AECOM

Appendix G

Biophysical Assessment 2016 (Foreshore Technologies)

AECOM

Appendix G1

Biophysical Assessment March 2016 (Foreshore Technologies)

Report Number: 3787-R-04.1

BIOPHYSICAL ASSESSMENT

BIOPHYSICAL SURVEY RESULTS OF SELECTED AREAS,
PORT METRO CENTERM CONTAINER TERMINALS, VANCOUVER, B.C.
MARCH 8, 2016

PREPARED BY:

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SUMMARY OF PROJECT SCOPE

Foreshore Technologies Inc. (Foreshore) has been secured by AECOM (Proponent) to perform a biophysical survey (the Project) of areas located at the Port Metro Vancouver Centerm Container Terminal Site (Centerm). The scope of work includes the collection and reporting on habitat conditions found within the following areas:

- subtidal zones beyond the Centerm physical structures,
- rip rap slopes located on the southern and western shores,
- Berth 1 shallow subtidal cobble trays, and,
- the fish refugia located in Berths 2 and 6.

CLARIFICATIONS REGARDING SERVICES/FINDINGS

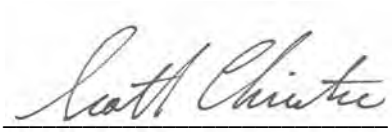
Foreshore Technologies Inc. (Foreshore) prepared this report for the exclusive use of AECOM. The contents, implied or written, of this document and its related media may not be utilized in whole or in part by any party other than AECOM without the signed written authorization of AECOM or Foreshore.

This report has been duly prepared by qualified environmental professionals with knowledge and experience relevant to the Project and the scope of work.

Foreshore prepared this report in a manner consistent with generally accepted Qualified Environmental Professional (QEP) practices, and in a manner consistent with that level of care normally exercised by QEPs currently practicing under similar conditions. The information presented in this report is accurate and complete to the best of Foreshore's knowledge. The information contained within this report reflects the opinion and best judgment of Foreshore in light of the information available to it at the time the report was prepared.

This report has been prepared by Foreshore Technologies Inc.

REVIEWED BY:



Scott Christie, R.P.Bio
Principal

SECTION 0 TABLE OF CONTENTS

BIOPHYSICAL SURVEY RESULTS OF SELECTED AREAS, PORT METRO CENTERM CONTAINER TERMINALS, VANCOUVER, BRITISH COLUMBIA

SECTION 1 INTRODUCTION

1.1 Project Overview

This biophysical survey was conducted in order to identify macro biophysical features and provide general condition statements regarding habitat conditions found at specific sites located around Port Metro's Centerm Container Terminal (Centerm). Areas investigated included undisturbed native habitat and anthropogenic compensation features.

During the mid to late 1990s the berth area between the west side of Ballantyne Pier and the east side of Centerm was filled as part of the then Vancouver Port Corporation's Centerm Improvement Project. A later expansion saw the addition of two concrete caissons and a fill area at the western end of the site. Habitat impacts associated with the works were compensated (see Appendix 1) in part with:

- fish refugia built into the structure of the concrete caissons that formed the north face of the future Berth 2, and,
- habitat rafts (trays) surfaced with cobbles and suspended at -2m to +1m Chart Datum at various locations under Ballantyne Pier that would,
- 18 fish refugia built into two (new at the time) installed concrete caissons, and,
- two habitat benches (-2m and +1m Chart Datum) built into the rip rap shore protection that runs along the western end of Centerm.

1.2 Project Location

Centerm is located on the south side of Vancouver Harbour east of the Vancouver Trade and Convention Centre/Cruise Ship Terminal, see Drawing 3787-D-00.1 in Appendix 2. The facility operates six gantry cranes and a variety of on-dock rail facilities to load and unload containers onto ocean going vessels. The terminal is largely made up of a concrete caisson supported landfill structure but, includes marginal wharf areas built on steel and concrete piles. The UTM and latitude/longitude coordinates for the site are generally:

Easting:	493213 m E	Latitude:	49° 17' 13.87" N
Northing:	5459386 m N	Longitude:	123° 5' 35.99" W
Zone:	10 U		

The areas of the Centerm facility identified for biophysical surveying included:

- native subtidal zones beyond the Centerm physical structures,
- five transect locations distributed along the southern and western rip rap shores,
- three transect locations distributed along the eastern end of Berths 1 and 2,
- 13 cobble trays found within Berth 1
- 9 fish refugia found within Berth 2, and, 18 fish refugia located within Berth 6.

For an illustration of the survey site locations, see Drawing 3787-D-00.1 in Appendix 2.

SECTION 2 BIOPHYSICAL SURVEY METHODOLOGY

2.1 General

The biophysical survey was conducted by SCUBA equipped Qualified Environmental Professionals (QEPs). The surveys were conducted from a boat during the dates of October 13, 14, and 15, 2015, and, February 16, 2016. Representative still and video photography was recorded of the habitat conditions. Substrate conditions were identified on the basis of the following guidelines:

Substrate Type	Diameter (mm)
▪ rip rap (angular rock)	> 64
▪ boulders	>255
▪ cobble	64 to <255
▪ pebble	2 to <64
▪ sand	0.0625 to <2
▪ mud	<0.0625

Additional substrate conditions noted during the survey included any significant build-up of shell hash, woody debris and/or anthropogenic materials. For purposes of clarity substrate "tags" on the drawings are limited to positions along either side of the transect lines. Unless noted, the tags shown along the transects can be assumed to be contiguous with those of the next adjacent transect.

Species and biota groups chosen for surveying and mapping purposes were selected by the QEPs at the time of the survey. Species and biota groups were selected that best represented the environmental and habitat conditions. A list of all species observed was also developed. The abundance levels of selected species or biota groups were based on the following criteria:

Abundance		
Amount	**% Areal Coverage**	**Individuals Along Transect**
Rare	<5%	1
Sparse	5% to 25%	2 to 5
Few	26% to 50%	6 to 10
Common	51% to 75%	11 to 30
Abundant	>75%	> 30

2.2 Southern, Western and Eastern Shorelines

Eight belt transect lines (2m in width) were laid out perpendicular to the foreshore along the southern, western and eastern shores of the terminal, see Drawing 3787-D-00.1 in Appendix 2. The transect lines were extended down the slopes from the highwater line or the face of the Centerm berth faces. The transect lines varied in length from 40m to 60m and depths ranging from +5m Chart Datum (CD) to -25m CD. The QEPs surveyed the type and abundance of selected species, biota groups and substrates present along each transect. A reconnaissance survey of the areas located between each transect was performed to confirm transect observations were representative of overall site habitat conditions.

2.3 Berth 1 Cobble Trays, Berths 2 and 6 Fish Refugia

The cobble trays and fish refugia were surveyed visually to determine general habitat conditions and species presence.

SECTION 3 BIOPHYSICAL OBSERVATIONS

3.1 Southern, Western and Eastern Shorelines – See Drawings 3787-D-01.1 through 08.1 in Appendix 2 and Tables 1 through 8 in Appendix 3

3.1.1 Substrates

The physical conditions observed along the southern and western shoreline of Centerm (Transects 1 through 5) were typically uniform in terms of substrate type and size. The shorelines were comprised of a boulder/cobble rip rap slope (typically 2h:1v to 3h:1v) that extended from above highwater (see Image 1) down through the intertidal zone into the shallow subtidal.

Image 1. Looking north at the rip rap shore protection that makes up the southern shoreline of Centerm.

Within the boulder/cobble slope some concrete and anthropogenic materials were noted and at a few locations wire mesh gabions (Transect 4) were observed with the latter in most cases being broken or distorted so as to be virtually contiguous with the boulder/cobble slope. Small amounts of woody debris were noted in the lower reaches of Transect 3. Beyond the toe of the rip rap slope, substrates transitioned to a shallow sloping (approximately 20h:1v) mud/silt seabed with the occasional cobble or pebble evident, see Images 2 and 3.

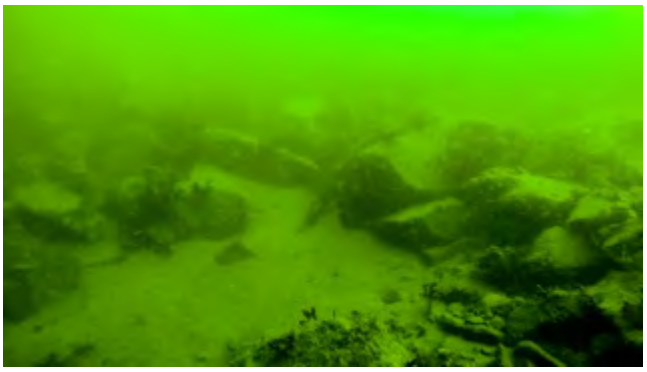


Image 2: Transition point at toe of rip rap.

