measurements from around August 26, 2009 and onward had started to drift up and down and that from the end of October, the values shifted up to record near-maximum values. A more thorough examination of these data is included in the Discussion in Section 3.0 of the report.

2.2.3 Monitoring of Erosion and Deposition

Table 11 to **Table 14** summarizes the bed elevation changes recorded for each monitoring period. Many of the DoD rods experience a combination of erosion and deposition during each quarterly monitoring period. A series of figures have been prepared to display the monitoring results graphically. **Figure 24** and **Figure 25** show plots of maximum erosion and net deposition during each monitoring quarter as a series of bar charts for each site. Measurements that may have been affected by accumulation of weed or damage to the rod are indicated for each quarter. The values of net change for various ranges are represented with colour-coded dots in **Figure 26** to **Figure 29**. **Figure 30** provides a summary of damage to the rods.

In some instances, erosion computations for DoD sites resulted in a negative value, which indicates that an error was made at some point in the measurement series. Negative erosion based on the washer position is clearly impossible as it requires either that the washer has risen over time or that the rod has sunk, neither of which are plausible. The values are generally relatively small (under 1 cm) and can be attributed to measurement error. In the 2009 monitoring year, the largest such error was 0.4 cm. In cases where this error appears, the negative erosion value is simply set to zero.

Periodic surveys of the tops of the DoD rods have been performed using an RTK GPS. These measurements show that the elevation of DoD rods Z03, Z04. and Z08 changed significantly within the Q1-2009 period, and so the measurements from this quarter were not reported. Discussion of the possible cause of this elevation change, as well as the reliability of the DoD rod data is included in Section 3.

2.2.4 Sediment Samples

Sediment samples were collected during the Q2-2009 monitoring on April 27 and the Q3-2009 monitoring on November 3, 2009 at each of the 26 original DoD rod locations. The results of the grain size analysis have been presented within the quarterly monitoring reports in which the samples were analyzed. As the AMS is primarily concerned with changes to the finer portion of the sediment sample, the analysis presented in this report focuses on changes to the percent silt content of the samples between monitoring periods. **Table 15** shows the results of the sediment analysis in terms of percent total organic carbon content by weight for each site in the two sampling periods and **Table 16** shows the percent by weight of silt for each sample. The percent silt content is displayed graphically in **Figure 31** and **Figure 32** for the two monitoring periods. **Figure 33** shows the change in percent silt between April and November at each of the sampling sites.

Sampling is limited to the top 10 cm of the sediments, which is a reasonable sampling depth considering the typical depth of disturbance that has been observed in the DoD rod data. The sediments consist primarily of medium to fine sand (median size typically 0.1 to 0.2 mm) with minor amounts of silt. The percentage of silt (less than 0.063 mm) in the samples was used as an indicator of fine sediment inputs to the site. The silt content of the sediment samples is classified into four categories, each with a range of 16 percentage points. The majority of samples contain low amounts of silt (16% or less) but one of the sites (D02) had a silt content of between 48% and 64% in April. The majority of the samples remained relatively stable in terms of percent silt between April and November but three sites (A03, C02, and D02) showed a decrease of more than 10% in silt content, and none of the sites showed an increase of more than 10% in silt content.

2.2.5 Interpretation of Orthophotographs

The study area for this monitoring activity includes the entire area of Roberts Bank within the inter-causeway tidal flats. **Figure 34** shows the results of the orthophotographic interpretation, which was completed using GIS mapping techniques under the direction of the project geomorphologist. Areas of disturbance, shown in light purple, are areas where channel activity or deposition is occurring, but individual bars and/or channels are too small to be mapped individually. Sand bars, either large forms near the low-tide edge of the tidal flats or smaller channel point bars, have been mapped in yellow. Tidal channels are delineated in green – a dark green colour for channels large enough to have its banks mapped with double lines and light green for smaller channels.

The main features of interest shown in **Figure 34** include:

1. New drainage channels that formed at the north-eastern margin of the perimeter dike.
2. Formation of sand bars on the tidal flats on the seaward side of the Crest Protection Structure.
3. The large system of dendritic channels draining into the turning basin.
4. The tidal channels adjacent to the BC Ferries Causeway.

Items 2 through 4 are historic features that pre-date the DP3 project and have been identified and described previously (NHC, 2004).

Figure 35 shows a comparison of the area of new drainage channels from July 2007, shortly after the new channels had formed, to July 2008, a year post-formation. Photo 6 and Photo 7 in **Appendix B** are photographs taken on February 3, 2009 of the new channels. **Figure 36** shows the outline of the large dendritic channels that were digitized from the 2007 and 2008 orthophotos.

2.2.6 Coastal Geomorphology Mapping

The baseline coastal geomorphology mapping survey was completed in 2007 and the results were presented in the AMS 2007 Annual Report (Hemmera 2008d). This activity is scheduled for re-survey in 2010 or 2011, based on the AMS Detailed Workplan (VFPA and Hemmera 2007). No additional results are presented in this report.

2.2.7 Wave and Current Monitoring

Three wave sensors were installed on the tidal flats on April 10, 2008. The location of the sensors is shown in **Figure 3**. Weather issues have affected the instruments in the 2009 monitoring year. During the Q1-2009 monitoring visit, Wave Sensors #1 and #2 were found to have been dragged some distance from their original installation locations. Sensor #1 was discovered approximately 200 m southeast of its original location on the built-up Crest Protection Structure around the tug basin. Sensor #2, which was installed in the pyramidal cage housing the turbidity sensor, had been dragged about 10 to 20 m to the east to lie on the Crest Protection Structure. Sensor #1 was removed for calibration after the dragging incident, and so data was not collected during the period between April 27 and May 26, 2009. Sensor # 2 has a data gap from July 20 to September 15, 2009 because of water penetration and resulting instrument failure.

Sensor #3 was re-deployed on March 5, 2009 following the completion of dredging operations in the ship turning basin. Download visits have been scheduled to coincide with Hemmera's quarterly sampling activities because a boat is required to access this sensor. Due to a delay in the timing of the download, the instrument's memory was filled before such a visit could be made, accounting for a data gap of about one month in May 2009.

Figure 37 shows the 2009 wave record (significant wave height, Hs) for all three sensors. The annual data has been divided into quarterly periods to correspond to the periods of analysis for the wind and wave data from Vancouver Airport and Halibut Bank that has been presented in **Sections 2.1.1** and **2.1.2** above. **Figure 38** shows the wave data between January and March, **Figure 39** shows the data between April and June, **Figure 40** shows the data between July and September, and **Figure 41** shows the data for the remainder of the year.

Measurements of current velocities in the vicinity of DP3 were made using an ADCP on June 23, 2009. **Figure 6** shows the location where velocity transects were measured, as well as the location where point velocities have been extracted from the numerical model for comparison to the ADCP measurements (Points #1, 2, 3, 4, and 5). **Figure 42** shows the relationship between tide height and velocity. **Figure 43a** and **Figure 43b** provide a comparison of the modelled flow velocities from the original model runs with the results of the ADCP measurements for two conditions: a) maximum velocity during a falling tide, and b) maximum velocity during a rising tide. The graphical plan model output in **Figure 43a/b** is from the original model runs and is provided for visual comparison only, but does illustrate the effects of horizontal smoothing of the data. The table included on the figure provides a comparison between the model runs and the ADCP measurements for the five points shown in **Figure 6**.

2.3 SURFACE WATER QUALITY

2.3.1 Quality Assurance / Quality Control

For metals in surface water, the data quality objective (DQO) for precision was to obtain a relative percent difference (RPD) of less than 20% or a difference factor (DF) of less than two. The DQO for completeness was 100%. For the organic parameters the DQO for precision was RPD of less than 50%. As RPDs/DFs for most parameters met the DQOs, it was concluded that the data were, on the whole, reliable and met project requirements for laboratory and field duplicate QA/QC evaluation. Detailed QA/QC evaluations are presented in the quarterly reports. A summary of issues encountered is presented in **Table 17** and discussed below.

There were no QA/QC issues in Q1-2009. In Q2-2009, the RPD for zinc was 28.2%, exceeding the DQO of 20%.

In Q3-2009, the RPDs for TSS, turbidity, copper, and zinc exceeded the DQO of 20%. The RPDs for turbidity and zinc were 55.6% and 52.3% respectively, while the TSS and copper RPDs were lower at 32.9% and 29.3%.

In Q4-2009, the RPDs for TSS, copper, nickel, and zinc exceeded the DQO of 20%. The RPDs for TSS, copper, nickel, and zinc were 44.9%, 31.5%, 26.5%, and 23.1% respectively.

The TSS RPD was consistently elevated, likely due to unevenly distributed sediment suspended by wave action. The sporadic elevated metal RPDs are believed to have been associated with suspended sediment in the samples rather than an indication of sampling or laboratory quality control concerns.

2.3.2 Chemistry

The parameters analyzed as indicators of potential toxicity to marine organisms were compared against the BC Water Quality Guidelines (WQG) for the Protection of Marine Aquatic Life (MAL) and the Canadian Council of Ministers of the Environment (CCME) MAL WQG. The data are presented in **Table 18**.

2.3.2.1 Metals

Total chromium, copper, and zinc concentrations were sporadically found to exceed the WQG in surface water. The chromium exceedances, noted at DP02, DP03, DP04, and DP07 in Q3-2009, were only marginally above the WQG of 56 µg/L. The two copper and zinc exceedances and noted at DP07 in Q2-2009 and Q3-2009 were less than two times the respective WQGs for copper and zinc of 3 µg/L and 10 µg/L, and the zinc exceedance noted at DP04 in Q1-2009. However, a zinc concentration of 147 µg/L was measured at DP06 in Q4-2009. Dissolved iron concentrations are usually less that the WQG for total iron; however, dissolved iron exceeded this WQG at station DP01.

Total boron concentrations measured during 2009 ranged from 490 to 4,300 µg/L. This is compatible with boron concentrations in coastal marine water in Canada (typically ranges from 3,700 to 4,300 µg/L) (Moss and Nagpal, 2003). The only stations where boron concentrations did not consistently exceed the BC WQG were DP01 (the drainage ditch), DP06, and DP07A (but not DP07B). The latter two stations are adjacent to the Fraser River, where there is greater freshwater influence.

The BC WQG apply to total metal concentrations. Dissolved iron was added to the program after total iron concentrations exceeding the BC WQG were measured in Q1-2007. Given that total iron includes iron associated with suspended sediments, dissolved iron is considered more relevant to the assessment of water quality for the AMS. The dissolved iron concentrations were less than the BC WQG, except at DP01 in Q2-2009 and Q3-2009. The dissolved iron results suggest that suspended particulate matter was responsible for the elevated total iron concentration measured.

The reported detection limit (RDL) for vanadium was greater than the BC WQG MAL, but a lower RDL could not be achieved by the laboratory. For cadmium, cobalt, copper, iron, lead, manganese, nickel, uranium, and zinc, a chelation procedure was used to remove the sodium; however, this procedure cannot be used for vanadium.

2.3.2.2 Eutrophication-related Parameters

Nitrate concentrations met the CCME MAL of 16 mg/L, except at DP01 in Q4-2008, where a nitrate concentration of 26.6 mg/L was measured. There are no other regulatory criteria applicable to nutrients in seawater. Other parameters will be discussed in the context of potential eutrophication in **Section 3.2.**

2.3.2.3 Sonde

Data from the YSI Sonde, located near DP04 (**Figure 7**) was available the following time periods in 2009: January 22 to February 3, July 23 to July 28, August 26 to September 2, September 23 to September 30, and November 25 to December 2. The sonde program experienced technical difficulties in previous years for various reasons including intense weather storms, aquatic vegetation and other marine life interference. Due to the high occurrence of sonde interference and malfunction in 2007 and 2008, the sonde was deployed in its usual location for select periods of time only. There were five deployments throughout the year where the sonde gathered data for one to two weeks. During the final deployment in late September the dissolved oxygen probe experienced a critical malfunction and reliable dissolved oxygen data was not obtained.

The sonde data is included as **Appendix C.** Analysis of the data indicated the following trends:

- Dissolved oxygen (DO) and pH variation mirrors the tidal cycle with peaks at low tide and dips at high tide;
- DO decreased from 12-14 mg/L in May & June to below 8% in August; and
- pH remained slightly below 8 during the first sonde deployment in late January to early February, then rose slightly above 8 throughout most of the second deployment in late July, then returned to slightly below 8 for the last two monitoring periods in late August and late September.

Turbidity data were not collected by Hemmera in 2008. Data from NHC's turbidity sondes, installed nearby (**Figure 3**), were presented in **Section 2.2.2**.

2.4 SEDIMENT QUALITY

2.4.1 Quality Assurance / Quality Control

For sediment, the DQOs were a RPD of less than 20% or a DF of less than two. The sediment data set was considered complete and accurate based on the results of the field and laboratory QA/QC. Detailed QA/QC evaluations are presented in the quarterly reports. A summary of issues encountered is presented in **Table 17** and discussed below.

The sulphide RPD exceeded the DQO in Q1-2009 (32.9%), Q2-2009 (29.7%), and Q3-2009 (54.6%). Above-average RPDs for sulphide were not unexpected, as the sediment for sulphide analysis was collected directly from the ponar without homogenization. No issues were encountered in Q4-2009.

2.4.2 Sediment Chemistry

The sediment toxicity parameters (metals) were compared against the BC Contaminated Sites Regulation (CSR), Schedule 9 Generic Numerical Sediment Criteria for sensitive marine and estuarine sediments ($SedQC_{ss}$) (**Table 19**). No exceedances of the $SedQC_{ss}$ were measured during the four quarterly monitoring events.

There are no regulatory criteria applicable to nutrients in sediment. Nutrient concentrations will be discussed in the context of potential eutrophication in **Section 3.2**.

2.4.3 Grain Size

Grain size samples were collected during the Q1-2009 monitoring event (**Table 19**). The sediment consisted of sand with a trace to some silt and clay, except at DP05 where the sediment was finer grained, consisting of sand and silt with some clay. This is consistent with the grain size results from NHC (**Section 2.2.4**) and with results from Q1-2007 and Q1-2008.

2.5 EELGRASS

2.5.1 Distribution and Mapping

The air photographs were captured during low tide on July 24, 2009 and available as digital orthophotographs on September 14, 2009. The orthophotos were interpreted between September 14 and 16, 2009. Field surveys dedicated to verifying the interpretation were conducted September 17 through 20, 2009. Additional data was collected for this section while monitoring Eelgrass Vigour and Health at the Roberts Bank Stations between July 19 and 22, 2009.

The clarity of the orthophotographs was excellent, however the tide height on July 24, 2009 was higher than during the previous missions in 2007 and 2008 when aerial photographs were recorded for the AMS.

The 2009 and 2003 distribution of eelgrass within the study area is shown in **Figure 44**. The eelgrass distribution mapped in 2007 and 2008 is provided in **Appendix D**.

Sediment deposition and drainage channel formation adjacent to the perimeter dyke in the inter-causeway area in 2007 altered the eelgrass distribution in that area. The remnant patches of *Z. marina* that survived expanded, especially within the new channels during the spring and summer of 2008. The area (m^2) colonized by eelgrass in 2008 in the vicinity of the area that was altered by sediment deposition from the new drainage channel formation was estimated using GIS and found to be comparable with the area occupied by eelgrass at this location in 2003. The 2009 survey found that surviving eelgrass has continued to multiply. The area colonized by *Z. marina* has increased, and areas that were unvegetated in 2003 and 2008 supported a patchy distribution of *Z. japonica* in 2009. A patchy distribution of *Z. japonica* at this location was noted in 2007.

Z. japonica distribution has declined adjacent to the Deltaport Causeway from west to east. The western section remains continuous, the centre section has become patchy, and the eastern section was devoid of vegetation. These areas all supported continuous *Z. japonica* in 2003, 2007, and 2008.

A new area of continuous *Z. marina* was noted in a drainage channel near the northeast corner of the inter-causeway.

The transition zone between continuous *Z.marina* and continuous *Z. japonica* habitat where the two species co-existed to provide continuous coverage has changed since 2003. The transition zone north of the sand lobe had encroached into monocultures of *Z. marina* and *Z. japonica* by 2007. Several areas in the adjacent *Z. marina* habitat became patchy. The enlarged transition zone became patchy by 2008, and the patchy *Z. marina* areas increased in size. Most of the patchy *Z. marina* areas had recovered by 2009 and supported a continuous distribution of the species. The majority of the patchy transition zone developed into patchy *Z. japonica* habitat by 2009.

The transition zone south of the sand lobe has changed less since 2003. A sand bar developed along a drainage channel near the ferry causeway that increased in size between 2003 and 2007. Most of the sand bar was colonized by a patchy distribution of *Z. marina* and *Z. japonica* by 2008. The area continued to support a patchy distribution of both species in 2009, except for a small area where two drainage channels have connected. The current within the channel during tidal exchanges has eliminated the eelgrass in its path.

The area of continuous *Z. marina* habitat west of the ferry terminal appears to have increased since 2007 and 2008. This area is relatively deep and was not ground truthed in 2007 or 2008; the absence of eelgrass was based solely on remote sensing. The 2009 SIMS survey documented eelgrass throughout most of this area.

The lower depth limit of eelgrass in 2009 shown on **Figure 45** was not visible on the orthophotograph, it was mapped using the SIMS data. The 2003 map was based solely on orthophotgraph interpretation.

2.5.2 SIMS Survey

The georeferenced imagery from the SIMS survey was assessed to determine presence, absence, and relative shoot density along the lower limit of the eelgrass bed in the inter-causeway (**Appendix D**). The data was used to construct a shape file tracking the lower limit of eelgrass presence. The shape files from; this survey, a similar SIMS survey conducted in 2003, and from orthophoto interpretation of 2003 imagery were combined on the 2009 orthophoto (**Figure 44**).

2.5.3 Monitoring Eelgrass Vigour and Health at the Established Stations

The field survey was conducted from July 19 through July 23, 2009. The station formerly referred to as Site 1 was renamed Site 1A. The new station that was added in 2009 near Site 1A was named Site 1B.

The epiphyte load at all stations was ranked as typical. *Beggiatoa sp.* was not present at any of the sites, nor was it observed when travelling to or from the sites.

The *Z. marina* distribution was classified as continuous at all Sites except Site 1A where it was classified as patchy. *Z. japonica* was absent from all sites except Site 1A where the density was sparse.

The parameters that were quantified at each of the stations included total shoot density, reproductive shoot density, shoot length, and shoot width. Means were calculated from 20 samples at each station, and were reduced to one decimal place (**Table 2.5-1**). Leaf Area Index values were calculated using two decimal places for each parameter in the equation (**Table 2.5-1**). A summary of the monitoring data from 2003, 2007, 2008, and 2009 is provided in **Appendix D**.

Leaf Area Indices (LAI) integrate total density, shoot length, and shoot width to estimate relative productivity. Histograms of the LAI data are presented in **Figures 2.5-1** through **2.5-4**. Histograms for each of the individual parameters are provided in **Appendix D.**

Table 2.5-1 Mean Eelgrass Shoot Density (Total and Reproductive), Length, Width, and LAI at each Reference Station in 2009

Site (#)	Total Density (#/0.25m^2)	Length (cm)	Width (mm)	LAI	Reproductive Shoot Density (#/0.25m^2)
Inter-causeway near Deltaport Causeway					
1A	8.1	50.0	5.5	0.09	0.2
1B	25.4	175.4	7.9	1.42	4.7
2	25.8	170.1	7.9	1.39	2.4
Inter-causeway area near Ferry Causeway					
5	25.0	178.0	7.4	1.32	2.0
6	20.2	143.2	7.4	0.86	1.2
West of Deltaport Causeway					
3	15.0	109.5	8.3	0.55	2.2
4	16.9	144.2	8.8	0.83	1.2
Boundary Bay					
WR1	79.4	44.0	4.4	0.61	0
WR2	28.5	85.0	6.4	0.62	0.5
WR3	26.0	198.4	7.6	1.57	0.6

T-tests using the Bonferroni correction adjustment were used to test for significant differences between years for each parameter, except in cases where there was no variation within a data set. A standard paired two-sample, 2-tailed t-test was used in cases where the Bonferroni correction adjustment could not be applied. The results of the analysis comparing the data from 2009 with that from 2008 and 2003 are summarized in **Table 2.5-2**. The p-values for all tests and summary of significant differences are provided in **Appendix D**.

Table 2.5-2 T-test Results Comparing the Data from 2009 with that from 2008 and 2003

Site (#)	Total Density (#/0.25m^2)		Length (cm)		Width (mm)		LAI		Reproductive Shoot Density (#/0.25m^2)	
	2008	2003	2008	2003	2008	2003	2008	2003	2008	2003
Inter-causeway area near Deltaport Causeway										
1A	√	√	√	√	-	√	√	√	-	-
1B	-	-	√	√	√	√	√	-	√	√
2	√	-	-	√	-	√	-	-	-	-
Inter-causeway area near BC Ferries Causeway										
5	√	√	-	-	√	√	-	√	√	√
6	-	-	-	-	-	-	-	-	-	-
West of Deltaport Causeway										
3	-	-	-	√	-	√	-	√	-	-
4	-	-	-	-	-	-	√	-	-	-
Boundary Bay										
WR1	-	√	-	-	-	-	-	√	-	√
WR2	-	√	√	√	-	√	√	-	√	-
WR3	-	-	-	-	-	-	-	-	-	-

Note: Comparisons that were significant are indicated by check marks.

Figure 2.5-1 LAI data from Roberts Bank, inter-causeway near Deltaport Causeway, Sites 1A, 1B, and 2

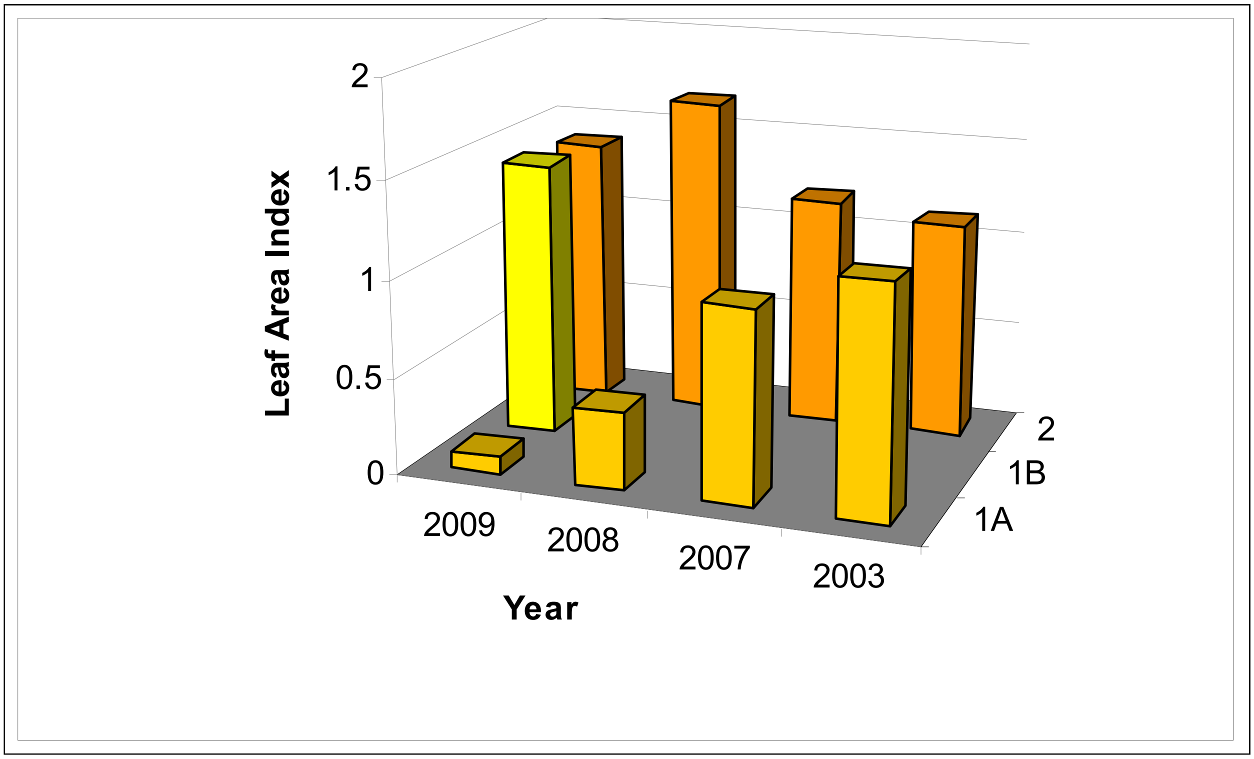


Figure 2.5-2 LAI data from Roberts Bank, west of Deltaport Causeway, Sites 3 and 4

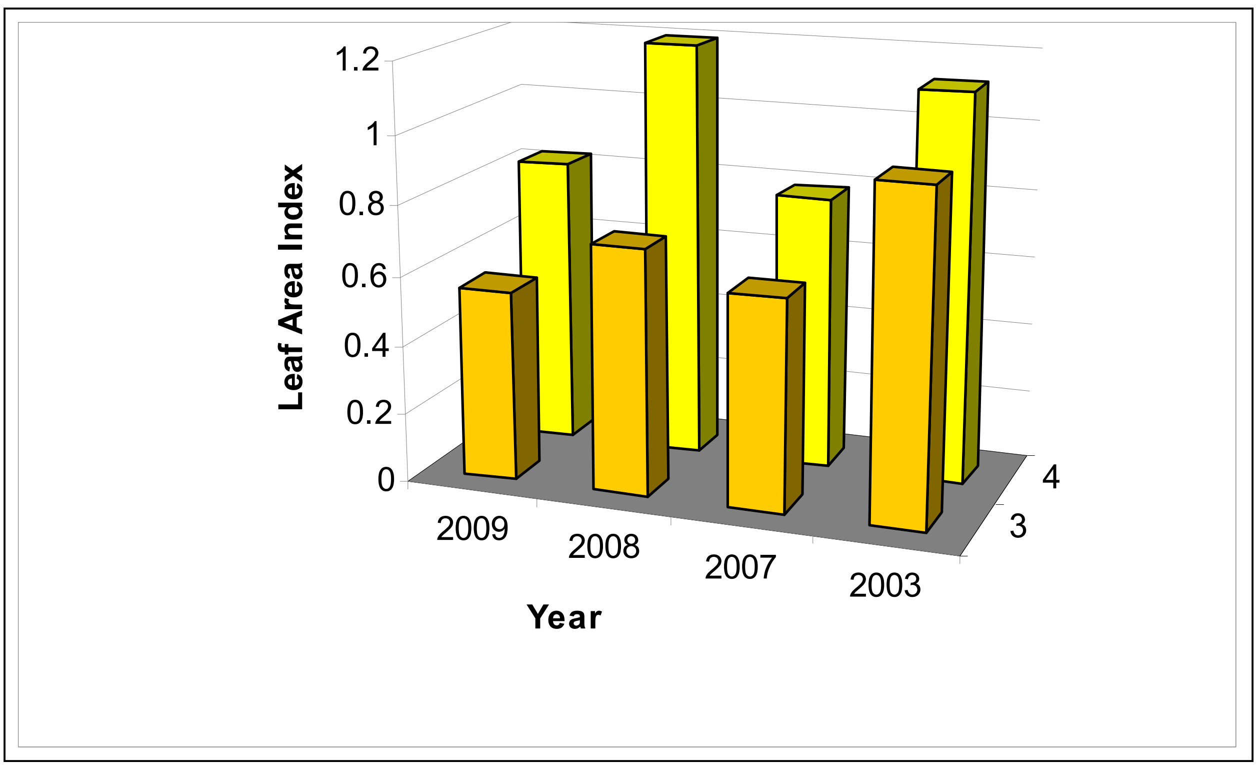


Figure 2.5-3 LAI data from Roberts Bank, inter-causeway area near the Ferry Causeway, Sites 5 and 6

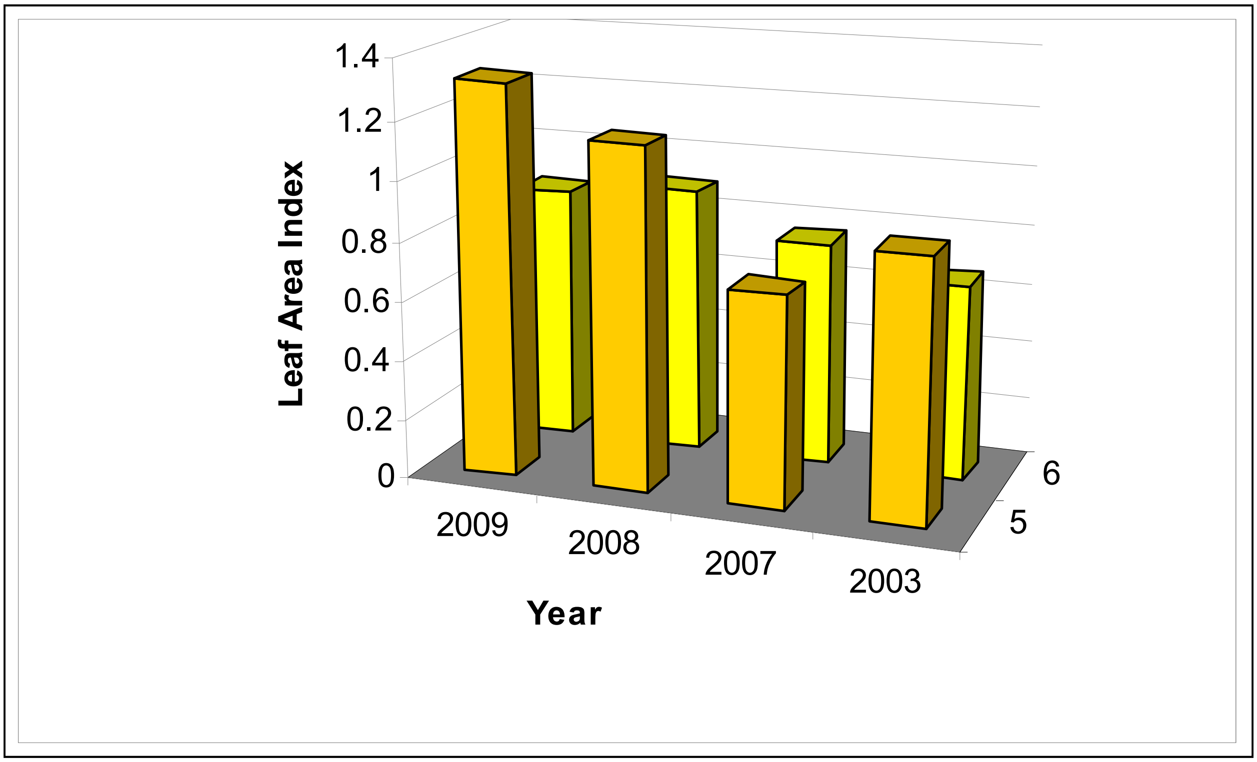
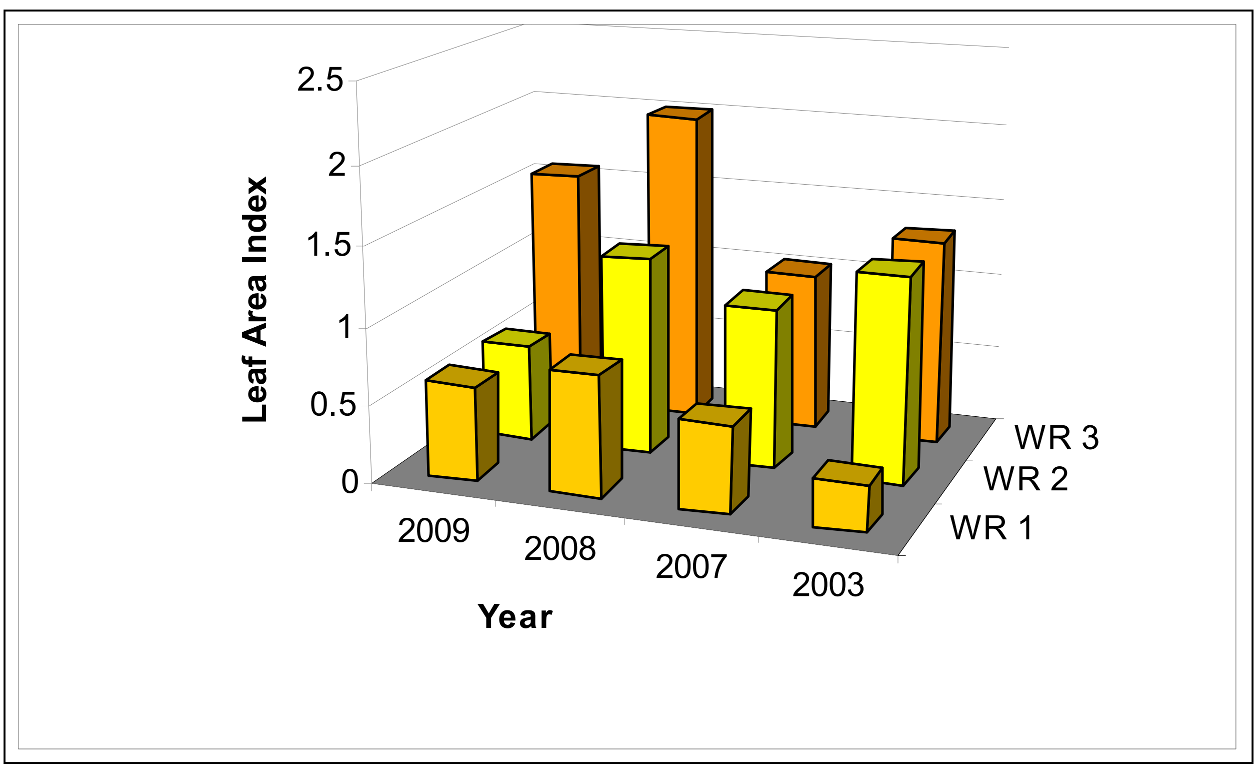


Figure 2.5-4 LAI data from Boundary Bay, Sites WR1, WR2, and WR3



2.6 BENTHIC COMMUNITY

In Q1-2009, sediment recovery volumes were estimated to average 5.0 L at each station. The exception to this was station DP05, where sample recovery was approximately 9.0L. Sediment at DP05 has a higher silt content which facilitates ponar penetration.

As indicated in **Section 1.3.5**, no sample was collected at DP01, a tidally influenced freshwater drainage ditch distinct from the other sampling stations. It should also be noted that a 0.5 mm sieve was used to screen the sediment samples. Benthic invertebrate data evaluated for the baseline sampling program are presented in **Appendix E**. The data has been organized to facilitate manipulation for statistical analysis. Adult, intermediate, and juvenile benthic invertebrates were observed at all stations.

In 2009, the greatest abundance of benthic invertebrates at station DP04 and the lowest abundance of benthic invertebrates was observed at reference stations DP07 (**Figure 46**).

The largest proportion of species belonged to the class *Bivalvia* followed by *Polychaeta* (**Figure 46**). *Tanaidacea* were abundant at stations DP04 and DP08. Reference station DP06 showed least diversity, with approximately 90% of species accounted for by the *Polychaeta* and *Bivalvia* classes. Stations DP02 and DP03 also showed relatively little diversity with over 80% of species accounted for by the *Polychaeta* class.

2.7 BIRDS

The following data are intended to provide an estimate of the number, composition, and distribution of species using the inter-causeway area during low and high tides on a monthly basis between January and December, 2009. Complete results of the monthly surveys are presented in **Table 20**.

The birds observed at Roberts Bank have been organized into six categories: great blue herons, brant, shorebirds, coastal waterbirds, raptors, and other birds to facilitate a clear presentation of the report's findings and conclusions. Point count survey locations are provided in **Figure 11**.

2.7.1 Great Blue Heron

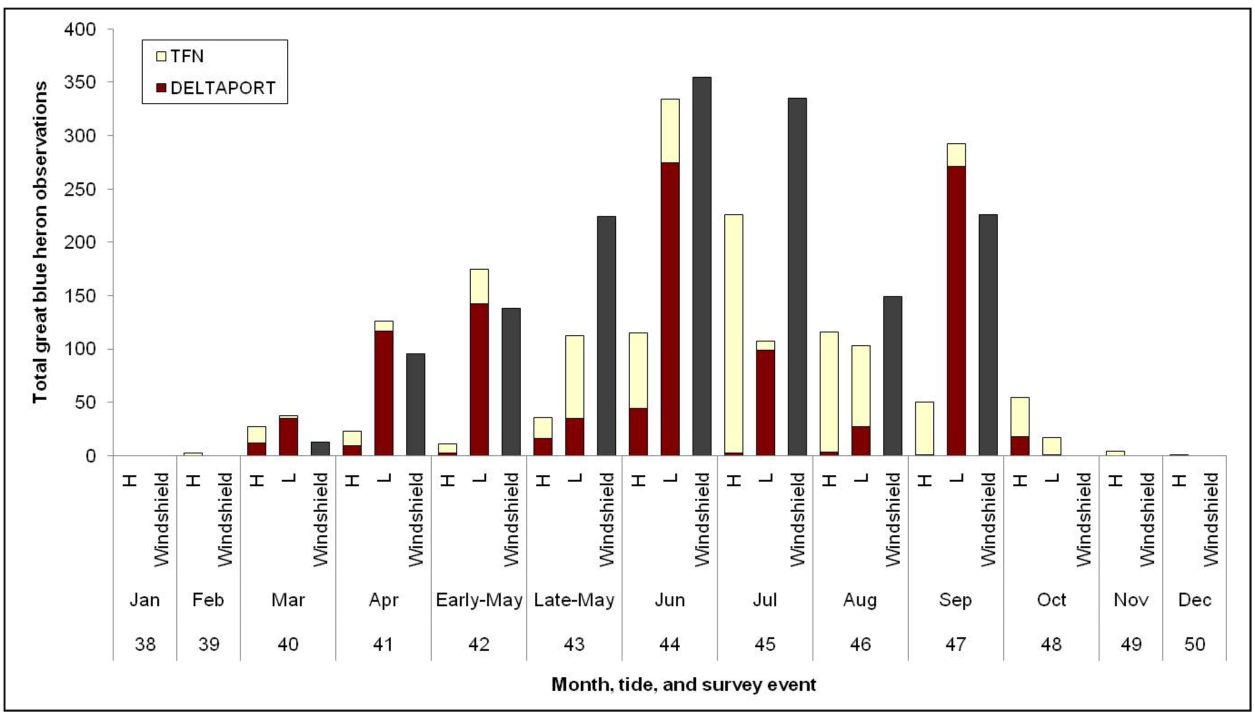
Great blue herons were recorded in the study area in 11 of the 12 months surveyed (January – December 2009) (**Figure 2.7-1**). Heron distribution and abundance changed seasonally within the inter-causeway area with no herons observed during the January survey.

Between 26 January and 13 December, 1968 herons were recorded either flying over or using the inter-causeway area for foraging and/or resting. Heron distribution between the Deltaport and TFN Transects was roughly equal, with roughly 56% of birds detected along the Deltaport and 44% of birds detected along the TFN transects, respectively (**Figure 2.7-1**). Similar to previous years (Hemmera 2008d and Hemmera 2009) herons were detected in greatest numbers from late spring through summer/early-fall

(April – September). During this period, herons typically used the long hours of daytime low tides to forage on exposed eelgrass beds, primarily along the Deltaport Transect during low tide. Use of the study area by herons decreased dramatically during the early-spring, late-fall and winter, with monthly counts averaging only 2 (± 2 standard error of the mean (SEM)) herons from October through March, compared to 224 (± 42 SEM) herons detected from April through August, 2009 (**Figure 2.7-1**).

In general, data from monthly point count and windshield surveys were similar, displaying the same general trend of heron use of the inter-causeway annually (**Figure 2.7-1**). When abundance estimates from low tide point count surveys were compared against windshield surveys, results differed by 0 – 228 herons per survey. In four instances (i.e., late-May through August) windshield surveys documented more herons (range of difference = 21 – 228 birds), while point counts yielded larger numbers (range of difference = 17 – 66 birds) during five surveys (March through early-May and September through October). Annually, windshield surveys averaged 18 (± 21 SEM) more herons per survey compared to point counts surveys.

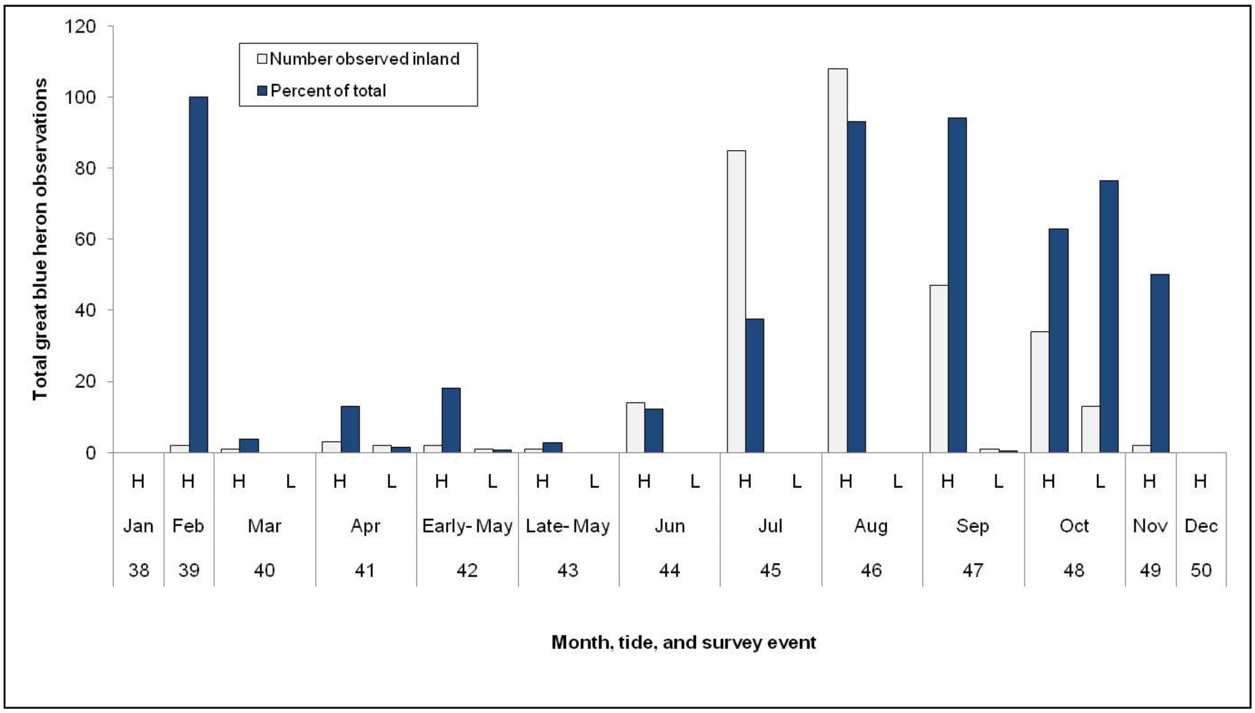
Figure 2.7-1 Abundance of Great Blue Herons Observed during High (H) and Low (L) Tides, and during Windshield Surveys along the Deltaport and TFN Transects, Deltaport Inter-causeway Area, 2009



Tide levels influenced heron use of the study area (**Figure 2.7-1 and 2.7-2**). During low tides, herons were found throughout much of the inter-causeway area, following the tide line as eelgrass beds were exposed. The importance of low tides and the subsequent availability/exposure of eelgrass beds are apparent as 66% (1,303/1,968) of all heron observations were recorded during low tides. Key low tide areas included PCs 14, 15, and 113, accounting for 72% (942/1,303) of heron observations. The duration and extent of seasonal low daytime tides lessened into late summer and fall, at which point daily low tides were short lived and exposed less of the eelgrass beds. This corresponded with a decrease in heron abundance within the study area, and herons shifting their distribution patterns to use the saltmarsh (100 m inland) along the TFN Transect during the winter (**Figure 2.7-2**). By August, the majority of herons using the study area were recorded inland as the tide no longer exposed sufficient patches of eelgrass. During high tides the most frequently used locations were PC 109 and PC 113, accounting for 71% (471/665) of high tide observations.

Figure 47 provides an overview of great blue heron distribution and relative abundance within the study area.

Figure 2.7-2 Percent of Great Blue Heron Observations and Number of Heron Recorded Inland along the TFN Transect, Deltaport Inter-causeway Area, 2009



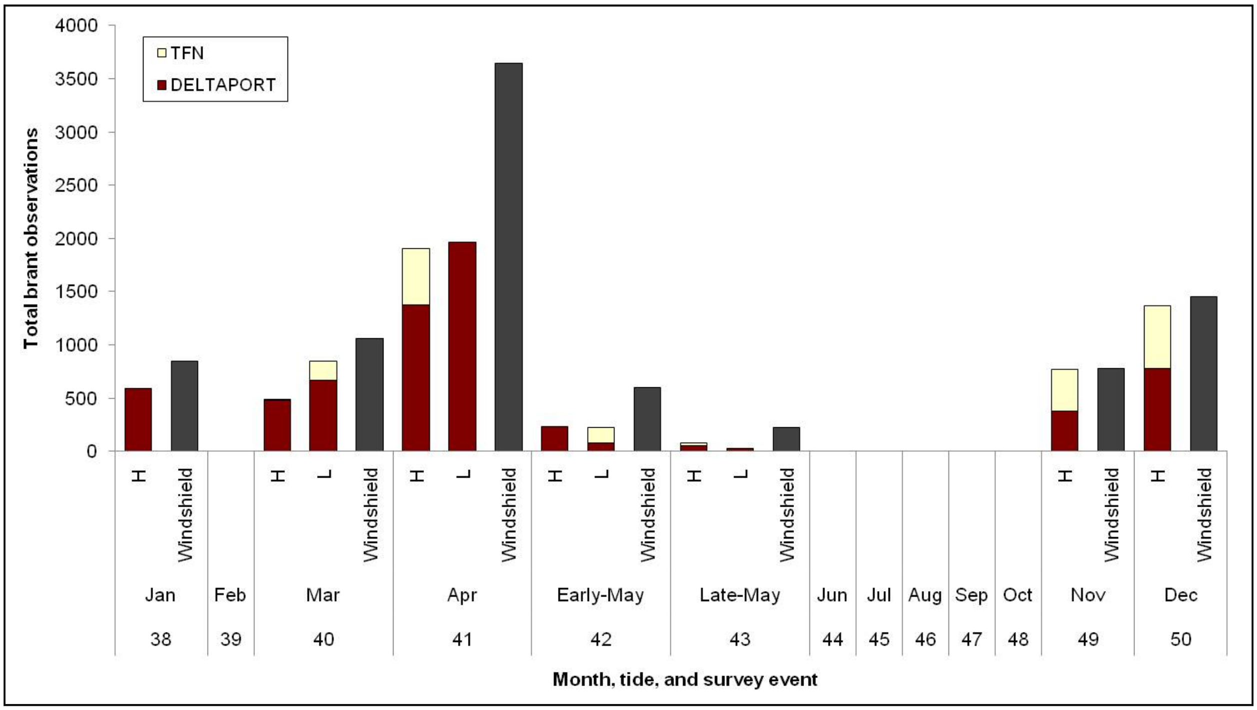
2.7.2 Brant Geese

Brant (*Branta bernicla*) numbers increased in the spring from approximately 850 birds documented in January to over 3,500 in April (**Figure 2.7-3**). During this period only black-bellied brant were observed in the study area. Numbers decreased through May, with no brant documented within the project area between June and October. Brant were again documented using the inter-causeway in November and December, with approximately 1,500 birds observed during the December survey. On average, abundance estimates derived from windshield surveys were 18% higher than point count estimates for the same period. Differences in estimates ranged from 0% to 62-65%.

Point count surveys documented flocks of up to several hundred brant offshore along the Deltaport Transect during April 2009, and along the TFN Transect in November and December 2009. In April, the majority of brant were observed >500 m off shore in PC 14 and PC 15, while in the winter months brant were typically observed along the TFN Transect in PC 109 and PC 113. Windshield surveys for brant yielded higher numbers of brant using the inter-causeway area, and were typically observed at distances greater than 500 m or 1 km from the Deltaport Transect in the centre of the inter-causeway area.

Figure 48 provides an overview of brant distribution and relative abundance within the study area.

Figure 2.7-3 Abundance of Brant Observed during High (H) and Low (L) Tides, and during Windshield Surveys along the Deltaport and TFN Transects, Deltaport Inter-causeway Area, 2009



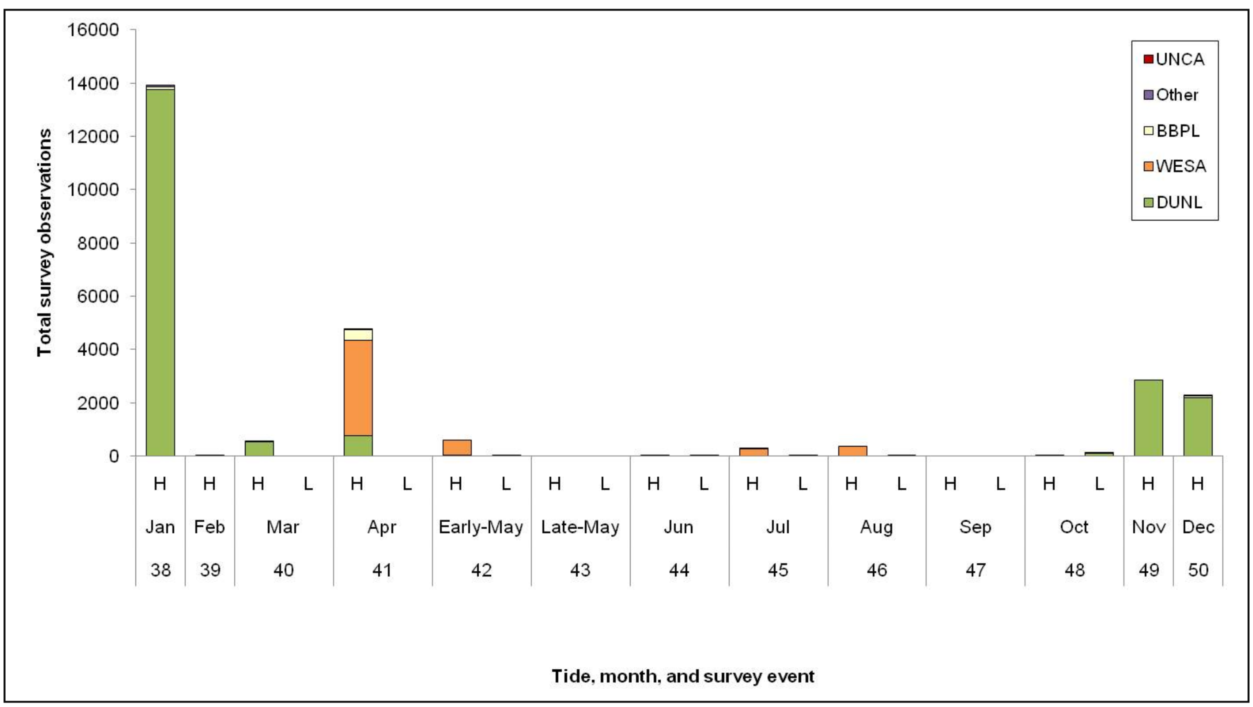
2.7.3 Shorebirds

In 2009, eight species of shorebirds totalling 25,846 individuals were observed within the project area, with two species making up 97% of observations (**Figure 2.7-4**). Dunlin (*Calidris alpina*) comprised 78% (n = 20,273) and western sandpiper (*Calidris mauri*) accounted for 19% (n = 4,802) of all shorebirds observed. Black-bellied plover (*Pluvialis squatarola*) comprised an additional 2%. All other species, including the unknown *Calidris* species (UNCA) category, comprised less than 1% of observations. Other species documented within the project area were: Baird's sandpiper (*Calidris bairdii*), black oystercatcher (*Haematopus bachmani*), black turnstone (*Arenaria melanocephala*), greater yellowlegs (*Tringa melanoleuca*), and killdeer (*Charadrius vociferous*).

Dunlin were detected on site during 8 of 12 months in 2009, and were absent from June through September. Dunlin were most abundant in January (n = 13,750). In 2009, 87% (17,621/20,273) of all dunlin were documented within stations 105 (n = 9,827), 109 (n = 5,750), and 19 (n = 2,044) during high tide.

Western sandpipers were documented using the study area in April, May, July, and August 2009. Sandpipers were documented in greatest numbers (n = 3,550) during the 16 April survey. Within the remainder of months sandpiper numbers ranged from approximately 260 – 600 birds. Due to logistical and weather delays, the survey scheduled for the last week of April was postponed until the first week of May. Typically, shorebird abundance in Roberts Bank peaks in the last week in April, and usually follows a pattern of one main peak followed by several smaller pulses which taper off in mid-May (Bird Studies Canada, 2009). According to surveys conducted by Bird Studies Canada in 2009, peak shorebird migration occurred on April 24, 2009 and most birds had moved northward by May 7, 2009, indicating that the spring migration stopover occurred in a shorter time window than in previous years. Peak estimates for the region were estimated at 160,000 birds, down from the 5-year high of approximately 250,000 individuals.

Figure 2.7-4 Cumulative Number and Composition of Shorebird Species Observed at Deltaport Inter-causeway Area, 2009



Note: Species grouped into Other = BASA, BLOY, BLTU, GRYE, and KILL; H = high tide; L= low tide

Shorebirds were observed in the inter-causeway area almost exclusively during high tides; 99% (25,612/25,846) of shorebird observations were recorded during this period. During high tides shorebirds were typically observed along the TFN Transect where there mudflat was exposed. During the peak months of April, November, and December 69% to 96% of shorebirds were documented along the TFN Transect. At low tides, shorebirds distribute themselves along exposed mudflat often following the tide line, and as such, shorebirds were observed more frequently along the Deltaport Transect during low tide events.

A list of all bird codes used in this report is included as **Appendix F**.

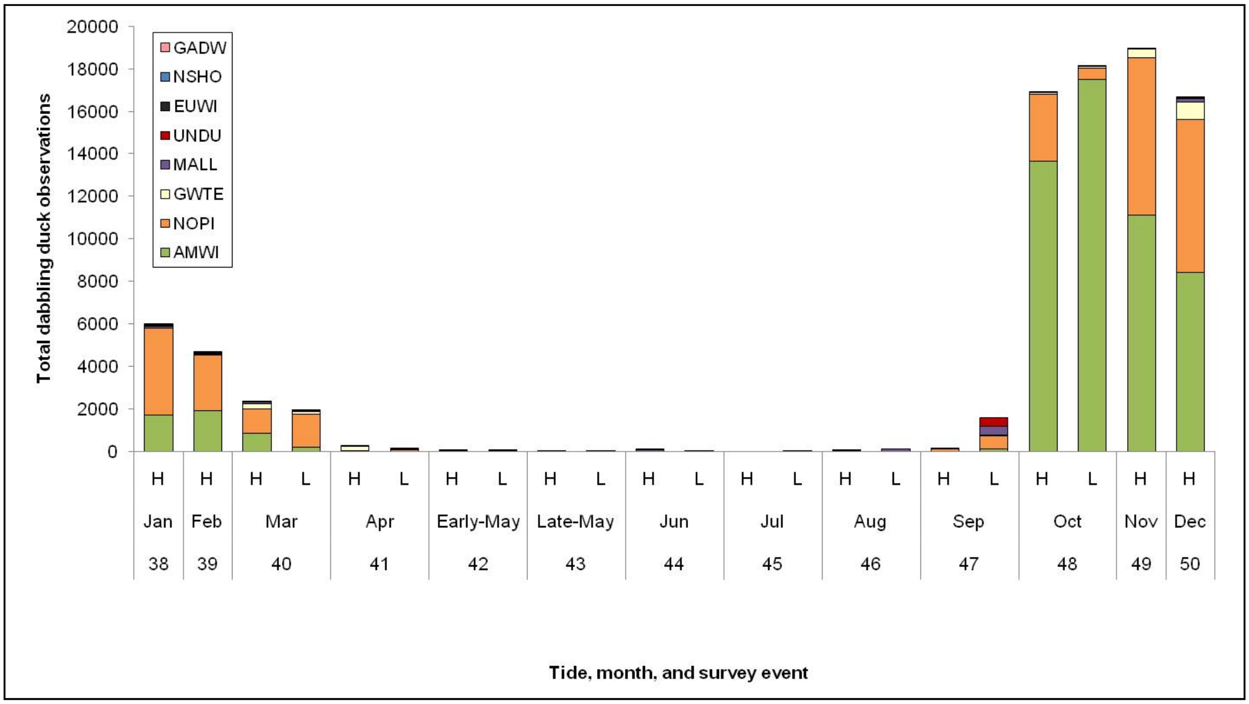
2.7.4 Coastal Waterbirds

The following section provides details of the distribution and relative abundance of dabbling ducks, diving ducks, gulls and terns, and other coastal waterbirds including cormorants, grebes, swans, and geese (other than brant; see **Section 2.7.1.2**).

2.7.4.1 Dabbling Ducks

Seven dabbling duck species totalling 88,051 observations were documented during 2009. The dabbling duck species observed included: American wigeon (*Anas americana*), Eurasian wigeon (*Anas penelope*), gadwall (*Anas strepera*), green-winged teal (*Anas carolinensis*), mallard (*Anas platyrhynchos*), northern pintail (*Anas acuta*), and northern shoveler (*Anas clypeata*) (**Figure 2.7-5)**. American wigeon (55,462) were observed most commonly, followed by northern pintail (28,629), green-winged teal (2,087), and mallard (1,107). The remaining three species totalled less than 250 observations each. During the early-May and September surveys an additional 453 dabbling ducks of undetermined species were documented. The birds were observed in large mixed flocks greater than 500 m from shore. The combination of distance and high glare prevented positive identification; however, based on the timing of the survey and the relative abundance of other species detected, the birds were believed to be most likely American wigeon and/or northern pintail.

Figure 2.7-5 Abundance and Composition of Dabbling Ducks Observed at Deltaport Inter-causeway Area, 2009

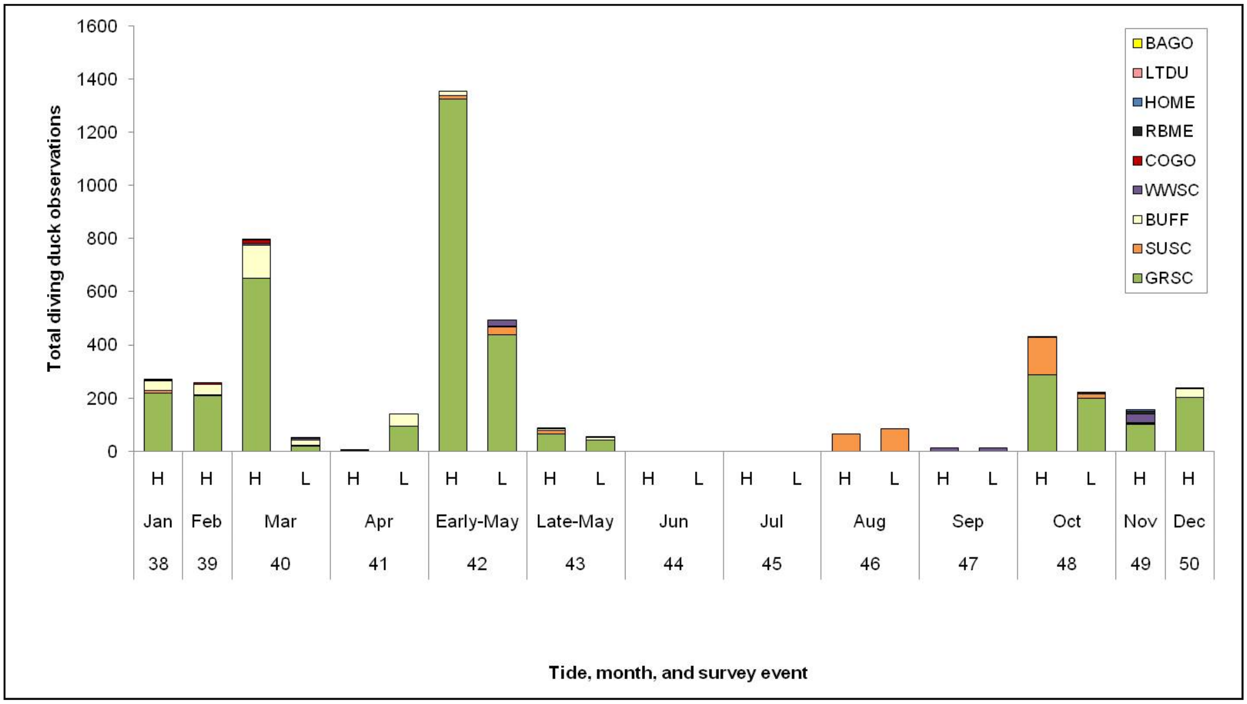


Dabbling ducks were consistently recorded in mixed flocks throughout the inter-causeway area, with greatest densities occurring between October and December**.** Eighty percent of dabblers using the inter-causeway area were documented from October to December. Dabblers were observed in higher densities along the TFN (73% of observations) Transect compared to the Deltaport Transect (23% of observations). The most abundant species were American wigeon (50,681) and northern pintail (18,288) accounting for 72% and 26% percent of all dabblers recorded, respectively. From October to December the abundance of dabbling ducks was consistently greatest within 250 m of shore. The highest densities along the Deltaport Transect were recorded at PC 19 (13% of observations). Along the TFN Transect greatest densities were consistently documented at PCs 105 (31%), 109 (30%), and 113 (12%).

2.7.4.2 Diving Ducks

Nine species of diving ducks, totalling 4,720 observations, were recorded during the study period (**Figure 2.7-6**). Of these, 82% were greater scaup (*Aythya marila*); surf scoter (*Melanitta perspicillata*), bufflehead (*Bucephala albeola*), and white-winged scoter (*Melanitta deglandi*) comprised an additional 8%, 7%, and 2%, respectively. All other species individually totalled less than 1% of observations. In general, diving ducks were considerably less abundant than dabbling ducks. The maximum count of diving ducks during a single tidal event was approximately 1,350 birds, compared to almost 33,000 dabblers. With the exception of surf and white-winged scoters, diving ducks were documented within the study area in eight of 12 months, from January through May and October through December. The only months in which no surf or white-winged scoters were detected were during June and July. Diving ducks were documented in greatest numbers during March and early-May, when greater scaup abundance was highest.

Figure 2.7-6 Abundance and Composition of Diving Ducks Observed at Deltaport Inter-causeway Area, 2009

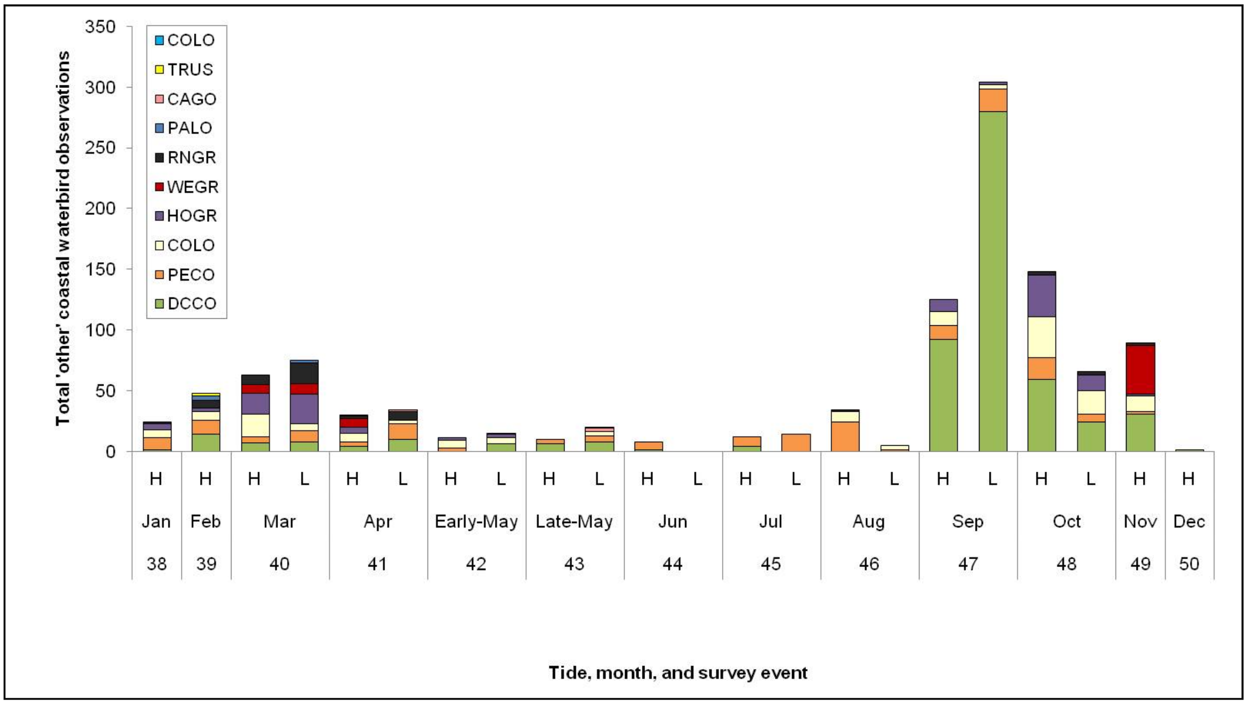


The majority (87%) of diving ducks were recorded offshore along the Deltaport Transect compared to the TFN Transect. Diving duck abundance decreased with proximity to the shoreline, with 59% of ducks observed > 500 m from shore, 32% within 250-500 m, and 9% within 250 m of the shoreline. Diving ducks were found most frequently and in greatest numbers within PCs 12-15 (71% of observations) along the Deltaport Transect and PC 109 (12% of observations) along the TFN Transect.

2.7.4.3 'Other' Coastal Waterbirds

Other relatively common coastal waterbirds were double-crested cormorant (*Phalacrocorax auritus*) and pelagic cormorant (*Phalacrocorax pelagicus*), common loon (*Gavia immer*), and horned grebe (*Podiceps auritus*) (**Figure 2.7-7**). These birds comprised approximately 89% (n=1,136) of all 'other' coastal waterbird observations: double-crested cormorant (49%), snow goose (15%), pelagic cormorant (14%), common loon (14%), and horned grebe (10%). Less common species included western grebe (*Aechmophorus occidentalis*), red-necked grebe (*Podiceps grisegena*), Pacific loon (*Gavia pacifica*), Canada goose (*Branta canadensis*), and trumpeter swan (*Cygnus buccinator*).

Figure 2.7-7 Abundance and Composition of 'Other' Coastal Waterbird Species Observed at Deltaport Inter-causeway Area, 2009

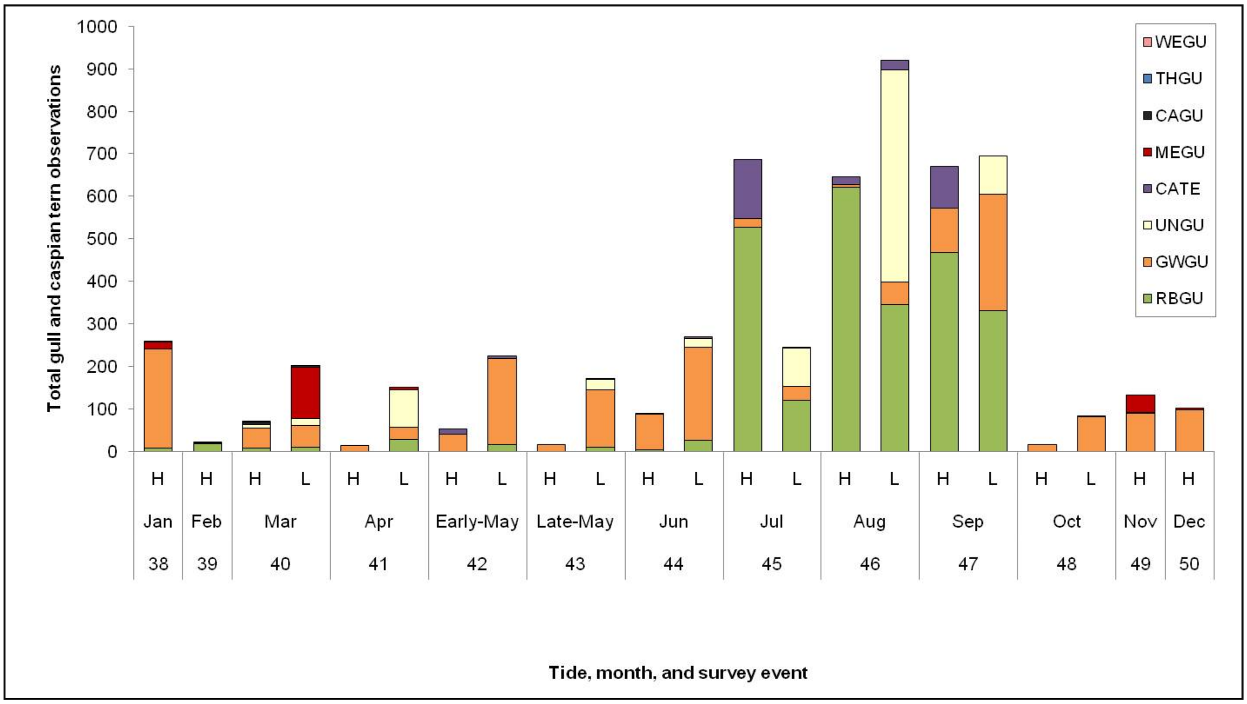


Similar to diving ducks, the majority of "other" coastal waterbird observations (84%) were recorded offshore along the Deltaport Transect with less frequent observations along the TFN Transect. Sixty-three percent (902/1,431) of observations occurred within PCs 12-14 along the Deltaport Transect. Stations used most frequently and in greatest numbers were PCs 12-14 (77% of observations) along the Deltaport Transect and PC 109 (11% of observations) along the TFN Transect.

2.7.4.4 Gulls and Caspian Tern

Six gull and one tern species were documented within the study area in 2009 (**Figure 2.7-8**). Eighty percent of gull observations were comprised of ring-billed (*Larus delawarensis*) (44%), glaucous-winged (*Larus glaucescens*) (32%), and mew gull (*Larus canus*) (3%), with California (*Larus californicus*), Thayer's (*Larus thayeri*) and western gull (*Larus occidentalis*) comprising less than 1% of observations. Fifteen percent of observations were recorded as "undetermined" gull species. Attempts were made to distinguish hybrid gulls (mixed species gulls assumed to contain part glaucous-winged gull), but accurate classification was often not possible in the field. Potential hybrid gulls were classified during the study as glaucous-winged and potential hybridization was noted. Caspian tern (*Hydroprogne caspia*) were observed (n=303) in 2009; comprising 5% of all gull/tern observations, with most observations occurring between July and September. Gulls were distributed throughout the inter-causeway area, and were regularly documented in approximately equal numbers along both the Deltaport and TFN Transects.

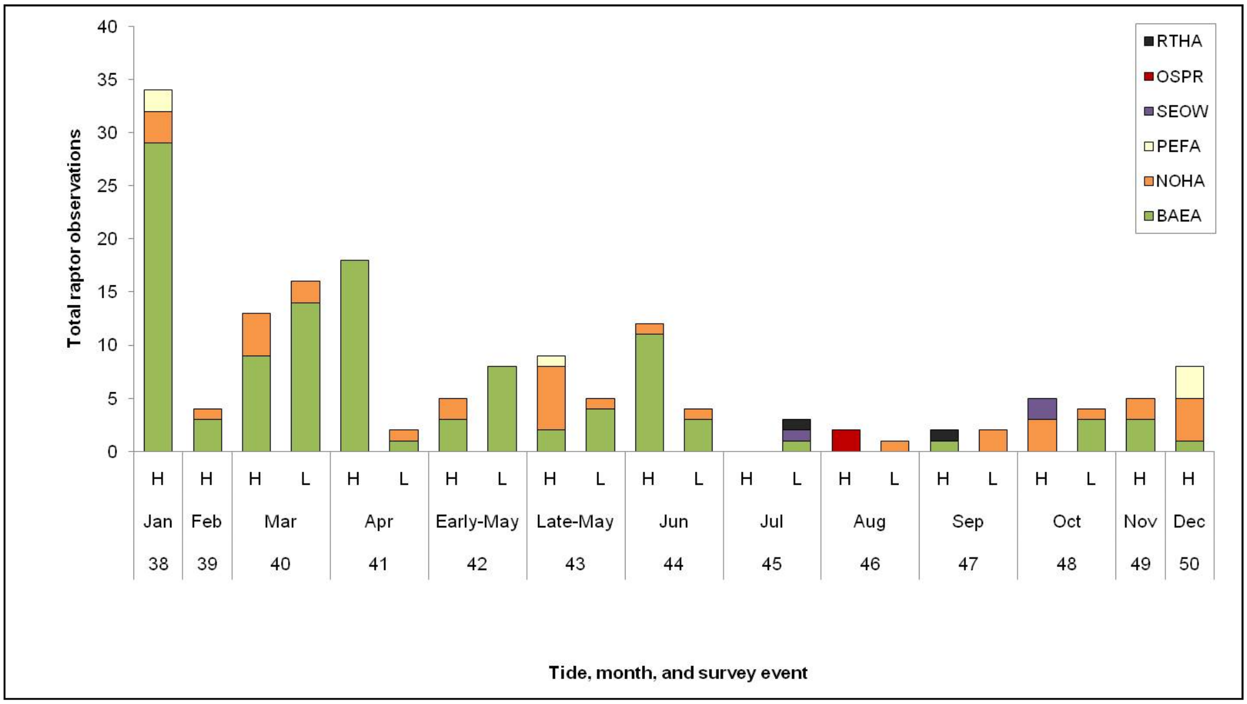
Figure 2.7-8 Abundance and Composition of Gull and Tern Species Observed at Deltaport Inter-causeway Area, 2008



2.7.4.5 Raptors

Six species of raptors were identified in and around the inter-causeway area (**Figure 2.7-9**). Bald eagles (*Haliaeetus leucocephalus*) were the most frequently documented, comprising 70% of 162 total observations, followed by northern harrier (*Circus cyaneus*) (22%). Other less frequently observed raptors were peregrine falcon (*Falco peregrinus*) (4%), short-eared owl (*Asio flammeus*) (2%), red-tailed hawk (*Buteo jamaicensis*) (1%), and osprey (*Pandion haliaetus*) (1%).

Figure 2.7-9 Abundance and Composition of Raptors Observed at Deltaport Inter-causeway Area, 2009



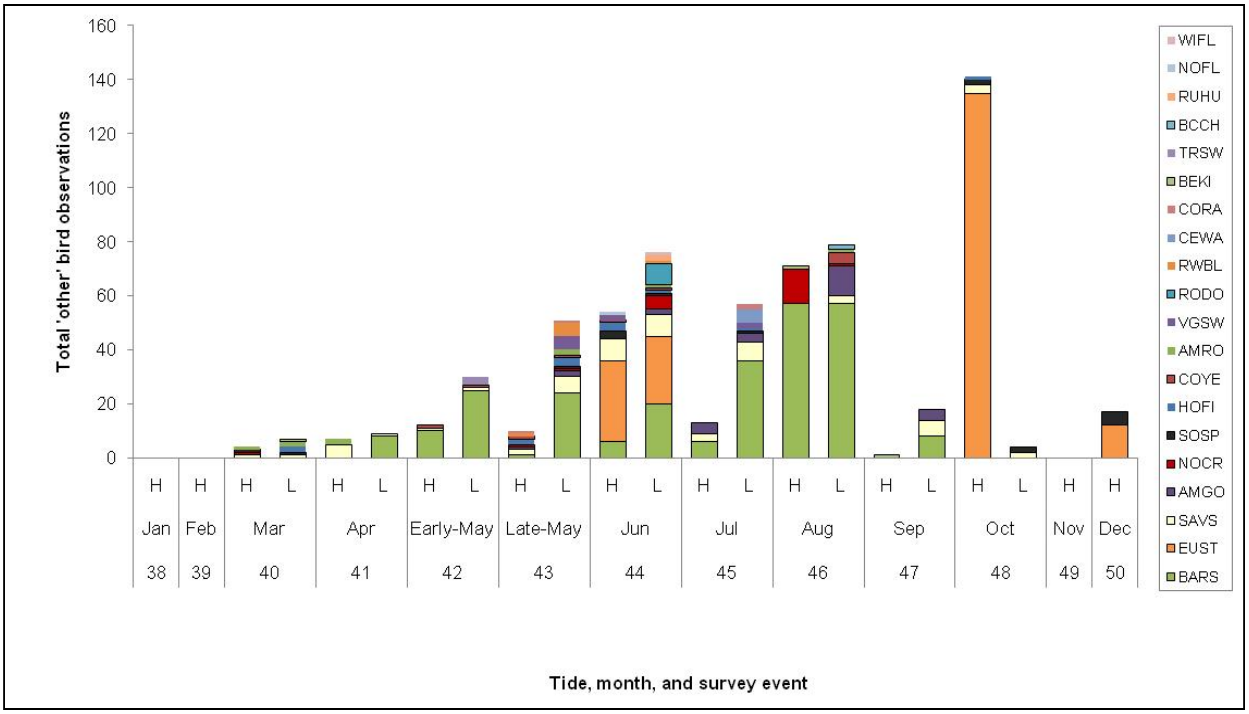
Eagles were observed as flyovers throughout much of the survey area and were the major cause of disturbance to resting and feeding ducks. Bald eagles were most frequently observed in the study area during January and March. Eagles were typically observed using the Deltaport Transect, as 58% (66/114) of observations were recorded along the Deltaport Transect, compared to 42% (48/114) along the TFN Transect. Northern harrier (89% of observations) and short-eared owl (100% of observations) were most commonly documented foraging within the TFN marsh. Peregrine falcons were observed on several occasions along the TFN Transect and once along the Deltaport Transect. Red-tailed hawk observations (n = 2) were split between the Deltaport and TFN Transects, while osprey (n = 2) were only observed along the Deltaport Transect.

Two osprey were observed along the Deltaport Transect in August, 2009. The osprey were observed flying over survey plots or perched on man-made structures along the port facility. No juvenile ospreys were observed during the survey period. No osprey nest building or breeding activity was observed in 2009, although at least one individual was observed resting on the nest platform.

2.7.4.6 Other Birds

Twenty additional bird species, totalling 661 individuals, were documented within the study area in 2009. Of these, barn swallow (*Hirundo rustica*) (39%) and European starling (*Sturnus vulgaris*) (31%) were most commonly observed, followed by savannah sparrow (*Passerculus sandwichensis*) (9%), American goldfinch (*Carduelis tristis*) (4%), northwestern crow (*Corvus caurinus*) (3%), song sparrow (*Melospiza melodia*) (3%), house finch (*Carpodacus mexicanus*) (2%), and common yellow-throat (*Geothlypis trichas*) (2%). All other species detected total less than 10 individuals (**Figure 2.7-10**).

Figure 2.7-10 Abundance and Composition of "Other" Species Observed at Deltaport Inter-causeway Area, 2009



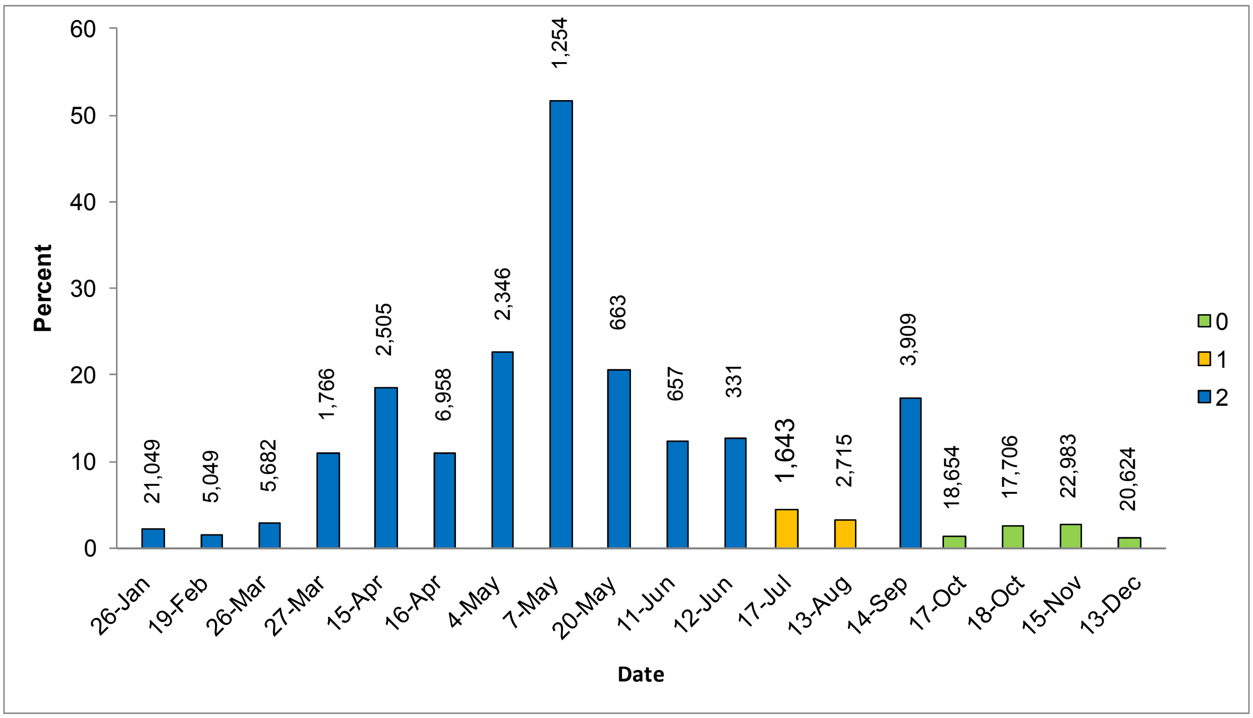
Note: Species grouped into the 'Other' category are: AMRO, BCCH, BEKI, CEWA, CORA, NOFL, RODO, RUHU, RWBL, TRSW, VGSW, and WIFL.

These birds were typically observed along the perimeter of the study area or heard singing or calling. In general, all birds, with the exception of European starling, were documented along the TFN Transect, often perched in the surrounding trees and shrubs. Seventy-one percent of birds were documented along the TFN Transect. Species most prevalent along the TFN Transect were barn swallow (47% of transect detections), European starling (14%), and savannah sparrow (12%). Species common along the Deltaport Transect were European starling (70% of transect detections) and barn swallow (20%).

2.7.4.7 Construction Impacts on Birds

If construction activities are impacting bird use of the inter-causeway area it should be reflected to the greatest degree in abundance and distribution data collected from stations closest to the construction area (i.e., PCs 12 and 13). **Figure 2.8-1** plots disturbance severity against the total bird observations recorded daily in PCs 12 and 13 as a percentage of total bird observations recorded throughout the entire study area on the survey date. This method was selected because if disturbance from construction was affecting bird distribution, overall bird abundance would be negatively correlated with construction impacts levels, with a smaller percentage of birds using PC 12 and 13 when impacts were greatest. No obvious trends in overall bird distribution with construction noise or activities were apparent; use of PC12 and 13 fluctuated independently of the disturbance severity rating (**Figure 2.8-1**). For example, the highest percentage of bird use of PC 12 and 13 was documented on the day (i.e., May 7) with the highest construction severity rating observed in 2009 (i.e., 2), while the days having the lowest rating (October through December surveys) had the smallest portion of use.

Figure 2.8-1 Percent of Birds Documented in PC12 and 13 by Date and Construction Severity Rating, Deltaport, 2009



Note: Column colour indicates disturbance severity as rated using the criteria in **Table 1.3-1.** Numbers above bars are the total number of birds detected along the Deltaport and TFN Transects.

Results from the general linear modeling analysis showed no relationship between the level of construction noise and/or construction activity and great blue heron or brant use of sites closest to DP3 construction (i.e., PC 12 and PC 13) (**Table 2.8-1**). Potential factors influencing great blue heron, brant, and coastal seabirds and shorebirds use of and distribution within the inter-causeway area are discussed in **Section 3.6.**

Table 2.8-1 Results of General Linear Modeling Testing for a Differences between the Use of PC 12 and PC 13 by Great Blue Heron and Brant and the Severity of Impacts from Construction Activities

Factor	SS[1]	df[2]	MS[3]	*F*[4]	*P*[5]
Great blue heron (r^2 = 0.16)					
Disturbance	122.9	2	61.5	1.70	0.21
Error	651.9	18	36.2		
Brant (r^2 = 0.05)					
Disturbance	542.8	1	542.8	0.62	0.45
Residual	9681.0	11	880.1		

Notes: [1] SS = Sum of squares [2] df = Degrees of freedom [3] MS = Mean square
[4] F = F-statistic [5] P = P-value

2.8 Bird Abundance and Distribution in the Deltaport Inter-causeway Area, 2003 – 2009

Data on bird abundance and distribution from 2009 was compared to data from previous study years (2003-2004, 2007, and 2008). Data on bird abundance and distribution in the Deltaport inter-causeway area from October 2003 through August 2004 were obtained from Envirowest and VFPA to investigate possible differences in abundance and distribution within the study area since the initiation of the Deltaport Third Berth expansion project. Consistent and complete data from the 2003-2004 study period is limited to surveys of the Deltaport Transect. Consequently, direct comparisons between 2003-2004, 2007, 2008, and 2009 do not include the TFN Transect and are therefore limited in scope.

2.8.1 Great Blue Heron

For most months of the year, great blue heron abundance along the Deltaport Transect between 2003-2009 were comparable and followed the same trend, with most heron observations occurring from May through July (**Figure 2.9-1**). Heron abundance was similar in 2007, 2008, and 2009, although it was slightly lower than previous years throughout the year in 2009. Fluctuations between months were evident, but the overall trend was the same, with peak use of the study area occurring in June. Maximum low tide heron counts in June were lower in 2009 (334 herons), than in previous years, with 433 herons documented in June 2007 and 424 in 2008 (**Figure 2.9-2**). However, another high count of 292 herons was documented in September 2009, unlike in any previous years.

Approximately 400 more herons in June were recorded during low tide surveys along the Deltaport Transect in 2003 compared to 2007, 2008, and 2009. This difference may partly be explained by daily variability in heron use of habitat within the inter-causeway area, as an additional 160 and 180 herons were detected along the TFN Transect in June 2007 and 2008, respectively, which was not surveyed in 2009 or 2003 (**Figure 2.9-1**).

Figure 2.9-1 Relative Abundance of Great Blue Heron during Low Tide, Deltaport Transect, 2003-2009

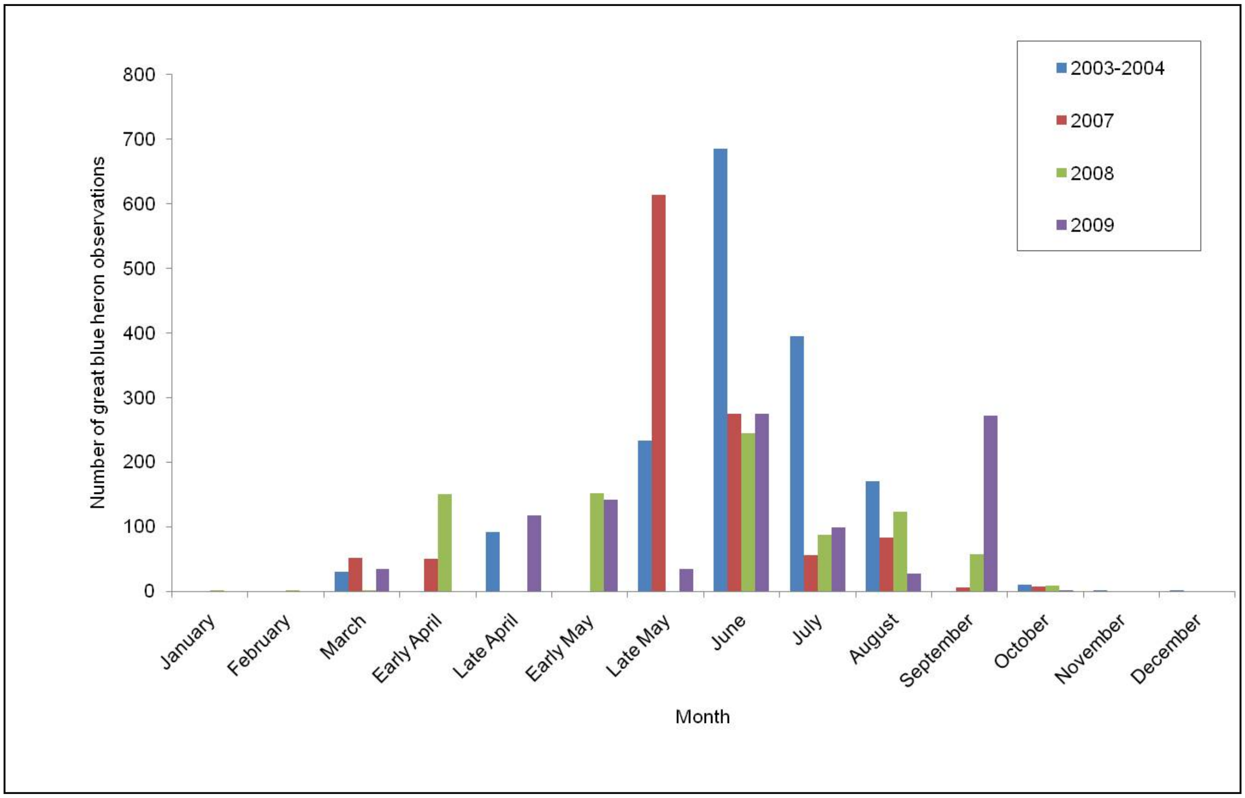
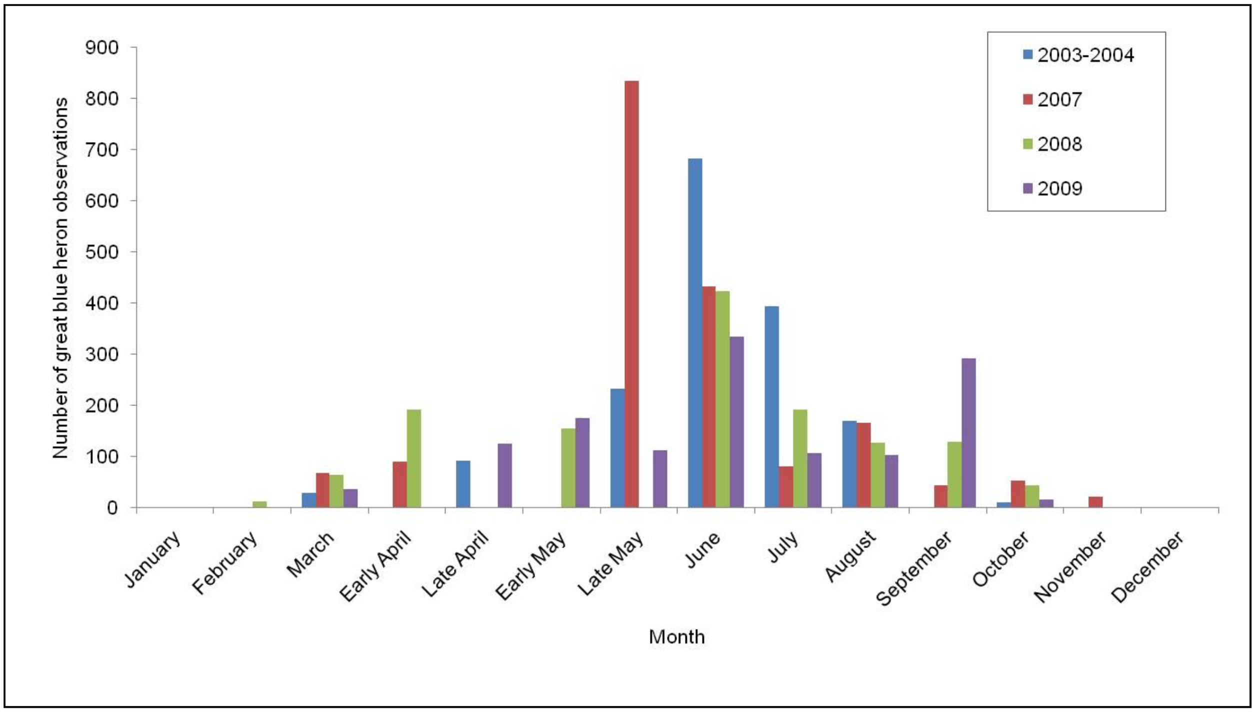


Figure 2.9-2 Relative Abundance of Great Blue Heron during Low Tide, Deltaport and TFN Transects, 2003-2009



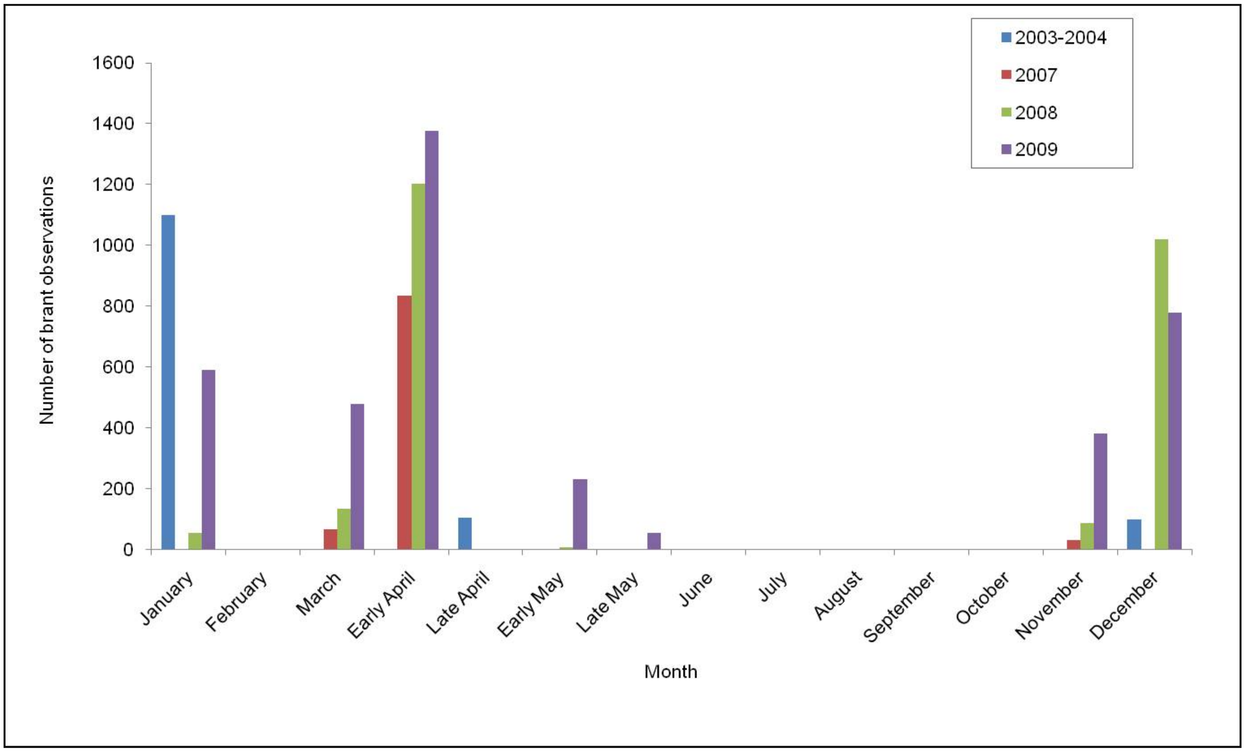
Notes: 1) The TFN Transect was not surveyed in 2003-2004.
2) No surveys were conducted in January or February 2007 within the study site.

Heron use of the inter-causeway area has shifted since 2003-2004, as fewer heron observations have been recorded at point count stations closest to Deltaport construction activities (i.e., PC 12, PC 13, and PC 14) (**Figure 47**). In 2009, 42% (467/1,108) of all heron observations along the Deltaport Transect were recorded in PC 12, PC 13, and PC 14, compared to 30% (300/1,012) in 2008, 53% (687/1,302) in 2007, and 73% (1,365/1,302) in 2003. While herons have apparently shifted their use of habitat away from points adjacent to construction activities, the proportion of great blue heron using the TFN Transect has only increased slightly. In 2009, 44% (860/1968) of all heron observations were recorded along the TFN Transect, compared to 50% (1,005/2,017) of observations in 2008 and 43% (976/2,275) in 2007. Heron distribution and abundance along the TFN Transect in 2003-2004 is unknown, as the Transect was not surveyed. Other possible factors affecting heron distribution and use of the inter-causeway area are discussed in **Section 3.6**.

2.8.2 Brant

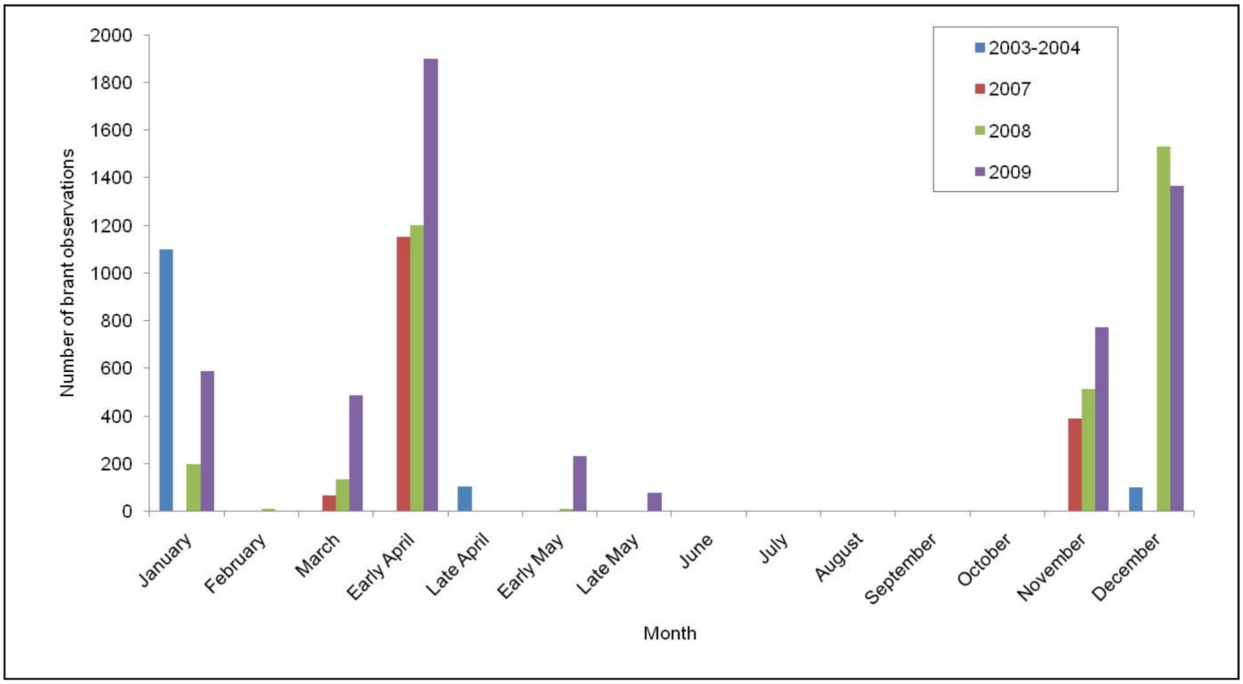
Brant distribution within and timing of use of the study area along the Deltaport Transect between 2003-2009 were comparable and followed the same trends from 2003 to 2009 (**Figure 2.9-3**). Most brant observations occurred in the winter months from November through January and again in April. Brant were observed later into spring in 2009, with observations in both early and late May. Typically, the majority of brant were documented along the Deltaport Transect. Brant abundance was higher in 2009 in all seasons compared to previously documented abundance estimates in 2003-2004, 2007, and 2008 (**Figure 2.9-4**). In all years, brant use of the inter-causeway area was greatest during high tide events compared to low tide events.

Figure 2.9-3 Relative Abundance of Brant during High Tide, Deltaport Transect, 2003-2009



Note: No surveys were conducted in January or February 2007 within the study site.

Figure 2.9-4 Relative Abundance of Brant during High Tide, Deltaport and TFN Transects, 2003-2009



Notes: 1) The TFN Transect was not surveyed in 2003-2004.
2) No surveys were conducted in January or February 2007 within the study site.

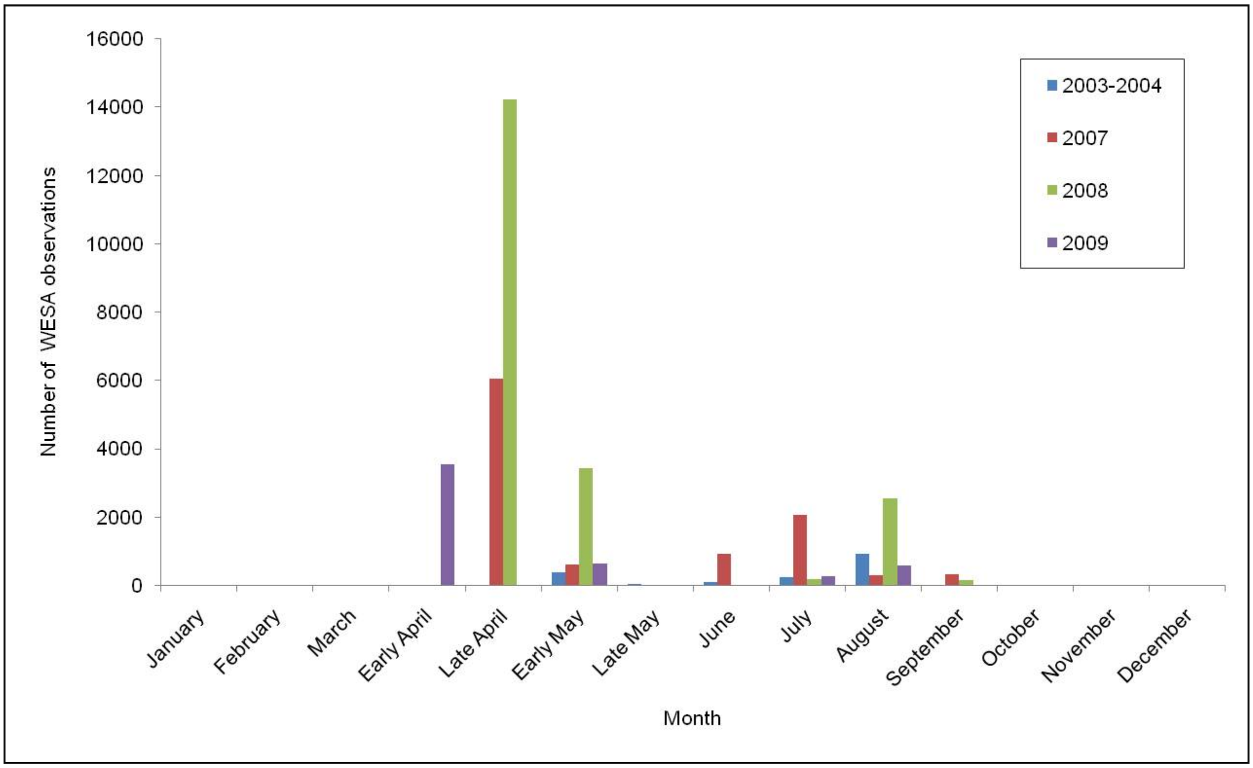
Brant use of the inter-causeway area appears to have not been affected by activities associated with Deltaport Third Berth construction as the distribution of brant along the Deltaport and TFN Transects has not changed (**Figure 48**). In all years, brant have been documented along the length of the Deltaport Transect, and in 2007, 2008, and 2009 large flocks have been recorded along TFN. Areas of frequent use have been PC 19 and PC 105 at the intersection of the Deltaport and TFN Transects, and greater than 250 m offshore within PC 13, PC 14, PC 15, and PC 18.

2.8.3 Shorebirds

2.8.3.1 Western Sandpiper

Annual western sandpiper abundance and distribution has been known to fluctuate greatly on an international scale, and counts within the inter-causeway area are typically variable from year to year. Annual peak estimates of sandpiper abundance along the TFN and Deltaport Transects have occurred in late April in 2007 and 2008, and in early/mid April in 2009 (**Figure 2.9-5)**. No estimate of sandpiper use of the TFN Transect in 2003-2004 is available. Use of the Deltaport Transect has typically been limited, with greater numbers of western sandpipers observed along the TFN Transect where large exposed mudflats provide abundant habitat for foraging birds (Hemmera, 2008).

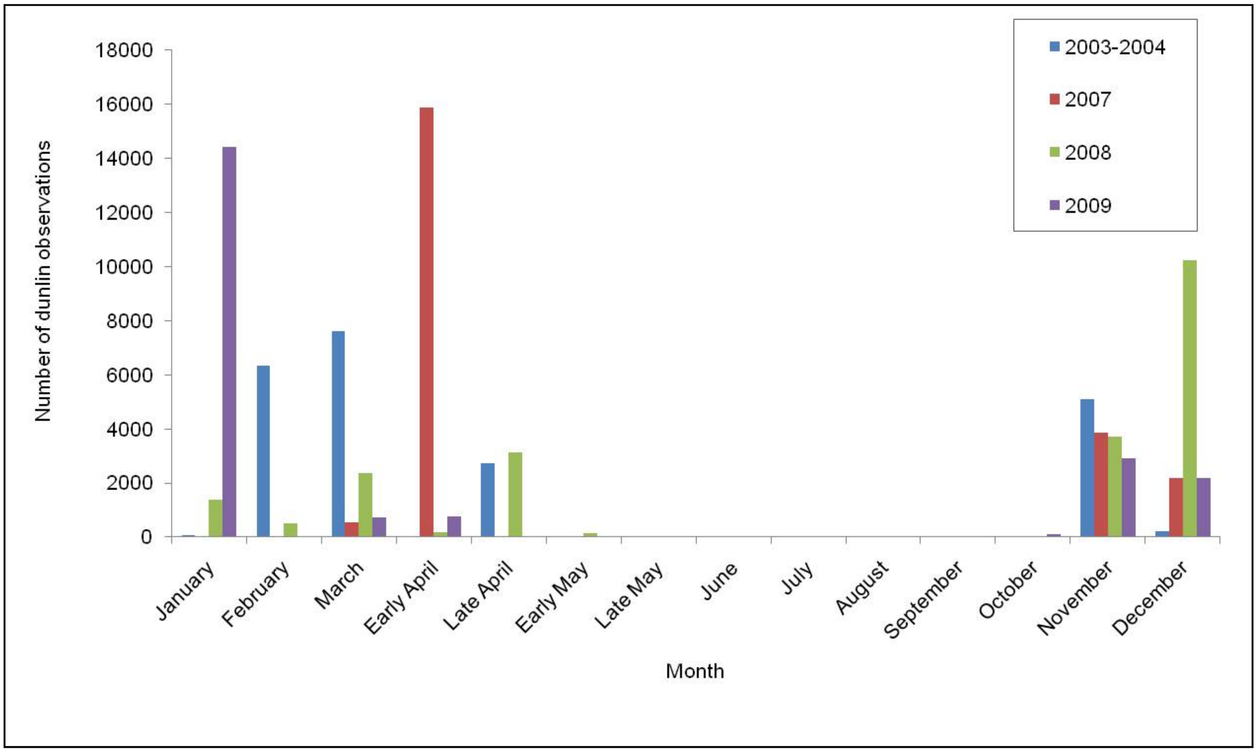
Figure 2.9-5 Relative Abundance of Western Sandpiper during High and Low Tide Combined, Deltaport and TFN Transects, 2003-2009



2.8.3.2 Dunlin

Dunlin abundance within and timing of use of the study area fluctuated from 2003-2009, with the winter months showing the greatest abundance. The timing of use fluctuated from year to year, with peak monthly abundances of approximately 15,000 birds occurring both in January (in 2009), and early April (in 2007) (**Figure 2.9-6)**. Dunlin have been consistently documented along the Deltaport and TFN Transects, although more dunlin have been regularly documented along TFN. This is related to the availability of extensive mudflats during low tide events, compared to the limited mudflat habitat available on the Deltaport Transect.

Figure 2.9-6 Relative Abundance of Dunlin during High and Low Tide Combined, Deltaport and TFN Transects, 2003-2009



Notes: 1) The TFN Transect was not surveyed in 2003-2004.
2) No surveys were conducted in January or February 2007 within the study site.

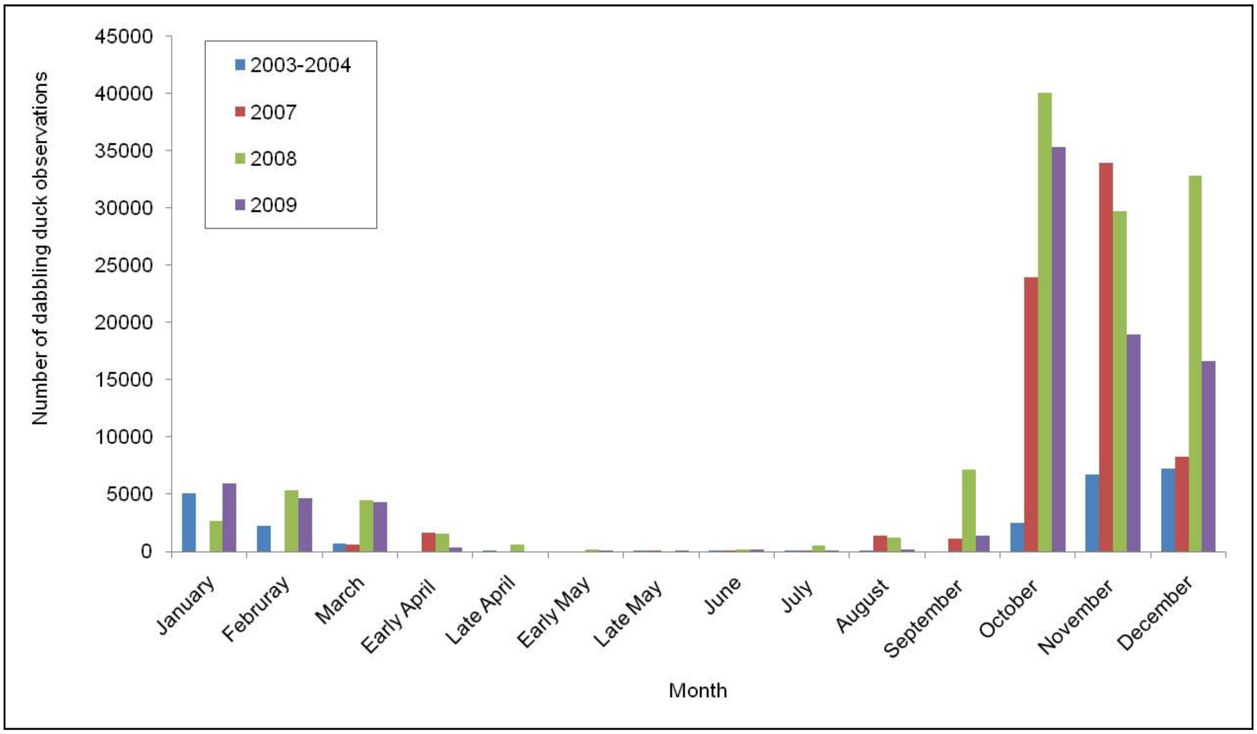
2.8.4 Coastal Waterbirds

2.8.4.1 Dabbling Ducks

Dabbling duck abundance and distribution along the Deltaport and TFN Transects from 2003-2009 were generally comparable and followed the same general seasonal trends (**Figure 2.9-7**). Dabbling ducks were most common within the inter-causeway area from October through December along the TFN Transect, where flocks of greater than 1,000 birds were frequently documented. Overall, large flocks of dabbling ducks annually used habitats contained within the inter-causeway area during late fall through early winter.

Dabbling duck abundance was noticeably lower in November and December of 2009 than in 2008; approximately 10,000 fewer ducks were observed in each month than in the previous year. However, abundance in December 2007 was also markedly lower than in 2008, suggesting that the variation in total dabbling duck numbers is likely due to natural variation in bird use of the inter-causeway area. In addition, the relative seasonal decrease from October to November was consistent with other years and abundance in all other months in 2009 were generally comparable to or greater than previous years. BC Coastal Waterbird Surveys from 2007 and 2008 indicate that dabbling duck abundance in the Boundary Bay and Fraser Delta (of which the inter-causeway area is a small portion), can fluctuate by several thousand birds each year (Bird Studies Canada 2009).

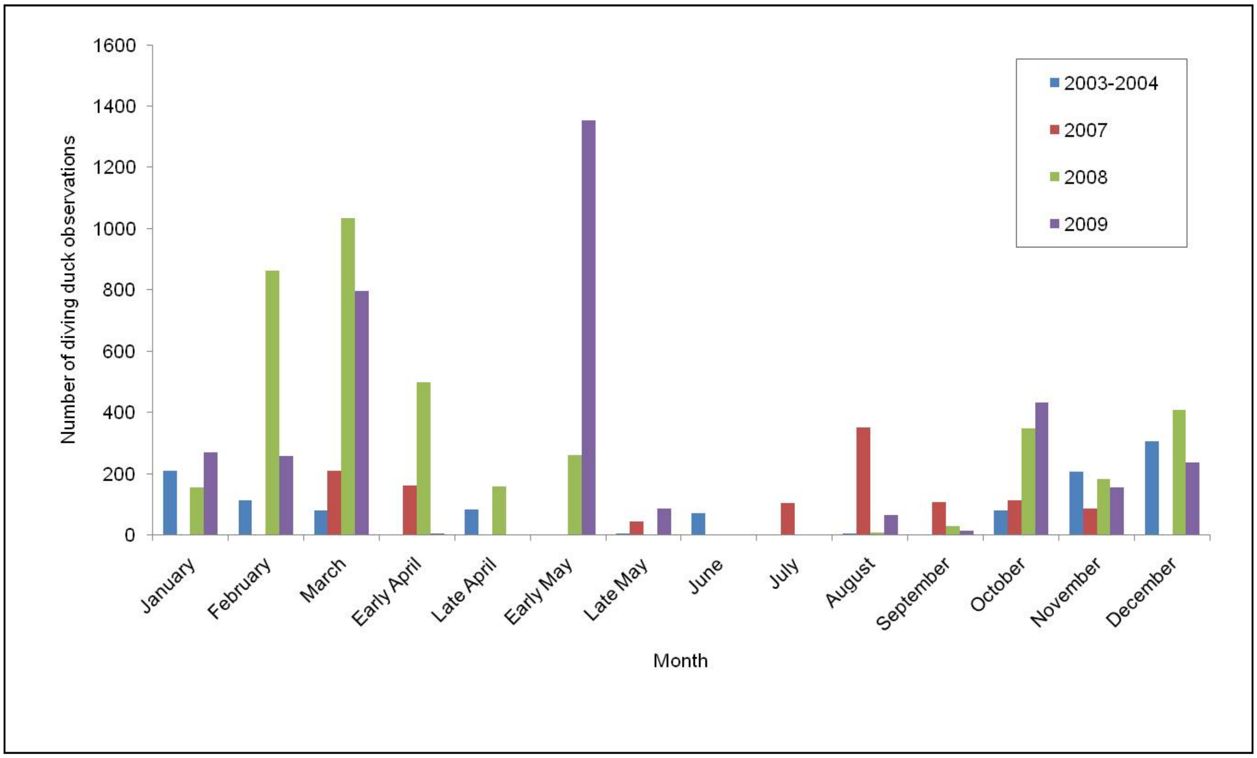
Figure 2.9-7 Relative Abundance of Dabbling Ducks during High and Low Tide, Deltaport and TFN Transects, 2003-2009



2.8.4.2 Diving Ducks

Diving duck abundance varied annually, but distribution within the inter-causeway area and annual timing of use varied little. General abundance estimates were comparable between years with a few exceptions (**Figure 2.9-8**), such as the peak in abundance in early May in 2009. This peak was composed of a large number of greater scaup using the inter-causeway area during spring migration. Diving ducks tended to remain in higher numbers longer throughout the year in 2009 compared to any of the previous documented year, as they were detected in July and August when few divers were detected in other years. Ducks documented at this time were surf scoter and greater scaup. Overall, diving duck abundance and habitat use within the inter-causeway area did not differ significantly between study years.

Figure 2.9-8 Relative Abundance of Diving Ducks during High Tide, Deltaport and TFN Transects, 2003-2009

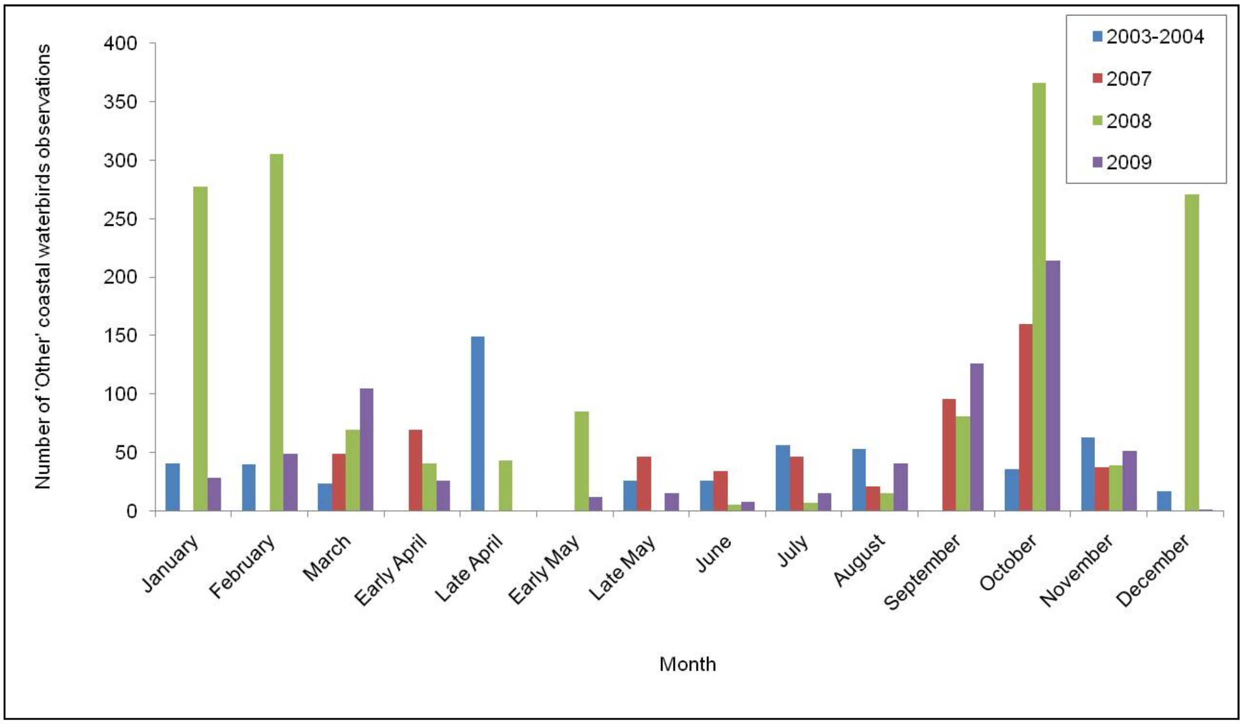


Notes: 1) The TFN Transect was not surveyed in 2003-2004.
2) No surveys were conducted in January or February 2007 within the study site.

2.8.4.3 'Other' Coastal Waterbirds

General trends in abundance, use, and distribution of 'other' coastal waterbirds did not differ between years (**Figure 2.9-9**). The vast majority of birds were observed using habitats along the Deltaport Transect. Peaks in monthly abundance estimates were almost always driven by the detection of a large single species flock. Often these detections were of birds that flew over or through a point count station. Species commonly documented as "fly-overs" were: snow goose, double crested cormorant, and pelagic cormorant, typically during migration seasons (fall and spring). Overall, 'other' coastal waterbird abundance and habitat use within the inter-causeway area did not differ significantly between 2003-2004, 2007, 2008, and 2009.

Figure 2.9-9 Relative Abundance of 'Other' Coastal Waterbirds during High Tide, Deltaport and TFN Transects, 2003-2009



3.0 DISCUSSION

3.1 COASTAL GEOMORPHOLOGY

One of the primary objectives of the AMS monitoring program is to make an assessment of the possible effects of the DP3 project on the surrounding physical environment of the Roberts Bank tidal flats, specifically, the inter-causeway area. Data collection for the AMS program was initiated in April 2007, after construction operations for the DP3 project had already begun, albeit in the early stages of construction. As a result, except for aerial photographs and some limited hydrographic surveys, there is no baseline data for which a comparison of the pre- and post-project conditions can be made. However, the rate of change of the processes affecting the physical environment in the vicinity of Deltaport is not rapid, and it is reasonable to expect that the parameters that are being monitored would have represented near-baseline conditions at the onset of the project. Analysis of the present data set therefore involves discussion of the existing conditions and attempting to place these existing conditions in the context of observations made in the AMS 2007 Annual Report (Hemmera 2008d).

3.1.1 Crest Protection Structure Monitoring

The Crest Protection Structure was installed on the tidal flats as an anti-erosion measure between 1982 and 1984 in conjunction with expansion of the turning basin. As drainage channels had formed around the perimeter of the initial excavated sediment borrow pit, the turning basin was installed in part to mitigate the formation of new channels. Since 1984, an extensive and complex system of channels has formed on the tidal flats, which are driven by tidal flow. Although these tidal channels continue to evolve, it is thought unlikely that the new DP3 berth will have any significant effect on the existing tidal channels.

The primary purpose for monitoring of the Crest Protection Structure, as outlined in the DP3 Project AMS Detailed Workplan (VPA & Hemmera, 2007) is to “detect channel incision, headcutting or dendritic channel formation around perimeter crest protection.” Tidal flows interact with the Crest Protection Structure at a range of tidal stages during both the flood and the ebb tide. Water flows over the structure during high tidal stages and is diverted laterally by the structure during lower tidal stages. The result is a complex, dynamic system resulting in channels and flow paths of various sizes at different orientations relative to the Crest Protection Structure. Some of these flow paths may have been altered somewhat by the construction of the temporary barge berth facility adjacent to the new tug basin as casual observations have indicated that there appears to be additional ponding of water due to the temporary fill placed on the tidal flats. The effect would likely be that the volume of water draining over the Crest Protection Structure in the vicinity of CRST-04 (**Figure 2**) would be increased somewhat, particularly during large tidal swings.

The Crest Protection Structure is not perfectly level. Therefore, water flowing over the structure at higher tide stages is concentrated into the areas where the crest is lower. Channels running perpendicular to the structure on both the seaward and landward sides are found in these areas. At tide stages near to the elevation of the crest, tidal flow is diverted laterally along the structure, and this has created significantly-sized channels running parallel to the structure. The main data collection tools used in the Crest Protection Structure monitoring program are: visual inspection, and repeat topographic surveys of established cross-sections. Repeat photography from established photo points during daytime low tides supplements the visual inspection. Additional information about the physical processes affecting the area in the vicinity of the Crest Protection Structure is provided from the other monitoring activities such as interpretation of orthophotos and monitoring of the DoD rods, which are discussed in the following sections.

Figure 20 shows the plotted cross-section data from March and July 2009 and **Figure 21** shows the plotted cross-section data from the 2008 monitoring as a comparison. The methods for generating these cross-sections are outlined in **Section 1.3.1.1**. In general, the 2009 surveys show only very minor elevation changes at the cross-sections that are within the accuracy of the survey instrument. Instrument inaccuracy is reduced as much as possible by re-surveying a known monument each time survey data is collected, but variations occur during the course of data collection occur that cannot be evaluated. These variations can be as high as 5 cm. Other sources of random error include slight variation in the position of the collected points from one survey period to the next, which show up as apparent changes in the plotted cross sections. For the points collected on the Crest Protection Structure, this variation could be as high as 10 cm because of the irregular elevation of the ground between boulders. Due to these random variations, elevation differences of less than 15 cm are difficult to resolve.

Monitoring of the Crest Protection Structure has demonstrated that the structure itself remains stable, with little detectable change over the 2009 monitoring period except where construction activities in the vicinity of the new tug basin and barge ramp have resulted in alterations to the structure shown in Cross-Section 1 (CRST-XS1). T he area of tidal flats and tidal channels in the immediate vicinity of the structure is generally stable but minor changes in elevation in the tidal channels near the structure have been measured. The apparent increase in the elevation of the top of the Crest Protection Structure at CRST-XS 2 of up to 30 cm in the July, 2008 surveys is not observed in either of the 2009 surveys. It is possible that this was the result of positioning the survey rod on a particularly high boulder or is related to survey error. The survey also appears to indicate that some sandy material may have accumulated on the seaward side of the structure, as shown in the March 2009 survey data, but that this material was subsequently eroded.

At CRST-XS 4, there is an increase in elevation of the Crest Protection Structure immediately seaward of the centreline that is of a similar magnitude to the increase previously observed at CRST-XS 2 in 2008. Again, this appears to be anomalous but will be monitored closely in future. The 2008 surveys at CRST-XS 5 had previously shown a steady increase in the ground elevation on the seaward side of the Crest Protection Structure between January and July on the order of 0.4 m to 0.6 m. This may have been related to migration of sand on the exposed tidal flats facing the ship turning basin. The 2009 surveys, however, show that the elevation on both sides of the centreline has remained constant.

A slight decrease in the elevation on the shoreward side of the Crest Protection Structure at CRST-XS 5 was identified based on the 2008 monitoring. Although the maximum change was on the order of 0.2 m, and therefore only slightly outside the precision of the surveys, the trend appears to be continuing. There has been an apparent lowering of the elevation in the back channel that runs parallel to the Crest Protection Structure between the March and July 2009 surveys. However, this difference is generally less than 0.1 m and is thus within the limits of precision of the instrument. A brief examination of orthophotos collected in 2002, 2006, 2007, 2008, and 2009 shows that the small channels on the seaward side of the Crest Protection Structure appear to be stable. Any apparent change in the location of the channels over time is within the error limits of the photos, particularly introduced by slight changes in tide levels. The elevation changes shown in cross-sections 3 and 5 are generally relatively small and appear to indicate cyclical variation, possibly related to winter storms versus the lower-energy summer periods. The two years of monitoring data show no clear trend towards either infilling or erosion and therefore no concerns about the long-term stability of the Crest Protection Structure, or the area immediately adjacent. The apparent decrease in elevation of the shoreward portion of CRST-XS 5 will be monitored closely to determine if it is a true change or related to survey error.

The AMS Detailed Workplan (VFPA & Hemmera, 2007) includes a methodology for evaluating change within the study area. For those monitoring parameters that do not have national, provincial or regional objectives or standards, a 20% effect level or percent change over background has been selected as the AMS threshold. The 20% effect level is derived from standard toxicity testing and as a result, does not necessarily have wide application to monitoring of geomorphic parameters. Many natural physical processes vary within a very large range of values. For example, the mean discharge in the Fraser River at Hope for the period March 1 to March 14, 2008 was approximately 820 m^3/s while the peak discharge during the spring freshet of 2007 was over 10,000 m^3/s (Water Survey of Canada), representing a change of over 1,100%. A further complication to applying this method for evaluating change at the Crest Protection Structure is that the survey data are not in an absolute scale and there is no record of typical background variation at the site. At this time it is necessary to rely on qualitative interpretation of the monitoring data to evaluate acceptable thresholds for change.

3.1.2 Automated Turbidity Monitoring

A time series plot of all available turbidity data collected in 2009 between May 26 and December 31 by Sensor 2 is shown in **Figure 22. Figure 23** shows the same time series with a smoothing function applied. The general range of values recorded between May 26 and August 23, 2009 is similar to that recorded in 2008 quarters. During the Q4-2009 monitoring on November 5, it was found that the wiper mechanism was missing from the instrument. Loss of the wiper mechanism likely occurred shortly before August 23, after which time the measured turbidity values display an upward drift. Replacement of the wiper mechanism on November 3 should have resulted in collection of a typical range of turbidity values, but during data download in January 2010, it was discovered that a colony of starfish had taken up residence inside the protective tube housing the instrument. The consistently high values that were recorded for the remainder of the year indicate that the instrument housing was likely invaded by these organisms very shortly after the site visit in November. It is possible that the presence of so many starfish living near and on the instrument was the cause of the wiper mechanism coming loose. The data from August 23 to December 31 cannot be considered reliable.

The turbidity sensor essentially measures the ability of light to pass through the water column in the immediate vicinity of the optical sensor. Any particle or object in the water column will affect the measurement of turbidity, including dead plant material and other organic debris, live organisms, and mineral sediment. This material may originate immediately around the sensor or it may be transported within the water column for some distance. The main physical processes that could influence turbidity on the tidal flats are waves and the tides. Conceptually, the tides would affect conditions at the turbidity sensor both in terms of the strength and direction of tidal flow, but also in terms of the potential for waves to interact with the surface of the tidal flats. The results of numerical modelling of water flow over the tidal flats completed for the Coastal Geomorphology Study (NHC, 2004) indicated that, outside of established tidal channels, tidal flow alone had insufficient velocity to entrain sediment from the tidal flats but that sediment would be transported under certain wave and tidal conditions if wave action lifted the sediment from the bottom of the water column. At very low tides, waves would break on the Crest Protection Structure or on the beach in front of it, while at higher tide stages, the depth of water over the instrument would dampen the force of the wave motion over the sediment. Only at medium tide stages would conditions be appropriate for waves to pass over the Crest Protection Structure and still be able to disturb surface sediment.

Given the complex relationship between tide stage, tidal flow direction, waves and turbidity, it is not possible to draw simple conclusions from the turbidity data. In order to analyze the data, the available reliable time series from May 26 to August 23, 2009 was broken into shorter segments of approximately 15 days and the turbidity data were converted to sediment concentrations using the derived relationship outlined in the Field Methodologies Section 1.3 above. An examination of these data shows that superimposed on the longer-term trends in the data, spanning several days for instance, are very short-term spikes in the turbidity values. These spikes are typically a single, anomalously high value amidst a series of reasonably similar values. The spikes, whether they represent valid measurements or not, create excessive visual distraction. In order to further simplify the data analysis process, all values over 150 NTU were removed from the raw data set and the maximum vertical scale on the graphs was set to 100 mg/L. Tide height observed at Point Atkinson was superimposed on the secondary axis of the graph to provide a graphical relation between turbidity events and tide stage. **Figure 49** shows a series of these plots for the period between June 1 and August 31, 2009 at approximately 15-day intervals.

The turbidity data plotted against tide level that is presented in **Figure 49** shows a very similar pattern to the data that was presented from the 2008 AMS monitoring. The typical background level of sediment concentration in the water column is between approximately 2 mg/L and 5 mg/L and this regularly rises to between approximately 10 mg/L and 20 mg/L during each tide cycle. Low tides that fall below about 2 m (Chart Datum) tend to induce a slightly higher peak in sediment concentration, that typically lasts for a few hours (for comparison, the elevation of the Crest Protection Structure in the vicinity of Sensor 2 is approximately 1.1 m). Short-duration episodes of higher sediment concentration that rise above 20 mg/L are associated with low tides that drop below 1 m (Chart Datum).

Against this backdrop pattern of tidally-induced increases to sediment concentration, are a number of turbidity events that appear to be related to wind events. The storm table referenced in **Section 2.1.2** lists all events in 2009 where there were sustained wind speeds of greater than 30 km/h; four of which occurred within the period of available turbidity data: 1) June 26 with average windspeed of 32.8 km/h from the NW, 2) June 29 with average windspeed of 31.9 km/h from the NW, 3) July 1 with average windspeed of 34.7 km/h from the NW, and 4) July 12 with average windspeed of 30.9 km/h from the SE. The three storms from the NW last between 12 hours and 16 hours while the one storm from the SE lasted only 8 hours. The various plots shown in **Figure 49** illustrate that only the July 12th storm appears to have resulted in a noticeable increase in sediment concentration. Of these four storms, only the July 12th event created waves above the background levels measured by the wave sensors (see **Section 3.1.7**). There is a demonstrable relationship between periods of higher sediment concentrations and strong wind events, but the relationship is modified by tide height and wind direction. Periods of high tide would tend to dampen the effects that waves would have on sediment concentrations and small summer storms from the N, NE, and NW tend not to produce large waves in the study area.

It is possible to deconstruct each significant wind event or each major rise in sediment concentration in order to relate the processes of tides, wind, and waves. However, there is very little value in this exercise as it relates to the objectives of the AMS. Sediment concentrations are generally very low and the larger events do not even usually approach the concentrations found in the Fraser River during the low-flow periods of the year. Given the challenges presented by the unreliable data record, it is not possible to detect a long-term trend in sediment concentrations throughout the year. The downloaded quarterly turbidity data will continue to be examined to ensure that negative trends are detected as early as possible.

3.1.3 Monitoring of Erosion and Deposition

The rates of erosion and deposition on the tidal flats in the vicinity of the DP3 project as well as the area of tidal flats on the seaward side of the Crest Protection Structure are monitored by an array of 26 DoD rods that were installed at the inception of the monitoring program and an additional eight DoD rods that were installed during Q2 and Q3 of 2008 (**Figure 4**). The DoD rod array covers an area approximately 750 m by 600 m, not including the DoD rods that extend southward along the perimeter of the turning basin. The rods measure maximum erosion and net deposition (see Field Methodologies Section 1.3 for discussion). Although the rods are installed as an array, they measure changes at point locations. Extrapolation of the values to the area surrounding the rod must be done with caution. Observations made during the 2007 monitoring year indicated that the magnitude of changes to the pattern of erosion and deposition over relatively small distances may outweigh the conclusions that can be made about changes over larger distances.

The magnitude of erosion and deposition measured at the DoD rod sites during each quarter is displayed graphically in **Figure 24** and **Figure 25** using bar charts. The bar charts represent the magnitude of change only and are not intended to show cumulative change in the elevation of the sediment surface. Measurements that may have been affected by the presence of significant accumulations of weed on the rod are marked on the figure. Any incidence of damage to the DoD rod that may have affected the accuracy of the measurement is also indicated. **Figure 26** to **Figure 29** show the net change (erosion and deposition) between each quarter in 2009 using colour-coded circles to denote various ranges in the magnitude of net change.

3.1.3.1 Analysis of Measurement Reliability

The effect that temporary vegetation accumulation may have on the DoD rod measurements has been raised as a possibly significant impact on the validity of the results. Eelgrass fronds are typically found loosely wrapped around or against the rods but occasionally more significant amounts of weed have been found on some of the rods during the annual spring and summer monitoring visits (Q2-2009 and Q3-2009). A fairly common sight at rods located at the western edge of the DoD rod array shoreward of the Crest Protection Structure (specifically the x01 and x02 numbered rods and Z series rods) are large cones of filamentous green algae on the DoD rod. The species *Enteromorpha* has regularly bloomed on the tidal flats each summer and represents a local source for this material. These cones can measure up to 60 cm across and up to 20 cm high. It is impossible to determine how long the cones remain on the rods but it is likely that the majority of the material floats away with the rising tide. As the weed is removed, some of the material at the base of the cone is occasionally observed to be partially buried in the sediment. There does not appear to be a trend with rods which have cones around them towards greater or lesser erosion or deposition, but the presence of these cones are noted in the field observations and the occurrence of the cone is marked on the summary figures.

Occasionally, damage to some of the rods has occurred during the period over which they have been installed on the tidal flats. Discussion of this damage is required to evaluate the potential impact it may have on the reliability of the measurements made using the DoD rods. **Table 21** lists all of the occurrences of damage to the DoD rods. The history of damage to the rods can be divided into three categories: a) sporadic damage, b) slightly leaning, and c) episodic damage.

Sporadic damage has occurred to four of the rods on five occasions in seemingly unrelated incidents. F06 was found damaged in January 2008, and G06 was found to be damaged in both July and October 2008. Both of these rods are located on the seaward side of the Crest Protection Structure and are exposed to damage from boats, logs, or other debris that are less likely to cross to the shoreward side of the structure. C01 and C05 were also discovered to be damaged in October 2008, but these are located on the shoreward side of the Crest Protection Structure. It is possible that they were damaged at the same time as G06 but equally plausible is the possibility that a large piece of wood drifted into the tidal flat area and damaged the rods at a different time.

A subset of the rods are leaning slightly. In some cases the rod may have been originally installed at a slight angle, while in others it can be assumed that the rod was slightly bent by floating debris or a boat.

Severe damage was sustained to a large number of the rods during one episode of disturbance that was discovered during the Q1-2009 monitoring visit. Rods were found to be bent anywhere from 30° to touching the ground and three of the rods (Z03, Z04, and Z08) were found to be pushed a significant distance into the ground. The winter season spanning December 2008 and January 2009 was a period of severe winter weather in the Lower Mainland. A significant amount of snow fell over the region during this time and temperatures remained below 0°C for weeks at a time. Ice was observed in many of the protected bays and inlets along the South Coast and there are reports that thick ice formed within the area of DoD rods at Deltaport. The lateral and vertical movement of ice sheets by tidal flow and wind would certainly be capable of causing the type of damage that was observed. Ice sheets could also be responsible for dragging the wave recorder (see below).

Of the 26 original rods and 8 additional rods (total of 34) that have been installed, the following summarises the history of damage:

- 4 rods are slightly leaning
- 12 rods have been damaged
- 11 rods damaged in Q1-2009 (Feb)
- 4 rods have been damaged multiple times
- 4 rods have been replaced
- 18 rods have never been damaged

The protocol for dealing with damaged rods has evolved as required in accordance with the specific circumstances that have arisen. Any damage to the rod is noted in the field in order to flag the measurement for later analysis. Very slightly leaning rods do not result in a measurable difference in height. If possible, a bent rod is straightened by hand and the measurement made as usual. If a rod is severely damaged and cannot be straightened it is replaced at the earliest opportunity and the measurement discarded as required. The measurements from the three rods that were pushed into the ground were discarded for that quarter.

A survey of the elevation of the top of the rods is made periodically using an RTK GPS. The vertical precision and accuracy of this instrument provide reliable, repeatable measurements to within approximately 0.1 m (**Figure 50**). The measurements show that the elevation of the rods has not changed beyond the limits of accuracy of the surveys. The apparent upward and downward shifts illustrate the variability in the RTK correction and the inherent inaccuracies in the GPS signal rather than any real change in the elevation of the rods.

The accuracy of the DoD rod data could be affected by a number of potential factors, including measurement error, settling of the washer into the soft surface sediment, the uneven sediment surface, settling or sinking of the rod, and subsidence of the sediment. Measurement error is minimized as much as possible by consistently taking measurements from the top of the rod, along its southwest side, to the washer, thereby negating the effect of a slightly leaning rod. The initial stability of the washer at the sediment surface is occasionally affected by the need to regrade the sediment to the surrounding surface elevation following excavation of the washer. Fine sediment within shallow standing water may be loose such that the washer will sink slightly after it is re-deployed.

The potential for the rod to settle into the sediment has been minimized by installing the rod to the point of refusal at an average depth of 2.4 m, and it has been demonstrated that within the limits of accuracy of the RTK GPS, the rod height is essentially static. It is assumed that the rod is co-responsive to any potential subsidence of the sediment, but it is not possible to evaluate this because of the limitations of the accuracy of survey instruments that can be deployed on the tidal flats. Hill, et al (2006) provide an evaluation of the estimated subsidence rates for Roberts Bank at up to 3 mm/year, but it is not known to what depth this subsidence occurs. The effects that any long-term changes to the height of the rods or to the elevation of the sediment surface may have on the accuracy of the DoD rod measurements is further diluted by the fact that the values are dependent only on the previous quarterly measurement and not on an absolute elevation that is tracked over the long-term.

3.1.3.2 Analysis of Results

In previous AMS Annual Reports (Hemmera 2008d, Hemmera 2007d), the DoD rods were considered in three separate populations: DoD rods located on the seaward side of the Crest Protection Structure, DoD rods located in the area of new drainage channels, and DoD rods located elsewhere on the tidal flats. Although the new drainage channels appear to have largely stabilized, this division of the rods into populations remains useful for comparison purposes.

The rods on the seaward side of the Crest Protection Structure continue to show the greatest amount of overall erosion and deposition, although the rods at D01 and B02 showed a similar magnitude of erosion and deposition in Q1-2009 as well as C05 in Q2-2009. The maximum net erosion or deposition was low, falling within the 2 cm to 4 cm range. While the rods seaward of the Crest Protection Structure are much more exposed to waves and are affected by sand bars that migrate along the perimeter of the ship turning basin, these sites did not appear to be as heavily affected as in past years. At the more exposed of these rods, F06 and G06, there is predominantly net erosion recorded, with a value as high as 11.4 cm that was measured at F06 for Q4-2009. Although these changes are nearly four times less than the high values recorded in 2007, the variation is attributed to the naturally dynamic nature of the sediment in this area.

The DoD rods in the vicinity of the new drainage channels had initially shown very high levels of erosion and deposition in early 2007 that was related to the formation of the channels and leakage of supernatant from the perimeter dike. Some of the rods in this area occasionally show slightly higher rates of erosion or deposition but there is no overall spatial or temporal trend. Q1 and Q2 monitoring show that all rods measured less than 2 cm of net change, except for the rod at C01 which measured over 3.5 cm of total erosion. This trend continued through the Q3 and Q4 monitoring periods with the exception that E02 had a net deposition of 2.3 cm in Q3. Overall the magnitude of erosion and deposition is generally very low except for at C01, which had erosion and deposition of 3.7 and 7.2 cm, respectively in Q1. This is possibly related to localized sediment transport in one of the small drainage channels.

The remaining DoD rods on the tidal flats show net change (erosion +/- deposition) that is less than 2 cm for all quarters except for Q3, where three rods (A05, B03, and B05) experienced net deposition in the slightly higher range of 2 cm to 4 cm. Some of the DoD rods measured fairly high values of erosion and deposition but there is no strong spatial or temporal trend. C05 measured almost no activity during the Q1 period and very low levels in the Q2 and Q4 periods, but in Q3 it measured erosion and deposition of 6.5 cm and 6.1 cm, respectively, but this appears to be an isolated occurrence. As has been observed in previous AMS Annual Reports (Hemmera 2007d, 2008d), these patterns tend to be highly localized and temporally unrelated. Because the effects of waves on the tidal flats is sensitive to tide height and wave direction, waves could be affecting one area of the tidal flats at a certain tide stage and then die down as the tide rises or falls so that they do not affect other areas during the same event. Also, small drainage channels can have a short-lived but significant localized effect.

As discussed above in **Section 3.1.1**, the DP3 Project AMS Detailed Workplan (Hemmera 2007) stipulates that changes in the monitoring parameters in the study be evaluated based on a 20% exceedence threshold. Similar to the elevation data collected during Crest Protection Structure monitoring, it is not possible to make a simple percentage calculation for a threshold of change because the values collected refer to relative, not absolute, change. Also, as described above, the magnitude of change to geomorphic parameters in a natural system can exceed one or more orders of magnitude. On the shoreward side of the Crest Protection Structure, the typical observed bedform height on the tidal flats is in the order of 5 cm to 10 cm. Any changes within this magnitude therefore are within natural variability due to bedform migration. Changes that are greater than 10 cm are likely to be caused by other processes such as channel formation or localized scour and may be indicative of larger-scale morphologic changes.

A methodology was developed to evaluate the DoD rod data objectively, meeting the commitments of the AMS Workplan, which was used in the analysis of DoD rod data in the AMS 2007 Annual Monitoring Report. The methodology change is a necessary departure from the original AMS document and was developed following discussions with members of the SAC (i.e., R. Atkins, pers. comm. March, 2008). As it is not possible to directly calculate a percentage change on individual measurements made using a relative scale, this methodology uses the existing population of DoD rod data as a basis for evaluating the typical range of values for erosion and deposition because pre-project, or baseline, data are not available. Consideration of the distribution of values around the mean allows the calculation of confidence limits to set a reasonable threshold for change.

For the purposes of the analysis, the DoD rods are separated into three areas having similar geomorphic characteristics: rods outside the Crest Protection Structure (n=5), rods within the area of new drainage channels (n=3 + 4), and the remaining rods on the tidal flats behind the Crest Protection Structure (n=18 + 4). Most DoD rods were sampled four times during 2009, resulting in four additional measurements of relative change. The quarterly measurements for each subset of rods were lumped together to provide a grouping of measurements describing change in elevation on the tidal flats throughout one year. The rods were assigned to the three groups as follows:

- Group 1 (area seaward of the Crest Protection Structure): D04, D05, E06, F06, G06
- Group 2 (area of new drainage channels): D01, E01, E02, with the addition of Z03, Z04, Z05, and Z06
- Group 3 (remainder of tidal flats): A03, A04, A05, A06, B02, B03, B04, B05, B06, C01, C02, C03, C04, C05, C06, D02, D03, and D06, with the addition of Z01, Z02, Z07 and Z08

Table 22 shows the summary statistics for each geomorphic area (group) by quarter and for the year, as well as the summary statistics for the combined erosion and deposition data for each group. Because the 2009 values were combined with the 2008 and 2007 values, the summary statistics are different than those reported in the previous AMS Annual Reports. Group 3 and Group 2 show almost zero net change in elevation for the year, while Group 1 shows net change of less than 1 cm. Not surprisingly, Group 1 showed the greatest range in erosion and deposition with a standard deviation of 5.16 cm, which has increased slightly from previous annual calculations. Group 2 and Group 3 experienced a much smaller range in erosion and deposition with a standard deviation of 2.43 cm and 1.99 cm, respectively. These values are generally consistent with the magnitude of change from migration of bedforms as outlined above.

The summary statistics provide a measure of variability and from these it is possible to set a reasonable threshold of change for consideration under the AMS. For normally distributed data, one standard deviation (1s) on either side of the mean accounts for 68.3% of the variance, while two standard deviations (2s) account for 95.5% of the variance. Given that there is a considerable amount of natural variability in most geomorphic systems, 1s seems too low of a threshold but 2s captures too much of the variability and does not provide enough conservatism for monitoring a sensitive environment such as the Roberts Bank tidal flats. A reasonable limit therefore, would be to consider that 80% of the variability is acceptable and that values falling outside of the 1.282s bear further investigation. The remaining variability falling outside of the 1.282s includes the 10% of values that are above the mean (net deposition) and the 10% that are below the mean (net erosion) for a total of 20%, a value that is in keeping with the original spirit of the AMS. **Table 22** provides a calculation of the 1.282s threshold.

For Group 1 all DoD rods were within the thresholds for erosion and deposition for all quarterly monitoring periods except for F06, which exceeded the threshold for erosion and deposition during Q2 and G06, which exceeded both thresholds in Q3. The threshold for erosion was exceeded at D04 in Q3 and at F06 in Q4. The values of erosion at F06 were also noted above as being particularly high. These values are most likely associated with natural cycles of erosion and deposition of sand bars along the exposed beach face.

There were two rods in Group 2 that exceeded the thresholds for both deposition and erosion and both occurred in Q1. The threshold for erosion and deposition was exceeded at D01 and Z05. The threshold for erosion was exceeded at Z06 in Q4. We know from observations, that following the initial disturbance of erosion and deposition that occurred when water and sediment were leaking from the perimeter dyke, that leakage ceased and the site has begun to stabilize. Except for D01, these rods exceeded the thresholds by less than 3 cm, which is not of concern in terms of immediate action. At D01, the magnitude of erosion and deposition was quite high (8.5 cm and 9.7 cm respectively), but the net change was very small.

In Group 3, the threshold for erosion and deposition was exceeded at a number of DoD rods during each of the four quarterly periods. None of the DoD rods has exceeded the thresholds in more than one quarter except at C06. High values for C06 have been discussed above. For the remainder of the instances of exceedence, the values are generally one-off during a single quarterly monitoring period and are not repeated and therefore do not point to a negative or positive trend.

3.1.4 Sediment Samples

The silt content (particles less than 0.063 mm) of the surface sediment is monitored as an indicator of potential effects to the physical environment in the area adjacent to DP3. Results from the DoD rod monitoring indicate that in most areas of the tidal flats, only the near-surface portion of the sediments undergo erosion and deposition, typically of an amount less than 4 cm. Only in the area on the seaward side of the Crest Protection Structure are these rates exceeded. **Table 15** and **Table 16** provide a summary by sampling period for carbon content and silt content, respectively. **Figure 31** and **Figure 32** show the silt content by site for April and November, and **Figure 33** shows the change in silt content between these two periods.

Organic carbon content was included as part of the sediment analysis in order to remove this material so that it did not skew the results of the grain size analysis. The organic carbon content presented in (**Table 15**) demonstrates that it is very low in the samples. Percent carbon for samples collected in April is between 0.1% and 1.2% but most samples are in the 0.2% to 0.6% range. For the November samples, the range is from 0.1% to 0.8% but most samples are in the 0.3% to 0.6% range. Noticeably higher carbon content is observed in the sample at A03 and at D02 collected in April, which also had much higher silt content, as well as the samples collected in the vicinity of the new drainage channels, at E01 and E02.

The percent silt content of the samples presented in **Table 16**, and graphically in **Figure 31** and **Figure 32**, show clear differences in the silt content over different areas of the tidal flats. The most obvious difference is that the samples collected on the seaward side of the Crest Protection Structure have consistently very low silt content, generally less than 10%. This area is subject to frequent wave action and higher velocity tidal currents and the surface sediment are typically characterized in the field notes as rippled sands. Two of the samples collected within the area of new drainage channels, E01 and E02, are quite high (between 22% and 40%) but the third sample at D01 is fairly low at 14%. Higher silt content was observed at these sites beginning in Q3-2007 because finer material was eroded from upslope, or was released through the perimeter dike during pre-load, and was deposited lower on the tidal flats near E01 and E02. The samples collected on the remainder of the tidal flats are all generally low, in the range from 10% to 16%. The samples collected at A03 and at D02 were very high in April and significantly lower in November. This same pattern was observed in 2007 and in 2008 and is very likely related to a heterogeneous sediment composition around those rods. Based on inspections of the orthophotos and on field observations, sediment are finer north and west of the rods at A03 and D02, and samples have been preferentially collected at these locations in the Q2 period of each monitoring year, resulting in an apparent, but artificial, temporal trend.

No overall increasing or decreasing trend in percent silt content is apparent in sediment sample data collected since monitoring began. The percent silt content of most samples collected in Q4-2009 does not differ greatly from Q2-2009 (**Figure 33**) or previous quarters (Q1 and Q3 in 2007; Q2 and Q4 in 2008). The most obvious exceptions are samples taken from sites at A03, C02, and D02.

The area of new drainage channels has been closely monitored since the inception of the monitoring program. Percent silt values reported in Q1-2007 at E01 and E02 averaged 12%, with higher silt content at E01 than at E02. Samples collected in Q3-2007 at these sites had 36% and 39% silt content respectively, which was attributed to fine sediment having leaked out of the porous perimeter dike. With no additional inputs of sediment, by the end of 2008, the silt content appeared to have stabilized at approximately 25%. The silt fraction increased at E01 in 2009, with up to 40% measured in April. This value declined to 34% in November but remains high relative to what was measured in 2008, Heterogeneity in sediment composition around the rod and sampling in preferred locations in a given year may account for the differences. More specifically, samples in 2008 were collected west and east of the rod, whereas 2009 samples were taken in north and south locations. A larger dataset is needed to verify such a trend as the leakage of sediment in 2007 introduces some complication.

Results of the carbon content analysis (**Table 15**) demonstrate that the values overall are very low in the samples. There is a correlation between organic carbon content and percent silt content as higher than average percent carbon values are observed in samples collected at A03, D02, E01 and E02. For instance, samples collected in the area of new drainage channels, which experienced an influx of fine sediment in 2007, show an increase in the percent carbon. The trend here may be caused in part by the burial of eelgrass and/or other organic matter as a result of the sediment leakage. Root fragments or blades of eelgrass can also have a marked effect on the results of the carbon analysis, and local variation in the samples due to micro site sampling selection appears to have a greater influence on the returned value than any expected temporal or geographic trend.

3.1.5 Interpretation of Orthophotographs

The study area for this monitoring activity, as outlined in the Detailed AMS Workplan (Hemmera, 2007), includes the area of Roberts Bank within the inter-causeway portion of the tidal flats. Important changes to the physical environment have been ongoing since the initiation of construction activities for the BC Ferries Causeway and terminal in 1958. These changes have been extensively documented in the Coastal Geomorphology Study (NHC, 2004) and include formation of large systems of dendritic channels, lateral expansion of eelgrass beds, and dredging for expansion of the ship turning basin.

Four main areas of geomorphic change have been identified from the interpretation and mapping of the orthophotos:

1. New drainage channels that formed at the north-eastern margin of the perimeter dike in 2007;
2. Formation of sand bars on the tidal flats on the seaward side of the Crest Protection Structure;
3. The large system of dendritic channels draining into the turning basin; and
4. The tidal channels adjacent to the BC Ferries Causeway.

These features are shown in **Figure 35**. **Figure 36** shows a detailed view of the area of new drainage channels.

3.1.5.1 New Drainage Channels

The new drainage channels that first became visible in the 2007 orthophoto were initially formed by seawater leaking from the perimeter dike enclosing the DP3 footprint. The south side of the perimeter dike was sealed with sand in July 2007 and flow was observed to have decreased from the perimeter dike the next day. Some leakage of sediment-laden waters was reported within this period but the precise quantity is not known. By the time the 2008 monitoring began, the area within the DP3 footprint had been filled with sediment from dredging activities and water drainage from the dike had ceased.

The channels affected an area of approximately 3.4 hectares, roughly divided between a zone of erosion and a zone of deposition. The channels on the upper mud flats (above approximately 1.5 m (Chart Datum) elevation), which were mostly free of vegetation, initially incised into the soft sediment and carried a significant amount of material into the lower tidal flats immediately shoreward of the Crest Protection Structure. The deposition zone resembles that of an alluvial fan and coincides with an area of medium to dense eelgrass beds. Areas within the eelgrass were observed to be buried under the soft sediment within the deposition zone.

Sediment redistribution along the area of new drainage channels appears to have been limited over the last year. The 2009 orthophotos were collected during a low-tide of 0.7 m (Chart Datum), which partially obscures some of the detail on the lower part of the tidal flats. However, DoD rods located in the area have shown bed elevation changes in 2009 to be consistent with much of the rest of the tidal flats. Rods at E01 and E02, for instance, generally experienced net erosion or net deposition of 2.0 cm or less.

In addition to stable ground elevations, the channels have not undergone appreciable lateral migration since 2008. The footprint of the active channel zone is also largely the same. Whereas the expansion of eelgrass beds observed in the 2008 photos was largely confined to the upper mud flats, according to orthophotos from 2009, eelgrass has now also colonized the lower flats and presumably increased its stability.

3.1.5.2 Sand Bars Seaward of the Crest Protection Structure

The portion of the tidal flats on the seaward side of the Crest Protection Structure has a much higher level of exposure to waves than the areas behind the structure. Breaking waves have often been observed in this area but never on the landward side of the structure. Although the tide level does render the mapping here less accurate, large bar forms visible in the orthophotos flown in 2009 have shown changes in lateral extents when compared the 2008 orthophotos. They lie within the same general area, however, because of the topographical constraints of the Crest Protection Structure and subtidal edge.

Natural modification of the sand bars in this area is expected to continue, with wave action and tidal flow moving the existing sediment along the edge of the turning basin, and some new sediment coming from the existing tidal channels. The DoD rods in this area have measured some of the largest amounts of erosion and deposition, which is discussed above, and the Crest Protection Structure monitoring cross-sections have captured some of the elevation changes. Future monitoring activities will continue to make note of changes to this area.

3.1.5.3 Large System of Dendritic Channels

The large system of dendritic channels shown in **Figure 35** was the focus of detailed geomorphic and hydrodynamic analysis as part of the Coastal Geomorphology Study (NHC, 2004). Historic orthophotos show that these channels evolved gradually since the ship turning basin was originally dredged in 1969 and developed further, following expansion of the turning basin and construction of the Crest Protection Structure in 1982. The system of channels and sand bars presently extends over a large area of the tidal flats. The sand bars alone covered an area of over 30 hectares in 2002. The results of previous analysis (Coastal Geomorphology Study, NHC 2004) concluded that the formation of these large channels is related to historic dredging of the ship turning basin. Given that they are relatively removed from the assumed area of influence of the new DP3, it is unlikely that they are being influenced by, or have influence on the present project.

The main features of interest in the large dendritic channels include the main trunk channel, a very large sand deposit at the shoreward end of the trunk channel, referred to as the ‘sand lobe’, and a system of smaller ‘tributary’ channels extending from the trunk channel shoreward across the tidal flats. **Figure 36** shows the outline of the channels that were digitized from the 2008 and 2009 orthophotos. The trunk channel has remained relatively stable, but the orthophoto comparison shows small changes to the rest of the system since July 2008. Shoreward extension of the tributary channels has continued to occur over the last year with some additional widening of these channels. The lateral migration of some of the larger tributary channels is accompanied by an evolution towards a more meandering planform. In some instances, flow appears to have split to form additional small tributaries.

3.1.5.4 Channel Development along the BC Ferries Causeway

The tidal channel and its tributaries that have formed adjacent to the BC Ferries Terminal do not appear to be related to any of the activities of Deltaport but the channels fall within the study area for the AMS monitoring program. These channels appear to have formed initially in response to expansion of the ferry terminal and have continued to headcut as a result of tidal drainage. In the period between 2008 and 2009 orthophotos, the channels have further extended shoreward.

A much smaller channel has developed on the upper tidal flats from overland drainage from the agricultural lands inside the dikes. The creek and its active channel zone have been extending seaward. As expected, these channels appear to have joined between July, 2008 and July, 2009, making it potentially possible for the larger connected channel to expand more rapidly in the future. The width of the active channel zone near the connecting area is noticeably smaller in 2009 as compared to the previous year. It has been mapped as such because in the 2008 photos, more sand than eelgrass is visible in the area whereas in 2009, the opposite is true. The apparent change may be attributed to natural variations in eelgrass coverage, in this case, local growth and expansion, or could be the result of a reduction in sediment being actively broadcast by the channel over the area. It is not possible to conclusively determine which of the two processes is occurring from the orthophotos alone, particularly within this transitional eelgrass zone.

3.1.6 Coastal Geomorphology Mapping

As outlined in the results section (Section 2.0), there was no new data collected under this activity. Resurvey of the inter-causeway portion of the study area is scheduled for year 3 or 4 of the monitoring program. At present, as there have been no major issues identified in the AMS monitoring program that would be captured by these surveys, there is no imminent requirement to conduct the follow-up surveys.

3.1.7 Wave and Current Monitoring

The wave climate at Deltaport is affected both by waves generated in deep water in the Strait of Georgia as well as waves generated locally from within the inter-causeway area. **Figure 12** shows the fetch lengths for waves based on winds from various directions at 10° increments. The focal point of the figure is the southern end of the Deltaport terminal. Fetch length was used in the hindcast wave calculations to generate an overall picture of the wave climate for 2009 that would potentially be measured by the wave sensors installed in the study area but is not a wholly accurate predictor because it does not account for wave reflection or refraction within the study area.

Waves generated by winds from the southeast to the northwest are generated in open water and, for those waves that interact with Deltaport or the BC Ferries terminal, they approach the ship turning basin with some degree of deflection. Winds from the northwest, clockwise through to the east southeast, have very short fetch lengths because of the proximity of the site to shore and its location relative to the two causeways and the terminals. Open water waves from other directions are likely to be mostly blocked by the causeways and terminals, and only local waves generated within the study area these winds would be measured by the sensors.

The locations of the three wave sensors in the study area were chosen to reflect a range of wave environments to be representative of overall conditions on the tidal flats (**Figure 6**). Sensor #3 is located within the ship turning basin and is exposed to open water waves from all directions that are not physically blocked by Deltaport or large ships berthed at the terminal. The instrument is deployed at a height of approximately -3 m (Chart Datum), and with the ground sloping upwards gradually shoreward, a majority of the waves are not significantly affected by interaction with the bottom at most tide heights. Sensor #2 is located immediately behind the Crest Protection Structure at an elevation of 0.7 m but the elevation of the Crest Protection Structure in this area is approximately 1.1 m. Sensor #2 is therefore in the same general wave path as Sensor #3 but waves at most tides are completely blocked or partially transformed by interaction with the Crest Protection Structure. Sensor #1 is located on the middle tidal flats, within eelgrass beds at an elevation of approximately 1.2 m. The wave climate measured by Sensor #1 has been reduced by the Crest Protection Structure, the Deltaport terminal, installations in the tug basin, and the shallow tidal flats surrounding the instrument. In general, the wave climate is expected to be most energetic at Sensor #3 and least energetic at Sensor #1. Whereas this trend may not apply to locally generated waves, such waves would typically be smaller than their open water counterparts.

The maximum significant wave height recorded in the inter-causeway area in 2009 was 1.01 m on November 18 at 6:00 pm. This large wave is part of several that correspond to a series of large wind events, mainly from the south, recorded at Vancouver Airport in the days before and after November 18. Although the hindcast wave of 1.93 m calculated for this date is significantly less than the 2.90 m calculated for a few days earlier (November 13), its more strongly measured impact is due to the coincidence of this wind event with high tides. The largest hindcast wave was predicted to be 3.00 m on March 31, 2009, resulting from a windstorm coming from the west. However, the largest corresponding wave for this date was measured by Sensor #2 at 0.29 m (Hs). Winds from the south and southeast have the greatest effect on wave heights at Deltaport.

In general, wave heights measured at Sensor #1 are less than 0.05 m and at Sensor #2 and #3 they are generally less than 0.2 m. Although there are significant data gaps, the wave heights shown in **Figure 37** for 2009 indicate that the expected general trend of highest wave energy at Sensor #3 and lowest energy at Sensor #1 is supported by the data, but the waves measured at Sensor #2 are very similar in height to Sensor #3. A period of large waves on March 15 illustrates this point well: significant wave heights at Sensor #3 and Sensor #2 are above 0.4 m while at Sensor #1 they barely exceeded 0.1 m. March 5 to July 20 (with a gap in May at Sensor #1 and #3) is the longest period of coincident measurements at all three sensors (**Figure 39**). The maximum significant wave heights during this period are listed below in **Table 3.1-1**. The largest wave measured in this period was 0.75 m at Sensor #2, and 0.46 m at Sensor #3, both on March 15, 2009.

Table 3.1-1 Maximum Significant Wave Heights for the Three Wave Sensors for the Period between March 5 and July 20

	Sensor #1	Sensor #2	Sensor #3
Max. wave height (m)	0.11	0.75	0.46

For the fall and winter season from September 15 to December 31, there was no data obtained from Sensor #3 but Sensors #1 and #2 were active (**Figure 41**). The maximum significant wave height measured at Sensor #1 and Sensor #2 during this period was more than five times as high as the wave heights typically measured at these sensors.

The Coastal Geomorphology Study (NHC, 2004) included a detailed analysis of tidal currents in the vicinity of the DP3 project, for both pre-project and with project conditions. The numerical model analysis was performed using River2D, a two-dimensional depth-averaged finite element model that uses tide height as the boundary condition when computing unsteady flow; in this case the tide curve from the gauge at Point Atkinson. River2D is designed to switch from open channel flow equations to groundwater flow equations in areas that dry, such as occurs over the tidal flats during most tide cycles. The model was used to calculate tidal flow around the existing Deltaport terminal as well as the new DP3 terminal. A comparison of the results provided a prediction of the effects that the DP3 terminal would have on local tidal currents.

In the initial stages of the model investigations, the main area of concern with respect to increased tidal currents was the area at the northeastern tip of the DP3 terminal where it was thought that an increase in current velocities could cause potential issues relating to scour and movement of various marine organisms such as pelagic-stage crabs. The results of the modelling showed that during certain tidal conditions there would be an increase in velocities at the tip of the wharf extension as flows accelerated around the end of the third berth caisson wall, but resulting in tidal currents of less than 0.2 m/s. The conclusion of the Coastal Geomorphology Study (NHC, 2004) was that these conditions were well below the threshold for any significant sediment transport.

Prediction of sediment movement by flowing water is typically based on a calculation of shear stress using the Shields equation, whose main components include grain size, flow depth, and water surface slope. Shear stress is calculated by the River2D model and was analysed during the original (2004) study. The Shields equation does not consider flow velocity so it is not possible to provide a reliable threshold for sediment movement based on velocity alone. However, Hjulstrom (1935) predicted sediment movement based on grain size and flow velocity for rivers based on average reach conditions. The Hjulstrom diagram indicates that the minimum velocity for erosion of sandy sediments in the 0.2 mm size range is 0.2 m/s. While this cannot be considered an absolute threshold velocity, it does provide a reasonable level of assurance that velocities of 0.2 m/s and lower will not result in significant sediment transport.

An alternate strategy was developed to assess the model results for the purposes of the AMS monitoring. Tidal current velocities were measured during a large tidal swing using and ADCP along a transect extending from the end of the caisson wall. The main purpose in doing this was to verify that the model predictions are reasonably accurate and to provide additional reassurance that it is possible to rely on the model predictions in lieu of ongoing monitoring of velocity. Preliminary results and analysis of the ADCP measurements were presented in the Q4-2009 AMS report. These results were compared to a model run from the Coastal Geomorphology Study (NHC, 2004) that had a similar tidal flow (large tide).

The ADCP results presented in **Figure 43a/b** are typical of vertical velocity profiles within slow moving water. Most of the bins (the vertical divisions in the water column) for a given position along the transect show velocities in the range of 0 m/s to 0.25 m/s, but values occasionally reach up to 0.5 m/s. The depth-averaged ADCP velocities though are generally very low, ranging from 0.14 m/s to almost 0.19 m/s. Although the sea conditions on the day of the ADCP measurements were nearly calm, small waves were present and have the potential to cause interference in the vertical velocity profile because of the orbital velocity within the wave as well as the pitch and roll of the instrument. These effects are typically irrelevant in faster currents but in slow moving water the effect can result in some unsteadiness in the measured profile. In order to compensate for this, the ADCP measurements were averaged along the transect using a rolling average spanning approximately 12 m.

Figure 43 provides a comparison between the measured velocities and the model results for both falling tide conditions (**Figure 43a**) and rising tide conditions (**Figure 43b**) for five discrete points. The measured velocities are approximately twice as high as the model predictions during the falling tide, though they are still very low. This appears to be due mostly to the fact that the model predicts that the slightly higher velocities that occur earlier in the dropping tide to slow down more rapidly than they do under the real world conditions. During the rising tide condtion, the model predictions agree with the ADCP measurements to within a difference of less than 0.05 m/s. These results demonstrate that the model provides a highly reliable prediction of tidal currents in the vicinity of DP3 and that the project can be expected to behave as predicted in the 2004 Coastal Geomorphology Study.

3.2 SURFACE WATER QUALITY

The discussion of surface water quality monitoring results considered both spatial and temporal trends.

Results from stations DP02, DP03, and DP04, intertidal stations in the inter-causeway area, were compared to results from DP06, the intertidal reference station (**Figure 8**). The results from station DP05, the subtidal station in the inter-causeway area were compared to those from the subtidal reference station (DP07). The A level and B level subtidal results were also considered separately. As noted in **Section 1.3.2**, the A level samples at DP05 and DP07 were collected one metre below the surface of the water and B level samples were collected 2.0 metres above the sediment. Station DP01 was not included in this comparison as it has no associated reference station. Stations DP08 and DP09 were not included in the temporal trend analysis since they were only sampled in Q1, as part of the benthic invertebrate monitoring program.

3.2.1 Spatial Trends between Inter-causeway and Reference Stations

The data collected within the inter-causeway area were compared with the results from the reference stations in **Figures 51** and **52**. Note that the average values presented in **Figures 51** and **52** include only data from the four quarters in 2009 as they are intended to capture spatial trends in 2009. Temporal trends (2007, 2008, and 2009) are captured in **Figures 53** and **54**.

3.2.1.1 Metals

Figure 51 compares average metal concentrations at the eight monitoring stations over the four quarters in 2009. In addition to copper and zinc (which exceeded the BC Water Quality Guideline (WQG), the figure also includes arsenic, barium, lead and cadmium, as these are metals with regulatory guidelines with detected concentrations generally greater than the RDL. Other regulated metals parameters, including beryllium, chromium, mercury, selenium and silver, were not included as most values were less than the RDL. Uranium was not included as concentrations were typically less than 2% of the BC WQG.

The highest metal concentrations in surface water were measured at DP06 and DP07, while the lowest were measured at DP08. Metal concentrations at the A and B levels at DP05 were more similar than metal concentrations at the A and B levels at DP07. Metal concentrations measured at DP07A were more similar to those at DP06 than to those at DP07B, suggesting Fraser River influence.

Chromium, copper, and zinc were the only three metals to exceed the BC WQG. The chromium exceedances were all noted in Q3-2009. Chromium concentrations at DP02, DP03, DP04, and DP07B ranged from 59 to 64 µg/L, marginally greater than the WQG of 56 µg/L. Given that both inter-causeway and reference stations were affected, it was likely a function of natural variability in background concentrations. Copper concentrations were in the highest range at DP01, DP04, DP05A, DP05B, DP06, and DP07B. It should be noted that the copper exceedances were less than two times the WQG of 3 µg/L. The zinc concentrations were in the highest range at DP06 and DP07A. The average zinc concentration at DP06 was skewed upward by the concentration measured in Q4-2009 (147 µg/L). The laboratory re-analyzed the sample and obtained the same result. Given that this exceedance was noted at reference station DP06 and that no other exceedances were noted in surface water in Q4-2009, the exceedance is not considered an issue with respect to DP3.

Overall, metal concentrations in surface water were lower in the inter-causeway area than at the reference stations.

3.2.1.2 Eutrophication-related Parameters

Figure 52 shows spatial trends in eutrophication-related parameters. The highest chlorophyll α, ammonia, and TKN concentrations in surface water were measured at DP01. The elevated concentrations at DP01 are attributed to upland inputs. Fertilizers are applied to agricultural land upgradient of DP01 to enhance crop growth. Excess nutrients subsequently make their way in groundwater and surface water that is conveyed to the ditch where DP01 is location.

The DO concentrations fell in the lowest range at DP05B and DP07B, in the highest range at DP02, DP03, and DP04, and in the intermediate range at the remaining stations. The elevated DO concentrations measured at DP02, DP03, and DP04 were likely a function of the presence of eelgrass at these stations. Relatively low DO was expected at DP05B and DP07B, as DO typically decreases with depth. The nitrate and nitrite concentrations were in the lowest range except at DP07B, where they were in the intermediate range. The relationship between nutrient concentrations in samples from DP07A and DP07B was more variable, than between concentrations in samples from DP05A and DP05B.

Key spatial trends observed in 2009 were relatively elevated nutrient concentrations at DP01 (upland run-off) and the low nutrient concentrations at DP03, DP04, DP05, and DP08. The higher ammonia concentrations measured at DP06 are likely due to inputs from the Fraser River as there is significant agricultural activity upstream. The spatial analysis did not suggest a trend towards eutrophication.

3.2.2 Temporal Trends

Metal concentrations in surface water did not show clear increasing or decreasing temporal trends between quarters or consistent seasonal patterns (**Figure 53**). Both the highest metal concentrations and the greatest variability were observed at DP01. Elevated cadmium, copper, lead, and zinc measured at DP07B in Q3-2009, decreased to levels in the same range as those measured at DP07B in previous events in Q4-2009. The temporary increase may have been linked to suspended sediment, perhaps linked to Fraser River inputs. The same is likely true for the two order of magnitude increase in zinc noted at DP06 in Q4-2009. The elevated concentrations noted at the reference stations in Q3-2009 and Q4-2009 were not noted stations in the inter-causeway area.

Dissolved oxygen concentrations did not show major fluctuations over time or distinct seasonal patterns (**Figure 54**). This is in agreement with the sonde data (**Section 2.3.2**), located in the subtidal portion of the inter-causeway area.

With the exception of a rise at DP01 and a drop at DP06 in Q2-2009, chlorophyll *α* concentrations were similar to those measured in 2007 and 2008, showing neither a distinct seasonal trend, nor a distinct increase or decrease over time (**Figure 54**).

The nitrate, nitrite, TKN, phosphorus and ammonia concentrations did not exhibit an increasing or decreasing trend over the course of three years of monitoring (**Figure 54**). The temporal analysis did not suggest a trend towards eutrophication.

3.2.3 Ecosystem Health and Function

As metal and nutrient concentrations in surface water have not shown an increasing trend in the three years of AMS monitoring, DP3 construction and operation have not had a negative impact on water quality in the inter-causeway area.

Phosphorus and nitrogen are two key nutrients associated with plant growth. Increasing concentrations of either may signal an increased risk of algal blooms or eutrophication. In marine environments, nitrogen is the limiting nutrient. Nitrate accounted for the bulk of total nitrogen in the water samples (**Figure 53**). Ammonium is the form of nitrogen preferentially taken up by aquatic plants from surface waters. For phosphorus, orthophosphate, the soluble, inorganic fraction, is the form taken up by plants.

Other key parameters that may act as indicators for eutrophication include chlorophyll *α,* dissolved oxygen, and TSS. Chlorophyll *α* levels fluctuate naturally with the seasons; rainfall, and warm summer water temperatures and light levels lead to greater phytoplankton numbers, and therefore higher chlorophyll *α* levels. However, long-term elevated concentrations of chlorophyll *α* can reflect an increase in nutrient loads and increasing trends can indicate eutrophication. An increase in TSS can also signal an increase in phytoplankton or detritus associated with eutrophication although inorganic particulate matter may account for a significant portion of TSS and confound any trends.

An extensive body of literature on eutrophication exists. Sources considered in to the evaluation of eutrophication-related data collected at DP3 included:

- National Oceanic and Atmospheric Association
- Australian and New Zealand Environment Conservation Council
- European Environment Agency
- HELCOM – Baltic Sea
- OSPAR – North-East Atlantic
- Canadian Council of Ministers of the Environment (CCME)

While most jurisdictions proposed gauging the potential for eutrophication by establishing local or regional baseline conditions, the CCME presented the following criteria from work by Vollenweider et al. (1998) and Bricker et al. (1999).

Table 3.2-1 Criteria for Evaluating Trophic Status of Marine Systems (Vollenweider et al. 1998)

Trophic Status	TN (mg/L)	TP (mg/L)	Chlorophyll α (µg/L)
Oligotrophic	< 0.26	<0.10	<1
Mesotrophic	≥0.26-0.35	≥0.10-0.30	≥1-3
Eutrophic	≥0.35-0.40	≥0.30-0.40	≥3-5
Hypereutrophic	≥0.40	≥0.40	≥5

Table 3.2-2 Trophic Status Classification Based on Nutrient and Chlorophyll (Bricker et al. 1999)

Degree of Eutrophication	TN (mg/L)	TP (mg/L)	Chlorophyll α (µg/L)
Low	0-≤0.1	0-≤0.01	0-≤5
Medium	>0.1-≤1	>0.01-≤0.1	>5-≤20
High	>1	>0.1	>20-≤60

The average nitrogen concentration in the study area over the first three years of data collection was 2.2 mg/L. While this suggests a high degree of enrichment under both classification systems, this falls within the range considered normal for the Strait of Georgia, which has naturally elevated nitrogen concentrations (Mackas and Harrison 1997). The average phosphorus concentration in the study area was 0.08 mg/L, which falls in the medium range under Bricker's classification system and oligotrophic under Vollenweider's classification system. The average chlorophyll α concentration in the study area was 1.3 µg/L, which is considered low and indicative of mesotrophic conditions.

Given that naturally occurring nutrient concentrations vary significantly from one area to another, many regulatory jurisdictions recommend the development of site-specific criteria where there is sufficient site-specific information to do so. Since VFPA now has several years of monitoring, it is recommended that the current 'trend analysis' approach be further supplemented with the development of site-specific criteria. As we have not seen increasing nutrient or chlorophyll α concentrations or decreasing oxygen concentrations suggesting that DP3 construction or operation has had an impact on these parameters, Hemmera proposes using averages of the first three years of data to define background conditions. While a larger data set would be desirable, three years of data is considered sufficient for defining background conditions by the Australian and New Zealand Environment Conservation Council, one the organizations that the CCME has looked to in developing its guidance framework for the management of nutrients in nearshore marine systems. OSPAR (2005), another organization whose work has been considered by the CCME, recommends setting eutrophication monitoring criteria at 50% above background concentrations for nitrogen, phosphorus, and chlorophyll α. For dissolved oxygen, which may change as an indirect effect of nutrient enrichment, the OSPAR recommends that a region-specific oxygen deficit level be established. The Australian and New Zealand Environment Conservation Council recommend using the 20^{th} and 80^{th} percentiles of the reference data.

Following discussions with VFPA and SAC, graphs showing the relationship between nitrate to ammonia and total nitrogen to total phosphorus in surface water were prepared to determine if station-specific or area-wide trends in these ratios exist which might be used as a line of evidence in evaluating ecosystem health (**Figure 55** and **Figure 56**). When present in excess, ammonia is toxic to organisms. Under eutrophic conditions, ammonia would be expected to accumulate. **Figure 55** suggests that while nitrate concentrations vary from station to station, the ammonia concentrations fall in a more restricted range, except at DP01 where there are nutrient inputs from upland sources and surface water in the drainage ditch is not oxygented to the same extent as surface water in the inter-causeway area or at the reference sites.

The Redfield ratio defines the optimal C:N:P ratio in the marine environment as 106:16:1. In particular, the N:P ratio of 16:1 is considered the optimal ratio for phytoplankton growth. Eutrophication can lead to a shift in this ratio. Given the lack of temporal trends in the inter-causeway area or the reference stations towards eutrophication, the current N:P ratio is considered to reflect that which naturally occurs in the study area. The average N:P ratio in the study area over the first three years of the AMS program is 34:1, which is more than double the predicted ratio. While nitrogen concentrations in the area are naturally elevated, **Figure 56** shows several outliers, which would further bias this ratio upwards.

3.3 SEDIMENT QUALITY

Similar to surface water, the discussion of sediment quality results considered both spatial and temporal trends, with particular attention given to parameters associated with eutrophication.

A lithium geonormalizing technique was applied to distinguish between metals inputs from anthropogenic sources and natural variations in background metal concentrations. Lithium occurs predominantly in several common silicate minerals where it substitutes for potassium, sodium, and magnesium and has been shown to be an effective means to normalize metals concentrations to background (Sutherland et. al. 2007).

Figure 57 shows sediment metals parameters normalized to lithium in 2007, 2008, and 2009. For most parameters, the normalized metal parameters lay close to the regression line suggesting natural background concentrations. Outliers representing potential external enrichment were noted for copper at DP01, aluminum, barium, and manganese at DP02 and mercury at DP06.

The lithium normalization plots suggest that elevated metal concentrations measured at DP05 and DP06 are reflective of background conditions, rather than inputs from DP3 construction.

3.3.1 Spatial Trends between Inter-causeway and Reference Stations

Figures 58 and **59** show a comparison of the relative variation of sediment metals and eutrophication-related parameters between the intertidal inter-causeway stations (DP02, DP03, DP04, DP05, DP08, and DP09) and their associated reference samples (DP06 and DP07).

3.3.1.1 Metals

Figure 58 shows spatial trends in metals concentrations for the CSR Schedule 9 sediment metals parameters (arsenic, chromium, copper, mercury and zinc)[3]. It should be stressed that there were no exceedances of the CSR standards. The lowest metal concentrations in sediment were measured at DP01, while the highest metal concentrations were measured at DP05 and the second highest at DP06. However, chromium not only fell in the highest range at DP05 and DP06, it also fell in that range at DP02 and DP07. Overall, metal concentrations were lower in the inter-causeway area than at the reference stations, possibly due to Fraser River inputs to DP06 and DP07.

3 Cadmium and lead were not included in the spatial trend graphs as concentrations were less than the RDL for all samples. CSR Schedule 9 sediment criteria are generally adopted by federal regulators in BC due to the extensive federal input into their development.

3.3.1.2 Eutrophication-related Parameters

As with surface water, phosphorus and nitrogen in sediment are two key nutrients associated with plant growth. Increasing concentrations of either may signal an increased risk of eutrophication. In sediment, nitrate is the primary nitrogen source for aquatic plants; however, both nitrite and ammonia have the potential to undergo nitrification to nitrate. Elevated TKN concentrations are usually the result of sewage and manure discharges to water bodies.

Concentrations of eutrophication-related parameters in sediments at the inter-causeway stations were generally greater than those at the reference stations (**Figure 59**), with nutrient concentrations consistently falling in the lowest range at DP06 and in the lowest range at DP07, except for phosphate and total nitrogen which fell in the intermediate range. The highest concentrations of eutrophication-related parameters were measured at DP05, where four of the five fell in the upper range. The exception was phosphate, which fell in the intermediate range. There was no spatial trend in concentrations of eutrophication-related parameters in the inter-causeway area. Ammonia fell in the intermediate range at DP02, DP03, and DP04, and in the lowest range at DP08. TKN fell in the low range at DP02, and in the intermediate range at DP03, DP04, and DP08 while total nitrogen and phosphate fell in the low range at DP08, and in the intermediate range at DP02, DP03, and DP04. Sulphide concentrations were in the upper range at DP04, in the intermediate range at DP08, and in the low range at DP02 and DP03.

The Eh values have generally been between 100 mV and –100 mV. There was no clear spatial trend in redox values (**Table 19**). If a consistent decrease in redox values were observed, it might suggest a trend towards eutrophication.

3.3.2 Temporal Trends

3.3.2.1 Metals

Temporal variation in metal concentrations in the intertidal sediments is shown in **Figure 60**.

Copper, chromium, and zinc concentrations showed the greatest variability at DP01, but remained within the same range as those measured in 2007 and 2008. No net increase or decrease in copper, chromium, or zinc concentrations was observed. Mercury concentrations at DP01 were greater than those recorded in 2008 in Q2-2009 and Q3-2009; however, the mercury concentration recorded at DP01 in Q4-2009 was the lowest recorded over the course of the three years of monitoring.

In 2009, mercury concentrations were stable at DP01, DP02, and DP04, with values generally falling between 0.020 and 0.030 mg/kg. Mercury concentrations were also stable at DP05, but ranged from 0.057 to 0.080 mg/kg. At DP06, mercury concentrations were similar to those measured in 2007, ranging from 0.0251 to 0.0513 mg/kg. Mercury concentrations at DP03 and DP07 were in the same range as at DP06.

3.3.2.2 Eutrophication-related Parameters

Phosphate concentrations showed very little variation at the seven stations monitored over the full three year period (**Figure 61**). Sulphide concentrations were most variable at DP01 and least variable at DP06. Short term increases in sulphide have been noted; however, there has been no net increase in sulphide concentrations. Ammonia, TKN, and total nitrogen concentrations varied over the course of 2009, but remained within the range within the range of those previously measured at DP01, in the inter-causeway area and at the reference stations.

3.3.3 Ecosystem Health and Function

The spatial and temporal analysis of the sediment data does not show a trend towards eutrophication or changes in metal concentrations resulting from DP3 construction or operation. Following discussions with VFPA and SAC, graphs showing the relationship between total nitrogen and total phosphorus, TOC and total nitrogen, and TOC and total phosphorus in sediment were prepared to determine if station-specific or area-wide trends in these nutrient ratios exist which might be used as a line of evidence in evaluating ecosystem health (**Figures 62**, **63**, and **64**). As noted in **Section 3.2.3,** the Redfield ratio defines the C:N:P ratio in the marine environment as 106:16:1. While this applies fairly consistently to surface water and phytoplankton, there appear to be more factors affecting the carbon, nitrogen and phosphorus balances in sediment, resulting in a wider range of these ratios in sediment. Eutrophication can lead to a shift in this ratio. However, given the lack of temporal trends in the inter-causeway area or the reference stations towards eutrophication, the C:N:P ratios are considered to reflect those naturally occurring in the study area. Neither the N:P nor the C:P ratios corresponded to the Redfield ratio, perhaps due to the variable nature of the estuarine environment, but the average C:N ratio was 8.0, falling in the same range as the predicted ratio of 6.6.

Given the number of site-specific factors that contribute to defining background concentrations and given that we now have several years of data to draw upon, it is recommended that site-specific sediment nutrient criteria are developed to supplement the trend-approach for evaluation of eutrophication.

3.4 EELGRASS

The eelgrass habitat in the area that was affected by sediment deposition and new drainage channel formation adjacent to the perimeter dyke in the inter-causeway area in 2007 has expanded. The continuous *Z. marina* habitat has increased and new areas of patchy *Z. marina* and mixed *Z. marina* and *Z. japonica* have developed. It is likely that the *Z. marina* will continue to expand vegetatively throughout this area, colonizing areas that are located at a suitable elevation for the species.

Z. japonica has colonized an area near the northwest corner of the inter-causeway that was unvegetated in 2003 and 2008. The area supported patchy *Z. japonica* in 2007. *Z. japonica* is an annual species, recruiting from seeds every year. The inter-annual variability of *Z. japonica* colonization in this area is likely related to inter-annual variability in climate.

Habitat changes in the area north of the sand lobe between the continuous *Z. marina* and continuous *Z. japonica* zones, and in the *Z. japonica* zone along the Deltaport Causeway may be due in part to sediment accretion resulting from the evolution of the sand lobe.

Z. marina and *Z. japonica* are both limited in their distribution by exposure during low tide (desiccation stress). The morphology of *Z. japonica* enables it to survive exposure better than *Z. marina*, thus it is able to survive at elevations beyond which *Z. marina* can survive. The shoot size of *Z. marina* decreases in response to increasing elevation.

The transition zone between the continuous *Z. marina* and continuous *Z. japonica* zones, where both species co-existed and combined to provide continuous cover, developed prior to the mid 1980s (C. Durance, pers. obs.) and was mapped in 2003 (Triton, 2004). The elevation in the transition zone was sub-optimal for *Z. marina*, it could not grow well enough to form a monoculture and *Z. japonica* was able to occupy the spaces between the *Z. marina* shoots in this area.

The transition zone expanded into the continuous *Z. marina* zone northwest of the sand lobe by 2007, indicating a decrease in the suitability of that area for *Z. marina*. Vertical rhizome growth occurs in *Z. marina* in response to sediment accretion and was noted in this area in 2008. Most of the transition area northwest of the sand lobe was reduced to patchy cover by 2008, and by 2009 the majority of area had developed into a patchy *Z. japonica* zone.

Site 1 was located in the area that has changed; by 2009 the habitat in the vicinity of Site 1 was classified as patchy mixed. The mean shoot size and density had decreased, and the relative productivity (LAI) had decreased by 92% relative to 2003.

The reduction in *Z .japonica* along the Deltaport Causeway may also indicate that sediment has been accreting northwest of the sand lobe.

An alternative possibility is that the responses in eelgrass growth and distribution are due to a decrease in mean sea level over this time. The transition zone was almost too high for *Z. marina* in 2003, therefore a decrease of a few centimetres in sea-level could have led to the observed change in habitat. However, it is unlikely that a decrease in mean sea level is the only factor responsible for the change in habitat since the transition zone northeast of the sand lobe has not changed to the same extent.

A bathymetric survey of the inter-causeway area has been commissioned for 2010; the results of this survey may assist in determining the factors that led to these habitat changes.

The SIMS survey was able to map eelgrass to a depth beyond which it is visible on orthophotos. A comparison of the survey results from 2009 with those from 2003 indicates that the lower limit of eelgrass distribution has remained relatively stable over this time period.

3.4.1 Eelgrass Vigour and Health Discussion

Research has shown that eutrophication may lead to an elevated epiphyte load on eelgrass. The epiphyte load on the eelgrass at all stations on Roberts Bank and at the reference stations at Boundary Bay in 2009 was comparable to previous years at the time these beds were surveyed.

Beggiatoa sp. is often used as an indicator species to identify degraded marine habitats. The filamentous preteobacteria forms visible whitish mats in many polluted marine environments, especially those with sediments rich in hydrogen sulphide. *Beggiatoa* sp. was not noted at either Roberts Bank or Boundary Bay during the 2009 eelgrass surveys.

The distribution of *Zostera marina* and the absence of *Z. japonica* at all sampling stations except Site 1A was consistent with records from previous years. Site 1A is located in the area that has changed from continuous *Z. marina* to patchy transition zone (**Section 1.2.1**).

The eelgrass density, shoot morphology, and relative productivity are compared between sampling dates in **Sections 3.4.1.1** through **3.4.1.4**.

3.4.1.1 Inter-causeway area near Deltaport Causeway, Sites 1A, 1B, and 2

The relative productivity (LAI) at Site 2, the reference station closest to DP3, has not changed significantly over the last six years. The mean density in 2009 was comparable to that recorded in 2003 and 2007, however it was less than in 2008 but the difference was not significant. The mean shoot length has increased between each monitoring event. The difference was not significant when the data from 2009 was compared with that from 2008; however it was significant when compared with the 2007 and 2003 datasets.

The morphological characteristics of eelgrass are influenced by a wide range of physical environmental parameters including; depth (Lee at al., 2000), light and nutrient availability (Short, 1983), temperature (Moore et al., 1993), substrate composition (Short, 1983), and tide and wave regimes (Fonseca et al., 1983; Koch and Beer, 1996).

The data from the other inter-causeway stations, excluding Site 1, have demonstrated similar increase in shoot length since 2007. The increase in shoot length at Site 2 from 2007 to 2009 is between that observed at Sites 5 and 6 over the same time period. Sites 5 and 6 are located more than two kilometres from DP3, therefore, it seems likely that the increases are due natural physical environmental variability rather than the development of DP3.

The eelgrass habitat in the vicinity of the original Site 1 has changed since 2003, it has evolved from dense, continuous *Z. marina* to a patchy distribution of relatively sparse *Z. marina* and *Z. japonica*. A decrease in shoot size and LAI was recorded at this site from 2003 to 2008 although the total density of shoots did not change significantly over this period. A comparison of the 2008 and 2009 data demonstrated declines in shoot size and density; these differences were significant. The reduction in eelgrass shoot size and the colonization by *Z. japonica* in the vicinity of Site 1 is likely in response to increased exposure during low tide. Habitat changes have been documented that extend from Site 1 to the sand lobe. The habitat changes may be due in part to sediment accretion caused by the evolution of the sand lobe or a decrease in mean sea level; these hypotheses are reviewed in Section 3.4.

The eelgrass habitat at Site 1 was very similar to that at Site 2 in 2003. Site 2 was selected due to its proximity to DP3. Site 1 was selected as a reference by which to assess changes in the eelgrass habitat adjacent to DP3 should they occur. Site 1 is no longer suitable for comparison to Site 2, therefore a new station, Site 1B was established. The eelgrass habitat at Site 1B is very similar to that at Site 2. Site 1 was renamed Site 1A, monitoring will continue at this site as it may provide insight into the evolution of the sand lobe.

The reproductive shoot density at Site 1A was less than in 2003 and 2007, the difference was significant. The reproductive shoot density at Site 2 was greater than in previous years; however the differences were not significant.

3.4.1.2 Inter-causeway area near BC Ferries Causeway, Sites 5 and 6

The density at Site 5 has been continually increasing since 2003 and the difference was significant when the data from 2009 was compared with the earlier datasets. The LAI at Site 5 has also continued to increase since 2003; the difference was not significant between 2009 and 2008; however it was when 2009 data was compared with that from 2007 and 2003. Shoot length and width did not show any distinct trends over time. The reproductive shoot density at Site 5 was greater than in previous years; the differences were significant.

The eelgrass habitat at Site 6 has remained consistent since 2003; there were no significant differences between any of the datasets from this site.

3.4.1.3 West of Deltaport Causeway, Sites 3 and 4

The length of eelgrass shoots at Site 3 has been steadily declining since 2003; however the difference was only significant between the datasets from 2009 and 2003. The density and width data do not demonstrate any clear trends. The LAI has declined by 46% since 2003; the difference was significant.

The area around Site 3 appears physically dynamic. The study team has often noted eelgrass leaves buried in sediment (sign of accretion) and shoots partially uprooted (sign of erosion) within several metres of each other. The substrate around Site 3 appeared highly disturbed in 2009, rough depressions were noted that varied in surface area from 0.06 to 1.0 m^2, and ranged from 10 to 30 cm in depth. Sea otters create similar depressions by digging clams out of eelgrass beds, although it seems highly improbable that these depressions were created by sea otters. It is likely that the decline in the productivity of the eelgrass is due in part to the physical conditions at this site.

Site 4 is located further into the meadow and is slightly deeper than Site 3. The eelgrass shoots at this site have also declined in length since 2003, however the differences were not statistically significant. The LAI was less than in 2008 and 2003, but greater than in 2007.

The reproductive shoot density at Sites 3 and 4 were greater than in previous years; however none of differences were significant.

3.4.1.4 Boundary Bay, Sites WR1, WR2, and WR3

Site WR1 is higher than any areas supporting *Z. marina* in the inter-causeway at Roberts Bank, the plants are smaller and the habitat not comparable to any of the other sites in the AMS. The data collected at this site may be useful for future projects but is not relevant for the AMS, and therefore it will not be included in this discussion.

The eelgrass shoots at WR2 were shorter than in previous years, in all comparisons the differences were significant. The shoot width has varied since 2003, while the density remained similar since 2007. The decrease in shoot length resulted in decreased productivity in 2009 relative to 2008 and 2007; these differences were significant.

Site WR3 is the deepest site in Boundary Bay. There are no distinct trends in the datasets. The only significant difference was between shoot length in 2009 when compared to 2007. The shoots were much shorter in 2007 than in other years.

The reproductive shoot density at the Boundary Bay sites was similar to that of 2003 and 2007, but less than in 2008. The difference in reproductive shoot density between 2008 and 2009 was only significant at Site WR2.

3.4.2 Ecosystem Health and Function

The assessment of epiphyte load and the absence of *Beggiatoa* sp. were consistent with results from previous years and indicate that the eelgrass habitat was in good condition.

The SIMS survey demonstrated that the lower depth distribution of *Z. marina* along the inter-causeway has remained stable relative to 2003. One of the main factors that govern the lower limit of *Z. marina* distribution is the availability of light. Any factor that reduces the depth of light penetration will cause a loss along the lower edge of the bed; the plants depend on light for photosynthesis. The results from the SIMS survey indicate that the development of DP3 has not caused a decrease in light availability along the lower edge of the eelgrass meadow.

The *Z. marina* and *Z. japonica* distribution in the area adjacent to the DP3 footprint has expanded over the last year.

The mapping surveys have demonstrated a continued loss of eelgrass coverage in the area northwest of the sand lobe. The changes could be due to evolution of the sand lobe and associated dendritic channels, a reduction in mean sea-level, or a combination of both. Bathymetric surveys will determine whether sediment has accreted in these areas.

Site 1 was originally selected as a reference station due to its proximity and similarity to Site 2, the site closest to DP3. Site 1 is located in the area northwest of the sand lobe where habitat has changed as discussed in the previous paragraph. The habitat at Site 1 changed from continuous *Z. marina* in 2003 to patchy mixed by 2009. The shoot density, shoot length, and LAI at this site have continued to decrease annually since 2003.

The habitat in the vicinity of Site 1 is no longer comparable to that at Site 2; therefore a new station Site 1B was established in 2009 that may be used to assess eelgrass habitat changes near DP3. Site 1 will continue to be monitored and will be referred to as Site 1A.

The eelgrass at the other sites in the inter-causeway was flourishing. The relative productivity (LAI) was slightly less at most of these sites in 2009 relative to 2008, although the differences were not significant. The relative productivity was greater in 2008 than in previous years, possibly due in part to a shift in the Pacific Decadal Oscillation (PDO) index, as it shifted from warm to cold. The PDO index began a shift towards warm in October 2008, a trend that continued until September 2009. The slight decrease may be due in part to the shift in the PDO.

The SIMS survey demonstrated that the depth range of subtidal eelgrass in the inter-causeway has not changed relative to the 2003 assessment.

The morphology, density, and distribution of eelgrass vary in response to a variety of chemical and physical forcing factors. The data from the reference sites in the inter-causeway demonstrates that the factors influencing eelgrass growth have not been negatively impacted during the construction of DP3.

The *Z. marina* habitat at the reference stations west of Deltaport Causeway has declined relative to previous years. The habitat in the vicinity of these stations appears physically dynamic.

The relative productivity at reference stations WR2 and WR3 in Boundary Bay was less than in 2008, but within the range documented previously.

Based on the data collected to date, there are no indications that the development of DP3 has negatively affected the inter-causeway eelgrass habitat.

3.5 BENTHIC COMMUNITY

Core indicators used to evaluate the baseline benthic invertebrate community data included total abundance, taxa richness, evenness, and the Shannon-Wiener diversity index, as defined in **Section 1.6**. Since 0.5 mm sieve data was available for Q1-2007, but not Q1-2008 or Q1-2009, only 1.0 mm sieve samples were included in the statistical analysis at each of the stations.

3.5.1 Temporal and Spatial Trends

To evaluate core indicators, the inter-causeway stations (DP02, DP03, DP04, DP05, DP08, and DP09) were assessed as a composite of the replicate numbers (A, B & C) (**Table 3.5-1**).

Table 3.5-1 Benthic Invertebrate Abundance, Richness, Evenness, and Diversity across Stations in 2007, 2008, and 2009

Station ID	Year	Abundance	Richness	Diversity	Evenness
DP02	2007	659	25	1.90	0.59
	2008	463	29	1.82	0.54
	2009	589	30	2.09	0.62
DP03	2007	229	22	1.96	0.64
	2008	870	28	1.73	0.52
	2009	1066	32	1.75	0.51
DP04	2007	1679	59	2.65	0.65
	2008	2015	65	2.59	0.62
	2009	3802	68	1.92	0.46
DP05	2007	796	53	3.03	0.76
	2008	1255	54	2.64	0.66
	2009	924	56	2.83	0.70
DP06	2007	61	7	1.09	0.56
	2008	100	10	1.53	0.66
	2009	840	16	1.23	0.44
DP07	2007	275	56	3.47	0.86
	2008	115	32	2.87	0.83
	2009	135	35	3.21	0.90
DP08	2008	1510	47	1.85	0.48
	2009	3538	60	1.68	0.41
DP09	2009	672	36	2.04	0.57

Results in the inter-causeway area in 2009 were generally similar to those from 2007 and 2008 (**Table 3.5-1** and **Figure 46**). As noted in **Section 2.6**, in 2009, the greatest abundance of benthic invertebrates at station DP04, the site closest to DP3. In the inter-causeway area, the lowest abundance of benthic invertebrates was observed at DP02. As in 2007 and 2008, abundance was low at the reference station DP07; however, more than an eightfold increase was noted at DP06 from 2008 to 2009. Despite the increase in abundance at DP06, the lowest richness and diversity were recorded at DP06. The highest richness was noted at DP04, while the highest diversity and evenness were noted at DP07. With the exception of DP05 in 2007, the intertidal sampling stations all had Shannon-Wiener diversity index values below 3.0, indicating a well balanced population.

Spatially, abundance and richness at DP08 was most similar to those at DP04. The core benthic invertebrate indicators at DP09 were most similar to those at DP02.

Data from reference stations DP06 and DP07 was not considered in the temporal analysis. As the abundance data presented in **Table 3.5-1** and the physico-chemical sediment data (**Table 19**) suggested that DP06 and DP07 were distinct from the inter-causeway stations, it was not considered appropriate to group data from those stations with data from the inter-causeway area. The exclusion of DP06 and DP07 from the statistical analysis of temporal trends in the benthic invertebrate community, allows the analysis to focus on near-field changes and avoid confounding factors such as sediment deposition from the Fraser River.

ANOVA was used to test for differences in abundance, richness, evenness, diversity, the ratio of *Polychaeta* abundance to *Amphipoda* abundance, the ratio of *Polychaeta sedentaria* abundance to *Polychaeta errantia* abundance, and the *Tanaidacea* abundance at the inter-casueway stations in 2007, 2008, and 2009. Prior to applying ANOVA, the normality of variables was assessed using normal probability plots. Log transformation was used on the following variables to normalize data: total benthic abundance, *Tanaidacea* abundance, *Polychaeta sedentaria* abundance, *Bivalvia* abundance, *Amphipoda* abundance, *Polychaeta errantia* abundance, *Gastropoda* abundance, *Cumacea* abundance, *Oligochaeta* abundance, total *Polychaeta* abundance, the ratio of *Polychaeta sedentaria* abundance to *Polychaeta errantia* abundance, and the ratio of *Polychaeta* abundance to *Amphipoda* abundance.

The results of the ANOVA tests are presented in **Appendix E**. None of the tests were statistically significant for the inter-causeway sites based on $\alpha = 0.05$. Both abundance and richness increased from 2007 to 2008 and again from 2008 to 2009. *Tanaidacea* abundance also increased. Diversity, evenness, and the ratio of *Polychaeta sedentaria* to Polychaeta *errantia* declined. Given that the results of the ANOVA tests were not statistically significant and that there has not been an increase in nutrient concentrations in surface water or sediment, these changes are likely a function of natural variability in the benthic invertebrate populations.

3.5.2 Correlation with Sediment Parameters

General Linear Modeling Regression was run using data for the following abiotic variables for sediment: total nitrogen, total phosphorus, sulphide, TOC, and percent sand. General Linear Modeling was also completed for the *Polychaeta sendentaria:Polychaeta errantia* ratio, Polychaete:Amphipod ratio, and

Tanaidacea abundance. Since no significant difference between years was found in the outcome of the ANOVA test, data was pooled across years when conducting regression analyses. The sulphide data from Q1-2007, collected prior to the implementation of the 24-hour rush analysis were excluded from the regression analyses.

The results of the regression analyses are presented in **Appendix E**. The regression analysis found the following statistically significant relationships:

- Abundance (Adjusted R^2 = 0.324)
  - A positive correlation between the percent sand and abundance
  - A positive correlation between total nitrogen and abundance
- Richness (Adjusted R^2 = 0.495)
  - A positive correlation between total nitrogen and richness
  - A negative correlation between phosphorus and richness
- Diversity (Adjusted R^2 = 0.485)
  - A positive correlation between sulphide and diversity
  - A negative correlation between the percent sand and diversity
  - A negative correlation between phosphorus and diversity
- Evenness (Adjusted R^2 = 0.337)
  - A negative correlation between the percent sand and evenness
- *Polychaeta sendentaria:Polychaeta Errantia* ratio (Adjusted R^2 = 0.270)
  - A positive correlation between the percent sand and the *Polychaeta sendentaria: Polychaeta Errantia* ratio
  - A positive correlation between phosphorus and the *Polychaeta sendentaria: Polychaeta Errantia* ratio
- Polychaete:Amphipod ratio (Adjusted R^2 = 0.443)
  - A negative correlation between the percent sand and the polychaete:amphipod ratio
- *Tanaidacea* (Adjusted R^2 = 0.488)
  - A positive correlation between the percent sand and the abundance of *Tanaidacea*
  - A positive correlation between the percent TOC and the abundance of *Tanaidace*
  - A positive correlation between sulphide and the abundance of *Tanaidacea*

The correlation coefficients were very low, indicating that sand, sulphide, phosphorus, nitrogen, and TOC were only weakly correlated with the abiotic and biotic variables considered (**Appendix E**). The only exception was total nitrogen and abundance. Greater nitrogen availability allows for more primary productivity and greater benthic invertebrate abundance. It should be noted that while the relationships were significant, the adjusted R^2 values were relatively low, so the regression models explain only a small portion of the variability in the abundance, richness, diversity, evenness, and the ratios. In an ecological context, an adjusted R^2 value in the range of 0.7 would indicate that high degree of the variation in the parameters in question was explained by the regression model. The small sample size should also be taken into account, as natural temporal or spatial variability in total nitrogen, total phosphorus, sulphide, TOC, and percent sand would have a greater effect on the regression results than if a larger number of samples were available. The validity of the weak positive correlation between sulphide and diversity is questionable given the amount of variability in the sulphide data set and the fact that the result is not supported by the literature.

3.5.3 Taxonomic Ratios

Species ratios can be used to evaluate trends towards eutrophication. As such, the polychaete-amphipod ratio was calculated for each station (**Table 3.5-2**). Polychaetes are considered a tolerant species, able to proliferate after an increase in organic matter. They are widely used as indicators of anthropogenic or natural disturbance. Amphipods, in contrast, are relatively sensitive to environmental changes.

Table 3.5-2 The Polychaete-Amphipod Ratio in 2007, 2008, and 2009

	DP02	DP03	DP04	DP05	DP06	DP07	DP08	DP09
2007	7.8	5.8	0.9	283.0	8.0	11.7	-	-
2008	22.6	5.8	13.9	94.0	1.2	3.4	1.6	-
2009	9.6	9.1	1.4	33.0	96.1	4.6	2.4	1.5

With both increases and decreases noted, the data does not suggest a trend towards eutrophication. The increase in the polychaete-amphipod ratio at from 2007 to 2008 at DP02 and DP04 resulted from a decrease in the number of amphipods collected, rather than a significant increase in the number of polychaetes. In contrast, the increase in the polychaete-amphipod ratio at DP03 is due to an increase in polycheates and a decrease in amphipods, while the increase at DP06 is linked to only an increase in the number of polychaetes. Given that the sediment chemistry results did not shown a significant change in metal or nutrient concentrations at these stations, the increases and decreases in polychaetes or amphipods is more likely to be a function of sediment recovery and natural variability, perhaps linked to the timing of the sampling.

Another ratio that can be used to evaluate nutrient enrichment is the *Polychaeta Sendentaria-Polychaeta Errantia* ratio (**Table 3.5-2**). *Polychaeta Sedentaria* are less sensitive to change than *Polychaeta Errantia*. An increase in the *Polychaeta Sendentaria-Polychaeta Errantia* ratio would thus be expected if a trend toward eutrophication were noted in sediment chemistry.

Table 3.5-3 The *Polychaeta Sedentaria-Polychaeta Errantia* Ratio in 2007, 2008, and 2009

	DP02	DP03	DP04	DP05	DP06	DP07	DP08	DP09
2007	24.1	183.0	3.3	1.0	-	3.7	-	-
2008	35.9	33.1	3.2	1.6	5.0	18.0	2.1	-
2009	27.8	27.1	2.4	1.9	73.8	2.8	9.8	0.6

While the *Polychaeta Sendentaria-Polychaeta Errantia* ratio was relatively consistent at DP02, DP03, DP04, and DP05, more variability was noted at the reference stations and at DP08. The eelgrass present in the inter-causeway area may help to stabilize the *Polychaeta Sendentaria* and *Polychaeta Errantia* populations. The elevated *Polychaeta Sendentaria-Polychaeta Errantia* ratio noted at DP03 in Q1-2007, was likely a function of reduced sample recovery during this event, with a single *Polychaeta Errantia* found in the sample.

The nematode-harpaticoid ratio is sometimes used to assess the impact of nutrient enrichment on benthic communites. Nematodes and harpaticoid copepods are considered meiofauna and to accurately quantify the number present in a sample, it is necessary to screen the sample using a 0.5 mm screen. Given that the AMS methodology employs only a 1.0 mm screen, a number of nematodes and harpaticoid copepods may have passed through the screen and the numbers present in the 1.0 mm screen sample was not considered to provide a sufficiently accurate representation of those taxa to allow for quantitative analysis. The nematode-harpaticoid ratio was therefore not calculated. An alternate methodology could be used to quantify meiofauna; however, given the lack of chemical trends in sediment or surface water suggestive of eutrophication, more detailed analysis of the benthic invertebrate community is considered outside the scope of the AMS.

3.5.4 Ecosystem Health and Function

Overall, benthic invertebrate abundance and richness suggested that benthic invertebrate populations in both the inter-causeway area and the reference area were healthy after the third year of benthic invertebrate monitoring. This was substantiated by the evenness and Shannon Wiener diversity indices, which showed that the benthic invertebrate communities in the inter-causeway area were relatively diverse and that there was fairly even distribution between taxa. This is consistent with the findings from 2007 and 2008.

3.6 BIRDS

3.6.1 Great Blue Heron

Similar to previous years, herons were detected in greatest numbers from late spring through summer (April – August) (Hemmera 2009). Increases in heron numbers within the study area in spring corresponded with territory establishment and nest initiation at the end of March/early April, while the large increase in heron numbers documented in June/July are most likely a result of the successful fledging of juvenile herons from nearby nests and the subsequent use of the inter-causeway area for foraging. Heron foraging in the inter-causeway area is tidally influenced because daylight low tides expose the extensive eelgrass beds, which provide shelter for a variety of prey during the summer months. During the spring and summer, great blue heron use the eelgrass beds within the inter-causeway area for foraging. Food resources available to herons within the inter-causeway area include sculpins, sticklebacks, herring, tube snout, starry flounder, gunnels, and surf perch. Through the winter months, the reduction or absence of daytime low tides reduces heron access to the eelgrass beds. In addition, fish are known to remain in the eelgrass beds during this time; however, they tend to be larger and harder for the herons to catch (Butler 1997). Butler (1997) provides an excellent overview of the seasonal behaviour of coastal great blue herons, and patterns described in his work are consistent with the observations collected during the survey period addressed in this report.

The number of herons (n=334) documented in 2009 is comparable to the maximum counts documented in 2007 (n=433) and 2008 (n=424), and 2003 (n=684). This apparent decrease in heron use of the Deltaport Transect may or may not be a real phenomenon, as fluctuations such as these can result from a number of factors. Firstly, more great blue herons could have been distributed along the TFN Transect than the Deltaport Transect on the day surveyed. This partly accounts for the difference, as the gap between 2003-2004 and 2007, 2008, and 2009 is reduced when data from the TFN Transect for 2007 and 2008 are incorporated. Secondly, survey results are known to fluctuate daily depending on a number of biotic and abiotic conditions (such as weather, predator abundance, and prey abundance) that can influence bird distribution and abundance within an area. It is possible that on the day surveys were conducted heron use of the study area was atypically low. This issue has been described in detail in a previous annual report (Hemmera, 2009).

Given the slightly lower heron abundance within the inter-causeway throughout all seasons of 2009, it is possible that fewer herons are using the region. The winter of 2008-2009 was particularly severe, with lower temperatures and longer periods of snow cover than in average years (Environment Canada, 2009). Herons forage for rodents in upland and marsh habitats, and the snow cover and cold temperatures may have made foraging more difficult over the winter and influenced overwinter survival. Similarly, the long and warm summer of 2009 may have provided better than average breeding conditions, as potentially evidenced by the pulse of herons observed in September. At this time it is believed that overall heron use of, and abundance within, the study area has not been affected, as herons were detected in similar numbers during 2007, 2008, and 2009.

The Deltaport Third Berth Environmental Assessment (VPA, 2005) predicted potential impacts to coastal seabirds and waterfowl would result from direct habitat loss associated with the DP3 footprint. Based on comparisons between distribution and abundance data collected in 2003-2004 along the Deltaport

Transect and current data, it is possible that great blue heron have shifted their use away from habitats immediately adjacent to construction activities (i.e. PCs 12-14), as anticipated. Habitat loss associated with the DP3 footprint has precluded heron usage of approximately 6% of the total resting/roosting and foraging habitat available in the study area associated with infilling a portion of PC 13 for DP3 construction. There appears to have been a possible shift by herons away from habitats adjacent to construction activities to other habitats within the study area (such as the TFN Transect) as the size of the DP3 footprint have increased. Based on the availability of alternative habitat and the extensive confirmed use of this alternative habitat by great blue herons during surveys conducted in 2007, 2008, and 2009, it is concluded that construction impacts have not had a detrimental effect on heron foraging in the inter-causeway area.

Observations recorded during the survey period also indicate that herons can be quite opportunistic and acclimatize to certain types of disturbance. For example, herons were frequently observed foraging along the riprap perimeter dyke during active construction. Additionally, herons appear habituated to traffic from both the Deltaport Causeway and the BC Ferries Causeway; however, less common, “acute disturbances” such as surveyors or recreational walkers and cyclists sometimes caused herons to abandon a resting or hunting locations if they were approached too closely.

Eagles appear to pose the greatest threat to herons nesting at the base of Tsatsu Bluffs, and in one instance, an eagle reportedly attacked and killed a full-grown heron (Westshore Terminals employee pers. comm. 2007).

3.6.2 Brant

During 2009 only black-bellied brant are present in the study area. The number of observations differed depending on which type of survey was conducted. Estimates derived from point count data tended to underestimate the number of brant using the inter-causeway compared to estimates derived from “windshield” surveys. Abundance estimates from windshield surveys are approximately twice as high as point count estimates for the same period, (**Figure 2.7-3**). The discrepancy between the estimates is believed to result from the fixed nature of the point counts, where birds can potentially move between points and avoid being counted, compared to the rapid assessment methodology employed using windshield surveys, which result in the entire inter-causeway area being sampled in a relatively short period of time ensuring that all brant are counted. As a result, Hemmera considers windshield surveys an effective and accurate method of determining the number of brant using the inter-causeway area.

Increasing numbers of brant observed during late April are attributed to migrants staging in the inter-causeway area on their way to summer breeding grounds in Alaska. During this period, brant were observed to use the inter-causeway area to feed on eelgrass, obtain gravel (generally along exposed shoreline along the TFN Transect), and loaf, rest, or preen. Peak estimates of 3,650 brant observed in

April 2009, 3,619 brant observed in April 2008, and 3,710 brant observed during late April 2007 are consistent with previous estimates of 3,560 brant documented using Roberts Bank as spring staging habitat (unpublished data cited in Moore *et al*., 2004). Additionally, estimates of 1,000 over-wintering brant in the inter-causeway area reported in Butler and Cannings (1989) are consistent with typical over-wintering brant numbers observed during 2007, 2008, and 2009.

With respect to diet, brant are adaptable to changes in the composition of eelgrass beds from the native Z. *marina* to the introduced *Z. japonica*. Dietary studies conducted on brant feeding in nearby Boundary Bay indicate consumption of both *Z. japonica* (57% dry mass) and *Z. marina* (41% dry mass) based on examination of esophageal contents (Baldwin and Lovvorn, 1994). As expected, general comparisons of brant and eelgrass distributions within the inter-causeway area indicate that brant primarily forage in areas of abundant eelgrass. However, it is important to note that the bird survey methodology is not conducive to examining detailed spatial relationships between brant and eelgrass. Brant use of the inter-causeway area appears to have not been affected by activities associated with Deltaport Third Berth construction as the distribution of brant along the Deltaport and TFN Transects has not changed (**Figure 48**).

As described in the AMS 2007 Annual Report (Hemmera 2008d), recent studies have found that both Boundary Bay (peak estimate of 1,660 brant during spring migration) and Roberts Bank (peak estimate of 3,170 during spring migration) received lower usage than expected by spring staging brant along the Pacific Flyway based on the amount of eelgrass habitat available and the site's degree of isolation from other staging locations (Moore et al. 2004). These studies found that there is sufficient eelgrass habitat to support more brant in both the inter-causeway area and at Boundary Bay, than are currently supported. Additionally, both of these staging areas were among the least isolated of the sites examined. In this same study, isolation from other staging areas was shown to influence brant usage, as isolated eelgrass habitats are implied to be more critical for staging brant than those in close proximity to other staging areas. The reason(s) for lower than expected usage of the inter-causeway and Boundary Bay habitats are not known.

During the survey period, observations of acute disturbances resulting in brant displacement were limited to bald eagles flying over, surveyors, cyclists, and walkers (sometimes with dogs), disturbing resting and feeding birds near the shoreline. In all instances, brant and other waterfowl took off and circled for a short period of time before settling down on or close to the same location. It is likely that birds using the inter-causeway area are habituated to a degree to disturbance as a result of fairly constant ship, truck, and rail traffic, as well as recreational users including people walking along the TFN dyke, and cars and trucks pulling off along the Deltaport Causeway. Brant were typically observed offshore (**Figure 48**) and did not react to regular traffic such as vehicles moving along the Deltaport Causeway or the BC Ferries Causeway or surveyors, cyclists, and walkers using the edges of the study area.

No negative impacts to brant from the DP3 construction were observed during the survey period. It is assumed that the main impact to brant is exclusion from the portion of the perimeter dyke lost to the DP3 footprint. This was a known resting site and a location where loose eelgrass fronds would wash up providing an easy foraging opportunity for brant.

3.6.3 Shorebirds

In 2009, eight species of shorebirds totalling 25,846 individuals were observed within the project area. Western sandpiper and dunlin made up the vast majority of these observations, with western sandpipers most abundant during spring (April to early May) and fall (July to early August), while dunlin were observed during most of the year, absent only during mid summer and most abundant in winter. Most observations were recorded along the TFN Transect where large exposed mudflats provide abundant habitat for foraging birds.

Annual western sandpiper abundance and distribution has been known to fluctuate greatly on an international scale. Dunlin followed a similar trend with peak annual counts and the timing of use of the study area fluctuating between years. The cause of these changes in use are unknown as the primary foraging area, where most dunlin and western sandpiper were documented, is along the TFN Transect more than 2.5 km away from Deltaport construction activities and appears unchanged. Peak estimates for the region for 2009 were estimated at 160,000 birds, down from the 5-year high of approximately 250,000 individuals (Bird Studies Canada, 2009).

No direct impacts to shorebirds have been observed. However, continued monitoring of sedimentation and eelgrass distribution as part of this AMS is recommended, as potential alterations to the mudflats resulting from changes to the inter-causeway topography, water elevations, and the distribution of eelgrass could negatively impact shorebirds. *Z. japonica* is able to grow in slightly more exposed locations than the native *Z. marina* and consequently, there is a potential for loss of critical mudflat feeding habitat if these changes were to occur.

3.6.4 Coastal Waterbirds

General trends in abundance, use, and distribution of coastal waterbirds did not differ between years, with the vast majority of birds observed using habitats along the Deltaport Transect in all study years, except for dabbling ducks, which primarily use the TFN Transect. Numbers of overwintering waterfowl were consistent with peak numbers of dabbling ducks (approximately 25,000 in December 1988) using the inter-causeway area as reported in Butler and Cannings (1989), and with numbers reported by BC Coastal Waterbird Surveys in 2007-2008, and 2008-2009 (Bird Studies Canada, 2009). Overall, coastal waterbird abundance and habitat use within the inter-causeway area did not differ significantly between 2003-2004, 2007, 2008, and 2009.

Coastal waterbirds observed in PC 12 and PC 13 appeared habituated to disturbance from DP3 construction activities, likely due to the extent of disturbance that already occurs in this area from operation of the existing two berths at Deltaport and the Seaspan tug facilities located in the embayment area. Diving birds including cormorants, grebes, loons, mergansers, and other diving ducks were regularly seen swimming, diving, and feeding in close proximity to active work, and continue to use the protected waters in the finished tug basin.

Dabbling ducks, primarily American wigeon and mallard, were frequently observed resting/roosting along the perimeter dyke, likely due to the protection from wind and wave action that it provides. Based on observed foraging patterns for dabbling ducks, DP3 related construction impacts are considered negligible. However, non-routine disturbance, such as observers, walkers, and cyclists using the dyke or walkway often caused birds closest to the shoreline to take flight. Disturbed birds would settle either slightly further out within the same PC, or move further along the Transect staying at approximately the same tidal line.

Based on the observations of bird activity in the inter-causeway area, it is concluded that coastal waterbird species using the study area have not been significantly impacted by DP3 related construction activities to date. Rather, it is habitat loss (estimated at 6% of total resting/roosting and foraging habitat available) that appears to have the greater impact. Based on the availability of alternative habitat within the study area, and the observed usage of alternative habitat by bird species in the inter-causeway area, this habitat loss does not appear to be significant and is consistent with the predicted impacts assessed in the EA.

3.6.5 Raptors

During studies in 2003-2004, a pair of osprey was observed nesting in a navigational aid situated within the DP3 footprint (ECL Envirowest, 2004). Hemmera and VFPA relocated this nest on March 12 and 13, 2007, under BC Ministry of Environment (MOE) permit SU07-31495 granted under provisions of the *Wildlife Act*, prior to the arrival of the osprey pair to the inter-causeway area in the spring of 2007. While the navigation marker and the remnant nest structure were successfully relocated and a pair of osprey returned to the inter-causeway area in 2007, 2008, and 2009, no nesting activity was observed either on the relocated platform or elsewhere in the vicinity of the study. However, the navigation marker is frequently used by both osprey and bald eagles as a perching platform **(Figure 3.1-1)**.

Figure 3.1-1 Osprey perched on relocated navigation marker in the Deltaport Inter-causeway Area, August 13, 2009

3.6.6 Ecosystem Health and Function

The main objectives of the bird study are to provide complimentary data towards addressing the concerns regarding potential marine eutrophication and changes to coastal erosion processes that could potentially result in changes in the distribution and composition of local biota, including shorebirds and coastal seabirds, in the inter-causeway area. To this end, the bird study data are considered one indicator of ecosystem structure and function. Due to the possibility that changes to the ecosystem over time can be linked to key species such as great blue heron, brant, western sandpiper, and dunlin, monitoring bird usage within the inter-causeway area is part of the overall strategy to monitor ecosystem structure and function in the inter-causeway area.

Comparisons of 2007, 2008, and 2009 AMS data and baseline data collected by Envirowest and CWS in 2003-2004 for the Deltaport Transect suggest few changes and high natural annual variability in bird abundance and usage of the inter-causeway area. To date, construction impacts on shorebirds and coastal seabirds appear to be minimal. The continued use of the study area appears to be driven by the availability of productive foraging habitat. As such, the maintenance of existing eelgrass beds and mudflats are believed to be the most important factor in ensuring the inter-causeway area remains an area of continued importance to shorebirds and coastal seabird populations within the Lower Mainland.

4.0 CONCLUSIONS AND RECOMMENDATIONS

4.1 COASTAL GEOMORPHOLOGY

The coastal geomorphology portion of the AMS monitoring program has been ongoing for almost 32 months from its inception in April 2007 to the end of 2009. For most of the monitoring activities, the data analyzed in this report represents two full years of quarterly monitoring, in addition to the nine months of data collected in 2007. However, for some of the activities, such as wave monitoring and some of the newer DoD rods, the period of record is shorter. For some of the monitoring activities, such as the monitoring of the Crest Protection Structure, portions of the interpretation of orthophotographs and portions of the coastal geomorphology mapping activities, this data can reasonably be considered to provide baseline data for the pre-project condition. In other cases, such as with wave monitoring, erosion/deposition monitoring, and monitoring of turbidity, the data will be considered to represent conditions with the new DP3 project in place. The distinction lies mainly with the proximity to the new project as well as the amount of time that would be expected to pass before effects would be detected.

To date, the most significant change within the study area has been the formation of the ‘new’ tidal channels on the mud flats adjacent to the DP3 perimeter dike. Observations in the field indicate that only very small amounts of sediment are transported within the channels. Mapping from the orthophotos shows that the position of the channels has not changed between the time that the 2007 and 2009 photos were taken, and the DoD rod data indicates a much lower level of erosion and deposition in this area. No other long-term physical changes have occurred on the tidal flats that could be attributed to the construction of DP3. The construction activities along the east side of the Deltaport causeway that are associated with the habitat compensation plan have the potential to have an effect on the proximal portions study area. Construction began in September 2009, but construction activities will not be active within the immediate study area until 2010. These activities, particularly in reference to the DoD rod results, will be given careful consideration during the 2010 AMS monitoring.

The AMS monitoring program has collected a significant amount of data that describes the ongoing physical processes at Roberts Bank. One of the most important conclusions that can be drawn from this data is that the magnitude of change on the tidal flats is not large. As expected, sedimentation and erosion rates are small (generally less than 10 cm) and turbidity levels are generally very low. These findings are consistent with the predictions that were made in the coastal geomorphology studies.

Analysis of turbidity measurements has shown that turbidity events are affected by waves during particular wind and tide conditions. There is no evidence to suggest that turbidity levels have been affected by either DP3 construction activities or the presence of the DP3 structure itself. As marine construction was completed in July 2009 and regular port operations commenced in January 2010, we recommend that turbidity monitoring proceed for the first half of 2010 to capture a reasonably long post-construction period and that it should then be terminated in early August to coincide with the Q3 monitoring site visit.

Monitoring of the Crest Protection Structure has demonstrated that there has been very little change in the elevation of the structure itself, or in the surrounding tidal flats. Minor changes have been identified that fall outside of the range of uncertainty of the survey instrument but there have been no long-term trends identified in the survey data, or in the annual monitoring photographs. There have, of course, been some significant changes to the Crest Protection Structure in the immediate vicinity of the tug basin that reflect modifications made during construction. There is no evidence to suggest that the minor changes to the structure that may have been previously observed at cross-sections 4 or 5 are at all related to DP3. We therefore recommend that monitoring of the Crest Protection Structure be limited in future to repeat surveys at cross sections 1, 2, and 3, and annual photographs from monitoring points CRST-01 to CRST-10 (see **Figure 4**).

As noted in Section 3.1.6, there have been no major issues identified in the AMS monitoring program that would be captured by the topographic and hydrographic surveys that were first carried out at the inception of the monitoring program. Follow-up surveys were scheduled to be completed after three or four years, as per the DP3 Project AMS Detailed Workplan (VPA & Hemmera 2007). Based on the above findings, we recommend that the surveys be conducted in 2010.

Measurement of waves within the vicinity of DP3 using non-directional wave recorders was proposed by NHC in a memo dated January 30, 2008 (NHC 2008) as an alternative to using the AWAC, which was destroyed in the late summer of 2007. This memo recommended that waves be monitored for at least one full year throughout the winter storm season. Three wave recorders were deployed on April 10, 2008 and have been collecting wave data through two winter seasons. To date the analysis has shown that the timing of wave events within the study area agrees quite well with hindcast wave predictions made based on wind data collected at Vancouver International Airport but that wave height depends on wind direction. The data also show that wave height declines significantly between the station in the ship turning basin and the stations on the tidal flats, with the upper station showing the smallest waves. The primary value in collecting wave data at present is that there is some correlation with turbidity events. We recommend that wave monitoring also be terminated in early August to coincide with the Q3 monitoring site visit.

Measurements of tidal velocity collected during a large tide swing on June 23, 2009 generally confirm the predictions of tidal flow velocity made using the 2D hydrodynamic model. Based on this confirmation, it can be concluded that the model predictions presented in the Coastal Geomorphology Report (NHC 2004) are accurate and reliable and provide sufficient confidence in the conclusions of the original analysis. The model results predicted that velocities at the northeast tip of the DP3 terminal would not increase by an appreciable amount and that velocities would remain generally very low. Baesd on the data collected to date, we have concluded that the DP3 terminal has not had a significant or adverse effect on tidal currents and recommend that no further monitoring of tidal currents be undertaken.

4.2 SURFACE WATER QUALITY

Elevated and sporadic metal exceedances were limited in number and magnitude in 2009. Continued elevated metal concentrations in surface water at DP01 (upland drainage station) do not appear to be having an adverse effect on adjacent surface water chemistry at stations DP02 or DP03. Overall, based on the data collected to date, there was no evidence of metals loading as a result of the DP3 construction or operation. Continued monitoring of metals concentrations in surface water is recommended for 2010 to document the first year of port operations, but if no change is noted it is recommended that they be dropped for 2011.

Key spatial trends observed in 2009 included the relatively elevated nutrient concentrations at DP01 (upland drainage station) and the low nutrient concentrations at DP03, DP04, DP05, and DP08. Overall, nutrient concentrations were lower in the inter-causeway area in 2009 than in 2008. The elevated nutrient concentrations at DP01 likely result from inputs from adjacent agricultural land but they do not appear to be affecting overall nutrient concentrations in the inter-causeway area. There were no clear temporal trends for nutrients in surface water. Continued monitoring of the nutrient concentrations in surface water is recommended for 2010.

Given that naturally occurring nutrient concentrations vary significantly from one area to another it is recommended that site-specific criteria for the AMS be developed. Since there have been no increasing nutrient or chlorophyll a trends or decreasing oxygen trends, Hemmera proposes using averages of the first three years of data to define background conditions for the development of site-specific criteria. Exceedances would be defined as concentrations 20% greater than the site-specific criteria. VFPA and SAC would be notified as soon as an exceedance is noted to discuss if an adaptation to the monitoring schedule or further investigation of the issues is required.

4.3 SEDIMENT QUALITY

Metal concentrations complied with the BC CSR sediment quality standards during 2009 as they did during 2007 and 2008.

Metal concentrations in 2009 did not exhibit a clear temporal trend up or down. Given that the metal concentrations in sediment at the majority of inter-causeway stations were lower than those measured at the reference stations, it is concluded that DP3 construction and initial operation activities have not contributed to metals loading at the site.

Based on the data collected to date, no evidence of eutrophication occurring as a result of DP3 construction or operation has been observed. Continued monitoring of the nutrient and metals concentrations in sediments is recommended for 2010 to document the first year of port operations, but if no change is noted it is recommended that metals be dropped from the 2011 sampling program.

4.4 EELGRASS

The distribution of *Z. marina* and *Z. japonica* in the area adjacent to the DP3 footprint has expanded over the last year. However, the mapping surveys have demonstrated a continued loss of eelgrass coverage in the area northwest of the sand lobe; changes which could be due to evolution of the sand lobe and associated dendritic channels, a reduction in mean sea-level, or a combination of both. Future bathymetric surveys will help determine whether sediment has undergone net accretion in these areas.

The eelgrass at most sites in the inter-causeway area are flourishing. The morphology, density, and distribution of eelgrass vary in response to a variety of chemical and physical forcing factors, and the data from the reference sites in the inter-causeway area demonstrates that the factors influencing eelgrass growth have not been negatively impacted during the construction of DP3. In addition, the SIMS survey demonstrated that the lower depth distribution of *Z. marina* along the inter-causeway area has remained stable relative to 2003, indicating that the development of DP3 has not caused an increase in suspended sediment or turbidity at this location. The assessment of epiphyte load and the absence of *Beggiatoa* sp. were consistent with results from previous years and indicate that the eelgrass habitat was in good condition and was showing no signs of eutrophication. All of these findings are consistent with the findings of the coastal geomorphology and surface water sampling programs.

Based on the data collected to date, no evident indications have been observed to indicate that the development of DP3 has negatively affected the inter-causeway eelgrass habitat, and consequently no changes to the eelgrass survey program are recommended for 2010.

4.5 BENTHIC COMMUNITY

Differences in abundance, richness, evenness, diversity, and the number of *Tanaidacea* between years were not statistically significant; however, an increase in abundance and richness was noted from 2007 to 2008, and again from 2008 to 2009. The increase in *Tanaidacea* noted in the ANOVA, was largely driven by increases in *Tanaidacea* noted at DP04 and DP08. The difference in the number of *Tanaidacea* in the ANOVA was not significant at α=0.05 (p=0.75). However, the power of the test was low due to the small sample size. Regression analysis did not find a statistically significant correlation between variation in abundance, richness, evenness, and diversity and any of abiotic factors tested (sediment grain size, TOC, sulphide, nitrogen, phosphorus). Neither polychaete-amphipod nor *Polychaeta sedentaria-Polychaeta errantia* ratios showed an increase which, if observed, could signal a trend towards eutrophication. Overall, the results indicated that the benthic invertebrate populations in both the inter-causeway area and the reference area are diverse, healthy and well established. The data did not suggest a trend towards eutrophication or direct DP3 construction or operation impacts. Continued monitoring of benthic invertebrates on a biennial basis is recommended, with surveys taking place in 2010 and 2012.

4.6 BIRDS

Overall, bird abundance and habitat use within the inter-causeway area did not differ significantly between 2003-2004, 2007, 2008, and 2009. The Deltaport Third Berth Environmental Assessment (Hemmera 2005) predicted potential impacts to coastal seabirds and waterfowl would be limited to direct habitat loss associated with the DP3 footprint. Based on the availability of alternative habitat and the extensive confirmed use of this alternative habitat by birds during the surveys conducted in 2007 through 2009, it is concluded that construction impacts have not had a detrimental effect on bird habitat use in the inter-causeway area.

The third year of the AMS bird monitoring program found consistent seasonal patterns and expected natural variability in the abundance and distribution of birds in the inter-causeway area. Hemmera recommends that the monitoring program be modified to focus specifically on windshield surveys of great blue heron and brant, two species at risk that use the inter-causeway as foraging, overwintering, and migratory stopover habitat, while discontinuing point count surveys for these species and for the other bird species.

4.7 SUMMARY

In conclusion, to date, the data collected during the AMS monitoring program has not shown compelling evidence to suggest that the DP3 construction activities are contributing to significant widespread adverse effects within the inter-causeway area.

Based on the findings to date, the following adaptations to the AMS program are recommended:

- Discontinue turbidity and wave monitoring in Q3-2010
- Continue metals sampling in 2010 to document the first year of port operations
- Develop site-specific nutrient criteria for evaluating eutrophication based on the first three years of nutrient data
- Discontinue bird point count surveys

5.0 CLOSING

We trust that the information contained in this report meets your needs at this time. If you have any questions, please do not hesitate to contact the undersigned.

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6.0 REFERENCES

Baldwin, J.R., and J.R. Lovvorn. 1994a. Habitats and tidal accessibility of marine foods of dabbling ducks and brant in Boundary Bay, British Columbia. Marine Biology 120:627-638.

Baldwin, J.R. and J.R. Lovvorn. 1994b. Expansion of seagrass habitats by the exotic Zostera japonica, and its use by dabbling ducks and brant in Boundary Bay, British Columbia. Marine Ecology Progress Series 103:119-127.

BC Ministry of Environment (BCMOE). 2006a. British Columbia Approved Water Quality Guidelines, 2006 Edition. September 1998, updated August, 2006.

BCMOE. 2006b. A Compendium of Working Water Quality Guidelines for British Columbia. 1998. Updated August 2006.

Beck, M.W., K.L. Heck, K.W. Able, D.L. Childers, D.B. Eggleston, B.M. Gillanders, B. Halpern, C.G. Hays, K. Hoshino, T.J. Minello, R.J. Orth, P.F. Sheridan, and M.P. Weinstein. 2001. The identification, conservation, and management of estuarine and marine nurseries for fish and invertebrates. Bioscience: 51:663-641.

Bird Studies Canada. 2009. British Columbia Coast Bird Watch – Newsletter of the BC Coastal Waterbird and Beached Bird Surveys. September 2009. Volume 2.

Bowen, J.L. and I. Valiela. 2001. The ecological effects of urbanization on coastal watersheds: Historical increase in nitrogen loads and eutrophication of Waquoit Bay estuaries. Canadian Journal of Fisheries and Aquatic Science 58:1489-155.

Baird D, Christian RR, Peterson CH, Johnson GA. 2004. Consequences sequences of hypoxia on estuarine food web and ecosystem function: energy diversion from consumers to microbes. Ecol Appl 14:805–822

British Columbia Contaminated Sites Regulation (BC CSR). BC Reg. 375/96 (Effective April 1997 and amended July 1999, February 2002, November 2003, and July 2004 and July 2007).

British Columbia Waterfowl Society. 2006. International significance of the Fraser Estuary. Available: http://www.reifelbirdsanctuary.com/fraser.html

Burd, B.J., P.A.G. Barnes, C.A. Wright, and R.E. Thompson. 2008. A review of subtidal benthic habitats and invertebrate biota of the Strait of Georgia, British Columbia. Marine Environmental Research. 66: S3–S38.

Burd, B.J., D. Moore, and R.O. Brinkhurst. 1987. Distribution and Abundance of Macrobenthic Fauna from Boundary and Mud Bays near the British Columbia/US Border. Canadian Technical Report of Hydrography and Ocean Sciences 84, pp. 1–34.

Butler, R.W. 1997. The Great Blue Heron. UBC Press, Vancouver, B.C.

Butler, R.W., and R.W. Campbell. 1987. The birds of the Fraser River Delta: populations, ecology, and international significance. Occasional Paper No. 65. Canadian Wildlife Service.

Butler, R.W., and R.J. Cannings. 1989. Distribution of birds in the intertidal portion of the Fraser River Delta, British Columbia. Technical Report Series No. 93. Canadian Wildlife Service.

Butler, R.W, and P.C.F. Shepherd, and M.J.F. Lemon. 2002. Site fidelity and local movements of migrating western sandpipers on the Fraser River estuary. Wilson Bulletin 114(4): 485-490.

Canadian Council of Ministers of the Environment (CCME), 2007. Canadian Guidance Framework for the Management of Nutrients in Nearshore Marine Systems: Scientific Supporting Document.

Canadian Council of Ministers of the Environment (CCME), 1999. Canadian Water Quality Guidelines. Updated July, 2006.

Constanza, R., R. d'Arge,R. deGroot, S. Farber, M. Grasso, B. Hannon, K. Limberg, and S. Naeem. 1997. The value of the world's ecosystem services and Natural Capitol. Nature 387: 253-260.

De Casabianca, M.L., T. Laugier, and D. Collart. 1997. Impact of shellfish farming eutrophication on benthic macrophyte communities in Thau Lagoon, France. Aquaculture Inter 5: 301-314.

Dean, T., and L. Halderson. 2000. The distribution of nearshore fishes in kelp and eelgrass communities in Prince William Sound, Alaska: Associations with vegetation and physical habitat characteristics. Environmental Biology of Fishes 57: 271-287

den Hartog, C. 1994. Suffocation of a littoral *Zostera* bed by *Enteromorpha radiate*. Aquatic Botany: 47:3-14.

Dennison, W.C., R.J. Orth, K.A. Moore, J.C. Steveson, V. Carter, S. Kollar, P. Bergstrom, and R. Batiuk. 1993. Assessing water quality with submerged aquatic vegetation. Bioscience 43:86-94.

Diaz R.J. and Rosenberg R. 1995. Marine benthic hypoxia: a review of its ecological effects and the behavioural responses of benthic macrofauna. Oceanographic Marine Biology Annual Review. 33:245–303

Duarte C.M., J. Borum, F. Short, and D. Walker. 2008. Seagrass Ecosystems: Their global status and prospects. In: Polunin NVC (ed) Aquatic Ecosystems: Trends and Global Prospects. Cambridge University Press.

Dunster, J. and Dunster, K. 1996. Dictionary of Natural Resource Management. UBC Press, Vancouver, Canada.

Durance, C. 2004b. Eelgrass mapping and habitat increases in the Fraser River Estuary. Pacific Estuarine Research Conference. Port Townsend, Washington, USA. May 2004.

ECL Envirowest Consultants Limited. 2004. Technical Volume 5 Deltaport Third Berth Project coastal seabird and waterfowl resources impact assessment. Prepared for the Vancouver Port Authority in support of the Roberts Bank Container Expansion Project.

Essinger, A.M. 2007. Great blue herons in Puget Sound. Puget Sound Nearshore Partnership Report no. 2006-06. Seattle District, U.S. Army Corps of Engineers, Seattle Washington, USA.

Flindt, MR., L. Kamp-Neilson, J.C. Marques, M.A. Pardal, M. Bocci, G. Bendoricchio, G. Salomsen, S.N. Neilsen, and S.I. Jorgensen. 1997. Description of three shallow estuaries: Mondego River (Portugal), Roskilde Fjord (Denmark), and the lagoon of Venice (Italy). Ecological Modelling 102:17-31.

Fonseca, M.S., J.C. Zieman, G.W. Thayer, and J.S. Fisher. 1983. The role of current velocity in structuring eelgrass *Zostera marina* meadows. Est. Coast Shelf Sci 17:367-380.

Fonseca, M. 1992. A preliminary evaluation of wave attenuation by four species of seagrass. Estuary, Coastal, and Shelf Science 35:565-576.

Fonseca, M.S. and S.S. Bell. 1998. Influence of physical setting on seagrass landscapes near Beaufort, North Carolina, USA. Mar Ecol Prog Ser 171:109-121.

Francoise, R., F.T. Short, and J.H. Weber. 1989. Accumulation and persistence of Tributyltin in eelgrass (*Zostera marina* L.) tissue. Environmental Science Technology 23:191-196.

Fredette, T.J., R. Diaz, J.J. van Montfrans, and R.J. Orth. 1990. Secondary production within a seagrass bed (*Zostera marina- Ruppia maritima*) in lower Chesapeake Bay. Estuaries 13:431-440.

FREMP. 2003. A living working river; Habitat Inventory. Fraser River Estuary Management Plan. http://www.bieapfremp.org/fremp/pdf_files/Habitat%20Brochure%20May04%20copy.pdf

Gebauer, M.B., and I.E. Moul. 2001. Status report of the great blue heron in British Columbia. Wildlife working report No. WR-102. Ministry of Environment, Lands and Parks, Wildlife Branch, Victoria, British Columbia.

Goodman, J.L., K.A. Moore, and W.C. Dennison. 1995. Photosynthetic response of eelgrass (*Zostera marina* L.) to light and sediment sulphide in a shallow barrier island lagoon. Aquat. Bot. 50:37-47.

Hansen, J.W., J.W. Udy, C.J. Perry, W.C. Dennison, and B.A. Lomstein. 2000. Effect of the seagrass *Zostera capricorni* on sediment microbial processes. Marine Ecology Progress Series 199: 83-96.

Harrison, P.G. and R.E. Bigley. 1982. The recent introduction of the seagrass *Zostera japonica* to Aschers, and Graebn. to the Pacific Coast of North America. Canadian Journal of Aquatic Sciences 39:1642-1648.

Harrison, P.G. and M. Dunn. 2004. Fraser River delta ecosystems, their distribution and importance to migratory birds in the Fraser Delta, British Columbia; Issues of an Urban Estuary. (ed.) B.J. Groulx, D.C. Mosher, J.L. Luternauer, and D.E. Bilderback; Geological Survey of Canada Bulletin 567; 173-188.

Heck, K.L., K.W. Able, M.P. Fahay, and C.T. Roman. 1989. Fishes and decapod crustaceans of Cape Cod eelgrass meadows: Species composition, seasonal abundance patterns, and comparison with unvegetated substrate. Estuaries 12:59-65.

Heck, K.L., K.W. Able, C.T. Roman, and M.P. Fahay. 1995. Composition, abundance, biomass, and production of macrofauna in a New England estuary: Comparisons among eelgrass meadows and other nursery habitats. Estuaries 18:379-389.

Heck, K.L., G. Hays, and R.J. Orth. 2003. Critical evaluation of the nursery role hypothesis for seagrass meadows. Marine Ecology Progress Series 253:123-136.

Heiss, W.M., A.M. Smith, and P.P. Keith. 2000. Influence of the small intertidal seagrass *Zostera novazelandica* on linear water flow and sediment texture. New Zealand Journal of Marine and Freshwater Resources 34:689-694.

Hemmera. 2005. Environmental Assessment Application for the Deltaport Third Berth Project.

Hemmera, 2008a. Adaptive Management Strategy Quarterly Report: Q2-2007, Deltaport Third Berth (Final Rep*ort)*. Prepared by Hemmera Envirochem for Vancouver Port Authority, February, 2008, 134 pp.

Hemmera, 2008b. Adaptive Management Strategy Quarterly Report: Q3-2007, Deltaport Third Berth (Final Report). Prepared by Hemmera Envirochem for Vancouver Port Authority, February, 2008, 141 pp.

Hemmera, 2008c. Adaptive Management Strategy Quarterly Report: Q4-2007, Deltaport Third Berth (Final Report). Prepared by Hemmera Envirochem for Vancouver Port Authority, January, 2008, 134 pp.

Hemmera, 2009. Adaptive Management Strategy 2008 Annual Report, Deltaport Third Berth (Final Report). Prepared by Hemmera Envirochem for Vancouver Fraser Port Authority, September, 2009, 305pp.

Hjulström, F., 1935. Studies of the Morphological Activity of Rivers as Illustrated by the River Fyris. Bull. Geol. Inst. Uppsala, 25.

Hoven, H.M., H.E. Gaudette, and F.T. Short. 1999. Isotope ratios of 206Pb/207Pb in an estuary. Mar Environ Res 48:377-387.

Kemp, W.M., W.R. Boynton, J.C. Stevenson, R.R. Twilley, and J.C. Means. 1983. The decline of submersed vascular plants in upper Chesapeake Bay: Summary of results concerning possible causes. Marine Technology Society J 17:78-89.

Koch, E. W. and S. Beer. 1996. Tides, light, and the distribution of Zostera marina in Long Island Sound, USA. Aquat Bot: 53: 97-107.

Koch, E.W. and J.J. Verdin. 2001. Measurements of physical parameters in seagrass habitats. In: Short F.T. and R.G. Coles (eds) Global Seagrass Research Methods, pp 325-344. Elsevier Science B.V., Amsterdam.

Lee,S.Y., C.J. Kwon, and C. Chung. 2000. Distribution of Zostera (Zosteraceae) and habitat characteristics in the eastern coastal waters of Korea. J Korean Fish Soc 33:501-507.

Lyngby, J.E. and H. Brix. 1982. Seasonal and environmental variations in cadmium, copper, lead, and zinc concentrations in eelgrass (*Zostera marina* L.) in Limfjord, Denmark. Aquatic Botany.14:59-74.

Mackas, D.L. and P.J. Harrison. 1997. Nitrogenous nutrient sources and sinks in the Juan de Fuca/Strait of Georgia/Puget Sound Estuarine System: Assessing Potential for Eutrophication. Estuarine, Coastal, and Shelf Science. 44:1–21.

Marba, N., M. Holmer, E. Gacia, and C. Barron. 2007. Chapter 6, Seagrass Beds and Coastal Biogeochemistry. In Seagrasses: Biology, Ecology and Conservation. Larkum, A., R. Orth, and C. Duarte (eds) Springer, The Netherlands.

Mateo, M.A., Cebrian, K. Dunton, and T. Mutchler. 2007. Chapter 7, Carbon flux in Seagrass Ecosystems. In Seagrasses: Biology, Ecology and Conservation. Larkum,A, R. Orth, and C. Duarte (eds.) Springer, The Netherlands.

McLean, D. G. and M. A. Church, 1986. A Re-Examination of Sediment Transport Observations in the Lower Fraser River. Water Resources Branch, Environment Canada, IWD-HQ-SS-86-6, Ottawa, 53 pp.

Moore, J.E., Colwell, M.A., Mathis, R.L., and J.M. Black. 2004. Staging of Pacific flyway brant in relation to eelgrass abundance and site isolation, with special consideration of Humboldt Bay, California. Biological Conservation 115:475-486.

Moore, K.A., R.J. Orth, and J.F. Nowak. 1993. Environmental regulation of seed germination in Zostera marina L. (eelgrass) in Chesapeake Bay: Effects of light, oxygen, and sediment burial. Aquat. Bot. 45:79-91.

Moore, K.A. and F.T. Short. 2007. Chapter 16, Biology of *Zostera*. In Seagrasses: Biology, Ecology and Conservation. Larkum, A, R. Orth, and C. Duarte Eds. Springer, The Netherlands.

Moore, K.A., R.L. Wetzel, and R.J. Orth. 1997. Seasonal pulses of turbidity and their relation to eelgrass (*Zostera marina* L.) survival in an estuary. Journal of Marine Biology Ecology 215: 115-134.

Moss, S.A. and Nagpal, N.K. 2003. Ambient Water Quality Guidelines for Boron: Overview Report. BC Ministry of Water Land and Air Protection - Water, Air and Climate Change Branch.

NHC, 2007a. Deltaport Third Berth Habitat Compensation, Dendritic Channel Intervention. Northwest Hydraulic Consultants Ltd. Discussion paper to Vancouver Port Authority, February 2007.

NHC, 2007b. Correlating Turbidity and Suspended Solids. Memo prepared by Northwest Hydraulic Consultants Ltd. for Hemmera Envirochem in support of the Roberts Bank DP3 AMS Program and Vancouver Port Authority, November 5, 2007, 6 pp.

NHC, 2004. Roberts Bank Container Expansion, Coastal Geomorphology Study. Northwest Hydraulic Consultants and Triton Consultants Ltd. Final report to Vancouver Port Authority, October 2004.

Orth, R.J. and K.L Heck. 1980. Structural components of eelgrass (*Zostera marina*) meadows in the lower Chesapeake Bay. Estuaries 3: 278-288.

Peterson C.H., C.H. Summerson, E. Thomson, H.S. Lenihan, J.H. Grabowski, L. Manning, F. Micheli, G. Johnson. 2000. Synthesis of linkages between benthic and fish communities as a key to protecting essential fish habitat. Bulletin of Marine Science. 66:759–744

Phillips, R.C. 1984. The ecology of eelgrass meadows in the Pacific Northwest: A community profile. U.S. Fish & Wildlife Service FWS/OBS-84/24. 85pp.

Pregnall, A.M., R.D. Smith, T.A. Kursar, and R.S. Alberte. 1984. Metabolic adaptation of *Zostera marina* (eelgrass) to diurnal periods of root anoxia. Mar Biol 83: 141-147.

Short, F.T. 1983. The seagrass Zostera marina: Plant morphology and bed structure in relation to sediment ammonium in Izembek Lagoon, Alaska. Aquat Bot 16: 149-161.

Short, F.T. 1987. Effects of sediment nutrients on seagrasses: Literature review and mesocosm experiments. Aquat Bot 27: 41-57.

Short, F.T. and D.M. Burdick. 1996. Quantifying eelgrass habitat loss in relation to housing development and nitrogen loading in Waquoit Bay, Massachusetts. Estuaries 19; 730-739.

Short, F.T., D.M. Burdick, J. Wolf, and G.E.Jones. 1993. Eelgrass in Estuarine Research Reserves along the east coast, U.S.A. Part 1. Declines from pollution and disease and Part 2. Management of Eelgrass meadows. NOAA-Coastal Ocean Program Publication.

Short, F.T. and S. Wyllie-Escheverria. 1996. Natural and human induced disturbance of seagrasses. Environmental Conservation 23:17-27.

Short, F.T. and S. Wyllie-Escheverria. 2000. Global seagrass declines and the effect of climate change. In: Sheppard, C.R.C. (ed) Seas at the millennium: An environmental evaluation. Vol. III: Global issues and processes, pp 10-11. Pergamon, Elsevier, Amsterdam.

Smith, F.T, A.M. Pregnall, and R.S. Alberte. 1988. Effects of anaerobiosis on root metabolism of *Zostera marina* (eelgrass): Implications for survival in reducing sediments. Marine Biology 98:131-141.

Sutherland, TF, S.A. Petersen, C.D. Levings and A.J. Martin, 2007. Distinguishing between natural and aquaculture-derived sediment concentrations of heavy metals in the Broughton Archipelago, British Columbia. Marine Pollution Bulletin. 54,1452-2460.

Swain, L.G., D.G. Walton, B. Phippen, H. Lewis, S. Brown, G. Bamford, D. Newsom, and I. Lundman. 1998. Water quality assessment and objectives for the Fraser River from Hope to Sturgeon and Roberts Banks, first update, technical appendix. Ministry of Environment, Land and Parks, Province of British Columbia, Victoria, BC.

Tarbotton, M. and P.G. Harrison. 1996. A Review of the Recent Physical and Biological Development of the Southern Roberts' Bank Seagrass System 1950 – 1994. Triton Consultants Ltd. Vancouver, British Columbia, Canada

Terrados, J., C.M. Duarte, L. Camp-Neilsen, N.S.R. Agawin, E. Gacia, D. Lacap, M.D. Fortes, J. Borum, M. Lubanski, and T. Greive. 1999. Are seagrass growth and survival constrained by the reducing conditions of the sediment? Aquatic Botany 65:175-197.

Thom, R.M., A.B. Borde, S. Rumrill, D.L. Wodruff, G.D. Williams, J.A. Southard, and S.L. Sargent. 2003. Factoring influencing spatial and annual variability in eelgrass (Zostera marina L.) meadows in Willapa Bay, Washington, and Coos Bay, Oregon, Estuaries. Estuaries 26:1117-1129.

Triton Environmental Consultants. 2004. Deltaport Third Berth Project Marine Resources Impact Assessment. Prepared for the Vancouver Port Authority.

Triton Environmental Consultants. 2001. Roberts Bank Cumulative Environmental Effects Study: Marine Habitat Study. Prepared for the Vancouver Port Authority.

VFPA and Hemmera. 2007. Deltaport Third Berth Adaptive Management Strategy Detailed Workplan.

Wang, F. And P.M. Chapman. 1999. Biological Implications of Sulphide in Sediment – A Review Focusing on Sediment Toxicity. Environmental Toxicology and Chemistry. 18: 11: 2526-2532.

Wyllie-Escheverria, S. and J.D. Ackerman. 2003. The seagrasses of the Pacific Coast of North America. In: Green, E.P. and F.T. Short (eds) World Atlas of Seagrasses, pp 199-206. University of California Press, Berkeley, USA.

7.0 STATEMENT OF LIMITATIONS

This report was prepared by Hemmera Envirochem Inc. (Hemmera), based on work conducted by the project team of Hemmera, Northwest Hydraulic Consultants (NHC) and Precision Identification (the Project Team) for the sole benefit and exclusive use of the Vancouver Fraser Port Authority. The material in it reflects the Project Team's best judgment in light of the information available to it at the time of preparing this report. Any use that a third party makes of this Report, or any reliance on or decision made based on it, is the responsibility of such third parties. The members of the Project Team accept no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions taken based on this report.

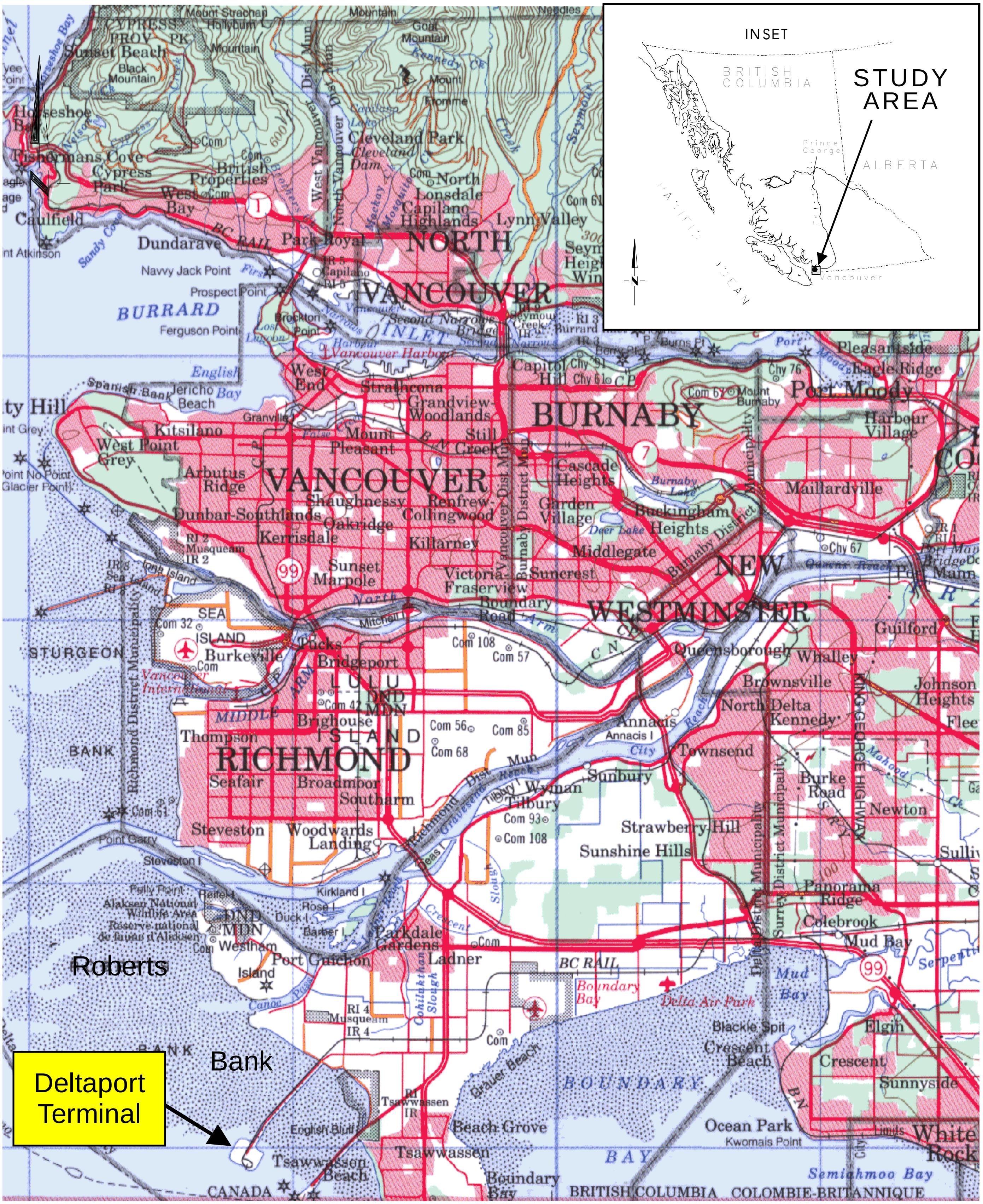
The Project Team has performed the work as described above and made the findings and conclusions set out in this report in a manner consistent with the level of care and skill normally exercised by members of the environmental science profession practicing under similar conditions at the time the work was performed.

This report represents a reasonable review of the information available to the Project Team within the established scope, work schedule and budgetary constraints. The conclusions and recommendations contained in this report are based upon applicable legislation existing at the time the report was drafted. Any changes in the legislation may alter the conclusions and/or recommendations contained in the report. Regulatory implications discussed in this report were based on the applicable legislation existing at the time this report was written.

In preparing this report, the Project Team have relied in good faith on information provided by others as noted in this report, and has assumed that the information provided by those individuals is both factual and accurate. The members of the Project Team accept no responsibility for any deficiency, mis-statement or inaccuracy in this report resulting from the information provided by those individuals.

The liability of the members of the Project Team to the Vancouver Fraser Port Authority shall be limited to injury or loss caused by the negligent acts of the Project Team. The total aggregate liability of Hemmera and the members of the Project Team related to this agreement shall not exceed the lesser of the actual damages incurred, or the total fee of the members of the Project Team for services rendered on this project.

FIGURES



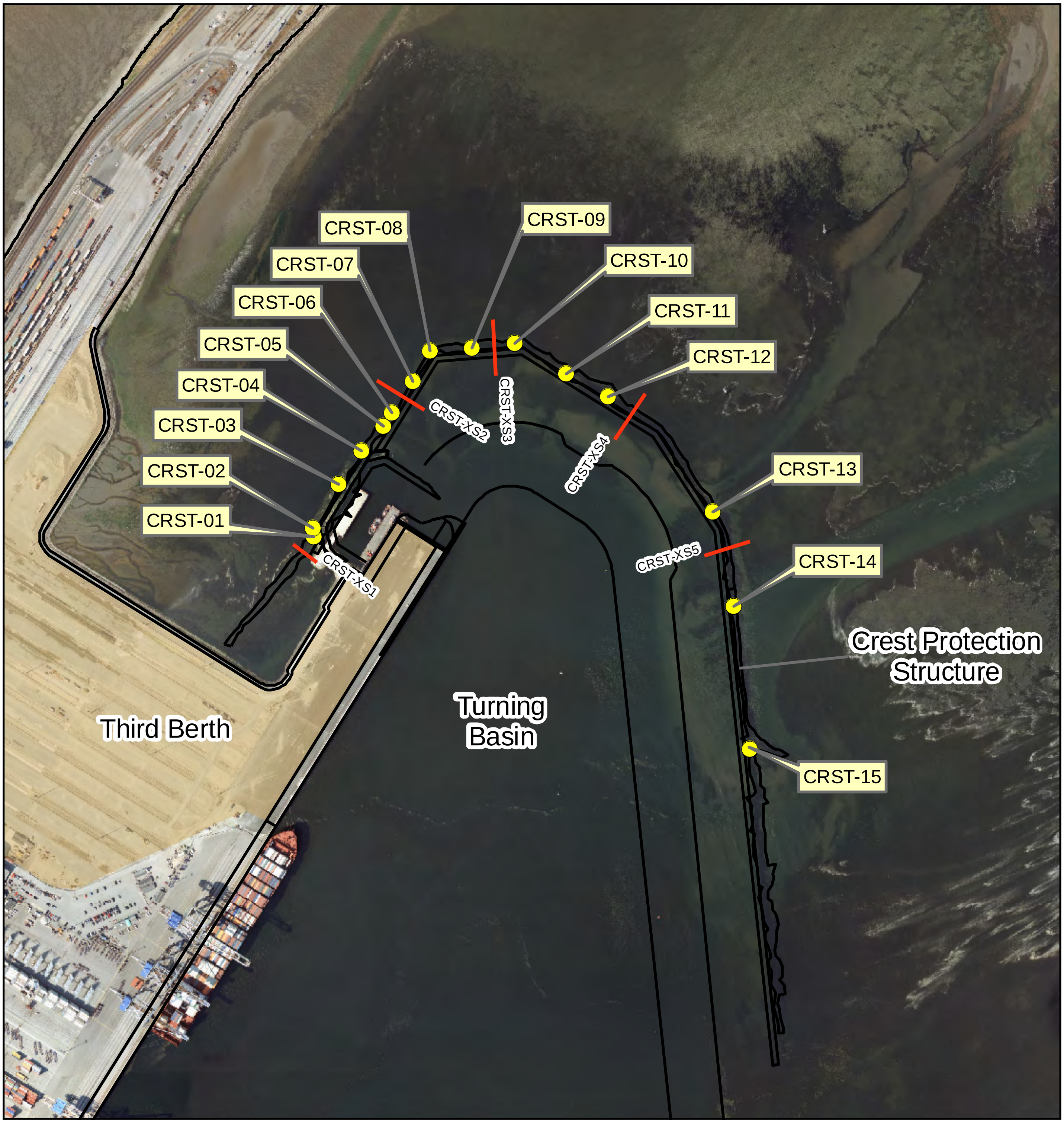
HEMMERA

CLIENT: PORT METRO vancouver

DELTAPORT THIRD BERTH - ADAPTIVE MANAGEMENT STRATEGY PROGRAM - 2009 ANNUAL REPORT

SITE LOCATION

PROJECT No.		
499-002.11	September 2010	FIGURE 1



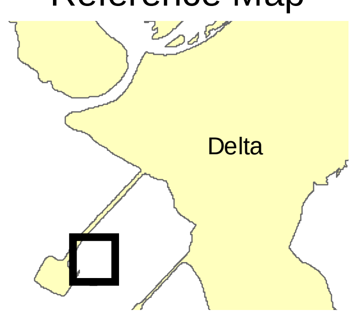
Legend

Monitoring Sites

Topographic Sections

Note:
- July 24, 2009 orthophoto image courtesy of PMV.

Reference Map



DELTAPORT THIRD BERTH ADAPTIVE MANAGEMENT STRATEGY PROGRAM 2009 ANNUAL REPORT

Crest Protection Structure
Monitoring Site Location Map

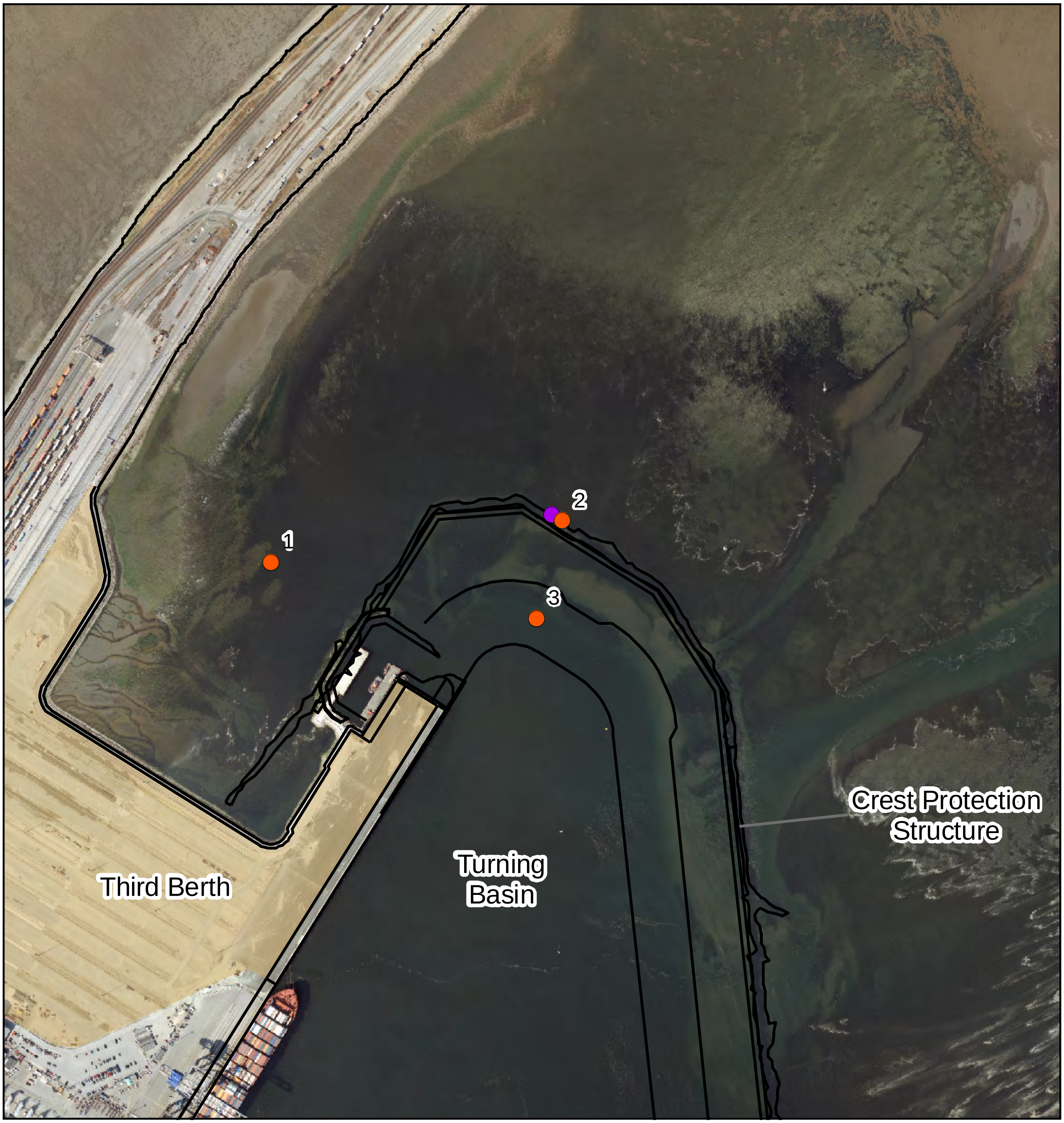
Scale - 1:7,500

100 50 0 100 200 Metres

coord. syst.: UTM Zone 10	horz. datum: NAD 83	horz. units: metres
northwest hydraulic consultants	project no. 3-4648	September 2010

MSN, 34648 Deltaport Monitoring\GIS\Fig_CrestProtectionSites.mxd

Figure 2

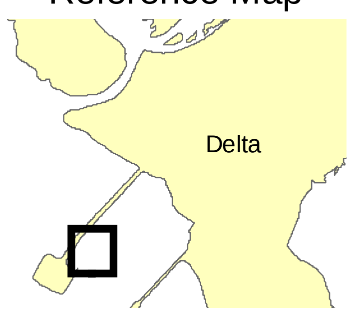


Legend

- Wave Sensor
- Turbidity Sensor 2

Note:
- July 24, 2009 orthophoto image courtesy of PMV.

Reference Map



DELTAPORT THIRD BERTH ADAPTIVE MANAGEMENT STRATEGY PROGRAM 2009 ANNUAL REPORT

Instrumentation Site Location Map

Scale - 1:7,500

100 50 0 100 200 Metres

coord. syst.: UTM Zone 10	horz. datum: NAD 83	horz. units: metres
northwest hydraulic consultants	project no. 3-4648	September 2010

CM, 34648 Deltaport Monitoring\GIS\Fig_AllInstrumentSites.mxd

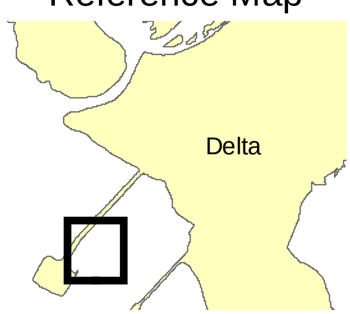
Figure 3

Legend

● Existing DOD Rod

Note:
- July 24, 2009 orthophoto image courtesy of PMV.

Reference Map



DELTAPORT THIRD BERTH ADAPTIVE MANAGEMENT STRATEGY PROGRAM Q4-2009 REPORT

Depth of Disturbance Rod Location Map

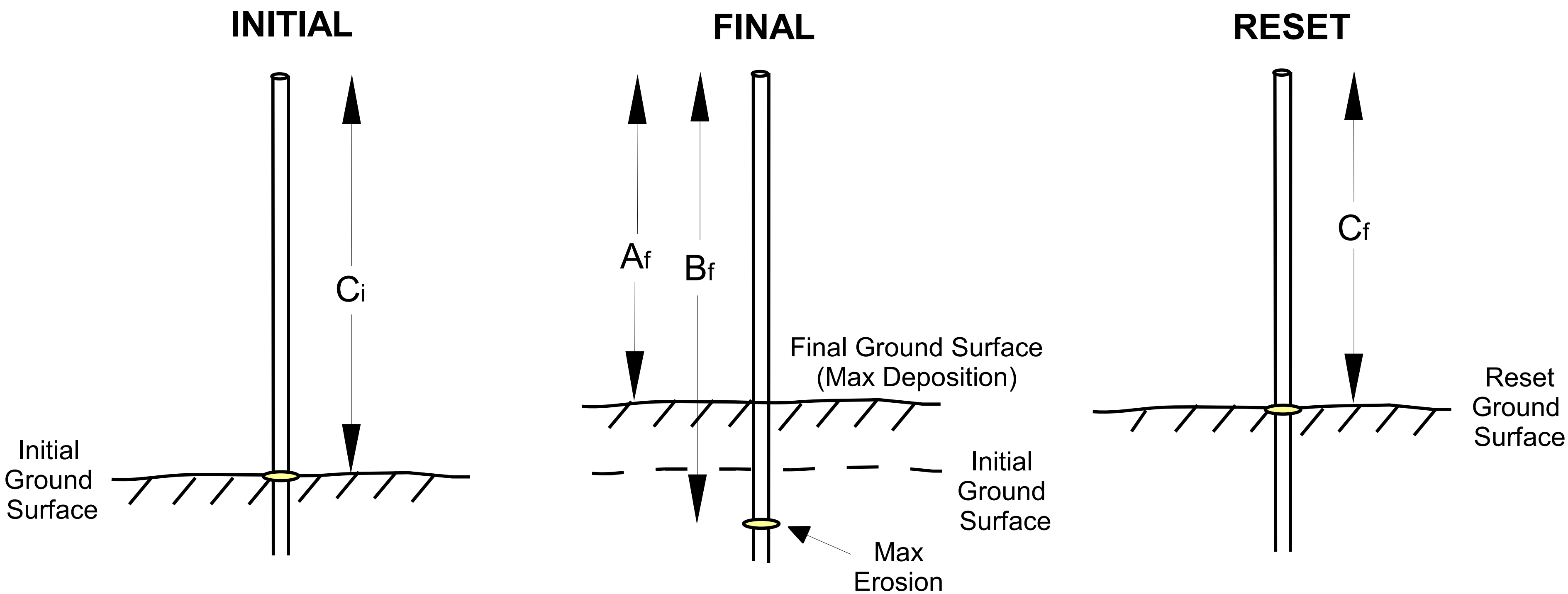
Scale - 1:10,000

100 50 0 100 200 300 Metres

coord. syst.: UTM Zone 10	horz. datum: NAD 83	horz. units: metres
northwest hydraulic consultants	project no. 3-464	September 2010

MSN, 34648 Deltaport Monitoring\GIS\Fig5DepthOfDisturbanceSites.mxd

Figure 4

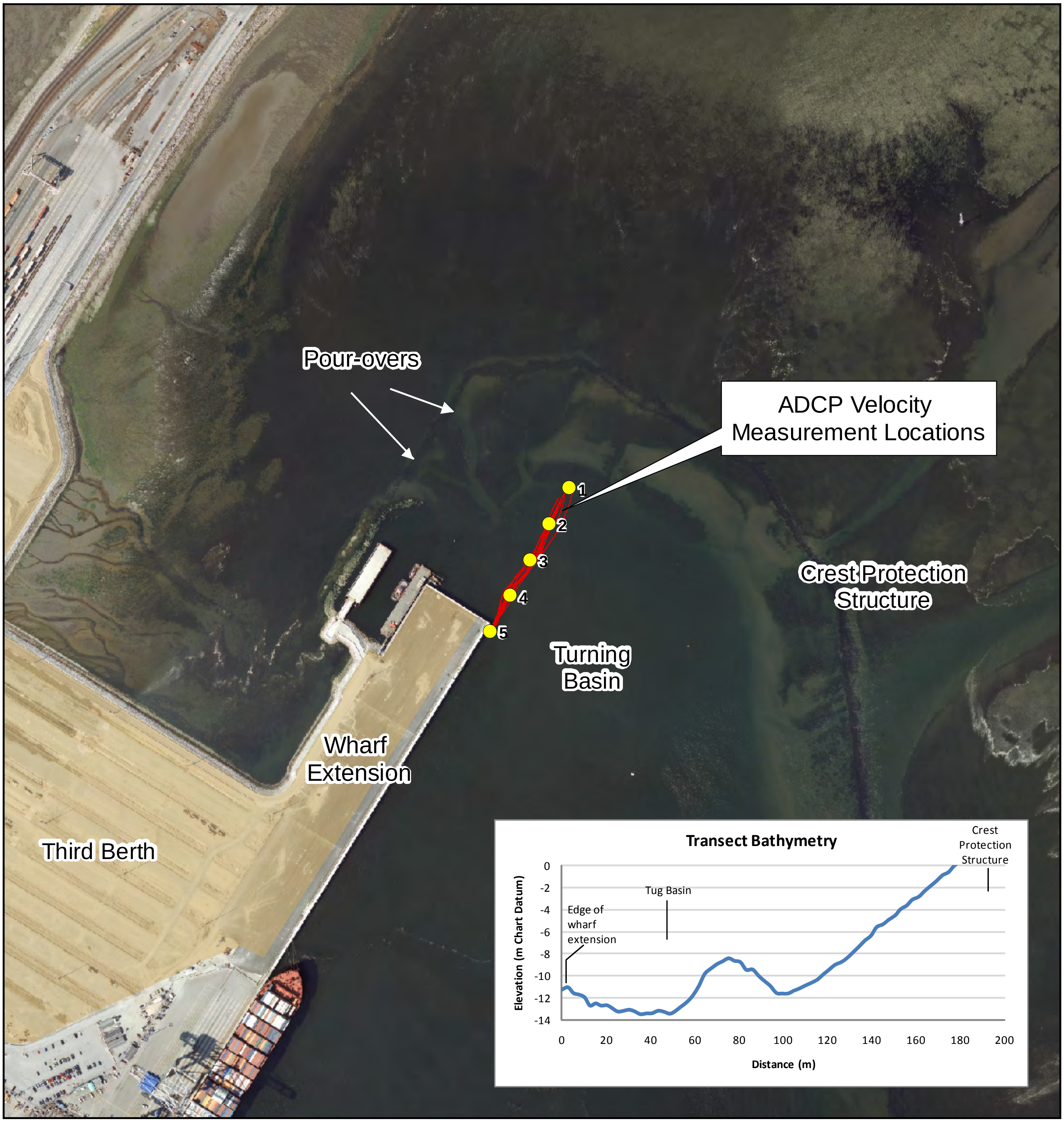


A = Height Above Ground
B = Height Above Washer
C = Reset: Height Above Ground/Washer

Deposition = $B_f - A_f$
Erosion = $B_f - C_i$ (if $B_f - C_i < 0$, then $B_f - C_i$ set to 0 to remove error)
Net Change = Deposition – Erosion

DELTAPORT THIRD BERTH ADAPTIVE MANAGEMENT STRATEGY PROGRAM 2009 ANNUAL REPORT		
Bed Level Change Computations at Depth of Disturbance Rods		
northwest hydraulic consultants	project no. 3-4648	March 2010

Figure 5

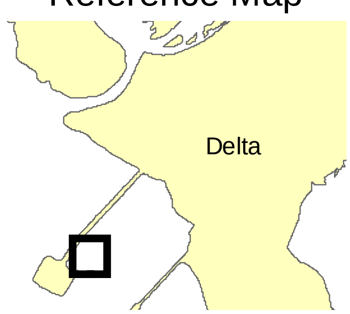


Legend

- Velocity Comparison Locations

Note:
- July 24, 2009 orthophoto image courtesy of PMV.

Reference Map



DELTAPORT THIRD BERTH ADAPTIVE MANAGEMENT STRATEGY PROGRAM 2009 ANNUAL REPORT

Location of ADCP Current Measurements

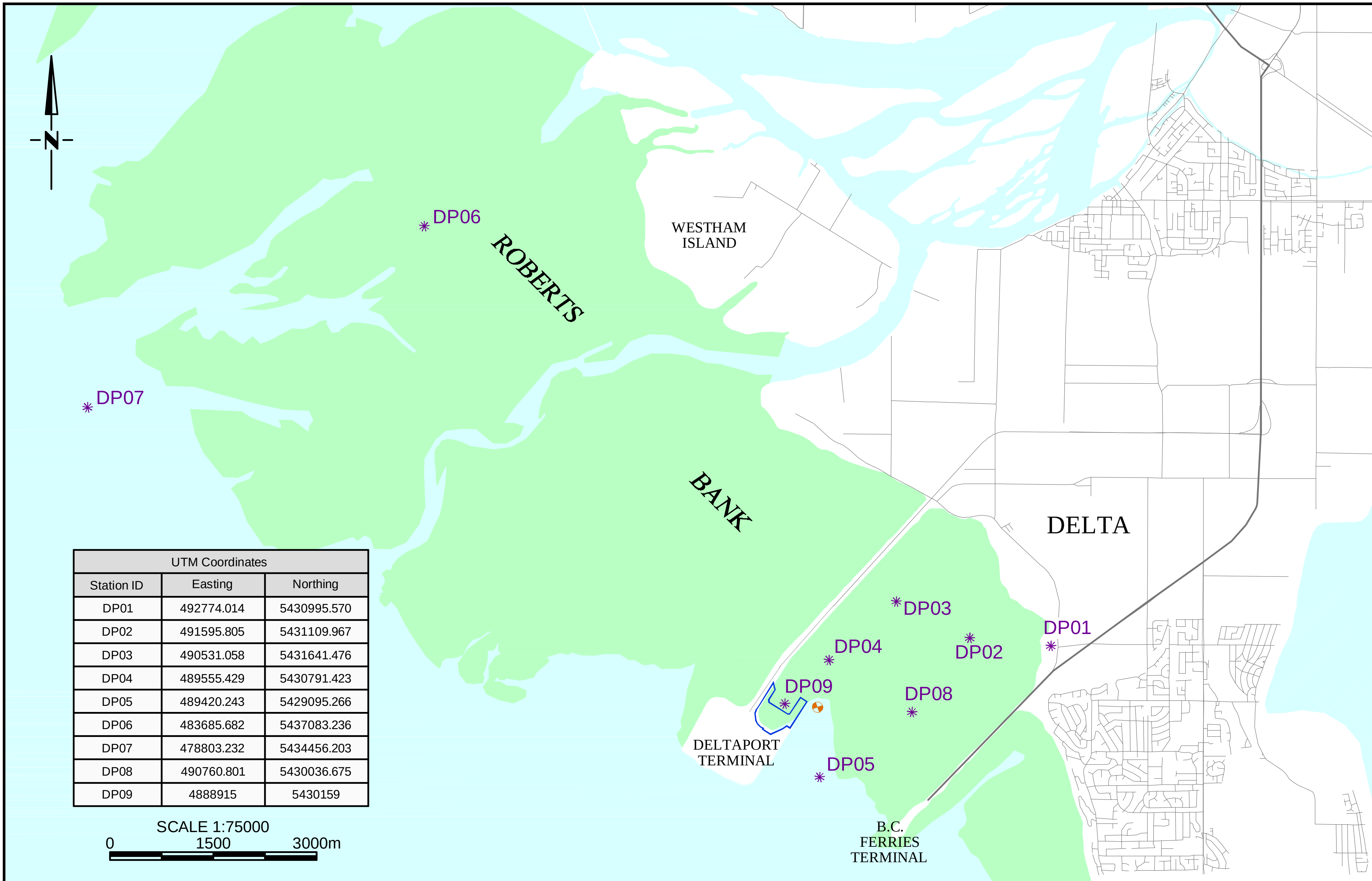
Scale - 1:6,000

100 50 0 100 Metres

coord. syst.: UTM Zone 10	horz. datum: NAD 83	horz. units: metres
northwest hydraulic consultants	project no. 3-464	September 2010

MSN, 34648 Deltaport Monitoring\GIS\Fig5DepthOfDisturbanceSites.mxd

Figure 6



UTM Coordinates		
Station ID	Easting	Northing
DP01	492774.014	5430995.570
DP02	491595.805	5431109.967
DP03	490531.058	5431641.476
DP04	489555.429	5430791.423
DP05	489420.243	5429095.266
DP06	483685.682	5437083.236
DP07	478803.232	5434456.203
DP08	490760.801	5430036.675
DP09	4888915	5430159

LEGEND
- Water
- Tidal Mud & Sand
- Sampling Station
- YSI Sonde

Note: DP8 & DP9 are only monitored in Q1.

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DELTAPORT THIRD BERTH - ADAPTIVE MANAGEMENT STRATEGY PROGRAM - 2009 ANNUAL REPORT

SURFACE WATER, SEDIMENT & BENTHIC INVERTEBRATE MONITORING STATIONS

PROJECT No.		
499-002.11	September 2010	FIGURE 7

LEGEND

✳ Water Quality Sampling Station

SCALE 1:5,000 (metres)
0 100 200

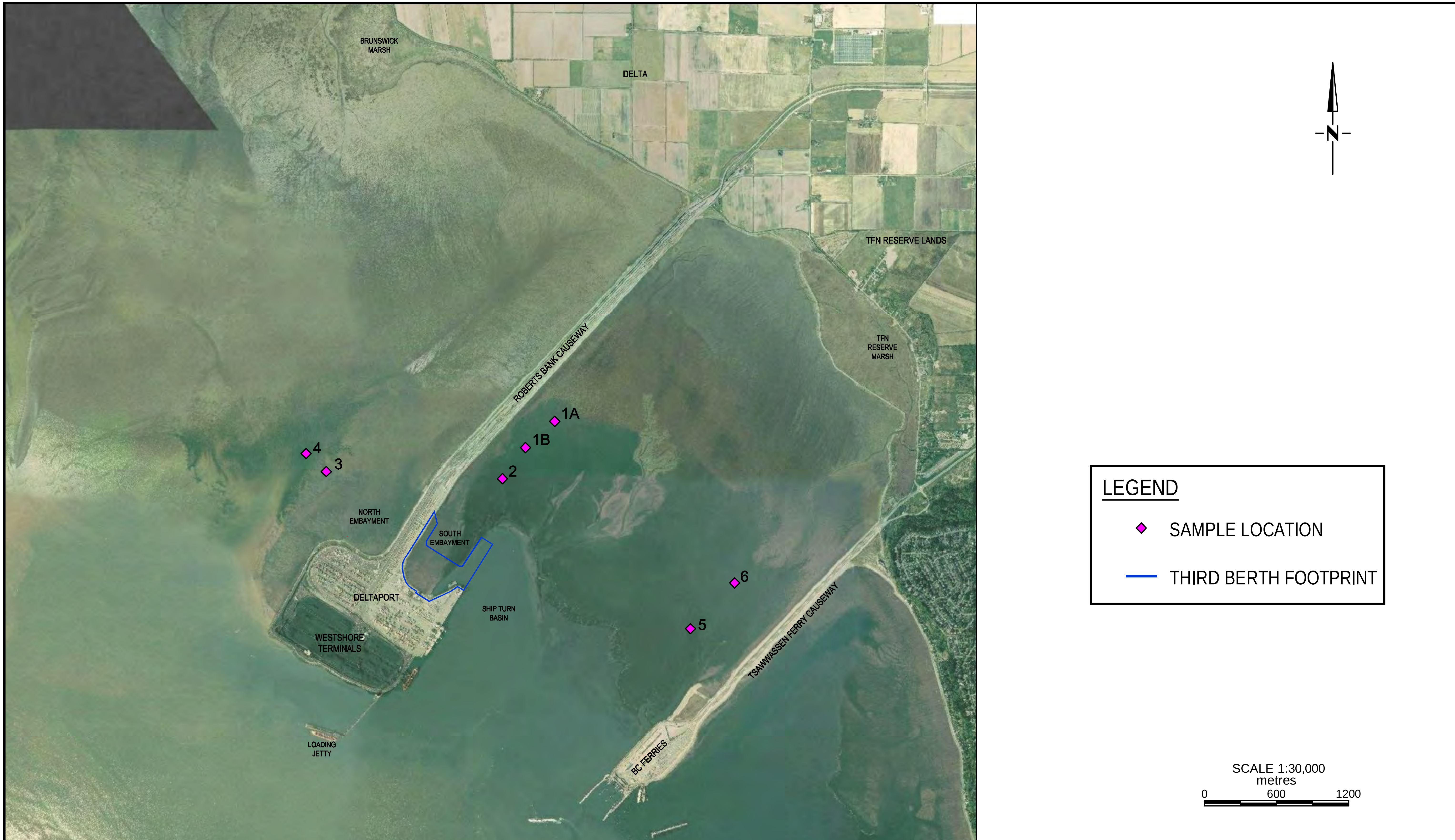
HEMMERA

CLIENT: PORT METRO vancouver

DELTAPORT THIRD BERTH - ADAPTIVE MANAGEMENT STRATEGY PROGRAM - 2009 ANNUAL REPORT

DETAILED LOCATION OF SAMPLE DP01

PROJECT No.		
499-002.11	September 2010	FIGURE 8



REFERENCE DRAWINGS

- Base Map Information Provided by Triton Consultants Ltd., dated Sept 2004.
- Envirowest Environmental Consultants Figure 'Appendix A', dated Nov. 1, 2004.

HEMMERA

CLIENT: PORT METRO vancouver

DELTAPORT THIRD BERTH - ADAPTIVE MANAGEMENT STRATEGY PROGRAM - 2009 ANNUAL REPORT

EELGRASS STATION REFERENCE LOCATIONS (DELTAPORT AREA)

PROJECT No. 499-002.11	September 2010	FIGURE 9

LEGEND

Eelgrass Sampling Station (UTM Coordinates Shown)

Note: The shallow and deep station are each approximately 10 metres away from the mid station.

HEMMERA

CLIENT: PORT METRO vancouver

DELTAPORT THIRD BERTH - ADAPTIVE MANAGEMENT STRATEGY PROGRAM - 2009 FINAL REPORT

EELGRASS REFERENCE STATION LOCATION (BOUNDARY BAY AREA)

PROJECT No. 499-002.11 | September 2010 | FIGURE 10

Legend

100 Contour Line Label

● Species Specific (GBHE & BRAN) "windshield" survey locations

American Ornithological Union Code
Common Name
GBHE
Great Blue Heron
BRAN
Brant

1:25,000

500 250 0 500 Meters

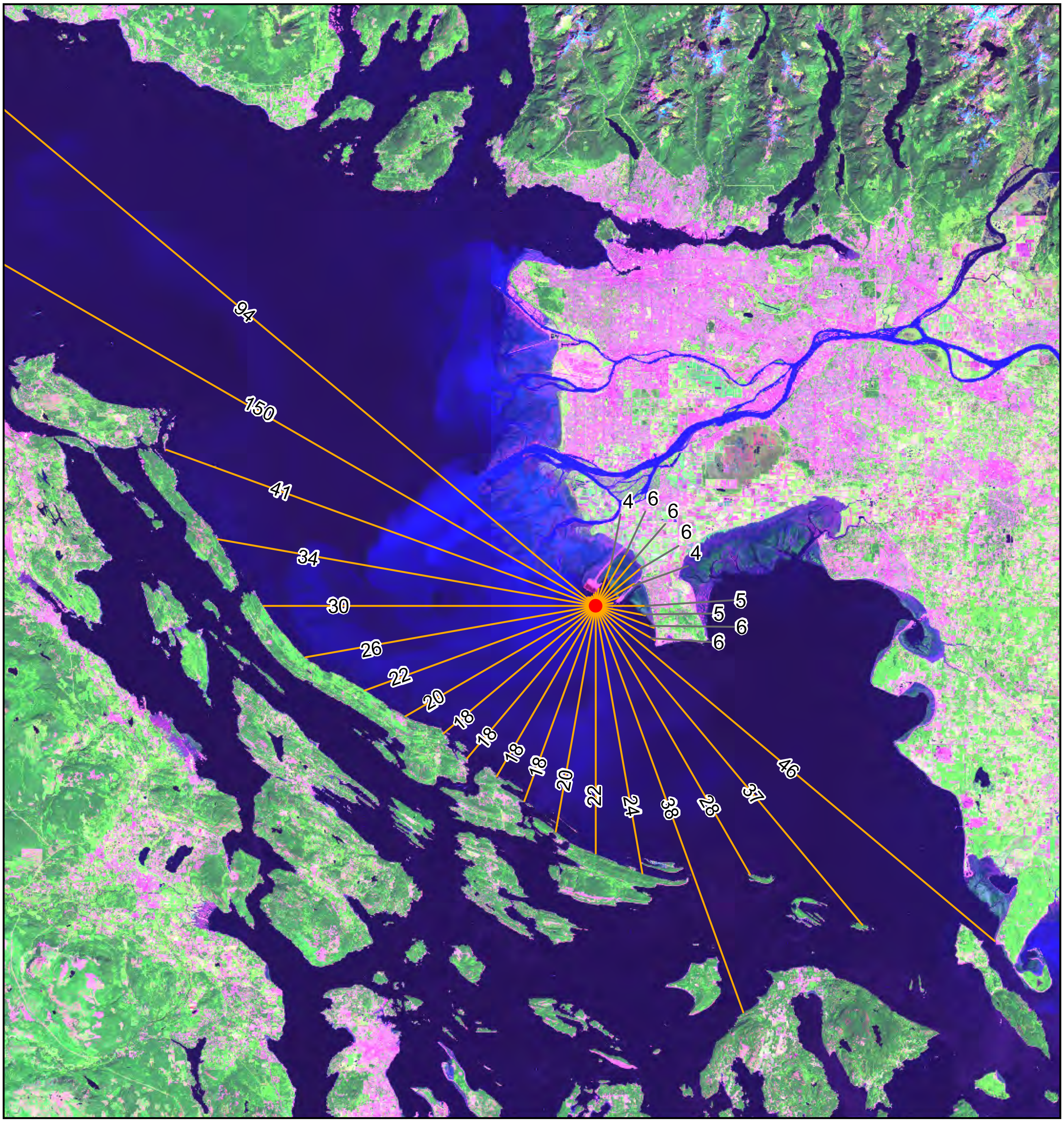
HEMMERA

PORT METRO vancouver

DELTAPORT THIRD BERTH - ADAPTIVE MANAGEMENT STRATEGY PROGRAM 2009 ANNUAL REPORT

BIRD SURVEY TRANSECT LOCATIONS

PROJECT NO: 499-002.11	SEPTEMBER 2010	FIGURE 11



Legend

● Reference Point

— Fetch Lengths at 10˚ intervals (km)

Note:
- July 30, 2000 Landsat composite image courtesy of Geogratis.