Image 3: Mud/silt typical of deeper subtidal zones.

The substrates observed in the eastern shoreline areas of Centerm (Transects 6 ,7 and 8) were similar to the subtidal areas of Transects 1 through 5 with mud/silt being the dominant substrate with cobbles and boulders being more prevalent than in the western and southern shoreline areas. Shell hash was a common substrate found in areas adjacent to the pier with significant amounts of wood debris found along Transect 8.

3.1.2 Biota

The western and southern rip rap shorelines contained a wide diversity of plants and animals (see Table 9 in Appendix 3) that was primarily affected by elevation and substrate type. The upper intertidal zone (5.0m to 3.9m CD) consisted of bare rip rap with no biota. In the mid intertidal zone (3.9m to 2.0m CD) the predominant species were Barnacles, Rockweed and Green Algae. The lower intertidal and subtidal zones were colonized by Green, Red and Brown Algae with Brown and Red Algae becoming dominant with depth. Percent biota coverage of the rip rap slope ranged from 5% to 100% with the higher percent coverage found on the large more stable substrates. Invertebrate communities were found to be well established from 3m CD down to the toe of the rip rap slope. Tables 1 through 8 in Appendix 3 provide percent areal coverage estimates and depth ranges for a number of selected macro biota. Visual survey of the areas located between the transect sites revealed similar levels of diversity and abundance as those found along the transects.

No significant macro biota communities were observed beyond the toe of the rip rap slope. Physical probing of the mud/silt seabed beyond the toe of the rip rap slope revealed no observable benthic biota.

3.1.3 Bull Kelp (Nereocystis luetkeana)

Bull Kelp was found between -2m and -7m CD with the majority of Bull Kelp holdfasts occurring within the range of -3m to -6m CD. The holdfasts were found attached to any stable substrate but, were predominantly attached to large stable rip rap faces. While Bull Kelp was observed along the entire western and southern shores kelp holdfasts qualitative assessments indicate Bull Kelp was most abundant in the areas along and around Transects 1 and 5. The occurrence of holdfasts decreased noticeably south of Transect 4 for a distance of approximately 25m where substrate size became predominantly more pebble-like.

3.2 Berth 1 Cobble Trays – see Drawing 3787-D-09.1 in Appendix 2 and Table 9 Below

Thirteen concrete trays approximately 4m wide x 8m long x 15cm thick are located in the shallow subtidal zone just inside the face of Berth 1, see Photo 7 in Drawing 3787-D-09.1. Numerical markings, pre-existing along the berth face, provide an identification system for each tray and include: 90, 110, 120, 130, 140, 150, 160, 180, 190, 200, 210, 220, and 270.

Ninety percent of the upper surfaces of the trays are covered with a layer of pebbles/cobbles approximately 7cm thick with an overlying layer of shell hash that covers 60% of the pebble/cobble surface, see Photos 8 and 9 in Drawing 3787-D-06.1. No vegetation was observed on the trays and invertebrate presence (Dungeness Crabs or Green Urchins) were sparse with less than two individuals per tray typical, see Table 9 below and Photo 9 in Drawing 3787-D-09.1 in Appendix 2.

Table 9 - Berth 1 Cobble Trays Abundance Estimates for Selected Biota

Biota Type/Group	Highest Level of Abundance	
	Amount	% Areal Coverage or No. of Individuals
Berth 1 Cobble Trays		
Barnacles (on cobble)	Rare	<5%
Barnacles (tray sides)	Common	51% to 75%
Dungeness Crabs	Sparse	2 to 5
Mussels (on cobble)	Rare	<5%
Mussels (tray sides)	Common	51% to 75%
Shell Hash (upper surface)	Abundant	>75%
Urchin	Sparse	2 to 5

3.3 Berth 2 Fish Refugia – see Drawing 3787-D-09.1 in Appendix 2 and Table 10 Below

Berth 2 contains 9 fish refugia that are accessed through a 1.5m x 2m opening on the north face of the concrete caissons, see Photo 2 in Drawing 3787-D-09.1 in Appendix 2. The internal dimensions of the refugia are approximately 4m wide x 6m deep and over 8m in height. Cargo nets are suspended from all four corners of the refuge one metre below the opening, see Photo 3 in Drawing 3787-D-09.1 in Appendix 2. Some of the cargo net anchor points have let go from their anchor points in the fish refugia wall.

The cargo nets have been colonized by Feather Duster Tubeworms with a percent areal cover ranging from 0% to over 75% depending on proximity to openings (higher concentration closer to openings and stronger water currents). The interior walls of the refugia have been colonized by Mussels, Barnacles, Sea Squirts, and Tubeworms. Other invertebrates found within the refugia include, Barnacles, Sea Stars, Dungeness and Red Rock Crabs, and Shrimp. The majority of macro biota observed were found in low numbers, see Table 10 below for species and biota group abundance levels.

Table 10 - Berth 2 Fish Refugia Abundance Estimates for Selected Biota

Biota Type/Group	Highest Level of Abundance	
	Amount	% Areal Coverage or No. of Individuals
Barnacles	Sparse	5% to 25%
Calcareous Tubeworms	Sparse	5% to 25%
Dungeness Crabs	Sparse	2 to 5
Feather Duster	Common	51% to 75%
Mussels	Sparse	5% to 25%
Red Rock Crabs	Sparse	2 to 5
Sea Squirts	Common	11 to 30
Shrimp	Common	11 to 30

3.4 Berth 6 Fish Refugia – see Drawing 3787-D-09.1 in Appendix 2 and Table 11 Below

Berth 6 contains 18 fish refugia that are accessed through a 0.75m diameter opening, see Photo 5 in Drawing 3787-D-09.1 in Appendix 2. The internal shape of the refugia tapers from 4m wide on the north wall (front) to 30cm at south wall (back).

The seabed within the refugia is located 2m below the lowest opening and made up of a fine/mud substrate with clam shells. A milky cloudy layer covers the bottom regions of the refugia and coincides with lower levels of marine life suggesting these undisturbed areas of reduced flushing are low in oxygen, see Photo 6 in Drawing 3787-D-09.1 in Appendix 2. Subsurface layers of the substrates found in the bottom of the caissons were black indicating anoxic conditions.

Shrimp and Dungeness Crabs were found within the refugia at abundance levels of “common” and “sparse” respectively. The surfaces of the internal side walls of the refugia are encrusted with Barnacles and Calcareous Tubeworms whose abundance ranges from <5% areal coverage furthest from the opening to >75% adjacent to the opening. See Table 11 below for the average species and biota group abundance levels within the Berth 6 fish refugia.

Table 11 - Berth 6 Fish Refugia Abundance Estimates for Selected Biota

Biota Type/Group	Average Level of Abundance	
	Amount	% Areal Coverage or No. of Individuals
Barnacles	Sparse	5% to 25%
Calcareous Tubeworms	Sparse	5% to 25%
Dungeness Crabs	Sparse	2 to 5
Shrimp	Common	11 to 30

3.5 Species Diversity

The greatest diversity of species was observed along the rip rap slopes of the western and southern shores surrounding Centerm. The Berth 1 cobble trays, Berth 2 refugia, Berth 6 refugia and deepr subtidal zones of mud/silt substrates demonstrated lower diversity and species counts, see Table 12 in Appendix 3 for a list of observed species and their Centerm survey site location.

SECTION 4 QEP COMMENTS

Species abundance and habitat productive capacities observed along the intertidal and subtidal shoreline areas surrounding Centerm are similar to those found in undisturbed areas of like substrate and depth in Burrard Inlet.

The southern rip rap shoreline exhibits similar diversity of species but lower abundances than the western rip rap shoreline. This is due to the southern shoreline's location further from the improved water quality associated with the stronger tidal currents of the main harbour channel. Similarly, in the eastern shore line areas Transect 6 showed higher levels of abundance than Transects 7 and 8 that were located further from the main harbour channel.

The fish refugia in Berths 2 and 6, and the cobble trays in Berth 1, exhibit diminished habitat values and diversity. Only those areas adjacent to the refugia entrances and connecting passages, where tidal generated currents improve flushing, was there any substantive abundance or diversity of biota observed.