DELTAPORT THIRD BERTH ADAPTIVE MANAGEMENT STRATEGY PROGRAM 2009 ANNUAL REPORT

Fetch Lengths at Deltaport

Scale - 1:500,000

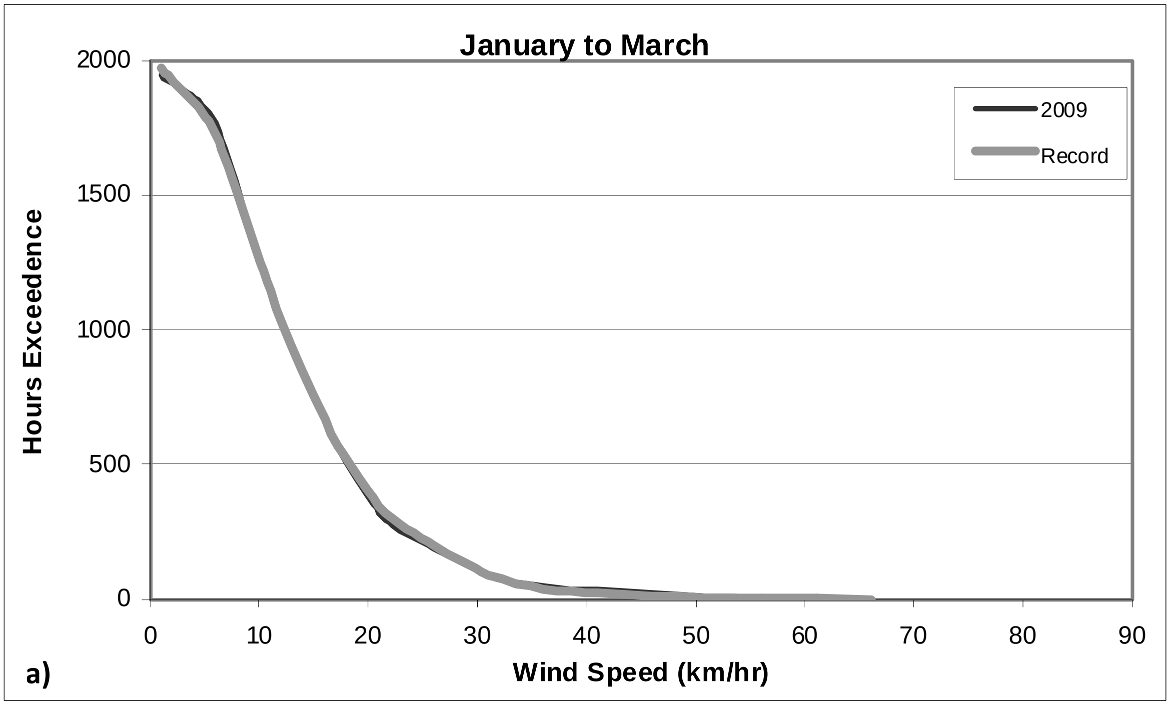
10 5 0 10 Kilometres

coord. syst.: UTM Zone 10	horz. datum: NAD 83	horz. units: metres
northwest hydraulic consultants	project no. 3-4648	September 2010

CXM/MSN, 34648 Deltaport Monitoring\GIS\Fig_FetchLength.mxd

Figure 12

Figure 13 Summary of hourly wind speed measured at Vancouver International Airport for the period a) January to March, and b) April to June



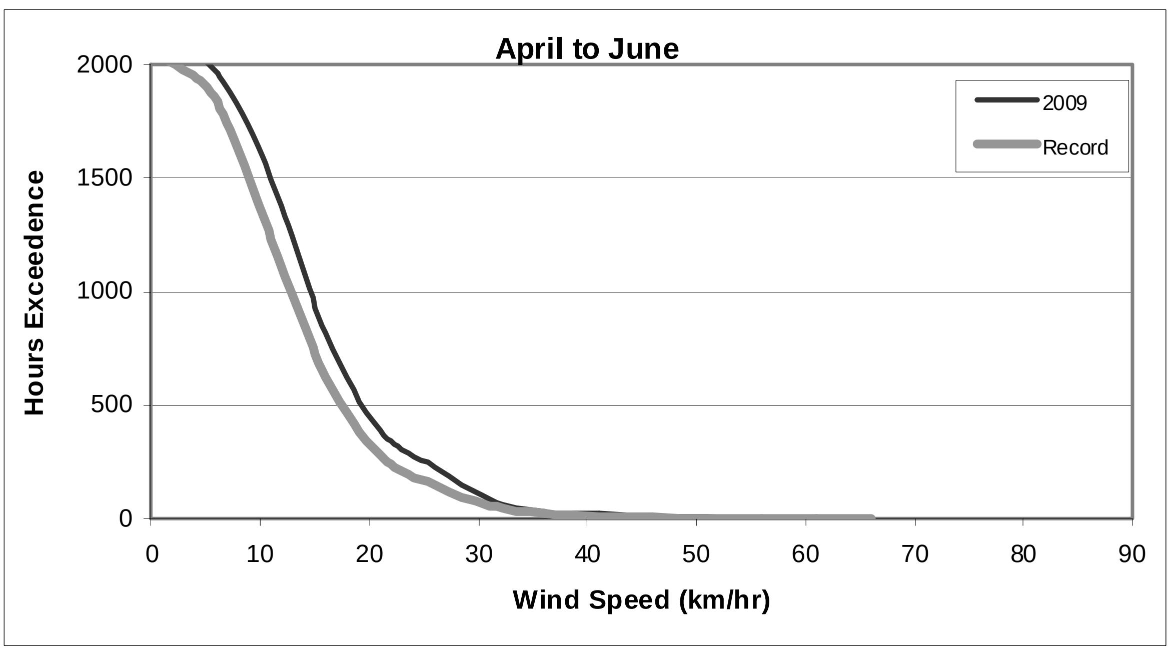
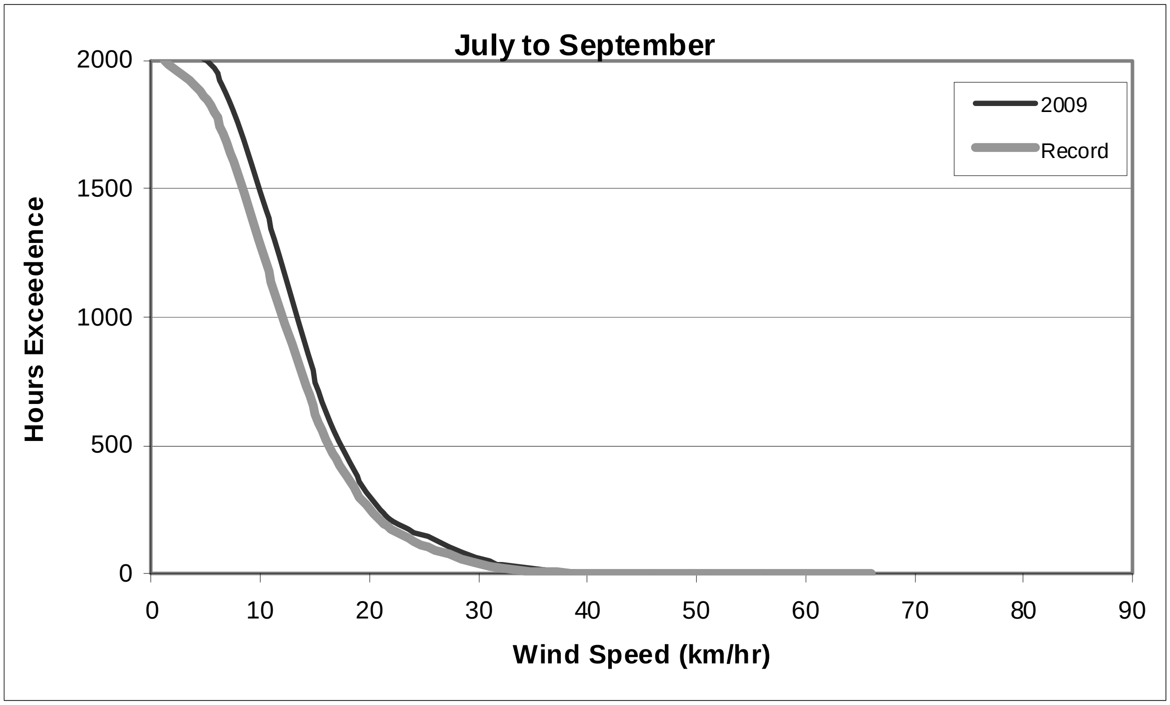


Figure 13 Summary of hourly wind speed measured at Vancouver International Airport for the period c) July to September and d) October to December



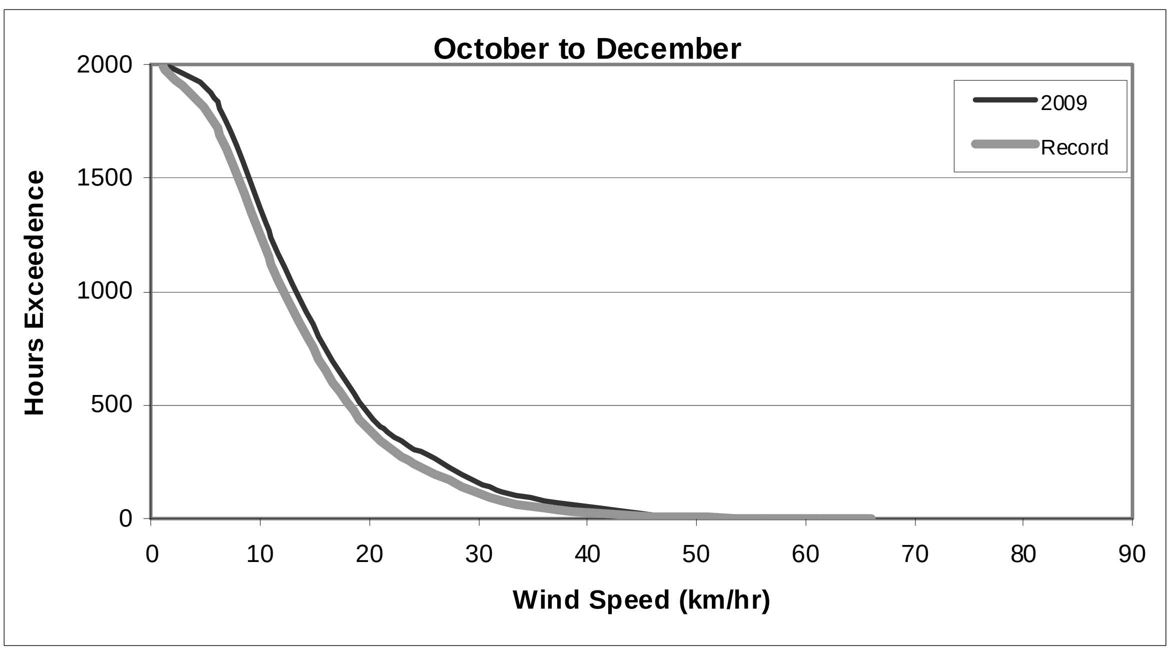
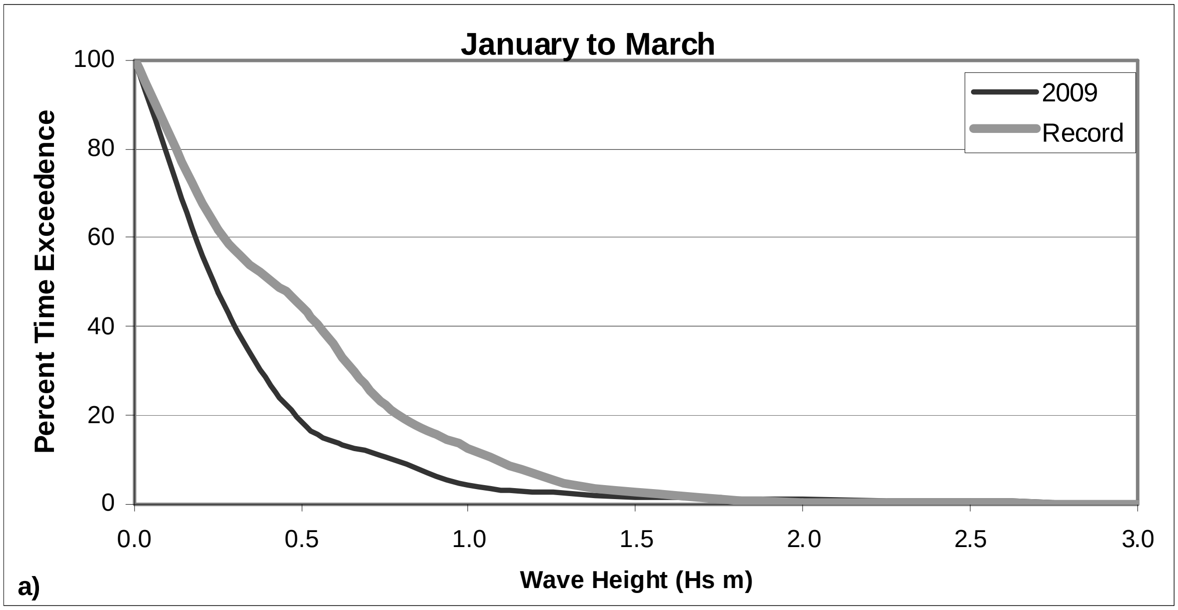


Figure 14 Summary of wave data from Station #46146 (Halibut Bank) for the period a) January to March, and b) April to June



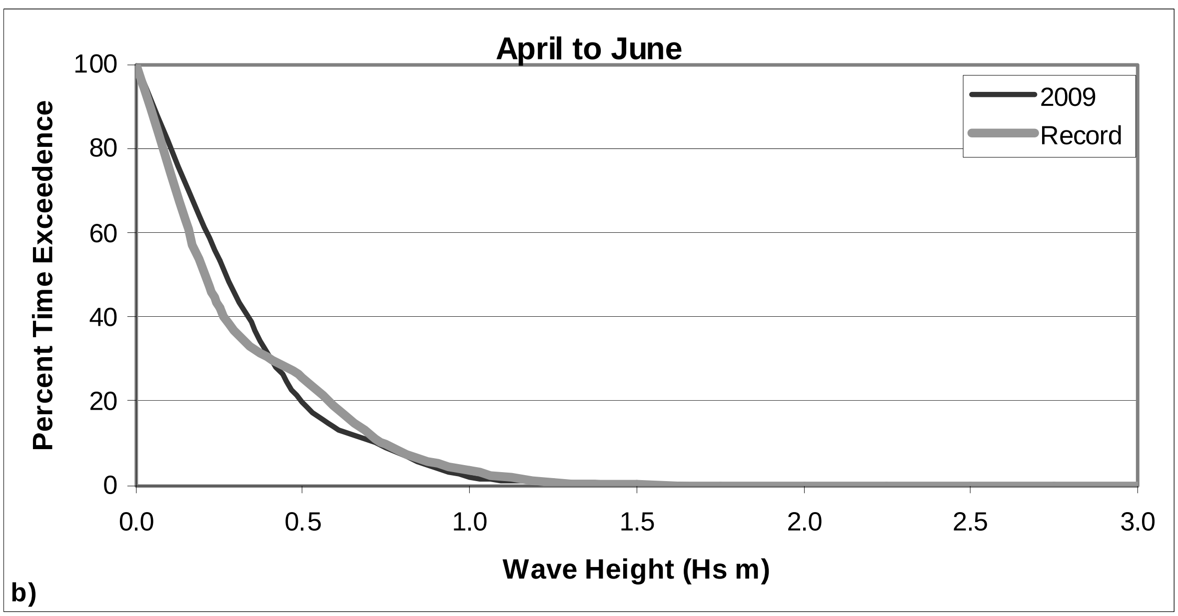
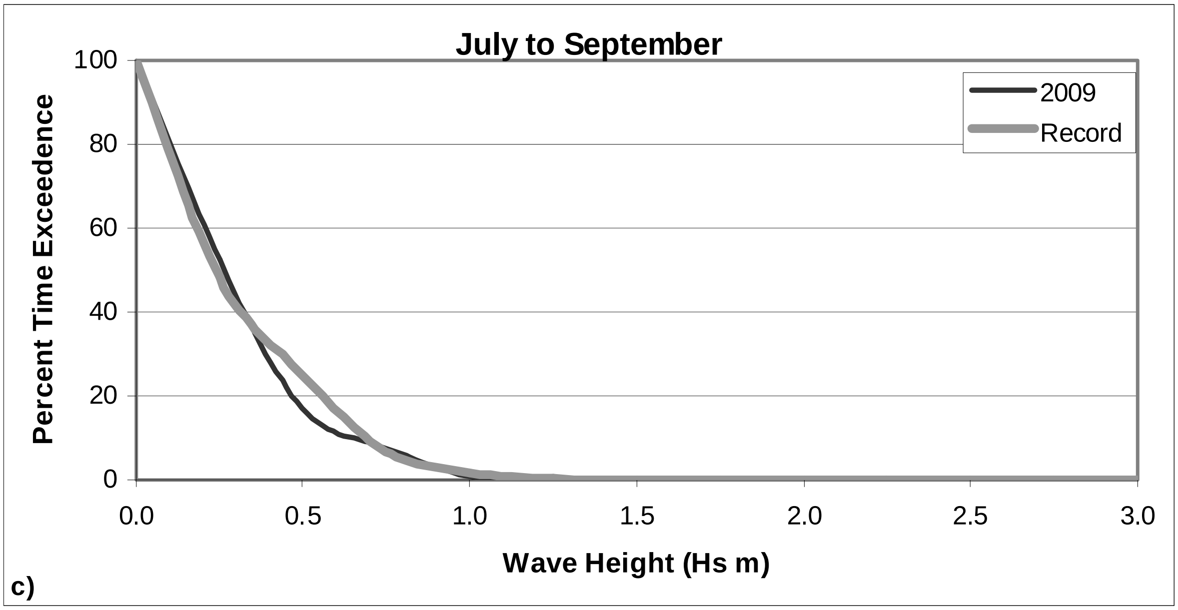


Figure 14 Summary of wave data from Station #46146 (Halibut Bank) for the period c) July to September, and b) October to December



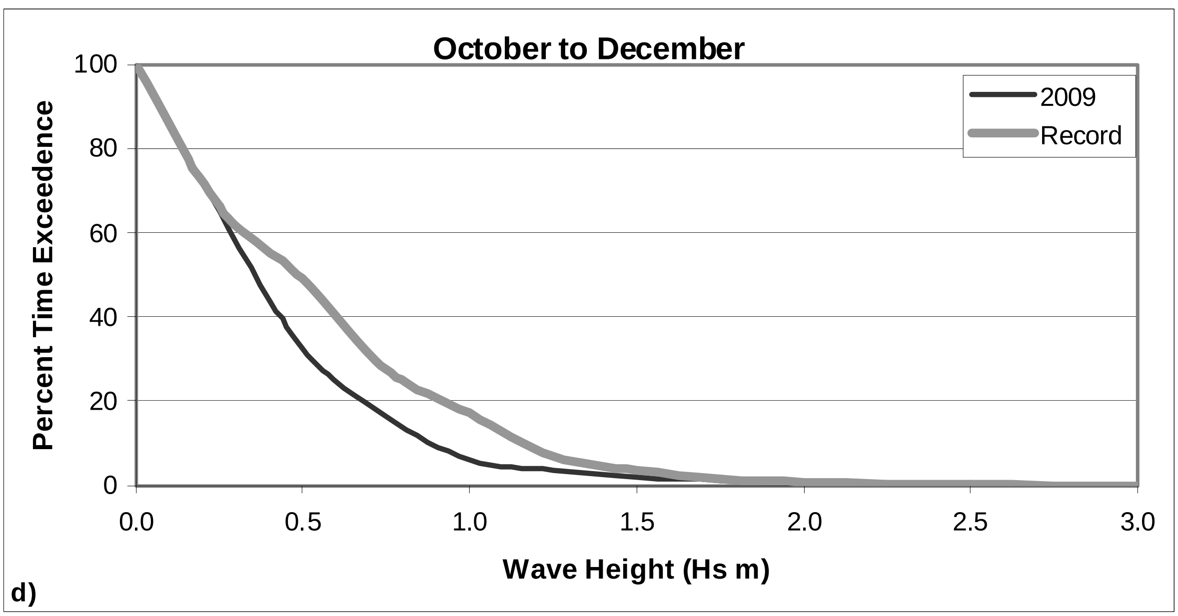


Figure 15 Observed Tide Levels at Point Atkinson, January to March

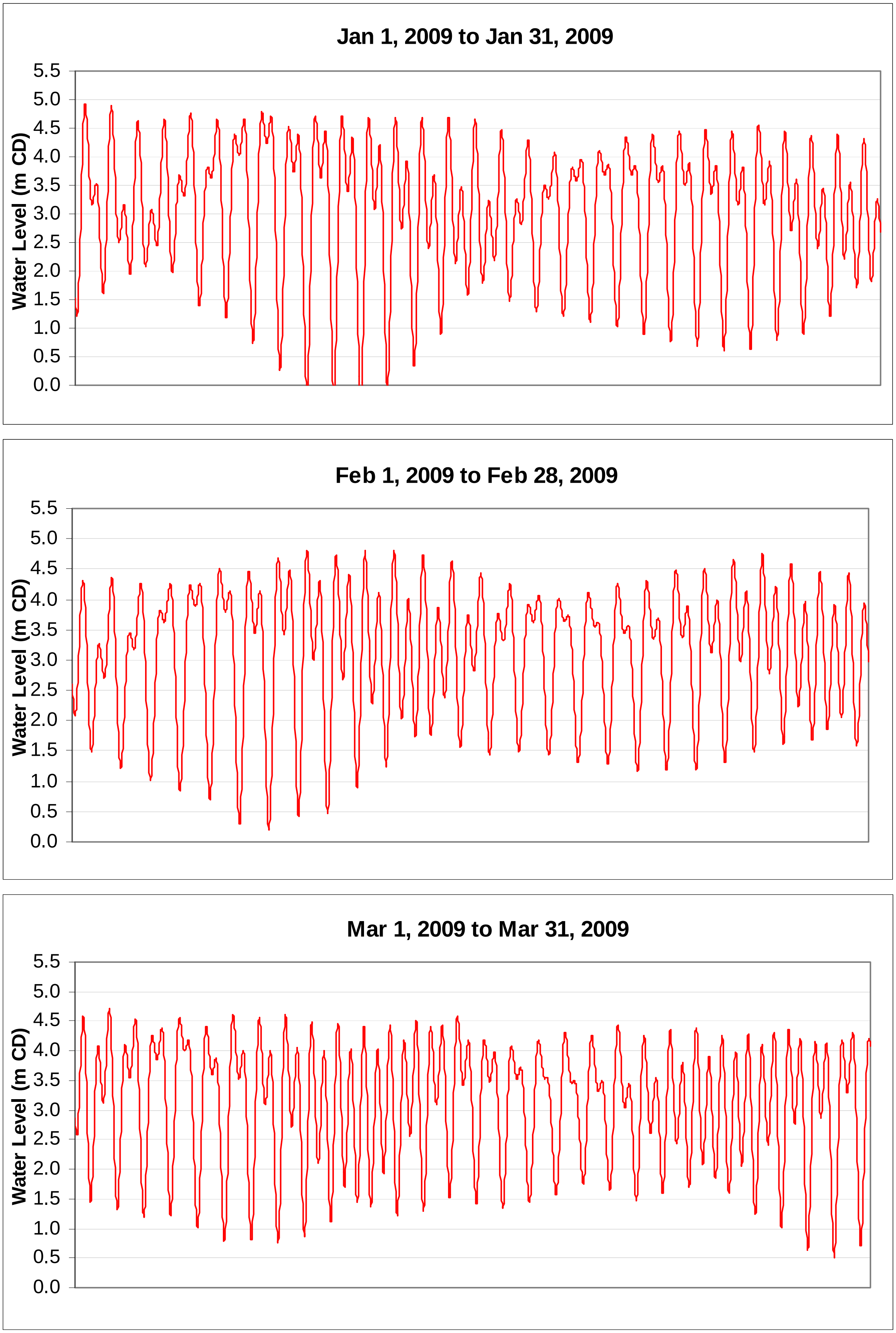
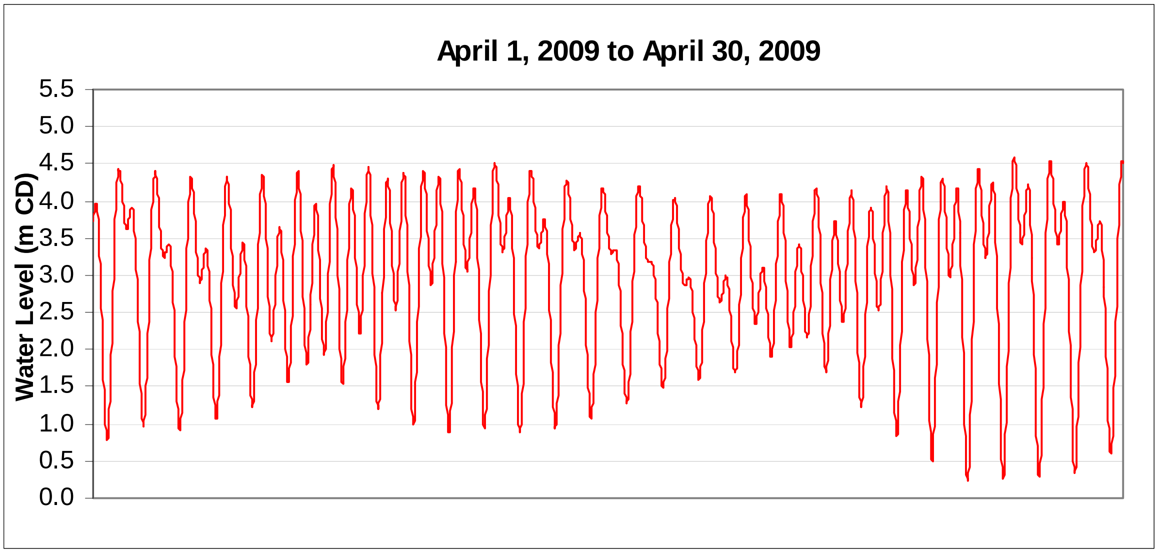
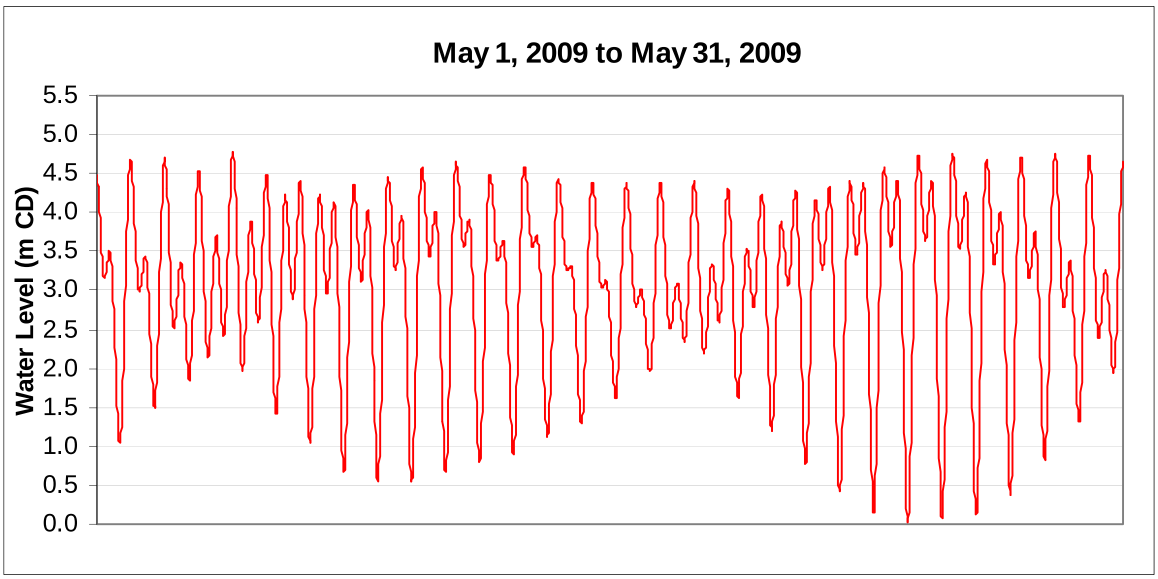


Figure 16 Observed Tide Levels at Point Atkinson, April to June





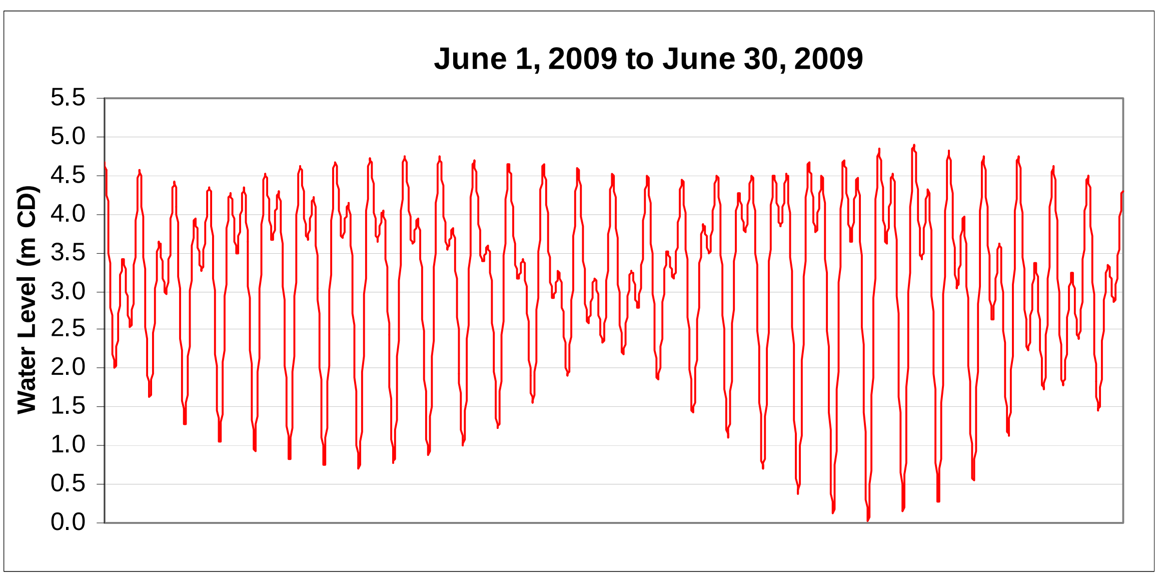
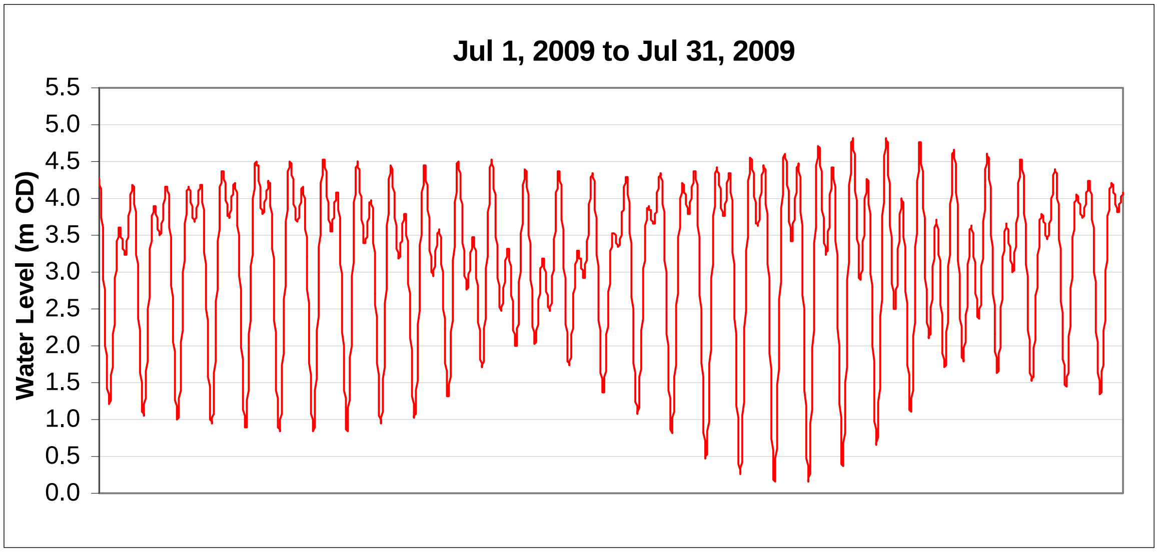
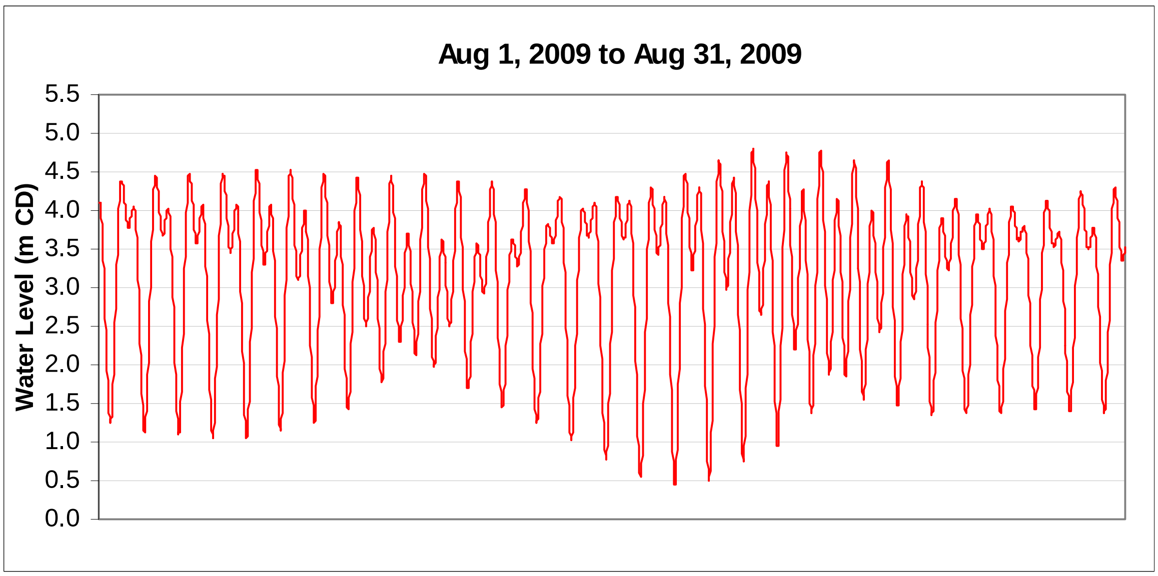


Figure 17 Observed Tide Levels at Point Atkinson, July to September





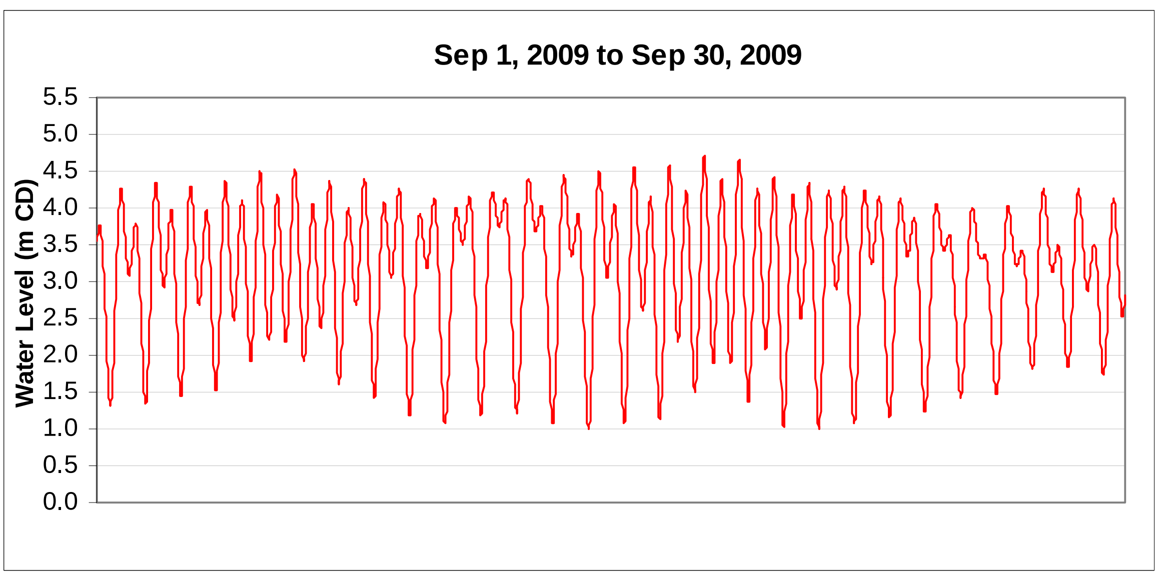
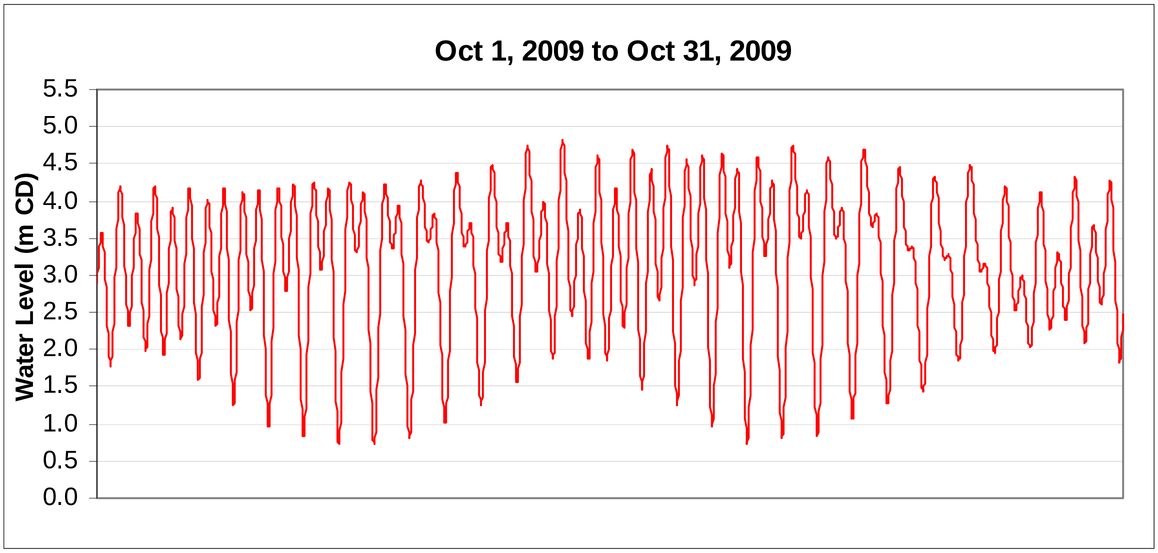
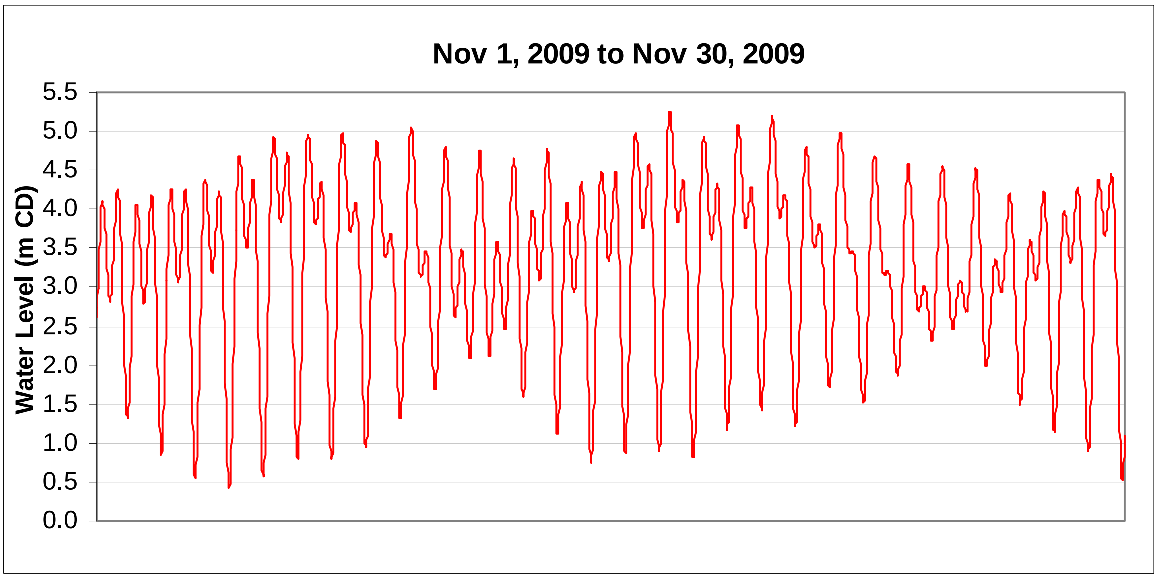


Figure 18 Observed Tide Levels at Point Atkinson, October to December





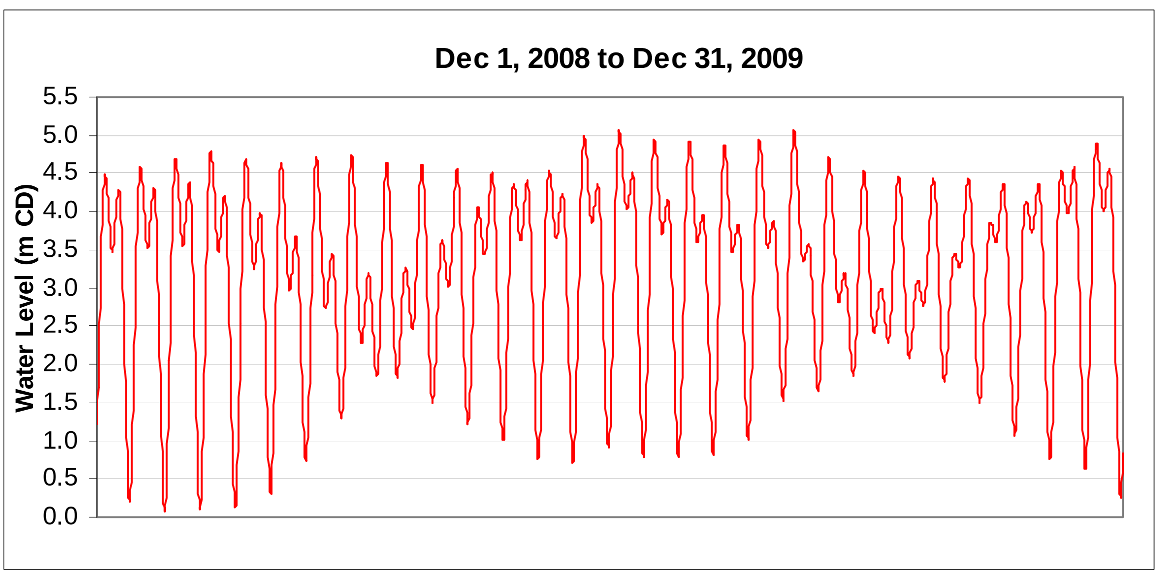
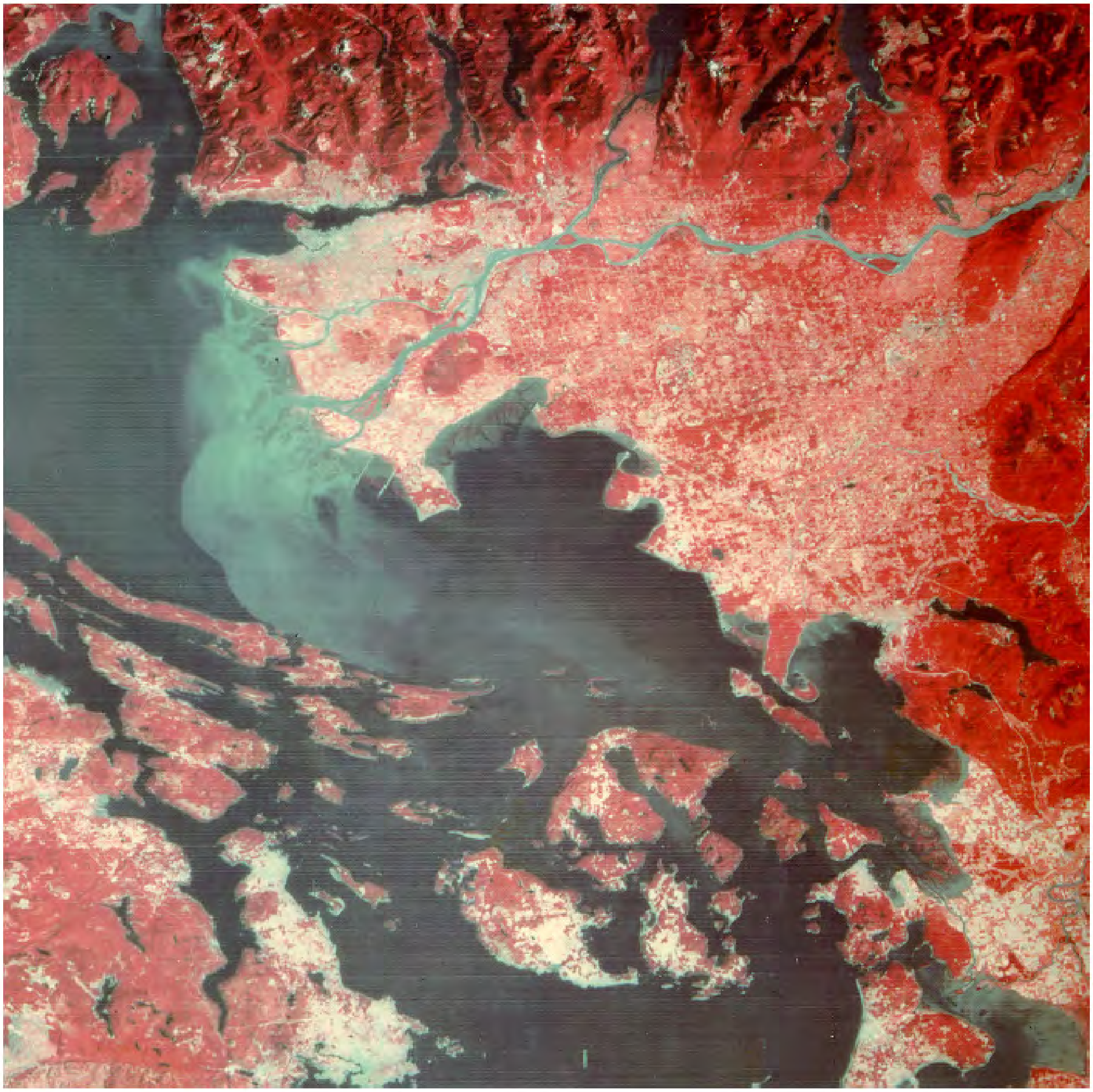
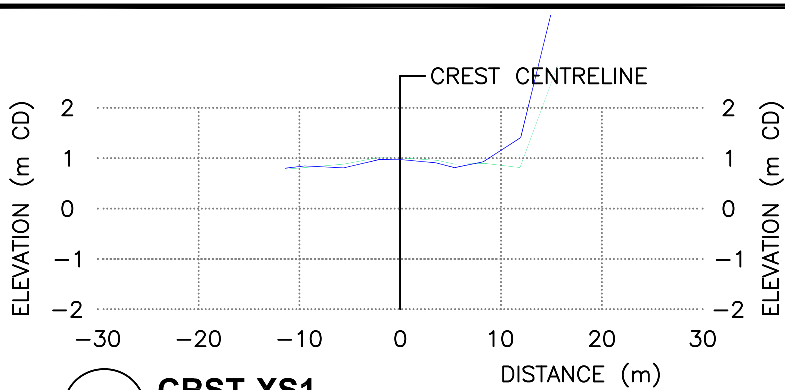
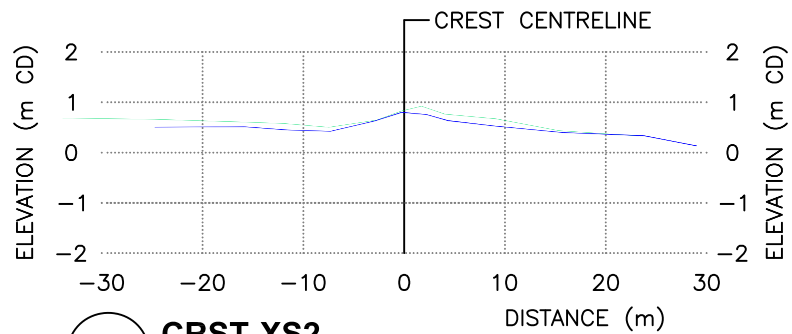


Figure 19 Fraser River Plume deflected by Roberts Bank Causeway during Ebb Tide

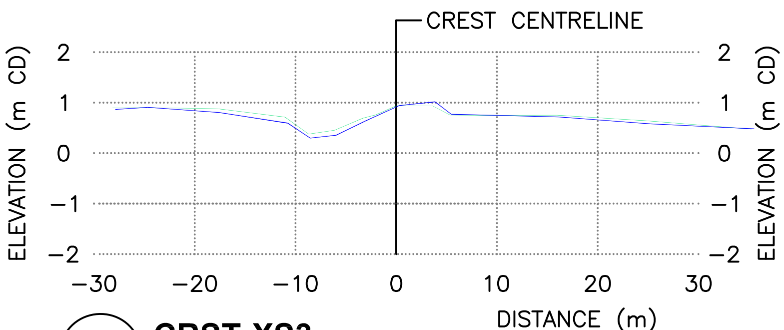




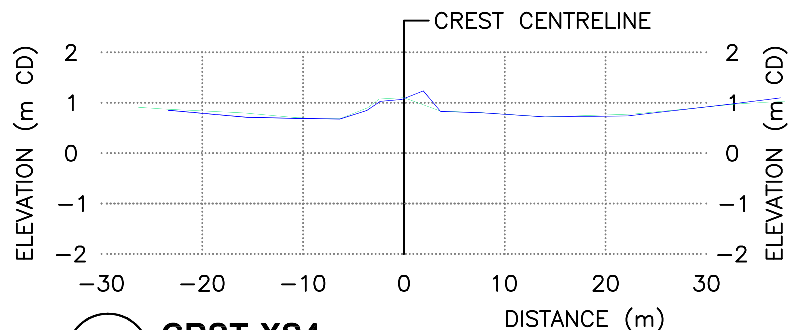
CRST-XS1
-
5H:1V



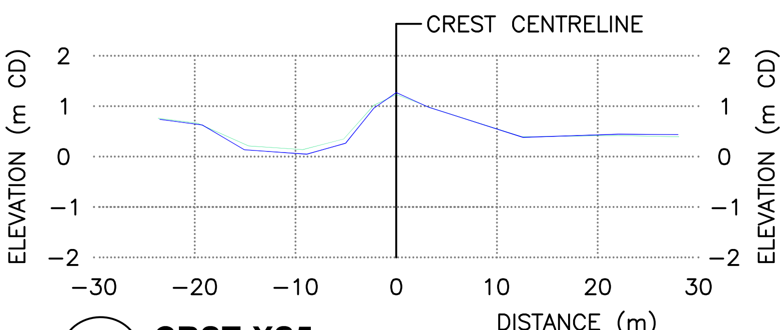
CRST-XS2
-
5H:1V



CRST-XS3
-
5H:1V



CRST-XS4
-
5H:1V



CRST-XS5
-
5H:1V

Note: sections drawn from shoreward (negative distance) to seaward (positive distance)

March 2009 survey
July 2009 survey

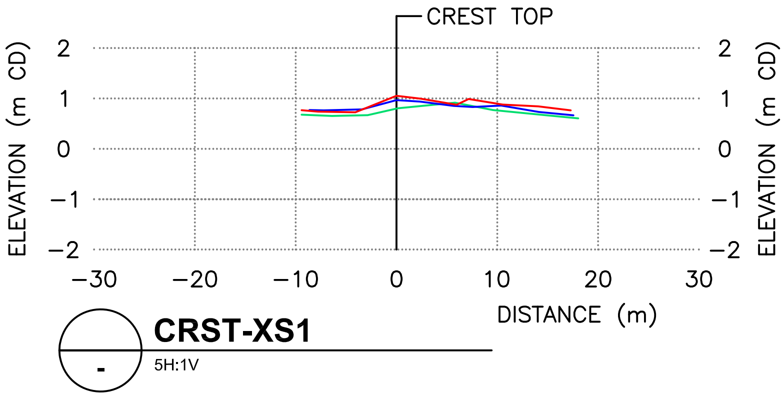
DELTAPORT THIRD BERTH ADAPTIVE MANAGEMENT STRATEGY PROGRAM
2009 ANNUAL REPORT

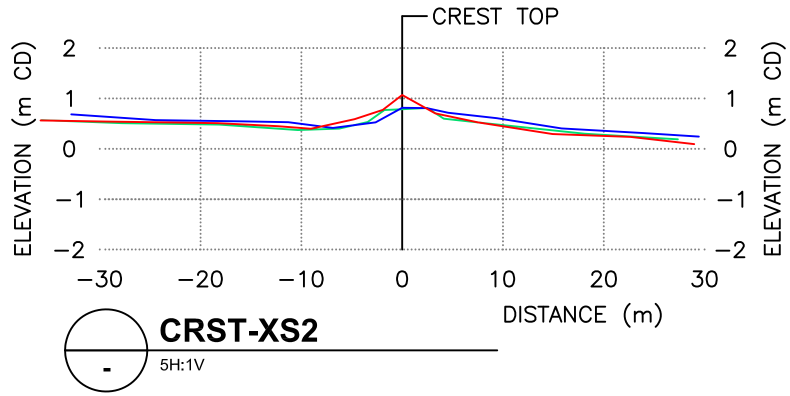
Crest Protection Structure
2009 Monitoring Cross Sections

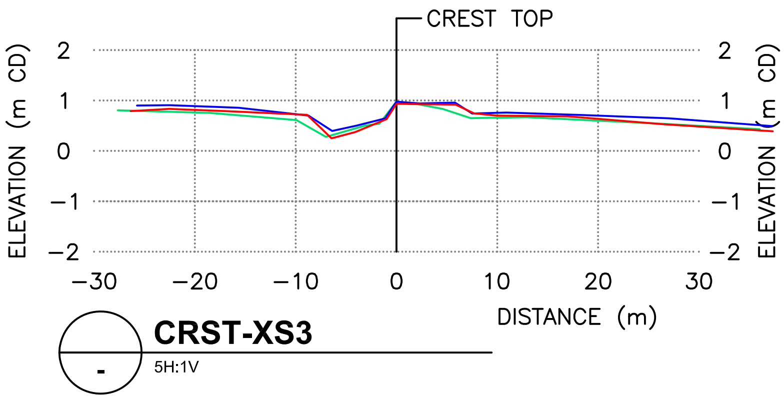
DWG. NO.	REV. NO.	DATE
crstpro–2009	00	10–02–12

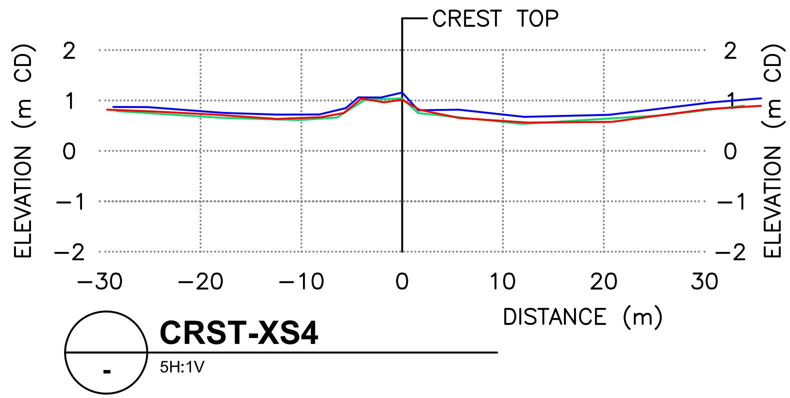
northwest hydraulic consultants

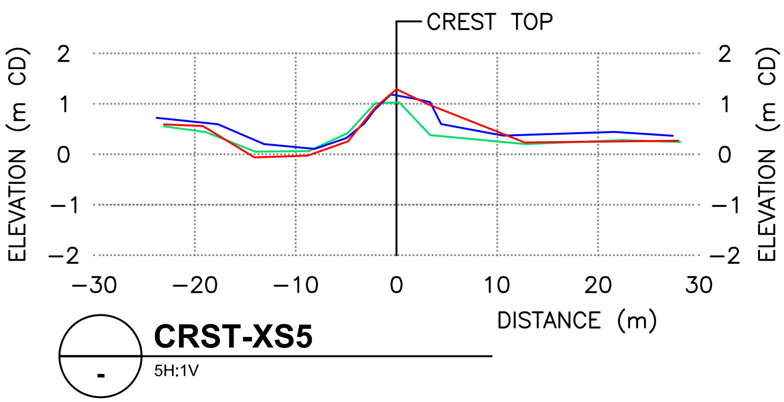
FIGURE 20











Note: sections drawn from shoreward (negative distance) to seaward (positive distance)

- Jan 2008 survey
- April 2008 survey
- July 2008 survey

DELTAPORT THIRD BERTH ADAPTIVE MANAGEMENT STRATEGY PROGRAM

2009 ANNUAL REPORT

Crest Protection Structure

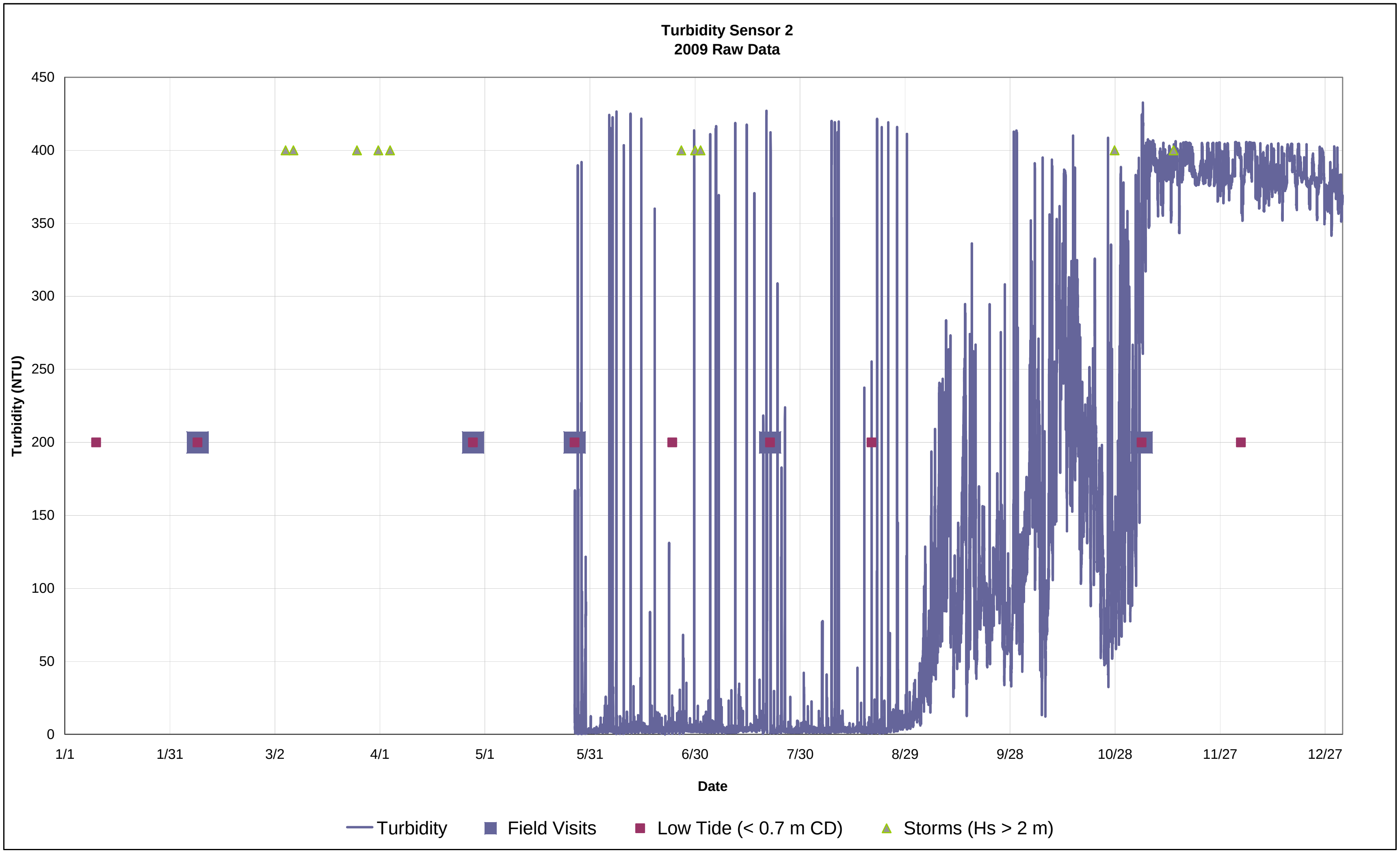
2008 Monitoring Cross Sections

DWG. NO.	REV. NO.	DATE
crstpro-2008	00	09-02-05

northwest hydraulic consultants

FIGURE 21

Figure 22 Time Series of 2009 Raw Turbidity Data from Sensor 2 – May 26 to December 31



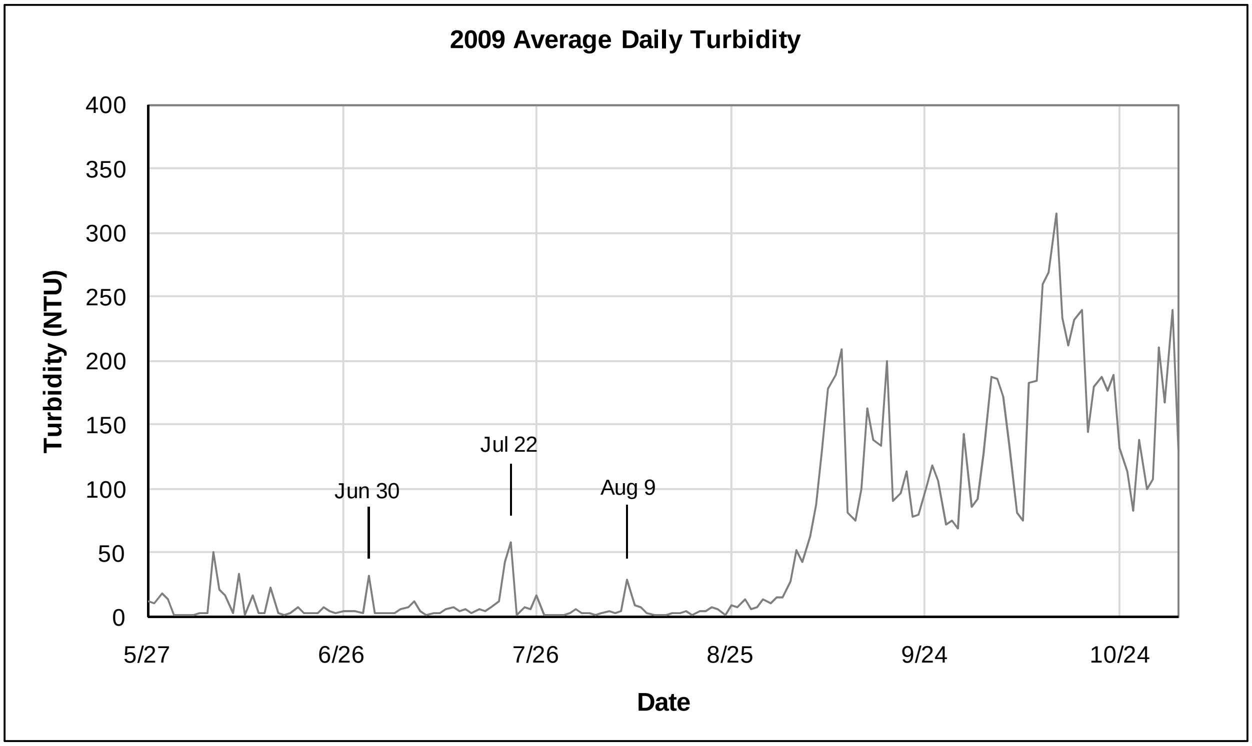
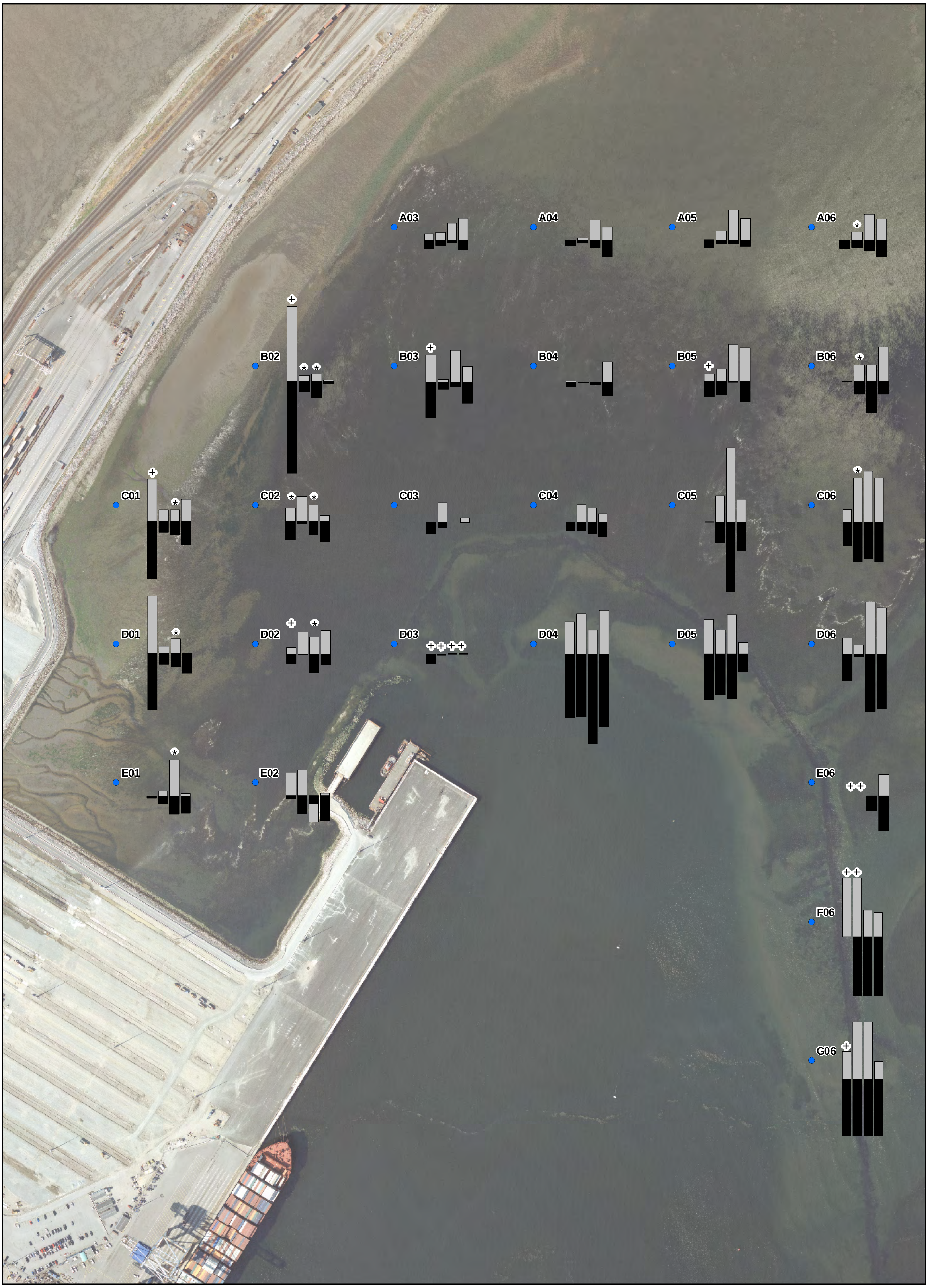


Figure 23. Time series of 2009 average daily turbidity data from Sensor 2 – May 26 to December 31

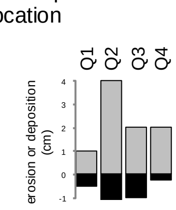


● DoD Rod Locations

\+ Refer to "DoD Rod Damage in 2009" figure

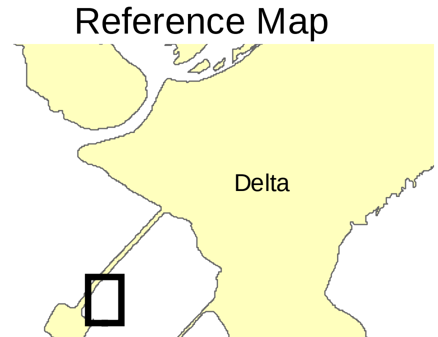
Note:
- July 24, 2009 orthophoto image courtesy of PMV.

Bar chart shows quarterly erosion and deposition at each DoD rod location



* indicates that measurement may be affected by cone of vegetation

Reference Map



DELTAPORT THIRD BERTH ADAPTIVE MANAGEMENT STRATEGY PROGRAM 2009 ANNUAL REPORT

Bar Charts of 2009 Quarterly Erosion and Deposition at Original DoD Rods

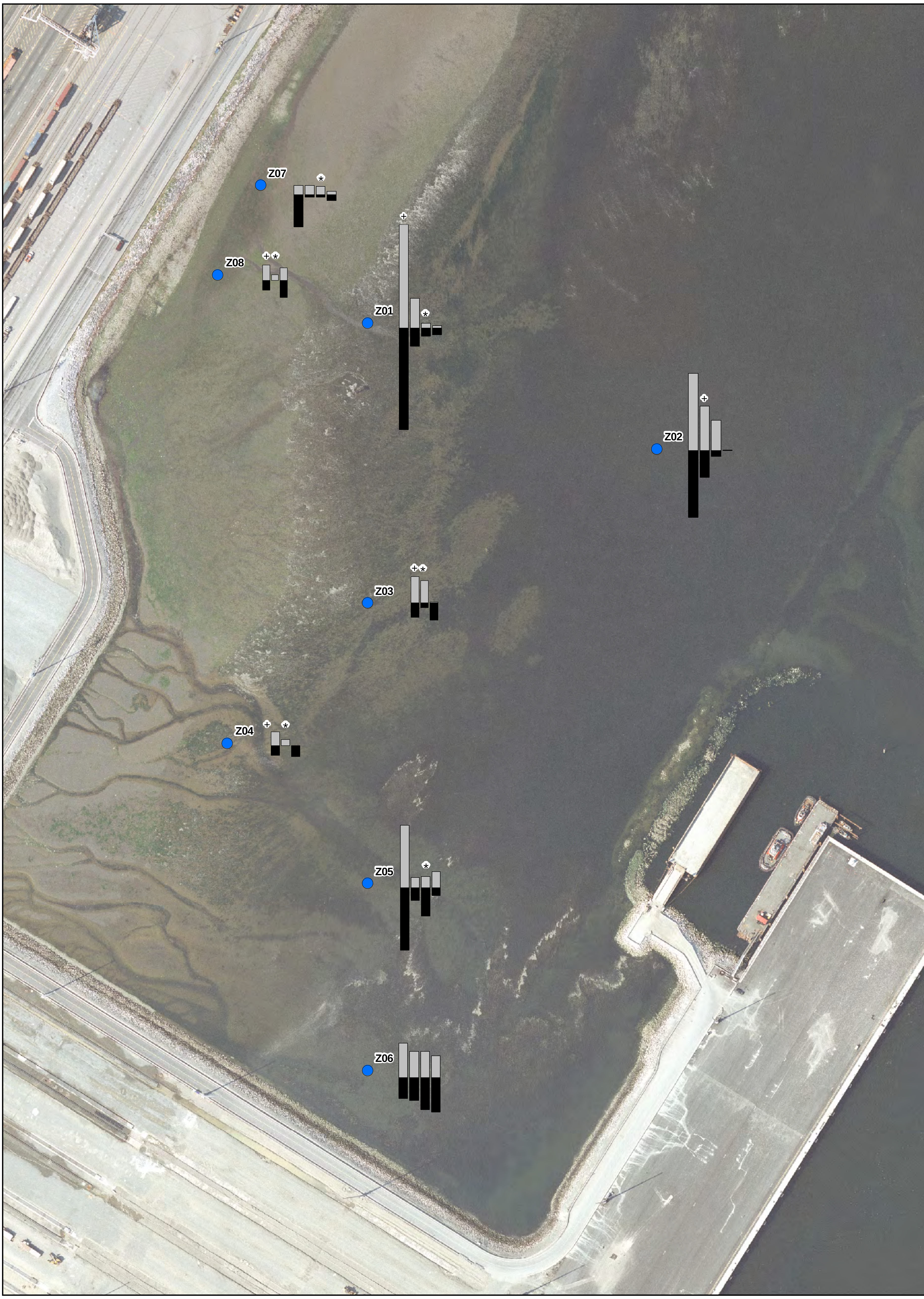
Scale - 1:4,000

100 50 0 100 Metres

coord. syst.: UTM Zone 10	horz. datum: NAD 83	horz. units: metres
northwest hydraulic consultants	project no. 3-4648	September 2010

Figure 24

JXD, 34648 Deltaport Monitoring\GIS\Fig_DoDErosionDepositionCharts_2008_AtoG.mxd

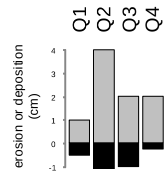


DoD Rod Locations

+ Refer to "DoD Rod Damage in 2009" figure

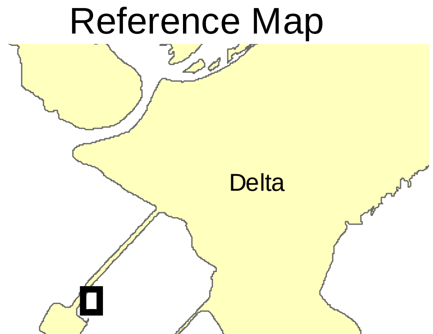
Note:
- July 24, 2009 orthophoto image courtesy of PMV.

Bar chart shows quarterly erosion and deposition at each DoD rod location



* indicates that measurement may be affected by cone of vegetation

Reference Map



DELTAPORT THIRD BERTH ADAPTIVE MANAGEMENT STRATEGY PROGRAM 2009 ANNUAL REPORT

Bar Charts of 2009 Quarterly Erosion and Deposition at Z series DoD Rods

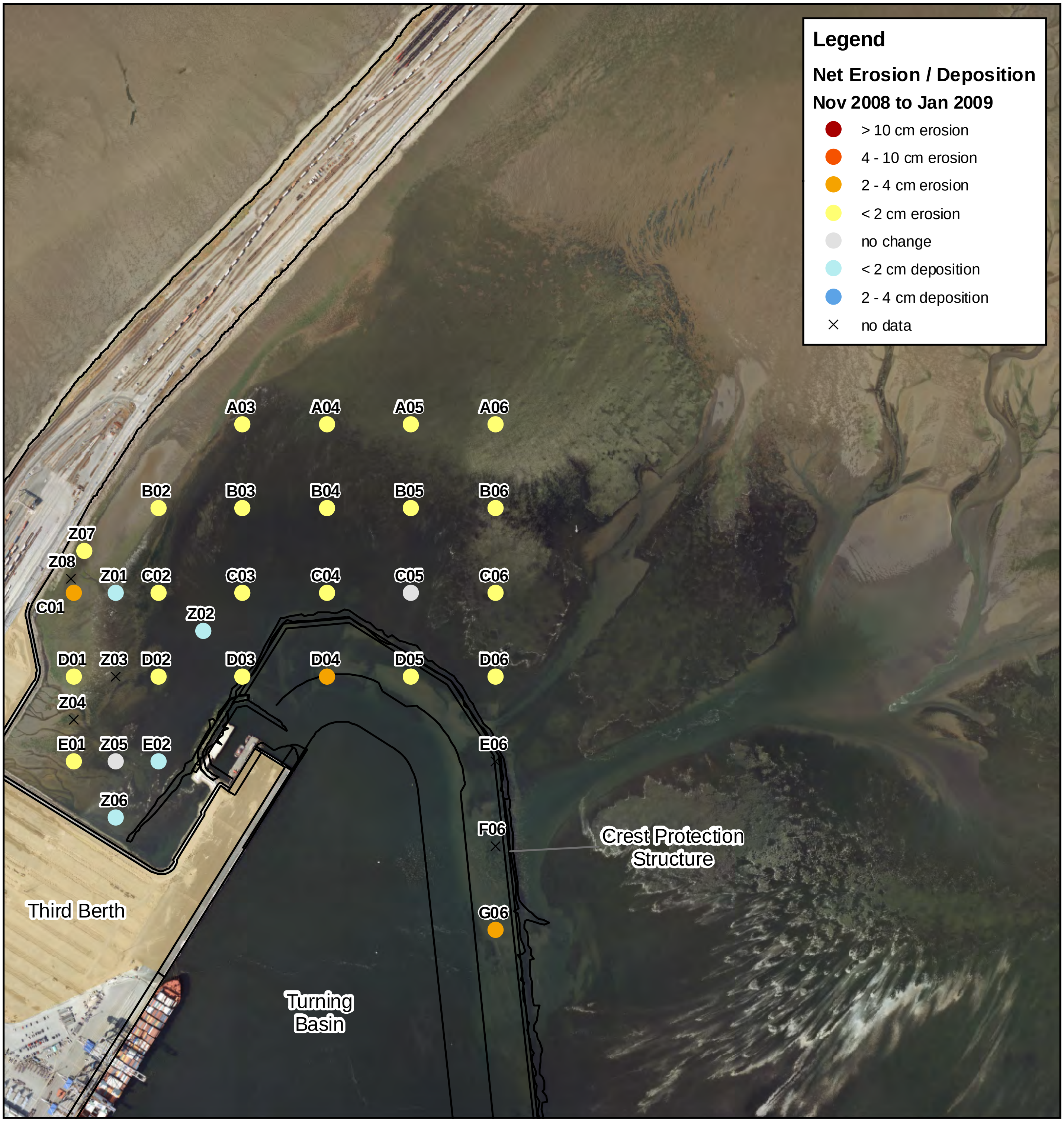
Scale - 1:2,000

100 50 0 Metres

coord. syst.: UTM Zone 10	horz. datum: NAD 83	horz. units: metres
northwest hydraulic consultants	project no. 3-4648	September 2010

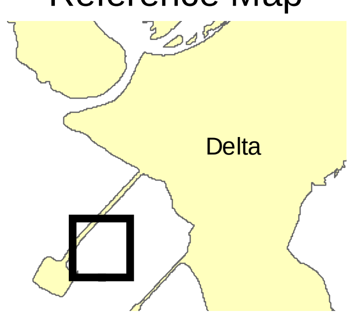
Figure 25

JXD, 34648 Deltaport Monitoring\GIS\Fig_DoDErosionDepositionCharts_2008_Z.mxd



Note:
- July 24, 2009 orthophoto image courtesy of PMV.

Reference Map



DELTAPORT THIRD BERTH ADAPTIVE MANAGEMENT STRATEGY PROGRAM 2009 ANNUAL REPORT

Net Change in Erosion/Deposition at DoD Rods Q1-2009

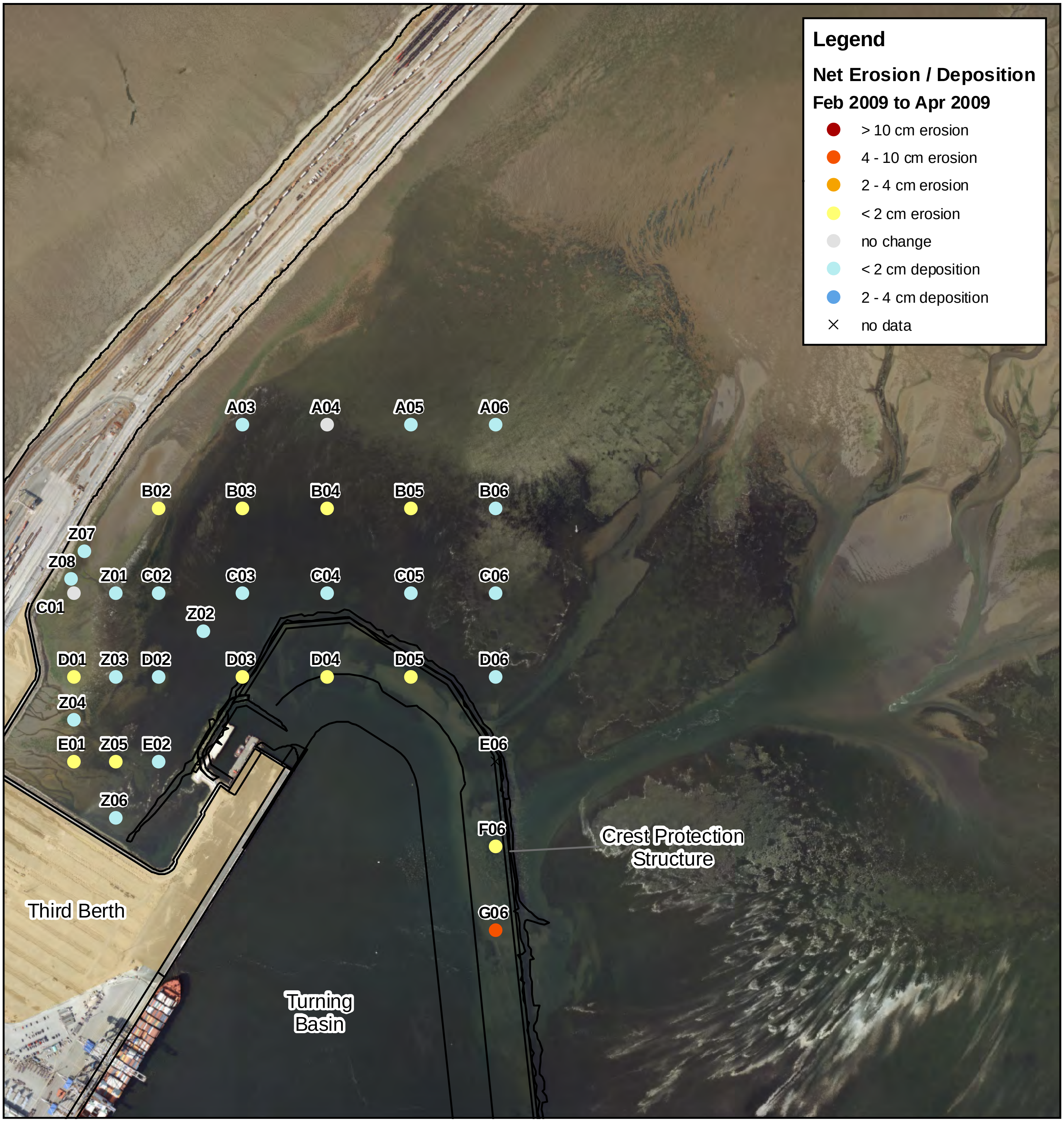
Scale - 1:10,000

100 50 0 100 200 300 Metres

coord. syst.: UTM Zone 10	horz. datum: NAD 83	horz. units: metres
northwest hydraulic consultants	project no. 3-4648	September 2010

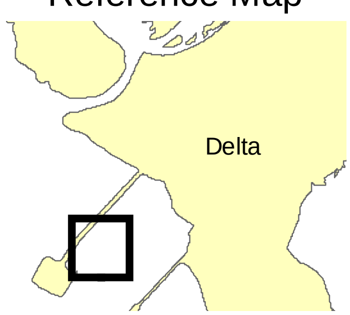
MSN, 34648 DP3 AMS\GIS\Fig_DoDResultsNet.mxd

Figure 26



Note:
- July 24, 2009 orthophoto image courtesy of PMV.

Reference Map



DELTAPORT THIRD BERTH ADAPTIVE MANAGEMENT STRATEGY PROGRAM 2009 ANNUAL REPORT

Net Change in Erosion/Deposition at DoD Rods Q2-2009

Scale - 1:10,000

100 50 0 100 200 300 Metres

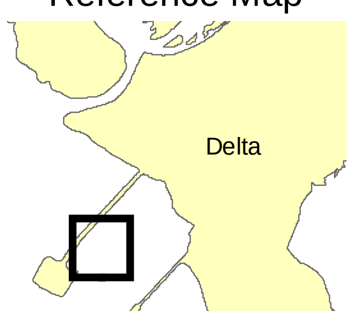
coord. syst.: UTM Zone 10	horz. datum: NAD 83	horz. units: metres
northwest hydraulic consultants	project no. 3-4648	September 2010

MSN, 34648 DP3 AMS\GIS\Fig_DoDResultsNet.mxd

Figure 27

Note:
- July 24, 2009 orthophoto image courtesy of PMV.

Reference Map



DELTAPORT THIRD BERTH ADAPTIVE MANAGEMENT STRATEGY PROGRAM 2009 ANNUAL REPORT

Net Change in Erosion/Deposition at DoD Rods Q3-2009

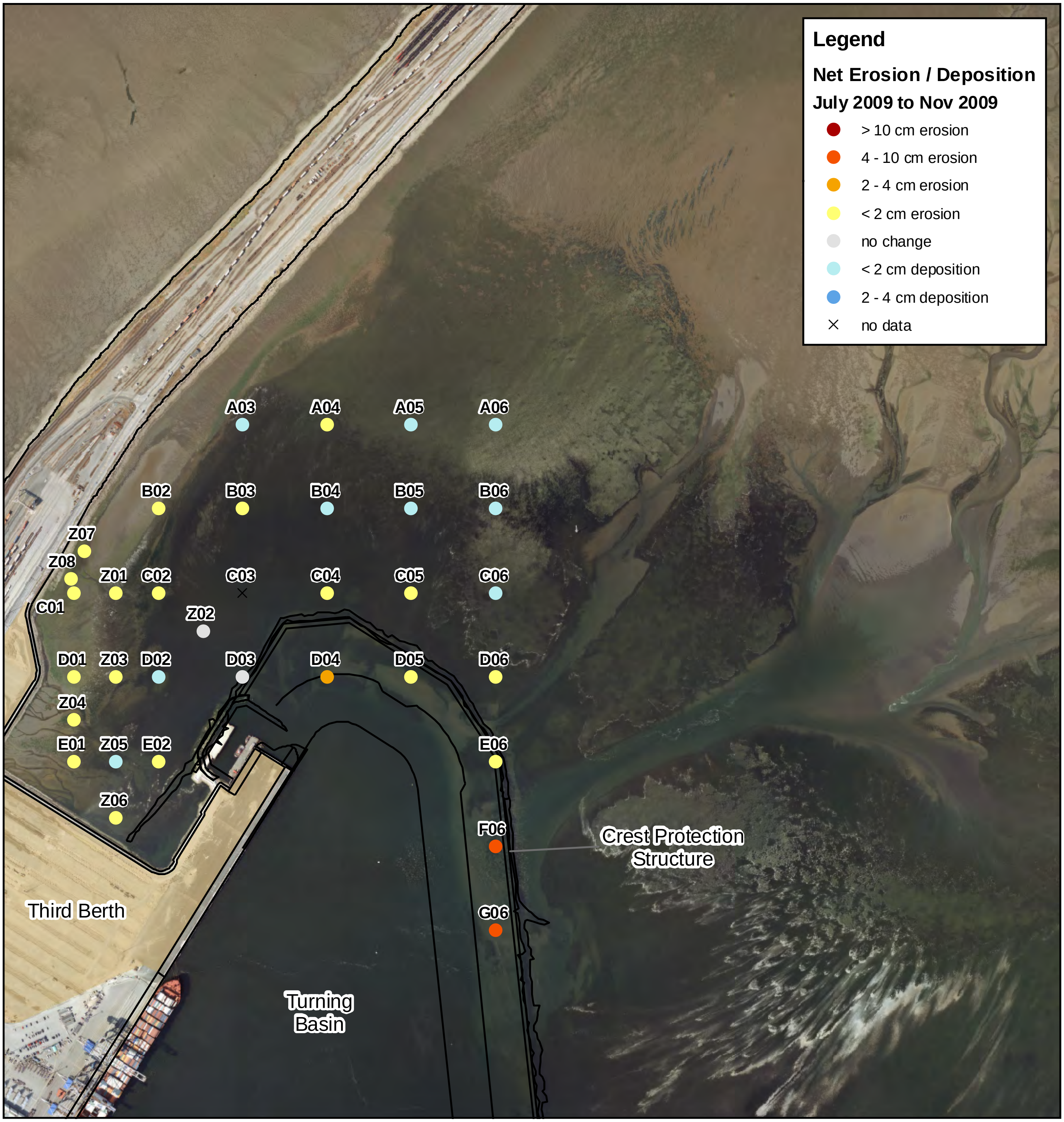
Scale - 1:10,000

100 50 0 100 200 300 Metres

coord. syst.: UTM Zone 10	horz. datum: NAD 83	horz. units: metres
northwest hydraulic consultants	project no. 3-464	September 2010

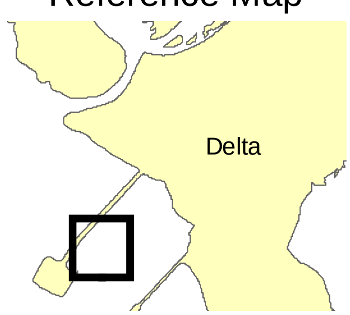
MSN, 34648 DP3 AMS\GIS\Fig_DoDResultsNet.mxd

Figure 28



Note:
- July 24, 2009 orthophoto image courtesy of PMV.

Reference Map



DELTAPORT THIRD BERTH ADAPTIVE MANAGEMENT STRATEGY PROGRAM 2009 ANNUAL REPORT

Net Change in Erosion/Deposition at DoD Rods Q4-2009

Scale - 1:10,000

100 50 0 100 200 300 Metres

coord. syst.: UTM Zone 10	horz. datum: NAD 83	horz. units: metres
northwest hydraulic consultants	project no. 3-4648	September 2010

MSN, 34648 DP3 AMS\GIS\Fig_DoDResultsNet.mxd

Figure 29

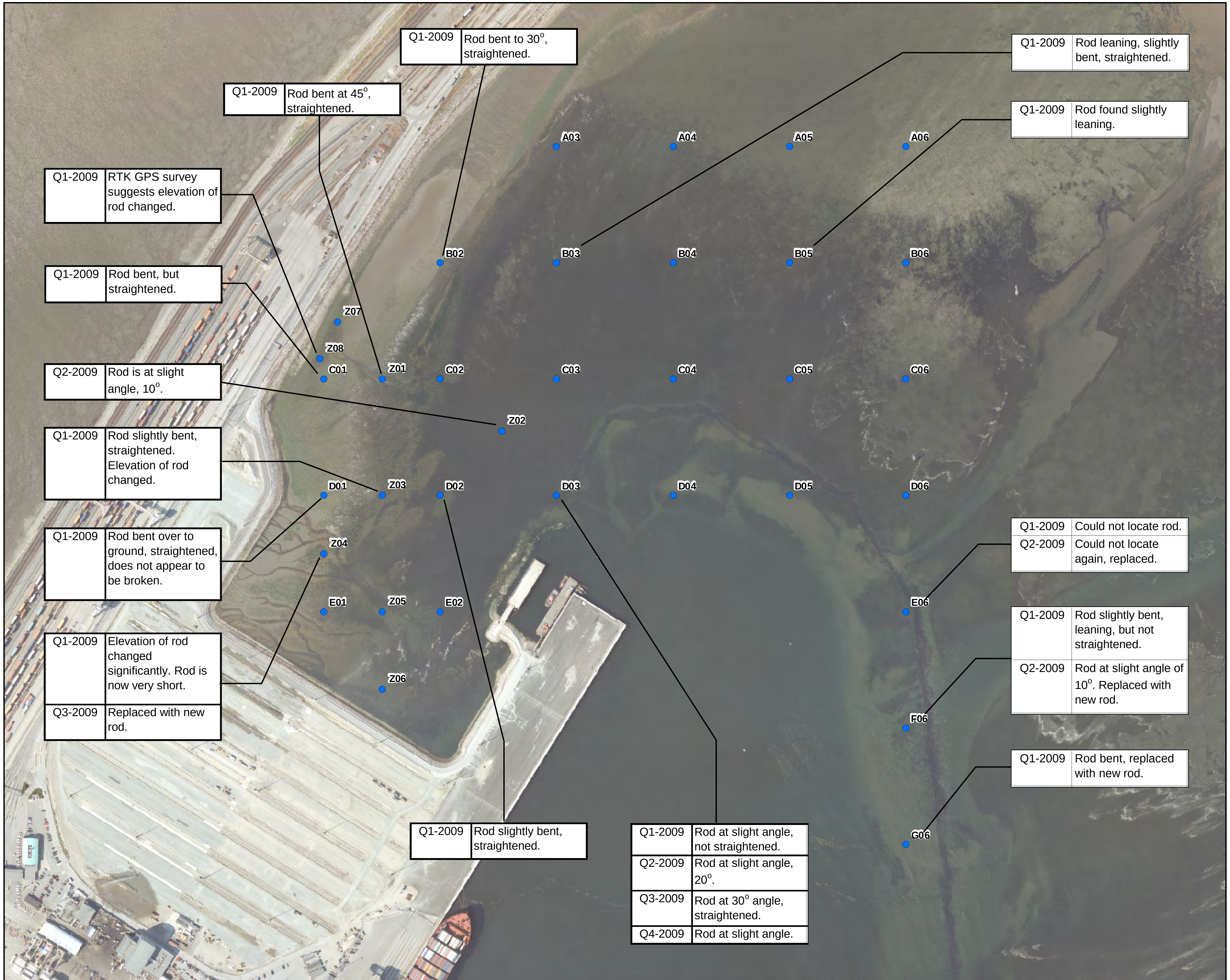
DP3 AMS PROGRAM 2009 ANNUAL REPORT

DoD Rod Damage in 2009

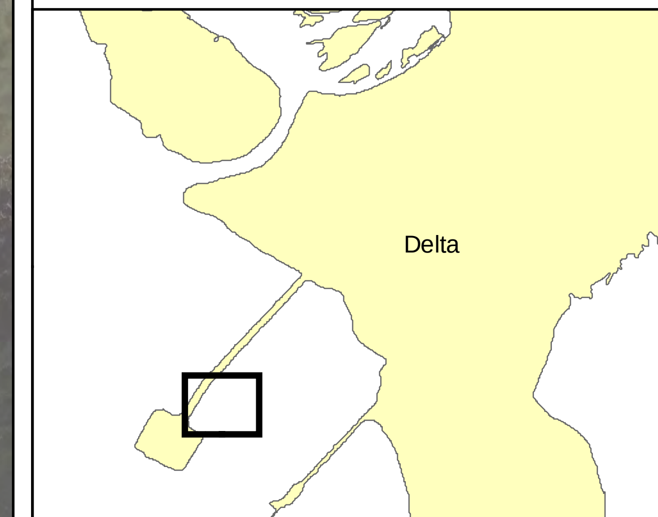
Scale - 1:5,000

250 125 0 Meters

coord. syst.: UTM Zone 10	horz. datum: NAD 83	horz. units: metres
northwest hydraulic consultants	project no. 3-4648	September 2010



Reference Map



DoD Rod Locations

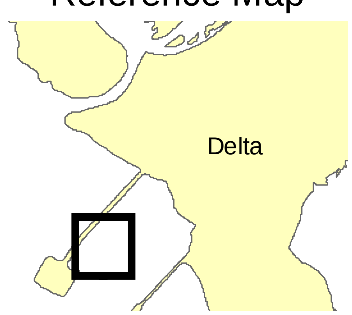
Note:
- July 24, 2009 orthophoto image courtesy of PMV.

CM, Van-mainfile\projects\34648 DP3 AMS\GIS\Fig_DoDDamageCharts_2009.mxd

Figure 30

Note:
- July 24, 2009 orthophoto image courtesy of PMV.

Reference Map



DELTAPORT THIRD BERTH ADAPTIVE MANAGEMENT STRATEGY PROGRAM 2009 ANNUAL REPORT

Percent Silt Content (< 0.063 mm)
at DoD Rod Locations Apr 2009

Scale - 1:10,000

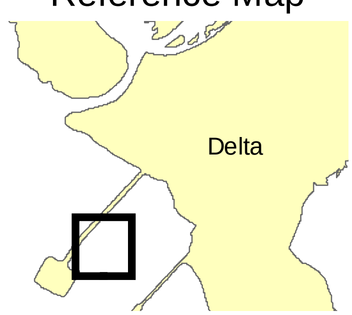
100 50 0 100 200 300 Metres

coord. syst.: UTM Zone 10	horz. datum: NAD 83	horz. units: metres
northwest hydraulic consultants	project no. 3-4648	September 2010

CM, 34648 Deltaport Monitoring\GIS\Fig_SiltContent.mxd

Figure 31

Note:
- July 24, 2009 orthophoto image courtesy of PMV.



DELTAPORT THIRD BERTH ADAPTIVE MANAGEMENT STRATEGY PROGRAM 2009 ANNUAL REPORT

Percent Silt Content (< 0.063 mm) at DoD Rod Locations Nov 2009

Scale - 1:10,000

100 50 0 100 200 300 Metres

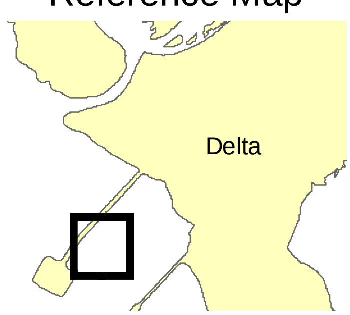
coord. syst.: UTM Zone 10	horz. datum: NAD 83	horz. units: metres
northwest hydraulic consultants	project no. 3-4648	September 2010

CM, 34648 Deltaport Monitoring\GIS\Fig_SiltContent.mxd

Figure 32

Note:
- July 24, 2009 orthophoto image courtesy of PMV.

Reference Map



DELTAPORT THIRD BERTH ADAPTIVE MANAGEMENT STRATEGY PROGRAM 2009 ANNUAL REPORT

Percent Silt Content Change Apr to Nov 2009

Scale - 1:10,000

100 50 0 100 200 300 Metres

coord. syst.: UTM Zone 10	horz. datum: NAD 83	horz. units: metres
northwest hydraulic consultants	project no. 3-4648	September 2010

CM, 34648 Deltaport Monitoring\GIS\Fig_SiltContent.mxd

Figure 33

DELTAPORT THIRD BERTH ADAPTIVE MANAGEMENT STRATEGY PROGRAM 2009 ANNUAL REPORT

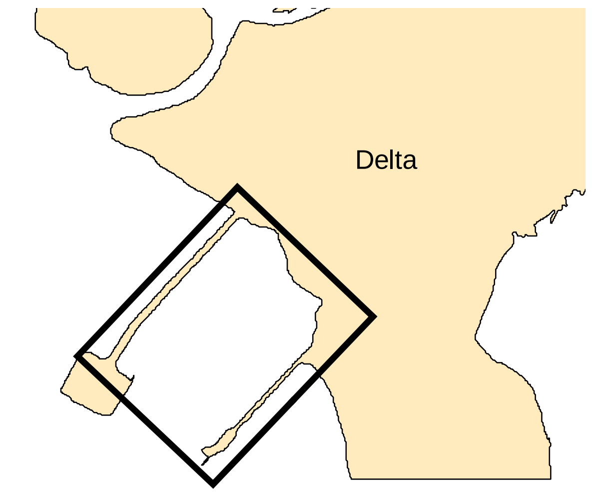
2009 Orthophoto Interpretation

Scale - 1:15,000

400 200 0 400 Metres

coord. syst.: UTM Zone 10	horz. datum: NAD 83	horz. units: metres
northwest hydraulic consultants	project no. 3-4648	September 2010

Reference Map



Legend

2009 Channel Mapping

- ACTIVE CHANNEL ZONE
- BAR
- CHANNEL - DOUBLE LINE
- CHANNEL - SINGLE LINE
- ACTIVE CHANNEL ZONE
- BAR
- CHANNEL

Note:
- July 24, 2009 orthophoto supplied by Port Metro Vancouver.

CM, linuxprojects\34648 DP3 AMS\GIS\Fig_Mapping2008.shp

Figure 34

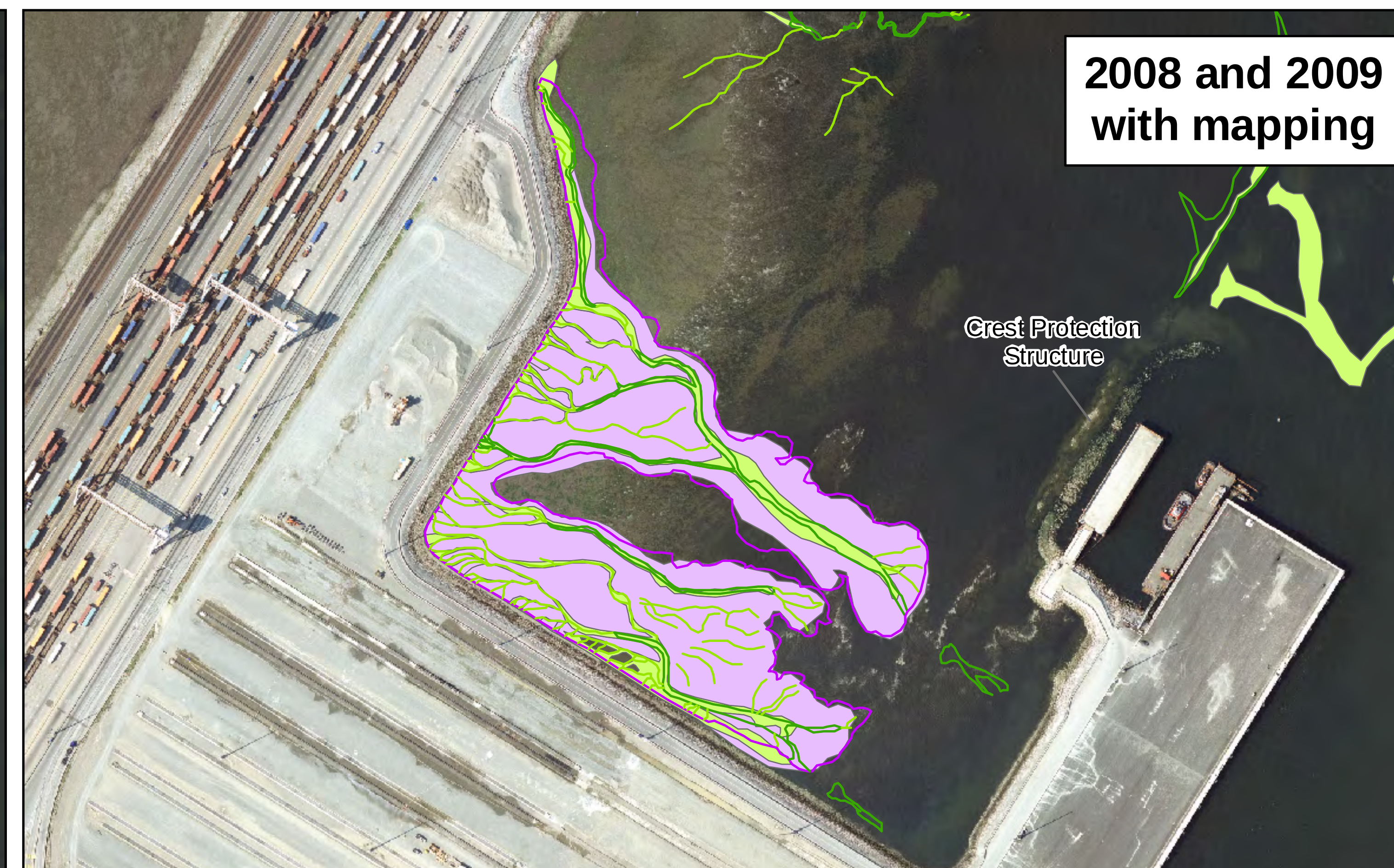
DELTAPORT THIRD BERTH ADAPTIVE MANAGEMENT STRATEGY PROGRAM 2009 ANNUAL REPORT

Drainage Channel Detailed Comparison, 2008 and 2009 Orthophotos

Scale - 1:4,000

100 50 0 100 Metres

coord. syst.: UTM Zone 10	horz. datum: NAD 83	horz. units: metres
northwest hydraulic consultants	project no. 3-4648	September 2010



Legend

2008 Channel Mapping

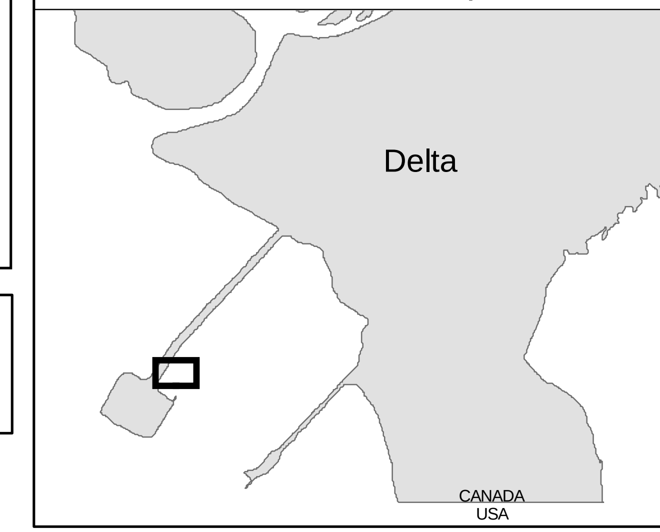
- ACTIVE CHANNEL ZONE
- CHANNEL-DOUBLE LINE
- CHANNEL-SINGLE LINE

2009 Channel Mapping

- ACTIVE CHANNEL ZONE
- CHANNEL

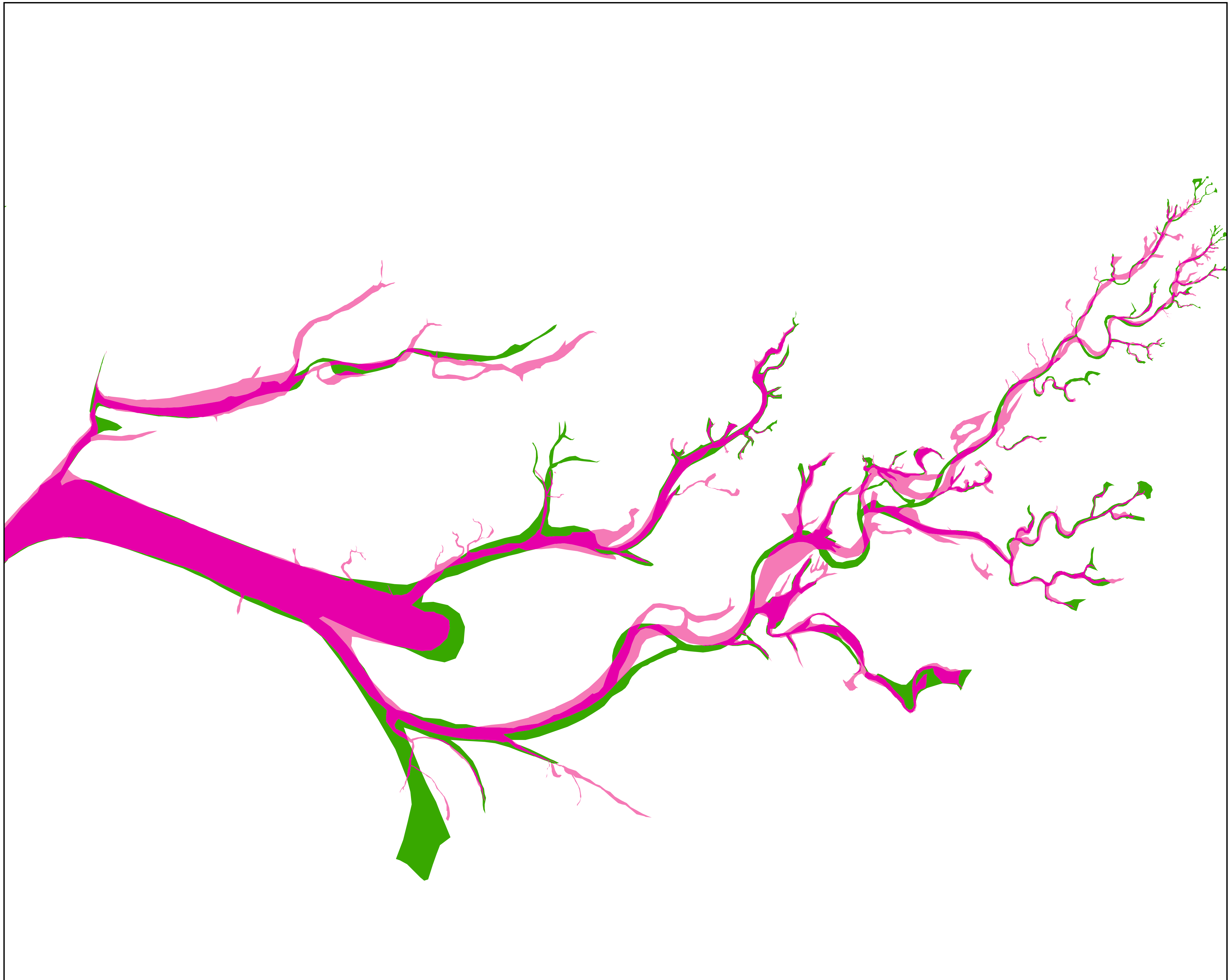
Note:
- 2008 and 2009 orthophotos supplied by Vancouver Fraser Port Authority.

Reference Map



MSN_34648 Deltaport Monitoring\GIS\Fig_New2008Channels.mxd

Figure 35



DELTAPORT THIRD BERTH ADAPTIVE MANAGEMENT STRATEGY PROGRAM 2009 ANNUAL REPORT

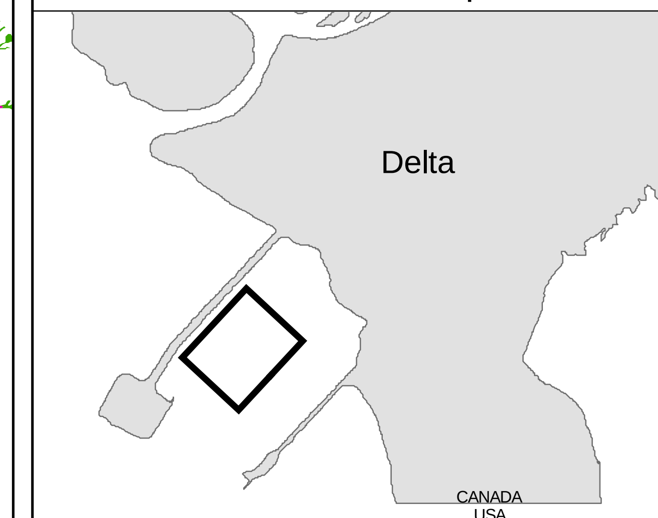
Mapped Channel Changes Based on 2008 and 2009 Orthophotos

Scale - 1:6,000

100 50 0 100 200 Metres

coord. syst.: UTM Zone 10	horz. datum: NAD 83	horz. units: metres
northwest hydraulic consultants	project no. 3-46	September 2010

Reference Map



Legend

Channel Changes

2008 to 2009

- channel in 2008 (not in 2009)
- channel in 2008 and 2009 (no change)
- channel in 2009 (not in 2008)

Note:
- Variation in conditions such as tide level, vegetation growth and water clarity may influence the accuracy of change mapping between 2008 and 2009.

MSN,P:\34648 DP3 AMS\GIS\Fig_Mapping2009Comp2008.mxd

Figure 36

Figure 37 Time-series record of significant wave heights (H_s) measured at the three wave sensors in the study area

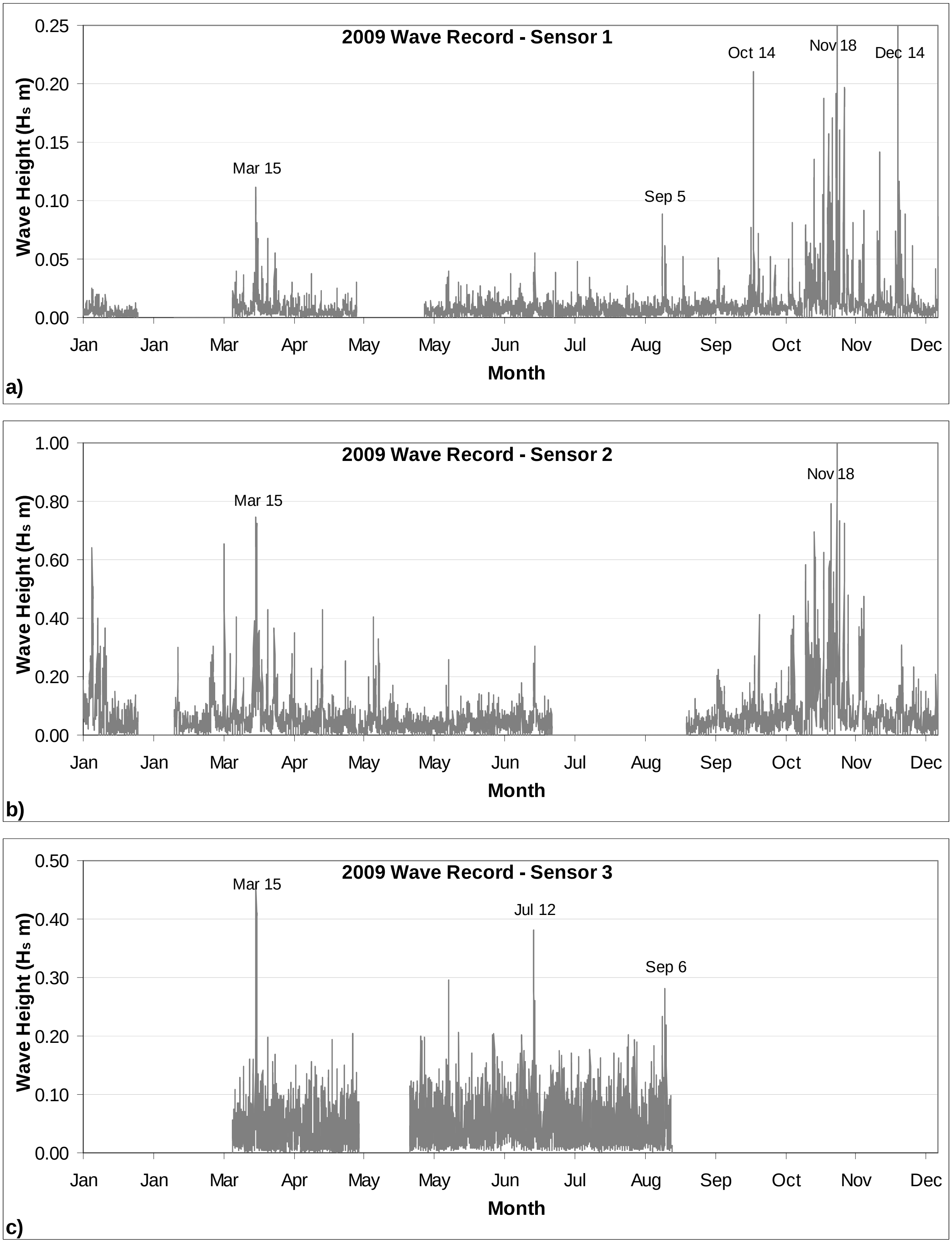


Figure 38 Time-series record of significant wave heights (H_s) measured at the three wave sensors in the study area for the period January to March, 2009

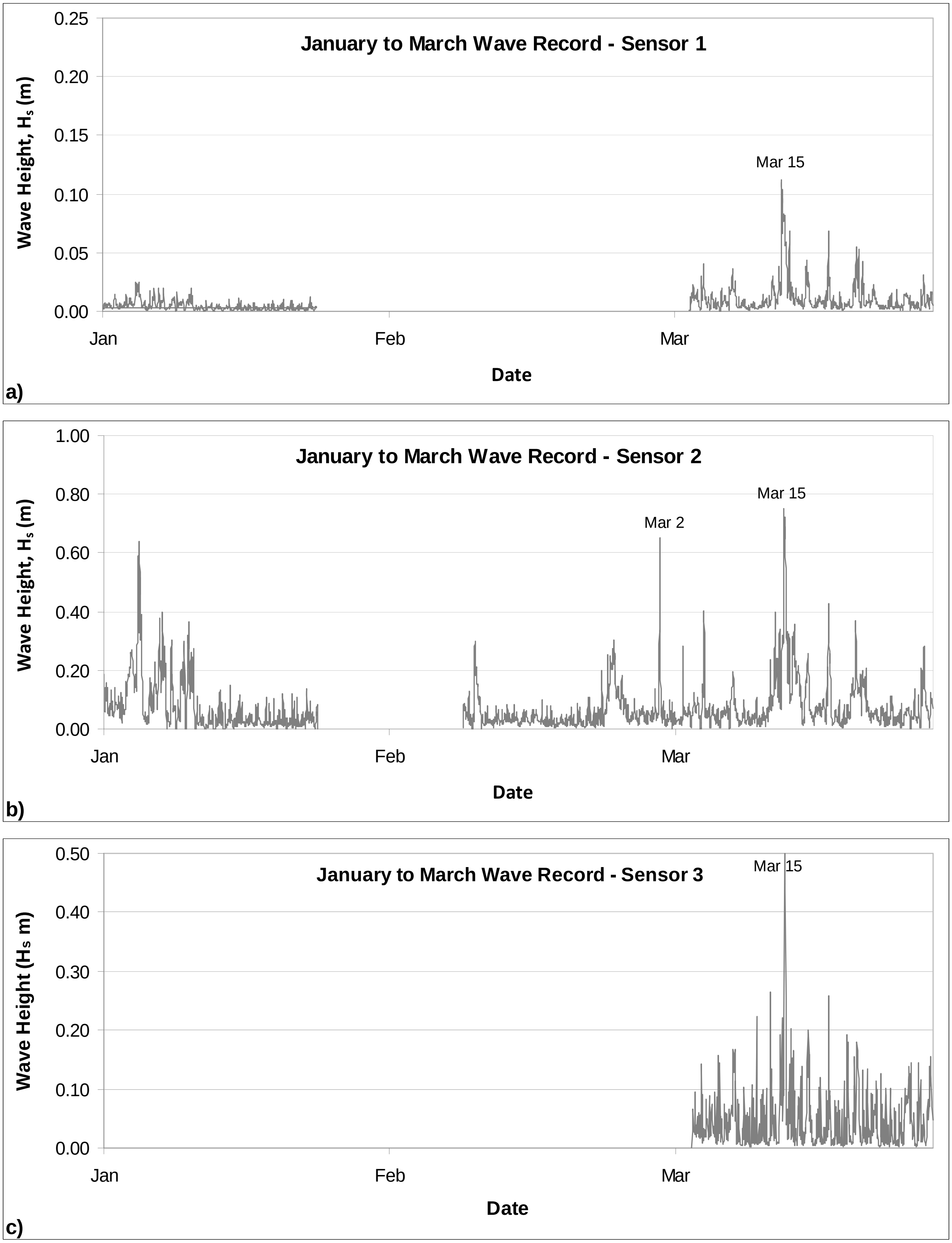


Figure 39 Time-series record of significant wave heights (H_s) measured at the three wave sensors in the study area for the period April to June, 2009

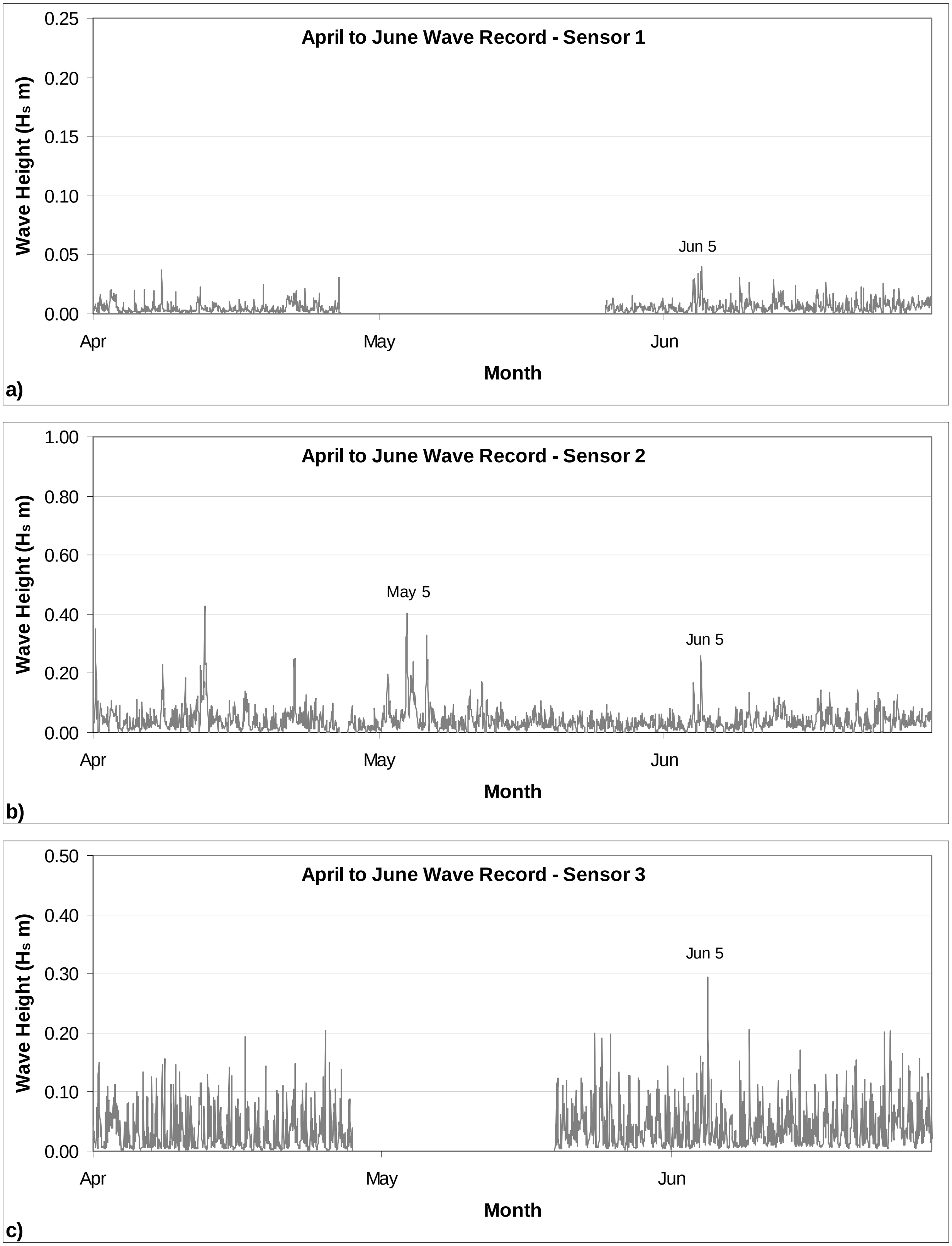


Figure 40 Time-series record of significant wave heights (H_s) measured at the three wave sensors in the study area for the period July to September, 2009

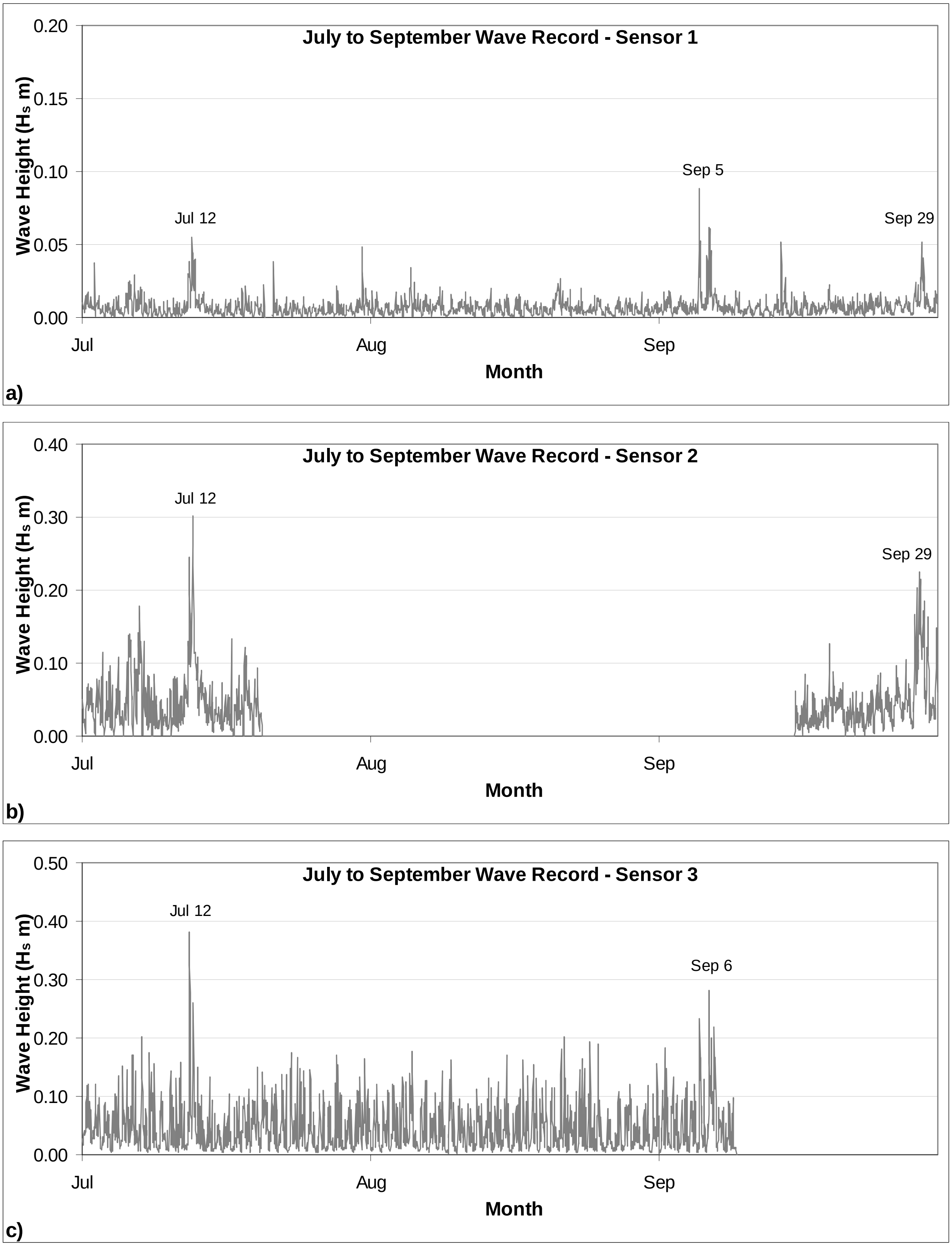


Figure 41 Time-series record of significant wave heights (H_s) measured at the three wave sensors in the study area for the period October to December, 2009

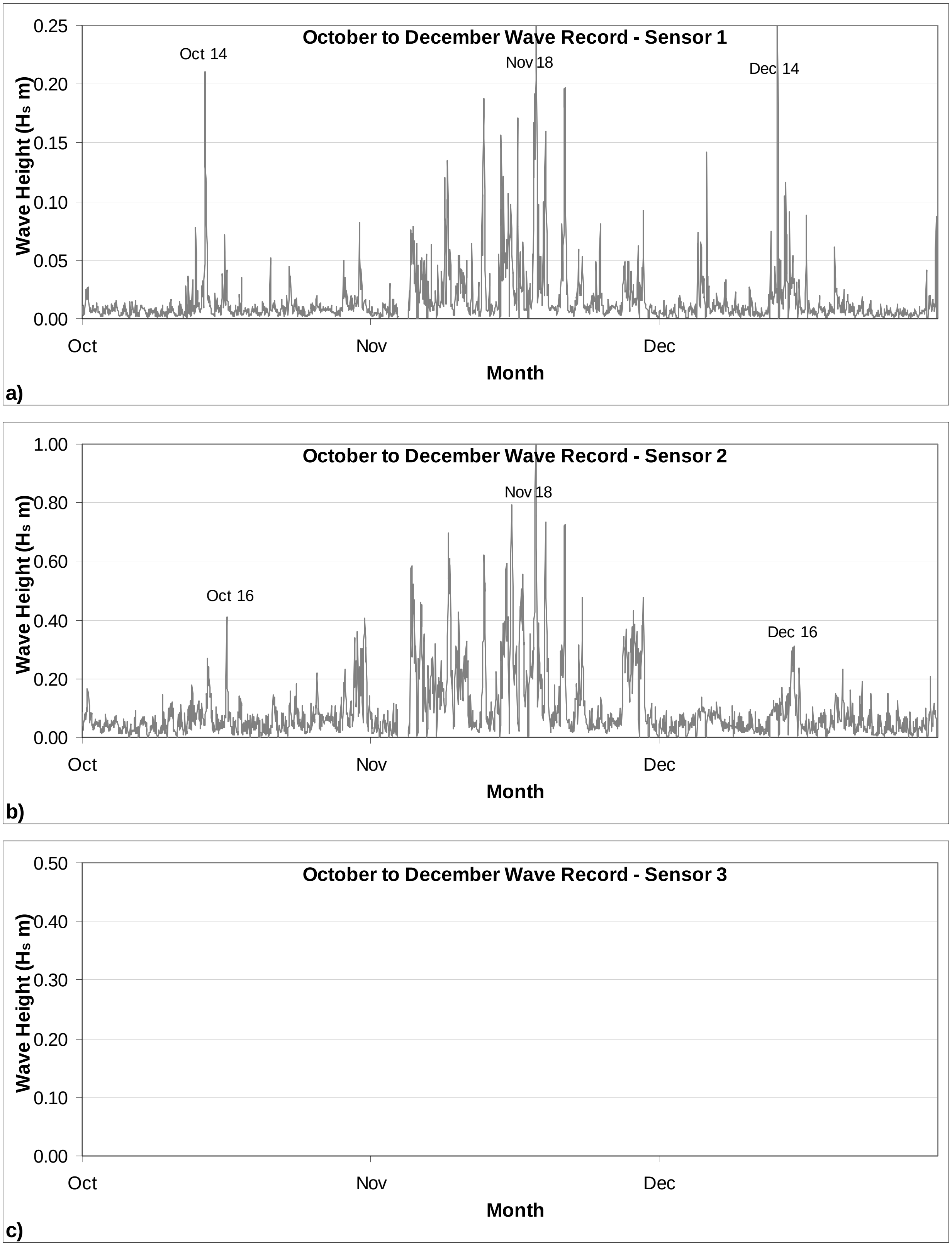
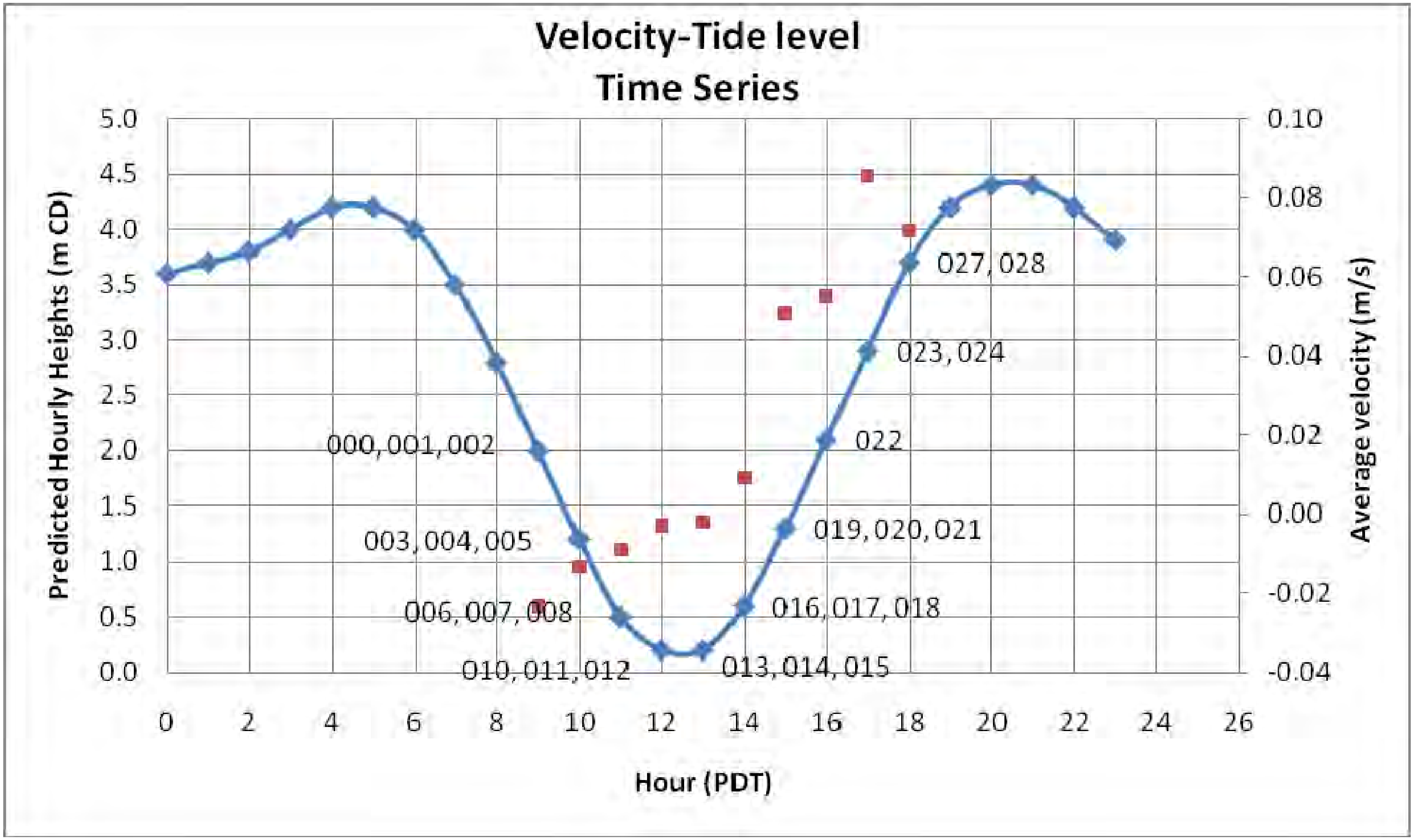
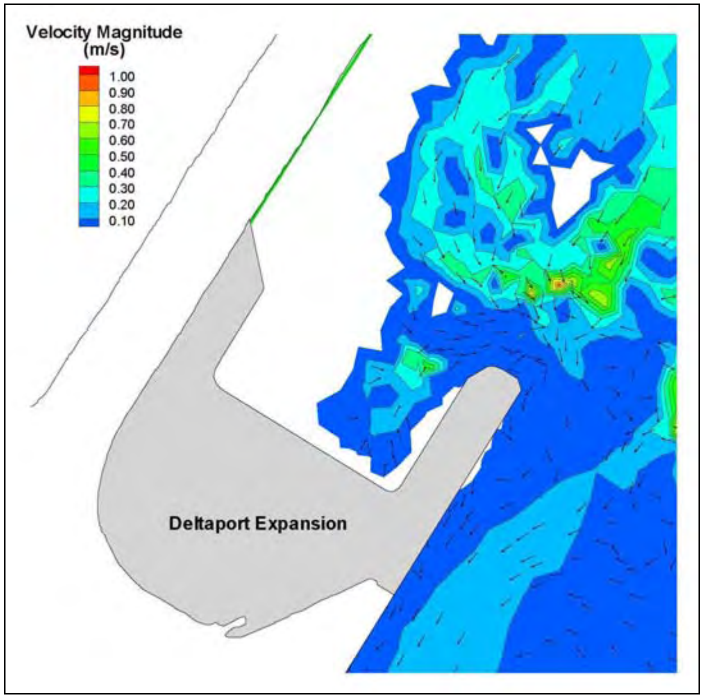


Figure 42 Tide level curve at Tsawwassen from 0900 to 1800 h on the day of ADCP measurements on June 23, 2009 (Average velocities across the transect for each hour are also shown.)

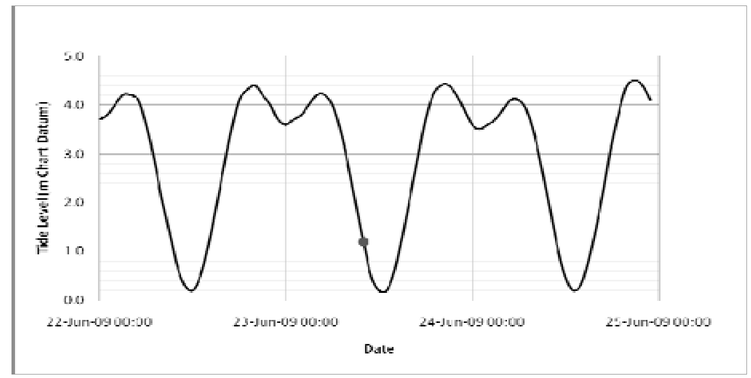




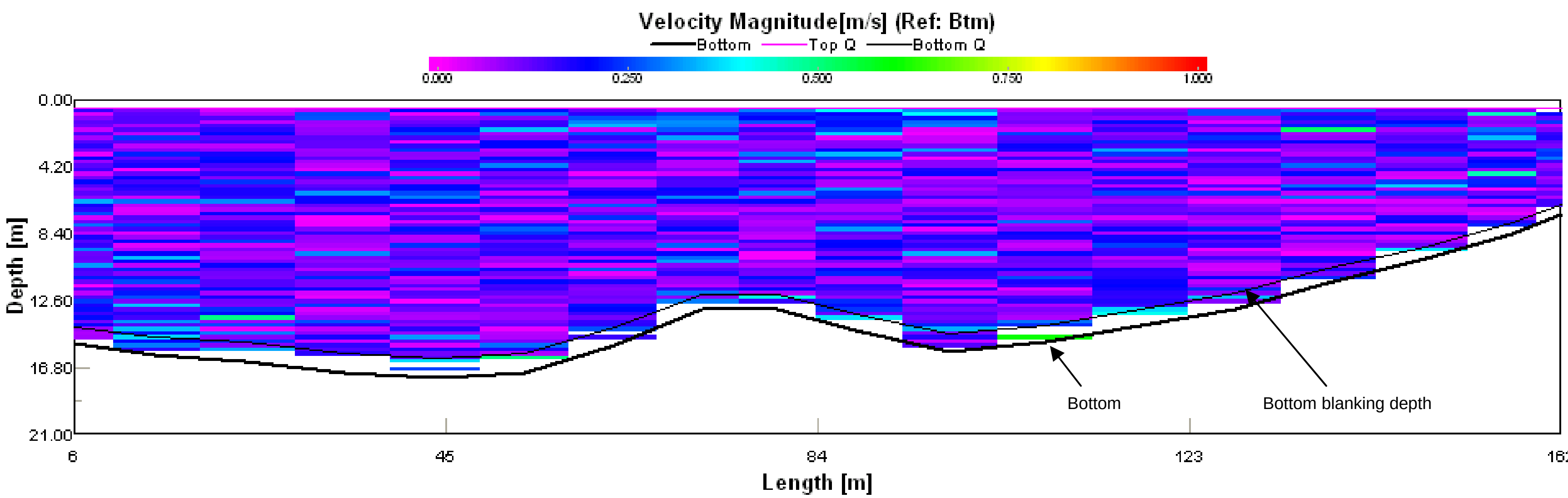
Original model results from NHC (2004) showing depth-averaged velocities for a falling tide during a large tide cycle.

	Depth-averaged velocity at comparison locations* (m/s)				
	5	4	3	2	1
Modelled	0.069	0.071	0.072	0.091	0.112
Measured	0.156	0.175	0.146	0.166	0.135

Comparison of depth averaged velocities from updated model to ADCP measurements. *Locations shown on Figure 8.

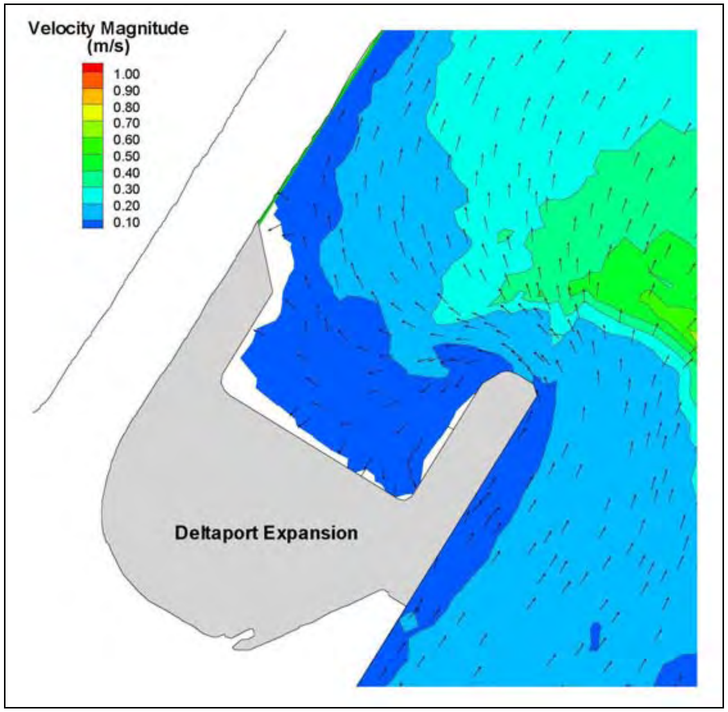


Tide heights for June 22 to June 25, 2009. Large dot shows time of ADCP measurement and model run.



ADCP transect measurement showing vertical velocity distribution versus distance along the transect.

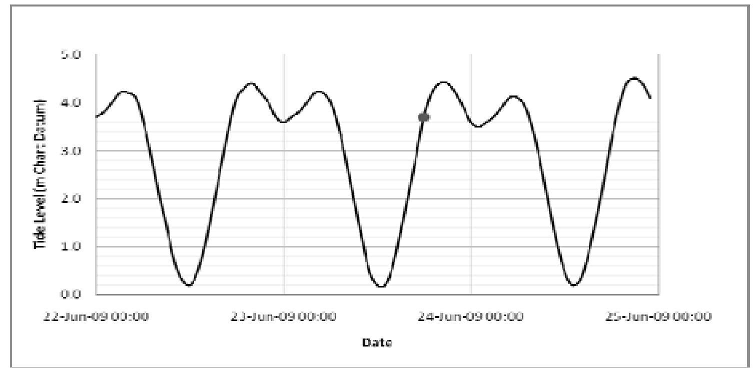
Figure 43a. Comparison of flow velocities measured on June 23, 2009 during falling tide of a large tide cycle with results of numerical modelling of the same tidal conditions.



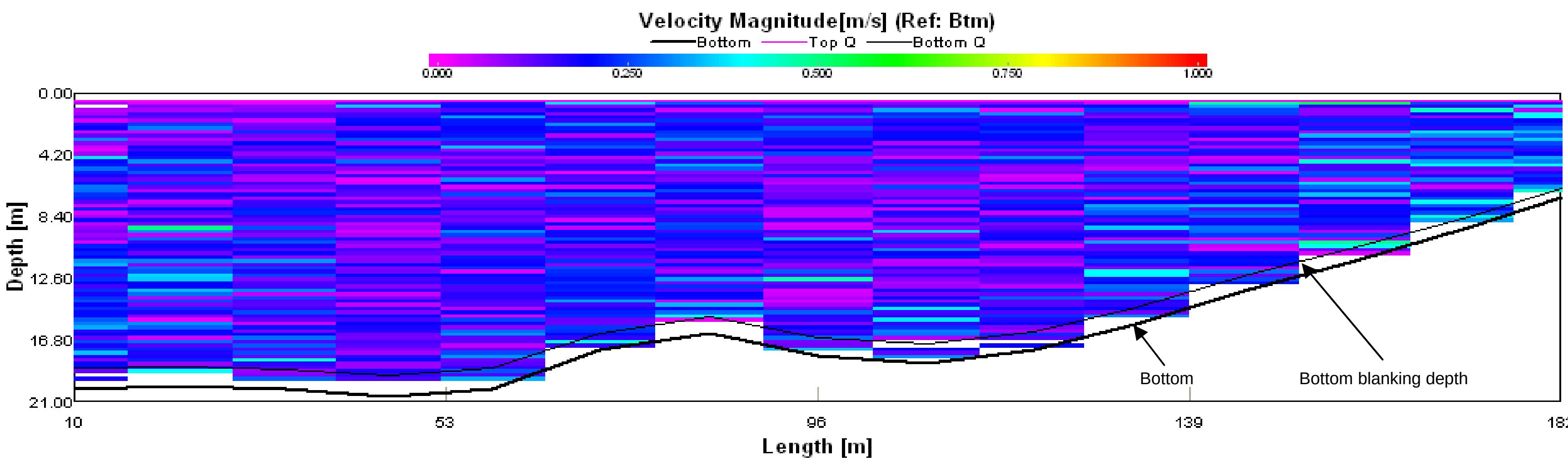
Original model results from NHC (2004) showing depth-averaged velocities for a rising tide during a large tide cycle.

	Depth-averaged velocity at comparison locations* (m/s)				
	5	4	3	2	1
Modelled	0.127	0.137	0.147	0.172	0.200
Measured	0.186	0.173	0.176	0.151	0.166

Comparison of depth averaged velocities from updated model to ADCP measurements. *Locations shown on Figure 8.



Tide heights for June 22 to June 25, 2009. Large dot shows time of ADCP measurement and model run.



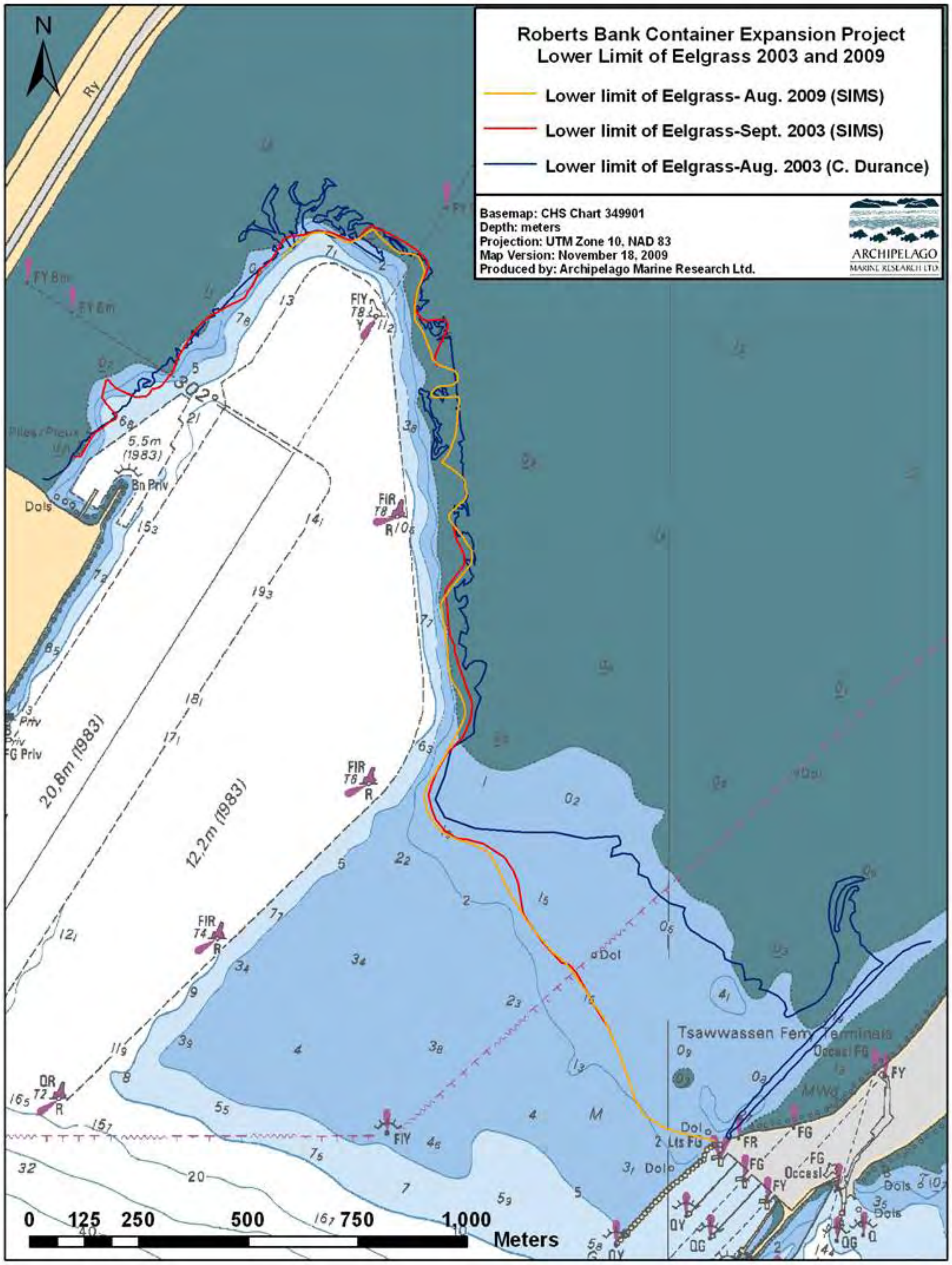
ADCP transect measurement showing vertical velocity distribution versus distance along the transect.

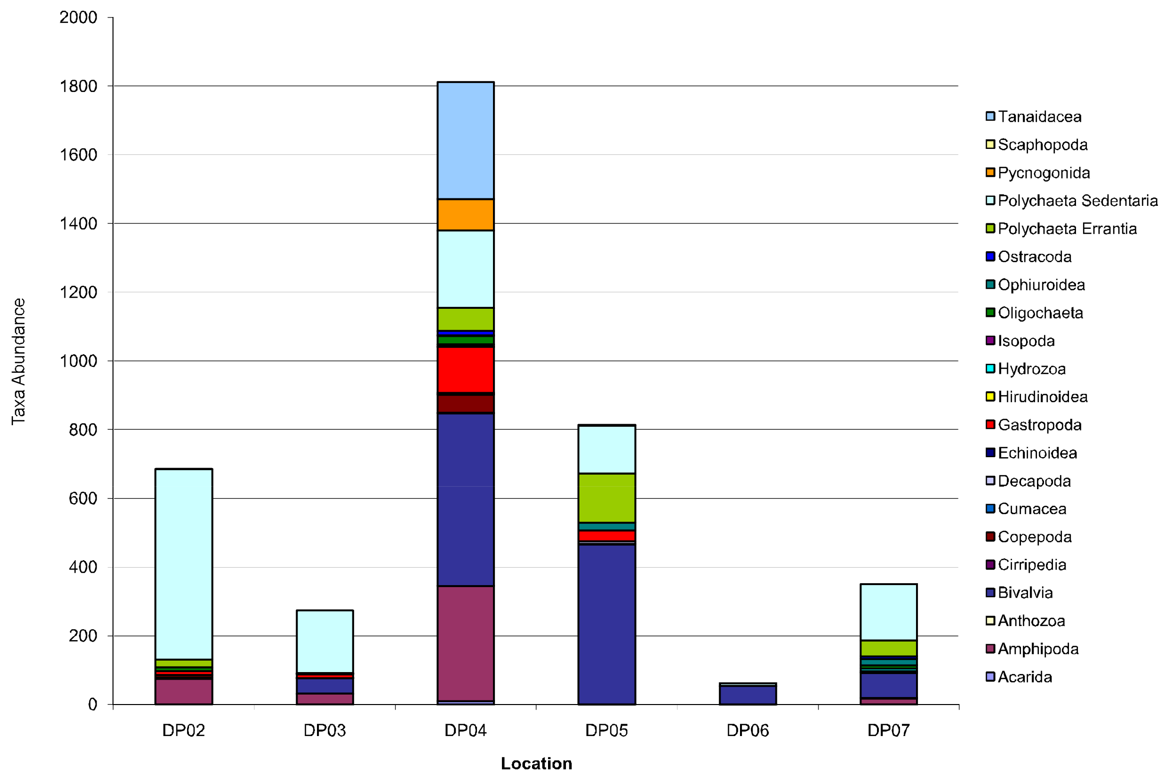
Figure 43b. Comparison of flow velocities measured on June 23, 2009 during rising tide of a large tide cycle with results of numerical modelling of the same tidal conditions.

MSN, 34789_RobertsBankEelgrass2007\GIS\MSN_FigEelgrass2007and2003.mxd

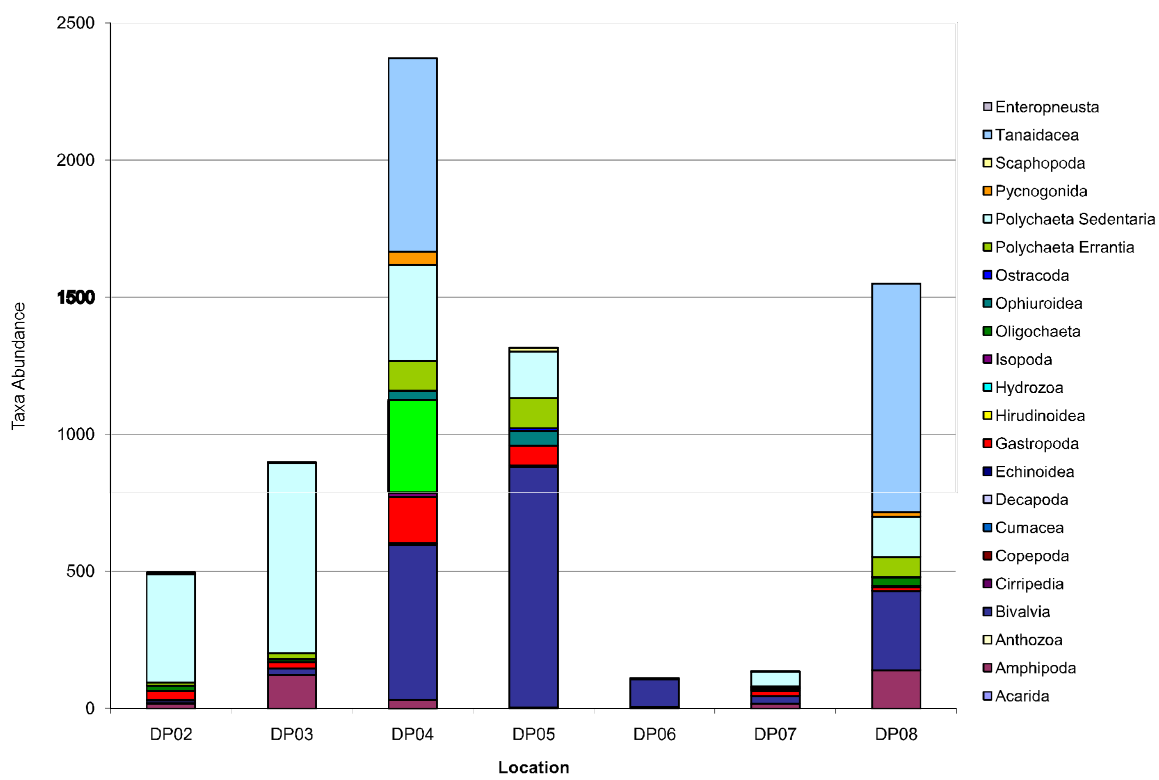
Figure 44

Figure 45 SIMS Survey Results

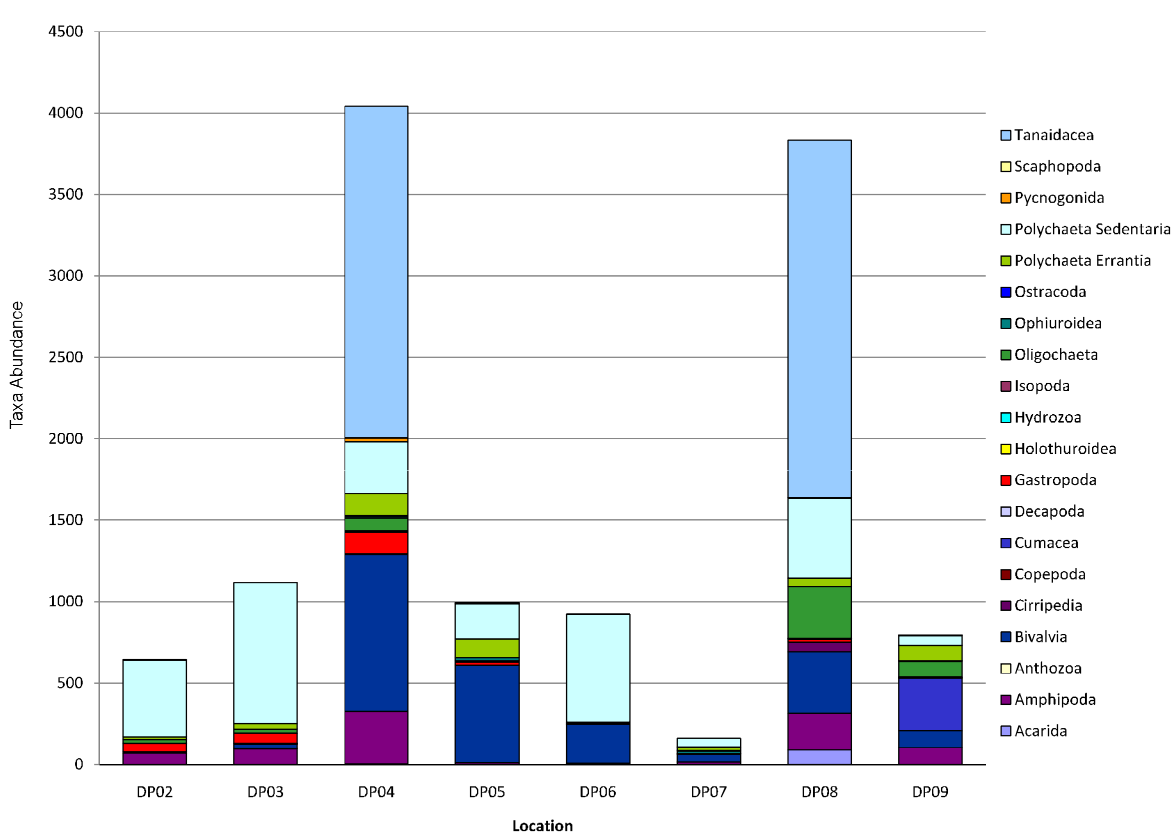




2007



2008



2009

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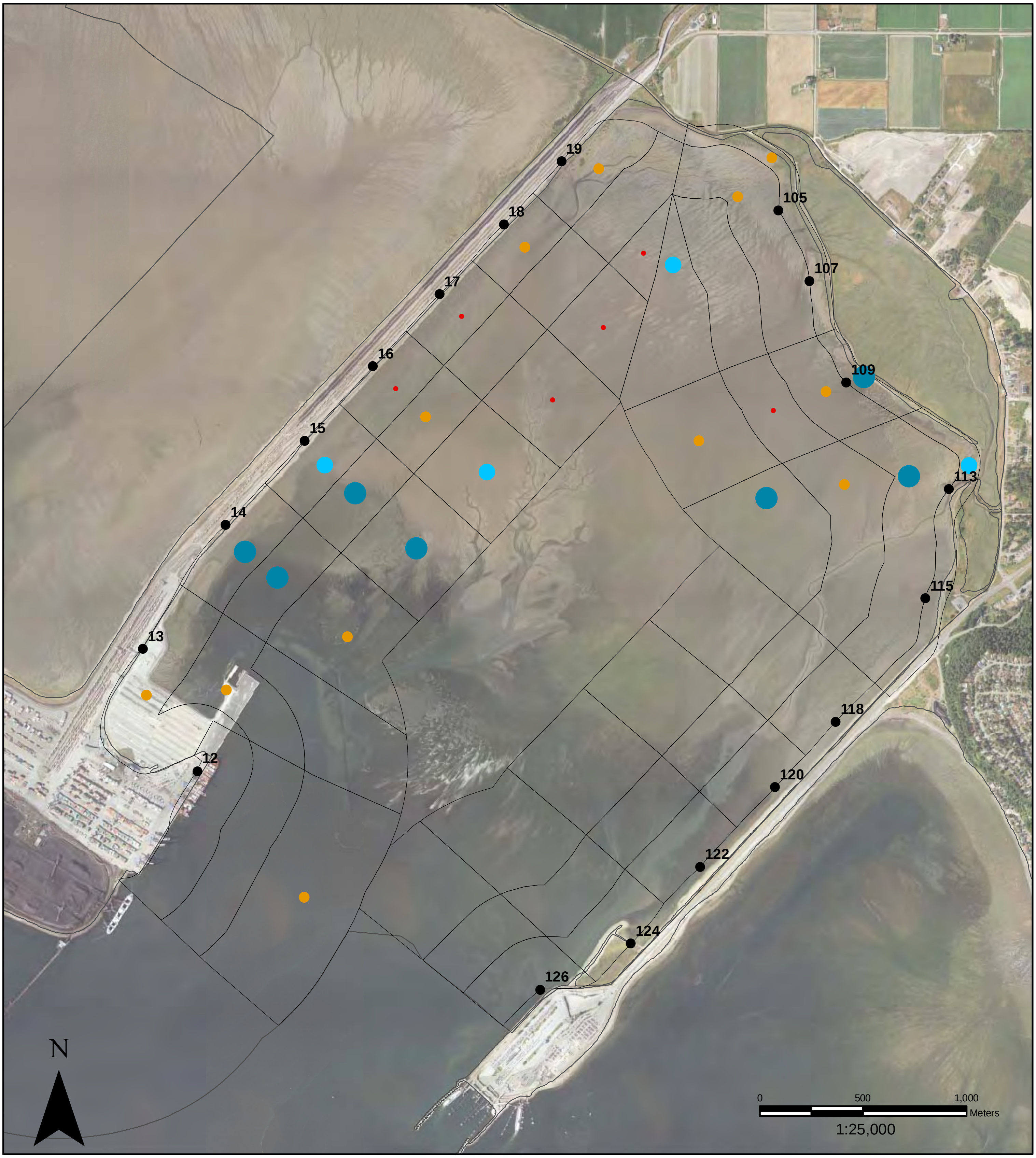
CLIENT: PORT METRO vancouver

DELTAPORT THIRD BERTH - ADAPTIVE MANAGEMENT STRATEGY PROGRAM - 2008 ANNUAL REPORT

BENTHIC INVERTEBRATE ABUNDANCE BY TAXA (2007, 2008, 2009)

PROJECT No.		
499-002.11	September 2010	FIGURE 46



Legend

- Study Stations

Species Count

- 1 - 10
- 11 - 50
- 51 - 100
- 101 - 250
- 251 - 500

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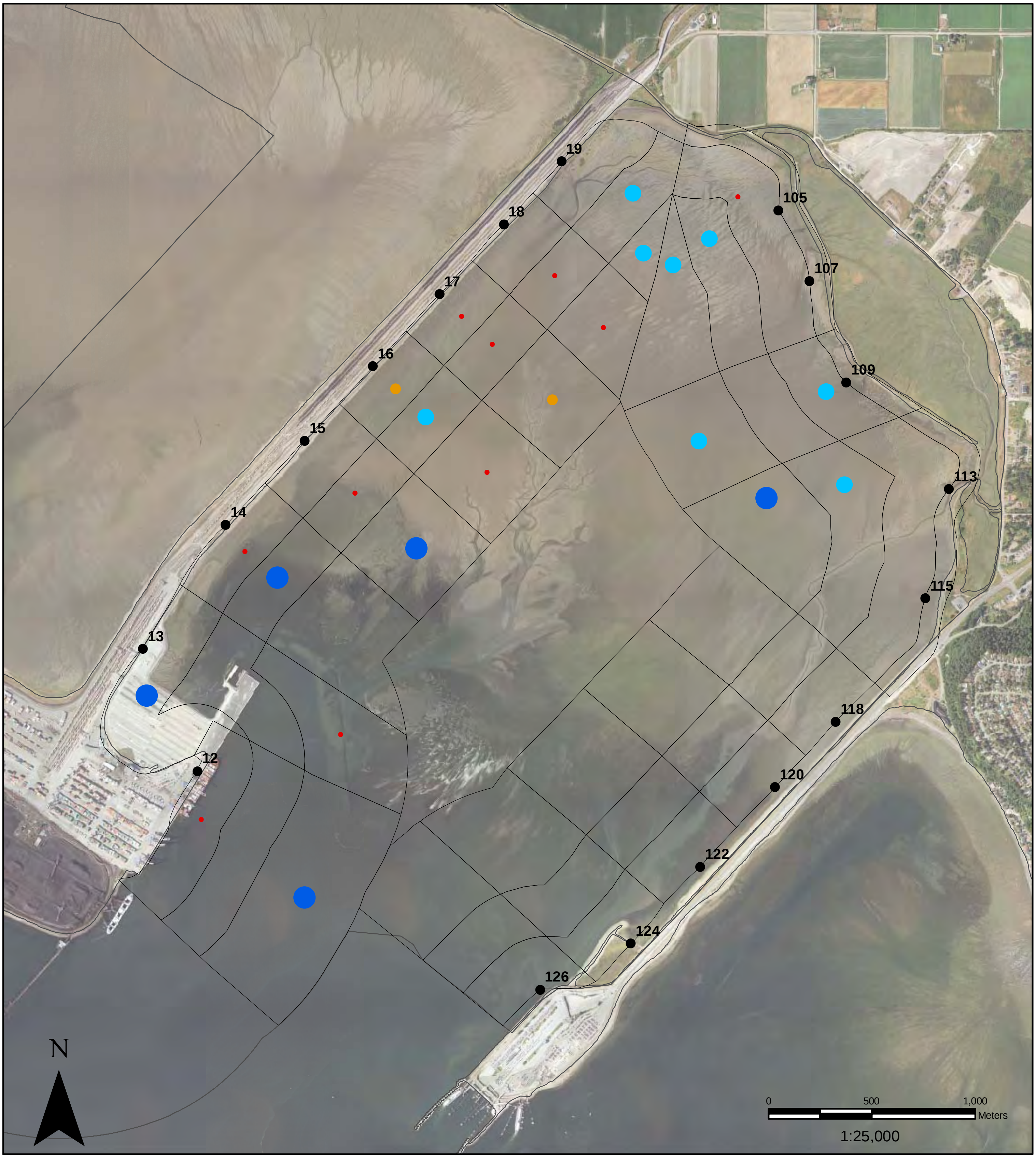
PORT METRO vancouver

DELTAPORT THIRD BERTH - ADAPTIVE MANAGEMENT STRATEGY PROGRAM 2009 ANNUAL REPORT

Great Blue Heron Distribution and Cumulative Abundance within the Inter-causeway Area during Low Tide Events, 2009

PROJECT NO:		
499-002.11	SEPTEMBER 2010	FIGURE 47



Legend

- Study Stations

Species Count

- 1 - 50
- 51 - 100
- 101 - 500
- 501 - 1000

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PORT METRO vancouver

DELTAPORT THIRD BERTH -
ADAPTIVE MANAGEMENT STRATEGY PROGRAM
2009 ANNUAL REPORT

Brant Distribution and Cumulative Abundance
within the Inter-causeway Area
during High Tide Events, 2009

PROJECT NO: 499-002.11	SEPTEMBER 2010	FIGURE 48

Figure 49 Time series of turbidity and sediment concentration data from Sensor 2 for the period from June 1 to August 31, 2009 at approximately 15-day intervals

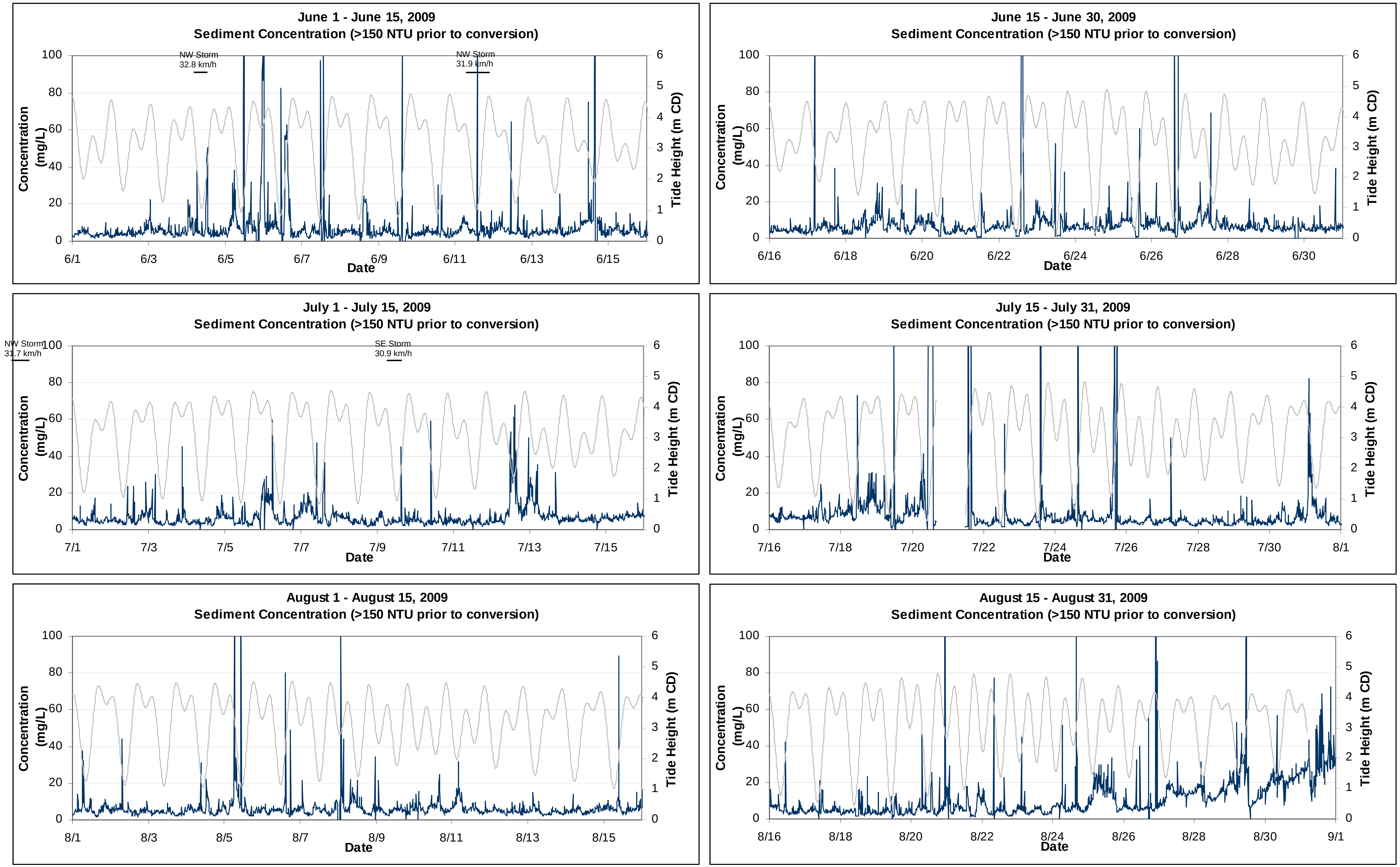
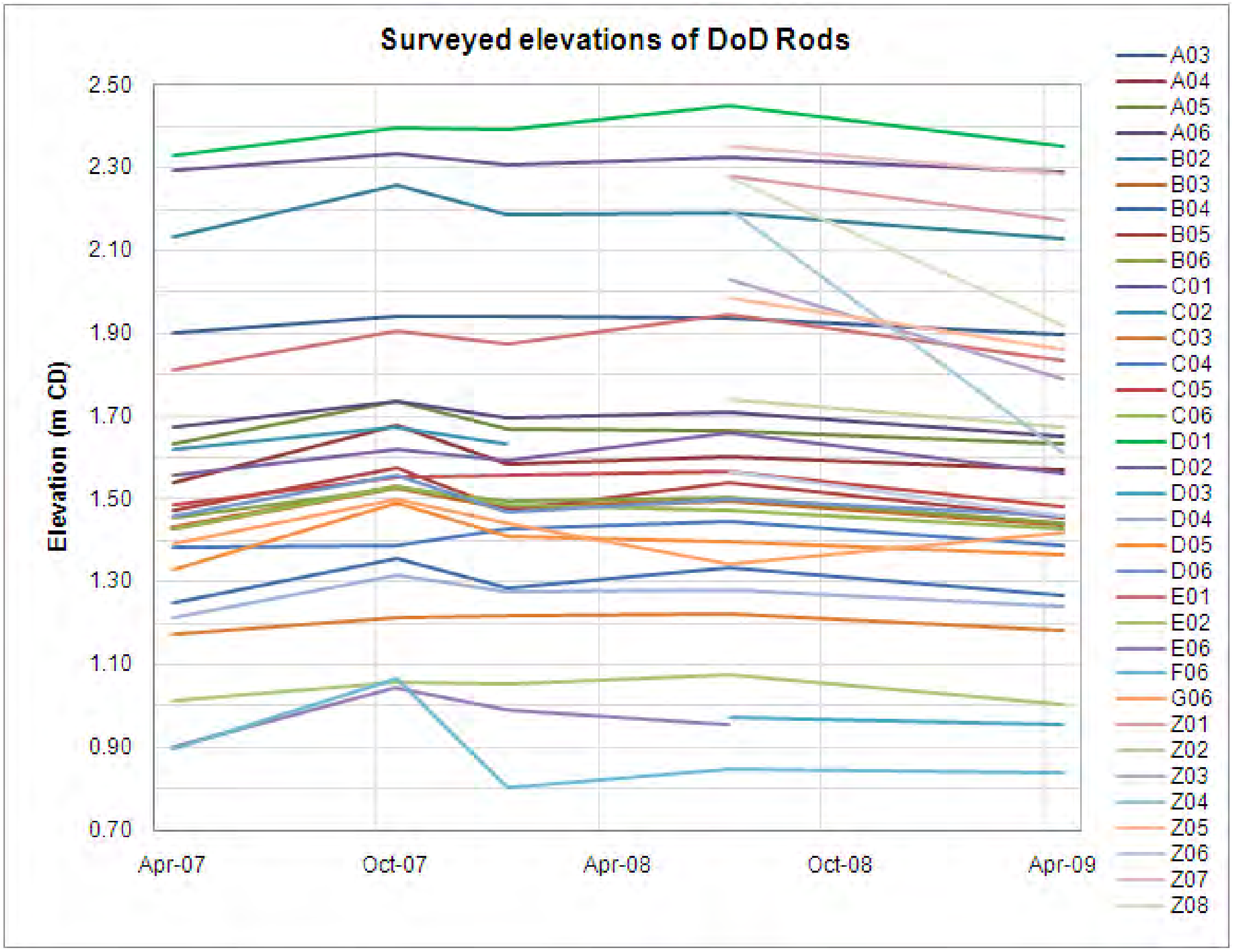
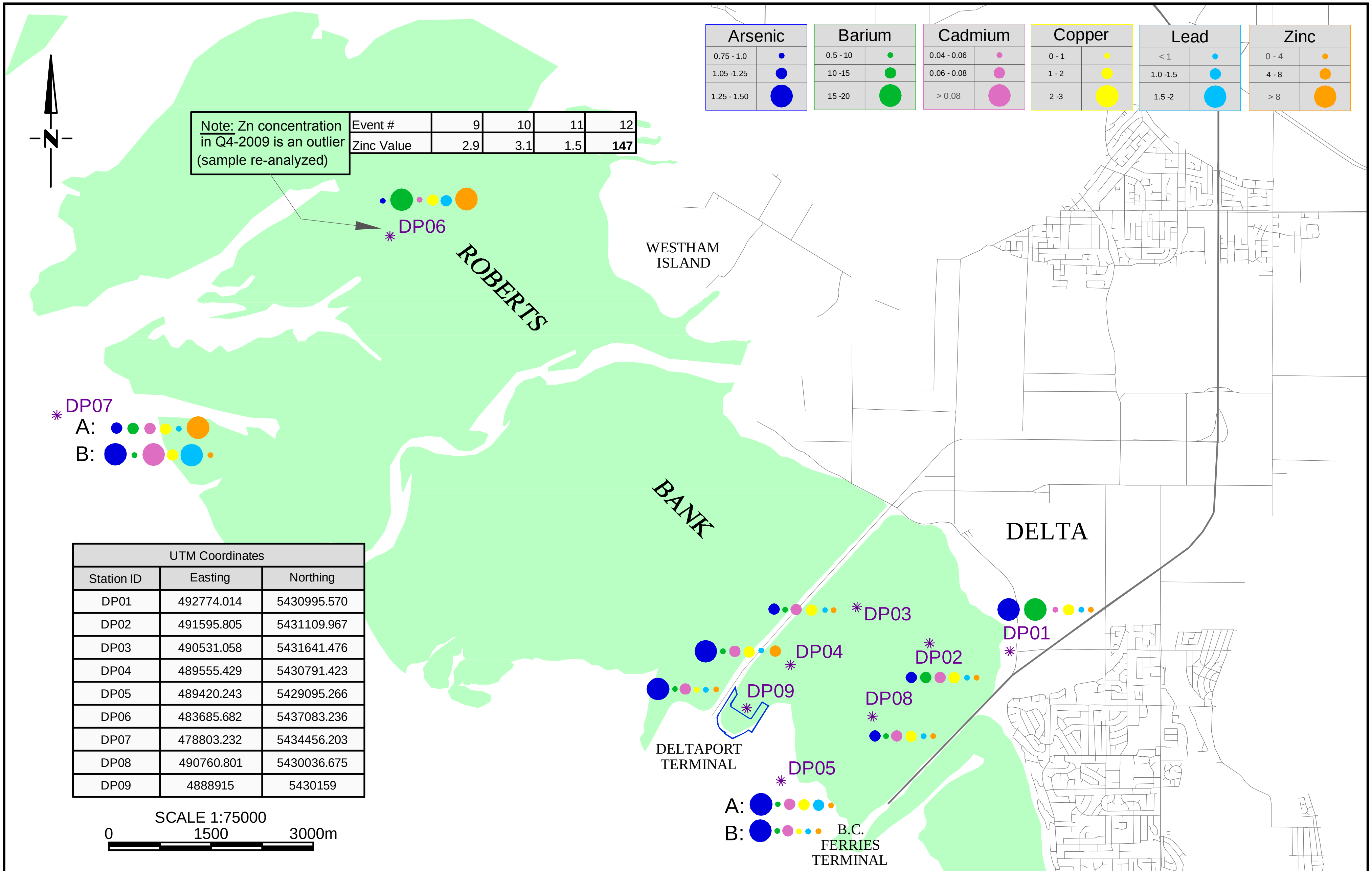


Figure 50 Surveyed elevations of DoD Rods since inception of AMS Monitoring program





Event #	9	10	11	12
Zinc Value	2.9	3.1	1.5	**147**

UTM Coordinates		
Station ID	Easting	Northing
DP01	492774.014	5430995.570
DP02	491595.805	5431109.967
DP03	490531.058	5431641.476
DP04	489555.429	5430791.423
DP05	489420.243	5429095.266
DP06	483685.682	5437083.236
DP07	478803.232	5434456.203
DP08	490760.801	5430036.675
DP09	4888915	5430159

LEGEND
- Water
- Tidal Mud & Sand
- ✳ Sampling Station

Note: Units for all Total Metals are µg/L.

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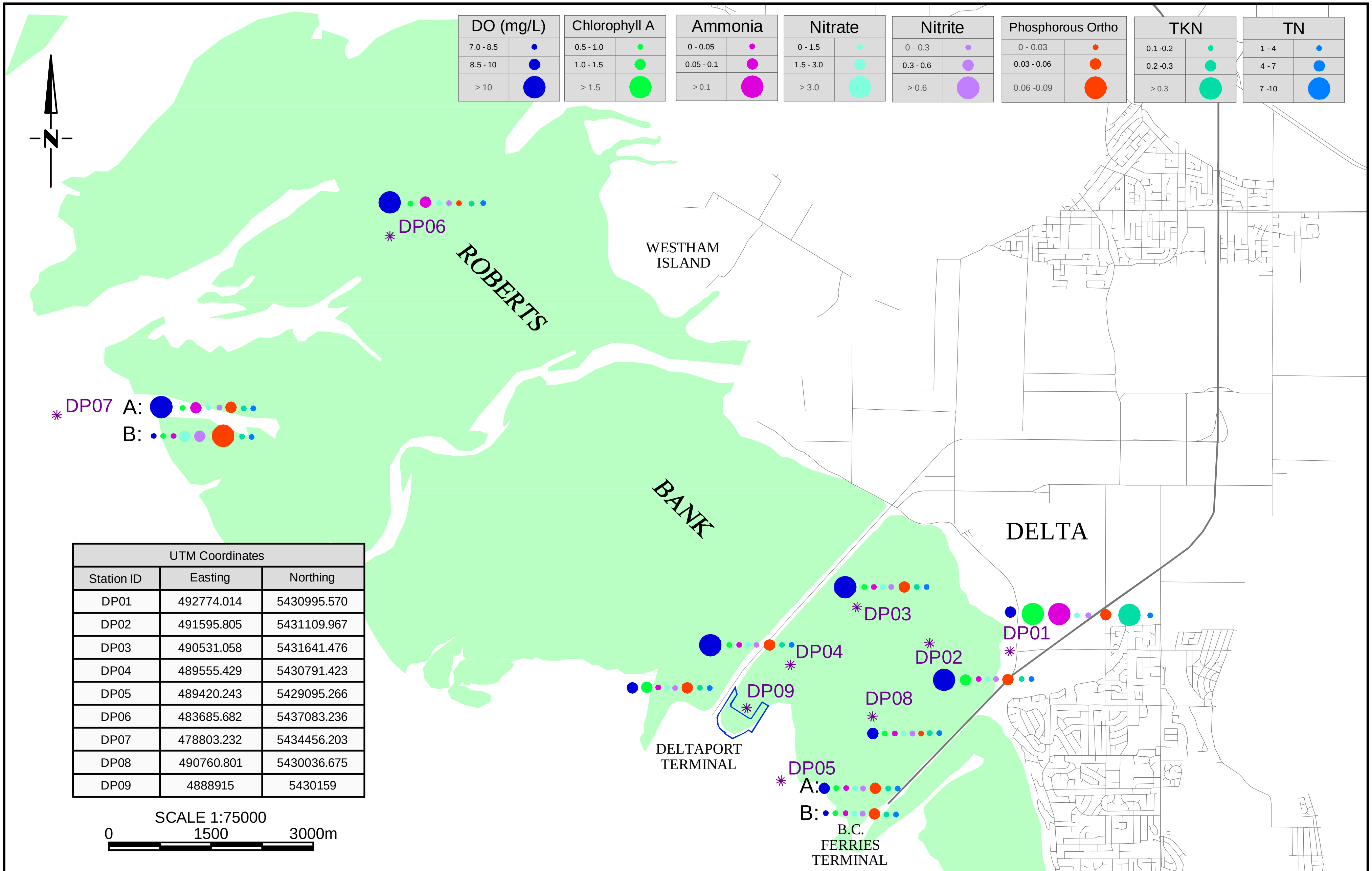
CLIENT: PORT METRO vancouver

DELTAPORT THIRD BERTH - ADAPTIVE MANAGEMENT STRATEGY PROGRAM - 2009 ANNUAL REPORT

SPATIAL TRENDS OF METAL PARAMETERS IN SURFACE WATER

PROJECT No. 499-002.11	September 2010	FIGURE 51



UTM Coordinates		
Station ID	Easting	Northing
DP01	492774.014	5430995.570
DP02	491595.805	5431109.967
DP03	490531.058	5431641.476
DP04	489555.429	5430791.423
DP05	489420.243	5429095.266
DP06	483685.682	5437083.236
DP07	478803.232	5434456.203
DP08	490760.801	5430036.675
DP09	4888915	5430159

LEGEND
- Water
- Tidal Mud & Sand
- ✳ Sampling Station

Note: Units for all parameters are µg/L, unless otherwise noted.

HEMMERA

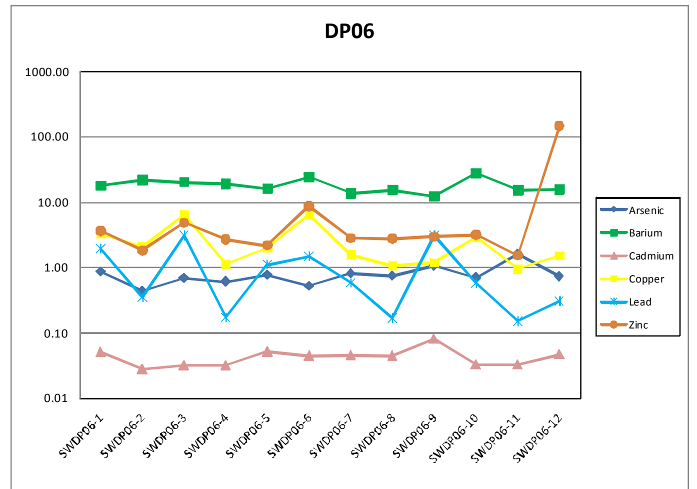
CLIENT: PORT METRO vancouver

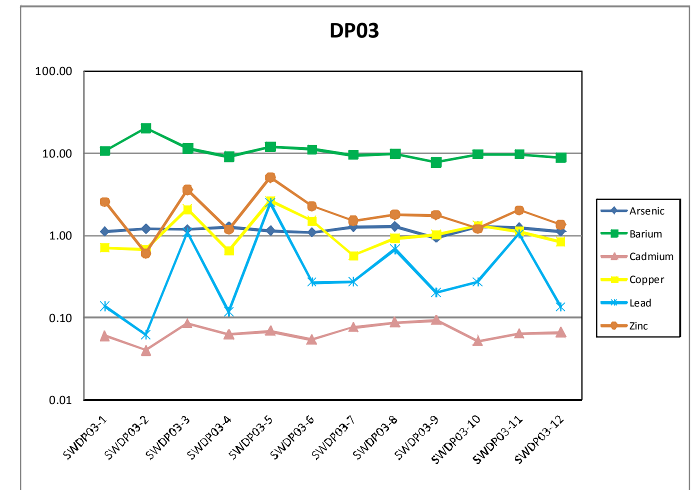
DELTAPORT THIRD BERTH - ADAPTIVE MANAGEMENT STRATEGY PROGRAM - 2009 ANNUAL REPORT

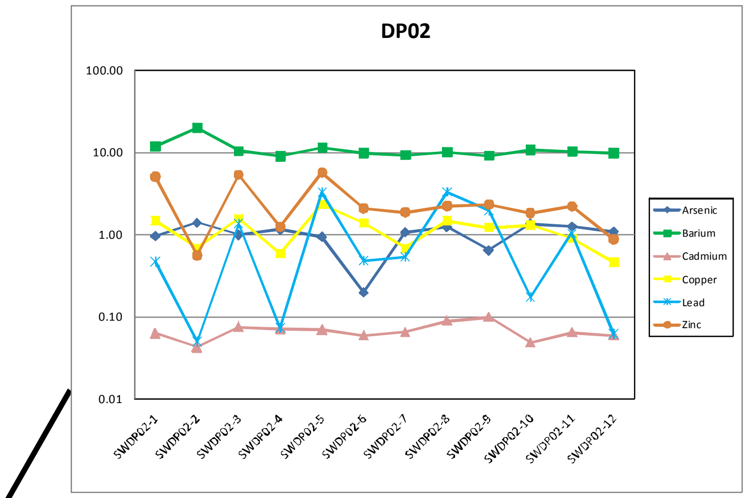
SPATIAL TRENDS OF EUTROPHICATION-RELATED PARAMETERS IN SURFACE WATER

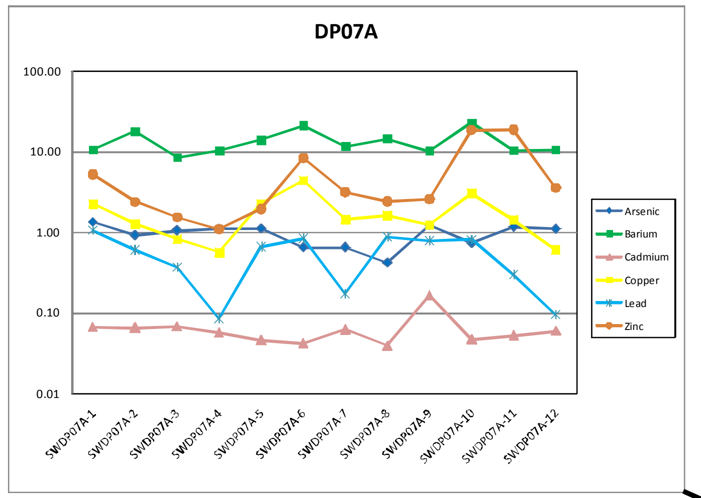
PROJECT No. 499-002.11	September 2010	FIGURE 52

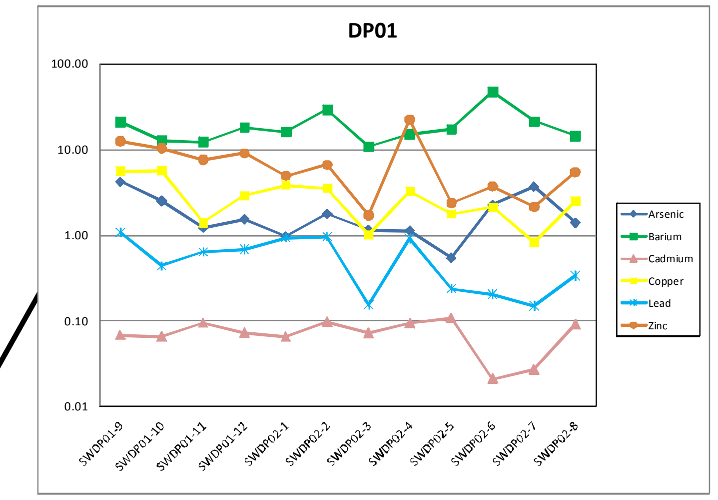
UTM Coordinates		
Station ID	Easting	Northing
DP01	492774.014	5430995.570
DP02	491595.805	5431109.967
DP03	490531.058	5431641.476
DP04	489555.429	5430791.423
DP05	489420.243	5429095.266
DP06	483685.682	5437083.236
DP07	478803.232	5434456.203

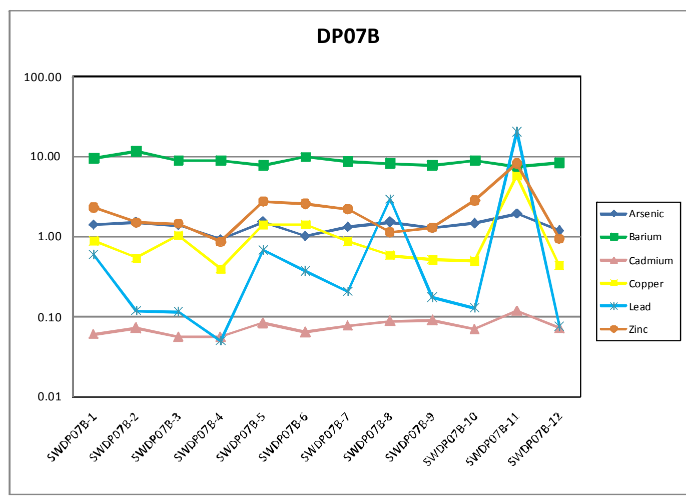


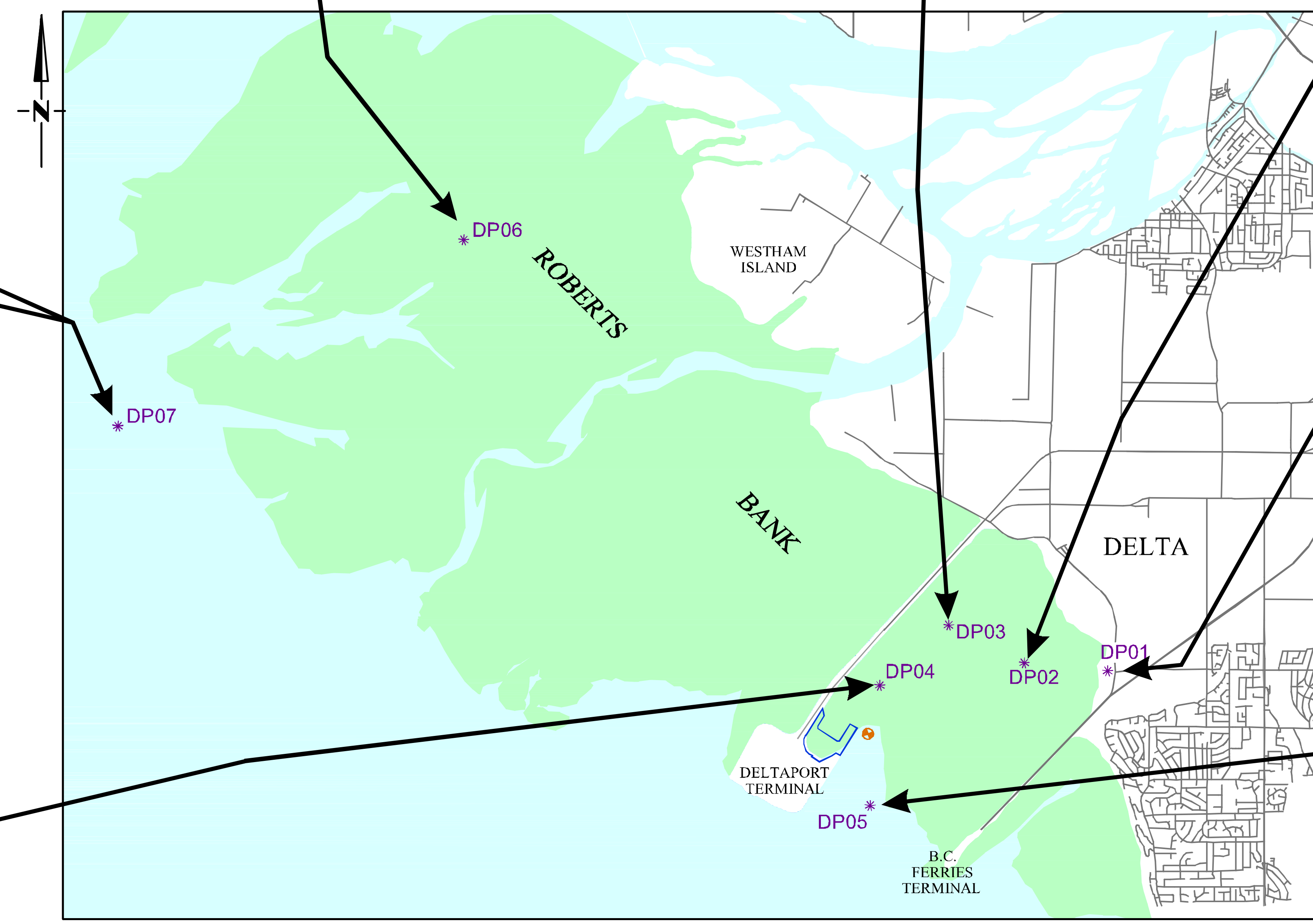


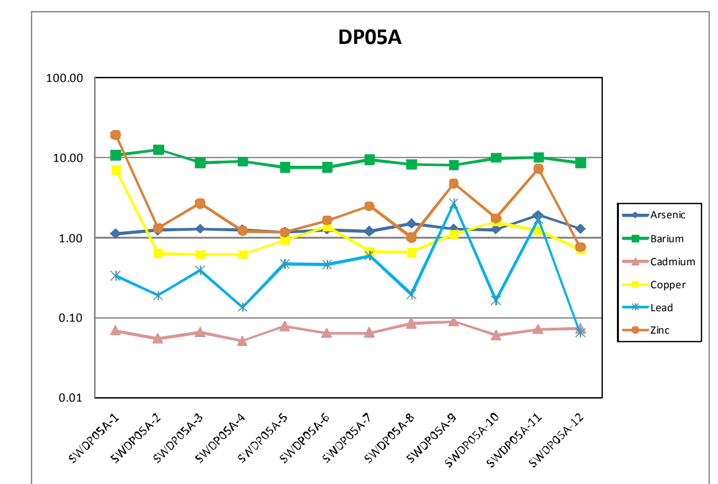


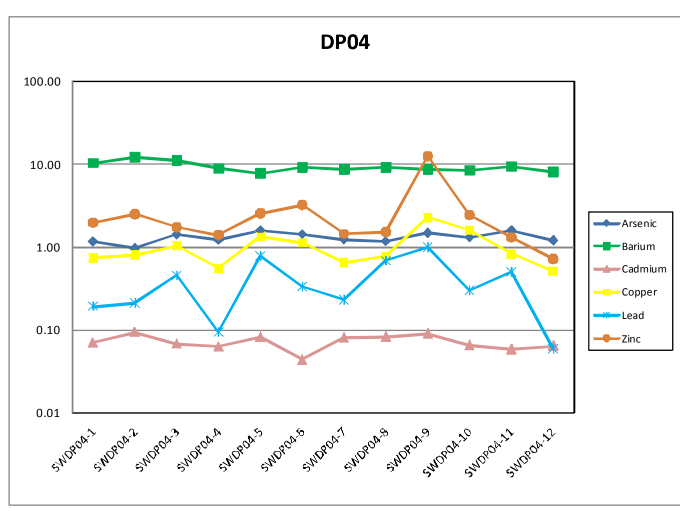


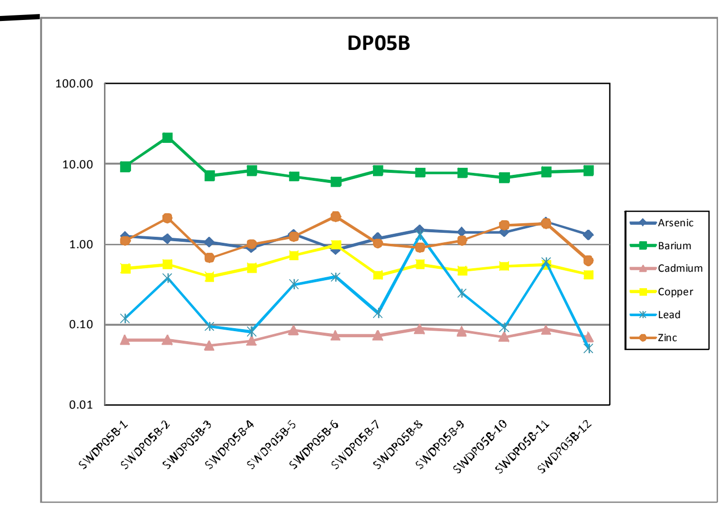












LEGEND
Water
Tidal Mud & Sand
Water Quality Sampling Station
YSI Sonde

SCALE 1:75000
0 1500 3000m

NOTE: All measurements are in µg/L

HEMMERA

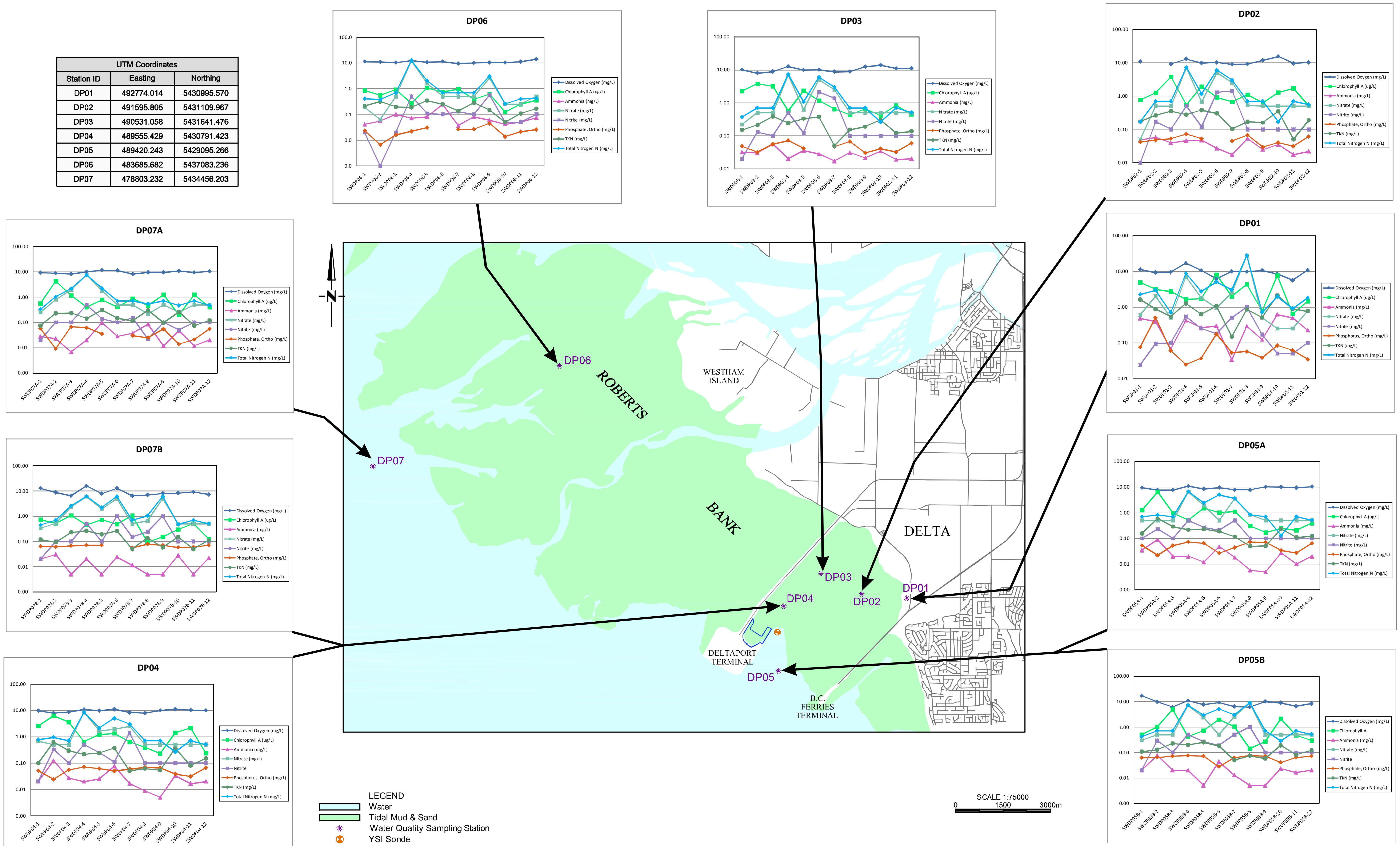
CLIENT: PORT METRO Vancouver

DELTAPORT THIRD BERTH - ADAPTIVE MANAGEMENT STRATEGY PROGRAM 2009 ANNUAL REPORT

TEMPORAL TRENDS OF METALS IN SURFACE WATER

PROJECT No		
499-002.11	September 2010	FIGURE 53

UTM Coordinates		
Station ID	Easting	Northing
DP01	492774.014	5430995.570
DP02	491595.805	5431109.967
DP03	490531.058	5431641.476
DP04	489555.429	5430791.423
DP05	489420.243	5429095.266
DP06	483685.682	5437083.236
DP07	478803.232	5434456.203



NOTE: All measurements are in mg/L

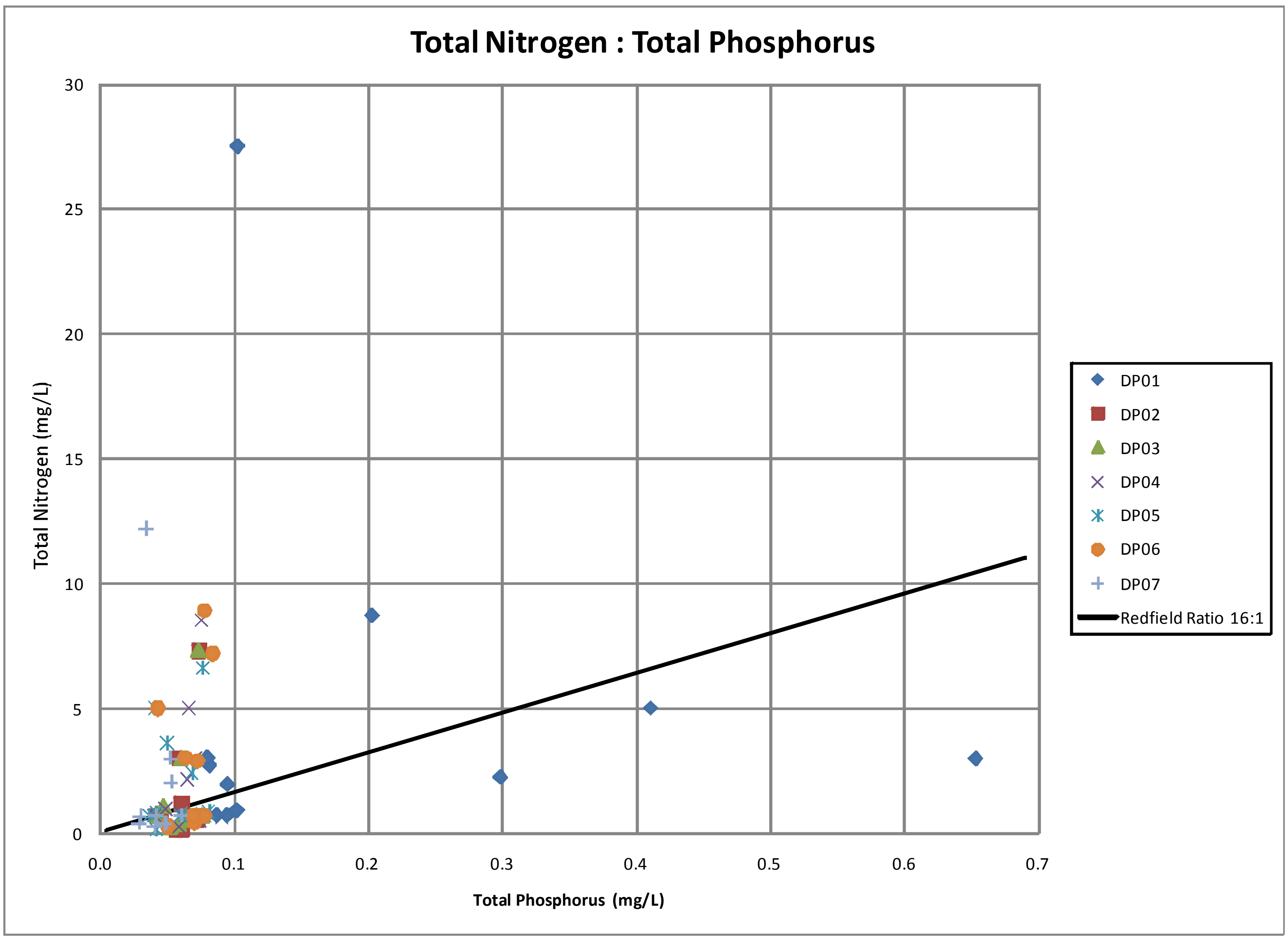
HEMMERA

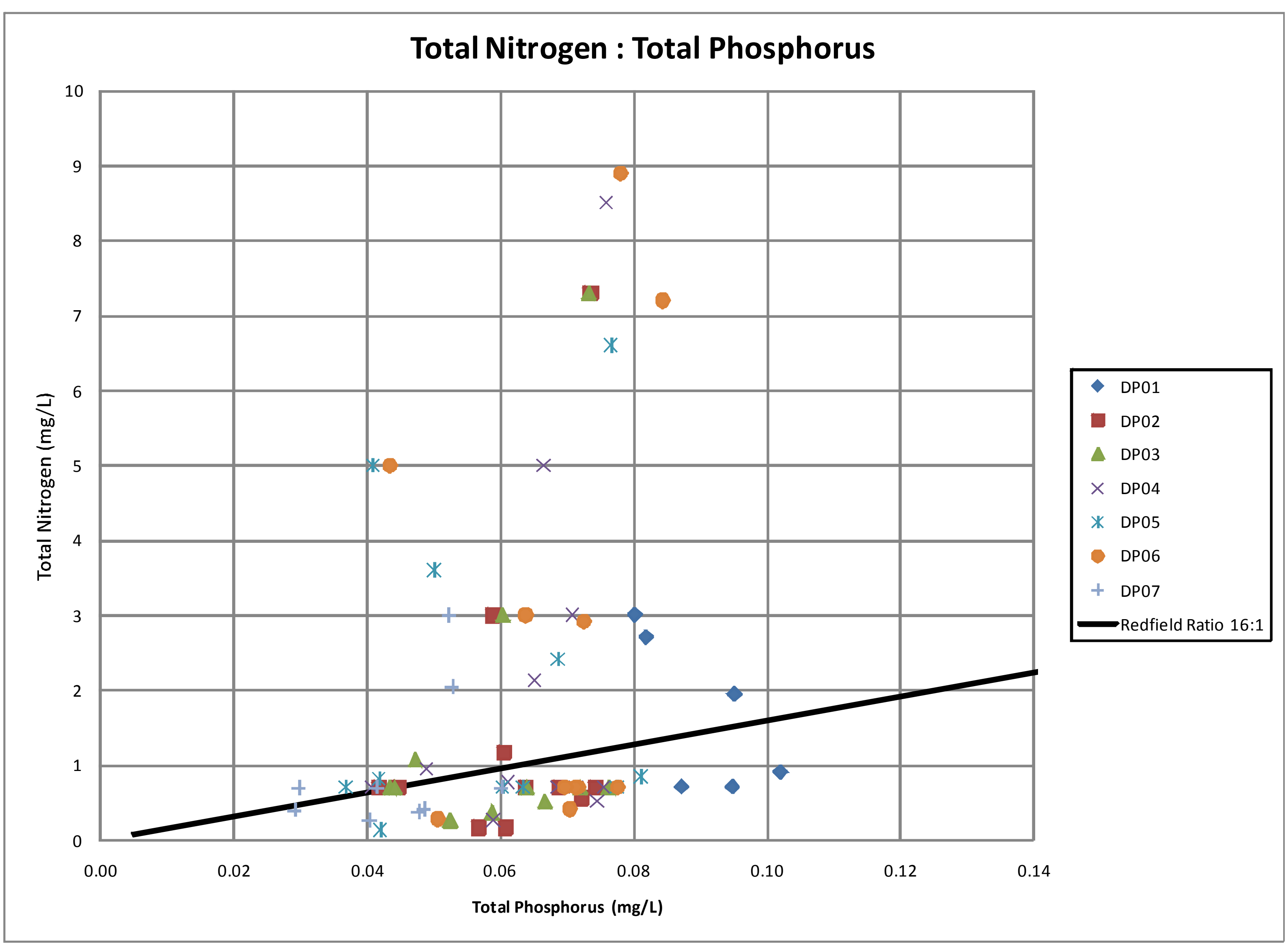
CLIENT: PORT METRO vancouver

DELTAPORT THIRD BERTH - ADAPTIVE MANAGEMENT STRATEGY PROGRAM 2009 ANNUAL REPORT

TEMPORAL TRENDS OF EUTROPHICATION-RELATED PARAMETERS IN SURFACE WATER

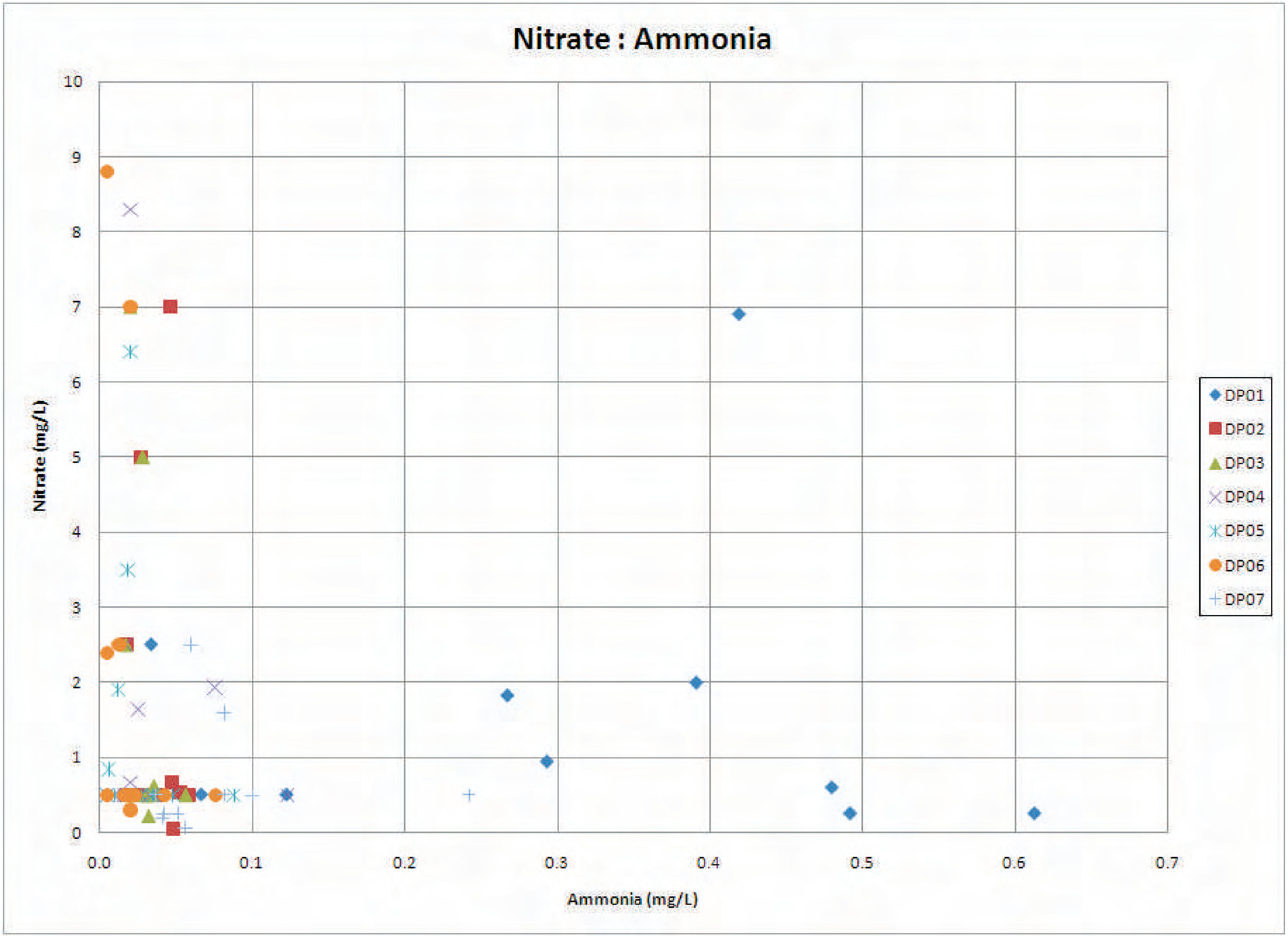
PROJECT No 499-002.11 | September 2010 | FIGURE 54





Note: This graph shows a close-up view of the same data shown above.

HEMMERA	DELTAPORT THIRD BERTH - ADAPTIVE MANAGEMENT STRATEGY PROGRAM - 2009 ANNUAL REPORT		
	RATIO OF TOTAL NITROGEN TO TOTAL PHOSPHORUS IN SURFACE WATER		
CLIENT: PORT METRO vancouver	PROJECT No. 499-002.11	September 2010	FIGURE 55



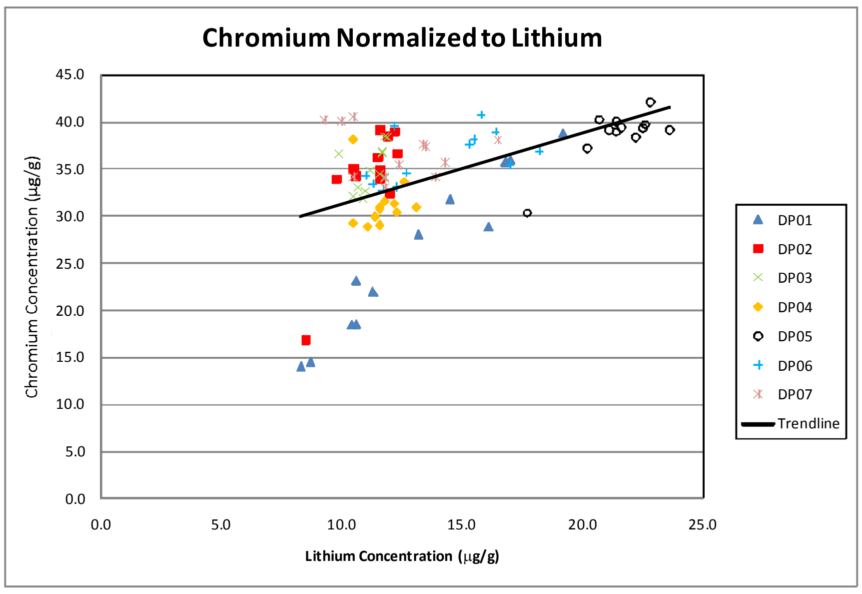
HEMMERA

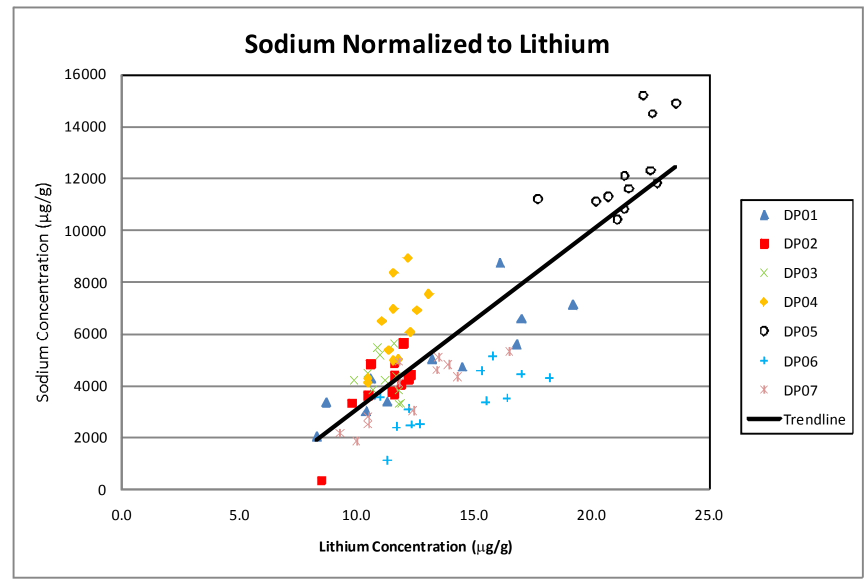
CLIENT: PORT METRO vancouver

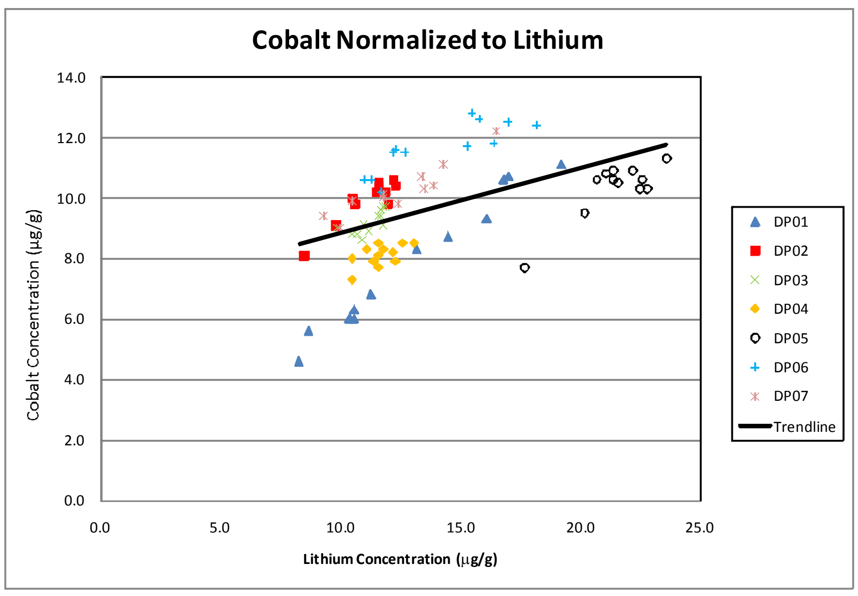
DELTAPORT THIRD BERTH - ADAPTIVE MANAGEMENT STRATEGY PROGRAM - 2009 ANNUAL REPORT

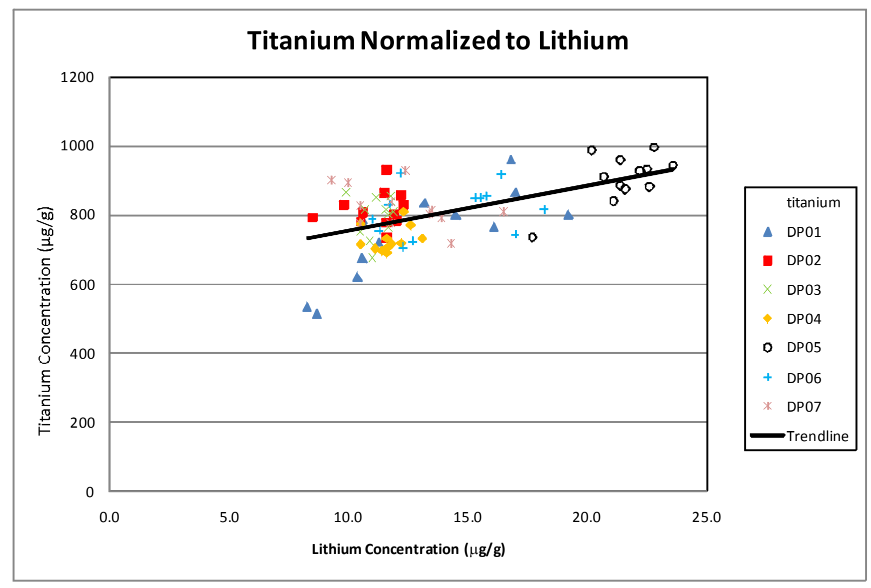
RATIO OF NITRATE TO AMMONIA IN SURFACE WATER

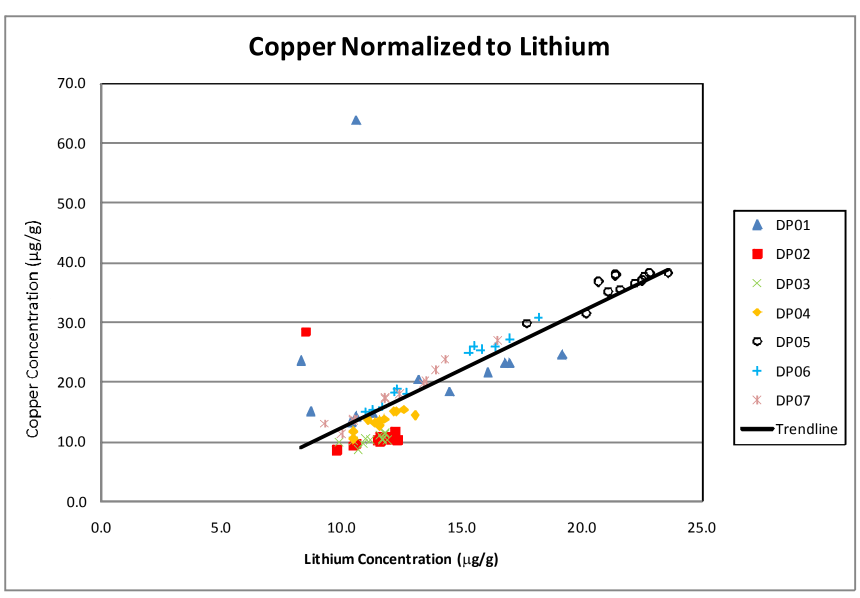
PROJECT No. 499-002.11	September 2010	FIGURE 56

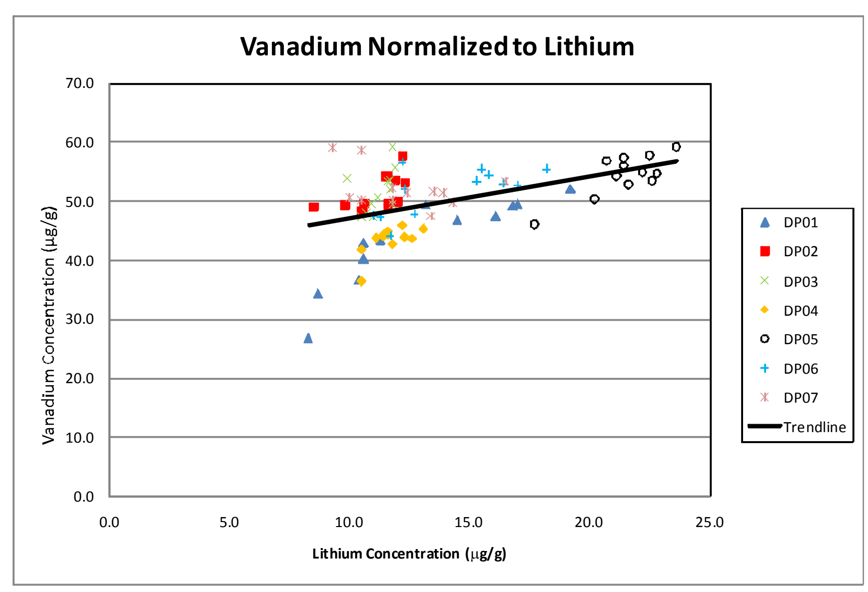


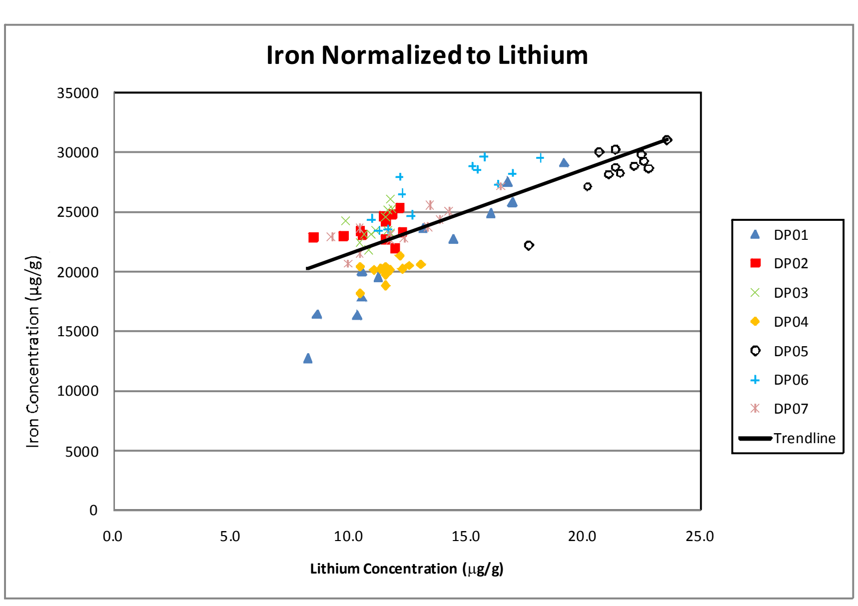


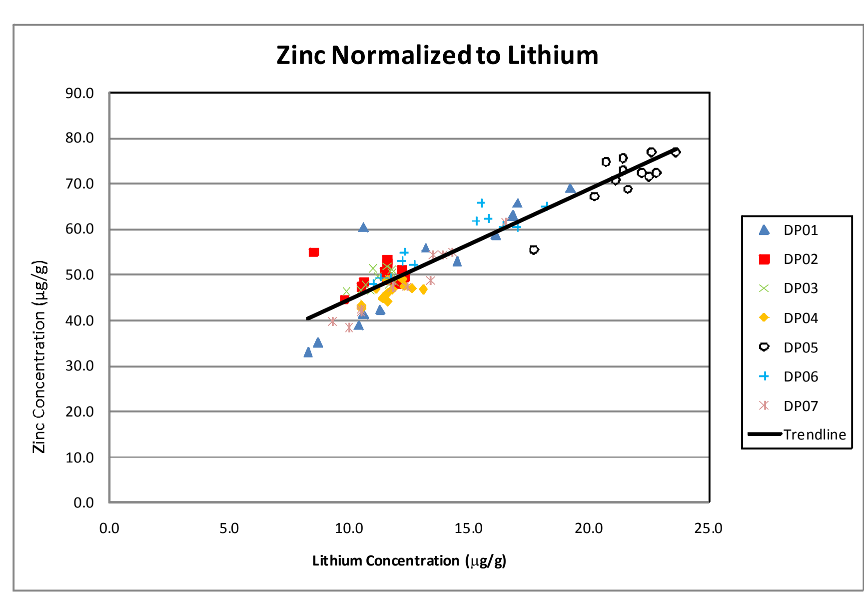












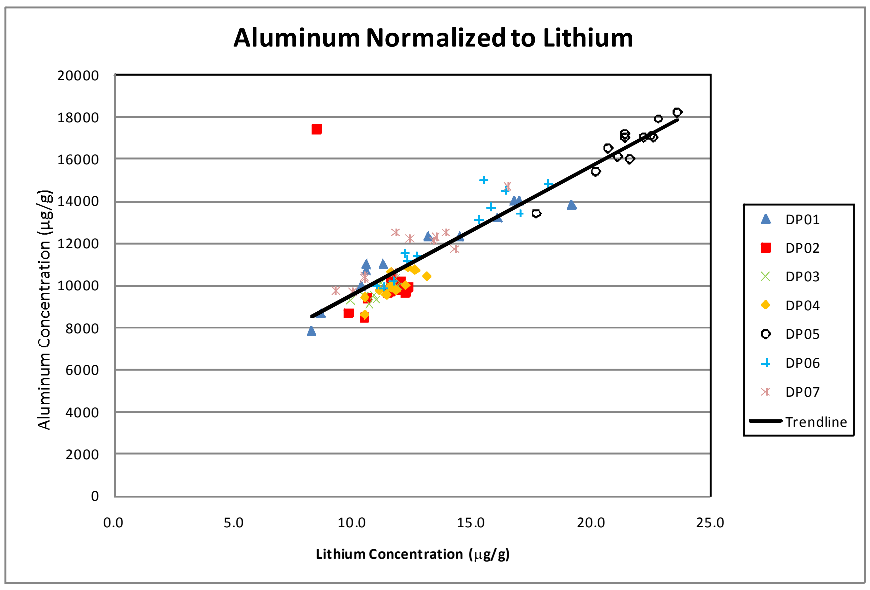
HEMMERA

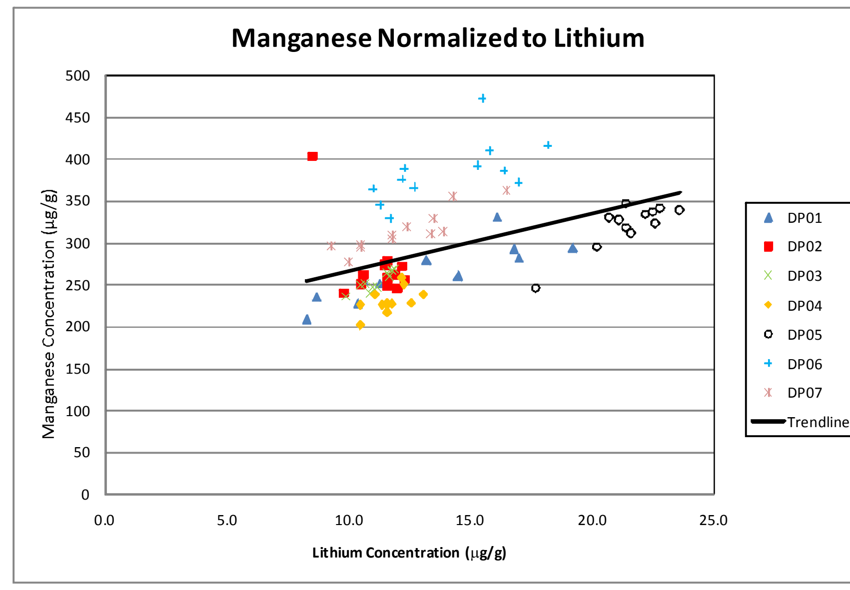
CLIENT: PORT METRO vancouver

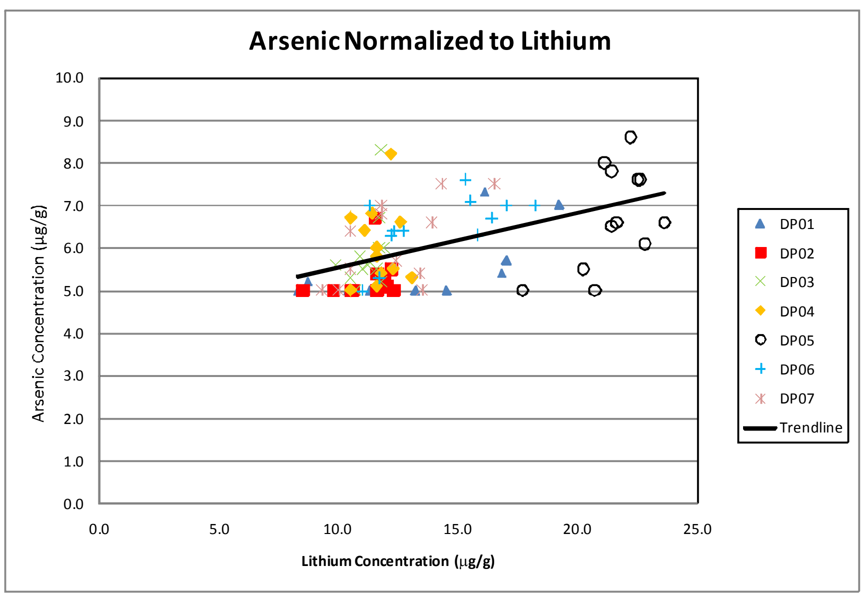
DELTAPORT THIRD BERTH - ADAPTIVE MANAGEMENT STRATEGY PROGRAM 2009 ANNUAL REPORT

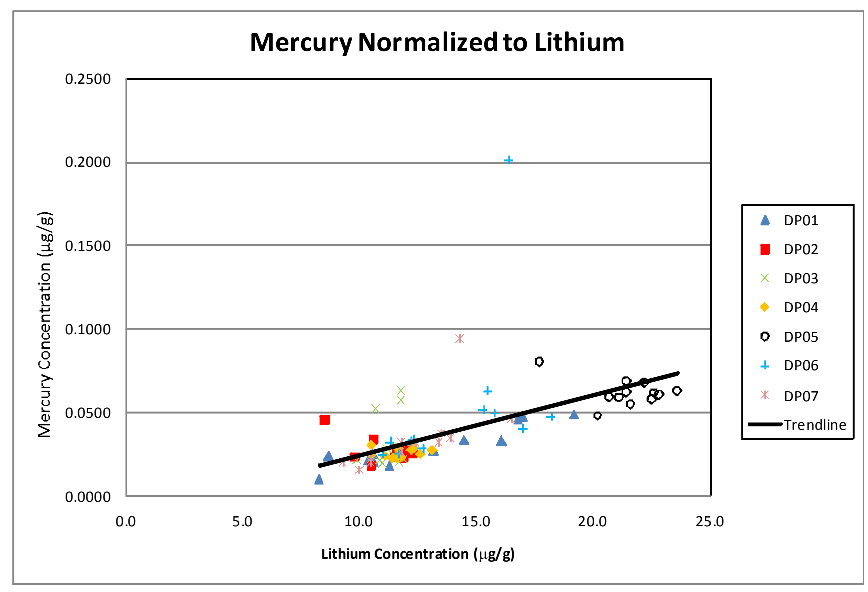
METAL CONCENTRATIONS IN SEDIMENT NORMALIZED TO LITHIUM

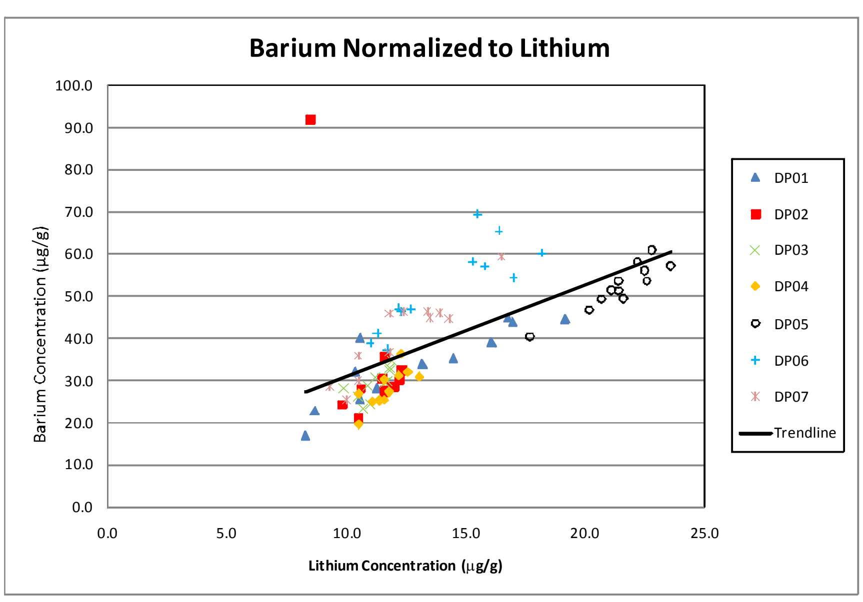
PROJECT No. 499-002.11 | September 2010 | FIGURE 57A

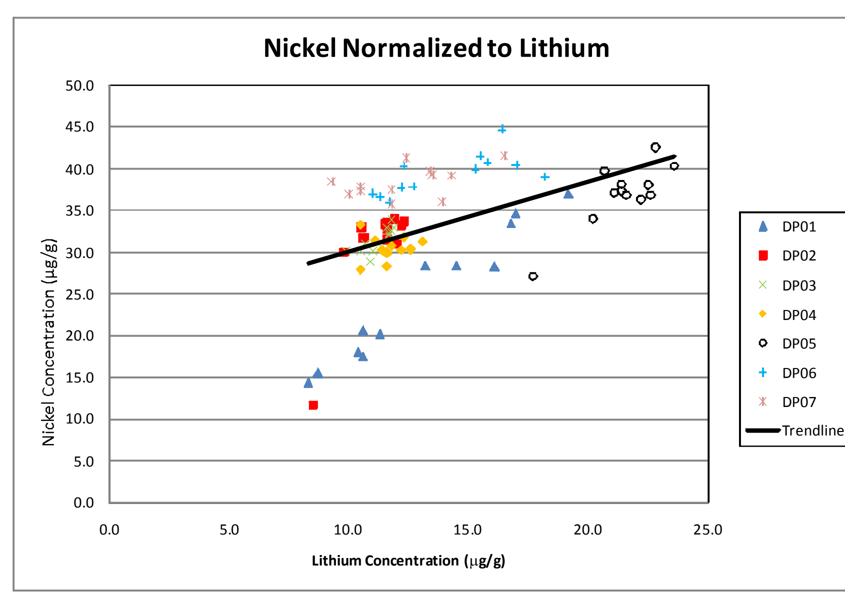

Aluminum Normalized to Lithium
Aluminum Concentration (µg/g)
Lithium Concentration (µg/g)
DP01
DP02
DP03
DP04
DP05
DP06
DP07
Trendline

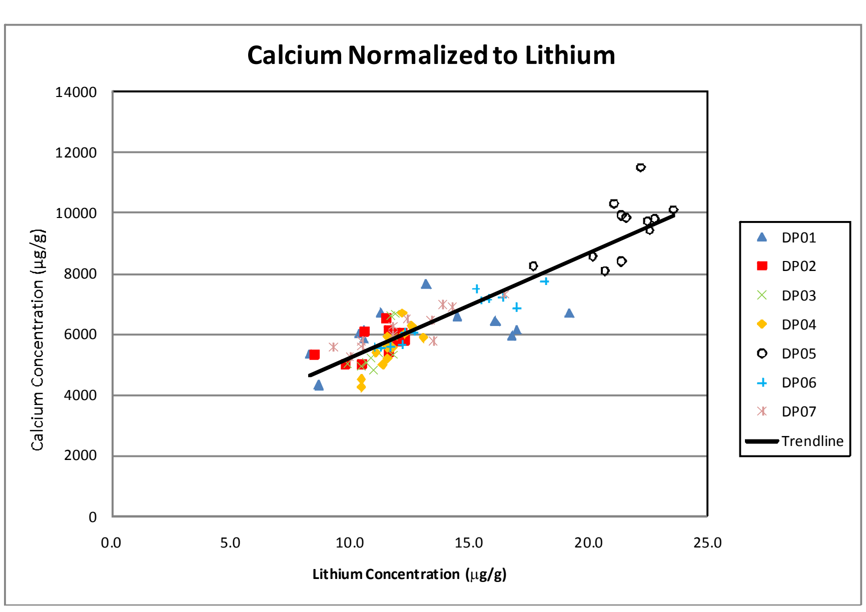

Manganese Normalized to Lithium
Manganese Concentration (µg/g)
Lithium Concentration (µg/g)
DP01
DP02
DP03
DP04
DP05
DP06
DP07
Trendline

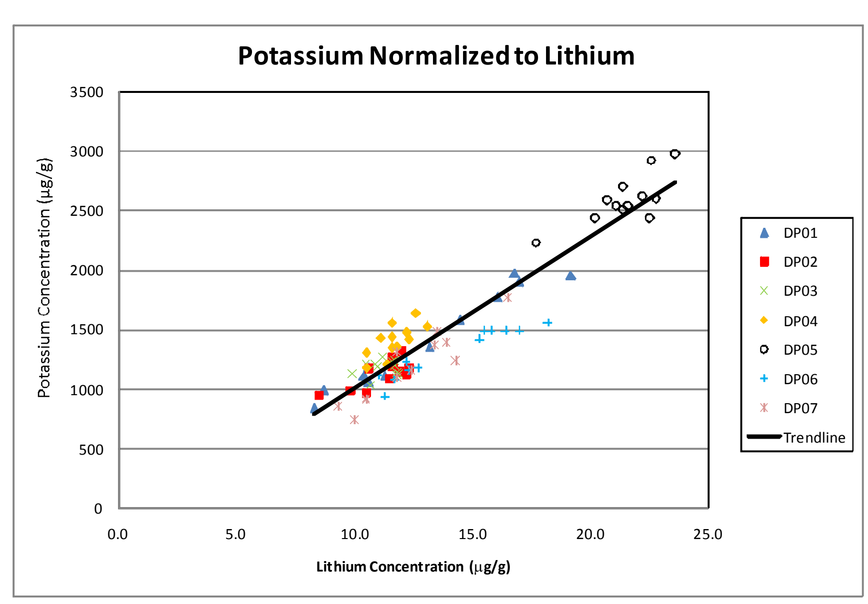

Arsenic Normalized to Lithium
Arsenic Concentration (µg/g)
Lithium Concentration (µg/g)
DP01
DP02
DP03
DP04
DP05
DP06
DP07
Trendline

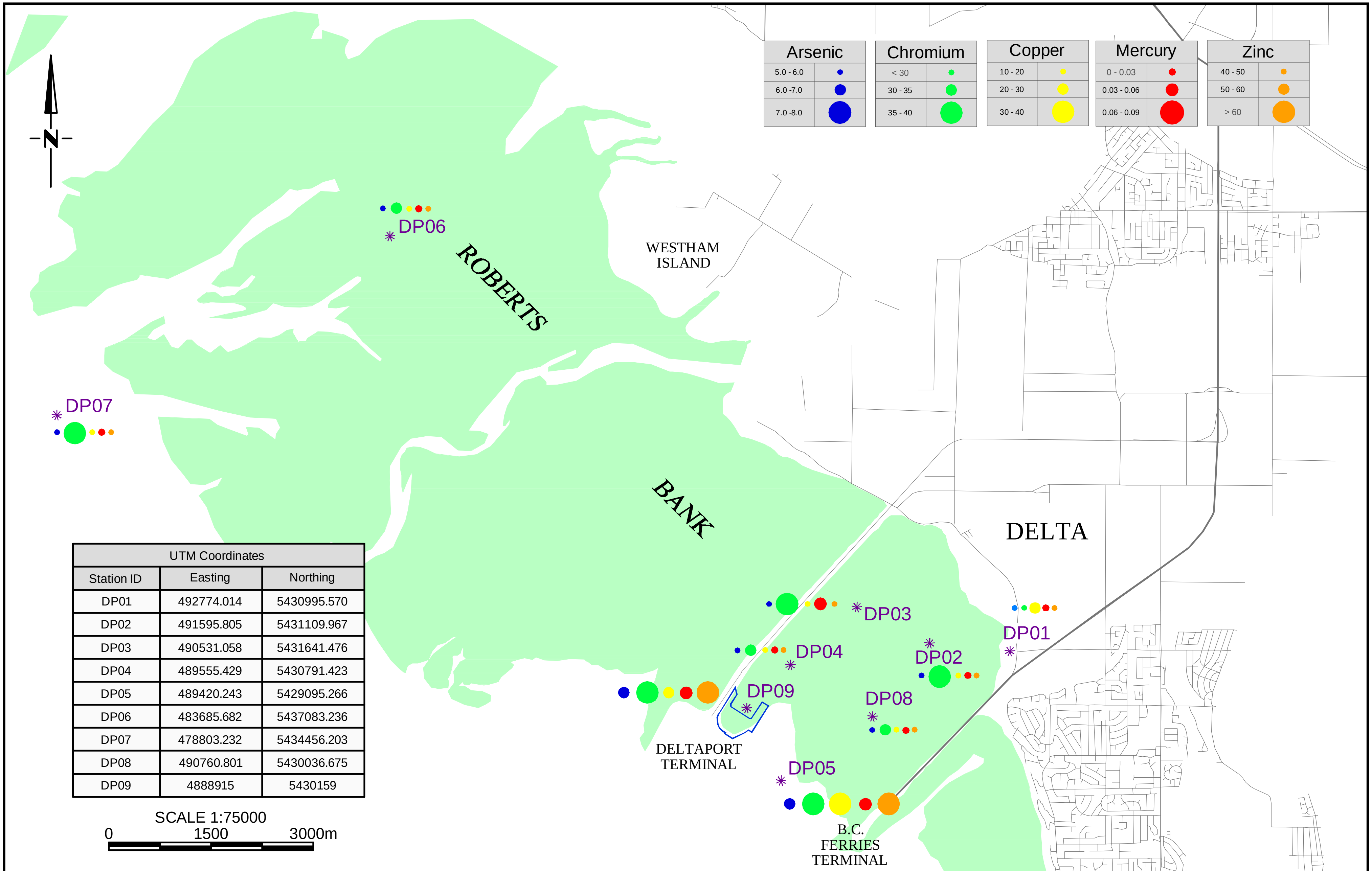

Mercury Normalized to Lithium
Mercury Concentration (µg/g)
Lithium Concentration (µg/g)
DP01
DP02
DP03
DP04
DP05
DP06
DP07
Trendline


Barium Normalized to Lithium
Barium Concentration (µg/g)
Lithium Concentration (µg/g)
DP01
DP02
DP03
DP04
DP05
DP06
DP07
Trendline


Nickel Normalized to Lithium
Nickel Concentration (µg/g)
Lithium Concentration (µg/g)
DP01
DP02
DP03
DP04
DP05
DP06
DP07
Trendline


Calcium Normalized to Lithium
Calcium Concentration (µg/g)
Lithium Concentration (µg/g)
DP01
DP02
DP03
DP04
DP05
DP06
DP07
Trendline


Potassium Normalized to Lithium
Potassium Concentration (µg/g)
Lithium Concentration (µg/g)
DP01
DP02
DP03
DP04
DP05
DP06
DP07
Trendline



UTM Coordinates		
Station ID	Easting	Northing
DP01	492774.014	5430995.570
DP02	491595.805	5431109.967
DP03	490531.058	5431641.476
DP04	489555.429	5430791.423
DP05	489420.243	5429095.266
DP06	483685.682	5437083.236
DP07	478803.232	5434456.203
DP08	490760.801	5430036.675
DP09	4888915	5430159

LEGEND
Water
Tidal Mud & Sand
Sampling Station
Note: Units for all parameters are µg/g, unless otherwise noted.

HEMMERA

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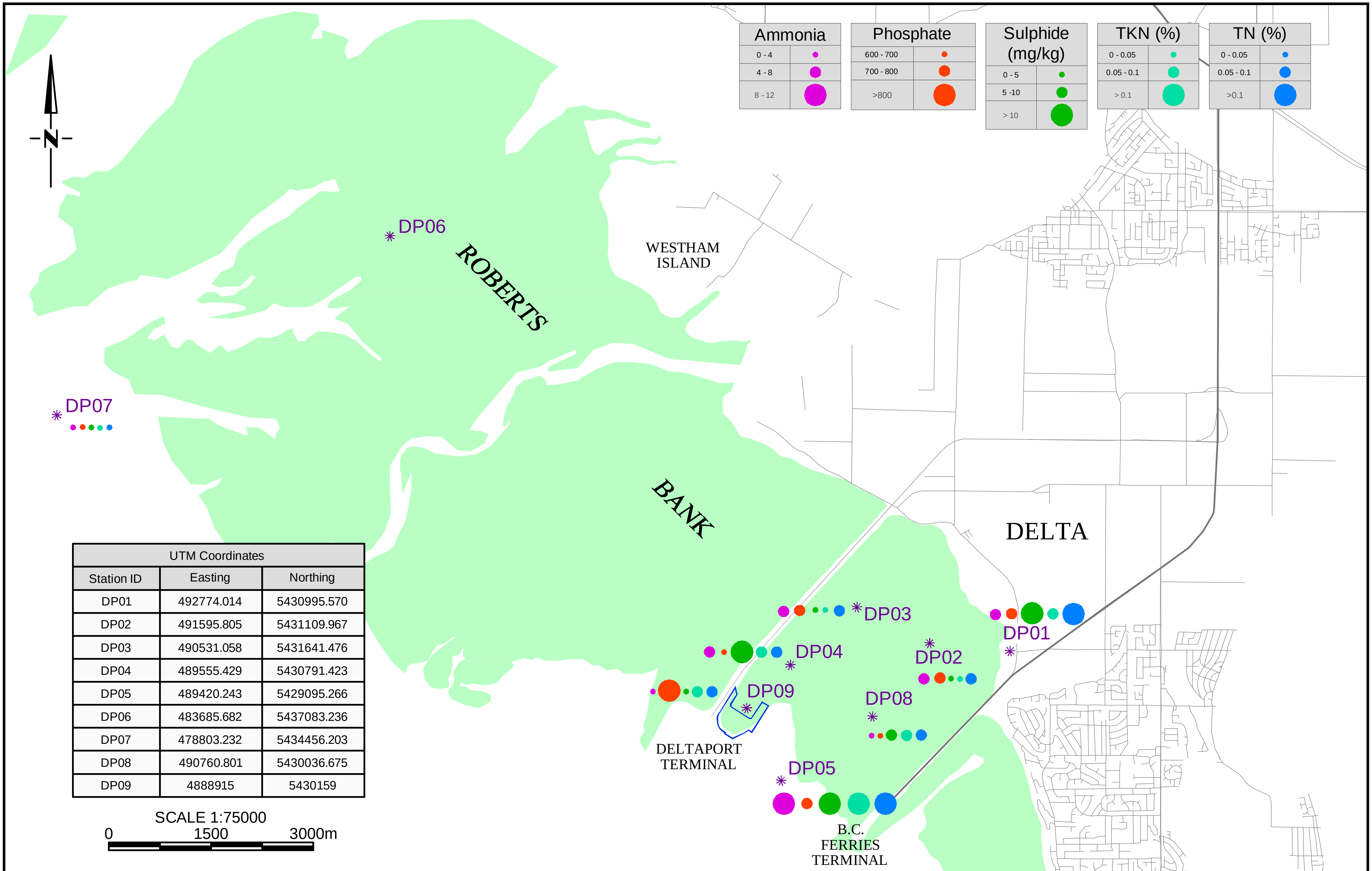
DELTAPORT THIRD BERTH - ADAPTIVE MANAGEMENT STRATEGY PROGRAM - 2009 ANNUAL REPORT

SPATIAL TRENDS OF METALS IN SEDIMENT

PROJECT No. 499-002.11	September 2010	FIGURE 58



UTM Coordinates		
Station ID	Easting	Northing
DP01	492774.014	5430995.570
DP02	491595.805	5431109.967
DP03	490531.058	5431641.476
DP04	489555.429	5430791.423
DP05	489420.243	5429095.266
DP06	483685.682	5437083.236
DP07	478803.232	5434456.203
DP08	490760.801	5430036.675
DP09	4888915	5430159

LEGEND
Water
Tidal Mud & Sand
Sampling Station
Note: Units for all parameters are µg/g, unless otherwise noted.

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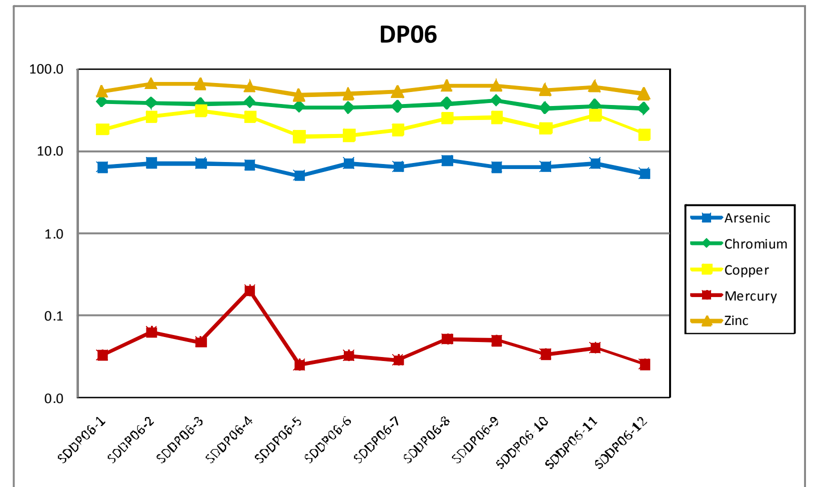
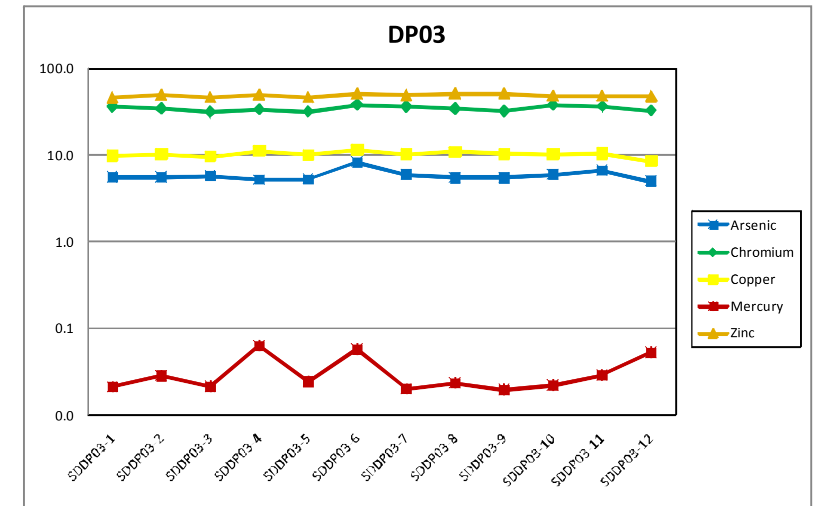
DELTAPORT THIRD BERTH - ADAPTIVE MANAGEMENT STRATEGY PROGRAM - 2009 ANNUAL REPORT

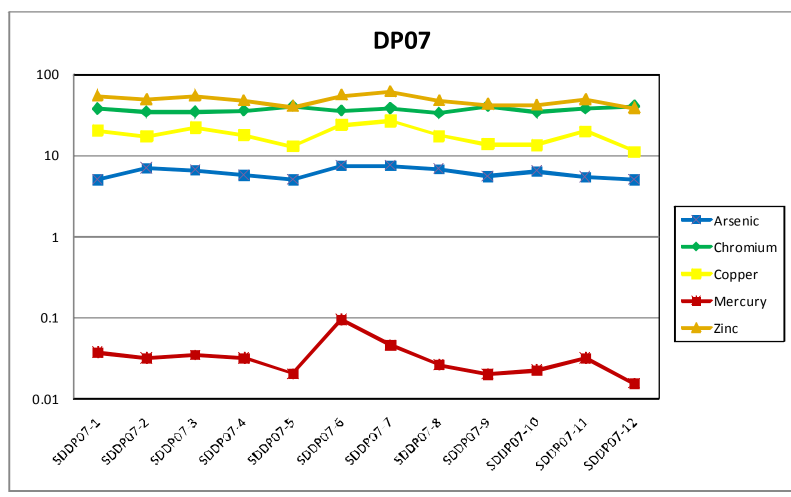
SPATIAL TRENDS OF EUTROPHICATION-RELATED PARAMETERS IN SEDIMENT

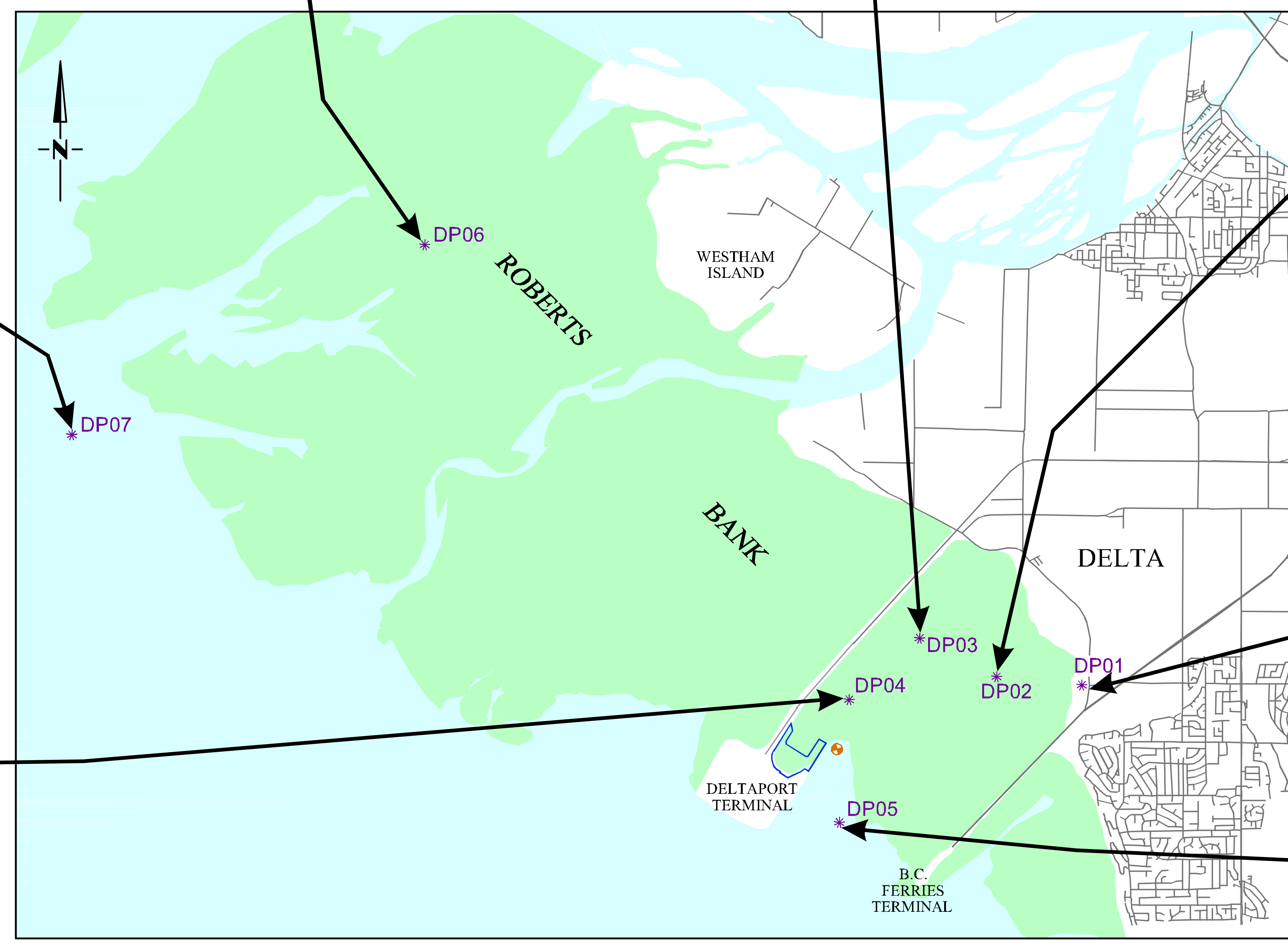
PROJECT No. 499-002.11	September 2010	FIGURE 59

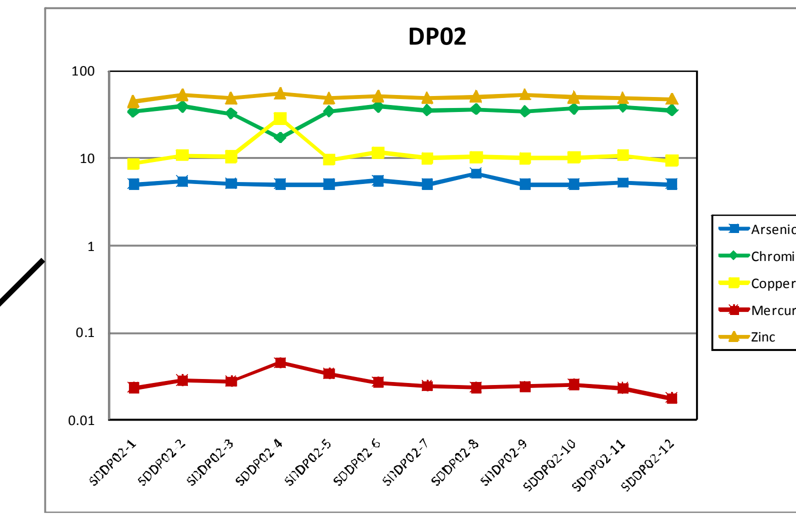
UTM Coordinates		
Station ID	Easting	Northing
DP01	492774.014	5430995.570
DP02	491595.805	5431109.967
DP03	490531.058	5431641.476
DP04	489555.429	5430791.423
DP05	489420.243	5429095.266
DP06	483685.682	5437083.236
DP07	478803.232	5434456.203

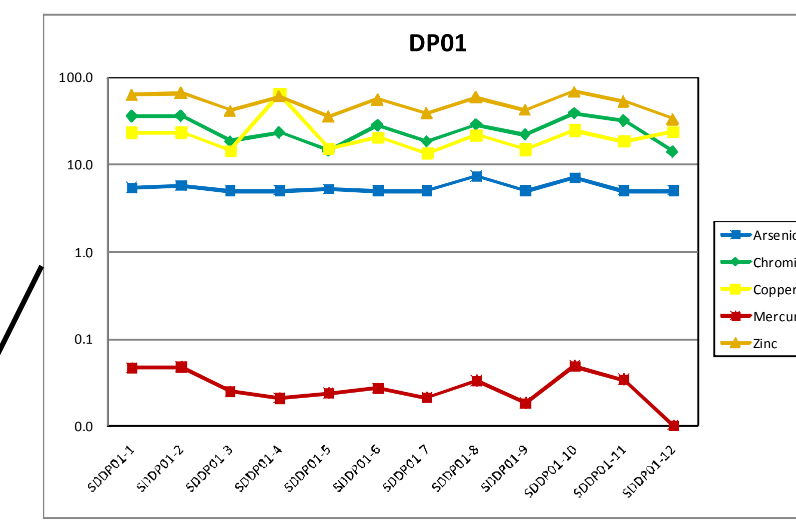


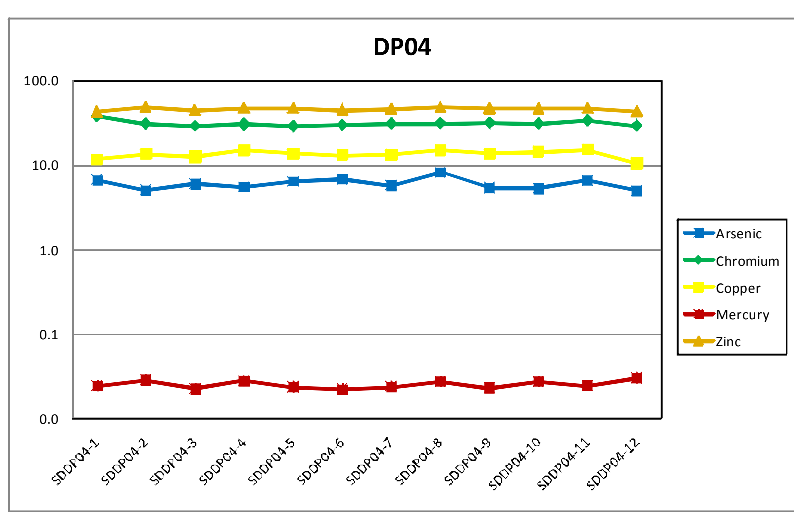


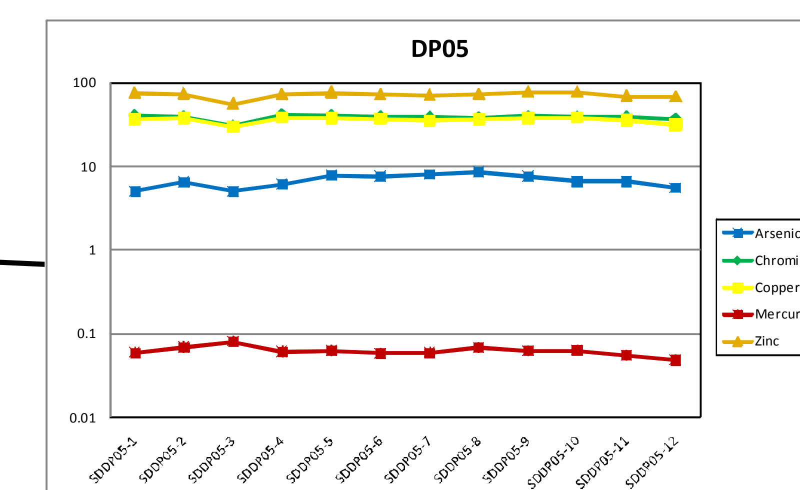












LEGEND
- Water
- Tidal Mud & Sand
- Sampling station
- YSI Sonde

SCALE 1:75000
0 1500 3000m

NOTE: All measurements are in mg/Kg.

HEMMERA

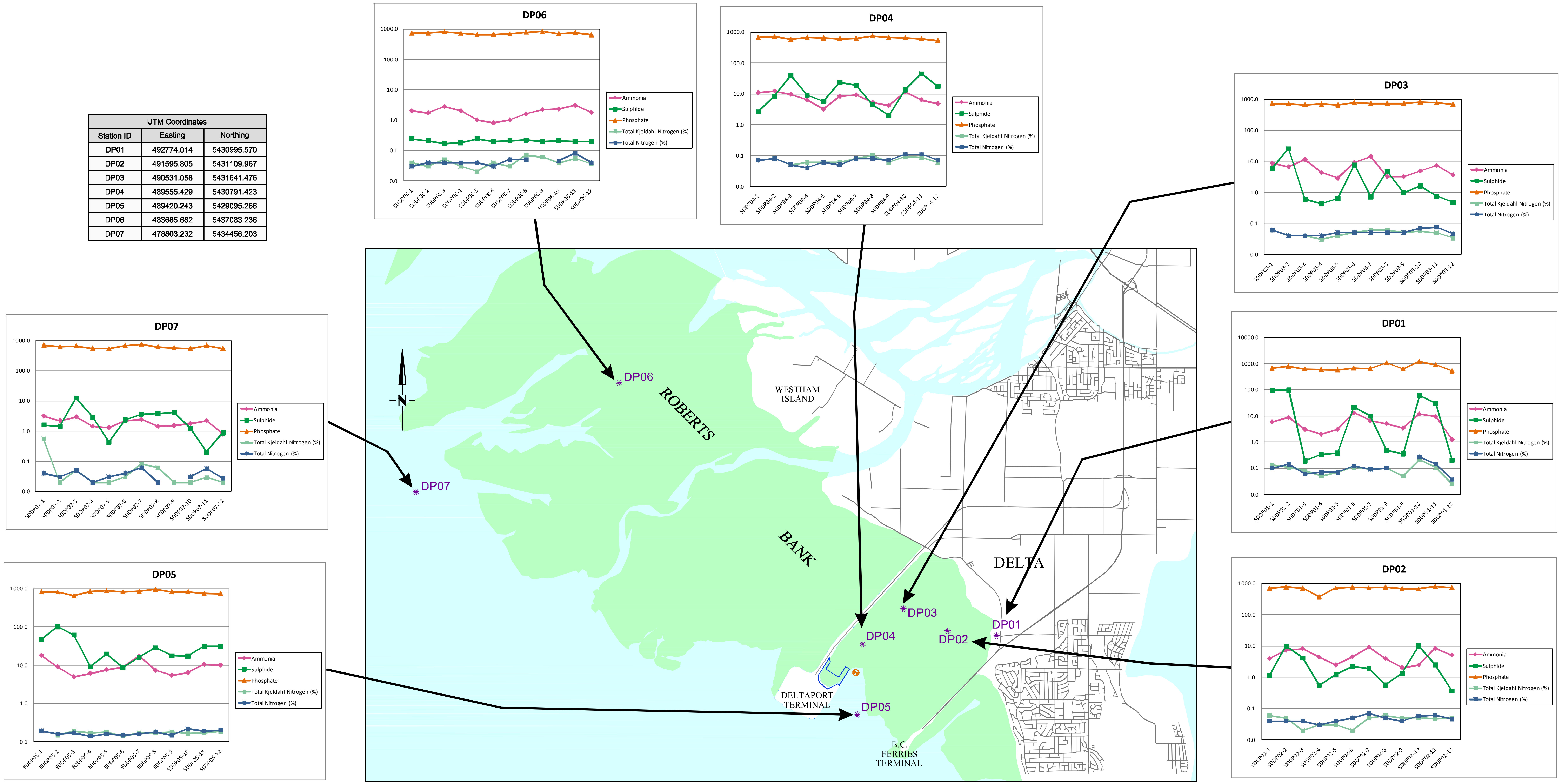
CLIENT: PORT METRO vancouver

DELTAPORT THIRD BERTH - ADAPTIVE MANAGEMENT STRATEGY PROGRAM 2009 ANNUAL REPORT

TEMPORAL TRENDS OF METALS IN SEDIMENT

PROJECT No 499-002.11 | September 2010 | FIGURE 60

UTM Coordinates		
Station ID	Easting	Northing
DP01	492774.014	5430995.570
DP02	491595.805	5431109.967
DP03	490531.058	5431641.476
DP04	489555.429	5430791.423
DP05	489420.243	5429095.266
DP06	483685.682	5437083.236
DP07	478803.232	5434456.203



LEGEND
Water
Tidal Mud & Sand
Sampling station
YSI Sonde

SCALE 1:75000
0 1500 3000m

NOTE: All measurements are in mg/Kg (unless otherwise noted).

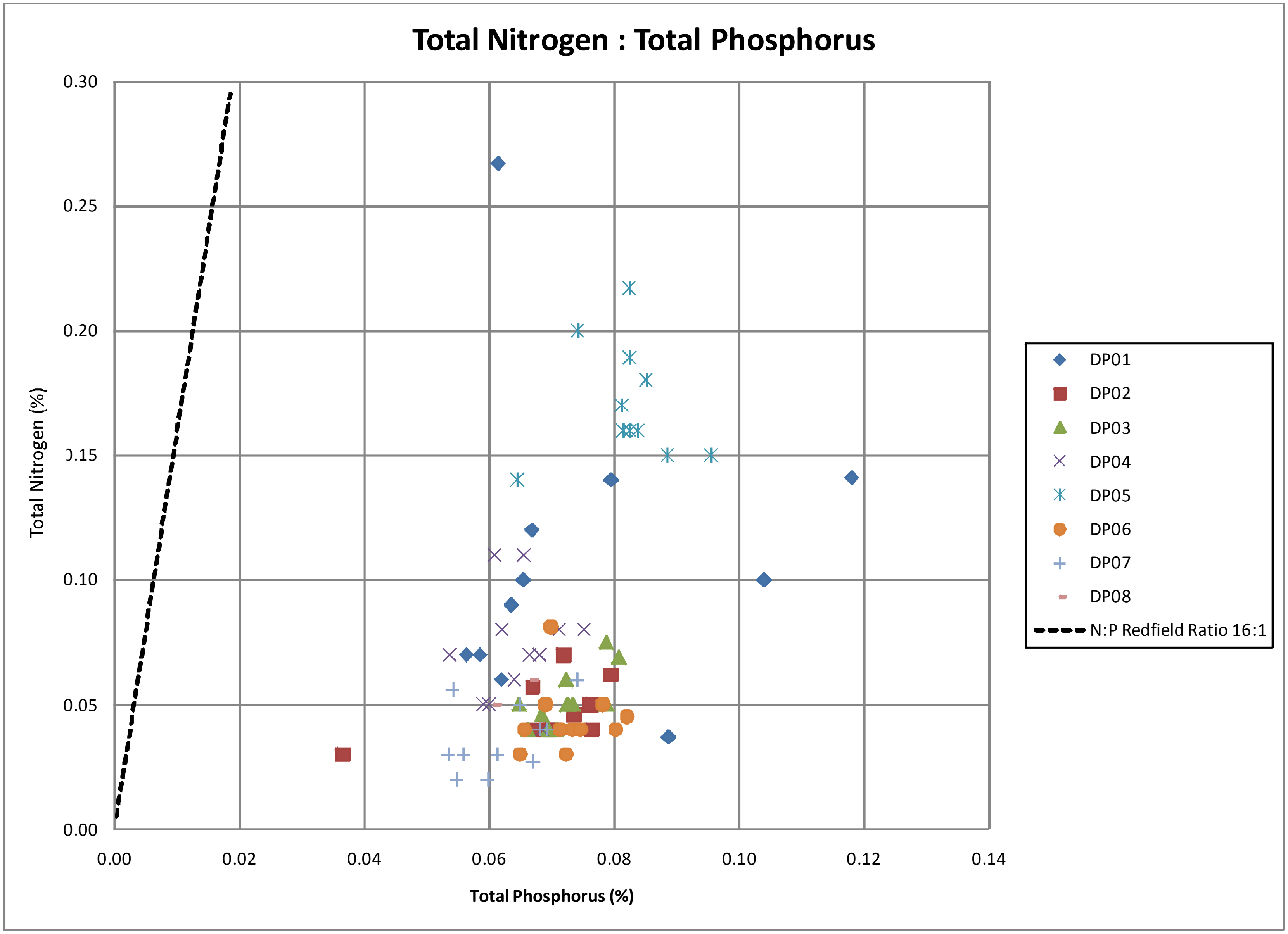
HEMMERA

CLIENT: PORT METRO vancouver

DELTAPORT THIRD BERTH - ADAPTIVE MANAGEMENT STRATEGY PROGRAM 2009 ANNUAL REPORT

TEMPORAL TRENDS OF EUTROPHICATION-RELATED PARAMETERS IN SEDIMENT

PROJECT No.		
499-002.11	September 2010	FIGURE 61



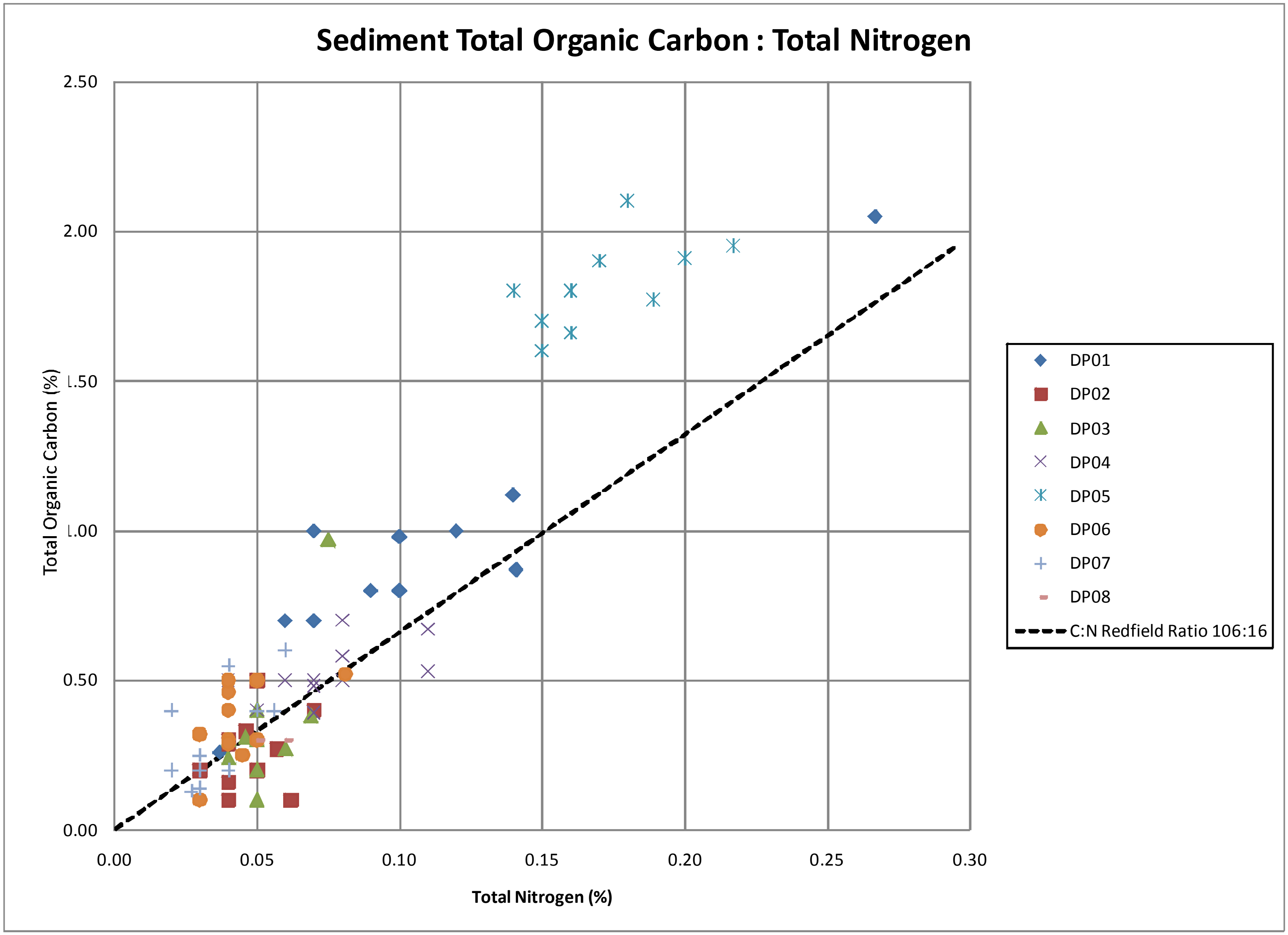
HEMMERA

CLIENT: PORT METRO vancouver

DELTAPORT THIRD BERTH - ADAPTIVE MANAGEMENT STRATEGY PROGRAM - 2009 ANNUAL REPORT

RATIO OF TOTAL NITROGEN TO TOTAL PHOSPHORUS IN SEDIMENT

PROJECT No. 499-002.11	September 2010	FIGURE 62



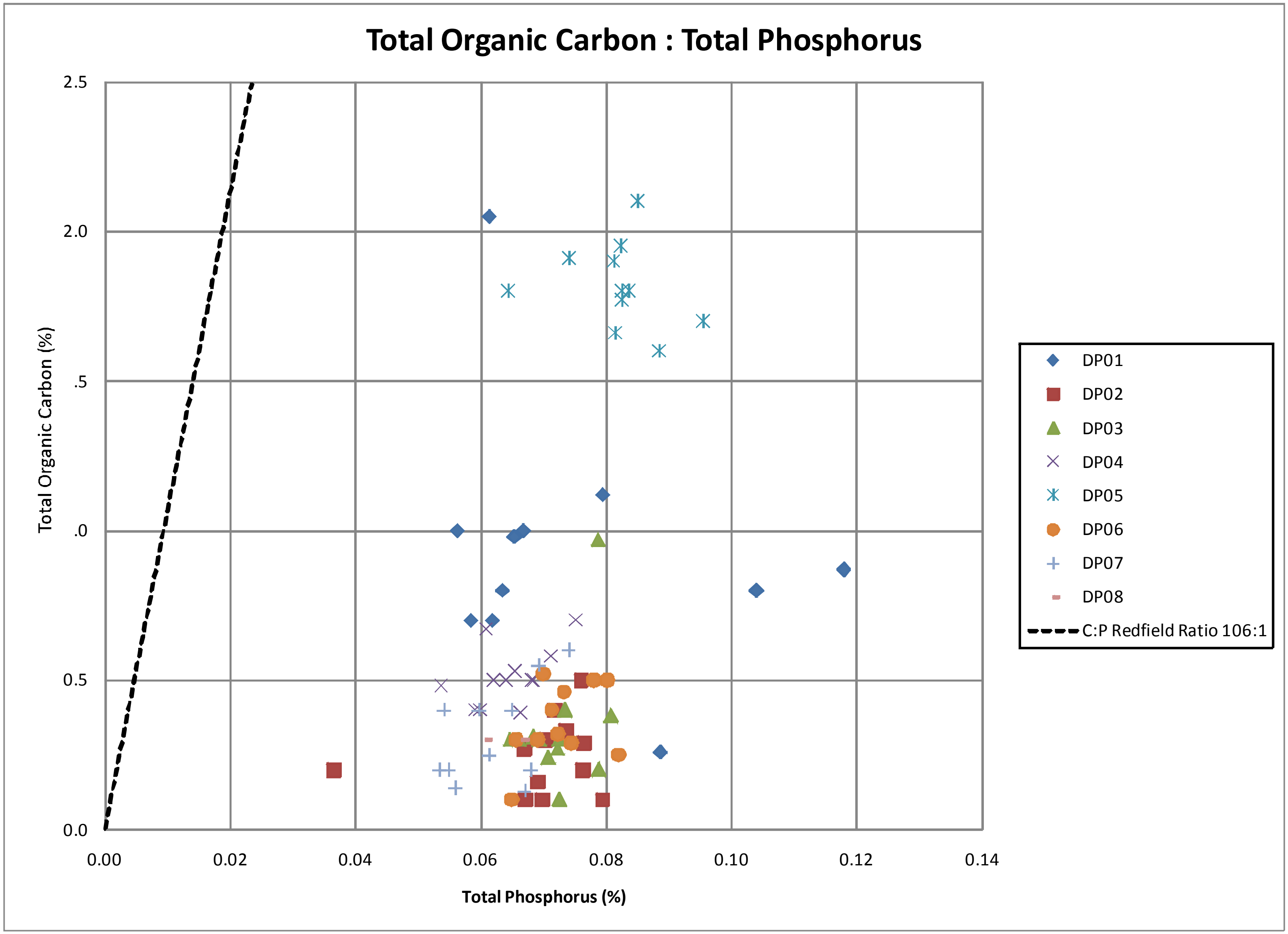
HEMMERA

CLIENT: PORT METRO vancouver

DELTAPORT THIRD BERTH - ADAPTIVE MANAGEMENT STRATEGY PROGRAM - 2009 ANNUAL REPORT

RATIO OF TOTAL ORGANIC CARBON TO TOTAL NITROGEN IN SEDIMENT

PROJECT No. 499-002.11	September 2010	FIGURE 63



HEMMERA

CLIENT: PORT METRO vancouver

DELTAPORT THIRD BERTH - ADAPTIVE MANAGEMENT STRATEGY PROGRAM - 2009 ANNUAL REPORT

RATIO OF TOTAL ORGANIC CARBON TO TOTAL PHOSPHORUS IN SEDIMENT

PROJECT No. 499-002.11	September 2010	FIGURE 64

TABLES

Table 1
Monitoring Dates

Year	Quarter	Date	Monitoring Activity
2007	1	March 22 - 24	Hemmera Sediment, Surface Water, and Benthic Invertebrate Samples
		March 24 - 25	Bird Survey
		April 7 - 12	Bird Survey
		April 20	Install DoD Rods Sediment Samples Crest Protection Monitoring - photos only
		April 23 - 24	Bird Survey
	2	May 7 - 8	Bird Survey
		May 22 - 23	Bird Survey
		June 5 - 6	Bird Survey
		June 18 - 19	Bird Survey
		June 20 - 21	Hemmera Sediment and Surface Water
		July 3 - 4	Bird Survey
		July 12 - 16	Eelgrass Survey
		July 16 - 17	Bird Survey
		July 30	DoD Rods Crest Protection Monitoring - photos & surveys Turbidity Sensor Download Aerial Photographs
	3	July 30 - 31	Bird Survey
		August 17 - 18	Bird Survey
		August 30 - 31	Bird Survey
		September 14 - 15	Bird Survey
		October 1 - 2	Hemmera Sediment and Surface Water
		October 2	DoD Rods Sediment Samples Crest Protection Monitoring - surveys only
		October 2 - 3	Bird Survey
		October 18 - 20	Bird Survey
		October 29	Remaining DoD Rods Remaining Sediment Samples Turbidity Sensor Download
	4	November 1 - 4	Bird Survey
		November 15 - 16	Bird Survey
		November 27	DoD Rods Crest Protection Monitoring - no surveys (equipment failure) Turbidity Sensor Download - Sensor 2 only
		November 29 - 30	Bird Survey
		December 10	Hemmera Sediment and Surface Water
		December 15	Bird Survey
		December 28	Bird Survey

Table 1
Monitoring Dates

Year	Quarter	Date	Monitoring Activity
2008	1	January 11	Bird Survey
		January 21	DoD Rods Crest Protection Monitoring - surveys only Turbidity Sensor Download - Sensor 2 only
		January 23	Bird Survey
		February 8	Bird Survey
		February 22 - 25	Bird Survey
		March 3-5	Hemmera Sediment, Surface Water, and Benthic Invertebrate Samples
		March 10 - 12	Bird Survey
		March 27 - 29	Bird Survey
	2	April 9	DoD Rods Installation of 6 additional DoD Rods Sediment Samples Crest Protection Monitoring - photos & surveys Turbidity Sensor Download - Sensor 2 only Install Wave Sensors
		April 10 - 11	Bird Survey
		April 24 - 25	Bird Survey
		May 8 - 9	Bird Survey
		May 22 - 23	Bird Survey
		May 29 - 30	Hemmera Sediment and Surface Water
		June 23	Bird Survey
	3	July 3	DoD Rods Installation of 2 additional DoD Rods Crest Protection Monitoring - photos & surveys Turbidity Sensor Download - Sensor 2 only Aerial Photographs Wave Sensors Download
		July 22	Bird Survey
		August 14 - 17	Eelgrass Survey
		August 19	Bird Survey
		September 20 - 21	Bird Survey
		September 23 - 24	Hemmera Sediment and Surface Water
	4	October 14	Bird Survey
		October 17	DoD Rods Sediment Samples Turbidity Sensor Download - Sensor 2 only Wave Sensors Download - #1 & #2 only
		November 20	Bird Survey
		December 10	Hemmera Sediment and Surface Water
		December 17 - 20	Bird Survey

Table 1
Monitoring Dates

Year	Quarter	Date	Monitoring Activity
2009	1	February 7	DoD Rods Wave Sensors Download - #1 & #2 only
		March 5	Crest Protection Monitoring - surveys only Install replacement Turbidity Sensor Installed Wave Sensors - #1 & #3 only
		January 26	Bird Survey
		February 19	Bird Survey
		February 23 - 24	Hemmera Sediment, Surface Water, and Benthic Invertebrate Samples
		March 26 - 27	Bird Survey
	2	April 15 - 16	Bird Survey
		April 27	DoD Rods Sediment Samples Turbidity Sensor Download - Sensor 2 only Wave Sensors Download - #1 & #2 only
		May 4 - 7	Bird Survey
		May 20	Bird Survey
		May 20	Hemmera Sediment and Surface Water
		May 20	Wave Sensors Download - #3 only
		May 26	Install replacement for Turbidity Sensor 2 (new design)
		June 12	Bird Survey
		June 23	Tidal Current Monitoring - collection of ADCP measurements
	3	July 17	Bird Survey
		July 20	DoD Rods Crest Protection Monitoring - photos & surveys Turbidity Sensor Download - Sensor 2 only Wave Sensors Download - #1 and #2 only Aerial Photographs
		August 14 - 17	Eelgrass Survey
		August 13	Bird Survey
		September 14	Bird Survey
		September 14 - 15	Hemmera Sediment and Surface Water
		September 15	Wave Sensors Download - #3 only
			Install replacement Wave Sensor #2
	4	October 8	Reprogram Wave Sensor #2
		October 17 - 18	Bird Survey
		November 3	DoD Rods Sediment Samples Turbidity Sensor Download - Sensor 2 only Wave Sensors - #1 & #2 only
		November 15	Bird Survey
		December 3	Hemmera Sediment and Surface Water
		December 13	Bird Survey

Table 2
Chronology of Adaptations to the Monitoring Programs

Activity & Sub-task	Date	Event	Description
Crest Protection Structure			
Photographs	April 19, 2007	Program Inception	Established initial photo points (CRST 01 to 14).
	July 30, 2007	Q2-2007	Establish additional photo monitoring point (CRST 15).
	July 3, 2008	Q3-2008	Last quarterly monitoring - switch to annual photos.
Surveys	July 30, 2007	Q2-2007	Establish 5 monitoring cross sections.
	July 3, 2008	Q3-2008	Last quarterly monitoring - switch to bi-annual surveys (Q1 and Q3).
Turbidity Monitoring			
Sensors	June 14, 2007	Sensor Installation	Two sensors installed in study area.
	July 12, 2007	Move Sensor	Sensor 1 moved from tide channel to new location inside Crest Protection Structure.
	July 31, 2007	Replace Sensor	Sensor 2 malfunctioning so replaced with temporary instrument.
	Oct 30, 2007	Sensor Failure	Sensor 1 malfunctioning due to water penetration, replaced with temporary instrument.
	Mar 6, 2008	Sensor Failure	Temporary instrument failed due to water penetration, replaced with original repaired Sensor 1
	April 10, 2008	Sensor Failure	Original Sensor 1 instrument failed due to water penetration. Sensor 1 removed from site permanently.
	Feb 7, 2009	Sensor Missing	Sensor installation disturbed during abnormal weather event. Turbidity Sensor 2 missing. All data back to 17 Oct, 2008 lost with instrument.
	May 26, 2009	New Sensor Installed	Replacement for Sensor 2 installed. Re-start turbidity monitoring
Tide Gauge	June 14, 2007	Gauge Installation	Installation on caisson.
	Sept 6, 2007	Gauge Damaged	Gauge damaged and repaired, loss of some data.
	Oct 29, 2007	Gauge Damaged	Instrument dangling from rope, apparently tampered with.
	April 10, 2008	Gauge Damaged	Pipe housing missing.
	April 21, 2008	Gauge Repaired	Pipe housing replaced.
	July 3, 2008	Gauge Damaged	Pipe housing missing - instrument secured temporarily
	Oct 17, 2008	Gauge Damaged	Removed from site permanently. Rely on CHS gauge data.
Water Samples	May 17, 2007	Data Collection	Collection of water samples. Turbidity of samples very low.
	Nov 5, 2007	TSS Memo	NHC memo outlining methodology for relating turbidty to total suspended solids. Suspend collection of water samples.
Monitoring of Erosion and Deposition			
DoD Rods	April 19, 2007	Installation	Twenty-six rods installed.
	April 9, 2008	Installation	Additional six rods installed in area of new drainage channels
	July 3, 2008	Installation	Additional 2 rods installed in pond feature.
Sediment Samples			
Sediment Sampling	April 19, 2007	Program Inception	Samples collected at each DoD rod location on a bi-annual basis.
Orthophotographic Interpretation			
Aerial Photos	July 14, 2007	Photos	Aerial photos of the study area flown.
	July 2, 2008	Photos	Aerial photos of the study area flown.
	July 24, 2009	Photos	Aerial photos of the study area flown.
Coastal Geomorphology Mapping			
Bathymetric & Topographic Surveys	July 8, 2007	Surveys	Combined bathymetric and topographic surveys.
	July 13, 2007	Surveys	Topographic surveys, bathymetric surveys suspended due to rough seas.
	Nov 7, 2007	Surveys	Bathymetric surveys completed.
Wave and Current Monitoring			
AWAC (work by ASL)	Feb 20, 2007	AWAC Deployed	
	April 20, 2007	AWAC Recovered	Found to have been dragged several hundred metres, pressure sensors not functioning.
	June 6, 2007	AWAC Re-Deployed	
	Sept 27, 2007	AWAC Damaged	Burial by temporary sediment placement. Recovered but damaged beyond repair.
NHC Wave Sensors	Jan 30, 2008	NHC Memo	Alternative strategy for current and wave monitoring
	April 10, 2008	Wave Sensors Installed	
	May 4, 2008	Sensor #3 Dragged	NHC contacted by Vancouver Pile and Dredge on June 19, instrument was dragged by tug boat operator.
	June 23, 2008	Sensor #3 Re-Deployed	
	Sept, 2008	Sensor #3 Removed	Sensor removed by DP3 construction worker to facilitate construction activity.
	Feb 7, 2009	Sensor #1 and #2 Dragged	Sensor #1 found to have been dragged approximately 200 metres. Sensor #2 found about 10-20 metres from original location.
	Mar 5, 2009	Sensor #3 Re-Deployment	
	April 27, 2009	Sensor #1 Removed	Sensor removed and sent to supplier for re-calibration after dragging episode.
	May 26, 2009	Sensor #1 Re-Deployed	
	July 20, 2009	Sensor #2 Removed	Sensor failed due to water penetration.
	Sep 15, 2009	New Sensor #2 Installed	
	Jan 28, 2010	Sensor #3 Missing	Instrument and data from Sep to Dec 2009 lost.
ADCP Tidal Current Measurements	June 23, 2009	Data Collection	ADCP measurments of tidal currents to verify results of NHC numerical modelling.
Sediment, Surface Water, and Benthic Invertebrate Sampling			
	June 20, 2007	Q2-2007	PAH and TBT dropped from sediment analytical program
			Dissolved iron added to surface water analytical program
	Dec 10, 2007	Q4-2007	Rush sulphide analysis implemented
	Mar 3, 2008	Q1-2008	Additional sampling station (DP08) added for benthic invertebrate sampling events
	Feb 23, 2009	Q1-2009	Additional sampling station (DP09) added for benthic invertebrate sampling events
Bird Surveys			
Surveys	June 23, 2008	Q2-2008	Survey frequency reduced to monthly
			Distance categories changed to larger categories
			TFN transect discontinued
			Point count stations on TFN merged
	Nov 20, 2008	Q4-2008	Implementation of windshield surveys for focal species (great blue heron and brant)
Eelgrass Surveys			
Distribution Mapping Field Survey	Sept 7-8, 2007	Surveys	Annual survey to ground-truth orthophoto interpretation
	Aug 14-17, 2008	Surveys	Annual survey to ground-truth orthophoto interpretation
	Sept. 14-16, 2009	Surveys	Annual survey to ground-truth orthophoto interpretation
Eelgrass Health & Vigour	July 12-16, 2007	Surveys	Annual monitoring at nine reference stations
	July 29-Aug 1, 2008	Surveys	Annual monitoring at nine reference stations
	July 19-23, 2009	Surveys	Annual monitoring at ten reference stations
SIMS Survey	August 25, 2009	Surveys	Triennial towed video survey to determine the lower limit of eelgrass distribution in the inter-causeway

Table 3
Rationale for Adaptations to the Adaptive Management Strategy

Change	Reason for Change	Reference
Dissolved iron analysis added for surface water	To determine if total iron exceedances were linked to particulate matter	Sec 2.2.2 (Q1-2007)
TBT not analyzed in sediment	No TBT source associated with DP3 construction, none detected in Q1-2007	Sec 1.3.1 (Q2-2007)
PAHs not analyzed in surface water	No PAH source associated with DP3 construction, none detected in Q1-2007	Sec 1.3.2 (Q2-2007)
Rush (24-hour) sulphide analysis implemented	To minimize sulphide volatilization	
Station DP08 added	To provided better spatial coverage in the inter-causeway area	Sec. 4.2 (2008 Annual report)
Station DP09 added	To evaluate the impact of new drainage channels in the inter-causeway area	Sec. 4.5 (2008 Annual report)
Addition of 8 new DoD rods	To provide greater resolution in area of new drainage channels & pond	Sec 4.1.1 (2007 Annual Report)
Removal of Turbidity Sensor 1	Turbidity levels not very high; harsh operating conditions; expensive repairs; redundancy with Turbidity Sensor 2	Sec 4.1.3 (2007 Annual Report)
Modifications to bird survey methodology	To increase the efficiency of data collection	Sec 4.6 (2007 Annual Report)
Reduction in Crest Protection surveys	Reduction to twice a year because measured very little change.	Sec 4.1.2 (2007 Annual Report)
Windshield surveys for Brant and Heron	To obtain a more accurate assessment of brant and heron numbers after reduction in point count stations at TFN and Tsawwassed Ferry transects	Sec 4.6 (2007 Annual Report)
Addition of 3 wave sensors	To replace destroyed AWAC and monitor wave height and wave period	NHC memo to VFPA of Jan 30, 2008
DP08 station added to benthic invertebrate sampling program	To provide better spatial coverage in the inter-causeway area	Sec 1.3.5 (Q1-2008)
Removal of Tide Gauge	Harsh operating conditions; developed relation between Point Atkinson station and local tide gauge	Sec 1.3.1.2 (Q3-2008)
Addition of an eelgrass reference station	Habitat changes at one of the established sites	Sec. 4.4 (2008 Annual report)

Table 4
Crest Protection Monitoring Station Coordinates

Monitor Point	Northing	Easting	Elevation (m CD)
CRST-01	5430224.0	489096.7	0.899
CRST-02	5430234.8	489095.9	1.759
CRST-03	5430294.1	489130.4	1.884
CRST-04	5430338.8	489161.0	0.970
CRST-05	5430370.9	489189.9	0.540
CRST-06	5430388.6	489200.6	0.596
CRST-07	5430431.4	489229.2	0.447
CRST-08	5430471.2	489252.1	1.070
CRST-09	5430475.4	489308.0	0.564
CRST-10	5430482.1	489364.8	0.663
CRST-11	5430440.7	489434.0	1.050
CRST-12	5430410.8	489489.7	1.116
CRST-13	5430256.7	489629.8	1.229
CRST-14	5430131.6	489656.9	1.250
CRST-15	5429940.9	489678.3	1.033

Table 5
Surveys Conducted for Waterfowl and Coastal Seabirds, 2009

Year	Month	Day	Event #
2009	January	26	38
	February	19	39
	March	26	40
		27	
	April	15	41
		16	
	May	4	42
		7	
		20	43
	June	12	44
	July	17	45
	August	13	46
	September	14	47
	October	17	48
		18	
	November	15	49
	December	13	50

Table 6
Summary of Wind Speed and Direction January to March, 2009

Wind Speed (km/h)	N	NE	E	SE	S	SW	W	NW
0-5	36	12	37	20	9	16	19	30
5-10	72	42	210	79	34	23	74	95
10-15	6	27	228	45	22	20	59	67
15-20	4	25	162	31	22	11	37	50
20-25	2	8	59	13	16	5	17	11
25-30		3	23	11	18	1	25	22
30-35			6	2	5	2	15	10
35-40				2	2	2	3	4
40-45							10	3
45-50				1	1	1	6	1
50-55							3	1
55-60					1		4	2
60-65								
65-70								
Total	120	117	725	204	130	81	272	296

Note:
Total records = 1945 h
Total time winds calm = 215 h
Total observations = 2160 h

Hourly Wind Speed and Direction Recorded at Vancouver International Airport-January to March, 2009

Table 7
Summary of Wind Speed and Direction April to June, 2009

Wind Speed (km/h)	N	NE	E	SE	S	SW	W	NW
0-5	22	6	20	14	17	11	14	7
5-10	43	22	100	69	59	42	79	53
10-15	8	11	224	121	52	61	127	78
15-20		1	116	93	37	47	63	71
20-25		2	31	27	11	7	29	50
25-30			18	12	13	10	42	50
30-35			4	9	1	5	16	20
35-40							4	6
40-45			1				5	5
45-50							2	1
50-55							3	1
55-60							1	
60-65								
65-70								
Total	73	42	514	345	190	183	385	342

Note:
Total records = 2074 h
Total time winds calm = 107 h
Total observations = 2181 h

Hourly Wind Speed and Direction Recorded at Vancouver International Airport-April to June, 2009

Table 8
Summary of Wind Speed and Direction July to September, 2009

Wind Speed (km/h)	N	NE	E	SE	S	SW	W	NW
0-5	2		32	15	4	21	16	28
5-10	19	19	170	86	35	74	86	117
10-15	36	7	208	157	51	60	87	101
15-20	42	3	85	88	37	24	53	53
20-25	23	1	19	17	14	3	20	19
25-30	24		18	2	7		17	18
30-35	9		5	1	1		5	10
35-40	5		2				1	3
40-45								2
45-50								3
50-55								1
55-60								
60-65								
65-70								
Total	160	30	539	366	149	182	285	355

Note:
Total records = 2066 h
Total time winds calm = 140 h
Total observations = 2206 h

Hourly Wind Speed and Direction Recorded at Vancouver International Airport-July to September, 2009

Table 9
Summary of Wind Speed and Direction October to December, 2009

Wind Speed (km/h)	N	NE	E	SE	S	SW	W	NW
0-5	29	14	63	19	17	5	15	17
5-10	38	40	305	79	35	16	38	45
10-15	9	23	288	52	24	8	30	58
15-20	2	20	182	47	34	4	14	34
20-25		5	61	25	17	6	11	22
25-30		2	43	20	19	3	17	20
30-35			14	18	8	2	6	10
35-40			5	15	7		5	4
40-45			1	7	4		15	2
45-50				1	2		6	2
50-55								
55-60				2				
60-65							1	
65-70								
Total	78	104	962	285	167	44	158	214

Note:
Total records = 2012 h
Total time winds calm = 196 h
Total observations = 2208 h

Hourly Wind Speed and Direction Recorded at Vancouver International Airport-October to December, 2009

Table 10
Storm Events During 2009 Monitoring Period

Start Date	Start time	End Date	End time	Time at	Water Level at Start	Water Level at End	Water Level at Max	Wind Speed		Probability of Exceedence	Wind Direction		Hs	Tp
								Maximum	Average		at Max	Average	m	sec
	(LST)		(LST)	Max Speed	m	m	m	km/h	km/h	(%)	10's deg	10's deg		
1/2/2009	5:00	1/2/2009	8:00	6:00	2.704	4.553	3.386	39	34.8	1.67%	NW	NW	1.94	5.90
1/8/2009	11:00	1/8/2009	20:00	13:00	4.455	0.637	4.700	52	40.4	0.24%	W	W	1.47	4.78
2/9/2009	2:00	2/9/2009	6:00	3:00	2.342	4.816	3.288	41	32.8	1.18%	W	W	1.08	4.27
3/2/2009	2:00	3/2/2009	8:00	6:00	3.126	4.714	4.217	39	31.1	1.67%	SE	SE	1.13	4.34
3/4/2009	23:00	3/5/2009	7:00	2:00	3.976	4.011	4.525	54	39.9	0.18%	W	W	2.25	6.38
3/7/2009	5:00	3/7/2009	10:00	7:00	4.430	3.590	3.896	52	40.3	0.24%	NW	W	2.87	7.03
3/15/2009	19:00	3/16/2009	2:00	20:00	3.774	3.511	3.499	56	40.3	0.13%	S	S	1.39	4.71
3/20/2009	15:00	3/20/2009	17:00	16:00	2.844	2.161	2.512	39	36.3	1.67%	SW	SW	0.81	3.54
3/25/2009	7:00	3/25/2009	17:00	11:00	3.813	3.907	2.093	41	36.2	1.18%	NW	NW	2.48	6.68
3/31/2009	8:00	3/31/2009	22:00	13:00	4.236	4.190	1.287	59	47.9	0.09%	W	W	3.00	6.93
4/2/2009	21:00	4/3/2009	3:00	22:00	2.886	4.033	3.499	52	43.9	0.24%	NW	NW	2.93	7.20
4/21/2009	23:00	4/22/2009	11:00	1:00	2.680	1.850	3.606	56	43.9	0.13%	W	W	1.94	5.42
4/25/2009	2:00	4/25/2009	5:00	4:00	3.662	4.265	4.296	54	44.0	0.18%	W	W	1.68	5.43
4/27/2009	10:00	4/27/2009	14:00	11:00	1.743	0.584	0.983	37	33.6	2.40%	NW	W	1.80	5.69
5/4/2009	17:00	5/4/2009	23:00	19:00	3.094	3.516	2.493	43	32.4	0.93%	E	E	1.05	4.18
6/25/2009	19:00	6/26/2009	7:00	2:00	4.353	3.959	3.065	41	32.8	1.18%	NW	NW	2.16	6.26
6/29/2009	21:00	6/30/2009	13:00	1:00	4.035	3.349	3.953	37	31.9	2.40%	NW	NW	2.10	6.18
7/1/2009	5:00	7/1/2009	17:00	14:00	1.867	3.372	3.562	39	34.7	1.67%	NW	NW	2.25	6.38
7/12/2009	13:00	7/12/2009	22:00	16:00	1.864	4.416	2.238	39	30.9	1.67%	SE	SE	1.04	4.26
9/6/2009	7:00	9/6/2009	15:00	15:00	4.095	3.139	3.139	37	31.2	2.40%	SE	SE	1.00	4.15
9/19/2009	22:00	9/20/2009	4:00	3:00	2.249	3.321	2.615	37	33.3	2.40%	W	W	1.44	5.06
9/26/2009	9:00	9/26/2009	19:00	17:00	2.917	3.306	3.412	52	40.8	0.24%	W	W	1.83	5.63
10/23/2009	18:00	10/24/2009	1:00	21:00	3.798	1.702	3.524	63	43.3	0.05%	W	W	1.74	5.52
10/26/2009	11:00	10/27/2009	4:00	21:00	4.252	2.188	3.078	48	39.3	0.46%	W	W	2.07	6.08
11/5/2009	7:00	11/5/2009	19:00	13:00	4.754	4.453	3.833	46	35.2	0.61%	S	SE	1.31	4.53
11/13/2009	2:00	11/13/2009	19:00	17:00	3.773	2.117	3.595	50	37.1	0.30%	NW	SW	2.90	7.17
11/15/2009	12:00	11/16/2009	8:00	4:00	3.636	4.580	4.388	44	35.7	0.81%	SE	SE	1.40	4.77
11/16/2009	21:00	11/17/2009	3:00	23:00	1.684	3.358	0.888	41	35.3	1.18%	S	S	1.21	4.47
11/18/2009	10:00	11/19/2009	3:00	19:00	4.285	2.326	3.848	57	38.6	0.12%	SE	SE	1.93	5.43
11/19/2009	15:00	11/20/2009	0:00	22:00	3.918	1.598	2.591	41	33.5	1.18%	SE	SE	1.22	4.46
11/21/2009	18:00	11/21/2009	22:00	20:00	3.743	3.128	3.725	35	32.8	3.14%	E	E	0.40	2.31
11/30/2009	8:00	11/30/2009	16:00	15:00	3.880	4.097	4.393	44	40.0	0.81%	W	W	1.41	4.75

Note 1: Water level data taken from Station #7795 (Point Atkinson) which has shown good correlation with local tide gauge in the past
Note 2: Wind data from Vancouver International Airport
Note 3: Wave hindcasting made at seaward end of Roberts Bank Causeway
Note 4: Annual probability of exceedence for maximum hourly wind speed based on analysis of 1953 to 2006 hourly wind data from Vancouver International Airport

Table 11
Bed Elevation Changes at DoD Rods in Q1-2009

Site #	Height Above Ground	Height Above Washer	Reset: Height Above Ground/ Washer	Previous Quarter Reset Height	Deposition	Erosion	Net Change
	(cm)	(cm)	(cm)	(cm)	(cm)	(cm)	(cm)
A03	68.6	69.2	68.8	68.5	0.6	0.7	-0.1
A04	45.0	45.0	45.0	44.5	0.0	0.5	-0.5
A05	46.5	46.6	46.5	46.0	0.1	0.6	-0.5
A06	41.3	41.3	41.3	40.6	0.0	0.7	-0.7
B02	51.6	57.9	48.9	50.1	6.3	7.8	-1.5
B03	47.2	49.5	47.6	46.5	2.3	3.0	-0.7
B04	25.4	25.5	25.2	25.1	0.1	0.4	-0.3
B05	45.3	45.9	45.3	44.6	0.6	1.3	-0.7
B06	33.3	33.3	33.3	33.2	0.0	0.1	-0.1
C01	47.4	51.1	45.8	43.9	3.7	7.2	-3.5
C02	45.3	46.4	45.6	44.8	1.1	1.6	-0.5
C03	35.0	35.0	35.0	34.0	0.0	1.0	-1.0
C04	46.9	46.9	46.9	46.1	0.0	0.8	-0.8
C05	70.3	70.3	70.3	70.7	0.0	0.0	0.0
C06	37.5	38.6	37.5	36.5	1.1	2.1	-1.0
D01	54.0	62.5	54.2	52.8	8.5	9.7	-1.2
D02	45.1	45.7	45.2	44.9	0.6	0.8	-0.2
D03	57.3	57.3	57.3	56.5	0.0	0.8	-0.8
D04	44.6	47.4	42.1	41.9	2.8	5.5	-2.7
D05	44.8	47.8	44.3	43.8	3.0	4.0	-1.0
D06	38.2	39.6	38.3	37.3	1.4	2.3	-0.9
E01	38.9	38.9	38.9	38.7	0.0	0.2	-0.2
E02	33.5	35.5	33.3	35.2	2.0	0.3	1.7
E06							
F06	27.5	33.6	24.7				
G06	65.6	68.1	53.3	62.5	2.5	5.6	-3.1
Z01	68.9	78.0	67.8	69.1	9.1	8.9	0.2
Z02	90.1	96.7	89.6	91.0	6.6	5.7	0.9
Z03	38.9	47.7	39.2	58.5			
Z04	9.4	18.0	8.0	56.2			
Z05	87.2	92.7	86.8	87.2	5.5	5.5	0.0
Z06	55.3	58.3	55.2	56.5	3.0	1.8	1.2
Z07	59.9	60.7	58.7	57.9	0.8	2.8	-2.0
Z08	21.7	21.7	21.7	46.7			

Note: Negative erosion values have been replaced by zeros as they represent minor measurement errors.