The lower reaches and deeper sections of the refugia, along with the cobble trays, demonstrate a significant lack of productive capacity and in some areas, like the refugia floors, show no presence of macro or benthic biota. The cargo nets installed in the Berth 2 refugia represent increased colonization surfaces for sessile plants and animals but the lack of any substantive light or current within the refugia renders them insignificant in terms of habitat value.

The deeper mud/silt subtidal areas surrounding Centerm are typical of undeveloped areas of similar elevation and substrate within Burrard Inlet having lower productive capacities than areas with hard substrates. Where the occasional stable boulder or anthropogenic material were found macro biota diversity and abundance increased significantly.

Over the past decade the productive capacities associated with the Centerm facilities compensation features has remained largely unchanged. Those areas with the highest tidal currents and stable hard substrates located between +4.0m CD and -10m CD have the highest levels of species diversity, abundance and productive capacity. Significant increases in bio-diversity and abundance were also observed below -10m CD where hard substrates were located. The artificial habitats represented by the refugia and the cobble trays represent little habitat value by comparison.

SECTION 5 SIGNATURES

This report has been duly prepared by qualified environmental professionals with knowledge and experience in performing marine biophysical surveys. The information presented in this report is accurate and complete to the best of Foreshore's knowledge.

Foreshore Technologies Inc.

Scott Christie, R.P.Bio
Senior Biologist/Principal

APPENDIX 1

Centerm Improvement Project, Clarification of Project Design Modifications
BERC File No. 9508-056, October 24, 1996

VANCOUVER
PORT CORPORATION

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SOCIETE DU PORT
DE VANCOUVER

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October 24, 1996

Mr. Adrian Duncan, Chair
Burrard Environmental Review Committee
Metrotown Place III
5945 Kathleen Avenue, Suite 501
Burnaby, B.C. V5H 4J7

Dear Mr. Duncan:

Re: ***Centerm Improvement Project***
Clarification of Project Design Modifications
BERC File No. 9508-056

Reference is made to the application to the Burrard Environmental Review Committee (BERC) for the Centerm Improvement project dated August 29, 1995 and the addendum dated November 22, 1995. As required by the BERC approval dated November 30, 1995, the Vancouver Port Corporation (VPC) supplied final design drawings for the Centerm Improvement project on September 24 and September 30, 1996.

Further the discussions at the October 23, 1996 BERC meeting the rational for the Centerm Improvement project, as presented in the application to BERC, will increase the capacity of Vancouver's Inner Harbour to handle pulp, paper and forest products by expanding the Centennial Terminal (Centerm) to the east. The Centerm improvement will increase storage space for forest products and increase the efficiency of Ballantyne and Centerm by integrating the two facilities into one world class terminal. This improvement will attractive to our customers and will provide a greater export throughput of products at the terminal. Consequently, the increased exports translate to a benefit to the Canadian economy.

The new berth will also improve better utilization of Ballantyne by accommodating two cruise ships without disruptions to the movement and storage of forest products. VPC will cost share the project with the Canadian Stevedoring Company Limited (CASCO), who operate the container terminal at Centerm and the forest products portion of Ballantyne. The project will increase the terminal's operating efficiency for forest products and cruise passengers and is consistent with VPC's Port 2010 Land Use Management Plan.

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Engineering Design Rational

VPC has elected to build the wharf structure with concrete caissons as opposed to a pile and deck construction. Concrete caissons were used to construct the wharf structures at the three VPC terminals in the inner harbour, Vanterm, Centerm and Lynnterm, as well as Deltaport at Roberts Bank. The advantages of a caisson construction over a pile and deck structure are numerous.

Firstly, the caissons have more operational flexibility than a pile and deck structure. Over the years the operation of a marine terminal often changes. For example, the size of equipment increases or container cranes are located on the wharf. This change usually means increased loadings on the dock. The pile and deck structures are constructed for a specific loading, usually in a specified area of the deck. Any changes in the loading would mean a reconstruction of the structure. If the changes were major a portion of the deck would have to be removed and an additional bent of piles driven to accommodate the additional loads. However, similar changes would require only minor modifications to the caisson wharf structure. The resulting downtime and loss of productivity for the retrofit of a caisson structure would be less than the same for a pile and deck structure.

The second important advantage is in relation to the durability of the concrete caissons over the pile and deck structure in the event of a collision. There have been several occasions in previous years when a ship has collided into the wharf while berthing and caused some damage to the front face of a caisson with the bulbous bow. The damage to the caisson was minimal and repairs consisted of covering the area with a layer of concrete for corrosion protection. A similar incident involving a piled structure would likely have resulted in major damage to one or more piles and either replacement of the piles or extensive retrofitting. Again the lower resulting downtime and loss of productivity for the retrofit of a caisson structure over a pile and deck structure would be significant.

The next important advantage relates to potential damage due to long term settlements after construction. The caissons are large structures filled with rock. Each caissons would settle at a uniform rate and differential settlement between caissons is usually not significant. Any differential settlement between caissons can be allowed for in the continuous cope wall which is constructed on top of the caisson structures. Differential settlements between individual piles, however, may cause significant damage to the deck structure. If the extent of damage was severe the reconstruction of the deck may be necessary, resulting in downtime and loss of productivity.

The next important advantage relates to structures, particulary crane stops, on the dock. the crane stops are designed to withstand a particular impact from a crane. In the event that the crane stops are overloaded, the foundations on the caissons would be more able to withstand the overload condition than the same situation on a pile and deck structure. This condition would result in a lower risk of accident if the wharf is constructed with caissons rather than pile and deck.

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The final advantage to consider is the performance of both structural designs in the event of an earthquake. In a severe seismic event the piles could shear at the mud line or, even worse, below the mud line and any damage would not be easily detectable. If the piles did shear they would have to be either removed and replaced or each damaged pile would require extensive repairs. The caisson structure is robust enough that in a seismic event it would likely remain intact. The caissons themselves would likely slide seaward horizontally a nominal distance. Any realigning of the wharf face would require a realignment of the copewall and the fenders. This would be a less significant repair compared to the reconstruction of a pile and deck structure. Consequently, the repairs required for a caisson wharf would cause less downtime and loss of productivity than repairs to the pile and deck structure.

The advantages of the caisson wharf structure of over the pile and deck structure include; greater operational flexibility, greater durability, less likelihood of damage due to long term settlement, better capacity for foundations on the wharf, and less risk of major damage in a seismic event.

Habitat Features: Design Changes vs. Previous Approval

Enclosed please find the revised drawing 5-B-37-4 showing modifications to the already approved concept (November, 30, 1995, attached). As stated in VPC's October 21, 1996 letter, you are aware the previously proposed habitat feature under the north face deck of Ballantyne pier has been found to be not seismically feasible. As a result and as discussed, we have proposed habitat rafts between piling on the east face of Ballantyne (previously submitted). These rafts total some 500 m^2 and also provide anchorage points for the attachment of artificial algae for herring spawn and sessile invertebrate colonization. Raft location has been determined by fendering needs and avoidance of high velocity areas to eliminate the possibility of scour (from prop wash and thrusters). Additionally, the sheet pile wall has been eliminated and cast rock (24" minus) will widen the "valley" remaining under the west face of Ballantyne decking. Changes (gains {+} or losses{-}) in mitigation features from the approved concept are summarized below (all in plan area):

1. Seismically unfeasible feature <u>-750 m^2</u>

2. Rock brace to lock block (replacing the fourth caisson) between elevation -2 and +1 m (chart datum) <u>+50 m^2</u>

3. Increase in "valley" area due to elimination of sheet pile <u>+ 650 m^2</u>

4. Raft area, not including algal strands + <u>500 m^2</u>
   (elevation - 2 to + 1m chart datum)

5. *Refugia*, three in each of three caissons - no change.