Table 12
Bed Elevation Changes at DoD Rods in Q2-2009

Site #	Height Above Ground	Height Above Washer	Reset: Height Above Ground/ Washer	Previous Quarter Reset Height	Deposition	Erosion	Net Change
	(cm)	(cm)	(cm)	(cm)	(cm)	(cm)	(cm)
A03	68.5	69.2	68.0	68.8	0.7	0.4	0.3
A04	45.0	45.2	44.5	45.0	0.2	0.2	0.0
A05	46.0	46.8	46.6	46.5	0.8	0.3	0.5
A06	41.2	41.9	41.7	41.3	0.7	0.6	0.1
B02	49.3	49.8	48.7	48.9	0.5	0.9	-0.4
B03	48.0	48.2	47.8	47.6	0.2	0.6	-0.4
B04	25.3	25.3	25.0	25.2	0.0	0.1	-0.1
B05	45.4	46.4	46.0	45.3	1.0	1.1	-0.1
B06	33.0	34.4	31.7	33.3	1.4	1.1	0.3
C01	45.8	46.8	45.3	45.8	1.0	1.0	0.0
C02	43.7	45.8	44.3	45.6	2.1	0.2	1.9
C03	33.7	35.4	32.7	35.0	1.7	0.4	1.3
C04	46.2	47.7	46.5	46.9	1.5	0.8	0.7
C05	69.8	72.1	69.6	70.3	2.3	1.8	0.5
C06	37.1	41.0	38.5	37.5	3.9	3.5	0.4
D01	54.6	55.2	54.1	54.2	0.6	1.0	-0.4
D02	43.3	45.2	42.9	45.2	1.9	0.0	1.9
D03	57.4	57.4	57.4	57.3	0.0	0.1	-0.1
D04	44.0	47.5	39.9	42.1	3.5	5.4	-1.9
D05	45.8	47.9	44.5	44.3	2.1	3.6	-1.5
D06	37.7	38.5	37.6	38.3	0.8	0.2	0.6
E01	39.2	39.6	38.9	38.9	0.4	0.7	-0.3
E02	32.7	34.9	33.2	33.3	2.2	1.6	0.6
E06	n/a	n/a	51.0	n/a			
F06	25.5	33.9	54.6	24.7	8.4	9.2	-0.8
G06	57.5	62.7	55.2	53.3	5.2	9.4	-4.2
Z01	66.8	69.4	65.5	67.8	2.6	1.6	1.0
Z02	88.1	91.9	88.1	89.6	3.8	2.3	1.5
Z03	38.0	40.7	37.5	39.2	2.7	1.5	1.2
Z04	7.6	9.0	8.5	8.0	1.4	1.0	0.4
Z05	87.0	87.9	85.9	86.8	0.9	1.1	-0.2
Z06	54.9	57.2	53.5	55.2	2.3	2.0	0.3
Z07	58.1	58.9	58.1	58.7	0.8	0.2	0.6
Z08	21.1	22.7	22.0	21.7	1.6	1.0	0.6

Note: Negative erosion values have been replaced by zeros as they represent minor measurement errors.

Table 13
Bed Elevation Changes at DoD Rods in Q3-2009

Site #	Height Above Ground	Height Above Washer	Reset: Height Above Ground/ Washer	Previous Quarter Reset Height	Deposition	Erosion	Net Change
	(cm)	(cm)	(cm)	(cm)	(cm)	(cm)	(cm)
A03	66.7	68.2	67.0	68.0	1.5	0.2	1.3
A04	43.4	45.1	44.2	44.5	1.7	0.6	1.1
A05	44.3	46.9	46.5	46.6	2.6	0.3	2.3
A06	40.4	42.6	41.6	41.7	2.2	0.9	1.3
B02	49.5	50.1	49.7	48.7	0.6	1.4	-0.8
B03	45.5	48.2	46.0	47.8	2.7	0.4	2.3
B04	25.2	25.2	25.2	25.0	0.0	0.2	-0.2
B05	43.0	46.1	44.5	46.0	3.1	0.1	3.0
B06	33.0	34.4	33.2	31.7	1.4	2.7	-1.3
C01	45.5	46.5	45.8	45.3	1.0	1.2	-0.2
C02	44.1	45.5	43.2	44.3	1.4	1.2	0.2
C03				32.7			
C04	46.3	47.5	46.4	46.5	1.2	1.0	0.2
C05	69.2	75.7	70.3	69.6	6.5	6.1	0.4
C06	37.2	41.7	38.0	38.5	4.5	3.2	1.3
D01	54.0	55.3	52.7	54.1	1.3	1.2	0.1
D02	43.0	44.5	42.8	42.9	1.5	1.6	-0.1
D03	57.2	57.2	57.2	57.4	0.0	0.0	0.0
D04	45.6	47.7	41.5	39.9	2.1	7.8	-5.7
D05	45.0	48.4	43.2	44.5	3.4	3.9	-0.5
D06	38.0	42.5	38.0	37.6	4.5	4.9	-0.4
E01	37.4	40.5	37.5	38.9	3.1	1.6	1.5
E02	35.5	33.9	33.0	33.2			-2.3
E06	52.3	52.3	52.3	51.0	0.0	1.3	-1.3
F06	58.5	60.8	53.6	54.6	2.3	6.2	-3.9
G06	58.2	65.5	57.8	55.2	7.3	10.3	-3.0
Z01	65.8	66.2	66.1	65.5	0.4	0.7	-0.3
Z02	86.0	88.6	88.5	88.1	2.6	0.5	2.1
Z03	35.7	38.0	35.6	37.5	2.3	0.5	1.8
Z04	7.9	8.5	40.4	8.5	0.6	0.0	0.6
Z05	87.4	88.4	87.7	85.9	1.0	2.5	-1.5
Z06	54.0	56.3	54.5	53.5	2.3	2.8	-0.5
Z07	57.6	58.3	58.2	58.1	0.7	0.2	0.5
Z08	21.4	22.0	21.0	22.0	0.6	0.0	0.6

Note: Negative erosion values have been replaced by zeros as they represent minor measurement errors.

Table 14
Bed Elevation Changes at DoD Rods in Q4-2009

Site #	Height Above Ground	Height Above Washer	Reset: Height Above Ground/ Washer	Previous Quarter Reset Height	Deposition	Erosion	Net Change
	(cm)	(cm)	(cm)	(cm)	(cm)	(cm)	(cm)
A03	65.9	67.8	67.5	67.0	1.9	0.8	1.1
A04	44.5	45.6	44.5	44.2	1.1	1.4	-0.3
A05	45.1	47.0	46.0	46.5	1.9	0.5	1.4
A06	41.2	43.0	42.3	41.6	1.8	1.4	0.4
B02	49.8	49.9	49.5	49.7	0.1	0.2	-0.1
B03	46.5	47.8	47.7	46.0	1.3	1.8	-0.5
B04	24.7	26.4	25.7	25.2	1.7	1.2	0.5
B05	43.4	46.2	45.0	44.5	2.8	1.7	1.1
B06	31.4	34.3	33.5	33.2	2.9	1.1	1.8
C01	46.0	47.9	46.1	45.8	1.9	2.1	-0.2
C02	44.5	45.0	44.8	43.2	0.5	1.8	-1.3
C03	33.8	34.2	34.0				
C04	47.0	47.7	46.2	46.4	0.7	1.3	-0.6
C05	70.8	72.8	71.8	70.3	2.0	2.5	-0.5
C06	37.6	41.5	38.4	38.0	3.9	3.5	0.4
D01	54.5	54.5	54.5	52.7	0.0	1.8	-1.8
D02	41.6	43.7	43.0	42.8	2.1	0.9	1.2
D03	57.0	57.0	58.0	57.2	0.0	0.0	0.0
D04	44.0	47.8	42.4	41.5	3.8	6.3	-2.5
D05	43.8	44.8	43.4	43.2	1.0	1.6	-0.6
D06	38.7	42.7	39.5	38.0	4.0	4.7	-0.7
E01	38.8	39.0	38.9	37.5	0.2	1.5	-1.3
E02	35.0	35.2	34.8	33.0	0.2	2.2	-2.0
E06	53.5	55.3	53.0	52.3	1.8	3.0	-1.2
F06	62.9	65.0	62.3	53.6	2.1	11.4	-9.3
G06	62.3	63.9	58.3	57.8	1.6	6.1	-4.5
Z01	66.5	66.7	66.5	66.1	0.2	0.6	-0.4
Z02	88.3	88.3	88.8	88.5	0.0	0.0	0.0
Z03	37.3	37.4	37.0	35.6	0.1	1.8	-1.7
Z04	41.5	41.5	41.5	40.4	0.0	1.1	-1.1
Z05	87.0	88.4	86.8	87.7	1.4	0.7	0.7
Z06	55.6	57.5	55.9	54.5	1.9	3.0	-1.1
Z07	58.4	58.7	58.3	58.2	0.3	0.5	-0.2
Z08	21.5	22.8	22.4	21.0	1.3	1.8	-0.5

Note: Negative erosion values have been replaced by zeros as they represent minor measurement errors.

Table 15
Total Organic Carbon Content (Percent by Weight) of Sediment Samples Collected in April and November 2009

Site #	April (%)	November (%)
A03	1.2	0.4
A04	0.6	0.7
A05	0.5	0.3
A06	0.4	0.4
B02	0.4	0.5
B03	0.7	0.8
B04	0.5	0.4
B05	0.3	0.2
B06	0.4	0.4
C01	0.2	0.6
C02	0.4	0.2
C03	0.3	0.6
C04	0.4	0.4
C05	0.2	0.4
C06	0.5	0.2
D01	0.2	0.4
D02	1.1	0.6
D03	0.1	0.7
D04	0.2	0.2
D05	0.3	0.1
D06	0.4	0.4
E01	0.7	0.2
E02	0.5	0.2
E06	0.3	0.3
F06	0.2	0.2
G06	0.2	0.2

Table 16
Silt Content (Percent by Weight) of Sediment Samples Collected in April and November 2009

Site #	April (%)	November (%)
A03	39	28
A04	18	16
A05	15	10
A06	17	11
B02	17	26
B03	29	29
B04	19	12
B05	11	10
B06	17	9
C01	10	14
C02	24	8
C03	16	13
C04	14	7
C05	11	7
C06	16	10
D01	14	13
D02	52	16
D03	11	10
D04	4	3
D05	7	3
D06	9	7
E01	40	34
E02	25	22
E06	8	5
F06	5	4
G06	5	3

Table 17
Summary of Quality Assurance/Quality Control Issues

Surface Water	
Q1 2009	The RDL for vanadium was above the WQG. The elevated RDL for vanadium was due to the dilution required to avoid sodium interference.
Q2 2009	Zinc had a RPD in excess of the DQO. Not considered to be indicative of low precision. Likely due to variability associated with suspended particulate matter.
Q3 2009	TSS, turbidity, copper, and zinc had RPDs in excess of the DQO. Not considered to be indicative of low precision. Likely due to variability associated with suspended particulate matter.
Q4 2009	TSS, copper, and zinc had RPDs in excess of the DQO. Not considered to be indicative of low precision. Likely due to variability associated with suspended particulate matter.

Sediment	
Q1 2009	Sulphide had an RPD in excess of the DQO. The sampling methodology and laboratory handling procedure was revised to minimize loss via volatilization in Q4 2007. In 2008, sulphide samples were collected directly from the ponar without homogenization.
Q2 2009	Sulphide had an RPD in excess of the DQO.
Q3 2009	Sulphide had an RPD in excess of the DQO.
Q4 2009	All of the sediment parameters met the DQO.

Table 18
2009 Surface Water Chemistry Results

		Location ID:	DP01	DP01	DP01	DP01	DP01	DP01	DP01	DP01	DP01	DP01	DP01	DP01	DP02	DP02	DP02	DP02	DP02
		Sample ID:	SWDP01-1	SWDP01-2	SWDP01-3	SWDP01-4	SWDP01-5	SWDP01-6	SWDP01-7	SWDP01-8	SWDP01-9	SWDP01-10	SWDP01-11	SWDP01-12	SWDP02-1	SWDP02-2	SWDP02-3	SWDP02-4	SWDP02-5
		Date Sampled:	2007-03-22	2007-06-20	2007-10-02	2007-12-10	2008-03-05	2008-05-30	2008-09-21	2008-11-27	2009-02-23	2009-05-20	2009-09-14	2009-12-03	2007-03-22	2007-06-21	2007-10-02	2007-12-10	2008-03-03
Parameter	**BCWQG MAL [3,4]**	**CCME MAL [5,6]**																	
Field Tests																			
Field Conductivity (uS/cm)	-	-	6696	33300	31208	23489	38716		42835	24952	26011	9123	13321	31580	32960	36600	31678	44274	40843
Field Dissolved Oxygen (mg/L)	-	-	11.26	9.21	9.48	16.67	10.56	6.14	9.92	9.7	10.63	8.42	5.64	10.69	10.99		9.18	13.01	9.87
Field pH	-	-	7.31	7.38		7.79	7.96	8.16	7.94	7.49	7.62	7.59	6.4	7.5	7.89	8.38		7.67	8.06
Field Redox, Uncorrected (mV)	-	-	121.3	136.2	207	199	-16.6	82.1	-83	-292	-296.2	70.8	278	135.7	248.7	231	214	274	-25.6
Field Eh, Corrected (mV)			321.3	336.2	407.0	399.0	183.4	282.1	117.0	-92.0	-96.2	270.8	478.0	335.7	448.7	431.0	414.0	474.0	174.4
Field Temperature (ºC)	-	-	7.93	22.8	12.4	2.73	8.14	14.8	14.8	4.4	7.58	17.73	16.95	5.48	6.94	16.1	11.4	4.95	7.31
Field Turbidity (NTU)	-	-	46.16	220						9.4		12	3	0.87		1.7		1.79	1.62
Physical Tests																			
Hardness, Total (CaCO3) (mg/L)	-	-	651	974	4740		3990	1460	5280	4500	4340	1160	1530	3330	3550	4060	4850		4620
Total Suspended Solids (mg/L)	-	-	22.0	27.2	43.7	21.5	22.2	35.9	20.7	14.4		24.5	11.0	23.8	12.0	28.0	21.7	8.8	13.0
Dissolved Inorganics																			
Phosphate (mg/L)	-	-	0.147	0.485	0.0569	0.0276	0.0387	0.215	0.0562	0.0643	0.0605	0.0222	0.0696	0.0415	0.0457	0.0579	0.0515	0.0707	<0.002
Inorganics																			
Ammonia (mg/L)	-	-	0.480	0.391	0.066	0.419	0.267	0.293	0.0331	0.287	0.122	0.613	0.492	0.221	0.048	0.058	0.039	0.046	0.0471
Chloride (mg/L)	-	-	1900								-	-	-	-	-	-	-	-	-
Nitrate (mg/L)	-	16.0	0.595	1.990	0.5	6.900	1.820	0.940	2.5	**26.6**	0.5	0.25	0.25	0.770	0.05	0.5	0.5	7.000	0.670
Nitrite (mg/L)	-	-	0.024	0.094	0.1	0.540	0.250	0.180	0.5	1	0.170	0.05	0.05	0.1	0.01	0.170	0.1	0.5	0.120
Phosphate, Ortho (mg/L)	-	-	0.0761	0.503	0.0600	0.0245	0.0367	0.175	0.0524	0.0570	0.0381	0.0839	0.0616	0.0345	0.0420	0.0479	0.0527	0.0724	0.0519
Silicon Dioxide (mg/L)	-	-	9.3	4.800				4.200					12.300	8.500	3.1	1.500			2.400
Total Inorganics																			
Chlorine (mg/L)	-	-		<0.200	<0.200	<0.200	<0.200	<0.100	<0.100	<0.100	<0.100	<0.100		<0.100					
Phosphate (mg/L)	-	-	0.299	0.654	0.0948	0.203	0.0819	0.411	0.0802	0.103	0.0872	0.0951	0.102	0.177	0.0568	0.0688	0.0637	0.0735	0.0606
Phosphorus (mg/L)	-	-	<0.6	0.640	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<0.6	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Total Kjeldahl Nitrogen (mg/L)	-	-	1.61	0.879	0.535	1.240	0.628	1.050	0.147	0.852	0.508	2.120	0.898	0.762	0.171	0.262	0.355	0.276	0.381
Total Nitrogen (mg/L)	-	-	2.23	2.97	0.70	8.70	2.70	5.00	3.00	27.50	0.70	1.94	0.90	1.77	0.17	0.70	0.70	7.30	1.17
Organics																			
Organic Nitrogen (mg/L)	-	-	1.13	0.488	-	0.819	0.360	0.757	0.114	0.565	0.386	1.510	0.406	0.541	0.123	-		0.230	0.334
Dissolved Metals																			
Iron	50 [9]	-	-	14	**<300**	10	<10	32	<10	25	12	**52**	**56**	23	-	<10	**<300**	<10	<10

Table 18
2009 Surface Water Chemistry Results

Parameter	BCWQG MAL [3,4]	CCME MAL [5,6]	DP01 SWDP01-1 2007-03-22	DP01 SWDP01-2 2007-06-20	DP01 SWDP01-3 2007-10-02	DP01 SWDP01-4 2007-12-10	DP01 SWDP01-5 2008-03-05	DP01 SWDP01-6 2008-05-30	DP01 SWDP01-7 2008-09-21	DP01 SWDP01-8 2008-11-27	DP01 SWDP01-9 2009-02-23	DP01 SWDP01-10 2009-05-20	DP01 SWDP01-11 2009-09-14	DP01 SWDP01-12 2009-12-03	DP02 SWDP02-1 2007-03-22	DP02 SWDP02-2 2007-06-21	DP02 SWDP02-3 2007-10-02	DP02 SWDP02-4 2007-12-10	DP02 SWDP02-5 2008-03-03
Total Metals																			
Aluminum	-	-	674	<500	<500	388	110	150	<200	<300	<100	184	59	490	<100	<200	<100	<100	<100
Antimony	-	-	<2.0	<2	<10	<5	<10	<10	<10	<10	<10	<2	<5	<10	<10	21	<10	<10	<10
Arsenic	-	12.5	4.22	2.52	1.22	1.54	0.97	1.78	1.14	1.13	0.54	2.26	3.71	1.4	0.97	1.41	1.01	1.16	0.95
Barium	200 [8]	-	21.0	12.9	12.2	18.1	16.0	29.5	10.8	15.0	17.3	47.5	21.3	14.5	11.9	20	10.5	9.1	11.6
Beryllium	100 [9]	-	<10	<10	<50	<25	<50	<50	<50	<50	<50	<10	<25	<50	<50	<50	<50	<50	<50
Bismuth	-	-	<10	<10	<50	<25	<50	<50	<50	<50	<50	<10	<25	<50	<50	<50	<50	<50	<50
Boron	1200 [10]	-	610	860	**3500**	**2010**	**2800**	**2000**	**3200**	**3000**	**2800**	840	1040	**2300**	**2700**	**2900**	**3700**	**3600**	**3000**
Cadmium	0.12 [11]	0.12	0.068	0.065	0.095	0.073	0.065	0.097	0.072	0.094	0.108	0.021	0.027	0.091	0.063	0.043	0.076	0.072	0.070
Calcium	-	-	65800	79800	346000	203000	266000	110000	343000	301000	279000	105000	128000	218000	236000	267000	348000	340000	284000
Chromium	56 [11]	56 [14]	<u><10</u>	<u><10</u>	<u><50</u>	<u><25</u>	<u><50</u>	<u><50</u>	<u><50</u>	<u><50</u>	<50	<10	<25	<50	<50	<50	<50	<50	<50
Cobalt	-	-	1.51	0.781	0.348	1.33	0.782	0.546	0.226	0.762	0.444	1.31	0.46	1.5	0.136	0.092	0.100	0.112	0.060
Copper	3 [10]	-	**5.59**	**5.71**	1.40	2.90	**3.85**	**3.56**	1.01	**3.27**	1.78	2.12	0.827	2.49	1.49	0.696	1.58	0.591	2.36
Iron	50 [9]	-	2070	718	451	1060	490	1080	**324**	**590**	**204**	**962**	**426**	**1070**	**116**	46	**111**	**69**	31
Lead	140 [10]	-	1.08	0.437	0.637	0.687	0.935	0.960	0.154	0.912	0.239	0.204	0.15	0.335	0.469	0.05	1.36	0.074	3.31
Lithium	-	-	<100	<100	<500	<250	<500	<500	<500	<500	<500	<100	<250	<500	<500	<500	<500	<500	<500
Magnesium	-	-	118000	188000	1070000	576000	808000	288000	1070000	911000	885000	219000	295000	675000	718000	825000	1100000	1100000	950000
Manganese	-	-	175	75.0	13.5	135	80.5	63.8	11.1	68.2	68.6	246	293	100	11.2	6.21	7.45	8.25	6.21
Mercury	2 [10]	0.016	<0.010	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.010	<0.01	<0.01	<0.01	<0.01
Molybdenum	-	-	2.6	5.8	8.2	6.1	8.0	6.3	8.4	8.3	6.4	2.7	<2.5	5.1	5.5	12.4	9.1	9.4	9.0
Nickel	-	-	8.25	5.62	1.49	5.71	4.15	2.92	1.12	6.14	2.88	6.87	1.92	5.82	0.879	0.612	0.758	0.737	0.835
Potassium	-	-	45200	64900	355000	188000	273000	92000	329000	280000	241000	62500	91000	204000	242000	271000	366000	362000	281000
Selenium	-	-	<0.50	0.56	0.88	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50	<0.5	<0.5	<0.5	<0.5
Silicon	-	-	5070	3170	2960	7370	2680	3040	1660	4590	2600	4390	6910	6330	1650	880	1540	1930	1370
Silver	3 [12]	-	<0.20	<0.2	<1	<0.5	<1	<1	<1	<1	<1	<0.2	<0.5	<1	<1.0	<1	<1	<1	<1
Sodium	-	-	1070000	1480000	7990000	4580000	6470000	2330000	8620000	7300000	7660000	1680000	2440000	5380000	6340000	7230000	8250000	8150000	7900000
Strontium	-	-	892	1200	6600	3270	4590	3300	5720	4880	5030	1370	1860	3820	4470	5060	7200	5820	5610
Thallium	-	-	<2.0	<2	<10	<5	<10	<10	<10	<10	<10	<2	<5	<10	<10	<10	<10	<10	<10
Tin	-	-	<2.0	<2	<10	<5	<10	<10	<10	<10	<10	<2	<5	<10	<10	<10	<10	<10	<10
Titanium	-	-	21	<20	<100	<100	<100	<100	<100	<100	<100	<20	<100	<100	<100	<100	<100	<100	<100
Uranium	100 [9]	-	0.629	0.392	1.99	1.41	1.92	0.197	2.03	2.16	2.01	0.628	0.63	1.78	1.56	0.949	2.09	2.08	1.75
Vanadium	50	-	<20	<20	**<100**	<50	**<100**	**<100**	**<100**	**<100**	**<100**	<20	<50	**<100**	**<100**	**<100**	**<100**	**<100**	**<100**
Zinc	10 [10]	-	**12.6**	**10.4**	7.64	9.08	4.96	6.66	1.71	**22.3**	2.39	3.71	2.15	5.48	5.10	0.56	5.35	1.24	5.72
Microbiological Analysis																			
Chlorophyll A	-	-	4.84	3.15	2.72	1.65	1.7	8.1	1.98	4.32	0.769	7.58	0.636	1.45	0.758	1.25	3.79	0.547	1.94

Table 18
2009 Surface Water Chemistry Results

		Location ID:	DP02	DP02	DP02	DP02	DP02	DP02	DP02	DP03	DP03	DP03	DP03	DP03	DP03	DP03	DP03	DP03	DP03
		Sample ID:	SWDP02-6	SWDP02-7	SWDP02-8	SWDP02-9	SWDP02-10	SWDP02-11	SWDP02-12	SWDP03-1	SWDP03-2	SWDP03-3	SWDP03-4	SWDP03-5	SWDP03-6	SWDP03-7	SWDP03-8	SWDP03-9	SWDP03-10
		Date Sampled:	2008-05-29	2008-09-20	2008-11-26	2009-02-24	2009-05-20	2009-09-14	2009-12-03	2007-03-22	2007-06-21	2007-10-02	2007-12-10	2008-03-03	2008-05-29	2008-09-20	2008-11-26	2009-02-24	2009-05-20
Parameter	**BCWQG MAL [3,4]**	**CCME MAL [5,6]**																	
Field Tests																			
Field Conductivity (uS/cm)	-	-	34500	43985	29268	29291	39001	36006	40989	10089	31300	31175	44401	38157	37169	44296	30029	29101	40202
Field Dissolved Oxygen (mg/L)	-	-	10.23	9.04	9.24	11.89	15.44	9.63	10.24	10.14	7.96	8.87	12.65	9.85	10.01	8.72	8.86	12.47	13.98
Field pH	-	-	7.79	7.8	7.69	7.64	8.69	7.94	7.68	7.8	8.55		7.73	8.01	7.88	7.80	7.76	7.7	8.5
Field Redox, Uncorrected (mV)	-	-	255.6	-13	-336	-348.6	168	201.2	135.1	236.1	258.6	230	252	-249.2	235.2	-1	-325.9	-354.5	148.5
Field Eh, Corrected (mV)			455.6	187.0	-136.0	-148.6	368.0	401.2	335.1	436.1	458.6	430.0	452.0	-49.2	435.2	199.0	-125.9	-154.5	348.5
Field Temperature (ºC)	-	-	14.98	13.27	6.78	7.84	17.5	16	6.11	8.53	14.9	11.6	6.38	6.57	16.16	13.23	7.46	7.82	14.69
Field Turbidity (NTU)	-	-	2.90	1.22	1.95	2.7	4.4	1.5	2.04	1.2	5.2		1.69	1.42	3.70	1.12	1.72	3.9	2.5
Physical Tests																			
Hardness, Total (CaCO3) (mg/L)	-	-	4050	5190	5540	5240	4610	4260	4710	4750	3440	4590		4170	4460	5380	5450	5200	4740
Total Suspended Solids (mg/L)	-	-	30.7	34.0	21.1		18.5	11.7	13.8	8.0	23.3	26.3	16.8	14.3	33.3	25.3	19.1		15.8
Dissolved Inorganics																			
Phosphate (mg/L)	-	-		0.0499	0.0653	0.0448	0.0447	0.0349	0.0637	0.0499	0.0405	0.0551	0.0693	0.0395		0.0535	0.0667	0.0363	0.0487
Inorganics																			
Ammonia (mg/L)	-	-	0.027	0.0175	0.0530	0.0247	0.035	0.0174	0.022	0.0320	0.030	0.056	0.02	0.0354	0.028	0.0172	0.0309	0.0212	0.034
Chloride (mg/L)	-	-	-	-	-														
Nitrate (mg/L)	-	16.0	5	2.5	0.530	0.5	0.5	0.5	0.5	0.220	0.5	0.5	7.000	0.620	5	2.5	0.5	0.5	0.5
Nitrite (mg/L)	-	-	1.300	1.430	0.1	0.1	0.1	0.1	0.1	0.02	0.130	0.1	0.5	0.120	2.100	1.370	0.1	0.1	0.1
Phosphate, Ortho (mg/L)	-	-		0.0449	0.0669	0.0294	0.0399	0.0312	0.0612	0.0482	0.0317	0.0555	0.0720	0.0412		0.0467	0.0664	0.0303	0.0407
Silicon Dioxide (mg/L)	-	-			3.400			1.800	3.300	2.200	1.600			2.100			3.000		
Total Inorganics																			
Chlorine (mg/L)	-	-																	
Phosphate (mg/L)	-	-		0.0588	0.0742	0.0418	0.0608	0.0448	0.0721	0.0589	0.0641	0.0764	0.0734	0.0474		0.0605	0.0721	0.0436	0.0526
Phosphorus (mg/L)	-	-	<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	<3.0	<3.0
Total Kjeldahl Nitrogen (mg/L)	-	-	0.304	0.102	0.170	0.160	0.347	0.05	0.187	0.150	0.211	0.385	0.246	0.331	0.378	0.05	0.153	0.189	0.298
Total Nitrogen (mg/L)	-	-	6.00	3.00	0.70	0.70	0.17	0.70	0.56	0.37	0.70	0.70	7.30	1.07	6.00	3.00	0.70	0.70	0.26
Organics																			
Organic Nitrogen (mg/L)	-	-	0.277	0.085	0.117	0.135	0.312	<0.060	-	-	-	-	0.246	0.296	0.351	<0.060	0.122	0.168	0.264
Dissolved Metals																			
Iron	50 [9]	-	<10	<10	<10	<10	<10	11	<10	-	<10	<300	<10	<10	12	<10	<10	<10	<10

Table 18
2009 Surface Water Chemistry Results

		Location ID:	DP02	DP02	DP02	DP02	DP02	DP02	DP02	DP03	DP03	DP03	DP03	DP03	DP03	DP03	DP03	DP03	DP03
		Sample ID:	SWDP02-6	SWDP02-7	SWDP02-8	SWDP02-9	SWDP02-10	SWDP02-11	SWDP02-12	SWDP03-1	SWDP03-2	SWDP03-3	SWDP03-4	SWDP03-5	SWDP03-6	SWDP03-7	SWDP03-8	SWDP03-9	SWDP03-10
		Date Sampled:	2008-05-29	2008-09-20	2008-11-26	2009-02-24	2009-05-20	2009-09-14	2009-12-03	2007-03-22	2007-06-21	2007-10-02	2007-12-10	2008-03-03	2008-05-29	2008-09-20	2008-11-26	2009-02-24	2009-05-20
Parameter	**BCWQG MAL [3,4]**	**CCME MAL [5,6]**																	
Total Metals																			
Aluminum	-	-	160	<100	<100	<100	<100	<100	<100	<100	<200	<200	<100	<100	130	<100	<100	<100	<100
Antimony	-	-	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Arsenic	-	12.5	0.2	1.08	1.24	0.65	1.37	1.27	1.09	1.11	1.20	1.18	1.26	1.14	1.09	1.27	1.28	0.93	1.30
Barium	200 [8]	-	10	9.4	10.1	9.2	10.9	10.4	10	10.6	20	11.5	9.0	12.0	11.1	9.5	9.9	7.7	9.7
Beryllium	100 [9]	-	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Bismuth	-	-	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Boron	1200 [10]	-	2700	3400	3500	4000	3000	3300	3300	3500	2600	3700	3500	2800	3100	3400	3600	3900	3000
Cadmium	0.12 [11]	0.12	0.060	0.066	0.090	0.100	0.049	0.065	0.06	0.06	0.040	0.085	0.062	0.069	0.054	0.076	0.087	0.092	0.052
Calcium	-	-	261000	342000	353000	337000	302000	278000	305000	305000	216000	338000	358000	258000	286000	344000	347000	335000	308000
Chromium	56 [11]	56 [14]	<50	<50	<50	<50	<50	**64**	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Cobalt	-	-	0.158	0.071	0.085	0.151	0.167	<0.05	0.062	0.069	0.079	0.166	0.052	0.065	0.156	0.059	0.066	0.136	0.096
Copper	3 [10]	-	1.40	0.690	1.50	1.23	1.31	0.905	0.465	0.709	0.672	2.06	0.652	2.61	1.49	0.562	0.921	1.02	1.32
Iron	50 [9]	-	138	67	84	103	131	33	73	55	63	186	59	31	158	58	71	111	51
Lead	140 [10]	-	0.484	0.535	3.33	1.96	0.174	1.04	0.062	0.137	0.061	1.09	0.117	2.49	0.269	0.273	0.674	0.201	0.270
Lithium	-	-	<500	<500	<500	<500	<500	<500	<500	<500	<500	<500	<500	<500	<500	<500	<500	<500	<500
Magnesium	-	-	824000	1050000	1130000	1070000	936000	867000	959000	968000	703000	1080000	1160000	857000	909000	1100000	1110000	1060000	964000
Manganese	-	-	13.2	5.23	8.63	13.1	11.1	6.46	5.64	5.88	7.13	11.4	4.16	7.70	12.9	5.44	6.07	14.0	6.75
Mercury	2 [10]	0.016	<0.01	**0.019**	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Molybdenum	-	-	5.6	9.6	7.7	9.6	9.4	8.1	8.4	7.6	7.6	9.8	8.8	7.6	6.5	10.3	8.5	8.4	8.9
Nickel	-	-	0.994	0.611	0.759	0.995	0.659	0.481	0.538	0.528	0.536	1.01	0.446	0.675	0.943	0.465	0.612	0.830	0.402
Potassium	-	-	249000	331000	344000	305000	279000	257000	286000	309000	226000	363000	385000	251000	275000	338000	332000	306000	284000
Selenium	-	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.51	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.82	<0.5	<0.5
Silicon	-	-	1260	1150	1920	700	770	1130	1940	1410	1360	1890	1860	1260	1130	1700	1680	710	760
Silver	3 [12]	-	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Sodium	-	-	7060000	8690000	8930000	9390000	7880000	7700000	8290000	7340000	5770000	8290000	8620000	7130000	7740000	8850000	8610000	9320000	8100000
Strontium	-	-	4520	6050	5480	6010	5000	5380	6070	5970	4270	6850	5960	5220	5060	6010	5590	6110	5140
Thallium	-	-	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Tin	-	-	<10	<10	<10	13	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Titanium	-	-	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
Uranium	100 [9]	-	1.79	2.10	2.26	2.41	1.86	1.92	1.75	1.96	1.24	1.99	1.77	1.85	1.90	2.24	2.40	2.26	1.72
Vanadium	50	-	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
Zinc	10 [10]	-	2.11	1.88	2.25	2.32	1.84	2.22	0.88	2.55	0.60	3.56	1.17	5.04	2.27	1.50	1.79	1.76	1.20
Microbiological Analysis																			
Chlorophyll A	-	-	0.905	0.675	1.09	0.628	1.28	1.72	0.501	2.25	3.77	3.19	0.572	2.3	1.17	0.652	0.427	0.656	0.414

Table 18
2009 Surface Water Chemistry Results

		Location ID:	DP03	DP03	DP04	DP04	DP04	DP04	DP04	DP04	DP04	DP04	DP04	DP04	DP04	DP04	DP05	DP05	DP05
		Sample ID:	SWDP03-11	SWDP03-12	SWDP04-1	SWDP04-2	SWDP04-3	SWDP04-4	SWDP04-5	SWDP04-6	SWDP04-7	SWDP04-8	SWDP04-9	SWDP04-10	SWDP04-11	SWDP04-12	SWDP05A-1	SWDP05A-2	SWDP05A-3
		Date Sampled:	2009-09-14	2009-12-03	2007-03-23	2007-06-20	2007-10-02	2007-12-10	2008-03-05	2008-05-30	2008-09-20	2008-11-26	2009-02-24	2009-05-20	2009-09-14	2009-12-03	2007-03-22	2007-06-20	2007-10-02
Parameter	**BCWQG MAL [3,4]**	**CCME MAL [5,6]**																	
Field Tests																			
Field Conductivity (uS/cm)	-	-	36040	40513	42603	30600	32241	44592	45283		45518	31575	30014	42909	35973	41659	43311	41900	32657
Field Dissolved Oxygen (mg/L)	-	-	10.97	11.11	9.79	8.03	8.66	10.95	9.80	11.02	8.29	7.92	10.02	11.26	10.36	9.97	9.42	7.74	7.73
Field pH	-	-	8.03	7.73	7.89			7.75	7.99		7.73	7.76	7.59	8.13	8.02	7.74	7.77		
Field Redox, Uncorrected (mV)	-	-	229.1	160	261.2		242	239	-36.9		54	-325.7	-368.4	172.7	235.1	171.8	251.9		253
Field Eh, Corrected (mV)			429.1	360.0	461.2	200.0	442.0	439.0	163.1	200.0	254.0	-125.7	-168.4	372.7	435.1	371.8	451.9	200.0	453.0
Field Temperature (ºC)	-	-	16.24	6.22	7.6		11.1	6.96	6.90		12.23	8.56	7.17	11.62	15.8	7.15	7.59		10.6
Field Turbidity (NTU)	-	-	0.9	1.02	0			1.44	1.16	1.49	1.10	1.37	0.9	2.3	0.8	0.8	3.87		
Physical Tests																			
Hardness, Total (CaCO3) (mg/L)	-	-	4180	4570	5060	4280	4970		5140	4510	5610	5790	5450	5180	4040	4800	4370	3750	5040
Total Suspended Solids (mg/L)	-	-	17.7	24.5	6.0	27.2	26.3	23.5	19.6	3.2	27.3	22.4		13.8	17.0	21.2	8.7	18.5	15.7
Dissolved Inorganics																			
Phosphate (mg/L)	-	-	0.0344	0.064	0.0548	0.0286	0.0493	0.0714	0.0626	0.0588	0.0600	0.0687	0.0739	0.0418	0.0338	0.0654	0.0580	0.0253	0.0527
Inorganics																			
Ammonia (mg/L)	-	-	0.019	0.02	0.02	0.123	0.027	0.02	0.0250	0.0753	0.0167	0.0088	0.005	0.033	0.0164	0.02	0.035	0.088	0.02
Chloride (mg/L)	-	-																	
Nitrate (mg/L)	-	16.0	0.5	0.5	0.670	0.5	0.5	8.300	1.640	1.930	2.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Nitrite (mg/L)	-	-	0.1	0.1	0.02	0.330	0.1	0.5	0.250	0.110	1.410	0.1	0.1	0.1	0.1	0.1	0.1	0.230	0.1
Phosphate, Ortho (mg/L)	-	-	0.0322	0.0597	0.0507	0.0241	0.0552	0.0712	0.0613	0.0501	0.0591	0.0695	0.0657	0.0383	0.031	0.0657	0.0531	0.0217	0.0527
Silicon Dioxide (mg/L)	-	-	1.800	3.200	2.100	2.000				1.400		3.000			1.800	3.000	2.8	2.500	
Total Inorganics																			
Chlorine (mg/L)	-	-																	
Phosphate (mg/L)	-	-	0.0443	0.0668	0.0612	0.0489	0.0687	0.0760	0.0652	0.0666	0.0709	0.0714	0.0755	0.0590	0.0407	0.0746	0.0634	0.0418	0.0604
Phosphorus (mg/L)	-	-	<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	<3.0	<3.0
Total Kjeldahl Nitrogen (mg/L)	-	-	0.122	0.137	0.0990	0.620	0.294	0.214	0.238	0.369	0.05	0.062	0.054	0.354	0.080	0.150	0.155	0.585	0.289
Total Nitrogen (mg/L)	-	-	0.70	0.51	0.77	0.95	0.70	8.50	2.13	5.00	3.00	0.70	0.70	0.26	0.70	0.51	0.70	0.81	0.70
Organics																			
Organic Nitrogen (mg/L)	-	-	0.103			0.497		0.214	0.213	0.294	<0.060	<0.060	<0.060	0.321	0.064		0.12	0.497	
Dissolved Metals																			
Iron	50 [9]	-	<10	<10		<10	<300	<10	<10	23	<10	<10	<10	<10	10	<10		<10	<300

Table 18
2009 Surface Water Chemistry Results

		Location ID:	DP03	DP03	DP04	DP04	DP04	DP04	DP04	DP04	DP04	DP04	DP04	DP04	DP04	DP04	DP05	DP05	DP05
		Sample ID:	SWDP03-11	SWDP03-12	SWDP04-1	SWDP04-2	SWDP04-3	SWDP04-4	SWDP04-5	SWDP04-6	SWDP04-7	SWDP04-8	SWDP04-9	SWDP04-10	SWDP04-11	SWDP04-12	SWDP05A-1	SWDP05A-2	SWDP05A-3
		Date Sampled:	2009-09-14	2009-12-03	2007-03-23	2007-06-20	2007-10-02	2007-12-10	2008-03-05	2008-05-30	2008-09-20	2008-11-26	2009-02-24	2009-05-20	2009-09-14	2009-12-03	2007-03-22	2007-06-20	2007-10-02
Parameter	**BCWQG MAL [3,4]**	**CCME MAL [5,6]**																	
Total Metals																			
Aluminum	-	-	<100	<100	<100	<100	<100	<100	<100	110	<100	<100	<100	<100	<100	<100	<100	<100	<100
Antimony	-	-	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Arsenic	-	12.5	1.24	1.12	1.17	0.97	1.42	1.23	1.60	1.43	1.24	1.18	1.48	1.32	1.59	1.21	1.11	1.24	1.28
Barium	200 [8]	-	9.7	8.8	10.4	12.2	11.2	9.0	7.8	9.3	8.7	9.2	8.7	8.5	9.4	8.2	10.8	12.6	8.6
Beryllium	100 [9]	-	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Bismuth	-	-	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Boron	1200 [10]	-	2800	3200	3500	3300	3800	3600	3700	2900	3500	3700	4100	3400	2800	3200	3300	3000	3700
Cadmium	0.12 [11]	0.12	0.064	0.066	0.07	0.093	0.068	0.063	0.082	0.044	0.080	0.082	0.090	0.065	0.058	0.064	0.069	0.055	0.066
Calcium	-	-	269000	298000	322000	251000	362000	359000	337000	309000	357000	372000	353000	335000	262000	314000	285000	228000	359000
Chromium	56 [11]	56 [14]	63	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	61	<50	<50	<50	<50
Cobalt	-	-	<0.05	0.055	<0.05	0.056	0.081	0.055	0.057	0.107	0.056	<0.05	<0.05	0.083	<0.05	<0.05	0.082	0.059	0.064
Copper	3 [10]	-	1.12	0.839	0.743	0.804	1.04	0.552	1.34	1.13	0.652	0.784	2.28	1.60	0.828	0.514	6.99	0.636	0.615
Iron	50 [9]	-	37	54	21	17	72	52	32	80	61	44	51	42	26	43	68	18	47
Lead	140 [10]	-	1.03	0.135	0.192	0.210	0.454	0.093	0.785	0.332	0.231	0.682	0.997	0.299	0.5	0.059	0.330	0.189	0.386
Lithium	-	-	<500	<500	<500	<500	<500	<500	<500	<500	<500	<500	<500	<500	<500	<500	<500	<500	<500
Magnesium	-	-	852000	928000	1030000	886000	1170000	1160000	1040000	908000	1150000	1180000	1110000	1060000	822000	975000	887000	772000	1170000
Manganese	-	-	6.82	5.79	3.22	5.77	6.86	4.50	4.85	10.1	5.60	4.22	4.20	4.75	5.93	4.12	6.48	7.97	5.43
Mercury	2 [10]	0.016	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.010	<0.01	<0.01
Molybdenum	-	-	7.1	7.1	7.5	9.1	9.4	9.9	9.7	5.6	10.3	8.5	10.6	11.1	6.1	5.8	6.9	7.1	9.4
Nickel	-	-	0.521	0.56	0.421	0.560	0.798	0.508	0.559	0.762	0.473	0.507	0.777	0.417	0.444	0.467	0.593	0.568	0.582
Potassium	-	-	256000	285000	331000	264000	387000	376000	361000	288000	357000	345000	319000	307000	248000	297000	296000	239000	384000
Selenium	-	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50	0.62	<0.5
Silicon	-	-	1090	1820	1170	1010	1420	1920	1430	910	1930	1500	1450	860	980	1730	1580	1380	1380
Silver	3 [12]	-	<1	<1	<1	<1	<1	<1	1.4	<1	<1	<1	<1	<1	<1	<1	<1.0	<1	<1
Sodium	-	-	7680000	8200000	7840000	6840000	8790000	8450000	8440000	8000000	9410000	8900000	9770000	8800000	7480000	8530000	7620000	6280000	8700000
Strontium	-	-	4570	5510	6100	5040	7200	6250	5740	4800	6410	5690	6630	5810	4780	5800	5750	4330	7050
Thallium	-	-	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Tin	-	-	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Titanium	-	-	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
Uranium	100 [9]	-	1.91	1.71	1.74	1.28	1.90	1.94	2.27	1.67	2.40	2.38	2.35	1.93	1.81	1.73	1.92	1.32	2.05
Vanadium	50	-	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
Zinc	10 [10]	-	2.01	1.35	1.96	2.50	1.74	1.39	2.56	3.25	1.45	1.52	12.5	2.45	1.32	0.72	19.0	1.30	2.67
Microbiological Analysis																			
Chlorophyll A	-	-	0.831	0.445	2.54	6.09	3.55	0.645	1.22	1.34	0.629	0.393	0.227	1.4	2.14	0.237	1.26	6.42	0.960

Table 18
2009 Surface Water Chemistry Results

		Location ID:	DP05	DP05	DP05	DP05	DP05	DP05	DP05	DP05	DP05	DP05	DP05	DP05	DP05	DP05	DP05	DP05	DP05
		Sample ID:	SWDP05A-4	SWDP05A-5	SWDP05A-6	SWDP05A-7	SWDP05A-8	SWDP05A-9	SWDP05A-10	SWDP05A-11	SWDP05A-12	SWDP05B-1	SWDP05B-2	SWDP05B-3	SWDP05B-4	SWDP05B-5	SWDP05B-6	SWDP05B-7	SWDP05B-8
		Date Sampled:	2007-12-10	2008-03-05	2008-05-30	2008-09-21	2008-11-27	2009-02-24	2009-05-20	2009-09-14	2009-12-03	2007-03-24	2007-06-20	2007-10-02	2007-12-10	2008-03-05	2008-05-30	2008-09-21	2008-11-27
Parameter	**BCWQG MAL [3,4]**	**CCME MAL [5,6]**																	
Field Tests																			
Field Conductivity (uS/cm)	-	-	44533	44250	37260	40733	32678	30023	40238	35306	42330	45143	1790	33099	44917	46613	42172	45770	33418
Field Dissolved Oxygen (mg/L)	-	-	10.86	8.48	9.5	7.91	7.9	10.22	9.95	9.4	10.39	16.92	9.71	6.02	10.86	7.66	9.06	6.42	6.08
Field pH	-	-	7.58	7.87	7.53	791	7.69	7.45	8.09	7.94	7.73	7.76			7.62	7.82	7.6	7.63	7.65
Field Redox, Uncorrected (mV)	-	-	221	-40.2	201.4	-86	-322.7	-346.8	209.8	299.4	152.3	227.2		251	230	-73.5	206.9	-66	-305.7
Field Eh, Corrected (mV)			421.0	159.8	401.4	114.0	-122.7	-146.8	409.8	499.4	352.3	427.2	200.0	451.0	430.0	126.5	406.9	134.0	-105.7
Field Temperature (ºC)	-	-	7.77	7.08	13.47	12.46	8.92	7.15	12.05	15.78	7.9	7.3		10.1	7.54	7.22	11.66	11.14	9.13
Field Turbidity (NTU)	-	-	0.88	0.58	1.66	1.87	0.71	0.75	2.8	0.75	0.62	10.19			1.46	0.72	2.04	1.07	1.11
Physical Tests																			
Hardness, Total (CaCO3) (mg/L)	-	-		5250	4430	4800	5470	5460	4760	4040	4790		5210	5120		5300	4790	5500	5600
Total Suspended Solids (mg/L)	-	-	30.8	14.2	9.9	11.3	7.1		13.8	14.3	10.5	20.2	36.5	51.7	14.8	12.9	19.9	11.3	4.4
Dissolved Inorganics																			
Phosphate (mg/L)	-	-	0.0733	0.0634	0.0312	0.0462	0.0732	0.0734	0.0353	0.0295	0.0682	0.0688	0.0648	0.0683	0.0670	0.0704	0.0326	0.0622	0.0777
Inorganics																			
Ammonia (mg/L)	-	-	0.02	0.0120	0.0478	0.0182	0.0057	0.005	0.027	0.0101	0.02	0.02	0.076	0.02	0.02	0.005	0.0426	0.0125	0.005
Chloride (mg/L)	-	-																	
Nitrate (mg/L)	-	16.0	6.400	1.900	0.5	3.500	0.840	0.5	0.5	0.5	0.5	0.30	0.5	0.5	7.000	2.390	0.5	2.5	8.800
Nitrite (mg/L)	-	-	0.5	0.270	0.210	0.5	0.1	0.1	0.1	0.1	0.1	0.02	0.290	0.1	0.5	0.270	0.190	0.5	1
Phosphate, Ortho (mg/L)	-	-	0.0735	0.0654	0.0264	0.0438	0.0727	0.0704	0.0340	0.0273	0.0652	0.0620	0.0634	0.0708	0.0745	0.0713	0.0273	0.0608	0.0754
Silicon Dioxide (mg/L)	-	-			1.200					2.000	3.000	2.3	2.300				<1.000		
Total Inorganics																			
Chlorine (mg/L)	-	-																	
Phosphate (mg/L)	-	-	0.0766	0.0687	0.0409	0.0501	0.0811	0.0775	0.0420	0.0368	0.0694	0.0705	0.0716	0.0713	0.0844	0.0726	0.0435	0.0638	0.0780
Phosphorus (mg/L)	-	-	<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	<3.0	<3.0
Total Kjeldahl Nitrogen (mg/L)	-	-	0.217	0.232	0.187	0.117	0.05	0.051	0.236	0.110	0.123	0.107	0.128	0.222	0.201	0.251	0.179	0.05	0.074
Total Nitrogen (mg/L)	-	-	6.60	2.41	5.00	3.60	0.84	0.70	0.13	0.70	0.51	0.41	0.70	0.70	7.20	2.91	5.00	3.00	8.90
Organics																			
Organic Nitrogen (mg/L)	-	-	0.217	0.220	0.139	0.099	<0.060	<0.060	0.209	0.100	-	-	<0.070	-	0.201	0.251	0.136	<0.060	0.074
Dissolved Metals																			
Iron	50 [9]	-	<10	<10	22	<10	12	<10	<10	<10	<10	-	<10	<300	<10	<10	22	<10	14

Table 18
2009 Surface Water Chemistry Results

		Location ID:	DP05	DP05	DP05	DP05	DP05	DP05	DP05	DP05	DP05	DP05	DP05	DP05	DP05	DP05	DP05	DP05	DP05
		Sample ID:	SWDP05A-4	SWDP05A-5	SWDP05A-6	SWDP05A-7	SWDP05A-8	SWDP05A-9	SWDP05A-10	SWDP05A-11	SWDP05A-12	SWDP05B-1	SWDP05B-2	SWDP05B-3	SWDP05B-4	SWDP05B-5	SWDP05B-6	SWDP05B-7	SWDP05B-8
		Date Sampled:	2007-12-10	2008-03-05	2008-05-30	2008-09-21	2008-11-27	2009-02-24	2009-05-20	2009-09-14	2009-12-03	2007-03-24	2007-06-20	2007-10-02	2007-12-10	2008-03-05	2008-05-30	2008-09-21	2008-11-27
Parameter	**BCWQG MAL [3,4]**	**CCME MAL [5,6]**																	
Total Metals																			
Aluminum	-	-	<100	<100	160	<100	<100	<100	<100	<100	<100	<100	<300	<100	<100	<100	130	<100	<100
Antimony	-	-	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Arsenic	-	12.5	1.25	1.17	1.26	1.19	1.49	1.28	1.26	1.89	1.28	1.26	1.16	1.05	0.88	1.31	0.84	1.19	1.51
Barium	200 [8]	-	8.9	7.5	7.5	9.4	8.2	8.0	9.9	10.1	8.6	9.3	21.2	7.1	8.3	7.0	6.0	8.3	7.8
Beryllium	100 [9]	-	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Bismuth	-	-	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Boron	1200 [10]	-	3500	3500	2800	3000	3700	4000	2900	3000	3200	3800	3900	3500	3500	3700	3100	3500	3600
Cadmium	0.12 [11]	0.12	0.051	0.078	0.064	0.065	0.085	0.090	0.060	0.072	0.073	0.064	0.064	0.054	0.062	0.085	0.073	0.073	0.088
Calcium	-	-	350000	346000	300000	312000	350000	352000	312000	263000	309000	345000	309000	395000	359000	348000	320000	357000	364000
Chromium	56 [11]	56 [14]	<50	<50	<50	<50	<50	<50	<50	52	<50	<50	<50	<50	<50	<50	<50	<50	<50
Cobalt	-	-	<0.05	<0.05	0.098	0.064	<0.05	<0.05	0.095	<0.05	<0.05	<0.050	0.052	<0.05	<0.05	<0.05	0.086	<0.05	<0.05
Copper	3 [10]	-	0.617	0.924	1.37	0.666	0.652	1.09	1.57	1.23	0.706	0.496	0.562	0.389	0.507	0.721	0.974	0.408	0.561
Iron	50 [9]	-	23	22	81	54	41	48	50	26	68	29	51	22	38	27	109	35	46
Lead	140 [10]	-	0.135	0.468	0.457	0.585	0.195	2.67	0.162	1.71	0.065	0.119	0.373	0.094	0.081	0.315	0.387	0.139	1.29
Lithium	-	-	<500	<500	<500	<500	<500	<500	<500	<500	<500	<500	<500	<500	<500	<500	<500	<500	<500
Magnesium	-	-	1140000	1070000	893000	978000	1120000	1110000	966000	821000	975000	1090000	1080000	1290000	1170000	1080000	970000	1120000	1140000
Manganese	-	-	2.28	2.49	8.43	5.85	3.33	2.21	7.05	6.86	3.44	2.47	3.58	2.31	2.89	1.76	7.02	3.68	2.59
Mercury	2 [10]	0.016	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.010	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Molybdenum	-	-	9.5	7.2	6.5	9.8	8.0	10.6	9.6	7.5	7.1	8.9	9.4	8.2	10.5	8.7	7.8	9.8	8.5
Nickel	-	-	0.356	0.590	0.941	0.546	0.493	0.562	0.510	0.61	0.47	0.640	0.520	0.416	0.425	0.565	0.735	0.479	0.481
Potassium	-	-	374000	366000	277000	306000	316000	317000	285000	250000	300000	348000	329000	415000	387000	371000	298000	352000	319000
Selenium	-	-	0.59	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50	<0.5	0.69	<0.5	<0.5	<0.5	<0.5	<0.5
Silicon	-	-	1750	1550	850	1350	1730	1530	1020	1220	1670	1340	1380	1560	1810	1530	750	1470	1630
Silver	3 [12]	-	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1.0	<1	<1	<1	<1	<1	<1	<1
Sodium	-	-	8370000	8590000	7800000	8060000	9750000	9720000	8130000	7500000	8610000	8230000	8620000	9380000	8660000	8660000	8200000	9270000	9900000
Strontium	-	-	6170	5860	4790	5250	5670	6250	5000	4900	5770	6680	6300	6460	6290	5700	5320	6340	5730
Thallium	-	-	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Tin	-	-	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Titanium	-	-	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
Uranium	100 [9]	-	1.74	2.19	1.81	2.00	2.56	2.39	1.82	1.93	2.12	1.97	1.28	1.82	1.87	2.40	2.29	2.27	2.65
Vanadium	50	-	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
Zinc	10 [10]	-	1.21	1.16	1.65	2.46	1.01	4.72	1.73	7.18	0.76	1.09	2.10	0.67	1.00	1.24	2.20	1.02	0.90
Microbiological Analysis																			
Chlorophyll A	-	-	0.504	1.5	1.01	1.11	0.304	0.17	0.25	0.209	0.397	0.5	1.00	4.96	0.422	0.722	1.95	1.03	0.142

Table 18
2009 Surface Water Chemistry Results

		Location ID:	DP05	DP05	DP05	DP05	DP06	DP06	DP06	DP06	DP06	DP06	DP06	DP06	DP06	DP06	DP06	DP06	DP07
		Sample ID:	SWDP05B-9	SWDP05B-10	SWDP05B-11	SWDP05B-12	SWDP06-1	SWDP06-2	SWDP06-3	SWDP06-4	SWDP06-5	SWDP06-6	SWDP06-7	SWDP06-8	SWDP06-9	SWDP06-10	SWDP06-11	SWDP06-12	SWDP07A-1
		Date Sampled:	2009-02-24	2009-05-20	2009-09-14	2009-12-03	2007-03-23	2007-06-20	2007-10-01	2007-12-10	2008-03-04	2008-05-29	2008-09-20	2008-11-26	2009-02-23	2009-05-20	2009-09-15	2009-12-03	2007-03-24
Parameter	**BCWQG MAL [3,4]**	**CCME MAL [5,6]**																	
Field Tests																			
Field Conductivity (uS/cm)	-	-	30189	47097	45499	45616	20042	18800	4877	11517	24116	20042	23071	24000	19360	10344	14450	15133	43933
Field Dissolved Oxygen (mg/L)	-	-	10.08	8.96	6.55	8.29	11.4	10.9	10.40	12.26	10.55	11.4	9.35	9.95	10.39	10.38	11.09	13.94	9.27
Field pH	-	-	7.45	7.9	7.6	7.64	7.81		6.5	7.45	7.97	7.81	7.83	7.47	7.69	8.24	7.8	6.73	7.8
Field Redox, Uncorrected (mV)	-	-	-351.2	210.9	258.1	145.5	207		212	176	-64.9	207.0	-22	-273.9	265.2	168.4	167.8	189.9	180.3
Field Eh, Corrected (mV)			-151.2	410.9	458.1	345.5	407.0	200.0	412.0	376.0	135.1	407.0	178.0	-73.9	465.2	368.4	367.8	389.9	380.3
Field Temperature (ºC)	-	-	7	9.3	11.43	8.75	6.4		12.4	3.96	6.23	6.40	13.51	7.74	6.08	14.63	17.44	5.51	7.85
Field Turbidity (NTU)	-	-	0.9	2.2	0.1	0.61	18.92			8.75	14.0	86.3	16.5	5.48	1.7	24	5.6	8.27	1.2
Physical Tests																			
Hardness, Total (CaCO3) (mg/L)	-	-	5520	5440	5310	5060	1950	212	615		2530	139	2640	1710	3940	767	1610	1800	
Total Suspended Solids (mg/L)	-	-		27.8	17.7	19.2	12.7	28.5	12.9	12.2	25.3	94.7	35.3	9.1		19.8		19.8	33.6
Dissolved Inorganics																			
Phosphate (mg/L)	-	-	0.0740	0.0414	0.0666	0.0704	0.0270	0.0080	0.0167	0.0218	0.0306		0.0284	0.0277	0.0424	0.0153	0.0215	0.0263	0.0618
Inorganics																			
Ammonia (mg/L)	-	-	0.005	0.023	0.0163	0.02	0.0410	0.056	0.100	0.071	0.0814	0.242	0.0365	0.0815	0.0597	0.042	0.051	0.073	0.028
Chloride (mg/L)	-	-																	
Nitrate (mg/L)	-	16.0	0.5	0.5	0.5	0.5	0.190	0.0634	0.490	12.000	1.590	0.5	0.5	0.5	2.5	0.25	0.25	0.5	0.25
Nitrite (mg/L)	-	-	0.1	0.1	0.1	0.1	0.02	0.001	0.02	0.5	0.110	0.1	0.130	0.1	0.560	0.05	0.05	0.1	0.02
Phosphate, Ortho (mg/L)	-	-	0.0706	0.0400	0.0639	0.0705	0.0237	0.0067	0.0160	0.0224	0.0310		0.0264	0.0267	0.0446	0.0138	0.0214	0.0259	0.0578
Silicon Dioxide (mg/L)	-	-			2.200	3.000	3.700	4.900						4.400			3.000	4.400	2.1
Total Inorganics																			
Chlorine (mg/L)	-	-																	
Phosphate (mg/L)	-	-	0.0776	0.0507	0.0697	0.0751	0.0486	0.0477	0.0298	0.0343	0.0528		0.0602	0.0415	0.0523	0.0404	0.0292	0.0497	0.0644
Phosphorus (mg/L)	-	-	<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	<0.6	<3.0	<3.0	<3.0
Total Kjeldahl Nitrogen (mg/L)	-	-	0.058	0.188	0.079	0.122	0.214	0.312	0.200	0.186	0.343	0.247	0.137	0.284	0.147	0.05	0.108	0.167	0.075
Total Nitrogen (mg/L)	-	-	0.70	0.28	0.70	0.51	0.41	0.38	0.69	12.20	2.04	0.70	0.70	0.70	3.00	0.26	0.40	0.42	0.33
Organics																			
Organic Nitrogen (mg/L)	-	-	<0.060	0.165	0.063	-	-	0.256	-	0.115	0.261	<0.070	0.100	0.203	0.087	<0.070	<0.070	-	-
Dissolved Metals																			
Iron	50 [9]	-	<10	<10	<10	<10	-	21	-	11	<10	59	<10	19	<10	23	11	14	-

Table 18
2009 Surface Water Chemistry Results

Parameter	BCWQG MAL [3,4]	CCME MAL [5,6]	DP05	DP05	DP05	DP05	DP06	DP06	DP06	DP06	DP06	DP06	DP06	DP06	DP06	DP06	DP06	DP06	DP07
		Sample ID:	SWDP05B-9	SWDP05B-10	SWDP05B-11	SWDP05B-12	SWDP06-1	SWDP06-2	SWDP06-3	SWDP06-4	SWDP06-5	SWDP06-6	SWDP06-7	SWDP06-8	SWDP06-9	SWDP06-10	SWDP06-11	SWDP06-12	SWDP07A-1
		Date Sampled:	2009-02-24	2009-05-20	2009-09-14	2009-12-03	2007-03-23	2007-06-20	2007-10-01	2007-12-10	2008-03-04	2008-05-29	2008-09-20	2008-11-26	2009-02-23	2009-05-20	2009-09-15	2009-12-03	2007-03-24
Total Metals																			
Aluminum	-	-	<100	<100	<100	<100	226	1110	170	200	282	1170	<500	181	<100	523	151	367	<100
Antimony	-	-	<10	<10	<10	<10	<5	<0.5	<10	<2	<5	<0.2	<10	<5	<10	<2	<5	<5	<10
Arsenic	-	12.5	1.41	1.41	1.89	1.3	0.86	0.43	0.69	0.61	0.77	0.52	0.81	0.74	1.06	0.70	1.6	0.73	1.34
Barium	200 [8]	-	7.7	6.8	7.9	8.3	17.8	22.0	20.3	19.0	16.2	24.2	13.7	15.5	12.3	27.7	15.2	15.8	10.6
Beryllium	100 [9]	-	<50	<50	<50	<50	<25	<2.5	<50	<10	<25	<1	<50	<25	<50	<10	<25	<25	<50
Bismuth	-	-	<50	<50	<50	<50	<25	<2.5	<50	<10	<25	<1	<50	<25	<50	<10	<25	<25	<50
Boron	1200 [10]	-	**4000**	**3300**	**3900**	**3500**	**1310**	129	**<1000**	740	**1760**	65	**1700**	1120	**2700**	490	1120	**1220**	**3900**
Cadmium	0.12 [11]	0.12	0.083	0.070	0.086	0.069	0.051	0.028	0.032	0.032	0.052	0.045	0.046	0.045	0.081	0.033	0.033	0.047	0.067
Calcium	-	-	356000	351000	346000	327000	133000	24500	49400	79900	168000	19300	170000	111000	246000	53400	110000	117000	332000
Chromium	56 [11]	56 [14]	<50	<50	54	<50	<25	4.1	<50	<10	<25	2.2	<50	<25	<50	<10	<25	<25	<50
Cobalt	-	-	<0.05	0.075	<0.05	<0.05	0.252	0.394	0.189	0.161	0.252	1.20	0.398	0.147	0.054	0.370	0.159	0.238	<0.050
Copper	3 [10]	-	0.464	0.532	0.552	0.413	**3.27**	2.07	**6.45**	1.12	2.01	**6.45**	1.57	1.07	1.19	2.89	0.95	1.52	2.25
Iron	50 [9]	-	30	45	24	38	**300**	**369**	**161**	**218**	**329**	**1350**	**599**	**231**	**53**	**467**	**159**	**310**	36
Lead	140 [10]	-	0.243	0.091	0.6	0.05	1.95	0.349	3.10	0.171	1.11	1.47	0.580	0.169	3.11	0.571	0.15	0.306	1.06
Lithium	-	-	<500	<500	<500	<500	<250	<25	<500	<100	<250	<10	<500	<250	<500	<100	<250	<250	<500
Magnesium	-	-	1120000	1110000	1080000	1030000	393000	36600	119000	225000	513000	22100	539000	348000	807000	154000	324000	367000	1060000
Manganese	-	-	1.96	2.78	3.32	3.2	22.8	38.8	39.1	21.9	21.3	74.0	23.9	18.8	11.2	27.7	21.9	28	2.30
Mercury	2 [10]	0.016	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	**0.017**	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.010
Molybdenum	-	-	9.7	11.2	9.5	8.4	2.6	1.26	<5	2.3	5.1	0.62	5.3	3.1	5.6	2.3	3	<2.5	10.5
Nickel	-	-	0.475	0.377	0.418	0.46	1.16	1.43	0.953	0.834	1.32	4.47	1.57	0.928	0.762	1.63	0.715	1.26	0.558
Potassium	-	-	328000	325000	326000	314000	123000	12000	37000	75000	178000	7000	170000	104000	226000	44200	97000	112000	333000
Selenium	-	-	<0.5	<0.5	0.76	<0.5	<0.5	0.61	0.80	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.70
Silicon	-	-	1600	720	1340	1620	2320	3330	2250	2840	2620	5340	2890	2810	1920	4810	2150	3130	1120
Silver	3 [12]	-	<1	<1	<1	<1	<0.5	<0.05	<1	<0.2	<0.5	0.022	<1	<0.5	<1	<0.2	<0.5	<0.5	<1.0
Sodium	-	-	9930000	9210000	9800000	8980000	3090000	257000	905000	1890000	4140000	162000	5040000	3140000	7120000	1200000	2720000	2910000	7920000
Strontium	-	-	6420	5970	6450	6280	2080	253	869	1320	2860	164	3020	1860	5440	900	1850	2070	6530
Thallium	-	-	<10	<10	<10	<10	<5	<0.5	<10	<2	<5	<0.2	<10	<5	<10	<2	<5	<5	<10
Tin	-	-	<10	<10	<10	<10	<5	2.22	<10	<2	<5	<0.2	<10	<5	<10	<2	<5	<5	<10
Titanium	-	-	<100	<100	<100	<100	<100	25	<100	<100	<100	53	<100	<100	<100	46	<100	<100	<100
Uranium	100 [9]	-	2.36	2.05	2.48	1.74	0.937	0.221	0.432	0.580	1.34	0.263	1.26	0.872	1.72	0.453	0.842	0.833	2.08
Vanadium	50	-	**<100**	**<100**	**<100**	**<100**	<50	5.0	**<100**	<20	<50	3.5	**<100**	<50	**<100**	<20	<50	<50	**<100**
Zinc	10 [10]	-	1.10	1.71	1.79	0.62	3.65	1.82	4.83	2.68	2.19	8.68	2.81	2.76	2.97	3.19	1.54	**147**	5.22
Microbiological Analysis																			
Chlorophyll A	-	-	0.266	2.11	0.462	0.295	0.847	0.554	0.932	0.267	1.07	0.747	0.964	0.389	0.622	0.123	0.251	0.358	0.561

Table 18
2009 Surface Water Chemistry Results

		Location ID:	DP07	DP07	DP07	DP07	DP07	DP07	DP07	DP07	DP07	DP07	DP07	DP07	DP07	DP07	DP07	DP07	DP07
		Sample ID:	SWDP07A-2	SWDP07A-3	SWDP07A-4	SWDP07A-5	SWDP07A-6	SWDP07A-7	SWDP07A-8	SWDP07A-9	SWDP07A-10	SWDP07A-11	SWDP07A-12	SWDP07B-1	SWDP07B-2	SWDP07B-3	SWDP07B-4	SWDP07B-5	SWDP07B-6
		Date Sampled:	2007-06-20	2007-10-01	2007-12-10	2008-03-04	2008-05-29	2008-09-20	2008-11-26	2009-02-23	2009-05-20	2009-09-14	2009-12-03	2007-03-24	2007-06-20	2007-10-01	2007-12-10	2008-03-04	2008-05-29
Parameter	**BCWQG MAL [3,4]**	**CCME MAL [5,6]**																	
Field Tests																			
Field Conductivity (uS/cm)	-	-	40400	32350	39268	23905		31003	25693	41521	13999	31966	30289	45970	30700	32733	41778	46773	45970
Field Dissolved Oxygen (mg/L)	-	-	8.92	8.27	10.10	11.81	11.5	8.20	96	9.62	10.85	9.52	10.51	12.75	8.76	6.39	15.58	7.71	12.75
Field pH	-	-			7.64	7.94		7.60	7.78	7.69	7.77	7.85	7.63	7.73			7.61	7.78	7.73
Field Redox, Uncorrected (mV)	-	-		257	172	-74.0		135	-276.2	-329.4	250.1	217.6	192.5	200.2		255	223	-92.7	200.2
Field Eh, Corrected (mV)			200.0	457.0	372.0	126.0	200.0	335.0	-76.2	-129.4	450.1	417.6	392.5	400.2	200.0	455.0	423.0	107.3	400.2
Field Temperature (ºC)	-	-		10.8	6.62	6.27		13.36	8.07	7.2	10.64	16.19	7.01	7.85		10.3	7.12	7.23	7.85
Field Turbidity (NTU)	-	-			2.21	4.88	50.0	4.86	5.45	1.1	23	1.1	1.49	0.09			1.70	0.48	4.30
Physical Tests																			
Hardness, Total (CaCO3) (mg/L)	-	-	2140	5110		2510	484	3380	5840	4830	992	3590	4090		5130	5210		5420	4260
Total Suspended Solids (mg/L)	-	-	21.2	3.7	22.2	12.7	48.7	6.0	11.8		25.8	11.7	17.8	10.9	25.2	51.0	9.5	15.3	38.0
Dissolved Inorganics																			
Phosphate (mg/L)	-	-	0.0134	0.0624	0.0603	0.0338		0.0336	0.0258	0.0517	0.0161	0.0218	0.0585	0.0656	0.0597	0.0590	0.0667	0.0711	
Inorganics																			
Ammonia (mg/L)	-	-	0.023	0.0067	0.02	0.0974	0.028	0.0372	0.0848	0.0116	0.046	0.0118	0.02	0.02	0.030	0.005	0.02	0.005	0.024
Chloride (mg/L)	-	-																	
Nitrate (mg/L)	-	16.0	0.790	1.930	7.400	1.750	0.5	0.5	0.218	0.5	0.25	0.5	0.5	0.33	0.520	2.360	5.900	1.920	5
Nitrite (mg/L)	-	-	0.1	0.1	0.5	0.140	0.1	0.150	0.022	0.1	0.05	0.1	0.1	0.02	0.1	0.1	0.5	0.100	1
Phosphate, Ortho (mg/L)	-	-	0.0091	0.0672	0.0618	0.0356		0.0302	0.0253	0.0548	0.0139	0.0209	0.056	0.0630	0.0606	0.0665	0.0719	0.0717	
Silicon Dioxide (mg/L)	-	-	3.200						4.700			2.000	3.100	2.1	2.300				
Total Inorganics																			
Chlorine (mg/L)	-	-																	
Phosphate (mg/L)	-	-	0.0352	0.0638	0.069	0.0452		0.0447	0.0349	0.0662	0.0447	0.0321	0.0616	0.0671	0.0666	0.0678	0.0745	0.0856	
Phosphorus (mg/L)	-	-	<1.5	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<0.6	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Total Kjeldahl Nitrogen (mg/L)	-	-	0.230	0.233	0.143	0.310	0.146	0.115	0.296	0.096	0.258	0.074	0.119	0.119	0.094	0.229	0.263	0.191	0.259
Total Nitrogen (mg/L)	-	-	1.02	2.16	7.60	2.20	0.70	0.70	0.54	0.70	0.46	0.70	0.47	0.45	0.70	2.59	6.10	2.21	6.00
Organics																			
Organic Nitrogen (mg/L)	-	-	0.207	-	0.143	0.213	0.119	0.078	0.211	0.084	0.212	0.062	-	-	<0.070	-	0.263	0.191	0.235
Dissolved Metals																			
Iron	50 [9]	-	<10	-	<10	<10	24	<10	18	<10	20	<10	<10	-	<10	-	<10	<10	<10

Table 18
2009 Surface Water Chemistry Results

		Location ID:	DP07	DP07	DP07	DP07	DP07	DP07	DP07	DP07	DP07	DP07	DP07	DP07	DP07	DP07	DP07	DP07	DP07
		Sample ID:	SWDP07A-2	SWDP07A-3	SWDP07A-4	SWDP07A-5	SWDP07A-6	SWDP07A-7	SWDP07A-8	SWDP07A-9	SWDP07A-10	SWDP07A-11	SWDP07A-12	SWDP07B-1	SWDP07B-2	SWDP07B-3	SWDP07B-4	SWDP07B-5	SWDP07B-6
		Date Sampled:	2007-06-20	2007-10-01	2007-12-10	2008-03-04	2008-05-29	2008-09-20	2008-11-26	2009-02-23	2009-05-20	2009-09-14	2009-12-03	2007-03-24	2007-06-20	2007-10-01	2007-12-10	2008-03-04	2008-05-29
Parameter	**BCWQG MAL[3,4]**	**CCME MAL[5,6]**																	
Total Metals																			
Aluminum	-	-	<400	<100	<100	102	723	<200	<200	<100	781	<100	<100	<100	<300	<100	<100	<100	260
Antimony	-	-	<5	<10	<10	<5	<1	<10	<10	<10	<2	<10	<10	<10	<10	<10	<10	<10	<10
Arsenic	-	12.5	0.92	1.06	1.11	1.12	0.65	0.65	0.42	1.22	0.74	1.17	1.11	1.41	1.51	1.40	0.93	1.53	1.02
Barium	200[8]	-	17.9	8.5	10.3	14.0	21.2	11.7	14.6	10.2	23.0	10.4	10.6	9.6	11.7	9.0	8.9	7.8	9.9
Beryllium	100[9]	-	<25	<50	<50	<25	<5	<50	<50	<50	<10	<50	<50	<50	<50	<50	<50	<50	<50
Bismuth	-	-	<25	<50	<50	<25	<5	<50	<50	<50	<10	<50	<50	<50	<50	<50	<50	<50	<50
Boron	1200[10]	-	**1560**	**4000**	**3000**	**1860**	300	**2100**	1000	**3500**	600	**2500**	**2800**	**4000**	**4000**	**4000**	**3400**	**3600**	**2900**
Cadmium	0.12[11]	0.12	0.066	0.068	0.057	0.046	0.042	0.062	0.039	**0.166**	0.047	0.053	0.06	0.060	0.073	0.056	0.056	0.084	0.064
Calcium	-	-	133000	338000	296000	167000	41600	215000	371000	294000	68300	234000	257000	346000	305000	334000	344000	364000	282000
Chromium	56[11]	56[14]	<25	<50	<50	<25	<5	<50	<50	<50	<10	55	<50	<50	<50	<50	<50	<50	<50
Cobalt	-	-	0.123	<0.05	0.056	0.108	0.864	0.181	0.131	<0.05	0.335	0.054	0.07	<0.050	0.065	<0.05	<0.05	<0.05	0.225
Copper	3[10]	-	1.27	0.825	0.563	2.25	**4.38**	1.45	1.62	1.24	**3.04**	1.43	0.609	0.887	0.539	1.04	0.396	1.41	1.42
Iron	50[9]	-	**92**	<10	**55**	**127**	**1020**	**240**	**205**	28	**443**	29	**62**	32	49	<10	32	17	**315**
Lead	140[10]	-	0.601	0.368	0.085	0.657	0.841	0.172	0.882	0.792	0.816	0.3	0.096	0.597	0.119	0.116	0.05	0.682	0.376
Lithium	-	-	<250	<500	<500	<250	<50	<500	<500	<500	<100	<500	<500	<500	<500	<500	<500	<500	<500
Magnesium	-	-	439000	1040000	942000	508000	92300	690000	1190000	994000	199000	729000	838000	1100000	1060000	1060000	1110000	1100000	863000
Manganese	-	-	13.9	1.93	5.33	12.3	55.7	15.4	16.8	6.35	20.9	7.88	7.54	2.03	9.46	1.86	2.87	1.68	15.5
Mercury	2[10]	0.016	<0.01	<0.01	<0.01	<0.01	0.013	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.010	<0.01	<0.01	<0.01	<0.01	<0.01
Molybdenum	-	-	4.4	9.5	8.7	4.9	0.97	5.8	<5	8.7	2.9	5.2	6.1	9.9	9.3	9.9	8.3	10.3	6.2
Nickel	-	-	0.767	0.453	0.503	0.898	3.43	0.947	0.901	0.685	1.97	1.03	0.606	0.362	0.646	0.420	0.388	0.265	1.14
Potassium	-	-	137000	297000	318000	178000	28100	221000	354000	277000	56700	218000	248000	351000	321000	297000	367000	379000	262000
Selenium	-	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.50	<0.5	<0.5	<0.5	<0.5	<0.5
Silicon	-	-	1990	1350	1890	2180	3960	2090	1490	1640	5180	1210	1820	1380	1300	1330	1770	1610	1760
Silver	3[12]	-	<0.5	<1	<1	<0.5	<0.1	<1	<1	<1	<0.2	<1	<1	<1.0	<1	<1	<1	<1	<1
Sodium	-	-	3570000	8420000	7170000	4110000	753000	5800000	9170000	8700000	1610000	6210000	7190000	8270000	8350000	8300000	8220000	8400000	7430000
Strontium	-	-	2520	7580	5190	2980	562	3690	1670	6780	1130	4050	4800	6850	6130	7450	5900	5910	4750
Thallium	-	-	<5	<10	<10	<5	<1	<10	<10	<10	<2	<10	<10	<10	<10	<10	<10	<10	<10
Tin	-	-	<5	<10	<10	<5	<1	<10	<10	<10	<2	<10	<10	<10	<10	<10	<10	<10	<10
Titanium	-	-	<50	<100	<100	<100	34	<100	<100	<100	57	<100	<100	<100	<100	<100	<100	<100	<100
Uranium	100[9]	-	0.762	1.94	1.76	1.25	0.399	1.52	0.783	2.05	0.512	1.62	1.59	2.01	1.44	1.79	1.80	1.86	1.87
Vanadium	50	-	<50	**<100**	**<100**	<50	<10	**<100**	**<100**	**<100**	<20	**<100**	**<100**	**<100**	**<100**	**<100**	**<100**	**<100**	**<100**
Zinc	10[10]	-	2.40	1.54	1.09	1.95	8.38	3.18	2.43	2.60	**18.6**	**18.9**	3.56	2.31	1.50	1.46	0.86	2.75	2.57
Microbiological Analysis																			
Chlorophyll A	-	-	4.30	1.17	0.401	0.766	0.407	0.864	0.462	1.25	0.2	1.23	0.399	0.714	0.521	1.07	0.445	0.71	0.481

Table 18
2009 Surface Water Chemistry Results

		Location ID:	DP07	DP07	DP07	DP07	DP07	DP07	DP08	DP08	DP09
		Sample ID:	SWDP07B-7	SWDP07B-8	SWDP07B-9	SWDP07B-10	SWDP07B-11	SWDP07B-12	SWDP08-5	SWDP08-9	SWDP09-9
		Date Sampled:	2008-09-20	2008-11-26	2009-02-23	2009-05-20	2009-09-14	2009-12-03	2008-03-04	2009-02-25	2009-02-25
Parameter	**BCWQG MAL [3,4]**	**CCME MAL [5,6]**									
Field Tests											
Field Conductivity (uS/cm)	-	-	45421	34323	30447	47732	45260	46179	42599	29566	29594
Field Dissolved Oxygen (mg/L)	-	-	6.38	6.91	7.96	8.28	9.1	7.15	9.04	10.7	9.72
Field pH	-	-	7.53	7.65	7.63	7.75	7.2	7.58	7.94	7.49	7.45
Field Redox, Uncorrected (mV)	-	-	-25	-272.2	-329.9	262.2	227.2	157.6	89.7	-379.3	-366.8
Field Eh, Corrected (mV)			175.0	-72.2	-129.9	462.2	427.2	357.6	289.7	-179.3	-166.8
Field Temperature (ºC)	-	-	11.32	9.19	7.15	8.7	11.93	8.91	6.76	7.16	7.22
Field Turbidity (NTU)	-	-	5.84	0.42	0.95	2.5	0.25	0.99		1.9	
Physical Tests											
Hardness, Total (CaCO3) (mg/L)	-	-	5460	6060	5520	5530	5400	5240	4720	5430	5370
Total Suspended Solids (mg/L)	-	-	31.3	18.4		21.2	19.7	25.2	9.3		
Dissolved Inorganics											
Phosphate (mg/L)	-	-	0.0588	0.0774	0.0757	0.0578	0.0665	0.0736	0.0485	0.0700	0.0644
Inorganics											
Ammonia (mg/L)	-	-	0.0114	0.005	0.005	0.028	0.005	0.022	0.0194	0.0099	0.0118
Chloride (mg/L)	-	-									
Nitrate (mg/L)	-	16.0	0.5	0.660	5	0.5	0.5	0.5	1.870	0.5	0.5
Nitrite (mg/L)	-	-	0.150	0.240	1	0.1	0.1	0.1	0.1	0.1	0.1
Phosphate, Ortho (mg/L)	-	-	0.0554	0.0788	0.0708	0.0579	0.0605	0.0712	0.0493	0.0667	0.0607
Silicon Dioxide (mg/L)	-	-		2.600			2.200	2.900			
Total Inorganics											
Chlorine (mg/L)	-	-									
Phosphate (mg/L)	-	-	0.0771	0.0723	0.0772	0.0638	0.0687	0.0774	0.0531	0.0793	0.0681
Phosphorus (mg/L)	-	-	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Total Kjeldahl Nitrogen (mg/L)	-	-	0.05	0.138	0.058	0.149	0.05	0.110	0.283	0.124	0.117
Total Nitrogen (mg/L)	-	-	0.70	1.04	6.00	0.47	0.70	0.51	2.15	0.70	0.70
Organics											
Organic Nitrogen (mg/L)	-	-	<0.060	0.138	<0.060	0.121	<0.060	-	0.263	0.114	0.105
Dissolved Metals											
Iron	50 [9]	-	<10	<10	<10	<10	<10	<10	<10	<10	<10

Table 18
2009 Surface Water Chemistry Results

Parameter	BCWQG MAL [3,4]	CCME MAL [5,6]	DP07	DP07	DP07	DP07	DP07	DP07	DP08	DP08	DP09
		Sample ID:	SWDP07B-7	SWDP07B-8	SWDP07B-9	SWDP07B-10	SWDP07B-11	SWDP07B-12	SWDP08-5	SWDP08-9	SWDP09-9
		Date Sampled:	2008-09-20	2008-11-26	2009-02-23	2009-05-20	2009-09-14	2009-12-03	2008-03-04	2009-02-25	2009-02-25
Total Metals											
Aluminum	-	-	<300	<200	<100	<100	<100	<100	<100	<100	<100
Antimony	-	-	<10	<10	<10	<10	<10	<10	<10	<10	<10
Arsenic	-	12.5	1.32	1.53	1.29	1.47	1.93	1.19	1.13	1.23	1.39
Barium	200 [8]	-	8.8	8.2	7.8	9.0	7.5	8.3	8.3	8.2	8.6
Beryllium	100 [9]	-	<50	<50	<50	<50	<50	<50	<50	<50	<50
Bismuth	-	-	<50	<50	<50	<50	<50	<50	<50	<50	<50
Boron	1200 [10]	-	3500	3800	4000	3500	3700	3600	3400	4100	4300
Cadmium	0.12 [11]	0.12	0.078	0.089	0.091	0.070	0.119	0.072	0.071	0.075	0.075
Calcium	-	-	352000	382000	334000	357000	349000	342000	317000	336000	330000
Chromium	56 [11]	56 [14]	<50	<50	<50	<50	59	<50	<50	<50	<50
Cobalt	-	-	0.224	<0.05	<0.05	0.075	0.07	<0.05	0.070	<0.05	<0.05
Copper	3 [10]	-	0.868	0.584	0.516	0.495	5.74	0.439	2.23	0.797	0.945
Iron	50 [9]	-	363	28	29	45	115	67	32	81	87
Lead	140 [10]	-	0.207	2.92	0.175	0.129	20.2	0.075	0.728	0.214	0.309
Lithium	-	-	<500	<500	<500	<500	<500	<500	<500	<500	<500
Magnesium	-	-	1110000	1240000	1140000	1130000	1100000	1070000	954000	1110000	1100000
Manganese	-	-	10.4	2.32	1.85	2.93	6.25	3.52	5.74	3.62	3.92
Mercury	2 [10]	0.016	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Molybdenum	-	-	10.1	9.2	9.3	12.9	7.4	7.8	10.2	8.5	10.1
Nickel	-	-	1.07	0.457	0.568	0.359	0.627	0.472	0.422	0.512	0.556
Potassium	-	-	343000	370000	319000	335000	324000	322000	335000	297000	298000
Selenium	-	-	<0.5	0.58	<0.5	<0.5	<0.5	<0.5	<0.5	1.68	0.82
Silicon	-	-	1660	1540	1580	1070	1370	1630	1360	1530	1530
Silver	3 [12]	-	<1	<1	<1	<1	<1	<1	<1	<1	<1
Sodium	-	-	8960000	9520000	9980000	9480000	9800000	9280000	7440000	9340000	9330000
Strontium	-	-	6330	5930	7890	6270	6260	6550	5560	5430	5490
Thallium	-	-	<10	<10	<10	<10	<10	<10	<10	<10	<10
Tin	-	-	<10	<10	<10	<10	<10	<10	<10	<10	<10
Titanium	-	-	<100	<100	<100	<100	<100	<100	<100	<100	<100
Uranium	100 [9]	-	2.35	2.50	2.35	1.83	2.37	1.74	2.11	2.13	2.21
Vanadium	50	-	<100	<100	<100	<100	<100	<100	<100	<100	<100
Zinc	10 [10]	-	2.21	1.13	1.29	2.82	8.16	0.94	1.84	3.5	3.5
Microbiological Analysis											
Chlorophyll A	-	-	1.05	0.0944	0.148	0.295	0.502	0.125	1.45	0.417	1.38

Table 18
2009 Surface Water Chemistry Results
Notes

(1) All values are reported as µg/L unless otherwise noted
(2) - = No standard or not analyzed
(3) BCWQG = British Columbia Approved Water Quality Guidelines, 1998, updated to August 2006; and A Compendium of Working Water Quality Guidelines for British Columbia, 1998, updated to August 2006
(4) BCWQG MAL = Marine and Estuarine Aquatic Life criteria from Approved Guidelines Tables 2 to 50 and/or Working Guidelines Table 1
(5) CCME = Canadian Council of Ministers of the Environment, Canadian Environmental Quality Guidelines, 1999, updated to October 22, 2008
(6) CCME MAL = Chapter 4, Canadian Water Quality Guidelines for the Protection of Aquatic Life, Marine, updated to October 22, 2008
(7) Approved - Tables 2 to 50 - Maximum, Interim
(8) Working - Table 1 - Maximum, Adverse Effects on a Bivalve
(9) Working - Table 1 - Maximum, Minimal Risk
(10) Approved - Tables 2 to 50 - Maximum
(11) Working Cr (III) - Table 1 - Maimum
(12) Approved - Tables 2 to 50 - Maximum, Open Coast and Estuaries
(13) CCME MAL stipulates pH not < 7 and not > 8.7
(14) Cr (III)

Table 19
AMS Sediment Chemistry Results

	Location ID:	DP01	DP01	DP01	DP01	DP01	DP01	DP01	DP01	DP01	DP01	DP01	DP01	DP02	DP02	DP02	DP02	DP02	DP02	DP02	DP02	DP02	DP02
	Sample ID:	SDDP01-1	SDDP01-2	SDDP01-3	SDDP01-4	SDDP01-5	SDDP01-6	SDDP01-7	SDDP01-8	SDDP01-9	SDDP01-10	SDDP01-11	SDDP01-12	SDDP02-1	SDDP02-2	SDDP02-3	SDDP02-4	SDDP02-5	SDDP02-6	SDDP02-7	SDDP02-8	SDDP02-9	SDDP02-10
	Date Sampled:	2007-03-22	2007-06-20	2007-10-02	2007-12-10	2008-03-05	2008-05-30	2008-09-21	2008-11-27	2009-02-23	2009-05-20	2009-09-14	2009-12-03	2007-03-22	2007-06-21	2007-10-02	2007-12-10	2008-03-03	2008-05-29	2008-09-20	2008-11-26	2009-02-24	2009-05-20
Parameter	**CSR SedQC(SS) Marine [3,4]**																						
Physical Tests																							
Moisture (%)	-	36.9	44.0	30.8	23.6	25.6	29.1	25.8	25.8	14.0	42.7	31.4	18.6	28	32.2	33.0	34.0	30.8	33.2	33.8	34.0	31.1	32.3
Oxidation Reduction Potential (mV)	-	-150	50	-120	-100	60	-300	-270	-350	-	-377	-163	33	-170	-	-200	-170	-170	-250	-280	-60	-100	-317
Eh (Corrected) (mV)		50	250	80	100	260	-100	-70	-150	-	-177	37	233	30	-	0	30	30	-50	-80	140	100	-117
pH	-	8.03	7.89	8.01	7.75	8.02	8.12	7.63	7.75	8.13	7.46	8.03	8.12	7.92	7.74	8.17	8.04	7.89	7.97	7.82	7.71	7.75	8.01
Grain Size																							
Clay (<0.004 mm) (%)	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	3	-	-	-	4	-
Silt (0.004-0.063 mm) (%)	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	4	-	-	-	6	-
Sand (0.063-2.0 mm) (%)	-	-	-	-	-	-	-	-	-	-	-	-	-	95	-	-	-	93	-	-	-	88	-
Gravel (>2.00 mm) (%)	-	-	-	-	-	-	-	-	-	-	-	-	-	<1	-	-	-	<1	-	-	-	1	-
Total Inorganics																							
Ammonia	-	5.9	8.7	3.1	2.0	3.1	13.1	6.6	5.0	3.4	11.8	9.48	1.24	3.9	7.3	8.1	4.3	2.4	4.4	9.0	3.9	2.0	2.40
Phosphate	-	654	795	619	585	563	668	635	1040	614	1180	887	516	691	764	698	365	703	763	718	760	671	669
Sulfide		95	97.5	0.19	0.33	0.38	21.2	9.86	0.49	0.35	58.8	30.1	0.2	1.15	9.74	4.16	0.55	1.2	2.17	1.91	0.56	1.3	9.88
Sulfide (mg/L)	-	0.0950	0.0975	0.00019	0.00033	0.00038	0.0212	0.00986	0.00049	0.00035	0.0588	0.0301	0.0002	0.00115	0.00974	0.00416	0.00055	0.00120	0.00217	0.00191	0.00056	0.00130	0.00988
Total Kjeldahl Nitrogen (%)	-	0.13	0.11	0.08	0.05	0.07	0.11	0.09	0.10	0.05	0.210	0.107	0.025	0.06	0.05	0.02	0.03	0.03	0.02	0.05	0.06	0.05	0.051
Total Nitrogen (%)	-	0.1	0.14	0.06	0.07	0.07	0.12	0.09	0.10	-	0.267	0.141	0.037	0.04	0.04	0.04	0.03	0.04	0.05	0.07	0.05	0.04	0.057
Organics																							
Organic Nitrogen (%)	-	0.13	0.11	0.08	0.05	0.07	0.11	0.09	0.1	0.05	0.209	0.106	0.025	0.06	0.05	<0.02	0.03	0.03	<0.02	0.05	0.06	0.05	0.051
Total Organic Carbon (%)	-	0.98	1.12	0.7	0.7	1.0	1.0	0.8	0.8	-	2.05	0.87	0.26	0.16	0.29	0.1	0.2	0.3	0.2	0.4	0.5	0.1	0.27
Total Metals																							
Aluminum	-	14000	14000	10700	11000	8640	12300	9930	13200	11000	13800	12300	7840	8680	10300	10200	17400	9380	9670	9700	9670	9950	9900
Antimony	-	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Arsenic	26	5.4	5.7	5	5	5.2	5	5	7.3	5	7.0	5	5	5	5.4	5.1	5	5	5.5	5	6.7	5	5
Barium	-	44.8	43.7	25.5	40.0	22.8	33.8	32.0	38.9	28.1	44.4	35.3	17.0	24.3	35.7	28.4	91.8	28.0	30.2	27.3	30.4	27.7	32.5
Beryllium	-	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Bismuth	-	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
Cadmium	2.6	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Calcium	-	5960	6140	5860	6140	4340	7660	6020	6430	6710	6700	6600	5340	5020	6140	5750	5330	6090	6040	5600	6530	5420	5800
Chromium	99	35.7	35.9	18.5	23.1	14.5	28.0	18.4	28.8	21.9	38.7	31.7	14.0	33.9	39.1	32.4	16.8	34.2	38.9	34.9	36.2	34.0	36.6
Cobalt	-	10.6	10.7	6.0	6.3	5.6	8.3	6.0	9.3	6.8	11.1	8.7	4.6	9.1	10.4	9.8	8.1	9.8	10.6	10.5	10.2	10.3	10.4
Copper	67	23.1	23.1	14.2	63.7	15.1	20.4	13.3	21.6	14.8	24.5	18.4	23.6	8.6	10.8	10.4	28.4	9.6	11.6	10	10.3	10	10.2
Iron	-	27500	25800	17800	20000	16400	23600	16300	24900	19500	29100	22700	12700	23000	24200	22000	22900	23100	25300	22700	24600	22700	23300
Lead	69	<30	<30	<30	<30	<30	<30	<30	<30	<30	<30	<30	<30	<30	<30	<30	<30	<30	<30	<30	<30	<30	<30
Lithium	-	16.8	17.0	10.6	10.6	8.7	13.2	10.4	16.1	11.3	19.2	14.5	8.3	9.8	11.6	12.0	8.5	10.6	12.2	11.6	11.5	11.6	12.3
Magnesium	-	10400	10700	7080	6450	5840	8390	6490	9570	7390	11500	9090	5100	8020	9520	9370	4930	8510	9340	9120	8910	9120	9410
Manganese	-	292	281	257	254	235	279	227	330	251	293	260	209	240	278	246	403	262	272	258	274	250	256
Mercury	0.43	0.0464	0.0476	0.0249	0.0208	0.0237	0.0272	0.0212	0.0330	0.0181	0.0488	0.0338	0.0101	0.0233	0.0284	0.0276	0.0453	0.0339	0.0270	0.0244	0.0234	0.0241	0.0255
Molybdenum	-	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
Nickel	-	33.4	34.6	17.4	20.5	15.4	28.3	17.9	28.2	20.1	36.9	28.3	14.3	30.0	33.5	31.0	11.7	31.7	33.2	32.8	33.4	31.5	33.7
Potassium	-	1970	1900	1180	1060	990	1350	1110	1770	1110	1950	1580	840	990	1240	1320	950	1180	1130	1200	1090	1270	1180
Selenium	-	<2.0	<3.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Silver	-	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Sodium	-	5570	6570	4250	3640	3330	5000	2980	8720	3350	7100	4690	2020	3320	3650	5630	340	4850	4250	4870	3780	4390	4410
Strontium	-	42.9	41.8	28.9	38.6	29.1	37.9	28.6	45.4	33.9	43.6	37.2	32.6	28.7	32.9	28.2	41.7	28.7	28.5	27.6	30.3	27.5	28.3
Thallium	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Tin	-	<5.0	<5.0	<5.0	<5.0	<5.0	5.1	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Titanium	-	959	864	673	786	513	833	620	764	720	799	798	532	828	931	784	792	808	858	734	863	778	828
Vanadium	-	49.1	49.4	42.9	40.2	34.2	49.3	36.6	47.3	43.3	52.0	46.7	26.7	49.3	54.3	49.9	49.0	49.6	57.6	49.6	54.3	48.9	53.1
Zinc	170	62.8	65.6	41.3	60.3	35.0	55.8	38.8	58.6	42.2	68.8	52.8	32.9	44.5	52.4	48.1	54.9	48.4	51.2	49.0	50.6	53.2	49.4

Table 19
AMS Sediment Chemistry Results

	Location ID:	DP02	DP02	DP03	DP03	DP03	DP03	DP03	DP03	DP03	DP03	DP03	DP03	DP03	DP03	DP04	DP04	DP04	DP04	DP04	DP04	DP04	DP04
	Sample ID:	SDDP02-11	SDDP02-12	SDDP03-1	SDDP03-2	SDDP03-3	SDDP03-4	SDDP03-5	SDDP03-6	SDDP03-7	SDDP03-8	SDDP03-9	SDDP03-10	SDDP03-11	SDDP03-12	SDDP04-1	SDDP04-2	SDDP04-3	SDDP04-4	SDDP04-5	SDDP04-6	SDDP04-7	SDDP04-8
	Date Sampled:	2009-09-14	2009-12-03	2007-03-23	2007-06-21	2007-10-02	2007-12-10	2008-03-03	2008-05-29	2008-09-20	2008-11-26	2009-02-24	2009-05-20	2009-09-14	2009-12-03	2007-03-23	2007-06-20	2007-10-02	2007-12-10	2008-03-05	2008-05-30	2008-09-20	2008-11-26
Parameter	**CSR SedQC(SS) Marine [3,4]**																						
Physical Tests																							
Moisture (%)	-	30.1	29.5	25.5	31.2	30.4	29.5	32.8	30.2	30.5	34.6	35.6	27.8	25.1	26.2	36.8	41.5	33.3	33.6	35.5	32.6	33.7	47.4
Oxidation Reduction Potential (mV)	-	-208	-33	-170	-	-170	-150	-180	-240	-220	-260	-170	-398	-155	37	-200	-220	-190	-120	-190	-320	-280	-220
Eh (Corrected) (mV)		-8	167	30	-	30	50	20	-40	-20	-60	30	-198	45	237	0	-20	10	80	10	-120	-80	-20
pH	-	8.06	7.91	7.99	7.90	8.13	7.83	7.96	7.96	7.94	7.81	7.91	8.04	8.01	7.90	7.86	8.55	8.21	7.88	8.06	7.92	7.95	7.72
Grain Size																							
Clay (<0.004 mm) (%)	-	-	-	3	-	-	-	3	-	-	-	3	-	-	-	4	-	-	-	3	-	-	-
Silt (0.004-0.063 mm) (%)	-	-	-	3	-	-	-	3	-	-	-	5	-	-	-	5	-	-	-	15	-	-	-
Sand (0.063-2.0 mm) (%)	-	-	-	94	-	-	-	94	-	-	-	91	-	-	-	91	-	-	-	-	-	-	-
Gravel (>2.00 mm) (%)	-	-	-	<1	-	-	-	<1	-	-	-	<1	-	-	-	<1	-	-	-	1	-	-	-
Total Inorganics																							
Ammonia	-	8.31	5.05	8.7	6.5	11.4	4.3	2.8	9.1	14.0	3.2	3.2	4.81	7.23	3.62	10.9	12.3	9.6	6.2	3.1	8.4	9.1	5.3
Phosphate	-	794	735	723	708	662	694	648	788	725	734	726	807	787	684	664	712	591	684	640	599	620	752
Sulfide		2.49	0.37	5.73	25.4	0.6	0.43	0.62	7.63	0.72	4.72	0.96	1.59	0.73	0.47	2.58	8.25	39.9	8.76	5.71	23.5	18.8	4.44
Sulfide (mg/L)	-	0.00249	0.00037	0.00573	0.0254	0.00060	0.00043	0.00062	0.00763	0.00072	0.00472	0.00096	0.00159	0.00073	0.00047	0.00258	0.00825	0.0399	0.00876	0.00571	0.0235	0.0188	0.00444
Total Kjeldahl Nitrogen (%)	-	0.047	0.050	0.06	0.04	0.04	0.03	0.04	0.05	0.06	0.06	0.05	0.057	0.049	0.033	0.07	0.08	0.05	0.06	0.06	0.06	0.08	0.10
Total Nitrogen (%)	-	0.062	0.046	0.06	0.04	0.04	0.04	0.05	0.05	0.05	0.05	0.05	0.069	0.075	0.046	0.07	0.08	0.05	0.04	0.06	0.05	0.08	0.08
Organics																							
Organic Nitrogen (%)	-	0.046	0.049	0.06	0.04	0.04	0.03	0.04	0.05	0.06	0.06	0.05	0.056	0.048	0.033	0.07	0.08	0.07	0.06	0.06	0.06	0.08	0.1
Total Organic Carbon (%)	-	<0.10	0.33	0.27	0.24	0.3	0.3	0.3	0.2	0.3	0.4	<0.1	0.38	0.97	0.31	0.39	0.58	0.4	0.5	0.5	0.4	0.5	0.7
Total Metals																							
Aluminum	-	9760	8480	9280	10100	9500	10300	9470	9920	10100	9900	9310	9930	9980	9120	9420	10600	9850	10800	9750	9530	9970	9990
Antimony	-	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Arsenic	26	5.2	5	5.6	5.6	5.8	5.2	5.3	8.3	6.0	5.5	5.5	6.0	6.7	5	6.7	5.1	6.0	5.5	6.4	6.8	5.8	8.2
Barium	-	28.6	20.9	28.1	30.5	28.5	32.9	26.0	32.3	29.7	29.4	24.2	34.7	29.6	23.0	26.8	30.0	25.3	36.2	24.9	25.2	30.2	31.1
Beryllium	-	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Bismuth	-	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
Cadmium	2.6	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Calcium	-	6050	5020	5000	5360	5220	5310	4920	5910	5740	5850	4800	6670	6600	5040	4530	5560	5200	6000	5390	5000	5910	6680
Chromium	99	38.5	35.0	36.5	34.8	31.8	34.0	32.0	38.4	36.7	34.4	32.6	38.3	36.8	33.0	38.1	30.7	29.0	30.4	28.8	29.9	30.9	31.3
Cobalt	-	10.2	10.0	9.0	8.9	8.6	9.1	8.8	9.7	9.6	9.4	9.1	9.7	9.4	8.8	8.0	8.1	7.7	7.9	8.3	7.9	8.5	8.2
Copper	67	10.8	9.3	9.8	10.3	9.7	11.2	10	11.5	10.3	11.0	10.4	10.2	10.5	8.6	11.8	13.6	12.7	15.1	13.7	13.2	13.3	15.1
Iron	-	24800	23400	24200	23400	21800	23200	22400	26000	23400	24500	23100	25200	25100	23100	20400	20400	18800	20200	20100	20200	19700	21300
Lead	69	<30	<30	<30	<30	<30	<30	<30	<30	<30	<30	<30	<30	<30	<30	<30	<30	<30	<30	<30	<30	<30	<30
Lithium	-	11.9	10.5	9.9	11.2	10.9	11.8	10.5	11.8	11.7	11.6	11.0	11.9	11.7	10.7	10.5	11.6	11.6	12.3	11.1	11.4	11.6	12.2
Magnesium	-	9310	8620	8190	8810	8420	7960	7950	8960	8780	8780	8710	9010	8740	8210	7670	9040	8690	7940	8360	7960	8380	8790
Manganese	-	263	251	236	247	239	267	250	266	260	264	247	268	260	251	226	226	217	250	238	226	228	258
Mercury	0.43	0.0231	0.0178	0.0211	0.0283	0.0213	0.0627	0.0242	0.0573	0.0199	0.0233	0.0194	0.0219	0.0286	0.0522	0.0245	0.0288	0.0227	0.0281	0.0236	0.0222	0.0239	0.0274
Molybdenum	-	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
Nickel	-	34.0	33.0	30.1	31.0	28.8	33.8	30.1	32.5	32.2	32.9	30.1	32.9	32.0	31.0	33.2	29.8	28.3	31.7	31.3	30.2	30.0	30.2
Potassium	-	1150	970	1130	1270	1210	1140	1210	1120	1240	1230	1190	1130	1200	1030	1310	1560	1440	1420	1430	1210	1350	1480
Selenium	-	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Silver	-	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Sodium	-	4060	3620	4200	4200	5440	3800	4480	3280	4910	5610	5160	3290	4350	3830	4240	8350	6950	6050	6490	5360	4950	8930
Strontium	-	29.5	26.3	29.6	30.7	27.4	31.8	25.7	30.0	30.3	30.2	26.7	35.4	33.6	29.8	30.4	34.8	27.4	38.5	29.2	27.5	29.4	35.7
Thallium	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Tin	-	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Titanium	-	802	782	865	851	724	838	750	854	763	814	674	809	799	816	774	732	690	808	703	697	704	719
Vanadium	-	53.5	48.4	53.8	50.6	49.5	49.4	47.2	59.1	51.9	53.3	47.3	55.7	53.4	47.9	41.7	44.7	44.2	43.8	43.6	44.0	44.7	45.8
Zinc	170	48.8	47.3	46.3	49.4	46.4	50.2	46.5	51.1	49.0	51.7	51.3	48.3	47.8	47.6	42.6	48.7	44.1	47.4	46.8	44.8	45.9	48.9

Table 19
AMS Sediment Chemistry Results

	Location ID:	DP04	DP04	DP04	DP04	DP05	DP05	DP05	DP05	DP05	DP05	DP05	DP05	DP05	DP05	DP05	DP05	DP06	DP06	DP06	DP06	DP06	DP06
	Sample ID:	SDDP04-9	SDDP04-10	SDDP04-11	SDDP04-12	SDDP05-1	SDDP05-2	SDDP05-3	SDDP05-4	SDDP05-5	SDDP05-6	SDDP05-7	SDDP05-8	SDDP05-9	SDDP05-10	SDDP05-11	SDDP05-12	SDDP06-1	SDDP06-2	SDDP06-3	SDDP06-4	SDDP06-5	SDDP06-6
	Date Sampled:	2009-02-24	2009-05-20	2009-09-14	2009-12-03	2007-03-24	2007-06-20	2007-10-02	2007-12-10	2008-03-05	2008-05-30	2008-09-21	2008-11-27	2009-02-24	2009-05-20	2009-09-14	2009-12-03	2007-03-23	2007-06-20	2007-10-01	2007-12-10	2008-03-04	2008-05-29
Parameter	**CSR SedQC(SS) Marine [3,4]**																						
Physical Tests																							
Moisture (%)	-	36.5	39.3	42.5	27.3	46.7	54.4	51.5	52.0	51.7	49.6	54.6	54.6	52.9	54.7	48.7	50.0	30.4	32.6	32.4	27.2	34.0	27.4
Oxidation Reduction Potential (mV)	-	-220	-384	-381	-298	-160	-200	-200	-200	-200	-280	-310	-430	-280	-412	-354	-303	-60	-50	-20	-140	70	-140
Eh (Corrected) (mV)		-20	-184	-181	-98	40	0	0	0	0	-80	-110	-230	-80	-212	-154	-103	140	150	180	60	270	60
pH	-	8.18	7.81	8.18	7.84	8.17	7.98	8.10	7.86	7.83	7.89	7.71	7.91	7.83	7.76	8.04	8.19	7.87	7.92	7.99	7.95	8.00	8.01
Grain Size																							
Clay (<0.004 mm) (%)	-	4	-	-	-	16	-	-	-	15	-	-	-	17	-	-	-	7	-	-	-	3	-
Silt (0.004-0.063 mm) (%)	-	9	-	-	-	41	-	-	-	53	-	-	-	49	-	-	-	16	-	-	-	8	-
Sand (0.063-2.0 mm) (%)	-	87	-	-	-	44	-	-	-	-	-	-	-	34	-	-	-	78	-	-	-	88	-
Gravel (>2.00 mm) (%)	-	<1	-	-	-	<1	-	-	-	<1	-	-	-	<1	-	-	-	<1	-	-	-	<1	-
Total Inorganics																							
Ammonia	-	4.1	11.5	6.28	4.76	17.9	9.0	4.9	6.1	7.5	8.9	17.4	7.3	5.4	6.38	10.4	9.96	2.0	1.7	2.8	2.0	1.0	0.8
Phosphate	-	681	655	609	537	814	812	644	837	885	825	851	955	824	825	741	726	723	733	802	713	656	649
Sulfide		1.97	13.5	44.7	17.4	46.2	101	61.6	9.1	19.7	8.69	15.9	28.5	17.8	17.4	31	31.2	0.24	0.21	0.17	0.18	0.24	0.2
Sulfide (mg/L)	-	0.00197	0.0135	0.0447	0.0174	0.0462	0.101	0.0616	0.0091	0.0197	0.00869	0.0159	0.0285	0.0178	0.0174	0.0310	0.0312	0.00024	0.00021	0.00017	0.00018	0.00024	0.0002
Total Kjeldahl Nitrogen (%)	-	0.06	0.091	0.085	0.058	-	0.15	0.19	0.17	0.18	0.14	0.17	0.17	0.18	0.168	0.171	0.188	0.04	0.03	0.05	0.03	0.02	0.04
Total Nitrogen (%)	-	0.07	0.110	0.110	0.070	0.19	0.16	0.17	0.14	0.16	0.15	0.16	0.18	0.15	0.217	0.189	0.200	0.03	0.04	0.04	0.04	0.04	0.03
Organics																							
Organic Nitrogen (%)	-	0.06	0.09	0.085	0.058	-	0.15	0.19	0.16	0.18	0.14	0.17	0.17	0.18	0.167	0.170	0.187	0.04	0.03	0.05	0.03	0.02	0.04
Total Organic Carbon (%)	-	0.5	0.53	0.67	0.48	-	1.66	1.9	1.8	1.8	1.6	1.8	2.1	1.7	1.95	1.77	1.91	0.32	0.46	0.5	0.4	0.3	<0.1
Total Metals																							
Aluminum	-	9750	10400	10700	8600	16500	17000	13400	17900	17200	17100	16100	17000	17000	18200	16000	15400	11500	15000	14800	14500	10000	9890
Antimony	-	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Arsenic	26	5.4	5.3	6.6	5	5	6.5	5.0	6.1	7.8	7.6	8.0	8.6	7.6	6.6	6.6	5.5	6.3	7.1	7.0	6.7	5.0	7.0
Barium	-	27.2	30.8	31.9	19.5	49.2	51.2	40.3	60.8	53.5	56.0	51.4	58.1	53.5	57.1	49.3	46.7	47.0	69.4	60.1	65.4	38.8	41.1
Beryllium	-	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0.54	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Bismuth	-	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
Cadmium	2.6	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0.91	<0.50	<0.50	<0.50	0.63	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Calcium	-	5550	5880	6260	4260	8070	8390	8240	9810	9910	9710	10300	11500	9420	10100	9830	8550	5660	7110	7750	7210	5560	5550
Chromium	99	31.5	30.9	33.6	29.2	40.2	38.9	30.3	42.1	40.0	39.3	39.1	38.3	39.7	39.1	39.4	37.2	39.5	38.1	36.9	38.9	34.3	33.4
Cobalt	-	8.3	8.5	8.5	7.3	10.6	10.6	7.7	10.3	10.9	10.3	10.8	10.9	10.6	11.3	10.5	9.5	11.5	12.8	12.4	11.8	10.6	10.6
Copper	67	13.8	14.5	15.4	10.5	36.8	37.8	29.8	38.2	38.0	37.0	35.1	36.5	37.7	38.2	35.5	31.4	18.3	26.0	30.8	25.9	15.0	15.4
Iron	-	20100	20600	20500	18100	30000	28700	22200	28600	30200	29800	28100	28800	29200	31000	28200	27100	27900	28500	29500	27300	24400	23400
Lead	69	<30	<30	<30	<30	<30	<30	<30	<30	<30	<30	<30	<30	<30	<30	<30	<30	<30	<30	<30	<30	<30	<30
Lithium	-	11.8	13.1	12.6	10.5	20.7	21.4	17.7	22.8	21.4	22.5	21.1	22.2	22.6	23.6	21.6	20.2	12.2	15.5	18.2	16.4	11.0	11.3
Magnesium	-	8330	9260	8830	7490	12200	12400	10200	11600	12300	12100	12500	12500	13100	13100	12200	11100	9720	11300	11900	10100	8990	9080
Manganese	-	227	238	228	202	330	318	246	341	347	337	327	334	323	339	312	295	376	472	416	386	364	345
Mercury	0.43	0.0233	0.0274	0.0248	0.0304	0.0592	0.0686	0.0805	0.0608	0.0623	0.0578	0.0590	0.0678	0.0619	0.0631	0.0548	0.0480	0.0326	0.0629	0.0474	0.201	0.0251	0.0323
Molybdenum	-	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
Nickel	-	30.7	31.2	30.3	27.9	39.7	37.3	27.1	42.5	38.1	38.0	37.1	36.3	36.8	40.3	36.8	34.0	37.7	41.5	39.0	44.7	37.0	36.6
Potassium	-	1360	1530	1640	1180	2590	2510	2230	2600	2700	2440	2540	2620	2920	2980	2540	2440	1230	1490	1560	1490	1120	940
Selenium	-	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<3.0	<2.0	<2.0	<3.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Silver	-	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Sodium	-	5000	7530	6890	4070	11300	10800	11200	11800	12100	12300	10400	15200	14500	14900	11600	11100	3110	3390	4300	3510	3580	1120
Strontium	-	28.6	33.2	32.5	25.6	47.7	49.5	41.8	58.7	54.2	53.2	51.0	59.7	52.5	58.1	49.6	52.2	36.7	41.6	40.4	43.9	31.3	29.0
Thallium	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Tin	-	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Titanium	-	716	732	769	715	910	884	734	995	959	932	839	928	882	943	875	986	921	850	816	917	788	754
Vanadium	-	42.6	45.2	43.5	36.3	56.8	56.0	46.1	54.6	57.3	57.7	54.2	54.8	53.4	59.2	52.8	50.3	56.6	55.4	55.4	53.0	47.5	47.3
Zinc	170	46.7	46.7	46.9	43.2	74.7	72.8	55.4	72.4	75.5	71.6	70.8	72.4	76.9	76.8	68.7	67.1	53.0	65.7	64.9	60.6	48.0	49.3

Table 19
AMS Sediment Chemistry Results

	Location ID:	DP06	DP06	DP06	DP06	DP06	DP06	DP07	DP07	DP07	DP07	DP07	DP07	DP07	DP07	DP07	DP07	DP07	DP07
	Sample ID:	SDDP06-7	SDDP06-8	SDDP06-9	SDDP06-10	SDDP06-11	SDDP06-12	SDDP07-1	SDDP07-2	SDDP07-3	SDDP07-4	SDDP07-5	SDDP07-6	SDDP07-7	SDDP07-8	SDDP07-9	SDDP07-10	SDDP07-11	SDDP07-12
	Date Sampled:	2008-09-20	2008-11-26	2009-02-23	2009-05-20	2009-09-15	2009-12-03	2007-03-24	2007-06-20	2007-10-01	2007-12-10	2008-03-04	2008-05-29	2008-09-20	2008-11-26	2009-02-23	2009-05-20	2009-09-14	2009-12-03
Parameter	**CSR SedQC(SS) Marine [3,4]**																		
Physical Tests																			
Moisture (%)	-	26.6	32.6	31.7	30.6	30.0	26.6	28.5	29.4	26.1	26.3	24.5	24.4	36.7	31.8	24.8	21.1	22.6	22.1
Oxidation Reduction Potential (mV)	-	-170	-190	-	-321	-269	-267	-110	-170	-200	-170	110	-250	-260	-270	-	-37	-278	-33
Eh (Corrected) (mV)		30	10	-	-121	-69	-67	90	30	0	30	310	-50	-60	-70	-	163	-78	167
pH	-	7.82	7.83	7.85	7.76	7.97	7.99	8.04	8.16	8.13	8.10	8.24	8.11	7.86	8.00	8.29	8.00	8.18	8.01
Grain Size																			
Clay (<0.004 mm) (%)	-	-	-	8	-	-	-	41	-	-	-	2	-	-	-	4	-	-	-
Silt (0.004-0.063 mm) (%)	-	-	-	30	-	-	-	15	-	-	-	4	-	-	-	6	-	-	-
Sand (0.063-2.0 mm) (%)	-	-	-	59	-	-	-	78	-	-	-	93	-	-	-	87	-	-	-
Gravel (>2.00 mm) (%)	-	-	-	4	-	-	-	<1	-	-	-	<1	-	-	-	2	-	-	-
Total Inorganics																			
Ammonia	-	1.0	1.6	2.2	2.30	3.07	1.78	3.1	2.2	2.9	1.4	1.3	2.2	2.4	1.4	1.5	1.75	2.15	0.8
Phosphate	-	690	781	820	699	745	637	692	613	649	548	534	680	740	597	559	541	670	532
Sulfide		0.21	0.22	0.2	0.21	0.2	0.2	1.59	1.42	12.5	2.87	0.42	2.34	3.6	3.84	4.1	1.22	0.2	0.87
Sulfide (mg/L)	-	0.00021	0.00022	0.0002	0.00021	0.0002	0.0002	0.00159	0.00142	0.0125	0.00287	0.00042	0.00234	0.00360	0.00384	0.00410	0.00122	0.00020	0.00087
Total Kjeldahl Nitrogen (%)	-	0.03	0.07	0.06	0.038	0.054	0.036	0.55	0.02	0.05	0.02	0.02	0.03	0.08	0.06	0.02	0.020	0.029	0.02
Total Nitrogen (%)	-	0.05	0.05	-	0.045	0.081	0.040	0.04	0.03	0.05	0.02	0.03	0.04	0.06	0.02	-	0.030	0.056	0.027
Organics																			
Organic Nitrogen (%)	-	0.03	0.07	0.06	0.037	0.054	0.035	-	<0.02	0.05	0.02	<0.02	0.03	0.08	0.06	<0.02	0.02	0.028	<0.020
Total Organic Carbon (%)	-	0.3	0.5	-	0.25	0.52	0.29	0.55	0.25	0.4	0.2	0.2	0.2	0.6	0.4	-	0.14	0.40	0.13
Total Metals																			
Aluminum	-	11400	13100	13700	11200	13400	10200	12300	12500	12500	12200	9720	11700	14700	10600	10300	10400	12100	9680
Antimony	-	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Arsenic	26	6.4	7.6	6.3	6.4	7.0	5.3	5	7.0	6.6	5.7	5	7.5	7.5	6.8	5.5	6.4	5.4	5
Barium	-	46.8	58.1	57.0	46.3	54.3	37.3	44.8	45.8	45.9	46.3	28.5	44.5	59.3	36.6	29.9	35.8	46.2	25.3
Beryllium	-	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Bismuth	-	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
Cadmium	2.6	<0.50	0.52	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Calcium	-	6070	7490	7160	6070	6880	5580	5760	6270	6970	6480	5580	6880	7300	5970	5780	5590	6440	5260
Chromium	99	34.6	37.6	40.7	33.1	35.4	32.8	37.3	34.1	34.1	35.4	40.1	35.6	38.0	33.0	40.5	34.1	37.6	40.0
Cobalt	-	11.5	11.7	12.6	11.6	12.5	10.2	10.3	10.1	10.4	9.8	9.4	11.1	12.2	10	9.9	9.9	10.7	9.0
Copper	67	18.1	25.0	25.4	18.8	27.2	15.8	20.2	17.2	22.0	17.9	13.0	23.7	26.8	17.4	13.8	13.5	19.7	11.2
Iron	-	24700	28800	29600	26500	28200	23500	25500	22600	24300	22800	22900	25000	27100	23100	23600	21500	23700	20600
Lead	69	<30	<30	<30	<30	<30	<30	<30	<30	<30	<30	<30	<30	<30	<30	<30	<30	<30	<30
Lithium	-	12.7	15.3	15.8	12.3	17.0	11.7	13.5	11.8	13.9	12.4	9.3	14.3	16.5	11.8	10.5	10.5	13.4	10.0
Magnesium	-	9560	10500	11300	9830	10900	8960	10300	9650	10400	9010	8890	10700	11100	9340	9250	8920	10200	8790
Manganese	-	366	392	410	389	372	329	329	309	313	319	296	355	362	304	294	297	310	277
Mercury	0.43	0.0283	0.0513	0.0495	0.0337	0.0402	0.0254	0.0372	0.0316	0.0346	0.0317	0.0201	0.0939	0.0458	0.0262	0.0200	0.0225	0.0318	0.0154
Molybdenum	-	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
Nickel	-	37.8	39.9	40.7	40.3	40.4	36.0	39.2	35.7	36.0	41.2	38.4	39.1	41.5	37.5	37.8	37.3	39.6	36.9
Potassium	-	1180	1420	1490	1160	1490	1080	1480	1310	1390	1160	850	1240	1770	1100	910	920	1370	740
Selenium	-	<2.0	<2.0	<2.0	<2.0	<3.0	<2.0	<2.0	<2.0	<2.0	<2.0	<3.0	<2.0	<2.0	<2.0	<4.0	<2.0	<2.0	<2.0
Silver	-	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Sodium	-	2520	4570	5140	2490	4450	2410	5080	4110	4810	3020	2160	4340	5310	4920	2800	2480	4590	1870
Strontium	-	31.6	39.2	40.1	32.0	38.8	32.8	33.8	31.4	32.3	33.9	25.6	32.9	37.2	27.6	25.8	25.0	31.2	23.5
Thallium	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Tin	-	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Titanium	-	724	850	854	706	743	831	811	835	791	928	899	716	809	775	826	773	802	893
Vanadium	-	47.8	53.4	54.4	52.0	52.6	44.1	51.6	50.1	51.4	51.3	58.9	49.7	53.3	52.2	58.5	50.2	47.4	50.5
Zinc	170	52.2	61.7	62.3	54.9	60.4	49.3	54.3	48.6	54.2	47.2	39.7	54.7	61.5	47.1	42.3	41.8	48.6	38.3

Table 19
AMS Sediment Chemistry Results
Notes

(1) All values are reported as μg/g unless otherwise noted
(2) - = No standard or not analyzed
(3) CSR = BC Environmental Management Act, Contaminated Sites Regulation, B.C. Reg. 375/96, including amendments up to B.C. Reg. 343/2008, effective January 1, 2009
(4) CSR SedQC(SS) Marine = Schedule 9, Column IV, Marine and Estuarine Sediment, Sensitive Site

Table 20
Summary of Bird Abundance Data

Year	Location	FamilyGroup	Family	Species	J F M A M J J A S O N D	Tide	J	F	M	A	M	J	J	A	S	O	N	D
2009	DELTAPORT	Brant	Geese, Ducks, Swans	BRAN		H	589		479	1376	284						380	778
						L			670	1965	100							
		Coastal Waterbirds	Cormorant	DCCO		H	2	15	7	4	6	1	4		93	59	30	1
						L			8	10	14				165	24		
				PECO		H	13	12	8	6	13	7	11	31	12	18	2	
						L			9	14	5		14	1	18	7		
			Geese, Ducks, Swans	AMWI		H	1245	787	634							3080	1444	6716
						L			110		2					3722		
				BAGO		H												1
				BUFF		H	34	41	124	3	21						3	34
						L			19	44	12							
				COGO		H	2	6	13	1	2					2		
						L			2		2							
				EUWI		H	57	34	68									39
						L			14	4								
				GRSC		H	220	203	112		1391					286	80	200
						L			19	95	479					200		
				GWTE		H		25	70									5
						L										5		
				LTDU		L			2									
				MALL		H	19	38	51		11	2		17		6		5
						L			6	2	2	2	18	51	405	10		
				NOPI		H	43	1076	681	97	15	11			100	1186	335	2058
						L			1206	92					650	563		
				RBME		H	1		2								12	
						L										6		
				SNGO		H			46							66		
						L										23		
				SUSC		H	10	2			24			66	1	143	3	
						L			3		31			84		15		
				UNDU		L					18				35			
				WWSC		H			6						13		3	
						L			6		21				11			
			Grebes	HOGR		H	5	3	17	5	2				10	34	1	
						L			24		3				2	13		
				RNGR		H	1	6	8	2				1		3		
						L			17	7	1					3		
				WEGR		H			7	7								
						L			9									
			Loon	COLO		H	7	7	19	8	6			9	6	34	1	
						L			6	3	9			4	4	17		
				PALO		H		4		1								
						L			2									
			Skuas, Gulls, Terns, Skimmers	CAGU		L			5									
				CATE		H					3	1	94	3	18			
						L					1	5	6	19	1			
				GWGU		H	83	9	29	22	15	24	9	1	4	17	16	10
						L			46	34	115	209	35	4	165	41		
				MEGU		H	5	1									12	
						L			60	6								
				RBGU		H	7	1	1	4		4	184	219	78			
						L			9	30	6	27	128	235	315			
				THGU		H	1											
				UNGU		H		3	4	2							3	
						L			16	92	26		85	380	90			
		Heron	Herons	GBHE		H			12	9	18	44	2	3	1	18		
						L			35	117	177	274	99	27	271	1		
		Other	Crows, Jays	CORA		H					1			1				
						L					1		2					
				NOCR		L			1		1	3						
			Emberizids	SOSP		H						2						
						L										2		
			Finches	AMGO		H							2					
			Pigeons, Doves	RODO		L						8						
			Starlings	EUST		H										135		
						L								2				
			Swallows	BARS		H					1			29				
						L					2	1		5				
		Raptors	Caracaras, Falcons	PEFA		H	1											
			Hawks, Kites, Eagles	BAEA		H	27	1	3	11	5	2					2	
						L			8	1	2	2				2		
				NOHA		H	1		2									
						L			1									
				OSPR		H								2				
				RTHA		L							1					
		Shorebirds	Lapwings, Plovers	BBPL		H	94			100								6
						L										5		
				KILL		H				2			3					
						L						1	5					
			Oystercatchers	BLOY		H	10		8	19		3				2		
						L							2			5		
			Sandpipers, Phalaropes	BASA		H				1								
				BLTU		H	65											1
						L										9		
				DUNL		H	2562	49	213	175							160	350
						L										15		
				UNCA		L								25				
				WESA		H				1150	76		275	357				
						L					50							

Table 20
Summary of Bird Abundance Data

Year	Location	FamilyGroup	Family	Species	J F M A M J J A S O N D	Tide	J	F	M	A	M	J	J	A	S	O	N	D
	TFN	Brant	Geese, Ducks, Swans	BRAN		H			6	525	26						393	589
						L			180		150							
		Coastal Waterbirds	Cormorant	DCCO		H											3	
						L									115			
			Geese, Ducks, Swans	AMWI		H	471	1130	202							10650	9685	1700
						L			100						100	13851		
				CAGO		L				1	3			3				
				EUWI		H	4	6										
				GADW		H	2	6			2	4						
						L					9							
				GRSC		H	1	6	540								20	1
				GWTE		H		42	206	175	38			7		71	390	815
						L			142	2	15				7	75		
				HOME		H	2										5	
				MALL		H	40	3	3	5		131		38	2	35	15	176
						L			16			1		81	0	2		
				NOPI		H	4055	1520	476		12			16	98	1950	7075	5127
						L			318							54		
				NSHO		H	27											5
				SNGO		L										126		
				TRUS		H		2										
				UNDU		L									400			
				WWSC		H											30	
			Grebes	RNGR		H											2	
				WEGR		H											40	
			Loon	COLO		H									5		12	
						L										2		
			Skuas, Gulls, Terns, Skimmers	CAGU		H			6									
						L										1		
				CATE		H					11	4	47	16	80			
						L					6			9				
				GWGU		H	162	6	29	14	59	64	20	6	101	6	79	97
						L			11	2	230	16		52	111	42		
				MEGU		H	12										29	5
						L			60									
				RBGU		H	3	17	8				350	411	390			
						L					21	2		113	15			
				UNGU		H			5									
						L			2	4		20	5	126		1		
				WEGU		H			1									
			Swans, Geese, Ducks	NSHO		H											32	
		Heron	Herons	GBHE		H		2	15	14	29	71	224	113	49	36	4	1
						L			2	9	110	60	8	76	21	16		
		Other	Blackbirds	RWBL		H					1							
						L					5	1						
			Crows, Jays	CORA		H					1							
				NOCR		H			1		1	1		13				
						L						2		1				
			Emberizids	COYE		H					2	1						
						L					2	1		4				
				SAVS		H			1	5	3	8	3			3		
						L			1	1	7	8	7	3	6	2		
				SOSP		H			1			1				2		5
						L			1		1	1	1					
			Finches	AMGO		H					1		2			1		
						L					2	2	3	13	4			
				HOFI		H					2	3				1		
						L			2		3	1	1					
			Flycatchers	WIFL		L						1						
			Hummingbirds	RUHU		L						2						
			Kingfishers	BEKI		H								1	1			
						L			1									
			Paridae	BCCH		L								2				
			Pigeons, Doves	RODO		L									58			
			Starlings	EUST		H						30						12
						L						25						
			Swallows	BARS		H					10	6	6	28				
						L				8	47	19	36	52	8			
				TRSW		L					3							
				VGSW		H						2						
						L					5		2					
			Thrushes	AMRO		H			1	2								
						L			2		2	1		1				
			Waxwings	CEWA		L							5					
			woodpeckers	NOFL		H						1						
		Raptors	Caracaras, Falcons	PEFA		H	1				1							3
			Hawks, Kites, Eagles	BAEA		H	2	2	6	7		9			1		1	1
						L			6		10	1	1			1		
				NOHA		H	2	1	2		8	1				3	2	4
						L			1	1	1	1		1	2	1		
				RTHA		H									1			
			Owls	SEOW		H										2		
						L							1					
		Shorebirds	Lapwings, Plovers	BBPL		H	2			320								41
						L										22		
				KILL		H						1	1					
						L							17					
			Sandpipers, Phalaropes	BASA		H				3								
				DUNL		H	11880		504	605	30						2755	1850
						L										89		
				GRYE		H				1								
				UNCA		L								30				
				WESA		H				2400	507			187				
						L								34				

Table 21
Summary of Damage to Depth of Disturbance Rods

DoD Rod	Alterations/damage sustained	Damage Observed in	Corresponding Quarter	Replaced?
A03	None			
A04	None			
A05	None			
A06	None			
B02	Rod bent to 30 degrees, straightened.	Feb-2009	Q1-2009	
B03	Rod leaning, slightly bent, straightened.	Feb-2009	Q1-2009	
B04	None			
B05	Rod found slightly leaning.	Feb-2009	Q1-2009	
B06	None			
C01	Rod at angle	Oct-2008	Q4-2008	
	Rod bent, but straightened.	Feb-2009	Q1-2009	
C02	None			
C03	None			
C04	None			
C05	Rod at 45 degree angle; straightened	Oct-2008	Q4-2008	
C06	None			
D01	Rod bent over to ground, straightened, does not appear to be broken.	Feb-2009	Q1-2009	
D02	Rod slightly bent, straightened.	Feb-2009	Q1-2009	
D03	Rod at slight angle, not straightened.	Feb-2009	Q1-2009	
	Rod at slight angle, 20 degrees.	Apr-2009	Q2-2009	
	Rod at 30 degree angle, straightened.	Jul-2009	Q3-2009	
	Rod at slight angle.	Nov-2009	Q4-2009	
D04	None			
D05	None			
D06	None			
E01	None			
E02	None			
E06	Could not locate rod	Feb-2009	Q1-2009	
	Could not locate again, replaced.	Apr-2009	Q2-2009	Yes
F06	Rod at an angle.	Jan-2008	Q1-2008	
	Rod at slight angle.	Jul-2008	Q3-2008	
	Could not locate rod.	Oct-2008	Q4-2008	
	Rod slightly bent, leaning, but not straightened.	Feb-2009	Q1-2009	
	Rod at slight angle of 10 degrees.	Apr-2009	Q2-2009	Yes
G06	Rod at 30 degree angle.	Jul-2008	Q3-2008	
	Rod completely bent, straightened & measured.	Oct-2008	Q4-2008	
	Rod bent, replaced with new rod.	Feb-2009	Q1-2009	Yes
Z01	Rod bent at 45 degrees, straightened.	Feb-2009	Q1-2009	
Z02	Rod is at slight angle, 10 degrees.	Apr-2009	Q2-2009	
Z03	Rod slightly bent, straightened. Elevation of rod changed significantly.	Feb-2009	Q1-2009	
Z04	Elevation of rod changed significantly. Rod is now very short.	Feb-2009	Q1-2009	
		Jul-2009	Q3-2009	Yes
Z05	None			
Z06	None			
Z07	None			
Z08	RTK GPS survey suggests elevation of rod changed significantly.	Feb-2009	Q1-2009	

Note 1: In Feb-2009 (Q1-2009), several rods were found bent, and were straightened at the time.
Note 2: Elevation of DoD rods was surveyed in Apr-2007, Oct-2007, Jan-2008, Jul-2008 and Apr-2009.
Differences were, on average, less than 10 cm.

Table 22
Summary Statistics for DoD Rod Data
Results from 2007/2008/2009 Analysis

		Group 1	Group 2	Group 3
Deposition	Q1 Mean ('08&'09 only)	2.4	2.4	1.1
	Q2 Mean	5.2	2.3	1.5
	Q3 Mean	1.7	2.1	1.1
	Q4 Mean	3	0.7	1.3
	Annual Mean	3.1	1.8	1.3
Erosion	Q1 Mean ('08&'09 only)	-3.9	-2.4	-1.6
	Q2 Mean	-2.5	-0.9	-0.9
	Q3 Mean	-4.9	-1.4	-0.8
	Q4 Mean	-4.9	-1.5	-1.3
	Annual Mean	-4.6	-1.5	-0.9
Combined Erosion and Deposition	Min	-14.9	-9.7	-8.9
	Max	21	8.5	9.1
	Mean	-0.73	0.13	0.10
	Std. Dev. (s)	5.16	2.43	1.99
	1.282 Std. Dev. (1.282s)	6.62	3.12	2.55
	Deposition Threshold	5.89	3.25	2.66
	Erosion Threshold	-7.35	-2.99	-2.45

Note: negative numbers denote erosion

APPENDIX A
Methodology

A-1 GEOMORPHOLOGY

A-1.1 INVESTIGATION METHODOLOGY

The main components of the monitoring program are based on the recommendations provided in the Deltaport Third Berth (DP3) Adaptive Management Strategy (AMS). Based on this information and Northwest Hydraulic Consultants' (NHC) general understanding of the processes at Deltaport, the detailed geomorphological monitoring work plan is described below. The Acoustic Wave and Current Meter (AWAC) was destroyed on September 27, 2007. An alternate monitoring methodology is currently being developed.

A-1.1.1 Crest Protection Monitoring

The purpose of crest protection monitoring is to detect channel incision, headcutting or dendritic channel formation around perimeter crest protection. The monitoring covers the entire perimeter of the crest protection structure, with particular focus in the vicinity of the tug basin and DP3 structures. Field reconnaissance and site observations are made quarterly during low tide by a qualified geomorphologist. Fixed points were established on the ground for taking repeat photography and for conducting terrestrial surveys. Ground surveys are carried out using a Real Time Kinematic (RTK) global positioning system (GPS) station to measure the dimensions of channels that are present or subsequently form.

A-1.1.2 Water Sampling of Suspended Solids

Periodic collection of water samples during a tidal cycle was initially proposed in order to derive a relationship between turbidity and total suspended sediment (TSS) concentration. NHC's memo of November 2007 presents the rationale for revising this methodology. With the development of a TSS-Turbidity relationship by laboratory methods, water samples will no longer be collected. Turbidity monitoring stations provide a continuous record of measured turbidity from which TSS will be computed using the expression **x=y/0.5123** (where x=TSS and y=turbidity).

A-1.1.3 Automated Turbidity Monitoring

The purpose of this monitoring activity is to measure turbidity continuously at fixed locations to provide a proxy record of sediment transport over the tidal flats. Two monitoring sites were chosen on the shoreward side of the crest protection structure, with Analite NEP495 Turbidity Logging Probes installed within a 2-inch PVC pipe with a flared base to protect the optics from debris. The pipe is securely attached within a stainless-steel pyramidal cage, which is weighted by 4 lb weights and marked by a small float. The instruments are programmed to record turbidity levels of up to 400 NTU every 15 minutes. A wiper assembly is programmed to clean the optics at 4-hour intervals to ensure consistent readings.

This sampling interval was selected to capture the effects of storms and other weather events with durations of several hours or more and is not designed to capture the impact of individual waves on turbidity. No cables or external power are required, which minimizes the risk of damage or loss of data. Regular maintenance of the equipment is carried out to ensure fouling or debris does not degrade the sensors. Data retrieval is performed by physically connecting the instrument to a laptop or PDA and directly downloading the data each month.

Analysis of data collected from the turbidity probes is supported by auxiliary tide level data. In order to monitor tide height, a local tide gauge was installed on a caisson at the Deltaport site. The monitoring station consists of a Solinst Levelogger, which records and stores stage (water-level) values at 15-minute intervals. The stage sensors record combined atmospheric and hydrostatic pressure. A Solinst Barologger is installed adjacent to the tide gauge in the DCL Site Office to independently record atmospheric pressure as a correction to the tide gauge. The Levelogger is housed inside a capped 2-inch PVC pipe secured to a pre-existing steel ladder on the caisson face.

A-1.1.4 Automated Monitoring of Erosion and Deposition

Measurements of the temporal variation in erosion and deposition at specified locations are collected using conventional erosion pins (depth of disturbance pins). The depth of disturbance (DoD) rods are monitored at three-month intervals during the course of other field investigations (crest protection monitoring and bed sediment sampling). The DoD rods have been spaced at 150-m intervals and located on the tidal flats above 0.5 m chart datum in elevation. Conventional depth of disturbance rods consist of a length of rebar that is embedded into the tidal flats and a large flat disk with a central hole (similar to a washer) is placed over it, flush with the ground. The initial distance from the top of the rebar to the disk is recorded at the time of installation. If the ground is lowered as a result of scour, the distance from the top of the rebar to the disk will increase over time. If deposition occurs, the sediment buries the disk. Vegetation accumulation on the DoD rod may occur on a seasonal basis related to growth and die off of the various plant species found at Roberts Bank. The presence of vegetation is noted and photo-documented and the height of accumulated weed is recorded. Accumulated weed is carefully removed to expose the bare sediments underneath and allow measurement of washer burial or scour as described above. Quarterly observations are made, and/or observations after any significant storm events, to determine the magnitude of erosion and deposition.

A-1.1.5 Sediment Samples

Sediment samples are scheduled for collection twice yearly, once in the spring and once in the fall, post Fraser River freshet. Samples are collected at each DoD rod site using a shallow hand corer. The top 10 cm of the sample are removed from the core and stored in a freezer until analysis to ensure that biological activity does not alter the percent fines. A sampling depth of 10 cm was chosen to ensure that there is sufficient sediment to perform a robust grain size analysis and to ensure that the sample captures undisturbed sediments at depth as well as newly deposited sediments. Preliminary monitoring of the DoD rods has demonstrated that a 10 cm sampling depth is appropriate at a majority of the sites. The first set of samples was collected at a distance of 5 m to the north of each rod. To avoid re-sampling in the same hole, subsequent sampling is rotated around the rod location.

The primary purpose of the laboratory analysis is to determine the particle size distribution of the samples. Subsequent results will be compared to determine if a fining or coarsening trend is occurring. The following is a description of the methodology used to determine the organic content of the sample, analyzed by ALS Laboratories:

> The sample is introduced into a quartz tube where it undergoes combustion at 900° C in the presence of oxygen. Combustion gases are first carried through a catalyst bed in the bottom of the combustion tube, where oxidation is completed and then carried through a reducing agent (copper), where the nitrogen oxides are reduced to elemental nitrogen. This mixture of N_2, CO_2, and H_2O is then passed through an absorber column containing magnesium perchlorate to remove water. N_2 and CO_2 gases are then separated in a gas chromatographic column and detected by thermal conductivity.

The remaining sample is then put through a series of sieves and a hydrograph to provide a graph of percent finer by weight down to 0.5 mm. The following graphs and tables show the results of the analysis.

A-1.1.6 Interpretation of Ortho Photographs

Aerial photographs are evaluated to assess trends and patterns of erosion and/or accretion on the tidal flats. This evaluation is conducted annually and covers the entire inter-causeway tidal flat area. The methodology consists of overlaying successive ortho-rectified photographs using GIS mapping techniques to delineate and identify morphological changes on the tidal flats. The maps show areas of erosion or sand accretion and changes in vegetation between successive surveys.

A-1.1.7 Coastal Geomorphology Mapping

This task assesses topographic changes due to long-term erosion or accretion adjacent to the terminal. An initial baseline survey was completed at the start of the study. The surveys will be repeated every three to four years. The highest resolution surveys are made near DP3. More limited surveys are made across the shallow inter-tidal flats where the relief is very low. Precise bathymetric surveying is performed using RTK GPS positioning for horizontal control and single beam digital echo sounding.

A-1.2 Data Evaluation

This section summarizes the geomorphological data that will be evaluated and interpreted for the monitoring components presented above. Interpretation of the DoD measurements and bathymetric survey data is straightforward, and is not included below. Results are provided only in the quarterly reports with data interpretation and discussion provided in the annual reports.

A-1.2.1 Crest Protection Monitoring

Comparisons of repeat terrestrial photographs will be performed to show seasonal and long-term changes. Comparison of ground surveys to document scour or erosion from channel formation or headcutting processes. This interpretation will be supplemented by assessment of annual aerial photography and periodic low-level over flights from a fixed wing aircraft, as described in **Section A-1.1.6**.

A-1.2.2 Water Sampling of Suspended Solids

Plots of suspended sediment concentration versus turbidity will be made to provide a basis for calibrating the continuous turbidity sensors. Variations in suspended sediment concentration will be related to tidal current velocities, tide levels and ambient conditions in the Lower Fraser River estuary.

A-1.2.3 Automated Turbidity Monitoring

Suspended sediment concentration will be computed from the turbidity values using correlations established from the manual sampling program. Time series plots of turbidity and suspended sediment concentration will be made and compared with tide levels, tidal current magnitude and wave climate conditions (as recorded by the AWAC unit provided by others). Predicted sediment concentrations and sediment transport rates under tidal currents and waves will be compared with the observed values.

The primary objective of the automated turbidity monitoring stations is to monitor sediment concentrations and sediment transport rates to assess long-term deposition/erosion processes and long-term changes in sediment concentration that might affect habitat (such as eelgrass). However, localized higher turbidity values generated from construction activities may be reflected in the record.

A-1.2.4 Sediment Samples

Measurements of short-term accretion and erosion will be correlated with met-ocean conditions (wave and tide conditions), construction activities and changes in vegetation or eelgrass. Comparisons will also be made with surveyed topographic changes along the crest protection and results of the photographic monitoring.

A-1.2.5 Interpretation of Ortho Photographs

Overlay maps will be interpreted to assess the key factors that are controlling morphological changes on the tidal flats. Results will be compared with other long-term assessments (as documented previously in the Coastal Geomorphology Study, NHC 2004). The results of this investigation will be integrated with other related studies on eelgrass extent and distribution in order to provide a complete understanding of any habitat changes.

A-2 SURFACE WATER

A-2.1 INVESTIGATION METHODOLOGY

Fixed sediment quality monitoring stations will be established adjacent to the Deltaport facility, within the inter-causeway area and at two reference locations along Robert's Bank. The proposed locations are described as follows:

- One station (Station 1) in the ditch near the base of the ferry terminal causeway to monitor nutrient and sediment loading from upland sources
- Two stations (Stations 2 and 3) located in the intertidal portion of the inter-causeway area within the eelgrass beds
- One station (Station 4) in the intertidal portion of the inter-causeway area at the head of the ship turning basin adjacent to DP3
- One station (Station 5) in the subtidal portion of the inter-causeway area within the ship turning basin adjacent to DP3
- One intertidal reference station (Station 6) located off Westham Island northwest of Deltaport
- One subtidal reference station (Station 7) located off Westham Island northwest of Deltaport

The surface water sampling methodology outlined below, including sample implement decontamination procedures, is based on the protocols developed for the Puget Sound Estuary Program (PSEP 1996). Representative surface water samples will be collected from each of the sampling stations.

A vessel equipped with a 5-litre Van Dorn sampler, constructed of clear lexan, will be used to collect surface water samples at each station. One water sample will be collected just below the surface and for the subtidal samples; one surface water sample will also be collected at a depth of two metres above the seafloor. As with the sediment sample, the surface water sampling stations will be located using a GPS. The vessel will be equipped with a depth sounder, however, to ensure that the sampler is triggered at an appropriate depth a two metre rope with a weight at the end will be attached to the base of the Van Dorn. To minimize the turbidity plume from disturbed sediment, the sampler will be lowered slowly and carefully as it approaches the bottom (based on depth sounder readings). Tripping the sampler is then delayed approximately one minute is used to allow currents at the site to transport turbidity generated by the weight out of the area of the sampler. Each recovered water sample will be examined to ensure acceptable sample quality, including no entrained sediment, and the water in the sampler decanted into laboratory prepared sample bottles. The five litre Van Dorn volume is sufficient to meet sample volume requirements. Similar to the sediment sampling process, field observations will be recorded at each station during sample collection. Field observations will include general information (e.g., station name, date, time), and a description of the site location, GPS coordinates, water depth and characteristics (e.g., colour, odour, turbidity).

As part of our quality assurance program, Hemmera will also undertake a number of measures including consistent use of the same field technicians, daily field reporting between field technicians and project manager, and submission of samples in laboratory supplied sterile sampling containers under chain of custody, following the directions provided by the analytical laboratory, etc. The required laboratory reported detection limits have been pre-determined with the laboratory so that the results can be compared to the appropriate regulatory screening levels. The detection limits and regulatory screening levels are provided in the AMS Detailed Workplan. One blind field duplicate sediment sample will also be collected during each sampling event to further assist in the evaluation of data quality. The data quality objective (DQO) for precision will be measured using the relative percent differences (RPD) between characterization and duplicate samples (to evaluate data precision) as well as percent completeness to evaluate the effectiveness of the sampling program with respect to the project objectives. Due to the limited number of samples, the DQO for completeness is 100%. The DQOs for precision will be 20% RPD for inorganic parameters and 50% RPD for organic parameters. Where reported concentrations of less than five times the detection limit are obtained, the DQO of a difference factor (DF) of < 2 will be used. The quality assurance program will also include review of the analytical laboratory's quality control results.

The samples will be stored in coolers on ice and transported directly to the laboratory at the end of the sampling day (approximately 1.5 hour travel time).

Data from Station 4, nearest the DP3 construction area, will also be monitored continuously for a number of water quality parameters (pH, temperature, conductivity, dissolved oxygen, and turbidity) using a YSI buoy-mounted sonde operated in conjunction with the DP3 construction environmental monitoring program. Data for the remaining water quality and sediment quality parameters will be collected during quarterly sampling programs.

A-2.2 Sample Analyses

The parameters analyzed to facilitate data interpretation include:

- Temperature
- pH
- Hardness
- Salinity

The parameters being analyzed to assess the presence/absence of toxicants include:

- Metals
- Chlorine[1]

[1] Chlorine will be collected from the ditch station only. The purpose is to evaluate potential impacts from chlorine to the inter-causeway area as historical releases of water from a nearby upland water park have been documented. Polycyclic aromatic hydrocarbons (PAHs) have been dropped from the program as no exceedances were noted during the Q1-2007 event.

Several of the water quality parameters were also selected for their use in facilitating identification of marine eutrophication and/or construction impacts. These include:

- Turbidity, TSS, Clarity (secchi disk)
- Nutrients (Phosphate, Phosphorus, Ortho-phosphorus, Total Kjeldahl Nitrogen (TKN), Total Nitrogen, Ammonia, Nitrate, Nitrite and Organic Nitrogen N)
- Chlorophyll *a*

A-2.3 DATA EVALUATION

As indicated above, a number of the monitored surface water parameters are to support data interpretation purposes and therefore do not require action levels. The other parameters collected, as indicators of potential toxicity to marine organisms, will be compared against the applicable provincial and federal water quality screening levels:

- British Columbia Approved Water Quality Guidelines (Criteria), 1998 Edition
- A Compendium of Working Water Quality Guidelines for British Columbia, 2001 Update
- Canadian Council of Ministers of the Environment (CCME) Water Quality Guidelines, 2006 Update

These analytical results will be provided in the quarterly reports with data interpretation and discussion of the sampling results provided only in the annual reports.

The remaining results will be presented in each quarterly report with evaluation for negative trends occurring within each annual report. As with the sediment sampling program, the data collected within the inter-causeway area will be tabulated, graphed, and statistically compared with the results from the relevant reference stations elsewhere along Robert's Bank. A 20-percent difference between the eutrophication parameter inter-causeway and far-field results will be used as a preliminary indicator of a potential for eutrophication impacts and will warrant discussion within the annual report. For some parameters, such as oxygen, where critical thresholds exist and changes of less than 20% may impact biota, the absolute value of the parameter will also be evaluated.

A-3 SEDIMENT

A-3.1 INVESTIGATION METHODOLOGY

As with the surface water sampling program, representative sediment grab samples will be collected from each sampling station on a quarterly basis (four times per year). The sampling methodology outlined below, including sample implement selection and decontamination procedures, is based on the protocols developed for the Puget Sound Estuary Program (PSEP 1996)[2]. A shallow draft vessel equipped with an

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[2] Puget Sound Estuary Program (PSEP) 1996. Recommended Guidelines for Sampling Marine Sediment, Water Column, and Tissue in Puget Sound. Prepared by King County Environmental Laboratory for Puget Sound Estuary Program, U.S. Environmental Protection Agency, Region 10, Seattle, WA.

8.2 L Ponar grab sampler will be used to collect the sediment samples. Field staff will work from the ditch bank to collect samples from the sediments at Station 1. Sampling stations will be located using global positioning system (GPS) coordinates. Each recovered grab sample will be examined to ensure acceptable sample quality, the supernatant water in the sampler will be decanted and the upper 5 cm of sediment will be placed in a clean stainless steel mixing bowl. Repeated grab samples may be required to fulfill sample volume requirements. The sample will be mixed with a stainless steel spoon until homogenous in texture and colour. However, sediment for hydrogen sulphide analysis will be collected prior to mixing to minimize oxidation and volatilization. Field observations will be recorded at each station during sample collection and will include general information (e.g., station name, date, time), a description of the site location, GPS coordinates, water depth, sediment characteristics (e.g., grain size, colour, odour, debris, visual contamination), and a record of the amount of effort required for sediment collection.

Aliquots of sediment for chemical analysis will be collected in 250mL laboratory prepared glass jars with Teflon lids for submission to the project laboratory for analysis of the parameters listed in **Section A-3.2**. The sediment samples are collected and transported to the lab generally by 5:30 pm the day the samples are collected. Sediment samples are placed in jars and immediately stored in a covered cooler with ice to keep them at a cold state, at or near $4^{o}C$ for delivery to the laboratory. All samples are analysed within the laboratory holding time.

Sediment samples for sulphide analysis are collected prior to homogenization and are placed in jars with no headspace in order to minimize the potential for oxidation. As with the other parameters, sulphide sample jars are then placed immediately on ice. The laboratory holding time for sulphides was 7 days during Q1 and Q2; however, it was reduced to 24 hours for subsequent events, to minimize potential loss through volatilization and increase the reliability of results. Sulphide analysis is via the laboratory method is described below:

- Add 8 – 12 drops of sodium hydroxide to a centrifuge tube to 5 g (based on dry weight) of sample into the tube.
- Add water.
- Shake for 20 minutes, then centrifuge.
- Filtered supernatant through a 0.45 micro filter.
- Transfer an aliquot to a test tube containing zinc acetate.
- Bulk the sample with MQ water and analyze colourimetrically.

The field sampling equipment (i.e., Ponar, bowls and spoons, etc.) will be decontaminated prior to sample collection at each station. This involves an initial rinse with site seawater, followed by washing with Alconox soap, a second rinse with site seawater, and final rinse with distilled water in accordance with the PSEP (1996) methodology.

Quality assurance measures (staff, sample handling, field duplicates and DQO) for the sediment sampling program will be the same as those outlined for the surface water sampling program (**Section A-2.1**) above. The detection limits and regulatory screening levels for sediment samples are provided in the AMS Detailed Workplan.

A-3.2 SAMPLE ANALYSES

Sediment samples are analyzed for the following parameters:

1. Metals were analyzed as indicators of potential toxicity to marine organisms (Tributlytin was analyzed only during the Q1-2007 event).
2. Parameters measured to evaluate sediment eutrophication include:
    - Total nitrogen
    - Ammonia
    - TKN
    - Total organic nitrogen
    - Phosphorous
    - Redox (Eh)
    - Hydrogen sulphide (H_2S)

Sediment grain size samples are collected annually.

A-3.3 DATA EVALUATION

The toxicity parameters, when sampled, will be compared against the BC Contaminated Sites Regulation, Schedule 9 Generic Numerical Sediment Criteria for sensitive marine and estuarine sediments ($SedQC_{ss}$) and the Puget Sound Dredge Disposal Analysis (PSDDA) criteria for TBT as indicated in the AMS workplan document. These analytical results will be provided in the quarterly reports. Anomalous results will be highlighted and briefly discussed. Data interpretation and discussion of the sampling results will be provided only in the annual reports

The remaining sediment quality parameters will be evaluated within each annual report for observable trends. The data collected within the inter-causeway area will be tabulated, graphed, and statistically compared with the sediment results from the reference stations and with data from previous years sampling. A 20-percent difference between the eutrophication parameter inter-causeway and far-field results or between results from year to year will be used as an indicator of a potential for eutrophication impacts and will warrant discussion within the annual report.

A-4 EELGRASS

A-4.1 INVESTIGATION METHODOLOGY

A-4.1.1 Eelgrass Distribution and Mapping

Aerial photograph interpretation will be used to develop a base layer for mapping the current distribution of eelgrass in the inter-causeway area. Aerial photograph flights used for the eelgrass monitoring program are to be flown in July 2007 and at the same time in subsequent years. The amount of cloud cover, sun angle, and season at the time when the photos are flown; and the resolution of the photos, will determine whether it is possible to distinguish between areas that support a monoculture of *Z. japonica* and areas that support a monoculture of *Zostra marina*. There is a 'transition' zone between these two habitats in the inter causeway area where the two species co-exist. It may be possible to approximate the boundaries of the transition area from the photos. Homogenous habitat types will be delineated to form polygons. We have proposed a minimum polygon size of 50 m by 50 m; however, this may be modified through discussions with Vancouver Fraser Port Authority (VFPA).

A field survey will follow the aerial photograph interpretation to confirm and/or determine the species composition of each polygon. The boundaries of the transition area will likely need to be determined on-site and mapped using a GPS. *Zostra japonica* is an annual species; although a small percentage of the shoots may survive throughout the winter. To accurately map the distribution of this species the field survey should be completed between June and early September.

The data collected during the field survey would be incorporated onto the base layer by Hemmera to create a GIS map that accurately depicts the current distribution of eelgrass in the inter-causeway area.

A-4.1.2 Monitoring Eelgrass Vigour and Health at the Established Stations

The annual eelgrass vigour and health survey will be conducted during one of the low tide cycles between mid July and mid August and will assess the health and growth of eelgrass at nine of the eelgrass monitoring stations that were established for the DP3 Environmental Assessment, including four stations in the inter-causeway area, two stations west of the Westshore Coal Terminal and Deltaport Causeway and three reference stations in Boundary Bay.

The parameters that will be monitored at each of the stations will include those assessed for the baseline study; shoot density, shoot length, and shoot width[3]. This data will be used to calculate Leaf Area Indices (LAI) at each location.

[3] Quadrat sampling along transects as described in *Methods for Mapping and Monitoring Eelgrass Habitat in British Columbia* (Precision 2002).

The distribution of *Zostra marina* at each station will be classified as patchy, continuous, or absent. The percent cover of *Zostra japonica* will be ranked according to the following scale: <1% present; 1% to 40% sparse; 41% – 75% moderate; >75% dense.

The monitoring plan includes noting the presence or absence of epiphytes at each of the stations. It would be possible for Ms. Durance, based on her 25 experience with this population of eelgrass to further classify the presence of epiphytes in the inter-causeway area as typical, less than usual, or more than usual.

The presence or absence of *Beggiatoa* sp. will also be noted. Ms. Durance has never observed *Beggiatoa* sp. at Roberts Bank. In the unlikely event that it is noted during an annual monitoring event, a strategy would need to be developed so that increases or decreases in the area covered by this species could be assessed. The location of the *Beggiatoa* sp. would be recorded using a GPS, for future reference. If there is sufficient time available the crew will map the area covered by *Beggiatoa* sp. VFPA will be notified immediately, with suggestions as to how to modify the AMS to include mapping and monitoring changes in the distribution of this species.

A-4.1.3 SIMS Survey

A Subtidal Imaging and Mapping System (SIMS) survey will be used to determine the lower limit of eelgrass in the inter-causeway during the summer of 2009. The SIMS method and equipment is only available through Archipelago Marine Research (AMR).

SIMS is a towed video system developed to carry out systematic mapping of marine vegetation, macroinvertebrates, seafloor substrates and morphology from the intertidal zone to depths of about 40m. The field of view is approximately 1 m by 2-3 m. The acquired imagery (digital video format) is geo-referenced using differential GPS with positions and time “burned onto” the video imagery with one-second update intervals. Depth of the towfish is also shown on the image. The towfish is maintained at an elevation of 1-1.5 m above the seafloor. Tow speed for SIMS is about 1 knot (2 km/hr) yielding a line coverage of 12 to 15 km in a typical survey day. A seven metre vessel provided and operated by Arrawac Marine Services is used to conduct the survey. A laptop computer is used for pre-plotting the navigation lines and for showing the vessel track lines during the survey. The position, depth and video time data is stored in custom MS Access database format developed for the SIMS classification system.

The video imagery is classified (by a geologist and a biologist) for substrate, epiflora (macrophytes) and epifauna (including fish) using a standard substrate and biotic classification system initially developed for the Province of British Columbia. The SIMS database system allows data entry for each second of video imagery collected. The interpreted data are interfaced with ArcView for map production. Typically the survey product is a comprehensive portfolio of maps, developed in GIS format, showing sediment type, major vegetative features, macroinvertebrates and fish observations and an interpretation of valued and sensitive biophysical features.

A-4.2 Data Evaluation

An eelgrass distribution map will be produced annually, based on aerial photograph interpretation and confirmed by ground truthing. A brief report will accompany a map that assesses changes that were observed in a local and regional context. This information will be compiled and summarized within each annual report for consideration by the SAC.

Natural eelgrass densities may vary significantly between years due to climatic changes. Although the mean density tends to be stable over time, environmental change such as El Niňo events may lead to severe changes in density. An El Niňo winter followed by a La Niňa summer once resulted in a ten-fold density increase in at least several eelgrass beds in British Columbia and Washington State. Data (vigour and epiphyte load) from the inter-causeway would be compared with many other sites in addition to Boundary Bay to ascertain whether changes subsequent to development at Roberts Bank are due to impacts attributable to the DP3 project, other non-DP3 anthropogenic causes, or natural causes.

A-5 BENTHIC COMMUNITY

A-5.1 Investigation Methodology

Benthic community health in the inter-causeway area is linked to sediment quality and water quality; and it is anticipated that if significant changes are seen in benthic community health, effects would also be observed in surface water quality and/or sediment quality (see **Sections A-2** and **A-3**). Therefore, sediment samples for benthic community analysis will be co-located with surface water and sediment samples from six of the seven sampling stations identified for the surface water and sediment quality monitoring programs. No benthic samples will be collected for station DP-01 as this station is located in a drainage ditch discharging to the inter-causeway area. The samples for benthic invertebrate analysis will be collected separately during the sediment sampling program. Samples will be preserved and packaged in the field, as required, and shipped to Biologica Environmental Services, Ltd., who process the samples and report taxonomic results to Hemmera.

The first benthic community sampling event will be completed during the first quarterly sampling event prior to the start of dredging. The next benthic invertebrate sample collection event is scheduled to occur during the Q1-2008 sampling event in March 2008. During the March 2008 event, a fourth benthic sampling station will be sampled. The location will form the fourth corner of a rectangle created by connecting stations DP02, DP03 and DP04 and the new station. Water quality and sediment samples will be collected at this station only during the benthic community sampling event and not during subsequent quarterly monitoring events. Further benthic community sampling will be completed at the end of construction during the first post-construction quarterly sediment sampling event. To facilitate data management, a fixed naming convention will be used. For instance, DP01A-1 will denote a sample collected at DP01, with the letter distinguishing between the three benthic invertebrate samples collected at this location, and the number specifying that the sample was collected during the first benthic invertebrate sampling event.

To capture inherent variability potentially present at the stations, three replicates will be initially collected per station for the benthic community sampling (*Benthic Marine Habitats and Communities of the Southern Kaipara*, Aukland Regional Council Technical Publication 275). Should the results of statistical analysis of variance of richness and abundance in the first year's benthic community sampling indicate acceptable variance observed between the replicates, we propose to reduce the sampling to one replicate sample per station during the second event. We have proposed an acceptable level of variance as being less than 20%.

Sampling methodology will be similar to that for the sediment sampling described in **Section A-3.1** but with some modifications. For the benthic community sample, the supernatant water is not decanted. After examination of grab quality, including consistent sample volume between stations, the sediment is placed in a plastic container (Tupperware bin) and transferred to a pre-cleaned stainless steel screening station on shore. The sample contents are gently rinsed through a 1.0 mm mesh sieve using seawater strained for zooplankton using a fine nylon mesh. The sample material remaining on 1.0 mm sieves is transferred into 1 L plastic containers and preserved in a 10% solution of formalin buffered with marble chips. These samples are then transported to Biologica for taxonomic identification. Taxonomic identification of benthic invertebrates will be down to the species level, where practical, and include both the diversity (number of species) and abundance of individuals for adult, juvenile and intermediate life stages.

A-5.2 Data Interpretation

As stated in the AMS, infaunal and epifaunal benthic community results will be evaluated and the data collected within the inter-causeway area will be tabulated, graphed, and statistically compared with the benthic results from reference stations elsewhere along Robert's Bank. A 20-percent difference from elsewhere along Robert's Bank will be used as an indicator of a potential for benthic community impacts in the inter-causeway area requiring further discussion within the final annual report.

Benthic community health is linked to sediment quality and water quality; therefore, it is expected that if significant changes are seen in benthic community health, effects would also be observed in surface sediment quality and/or water quality.

The sampling results will also be compared to video observations made during the SIMS survey that is part of the Eelgrass program (**Section A-4.1.3**). As stated above, the video imagery will be used for epiflora (macrophytes) and epifauna (including demersal fish) classification using a standard system initially developed for the Province of British Columbia. The SIMS database system allows data entry for each second of video imagery collected. The interpreted data are interfaced with ArcView showing sediment type, major vegetative features, macroinvertebrates and fish observations and an interpretation of valued and sensitive biophysical features.

A-6 BIRDS

A-6.1 INVESTIGATION METHODOLOGY

A-6.1.1 2009 Methodology

Hemmera has conducted coastal seabird surveys as part of the DP3 AMS from 2007 until the present. As of May 2008, the survey methodology previously used in the DP3 AMS, DP3 supporting studies, and by CWS was modified to incorporate adaptations to the scope of the AMS. Following input from Hemmera and discussion with the Scientific Advisory Committee (SAC) and CWS, these adaptations were implemented pursuant to SAC and CWS recommendations. To supplement the original methodology (described below) for key species, Hemmera recommended conducting time effective "windshield" peak count surveys for brant geese (brant) and great blue heron during the key timing windows for each species (February to April for brant, and June to August for great blue heron).

Bird studies will be completed along the south side of the Deltaport Causeway and along the shoreline at the head of the inter-causeway area (Tsawwassen First Nation Lands). Multiple, fixed-distance point counts will be completed along the following two transects:

- Deltaport Transect: South side of Deltaport Causeway (point count stations 12 – 19)
- Tsawwassen First Nation (TFN) Transect: TFN Lands (point count stations 105, 109, and 115)

Point count locations are already established near landmarks, and can be located by GPS if necessary if shoreline habitat changes (such as during habitat restoration along the East Causeway). The sample plot associated with each point count station is approximately 500 m^2, except for point count stations 105 and 115, which are approximately 1,000 m^2 (due to the merging of five point count stations into three during AMS scope adaptations).

One monitoring event will be completed every month. Observations will be made once during a daily high tide and once during a daily low tide. Observations will be made at each tide level each survey day, as daylight permits, or on two consecutive days within a 3-day monitoring window. Low-tide observations along the Deltaport Transect will commence approximately 30 minutes before the daily low tide, and will be made when a minimum of 500 m of mudflat is exposed. The low-tide surveys will progress from the tip of the causeway to the base. Observers will use binoculars and spotting scopes to identify species and distances from the point count stations. Observers will count individuals and groups of birds and document bird behaviour. Data will be recorded into a hand-held PDA with digital forms that are consistent with those used by VFPA and Canadian Wildlife Service (CWS) in past bird studies.Observers will count birds within the following distance categories, according to the following scheme:

- 100 m inland to the shore (TFN Transect only)
- 0 – 250 m from shore
- 250 – 500 m from the shore
- > 500 m to approximately 1 km

If large numbers of birds are observed within a sample plot, then observers will count a group of 100 individuals and then multiply the total number of groups within the sample plot. Birds observed in flight will be recorded as 'flyovers' and the flight direction will also be recorded; these records will be distinguished from records made for birds occurring on water or land. The duration of observation at each point count station will be 20 minutes, during which time all birds will be counted within the boundaries of the sample plot (approximately 500 m^2 and up to distance of 1 km from land, and 100 m inland).

Windshield surveys are a fast and efficient method for determining peak numbers of focal species within the inter-causeway area. Windshield survey methodology involves stopping at a subset of the proposed point count stations to count all visible individuals of the given focal species, with no minimum time requirement. Windshield surveys are conducted at the most ideal time to identify the maximum number of individuals within a short period of time. In the experience of Hemmera's biologists, we have found that the most productive time to count brant is within approximately one hour on either side of the peak high tide during the winter months, when brant flock together in the middle of the inter-causeway area, making them more visible to observers. Similarly, the most productive time to count great blue heron is within one hour on either side of the peak low tide during the summer months, when herons come to hunt amongst the eelgrass beds.

A.61.2 2007 – 2008 Methodology and Adaptations

Bird studies were completed along the south side of the Roberts Bank causeway, north side of the Tsawwassen Ferry Causeway and the intervening shoreline at the head of the inter-causeway area. Multiple, fixed-distance point counts will be completed along the following 3 transects:

- South Roberts Bank Transect (Deltaport Transect): South Roberts Bank causeway (point count stations 12 – 19)
- Tsawwassen First Nation (TFN) Reserve Lands Transect: TFN Lands (point count stations 105 – 115)
- Tsawwassen Ferry Causeway (BC Ferries) Transect: Tsawwassen Ferry Jetty (point count stations 118 – 126)

The sample plot associated with each point count station will be approximately 500 m^2. The coordinates of the point count stations will be determined using GPS. Point count stations will be identified with either flagging tape or paint sprayed on the ground surface. Stakes will be used along the South Roberts Bank Transects to mark the point count stations at intervals of 500 m. Point count estimates will also be made at distances ranging from greater than 500 m to approximately 1 km.

One monitoring event will be completed every two weeks. Observations will be made at a frequency of twice each day, as daylight permits, or on two consecutive days within a 3-day monitoring window. Observations will be made once during a daily high tide and once during a daily low tide. Low-tide observations along the South Roberts Bank Transect will commence approximately 30 minutes before the daily low tide, and will be made when a minimum of 500 m of mudflat is exposed. The low-tide surveys will progress from the tip of the causeway to the base. Observers will use binoculars, spotting scopes and range-finding binoculars to identify species and their distances from the point count stations. Observers will count individuals and groups of birds and document bird behaviour. Observational data will be recorded on survey forms that are consistent with those used by VFPA and Canadian Wildlife Service (CWS) in past bird studies.

The South Roberts Bank Causeway Transect (point count stations 12 - 19) will undergo a more intensive survey in comparison to the other observational transects. Observers will use consistent survey methodology along all transects; however, observers working along the South Roberts Bank Transect will conduct fixed-distance point counts within smaller sub-plots, according to the following scheme:

- 0 – 100 m from the shore
- 100 – 200 m from shore
- 200 – 300 m from shore
- 300 – 400 m from shore
- 400 – 500 m from shore
- > 500 m to approximately 1 km

Observers along the TFN Reserve Lands and Tsawwassen Ferry Causeway Transects will count birds within relatively larger sub-plots, according to the following scheme:

- 100 m inland to the shore
- 0 – 250 m from shore
- 250 – 500 m from the shore
- > 500 m to approximately 1 km

If large numbers of birds are observed within a sample plot, then observers will count a group of 100 individuals and then multiply the total number of groups within the sample plot. Birds observed in flight will be recorded as ‘flyovers’ and the flight direction will also be recorded; these records will be distinguished from records made for birds occurring on water or land. The duration of observation at each point count station will be 20 minutes, during which time all birds will be counted within the boundaries of the sample plot (approximately 500 m^2 and up to distance of 1 km from land, and 100 m inland).

As of May 2008, the bird survey methodology described above was modified following adaptations to the scope of the AMS. Following discussion with the Scientific Advisory Committee (SAC) and CWS, the following adaptations have been implemented pursuant to SAC and CWS recommendations:

- Bi-weekly survey events will be reduced to monthly survey events with the exception of a six-week window during the spring western sandpiper migration;
- Point count stations on the TFN transect will be reduced from 5 to 3 (PCs 113 and 115 will be merged, PCs 105 and 107 will be merged, and PC 109 will be retained);
- Surveys along the BC Ferries transect will be discontinued;
- Subplots on the Deltaport transect will now be consistent with subplots on the TFN transect and consistent with CWS methodology from 2004 surveys along Robert's Bank (**0-250 m, 250 – 500 m, and 500 m – 1 km)**.

One tidal survey event (as opposed to a low and high-tide event) is conducted during the winter months (December to February) as previously agreed by CWS (R. Butler and B. Elner pers. comm., Nov 2007).

A-6.2 DATA EVALUATION

Hemmera will document changes in species distributions that are linked to operation and post-construction activities. Hemmera's analysis of the bird monitoring data will yield: (1) total estimated counts and relative abundance of birds for a particular sample plot and/or sub-plot, and (2) the number of birds per unit area (i.e., km^2) or density. A total estimated count is indicated by the sum of the total number of birds observed in each sample plot, along a specific transect and at a given time. Species densities will be derived from post-construction monitoring conducted as part of the AMS monitoring program. Densities will be determined using the formula below.

$$D = B/A$$

Where:

D = density of birds (i.e., birds / km^2)

B = No. of birds observed

A = area surveyed

Data interpretation of windshield survey data will differ from point count data interpretation. These surveys allow a more representative total population count of the individuals using the inter-causeway area than the point count surveys, as the duration of the survey minimizes possible recounting of individuals. However, the short duration of windshield surveys minimizes the ability to collect data about the spatial distribution of birds. This will likely limit the ability to report on spatial distribution of birds within the inter-causeway area. However, Hemmera's biologists believe that data from Years 1-3 of the AMS and baseline studies has well documented habitat use patterns within the inter-causeway area. Hemmera biologists also note that the monthly frequency and short (but efficient) duration of windshield surveys may not entirely encompass variability in bird populations or account for movement in and out of the inter-causeway area from day to day, which may obscure more accurate seasonal patterns.

Data collected during the monitoring period will be compared to pre-construction baseline data and construction period data to determine whether operation and post-construction activities result in significant changes in species populations. Hemmera will import the baseline data into its data management system to facilitate interpretation. Data interpretation will include comparisons between baseline monitoring results and construction and post-construction results, as well as spatial and temporal trend analyses using a standard statistical package (i.e., T-test, linear regression) to detect positive or negative trends occurring among the sample plots. VFPA will be immediately notified if negative trends are observed during data interpretation. Additionally, Hemmera will provide VFPA with recommendations, if necessary, to implement or modify mitigation measures to prevent or attenuate observed negative ecosystem trends. The data will be reported in event summary reports for each survey, quarterly reports and annual reports. Following the conclusion of point count surveys in June of 2010, the content of all reports will be limited to only two species (brant and great blue heron), and will have limitations on the ability to comment on spatial distribution. Hemmera will continue to provide current advice regarding potential changes in survey methodology in consultation with the SAC and/or VFPA, and will remain open to changes in methodology.

APPENDIX B
NHC Photos

Photo 1: Crest Protection Monitoring XS 1 looking back at Deltaport, July 2009

Photo 2: Crest Protection Monitoring XS 2 looking north, July 2009

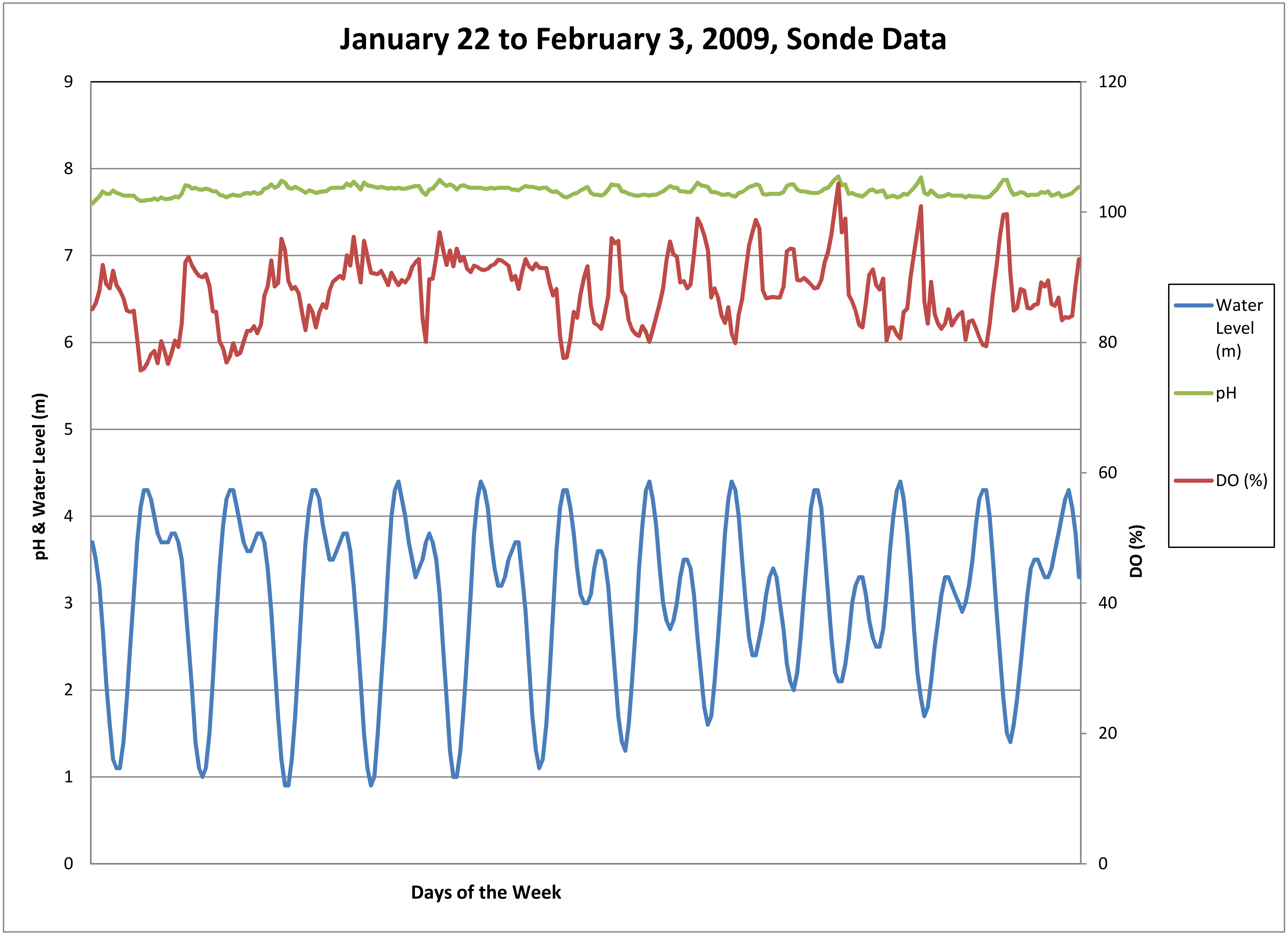
Photo 3: Crest Protection Monitoring XS 3 looking northeast, July 2009

Photo 4: Crest Protection Monitoring XS 4 looking east, July 2009

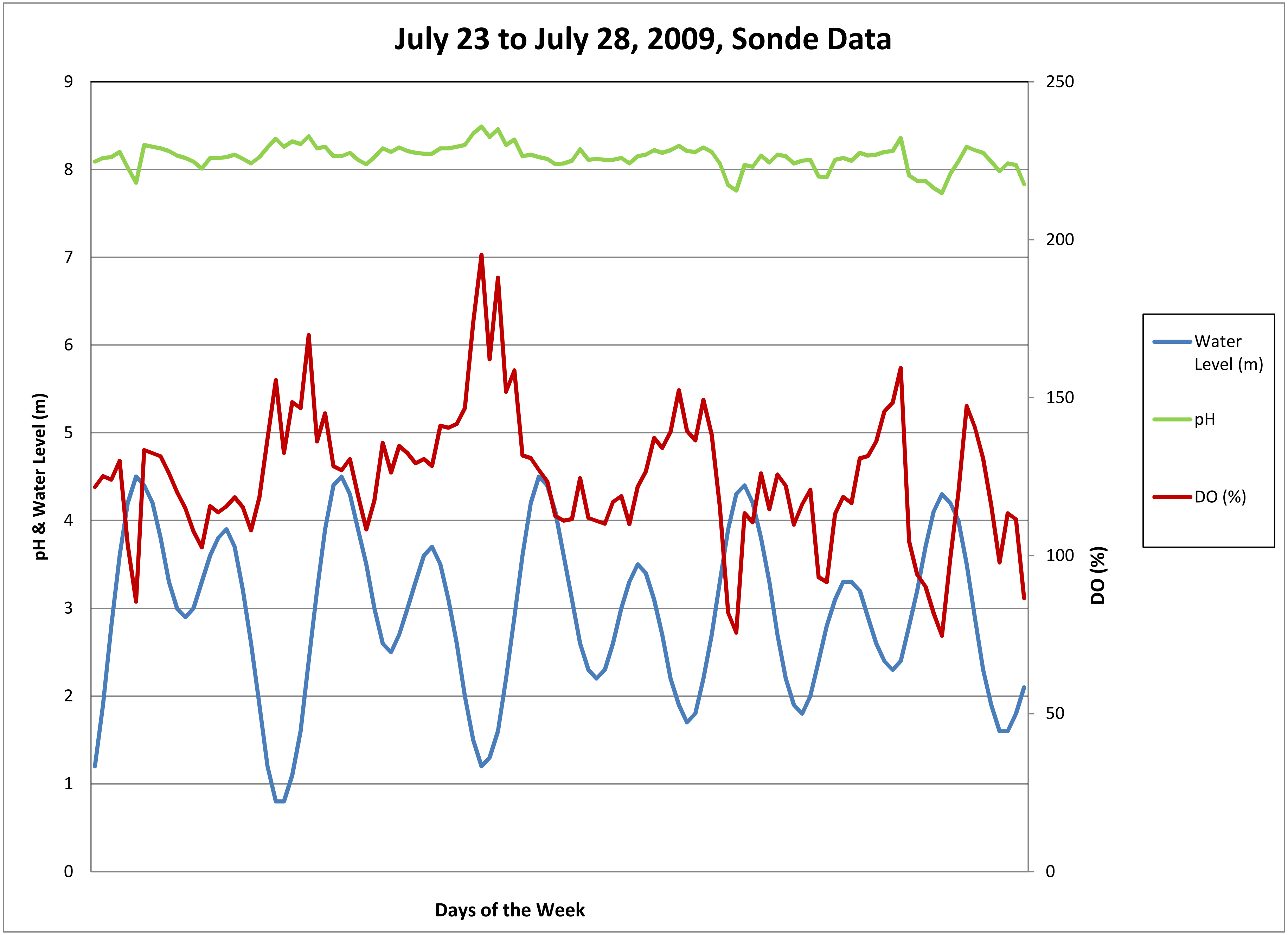
Photo 5: Crest Protection Monitoring XS 5 looking southeast, July 2009

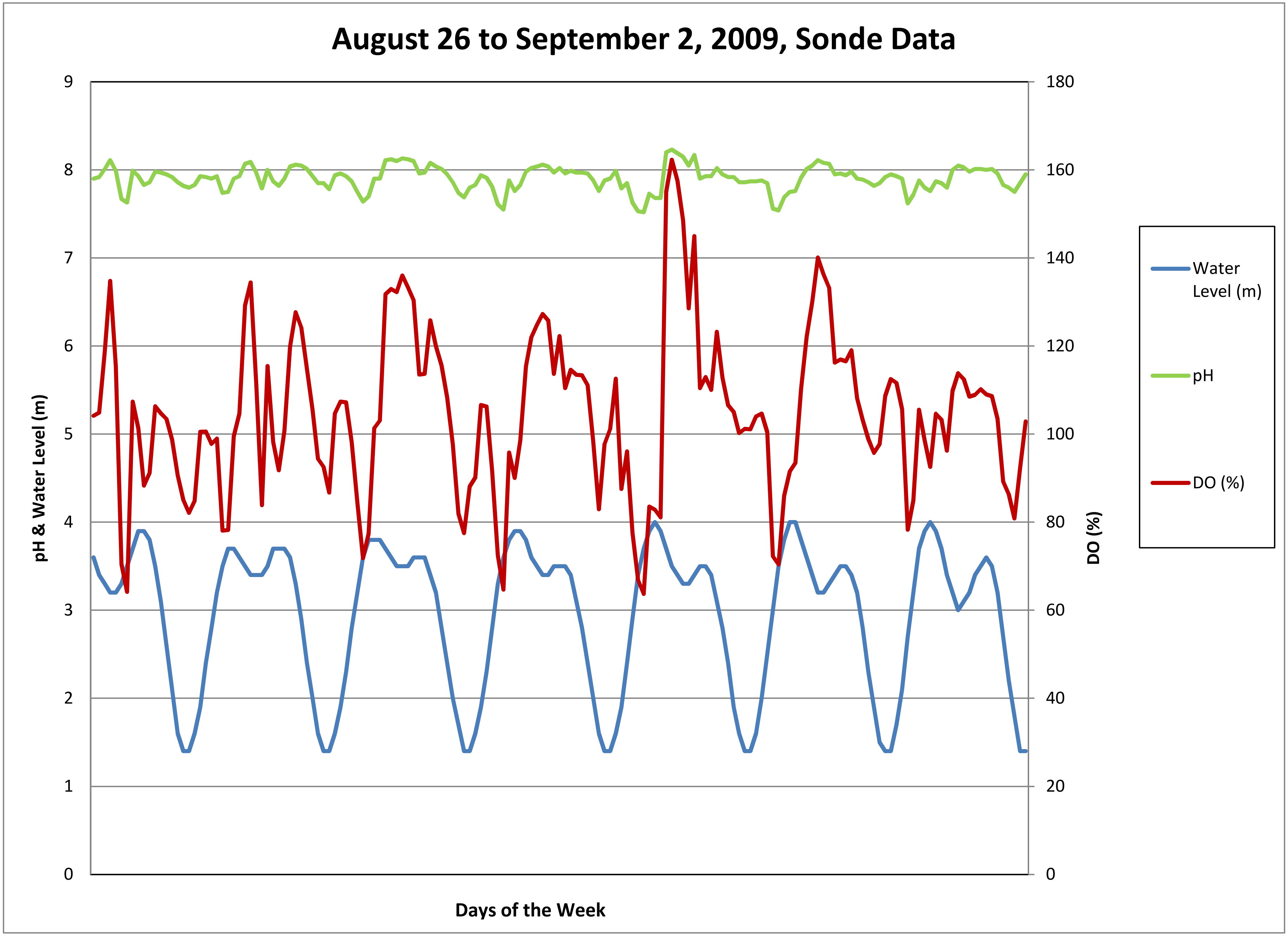
APPENDIX C

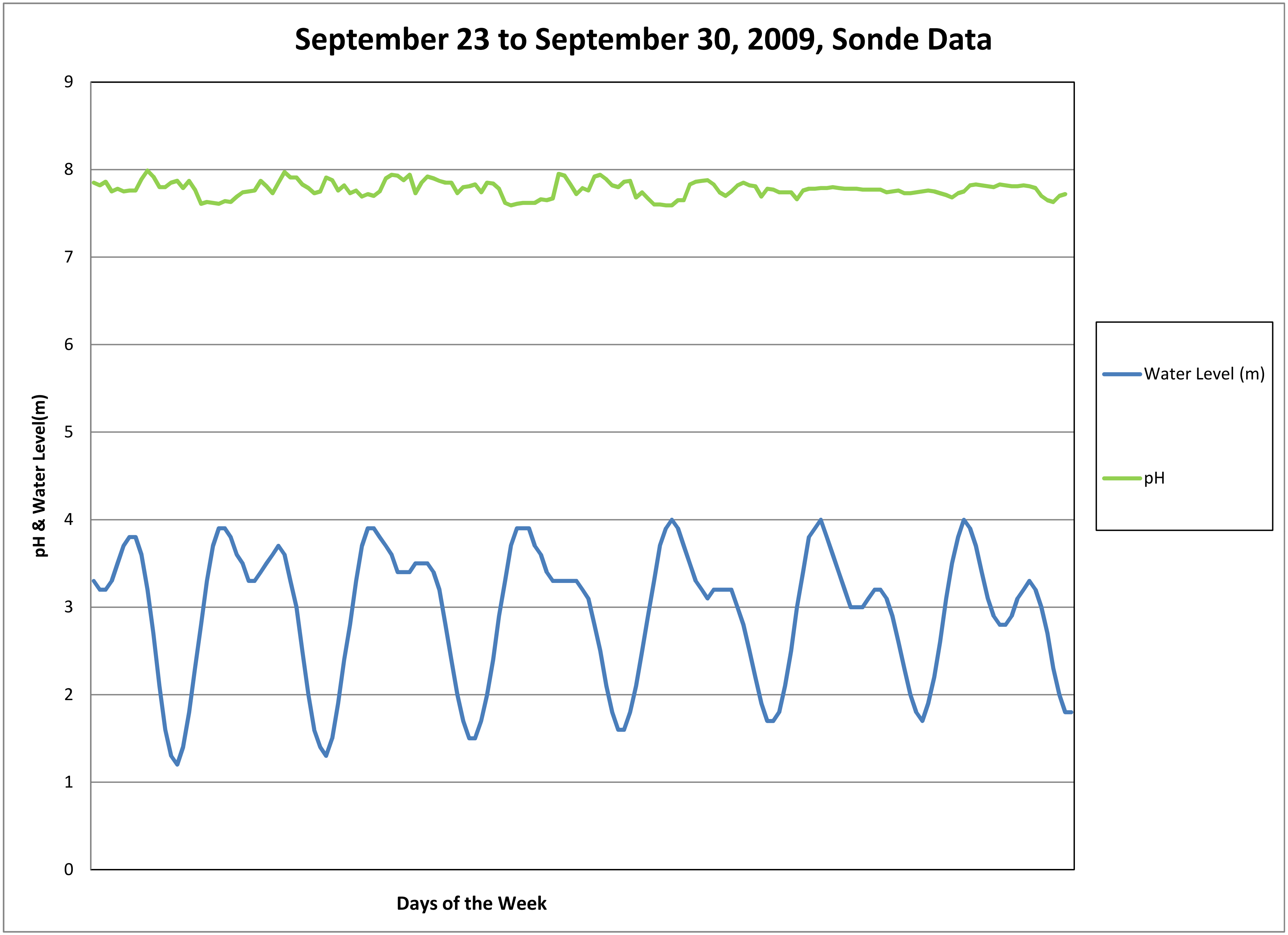
Sonde Data

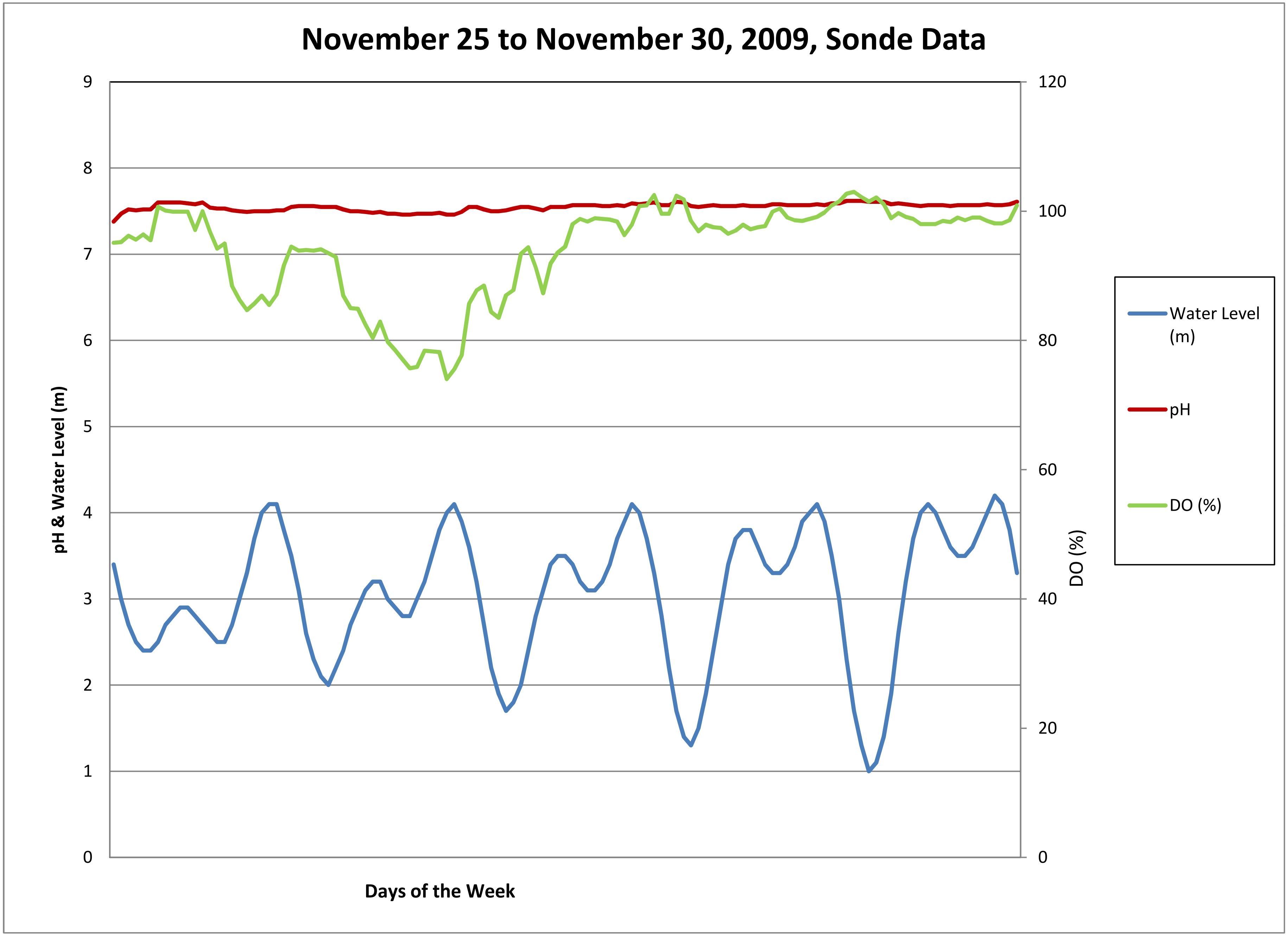


January 22 to February 3, 2009, Sonde Data
9
8
7
6
5
4
3
2
1
0
pH & Water Level (m)
120
100
80
60
40
20
0
DO (%)
Days of the Week
Water Level (m)
pH
DO (%)


July 23 to July 28, 2009, Sonde Data
pH & Water Level (m)
0
1
2
3
4
5
6
7
8
9
DO (%)
0
50
100
150
200
250
Days of the Week
Water Level (m)
pH
DO (%)


August 26 to September 2, 2009, Sonde Data
pH & Water Level (m)
0
1
2
3
4
5
6
7
8
9
DO (%)
0
20
40
60
80
100
120
140
160
180
Days of the Week
Water Level (m)
pH
DO (%)


September 23 to September 30, 2009, Sonde Data
pH & Water Level(m)
0
1
2
3
4
5
6
7
8
9
Days of the Week
Water Level (m)
pH



November 25 to November 30, 2009, Sonde Data
pH & Water Level (m)
DO (%)
Days of the Week
0
1
2
3
4
5
6
7
8
9
0
20
40
60
80
100
120
Water Level (m)
pH
DO (%)

APPENDIX D
Eelgrass Statistical Analysis Results

APPENDIX D: EELGRASS

Figures and tables are provided in the following order:

Figure A-1 Eelgrass distribution in the inter-causeway based on orthophoto interpretation and field surveys conducted in 2003 and 2007

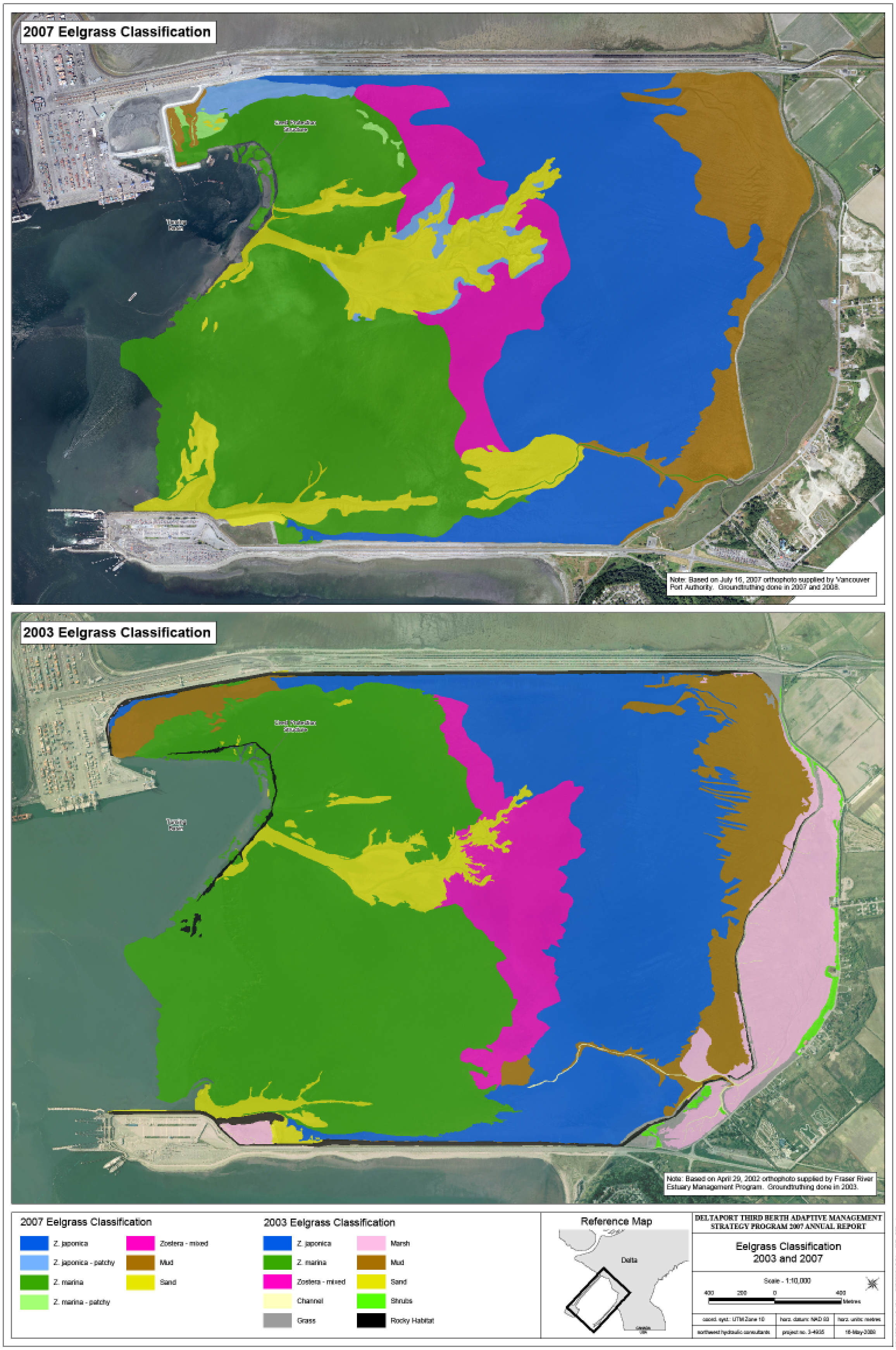


Figure X

Figure A-2. Eelgrass distribution in the inter-causeway based on orthophoto interpretation and field surveys conducted in 2008

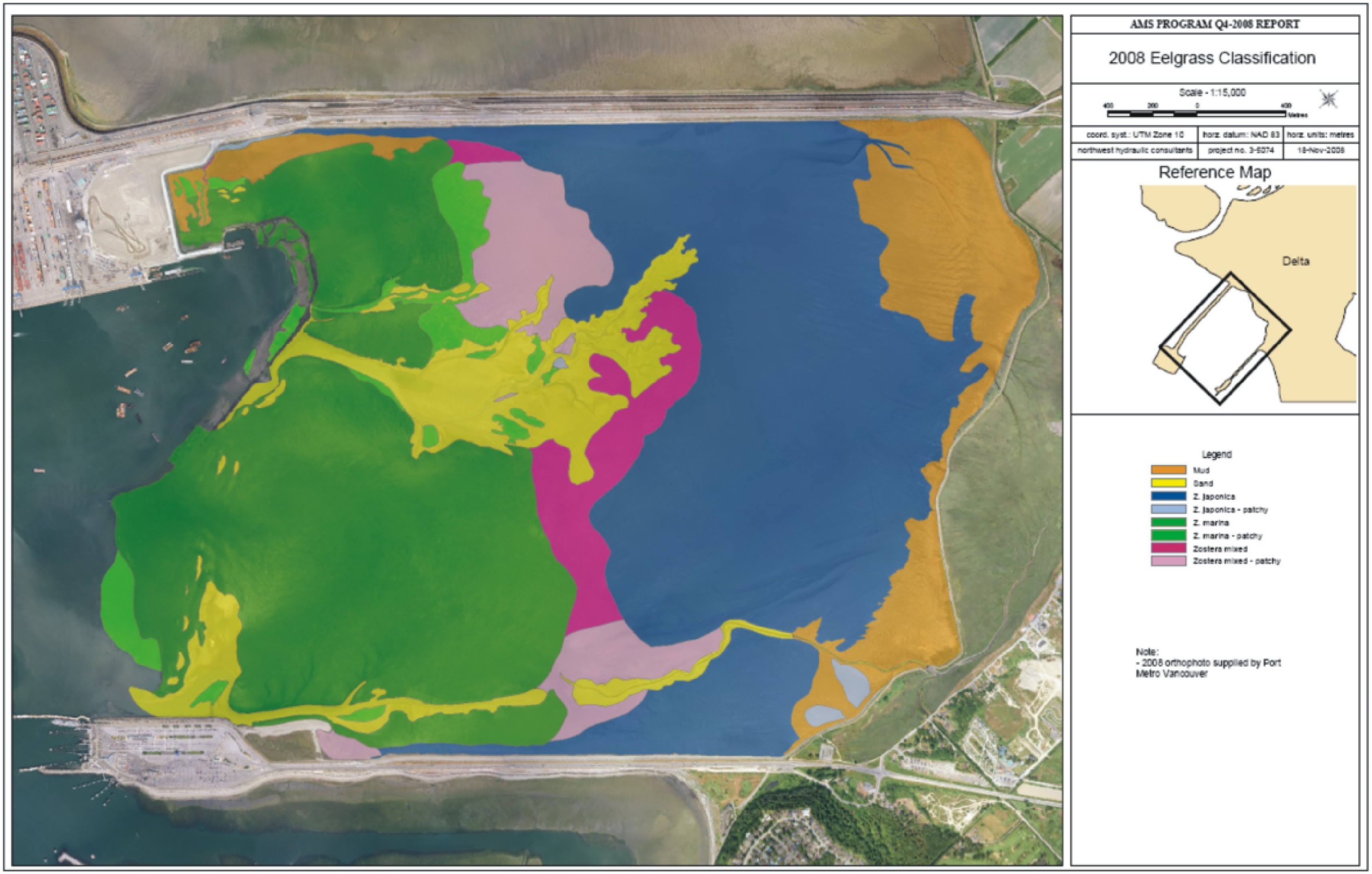


Figure A-3 SIMS survey. The track lines followed for the SIMS survey in August 2009 are shown below. The eelgrass cover was based on a review of the towed video imagery. The lower limit of eelgrass that was visible on the 2003 orthophoto is shown.

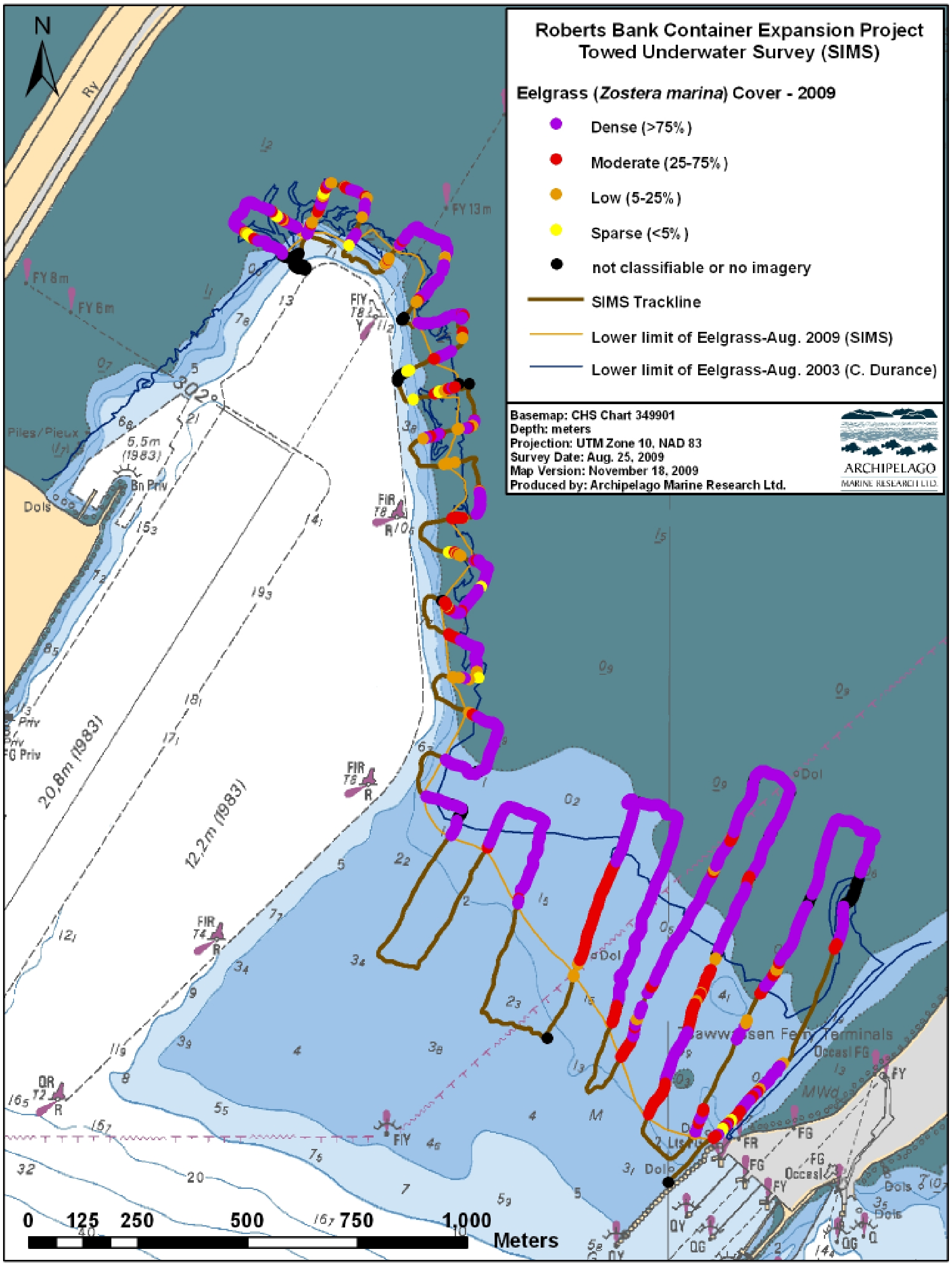


Figure A-4 Mean eelgrass shoot density data from Roberts Bank, Inter-causeway near Deltaport Causeway, Sites 1A, 1B, and 2

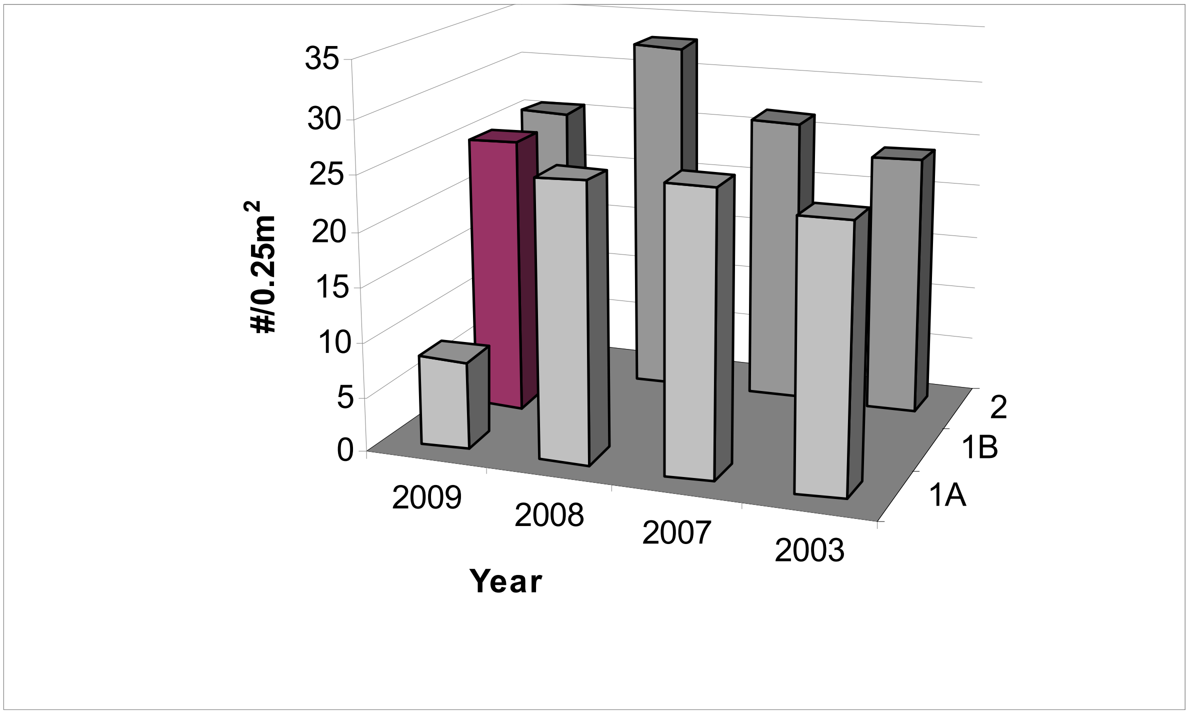


Figure A-5 Mean eelgrass shoot density data from Roberts Bank, west of Deltaport Causeway, Sites 3 and 4

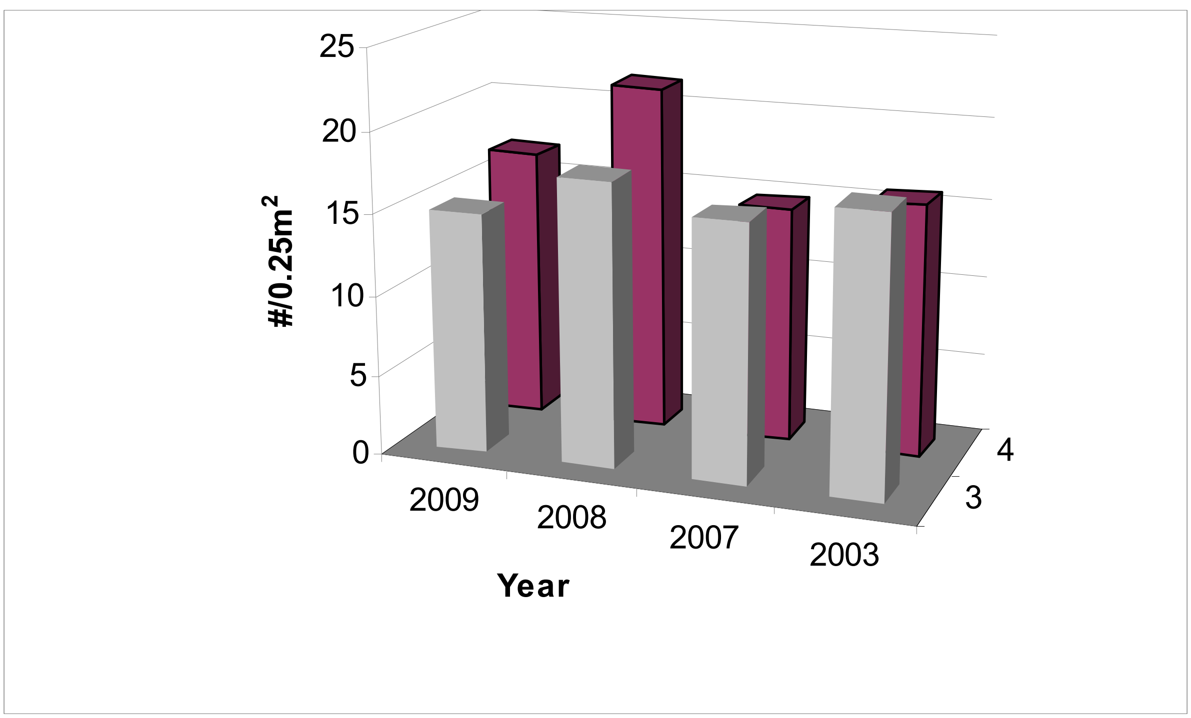


Figure A-6 Mean eelgrass shoot density data from Roberts Bank, Inter-causeway near Ferry Causeway, Sites 5 and 6

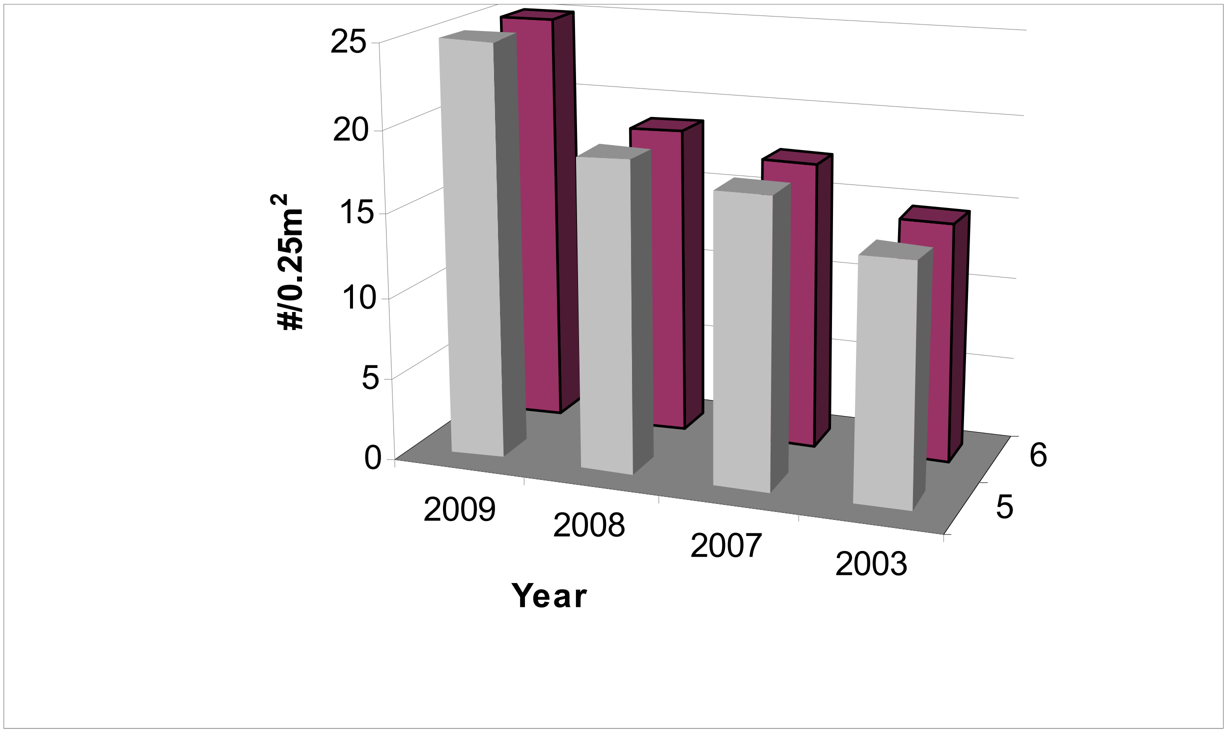


Figure A-7 Mean eelgrass shoot density data from Boundary Bay, Sites WR1, WR2, and WR3

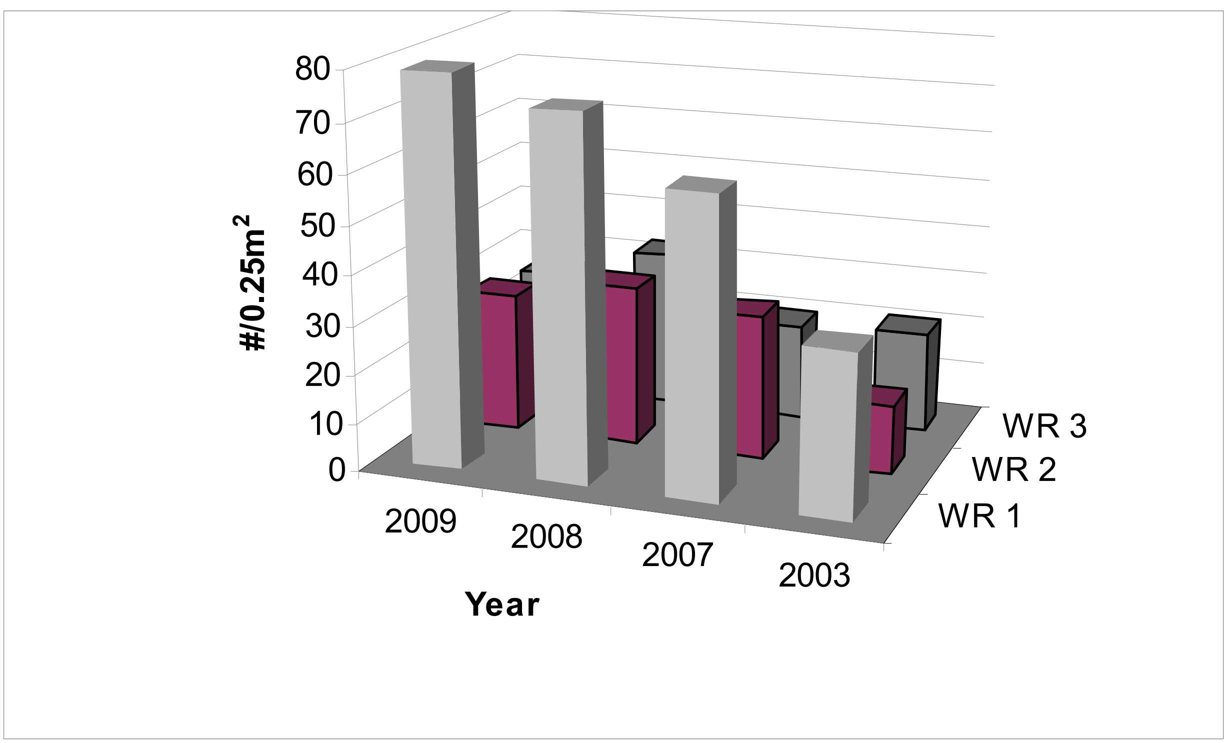


Figure A-8 Mean eelgrass shoot length data from Roberts Bank, Inter-causeway near Deltaport Causeway, Sites 1A, 1B, and 2

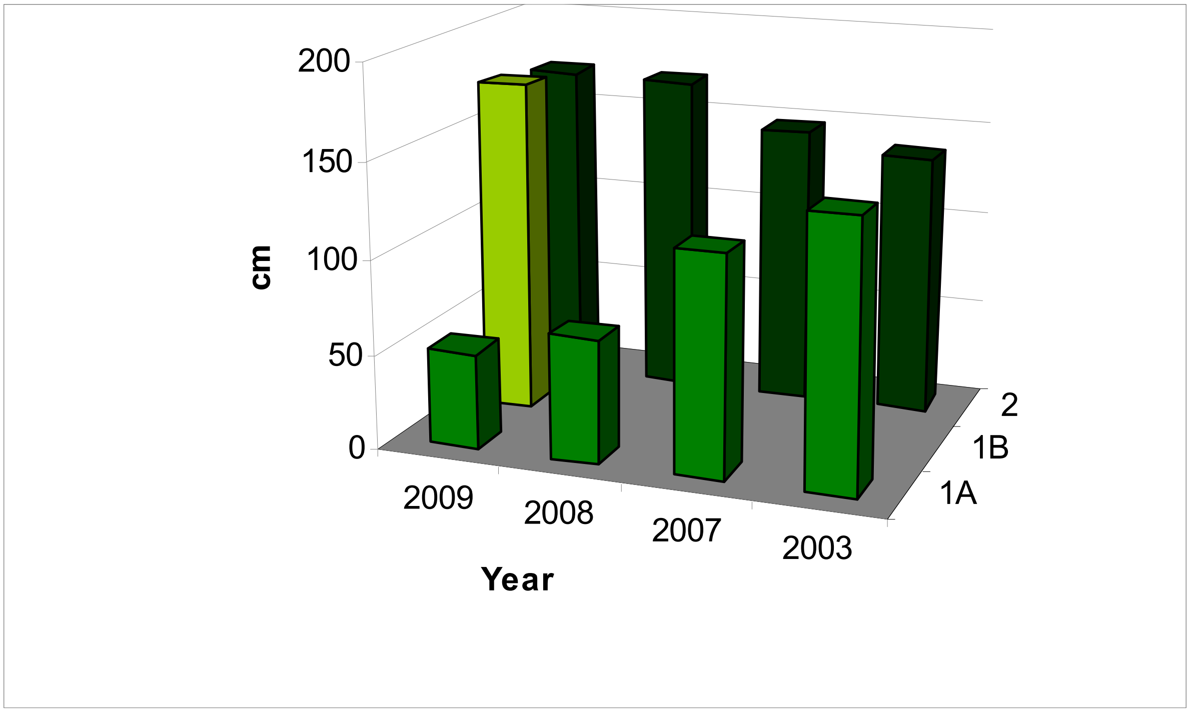


Figure A-9 Mean eelgrass shoot length data from Roberts Bank, west of Deltaport Causeway, Sites 3 and 4

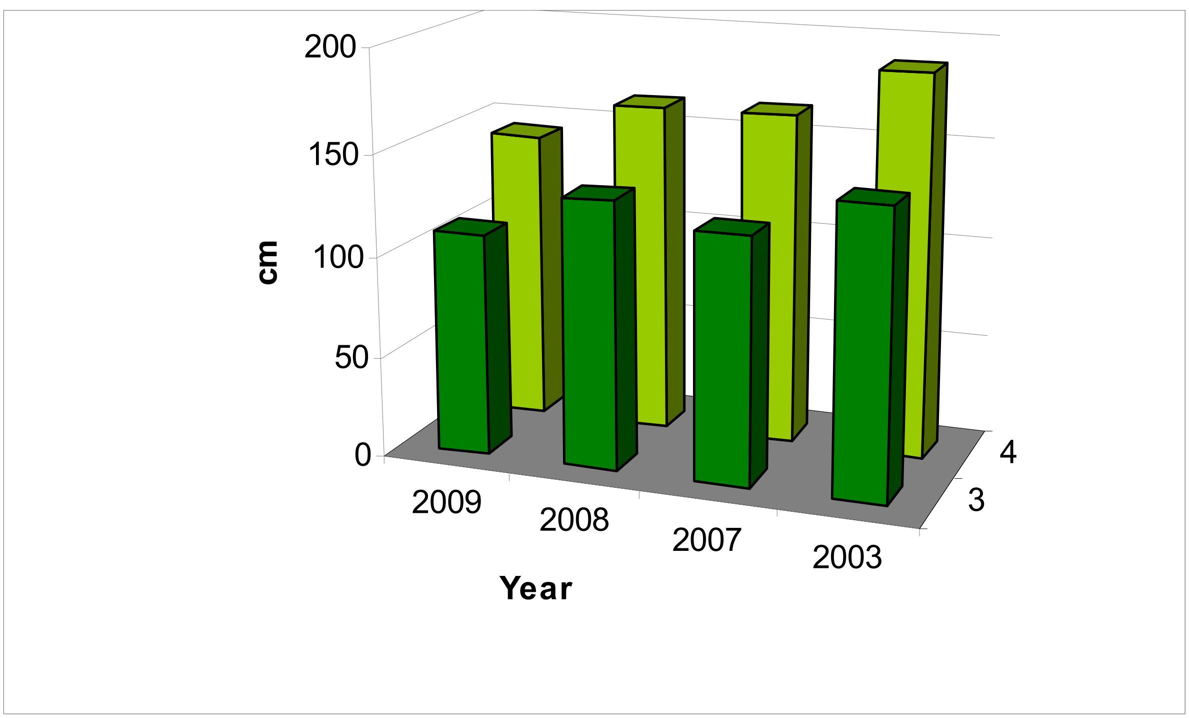


Figure A-10 Mean eelgrass shoot length data from Roberts Bank, Inter-causeway near Ferry Causeway, Sites 5 and 6

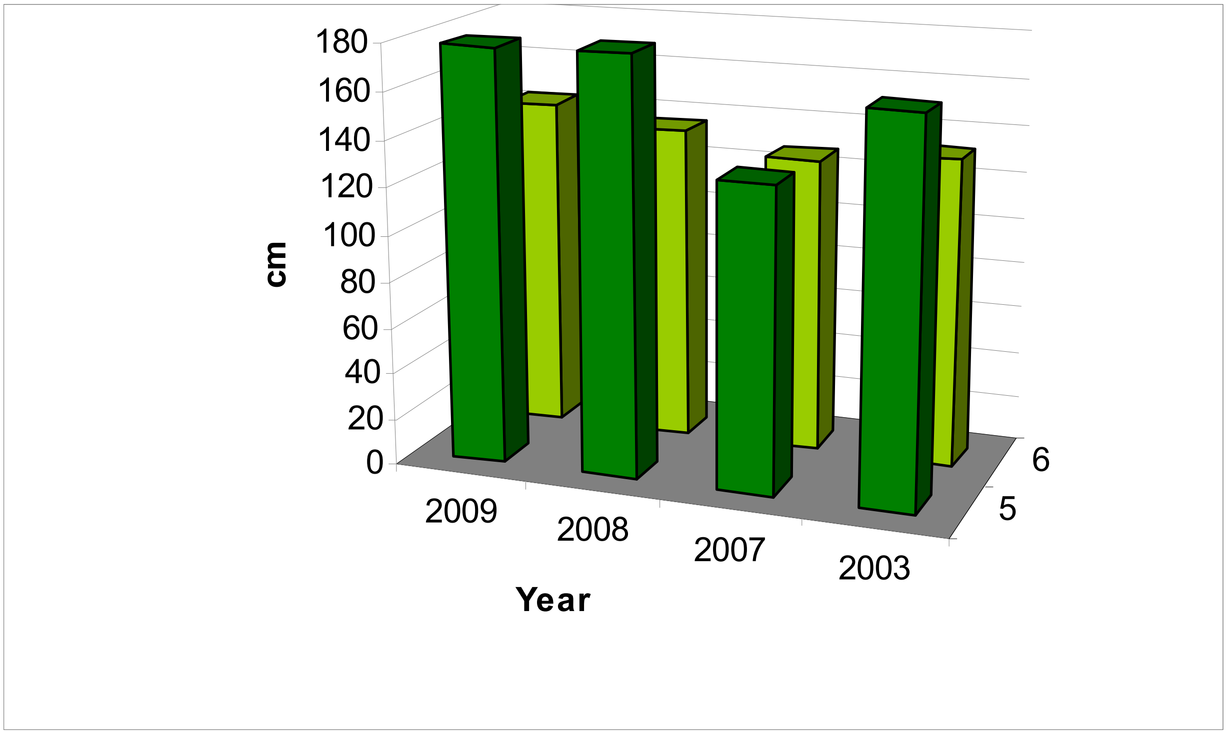


Figure A-11 Mean eelgrass shoot length data from Boundary Bay, Sites WR1, WR2, and WR3

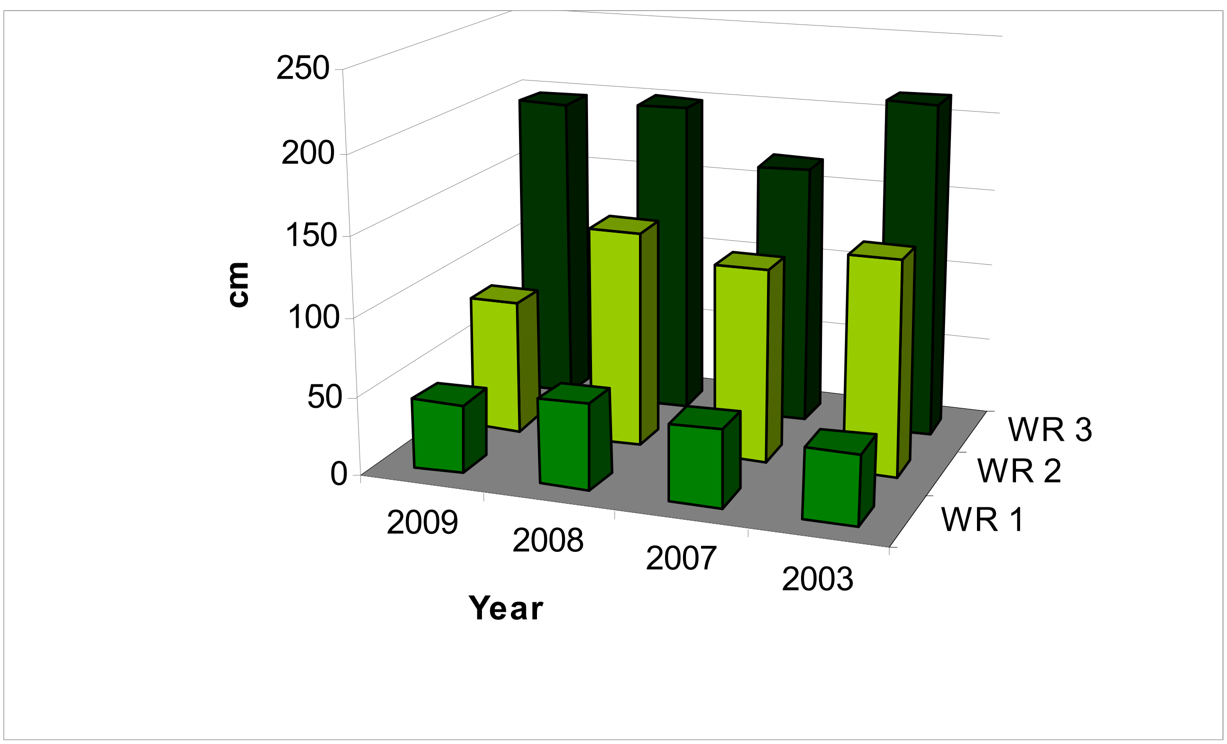


Figure A-12 Mean eelgrass shoot width data from Roberts Bank, Inter-causeway near Deltaport Causeway, Sites 1A, 1B, and 2

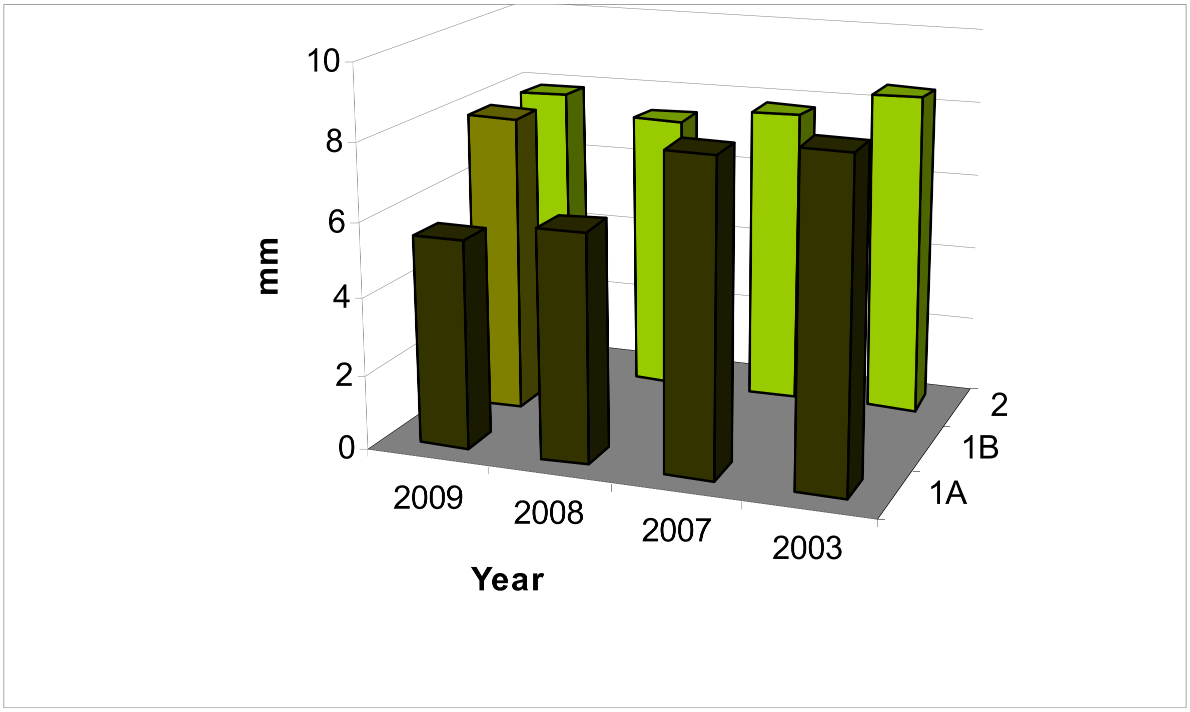


Figure A-13 Mean eelgrass shoot width data from Roberts Bank, west of Deltaport Causeway, Sites 3 and 4

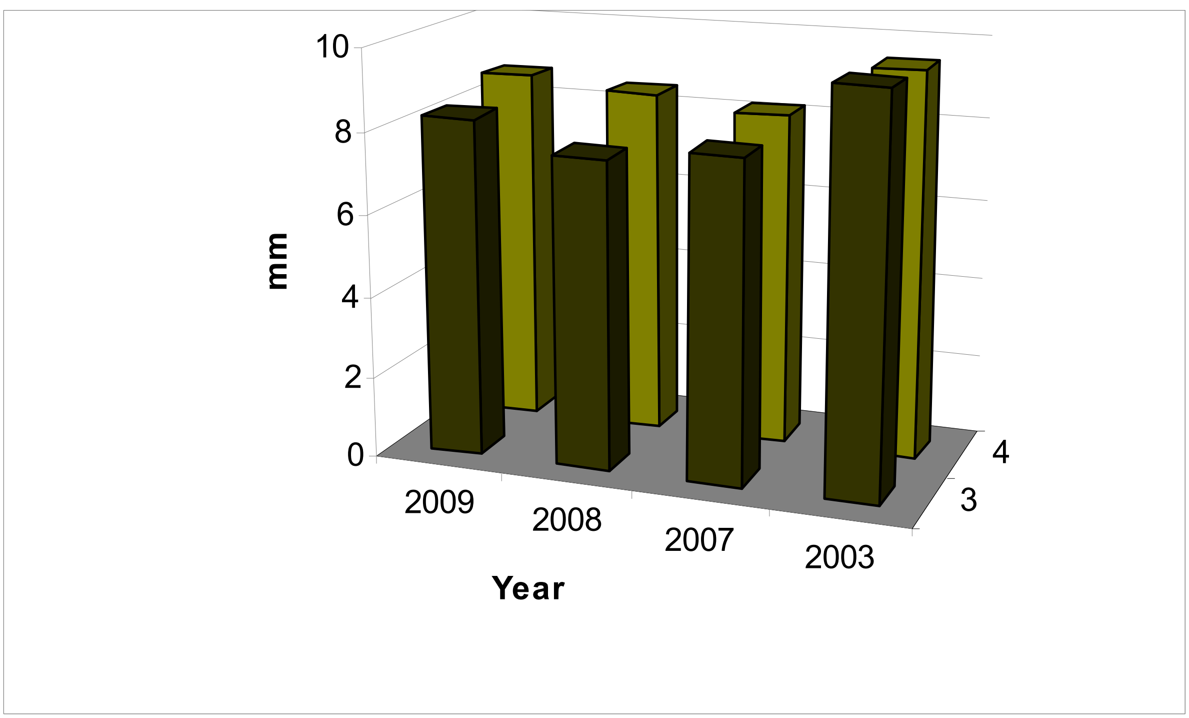


Figure A- 14 Mean eelgrass shoot width data from Roberts Bank, Inter-causeway near Ferry Causeway, Sites 5 and 6

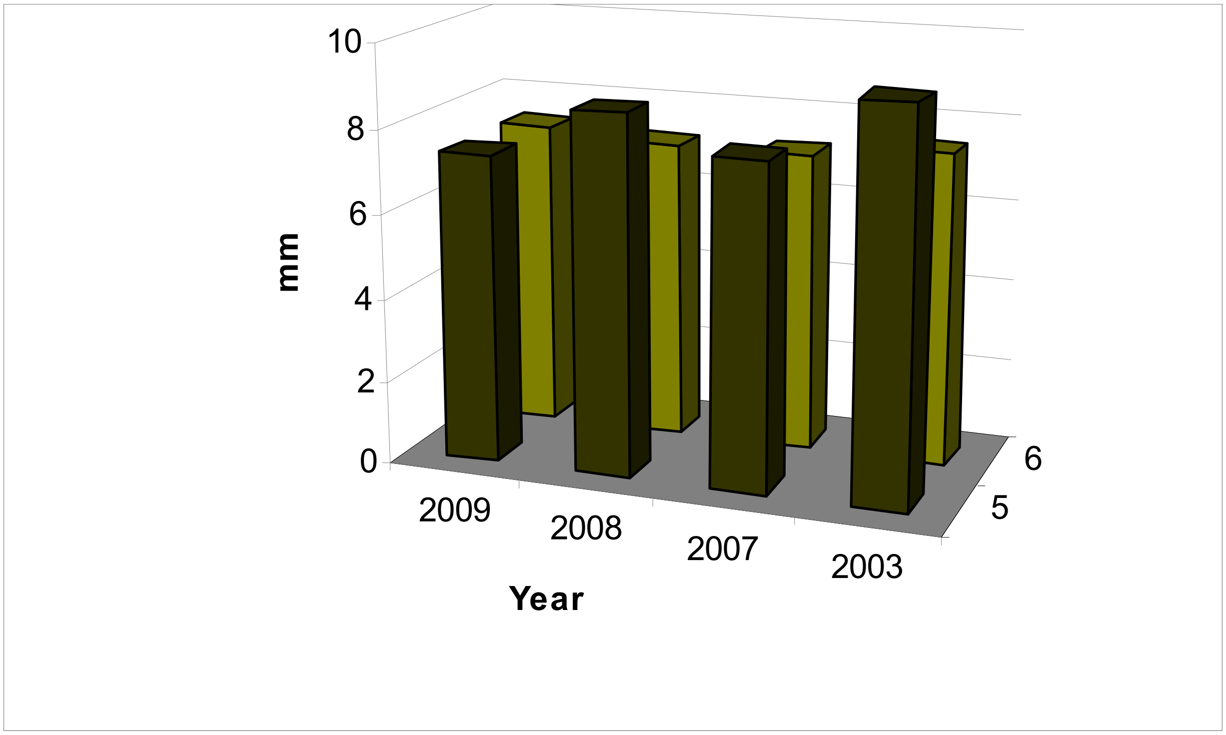


Figure A-15 Mean eelgrass shoot width data from Boundary Bay, Sites WR1, WR2, and WR3

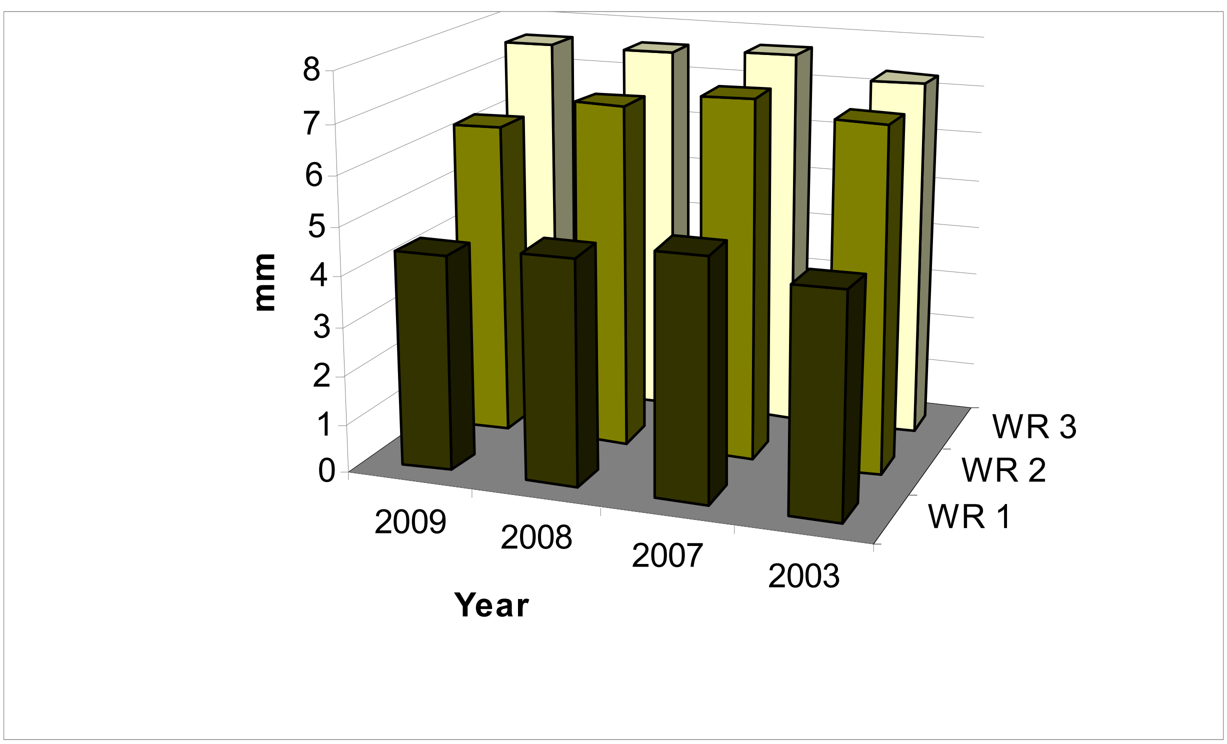


Figure A-16 Mean reproductive shoot density data from Roberts Bank, Inter-causeway near Deltaport Causeway, Sites 1A, 1B, and 2

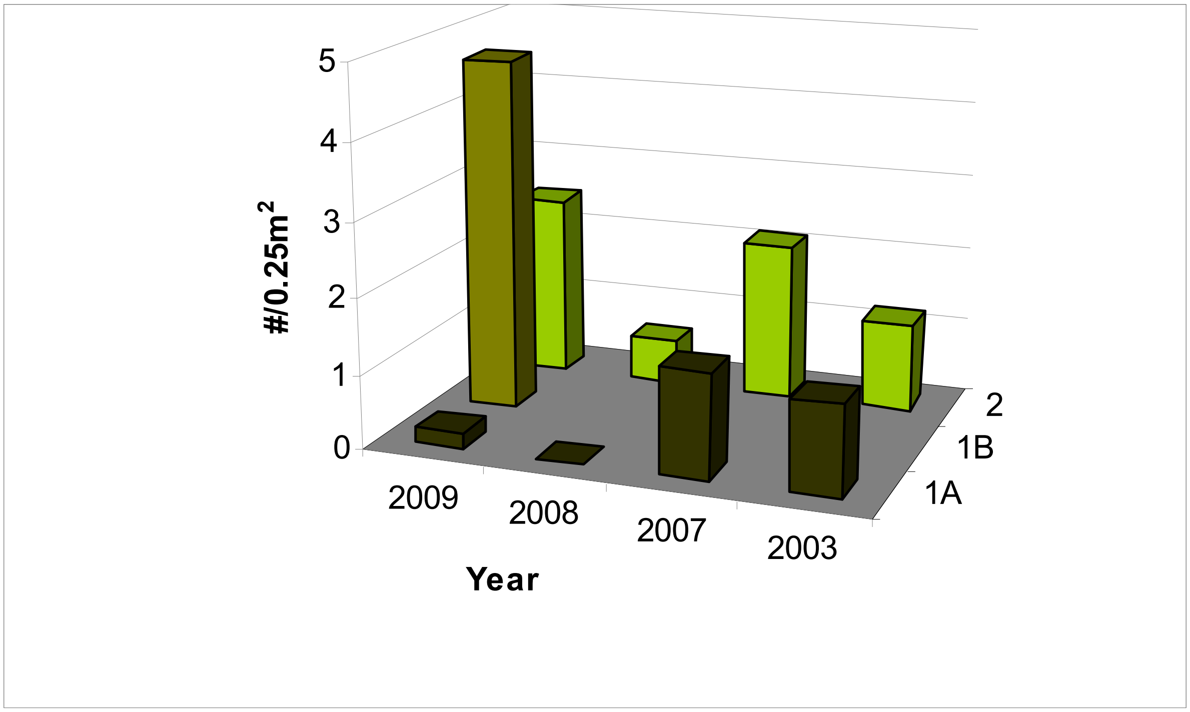


Figure A-17 Mean reproductive shoot density data from Roberts Bank, west of Deltaport Causeway, Sites 3 and 4

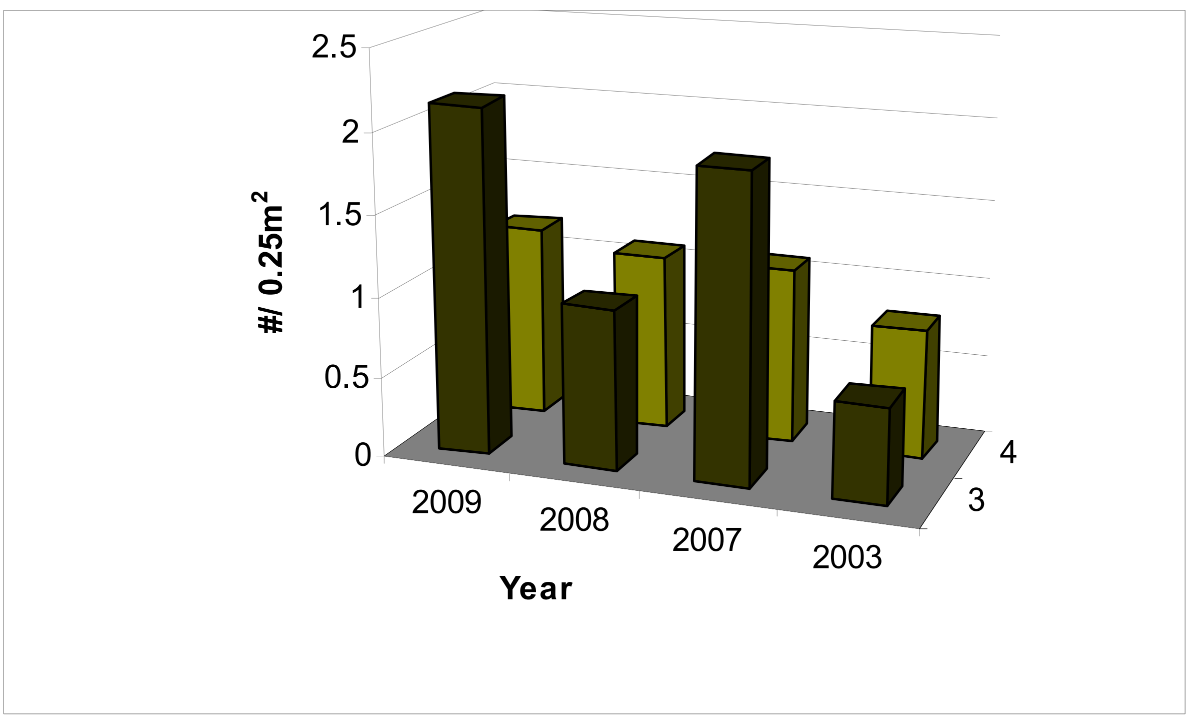


Figure A-18 Mean eelgrass reproductive shoot density data from Roberts Bank, Inter-causeway near Ferry Causeway, Sites 5 and 6

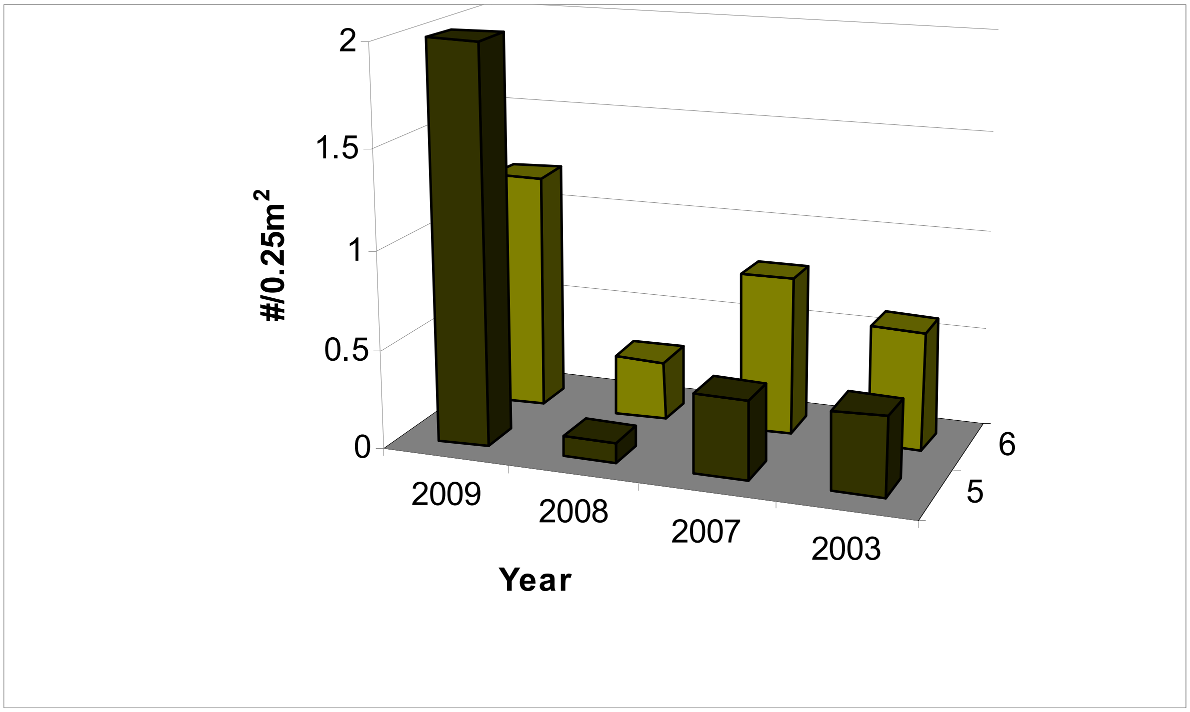


Figure A-19 Mean eelgrass reproductive shoot density data from Boundary Bay, Sites WR1, WR2, and WR3

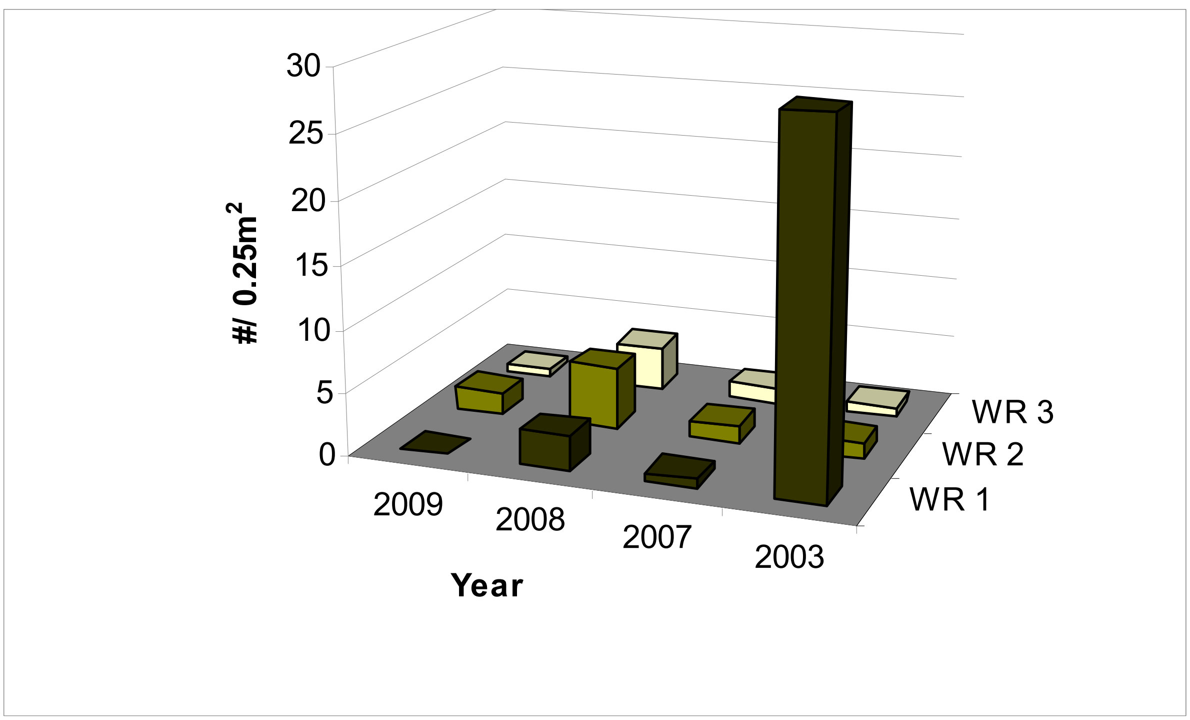


Figure A-20 Mean eelgrass reproductive shoot density data from Boundary Bay, Sites WR1, WR2, and WR3 (The data for Site WR1 in 2003 has been omitted.)

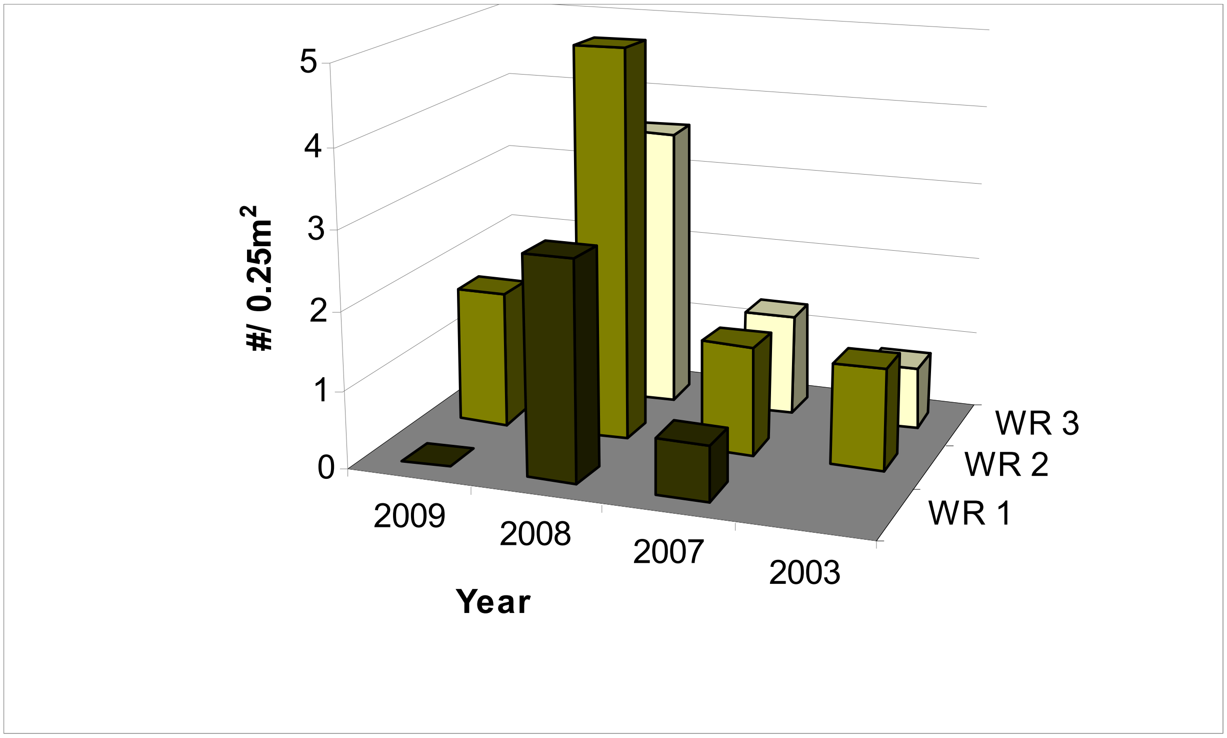


Table A-1 Mean eelgrass shoot density (total and reproductive), length, width, and LAI at each reference station in 2009, 2008, 2007, and 2003 (Means are based on a sample of ten replicates.)

Site	Total Density #/0.25m^2				Length (cm)				Width (mm)				LAI				Reproductive Shoot Density ((#/0.25m^2)			
	2009	2008	2007	2003	2009	2008	2007	2003	2009	2008	2007	2003	2009	2008	2007	2003	2009	2008	2007	2003
Inter-causeway area near Deltaport Causeway																				
1	8.1	25.4	25.8	24	50	65	115.8	140	5.5	6	8.2	8.5	0.09	0.4	0.99	1.18	0.2	0	1.4	1.2
new	25.4	-	-	-	175.4	-	-	-	7.9	-	-	-	1.42	-	-	-	4.7	-	-	-
2	25.8	32.8	26.5	23.9	170.1	168.9	146.7	137.6	7.9	7.4	7.8	8.5	1.39	1.66	1.19	1.12	2.45	0.6	2.1	1.2
Inter-causeway area near BC Ferries Causeway																				
5	25	18.8	17.4	14.5	178	179	130.7	163.5	7.4	8.6	7.8	9.3	1.32	1.15	0.71	0.88	2	0.1	0.4	0.4
6	20.2	22.6	20.6	16.8	143.15	135.8	127.3	132.4	7.4	7.2	7.2	7.5	0.86	0.9	0.76	0.66	1.2	0.3	0.8	0.6
West of Deltaport Causeway																				
3	15	17.65	16	17.3	109.5	132.15	121.8	141.1	8.3	7.6	7.9	9.7	0.55	0.71	0.61	0.95	2.15	1	1.9	0.6
4	16.9	21.6	14.7	15.7	144.15	163.35	164	188.8	8.75	8.5	8.2	9.5	0.83	1.2	0.79	1.12	1.2	1.1	1.1	0.8
Boundary Bay																				
WR1	79.4	73.8	60.6	33	44	54.4	48.4	44.4	4.4	4.6	4.9	4.5	0.61	0.78	0.56	0.29	0	2.8	0.7	28.7
WR2	28.53	32.4	29.4	14	85	139	122.7	137.4	6.3	7	7.3	7	0.62	1.28	1.04	0.54	1.75	5.0	1.4	0.5
WR3	26.05	32.5	19.9	21	198.35	201	167.4	215.2	7.6	7.6	7.7	7.3	1.57	2.02	1.04	1.33	0.63	3.6	1.3	0.8

Bonferroni adjusted probability values using separate variances are provided followed by the probability values calculated using pooled variance in brackets. p-values <0.0025 were considered significant (0.05/20). The Bonferroni adjustment requires that each data set has variation; standard two-sample, 2-tailed t-tests were used to analyze data in cases where the variance was zero.

Table A-2 Bonferroni adjusted probability values attained for each parameter using a two-sample t-test comparing data sets from 2009 and 2008

Site #	Total Density	Length	Width	LAI	Reproductive Density
Inter-causeway near Coal Port Causeway					
1	0 (0)	0 (0)	0.018 (0.018)	0 (0)	0.0356*
1B	1.0 (1.0)	0 (0)	0 (0)	0 (0)	3.56E-2*
2	0 (0)	1.0 (1.0)	0.169 (0.167)	0.104 (0.103)	0.012 (0.008)
Inter-causeway near Ferry Causeway					
5	0 (0)	1.0 (1.0)	0 (0)	0.250 (0.248)	0 (0)
6	0.798 (0.787)	1.0 (1.0)	1.0 (1.0)	1.0 (1.0)	0.017 (0.013)
West of Coal Port Causeway					
3	0.347 (0.335)	0.079 (0.078)	0.011 (0.011)	0.309 (0.306)	0.092 (0.085)
4	0.025 (0.025)	0.070 (0.067)	1.0 (1.0)	0.002 (0.001)	1.0 (1.0)
Boundary Bay					
WR1	1.0 (1.0)	0.037 (0.029)	1.0 (1.0)	1.0 (1.0)	0.0096*
WR2	0.308 (0.307)	0 (0)	0.007 (0.007)	0 (0)	0 (0)
WR3	0.041 (0.041)	1.0 (1.0)	1.0 (1.0)	0.641 (0.641)	0.019 (0.012)

Note: * Standard t-test p-value (not adjusted)

Bonferroni adjusted probability values using separate variances are provided followed by the probability values calculated using pooled variance in brackets. p-values <0.0025 were considered significant (0.05/20). The Bonferroni adjustment requires that each data set has variation; standard two-sample, 2-tailed t-tests were used to analyze data in cases where the variance was zero.

Table A-3 Bonferroni adjusted probability values attained for each parameter using a two-sample t-test comparing data sets from 2009 and 2007

Site #	Total Density	Length	Width	LAI	Reproductive Density
Inter-causeway near Coal Port Causeway					
1	0 (0)	0 (0)	0 (0)	0 (0)	0.10 (006)
1B	1.0 (1.0)	0 (0)	1.0 (1.0)	0.003 (0.003)	0 (0)
2	1.0 (1.0)	0.002 (0.001)	1.0 (1.0)	0.504 (0.501)	1.0 (1.0)
Inter-causeway near Ferry Causeway					
5	0 (0)	0 (0)	0.506 (0.493)	0 (0)	0.004 (0.003)
6	1.0 (1.0)	0.701 (0.678)	1.0 (1.0)	1.0 (1.0)	1.0 (1.0)
West of Coal Port Causeway					
3	1.0 (1.0)	0.873 (0.871)	0.779 (0.776)	1.0 (1.0)	1.0 (1.0)
4	0.497 (0.494)	0.068 (0.066)	0.573 (0.558)	1.0 (1.0)	1.0 (1.0)
Boundary Bay					
WR1	0.095 (0.094)	0.304 (0.297)	0.079 (0.067)	1.0 (1.0)	0.0738*
WR2	1.0 (1.0)	0 (0)	0 (0)	0 (0)	0.166 (0.158)
WR3	0.012 (0.012)	0.002 (0.001)	1.0 (1.0)	0.013 (0.010)	0.600 (0.589)

Note: *Standard t-test p-value (not adjusted)

Bonferroni adjusted probability values using separate variances are provided followed by the probability values calculated using pooled variance in brackets. p-values <0.0025 were considered significant (0.05/20). The Bonferroni adjustment requires that each data set has variation; standard two-sample, 2-tailed t-tests were used to analyze data in cases where the variance was zero.

Table A-4 Bonferroni adjusted probability values attained for each parameter using a two-sample t-test comparing data sets from 2009 and 2003

Site #	Total Density	Length	Width	LAI	Reproductive Density
Inter-causeway near Coal Port Causeway					
1	0 (0)	0 (0)	4.6E-28*	0 (0)	0.023 (0.016)
1B	1.0 (1.0)	0 (0)	3.34E-08*	0.036 (0.033)	0 (0)
2	0.880 (0.871)	9.85E-05*	0 (0)	0.008 (0.001)	0.228 (0.225)
Inter-causeway near Ferry Causeway					
5	0 (0)	0.040 (0.039)	0 (0)	0 (0)	0.004 (0.002)
6	0.464 (0.462)	0.370 (0.369)	1.0 (1.0)	0.304 (0.301)	0.299 (0.059)
West of Coal Port Causeway					
3	0.529 (0.513)	0 (0)	0 (0)	0 (0)	0.009 (0.006)
4	1.0 (1.0)	0.015 (0.012)	0.124 (0.105)	0.014 (0.013)	1.0 (1.0)
Boundary Bay					
WR1	0 (0)	0.588 (0.588)	1.0 (1.0)	0 (0)	2.69E-12*
WR2	0 (0)	0 (0)	0 (0)	0.601 (0.600)	1.0 (1.0)
WR3	0.073 (0.015)	0.198 (0.187)	0.842 (0.825)	0.529 (0.516)	1.0 (1.0)

Note: * *Standard t-test p-value (not adjusted)

Table A-5 A summary of the comparisons where significant differences resulted when each parameter measured in 2009 was compared with the data from 2003 2007, and 2008

Site #	Total Density	Length	Width	LAI	Reproductive Density
Inter-causeway near Deltaport Causeway					
1	All years	All years	2007/2003	All years	-
1B	-	All years	2007/2003	2008	2007/2003
2	2008	2007/2003	2003	-	-
Inter-causeway area near BC Ferries Causeway					
5	All years	2007/2003	2003	2007	All years
6	-	-	-	-	-
West of Deltaport Causeway					
3	-	2003	20003	2003	-
4	-	-	-	2008	-
Boundary Bay					
WR1	2003	-	-	2003	2003
WR2	2003	All years	2007/2003	2007/2003	2008
WR3	-	2007/2003	-	-	-

APPENDIX E

Benthic Invertebrate Results

Appendix E
2007, 2008, 2009 Benthic Invertebrate Data

Phylum	Class	Sub Phylum	Order	Subclass	Genus_species	SampleID	Year	Station	Grab	Count	LifeStage
ANNELIDA	Polychaeta			Sedentaria	Pygospio elegans	02A-1 (1.0)	2007	DP02	C	108	J
MOLLUSCA	Bivalvia				Modiolus modiolus	02A-1 (1.0)	2007	DP02	A	1	J
ANNELIDA	Polychaeta			Sedentaria	Pseudopolydora paucibranchiata	02A-1 (1.0)	2007	DP02	C	23	A
ANNELIDA	Polychaeta			Sedentaria	Pseudopolydora paucibranchiata	02A-1 (1.0)	2007	DP02	A	2	Int
ANNELIDA	Polychaeta			Sedentaria	Pseudopolydora paucibranchiata	02A-1 (1.0)	2007	DP02	B	1	Int
ANNELIDA	Polychaeta			Sedentaria	Pygospio elegans	02A-1 (1.0)	2007	DP02	A	13	A
ANNELIDA	Polychaeta			Sedentaria	Pygospio elegans	02A-1 (1.0)	2007	DP02	B	28	A
ANNELIDA	Polychaeta			Sedentaria	Pygospio elegans	02A-1 (1.0)	2007	DP02	C	71	A
ANNELIDA	Polychaeta			Sedentaria	Pygospio elegans	02A-1 (1.0)	2007	DP02	C	9	Int
ANNELIDA	Polychaeta			Sedentaria	Tharyx parvus	02A-1 (1.0)	2007	DP02	C	29	Int
ANNELIDA	Polychaeta			Errantia	Scoletoma luti	02A-1 (1.0)	2007	DP02	A	1	Int
ANNELIDA	Polychaeta			Sedentaria	Pseudopolydora kempi	02A-1 (1.0)	2007	DP02	C	1	Int
MOLLUSCA	Bivalvia				Mya arenaria	02A-1 (1.0)	2007	DP02	C	1	J
ANNELIDA	Polychaeta			Sedentaria	Tharyx parvus	02A-1 (1.0)	2007	DP02	A	19	A
ANNELIDA	Polychaeta			Sedentaria	Tharyx parvus	02A-1 (1.0)	2007	DP02	B	98	A
MOLLUSCA	Gastropoda				Amphissa versicolor	02A-1 (1.0)	2007	DP02	C	1	A
ANNELIDA	Polychaeta			Sedentaria	Tharyx parvus	02A-1 (1.0)	2007	DP02	C	23	A
MOLLUSCA	Gastropoda				Amphissa versicolor	02A-1 (1.0)	2007	DP02	A	1	Int
ANNELIDA	Polychaeta			Sedentaria	Tharyx parvus	02A-1 (1.0)	2007	DP02	B	10	Int
MOLLUSCA	Gastropoda				Amphissa versicolor	02A-1 (1.0)	2007	DP02	B	4	Int
ANNELIDA	Polychaeta			Sedentaria	Pygospio elegans	02A-1 (1.0)	2007	DP02	A	3	J
MOLLUSCA	Bivalvia				Venerupis philippinarum	02A-1 (1.0)	2007	DP02	C	3	J
ANNELIDA	Polychaeta			Sedentaria	Arenicolidae indet.	02A-1 (1.0)	2007	DP02	A	1	J
ANNELIDA	Polychaeta			Sedentaria	Arenicolidae indet.	02A-1 (1.0)	2007	DP02	B	4	J
ANNELIDA	Polychaeta			Sedentaria	Arenicolidae indet.	02A-1 (1.0)	2007	DP02	C	5	J
ANNELIDA	Polychaeta			Sedentaria	Armandia brevis	02A-1 (1.0)	2007	DP02	A	11	A
ANNELIDA	Polychaeta			Sedentaria	Armandia brevis	02A-1 (1.0)	2007	DP02	B	15	A
ANNELIDA	Polychaeta			Sedentaria	Armandia brevis	02A-1 (1.0)	2007	DP02	C	5	A
ANNELIDA	Polychaeta			Sedentaria	Armandia brevis	02A-1 (1.0)	2007	DP02	A	7	Int
ANNELIDA	Polychaeta			Sedentaria	Armandia brevis	02A-1 (1.0)	2007	DP02	B	11	Int
ANNELIDA	Polychaeta			Sedentaria	Pseudopolydora paucibranchiata	02A-1 (1.0)	2007	DP02	B	12	A
ANNELIDA	Polychaeta			Sedentaria	Capitella capitata complex	02A-1 (1.0)	2007	DP02	A	1	Int
ANNELIDA	Polychaeta			Sedentaria	Pseudopolydora paucibranchiata	02A-1 (1.0)	2007	DP02	A	9	A
ANNELIDA	Polychaeta			Sedentaria	Capitellidae indet.	02A-1 (1.0)	2007	DP02	A	1	Int
MOLLUSCA	Bivalvia				Nutricola tantilla	02A-1 (1.0)	2007	DP02	A	1	Int
ANNELIDA	Polychaeta			Sedentaria	Owenia nr. johnsoni	02A-1 (1.0)	2007	DP02	C	1	A
ANNELIDA	Polychaeta			Sedentaria	Polydora cornuta	02A-1 (1.0)	2007	DP02	B	1	A
ANNELIDA	Polychaeta			Sedentaria	Prionospio (Minuspio) lighti	02A-1 (1.0)	2007	DP02	B	1	Int
ANNELIDA	Polychaeta			Sedentaria	Pseudopolydora kempi	02A-1 (1.0)	2007	DP02	A	5	A
ANNELIDA	Polychaeta			Sedentaria	Pseudopolydora kempi	02A-1 (1.0)	2007	DP02	B	4	A
ANNELIDA	Polychaeta			Sedentaria	Pseudopolydora kempi	02A-1 (1.0)	2007	DP02	C	14	A
ANNELIDA	Polychaeta			Sedentaria	Rhynchospio glutaea	02A-1 (1.0)	2007	DP02	A	1	A
ANNELIDA	Polychaeta			Sedentaria	Armandia brevis	02A-1 (1.0)	2007	DP02	C	4	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Grandidierella japonica	02A-1 (1.0)	2007	DP02	B	6	Int
ANNELIDA	Polychaeta			Errantia	Eteone californica	02A-1 (1.0)	2007	DP02	C	5	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Monocorophium insidiosum	02A-1 (1.0)	2007	DP02	C	2	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Grandidierella japonica	02A-1 (1.0)	2007	DP02	A	2	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Monocorophium insidiosum	02A-1 (1.0)	2007	DP02	B	2	Int
ANNELIDA	Oligochaeta				Tubificidae indet. Group 5	02A-1 (1.0)	2007	DP02	B	2	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Monocorophium insidiosum	02A-1 (1.0)	2007	DP02	A	1	Int
ANNELIDA	Polychaeta			Errantia	Eteone californica	02A-1 (1.0)	2007	DP02	A	2	A
ARTHROPODA	Copepoda	CRUSTACEA			Harpacticoida indet.	02A-1 (1.0)	2007	DP02	A	2	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Monocorophium insidiosum	02A-1 (1.0)	2007	DP02	B	17	A
ANNELIDA	Polychaeta			Errantia	Eteone californica	02A-1 (1.0)	2007	DP02	B	7	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Grandidierella japonica	02A-1 (1.0)	2007	DP02	C	7	Int
ANNELIDA	Polychaeta			Sedentaria	Tharyx parvus	02A-1 (1.0)	2007	DP02	C	4	J
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Monocorophium insidiosum	02A-1 (1.0)	2007	DP02	A	2	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Monocorophium acherusicum	02A-1 (1.0)	2007	DP02	B	3	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Monocorophium acherusicum	02A-1 (1.0)	2007	DP02	B	1	Int
ANNELIDA	Oligochaeta				Tubificidae indet. Group 5	02A-1 (1.0)	2007	DP02	C	1	Int
MOLLUSCA	Gastropoda				Batillaria cumingi	02A-1 (1.0)	2007	DP02	B	1	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Monocorophium insidiosum	02A-1 (1.0)	2007	DP02	C	7	A
ARTHROPODA	Copepoda	CRUSTACEA			Harpacticoida indet.	02A-1 (1.0)	2007	DP02	C	3	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Eobrolgus chumashi	02A-1 (1.0)	2007	DP02	B	1	A
ANNELIDA	Polychaeta			Errantia	Eteone californica	02A-1 (1.0)	2007	DP02	B	8	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Grandidierella japonica	02A-1 (1.0)	2007	DP02	A	2	A
ARTHROPODA	Malacostraca	CRUSTACEA	Tanaidacea		Leptochelia savignyi	02A-1 (1.0)	2007	DP02	A	1	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Cumacea		Cumella vulgaris	02A-1 (1.0)	2007	DP02	C	1	A
MOLLUSCA	Gastropoda				Amphissa versicolor	02A-1 (1.0)	2007	DP02	C	2	Int
ANNELIDA	Oligochaeta				Enchytraeidae indet.	02A-1 (1.0)	2007	DP02	C	8	J
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Grandidierella japonica	02A-1 (1.0)	2007	DP02	B	8	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Grandidierella japonica	02A-1 (1.0)	2007	DP02	C	13	A
ARTHROPODA	Copepoda	CRUSTACEA			Harpacticoida indet.	02A-1 (1.0)	2007	DP02	A	1	Int
MOLLUSCA	Gastropoda				Cylichna culcitella	02A-1 (1.0)	2007	DP02	A	1	Int
ANNELIDA	Polychaeta			Sedentaria	Dipolydora nr. quadrilobata	02A-1 (1.0)	2007	DP03	B	1	J
MOLLUSCA	Bivalvia				Mya arenaria	02A-1 (1.0)	2007	DP03	C	1	J
ANNELIDA	Polychaeta			Sedentaria	Arenicolidae indet.	02A-1 (1.0)	2007	DP03	A	1	J
MOLLUSCA	Bivalvia				Nemocardium centifilosum	02A-1 (1.0)	2007	DP03	C	1	J
ANNELIDA	Polychaeta			Sedentaria	Arenicolidae indet.	02A-1 (1.0)	2007	DP03	C	3	J
ECHINODERMATA	Echinoidea				Strongylocentrotus droebachiensis	02A-1 (1.0)	2007	DP03	A	1	J
ANNELIDA	Polychaeta			Sedentaria	Owenia nr. johnsoni	02A-1 (1.0)	2007	DP03	C	1	A
ANNELIDA	Polychaeta			Sedentaria	Armandia brevis	02A-1 (1.0)	2007	DP03	B	1	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Cumacea		Cumella vulgaris	02A-1 (1.0)	2007	DP03	A	1	A
ANNELIDA	Polychaeta			Sedentaria	Armandia brevis	02A-1 (1.0)	2007	DP03	B	6	A
ANNELIDA	Polychaeta			Sedentaria	Armandia brevis	02A-1 (1.0)	2007	DP03	C	1	A
ANNELIDA	Polychaeta			Sedentaria	Armandia brevis	02A-1 (1.0)	2007	DP03	C	4	Int
MOLLUSCA	Bivalvia				Mya arenaria	02A-1 (1.0)	2007	DP03	A	1	J
MOLLUSCA	Bivalvia				Modiolus modiolus	02A-1 (1.0)	2007	DP03	A	1	J
ANNELIDA	Polychaeta			Sedentaria	Armandia brevis	02A-1 (1.0)	2007	DP03	A	3	Int
ANNELIDA	Polychaeta			Sedentaria	Armandia brevis	02A-1 (1.0)	2007	DP03	A	4	A
ANNELIDA	Polychaeta			Sedentaria	Pygospio elegans	02A-1 (1.0)	2007	DP03	B	2	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Anisogammarus pugettensis	02A-1 (1.0)	2007	DP03	C	1	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Anisogammarus pugettensis	02A-1 (1.0)	2007	DP03	B	2	Int
ANNELIDA	Polychaeta			Sedentaria	Tharyx parvus	02A-1 (1.0)	2007	DP03	A	18	Int
ANNELIDA	Polychaeta			Sedentaria	Tharyx parvus	02A-1 (1.0)	2007	DP03	C	18	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Anisogammarus pugettensis	02A-1 (1.0)	2007	DP03	C	1	J
ANNELIDA	Polychaeta			Sedentaria	Tharyx parvus	02A-1 (1.0)	2007	DP03	B	10	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Eobrolgus chumashi	02A-1 (1.0)	2007	DP03	B	1	A
ANNELIDA	Polychaeta			Sedentaria	Tharyx parvus	02A-1 (1.0)	2007	DP03	A	61	A
ANNELIDA	Polychaeta			Sedentaria	Scoloplos armiger	02A-1 (1.0)	2007	DP03	A	1	J

Appendix E
2007, 2008, 2009 Benthic Invertebrate Data

Phylum	Class	Sub Phylum	Order	Subclass	Genus_species	SampleID	Year	Station	Grab	Count	LifeStage
ANNELIDA	Polychaeta			Sedentaria	Rhynchospio glutaea	02A-1 (1.0)	2007	DP03	C	2	A
ANNELIDA	Polychaeta			Sedentaria	Rhynchospio glutaea	02A-1 (1.0)	2007	DP03	A	10	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Grandidierella japonica	02A-1 (1.0)	2007	DP03	A	4	A
ANNELIDA	Polychaeta			Sedentaria	Pseudopolydora paucibranchiata	02A-1 (1.0)	2007	DP03	A	4	A
ANNELIDA	Polychaeta			Sedentaria	Pygospio elegans	02A-1 (1.0)	2007	DP03	C	1	A
MOLLUSCA	Bivalvia				Modiolus modiolus	02A-1 (1.0)	2007	DP03	C	2	J
MOLLUSCA	Bivalvia				Macoma sp.	02A-1 (1.0)	2007	DP03	B	6	J
ANNELIDA	Polychaeta			Sedentaria	Pygospio elegans	02A-1 (1.0)	2007	DP03	A	15	A
ANNELIDA	Polychaeta			Sedentaria	Pseudopolydora paucibranchiata	02A-1 (1.0)	2007	DP03	C	1	J
MOLLUSCA	Bivalvia				Macoma sp.	02A-1 (1.0)	2007	DP03	C	23	J
ANNELIDA	Polychaeta			Sedentaria	Pseudopolydora paucibranchiata	02A-1 (1.0)	2007	DP03	B	1	Int
ANNELIDA	Polychaeta			Sedentaria	Pseudopolydora paucibranchiata	02A-1 (1.0)	2007	DP03	A	2	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Grandidierella japonica	02A-1 (1.0)	2007	DP03	A	1	Int
ANNELIDA	Polychaeta			Sedentaria	Pseudopolydora paucibranchiata	02A-1 (1.0)	2007	DP03	C	9	A
ANNELIDA	Polychaeta			Sedentaria	Pseudopolydora paucibranchiata	02A-1 (1.0)	2007	DP03	B	3	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Grandidierella japonica	02A-1 (1.0)	2007	DP03	C	7	Int
MOLLUSCA	Bivalvia				Macoma sp.	02A-1 (1.0)	2007	DP03	A	8	J
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Monocorophium acherusicum	02A-1 (1.0)	2007	DP03	C	2	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Monocorophium acherusicum	02A-1 (1.0)	2007	DP03	C	3	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Grandidierella japonica	02A-1 (1.0)	2007	DP03	C	10	A
MOLLUSCA	Gastropoda				Amphissa sp.	02A-1 (1.0)	2007	DP03	A	1	Int
ANNELIDA	Oligochaeta				Tubificidae indet. Group 5	02A-1 (1.0)	2007	DP03	A	2	A
ANNELIDA	Polychaeta			Errantia	Eteone californica	02A-1 (1.0)	2007	DP03	A	1	A
MOLLUSCA	Gastropoda				Batillaria cumingi	02A-1 (1.0)	2007	DP03	C	1	Int
MOLLUSCA	Bivalvia				Venerupis philippinarum	02A-1 (1.0)	2007	DP03	A	1	J
MOLLUSCA	Gastropoda				Amphissa versicolor	02A-1 (1.0)	2007	DP03	C	2	Int
MOLLUSCA	Gastropoda				Amphissa versicolor	02A-1 (1.0)	2007	DP03	B	1	A
MOLLUSCA	Gastropoda				Amphissa versicolor	02A-1 (1.0)	2007	DP03	B	1	Int
MOLLUSCA	Gastropoda				Amphissa versicolor	02A-1 (1.0)	2007	DP03	C	1	A
MOLLUSCA	Gastropoda				Amphissa versicolor	02A-1 (1.0)	2007	DP03	C	1	J
MOLLUSCA	Gastropoda				Cylichnella sp.	02A-1 (1.0)	2007	DP03	A	1	J
MOLLUSCA	Gastropoda				Haminoea vesicula	02A-1 (1.0)	2007	DP03	C	1	Int
ARTHROPODA	Arachnida	CHELICERATA	Acarida		Hydracarina indet.	02A-1 (1.0)	2007	DP04	C	2	A
ARTHROPODA	Pycnogonida	CHELICERATA			Anoplodactylus viridintestinalis	02A-1 (1.0)	2007	DP04	C	24	A
ARTHROPODA	Pycnogonida	CHELICERATA			Anoplodactylus viridintestinalis	02A-1 (1.0)	2007	DP04	A	1	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Americhelidium shoemakeri	02A-1 (1.0)	2007	DP04	B	4	A
BRYOZOA	Gymnolaemata				Celleporella hyalina	02A-1 (1.0)	2007	DP04	C	1	A
ARTHROPODA	Malacostraca	CRUSTACEA	Tanaidacea		Leptochelia savigyni	02A-1 (1.0)	2007	DP04	C	5	Int
ARTHROPODA	Pycnogonida	CHELICERATA			Anoplodactylus viridintestinalis	02A-1 (1.0)	2007	DP04	C	3	Int
ARTHROPODA	Pycnogonida	CHELICERATA			Anoplodactylus viridintestinalis	02A-1 (1.0)	2007	DP04	B	20	A
ARTHROPODA	Arachnida	CHELICERATA	Acarida		Hydracarina indet.	02A-1 (1.0)	2007	DP04	B	3	Int
ARTHROPODA	Arachnida	CHELICERATA	Acarida		Hydracarina indet.	02A-1 (1.0)	2007	DP04	B	5	A
ARTHROPODA	Arachnida	CHELICERATA	Acarida		Hydracarina indet.	02A-1 (1.0)	2007	DP04	A	1	A
MOLLUSCA	Bivalvia				Macoma nasuta	02A-1 (1.0)	2007	DP04	A	8	J
CNIDARIA	Hydrozoa				Obelia dichotoma	02A-1 (1.0)	2007	DP04	B	1	A
CNIDARIA	Hydrozoa				Obelia dichotoma	02A-1 (1.0)	2007	DP04	C	1	A
ANNELIDA	Polychaeta			Sedentaria	Leitoscoloplos pugettensis	02A-1 (1.0)	2007	DP04	A	2	A
ARTHROPODA	Pycnogonida	CHELICERATA			Anoplodactylus viridintestinalis	02A-1 (1.0)	2007	DP04	A	43	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Caprella sp.	02A-1 (1.0)	2007	DP04	B	21	J
MOLLUSCA	Bivalvia				Cardiidae indet.	02A-1 (1.0)	2007	DP04	C	1	J
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Grandidierella japonica	02A-1 (1.0)	2007	DP04	B	1	A
ARTHROPODA	Malacostraca	CRUSTACEA	Tanaidacea		Leptochelia savigyni	02A-1 (1.0)	2007	DP04	B	92	A
MOLLUSCA	Bivalvia				Rochefortia tumida	02A-1 (1.0)	2007	DP04	A	89	A
MOLLUSCA	Bivalvia				Protothaca tenerrima	02A-1 (1.0)	2007	DP04	B	2	J
ARTHROPODA	Malacostraca	CRUSTACEA	Tanaidacea		Leptochelia savigyni	02A-1 (1.0)	2007	DP04	C	75	A
ARTHROPODA	Malacostraca	CRUSTACEA	Tanaidacea		Leptochelia savigyni	02A-1 (1.0)	2007	DP04	A	8	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Tanaidacea		Leptochelia savigyni	02A-1 (1.0)	2007	DP04	B	6	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Caprella laeviuscula	02A-1 (1.0)	2007	DP04	A	18	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Caprella sp.	02A-1 (1.0)	2007	DP04	C	31	J
MOLLUSCA	Bivalvia				Modiolus modiolus	02A-1 (1.0)	2007	DP04	C	54	J
MOLLUSCA	Bivalvia				Protothaca sp.	02A-1 (1.0)	2007	DP04	B	2	J
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Caprella laeviuscula	02A-1 (1.0)	2007	DP04	A	16	J
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Caprella laeviuscula	02A-1 (1.0)	2007	DP04	C	6	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Caprella laeviuscula	02A-1 (1.0)	2007	DP04	B	4	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Caprella laeviuscula	02A-1 (1.0)	2007	DP04	A	8	Int
MOLLUSCA	Bivalvia				Macoma inquinata	02A-1 (1.0)	2007	DP04	C	10	J
MOLLUSCA	Gastropoda				Alvania compacta	02A-1 (1.0)	2007	DP04	B	17	A
ANNELIDA	Polychaeta			Sedentaria	Galathowenia oculata	02A-1 (1.0)	2007	DP04	A	1	A
ANNELIDA	Polychaeta			Errantia	Eulalia quadrioculata	02A-1 (1.0)	2007	DP04	C	2	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Eobrolgus chumashi	02A-1 (1.0)	2007	DP04	A	1	A
ANNELIDA	Polychaeta			Errantia	Nephtys caeca	02A-1 (1.0)	2007	DP04	B	1	Int
MOLLUSCA	Bivalvia				Tellina modesta	02A-1 (1.0)	2007	DP04	B	3	J
ANNELIDA	Polychaeta			Errantia	Glycinde polygnatha	02A-1 (1.0)	2007	DP04	B	1	Int
MOLLUSCA	Bivalvia				Mytilidae indet.	02A-1 (1.0)	2007	DP04	C	1	J
ANNELIDA	Polychaeta			Sedentaria	Pseudopolydora paucibranchiata	02A-1 (1.0)	2007	DP04	B	1	Int
ANNELIDA	Polychaeta			Sedentaria	Pectinaria granulata	02A-1 (1.0)	2007	DP04	C	1	A
ANNELIDA	Polychaeta			Sedentaria	Pseudopolydora paucibranchiata	02A-1 (1.0)	2007	DP04	C	5	A
MOLLUSCA	Gastropoda				Alvania compacta	02A-1 (1.0)	2007	DP04	C	14	A
ANNELIDA	Polychaeta			Sedentaria	Pseudopolydora paucibranchiata	02A-1 (1.0)	2007	DP04	B	10	A
MOLLUSCA	Bivalvia				Macoma nasuta	02A-1 (1.0)	2007	DP04	B	33	J
ANNELIDA	Polychaeta			Errantia	Nephtys caeca	02A-1 (1.0)	2007	DP04	B	1	A
ANNELIDA	Polychaeta			Sedentaria	Owenia nr. johnsoni	02A-1 (1.0)	2007	DP04	B	45	A
ANNELIDA	Polychaeta			Sedentaria	Prionospio (Minuspio) lighti	02A-1 (1.0)	2007	DP04	B	1	A
MOLLUSCA	Bivalvia				Modiolus modiolus	02A-1 (1.0)	2007	DP04	A	28	J
ANNELIDA	Polychaeta			Sedentaria	Pseudopolydora paucibranchiata	02A-1 (1.0)	2007	DP04	A	3	A
ANNELIDA	Polychaeta			Errantia	Nephtys caecoides	02A-1 (1.0)	2007	DP04	A	1	A
ANNELIDA	Polychaeta			Sedentaria	Prionospio (Minuspio) lighti	02A-1 (1.0)	2007	DP04	C	1	A
ANNELIDA	Polychaeta			Errantia	Nephtys caecoides	02A-1 (1.0)	2007	DP04	B	1	A
MOLLUSCA	Bivalvia				Modiolus modiolus	02A-1 (1.0)	2007	DP04	B	32	J
ANNELIDA	Polychaeta			Sedentaria	Prionospio (Minuspio) multibranchiata	02A-1 (1.0)	2007	DP04	A	1	A
ANNELIDA	Polychaeta			Errantia	Nephtys caecoides	02A-1 (1.0)	2007	DP04	B	1	Int
ANNELIDA	Polychaeta			Errantia	Micropodarke dubia	02A-1 (1.0)	2007	DP04	B	1	A
ANNELIDA	Polychaeta			Sedentaria	Scoloplos acmeceps	02A-1 (1.0)	2007	DP04	B	1	Int
ANNELIDA	Polychaeta			Sedentaria	Leitoscoloplos pugettensis	02A-1 (1.0)	2007	DP04	B	2	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Caprella laeviuscula	02A-1 (1.0)	2007	DP04	C	5	A
ANNELIDA	Polychaeta			Sedentaria	Leitoscoloplos pugettensis	02A-1 (1.0)	2007	DP04	C	1	A
ANNELIDA	Polychaeta			Sedentaria	Tharyx parvus	02A-1 (1.0)	2007	DP04	B	1	A
MOLLUSCA	Bivalvia				Macoma nasuta	02A-1 (1.0)	2007	DP04	C	10	J
ANNELIDA	Polychaeta			Sedentaria	Tharyx parvus	02A-1 (1.0)	2007	DP04	A	1	A
MOLLUSCA	Bivalvia				Nutricola tantilla	02A-1 (1.0)	2007	DP04	C	3	Int

Phylum	Class	Sub Phylum	Order	Subclass	Genus_species	SampleID	Year	Station	Grab	Count	LifeStage
MOLLUSCA	Gastropoda				Amphissa versicolor	02A-1 (1.0)	2007	DP04	A	1	A
MOLLUSCA	Bivalvia				Nutricola tantilla	02A-1 (1.0)	2007	DP04	B	5	Int
ANNELIDA	Polychaeta			Sedentaria	Owenia nr. johnsoni	02A-1 (1.0)	2007	DP04	C	35	A
MOLLUSCA	Bivalvia				Nutricola tantilla	02A-1 (1.0)	2007	DP04	C	1	A
MOLLUSCA	Gastropoda				Alvania compacta	02A-1 (1.0)	2007	DP04	A	21	A
ANNELIDA	Polychaeta			Sedentaria	Mediomastus californiensis	02A-1 (1.0)	2007	DP04	B	5	A
MOLLUSCA	Bivalvia				Nutricola tantilla	02A-1 (1.0)	2007	DP04	B	1	A
ECHINODERMATA	Ophiuroidea				Amphiodia sp.	02A-1 (1.0)	2007	DP04	C	2	Int
ANNELIDA	Polychaeta			Sedentaria	Mediomastus californiensis	02A-1 (1.0)	2007	DP04	B	1	Int
ANNELIDA	Polychaeta			Sedentaria	Rhynchospio glutaea	02A-1 (1.0)	2007	DP04	C	5	A
ANNELIDA	Polychaeta			Sedentaria	Rhynchospio glutaea	02A-1 (1.0)	2007	DP04	B	10	A
ANNELIDA	Polychaeta			Sedentaria	Rhynchospio glutaea	02A-1 (1.0)	2007	DP04	A	5	A
ANNELIDA	Polychaeta			Sedentaria	Owenia nr. johnsoni	02A-1 (1.0)	2007	DP04	A	42	A
MOLLUSCA	Gastropoda				Cuthona concinna	02A-1 (1.0)	2007	DP04	B	5	J
ANNELIDA	Polychaeta			Sedentaria	Scoloplos acmeceps	02A-1 (1.0)	2007	DP04	C	1	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Pontogeneia rostrata	02A-1 (1.0)	2007	DP04	B	1	A
ANNELIDA	Oligochaeta				Tectidrilus spp.	02A-1 (1.0)	2007	DP04	C	2	J
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Caprella laeviuscula	02A-1 (1.0)	2007	DP04	B	12	A
ARTHROPODA	Copepoda	CRUSTACEA			Harpacticoida indet.	02A-1 (1.0)	2007	DP04	B	50	A
ARTHROPODA	Malacostraca	CRUSTACEA	Tanaidacea		Leptochelia savignyi	02A-1 (1.0)	2007	DP04	A	154	A
ANNELIDA	Polychaeta			Sedentaria	Ampharete labrops	02A-1 (1.0)	2007	DP04	A	1	J
ARTHROPODA	Malacostraca	CRUSTACEA	Isopoda		Idotea rescata	02A-1 (1.0)	2007	DP04	A	3	A
ARTHROPODA	Cirripedia	CRUSTACEA			Semibalanus balanoides	02A-1 (1.0)	2007	DP04	B	1	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Photis brevipes	02A-1 (1.0)	2007	DP04	C	46	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Pontogeneia rostrata	02A-1 (1.0)	2007	DP04	A	1	Int
ANNELIDA	Polychaeta			Sedentaria	Ampharete labrops	02A-1 (1.0)	2007	DP04	B	13	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Pontogeneia rostrata	02A-1 (1.0)	2007	DP04	A	1	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Photis brevipes	02A-1 (1.0)	2007	DP04	B	8	J
ANNELIDA	Polychaeta			Errantia	Platynereis bicanaliculata	02A-1 (1.0)	2007	DP04	B	7	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Photis brevipes	02A-1 (1.0)	2007	DP04	C	3	Int
ANNELIDA	Polychaeta			Errantia	Platynereis bicanaliculata	02A-1 (1.0)	2007	DP04	A	7	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Photis brevipes	02A-1 (1.0)	2007	DP04	B	4	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Photis brevipes	02A-1 (1.0)	2007	DP04	A	6	Int
MOLLUSCA	Bivalvia				Tellina modesta	02A-1 (1.0)	2007	DP04	B	2	A
ARTHROPODA	Malacostraca	CRUSTACEA	Cumacea		Hemilamprops californicus	02A-1 (1.0)	2007	DP04	B	1	A
ANNELIDA	Polychaeta			Errantia	Platynereis bicanaliculata	02A-1 (1.0)	2007	DP04	C	8	A
ANNELIDA	Polychaeta			Errantia	Platynereis bicanaliculata	02A-1 (1.0)	2007	DP04	A	15	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Decapoda		Pinnixa schmitti	02A-1 (1.0)	2007	DP04	A	1	A
ARTHROPODA	Malacostraca	CRUSTACEA	Decapoda		Pagarus sp.	02A-1 (1.0)	2007	DP04	C	1	Int
ANNELIDA	Polychaeta			Errantia	Platynereis bicanaliculata	02A-1 (1.0)	2007	DP04	B	8	Int
ANNELIDA	Polychaeta			Errantia	Platynereis bicanaliculata	02A-1 (1.0)	2007	DP04	C	7	Int
ANNELIDA	Polychaeta			Errantia	Platynereis bicanaliculata	02A-1 (1.0)	2007	DP04	A	3	J
ANNELIDA	Polychaeta			Sedentaria	Ampharete labrops	02A-1 (1.0)	2007	DP04	A	1	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Decapoda		Cancer gracilis	02A-1 (1.0)	2007	DP04	C	1	Int
ANNELIDA	Polychaeta			Sedentaria	Ampharete labrops	02A-1 (1.0)	2007	DP04	C	4	A
MOLLUSCA	Bivalvia				Tellina modesta	02A-1 (1.0)	2007	DP04	C	3	Int
ANNELIDA	Oligochaeta				Tectidrilus diversus	02A-1 (1.0)	2007	DP04	A	1	A
ARTHROPODA	Malacostraca	CRUSTACEA	Cumacea		Cumella vulgaris	02A-1 (1.0)	2007	DP04	A	1	A
ANNELIDA	Oligochaeta				Tectidrilus spp.	02A-1 (1.0)	2007	DP04	C	7	Int
ARTHROPODA	Copepoda	CRUSTACEA			Harpacticoida indet.	02A-1 (1.0)	2007	DP04	C	3	A
MOLLUSCA	Bivalvia				Tellina modesta	02A-1 (1.0)	2007	DP04	B	1	Int
ANNELIDA	Polychaeta			Sedentaria	Ampharete labrops	02A-1 (1.0)	2007	DP04	A	11	A
ANNELIDA	Polychaeta			Sedentaria	Ampharete labrops	02A-1 (1.0)	2007	DP04	C	4	Int
ANNELIDA	Polychaeta			Errantia	Platynereis bicanaliculata	02A-1 (1.0)	2007	DP04	B	3	J
MOLLUSCA	Bivalvia				Clinocardium nuttallii	02A-1 (1.0)	2007	DP04	B	1	J
MOLLUSCA	Bivalvia				Rochefortia tumida	02A-1 (1.0)	2007	DP04	B	86	A
ANNELIDA	Polychaeta			Sedentaria	Cirratulus spectabilis	02A-1 (1.0)	2007	DP04	A	1	A
ANNELIDA	Polychaeta			Sedentaria	Armandia brevis	02A-1 (1.0)	2007	DP04	A	1	Int
ANNELIDA	Oligochaeta				Tubificidae indet. Group 5	02A-1 (1.0)	2007	DP04	B	5	A
ANNELIDA	Oligochaeta				Tubificidae indet. Group 5	02A-1 (1.0)	2007	DP04	C	1	A
ANNELIDA	Polychaeta			Errantia	Onuphis geophiliformis	02A-1 (1.0)	2007	DP04	A	1	A
ANNELIDA	Polychaeta			Sedentaria	Cirratulus spectabilis	02A-1 (1.0)	2007	DP04	C	1	A
ARTHROPODA	Ostracoda	CRUSTACEA			Cyprideis sp.	02A-1 (1.0)	2007	DP04	B	12	A
MOLLUSCA	Bivalvia				Rochefortia tumida	02A-1 (1.0)	2007	DP04	A	15	Int
ANNELIDA	Polychaeta			Sedentaria	Capitella capitata complex	02A-1 (1.0)	2007	DP04	B	1	A
ANNELIDA	Oligochaeta				Tubificidae indet. Group 5	02A-1 (1.0)	2007	DP04	C	1	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Ischyrocerus anguipes	02A-1 (1.0)	2007	DP04	A	3	A
ANNELIDA	Oligochaeta				Tubificidae indet. Group 5	02A-1 (1.0)	2007	DP04	B	1	J
MOLLUSCA	Bivalvia				Rochefortia tumida	02A-1 (1.0)	2007	DP04	C	91	A
ANNELIDA	Polychaeta			Sedentaria	Ampharete labrops	02A-1 (1.0)	2007	DP04	B	3	Int
ANNELIDA	Polychaeta			Sedentaria	Capitella capitata complex	02A-1 (1.0)	2007	DP04	C	1	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Photis brevipes	02A-1 (1.0)	2007	DP04	B	63	A
ANNELIDA	Oligochaeta				Tubificidae indet. Group 5	02A-1 (1.0)	2007	DP04	B	7	Int
MOLLUSCA	Bivalvia				Rochefortia tumida	02A-1 (1.0)	2007	DP04	C	14	Int
ANNELIDA	Polychaeta			Errantia	Phyllodoce williamsi	02A-1 (1.0)	2007	DP04	C	1	A
ARTHROPODA	Malacostraca	CRUSTACEA	Isopoda		Munna ubiquita	02A-1 (1.0)	2007	DP04	B	1	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Photis brevipes	02A-1 (1.0)	2007	DP04	A	71	A
MOLLUSCA	Bivalvia				Clinocardium nuttallii	02A-1 (1.0)	2007	DP04	C	1	J
MOLLUSCA	Bivalvia				Rochefortia tumida	02A-1 (1.0)	2007	DP04	B	17	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Isopoda		Synidotea nodulosa	02A-1 (1.0)	2007	DP04	B	1	Int
ANNELIDA	Polychaeta			Sedentaria	Armandia brevis	02A-1 (1.0)	2007	DP04	C	3	A
MOLLUSCA	Bivalvia				Clinocardium nuttallii	02A-1 (1.0)	2007	DP04	A	1	Int
MOLLUSCA	Gastropoda				Lottia parallela	02A-1 (1.0)	2007	DP04	A	8	A
MOLLUSCA	Gastropoda				Lottia parallela	02A-1 (1.0)	2007	DP04	C	17	A
MOLLUSCA	Gastropoda				Lacuna vincta	02A-1 (1.0)	2007	DP04	C	1	Int
MOLLUSCA	Gastropoda				Lacuna vincta	02A-1 (1.0)	2007	DP04	B	1	Int
MOLLUSCA	Gastropoda				Lottia parallela	02A-1 (1.0)	2007	DP04	A	8	Int
MOLLUSCA	Gastropoda				Lacuna vincta	02A-1 (1.0)	2007	DP04	A	1	Int
MOLLUSCA	Gastropoda				Lottia parallela	02A-1 (1.0)	2007	DP04	B	4	Int
MOLLUSCA	Gastropoda				Lottia parallela	02A-1 (1.0)	2007	DP04	B	18	A
PLATYHELMINTHES	Turbellaria				Pseudostylochus burchami	02A-1 (1.0)	2007	DP04	C	2	A
MOLLUSCA	Gastropoda				Lottia parallela	02A-1 (1.0)	2007	DP04	C	14	Int
MOLLUSCA	Gastropoda				Lacuna variegata	02A-1 (1.0)	2007	DP04	C	1	J
MOLLUSCA	Gastropoda				Lacuna sp.	02A-1 (1.0)	2007	DP04	C	1	J
MOLLUSCA	Gastropoda				Cyclostremella concordia	02A-1 (1.0)	2007	DP04	B	5	J
MOLLUSCA	Gastropoda				Cyclostremella concordia	02A-1 (1.0)	2007	DP04	A	2	J
MOLLUSCA	Gastropoda				Cuthona concinna	02A-1 (1.0)	2007	DP04	C	5	J
PLATYHELMINTHES	Turbellaria				Pseudostylochus burchami	02A-1 (1.0)	2007	DP04	B	1	A
MOLLUSCA	Gastropoda				Alvania compacta	02A-1 (1.0)	2007	DP05	C	4	A
ANNELIDA	Polychaeta			Errantia	Lumbrineris cruzensis	02A-1 (1.0)	2007	DP05	C	3	A