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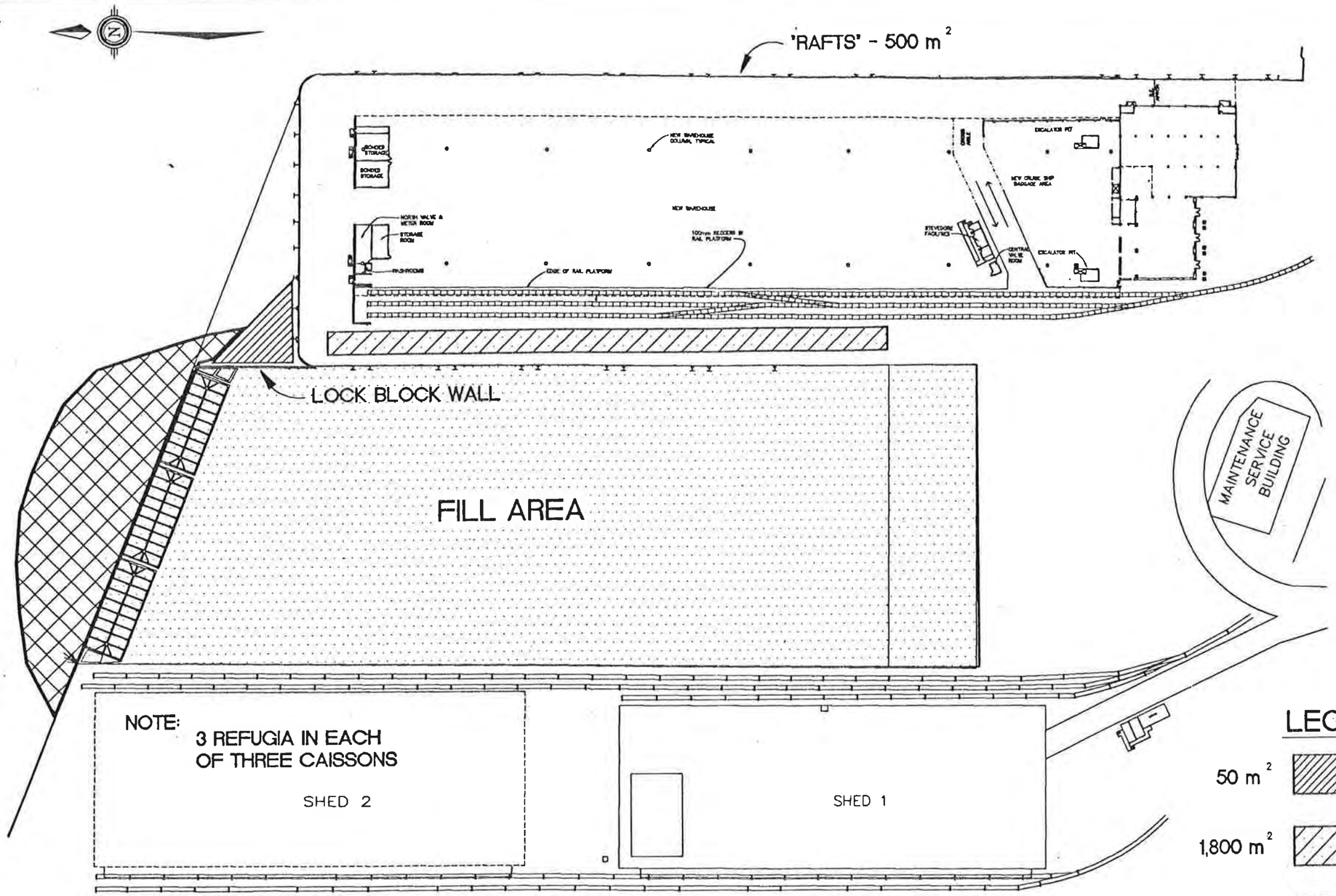
These designs changes have resulted in an overall increase of 500 m^2 over the original concept. As committed in VPC's November 22, 1995 addendum, VPC will monitor colonization and structure utility on an annual basis and develop remediation plans, if required. VPC looks forward to charting the progress of the raft concept as it represents an improved mitigation feature.

Sincerely,

A.J.Jordan, Ph.D.
Manager, Environmental Services

cc: B. Clark, DFO
D.Desjardin, VPC
A. Barker, VPC



LEGEND:

50 m 2	AREA INCLUDED IN HABITAT CALCULATIONS (ABOVE −2.0 m)
1,800 m 2	EXISTING ROCK FILL TO REMAIN
4,200 m 2	ROCK MATTRESS (−15.6 TO 27 m)

AMENDMENT TO PREVIOUSLY APPROVED DESIGN

Ref.No.	REFERENCE

No.	Date	REVISION	Dr'n	Ch'd
1	93/04/08	MITIGATION FEATURES ADDED	S.N.	

Vancouver Port Corporation / Société du Port de Vancouver
ENGINEERING DEPARTMENT
Canada

DESIGN BY: J.J.
DRAWN BY: S.N.
DATE: MARCH 8, '88
SCALE: 1:750
ENGINEER:
ACAD FILE # 37-4A1
ACAD DWG #

PROJECT
CENTERM REDEVELOPMENT
BIGHT FILL-IN
PLAN

DWG. No. 5 - B - 37 - 4
SHEET 1

APPENDIX 2

BIOPHYSICAL DRAWINGS AND PHOTOGRAPHS

Drawing 3787-D-00.1 Location Map

Drawing 3787-D-01.1 Biophysical Conditions Transect 1

Drawing 3787-D-02.1 Biophysical Conditions Transect 2

Drawing 3787-D-03.1 Biophysical Conditions Transect 3

Drawing 3787-D-04.1 Biophysical Conditions Transect 4

Drawing 3787-D-05.1 Biophysical Conditions Transect 5

Drawing 3787-D-06.1 Biophysical Conditions Transect 6

Drawing 3787-D-07.1 Biophysical Conditions Transect 7

Drawing 3787-D-08.1 Biophysical Conditions Transect 8

Drawing 3787-D-09.1 Berths 2 & 6 Fish Refugia and Berth 1 Trays

Aerial Photo Project Site in Metro Vancouver

DRAWING NOTES (3787-D-01.1 through 07.1)

- All Drawings are not As-Built.
- Transect location positions are approximated and based on local geographical features.
- Biophysical survey was conducted between October 13th and 15th, 2015.
- All elevations are in metres and related to Canadian Hydrographic Service Chart Datum and taken from Public Works Canada Survey 2012 drawing CEP-XR-Bathymetric Survey (2D).dwg dated April 8, 2014.
- The information, including bathymetric and survey data, presented on the drawings may vary from current conditions due to the passage of time or seasonal changes in substrate and biota.
- The data presented on the drawings represents, in general terms, the substrate and biota types.
- Substrate and biota are mapped on the basis of "presence" (not density), however, the number of tags/symbols present in a given area can provide, in relative terms, an indication of abundance and uniformity. Where tags/symbols are grouped together in an area, the tagged substrate or biota can be assumed to be contiguous.

Ref. No.	REFERENCE

Client

AECOM

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Checked by	xie
Drawn by	DB
Date	28-FEB-16
Scale	see barscale
Inspectors	DV, TB, DV
Paper	11 x 17

PROJECT

LOCATION MAP SHOWING
BIOPHYSICAL SURVEY SITES AT
PORT METRO'S CENTERM TERMINALS,
VANCOUVER, BRITISH COLUMBIA

DWG. No. 3787 -D-00.1

Photo 3. Large stable substrates provide attachment points for encrusting species and feeding opportunities for Leather Stars.

Photo 4. Wire mesh Gabions filled with cobbles found amongst rip rap boulders and cobbles.