Phylum	Class	Sub Phylum	Order	Subclass	Genus_species	SampleID	Year	Station	Grab	Count	LifeStage
ANNELIDA	Polychaeta			Errantia	Lumbrineris cruzensis	02A-1 (1.0)	2007	DP05	A	2	A
ANNELIDA	Polychaeta			Errantia	Lumbrineris cruzensis	02A-1 (1.0)	2007	DP05	B	4	A
MOLLUSCA	Bivalvia				Macoma carlottensis	02A-1 (1.0)	2007	DP05	C	11	J
MOLLUSCA	Bivalvia				Ennucula tenuis	02A-1 (1.0)	2007	DP05	A	2	J
MOLLUSCA	Bivalvia				Macoma carlottensis	02A-1 (1.0)	2007	DP05	B	6	J
MOLLUSCA	Bivalvia				Axinopsida serricata	02A-1 (1.0)	2007	DP05	B	8	Int
ECHINODERMATA	Ophiuroidea				Amphiodia urtica	02A-1 (1.0)	2007	DP05	A	3	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Decapoda		Pinnixa schmitti	02A-1 (1.0)	2007	DP05	B	1	A
ECHINODERMATA	Ophiuroidea				Amphiodia urtica	02A-1 (1.0)	2007	DP05	C	1	A
MOLLUSCA	Bivalvia				Ennucula tenuis	02A-1 (1.0)	2007	DP05	C	27	Int
MOLLUSCA	Bivalvia				Ennucula tenuis	02A-1 (1.0)	2007	DP05	B	1	J
ECHINODERMATA	Ophiuroidea				Amphiodia urtica	02A-1 (1.0)	2007	DP05	C	4	Int
ECHINODERMATA	Ophiuroidea				Amphiodia urtica	02A-1 (1.0)	2007	DP05	B	2	Int
MOLLUSCA	Bivalvia				Axinopsida serricata	02A-1 (1.0)	2007	DP05	A	10	Int
MOLLUSCA	Bivalvia				Clinocardium nuttallii	02A-1 (1.0)	2007	DP05	A	1	J
ANNELIDA	Polychaeta			Errantia	Glycinde polygnatha	02A-1 (1.0)	2007	DP05	A	3	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Heterophoxus affinis	02A-1 (1.0)	2007	DP05	B	1	A
MOLLUSCA	Bivalvia				Ennucula tenuis	02A-1 (1.0)	2007	DP05	B	12	Int
ANNELIDA	Polychaeta			Errantia	Glycinde armigera	02A-1 (1.0)	2007	DP05	B	1	A
MOLLUSCA	Bivalvia				Compsomyax subdiaphana	02A-1 (1.0)	2007	DP05	C	2	J
MOLLUSCA	Bivalvia				Ennucula tenuis	02A-1 (1.0)	2007	DP05	A	19	Int
MOLLUSCA	Gastropoda				Alvania compacta	02A-1 (1.0)	2007	DP05	B	9	A
ANNELIDA	Polychaeta			Errantia	Nephtys cornuta	02A-1 (1.0)	2007	DP05	A	11	A
ANNELIDA	Polychaeta			Errantia	Nephtys cornuta	02A-1 (1.0)	2007	DP05	B	51	A
ARTHROPODA	Malacostraca	CRUSTACEA	Decapoda		Pinnixa schmitti	02A-1 (1.0)	2007	DP05	A	4	A
MOLLUSCA	Bivalvia				Megayoldia martyria	02A-1 (1.0)	2007	DP05	A	1	J
MOLLUSCA	Bivalvia				Macoma elimata	02A-1 (1.0)	2007	DP05	B	1	Int
ARTHROPODA	Copepoda	CRUSTACEA			Cyclopoida indet.	02A-1 (1.0)	2007	DP05	B	2	A
ANNELIDA	Polychaeta			Sedentaria	Scoloplos acmeceps	02A-1 (1.0)	2007	DP05	C	2	A
MOLLUSCA	Bivalvia				Macoma carlottensis	02A-1 (1.0)	2007	DP05	B	4	Int
ANNELIDA	Polychaeta			Errantia	Glycera nana	02A-1 (1.0)	2007	DP05	A	2	Int
ANNELIDA	Polychaeta			Sedentaria	Spiophanes berkeleyorum	02A-1 (1.0)	2007	DP05	A	1	Int
ANNELIDA	Polychaeta			Sedentaria	Spiophanes berkeleyorum	02A-1 (1.0)	2007	DP05	B	2	Int
ANNELIDA	Polychaeta			Sedentaria	Spiophanes berkeleyorum	02A-1 (1.0)	2007	DP05	B	1	J
MOLLUSCA	Bivalvia				Clinocardium sp.	02A-1 (1.0)	2007	DP05	C	1	J
ANNELIDA	Polychaeta			Sedentaria	Sternaspis nr. fossor	02A-1 (1.0)	2007	DP05	C	1	A
MOLLUSCA	Bivalvia				Macoma carlottensis	02A-1 (1.0)	2007	DP05	A	13	J
ARTHROPODA	Pycnogonida	CHELICERATA			Anoplodactylus viridintestinalis	02A-1 (1.0)	2007	DP05	A	1	Int
MOLLUSCA	Bivalvia				Macoma carlottensis	02A-1 (1.0)	2007	DP05	A	16	Int
MOLLUSCA	Bivalvia				Lucinoma annulatum	02A-1 (1.0)	2007	DP05	B	2	J
MOLLUSCA	Bivalvia				Macoma nasuta	02A-1 (1.0)	2007	DP05	C	6	J
ANNELIDA	Polychaeta			Errantia	Glycera nana	02A-1 (1.0)	2007	DP05	B	2	A
MOLLUSCA	Bivalvia				Clinocardium nuttallii	02A-1 (1.0)	2007	DP05	C	2	J
ANNELIDA	Polychaeta			Errantia	Glycera nana	02A-1 (1.0)	2007	DP05	A	3	A
ANNELIDA	Polychaeta			Sedentaria	Sternaspis nr. fossor	02A-1 (1.0)	2007	DP05	B	1	A
ANNELIDA	Polychaeta			Errantia	Glycera pacifica	02A-1 (1.0)	2007	DP05	C	1	A
ANNELIDA	Polychaeta			Sedentaria	Prionospio (Minuspio) lighti	02A-1 (1.0)	2007	DP05	A	1	A
MOLLUSCA	Bivalvia				Macoma sp.	02A-1 (1.0)	2007	DP05	B	1	J
ANNELIDA	Polychaeta			Errantia	Glycinde polygnatha	02A-1 (1.0)	2007	DP05	B	3	A
ANNELIDA	Polychaeta			Errantia	Glycinde armigera	02A-1 (1.0)	2007	DP05	C	4	Int
ANNELIDA	Polychaeta			Errantia	Glycinde armigera	02A-1 (1.0)	2007	DP05	A	2	Int
ANNELIDA	Polychaeta			Errantia	Glycinde armigera	02A-1 (1.0)	2007	DP05	C	3	A
ARTHROPODA	Malacostraca	CRUSTACEA	Decapoda		Pinnixa schmitti	02A-1 (1.0)	2007	DP05	C	2	Int
ANNELIDA	Polychaeta			Sedentaria	Scoloplos acmeceps	02A-1 (1.0)	2007	DP05	A	5	A
MOLLUSCA	Bivalvia				Macoma nasuta	02A-1 (1.0)	2007	DP05	A	4	J
MOLLUSCA	Bivalvia				Macoma carlottensis	02A-1 (1.0)	2007	DP05	C	19	Int
ECHINODERMATA	Ophiuroidea				Amphiodia urtica	02A-1 (1.0)	2007	DP05	B	4	A
ECHINODERMATA	Ophiuroidea				Amphiodia urtica	02A-1 (1.0)	2007	DP05	A	2	A
ECHINODERMATA	Ophiuroidea				Amphiodia sp.	02A-1 (1.0)	2007	DP05	B	6	J
ECHINODERMATA	Ophiuroidea				Amphiodia sp.	02A-1 (1.0)	2007	DP05	A	1	J
ANNELIDA	Polychaeta			Errantia	Glycera nana	02A-1 (1.0)	2007	DP05	C	1	Int
ANNELIDA	Polychaeta			Errantia	Glycera nana	02A-1 (1.0)	2007	DP05	B	2	Int
MOLLUSCA	Bivalvia				Axinopsida serricata	02A-1 (1.0)	2007	DP05	C	6	Int
MOLLUSCA	Bivalvia				Ennucula tenuis	02A-1 (1.0)	2007	DP05	C	4	J
ANNELIDA	Polychaeta			Sedentaria	Aphelochaeta sp. 2	02A-1 (1.0)	2007	DP05	C	1	A
MOLLUSCA	Bivalvia				Nutricola tantilla	02A-1 (1.0)	2007	DP05	C	1	A
MOLLUSCA	Bivalvia				Nutricola tantilla	02A-1 (1.0)	2007	DP05	A	1	A
ANNELIDA	Polychaeta			Sedentaria	Aphelochaeta sp. 2	02A-1 (1.0)	2007	DP05	A	1	Int
ANNELIDA	Polychaeta			Errantia	Pholoe glabra	02A-1 (1.0)	2007	DP05	A	1	A
MOLLUSCA	Bivalvia				Parvilucina tenuisculpta	02A-1 (1.0)	2007	DP05	A	15	Int
ANNELIDA	Polychaeta			Sedentaria	Heteromastus filobranchus	02A-1 (1.0)	2007	DP05	C	6	A
ANNELIDA	Polychaeta			Sedentaria	Notomastus spp.	02A-1 (1.0)	2007	DP05	B	1	Int
ANNELIDA	Polychaeta			Sedentaria	Heteromastus filobranchus	02A-1 (1.0)	2007	DP05	B	5	A
MOLLUSCA	Bivalvia				Parvilucina tenuisculpta	02A-1 (1.0)	2007	DP05	B	10	Int
ANNELIDA	Polychaeta			Errantia	Pholoe glabra	02A-1 (1.0)	2007	DP05	B	3	Int
ANNELIDA	Polychaeta			Sedentaria	Owenia nr. collaris	02A-1 (1.0)	2007	DP05	A	1	A
ANNELIDA	Polychaeta			Sedentaria	Aphelochaeta sp. N1	02A-1 (1.0)	2007	DP05	A	1	Int
ANNELIDA	Polychaeta			Sedentaria	Owenia nr. collaris	02A-1 (1.0)	2007	DP05	C	2	A
ANNELIDA	Polychaeta			Sedentaria	Owenia nr. johnsoni	02A-1 (1.0)	2007	DP05	B	3	A
MOLLUSCA	Bivalvia				Axinopsida serricata	02A-1 (1.0)	2007	DP05	A	69	A
ANNELIDA	Polychaeta			Errantia	Nephtys ferruginea	02A-1 (1.0)	2007	DP05	B	1	A
ANNELIDA	Polychaeta			Sedentaria	Aphelochaeta sp. 2	02A-1 (1.0)	2007	DP05	B	1	A
ANNELIDA	Polychaeta			Sedentaria	Ampharete spp.	02A-1 (1.0)	2007	DP05	C	1	J
MOLLUSCA	Bivalvia				Parvilucina tenuisculpta	02A-1 (1.0)	2007	DP05	C	7	Int
ANNELIDA	Polychaeta			Sedentaria	Ampharete spp.	02A-1 (1.0)	2007	DP05	A	1	J
ANNELIDA	Polychaeta			Sedentaria	Paraprionospio pinnata	02A-1 (1.0)	2007	DP05	B	5	A
ANNELIDA	Polychaeta			Sedentaria	Heteromastus filobranchus	02A-1 (1.0)	2007	DP05	A	6	A
MOLLUSCA	Bivalvia				Nutricola tantilla	02A-1 (1.0)	2007	DP05	B	7	Int
ANNELIDA	Polychaeta			Sedentaria	Leitoscoloplos pugettensis	02A-1 (1.0)	2007	DP05	C	1	A
MOLLUSCA	Bivalvia				Rochefortia tumida	02A-1 (1.0)	2007	DP05	B	2	Int
ANNELIDA	Polychaeta			Sedentaria	Levinsenia gracilis	02A-1 (1.0)	2007	DP05	B	1	A
ANNELIDA	Polychaeta			Errantia	Phyllodoce hartmanae	02A-1 (1.0)	2007	DP05	B	1	A
ANNELIDA	Polychaeta			Sedentaria	Leitoscoloplos pugettensis	02A-1 (1.0)	2007	DP05	B	3	A
ANNELIDA	Polychaeta			Errantia	Pilargis berkeleyae	02A-1 (1.0)	2007	DP05	C	1	A
MOLLUSCA	Bivalvia				Nutricola tantilla	02A-1 (1.0)	2007	DP05	C	4	Int
ANNELIDA	Polychaeta			Errantia	Pilargis berkeleyae	02A-1 (1.0)	2007	DP05	B	1	Int
MOLLUSCA	Bivalvia				Parvilucina tenuisculpta	02A-1 (1.0)	2007	DP05	A	4	A
ANNELIDA	Polychaeta			Sedentaria	Aphelochaeta sp. 2	02A-1 (1.0)	2007	DP05	B	2	Int
MOLLUSCA	Bivalvia				Rochefortia tumida	02A-1 (1.0)	2007	DP05	C	4	Int
MOLLUSCA	Bivalvia				Tellina modesta	02A-1 (1.0)	2007	DP05	A	7	Int

Appendix E
2007, 2008, 2009 Benthic Invertebrate Data

Phylum	Class	Sub Phylum	Order	Subclass	Genus_species	SampleID	Year	Station	Grab	Count	LifeStage
MOLLUSCA	Bivalvia				Nutricola tantilla	02A-1 (1.0)	2007	DP05	A	7	Int
MOLLUSCA	Bivalvia				Rochefortia tumida	02A-1 (1.0)	2007	DP05	A	3	Int
ANNELIDA	Polychaeta			Errantia	Pilargis berkeleyae	02A-1 (1.0)	2007	DP05	C	1	Int
ANNELIDA	Polychaeta			Sedentaria	Cossura pygodactylata	02A-1 (1.0)	2007	DP05	C	2	A
MOLLUSCA	Bivalvia				Parvilucina tenuisculpta	02A-1 (1.0)	2007	DP05	B	1	A
ANNELIDA	Polychaeta			Sedentaria	Heteromastus filobranchus	02A-1 (1.0)	2007	DP05	C	3	Int
MOLLUSCA	Bivalvia				Tellina modesta	02A-1 (1.0)	2007	DP05	C	1	J
MOLLUSCA	Bivalvia				Parvilucina tenuisculpta	02A-1 (1.0)	2007	DP05	C	6	A
ANNELIDA	Polychaeta			Sedentaria	Heteromastus filobranchus	02A-1 (1.0)	2007	DP05	B	2	Int
ANNELIDA	Polychaeta			Errantia	Pholoe minuta	02A-1 (1.0)	2007	DP05	B	3	Int
MOLLUSCA	Bivalvia				Tellina modesta	02A-1 (1.0)	2007	DP05	C	3	Int
ANNELIDA	Polychaeta			Sedentaria	Paraprionospio pinnata	02A-1 (1.0)	2007	DP05	A	7	A
MOLLUSCA	Gastropoda				Alvania compacta	02A-1 (1.0)	2007	DP05	A	14	A
MOLLUSCA	Bivalvia				Axinopsida serricata	02A-1 (1.0)	2007	DP05	B	37	A
ANNELIDA	Polychaeta			Sedentaria	Euclymene nr. zonalis	02A-1 (1.0)	2007	DP05	A	1	A
ANNELIDA	Polychaeta			Sedentaria	Prionospio (Minuspio) lighti	02A-1 (1.0)	2007	DP05	B	17	A
MOLLUSCA	Bivalvia				Axinopsida serricata	02A-1 (1.0)	2007	DP05	C	42	A
ANNELIDA	Polychaeta			Sedentaria	Dipolydora spp.	02A-1 (1.0)	2007	DP05	B	2	J
MOLLUSCA	Bivalvia				Rochefortia tumida	02A-1 (1.0)	2007	DP05	B	10	A
ANNELIDA	Polychaeta			Errantia	Nephtys cornuta	02A-1 (1.0)	2007	DP05	C	5	A
ANNELIDA	Polychaeta			Errantia	Scoletoma luti	02A-1 (1.0)	2007	DP05	C	3	A
ANNELIDA	Polychaeta			Errantia	Nephtys ferruginea	02A-1 (1.0)	2007	DP05	C	1	A
MOLLUSCA	Bivalvia				Acila castrensis	02A-1 (1.0)	2007	DP05	C	1	Int
ANNELIDA	Polychaeta			Errantia	Scoletoma luti	02A-1 (1.0)	2007	DP05	A	6	A
ANNELIDA	Polychaeta			Sedentaria	Prionospio (Minuspio) lighti	02A-1 (1.0)	2007	DP05	B	1	Int
ANNELIDA	Polychaeta			Errantia	Podarkeopsis glabrus	02A-1 (1.0)	2007	DP05	B	6	Int
MOLLUSCA	Bivalvia				Rochefortia tumida	02A-1 (1.0)	2007	DP05	A	29	A
ANNELIDA	Polychaeta			Sedentaria	Cossura pygodactylata	02A-1 (1.0)	2007	DP05	A	1	A
ANNELIDA	Polychaeta			Sedentaria	Prionospio (Prionospio) steenstrupi	02A-1 (1.0)	2007	DP05	A	2	A
ANNELIDA	Polychaeta			Errantia	Podarkeopsis glabrus	02A-1 (1.0)	2007	DP05	B	1	A
ANNELIDA	Polychaeta			Errantia	Platynereis bicanaliculata	02A-1 (1.0)	2007	DP05	A	2	Int
ANNELIDA	Polychaeta			Sedentaria	Cossura pygodactylata	02A-1 (1.0)	2007	DP05	B	13	A
ANNELIDA	Polychaeta			Errantia	Scoletoma luti	02A-1 (1.0)	2007	DP05	B	5	A
MOLLUSCA	Bivalvia				Nuculana hamata	02A-1 (1.0)	2007	DP05	C	1	J
ANNELIDA	Polychaeta			Sedentaria	Prionospio (Prionospio) steenstrupi	02A-1 (1.0)	2007	DP05	B	1	A
ANNELIDA	Polychaeta			Sedentaria	Paraprionospio pinnata	02A-1 (1.0)	2007	DP05	A	5	Int
ANNELIDA	Polychaeta			Sedentaria	Paraprionospio pinnata	02A-1 (1.0)	2007	DP05	C	5	Int
ANNELIDA	Polychaeta			Sedentaria	Paraprionospio pinnata	02A-1 (1.0)	2007	DP05	B	4	J
ANNELIDA	Polychaeta			Errantia	Scoletoma luti	02A-1 (1.0)	2007	DP05	C	1	J
ANNELIDA	Polychaeta			Sedentaria	Paraprionospio pinnata	02A-1 (1.0)	2007	DP05	C	2	J
ANNELIDA	Polychaeta			Errantia	Scoletoma luti	02A-1 (1.0)	2007	DP05	B	1	Int
ANNELIDA	Polychaeta			Sedentaria	Euclymene nr. zonalis	02A-1 (1.0)	2007	DP05	B	5	A
ANNELIDA	Polychaeta			Sedentaria	Pectinaria californiensis	02A-1 (1.0)	2007	DP05	A	1	A
ANNELIDA	Polychaeta			Sedentaria	Paraprionospio pinnata	02A-1 (1.0)	2007	DP05	C	3	A
ANNELIDA	Polychaeta			Sedentaria	Galathowenia oculata	02A-1 (1.0)	2007	DP05	B	2	A
ANNELIDA	Polychaeta			Sedentaria	Pectinaria californiensis	02A-1 (1.0)	2007	DP05	C	1	A
MOLLUSCA	Bivalvia				Tellina modesta	02A-1 (1.0)	2007	DP05	B	1	Int
MOLLUSCA	Bivalvia				Rochefortia tumida	02A-1 (1.0)	2007	DP05	C	11	A
ANNELIDA	Polychaeta			Errantia	Scoletoma luti	02A-1 (1.0)	2007	DP05	A	1	Int
ANNELIDA	Polychaeta			Sedentaria	Polycirrus sp. I (Banse 1980)	02A-1 (1.0)	2007	DP05	B	1	A
MOLLUSCA	Bivalvia				Tellina modesta	02A-1 (1.0)	2007	DP05	B	1	J
ANNELIDA	Polychaeta			Sedentaria	Euclymeninae indet.	02A-1 (1.0)	2007	DP05	B	1	J
ANNELIDA	Polychaeta			Sedentaria	Euclymene nr. zonalis	02A-1 (1.0)	2007	DP05	C	2	Int
ANNELIDA	Polychaeta			Sedentaria	Euclymene nr. zonalis	02A-1 (1.0)	2007	DP05	A	1	Int
MOLLUSCA	Bivalvia				Parvilucina tenuisculpta	02A-1 (1.0)	2007	DP05	A	1	J
NEMERTEA	Anopla				Tubulanus polymorphus	02A-1 (1.0)	2007	DP05	C	1	A
MOLLUSCA	Gastropoda				Turbonilla sp.	02A-1 (1.0)	2007	DP05	A	1	Int
MOLLUSCA	Gastropoda				Turbonilla sp.	02A-1 (1.0)	2007	DP05	A	1	A
NEMERTEA	Anopla				Cerebratulus californiensis	02A-1 (1.0)	2007	DP05	C	1	J
NEMERTEA	Anopla				Cerebratulus californiensis	02A-1 (1.0)	2007	DP05	B	1	J
MOLLUSCA	Gastropoda				Haminoea vesicula	02A-1 (1.0)	2007	DP05	B	1	J
NEMERTEA	Anopla				Cerebratulus californiensis	02A-1 (1.0)	2007	DP05	B	1	Int
NEMERTEA	Anopla				Cerebratulus californiensis	02A-1 (1.0)	2007	DP05	A	1	Int
NEMERTEA	Anopla				Cerebratulus californiensis	02A-1 (1.0)	2007	DP05	B	1	A
NEMERTEA	Anopla				Cerebratulus californiensis	02A-1 (1.0)	2007	DP05	A	1	A
MOLLUSCA	Scaphopoda				Pulsellum salishorum	02A-1 (1.0)	2007	DP05	C	1	A
MOLLUSCA	Scaphopoda				Pulsellum salishorum	02A-1 (1.0)	2007	DP05	B	1	A
MOLLUSCA	Gastropoda				Volvulella sp.	02A-1 (1.0)	2007	DP05	B	2	J
NEMERTEA	Anopla				Tubulanus polymorphus	02A-1 (1.0)	2007	DP05	B	1	A
MOLLUSCA	Bivalvia				Macoma balthica	02A-1 (1.0)	2007	DP06	C	13	J
ANNELIDA	Polychaeta			Sedentaria	Pseudopolydora kempi	02A-1 (1.0)	2007	DP06	C	1	Int
MOLLUSCA	Bivalvia				Macoma balthica	02A-1 (1.0)	2007	DP06	B	12	J
ANNELIDA	Polychaeta			Sedentaria	Pseudopolydora spp.	02A-1 (1.0)	2007	DP06	C	1	Int
ANNELIDA	Polychaeta			Sedentaria	Pseudopolydora kempi	02A-1 (1.0)	2007	DP06	B	3	Int
MOLLUSCA	Bivalvia				Mya arenaria	02A-1 (1.0)	2007	DP06	A	2	J
MOLLUSCA	Bivalvia				Mya arenaria	02A-1 (1.0)	2007	DP06	B	3	J
MOLLUSCA	Bivalvia				Mya arenaria	02A-1 (1.0)	2007	DP06	C	7	J
ANNELIDA	Polychaeta			Sedentaria	Pseudopolydora paucibranchiata	02A-1 (1.0)	2007	DP06	B	1	J
MOLLUSCA	Bivalvia				Nuttallia obscurata	02A-1 (1.0)	2007	DP06	A	1	J
ANNELIDA	Polychaeta			Sedentaria	Pygospio elegans	02A-1 (1.0)	2007	DP06	B	2	A
MOLLUSCA	Bivalvia				Macoma balthica	02A-1 (1.0)	2007	DP06	A	1	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Americorophium brevis	02A-1 (1.0)	2007	DP06	A	1	A
MOLLUSCA	Bivalvia				Macoma balthica	02A-1 (1.0)	2007	DP06	A	8	J
MOLLUSCA	Bivalvia				Macoma balthica	02A-1 (1.0)	2007	DP06	B	6	Int
ANNELIDA	Polychaeta			Errantia	Phyllodoce spp.	02A-1 (1.0)	2007	DP07	B	1	J
MOLLUSCA	Bivalvia				Macoma carlottensis	02A-1 (1.0)	2007	DP07	C	2	Int
ANNELIDA	Polychaeta			Errantia	Scoletoma luti	02A-1 (1.0)	2007	DP07	C	1	A
MOLLUSCA	Bivalvia				Ennucula tenuis	02A-1 (1.0)	2007	DP07	C	1	Int
ECHIURA	Unspecified				Echiuridae indet.	02A-1 (1.0)	2007	DP07	B	1	J
ARTHROPODA	Malacostraca	CRUSTACEA	Cumacea		Cumella vulgaris	02A-1 (1.0)	2007	DP07	B	2	A
ARTHROPODA	Ostracoda	CRUSTACEA			Euphilomedes carcharodonta	02A-1 (1.0)	2007	DP07	A	1	A
ANNELIDA	Polychaeta			Errantia	Scoletoma luti	02A-1 (1.0)	2007	DP07	B	3	A
ARTHROPODA	Ostracoda	CRUSTACEA			Euphilomedes carcharodonta	02A-1 (1.0)	2007	DP07	B	2	A
ANNELIDA	Polychaeta			Sedentaria	Boccardia polybranchia	02A-1 (1.0)	2007	DP07	C	1	J
MOLLUSCA	Bivalvia				Compsomyax subdiaphana	02A-1 (1.0)	2007	DP07	A	1	J
ANNELIDA	Polychaeta			Errantia	Scoletoma luti	02A-1 (1.0)	2007	DP07	A	6	A
MOLLUSCA	Bivalvia				Macoma elimata	02A-1 (1.0)	2007	DP07	C	1	Int
MOLLUSCA	Bivalvia				Yoldia seminuda	02A-1 (1.0)	2007	DP07	A	1	Int
MOLLUSCA	Bivalvia				Tellina modesta	02A-1 (1.0)	2007	DP07	C	2	Int
ARTHROPODA	Ostracoda	CRUSTACEA			Euphilomedes carcharodonta	02A-1 (1.0)	2007	DP07	C	1	A

Phylum	Class	Sub Phylum	Order	Subclass	Genus_species	SampleID	Year	Station	Grab	Count	LifeStage
ARTHROPODA	Ostracoda	CRUSTACEA			Bathyleberis sp.	02A-1 (1.0)	2007	DP07	B	1	A
ARTHROPODA	Ostracoda	CRUSTACEA			Euphilomedes carcharodonta	02A-1 (1.0)	2007	DP07	B	1	Int
MOLLUSCA	Bivalvia				Tellina modesta	02A-1 (1.0)	2007	DP07	A	1	J
ARTHROPODA	Ostracoda	CRUSTACEA			Euphilomedes carcharodonta	02A-1 (1.0)	2007	DP07	C	1	Int
ANNELIDA	Polychaeta			Sedentaria	Boccardia polybranchia	02A-1 (1.0)	2007	DP07	C	1	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Wecomedon wecomus	02A-1 (1.0)	2007	DP07	A	1	A
MOLLUSCA	Bivalvia				Solen sicarius	02A-1 (1.0)	2007	DP07	A	1	Int
MOLLUSCA	Bivalvia				Solen sicarius	02A-1 (1.0)	2007	DP07	A	1	J
MOLLUSCA	Bivalvia				Tellina modesta	02A-1 (1.0)	2007	DP07	C	2	J
ANNELIDA	Polychaeta			Errantia	Pholoe glabra	02A-1 (1.0)	2007	DP07	C	1	A
ANNELIDA	Oligochaeta				Tubificidae indet. Group 5	02A-1 (1.0)	2007	DP07	A	2	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Protomedeia grandimana	02A-1 (1.0)	2007	DP07	C	1	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Protomedeia sp.	02A-1 (1.0)	2007	DP07	A	1	J
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Rhepoxynius boreovariatus	02A-1 (1.0)	2007	DP07	A	1	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Rhepoxynius boreovariatus	02A-1 (1.0)	2007	DP07	B	8	A
ARTHROPODA	Ostracoda	CRUSTACEA			Bathyleberis sp.	02A-1 (1.0)	2007	DP07	A	1	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Rhepoxynius boreovariatus	02A-1 (1.0)	2007	DP07	C	2	A
ANNELIDA	Oligochaeta				Tectidrilus spp.	02A-1 (1.0)	2007	DP07	A	6	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Wecomedon wecomus	02A-1 (1.0)	2007	DP07	B	1	A
ANNELIDA	Polychaeta			Errantia	Pholoe minuta	02A-1 (1.0)	2007	DP07	C	1	A
MOLLUSCA	Bivalvia				Tellina modesta	02A-1 (1.0)	2007	DP07	A	1	Int
MOLLUSCA	Bivalvia				Axinopsida serricata	02A-1 (1.0)	2007	DP07	B	3	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Pachynus barnardi	02A-1 (1.0)	2007	DP07	B	1	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Orchomene decipens	02A-1 (1.0)	2007	DP07	C	1	A
ANNELIDA	Polychaeta			Errantia	Pilargis berkeleyae	02A-1 (1.0)	2007	DP07	C	1	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Decapoda		Pinnixa schmitti	02A-1 (1.0)	2007	DP07	C	1	Int
ANNELIDA	Polychaeta			Errantia	Scoletoma luti	02A-1 (1.0)	2007	DP07	A	2	Int
MOLLUSCA	Bivalvia				Axinopsida serricata	02A-1 (1.0)	2007	DP07	A	12	A
ANNELIDA	Polychaeta			Sedentaria	Monticellina spp.	02A-1 (1.0)	2007	DP07	C	1	J
ANNELIDA	Polychaeta			Sedentaria	Paraprionospio pinnata	02A-1 (1.0)	2007	DP07	C	1	A
ANNELIDA	Polychaeta			Errantia	Glycinde armigera	02A-1 (1.0)	2007	DP07	C	1	J
ECHIURA	Unspecified				Arhynchite pugettensis	02A-1 (1.0)	2007	DP07	A	1	J
ECHIURA	Unspecified				Arhynchite pugettensis	02A-1 (1.0)	2007	DP07	B	1	J
ANNELIDA	Polychaeta			Errantia	Glycinde armigera	02A-1 (1.0)	2007	DP07	B	1	A
MOLLUSCA	Bivalvia				Macoma sp.	02A-1 (1.0)	2007	DP07	A	3	J
ECHINODERMATA	Ophiuroidea				Amphiodia urtica	02A-1 (1.0)	2007	DP07	A	1	A
ECHINODERMATA	Ophiuroidea				Amphiodia sp.	02A-1 (1.0)	2007	DP07	B	3	J
ANNELIDA	Polychaeta			Sedentaria	Mediomastus californiensis	02A-1 (1.0)	2007	DP07	A	3	A
ANNELIDA	Polychaeta			Errantia	Glycera nana	02A-1 (1.0)	2007	DP07	B	2	J
ANNELIDA	Polychaeta			Errantia	Nephtys ferruginea	02A-1 (1.0)	2007	DP07	A	1	A
ANNELIDA	Polychaeta			Sedentaria	Mediomastus californiensis	02A-1 (1.0)	2007	DP07	B	1	J
ANNELIDA	Polychaeta			Sedentaria	Mediomastus californiensis	02A-1 (1.0)	2007	DP07	C	1	Int
ANNELIDA	Polychaeta			Sedentaria	Mediomastus californiensis	02A-1 (1.0)	2007	DP07	B	3	Int
ANNELIDA	Polychaeta			Errantia	Glycera nana	02A-1 (1.0)	2007	DP07	A	2	Int
MOLLUSCA	Bivalvia				Nutricola tantilla	02A-1 (1.0)	2007	DP07	A	1	A
ANNELIDA	Polychaeta			Sedentaria	Mediomastus californiensis	02A-1 (1.0)	2007	DP07	A	1	Int
ECHINODERMATA	Ophiuroidea				Amphiodia sp.	02A-1 (1.0)	2007	DP07	B	1	Int
ANNELIDA	Polychaeta			Sedentaria	Mediomastus californiensis	02A-1 (1.0)	2007	DP07	C	1	A
CNIDARIA	Anthozoa				Edwardsiidae indet.	02A-1 (1.0)	2007	DP07	C	1	A
ANNELIDA	Polychaeta			Errantia	Glycera nana	02A-1 (1.0)	2007	DP07	C	3	J
ECHINODERMATA	Ophiuroidea				Ophiura sp.	02A-1 (1.0)	2007	DP07	B	2	J
ANNELIDA	Polychaeta			Sedentaria	Prionospio (Prionospio) steenstrupi	02A-1 (1.0)	2007	DP07	B	1	Int
ANNELIDA	Polychaeta			Errantia	Nephtys cornuta	02A-1 (1.0)	2007	DP07	A	1	A
ANNELIDA	Polychaeta			Sedentaria	Prionospio (Prionospio) steenstrupi	02A-1 (1.0)	2007	DP07	A	2	A
ANNELIDA	Polychaeta			Sedentaria	Prionospio (Prionospio) jubata	02A-1 (1.0)	2007	DP07	A	1	Int
ANNELIDA	Polychaeta			Sedentaria	Prionospio (Minuspio) lighti	02A-1 (1.0)	2007	DP07	A	5	J
ANNELIDA	Polychaeta			Errantia	Nephtys cornuta	02A-1 (1.0)	2007	DP07	B	2	A
ECHINODERMATA	Ophiuroidea				Ophiura sp.	02A-1 (1.0)	2007	DP07	A	3	J
ECHINODERMATA	Ophiuroidea				Amphiodia urtica	02A-1 (1.0)	2007	DP07	C	2	Int
MOLLUSCA	Bivalvia				Axinopsida serricata	02A-1 (1.0)	2007	DP07	A	1	Int
MOLLUSCA	Bivalvia				Macoma sp.	02A-1 (1.0)	2007	DP07	B	10	J
ANNELIDA	Polychaeta			Sedentaria	Prionospio (Minuspio) lighti	02A-1 (1.0)	2007	DP07	B	1	A
ECHINODERMATA	Ophiuroidea				Amphiodia urtica	02A-1 (1.0)	2007	DP07	C	1	A
ANNELIDA	Polychaeta			Sedentaria	Polydora sp.	02A-1 (1.0)	2007	DP07	B	1	J
ECHINODERMATA	Ophiuroidea				Ophiura sp.	02A-1 (1.0)	2007	DP07	C	5	J
MOLLUSCA	Bivalvia				Axinopsida serricata	02A-1 (1.0)	2007	DP07	C	2	A
MOLLUSCA	Bivalvia				Mya arenaria	02A-1 (1.0)	2007	DP07	C	1	J
ANNELIDA	Polychaeta			Errantia	Nephtys cornuta	02A-1 (1.0)	2007	DP07	B	4	Int
ANNELIDA	Polychaeta			Sedentaria	Pectinaria granulata	02A-1 (1.0)	2007	DP07	C	2	A
ANNELIDA	Polychaeta			Sedentaria	Pectinaria californiensis	02A-1 (1.0)	2007	DP07	C	2	A
ANNELIDA	Polychaeta			Errantia	Glycinde polygnatha	02A-1 (1.0)	2007	DP07	B	1	Int
MOLLUSCA	Bivalvia				Macoma sp.	02A-1 (1.0)	2007	DP07	A	1	Int
ANNELIDA	Polychaeta			Sedentaria	Prionospio (Minuspio) lighti	02A-1 (1.0)	2007	DP07	C	2	A
ANNELIDA	Polychaeta			Sedentaria	Dipolydora spp.	02A-1 (1.0)	2007	DP07	A	1	Int
ANNELIDA	Polychaeta			Sedentaria	Galathowenia oculata	02A-1 (1.0)	2007	DP07	B	1	Int
ANNELIDA	Polychaeta			Sedentaria	Galathowenia oculata	02A-1 (1.0)	2007	DP07	C	1	A
ANNELIDA	Polychaeta			Sedentaria	Galathowenia oculata	02A-1 (1.0)	2007	DP07	B	1	A
ANNELIDA	Polychaeta			Sedentaria	Galathowenia oculata	02A-1 (1.0)	2007	DP07	A	5	A
ANNELIDA	Polychaeta			Sedentaria	Euclymene nr. zonalis	02A-1 (1.0)	2007	DP07	C	1	A
ANNELIDA	Polychaeta			Sedentaria	Dipolydora spp.	02A-1 (1.0)	2007	DP07	C	4	J
ANNELIDA	Polychaeta			Sedentaria	Dipolydora spp.	02A-1 (1.0)	2007	DP07	B	27	J
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Chromopleustes oculatus	02A-1 (1.0)	2007	DP07	C	1	A
ANNELIDA	Polychaeta			Sedentaria	Mediomastus californiensis	02A-1 (1.0)	2007	DP07	B	15	A
ANNELIDA	Polychaeta			Sedentaria	Dipolydora spp.	02A-1 (1.0)	2007	DP07	B	7	Int
ANNELIDA	Polychaeta			Sedentaria	Heteromastus filobranchus	02A-1 (1.0)	2007	DP07	A	2	Int
ANNELIDA	Oligochaeta				Limnodriloides victoriensis	02A-1 (1.0)	2007	DP07	A	1	A
ANNELIDA	Polychaeta			Sedentaria	Decamastus nr. gracilis	02A-1 (1.0)	2007	DP07	B	2	Int
ANNELIDA	Polychaeta			Sedentaria	Decamastus nr. gracilis	02A-1 (1.0)	2007	DP07	C	8	A
ANNELIDA	Polychaeta			Sedentaria	Decamastus nr. gracilis	02A-1 (1.0)	2007	DP07	B	5	A
MOLLUSCA	Gastropoda				Astyris gausapata	02A-1 (1.0)	2007	DP07	A	1	A
ANNELIDA	Polychaeta			Sedentaria	Decamastus nr. gracilis	02A-1 (1.0)	2007	DP07	A	3	A
ANNELIDA	Polychaeta			Errantia	Epidiopatra hupferiana monroi	02A-1 (1.0)	2007	DP07	B	2	Int
ANNELIDA	Polychaeta			Errantia	Epidiopatra hupferiana monroi	02A-1 (1.0)	2007	DP07	B	1	A
MOLLUSCA	Gastropoda				Astyris gausapata	02A-1 (1.0)	2007	DP07	C	1	Int
ANNELIDA	Polychaeta			Sedentaria	Dipolydora spp.	02A-1 (1.0)	2007	DP07	A	7	J
ANNELIDA	Polychaeta			Errantia	Glycera nana	02A-1 (1.0)	2007	DP07	A	4	A
MOLLUSCA	Bivalvia				Yoldia seminuda	02A-1 (1.0)	2007	DP07	C	1	Int
ANNELIDA	Polychaeta			Sedentaria	Spio cirrifera	02A-1 (1.0)	2007	DP07	B	1	A
ANNELIDA	Polychaeta			Sedentaria	Mediomastus ambiseta	02A-1 (1.0)	2007	DP07	A	2	Int
MOLLUSCA	Bivalvia				Nutricola tantilla	02A-1 (1.0)	2007	DP07	B	2	Int

Phylum	Class	Sub Phylum	Order	Subclass	Genus_species	SampleID	Year	Station	Grab	Count	LifeStage
ANNELIDA	Polychaeta			Sedentaria	Mediomastus ambiseta	02A-1 (1.0)	2007	DP07	B	1	A
ANNELIDA	Polychaeta			Sedentaria	Magelona longicornis	02A-1 (1.0)	2007	DP07	B	5	J
MOLLUSCA	Bivalvia				Nutricola tantilla	02A-1 (1.0)	2007	DP07	C	8	Int
ANNELIDA	Polychaeta			Errantia	Glycera nana	02A-1 (1.0)	2007	DP07	C	2	A
MOLLUSCA	Bivalvia				Macoma nasuta	02A-1 (1.0)	2007	DP07	C	13	J
ANNELIDA	Polychaeta			Sedentaria	Heteromastus filobranchus	02A-1 (1.0)	2007	DP07	A	2	A
ANNELIDA	Polychaeta			Sedentaria	Leitoscoloplos pugettensis	02A-1 (1.0)	2007	DP07	C	7	A
ANNELIDA	Polychaeta			Sedentaria	Heteromastus filobranchus	02A-1 (1.0)	2007	DP07	C	4	A
ANNELIDA	Polychaeta			Sedentaria	Leitoscoloplos pugettensis	02A-1 (1.0)	2007	DP07	B	4	A
MOLLUSCA	Bivalvia				Macoma nasuta	02A-1 (1.0)	2007	DP07	B	2	J
ANNELIDA	Polychaeta			Errantia	Eteone spilotus	02A-1 (1.0)	2007	DP07	A	1	A
ANNELIDA	Polychaeta			Sedentaria	Leitoscoloplos pugettensis	02A-1 (1.0)	2007	DP07	A	16	A
ANNELIDA	Polychaeta			Sedentaria	Heteromastus filobranchus	02A-1 (1.0)	2007	DP07	A	1	J
ANNELIDA	Hirudinoidea				Notostomum sp.	02A-1 (1.0)	2007	DP07	B	1	A
CNIDARIA	Hydrozoa				Campanularia groenlandica	02A-1 (1.0)	2007	DP07	C	8	Int
CNIDARIA	Anthozoa				Edwardsiidae indet.	02A-1 (1.0)	2007	DP07	A	1	J
ANNELIDA	Polychaeta			Errantia	Diopatra ornata	02A-1 (1.0)	2007	DP07	A	1	Int
ANNELIDA	Polychaeta			Sedentaria	Magelona longicornis	02A-1 (1.0)	2007	DP07	A	1	J
NEMERTEA	Anopla				Cerebratulus californiensis	02A-1 (1.0)	2007	DP07	B	3	Int
NEMERTEA	Anopla				Cerebratulus californiensis	02A-1 (1.0)	2007	DP07	C	1	Int
NEMERTEA	Anopla				Lineus bilineatus	02A-1 (1.0)	2007	DP07	C	1	A
NEMERTEA	Anopla				Cerebratulus californiensis	02A-1 (1.0)	2007	DP07	C	1	A
NEMERTEA	Anopla				Lineus bilineatus	02A-1 (1.0)	2007	DP07	A	1	A
NEMERTEA	Anopla				Lineus bilineatus	02A-1 (1.0)	2007	DP07	B	1	J
NEMERTEA	Anopla				Tubulanus polymorphus	02A-1 (1.0)	2007	DP07	A	1	Int
NEMERTEA	Anopla				Lineidae indet.	02A-1 (1.0)	2007	DP07	C	1	J
NEMERTEA	Anopla				Tubulanus polymorphus	02A-1 (1.0)	2007	DP07	A	1	J
NEMERTEA	Anopla				Tubulanus polymorphus	02A-1 (1.0)	2007	DP07	A	1	A
NEMERTEA	Enopla				Paranemertes sp.	02A-1 (1.0)	2007	DP07	A	1	J
NEMERTEA	Unspecified				Nemertea indet.	02A-1 (1.0)	2007	DP07	A	1	J
NEMERTEA	Unspecified				Nemertea indet.	02A-1 (1.0)	2007	DP07	C	1	J
ANNELIDA	Polychaeta			Sedentaria	Capitella capitata complex	02A-1 (1.0)	2008	DP02	C	7	A
ANNELIDA	Polychaeta			Sedentaria	Pseudopolydora paucibranchiata	02A-1 (1.0)	2008	DP02	B	4	J
ANNELIDA	Polychaeta			Errantia	Eteone californica	02A-1 (1.0)	2008	DP02	C	2	A
CNIDARIA	Anthozoa				Actinaria indet.	02A-1 (1.0)	2008	DP02	B	1	J
ANNELIDA	Polychaeta			Sedentaria	Pygospio elegans	02A-1 (1.0)	2008	DP02	A	1	A
CNIDARIA	Anthozoa				Edwardsiidae indet.	02A-1 (1.0)	2008	DP02	C	1	Int
ANNELIDA	Polychaeta			Sedentaria	Pygospio elegans	02A-1 (1.0)	2008	DP02	B	2	A
ANNELIDA	Polychaeta			Sedentaria	Pygospio elegans	02A-1 (1.0)	2008	DP02	C	9	A
ANNELIDA	Polychaeta			Sedentaria	Capitella capitata complex	02A-1 (1.0)	2008	DP02	B	3	A
ARTHROPODA	Ostracoda	CRUSTACEA			Ostracoda indet.	02A-1 (1.0)	2008	DP02	A	1	A
MOLLUSCA	Gastropoda				Amphissa versicolor	02A-1 (1.0)	2008	DP02	A	2	A
MOLLUSCA	Gastropoda				Batillaria cumingi	02A-1 (1.0)	2008	DP02	A	9	A
ANNELIDA	Polychaeta			Sedentaria	Pseudopolydora paucibranchiata	02A-1 (1.0)	2008	DP02	A	1	Int
MOLLUSCA	Bivalvia				Macoma balthica	02A-1 (1.0)	2008	DP02	B	1	Int
MOLLUSCA	Bivalvia				Veneridae sp. A	02A-1 (1.0)	2008	DP02	A	2	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Photis brevipes	02A-1 (1.0)	2008	DP02	C	1	A
ANNELIDA	Polychaeta			Sedentaria	Scoloplos armiger	02A-1 (1.0)	2008	DP02	B	2	A
ANNELIDA	Polychaeta			Sedentaria	Scoloplos armiger	02A-1 (1.0)	2008	DP02	C	1	A
MOLLUSCA	Bivalvia				Macoma balthica	02A-1 (1.0)	2008	DP02	C	1	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Monocorophium sp.	02A-1 (1.0)	2008	DP02	C	3	Int
MOLLUSCA	Bivalvia				Venerupis philippinarum	02A-1 (1.0)	2008	DP02	A	2	A
ANNELIDA	Polychaeta			Sedentaria	Tharyx parvus	02A-1 (1.0)	2008	DP02	A	10	A
ANNELIDA	Polychaeta			Sedentaria	Capitella capitata complex	02A-1 (1.0)	2008	DP02	B	1	Int
MOLLUSCA	Bivalvia				Thyasira flexuosa	02A-1 (1.0)	2008	DP02	A	2	A
ANNELIDA	Polychaeta			Sedentaria	Pseudopolydora kempi	02A-1 (1.0)	2008	DP02	C	22	A
ANNELIDA	Oligochaeta				Tubificidae indet. Group 5	02A-1 (1.0)	2008	DP02	B	1	A
MOLLUSCA	Bivalvia				Cardiidae indet.	02A-1 (1.0)	2008	DP02	C	1	J
ANNELIDA	Oligochaeta				Tubificidae indet. Group 5	02A-1 (1.0)	2008	DP02	C	2	A
MOLLUSCA	Gastropoda				Batillaria cumingi	02A-1 (1.0)	2008	DP02	C	4	A
ANNELIDA	Oligochaeta				Tubificidae indet. Group 5	02A-1 (1.0)	2008	DP02	A	1	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Tanaidacea		Leptochelia savigyni	02A-1 (1.0)	2008	DP02	C	2	A
ANNELIDA	Oligochaeta				Tubificidae indet. Group 5	02A-1 (1.0)	2008	DP02	B	5	Int
ANNELIDA	Oligochaeta				Tubificidae indet. Group 5	02A-1 (1.0)	2008	DP02	C	10	Int
MOLLUSCA	Gastropoda				Batillaria cumingi	02A-1 (1.0)	2008	DP02	A	3	J
MOLLUSCA	Bivalvia				Modiolus modiolus	02A-1 (1.0)	2008	DP02	C	1	J
ANNELIDA	Polychaeta			Sedentaria	Pseudopolydora paucibranchiata	02A-1 (1.0)	2008	DP02	C	9	Int
ANNELIDA	Polychaeta			Sedentaria	Pseudopolydora kempi	02A-1 (1.0)	2008	DP02	B	26	A
ANNELIDA	Polychaeta			Sedentaria	Pseudopolydora paucibranchiata	02A-1 (1.0)	2008	DP02	B	14	Int
ANNELIDA	Polychaeta			Sedentaria	Pseudopolydora paucibranchiata	02A-1 (1.0)	2008	DP02	A	25	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Eobrolgus chumashi	02A-1 (1.0)	2008	DP02	C	2	A
MOLLUSCA	Bivalvia				Hiatella arctica	02A-1 (1.0)	2008	DP02	A	1	J
ARTHROPODA	Copepoda	CRUSTACEA			Harpacticoida indet.	02A-1 (1.0)	2008	DP02	C	3	A
MOLLUSCA	Bivalvia				Hiatella arctica	02A-1 (1.0)	2008	DP02	C	1	J
ARTHROPODA	Malacostraca	CRUSTACEA	Tanaidacea		Leptochelia savigyni	02A-1 (1.0)	2008	DP02	C	3	Int
ANNELIDA	Polychaeta			Sedentaria	Pseudopolydora paucibranchiata	02A-1 (1.0)	2008	DP02	B	65	A
ANNELIDA	Polychaeta			Errantia	Eteone californica	02A-1 (1.0)	2008	DP02	A	2	A
ANNELIDA	Polychaeta			Sedentaria	Pseudopolydora paucibranchiata	02A-1 (1.0)	2008	DP02	C	116	A
ANNELIDA	Polychaeta			Errantia	Eteone californica	02A-1 (1.0)	2008	DP02	B	1	A
ANNELIDA	Polychaeta			Sedentaria	Rhynchospio glutaea	02A-1 (1.0)	2008	DP02	A	1	A
ANNELIDA	Polychaeta			Sedentaria	Pseudopolydora kempi	02A-1 (1.0)	2008	DP02	A	24	A
MOLLUSCA	Gastropoda				Amphissa sp.	02A-1 (1.0)	2008	DP02	A	4	Int
HEMICHORDATA	Enteropneusta				Enteropneusta indet.	02A-1 (1.0)	2008	DP02	C	1	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Grandidierella japonica	02A-1 (1.0)	2008	DP02	C	3	Int
ANNELIDA	Polychaeta			Errantia	Nephtys caecoides	02A-1 (1.0)	2008	DP02	C	1	A
ANNELIDA	Polychaeta			Errantia	Nephtys caecoides	02A-1 (1.0)	2008	DP02	A	1	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Monocorophium acherusicum	02A-1 (1.0)	2008	DP02	C	2	A
ANNELIDA	Polychaeta			Sedentaria	Tharyx parvus	02A-1 (1.0)	2008	DP02	C	1	Int
ANNELIDA	Polychaeta			Sedentaria	Tharyx parvus	02A-1 (1.0)	2008	DP02	B	3	Int
ANNELIDA	Polychaeta			Errantia	Nephtys caeca	02A-1 (1.0)	2008	DP02	A	1	A
ANNELIDA	Polychaeta			Sedentaria	Tharyx parvus	02A-1 (1.0)	2008	DP02	B	1	J
MOLLUSCA	Gastropoda				Amphissa columbiana	02A-1 (1.0)	2008	DP02	A	4	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Grandidierella japonica	02A-1 (1.0)	2008	DP02	C	4	A
ANNELIDA	Polychaeta			Sedentaria	Dipolydora nr. quadrilobata	02A-1 (1.0)	2008	DP02	C	1	A
MOLLUSCA	Gastropoda				Amphissa sp.	02A-1 (1.0)	2008	DP02	B	1	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Grandidierella japonica	02A-1 (1.0)	2008	DP02	A	2	A
ARTHROPODA	Pycnogonida	CHELICERATA			Anoplodactylus viridintestinalis	02A-1 (1.0)	2008	DP02	C	1	A
ANNELIDA	Polychaeta			Sedentaria	Tharyx parvus	02A-1 (1.0)	2008	DP02	B	3	A
ANNELIDA	Polychaeta			Errantia	Glycinde polygnatha	02A-1 (1.0)	2008	DP02	C	1	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Grandidierella japonica	02A-1 (1.0)	2008	DP02	B	1	A

Appendix E
2007, 2008, 2009 Benthic Invertebrate Data

Phylum	Class	Sub Phylum	Order	Subclass	Genus_species	SampleID	Year	Station	Grab	Count	LifeStage
ANNELIDA	Polychaeta			Sedentaria	Capitella capitata complex	02A-1 (1.0)	2008	DP02	C	1	Int
MOLLUSCA	Gastropoda				Amphissa sp.	02A-1 (1.0)	2008	DP02	C	1	Int
ANNELIDA	Polychaeta			Sedentaria	Tharyx parvus	02A-1 (1.0)	2008	DP02	C	42	A
ANNELIDA	Polychaeta			Errantia	Glycinde polygnatha	02A-1 (1.0)	2008	DP02	B	2	A
NEMERTEA	Enopla				Paranemertes nigrina	02A-1 (1.0)	2008	DP02	B	1	Int
MOLLUSCA	Gastropoda				Haminoea vesicula	02A-1 (1.0)	2008	DP02	B	1	Int
MOLLUSCA	Gastropoda				Cylichnella sp.	02A-1 (1.0)	2008	DP02	C	3	Int
MOLLUSCA	Gastropoda				Nassarius fraterculus	02A-1 (1.0)	2008	DP02	C	3	A
MOLLUSCA	Gastropoda				Cylichnella sp.	02A-1 (1.0)	2008	DP02	B	1	J
MOLLUSCA	Bivalvia				Macoma nasuta	02A-1 (1.0)	2008	DP03	B	1	Int
MOLLUSCA	Bivalvia				Hiatella arctica	02A-1 (1.0)	2008	DP03	A	1	J
MOLLUSCA	Bivalvia				Hiatella arctica	02A-1 (1.0)	2008	DP03	C	2	J
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Grandidierella japonica	02A-1 (1.0)	2008	DP03	C	17	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Grandidierella japonica	02A-1 (1.0)	2008	DP03	B	9	Int
ANNELIDA	Polychaeta			Sedentaria	Pseudopolydora paucibranchiata	02A-1 (1.0)	2008	DP03	A	25	A
MOLLUSCA	Bivalvia				Macoma nasuta	02A-1 (1.0)	2008	DP03	A	2	Int
ANNELIDA	Polychaeta			Sedentaria	Pseudopolydora kempi	02A-1 (1.0)	2008	DP03	C	11	A
ANNELIDA	Polychaeta			Errantia	Glycinde polygnatha	02A-1 (1.0)	2008	DP03	C	5	A
MOLLUSCA	Bivalvia				Macoma nasuta	02A-1 (1.0)	2008	DP03	B	2	A
ANNELIDA	Polychaeta			Sedentaria	Pseudopolydora paucibranchiata	02A-1 (1.0)	2008	DP03	B	19	A
ANNELIDA	Oligochaeta				Tubificidae indet. Group 5	02A-1 (1.0)	2008	DP03	B	1	Int
ANNELIDA	Polychaeta			Sedentaria	Arenicolidae indet.	02A-1 (1.0)	2008	DP03	A	3	J
ANNELIDA	Polychaeta			Sedentaria	Polydora cornuta	02A-1 (1.0)	2008	DP03	A	1	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Eobrolgus chumashi	02A-1 (1.0)	2008	DP03	A	1	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Grandidierella japonica	02A-1 (1.0)	2008	DP03	A	41	A
ANNELIDA	Polychaeta			Sedentaria	Polydora cornuta	02A-1 (1.0)	2008	DP03	C	2	A
ANNELIDA	Oligochaeta				Tubificidae indet. Group 5	02A-1 (1.0)	2008	DP03	C	3	A
ANNELIDA	Polychaeta			Sedentaria	Tharyx parvus	02A-1 (1.0)	2008	DP03	B	1	J
ANNELIDA	Polychaeta			Errantia	Nephtys caecoides	02A-1 (1.0)	2008	DP03	B	1	A
ANNELIDA	Oligochaeta				Tubificidae indet. Group 5	02A-1 (1.0)	2008	DP03	A	1	Int
ANNELIDA	Polychaeta			Sedentaria	Pseudopolydora kempi	02A-1 (1.0)	2008	DP03	B	7	A
MOLLUSCA	Bivalvia				Modiolus sp.	02A-1 (1.0)	2008	DP03	C	1	J
ANNELIDA	Oligochaeta				Tubificidae indet. Group 5	02A-1 (1.0)	2008	DP03	C	3	Int
ANNELIDA	Polychaeta			Sedentaria	Pseudopolydora paucibranchiata	02A-1 (1.0)	2008	DP03	B	1	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Grandidierella japonica	02A-1 (1.0)	2008	DP03	C	11	A
ANNELIDA	Polychaeta			Errantia	Eteone californica	02A-1 (1.0)	2008	DP03	A	7	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Grandidierella japonica	02A-1 (1.0)	2008	DP03	A	8	Int
ANNELIDA	Polychaeta			Sedentaria	Pseudopolydora kempi	02A-1 (1.0)	2008	DP03	A	10	A
MOLLUSCA	Gastropoda				Batillaria cumingi	02A-1 (1.0)	2008	DP03	A	1	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Grandidierella japonica	02A-1 (1.0)	2008	DP03	B	12	A
ANNELIDA	Polychaeta			Sedentaria	Scoloplos armiger	02A-1 (1.0)	2008	DP03	B	1	A
ANNELIDA	Polychaeta			Errantia	Eteone californica	02A-1 (1.0)	2008	DP03	B	2	A
ANNELIDA	Polychaeta			Sedentaria	Pygospio elegans	02A-1 (1.0)	2008	DP03	C	1	Int
ANNELIDA	Polychaeta			Sedentaria	Pygospio elegans	02A-1 (1.0)	2008	DP03	A	2	J
ANNELIDA	Polychaeta			Sedentaria	Pygospio elegans	02A-1 (1.0)	2008	DP03	B	7	J
ANNELIDA	Polychaeta			Sedentaria	Tharyx parvus	02A-1 (1.0)	2008	DP03	A	5	J
ANNELIDA	Polychaeta			Sedentaria	Rhynchospio glutaea	02A-1 (1.0)	2008	DP03	A	6	A
ANNELIDA	Polychaeta			Sedentaria	Tharyx parvus	02A-1 (1.0)	2008	DP03	A	5	Int
ANNELIDA	Polychaeta			Sedentaria	Rhynchospio glutaea	02A-1 (1.0)	2008	DP03	B	2	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Monocorophium carlottensis	02A-1 (1.0)	2008	DP03	A	3	A
MOLLUSCA	Gastropoda				Amphissa sp.	02A-1 (1.0)	2008	DP03	A	2	Int
ANNELIDA	Polychaeta			Sedentaria	Pygospio elegans	02A-1 (1.0)	2008	DP03	C	127	A
ANNELIDA	Polychaeta			Sedentaria	Tharyx parvus	02A-1 (1.0)	2008	DP03	C	1	A
MOLLUSCA	Bivalvia				Macoma balthica	02A-1 (1.0)	2008	DP03	C	1	Int
MOLLUSCA	Bivalvia				Macoma nasuta	02A-1 (1.0)	2008	DP03	C	2	J
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Monocorophium sp.	02A-1 (1.0)	2008	DP03	A	3	Int
ANNELIDA	Polychaeta			Sedentaria	Tharyx parvus	02A-1 (1.0)	2008	DP03	B	10	A
ANNELIDA	Polychaeta			Sedentaria	Tharyx parvus	02A-1 (1.0)	2008	DP03	A	16	A
MOLLUSCA	Gastropoda				Amphissa sp.	02A-1 (1.0)	2008	DP03	B	1	J
MOLLUSCA	Gastropoda				Amphissa sp.	02A-1 (1.0)	2008	DP03	A	2	J
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Monocorophium insidiosum	02A-1 (1.0)	2008	DP03	C	4	A
ANNELIDA	Polychaeta			Sedentaria	Tharyx parvus	02A-1 (1.0)	2008	DP03	C	2	J
ARTHROPODA	Cirripedia	CRUSTACEA			Balanus crenatus	02A-1 (1.0)	2008	DP03	B	1	A
ANNELIDA	Polychaeta			Errantia	Glycinde polygnatha	02A-1 (1.0)	2008	DP03	B	2	A
ARTHROPODA	Pycnogonida	CHELICERATA			Anoplodactylus viridintestinalis	02A-1 (1.0)	2008	DP03	B	1	A
ANNELIDA	Polychaeta			Sedentaria	Pygospio elegans	02A-1 (1.0)	2008	DP03	C	35	J
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Monocorophium acherusicum	02A-1 (1.0)	2008	DP03	A	6	A
ANNELIDA	Polychaeta			Sedentaria	Pseudopolydora paucibranchiata	02A-1 (1.0)	2008	DP03	C	12	Int
ANNELIDA	Polychaeta			Sedentaria	Pseudopolydora paucibranchiata	02A-1 (1.0)	2008	DP03	A	2	J
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Monocorophium acherusicum	02A-1 (1.0)	2008	DP03	B	2	A
MOLLUSCA	Gastropoda				Amphissa versicolor	02A-1 (1.0)	2008	DP03	B	3	Int
MOLLUSCA	Bivalvia				Macoma nasuta	02A-1 (1.0)	2008	DP03	A	1	J
ANNELIDA	Polychaeta			Sedentaria	Pseudopolydora paucibranchiata	02A-1 (1.0)	2008	DP03	C	59	A
MOLLUSCA	Bivalvia				Macoma balthica	02A-1 (1.0)	2008	DP03	C	2	A
ANNELIDA	Polychaeta			Sedentaria	Pygospio elegans	02A-1 (1.0)	2008	DP03	A	184	A
ANNELIDA	Polychaeta			Errantia	Eteone californica	02A-1 (1.0)	2008	DP03	C	1	A
ANNELIDA	Polychaeta			Errantia	Glycinde polygnatha	02A-1 (1.0)	2008	DP03	A	3	A
ANNELIDA	Polychaeta			Sedentaria	Pygospio elegans	02A-1 (1.0)	2008	DP03	B	115	A
MOLLUSCA	Gastropoda				Amphissa versicolor	02A-1 (1.0)	2008	DP03	C	5	Int
MOLLUSCA	Bivalvia				Macoma balthica	02A-1 (1.0)	2008	DP03	A	2	Int
MOLLUSCA	Bivalvia				Macoma nasuta	02A-1 (1.0)	2008	DP03	B	4	J
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Monocorophium acherusicum	02A-1 (1.0)	2008	DP03	C	6	A
ANNELIDA	Polychaeta			Sedentaria	Capitella capitata complex	02A-1 (1.0)	2008	DP03	C	1	J
ANNELIDA	Oligochaeta				Tubificidae indet. Group 5	02A-1 (1.0)	2008	DP03	A	1	A
HEMICHORDATA	Enteropneusta				Saccoglossus sp.	02A-1 (1.0)	2008	DP03	A	1	J
ANNELIDA	Polychaeta			Sedentaria	Armandia brevis	02A-1 (1.0)	2008	DP03	A	3	A
ANNELIDA	Oligochaeta				Enchytraeus sp.	02A-1 (1.0)	2008	DP03	C	1	A
ANNELIDA	Polychaeta			Sedentaria	Capitella capitata complex	02A-1 (1.0)	2008	DP03	C	1	A
ANNELIDA	Polychaeta			Sedentaria	Capitella capitata complex	02A-1 (1.0)	2008	DP03	A	1	Int
ANNELIDA	Oligochaeta				Enchytraeus multiannulatus	02A-1 (1.0)	2008	DP03	B	1	A
ANNELIDA	Polychaeta			Sedentaria	Capitella capitata complex	02A-1 (1.0)	2008	DP03	B	3	Int
MOLLUSCA	Bivalvia				Protothaca tenerrima	02A-1 (1.0)	2008	DP03	B	1	J
ANNELIDA	Polychaeta			Sedentaria	Capitella capitata complex	02A-1 (1.0)	2008	DP03	C	1	Int
ANNELIDA	Polychaeta			Sedentaria	Armandia brevis	02A-1 (1.0)	2008	DP03	B	4	A
ANNELIDA	Oligochaeta				Enchytraeidae indet.	02A-1 (1.0)	2008	DP03	A	1	Int
ECHINODERMATA	Ophiuroidea				Amphiodia sp.	02A-1 (1.0)	2008	DP03	A	1	J
ANNELIDA	Polychaeta			Sedentaria	Capitella capitata complex	02A-1 (1.0)	2008	DP03	A	5	A
ANNELIDA	Polychaeta			Sedentaria	Clymenella nr. torquata	02A-1 (1.0)	2008	DP03	B	1	A
ANNELIDA	Polychaeta			Sedentaria	Armandia brevis	02A-1 (1.0)	2008	DP03	C	3	A
MOLLUSCA	Gastropoda				Gastropoda indet.	02A-1 (1.0)	2008	DP03	A	1	J

Appendix E
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Phylum	Class	Sub Phylum	Order	Subclass	Genus_species	SampleID	Year	Station	Grab	Count	LifeStage
MOLLUSCA	Gastropoda				Gastropoda indet.	02A-1 (1.0)	2008	DP03	C	1	Int
MOLLUSCA	Gastropoda				Cylichnella sp.	02A-1 (1.0)	2008	DP03	C	1	Int
MOLLUSCA	Gastropoda				Cylichnella sp.	02A-1 (1.0)	2008	DP03	A	1	Int
MOLLUSCA	Gastropoda				Nassarius fraterculus	02A-1 (1.0)	2008	DP03	A	2	A
MOLLUSCA	Gastropoda				Nassarius fraterculus	02A-1 (1.0)	2008	DP03	B	2	A
ANNELIDA	Polychaeta			Errantia	Pholoe minuta	02A-1 (1.0)	2008	DP04	B	6	A
ECHINODERMATA	Ophiuroidea				Amphiodia urtica	02A-1 (1.0)	2008	DP04	A	8	A
ANNELIDA	Polychaeta			Sedentaria	Spionidae indet.	02A-1 (1.0)	2008	DP04	A	3	A
ANNELIDA	Oligochaeta				Tectidrilus spp.	02A-1 (1.0)	2008	DP04	A	18	Int
ANNELIDA	Polychaeta			Errantia	Pholoe minuta	02A-1 (1.0)	2008	DP04	A	8	A
MOLLUSCA	Bivalvia				Macoma sp.	02A-1 (1.0)	2008	DP04	A	2	Int
ANNELIDA	Polychaeta			Sedentaria	Leitoscoloplos pugettensis	02A-1 (1.0)	2008	DP04	A	12	A
ANNELIDA	Polychaeta			Errantia	Pholoe glabra	02A-1 (1.0)	2008	DP04	C	2	A
ECHINODERMATA	Ophiuroidea				Amphiodia urtica	02A-1 (1.0)	2008	DP04	B	1	A
ANNELIDA	Polychaeta			Errantia	Pholoe minuta	02A-1 (1.0)	2008	DP04	C	7	A
ANNELIDA	Polychaeta			Sedentaria	Tharyx parvus	02A-1 (1.0)	2008	DP04	A	2	A
ANNELIDA	Polychaeta			Errantia	Eulalia quadrioculata	02A-1 (1.0)	2008	DP04	C	1	A
MOLLUSCA	Bivalvia				Macoma nasuta	02A-1 (1.0)	2008	DP04	C	4	J
ANNELIDA	Oligochaeta				Tectidrilus spp.	02A-1 (1.0)	2008	DP04	B	78	A
ANNELIDA	Polychaeta			Sedentaria	Capitella capitata complex	02A-1 (1.0)	2008	DP04	B	1	Int
ECHINODERMATA	Ophiuroidea				Amphiodia urtica	02A-1 (1.0)	2008	DP04	C	5	A
MOLLUSCA	Bivalvia				Parvilucina tenuisculpta	02A-1 (1.0)	2008	DP04	A	1	Int
ANNELIDA	Polychaeta			Sedentaria	Tharyx parvus	02A-1 (1.0)	2008	DP04	C	2	A
ANNELIDA	Oligochaeta				Tectidrilus spp.	02A-1 (1.0)	2008	DP04	A	48	A
ECHINODERMATA	Ophiuroidea				Amphiodia urtica	02A-1 (1.0)	2008	DP04	A	3	Int
ANNELIDA	Polychaeta			Errantia	Pholoe glabra	02A-1 (1.0)	2008	DP04	B	10	A
MOLLUSCA	Bivalvia				Macoma sp.	02A-1 (1.0)	2008	DP04	A	3	J
ANNELIDA	Polychaeta			Sedentaria	Mediomastus californiensis	02A-1 (1.0)	2008	DP04	A	9	A
ANNELIDA	Polychaeta			Errantia	Platynereis bicanaliculata	02A-1 (1.0)	2008	DP04	C	4	A
ANNELIDA	Polychaeta			Errantia	Platynereis bicanaliculata	02A-1 (1.0)	2008	DP04	B	5	A
ANNELIDA	Polychaeta			Sedentaria	Capitella capitata complex	02A-1 (1.0)	2008	DP04	A	2	A
MOLLUSCA	Gastropoda				Columbellidae indet.	02A-1 (1.0)	2008	DP04	B	1	Int
ECHINODERMATA	Ophiuroidea				Amphiodia sp.	02A-1 (1.0)	2008	DP04	A	6	Int
ANNELIDA	Polychaeta			Errantia	Platynereis bicanaliculata	02A-1 (1.0)	2008	DP04	A	3	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Pontogeneia rostrata	02A-1 (1.0)	2008	DP04	C	1	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Pontogeneia rostrata	02A-1 (1.0)	2008	DP04	B	1	A
MOLLUSCA	Bivalvia				Macoma balthica	02A-1 (1.0)	2008	DP04	A	4	Int
ANNELIDA	Polychaeta			Sedentaria	Leitoscoloplos pugettensis	02A-1 (1.0)	2008	DP04	C	5	A
ANNELIDA	Polychaeta			Sedentaria	Capitella capitata complex	02A-1 (1.0)	2008	DP04	B	17	A
ANNELIDA	Polychaeta			Sedentaria	Rhynchospio glutaea	02A-1 (1.0)	2008	DP04	C	7	A
ANNELIDA	Polychaeta			Errantia	Eteone sp.	02A-1 (1.0)	2008	DP04	C	1	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Photis brevipes	02A-1 (1.0)	2008	DP04	B	4	A
ANNELIDA	Polychaeta			Errantia	Phyllodoce williamsi	02A-1 (1.0)	2008	DP04	B	1	A
MOLLUSCA	Bivalvia				Modiolus modiolus	02A-1 (1.0)	2008	DP04	A	9	J
ECHINODERMATA	Ophiuroidea				Amphiodia sp.	02A-1 (1.0)	2008	DP04	A	1	J
ANNELIDA	Polychaeta			Errantia	Eulalia quadrioculata	02A-1 (1.0)	2008	DP04	B	2	A
ANNELIDA	Polychaeta			Sedentaria	Leitoscoloplos pugettensis	02A-1 (1.0)	2008	DP04	B	7	A
MOLLUSCA	Bivalvia				Macoma sp.	02A-1 (1.0)	2008	DP04	C	4	Int
ANNELIDA	Polychaeta			Sedentaria	Rhynchospio glutaea	02A-1 (1.0)	2008	DP04	A	13	A
ANNELIDA	Polychaeta			Sedentaria	Rhynchospio glutaea	02A-1 (1.0)	2008	DP04	B	14	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Photis brevipes	02A-1 (1.0)	2008	DP04	C	1	A
ANNELIDA	Polychaeta			Sedentaria	Capitella capitata complex	02A-1 (1.0)	2008	DP04	B	6	J
MOLLUSCA	Bivalvia				Macoma sp.	02A-1 (1.0)	2008	DP04	B	5	Int
ANNELIDA	Polychaeta			Sedentaria	Scoloplos acmeceps	02A-1 (1.0)	2008	DP04	C	2	A
ECHINODERMATA	Ophiuroidea				Amphiodia sp.	02A-1 (1.0)	2008	DP04	C	1	Int
MOLLUSCA	Bivalvia				Macoma inquinata	02A-1 (1.0)	2008	DP04	C	4	J
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Anisogammarus pugettensis	02A-1 (1.0)	2008	DP04	B	4	A
MOLLUSCA	Bivalvia				Macoma golikovi	02A-1 (1.0)	2008	DP04	C	1	Int
ANNELIDA	Polychaeta			Errantia	Glycinde polygnatha	02A-1 (1.0)	2008	DP04	C	13	A
MOLLUSCA	Bivalvia				Macoma nasuta	02A-1 (1.0)	2008	DP04	A	16	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Anisogammarus pugettensis	02A-1 (1.0)	2008	DP04	C	2	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Anisogammarus pugettensis	02A-1 (1.0)	2008	DP04	C	1	Int
ANNELIDA	Polychaeta			Errantia	Nephtys caecoides	02A-1 (1.0)	2008	DP04	B	1	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Aoroides sp.	02A-1 (1.0)	2008	DP04	C	2	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Aoroides sp.	02A-1 (1.0)	2008	DP04	C	1	Int
MOLLUSCA	Gastropoda				Alvania compacta	02A-1 (1.0)	2008	DP04	B	48	A
ANNELIDA	Polychaeta			Errantia	Glycinde polygnatha	02A-1 (1.0)	2008	DP04	A	4	Int
ANNELIDA	Polychaeta			Sedentaria	Dipolydora socialis	02A-1 (1.0)	2008	DP04	A	1	A
ECHINODERMATA	Ophiuroidea				Amphiodia urtica	02A-1 (1.0)	2008	DP04	B	4	Int
ANNELIDA	Polychaeta			Sedentaria	Dipolydora nr. quadrilobata	02A-1 (1.0)	2008	DP04	B	7	J
ANNELIDA	Polychaeta			Errantia	Nephtys caecoides	02A-1 (1.0)	2008	DP04	C	5	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Caprella laeviuscula	02A-1 (1.0)	2008	DP04	C	5	A
ANNELIDA	Polychaeta			Errantia	Nephtys caecoides	02A-1 (1.0)	2008	DP04	A	3	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Caprella laeviuscula	02A-1 (1.0)	2008	DP04	A	3	Int
ANNELIDA	Polychaeta			Errantia	Nephtys caeca	02A-1 (1.0)	2008	DP04	B	1	A
ANNELIDA	Polychaeta			Sedentaria	Dipolydora nr. quadrilobata	02A-1 (1.0)	2008	DP04	B	4	A
MOLLUSCA	Bivalvia				Macoma inquinata	02A-1 (1.0)	2008	DP04	C	11	Int
MOLLUSCA	Gastropoda				Alvania compacta	02A-1 (1.0)	2008	DP04	C	32	A
MOLLUSCA	Bivalvia				Rochefortia tumida	02A-1 (1.0)	2008	DP04	A	161	A
ANNELIDA	Polychaeta			Sedentaria	Dipolydora nr. quadrilobata	02A-1 (1.0)	2008	DP04	A	1	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Eobrolgus chumashi	02A-1 (1.0)	2008	DP04	A	1	A
ANNELIDA	Polychaeta			Errantia	Harmothoe imbricata	02A-1 (1.0)	2008	DP04	C	1	A
ANNELIDA	Polychaeta			Errantia	Glycinde polygnatha	02A-1 (1.0)	2008	DP04	C	4	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Caprella laeviuscula	02A-1 (1.0)	2008	DP04	B	2	A
ANNELIDA	Polychaeta			Errantia	Nereidae indet.	02A-1 (1.0)	2008	DP04	B	1	Int
ANNELIDA	Polychaeta			Errantia	Ophiodromus pugettensis	02A-1 (1.0)	2008	DP04	C	2	Int
MOLLUSCA	Bivalvia				Macoma nasuta	02A-1 (1.0)	2008	DP04	B	6	J
MOLLUSCA	Bivalvia				Macoma sp.	02A-1 (1.0)	2008	DP04	B	10	J
MOLLUSCA	Bivalvia				Parvilucina tenuisculpta	02A-1 (1.0)	2008	DP04	B	1	Int
MOLLUSCA	Gastropoda				Cuthona concinna	02A-1 (1.0)	2008	DP04	B	4	J
ECHINODERMATA	Ophiuroidea				Amphiodia urtica	02A-1 (1.0)	2008	DP04	C	7	Int
MOLLUSCA	Bivalvia				Macoma nasuta	02A-1 (1.0)	2008	DP04	A	7	J
ANNELIDA	Polychaeta			Errantia	Glycinde polygnatha	02A-1 (1.0)	2008	DP04	A	5	A
ARTHROPODA	Arachnida	CHELICERATA	Acarida		Hydracarina indet.	02A-1 (1.0)	2008	DP04	A	1	A
ANNELIDA	Polychaeta			Errantia	Ophiodromus pugettensis	02A-1 (1.0)	2008	DP04	C	2	A
ANNELIDA	Polychaeta			Errantia	Ophiodromus pugettensis	02A-1 (1.0)	2008	DP04	A	2	A
MOLLUSCA	Bivalvia				Macoma nasuta	02A-1 (1.0)	2008	DP04	C	11	Int
ANNELIDA	Polychaeta			Sedentaria	Clymenella nr. torquata	02A-1 (1.0)	2008	DP04	A	1	Int
ARTHROPODA	Pycnogonida	CHELICERATA			Anoplodactylus viridintestinalis	02A-1 (1.0)	2008	DP04	A	5	A
ANNELIDA	Polychaeta			Sedentaria	Clymenella nr. torquata	02A-1 (1.0)	2008	DP04	C	3	A

Phylum	Class	Sub Phylum	Order	Subclass	Genus_species	SampleID	Year	Station	Grab	Count	LifeStage
MOLLUSCA	Bivalvia				Rochefortia tumida	02A-1 (1.0)	2008	DP04	B	108	A
MOLLUSCA	Gastropoda				Alvania compacta	02A-1 (1.0)	2008	DP04	A	1	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Ischyrocerus anguipes	02A-1 (1.0)	2008	DP04	C	1	Int
ARTHROPODA	Pycnogonida	CHELICERATA			Anoplodactylus viridintestinalis	02A-1 (1.0)	2008	DP04	B	20	A
ANNELIDA	Polychaeta			Errantia	Glycinde polygnatha	02A-1 (1.0)	2008	DP04	B	5	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Ischyrocerus anguipes	02A-1 (1.0)	2008	DP04	C	1	A
ANNELIDA	Polychaeta			Sedentaria	Clymenella nr. torquata	02A-1 (1.0)	2008	DP04	A	9	A
ARTHROPODA	Pycnogonida	CHELICERATA			Anoplodactylus viridintestinalis	02A-1 (1.0)	2008	DP04	C	26	A
MOLLUSCA	Bivalvia				Macoma nasuta	02A-1 (1.0)	2008	DP04	B	7	Int
ANNELIDA	Polychaeta			Sedentaria	Clymenella nr. torquata	02A-1 (1.0)	2008	DP04	B	1	A
MOLLUSCA	Bivalvia				Macoma golikovi	02A-1 (1.0)	2008	DP04	B	4	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Americhelidium shoemakeri	02A-1 (1.0)	2008	DP04	C	3	A
ANNELIDA	Polychaeta			Errantia	Pholoe glabra	02A-1 (1.0)	2008	DP04	A	2	A
ANNELIDA	Polychaeta			Sedentaria	Prionospio (Minuspio) lighti	02A-1 (1.0)	2008	DP04	A	12	A
ANNELIDA	Oligochaeta				Tectidrilus spp.	02A-1 (1.0)	2008	DP04	A	31	J
ANNELIDA	Polychaeta			Sedentaria	Prionospio (Prionospio) jubata	02A-1 (1.0)	2008	DP04	C	1	A
ANNELIDA	Polychaeta			Sedentaria	Prionospio (Prionospio) steenstrupi	02A-1 (1.0)	2008	DP04	A	2	A
ANNELIDA	Polychaeta			Sedentaria	Armandia brevis	02A-1 (1.0)	2008	DP04	A	1	A
MOLLUSCA	Gastropoda				Batillaria cumingi	02A-1 (1.0)	2008	DP04	A	1	A
ARTHROPODA	Malacostraca	CRUSTACEA	Decapoda		Pinnixa schmitti	02A-1 (1.0)	2008	DP04	C	2	A
ANNELIDA	Polychaeta			Sedentaria	Ampharete labrops	02A-1 (1.0)	2008	DP04	B	4	Int
ANNELIDA	Polychaeta			Sedentaria	Ampharete labrops	02A-1 (1.0)	2008	DP04	B	5	A
ANNELIDA	Polychaeta			Sedentaria	Prionospio (Prionospio) steenstrupi	02A-1 (1.0)	2008	DP04	B	1	A
MOLLUSCA	Bivalvia				Modiolus modiolus	02A-1 (1.0)	2008	DP04	C	20	J
MOLLUSCA	Bivalvia				Tellina modesta	02A-1 (1.0)	2008	DP04	B	1	Int
ANNELIDA	Oligochaeta				Tubificidae indet. Group 5	02A-1 (1.0)	2008	DP04	A	3	J
ANNELIDA	Polychaeta			Sedentaria	Owenia nr. johnsoni	02A-1 (1.0)	2008	DP04	A	2	Int
ARTHROPODA	Copepoda	CRUSTACEA			Harpacticoida indet.	02A-1 (1.0)	2008	DP04	B	2	A
ANNELIDA	Polychaeta			Sedentaria	Asabellides nr.lineata	02A-1 (1.0)	2008	DP04	C	1	A
ARTHROPODA	Malacostraca	CRUSTACEA	Isopoda		Idotea rescata	02A-1 (1.0)	2008	DP04	B	5	A
ANNELIDA	Polychaeta			Sedentaria	Owenia nr. johnsoni	02A-1 (1.0)	2008	DP04	C	46	A
ANNELIDA	Oligochaeta				Tubificoides sp.	02A-1 (1.0)	2008	DP04	C	1	A
ARTHROPODA	Malacostraca	CRUSTACEA	Cumacea		Cumella vulgaris	02A-1 (1.0)	2008	DP04	A	1	A
MOLLUSCA	Bivalvia				Modiolus modiolus	02A-1 (1.0)	2008	DP04	B	60	J
ARTHROPODA	Copepoda	CRUSTACEA			Porcellidium sp.	02A-1 (1.0)	2008	DP04	B	1	A
MOLLUSCA	Bivalvia				Bivalvia indet.	02A-1 (1.0)	2008	DP04	C	3	J
ANNELIDA	Polychaeta			Errantia	Nereis procera	02A-1 (1.0)	2008	DP04	A	1	A
ARTHROPODA	Malacostraca	CRUSTACEA	Tanaidacea		Leptochelia savigyni	02A-1 (1.0)	2008	DP04	B	114	Int
ANNELIDA	Polychaeta			Sedentaria	Armandia brevis	02A-1 (1.0)	2008	DP04	C	1	A
ANNELIDA	Oligochaeta				Tectidrilus spp.	02A-1 (1.0)	2008	DP04	C	1	Int
ANNELIDA	Polychaeta			Sedentaria	Pseudopolydora paucibranchiata	02A-1 (1.0)	2008	DP04	A	2	A
ANNELIDA	Polychaeta			Sedentaria	Owenia nr. johnsoni	02A-1 (1.0)	2008	DP04	B	55	A
ANNELIDA	Oligochaeta				Tubificidae indet. Group 5	02A-1 (1.0)	2008	DP04	B	15	J
MOLLUSCA	Bivalvia				Clinocardium nuttallii	02A-1 (1.0)	2008	DP04	B	4	J
ARTHROPODA	Malacostraca	CRUSTACEA	Tanaidacea		Leptochelia savigyni	02A-1 (1.0)	2008	DP04	A	75	A
ANNELIDA	Oligochaeta				Tubificidae indet. Group 5	02A-1 (1.0)	2008	DP04	B	24	A
ANNELIDA	Polychaeta			Sedentaria	Arenicolidae indet.	02A-1 (1.0)	2008	DP04	B	1	J
ARTHROPODA	Ostracoda	CRUSTACEA			Philomedes dentata	02A-1 (1.0)	2008	DP04	B	1	A
MOLLUSCA	Bivalvia				Clinocardium ciliatum	02A-1 (1.0)	2008	DP04	C	2	J
ANNELIDA	Polychaeta			Sedentaria	Polydora cornuta	02A-1 (1.0)	2008	DP04	B	1	A
ARTHROPODA	Malacostraca	CRUSTACEA	Tanaidacea		Leptochelia savigyni	02A-1 (1.0)	2008	DP04	B	166	A
MOLLUSCA	Bivalvia				Tellina modesta	02A-1 (1.0)	2008	DP04	A	4	A
MOLLUSCA	Bivalvia				Nutricola sp.	02A-1 (1.0)	2008	DP04	B	1	A
ARTHROPODA	Ostracoda	CRUSTACEA			Euphilomedes carcharodonta	02A-1 (1.0)	2008	DP04	B	1	A
ANNELIDA	Oligochaeta				Tubificidae indet. Group 5	02A-1 (1.0)	2008	DP04	A	17	A
ANNELIDA	Polychaeta			Sedentaria	Prionospio (Minuspio) lighti	02A-1 (1.0)	2008	DP04	B	7	A
MOLLUSCA	Bivalvia				Tellina modesta	02A-1 (1.0)	2008	DP04	A	2	Int
MOLLUSCA	Bivalvia				Cardiidae indet.	02A-1 (1.0)	2008	DP04	A	3	J
ANNELIDA	Polychaeta			Sedentaria	Ampharete labrops	02A-1 (1.0)	2008	DP04	B	1	J
ANNELIDA	Oligochaeta				Tubificidae indet. Group 5	02A-1 (1.0)	2008	DP04	A	18	Int
ANNELIDA	Polychaeta			Sedentaria	Prionospio (Minuspio) lighti	02A-1 (1.0)	2008	DP04	C	6	A
ARTHROPODA	Malacostraca	CRUSTACEA	Tanaidacea		Leptochelia savigyni	02A-1 (1.0)	2008	DP04	C	92	A
MOLLUSCA	Bivalvia				Tellina modesta	02A-1 (1.0)	2008	DP04	C	1	A
ANNELIDA	Polychaeta			Sedentaria	Ampharete spp.	02A-1 (1.0)	2008	DP04	A	3	J
ARTHROPODA	Malacostraca	CRUSTACEA	Isopoda		Idotea rescata	02A-1 (1.0)	2008	DP04	C	2	Int
ANNELIDA	Polychaeta			Sedentaria	Prionospio (Minuspio) lighti	02A-1 (1.0)	2008	DP04	A	1	Int
ANNELIDA	Polychaeta			Sedentaria	Ampharete spp.	02A-1 (1.0)	2008	DP04	A	1	Int
ANNELIDA	Oligochaeta				Tubificidae indet. Group 5	02A-1 (1.0)	2008	DP04	B	28	Int
ANNELIDA	Polychaeta			Sedentaria	Prionospio (Minuspio) lighti	02A-1 (1.0)	2008	DP04	B	1	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Isopoda		Idotea rescata	02A-1 (1.0)	2008	DP04	C	6	A
ANNELIDA	Polychaeta			Sedentaria	Prionospio (Minuspio) multibranchiata	02A-1 (1.0)	2008	DP04	B	2	A
ANNELIDA	Oligochaeta				Tectidrilus spp.	02A-1 (1.0)	2008	DP04	B	30	J
MOLLUSCA	Bivalvia				Tellina modesta	02A-1 (1.0)	2008	DP04	B	5	A
ANNELIDA	Polychaeta			Sedentaria	Mediomastus californiensis	02A-1 (1.0)	2008	DP04	A	3	Int
MOLLUSCA	Bivalvia				Nutricola sp.	02A-1 (1.0)	2008	DP04	B	1	Int
ANNELIDA	Polychaeta			Sedentaria	Armandia brevis	02A-1 (1.0)	2008	DP04	A	1	Int
ANNELIDA	Polychaeta			Errantia	Platynereis bicanaliculata	02A-1 (1.0)	2008	DP04	C	3	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Tanaidacea		Leptochelia savigyni	02A-1 (1.0)	2008	DP04	B	1	J
MOLLUSCA	Bivalvia				Tellina modesta	02A-1 (1.0)	2008	DP04	A	1	J
ANNELIDA	Polychaeta			Sedentaria	Mediomastus californiensis	02A-1 (1.0)	2008	DP04	B	3	J
ANNELIDA	Polychaeta			Errantia	Eteone californica	02A-1 (1.0)	2008	DP04	A	1	A
ANNELIDA	Polychaeta			Sedentaria	Mediomastus californiensis	02A-1 (1.0)	2008	DP04	A	1	J
BRYOZOA	Gymnolaemata				Celleporella hyalina	02A-1 (1.0)	2008	DP04	A	2	A
ARTHROPODA	Malacostraca	CRUSTACEA	Tanaidacea		Leptochelia savigyni	02A-1 (1.0)	2008	DP04	C	119	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Tanaidacea		Leptochelia savigyni	02A-1 (1.0)	2008	DP04	A	138	Int
MOLLUSCA	Bivalvia				Lucinoma annulatum	02A-1 (1.0)	2008	DP04	A	1	J
ANNELIDA	Polychaeta			Errantia	Eteone californica	02A-1 (1.0)	2008	DP04	B	1	A
ANNELIDA	Polychaeta			Sedentaria	Mediomastus californiensis	02A-1 (1.0)	2008	DP04	C	9	A
ANNELIDA	Polychaeta			Sedentaria	Pseudopolydora paucibranchiata	02A-1 (1.0)	2008	DP04	B	1	Int
ANNELIDA	Oligochaeta				Tectidrilus spp.	02A-1 (1.0)	2008	DP04	B	24	Int
MOLLUSCA	Bivalvia				Rochefortia tumida	02A-1 (1.0)	2008	DP04	C	90	A
ANNELIDA	Polychaeta			Sedentaria	Mediomastus californiensis	02A-1 (1.0)	2008	DP04	B	18	A
ANNELIDA	Polychaeta			Errantia	Platynereis bicanaliculata	02A-1 (1.0)	2008	DP04	A	1	Int
MOLLUSCA	Bivalvia				Macoma balthica	02A-1 (1.0)	2008	DP04	A	2	A
ANNELIDA	Polychaeta			Sedentaria	Asabellides nr.lineata	02A-1 (1.0)	2008	DP04	A	1	A
ANNELIDA	Polychaeta			Sedentaria	Mediomastus californiensis	02A-1 (1.0)	2008	DP04	B	4	Int
ARTHROPODA	Copepoda	CRUSTACEA			Harpacticoida indet.	02A-1 (1.0)	2008	DP04	A	1	A
ANNELIDA	Polychaeta			Sedentaria	Owenia nr. johnsoni	02A-1 (1.0)	2008	DP04	A	23	A
NEMERTEA	Anopla				Anopla sp. D	02A-1 (1.0)	2008	DP04	C	1	Int
NEMERTEA	Anopla				Anopla sp. D	02A-1 (1.0)	2008	DP04	C	4	A

Phylum	Class	Sub Phylum	Order	Subclass	Genus_species	SampleID	Year	Station	Grab	Count	LifeStage
MOLLUSCA	Gastropoda				Lottia parallela	02A-1 (1.0)	2008	DP04	C	20	Int
MOLLUSCA	Gastropoda				Cyclostremella concordia	02A-1 (1.0)	2008	DP04	B	4	J
MOLLUSCA	Gastropoda				Lottia parallela	02A-1 (1.0)	2008	DP04	B	15	Int
MOLLUSCA	Gastropoda				Odostomia sp.	02A-1 (1.0)	2008	DP04	B	2	Int
MOLLUSCA	Gastropoda				Cyclostremella concordia	02A-1 (1.0)	2008	DP04	A	3	J
MOLLUSCA	Gastropoda				Cuthona concinna	02A-1 (1.0)	2008	DP04	C	4	J
NEMERTEA	Anopla				Cerebratulus californiensis	02A-1 (1.0)	2008	DP04	B	3	A
NEMERTEA	Anopla				Cerebratulus californiensis	02A-1 (1.0)	2008	DP04	A	2	A
NEMERTEA	Enopla				Tetrastemmidae nigrifons	02A-1 (1.0)	2008	DP04	B	1	A
NEMERTEA	Anopla				Procephalothrix sp.	02A-1 (1.0)	2008	DP04	A	1	A
NEMERTEA	Anopla				Procephalothrix sp.	02A-1 (1.0)	2008	DP04	C	1	A
NEMERTEA	Anopla				Procephalothrix sp.	02A-1 (1.0)	2008	DP04	A	1	Int
NEMERTEA	Enopla				Tetrastemmidae nigrifons	02A-1 (1.0)	2008	DP04	A	1	A
NEMERTEA	Anopla				Cerebratulus californiensis	02A-1 (1.0)	2008	DP04	C	4	A
MOLLUSCA	Gastropoda				Gastropoda indet.	02A-1 (1.0)	2008	DP04	A	1	J
NEMERTEA	Anopla				Cerebratulus californiensis	02A-1 (1.0)	2008	DP04	A	1	Int
NEMERTEA	Anopla				Cerebratulus californiensis	02A-1 (1.0)	2008	DP04	C	1	Int
MOLLUSCA	Gastropoda				Lottia parallela	02A-1 (1.0)	2008	DP04	A	7	A
MOLLUSCA	Gastropoda				Lottia parallela	02A-1 (1.0)	2008	DP04	B	14	A
MOLLUSCA	Gastropoda				Lottia parallela	02A-1 (1.0)	2008	DP04	C	15	A
MOLLUSCA	Gastropoda				Gastropoda indet.	02A-1 (1.0)	2008	DP04	A	1	Int
MOLLUSCA	Gastropoda				Lottia parallela	02A-1 (1.0)	2008	DP04	A	4	Int
NEMERTEA	Unspecified				Nemertea indet.	02A-1 (1.0)	2008	DP04	A	2	J
MOLLUSCA	Bivalvia				Tellina modesta	02A-1 (1.0)	2008	DP05	C	2	J
ANNELIDA	Polychaeta			Sedentaria	Leitoscoloplos pugettensis	02A-1 (1.0)	2008	DP05	C	1	Int
ANNELIDA	Polychaeta			Sedentaria	Aphelochaeta sp. 2	02A-1 (1.0)	2008	DP05	B	2	A
ANNELIDA	Polychaeta			Sedentaria	Spiophanes berkeleyorum	02A-1 (1.0)	2008	DP05	A	1	A
ANNELIDA	Polychaeta			Sedentaria	Cossura pygodactylata	02A-1 (1.0)	2008	DP05	C	1	A
ANNELIDA	Polychaeta			Sedentaria	Prionospio (Minuspio) lighti	02A-1 (1.0)	2008	DP05	B	4	A
ANNELIDA	Polychaeta			Sedentaria	Cossura pygodactylata	02A-1 (1.0)	2008	DP05	B	1	A
MOLLUSCA	Bivalvia				Tellina modesta	02A-1 (1.0)	2008	DP05	C	4	Int
ANNELIDA	Polychaeta			Sedentaria	Cossura pygodactylata	02A-1 (1.0)	2008	DP05	A	4	A
ANNELIDA	Polychaeta			Sedentaria	Leitoscoloplos pugettensis	02A-1 (1.0)	2008	DP05	B	1	Int
ANNELIDA	Polychaeta			Sedentaria	Aphelochaeta sp. 2	02A-1 (1.0)	2008	DP05	A	3	A
ANNELIDA	Polychaeta			Sedentaria	Spiophanes berkeleyorum	02A-1 (1.0)	2008	DP05	B	2	A
MOLLUSCA	Bivalvia				Macoma sp.	02A-1 (1.0)	2008	DP05	A	7	J
ANNELIDA	Polychaeta			Errantia	Pilargis berkeleyae	02A-1 (1.0)	2008	DP05	C	1	J
ANNELIDA	Polychaeta			Sedentaria	Aphelochaeta sp. 2	02A-1 (1.0)	2008	DP05	C	1	A
ANNELIDA	Polychaeta			Sedentaria	Paraprionospio pinnata	02A-1 (1.0)	2008	DP05	A	6	A
ANNELIDA	Polychaeta			Errantia	Pilargis berkeleyae	02A-1 (1.0)	2008	DP05	C	1	A
ANNELIDA	Polychaeta			Sedentaria	Euclymene nr. zonalis	02A-1 (1.0)	2008	DP05	A	1	Int
ANNELIDA	Polychaeta			Sedentaria	Prionospio (Minuspio) lighti	02A-1 (1.0)	2008	DP05	C	5	A
ANNELIDA	Polychaeta			Sedentaria	Leitoscoloplos pugettensis	02A-1 (1.0)	2008	DP05	C	3	A
ANNELIDA	Polychaeta			Errantia	Nephtys cornuta	02A-1 (1.0)	2008	DP05	A	5	A
ANNELIDA	Polychaeta			Sedentaria	Ampharete spp.	02A-1 (1.0)	2008	DP05	B	1	Int
MOLLUSCA	Bivalvia				Macoma sp.	02A-1 (1.0)	2008	DP05	C	4	J
ANNELIDA	Polychaeta			Errantia	Nephtys cornuta	02A-1 (1.0)	2008	DP05	B	14	A
ANNELIDA	Polychaeta			Sedentaria	Spiophanes berkeleyorum	02A-1 (1.0)	2008	DP05	C	1	A
MOLLUSCA	Gastropoda				Alvania compacta	02A-1 (1.0)	2008	DP05	A	18	A
ANNELIDA	Polychaeta			Sedentaria	Euclymene nr. zonalis	02A-1 (1.0)	2008	DP05	A	3	A
MOLLUSCA	Bivalvia				Rochefortia tumida	02A-1 (1.0)	2008	DP05	A	75	A
ANNELIDA	Polychaeta			Sedentaria	Paraprionospio pinnata	02A-1 (1.0)	2008	DP05	A	1	J
ANNELIDA	Polychaeta			Sedentaria	Heteromastus filobranchus	02A-1 (1.0)	2008	DP05	C	1	J
ANNELIDA	Polychaeta			Sedentaria	Asabellides sp.	02A-1 (1.0)	2008	DP05	B	1	J
ANNELIDA	Polychaeta			Sedentaria	Barantolla nr. americana	02A-1 (1.0)	2008	DP05	A	3	A
ANNELIDA	Polychaeta			Errantia	Lumbrineris cruzensis	02A-1 (1.0)	2008	DP05	A	4	A
MOLLUSCA	Bivalvia				Macoma sp.	02A-1 (1.0)	2008	DP05	B	3	J
MOLLUSCA	Bivalvia				Nuculana minuta	02A-1 (1.0)	2008	DP05	B	1	Int
ANNELIDA	Polychaeta			Sedentaria	Paraprionospio pinnata	02A-1 (1.0)	2008	DP05	A	5	Int
ANNELIDA	Polychaeta			Errantia	Lumbrineris cruzensis	02A-1 (1.0)	2008	DP05	B	8	A
ANNELIDA	Polychaeta			Errantia	Lumbrineris cruzensis	02A-1 (1.0)	2008	DP05	C	9	A
MOLLUSCA	Bivalvia				Nutricola lordi	02A-1 (1.0)	2008	DP05	B	6	Int
MOLLUSCA	Bivalvia				Rochefortia tumida	02A-1 (1.0)	2008	DP05	C	42	A
ANNELIDA	Polychaeta			Errantia	Lumbrineris cruzensis	02A-1 (1.0)	2008	DP05	A	2	Int
ANNELIDA	Polychaeta			Sedentaria	Levinsenia gracilis	02A-1 (1.0)	2008	DP05	A	1	A
ANNELIDA	Polychaeta			Sedentaria	Paraprionospio pinnata	02A-1 (1.0)	2008	DP05	C	2	A
MOLLUSCA	Bivalvia				Nutricola sp.	02A-1 (1.0)	2008	DP05	A	8	Int
MOLLUSCA	Gastropoda				Alvania compacta	02A-1 (1.0)	2008	DP05	B	14	A
ANNELIDA	Polychaeta			Sedentaria	Scoloplos acmeceps	02A-1 (1.0)	2008	DP05	C	1	Int
ANNELIDA	Polychaeta			Sedentaria	Aphelochaeta sp. N1	02A-1 (1.0)	2008	DP05	A	1	Int
MOLLUSCA	Bivalvia				Tellina modesta	02A-1 (1.0)	2008	DP05	B	6	J
MOLLUSCA	Bivalvia				Rochefortia tumida	02A-1 (1.0)	2008	DP05	C	5	Int
ANNELIDA	Polychaeta			Sedentaria	Aphelochaeta sp. N1	02A-1 (1.0)	2008	DP05	A	3	A
MOLLUSCA	Bivalvia				Rochefortia tumida	02A-1 (1.0)	2008	DP05	A	4	Int
ANNELIDA	Polychaeta			Sedentaria	Paraprionospio pinnata	02A-1 (1.0)	2008	DP05	B	4	A
ANNELIDA	Polychaeta			Sedentaria	Scoloplos acmeceps	02A-1 (1.0)	2008	DP05	C	1	A
ANNELIDA	Polychaeta			Sedentaria	Aphelochaeta sp. 2	02A-1 (1.0)	2008	DP05	A	1	Int
ANNELIDA	Polychaeta			Sedentaria	Pectinaria granulata	02A-1 (1.0)	2008	DP05	C	1	A
MOLLUSCA	Bivalvia				Macoma sp.	02A-1 (1.0)	2008	DP05	B	5	Int
ANNELIDA	Polychaeta			Errantia	Nephtys cornuta	02A-1 (1.0)	2008	DP05	C	5	A
ANNELIDA	Polychaeta			Sedentaria	Prionospio (Prionospio) steenstrupi	02A-1 (1.0)	2008	DP05	B	2	A
ANNELIDA	Polychaeta			Sedentaria	Heteromastus filobranchus	02A-1 (1.0)	2008	DP05	A	1	J
ANNELIDA	Polychaeta			Errantia	Scoletoma luti	02A-1 (1.0)	2008	DP05	B	1	J
ANNELIDA	Polychaeta			Sedentaria	Heteromastus filobranchus	02A-1 (1.0)	2008	DP05	B	10	A
ANNELIDA	Polychaeta			Sedentaria	Owenia nr. johnsoni	02A-1 (1.0)	2008	DP05	B	1	Int
MOLLUSCA	Bivalvia				Parvilucina tenuisculpta	02A-1 (1.0)	2008	DP05	A	8	Int
MOLLUSCA	Bivalvia				Pandora bilirata	02A-1 (1.0)	2008	DP05	C	2	Int
ANNELIDA	Polychaeta			Sedentaria	Heteromastus filobranchus	02A-1 (1.0)	2008	DP05	C	6	A
ANNELIDA	Polychaeta			Sedentaria	Heteromastus filobranchus	02A-1 (1.0)	2008	DP05	C	3	Int
MOLLUSCA	Bivalvia				Macoma sp.	02A-1 (1.0)	2008	DP05	C	1	Int
MOLLUSCA	Bivalvia				Nutricola sp.	02A-1 (1.0)	2008	DP05	C	6	Int
ANNELIDA	Polychaeta			Errantia	Pholoe sp. N-1	02A-1 (1.0)	2008	DP05	A	2	A
ANNELIDA	Polychaeta			Errantia	Pholoe glabra	02A-1 (1.0)	2008	DP05	B	2	A
MOLLUSCA	Bivalvia				Tellina modesta	02A-1 (1.0)	2008	DP05	B	1	Int
ANNELIDA	Polychaeta			Sedentaria	Heteromastus filobranchus	02A-1 (1.0)	2008	DP05	A	2	Int
ANNELIDA	Polychaeta			Errantia	Scoletoma luti	02A-1 (1.0)	2008	DP05	A	2	Int
MOLLUSCA	Bivalvia				Parvilucina tenuisculpta	02A-1 (1.0)	2008	DP05	B	18	A
ANNELIDA	Polychaeta			Errantia	Scoletoma luti	02A-1 (1.0)	2008	DP05	C	8	A
MOLLUSCA	Bivalvia				Mactromeris sp.	02A-1 (1.0)	2008	DP05	A	1	J
ANNELIDA	Polychaeta			Sedentaria	Scoloplos acmeceps	02A-1 (1.0)	2008	DP05	A	1	A

Appendix E
2007, 2008, 2009 Benthic Invertebrate Data

Phylum	Class	Sub Phylum	Order	Subclass	Genus_species	SampleID	Year	Station	Grab	Count	LifeStage
MOLLUSCA	Bivalvia				Parvilucina tenuisculpta	02A-1 (1.0)	2008	DP05	C	9	A
ANNELIDA	Polychaeta			Errantia	Pholoe glabra	02A-1 (1.0)	2008	DP05	A	1	A
ANNELIDA	Polychaeta			Sedentaria	Heteromastus filobranchus	02A-1 (1.0)	2008	DP05	B	6	Int
ANNELIDA	Polychaeta			Errantia	Scoletoma luti	02A-1 (1.0)	2008	DP05	B	13	A
MOLLUSCA	Bivalvia				Parvilucina tenuisculpta	02A-1 (1.0)	2008	DP05	A	2	A
MOLLUSCA	Bivalvia				Nutricola sp.	02A-1 (1.0)	2008	DP05	B	6	Int
ANNELIDA	Polychaeta			Errantia	Nereis procera	02A-1 (1.0)	2008	DP05	A	1	A
ANNELIDA	Polychaeta			Errantia	Nephtys ferruginea	02A-1 (1.0)	2008	DP05	A	1	A
ANNELIDA	Polychaeta			Errantia	Pilargis berkeleyae	02A-1 (1.0)	2008	DP05	A	1	A
ANNELIDA	Polychaeta			Sedentaria	Owenia nr. johnsoni	02A-1 (1.0)	2008	DP05	C	1	Int
MOLLUSCA	Bivalvia				Tellina modesta	02A-1 (1.0)	2008	DP05	A	3	J
MOLLUSCA	Bivalvia				Parvilucina tenuisculpta	02A-1 (1.0)	2008	DP05	C	8	J
ANNELIDA	Polychaeta			Sedentaria	Leitoscoloplos pugettensis	02A-1 (1.0)	2008	DP05	B	2	A
MOLLUSCA	Bivalvia				Parvilucina tenuisculpta	02A-1 (1.0)	2008	DP05	B	9	J
ANNELIDA	Polychaeta			Sedentaria	Galathowenia oculata	02A-1 (1.0)	2008	DP05	A	11	A
ANNELIDA	Polychaeta			Sedentaria	Heteromastus filobranchus	02A-1 (1.0)	2008	DP05	B	1	J
ANNELIDA	Polychaeta			Sedentaria	Spiophanes berkeleyorum	02A-1 (1.0)	2008	DP05	A	2	Int
ANNELIDA	Polychaeta			Sedentaria	Leitoscoloplos pugettensis	02A-1 (1.0)	2008	DP05	A	1	A
ANNELIDA	Polychaeta			Sedentaria	Heteromastus filobranchus	02A-1 (1.0)	2008	DP05	A	7	A
MOLLUSCA	Bivalvia				Pandora bilirata	02A-1 (1.0)	2008	DP05	B	1	Int
ANNELIDA	Polychaeta			Errantia	Pilargis berkeleyae	02A-1 (1.0)	2008	DP05	B	1	A
MOLLUSCA	Bivalvia				Parvilucina tenuisculpta	02A-1 (1.0)	2008	DP05	A	6	J
MOLLUSCA	Bivalvia				Nuculana minuta	02A-1 (1.0)	2008	DP05	C	1	Int
ANNELIDA	Polychaeta			Errantia	Nereis procera	02A-1 (1.0)	2008	DP05	C	1	A
ANNELIDA	Polychaeta			Sedentaria	Galathowenia oculata	02A-1 (1.0)	2008	DP05	B	18	A
ANNELIDA	Polychaeta			Errantia	Pholoe glabra	02A-1 (1.0)	2008	DP05	C	2	A
ANNELIDA	Polychaeta			Sedentaria	Sternaspis nr. fossor	02A-1 (1.0)	2008	DP05	A	1	A
ANNELIDA	Polychaeta			Sedentaria	Galathowenia oculata	02A-1 (1.0)	2008	DP05	C	27	A
ANNELIDA	Polychaeta			Sedentaria	Scoloplos acmeceps	02A-1 (1.0)	2008	DP05	B	2	A
MOLLUSCA	Bivalvia				Parvilucina tenuisculpta	02A-1 (1.0)	2008	DP05	C	17	Int
MOLLUSCA	Bivalvia				Parvilucina tenuisculpta	02A-1 (1.0)	2008	DP05	B	8	Int
ANNELIDA	Polychaeta			Sedentaria	Prionospio (Prionospio) steenstrupi	02A-1 (1.0)	2008	DP05	A	1	A
ANNELIDA	Polychaeta			Errantia	Scoletoma luti	02A-1 (1.0)	2008	DP05	A	6	A
MOLLUSCA	Bivalvia				Rochefortia tumida	02A-1 (1.0)	2008	DP05	B	53	A
ARTHROPODA	Malacostraca	CRUSTACEA	Decapoda		Pinnixa schmitti	02A-1 (1.0)	2008	DP05	A	1	A
ECHINODERMATA	Ophiuroidea				Amphiodia sp.	02A-1 (1.0)	2008	DP05	C	4	Int
MOLLUSCA	Bivalvia				Bivalvia indet.	02A-1 (1.0)	2008	DP05	A	1	Int
ECHINODERMATA	Ophiuroidea				Amphiodia sp.	02A-1 (1.0)	2008	DP05	A	8	J
ECHINODERMATA	Ophiuroidea				Amphiodia sp.	02A-1 (1.0)	2008	DP05	B	4	J
ANNELIDA	Polychaeta			Errantia	Glycera nana	02A-1 (1.0)	2008	DP05	C	2	A
MOLLUSCA	Bivalvia				Macoma carlottensis	02A-1 (1.0)	2008	DP05	C	7	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Decapoda		Pinnixa schmitti	02A-1 (1.0)	2008	DP05	B	1	A
ARTHROPODA	Ostracoda	CRUSTACEA			Euphilomedes carcharodonta	02A-1 (1.0)	2008	DP05	C	1	A
ECHINODERMATA	Ophiuroidea				Amphiodia urtica	02A-1 (1.0)	2008	DP05	B	2	Int
ECHINODERMATA	Ophiuroidea				Amphiodia urtica	02A-1 (1.0)	2008	DP05	A	6	A
ARTHROPODA	Ostracoda	CRUSTACEA			Euphilomedes carcharodonta	02A-1 (1.0)	2008	DP05	B	1	A
MOLLUSCA	Bivalvia				Axinopsida serricata	02A-1 (1.0)	2008	DP05	C	42	Int
ECHINODERMATA	Ophiuroidea				Amphiodia urtica	02A-1 (1.0)	2008	DP05	B	3	A
ARTHROPODA	Ostracoda	CRUSTACEA			Euphilomedes producta	02A-1 (1.0)	2008	DP05	A	2	A
MOLLUSCA	Bivalvia				Compsomyax subdiaphana	02A-1 (1.0)	2008	DP05	C	1	J
ECHINODERMATA	Ophiuroidea				Amphiodia urtica	02A-1 (1.0)	2008	DP05	C	5	A
MOLLUSCA	Bivalvia				Ennucula tenuis	02A-1 (1.0)	2008	DP05	A	5	A
MOLLUSCA	Bivalvia				Axinopsida serricata	02A-1 (1.0)	2008	DP05	B	42	Int
ECHINODERMATA	Ophiuroidea				Amphiodia urtica	02A-1 (1.0)	2008	DP05	A	4	Int
MOLLUSCA	Bivalvia				Ennucula tenuis	02A-1 (1.0)	2008	DP05	C	1	A
ANNELIDA	Polychaeta			Errantia	Glycera nana	02A-1 (1.0)	2008	DP05	B	1	A
ECHINODERMATA	Ophiuroidea				Amphiodia sp.	02A-1 (1.0)	2008	DP05	A	5	Int
CNIDARIA	Anthozoa				Actinaria indet.	02A-1 (1.0)	2008	DP05	A	1	J
MOLLUSCA	Bivalvia				Macoma carlottensis	02A-1 (1.0)	2008	DP05	A	4	J
MOLLUSCA	Bivalvia				Macoma carlottensis	02A-1 (1.0)	2008	DP05	B	15	Int
MOLLUSCA	Bivalvia				Clinocardium nuttallii	02A-1 (1.0)	2008	DP05	B	3	J
ARTHROPODA	Ostracoda	CRUSTACEA			Diastylis abbotti	02A-1 (1.0)	2008	DP05	B	1	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Protomedeia grandimana	02A-1 (1.0)	2008	DP05	C	1	Int
MOLLUSCA	Bivalvia				Macoma carlottensis	02A-1 (1.0)	2008	DP05	B	7	J
ANNELIDA	Polychaeta			Errantia	Eteone californica	02A-1 (1.0)	2008	DP05	C	1	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Protomedeia sp.	02A-1 (1.0)	2008	DP05	A	1	Int
MOLLUSCA	Bivalvia				Lucinoma annulatum	02A-1 (1.0)	2008	DP05	C	2	J
ANNELIDA	Polychaeta			Errantia	Eteone longa complex	02A-1 (1.0)	2008	DP05	A	2	A
ARTHROPODA	Malacostraca	CRUSTACEA	Decapoda		Pinnixa schmitti	02A-1 (1.0)	2008	DP05	C	1	Int
MOLLUSCA	Bivalvia				Macoma carlottensis	02A-1 (1.0)	2008	DP05	A	6	Int
ANNELIDA	Polychaeta			Errantia	Eteone longa complex	02A-1 (1.0)	2008	DP05	B	4	A
ARTHROPODA	Ostracoda	CRUSTACEA			Euphilomedes carcharodonta	02A-1 (1.0)	2008	DP05	A	4	A
ECHINODERMATA	Ophiuroidea				Amphiodia sp.	02A-1 (1.0)	2008	DP05	B	3	Int
MOLLUSCA	Bivalvia				Clinocardium sp.	02A-1 (1.0)	2008	DP05	A	2	J
ANNELIDA	Polychaeta			Errantia	Glycinde polygnatha	02A-1 (1.0)	2008	DP05	B	2	A
MOLLUSCA	Bivalvia				Macoma carlottensis	02A-1 (1.0)	2008	DP05	C	3	J
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Rhepoxynius boreovariatus	02A-1 (1.0)	2008	DP05	C	1	A
ECHINODERMATA	Ophiuroidea				Amphiodia sp.	02A-1 (1.0)	2008	DP05	C	4	J
MOLLUSCA	Bivalvia				Bivalvia indet.	02A-1 (1.0)	2008	DP05	A	3	J
MOLLUSCA	Bivalvia				Acila castrensis	02A-1 (1.0)	2008	DP05	A	1	Int
MOLLUSCA	Bivalvia				Ennucula tenuis	02A-1 (1.0)	2008	DP05	C	17	Int
MOLLUSCA	Bivalvia				Compsomyax subdiaphana	02A-1 (1.0)	2008	DP05	A	1	J
ANNELIDA	Polychaeta			Errantia	Glycinde polygnatha	02A-1 (1.0)	2008	DP05	B	1	Int
MOLLUSCA	Bivalvia				Lucinoma annulatum	02A-1 (1.0)	2008	DP05	C	1	Int
MOLLUSCA	Gastropoda				Alvania compacta	02A-1 (1.0)	2008	DP05	C	35	A
MOLLUSCA	Bivalvia				Ennucula tenuis	02A-1 (1.0)	2008	DP05	A	3	J
MOLLUSCA	Bivalvia				Axinopsida serricata	02A-1 (1.0)	2008	DP05	A	25	Int
MOLLUSCA	Bivalvia				Axinopsida serricata	02A-1 (1.0)	2008	DP05	C	118	A
MOLLUSCA	Bivalvia				Ennucula tenuis	02A-1 (1.0)	2008	DP05	B	26	Int
ECHINODERMATA	Ophiuroidea				Amphiuridae indet.	02A-1 (1.0)	2008	DP05	C	2	J
MOLLUSCA	Bivalvia				Acila castrensis	02A-1 (1.0)	2008	DP05	B	1	Int
MOLLUSCA	Bivalvia				Acila castrensis	02A-1 (1.0)	2008	DP05	C	2	Int
MOLLUSCA	Bivalvia				Ennucula tenuis	02A-1 (1.0)	2008	DP05	C	1	J
ARTHROPODA	Malacostraca	CRUSTACEA	Tanaidacea		Leptochelia savigyni	02A-1 (1.0)	2008	DP05	C	1	A
ARTHROPODA	Ostracoda	CRUSTACEA			Euphilomedes producta	02A-1 (1.0)	2008	DP05	C	2	A
MOLLUSCA	Bivalvia				Ennucula tenuis	02A-1 (1.0)	2008	DP05	A	30	Int
ECHINODERMATA	Ophiuroidea				Amphiuridae indet.	02A-1 (1.0)	2008	DP05	A	1	J
MOLLUSCA	Bivalvia				Axinopsida serricata	02A-1 (1.0)	2008	DP05	B	98	A
MOLLUSCA	Bivalvia				Ennucula tenuis	02A-1 (1.0)	2008	DP05	B	4	J
MOLLUSCA	Bivalvia				Axinopsida serricata	02A-1 (1.0)	2008	DP05	A	79	A

Phylum	Class	Sub Phylum	Order	Subclass	Genus_species	SampleID	Year	Station	Grab	Count	LifeStage
ARTHROPODA	Malacostraca	CRUSTACEA	Decapoda		Crangon alaskensis	02A-1 (1.0)	2008	DP05	B	1	A
ECHINODERMATA	Ophiuroidea				Amphiodia urtica	02A-1 (1.0)	2008	DP05	C	2	Int
ANNELIDA	Polychaeta			Errantia	Glycera nana	02A-1 (1.0)	2008	DP05	A	5	A
MOLLUSCA	Gastropoda				Gastropoda indet.	02A-1 (1.0)	2008	DP05	C	1	Int
MOLLUSCA	Gastropoda				Gastropteron pacificum	02A-1 (1.0)	2008	DP05	C	1	Int
MOLLUSCA	Gastropoda				Odostomia sp.	02A-1 (1.0)	2008	DP05	A	3	Int
MOLLUSCA	Gastropoda				Turbonilla sp.	02A-1 (1.0)	2008	DP05	C	1	A
MOLLUSCA	Gastropoda				Cylichna culcitella	02A-1 (1.0)	2008	DP05	B	1	A
NEMERTEA	Anopla				Cerebratulus californiensis	02A-1 (1.0)	2008	DP05	B	1	Int
NEMERTEA	Anopla				Cerebratulus californiensis	02A-1 (1.0)	2008	DP05	B	2	A
NEMERTEA	Anopla				Cerebratulus californiensis	02A-1 (1.0)	2008	DP05	A	11	Int
NEMERTEA	Anopla				Cerebratulus californiensis	02A-1 (1.0)	2008	DP05	A	14	A
MOLLUSCA	Scaphopoda				Pulsellum salishorum	02A-1 (1.0)	2008	DP05	B	5	A
MOLLUSCA	Scaphopoda				Pulsellum salishorum	02A-1 (1.0)	2008	DP05	A	5	A
NEMERTEA	Anopla				Tubulanus polymorphus	02A-1 (1.0)	2008	DP05	A	1	A
MOLLUSCA	Gastropoda				Turbonilla sp.	02A-1 (1.0)	2008	DP05	A	1	Int
MOLLUSCA	Scaphopoda				Pulsellum salishorum	02A-1 (1.0)	2008	DP05	C	4	A
MOLLUSCA	Bivalvia				Macoma balthica	02A-1 (1.0)	2008	DP06	A	2	Int
MOLLUSCA	Bivalvia				Macoma sp.	02A-1 (1.0)	2008	DP06	A	7	J
MOLLUSCA	Bivalvia				Macoma balthica	02A-1 (1.0)	2008	DP06	B	24	Int
ANNELIDA	Polychaeta			Sedentaria	Pygospio elegans	02A-1 (1.0)	2008	DP06	B	2	A
MOLLUSCA	Bivalvia				Bivalvia indet.	02A-1 (1.0)	2008	DP06	C	1	Int
ANNELIDA	Polychaeta			Errantia	Glycinde polygnatha	02A-1 (1.0)	2008	DP06	B	1	A
ANNELIDA	Polychaeta			Sedentaria	Pygospio elegans	02A-1 (1.0)	2008	DP06	C	2	A
MOLLUSCA	Bivalvia				Nuttallia obscurata	02A-1 (1.0)	2008	DP06	C	3	Int
MOLLUSCA	Bivalvia				Macoma sp.	02A-1 (1.0)	2008	DP06	B	7	J
MOLLUSCA	Bivalvia				Macoma golikovi	02A-1 (1.0)	2008	DP06	C	4	J
MOLLUSCA	Bivalvia				Venerupis philippinarum	02A-1 (1.0)	2008	DP06	A	4	J
MOLLUSCA	Bivalvia				Macoma balthica	02A-1 (1.0)	2008	DP06	C	2	A
MOLLUSCA	Bivalvia				Macoma balthica	02A-1 (1.0)	2008	DP06	B	4	J
MOLLUSCA	Bivalvia				Nuttallia obscurata	02A-1 (1.0)	2008	DP06	C	1	J
MOLLUSCA	Bivalvia				Macoma balthica	02A-1 (1.0)	2008	DP06	B	5	A
MOLLUSCA	Bivalvia				Venerupis philippinarum	02A-1 (1.0)	2008	DP06	B	3	J
MOLLUSCA	Bivalvia				Macoma balthica	02A-1 (1.0)	2008	DP06	C	1	J
MOLLUSCA	Bivalvia				Bivalvia indet.	02A-1 (1.0)	2008	DP06	B	1	A
MOLLUSCA	Bivalvia				Macoma sp.	02A-1 (1.0)	2008	DP06	A	1	Int
MOLLUSCA	Bivalvia				Mya sp.	02A-1 (1.0)	2008	DP06	A	4	J
MOLLUSCA	Bivalvia				Macoma golikovi	02A-1 (1.0)	2008	DP06	C	3	Int
ANNELIDA	Polychaeta			Sedentaria	Pseudopolydora kempi	02A-1 (1.0)	2008	DP06	B	1	A
MOLLUSCA	Bivalvia				Bivalvia indet.	02A-1 (1.0)	2008	DP06	A	1	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Rhepoxynius boreovariatus	02A-1 (1.0)	2008	DP06	B	1	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Rhepoxynius boreovariatus	02A-1 (1.0)	2008	DP06	C	1	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Rhepoxynius boreovariatus	02A-1 (1.0)	2008	DP06	C	1	A
MOLLUSCA	Bivalvia				Macoma secta	02A-1 (1.0)	2008	DP06	B	7	J
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Rhepoxynius boreovariatus	02A-1 (1.0)	2008	DP06	B	2	Int
MOLLUSCA	Bivalvia				Macoma balthica	02A-1 (1.0)	2008	DP06	C	17	Int
MOLLUSCA	Bivalvia				Macoma secta	02A-1 (1.0)	2008	DP06	A	7	J
MOLLUSCA	Bivalvia				Hiatella arctica	02A-1 (1.0)	2008	DP06	C	1	J
MOLLUSCA	Bivalvia				Bivalvia indet.	02A-1 (1.0)	2008	DP06	A	1	Int
MOLLUSCA	Bivalvia				Macoma secta	02A-1 (1.0)	2008	DP06	A	1	Int
MOLLUSCA	Bivalvia				Mya sp.	02A-1 (1.0)	2008	DP06	B	4	J
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Orchomene minutus	02A-1 (1.0)	2008	DP07	B	2	A
MOLLUSCA	Gastropoda				Clinchna attonsa	02A-1 (1.0)	2008	DP07	A	1	A
MOLLUSCA	Bivalvia				Solen sicarius	02A-1 (1.0)	2008	DP07	A	1	Int
ANNELIDA	Polychaeta			Sedentaria	Scoloplos armiger	02A-1 (1.0)	2008	DP07	B	11	A
ANNELIDA	Polychaeta			Sedentaria	Pectinaria granulata	02A-1 (1.0)	2008	DP07	A	1	Int
MOLLUSCA	Bivalvia				Tellinidae indet.	02A-1 (1.0)	2008	DP07	A	1	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Pacifoculodes zernovi	02A-1 (1.0)	2008	DP07	C	1	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Pacifoculodes zernovi	02A-1 (1.0)	2008	DP07	B	1	A
ANNELIDA	Polychaeta			Sedentaria	Pectinaria granulata	02A-1 (1.0)	2008	DP07	C	1	Int
MOLLUSCA	Bivalvia				Rochefortia tumida	02A-1 (1.0)	2008	DP07	C	1	A
MOLLUSCA	Bivalvia				Nutricola sp.	02A-1 (1.0)	2008	DP07	C	2	A
MOLLUSCA	Bivalvia				Macoma carlottensis	02A-1 (1.0)	2008	DP07	B	1	Int
ANNELIDA	Polychaeta			Sedentaria	Scoloplos armiger	02A-1 (1.0)	2008	DP07	C	8	A
ANNELIDA	Polychaeta			Sedentaria	Aricidea minuta	02A-1 (1.0)	2008	DP07	C	1	A
ARTHROPODA	Ostracoda	CRUSTACEA			Philomedes dentata	02A-1 (1.0)	2008	DP07	A	1	A
MOLLUSCA	Bivalvia				Nutricola sp.	02A-1 (1.0)	2008	DP07	C	1	Int
MOLLUSCA	Bivalvia				Macoma sp.	02A-1 (1.0)	2008	DP07	A	4	J
MOLLUSCA	Bivalvia				Macoma sp.	02A-1 (1.0)	2008	DP07	A	3	Int
ANNELIDA	Polychaeta			Sedentaria	Scoloplos armiger	02A-1 (1.0)	2008	DP07	A	6	A
ANNELIDA	Polychaeta			Errantia	Pholoe glabra	02A-1 (1.0)	2008	DP07	A	1	A
ANNELIDA	Polychaeta			Sedentaria	Aricidea minuta	02A-1 (1.0)	2008	DP07	B	1	A
ANNELIDA	Polychaeta			Sedentaria	Scoloplos acmeceps	02A-1 (1.0)	2008	DP07	B	3	A
ARTHROPODA	Ostracoda	CRUSTACEA			Euphilomedes carcharodonta	02A-1 (1.0)	2008	DP07	B	1	A
ARTHROPODA	Ostracoda	CRUSTACEA			Euphilomedes carcharodonta	02A-1 (1.0)	2008	DP07	A	2	A
MOLLUSCA	Bivalvia				Nutricola sp.	02A-1 (1.0)	2008	DP07	B	1	Int
ANNELIDA	Polychaeta			Sedentaria	Prionospio (Minuspio) lighti	02A-1 (1.0)	2008	DP07	A	1	A
MOLLUSCA	Bivalvia				Nutricola sp.	02A-1 (1.0)	2008	DP07	A	1	Int
ARTHROPODA	Ostracoda	CRUSTACEA			Euphilomedes producta	02A-1 (1.0)	2008	DP07	B	2	A
ANNELIDA	Polychaeta			Sedentaria	Chone magna	02A-1 (1.0)	2008	DP07	C	1	Int
ECHINODERMATA	Ophiuroidea				Amphiodia sp.	02A-1 (1.0)	2008	DP07	A	1	J
MOLLUSCA	Gastropoda				Astyris gausapata	02A-1 (1.0)	2008	DP07	B	8	A
ANNELIDA	Polychaeta			Sedentaria	Prionospio (Prionospio) jubata	02A-1 (1.0)	2008	DP07	C	1	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Rhepoxynius boreovariatus	02A-1 (1.0)	2008	DP07	A	1	Int
ANNELIDA	Polychaeta			Errantia	Nephtys caecoides	02A-1 (1.0)	2008	DP07	C	1	A
ANNELIDA	Polychaeta			Sedentaria	Leitoscoloplos pugettensis	02A-1 (1.0)	2008	DP07	A	10	A
ECHINODERMATA	Ophiuroidea				Amphiodia sp.	02A-1 (1.0)	2008	DP07	B	2	J
ANNELIDA	Polychaeta			Sedentaria	Prionospio (Prionospio) steenstrupi	02A-1 (1.0)	2008	DP07	A	1	A
ECHINODERMATA	Ophiuroidea				Amphiodia urtica	02A-1 (1.0)	2008	DP07	A	1	A
MOLLUSCA	Bivalvia				Macoma sp.	02A-1 (1.0)	2008	DP07	C	2	J
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Rhepoxynius boreovariatus	02A-1 (1.0)	2008	DP07	C	5	A
ANNELIDA	Polychaeta			Sedentaria	Chaetozone nr. columbiana	02A-1 (1.0)	2008	DP07	A	2	A
MOLLUSCA	Bivalvia				Tellina modesta	02A-1 (1.0)	2008	DP07	A	1	Int
MOLLUSCA	Gastropoda				Astyris gausapata	02A-1 (1.0)	2008	DP07	C	3	A
ANNELIDA	Polychaeta			Sedentaria	Prionospio (Prionospio) steenstrupi	02A-1 (1.0)	2008	DP07	C	1	A
ECHINODERMATA	Ophiuroidea				Amphiuridae indet.	02A-1 (1.0)	2008	DP07	B	1	J
MOLLUSCA	Bivalvia				Tellina modesta	02A-1 (1.0)	2008	DP07	C	1	Int
ECHINODERMATA	Ophiuroidea				Ophiura sp.	02A-1 (1.0)	2008	DP07	A	1	J
MOLLUSCA	Bivalvia				Tellina modesta	02A-1 (1.0)	2008	DP07	B	1	Int
MOLLUSCA	Bivalvia				Axinopsida serricata	02A-1 (1.0)	2008	DP07	C	3	A

Appendix E
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Phylum	Class	Sub Phylum	Order	Subclass	Genus_species	SampleID	Year	Station	Grab	Count	LifeStage
MOLLUSCA	Gastropoda				Astyris gausapata	02A-1 (1.0)	2008	DP07	B	1	Int
ANNELIDA	Polychaeta			Sedentaria	Decamastus nr. gracilis	02A-1 (1.0)	2008	DP07	A	2	A
ANNELIDA	Polychaeta			Errantia	Scoletoma luti	02A-1 (1.0)	2008	DP07	A	1	A
MOLLUSCA	Bivalvia				Axinopsida serricata	02A-1 (1.0)	2008	DP07	A	2	A
MOLLUSCA	Bivalvia				Axinopsida serricata	02A-1 (1.0)	2008	DP07	A	2	Int
ANNELIDA	Polychaeta			Sedentaria	Leitoscoloplos pugettensis	02A-1 (1.0)	2008	DP07	C	1	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Orchomene minutus	02A-1 (1.0)	2008	DP07	A	1	A
MOLLUSCA	Gastropoda				Astyris gausapata	02A-1 (1.0)	2008	DP07	A	1	A
ANNELIDA	Polychaeta			Sedentaria	Leitoscoloplos pugettensis	02A-1 (1.0)	2008	DP07	C	1	Int
MOLLUSCA	Bivalvia				Macoma carlottensis	02A-1 (1.0)	2008	DP07	B	1	J
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Rhepoxynius boreovariatus	02A-1 (1.0)	2008	DP07	A	1	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Rhepoxynius boreovariatus	02A-1 (1.0)	2008	DP07	B	5	A
MOLLUSCA	Bivalvia				Yoldia seminuda	02A-1 (1.0)	2008	DP07	B	1	J
ANNELIDA	Polychaeta			Sedentaria	Prionospio (Prionospio) jubata	02A-1 (1.0)	2008	DP07	B	1	A
ECHINODERMATA	Ophiuroidea				Amphiodia sp.	02A-1 (1.0)	2008	DP07	B	1	Int
ARTHROPODA	Pycnogonida	CHELICERATA			Anoplodactylus viridintestinalis	02A-1 (1.0)	2008	DP07	C	1	A
MOLLUSCA	Gastropoda				Nassariidae indet.	02A-1 (1.0)	2008	DP07	A	2	A
MOLLUSCA	Gastropoda				Olivella baetica	02A-1 (1.0)	2008	DP07	C	1	A
MOLLUSCA	Gastropoda				Turbonilla sp.	02A-1 (1.0)	2008	DP07	B	1	A
NEMERTEA	Anopla				Cerebratulus californiensis	02A-1 (1.0)	2008	DP07	A	3	A
MOLLUSCA	Bivalvia				Modiolus modiolus	02A-1 (1.0)	2008	DP08	B	15	J
ARTHROPODA	Malacostraca	CRUSTACEA	Isopoda		Idotea rescata	02A-1 (1.0)	2008	DP08	B	2	Int
ANNELIDA	Polychaeta			Sedentaria	Rhynchospio glutaea	02A-1 (1.0)	2008	DP08	A	33	A
ANNELIDA	Polychaeta			Sedentaria	Ampharete nr. acutifrons	02A-1 (1.0)	2008	DP08	B	1	A
ANNELIDA	Oligochaeta				Tubificidae indet. Group 5	02A-1 (1.0)	2008	DP08	B	2	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Photis brevipes	02A-1 (1.0)	2008	DP08	A	2	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Tanaidacea		Leptochelia savigyni	02A-1 (1.0)	2008	DP08	A	158	A
ANNELIDA	Oligochaeta				Tubificidae indet. Group 5	02A-1 (1.0)	2008	DP08	B	5	Int
MOLLUSCA	Bivalvia				Tellina modesta	02A-1 (1.0)	2008	DP08	B	1	Int
ANNELIDA	Polychaeta			Errantia	Phyllodoce spp.	02A-1 (1.0)	2008	DP08	B	1	Int
ANNELIDA	Polychaeta			Sedentaria	Pseudopolydora paucibranchiata	02A-1 (1.0)	2008	DP08	A	1	A
ANNELIDA	Polychaeta			Sedentaria	Ampharete spp.	02A-1 (1.0)	2008	DP08	A	1	J
ANNELIDA	Polychaeta			Sedentaria	Rhynchospio glutaea	02A-1 (1.0)	2008	DP08	B	7	A
ANNELIDA	Oligochaeta				Tubificoides sp.	02A-1 (1.0)	2008	DP08	C	2	A
MOLLUSCA	Bivalvia				Clinocardium nuttallii	02A-1 (1.0)	2008	DP08	C	1	J
ANNELIDA	Oligochaeta				Tubificidae indet. Group 5	02A-1 (1.0)	2008	DP08	A	1	A
ARTHROPODA	Malacostraca	CRUSTACEA	Tanaidacea		Leptochelia savigyni	02A-1 (1.0)	2008	DP08	B	42	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Photis brevipes	02A-1 (1.0)	2008	DP08	C	15	A
MOLLUSCA	Bivalvia				Nutricola sp.	02A-1 (1.0)	2008	DP08	B	1	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Pontogeneia rostrata	02A-1 (1.0)	2008	DP08	C	1	A
MOLLUSCA	Bivalvia				Macoma sp.	02A-1 (1.0)	2008	DP08	A	2	J
ANNELIDA	Polychaeta			Errantia	Platynereis bicanaliculata	02A-1 (1.0)	2008	DP08	A	3	A
MOLLUSCA	Bivalvia				Clinocardium nuttallii	02A-1 (1.0)	2008	DP08	A	2	J
ANNELIDA	Polychaeta			Errantia	Platynereis bicanaliculata	02A-1 (1.0)	2008	DP08	A	1	Int
MOLLUSCA	Bivalvia				Tellina modesta	02A-1 (1.0)	2008	DP08	A	1	A
ANNELIDA	Polychaeta			Errantia	Phyllodoce williamsi	02A-1 (1.0)	2008	DP08	C	2	A
ANNELIDA	Polychaeta			Errantia	Eteone longa complex	02A-1 (1.0)	2008	DP08	C	1	A
MOLLUSCA	Bivalvia				Macoma sp.	02A-1 (1.0)	2008	DP08	B	4	J
ANNELIDA	Polychaeta			Sedentaria	Prionospio (Minuspio) lighti	02A-1 (1.0)	2008	DP08	A	1	A
ARTHROPODA	Ostracoda	CRUSTACEA			Euphilomedes carcharodonta	02A-1 (1.0)	2008	DP08	B	2	A
MOLLUSCA	Bivalvia				Modiolus modiolus	02A-1 (1.0)	2008	DP08	C	30	J
ANNELIDA	Polychaeta			Errantia	Platynereis bicanaliculata	02A-1 (1.0)	2008	DP08	C	3	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Pontogeneia rostrata	02A-1 (1.0)	2008	DP08	B	1	A
ANNELIDA	Polychaeta			Sedentaria	Prionospio (Minuspio) multibranchiata	02A-1 (1.0)	2008	DP08	C	1	A
MOLLUSCA	Bivalvia				Mya sp.	02A-1 (1.0)	2008	DP08	A	1	J
ANNELIDA	Polychaeta			Errantia	Phyllodoce williamsi	02A-1 (1.0)	2008	DP08	B	1	A
ANNELIDA	Polychaeta			Errantia	Platynereis bicanaliculata	02A-1 (1.0)	2008	DP08	B	2	Int
ANNELIDA	Polychaeta			Sedentaria	Pseudopolydora paucibranchiata	02A-1 (1.0)	2008	DP08	C	3	A
ANNELIDA	Polychaeta			Sedentaria	Rhynchospio glutaea	02A-1 (1.0)	2008	DP08	C	6	A
MOLLUSCA	Bivalvia				Macoma sp.	02A-1 (1.0)	2008	DP08	C	5	J
ANNELIDA	Polychaeta			Sedentaria	Ampharete labrops	02A-1 (1.0)	2008	DP08	A	1	A
ANNELIDA	Polychaeta			Sedentaria	Ampharete nr. acutifrons	02A-1 (1.0)	2008	DP08	A	1	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Photis brevipes	02A-1 (1.0)	2008	DP08	C	1	Int
ANNELIDA	Polychaeta			Sedentaria	Pseudopolydora paucibranchiata	02A-1 (1.0)	2008	DP08	B	1	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Photis brevipes	02A-1 (1.0)	2008	DP08	B	8	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Isopoda		Idotea rescata	02A-1 (1.0)	2008	DP08	C	3	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Caprella laeviuscula	02A-1 (1.0)	2008	DP08	A	1	A
ANNELIDA	Polychaeta			Sedentaria	Barantolla nr. americana	02A-1 (1.0)	2008	DP08	C	1	A
ANNELIDA	Polychaeta			Sedentaria	Mediomastus californiensis	02A-1 (1.0)	2008	DP08	A	2	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Anisogammarus pugettensis	02A-1 (1.0)	2008	DP08	B	2	A
ANNELIDA	Polychaeta			Errantia	Ophiodromus pugettensis	02A-1 (1.0)	2008	DP08	A	1	Int
ECHINODERMATA	Ophiuroidea				Amphiodia urtica	02A-1 (1.0)	2008	DP08	A	1	A
BRYOZOA	Gymnolaemata				Celleporella hyalina	02A-1 (1.0)	2008	DP08	C	5	J
ANNELIDA	Polychaeta			Errantia	Glycinde polygnatha	02A-1 (1.0)	2008	DP08	C	22	A
ANNELIDA	Oligochaeta				Tectidrilus spp.	02A-1 (1.0)	2008	DP08	A	6	A
ANNELIDA	Polychaeta			Sedentaria	Capitella capitata complex	02A-1 (1.0)	2008	DP08	C	1	A
MOLLUSCA	Gastropoda				Alvania compacta	02A-1 (1.0)	2008	DP08	C	1	A
ANNELIDA	Polychaeta			Sedentaria	Owenia nr. johnsoni	02A-1 (1.0)	2008	DP08	B	14	A
MOLLUSCA	Bivalvia				Rochefortia tumida	02A-1 (1.0)	2008	DP08	C	64	A
MOLLUSCA	Bivalvia				Macoma nasuta	02A-1 (1.0)	2008	DP08	B	1	J
ANNELIDA	Polychaeta			Errantia	Nephtys caecoides	02A-1 (1.0)	2008	DP08	A	1	A
ANNELIDA	Polychaeta			Sedentaria	Mediomastus californiensis	02A-1 (1.0)	2008	DP08	C	7	A
ANNELIDA	Polychaeta			Sedentaria	Armandia brevis	02A-1 (1.0)	2008	DP08	B	1	Int
BRYOZOA	Gymnolaemata				Celleporella hyalina	02A-1 (1.0)	2008	DP08	B	1	A
MOLLUSCA	Bivalvia				Nutricola tantilla	02A-1 (1.0)	2008	DP08	A	1	A
ANNELIDA	Polychaeta			Sedentaria	Leitoscoloplos pugettensis	02A-1 (1.0)	2008	DP08	B	2	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Caprella laeviuscula	02A-1 (1.0)	2008	DP08	B	6	A
ANNELIDA	Polychaeta			Sedentaria	Mediomastus californiensis	02A-1 (1.0)	2008	DP08	B	7	A
ANNELIDA	Polychaeta			Errantia	Nephtys caecoides	02A-1 (1.0)	2008	DP08	C	3	A
MOLLUSCA	Bivalvia				Macoma golikovi	02A-1 (1.0)	2008	DP08	A	1	Int
MOLLUSCA	Bivalvia				Rochefortia tumida	02A-1 (1.0)	2008	DP08	B	68	A
ANNELIDA	Polychaeta			Errantia	Glycinde polygnatha	02A-1 (1.0)	2008	DP08	B	9	A
ARTHROPODA	Pycnogonida	CHELICERATA			Anoplodactylus viridintestinalis	02A-1 (1.0)	2008	DP08	C	4	A
ARTHROPODA	Pycnogonida	CHELICERATA			Anoplodactylus viridintestinalis	02A-1 (1.0)	2008	DP08	B	11	A
MOLLUSCA	Bivalvia				Macoma nasuta	02A-1 (1.0)	2008	DP08	B	6	Int
MOLLUSCA	Gastropoda				Alvania compacta	02A-1 (1.0)	2008	DP08	A	1	A
ANNELIDA	Polychaeta			Sedentaria	Leitoscoloplos pugettensis	02A-1 (1.0)	2008	DP08	C	2	A
ANNELIDA	Polychaeta			Errantia	Nephtys caecoides	02A-1 (1.0)	2008	DP08	B	2	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Monocorophium acherusicum	02A-1 (1.0)	2008	DP08	A	1	A
MOLLUSCA	Bivalvia				Macoma golikovi	02A-1 (1.0)	2008	DP08	A	1	J

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Phylum	Class	Sub Phylum	Order	Subclass	Genus_species	SampleID	Year	Station	Grab	Count	LifeStage
ANNELIDA	Polychaeta			Sedentaria	Capitella capitata complex	02A-1 (1.0)	2008	DP08	A	5	A
ANNELIDA	Polychaeta			Errantia	Glycinde polygnatha	02A-1 (1.0)	2008	DP08	A	15	A
MOLLUSCA	Bivalvia				Bivalvia indet.	02A-1 (1.0)	2008	DP08	A	1	J
MOLLUSCA	Bivalvia				Macoma nasuta	02A-1 (1.0)	2008	DP08	C	3	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Americhelidium shoemakeri	02A-1 (1.0)	2008	DP08	B	5	A
ANNELIDA	Oligochaeta				Tectidrilus spp.	02A-1 (1.0)	2008	DP08	A	1	Int
ANNELIDA	Polychaeta			Sedentaria	Leitoscoloplos pugettensis	02A-1 (1.0)	2008	DP08	A	2	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Americhelidium shoemakeri	02A-1 (1.0)	2008	DP08	C	5	A
MOLLUSCA	Bivalvia				Macoma nasuta	02A-1 (1.0)	2008	DP08	A	4	Int
ARTHROPODA	Pycnogonida	CHELICERATA			Anoplodactylus viridintestinalis	02A-1 (1.0)	2008	DP08	A	1	A
ANNELIDA	Oligochaeta				Grania incerta	02A-1 (1.0)	2008	DP08	B	1	A
ANNELIDA	Polychaeta			Errantia	Glycinde polygnatha	02A-1 (1.0)	2008	DP08	A	1	Int
MOLLUSCA	Gastropoda				Alvania compacta	02A-1 (1.0)	2008	DP08	B	2	A
ANNELIDA	Polychaeta			Sedentaria	Mediomastus californiensis	02A-1 (1.0)	2008	DP08	A	1	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Photis brevipes	02A-1 (1.0)	2008	DP08	A	35	A
MOLLUSCA	Bivalvia				Nutricola sp.	02A-1 (1.0)	2008	DP08	C	1	A
ANNELIDA	Polychaeta			Errantia	Glycinde polygnatha	02A-1 (1.0)	2008	DP08	B	1	Int
ANNELIDA	Polychaeta			Sedentaria	Armandia brevis	02A-1 (1.0)	2008	DP08	B	1	A
ANNELIDA	Polychaeta			Sedentaria	Owenia nr. johnsoni	02A-1 (1.0)	2008	DP08	C	21	A
ANNELIDA	Polychaeta			Sedentaria	Scoloplos acmeceps	02A-1 (1.0)	2008	DP08	C	1	A
ANNELIDA	Oligochaeta				Tectidrilus spp.	02A-1 (1.0)	2008	DP08	C	2	Int
MOLLUSCA	Bivalvia				Macoma sp.	02A-1 (1.0)	2008	DP08	A	1	Int
ANNELIDA	Polychaeta			Sedentaria	Clymenella nr. torquata	02A-1 (1.0)	2008	DP08	A	1	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Photis brevipes	02A-1 (1.0)	2008	DP08	B	48	A
ARTHROPODA	Malacostraca	CRUSTACEA	Tanaidacea		Leptochelia savigyni	02A-1 (1.0)	2008	DP08	A	292	Int
MOLLUSCA	Bivalvia				Rochefortia tumida	02A-1 (1.0)	2008	DP08	A	55	A
ANNELIDA	Polychaeta			Sedentaria	Scoloplos acmeceps	02A-1 (1.0)	2008	DP08	A	1	A
MOLLUSCA	Bivalvia				Macoma inquinata	02A-1 (1.0)	2008	DP08	A	1	Int
ANNELIDA	Polychaeta			Sedentaria	Owenia nr. johnsoni	02A-1 (1.0)	2008	DP08	A	1	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Eobrolgus chumashi	02A-1 (1.0)	2008	DP08	C	1	A
ANNELIDA	Polychaeta			Errantia	Glycinde polygnatha	02A-1 (1.0)	2008	DP08	C	1	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Tanaidacea		Leptochelia savigyni	02A-1 (1.0)	2008	DP08	C	79	A
MOLLUSCA	Bivalvia				Macoma balthica	02A-1 (1.0)	2008	DP08	B	2	Int
ANNELIDA	Polychaeta			Errantia	Pholoe glabra	02A-1 (1.0)	2008	DP08	C	1	A
ANNELIDA	Polychaeta			Sedentaria	Mediomastus californiensis	02A-1 (1.0)	2008	DP08	C	1	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Caprella laeviuscula	02A-1 (1.0)	2008	DP08	C	5	A
ARTHROPODA	Malacostraca	CRUSTACEA	Tanaidacea		Leptochelia savigyni	02A-1 (1.0)	2008	DP08	C	1	J
ANNELIDA	Oligochaeta				Grania sp.	02A-1 (1.0)	2008	DP08	A	8	A
ARTHROPODA	Malacostraca	CRUSTACEA	Tanaidacea		Leptochelia savigyni	02A-1 (1.0)	2008	DP08	C	171	Int
ANNELIDA	Polychaeta			Sedentaria	Owenia nr. johnsoni	02A-1 (1.0)	2008	DP08	A	20	A
MOLLUSCA	Bivalvia				Modiolus modiolus	02A-1 (1.0)	2008	DP08	A	17	J
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Caprella laeviuscula	02A-1 (1.0)	2008	DP08	A	1	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Grandidierella japonica	02A-1 (1.0)	2008	DP08	B	1	A
ARTHROPODA	Malacostraca	CRUSTACEA	Tanaidacea		Leptochelia savigyni	02A-1 (1.0)	2008	DP08	B	91	Int
ANNELIDA	Polychaeta			Sedentaria	Armandia brevis	02A-1 (1.0)	2008	DP08	C	1	A
ARTHROPODA	Copepoda	CRUSTACEA			Harpacticoida indet.	02A-1 (1.0)	2008	DP08	A	1	A
ANNELIDA	Oligochaeta				Grania incerta	02A-1 (1.0)	2008	DP08	C	3	A
MOLLUSCA	Bivalvia				Macoma inquinata	02A-1 (1.0)	2008	DP08	A	1	J
MOLLUSCA	Gastropoda				Lottia parallela	02A-1 (1.0)	2008	DP08	C	2	Int
MOLLUSCA	Gastropoda				Lottia parallela	02A-1 (1.0)	2008	DP08	B	1	Int
MOLLUSCA	Gastropoda				Lottia parallela	02A-1 (1.0)	2008	DP08	C	1	A
MOLLUSCA	Gastropoda				Lacuna sp.	02A-1 (1.0)	2008	DP08	B	4	J
NEMERTEA	Unspecified				Nemertea indet.	02A-1 (1.0)	2008	DP08	B	1	Int
MOLLUSCA	Gastropoda				Lottia parallela	02A-1 (1.0)	2008	DP08	B	1	A
ANNELIDA	Polychaeta			Sedentaria	Arenicolidae indet.	02A-1 (1.0)	2009	DP02	A	1	J
ANNELIDA	Polychaeta			Errantia	Glycinde polygnatha	02A-1 (1.0)	2009	DP02	C	3	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Photis brevipes	02A-1 (1.0)	2009	DP02	B	2	A
ANNELIDA	Polychaeta			Sedentaria	Capitella capitata complex	02A-1 (1.0)	2009	DP02	B	6	A
ANNELIDA	Polychaeta			Sedentaria	Pygospio elegans	02A-1 (1.0)	2009	DP02	C	3	J
MOLLUSCA	Bivalvia				Macoma nasuta	02A-1 (1.0)	2009	DP02	A	1	J
ANNELIDA	Polychaeta			Sedentaria	Rhynchospio glutaea	02A-1 (1.0)	2009	DP02	C	4	A
MOLLUSCA	Gastropoda				Batillaria cumingi	02A-1 (1.0)	2009	DP02	C	1	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Monocorophium acherusicum	02A-1 (1.0)	2009	DP02	C	2	A
ANNELIDA	Polychaeta			Sedentaria	Capitella capitata complex	02A-1 (1.0)	2009	DP02	A	5	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Monocorophium insidiosum	02A-1 (1.0)	2009	DP02	A	2	Int
MOLLUSCA	Gastropoda				Amphissa versicolor	02A-1 (1.0)	2009	DP02	B	3	Int
MOLLUSCA	Bivalvia				Macoma nasuta	02A-1 (1.0)	2009	DP02	B	2	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Monocorophium sp.	02A-1 (1.0)	2009	DP02	C	1	Int
ANNELIDA	Polychaeta			Sedentaria	Rhynchospio glutaea	02A-1 (1.0)	2009	DP02	B	5	A
MOLLUSCA	Gastropoda				Batillaria cumingi	02A-1 (1.0)	2009	DP02	C	4	A
MOLLUSCA	Bivalvia				Macoma golikovi	02A-1 (1.0)	2009	DP02	B	1	Int
ANNELIDA	Polychaeta			Sedentaria	Arenicolidae indet.	02A-1 (1.0)	2009	DP02	B	4	J
MOLLUSCA	Bivalvia				Bivalvia indet.	02A-1 (1.0)	2009	DP02	A	2	Int
ANNELIDA	Polychaeta			Sedentaria	Arenicolidae indet.	02A-1 (1.0)	2009	DP02	C	5	J
MOLLUSCA	Gastropoda				Amphissa versicolor	02A-1 (1.0)	2009	DP02	A	2	Int
ANNELIDA	Oligochaeta				Tubificidae indet. Group 5	02A-1 (1.0)	2009	DP02	B	2	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Allorchestes angusta	02A-1 (1.0)	2009	DP02	A	1	A
ANNELIDA	Polychaeta			Sedentaria	Capitella capitata complex	02A-1 (1.0)	2009	DP02	C	1	A
ANNELIDA	Polychaeta			Sedentaria	Rhynchospio glutaea	02A-1 (1.0)	2009	DP02	A	2	A
MOLLUSCA	Gastropoda				Amphissa versicolor	02A-1 (1.0)	2009	DP02	C	4	A
ANNELIDA	Polychaeta			Errantia	Glycinde polygnatha	02A-1 (1.0)	2009	DP02	B	1	A
ANNELIDA	Polychaeta			Sedentaria	Rhynchospio glutaea	02A-1 (1.0)	2009	DP02	B	1	Int
MOLLUSCA	Gastropoda				Amphissa columbiana	02A-1 (1.0)	2009	DP02	A	1	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Grandidierella japonica	02A-1 (1.0)	2009	DP02	C	5	A
ANNELIDA	Polychaeta			Errantia	Glycinde polygnatha	02A-1 (1.0)	2009	DP02	A	7	A
ANNELIDA	Polychaeta			Errantia	Eteone californica	02A-1 (1.0)	2009	DP02	B	2	A
ANNELIDA	Polychaeta			Sedentaria	Pygospio elegans	02A-1 (1.0)	2009	DP02	C	33	A
ANNELIDA	Polychaeta			Sedentaria	Pseudopolydora paucibranchiata	02A-1 (1.0)	2009	DP02	C	29	A
ANNELIDA	Polychaeta			Errantia	Eteone californica	02A-1 (1.0)	2009	DP02	A	3	A
MOLLUSCA	Bivalvia				Modiolus modiolus	02A-1 (1.0)	2009	DP02	C	1	J
ANNELIDA	Oligochaeta				Tubificidae indet. Group 5	02A-1 (1.0)	2009	DP02	B	1	J
ANNELIDA	Polychaeta			Sedentaria	Pseudopolydora kempi	02A-1 (1.0)	2009	DP02	A	101	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Grandidierella japonica	02A-1 (1.0)	2009	DP02	B	5	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Monocorophium insidiosum	02A-1 (1.0)	2009	DP02	B	4	Int
ANNELIDA	Oligochaeta				Tubificidae indet. Group 5	02A-1 (1.0)	2009	DP02	A	2	J
MOLLUSCA	Gastropoda				Batillaria cumingi	02A-1 (1.0)	2009	DP02	A	1	A
ANNELIDA	Polychaeta			Sedentaria	Pseudopolydora paucibranchiata	02A-1 (1.0)	2009	DP02	A	5	Int
ANNELIDA	Oligochaeta				Tubificoides coatesae	02A-1 (1.0)	2009	DP02	A	4	A
ANNELIDA	Polychaeta			Sedentaria	Tharyx parvus	02A-1 (1.0)	2009	DP02	B	1	A
ANNELIDA	Polychaeta			Sedentaria	Pseudopolydora kempi	02A-1 (1.0)	2009	DP02	C	29	A

Phylum	Class	Sub Phylum	Order	Subclass	Genus_species	SampleID	Year	Station	Grab	Count	LifeStage
ANNELIDA	Polychaeta			Sedentaria	Pseudopolydora paucibranchiata	02A-1 (1.0)	2009	DP02	B	22	A
MOLLUSCA	Bivalvia				Protothaca staminea	02A-1 (1.0)	2009	DP02	B	1	A
ANNELIDA	Polychaeta			Sedentaria	Pseudopolydora kempi	02A-1 (1.0)	2009	DP02	A	7	Int
ANNELIDA	Oligochaeta				Tubificoides coatesae	02A-1 (1.0)	2009	DP02	B	7	A
ANNELIDA	Polychaeta			Sedentaria	Pseudopolydora kempi	02A-1 (1.0)	2009	DP02	B	3	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Grandidierella japonica	02A-1 (1.0)	2009	DP02	A	7	A
ARTHROPODA	Pycnogonida	CHELICERATA			Anoplodactylus viridintestinalis	02A-1 (1.0)	2009	DP02	A	1	A
MOLLUSCA	Bivalvia				Modiolus modiolus	02A-1 (1.0)	2009	DP02	B	1	J
ANNELIDA	Polychaeta			Sedentaria	Pseudopolydora paucibranchiata	02A-1 (1.0)	2009	DP02	A	41	A
ANNELIDA	Polychaeta			Sedentaria	Pseudopolydora kempi	02A-1 (1.0)	2009	DP02	B	57	A
ANNELIDA	Polychaeta			Sedentaria	Tharyx parvus	02A-1 (1.0)	2009	DP02	B	1	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Grandidierella japonica	02A-1 (1.0)	2009	DP02	B	4	Int
ANNELIDA	Oligochaeta				Tectidrilus spp.	02A-1 (1.0)	2009	DP02	C	6	A
ANNELIDA	Polychaeta			Sedentaria	Tharyx parvus	02A-1 (1.0)	2009	DP02	A	1	J
MOLLUSCA	Gastropoda				Amphissa versicolor	02A-1 (1.0)	2009	DP02	C	2	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Anisogammarus pugettensis	02A-1 (1.0)	2009	DP02	B	1	Int
ANNELIDA	Polychaeta			Sedentaria	Pygospio elegans	02A-1 (1.0)	2009	DP02	B	3	J
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Grandidierella japonica	02A-1 (1.0)	2009	DP02	C	5	Int
ANNELIDA	Polychaeta			Sedentaria	Abarenicola pacifica	02A-1 (1.0)	2009	DP02	B	1	J
ANNELIDA	Polychaeta			Sedentaria	Pygospio elegans	02A-1 (1.0)	2009	DP02	A	2	J
ANNELIDA	Polychaeta			Sedentaria	Clymenella nr. torquata	02A-1 (1.0)	2009	DP02	A	2	A
ANNELIDA	Polychaeta			Sedentaria	Pygospio elegans	02A-1 (1.0)	2009	DP02	B	33	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Monocorophium insidiosum	02A-1 (1.0)	2009	DP02	A	7	A
ANNELIDA	Oligochaeta				Tectidrilus spp.	02A-1 (1.0)	2009	DP02	C	2	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Grandidierella japonica	02A-1 (1.0)	2009	DP02	A	4	Int
ANNELIDA	Polychaeta			Sedentaria	Pygospio elegans	02A-1 (1.0)	2009	DP02	A	61	A
ANNELIDA	Polychaeta			Sedentaria	Tharyx parvus	02A-1 (1.0)	2009	DP02	A	1	A
ANNELIDA	Polychaeta			Sedentaria	Capitella capitata complex	02A-1 (1.0)	2009	DP02	C	1	J
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Pontogeneia rostrata	02A-1 (1.0)	2009	DP02	A	1	A
MOLLUSCA	Gastropoda				Batillaria cumingi	02A-1 (1.0)	2009	DP02	B	10	A
MOLLUSCA	Bivalvia				Clinocardium sp.	02A-1 (1.0)	2009	DP02	A	1	J
MOLLUSCA	Gastropoda				Amphissa versicolor	02A-1 (1.0)	2009	DP02	A	1	A
ANNELIDA	Polychaeta			Errantia	Nephtys caecoides	02A-1 (1.0)	2009	DP02	B	1	A
ANNELIDA	Polychaeta			Sedentaria	Pseudopolydora paucibranchiata	02A-1 (1.0)	2009	DP02	B	1	Int
MOLLUSCA	Gastropoda				Haminoea vesicula	02A-1 (1.0)	2009	DP02	C	1	Int
MOLLUSCA	Gastropoda				Acteocina culcitella	02A-1 (1.0)	2009	DP02	A	1	A
MOLLUSCA	Gastropoda				Acteocina culcitella	02A-1 (1.0)	2009	DP02	C	1	Int
MOLLUSCA	Gastropoda				Acteocina culcitella	02A-1 (1.0)	2009	DP02	A	1	Int
MOLLUSCA	Gastropoda				Acteocina culcitella	02A-1 (1.0)	2009	DP02	C	1	J
NEMERTEA	Enopla				Tetrastemmidae nigrifons	02A-1 (1.0)	2009	DP02	A	1	A
MOLLUSCA	Gastropoda				Acteocina culcitella	02A-1 (1.0)	2009	DP02	B	1	Int
MOLLUSCA	Gastropoda				Acteocina culcitella	02A-1 (1.0)	2009	DP02	B	5	J
MOLLUSCA	Gastropoda				Amphissa sp.	02A-1 (1.0)	2009	DP03	A	1	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Monocorophium acherusicum	02A-1 (1.0)	2009	DP03	C	9	A
MOLLUSCA	Bivalvia				Bivalvia indet.	02A-1 (1.0)	2009	DP03	B	7	J
ANNELIDA	Polychaeta			Sedentaria	Tharyx parvus	02A-1 (1.0)	2009	DP03	C	8	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Monocorophium insidiosum	02A-1 (1.0)	2009	DP03	C	5	A
CNIDARIA	Anthozoa				Edwardsiidae indet.	02A-1 (1.0)	2009	DP03	B	1	J
ANNELIDA	Oligochaeta				Tectidrilus spp.	02A-1 (1.0)	2009	DP03	B	2	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Monocorophium insidiosum	02A-1 (1.0)	2009	DP03	B	4	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Monocorophium acherusicum	02A-1 (1.0)	2009	DP03	A	1	Int
ANNELIDA	Polychaeta			Errantia	Glycinde polygnatha	02A-1 (1.0)	2009	DP03	A	9	A
ANNELIDA	Polychaeta			Sedentaria	Armandia brevis	02A-1 (1.0)	2009	DP03	C	1	Int
ANNELIDA	Polychaeta			Sedentaria	Tharyx parvus	02A-1 (1.0)	2009	DP03	A	1	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Monocorophium insidiosum	02A-1 (1.0)	2009	DP03	A	7	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Grandidierella japonica	02A-1 (1.0)	2009	DP03	A	7	Int
ANNELIDA	Oligochaeta				Enchytraeidae indet.	02A-1 (1.0)	2009	DP03	B	1	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Eyakia robusta	02A-1 (1.0)	2009	DP03	C	1	A
ANNELIDA	Polychaeta			Errantia	Glycinde polygnatha	02A-1 (1.0)	2009	DP03	C	1	Int
MOLLUSCA	Bivalvia				Protothaca staminea	02A-1 (1.0)	2009	DP03	A	1	A
ANNELIDA	Oligochaeta				Enchytraeus sp.	02A-1 (1.0)	2009	DP03	C	2	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Eobrolgus chumashi	02A-1 (1.0)	2009	DP03	A	1	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Grandidierella japonica	02A-1 (1.0)	2009	DP03	A	6	A
ANNELIDA	Polychaeta			Sedentaria	Clymenella nr. torquata	02A-1 (1.0)	2009	DP03	B	1	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Grandidierella japonica	02A-1 (1.0)	2009	DP03	B	9	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Grandidierella japonica	02A-1 (1.0)	2009	DP03	C	11	A
ANNELIDA	Polychaeta			Sedentaria	Capitella capitata complex	02A-1 (1.0)	2009	DP03	C	1	J
ANNELIDA	Oligochaeta				Marionina sp.	02A-1 (1.0)	2009	DP03	A	2	A
ANNELIDA	Oligochaeta				Marionina sp.	02A-1 (1.0)	2009	DP03	C	1	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Grandidierella japonica	02A-1 (1.0)	2009	DP03	C	9	Int
ANNELIDA	Polychaeta			Sedentaria	Capitella capitata complex	02A-1 (1.0)	2009	DP03	C	4	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Monocorophium acherusicum	02A-1 (1.0)	2009	DP03	B	2	A
ANNELIDA	Polychaeta			Sedentaria	Dipolydora nr. quadrilobata	02A-1 (1.0)	2009	DP03	A	1	A
MOLLUSCA	Bivalvia				Bivalvia indet.	02A-1 (1.0)	2009	DP03	A	5	J
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Monocorophium acherusicum	02A-1 (1.0)	2009	DP03	A	10	A
ANNELIDA	Polychaeta			Errantia	Glycinde polygnatha	02A-1 (1.0)	2009	DP03	B	3	A
ANNELIDA	Polychaeta			Errantia	Nephtys caecoides	02A-1 (1.0)	2009	DP03	B	1	A
MOLLUSCA	Gastropoda				Alvania compacta	02A-1 (1.0)	2009	DP03	B	1	A
ANNELIDA	Polychaeta			Errantia	Glycinde polygnatha	02A-1 (1.0)	2009	DP03	A	1	Int
ANNELIDA	Polychaeta			Errantia	Glycinde polygnatha	02A-1 (1.0)	2009	DP03	C	8	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Ampithoe valida	02A-1 (1.0)	2009	DP03	C	1	Int
ANNELIDA	Oligochaeta				Tectidrilus spp.	02A-1 (1.0)	2009	DP03	C	4	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Grandidierella japonica	02A-1 (1.0)	2009	DP03	B	5	Int
ANNELIDA	Oligochaeta				Tectidrilus spp.	02A-1 (1.0)	2009	DP03	B	4	A
ANNELIDA	Polychaeta			Sedentaria	Capitella capitata complex	02A-1 (1.0)	2009	DP03	A	4	A
ANNELIDA	Polychaeta			Sedentaria	Capitella capitata complex	02A-1 (1.0)	2009	DP03	B	1	A
ANNELIDA	Polychaeta			Sedentaria	Pygospio elegans	02A-1 (1.0)	2009	DP03	A	7	J
ANNELIDA	Polychaeta			Sedentaria	Rhynchospio glutaea	02A-1 (1.0)	2009	DP03	A	29	A
ANNELIDA	Polychaeta			Sedentaria	Pseudopolydora paucibranchiata	02A-1 (1.0)	2009	DP03	A	2	Int
ANNELIDA	Polychaeta			Sedentaria	Arenicolidae indet.	02A-1 (1.0)	2009	DP03	A	3	J
ANNELIDA	Polychaeta			Sedentaria	Arenicolidae indet.	02A-1 (1.0)	2009	DP03	B	2	J
ANNELIDA	Polychaeta			Sedentaria	Arenicolidae indet.	02A-1 (1.0)	2009	DP03	C	1	J
ANNELIDA	Polychaeta			Sedentaria	Rhynchospio glutaea	02A-1 (1.0)	2009	DP03	B	31	A
ANNELIDA	Polychaeta			Sedentaria	Pseudopolydora kempi	02A-1 (1.0)	2009	DP03	A	10	A
ANNELIDA	Polychaeta			Sedentaria	Rhynchospio glutaea	02A-1 (1.0)	2009	DP03	C	36	A
ANNELIDA	Polychaeta			Sedentaria	Pygospio elegans	02A-1 (1.0)	2009	DP03	C	5	J
ANNELIDA	Polychaeta			Sedentaria	Pseudopolydora paucibranchiata	02A-1 (1.0)	2009	DP03	C	22	A
ARTHROPODA	Cirripedia	CRUSTACEA			Balanus crenatus	02A-1 (1.0)	2009	DP03	C	1	A
ANNELIDA	Polychaeta			Sedentaria	Rhynchospio glutaea	02A-1 (1.0)	2009	DP03	A	1	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Decapoda		Pagarus sp.	02A-1 (1.0)	2009	DP03	C	1	Int

Phylum	Class	Sub Phylum	Order	Subclass	Genus_species	SampleID	Year	Station	Grab	Count	LifeStage
MOLLUSCA	Gastropoda				Amphissa versicolor	02A-1 (1.0)	2009	DP03	C	2	A
MOLLUSCA	Gastropoda				Batillaria cumingi	02A-1 (1.0)	2009	DP03	A	4	A
ANNELIDA	Polychaeta			Errantia	Eteone californica	02A-1 (1.0)	2009	DP03	A	4	A
MOLLUSCA	Bivalvia				Mya arenaria	02A-1 (1.0)	2009	DP03	B	2	J
ANNELIDA	Polychaeta			Sedentaria	Pygospio elegans	02A-1 (1.0)	2009	DP03	A	186	A
MOLLUSCA	Bivalvia				Mya arenaria	02A-1 (1.0)	2009	DP03	A	2	J
MOLLUSCA	Gastropoda				Amphissa versicolor	02A-1 (1.0)	2009	DP03	C	7	Int
ANNELIDA	Polychaeta			Sedentaria	Pygospio elegans	02A-1 (1.0)	2009	DP03	B	187	A
MOLLUSCA	Gastropoda				Batillaria cumingi	02A-1 (1.0)	2009	DP03	B	9	A
ANNELIDA	Polychaeta			Sedentaria	Pygospio elegans	02A-1 (1.0)	2009	DP03	C	235	A
MOLLUSCA	Bivalvia				Mya sp.	02A-1 (1.0)	2009	DP03	A	1	J
ANNELIDA	Polychaeta			Errantia	Eteone californica	02A-1 (1.0)	2009	DP03	B	2	A
ANNELIDA	Polychaeta			Errantia	Eteone spilotus	02A-1 (1.0)	2009	DP03	C	2	A
MOLLUSCA	Gastropoda				Amphissa versicolor	02A-1 (1.0)	2009	DP03	B	5	Int
ANNELIDA	Polychaeta			Sedentaria	Pygospio elegans	02A-1 (1.0)	2009	DP03	C	1	Int
ANNELIDA	Polychaeta			Errantia	Phyllodoce williamsi	02A-1 (1.0)	2009	DP03	C	1	Int
ANNELIDA	Polychaeta			Sedentaria	Tharyx parvus	02A-1 (1.0)	2009	DP03	B	4	A
ANNELIDA	Polychaeta			Sedentaria	Pygospio elegans	02A-1 (1.0)	2009	DP03	B	10	J
MOLLUSCA	Bivalvia				Mya arenaria	02A-1 (1.0)	2009	DP03	C	3	J
ANNELIDA	Oligochaeta				Tubificidae indet. Group 5	02A-1 (1.0)	2009	DP03	A	1	A
ANNELIDA	Polychaeta			Sedentaria	Pseudopolydora paucibranchiata	02A-1 (1.0)	2009	DP03	C	2	Int
ANNELIDA	Polychaeta			Sedentaria	Pseudopolydora kempi	02A-1 (1.0)	2009	DP03	A	1	J
ANNELIDA	Polychaeta			Sedentaria	Pseudopolydora kempi	02A-1 (1.0)	2009	DP03	C	1	Int
ANNELIDA	Polychaeta			Sedentaria	Armandia brevis	02A-1 (1.0)	2009	DP03	A	2	Int
MOLLUSCA	Bivalvia				Modiolus modiolus	02A-1 (1.0)	2009	DP03	A	1	J
MOLLUSCA	Gastropoda				Amphissa versicolor	02A-1 (1.0)	2009	DP03	B	1	A
MOLLUSCA	Gastropoda				Amphissa versicolor	02A-1 (1.0)	2009	DP03	A	2	Int
MOLLUSCA	Bivalvia				Bivalvia indet.	02A-1 (1.0)	2009	DP03	C	2	J
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Monocorophium sp.	02A-1 (1.0)	2009	DP03	A	1	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Monocorophium sp.	02A-1 (1.0)	2009	DP03	C	5	Int
ANNELIDA	Oligochaeta				Tectidrilus spp.	02A-1 (1.0)	2009	DP03	C	2	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Monocorophium sp.	02A-1 (1.0)	2009	DP03	B	1	Int
MOLLUSCA	Gastropoda				Amphissa versicolor	02A-1 (1.0)	2009	DP03	A	3	A
ANNELIDA	Polychaeta			Sedentaria	Tharyx parvus	02A-1 (1.0)	2009	DP03	A	14	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Monocorophium insidiosum	02A-1 (1.0)	2009	DP03	C	1	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Monocorophium insidiosum	02A-1 (1.0)	2009	DP03	B	1	Int
ANNELIDA	Polychaeta			Sedentaria	Pseudopolydora paucibranchiata	02A-1 (1.0)	2009	DP03	A	19	A
ANNELIDA	Polychaeta			Sedentaria	Armandia brevis	02A-1 (1.0)	2009	DP03	B	1	Int
MOLLUSCA	Bivalvia				Modiolus modiolus	02A-1 (1.0)	2009	DP03	B	1	J
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Monocorophium insidiosum	02A-1 (1.0)	2009	DP03	A	2	Int
ARTHROPODA	Copepoda	CRUSTACEA			Harpacticoida indet.	02A-1 (1.0)	2009	DP03	C	1	A
ANNELIDA	Oligochaeta				Tubificoides coatesae	02A-1 (1.0)	2009	DP03	A	7	A
ARTHROPODA	Malacostraca	CRUSTACEA	Cumacea		Lamprops tomalesi	02A-1 (1.0)	2009	DP03	B	1	A
ANNELIDA	Polychaeta			Sedentaria	Pseudopolydora kempi	02A-1 (1.0)	2009	DP03	B	12	A
ANNELIDA	Polychaeta			Sedentaria	Scoloplos armiger	02A-1 (1.0)	2009	DP03	B	1	A
ANNELIDA	Polychaeta			Sedentaria	Scoloplos armiger	02A-1 (1.0)	2009	DP03	A	1	Int
ANNELIDA	Polychaeta			Sedentaria	Pseudopolydora paucibranchiata	02A-1 (1.0)	2009	DP03	B	11	A
ANNELIDA	Polychaeta			Sedentaria	Pseudopolydora kempi	02A-1 (1.0)	2009	DP03	C	8	A
ANNELIDA	Polychaeta			Sedentaria	Pseudopolydora kempi	02A-1 (1.0)	2009	DP03	B	1	Int
MOLLUSCA	Gastropoda				Acteocina culcitella	02A-1 (1.0)	2009	DP03	B	14	J
MOLLUSCA	Gastropoda				Haminoea vesicula	02A-1 (1.0)	2009	DP03	C	1	J
MOLLUSCA	Gastropoda				Haminoea vesicula	02A-1 (1.0)	2009	DP03	B	1	Int
MOLLUSCA	Gastropoda				Acteocina culcitella	02A-1 (1.0)	2009	DP03	B	1	Int
MOLLUSCA	Gastropoda				Acteocina culcitella	02A-1 (1.0)	2009	DP03	A	4	Int
MOLLUSCA	Gastropoda				Acteocina culcitella	02A-1 (1.0)	2009	DP03	C	6	J
ANNELIDA	Polychaeta			Sedentaria	Cirratulus spectabilis	02A-1 (1.0)	2009	DP04	B	2	A
MOLLUSCA	Bivalvia				Tellina modesta	02A-1 (1.0)	2009	DP04	C	1	A
MOLLUSCA	Gastropoda				Alvania compacta	02A-1 (1.0)	2009	DP04	B	39	A
ANNELIDA	Polychaeta			Sedentaria	Ampharete labrops	02A-1 (1.0)	2009	DP04	C	6	Int
ANNELIDA	Oligochaeta				Limnodriloides sp.	02A-1 (1.0)	2009	DP04	C	2	Int
ANNELIDA	Polychaeta			Sedentaria	Ampharete labrops	02A-1 (1.0)	2009	DP04	C	2	A
ANNELIDA	Polychaeta			Errantia	Platynereis bicanaliculata	02A-1 (1.0)	2009	DP04	C	2	Int
ANNELIDA	Polychaeta			Sedentaria	Ampharete labrops	02A-1 (1.0)	2009	DP04	A	4	A
MOLLUSCA	Bivalvia				Rochefortia tumida	02A-1 (1.0)	2009	DP04	A	84	A
ANNELIDA	Polychaeta			Errantia	Platynereis bicanaliculata	02A-1 (1.0)	2009	DP04	A	3	Int
MOLLUSCA	Bivalvia				Rochefortia tumida	02A-1 (1.0)	2009	DP04	B	106	A
ANNELIDA	Polychaeta			Errantia	Harmothoe imbricata	02A-1 (1.0)	2009	DP04	B	1	A
ANNELIDA	Polychaeta			Errantia	Nephtys caeca	02A-1 (1.0)	2009	DP04	B	1	A
ANNELIDA	Polychaeta			Sedentaria	Chone bimaculata	02A-1 (1.0)	2009	DP04	B	1	A
ANNELIDA	Polychaeta			Sedentaria	Clymenella nr. torquata	02A-1 (1.0)	2009	DP04	B	1	A
MOLLUSCA	Bivalvia				Tellina modesta	02A-1 (1.0)	2009	DP04	B	1	Int
ANNELIDA	Oligochaeta				Limnodriloides sp.	02A-1 (1.0)	2009	DP04	B	11	Int
ANNELIDA	Oligochaeta				Limnodriloides sp.	02A-1 (1.0)	2009	DP04	B	10	A
ANNELIDA	Polychaeta			Errantia	Platynereis bicanaliculata	02A-1 (1.0)	2009	DP04	B	1	Int
ANNELIDA	Polychaeta			Errantia	Nephtys caecoides	02A-1 (1.0)	2009	DP04	A	2	A
ANNELIDA	Polychaeta			Sedentaria	Cirratulus spectabilis	02A-1 (1.0)	2009	DP04	A	1	A
ANNELIDA	Oligochaeta				Limnodriloides sp.	02A-1 (1.0)	2009	DP04	C	1	A
MOLLUSCA	Gastropoda				Cuthona concinna	02A-1 (1.0)	2009	DP04	B	1	A
ANNELIDA	Polychaeta			Errantia	Glycinde polygnatha	02A-1 (1.0)	2009	DP04	C	3	Int
MOLLUSCA	Gastropoda				Cuthona concinna	02A-1 (1.0)	2009	DP04	C	1	A
ANNELIDA	Polychaeta			Sedentaria	Ampharete labrops	02A-1 (1.0)	2009	DP04	B	2	Int
ANNELIDA	Polychaeta			Sedentaria	Clymenella nr. torquata	02A-1 (1.0)	2009	DP04	A	1	A
ANNELIDA	Polychaeta			Sedentaria	Ampharete labrops	02A-1 (1.0)	2009	DP04	B	6	A
MOLLUSCA	Gastropoda				Alvania compacta	02A-1 (1.0)	2009	DP04	C	28	A
ANNELIDA	Polychaeta			Errantia	Glycinde polygnatha	02A-1 (1.0)	2009	DP04	A	10	A
ANNELIDA	Polychaeta			Sedentaria	Armandia brevis	02A-1 (1.0)	2009	DP04	A	6	A
MOLLUSCA	Bivalvia				Veneridae sp. A	02A-1 (1.0)	2009	DP04	B	1	J
ANNELIDA	Oligochaeta				Tectidrilus spp.	02A-1 (1.0)	2009	DP04	B	3	J
ANNELIDA	Polychaeta			Sedentaria	Armandia brevis	02A-1 (1.0)	2009	DP04	B	9	A
ANNELIDA	Polychaeta			Errantia	Pholoe minuta	02A-1 (1.0)	2009	DP04	C	5	A
MOLLUSCA	Bivalvia				Rochefortia tumida	02A-1 (1.0)	2009	DP04	B	62	Int
ANNELIDA	Polychaeta			Errantia	Nereis procera	02A-1 (1.0)	2009	DP04	B	1	Int
ANNELIDA	Polychaeta			Errantia	Pholoe minuta	02A-1 (1.0)	2009	DP04	B	12	A
ANNELIDA	Polychaeta			Errantia	Glycera nana	02A-1 (1.0)	2009	DP04	B	1	A
ANNELIDA	Polychaeta			Sedentaria	Barantolla nr. americana	02A-1 (1.0)	2009	DP04	B	1	Int
ANNELIDA	Oligochaeta				Tubificidae indet. Group 5	02A-1 (1.0)	2009	DP04	C	5	A
ANNELIDA	Polychaeta			Sedentaria	Armandia brevis	02A-1 (1.0)	2009	DP04	C	4	A
ANNELIDA	Polychaeta			Errantia	Glycinde polygnatha	02A-1 (1.0)	2009	DP04	B	7	A
ANNELIDA	Polychaeta			Sedentaria	Barantolla nr. americana	02A-1 (1.0)	2009	DP04	B	1	A
MOLLUSCA	Bivalvia				Tellina modesta	02A-1 (1.0)	2009	DP04	C	3	Int

Phylum	Class	Sub Phylum	Order	Subclass	Genus_species	SampleID	Year	Station	Grab	Count	LifeStage
ANNELIDA	Polychaeta			Sedentaria	Asabellides nr.lineata	02A-1 (1.0)	2009	DP04	C	1	A
ANNELIDA	Polychaeta			Errantia	Ophiodromus pugettensis	02A-1 (1.0)	2009	DP04	B	1	Int
MOLLUSCA	Bivalvia				Rochefortia tumida	02A-1 (1.0)	2009	DP04	C	153	A
ANNELIDA	Polychaeta			Errantia	Pholoe glabra	02A-1 (1.0)	2009	DP04	B	3	A
ANNELIDA	Polychaeta			Sedentaria	Armandia brevis	02A-1 (1.0)	2009	DP04	A	1	Int
MOLLUSCA	Bivalvia				Rochefortia tumida	02A-1 (1.0)	2009	DP04	A	49	Int
ANNELIDA	Oligochaeta				Tectidrilus spp.	02A-1 (1.0)	2009	DP04	B	27	Int
ANNELIDA	Polychaeta			Sedentaria	Armandia brevis	02A-1 (1.0)	2009	DP04	B	7	Int
ANNELIDA	Polychaeta			Errantia	Pholoe minuta	02A-1 (1.0)	2009	DP04	A	7	A
ANNELIDA	Polychaeta			Errantia	Nephtys caecoides	02A-1 (1.0)	2009	DP04	C	2	A
ANNELIDA	Polychaeta			Sedentaria	Ampharete labrops	02A-1 (1.0)	2009	DP04	B	6	J
ANNELIDA	Polychaeta			Sedentaria	Ampharete labrops	02A-1 (1.0)	2009	DP04	C	3	J
ANNELIDA	Polychaeta			Errantia	Platynereis bicanaliculata	02A-1 (1.0)	2009	DP04	B	12	A
ANNELIDA	Oligochaeta				Tectidrilus spp.	02A-1 (1.0)	2009	DP04	A	3	A
ANNELIDA	Polychaeta			Errantia	Glycinde polygnatha	02A-1 (1.0)	2009	DP04	C	14	A
ANNELIDA	Polychaeta			Errantia	Platynereis bicanaliculata	02A-1 (1.0)	2009	DP04	A	16	A
ANNELIDA	Polychaeta			Errantia	Nephtys caecoides	02A-1 (1.0)	2009	DP04	B	1	A
MOLLUSCA	Bivalvia				Tellina modesta	02A-1 (1.0)	2009	DP04	B	3	A
ANNELIDA	Oligochaeta				Tectidrilus spp.	02A-1 (1.0)	2009	DP04	C	12	A
MOLLUSCA	Bivalvia				Veneridae sp. A	02A-1 (1.0)	2009	DP04	C	1	J
MOLLUSCA	Bivalvia				Veneridae sp. A	02A-1 (1.0)	2009	DP04	B	3	Int
ANNELIDA	Polychaeta			Sedentaria	Capitella capitata complex	02A-1 (1.0)	2009	DP04	C	1	A
ANNELIDA	Polychaeta			Errantia	Pholoe sp. N-1	02A-1 (1.0)	2009	DP04	A	1	A
ANNELIDA	Polychaeta			Errantia	Phyllodoce williamsi	02A-1 (1.0)	2009	DP04	B	3	A
ANNELIDA	Polychaeta			Errantia	Eulalia quadrioculata	02A-1 (1.0)	2009	DP04	A	1	A
ANNELIDA	Polychaeta			Errantia	Eulalia quadrioculata	02A-1 (1.0)	2009	DP04	B	2	A
ANNELIDA	Polychaeta			Errantia	Phyllodoce williamsi	02A-1 (1.0)	2009	DP04	A	2	A
ANNELIDA	Polychaeta			Sedentaria	Capitella capitata complex	02A-1 (1.0)	2009	DP04	B	5	A
ANNELIDA	Oligochaeta				Tectidrilus spp.	02A-1 (1.0)	2009	DP04	A	4	Int
ANNELIDA	Polychaeta			Sedentaria	Arenicolidae indet.	02A-1 (1.0)	2009	DP04	C	1	J
ANNELIDA	Polychaeta			Errantia	Pholoe sp. N-1	02A-1 (1.0)	2009	DP04	C	4	A
MOLLUSCA	Bivalvia				Rochefortia tumida	02A-1 (1.0)	2009	DP04	C	17	Int
MOLLUSCA	Gastropoda				Alvania compacta	02A-1 (1.0)	2009	DP04	A	18	A
ANNELIDA	Polychaeta			Errantia	Platynereis bicanaliculata	02A-1 (1.0)	2009	DP04	C	13	A
ANNELIDA	Polychaeta			Errantia	Phyllodoce williamsi	02A-1 (1.0)	2009	DP04	C	1	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Aoroides inermis	02A-1 (1.0)	2009	DP04	A	1	A
ARTHROPODA	Pycnogonida	CHELICERATA			Anoplodactylus viridintestinalis	02A-1 (1.0)	2009	DP04	A	1	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Caprella laeviuscula	02A-1 (1.0)	2009	DP04	A	2	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Caprella laeviuscula	02A-1 (1.0)	2009	DP04	C	57	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Caprella laeviuscula	02A-1 (1.0)	2009	DP04	B	53	A
MOLLUSCA	Bivalvia				Macoma inquinata	02A-1 (1.0)	2009	DP04	C	1	J
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Caprella laeviuscula	02A-1 (1.0)	2009	DP04	A	15	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Caprella laeviuscula	02A-1 (1.0)	2009	DP04	B	4	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Aoroides sp.	02A-1 (1.0)	2009	DP04	C	1	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Caprella laeviuscula	02A-1 (1.0)	2009	DP04	C	17	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Anisogammarus pugettensis	02A-1 (1.0)	2009	DP04	B	1	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Ampithoe valida	02A-1 (1.0)	2009	DP04	A	1	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Ampithoe sp.	02A-1 (1.0)	2009	DP04	C	1	Int
ANNELIDA	Polychaeta			Sedentaria	Owenia nr. johnsoni	02A-1 (1.0)	2009	DP04	B	35	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Americhelidium shoemakeri	02A-1 (1.0)	2009	DP04	B	1	A
MOLLUSCA	Bivalvia				Nutricola sp.	02A-1 (1.0)	2009	DP04	A	1	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Ischyrocerus anguipes	02A-1 (1.0)	2009	DP04	C	3	Int
ANNELIDA	Polychaeta			Sedentaria	Owenia nr. johnsoni	02A-1 (1.0)	2009	DP04	A	32	A
ECHINODERMATA	Ophiuroidea				Amphiodia urtica	02A-1 (1.0)	2009	DP04	B	6	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Ischyrocerus anguipes	02A-1 (1.0)	2009	DP04	C	2	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Ischyrocerus anguipes	02A-1 (1.0)	2009	DP04	B	1	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Ischyrocerus anguipes	02A-1 (1.0)	2009	DP04	A	1	A
ANNELIDA	Polychaeta			Sedentaria	Mediomastus ambiseta	02A-1 (1.0)	2009	DP04	B	1	A
ECHINODERMATA	Ophiuroidea				Amphiodia urtica	02A-1 (1.0)	2009	DP04	A	4	A
MOLLUSCA	Bivalvia				Macoma golikovi	02A-1 (1.0)	2009	DP04	B	1	Int
ANNELIDA	Polychaeta			Sedentaria	Rhynchospio glutaea	02A-1 (1.0)	2009	DP04	A	14	A
ANNELIDA	Polychaeta			Sedentaria	Mediomastus californiensis	02A-1 (1.0)	2009	DP04	A	5	A
ANNELIDA	Polychaeta			Sedentaria	Owenia nr. johnsoni	02A-1 (1.0)	2009	DP04	C	34	A
MOLLUSCA	Bivalvia				Macoma golikovi	02A-1 (1.0)	2009	DP04	B	1	J
ANNELIDA	Polychaeta			Sedentaria	Mediomastus californiensis	02A-1 (1.0)	2009	DP04	B	18	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Eobrolgus chumashi	02A-1 (1.0)	2009	DP04	C	1	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Caprella sp.	02A-1 (1.0)	2009	DP04	C	58	J
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Caprella sp.	02A-1 (1.0)	2009	DP04	B	11	J
ANNELIDA	Polychaeta			Sedentaria	Mediomastus californiensis	02A-1 (1.0)	2009	DP04	C	12	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Caprella sp.	02A-1 (1.0)	2009	DP04	A	1	J
ANNELIDA	Polychaeta			Sedentaria	Mediomastus ambiseta	02A-1 (1.0)	2009	DP04	B	1	J
ANNELIDA	Polychaeta			Sedentaria	Pseudopolydora paucibranchiata	02A-1 (1.0)	2009	DP04	B	3	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Americhelidium shoemakeri	02A-1 (1.0)	2009	DP04	A	3	A
ANNELIDA	Polychaeta			Sedentaria	Prionospio (Minuspio) lighti	02A-1 (1.0)	2009	DP04	B	7	A
MOLLUSCA	Bivalvia				Mya arenaria	02A-1 (1.0)	2009	DP04	B	5	J
ANNELIDA	Polychaeta			Sedentaria	Pygospio elegans	02A-1 (1.0)	2009	DP04	C	1	A
MOLLUSCA	Bivalvia				Macoma sp.	02A-1 (1.0)	2009	DP04	B	18	J
MOLLUSCA	Bivalvia				Macoma sp.	02A-1 (1.0)	2009	DP04	C	23	J
MOLLUSCA	Bivalvia				Axinopsida serricata	02A-1 (1.0)	2009	DP04	B	2	A
ANNELIDA	Polychaeta			Sedentaria	Prionospio (Minuspio) lighti	02A-1 (1.0)	2009	DP04	C	1	A
ANNELIDA	Polychaeta			Sedentaria	Prionospio (Minuspio) lighti	02A-1 (1.0)	2009	DP04	A	2	A
MOLLUSCA	Bivalvia				Modiolus modiolus	02A-1 (1.0)	2009	DP04	A	33	J
MOLLUSCA	Bivalvia				Modiolus modiolus	02A-1 (1.0)	2009	DP04	B	235	J
ANNELIDA	Polychaeta			Sedentaria	Prionospio (Minuspio) multibranchiata	02A-1 (1.0)	2009	DP04	C	1	A
ANNELIDA	Polychaeta			Sedentaria	Prionospio (Prionospio) jubata	02A-1 (1.0)	2009	DP04	B	1	A
ANNELIDA	Polychaeta			Sedentaria	Prionospio (Prionospio) steenstrupi	02A-1 (1.0)	2009	DP04	A	3	A
MOLLUSCA	Bivalvia				Modiolus modiolus	02A-1 (1.0)	2009	DP04	C	110	J
ECHINODERMATA	Ophiuroidea				Amphiuridae indet.	02A-1 (1.0)	2009	DP04	B	1	J
ANNELIDA	Polychaeta			Sedentaria	Pseudopolydora paucibranchiata	02A-1 (1.0)	2009	DP04	C	2	A
MOLLUSCA	Bivalvia				Macoma nasuta	02A-1 (1.0)	2009	DP04	A	10	J
ARTHROPODA	Pycnogonida	CHELICERATA			Anoplodactylus viridintestinalis	02A-1 (1.0)	2009	DP04	C	9	A
MOLLUSCA	Bivalvia				Macoma nasuta	02A-1 (1.0)	2009	DP04	B	1	Int
ARTHROPODA	Pycnogonida	CHELICERATA			Anoplodactylus viridintestinalis	02A-1 (1.0)	2009	DP04	B	12	A
ARTHROPODA	Pycnogonida	CHELICERATA			Anoplodactylus viridintestinalis	02A-1 (1.0)	2009	DP04	A	2	A
ANNELIDA	Polychaeta			Sedentaria	Owenia nr. johnsoni	02A-1 (1.0)	2009	DP04	C	1	Int
ARTHROPODA	Arachnida	CHELICERATA	Acarida		Hydracarina indet.	02A-1 (1.0)	2009	DP04	B	1	Int
ANNELIDA	Polychaeta			Sedentaria	Pygospio elegans	02A-1 (1.0)	2009	DP04	C	1	Int
ARTHROPODA	Arachnida	CHELICERATA	Acarida		Hydracarina indet.	02A-1 (1.0)	2009	DP04	A	1	A
MOLLUSCA	Bivalvia				Axinopsida serricata	02A-1 (1.0)	2009	DP04	C	2	A
ANNELIDA	Polychaeta			Sedentaria	Spiophanes berkeleyorum	02A-1 (1.0)	2009	DP04	C	1	J

Appendix E
2007, 2008, 2009 Benthic Invertebrate Data

Phylum	Class	Sub Phylum	Order	Subclass	Genus_species	SampleID	Year	Station	Grab	Count	LifeStage
ANNELIDA	Polychaeta			Sedentaria	Rhynchospio glutaea	02A-1 (1.0)	2009	DP04	C	24	A
ANNELIDA	Polychaeta			Sedentaria	Rhynchospio glutaea	02A-1 (1.0)	2009	DP04	B	27	A
ANNELIDA	Polychaeta			Sedentaria	Polydora cornuta	02A-1 (1.0)	2009	DP04	B	1	A
MOLLUSCA	Bivalvia				Macoma nasuta	02A-1 (1.0)	2009	DP04	B	1	J
MOLLUSCA	Bivalvia				Macoma sp.	02A-1 (1.0)	2009	DP04	A	10	J
MOLLUSCA	Bivalvia				Mya arenaria	02A-1 (1.0)	2009	DP04	C	4	J
MOLLUSCA	Bivalvia				Macoma nasuta	02A-1 (1.0)	2009	DP04	C	1	Int
MOLLUSCA	Bivalvia				Protothaca sp.	02A-1 (1.0)	2009	DP04	B	8	J
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Monocorophium sp.	02A-1 (1.0)	2009	DP04	B	1	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Photis brevipes	02A-1 (1.0)	2009	DP04	B	22	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Photis brevipes	02A-1 (1.0)	2009	DP04	C	42	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Photis brevipes	02A-1 (1.0)	2009	DP04	B	6	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Photis brevipes	02A-1 (1.0)	2009	DP04	C	6	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Tanaidacea		Leptochelia savigyni	02A-1 (1.0)	2009	DP04	C	41	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Pontogeneia rostrata	02A-1 (1.0)	2009	DP04	A	1	A
MOLLUSCA	Bivalvia				Protothaca sp.	02A-1 (1.0)	2009	DP04	C	6	J
ARTHROPODA	Malacostraca	CRUSTACEA	Tanaidacea		Leptochelia savigyni	02A-1 (1.0)	2009	DP04	A	49	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Pontogeneia rostrata	02A-1 (1.0)	2009	DP04	C	4	A
ANNELIDA	Polychaeta			Sedentaria	Dipolydora spp.	02A-1 (1.0)	2009	DP04	B	1	J
ARTHROPODA	Malacostraca	CRUSTACEA	Tanaidacea		Leptochelia savigyni	02A-1 (1.0)	2009	DP04	C	713	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Pontogeneia rostrata	02A-1 (1.0)	2009	DP04	B	1	A
ARTHROPODA	Malacostraca	CRUSTACEA	Isopoda		Idotea rescata	02A-1 (1.0)	2009	DP04	C	1	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Isopoda		Idotea rescata	02A-1 (1.0)	2009	DP04	A	1	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Isopoda		Idotea rescata	02A-1 (1.0)	2009	DP04	C	7	A
MOLLUSCA	Bivalvia				Protothaca sp.	02A-1 (1.0)	2009	DP04	A	4	J
ANNELIDA	Polychaeta			Sedentaria	Galathowenia oculata	02A-1 (1.0)	2009	DP04	B	1	A
ARTHROPODA	Malacostraca	CRUSTACEA	Isopoda		Idotea rescata	02A-1 (1.0)	2009	DP04	B	2	A
ARTHROPODA	Malacostraca	CRUSTACEA	Decapoda		Pinnixa schmitti	02A-1 (1.0)	2009	DP04	B	2	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Tanaidacea		Leptochelia savigyni	02A-1 (1.0)	2009	DP04	B	72	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Monocorophium acherusicum	02A-1 (1.0)	2009	DP04	A	1	A
ANNELIDA	Polychaeta			Sedentaria	Mediomastus californiensis	02A-1 (1.0)	2009	DP04	B	2	Int
MOLLUSCA	Bivalvia				Bivalvia indet.	02A-1 (1.0)	2009	DP04	C	1	J
ARTHROPODA	Ostracoda	CRUSTACEA			Cyprideis sp.	02A-1 (1.0)	2009	DP04	B	4	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Monocorophium insidiosum	02A-1 (1.0)	2009	DP04	C	1	A
ANNELIDA	Polychaeta			Sedentaria	Dipolydora nr. quadrilobata	02A-1 (1.0)	2009	DP04	A	1	A
ARTHROPODA	Malacostraca	CRUSTACEA	Tanaidacea		Leptochelia savigyni	02A-1 (1.0)	2009	DP04	A	445	A
MOLLUSCA	Bivalvia				Axinopsida serricata	02A-1 (1.0)	2009	DP04	A	2	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Monocorophium insidiosum	02A-1 (1.0)	2009	DP04	B	1	A
ANNELIDA	Polychaeta			Sedentaria	Leitoscoloplos pugettensis	02A-1 (1.0)	2009	DP04	C	4	A
ANNELIDA	Polychaeta			Sedentaria	Dipolydora nr. quadrilobata	02A-1 (1.0)	2009	DP04	B	4	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Pontogeneia rostrata	02A-1 (1.0)	2009	DP04	C	1	Int
MOLLUSCA	Bivalvia				Clinocardium ciliatum	02A-1 (1.0)	2009	DP04	B	1	A
MOLLUSCA	Bivalvia				Clinocardium nuttallii	02A-1 (1.0)	2009	DP04	C	1	Int
ANNELIDA	Polychaeta			Sedentaria	Leitoscoloplos pugettensis	02A-1 (1.0)	2009	DP04	A	2	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Monocorophium insidiosum	02A-1 (1.0)	2009	DP04	C	1	Int
ANNELIDA	Polychaeta			Sedentaria	Leitoscoloplos pugettensis	02A-1 (1.0)	2009	DP04	B	4	A
ARTHROPODA	Malacostraca	CRUSTACEA	Tanaidacea		Leptochelia savigyni	02A-1 (1.0)	2009	DP04	B	717	A
MOLLUSCA	Gastropoda				Lacuna variegata	02A-1 (1.0)	2009	DP04	C	5	Int
MOLLUSCA	Gastropoda				Lacuna variegata	02A-1 (1.0)	2009	DP04	B	3	Int
MOLLUSCA	Gastropoda				Odostomia sp.	02A-1 (1.0)	2009	DP04	B	1	Int
NEMERTEA	Enopla				Tetrastemmidae nigrifons	02A-1 (1.0)	2009	DP04	A	1	A
MOLLUSCA	Gastropoda				Lacuna variegata	02A-1 (1.0)	2009	DP04	A	9	Int
MOLLUSCA	Gastropoda				Lottia parallela	02A-1 (1.0)	2009	DP04	B	5	A
MOLLUSCA	Gastropoda				Lacuna variegata	02A-1 (1.0)	2009	DP04	C	1	J
NEMERTEA	Enopla				Tetrastemmidae nigrifons	02A-1 (1.0)	2009	DP04	B	2	A
MOLLUSCA	Gastropoda				Lacuna variegata	02A-1 (1.0)	2009	DP04	A	1	J
NEMERTEA	Anopla				Anopla sp. D	02A-1 (1.0)	2009	DP04	C	1	A
MOLLUSCA	Gastropoda				Lottia parallela	02A-1 (1.0)	2009	DP04	C	1	Int
MOLLUSCA	Gastropoda				Lottia parallela	02A-1 (1.0)	2009	DP04	B	2	Int
MOLLUSCA	Gastropoda				Margarites pupillus	02A-1 (1.0)	2009	DP04	B	1	A
MOLLUSCA	Gastropoda				Margarites pupillus	02A-1 (1.0)	2009	DP04	B	1	Int
MOLLUSCA	Gastropoda				Lottia parallela	02A-1 (1.0)	2009	DP04	A	2	Int
MOLLUSCA	Gastropoda				Margarites pupillus	02A-1 (1.0)	2009	DP04	B	1	J
MOLLUSCA	Gastropoda				Margarites pupillus	02A-1 (1.0)	2009	DP04	C	1	J
NEMERTEA	Anopla				Cerebratulus californiensis	02A-1 (1.0)	2009	DP04	C	3	Int
MOLLUSCA	Gastropoda				Lottia parallela	02A-1 (1.0)	2009	DP04	C	3	A
MOLLUSCA	Gastropoda				Lottia parallela	02A-1 (1.0)	2009	DP04	A	5	A
MOLLUSCA	Gastropoda				Odostomia sp.	02A-1 (1.0)	2009	DP04	A	1	Int
MOLLUSCA	Gastropoda				Odostomia sp.	02A-1 (1.0)	2009	DP04	A	2	A
MOLLUSCA	Bivalvia				Macoma sp.	02A-1 (1.0)	2009	DP05	A	25	J
ANNELIDA	Polychaeta			Errantia	Scoletoma luti	02A-1 (1.0)	2009	DP05	A	9	A
ANNELIDA	Polychaeta			Errantia	Scoletoma luti	02A-1 (1.0)	2009	DP05	A	1	J
ANNELIDA	Polychaeta			Errantia	Scoletoma luti	02A-1 (1.0)	2009	DP05	C	1	J
ANNELIDA	Polychaeta			Sedentaria	Prionospio (Prionospio) steenstrupi	02A-1 (1.0)	2009	DP05	C	2	A
MOLLUSCA	Bivalvia				Thyasira flexuosa	02A-1 (1.0)	2009	DP05	C	1	A
MOLLUSCA	Bivalvia				Tellina modesta	02A-1 (1.0)	2009	DP05	C	1	J
ANNELIDA	Polychaeta			Errantia	Phyllodoce hartmanae	02A-1 (1.0)	2009	DP05	B	1	A
MOLLUSCA	Bivalvia				Modiolus modiolus	02A-1 (1.0)	2009	DP05	A	1	J
ANNELIDA	Polychaeta			Errantia	Podarkeopsis glabrus	02A-1 (1.0)	2009	DP05	B	1	A
MOLLUSCA	Bivalvia				Compsomyax subdiaphana	02A-1 (1.0)	2009	DP05	B	1	J
ANNELIDA	Polychaeta			Errantia	Pholoe sp. N-1	02A-1 (1.0)	2009	DP05	B	1	Int
ANNELIDA	Polychaeta			Errantia	Pholoe sp. N-1	02A-1 (1.0)	2009	DP05	C	5	A
ANNELIDA	Polychaeta			Errantia	Podarkeopsis glabrus	02A-1 (1.0)	2009	DP05	A	3	Int
ANNELIDA	Polychaeta			Errantia	Pholoe sp. N-1	02A-1 (1.0)	2009	DP05	B	8	A
MOLLUSCA	Bivalvia				Bivalvia indet.	02A-1 (1.0)	2009	DP05	C	1	J
ANNELIDA	Polychaeta			Errantia	Pholoe minuta	02A-1 (1.0)	2009	DP05	C	1	A
ANNELIDA	Polychaeta			Errantia	Pholoe minuta	02A-1 (1.0)	2009	DP05	B	3	A
ARTHROPODA	Malacostraca	CRUSTACEA	Decapoda		Pinnixa schmitti	02A-1 (1.0)	2009	DP05	A	1	Int
ANNELIDA	Polychaeta			Errantia	Scoletoma luti	02A-1 (1.0)	2009	DP05	A	1	Int
MOLLUSCA	Bivalvia				Modiolus modiolus	02A-1 (1.0)	2009	DP05	B	3	J
ARTHROPODA	Ostracoda	CRUSTACEA			Euphilomedes carcharodonta	02A-1 (1.0)	2009	DP05	C	1	A
ANNELIDA	Polychaeta			Errantia	Scoletoma luti	02A-1 (1.0)	2009	DP05	B	5	A
ANNELIDA	Polychaeta			Errantia	Scoletoma luti	02A-1 (1.0)	2009	DP05	C	8	A
ANNELIDA	Polychaeta			Errantia	Pholoe minuta	02A-1 (1.0)	2009	DP05	A	2	A
MOLLUSCA	Bivalvia				Macoma sp.	02A-1 (1.0)	2009	DP05	C	15	J
MOLLUSCA	Bivalvia				Tellina modesta	02A-1 (1.0)	2009	DP05	B	2	Int
MOLLUSCA	Bivalvia				Axinopsida serricata	02A-1 (1.0)	2009	DP05	A	7	Int
ANNELIDA	Polychaeta			Errantia	Scoletoma luti	02A-1 (1.0)	2009	DP05	C	2	Int
MOLLUSCA	Bivalvia				Macoma sp.	02A-1 (1.0)	2009	DP05	B	6	J
ANNELIDA	Oligochaeta				Tubificidae indet. Group 5	02A-1 (1.0)	2009	DP05	B	4	Int

Phylum	Class	Sub Phylum	Order	Subclass	Genus_species	SampleID	Year	Station	Grab	Count	LifeStage
ECHINODERMATA	Ophiuroidea				Amphiodia urtica	02A-1 (1.0)	2009	DP05	C	2	Int
ECHINODERMATA	Ophiuroidea				Amphiodia urtica	02A-1 (1.0)	2009	DP05	B	1	Int
MOLLUSCA	Bivalvia				Tellina modesta	02A-1 (1.0)	2009	DP05	B	2	J
ARTHROPODA	Malacostraca	CRUSTACEA	Tanaidacea		Leptochelia savigyni	02A-1 (1.0)	2009	DP05	C	1	A
MOLLUSCA	Bivalvia				Tellina modesta	02A-1 (1.0)	2009	DP05	C	2	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Tanaidacea		Leptochelia savigyni	02A-1 (1.0)	2009	DP05	B	1	A
ANNELIDA	Polychaeta			Errantia	Pilargis berkeleyae	02A-1 (1.0)	2009	DP05	B	1	Int
ANNELIDA	Polychaeta			Errantia	Pilargis berkeleyae	02A-1 (1.0)	2009	DP05	B	2	A
MOLLUSCA	Bivalvia				Tellina modesta	02A-1 (1.0)	2009	DP05	A	1	J
ANNELIDA	Polychaeta			Errantia	Glycinde polygnatha	02A-1 (1.0)	2009	DP05	B	1	Int
MOLLUSCA	Bivalvia				Ennucula tenuis	02A-1 (1.0)	2009	DP05	A	16	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Protomedeia grandimana	02A-1 (1.0)	2009	DP05	B	2	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Protomedeia grandimana	02A-1 (1.0)	2009	DP05	A	2	A
ECHINODERMATA	Ophiuroidea				Amphiodia urtica	02A-1 (1.0)	2009	DP05	C	3	A
ANNELIDA	Polychaeta			Sedentaria	Prionospio (Prionospio) steenstrupi	02A-1 (1.0)	2009	DP05	B	5	A
MOLLUSCA	Gastropoda				Alvania compacta	02A-1 (1.0)	2009	DP05	B	4	A
ANNELIDA	Polychaeta			Errantia	Glycera nana	02A-1 (1.0)	2009	DP05	C	2	A
ANNELIDA	Polychaeta			Errantia	Glycera nana	02A-1 (1.0)	2009	DP05	A	1	Int
ANNELIDA	Polychaeta			Errantia	Lumbrineris cruzensis	02A-1 (1.0)	2009	DP05	C	2	A
MOLLUSCA	Bivalvia				Macoma balthica	02A-1 (1.0)	2009	DP05	A	1	J
ANNELIDA	Polychaeta			Errantia	Lumbrineris cruzensis	02A-1 (1.0)	2009	DP05	A	1	A
MOLLUSCA	Bivalvia				Macoma balthica	02A-1 (1.0)	2009	DP05	B	1	J
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Protomedeia grandimana	02A-1 (1.0)	2009	DP05	C	2	A
ECHINODERMATA	Ophiuroidea				Amphiodia urtica	02A-1 (1.0)	2009	DP05	B	6	A
ANNELIDA	Polychaeta			Errantia	Eteone californica	02A-1 (1.0)	2009	DP05	C	1	A
MOLLUSCA	Gastropoda				Alvania compacta	02A-1 (1.0)	2009	DP05	C	4	A
BRYOZOA	Gymnolaemata				Celleporella hyalina	02A-1 (1.0)	2009	DP05	B	3	A
MOLLUSCA	Bivalvia				Axinopsida serricata	02A-1 (1.0)	2009	DP05	C	16	Int
ANNELIDA	Polychaeta			Errantia	Glycinde polygnatha	02A-1 (1.0)	2009	DP05	C	2	A
MOLLUSCA	Bivalvia				Macoma carlottensis	02A-1 (1.0)	2009	DP05	A	3	Int
ECHINODERMATA	Ophiuroidea				Amphiodia urtica	02A-1 (1.0)	2009	DP05	A	5	A
MOLLUSCA	Bivalvia				Bivalvia indet.	02A-1 (1.0)	2009	DP05	B	1	J
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Heterophoxus affinis	02A-1 (1.0)	2009	DP05	B	1	A
MOLLUSCA	Bivalvia				Macoma carlottensis	02A-1 (1.0)	2009	DP05	C	4	Int
ANNELIDA	Polychaeta			Errantia	Glycinde polygnatha	02A-1 (1.0)	2009	DP05	B	3	A
MOLLUSCA	Bivalvia				Macoma carlottensis	02A-1 (1.0)	2009	DP05	A	1	J
ANNELIDA	Polychaeta			Errantia	Glycinde polygnatha	02A-1 (1.0)	2009	DP05	A	9	A
ANNELIDA	Polychaeta			Errantia	Glycinde polygnatha	02A-1 (1.0)	2009	DP05	C	1	Int
ANNELIDA	Polychaeta			Errantia	Nephtys cornuta	02A-1 (1.0)	2009	DP05	A	1	Int
ANNELIDA	Polychaeta			Sedentaria	Spiophanes berkeleyorum	02A-1 (1.0)	2009	DP05	C	1	A
ANNELIDA	Polychaeta			Sedentaria	Spiophanes berkeleyorum	02A-1 (1.0)	2009	DP05	A	1	Int
ANNELIDA	Polychaeta			Sedentaria	Spiophanes berkeleyorum	02A-1 (1.0)	2009	DP05	C	3	Int
ANNELIDA	Polychaeta			Errantia	Pholoe glabra	02A-1 (1.0)	2009	DP05	C	1	A
ANNELIDA	Polychaeta			Sedentaria	Sternaspis nr. fossor	02A-1 (1.0)	2009	DP05	A	2	A
ANNELIDA	Oligochaeta				Limnodriloides victoriensis	02A-1 (1.0)	2009	DP05	B	4	A
ANNELIDA	Polychaeta			Errantia	Pholoe glabra	02A-1 (1.0)	2009	DP05	A	1	A
ARTHROPODA	Malacostraca	CRUSTACEA	Tanaidacea		Leptochelia savigyni	02A-1 (1.0)	2009	DP05	A	1	Int
MOLLUSCA	Bivalvia				Ennucula tenuis	02A-1 (1.0)	2009	DP05	B	16	Int
MOLLUSCA	Bivalvia				Ennucula tenuis	02A-1 (1.0)	2009	DP05	C	13	Int
ANNELIDA	Polychaeta			Errantia	Nephtys ferruginea	02A-1 (1.0)	2009	DP05	C	1	A
ARTHROPODA	Pycnogonida	CHELICERATA			Anoplodactylus viridintestinalis	02A-1 (1.0)	2009	DP05	A	1	A
MOLLUSCA	Bivalvia				Axinopsida serricata	02A-1 (1.0)	2009	DP05	B	9	Int
ANNELIDA	Polychaeta			Errantia	Nephtys cornuta	02A-1 (1.0)	2009	DP05	B	1	Int
ANNELIDA	Polychaeta			Sedentaria	Spiophanes berkeleyorum	02A-1 (1.0)	2009	DP05	A	1	A
ANNELIDA	Polychaeta			Errantia	Nephtys cornuta	02A-1 (1.0)	2009	DP05	C	6	A
ARTHROPODA	Malacostraca	CRUSTACEA	Tanaidacea		Leptochelia savigyni	02A-1 (1.0)	2009	DP05	B	1	Int
MOLLUSCA	Gastropoda				Alvania compacta	02A-1 (1.0)	2009	DP05	A	3	A
MOLLUSCA	Bivalvia				Ennucula tenuis	02A-1 (1.0)	2009	DP05	B	6	J
ANNELIDA	Polychaeta			Errantia	Nephtys cornuta	02A-1 (1.0)	2009	DP05	B	11	A
MOLLUSCA	Bivalvia				Ennucula tenuis	02A-1 (1.0)	2009	DP05	C	1	J
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Rhepoxynius boreovariatus	02A-1 (1.0)	2009	DP05	C	1	Int
ANNELIDA	Polychaeta			Errantia	Nephtys cornuta	02A-1 (1.0)	2009	DP05	A	9	A
ECHINODERMATA	Ophiuroidea				Amphiodia urtica	02A-1 (1.0)	2009	DP05	A	2	Int
ANNELIDA	Polychaeta			Errantia	Eteone californica	02A-1 (1.0)	2009	DP05	B	6	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Protomedeia grandimana	02A-1 (1.0)	2009	DP05	B	1	J
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Protomedeia grandimana	02A-1 (1.0)	2009	DP05	C	1	Int
MOLLUSCA	Bivalvia				Ennucula tenuis	02A-1 (1.0)	2009	DP05	A	6	J
ANNELIDA	Polychaeta			Sedentaria	Ampharete spp.	02A-1 (1.0)	2009	DP05	B	1	J
MOLLUSCA	Bivalvia				Nuculana minuta	02A-1 (1.0)	2009	DP05	B	2	Int
MOLLUSCA	Bivalvia				Nutricola sp.	02A-1 (1.0)	2009	DP05	B	2	J
ANNELIDA	Polychaeta			Sedentaria	Paraprionospio pinnata	02A-1 (1.0)	2009	DP05	A	1	J
ANNELIDA	Polychaeta			Sedentaria	Heteromastus filobranchus	02A-1 (1.0)	2009	DP05	A	2	J
ANNELIDA	Polychaeta			Sedentaria	Armandia brevis	02A-1 (1.0)	2009	DP05	A	1	Int
ANNELIDA	Polychaeta			Sedentaria	Galathowenia oculata	02A-1 (1.0)	2009	DP05	B	5	A
MOLLUSCA	Bivalvia				Nutricola tantilla	02A-1 (1.0)	2009	DP05	B	4	Int
MOLLUSCA	Bivalvia				Rochefortia tumida	02A-1 (1.0)	2009	DP05	C	17	Int
MOLLUSCA	Bivalvia				Rochefortia tumida	02A-1 (1.0)	2009	DP05	C	76	A
ANNELIDA	Polychaeta			Sedentaria	Paraprionospio pinnata	02A-1 (1.0)	2009	DP05	B	11	Int
ANNELIDA	Polychaeta			Sedentaria	Paraprionospio pinnata	02A-1 (1.0)	2009	DP05	A	5	Int
ANNELIDA	Polychaeta			Sedentaria	Aphelochaeta sp. 2	02A-1 (1.0)	2009	DP05	B	1	Int
MOLLUSCA	Bivalvia				Protothaca sp.	02A-1 (1.0)	2009	DP05	A	1	J
ANNELIDA	Polychaeta			Sedentaria	Aphelochaeta sp. 2	02A-1 (1.0)	2009	DP05	C	2	A
MOLLUSCA	Bivalvia				Parvilucina tenuisculpta	02A-1 (1.0)	2009	DP05	C	19	Int
MOLLUSCA	Bivalvia				Nuculana minuta	02A-1 (1.0)	2009	DP05	C	1	Int
ANNELIDA	Polychaeta			Sedentaria	Paraprionospio pinnata	02A-1 (1.0)	2009	DP05	C	10	Int
ANNELIDA	Polychaeta			Sedentaria	Aphelochaeta sp. N1	02A-1 (1.0)	2009	DP05	A	1	Int
ANNELIDA	Polychaeta			Sedentaria	Aphelochaeta sp. 2	02A-1 (1.0)	2009	DP05	A	1	Int
MOLLUSCA	Bivalvia				Parvilucina tenuisculpta	02A-1 (1.0)	2009	DP05	C	5	J
MOLLUSCA	Bivalvia				Rochefortia tumida	02A-1 (1.0)	2009	DP05	B	15	Int
ANNELIDA	Polychaeta			Sedentaria	Galathowenia oculata	02A-1 (1.0)	2009	DP05	A	3	A
ANNELIDA	Polychaeta			Sedentaria	Galathowenia oculata	02A-1 (1.0)	2009	DP05	C	4	A
ANNELIDA	Polychaeta			Sedentaria	Prionospio (Minuspio) lighti	02A-1 (1.0)	2009	DP05	A	3	A
MOLLUSCA	Bivalvia				Rochefortia tumida	02A-1 (1.0)	2009	DP05	B	28	A
ANNELIDA	Polychaeta			Sedentaria	Heteromastus filobranchus	02A-1 (1.0)	2009	DP05	C	1	J
MOLLUSCA	Bivalvia				Axinopsida serricata	02A-1 (1.0)	2009	DP05	A	37	A
MOLLUSCA	Bivalvia				Acila castrensis	02A-1 (1.0)	2009	DP05	B	1	Int
ANNELIDA	Polychaeta			Sedentaria	Aphelochaeta sp. 2	02A-1 (1.0)	2009	DP05	B	2	A
ANNELIDA	Polychaeta			Sedentaria	Aphelochaeta sp. 2	02A-1 (1.0)	2009	DP05	A	1	A
ANNELIDA	Polychaeta			Sedentaria	Prionospio (Minuspio) lighti	02A-1 (1.0)	2009	DP05	B	6	A
ANNELIDA	Polychaeta			Sedentaria	Lanassa venusta venusta	02A-1 (1.0)	2009	DP05	A	1	Int

Appendix E
2007, 2008, 2009 Benthic Invertebrate Data

Phylum	Class	Sub Phylum	Order	Subclass	Genus_species	SampleID	Year	Station	Grab	Count	LifeStage
MOLLUSCA	Bivalvia				Parvilucina tenuisculpta	02A-1 (1.0)	2009	DP05	A	3	J
ANNELIDA	Polychaeta			Sedentaria	Paraprionospio pinnata	02A-1 (1.0)	2009	DP05	C	2	J
ANNELIDA	Polychaeta			Sedentaria	Ampharete spp.	02A-1 (1.0)	2009	DP05	A	1	J
MOLLUSCA	Bivalvia				Parvilucina tenuisculpta	02A-1 (1.0)	2009	DP05	A	10	A
MOLLUSCA	Bivalvia				Rochefortia tumida	02A-1 (1.0)	2009	DP05	A	45	A
ANNELIDA	Polychaeta			Sedentaria	Paraprionospio pinnata	02A-1 (1.0)	2009	DP05	B	4	A
MOLLUSCA	Bivalvia				Nutricola tantilla	02A-1 (1.0)	2009	DP05	C	7	J
ANNELIDA	Polychaeta			Sedentaria	Leitoscoloplos pugettensis	02A-1 (1.0)	2009	DP05	C	1	A
ANNELIDA	Polychaeta			Sedentaria	Heteromastus filobranchus	02A-1 (1.0)	2009	DP05	C	8	Int
MOLLUSCA	Bivalvia				Nutricola sp.	02A-1 (1.0)	2009	DP05	A	1	J
ANNELIDA	Polychaeta			Sedentaria	Ampharete labrops	02A-1 (1.0)	2009	DP05	C	1	Int
ANNELIDA	Polychaeta			Sedentaria	Paraprionospio pinnata	02A-1 (1.0)	2009	DP05	A	11	A
ANNELIDA	Polychaeta			Sedentaria	Prionospio (Prionospio) steenstrupi	02A-1 (1.0)	2009	DP05	A	5	A
ANNELIDA	Polychaeta			Sedentaria	Heteromastus filobranchus	02A-1 (1.0)	2009	DP05	C	12	A
ANNELIDA	Polychaeta			Sedentaria	Armandia brevis	02A-1 (1.0)	2009	DP05	C	1	A
MOLLUSCA	Bivalvia				Parvilucina tenuisculpta	02A-1 (1.0)	2009	DP05	A	11	Int
MOLLUSCA	Bivalvia				Modiolus modiolus	02A-1 (1.0)	2009	DP05	C	1	J
ANNELIDA	Polychaeta			Sedentaria	Levinsenia gracilis	02A-1 (1.0)	2009	DP05	B	1	A
MOLLUSCA	Bivalvia				Tellina modesta	02A-1 (1.0)	2009	DP05	A	4	Int
ANNELIDA	Polychaeta			Sedentaria	Armandia brevis	02A-1 (1.0)	2009	DP05	A	1	A
ANNELIDA	Polychaeta			Sedentaria	Heteromastus filobranchus	02A-1 (1.0)	2009	DP05	A	9	A
ANNELIDA	Polychaeta			Sedentaria	Cossura pygodactylata	02A-1 (1.0)	2009	DP05	C	9	A
ECHINODERMATA	Ophiuroidea				Amphiuridae indet.	02A-1 (1.0)	2009	DP05	B	1	J
ANNELIDA	Polychaeta			Sedentaria	Cossura pygodactylata	02A-1 (1.0)	2009	DP05	A	23	A
ANNELIDA	Polychaeta			Sedentaria	Prionospio (Minuspio) lighti	02A-1 (1.0)	2009	DP05	A	2	Int
MOLLUSCA	Bivalvia				Rochefortia tumida	02A-1 (1.0)	2009	DP05	A	14	Int
ANNELIDA	Polychaeta			Sedentaria	Heteromastus filobranchus	02A-1 (1.0)	2009	DP05	B	8	Int
MOLLUSCA	Bivalvia				Axinopsida serricata	02A-1 (1.0)	2009	DP05	C	73	A
ANNELIDA	Polychaeta			Sedentaria	Owenia nr. johnsoni	02A-1 (1.0)	2009	DP05	C	1	A
ANNELIDA	Polychaeta			Sedentaria	Heteromastus filobranchus	02A-1 (1.0)	2009	DP05	B	18	A
MOLLUSCA	Bivalvia				Parvilucina tenuisculpta	02A-1 (1.0)	2009	DP05	C	14	A
MOLLUSCA	Bivalvia				Axinopsida serricata	02A-1 (1.0)	2009	DP05	B	44	A
ANNELIDA	Polychaeta			Sedentaria	Paraprionospio pinnata	02A-1 (1.0)	2009	DP05	C	2	A
ANNELIDA	Polychaeta			Sedentaria	Cossura pygodactylata	02A-1 (1.0)	2009	DP05	B	12	A
ANNELIDA	Polychaeta			Sedentaria	Leitoscoloplos pugettensis	02A-1 (1.0)	2009	DP05	A	1	Int
MOLLUSCA	Bivalvia				Nutricola lordi	02A-1 (1.0)	2009	DP05	B	2	Int
ANNELIDA	Polychaeta			Sedentaria	Heteromastus filobranchus	02A-1 (1.0)	2009	DP05	A	5	Int
MOLLUSCA	Gastropoda				Gastropteron pacificum	02A-1 (1.0)	2009	DP05	C	3	A
MOLLUSCA	Scaphopoda				Pulsellum salishorum	02A-1 (1.0)	2009	DP05	A	2	A
NEMERTEA	Anopla				Tubulanus polymorphus	02A-1 (1.0)	2009	DP05	B	1	J
NEMERTEA	Anopla				Tubulanus polymorphus	02A-1 (1.0)	2009	DP05	A	1	Int
NEMERTEA	Anopla				Cerebratulus californiensis	02A-1 (1.0)	2009	DP05	B	4	J
MOLLUSCA	Gastropoda				Turbonilla sp.	02A-1 (1.0)	2009	DP05	C	1	A
MOLLUSCA	Gastropoda				Gastropteron pacificum	02A-1 (1.0)	2009	DP05	B	1	A
NEMERTEA	Anopla				Cerebratulus californiensis	02A-1 (1.0)	2009	DP05	B	1	Int
NEMERTEA	Anopla				Cerebratulus californiensis	02A-1 (1.0)	2009	DP05	A	3	Int
MOLLUSCA	Gastropoda				Odostomia sp.	02A-1 (1.0)	2009	DP05	C	1	Int
MOLLUSCA	Gastropoda				Acteocina culcitella	02A-1 (1.0)	2009	DP05	A	1	Int
ANNELIDA	Polychaeta			Sedentaria	Capitellidae indet.	02A-1 (1.0)	2009	DP06	C	1	J
MOLLUSCA	Bivalvia				Mya arenaria	02A-1 (1.0)	2009	DP06	C	9	J
ANNELIDA	Polychaeta			Sedentaria	Capitella capitata complex	02A-1 (1.0)	2009	DP06	C	1	J
ANNELIDA	Polychaeta			Errantia	Eteone californica	02A-1 (1.0)	2009	DP06	B	1	A
MOLLUSCA	Bivalvia				Macoma sp.	02A-1 (1.0)	2009	DP06	C	5	Int
ANNELIDA	Polychaeta			Sedentaria	Polydora cornuta	02A-1 (1.0)	2009	DP06	A	2	A
MOLLUSCA	Bivalvia				Macoma sp.	02A-1 (1.0)	2009	DP06	B	8	Int
MOLLUSCA	Bivalvia				Macoma sp.	02A-1 (1.0)	2009	DP06	A	6	Int
ANNELIDA	Polychaeta			Errantia	Eteone californica	02A-1 (1.0)	2009	DP06	A	3	A
MOLLUSCA	Bivalvia				Macoma secta	02A-1 (1.0)	2009	DP06	C	10	J
MOLLUSCA	Bivalvia				Macoma secta	02A-1 (1.0)	2009	DP06	B	3	J
MOLLUSCA	Bivalvia				Macoma secta	02A-1 (1.0)	2009	DP06	A	13	J
MOLLUSCA	Bivalvia				Macoma secta	02A-1 (1.0)	2009	DP06	C	1	Int
MOLLUSCA	Bivalvia				Macoma balthica	02A-1 (1.0)	2009	DP06	A	28	Int
MOLLUSCA	Bivalvia				Macoma balthica	02A-1 (1.0)	2009	DP06	B	22	Int
ANNELIDA	Oligochaeta				Limnodriloides sp.	02A-1 (1.0)	2009	DP06	A	1	A
MOLLUSCA	Bivalvia				Macoma sp.	02A-1 (1.0)	2009	DP06	B	7	J
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Grandidierella japonica	02A-1 (1.0)	2009	DP06	C	1	A
MOLLUSCA	Bivalvia				Macoma balthica	02A-1 (1.0)	2009	DP06	B	2	J
MOLLUSCA	Bivalvia				Macoma golikovi	02A-1 (1.0)	2009	DP06	A	4	J
ANNELIDA	Polychaeta			Sedentaria	Barantolla nr. americana	02A-1 (1.0)	2009	DP06	A	1	A
ANNELIDA	Polychaeta			Sedentaria	Pygospio elegans	02A-1 (1.0)	2009	DP06	C	21	J
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Grandidierella japonica	02A-1 (1.0)	2009	DP06	A	1	Int
ANNELIDA	Polychaeta			Sedentaria	Pygospio elegans	02A-1 (1.0)	2009	DP06	A	15	J
MOLLUSCA	Bivalvia				Macoma sp.	02A-1 (1.0)	2009	DP06	C	37	J
ANNELIDA	Polychaeta			Errantia	Glycinde polygnatha	02A-1 (1.0)	2009	DP06	C	2	A
MOLLUSCA	Bivalvia				Mya arenaria	02A-1 (1.0)	2009	DP06	A	8	J
ANNELIDA	Polychaeta			Sedentaria	Capitella capitata complex	02A-1 (1.0)	2009	DP06	B	2	A
ANNELIDA	Polychaeta			Errantia	Glycinde polygnatha	02A-1 (1.0)	2009	DP06	A	1	Int
MOLLUSCA	Bivalvia				Macoma golikovi	02A-1 (1.0)	2009	DP06	B	2	Int
MOLLUSCA	Bivalvia				Macoma golikovi	02A-1 (1.0)	2009	DP06	C	8	Int
ANNELIDA	Polychaeta			Sedentaria	Barantolla nr. americana	02A-1 (1.0)	2009	DP06	B	1	Int
MOLLUSCA	Bivalvia				Macoma golikovi	02A-1 (1.0)	2009	DP06	A	19	Int
ANNELIDA	Polychaeta			Sedentaria	Ampharete labrops	02A-1 (1.0)	2009	DP06	A	2	J
MOLLUSCA	Bivalvia				Nuttallia obscurata	02A-1 (1.0)	2009	DP06	C	3	Int
ANNELIDA	Polychaeta			Sedentaria	Pseudopolydora kempi	02A-1 (1.0)	2009	DP06	B	4	Int
ANNELIDA	Polychaeta			Sedentaria	Pseudopolydora kempi	02A-1 (1.0)	2009	DP06	A	16	Int
ANNELIDA	Polychaeta			Sedentaria	Pseudopolydora kempi	02A-1 (1.0)	2009	DP06	C	8	A
ANNELIDA	Polychaeta			Sedentaria	Pseudopolydora kempi	02A-1 (1.0)	2009	DP06	B	8	A
ANNELIDA	Polychaeta			Sedentaria	Pseudopolydora kempi	02A-1 (1.0)	2009	DP06	A	41	A
ANNELIDA	Polychaeta			Errantia	Glycinde polygnatha	02A-1 (1.0)	2009	DP06	A	2	A
MOLLUSCA	Bivalvia				Nuttallia obscurata	02A-1 (1.0)	2009	DP06	A	1	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Tanaidacea		Leptochelia savigyni	02A-1 (1.0)	2009	DP06	A	1	A
MOLLUSCA	Bivalvia				Nuttallia obscurata	02A-1 (1.0)	2009	DP06	C	1	J
MOLLUSCA	Bivalvia				Macoma balthica	02A-1 (1.0)	2009	DP06	C	20	Int
ANNELIDA	Oligochaeta				Limnodriloides sp.	02A-1 (1.0)	2009	DP06	C	2	Int
MOLLUSCA	Bivalvia				Mya arenaria	02A-1 (1.0)	2009	DP06	B	1	J
ANNELIDA	Polychaeta			Sedentaria	Ampharete spp.	02A-1 (1.0)	2009	DP06	A	1	J
ANNELIDA	Polychaeta			Sedentaria	Amphicteis sp.	02A-1 (1.0)	2009	DP06	C	1	Int
ANNELIDA	Polychaeta			Sedentaria	Pygospio elegans	02A-1 (1.0)	2009	DP06	B	13	Int
MOLLUSCA	Bivalvia				Macoma sp.	02A-1 (1.0)	2009	DP06	A	12	J
ANNELIDA	Polychaeta			Sedentaria	Amphicteis sp.	02A-1 (1.0)	2009	DP06	C	1	J

Phylum	Class	Sub Phylum	Order	Subclass	Genus_species	SampleID	Year	Station	Grab	Count	LifeStage
MOLLUSCA	Bivalvia				Macoma golikovi	02A-1 (1.0)	2009	DP06	B	1	J
ANNELIDA	Polychaeta			Sedentaria	Pygospio elegans	02A-1 (1.0)	2009	DP06	B	120	A
ANNELIDA	Polychaeta			Sedentaria	Pygospio elegans	02A-1 (1.0)	2009	DP06	C	120	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Grandidierella japonica	02A-1 (1.0)	2009	DP06	A	5	A
ANNELIDA	Polychaeta			Sedentaria	Amphicteis sp.	02A-1 (1.0)	2009	DP06	B	2	J
ANNELIDA	Polychaeta			Sedentaria	Pygospio elegans	02A-1 (1.0)	2009	DP06	A	283	A
MOLLUSCA	Bivalvia				Macoma balthica	02A-1 (1.0)	2009	DP06	A	8	J
NEMERTEA	Anopla				Cerebratulus californiensis	02A-1 (1.0)	2009	DP06	A	1	A
MOLLUSCA	Bivalvia				Axinopsida serricata	02A-1 (1.0)	2009	DP07	C	3	A
MOLLUSCA	Bivalvia				Axinopsida serricata	02A-1 (1.0)	2009	DP07	B	1	A
ANNELIDA	Polychaeta			Errantia	Glycinde polygnatha	02A-1 (1.0)	2009	DP07	B	3	A
MOLLUSCA	Bivalvia				Nutricola sp.	02A-1 (1.0)	2009	DP07	C	1	A
ANNELIDA	Polychaeta			Sedentaria	Mediomastus californiensis	02A-1 (1.0)	2009	DP07	B	4	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Americhelidium shoemakeri	02A-1 (1.0)	2009	DP07	A	1	A
ANNELIDA	Polychaeta			Errantia	Glycera nana	02A-1 (1.0)	2009	DP07	C	3	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Rhepoxynius boreovariatus	02A-1 (1.0)	2009	DP07	A	1	A
ANNELIDA	Polychaeta			Sedentaria	Leitoscoloplos pugettensis	02A-1 (1.0)	2009	DP07	C	3	A
CNIDARIA	Hydrozoa				Campanularia sp.	02A-1 (1.0)	2009	DP07	B	1	A
ECHINODERMATA	Ophiuroidea				Amphiodia urtica	02A-1 (1.0)	2009	DP07	A	1	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Rhepoxynius boreovariatus	02A-1 (1.0)	2009	DP07	C	2	A
ECHINODERMATA	Ophiuroidea				Amphiodia sp.	02A-1 (1.0)	2009	DP07	B	1	Int
ANNELIDA	Polychaeta			Errantia	Glycera nana	02A-1 (1.0)	2009	DP07	A	2	A
ANNELIDA	Polychaeta			Errantia	Glycera nana	02A-1 (1.0)	2009	DP07	B	2	Int
MOLLUSCA	Bivalvia				Nutricola tantilla	02A-1 (1.0)	2009	DP07	A	1	A
MOLLUSCA	Bivalvia				Parvilucina tenuisculpta	02A-1 (1.0)	2009	DP07	A	1	A
ANNELIDA	Polychaeta			Sedentaria	Mediomastus californiensis	02A-1 (1.0)	2009	DP07	C	1	A
ANNELIDA	Polychaeta			Sedentaria	Mediomastus californiensis	02A-1 (1.0)	2009	DP07	A	5	A
ANNELIDA	Polychaeta			Errantia	Glycera nana	02A-1 (1.0)	2009	DP07	A	3	Int
MOLLUSCA	Bivalvia				Axinopsida serricata	02A-1 (1.0)	2009	DP07	B	1	Int
ANNELIDA	Polychaeta			Errantia	Glycinde polygnatha	02A-1 (1.0)	2009	DP07	C	1	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Americhelidium shoemakeri	02A-1 (1.0)	2009	DP07	B	2	A
MOLLUSCA	Bivalvia				Nutricola tantilla	02A-1 (1.0)	2009	DP07	B	1	A
ANNELIDA	Polychaeta			Errantia	Glycera nana	02A-1 (1.0)	2009	DP07	B	1	A
ECHINODERMATA	Ophiuroidea				Amphiodia urtica	02A-1 (1.0)	2009	DP07	C	1	A
ANNELIDA	Polychaeta			Sedentaria	Leitoscoloplos pugettensis	02A-1 (1.0)	2009	DP07	B	7	A
MOLLUSCA	Bivalvia				Nutricola tantilla	02A-1 (1.0)	2009	DP07	B	6	Int
ECHINODERMATA	Ophiuroidea				Amphiodia urtica	02A-1 (1.0)	2009	DP07	B	2	A
ANNELIDA	Polychaeta			Sedentaria	Leitoscoloplos pugettensis	02A-1 (1.0)	2009	DP07	A	5	A
ANNELIDA	Polychaeta			Sedentaria	Euclymene nr. zonalis	02A-1 (1.0)	2009	DP07	C	1	Int
ANNELIDA	Polychaeta			Sedentaria	Pygospio elegans	02A-1 (1.0)	2009	DP07	C	1	A
ANNELIDA	Polychaeta			Sedentaria	Pectinaria granulata	02A-1 (1.0)	2009	DP07	A	1	A
MOLLUSCA	Bivalvia				Ennucula tenuis	02A-1 (1.0)	2009	DP07	A	1	J
ANNELIDA	Polychaeta			Errantia	Scoletoma luti	02A-1 (1.0)	2009	DP07	A	2	A
MOLLUSCA	Bivalvia				Axinopsida serricata	02A-1 (1.0)	2009	DP07	A	2	Int
MOLLUSCA	Bivalvia				Nuculana minuta	02A-1 (1.0)	2009	DP07	B	1	Int
MOLLUSCA	Bivalvia				Clinocardium nuttallii	02A-1 (1.0)	2009	DP07	C	1	J
MOLLUSCA	Bivalvia				Solen sicarius	02A-1 (1.0)	2009	DP07	A	1	J
ANNELIDA	Polychaeta			Sedentaria	Euclymene nr. zonalis	02A-1 (1.0)	2009	DP07	A	1	Int
ANNELIDA	Polychaeta			Sedentaria	Galathowenia oculata	02A-1 (1.0)	2009	DP07	A	4	A
ANNELIDA	Polychaeta			Sedentaria	Pygospio elegans	02A-1 (1.0)	2009	DP07	A	2	J
ARTHROPODA	Ostracoda	CRUSTACEA			Euphilomedes carcharodonta	02A-1 (1.0)	2009	DP07	B	1	A
ECHINODERMATA	Ophiuroidea				Amphiuridae indet.	02A-1 (1.0)	2009	DP07	A	7	J
ANNELIDA	Polychaeta			Sedentaria	Scoloplos acmeceps	02A-1 (1.0)	2009	DP07	A	2	Int
MOLLUSCA	Bivalvia				Rochefortia tumida	02A-1 (1.0)	2009	DP07	A	1	J
MOLLUSCA	Bivalvia				Tellina modesta	02A-1 (1.0)	2009	DP07	A	1	J
MOLLUSCA	Bivalvia				Parvilucina tenuisculpta	02A-1 (1.0)	2009	DP07	B	1	Int
MOLLUSCA	Bivalvia				Macoma sp.	02A-1 (1.0)	2009	DP07	B	4	J
ANNELIDA	Polychaeta			Sedentaria	Euclymene nr. zonalis	02A-1 (1.0)	2009	DP07	B	1	A
ANNELIDA	Polychaeta			Sedentaria	Euclymene nr. zonalis	02A-1 (1.0)	2009	DP07	C	2	A
MOLLUSCA	Bivalvia				Rochefortia tumida	02A-1 (1.0)	2009	DP07	B	1	J
ANNELIDA	Polychaeta			Sedentaria	Scoloplos armiger	02A-1 (1.0)	2009	DP07	A	2	A
MOLLUSCA	Bivalvia				Tellina modesta	02A-1 (1.0)	2009	DP07	A	4	Int
ECHINODERMATA	Ophiuroidea				Ophiura sp.	02A-1 (1.0)	2009	DP07	A	1	Int
MOLLUSCA	Bivalvia				Lucinoma annulatum	02A-1 (1.0)	2009	DP07	B	1	J
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Wecomedon wecomus	02A-1 (1.0)	2009	DP07	A	6	A
ECHINODERMATA	Ophiuroidea				Amphiuridae indet.	02A-1 (1.0)	2009	DP07	B	2	J
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Wecomedon wecomus	02A-1 (1.0)	2009	DP07	B	1	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Wecomedon wecomus	02A-1 (1.0)	2009	DP07	C	3	A
MOLLUSCA	Bivalvia				Yoldia seminuda	02A-1 (1.0)	2009	DP07	B	3	Int
ANNELIDA	Polychaeta			Sedentaria	Prionospio (Prionospio) steenstrupi	02A-1 (1.0)	2009	DP07	A	2	A
ANNELIDA	Polychaeta			Sedentaria	Prionospio (Prionospio) steenstrupi	02A-1 (1.0)	2009	DP07	B	5	A
ARTHROPODA	Ostracoda	CRUSTACEA			Euphilomedes carcharodonta	02A-1 (1.0)	2009	DP07	A	2	A
ANNELIDA	Polychaeta			Errantia	Onuphis iridescens	02A-1 (1.0)	2009	DP07	A	1	Int
MOLLUSCA	Bivalvia				Tellina modesta	02A-1 (1.0)	2009	DP07	B	1	Int
ANNELIDA	Polychaeta			Sedentaria	Amphicteis sp.	02A-1 (1.0)	2009	DP07	A	1	J
ANNELIDA	Polychaeta			Errantia	Scoletoma luti	02A-1 (1.0)	2009	DP07	C	1	J
ANNELIDA	Polychaeta			Sedentaria	Euclymene nr. zonalis	02A-1 (1.0)	2009	DP07	B	1	Int
ANNELIDA	Polychaeta			Sedentaria	Prionospio (Prionospio) steenstrupi	02A-1 (1.0)	2009	DP07	C	1	A
ARTHROPODA	Ostracoda	CRUSTACEA			Philomedes dentata	02A-1 (1.0)	2009	DP07	B	1	A
ANNELIDA	Oligochaeta				Tectidrilus spp.	02A-1 (1.0)	2009	DP07	A	1	Int
MOLLUSCA	Gastropoda				Astyris gausapata	02A-1 (1.0)	2009	DP07	C	1	A
MOLLUSCA	Bivalvia				Macoma sp.	02A-1 (1.0)	2009	DP07	A	7	J
ANNELIDA	Polychaeta			Sedentaria	Pygospio elegans	02A-1 (1.0)	2009	DP07	A	2	A
MOLLUSCA	Gastropoda				Turbonilla sp.	02A-1 (1.0)	2009	DP07	A	1	Int
MOLLUSCA	Gastropoda				Gastropteron pacificum	02A-1 (1.0)	2009	DP07	A	1	A
NEMERTEA	Enopla				Monostylifera sp. C (Scamit)	02A-1 (1.0)	2009	DP07	B	1	Int
NEMERTEA	Anopla				Tubulanus polymorphus	02A-1 (1.0)	2009	DP07	B	1	A
NEMERTEA	Anopla				Cerebratulus californiensis	02A-1 (1.0)	2009	DP07	A	1	Int
MOLLUSCA	Gastropoda				Trochidae indet.	02A-1 (1.0)	2009	DP07	A	1	Int
ECHINODERMATA	Holothuroidea				Chiridota albatrossii	02A-1 (1.0)	2009	DP07	A	1	Int
NEMERTEA	Anopla				Cerebratulus californiensis	02A-1 (1.0)	2009	DP07	B	1	Int
ANNELIDA	Polychaeta			Sedentaria	Capitella capitata complex	02A-1 (1.0)	2009	DP08	B	5	A
MOLLUSCA	Bivalvia				Parvilucina tenuisculpta	02A-1 (1.0)	2009	DP08	C	1	J
ANNELIDA	Polychaeta			Sedentaria	Leitoscoloplos pugettensis	02A-1 (1.0)	2009	DP08	A	2	A
MOLLUSCA	Gastropoda				Batillaria cumingi	02A-1 (1.0)	2009	DP08	B	2	A
ANNELIDA	Polychaeta			Sedentaria	Dipolydora nr. quadrilobata	02A-1 (1.0)	2009	DP08	A	1	A
ANNELIDA	Polychaeta			Sedentaria	Capitella capitata complex	02A-1 (1.0)	2009	DP08	A	16	A
ANNELIDA	Polychaeta			Sedentaria	Dipolydora nr. quadrilobata	02A-1 (1.0)	2009	DP08	B	1	A
ANNELIDA	Oligochaeta				Tectidrilus spp.	02A-1 (1.0)	2009	DP08	A	2	Int
MOLLUSCA	Bivalvia				Bivalvia indet.	02A-1 (1.0)	2009	DP08	A	1	J

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Phylum	Class	Sub Phylum	Order	Subclass	Genus_species	SampleID	Year	Station	Grab	Count	LifeStage
ARTHROPODA	Malacostraca	CRUSTACEA	Tanaidacea		Leptochelia savigyni	02A-1 (1.0)	2009	DP08	B	371	A
MOLLUSCA	Bivalvia				Rochefortia tumida	02A-1 (1.0)	2009	DP08	A	50	A
ARTHROPODA	Malacostraca	CRUSTACEA	Isopoda		Idotea rescata	02A-1 (1.0)	2009	DP08	A	2	A
MOLLUSCA	Bivalvia				Protothaca sp.	02A-1 (1.0)	2009	DP08	B	6	J
ANNELIDA	Polychaeta			Sedentaria	Clymenella nr. torquata	02A-1 (1.0)	2009	DP08	C	1	Int
MOLLUSCA	Bivalvia				Protothaca sp.	02A-1 (1.0)	2009	DP08	A	9	J
ARTHROPODA	Malacostraca	CRUSTACEA	Isopoda		Idotea rescata	02A-1 (1.0)	2009	DP08	C	1	A
ANNELIDA	Oligochaeta				Tubificidae indet. Group 5	02A-1 (1.0)	2009	DP08	B	3	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Monocorophium insidiosum	02A-1 (1.0)	2009	DP08	A	1	Int
MOLLUSCA	Bivalvia				Protothaca sp.	02A-1 (1.0)	2009	DP08	C	8	J
ARTHROPODA	Cirripedia	CRUSTACEA			Balanus sp.	02A-1 (1.0)	2009	DP08	B	6	J
ANNELIDA	Oligochaeta				Tectidrilus spp.	02A-1 (1.0)	2009	DP08	B	1	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Photis brevipes	02A-1 (1.0)	2009	DP08	C	18	Int
ANNELIDA	Oligochaeta				Tubificoides sp.	02A-1 (1.0)	2009	DP08	A	1	Int
ANNELIDA	Oligochaeta				Tubificoides sp.	02A-1 (1.0)	2009	DP08	C	1	Int
ANNELIDA	Polychaeta			Sedentaria	Capitella capitata complex	02A-1 (1.0)	2009	DP08	A	1	Int
MOLLUSCA	Bivalvia				Macoma inquinata	02A-1 (1.0)	2009	DP08	C	2	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Pontogeneia rostrata	02A-1 (1.0)	2009	DP08	A	5	A
MOLLUSCA	Bivalvia				Macoma balthica	02A-1 (1.0)	2009	DP08	A	1	Int
ANNELIDA	Polychaeta			Sedentaria	Heteromastus filobranchus	02A-1 (1.0)	2009	DP08	A	1	Int
ANNELIDA	Polychaeta			Sedentaria	Chone nr. infundibuliformis	02A-1 (1.0)	2009	DP08	A	3	A
ARTHROPODA	Cirripedia	CRUSTACEA			Balanus sp.	02A-1 (1.0)	2009	DP08	B	2	Int
ARTHROPODA	Cirripedia	CRUSTACEA			Balanus crenatus	02A-1 (1.0)	2009	DP08	B	12	Int
ARTHROPODA	Cirripedia	CRUSTACEA			Balanus crenatus	02A-1 (1.0)	2009	DP08	A	9	Int
ARTHROPODA	Cirripedia	CRUSTACEA			Balanus crenatus	02A-1 (1.0)	2009	DP08	B	12	A
ARTHROPODA	Cirripedia	CRUSTACEA			Balanus crenatus	02A-1 (1.0)	2009	DP08	A	19	A
ANNELIDA	Polychaeta			Errantia	Eteone californica	02A-1 (1.0)	2009	DP08	A	1	A
MOLLUSCA	Gastropoda				Astyris gausapata	02A-1 (1.0)	2009	DP08	B	1	A
ARTHROPODA	Malacostraca	CRUSTACEA	Tanaidacea		Leptochelia savigyni	02A-1 (1.0)	2009	DP08	B	28	Int
ANNELIDA	Polychaeta			Sedentaria	Capitella capitata complex	02A-1 (1.0)	2009	DP08	C	16	A
ARTHROPODA	Malacostraca	CRUSTACEA	Tanaidacea		Leptochelia savigyni	02A-1 (1.0)	2009	DP08	C	702	A
ANNELIDA	Oligochaeta				Tectidrilus spp.	02A-1 (1.0)	2009	DP08	C	1	J
ANNELIDA	Polychaeta			Sedentaria	Clymenella nr. torquata	02A-1 (1.0)	2009	DP08	A	1	A
MOLLUSCA	Gastropoda				Astyris gausapata	02A-1 (1.0)	2009	DP08	A	3	Int
ANNELIDA	Polychaeta			Sedentaria	Cirratulus spectabilis	02A-1 (1.0)	2009	DP08	C	1	A
ARTHROPODA	Malacostraca	CRUSTACEA	Tanaidacea		Leptochelia savigyni	02A-1 (1.0)	2009	DP08	A	94	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Tanaidacea		Leptochelia savigyni	02A-1 (1.0)	2009	DP08	C	37	Int
ANNELIDA	Oligochaeta				Tubificoides sp.	02A-1 (1.0)	2009	DP08	C	15	A
ANNELIDA	Oligochaeta				Tubificoides sp.	02A-1 (1.0)	2009	DP08	A	6	A
ANNELIDA	Oligochaeta				Tubificidae indet. Group 5	02A-1 (1.0)	2009	DP08	C	2	Int
ANNELIDA	Oligochaeta				Tectidrilus spp.	02A-1 (1.0)	2009	DP08	C	1	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Photis brevipes	02A-1 (1.0)	2009	DP08	B	40	A
ANNELIDA	Polychaeta			Errantia	Eulalia quadrioculata	02A-1 (1.0)	2009	DP08	C	1	A
ANNELIDA	Oligochaeta				Tubificoides sp.	02A-1 (1.0)	2009	DP08	B	2	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Photis brevipes	02A-1 (1.0)	2009	DP08	C	37	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Photis brevipes	02A-1 (1.0)	2009	DP08	A	17	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Photis brevipes	02A-1 (1.0)	2009	DP08	B	4	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Photis brevipes	02A-1 (1.0)	2009	DP08	A	43	A
ANNELIDA	Polychaeta			Errantia	Pholoe minuta	02A-1 (1.0)	2009	DP08	B	1	A
ANNELIDA	Polychaeta			Errantia	Phyllodoce williamsi	02A-1 (1.0)	2009	DP08	A	4	A
ANNELIDA	Polychaeta			Sedentaria	Arenicolidae indet.	02A-1 (1.0)	2009	DP08	C	1	J
ANNELIDA	Polychaeta			Errantia	Pholoe glabra	02A-1 (1.0)	2009	DP08	C	2	A
MOLLUSCA	Bivalvia				Rochefortia tumida	02A-1 (1.0)	2009	DP08	C	37	Int
ANNELIDA	Polychaeta			Sedentaria	Arenicolidae indet.	02A-1 (1.0)	2009	DP08	B	1	J
ANNELIDA	Polychaeta			Sedentaria	Tharyx parvus	02A-1 (1.0)	2009	DP08	A	1	A
ANNELIDA	Polychaeta			Sedentaria	Spio filicornis	02A-1 (1.0)	2009	DP08	A	1	A
MOLLUSCA	Bivalvia				Macoma nasuta	02A-1 (1.0)	2009	DP08	C	9	J
MOLLUSCA	Bivalvia				Macoma sp.	02A-1 (1.0)	2009	DP08	A	6	Int
ANNELIDA	Polychaeta			Sedentaria	Rhynchospio glutaea	02A-1 (1.0)	2009	DP08	C	119	A
ANNELIDA	Polychaeta			Sedentaria	Rhynchospio glutaea	02A-1 (1.0)	2009	DP08	B	14	A
MOLLUSCA	Bivalvia				Mya arenaria	02A-1 (1.0)	2009	DP08	C	2	J
MOLLUSCA	Bivalvia				Macoma sp.	02A-1 (1.0)	2009	DP08	B	2	Int
MOLLUSCA	Bivalvia				Rochefortia tumida	02A-1 (1.0)	2009	DP08	B	6	Int
ANNELIDA	Polychaeta			Errantia	Pholoe minuta	02A-1 (1.0)	2009	DP08	A	1	A
ARTHROPODA	Arachnida	CHELICERATA	Acarida		Hydracarina indet.	02A-1 (1.0)	2009	DP08	A	73	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Caprella sp.	02A-1 (1.0)	2009	DP08	A	1	J
ARTHROPODA	Pycnogonida	CHELICERATA			Anoplodactylus viridintestinalis	02A-1 (1.0)	2009	DP08	A	3	A
ANNELIDA	Polychaeta			Sedentaria	Armandia brevis	02A-1 (1.0)	2009	DP08	A	13	A
ANNELIDA	Oligochaeta				Grania incerta	02A-1 (1.0)	2009	DP08	A	3	Int
ARTHROPODA	Arachnida	CHELICERATA	Acarida		Hydracarina indet.	02A-1 (1.0)	2009	DP08	C	1	Int
ANNELIDA	Polychaeta			Errantia	Pholoe glabra	02A-1 (1.0)	2009	DP08	A	1	A
ARTHROPODA	Arachnida	CHELICERATA	Acarida		Hydracarina indet.	02A-1 (1.0)	2009	DP08	C	2	A
MOLLUSCA	Bivalvia				Macoma sp.	02A-1 (1.0)	2009	DP08	C	3	Int
ANNELIDA	Polychaeta			Errantia	Ophiodromus pugettensis	02A-1 (1.0)	2009	DP08	A	1	A
MOLLUSCA	Bivalvia				Macoma nasuta	02A-1 (1.0)	2009	DP08	A	15	J
MOLLUSCA	Bivalvia				Mya arenaria	02A-1 (1.0)	2009	DP08	B	1	J
ANNELIDA	Oligochaeta				Limnodriloides victoriensis	02A-1 (1.0)	2009	DP08	C	1	A
ANNELIDA	Polychaeta			Sedentaria	Dipolydora cardalia	02A-1 (1.0)	2009	DP08	A	2	A
MOLLUSCA	Bivalvia				Macoma nasuta	02A-1 (1.0)	2009	DP08	B	6	J
ARTHROPODA	Arachnida	CHELICERATA	Acarida		Hydracarina indet.	02A-1 (1.0)	2009	DP08	A	14	Int
ANNELIDA	Polychaeta			Sedentaria	Prionospio (Minuspio) multibranchiata	02A-1 (1.0)	2009	DP08	C	2	A
ARTHROPODA	Malacostraca	CRUSTACEA	Tanaidacea		Leptochelia savigyni	02A-1 (1.0)	2009	DP08	A	961	A
ANNELIDA	Oligochaeta				Grania incerta	02A-1 (1.0)	2009	DP08	C	2	J
ANNELIDA	Polychaeta			Sedentaria	Prionospio (Minuspio) lighti	02A-1 (1.0)	2009	DP08	C	1	Int
MOLLUSCA	Bivalvia				Modiolus modiolus	02A-1 (1.0)	2009	DP08	A	24	J
MOLLUSCA	Bivalvia				Modiolus modiolus	02A-1 (1.0)	2009	DP08	C	26	J
ANNELIDA	Polychaeta			Sedentaria	Prionospio (Minuspio) lighti	02A-1 (1.0)	2009	DP08	C	1	A
MOLLUSCA	Bivalvia				Tellina modesta	02A-1 (1.0)	2009	DP08	B	3	Int
ANNELIDA	Oligochaeta				Limnodriloides sp.	02A-1 (1.0)	2009	DP08	A	7	A
MOLLUSCA	Bivalvia				Modiolus modiolus	02A-1 (1.0)	2009	DP08	B	1	J
ANNELIDA	Polychaeta			Sedentaria	Prionospio (Minuspio) multibranchiata	02A-1 (1.0)	2009	DP08	C	1	Int
ANNELIDA	Polychaeta			Sedentaria	Prionospio (Prionospio) steenstrupi	02A-1 (1.0)	2009	DP08	C	3	A
ANNELIDA	Polychaeta			Sedentaria	Ampharete labrops	02A-1 (1.0)	2009	DP08	A	2	Int
ANNELIDA	Polychaeta			Sedentaria	Prionospio (Prionospio) steenstrupi	02A-1 (1.0)	2009	DP08	B	1	A
MOLLUSCA	Bivalvia				Tellina modesta	02A-1 (1.0)	2009	DP08	A	3	Int
ANNELIDA	Polychaeta			Sedentaria	Prionospio (Minuspio) multibranchiata	02A-1 (1.0)	2009	DP08	A	1	A
MOLLUSCA	Bivalvia				Macoma sp.	02A-1 (1.0)	2009	DP08	B	5	J
ANNELIDA	Oligochaeta				Limnodriloides victoriensis	02A-1 (1.0)	2009	DP08	A	1	A
ANNELIDA	Polychaeta			Errantia	Phyllodoce williamsi	02A-1 (1.0)	2009	DP08	C	5	A
ANNELIDA	Polychaeta			Errantia	Platynereis bicanaliculata	02A-1 (1.0)	2009	DP08	A	5	A

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Phylum	Class	Sub Phylum	Order	Subclass	Genus_species	SampleID	Year	Station	Grab	Count	LifeStage
MOLLUSCA	Bivalvia				Macoma sp.	02A-1 (1.0)	2009	DP08	A	13	J
ANNELIDA	Polychaeta			Errantia	Platynereis bicanaliculata	02A-1 (1.0)	2009	DP08	B	1	A
ANNELIDA	Polychaeta			Sedentaria	Prionospio (Minuspio) lighti	02A-1 (1.0)	2009	DP08	A	1	Int
ANNELIDA	Polychaeta			Errantia	Platynereis bicanaliculata	02A-1 (1.0)	2009	DP08	C	6	A
ANNELIDA	Polychaeta			Sedentaria	Owenia nr. johnsoni	02A-1 (1.0)	2009	DP08	C	11	A
ANNELIDA	Oligochaeta				Grania incerta	02A-1 (1.0)	2009	DP08	C	12	Int
ANNELIDA	Polychaeta			Errantia	Platynereis bicanaliculata	02A-1 (1.0)	2009	DP08	A	1	Int
MOLLUSCA	Bivalvia				Mya arenaria	02A-1 (1.0)	2009	DP08	A	2	J
ANNELIDA	Polychaeta			Sedentaria	Pseudopolydora paucibranchiata	02A-1 (1.0)	2009	DP08	C	2	A
MOLLUSCA	Bivalvia				Macoma sp.	02A-1 (1.0)	2009	DP08	C	9	J
MOLLUSCA	Bivalvia				Tellina modesta	02A-1 (1.0)	2009	DP08	C	1	Int
ANNELIDA	Oligochaeta				Limnodriloides sp.	02A-1 (1.0)	2009	DP08	C	5	A
MOLLUSCA	Bivalvia				Nutricola tantilla	02A-1 (1.0)	2009	DP08	B	1	A
ANNELIDA	Polychaeta			Errantia	Glycinde polygnatha	02A-1 (1.0)	2009	DP08	A	6	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Eobrolgus chumashi	02A-1 (1.0)	2009	DP08	A	7	A
ANNELIDA	Oligochaeta				Grania incerta	02A-1 (1.0)	2009	DP08	C	90	A
MOLLUSCA	Bivalvia				Macoma golikovi	02A-1 (1.0)	2009	DP08	C	5	J
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Eobrolgus chumashi	02A-1 (1.0)	2009	DP08	B	1	A
ANNELIDA	Polychaeta			Errantia	Glycinde polygnatha	02A-1 (1.0)	2009	DP08	C	1	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Eobrolgus chumashi	02A-1 (1.0)	2009	DP08	C	3	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Eobrolgus chumashi	02A-1 (1.0)	2009	DP08	A	9	Int
MOLLUSCA	Bivalvia				Macoma golikovi	02A-1 (1.0)	2009	DP08	B	1	J
ANNELIDA	Oligochaeta				Enchytraeidae indet.	02A-1 (1.0)	2009	DP08	C	1	J
ANNELIDA	Polychaeta			Sedentaria	Mediomastus californiensis	02A-1 (1.0)	2009	DP08	A	7	A
ANNELIDA	Oligochaeta				Tectidrilus spp.	02A-1 (1.0)	2009	DP08	B	9	A
ANNELIDA	Polychaeta			Sedentaria	Mediomastus californiensis	02A-1 (1.0)	2009	DP08	B	3	A
MOLLUSCA	Bivalvia				Macoma golikovi	02A-1 (1.0)	2009	DP08	A	2	J
MOLLUSCA	Bivalvia				Macoma inquinata	02A-1 (1.0)	2009	DP08	A	1	Int
ANNELIDA	Polychaeta			Errantia	Glycinde polygnatha	02A-1 (1.0)	2009	DP08	C	9	A
ANNELIDA	Polychaeta			Sedentaria	Barantolla nr. americana	02A-1 (1.0)	2009	DP08	A	1	A
ANNELIDA	Oligochaeta				Tectidrilus spp.	02A-1 (1.0)	2009	DP08	C	52	A
MOLLUSCA	Bivalvia				Macoma golikovi	02A-1 (1.0)	2009	DP08	A	5	Int
ANNELIDA	Polychaeta			Errantia	Glycinde polygnatha	02A-1 (1.0)	2009	DP08	B	3	A
ANNELIDA	Polychaeta			Sedentaria	Barantolla nr. americana	02A-1 (1.0)	2009	DP08	C	1	Int
MOLLUSCA	Bivalvia				Rochefortia tumida	02A-1 (1.0)	2009	DP08	B	27	A
MOLLUSCA	Bivalvia				Nutricola tantilla	02A-1 (1.0)	2009	DP08	B	1	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Ischyrocerus anguipes	02A-1 (1.0)	2009	DP08	A	6	A
MOLLUSCA	Gastropoda				Alvania compacta	02A-1 (1.0)	2009	DP08	C	4	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Ischyrocerus anguipes	02A-1 (1.0)	2009	DP08	C	3	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Ischyrocerus anguipes	02A-1 (1.0)	2009	DP08	A	2	Int
CNIDARIA	Hydrozoa				Obelia geniculata	02A-1 (1.0)	2009	DP08	C	1	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Grandidierella japonica	02A-1 (1.0)	2009	DP08	B	1	A
MOLLUSCA	Gastropoda				Crepipatella dorsata	02A-1 (1.0)	2009	DP08	A	1	Int
ANNELIDA	Polychaeta			Sedentaria	Owenia nr. johnsoni	02A-1 (1.0)	2009	DP08	A	20	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Anisogammarus pugettensis	02A-1 (1.0)	2009	DP08	C	1	A
MOLLUSCA	Bivalvia				Rochefortia tumida	02A-1 (1.0)	2009	DP08	A	41	Int
ANNELIDA	Oligochaeta				Grania incerta	02A-1 (1.0)	2009	DP08	A	79	A
ANNELIDA	Polychaeta			Sedentaria	Armandia brevis	02A-1 (1.0)	2009	DP08	C	2	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Americhelidium shoemakeri	02A-1 (1.0)	2009	DP08	C	1	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Caprella sp.	02A-1 (1.0)	2009	DP08	C	4	J
ANNELIDA	Polychaeta			Errantia	Nephtys caecoides	02A-1 (1.0)	2009	DP08	C	1	A
MOLLUSCA	Bivalvia				Macoma inquinata	02A-1 (1.0)	2009	DP08	C	2	J
ANNELIDA	Polychaeta			Sedentaria	Owenia nr. johnsoni	02A-1 (1.0)	2009	DP08	B	6	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Americhelidium shoemakeri	02A-1 (1.0)	2009	DP08	A	4	A
ANNELIDA	Oligochaeta				Grania incerta	02A-1 (1.0)	2009	DP08	B	4	A
MOLLUSCA	Gastropoda				Alvania compacta	02A-1 (1.0)	2009	DP08	A	6	A
ANNELIDA	Polychaeta			Sedentaria	Armandia brevis	02A-1 (1.0)	2009	DP08	B	3	A
ARTHROPODA	Pycnogonida	CHELICERATA			Anoplodactylus viridintestinalis	02A-1 (1.0)	2009	DP08	C	1	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Americhelidium shoemakeri	02A-1 (1.0)	2009	DP08	B	1	A
ANNELIDA	Polychaeta			Sedentaria	Mediomastus californiensis	02A-1 (1.0)	2009	DP08	C	6	A
ANNELIDA	Polychaeta			Sedentaria	Notomastus spp.	02A-1 (1.0)	2009	DP08	C	1	Int
ANNELIDA	Oligochaeta				Tectidrilus spp.	02A-1 (1.0)	2009	DP08	A	18	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Caprella laeviuscula	02A-1 (1.0)	2009	DP08	A	4	A
ANNELIDA	Polychaeta			Sedentaria	Armandia brevis	02A-1 (1.0)	2009	DP08	A	7	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Caprella laeviuscula	02A-1 (1.0)	2009	DP08	B	3	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Caprella laeviuscula	02A-1 (1.0)	2009	DP08	C	7	A
ANNELIDA	Polychaeta			Sedentaria	Armandia brevis	02A-1 (1.0)	2009	DP08	C	5	Int
MOLLUSCA	Bivalvia				Macoma inquinata	02A-1 (1.0)	2009	DP08	A	4	J
ANNELIDA	Polychaeta			Sedentaria	Rhynchospio glutaea	02A-1 (1.0)	2009	DP08	A	195	A
MOLLUSCA	Bivalvia				Nutricola tantilla	02A-1 (1.0)	2009	DP08	A	3	A
ANNELIDA	Polychaeta			Sedentaria	Prionospio (Prionospio) steenstrupi	02A-1 (1.0)	2009	DP08	A	8	A
MOLLUSCA	Bivalvia				Rochefortia tumida	02A-1 (1.0)	2009	DP08	C	34	A
NEMERTEA	Enopla				Monostylifera sp. C (Scamit)	02A-1 (1.0)	2009	DP08	C	3	J
NEMERTEA	Enopla				Monostylifera sp. C (Scamit)	02A-1 (1.0)	2009	DP08	B	1	Int
MOLLUSCA	Gastropoda				Lottia parallela	02A-1 (1.0)	2009	DP08	A	1	A
MOLLUSCA	Gastropoda				Lottia parallela	02A-1 (1.0)	2009	DP08	A	1	Int
ANNELIDA	Oligochaeta				Tectidrilus spp.	02A-1 (1.0)	2009	DP09	A	37	A
ANNELIDA	Oligochaeta				Tectidrilus spp.	02A-1 (1.0)	2009	DP09	B	16	A
BRYOZOA	Gymnolaemata				Celleporella hyalina	02A-1 (1.0)	2009	DP09	C	2	A
ANNELIDA	Oligochaeta				Limnodriloides sp.	02A-1 (1.0)	2009	DP09	B	4	A
ANNELIDA	Oligochaeta				Tectidrilus spp.	02A-1 (1.0)	2009	DP09	C	19	A
ANNELIDA	Oligochaeta				Tectidrilus spp.	02A-1 (1.0)	2009	DP09	B	1	Int
ANNELIDA	Oligochaeta				Limnodriloides sp.	02A-1 (1.0)	2009	DP09	B	2	Int
MOLLUSCA	Bivalvia				Macoma sp.	02A-1 (1.0)	2009	DP09	C	1	Int
MOLLUSCA	Bivalvia				Tellina modesta	02A-1 (1.0)	2009	DP09	C	1	Int
ANNELIDA	Polychaeta			Sedentaria	Pseudopolydora paucibranchiata	02A-1 (1.0)	2009	DP09	C	1	A
MOLLUSCA	Bivalvia				Macoma sp.	02A-1 (1.0)	2009	DP09	B	3	J
MOLLUSCA	Bivalvia				Tellina modesta	02A-1 (1.0)	2009	DP09	A	2	J
ANNELIDA	Polychaeta			Sedentaria	Pygospio elegans	02A-1 (1.0)	2009	DP09	A	7	A
MOLLUSCA	Bivalvia				Macoma sp.	02A-1 (1.0)	2009	DP09	A	9	J
ANNELIDA	Polychaeta			Sedentaria	Pygospio elegans	02A-1 (1.0)	2009	DP09	B	2	A
MOLLUSCA	Bivalvia				Macoma nasuta	02A-1 (1.0)	2009	DP09	A	6	J
ANNELIDA	Polychaeta			Sedentaria	Pygospio elegans	02A-1 (1.0)	2009	DP09	C	11	A
MOLLUSCA	Bivalvia				Tellina modesta	02A-1 (1.0)	2009	DP09	A	2	Int
MOLLUSCA	Bivalvia				Macoma nasuta	02A-1 (1.0)	2009	DP09	C	6	J
ANNELIDA	Polychaeta			Sedentaria	Tharyx parvus	02A-1 (1.0)	2009	DP09	C	1	A
ANNELIDA	Polychaeta			Errantia	Nephtys cornuta	02A-1 (1.0)	2009	DP09	A	2	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Americhelidium shoemakeri	02A-1 (1.0)	2009	DP09	A	2	A
ANNELIDA	Polychaeta			Errantia	Nephtys caecoides	02A-1 (1.0)	2009	DP09	C	2	A
ANNELIDA	Polychaeta			Errantia	Nephtys caecoides	02A-1 (1.0)	2009	DP09	B	1	A

Appendix E
2007, 2008, 2009 Benthic Invertebrate Data

Phylum	Class	Sub Phylum	Order	Subclass	Genus_species	SampleID	Year	Station	Grab	Count	LifeStage
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Anisogammarus pugettensis	02A-1 (1.0)	2009	DP09	A	1	A
ANNELIDA	Polychaeta			Errantia	Nephtys caecoides	02A-1 (1.0)	2009	DP09	A	1	A
MOLLUSCA	Bivalvia				Tellina modesta	02A-1 (1.0)	2009	DP09	C	1	J
ANNELIDA	Polychaeta			Sedentaria	Owenia nr. johnsoni	02A-1 (1.0)	2009	DP09	B	2	A
MOLLUSCA	Bivalvia				Rochefortia tumida	02A-1 (1.0)	2009	DP09	A	36	A
ANNELIDA	Polychaeta			Sedentaria	Leitoscoloplos pugettensis	02A-1 (1.0)	2009	DP09	B	1	A
ANNELIDA	Polychaeta			Sedentaria	Capitella capitata complex	02A-1 (1.0)	2009	DP09	A	1	A
ANNELIDA	Polychaeta			Sedentaria	Mediomastus californiensis	02A-1 (1.0)	2009	DP09	A	6	A
MOLLUSCA	Bivalvia				Rochefortia tumida	02A-1 (1.0)	2009	DP09	B	10	A
ANNELIDA	Polychaeta			Sedentaria	Mediomastus californiensis	02A-1 (1.0)	2009	DP09	B	1	A
ANNELIDA	Polychaeta			Sedentaria	Mediomastus californiensis	02A-1 (1.0)	2009	DP09	A	1	Int
ANNELIDA	Polychaeta			Sedentaria	Armandia brevis	02A-1 (1.0)	2009	DP09	C	2	A
MOLLUSCA	Bivalvia				Macoma sp.	02A-1 (1.0)	2009	DP09	C	2	J
MOLLUSCA	Bivalvia				Rochefortia tumida	02A-1 (1.0)	2009	DP09	A	19	Int
ANNELIDA	Polychaeta			Sedentaria	Pseudopolydora paucibranchiata	02A-1 (1.0)	2009	DP09	A	2	A
ANNELIDA	Polychaeta			Sedentaria	Owenia nr. johnsoni	02A-1 (1.0)	2009	DP09	C	6	A
MOLLUSCA	Bivalvia				Rochefortia tumida	02A-1 (1.0)	2009	DP09	B	3	Int
ANNELIDA	Polychaeta			Sedentaria	Armandia brevis	02A-1 (1.0)	2009	DP09	A	1	A
ANNELIDA	Polychaeta			Sedentaria	Owenia nr. johnsoni	02A-1 (1.0)	2009	DP09	B	2	Int
ANNELIDA	Polychaeta			Sedentaria	Prionospio (Minuspio) lighti	02A-1 (1.0)	2009	DP09	B	1	A
ANNELIDA	Polychaeta			Sedentaria	Ampharete nr. acutifrons	02A-1 (1.0)	2009	DP09	A	1	A
ANNELIDA	Polychaeta			Sedentaria	Prionospio (Minuspio) lighti	02A-1 (1.0)	2009	DP09	A	1	J
ANNELIDA	Polychaeta			Errantia	Glycinde polygnatha	02A-1 (1.0)	2009	DP09	C	12	Int
ANNELIDA	Polychaeta			Sedentaria	Owenia nr. johnsoni	02A-1 (1.0)	2009	DP09	A	10	A
ARTHROPODA	Malacostraca	CRUSTACEA	Cumacea		Nippoleucon hinumensis	02A-1 (1.0)	2009	DP09	A	154	A
MOLLUSCA	Bivalvia				Macoma inquinata	02A-1 (1.0)	2009	DP09	B	1	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Monocorophium sp.	02A-1 (1.0)	2009	DP09	C	2	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Photis sp.	02A-1 (1.0)	2009	DP09	A	1	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Pontogeneia rostrata	02A-1 (1.0)	2009	DP09	B	1	A
ANNELIDA	Oligochaeta				Tubificoides sp.	02A-1 (1.0)	2009	DP09	C	2	A
ARTHROPODA	Malacostraca	CRUSTACEA	Cumacea		Cumella vulgaris	02A-1 (1.0)	2009	DP09	A	6	A
ANNELIDA	Oligochaeta				Tubificoides sp.	02A-1 (1.0)	2009	DP09	A	6	A
ARTHROPODA	Malacostraca	CRUSTACEA	Cumacea		Cumella vulgaris	02A-1 (1.0)	2009	DP09	C	1	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Monocorophium sp.	02A-1 (1.0)	2009	DP09	A	10	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Cumacea		Leucon falcicostata	02A-1 (1.0)	2009	DP09	A	1	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Monocorophium insidiosum	02A-1 (1.0)	2009	DP09	C	5	A
ARTHROPODA	Malacostraca	CRUSTACEA	Cumacea		Nippoleucon hinumensis	02A-1 (1.0)	2009	DP09	B	48	A
ARTHROPODA	Malacostraca	CRUSTACEA	Cumacea		Nippoleucon hinumensis	02A-1 (1.0)	2009	DP09	C	110	A
ANNELIDA	Oligochaeta				Tubificidae indet. Group 5	02A-1 (1.0)	2009	DP09	C	2	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Isopoda		Synidotea nodulosa	02A-1 (1.0)	2009	DP09	A	2	A
ARTHROPODA	Malacostraca	CRUSTACEA	Isopoda		Synidotea nodulosa	02A-1 (1.0)	2009	DP09	C	1	A
ANNELIDA	Oligochaeta				Tubificidae indet. Group 5	02A-1 (1.0)	2009	DP09	A	8	Int
MOLLUSCA	Bivalvia				Clinocardium nuttallii	02A-1 (1.0)	2009	DP09	A	1	J
ARTHROPODA	Ostracoda	CRUSTACEA			Euphilomedes carcharodonta	02A-1 (1.0)	2009	DP09	A	2	A
ARTHROPODA	Malacostraca	CRUSTACEA	Cumacea		Diastylopsis dawsoni	02A-1 (1.0)	2009	DP09	A	2	A
ANNELIDA	Polychaeta			Errantia	Glycinde polygnatha	02A-1 (1.0)	2009	DP09	B	4	A
ARTHROPODA	Malacostraca	CRUSTACEA	Tanaidacea		Leptochelia savigyni	02A-1 (1.0)	2009	DP09	A	4	A
ANNELIDA	Polychaeta			Errantia	Glycinde polygnatha	02A-1 (1.0)	2009	DP09	B	11	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Grandidierella japonica	02A-1 (1.0)	2009	DP09	A	1	A
MOLLUSCA	Bivalvia				Macoma golikovi	02A-1 (1.0)	2009	DP09	A	1	J
ANNELIDA	Polychaeta			Errantia	Glycinde polygnatha	02A-1 (1.0)	2009	DP09	A	4	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Grandidierella japonica	02A-1 (1.0)	2009	DP09	C	1	A
ANNELIDA	Polychaeta			Errantia	Glycinde polygnatha	02A-1 (1.0)	2009	DP09	C	19	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Grandidierella japonica	02A-1 (1.0)	2009	DP09	A	3	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Monocorophium sp.	02A-1 (1.0)	2009	DP09	B	3	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Grandidierella japonica	02A-1 (1.0)	2009	DP09	C	2	Int
ANNELIDA	Polychaeta			Errantia	Glycinde polygnatha	02A-1 (1.0)	2009	DP09	B	1	J
ANNELIDA	Polychaeta			Errantia	Glycinde polygnatha	02A-1 (1.0)	2009	DP09	A	38	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Monocorophium acherusicum	02A-1 (1.0)	2009	DP09	A	23	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Monocorophium acherusicum	02A-1 (1.0)	2009	DP09	B	12	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Monocorophium acherusicum	02A-1 (1.0)	2009	DP09	C	15	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Monocorophium acherusicum	02A-1 (1.0)	2009	DP09	A	3	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Monocorophium acherusicum	02A-1 (1.0)	2009	DP09	B	2	Int
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Monocorophium insidiosum	02A-1 (1.0)	2009	DP09	A	12	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Monocorophium insidiosum	02A-1 (1.0)	2009	DP09	B	3	A
ARTHROPODA	Malacostraca	CRUSTACEA	Amphipoda		Grandidierella japonica	02A-1 (1.0)	2009	DP09	B	1	Int
MOLLUSCA	Gastropoda				Haminoea japonica	02A-1 (1.0)	2009	DP09	C	2	Int
MOLLUSCA	Gastropoda				Cyclostremella sp.	02A-1 (1.0)	2009	DP09	A	2	A
NEMERTEA	Anopla				Cerebratulus californiensis	02A-1 (1.0)	2009	DP09	C	1	J
NEMERTEA	Anopla				Cerebratulus californiensis	02A-1 (1.0)	2009	DP09	A	2	J
NEMERTEA	Anopla				Cerebratulus californiensis	02A-1 (1.0)	2009	DP09	B	2	Int
MOLLUSCA	Gastropoda				Lottia parallela	02A-1 (1.0)	2009	DP09	A	1	A

Statistical Analysis of Benthic Invertebrate Data

The normality of variables was assessed using normal probability plots.

Log transformation was used on the following variables to normalize data: total benthic abundance, Sulfide (mg\L), total percent nitrogen, percent total organic carbon, *Tanaidacea* abundance, *Polychaeta sedentaria* abundance, *Bivalvia* abundance, *Amphipoda* abundance, *Polychaeta errantia* abundance, *Gastropoda* abundance, *Cumacea* abundance, *Oligochaeta* abundance, total *Polychaeta* abundance, the ratio of *Polychaeta sedentaria* abundance to *Polychaeta errantia* abundance, and the ratio of *Polychaeta* abundance to *Amphipoda* abundance. One was added to all records for variables containing record(s) equal to zero prior to log transformation (e.g., y = log(x + 1)); those variables were: *Tanaidacea* abundance, *Polychaeta errantia* abundance, *Gastropoda* abundance, *Cumacea* abundance, *Oligochaeta* abundance, and the ratio of *Polychaeta sedentaria* abundance to *Polychaeta errantia* abundance. All records of variables containing data between zero and one were multiplied by a constant (which varied depending on the distribution of the data inquestion) to ensure transformed data were not negative.

Stations with data by year

Inter-causeway Stations	2007	2008	2009
DP02	X	X	X
DP03	X	X	X
DP04	X	X	X
DP05	X	X	X
DP08		X	X
DP09			X
Reference Stations			
DP06	X	X	X
DP07	X	X	X

1.0 ANOVA

ANOVA was used to test for differences in richness, Shannon Weiner diversity, evenness, and overall benthic invertebrate abundance between years (2007, 2008, and 2009) within the inter-causeway. Analyses were restricted to only sites within the Inter-causeway (stations: DP02, DP03, DP04, DP05, DP8, DP09).

ANOVA Results

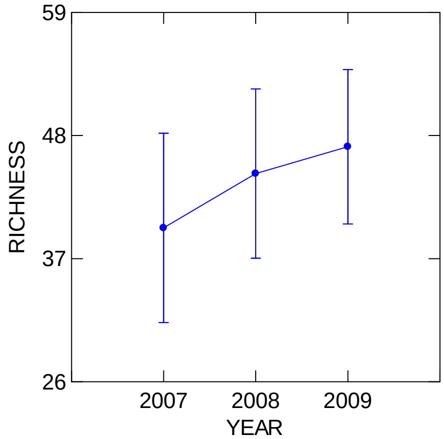
1.1 RICHNESS * YEAR

Dep Var: RICHNESS N: 15 Multiple R: 0.189 Squared multiple R: 0.036

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
YEAR	126.983	2	63.492	0.222	0.80
Error	3433.95	12	286.162		

Least Squares Means



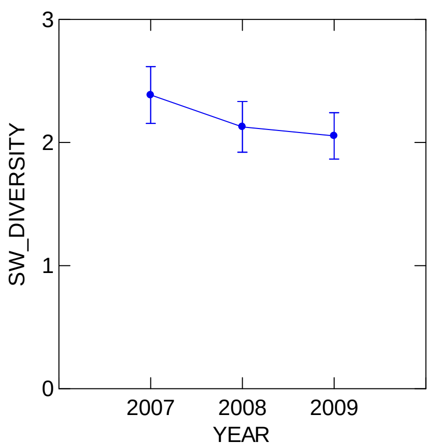
1.2 SHANNON WEINER DIVERSITY

Dep Var: SW_DIVERSITY   N: 15   Multiple R: 0.312   Squared multiple R: 0.098

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
YEAR	0.276	2	0.138	0.649	0.54
Error	2.555	12	0.213		

Least Squares Means



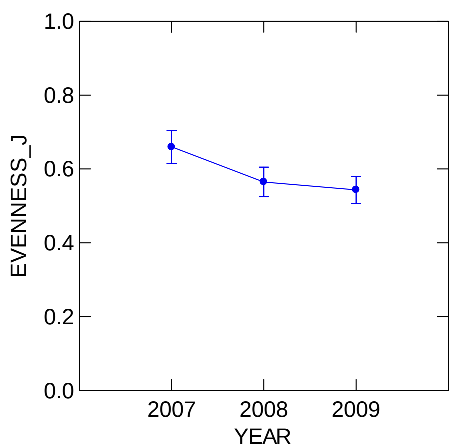
1.3 EVENNESS

Dep Var: EVENNESS_J   N: 15   Multiple R: 0.513   Squared multiple R: 0.263

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
YEAR	0.035	2	0.017	2.145	0.16
Error	0.097	12	0.008		

Least Squares Means

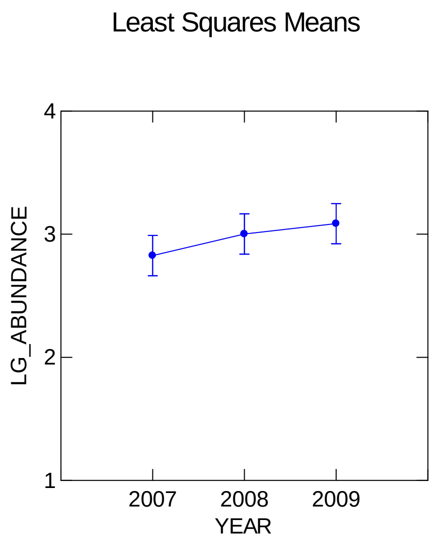


1.4 TOTAL ABUNDANCE

Dep Var: LG_ABUNDANCE   N: 12   Multiple R: 0.357   Squared multiple R: 0.128

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
YEAR	0.141	2	0.07	0.658	0.54
Error	0.962	9	0.107		

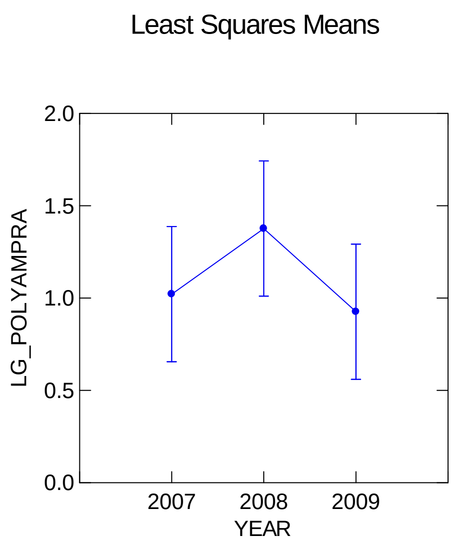


1.5 *POLYCHAETA*:*AMPHIPODA* ABUNDANCE

Dep Var: LG_POLYAMPRA N: 12 Multiple R: 0.292 Squared multiple R: 0.085

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
YEAR	0.451	2	0.225	0.42	0.67
Error	4.83	9	0.537		



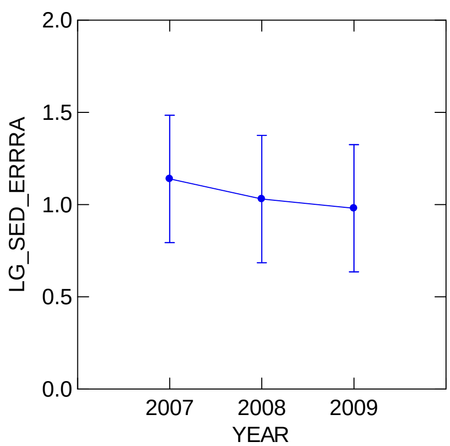
1.6 *POLYCHAETA SEDENTARIA*:*POLYCHAETA ERRANTIA* ABUNDANCE

Dep Var: LG_SED_ERRRA   N: 12   Multiple R: 0.110   Squared multiple R: 0.012

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
YEAR	0.053	2	0.026	0.056	0.95
Error	4.288	9	0.476		

Least Squares Means



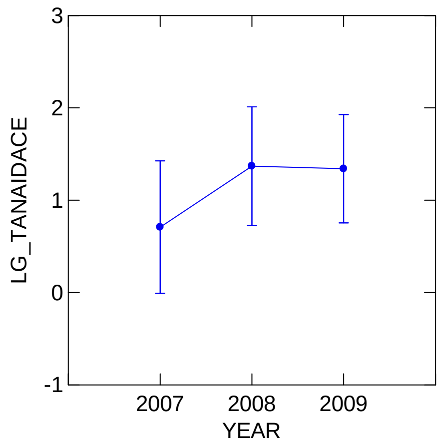
1.7 TANAIDACEA ABUNDANCE

Dep Var: LG_TANAIDACEA   N: 15   Multiple R: 0.217   Squared multiple R: 0.047

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
YEAR	1.226	2	0.613	0.297	0.75
Error	24.758	12	2.063		

Least Squares Means



2.0 REGRESSION

Regression (General Linear Modeling) was run using data from the following abiotic variables (Total N, percent sand, phosphorus, sulfphide, and TOC). Since no significant difference between years was found in the outcome variables (richness, Shannon Weiner diversity, evenness, and overall benthic invertebrate abundance) data was pooled across years when conducting regression analyses (i.e., year was not used as a factor in models). Data from all stations were used when investigating possible factors influencing dependent variables.

2.1 RICHNESS

ep Var: RICHNESS N: 21 Multiple R: 0.739 Squared multiple R: 0.546

Adjusted squared multiple R: 0.495 Standard error of estimate: 13.025

Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)
CONSTANT	65.93	24.14	0.00	.	2.73	0.01
PHOSPHORUS	-0.12	0.04	-0.61	0.56	-2.86	0.01
LG_PER_TOT_N	80.04	17.24	0.99	0.56	4.64	<0.01

Effect	Coefficient	Lower 95%	Upper 95%
CONSTANT	65.93	15.21	116.65
PHOSPHORUS	-0.12	-0.22	-0.03
LG_PER_TOT_N	80.04	43.81	116.26

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
Regression	3671.2	2.0	1835.6	10.8	<0.01
Residual	3053.8	18.0	169.7		

2.2 Shannon Weiner Diversity

Dep Var: SW_DIVERSITY   N: 21   Multiple R: 0.750   Squared multiple R: 0.562

Adjusted squared multiple R: 0.485   Standard error of estimate: 0.468

Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)
CONSTANT	8.57	2.16	0.00	.	3.97	<0.01
SAND	-0.03	0.01	-0.85	0.28	-2.80	0.01
PHOSPHORUS	-0.01	0.00	-0.94	0.33	-3.36	<0.01
LG_SULFD1000	0.41	0.18	0.42	0.73	2.26	0.04

Effect	Coefficient	Lower 95%	Upper 95%
CONSTANT	8.57	4.01	13.12
SAND	-0.03	-0.05	-0.01
PHOSPHORUS	-0.01	-0.01	0.00
LG_SULFD1000	0.41	0.03	0.80

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
Regression	4.79	3.00	1.60	7.28	<0.01
Residual	3.73	17.00	0.22		

2.3 Evenness

Dep Var: EVENNESS_J   N: 21   Multiple R: 0.635   Squared multiple R: 0.403

Adjusted squared multiple R: 0.337   Standard error of estimate: 0.111

Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)
CONSTANT	2.29	0.48	0.00	.	4.75	<0.01
PHOSPHORUS	0.00	0.00	-1.05	0.34	-3.32	<0.01
SAND	-0.01	0.00	-1.05	0.34	-3.33	<0.01

Effect	Coefficient	Lower 95%	Upper 95%
CONSTANT	2.29	1.27	3.30
PHOSPHORUS	0.00	0.00	0.00
SAND	-0.01	-0.01	0.00

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
Regression	0.15	2.00	0.08	6.09	0.01
Residual	0.22	18.00	0.01		

2.4 Total Abundance

Dep Var: LG_ABUNDANCE   N: 21   Multiple R: 0.626   Squared multiple R: 0.391

Adjusted squared multiple R: 0.324   Standard error of estimate: 0.410

Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)
CONSTANT	0.08	0.96	0.00	.	0.08	0.94
SAND	0.01	0.01	0.59	0.42	2.07	0.05
LG_PER_TOT_N	2.08	0.63	0.95	0.42	3.33	<0.01

Effect	Coefficient	Lower 95%	Upper 95%
CONSTANT	0.08	-1.95	2.10
SAND	0.01	0.00	0.03
LG_PER_TOT_N	2.08	0.77	3.40

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
Regression	1.94	2.00	0.97	5.79	0.01
Residual	3.02	18.00	0.17		

2.5 ***Polychaeta sedentaria*****:** ***Polychaeta errantia*** **Abundance**

Dep Var: LG_SED_ERRRA   N: 21   Multiple R: 0.586   Squared multiple R: 0.343

Adjusted squared multiple R: 0.270   Standard error of estimate: 0.519

Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)
CONSTANT	-4.56	2.26	0.00	.	-2.02	0.06
SAND	0.03	0.01	0.98	0.34	2.98	0.01
PHOSPHORUS	0.01	0.00	0.66	0.34	2.01	0.06

Effect	Coefficient	Lower 95%	Upper 95%
CONSTANT	-4.56	-9.29	0.18
SAND	0.03	0.01	0.05
PHOSPHORUS	0.01	0.00	0.01

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
Regression	2.53	2.00	1.27	4.70	0.02
Residual	4.85	18.00	0.27		

2.6 ***Polychaeta*****:*****Amphipoda*** **Abundance**

Dep Var: LG_POLYAMPRA   N: 21   Multiple R: 0.686   Squared multiple R: 0.471

Adjusted squared multiple R: 0.443   Standard error of estimate: 0.501

Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)

CONSTANT	2.70	0.45	0.00	.	6.03	<0.01
SAND	-0.02	0.01	-0.69	1.00	-4.11	<0.01

Effect	Coefficient	Lower 95%	Upper 95%
CONSTANT	2.70	1.76	3.64
SAND	-0.02	-0.03	-0.01

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
Regression	4.25	1.00	4.25	16.91	<0.01
Residual	4.77	19.00	0.25		

2.7 TANAIDACEA ABUNDANCE

Dep Var: LG_TANAIDACEA   N: 16   Multiple R: 0.768   Squared multiple R: 0.590

Adjusted squared multiple R: 0.488   Standard error of estimate: 0.944

Effect	Coefficient	Std Error	Std Coef	Tolerance	t	P(2 Tail)
CONSTANT	-6.99	2.11	0.00	.	-3.31	<0.01
SAND	0.05	0.02	0.84	0.53	3.30	<0.01
LG_SULFD1000	1.28	0.40	0.66	0.79	3.18	<0.01
LG_PER_TOC	1.41	0.60	0.57	0.60	2.36	0.04

Effect	Coefficient	Lower 95%	Upper 95%
CONSTANT	-6.99	-11.59	-2.39
SAND	0.05	0.02	0.09
LG_SULFD1000	1.28	0.40	2.15
LG_PER_TOC	1.41	0.11	2.72

Analysis of Variance

Source	Sum-of-Squares	df	Mean-Square	F-ratio	P
Regression	15.40	3	5.13	5.76	0.01
Residual	10.69	12	0.89		

APPENDIX F

Bird Identification Codes

Bird Identification Codes

Code	Species	sp	su	f	w
AMAV	American Avocet			ac	ac
ABDU	American Black Duck [I]			ca	ca
AMCO	American Coot	u			u
AMDI	American Dipper				ac
AGPL	American Golden-Plover			ca	
AMGO	American Goldfinch	f	f	f	f
AMKE	American Kestrel	r	r	r	ca
AMPI	American Pipit	u		f	ca
AMRO	American Robin	f	f	f	f
ATSP	American Tree Sparrow	ca			ca
AMWI	American Wigeon	a	r	a	a
ANHU	Anna's Hummingbird		ca	ca	ca
BASA	Baird's Sandpiper	r		u	
BAEA	Bald Eagle	c	f	f	c
BTPI	Band-tailed Pigeon	r	r	r	ca
BKSW	Bank Swallow		r	r	
BNOW	Barn Owl	r	r	r	r
BASW	Barn Swallow	f	f	c	ac
BDOW	Barred Owl				ac
BAGO	Barrow's Goldeneye	r		r	r
BEKI	Belted Kingfisher	u	u	u	u
BEWR	Bewick's Wren	r	ca	r	r
BLSC	Black Scoter	r		r	r
BLSW	Black Swift	f	f		
BLTU	Black Turnstone			r	r
BBPL	Black-bellied Plover	a	u	a	c
BCCH	Black-capped Chickadee	f	f	f	f
BCNH	Black-crowned Night-Heron			ac	
BHGR	Black-headed Grosbeak	r	r		
BLKI	Black-legged Kittiwake	ac			
BTWE	Blue-winged Teal	r	r	r	
BOGU	Bonaparte's Gull	a	c	a	r
BRCO	Brandt's Cormorant				r
BRAN	Brant	a	r	u	c
BRBL	Brewer's Blackbird	c	u	c	a
BRCR	Brown Creeper				r
BHCO	Brown-headed Cowbird	f	u	u	r
BUFF	Bufflehead	c	r	c	f
BUOR	Bullock's Oriole		ca		
BUSH	Bushtit	f	f	f	c
CAGU	California Gull	c	f	c	r
CAGO	Canada Goose	a	f	c	a
CANV	Canvasback	r		r	r
CATE	Caspian Tern	f	f	f	
CAVI	Cassin's Vireo	ca		ca	
CEWA	Cedar Waxwing	u	f	f	ca
CBCH	Chestnut-backed Chickadee				r
CHSP	Chipping Sparrow			ca	
CITE	Cinnamon Teal	r	r	r	ca
CLGR	Clark's Grebe			ca	
CLSW	Cliff Swallow	u	u	u	
COGO	Common Goldeneye	u	r	u	f
COGR	Common Grackle				ac
COLO	Common Loon	a	u	a	c
COME	Common Merganser			r	r
COMU	Common Murre			r	r
CONI	Common Nighthawk		ca	ca	
CORA	Common Raven	r	r	r	r
CORE	Common Redpoll				ac
COSN	Common Snipe	r	ca	r	r
COTE	Common Tern	u	r	f	
COYE	Common Yellowthroat	u	u	u	
COHA	Cooper's Hawk	u	u	u	u
DEJU	Dark-eyed Junco	f	ca	f	f
DCCO	Double-crested Cormorant	f	u	f	f
DOWO	Downy Woodpecker	r	r	r	r
DUNL	Dunlin	a		a	a
EAGR	Eared Grebe				ca
EAKI	Eastern Kingbird	r	r		
EMGO	Emperor Goose				ac
EUWI	Eurasian Wigeon	f		f	f
EUST	European Starling [I]	c	c	c	a
EVGR	Evening Grosbeak	r		r	r
FOSP	Fox Sparrow	u		u	u
FRGU	Franklin's Gull		r	r	
GADW	Gadwall	f	u	f	f
GLGU	Glaucous Gull				r
GWGU	Glaucous-winged Gull	a	a	a	a
GOEA	Golden Eagle	ca			
GCKI	Golden-crowned Kinglet				r
GCSP	Golden-crowned Sparrow	u		u	u
GCRF	Gray-crowned Rosy-Finch				ac
GBHE	Great Blue Heron	c	c	c	c
GREG	Great Egret		ca		
GHOW	Great Horned Owl		ca		
GRSC	Greater Scaup	a	r	a	a
GWFG	Greater White-fronted Goose	ca			ca
GRYE	Greater Yellowlegs	f	r	f	u
GRHE	Green Heron	r	r	r	
GWTE	Green-winged Teal	a	r	a	a
GYRF	Gyrfalcon	ca			r
HAWO	Hairy Woodpecker				ca
HADU	Harlequin Duck	r			r
HASP	Harris's Sparrow			ca	ca
HEEG	Heermann's Gull			ca	
HETH	Hermit Thrush				ca
HEGU	Herring Gull	u		u	u
HOME	Hooded Merganser			r	r
HOGR	Horned Grebe	c		c	c
HOLA	Horned Lark			r	
HOFI	House Finch	f	f	f	c
HOSP	House Sparrow [I]	c	c	c	c
HUGO	Hudsonian Godwit			ca	
HUVI	Hutton's Vireo	ca			
KILL	Killdeer	f	u	f	u
LZBU	Lazuli Bunting		ac		
LESA	Least Sandpiper	a	r	a	
LESC	Lesser Scaup	f	ca	f	f
LEYE	Lesser Yellowlegs	c	ca	c	
LISP	Lincoln's Sparrow	r		r	r
LIST	Little Stint			ac	
LBCU	Long-billed Curlew			ca	
LBDO	Long-billed Dowitcher	f	ca	c	u
LEOW	Long-eared Owl				ac
LTDU	Long-tailed Duck (formerly Oldsquaw)		ca	r	r
MALL	Mallard	a	f	a	a
MAGO	Marbled Godwit		ca	ca	ac
MAMU	Marbled Murrelet				ac
MAWR	Marsh Wren	u	u	u	r
MERL	Merlin	r	r		r
MEGU	Mew Gull	a	r	a	a
MOBL	Mountain Bluebird	ca			
MODO	Mourning Dove	r	r	r	
MUSW	Mute Swan [I]	ca			ca
NOFL	Northern Flicker	f	ca	f	u
NOGO	Northern Goshawk			ca	ca
NOHA	Northern Harrier	u	u	u	u
NHOW	Northern Hawk Owl				ac

Bird Identification Codes

Code	Species	sp	su	f	w
NOPI	Northern Pintail	a	r	a	a
NRWS	Northern Rough-winged Swallow	r	r	r	
NOSL	Northern Shoveler	u	f	u	f
NOSH	Northern Shrike	r		r	r
NOCR	Northwestern Crow	c	f	c	c
OSFL	Olive-sided Flycatcher	ca			
OCWA	Orange-crowned Warbler	f	u	f	ac
OSPR	Osprey		ca	ca	
PALO	Pacific Loon	r		r	r
PSFL	Pacific-slope Flycatcher	r			
PAJA	Parasitic Jaeger			r	
PESA	Pectoral Sandpiper		r	f	
PECO	Pelagic Cormorant	u		u	f
PEFA	Peregrine Falcon	u	r	u	u
PBGR	Pied-billed Grebe	r		r	r
PIGU	Pigeon Guillemot				ca
PIWO	Pileated Woodpecker				ac
PISI	Pine Siskin	f	r	f	f
PRFA	Prairie Falcon				ca
PUFI	Purple Finch	r		r	r
RECR	Red Crossbill	r	r	r	r
REKN	Red Knot			ca	
RBME	Red-breasted Merganser	f	ca	f	u
RBNU	Red-breasted Nuthatch				ca
RBSA	Red-breasted Sapsucker				ac
REVI	Red-eyed Vireo	ca		ca	
REDH	Redhead				ca
RNGR	Red-necked Grebe	u		c	u
RNPL	Red-necked Phalarope	r		r	
RNST	Red-necked Stint			ac	
RTHA	Red-tailed Hawk	u	r	u	u
RTLO	Red-throated Loon	f		u	f
RWBL	Red-winged Blackbird	a	f	a	a
RBGU	Ring-billed Gull	a	a	a	f
RNPH	Ring-necked Pheasant [I]	u	u	u	u
RODO	Rock Dove [I]	f	f	f	f
ROSA	Rock Sandpiper				ca
RLHA	Rough-legged Hawk	r		r	r
RCKI	Ruby-crowned Kinglet	r		r	ca
RUDU	Ruddy Duck	r		r	r
RUTU	Ruddy Turnstone	r		r	ca
RUFF	Ruff			ca	
RUHU	Rufous Hummingbird	f	u	u	
SAND	Sanderling	c		c	c
SACR	Sandhill Crane	ca			
SAVS	Savannah Sparrow	f	f	f	f
SEPL	Semipalmated Plover	f	ca	f	ca
SESA	Semipalmated Sandpiper	ca		u	
SSHA	Sharp-shinned Hawk	r		r	r
SBDO	Short-billed Dowitcher	f		f	ca
SEOW	Short-eared Owl	r	r	r	r
SNBU	Snow Bunting			ca	
SNGO	Snow Goose	u		u	f
SNOW	Snowy Owl				ca
SOSA	Solitary Sandpiper		r	r	
SOSP	Song Sparrow	f	u	f	f
SORA	Sora	r	r		
SPSA	Spotted Sandpiper	u	r	u	ca

Code	Species	sp	su	f	w
SPTO	Spotted Towhee	u	u	u	f
STJA	Steller's Jay			ca	r
STSA	Stilt Sandpiper		r	r	
SUSC	Surf Scoter	a	r	a	a
SURF	Surfbird				ca
SWTH	Swainson's Thrush	r	r		
SWSP	Swamp Sparrow			ca	ca
THGU	Thayer's Gull	f		f	f
TOSO	Townsend's Solitaire	r			
TOWA	Townsend's Warbler				ac
TRSW	Tree Swallow	f	f	c	
TRUS	Trumpeter Swan	r		r	r
TUSW	Tundra Swan	c			c
TUVU	Turkey Vulture	r	ca	r	ca
UNCA	Unknown *Calidris* Species				
UNDU	Unknown Duck Species				
UNGU	Unknown Gull Species				
VATH	Varied Thrush				ca
VASW	Vaux's Swift	f	f	u	
VGSW	Violet-green Swallow	f	f	c	
VIRA	Virginia Rail	ca	ca		ca
WAVI	Warbling Vireo	ca		ca	
WEGR	Western Grebe	u		c	u
WEGU	Western Gull	r		r	r
WEKI	Western Kingbird		ca		
WEME	Western Meadowlark	r	ca	r	r
WESA	Western Sandpiper	a	r	a	r
WSOW	Western Screech-Owl				ac
WETA	Western Tanager		ca		
WWPE	Western Wood-Pewee	ca			
WHIM	Whimbrel	ca	ca	ca	
WCSP	White-crowned Sparrow	f	u	f	u
WWSC	White-winged Scoter	f	r	f	f
WILL	Willet			ac	
WIFL	Willow Flycatcher	r	r	r	
WIPH	Wilson's Phalarope			r	
WIWA	Wilson's Warbler	r		r	
WIWR	Winter Wren			ca	ca
WODU	Wood Duck	ca			ca
YEWA	Yellow Warbler	f	u	f	
YHBL	Yellow-headed Blackbird	ac			
YRWA	Yellow-rumped Warbler	f	r	f	r

Seasonal Occurrence
Sp = Spring (Mar. - May; including spring migrants)
S = Summer (June - mid Aug.; including spring arrival and fall departure)
F = Fall (mid Aug. - Nov.; including fall migrants)
W = Winter (Nov./Dec. - Feb.; including fall arrival and spring departures)

Relative Abundance
a = abundant [100 or more per day]
c = common [25 to 100 per day]
f = fairly common [5 to 25 per day]
u = uncommon [1 to 5 per day, with at least 10 records per year]
r = rare, but regular [1 to 10 records per year]
ca = casual [2 to 10 documented records in checklist area]
ac = accidental [only 1 documented record in checklist area during the specified season]