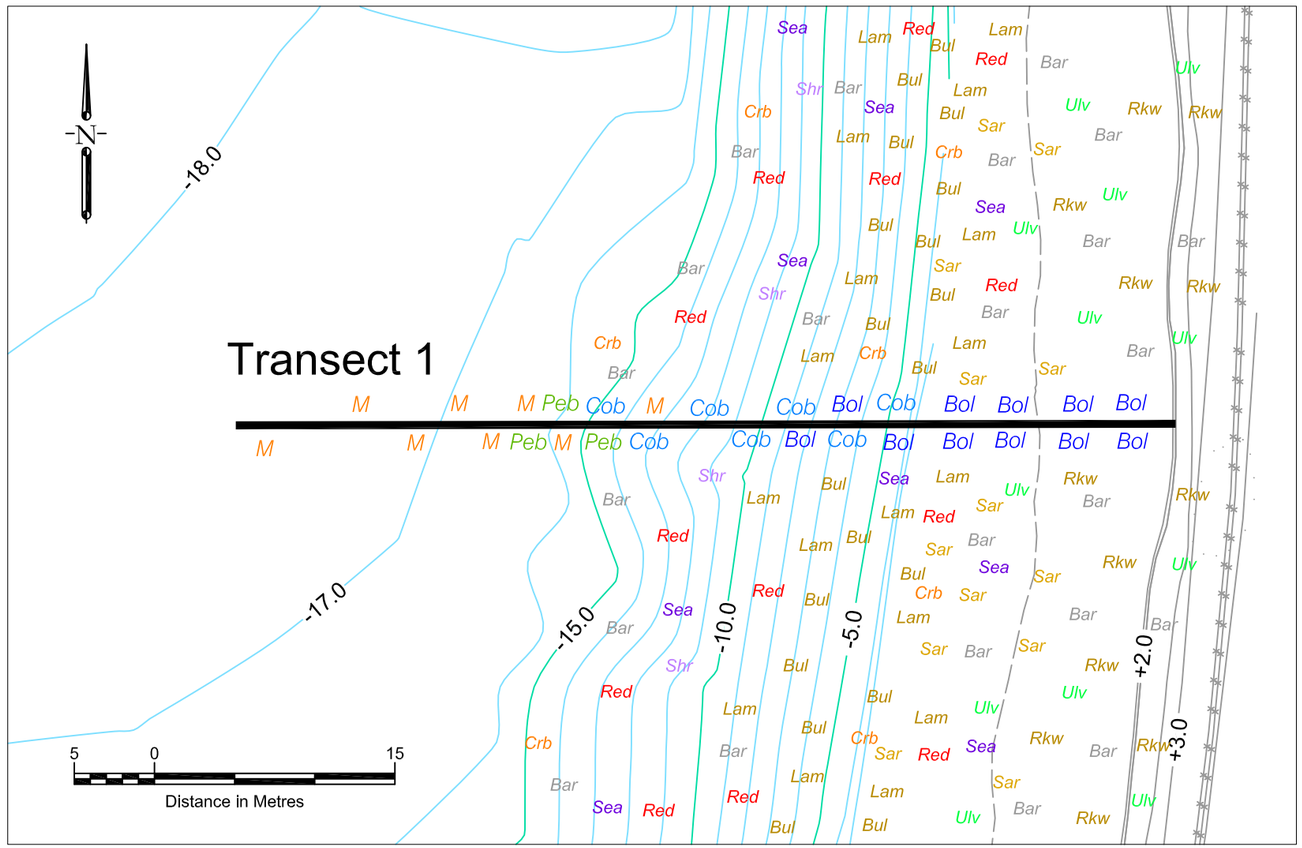
Photo 5. Perch were found throughout Transect 1 along with well established algae communities.

Photo 6. Lingcod amongst subtidal cobble/boulders.

Photo 7. Gravel/pebble substrates found at the toe of the rip rap slope.

Photo 2. Green sea lettuce, kelp and broad bladed algae were abundant in areas with hard stable substrates.

Photo 1. Upper intertidal and riparian zone rip rap substrates at the shoreward end of Transect 1.



DRAWING NOTES

- See Drawing 3787-D-00.1

LEGENDS

Substrate

Ant	Anthropogenic Materials
Bed	Bedrock
RR	Riprap (Angular rock > 64mmØ)
Bol	Boulders (>255mmØ)
Cob	Cobble (64mm to 255mmØ)
Peb	Pebble (2mm to 64mmØ)
S	Sand (0.0625mm to 2mmØ)
M	Mud (<0.0625mmØ)
Shl	Shell Hash
Wd	Woody Debris

BIOTA

Ane	Anemone
Bar	Barnacles
Bul	Bull Kelp
Crb	Crabs
Lam	Laminarian
Mus	Mussels
Red	Red Algae
Rkw	Rockweed
Sar	Sargassum
Ulv	Sea Lettuce
Sea	Sea Star
Shr	Shrimp
Tub	Tube Worms
Urc	Sea Urchin

Ref. No.	REFERENCE

Client: AECOM

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Drawn by	DB
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Scale	see barscale
Inspectors	DV, TB, DV
Paper	11 x 17

PROJECT
TRANSECT 1
BIOPHYSICAL SURVEY
CENTERM TERMINAL,
VANCOUVER, BRITISH COLUMBIA

DWG. No. 3787-D-01.1

Photo 3. Dungeness crabs were found throughout the survey.

Photo 4. Broad bladed algae attached to cobbles on Transect 2.

Photo 5. Gravel substrates found at the toe of the rip rap slope between Transects 2 and 4.

Photo 6. Boulders amongst silt/mud substrates at the base of the rip rap slope on Transect 2.

Photo 7. Dungeness crab (buried) and shrimp at toe of rip rap slope.

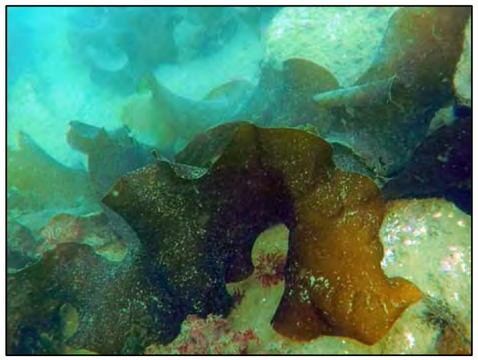
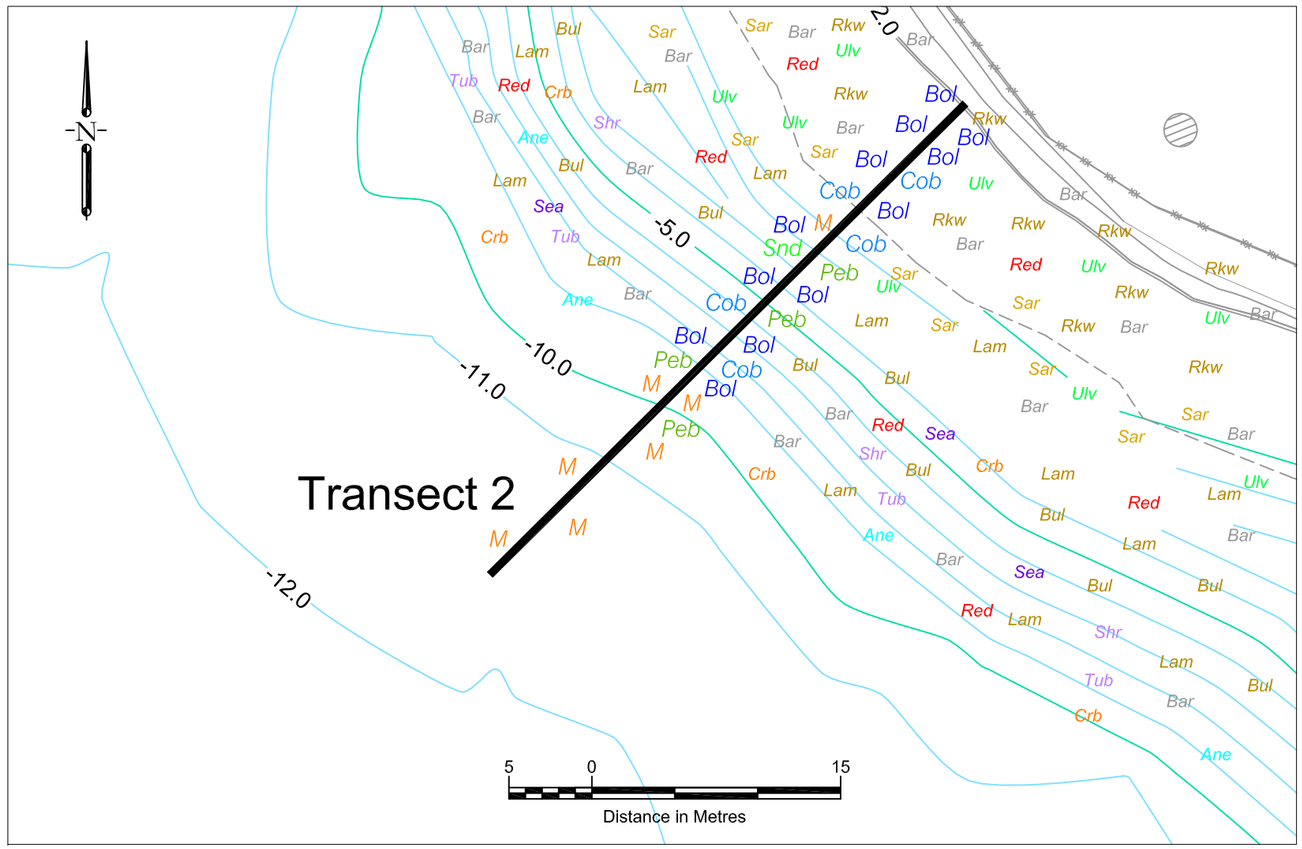


Photo 2. Broad bladed algae common to shallow subtidal areas.

Photo 1. Sea lemon, barnacles and red algae identified on rip rap along Transect 2.



DRAWING NOTES

- See Drawing 3787-D-00.1

LEGENDS

Substrate

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Bed	Bedrock
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PROJECT
TRANSECT 2
BIOPHYSICAL SURVEY
CENTERM TERMINAL,
VANCOUVER, BRITISH COLUMBIA

DWG. No. 3787 -D-02.1

Photo 3. Bull kelp (*Nereocystis luetkeana*) near Transect 3.

Photo 4. Broad bladed algae attached to large stable rip rap.

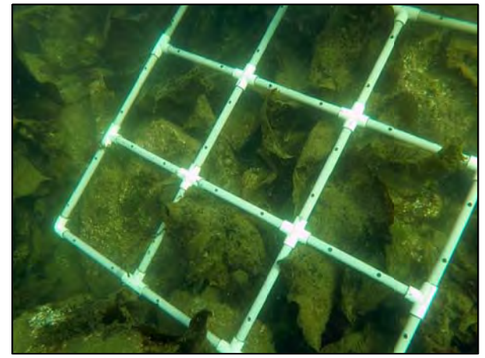


Photo 5. Quadrat placed over typical shallow subtidal substrate and biota.

Photo 6. Sugar kelp (*Laminaria saccharina*) common to the shallow subtidal areas of the rip rap slopes.

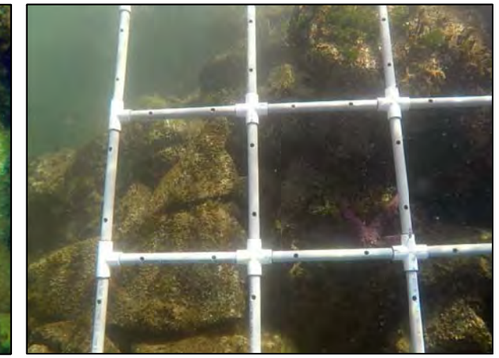


Photo 7. South end of Transect 3 in the mid intertidal to lower intertdial zone with Purple Ochre Star and Barnacles.

Photo 2. Divers at setting up the start point for Transect 3 on rip rap slope.

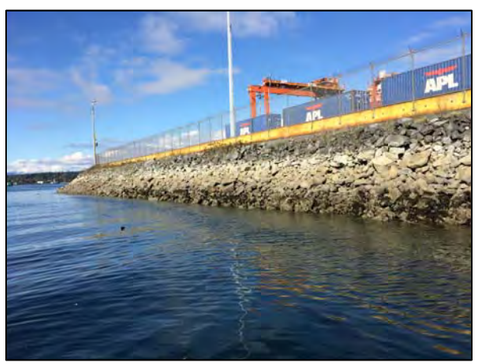
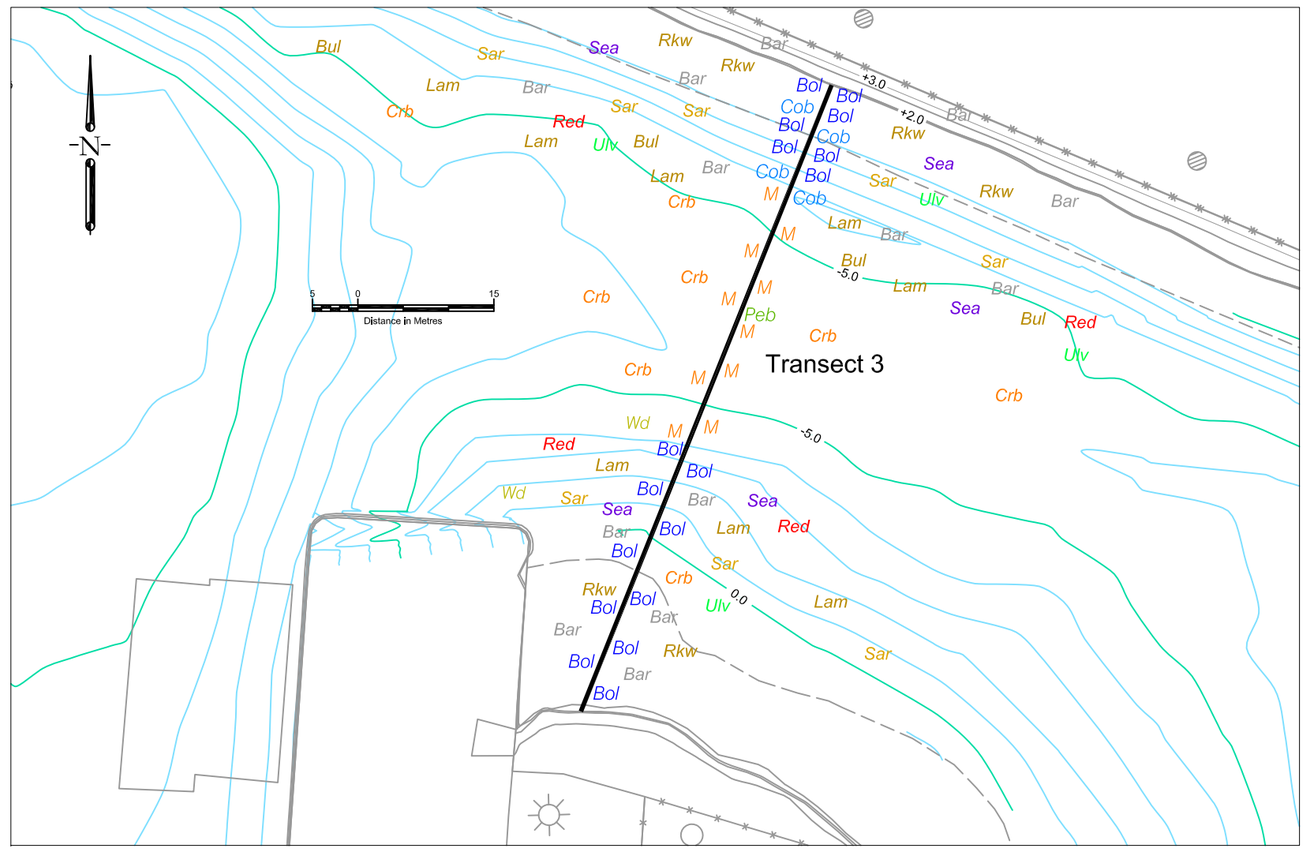


Photo 1. Looking west along rip rap slope from Transect 3.



DRAWING NOTES

- See Drawing 3787-D-00.1

LEGENDS

Substrate

Ant	Anthropogenic Materials
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Wd	Woody Debris

BIOTA

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Mus	Mussels
Red	Red Algae
Rkw	Rockweed
Sar	Sargassum
Ulv	Sea Lettuce
Sea	Sea Star
Shr	Shrimp
Tub	Tube Worms
Urc	Sea Urchin

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PROJECT

TRANSECT 3
BIOPHYSICAL SURVEY
CENTERM TERMINAL,
VANCOUVER, BRITISH COLUMBIA

DWG. No. 3787 -D-03.1

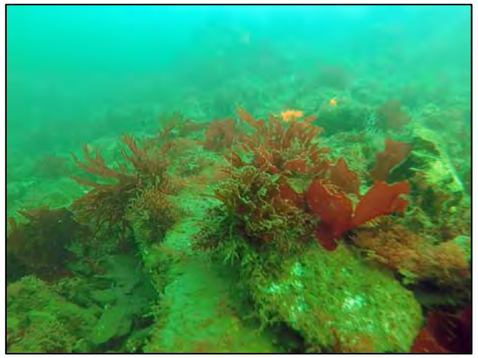


Photo 3. Red bladed algae attached to stable rip rap substrate.

Photo 4. Gabions located along Transect 4.

Photo 5. Broad bladed algae attached to gabions in shallow subtidal.

Photo 6. Gravel substrates located at the toe of slope between Transect 4 and Transect 2.

Photo 7. Boulders and silt common to deeper subtidal areas along the toe of the rip rap slope.

Photo 2. Copper rockfish resting on large rip rap with anthropogenic debris in the background.

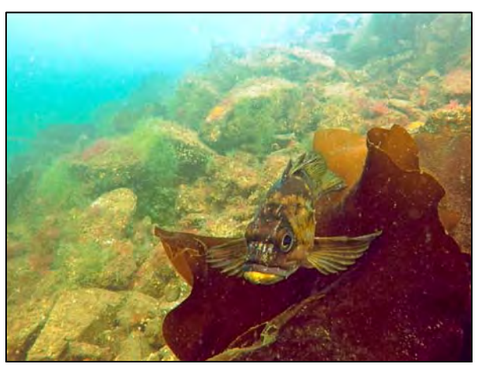
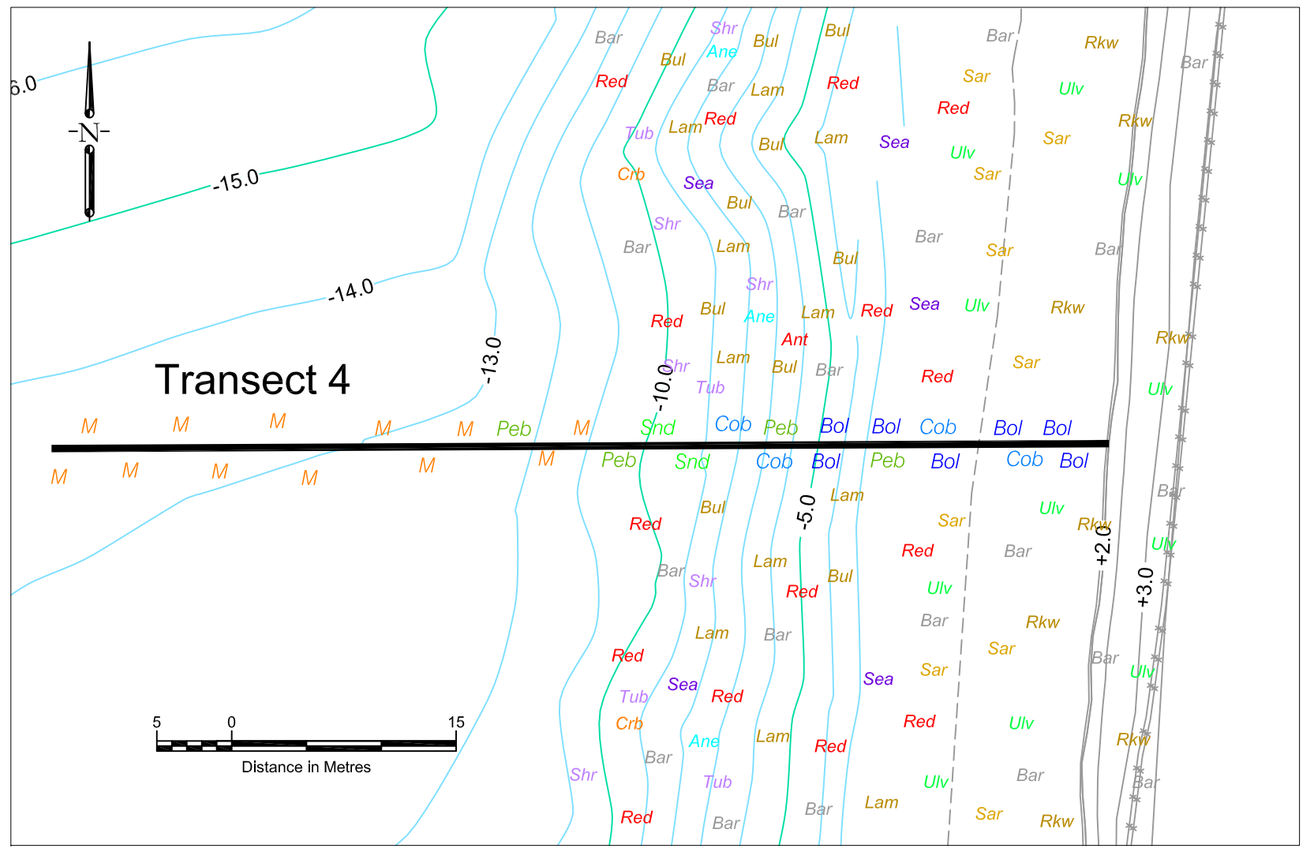


Photo 1. Copper rock fish found amongst the boulders and cobbles of Transect 4.



DRAWING NOTES

- See Drawing 3787-D-00.1

LEGENDS

Substrate

Ant	Anthropogenic Materials
Bed	Bedrock
RR	Riprap (Angular rock > 64mmØ)
Bol	Boulders (>255mmØ)
Cob	Cobble (64mm to 255mmØ)
Peb	Pebble (2mm to 64mmØ)
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M	Mud (<0.0625mmØ)
Shl	Shell Hash
Wd	Woody Debris

BIOTA

Ane	Anemone
Bar	Barnacles
Bul	Bull Kelp
Crb	Crabs
Lam	Laminarian
Mus	Mussels
Red	Red Algae
Rkw	Rockweed
Sar	Sargassum
Ulv	Sea Lettuce
Sea	Sea Star
Shr	Shrimp
Tub	Tube Worms
Urc	Sea Urchin

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PROJECT
TRANSECT 4
BIOPHYSICAL SURVEY
CENTERM TERMINAL,
VANCOUVER, BRITISH COLUMBIA

DWG. No. 3787 -D-04.1

Photo 3. Leather star (*Dermasterias imbricata*).

Photo 4. Kelp perch (*Brachyistius frenatus*) amongst green and broad bladed algae attached to large rip rap.

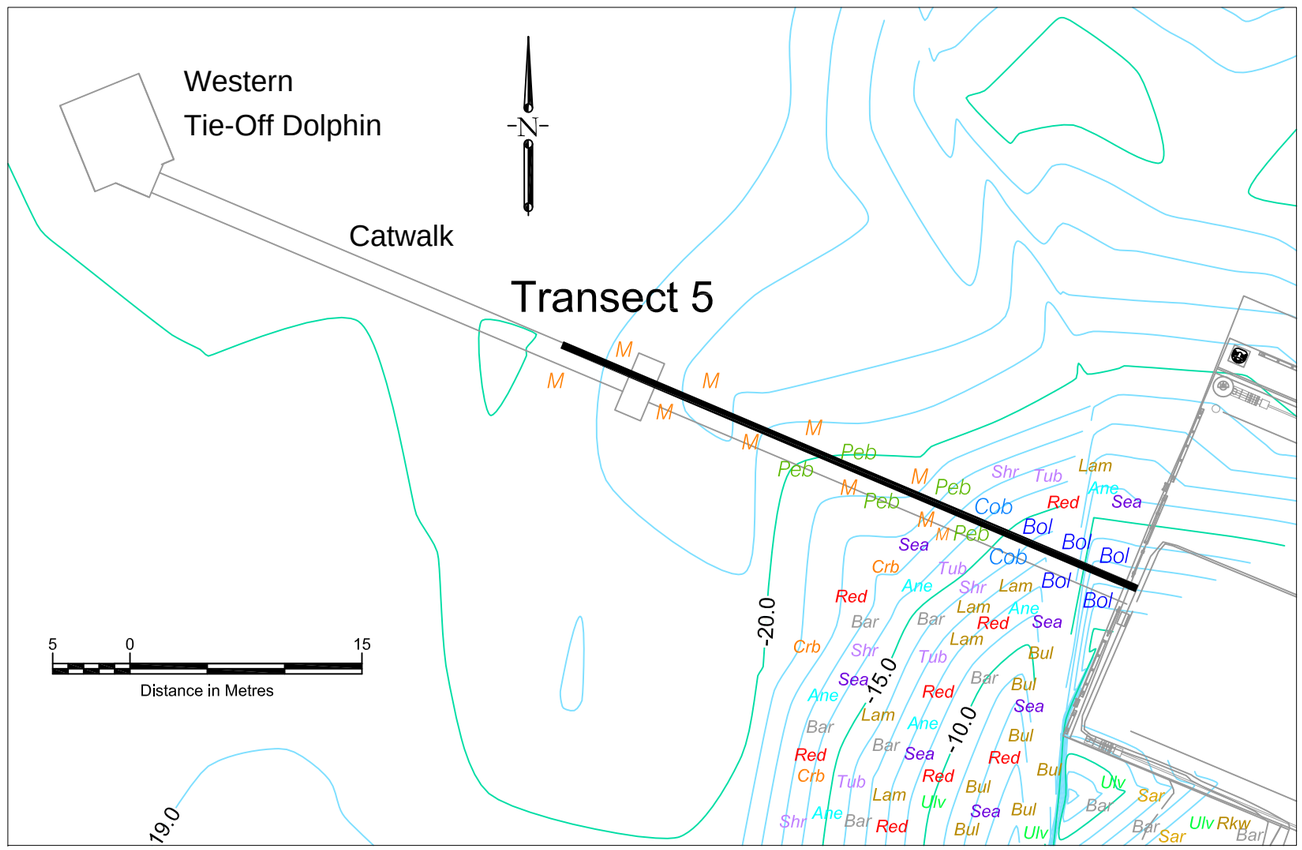
Photo 5. Sea Cucumber (*Parastichopus californicus*).

Photo 6. Bull Kelp holdfast.

Photo 7. Perch amongst large rip rap.

Photo 2. Perch common to the rip rap slope areas.

Photo 1. Western end of Centerm at the start of Transect 5.



DRAWING NOTES

- See Drawing 3787-D-00.1

LEGENDS

Substrate

Ant	Anthropogenic Materials
Bed	Bedrock
RR	Riprap (Angular rock > 64mmØ)
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BIOTA

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Crb	Crabs
Lam	Laminarian
Mus	Mussels
Red	Red Algae
Rkw	Rockweed
Sar	Sargassum
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PROJECT

TRANSECT 5
BIOPHYSICAL SURVEY
CENTERM TERMINAL,
VANCOUVER, BRITISH COLUMBIA

DWG. No. 3787 -D-05.1

Photo 3. Plumose anemones clustered on a boulder.

Photo 4. Dungeness crab amongst mud/silt covered wood debris.

Photo 5. Plumose anemones were common where hard substrates presented in deeper subtidal zones.

Photo 6. Mud/silt was the predominant substrate found in deeper subtidal zones.

Photo 7. Painted anemone (*Urticina crassicornis*) attached to a bottle. Note underlying cobbles/pebbles.

Photo 2. Red rock crab located near face of Berth 1.

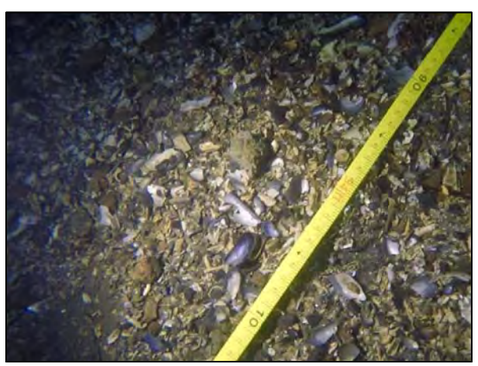
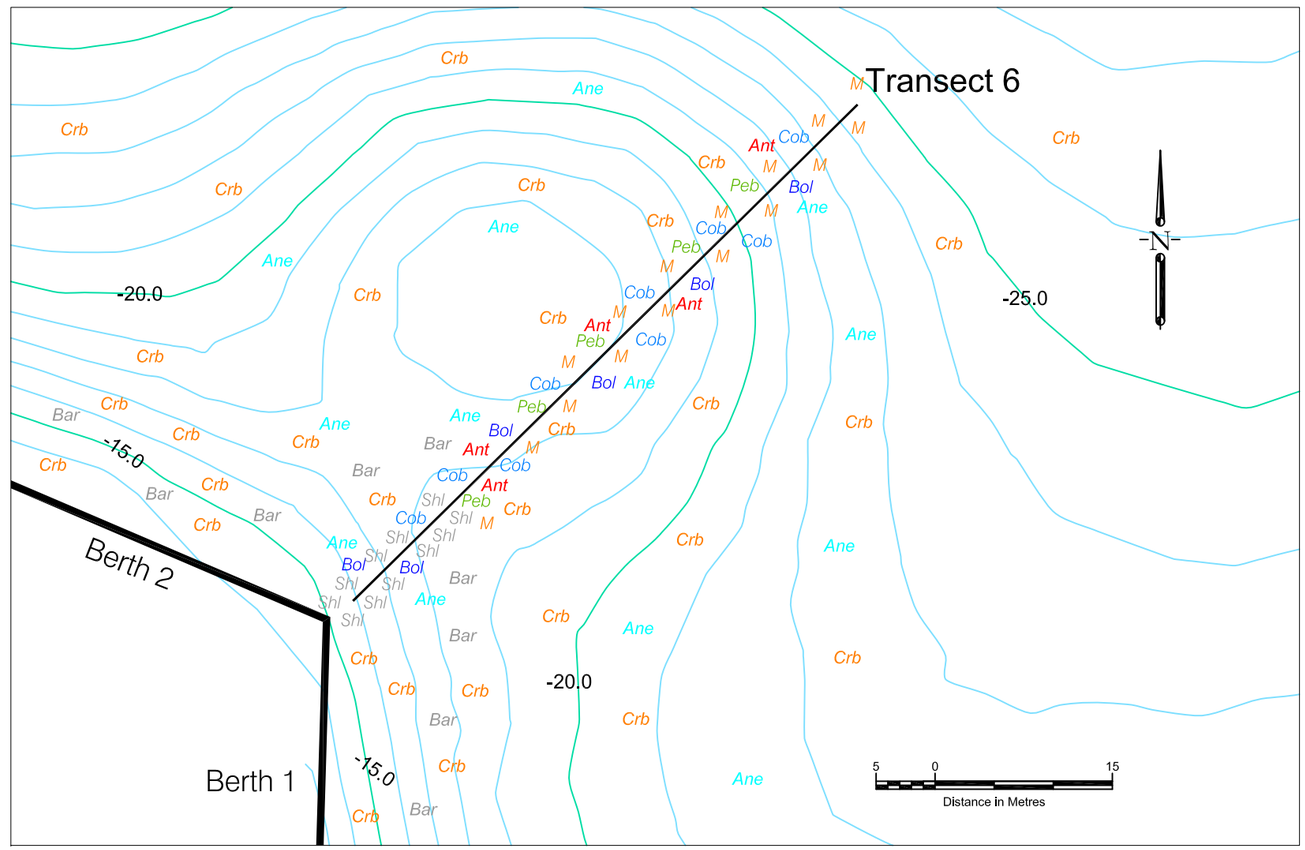


Photo 1. Shell hash substrate common along perimeter of Centerm, Berth 1 and 2.



DRAWING NOTES

- See Drawing 3787-D-00.1

LEGENDS

Substrate

Ant	Anthropogenic Materials
Bed	Bedrock
RR	Riprap (Angular rock > 64mmØ)
Bol	Boulders (>255mmØ)
Cob	Cobble (64mm to 255mmØ)
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BIOTA

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PROJECT

TRANSECT 6
BIOPHYSICAL SURVEY
CENTERM TERMINAL,
VANCOUVER, BRITISH COLUMBIA

DWG. No. 3787 -D-06.1

Photo 3. Dungeness crab, wood debris and an exposed cobble on a mud/silt seabed.

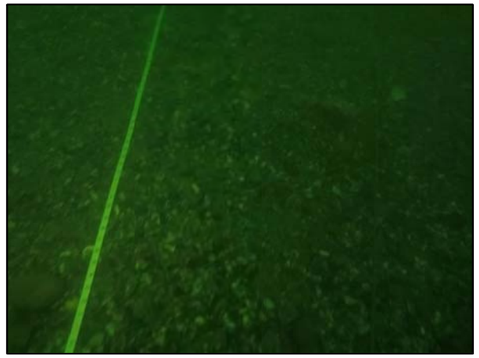


Photo 4. Area of shell hash located adjacent o the Berth 1 face..

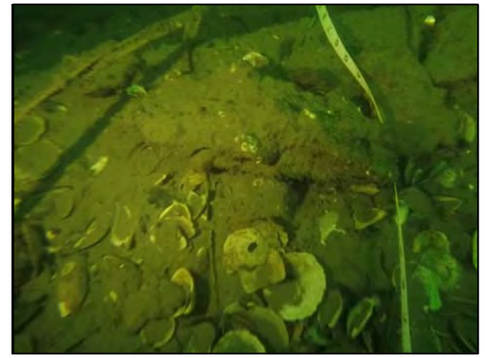


Photo 5. Deposit of clam shells found amongst mud/silt covered wood debris.

Photo 6. Boulder day-lighting through mud/silt layer.

Photo 7. Cobble on mud/silt seabed.

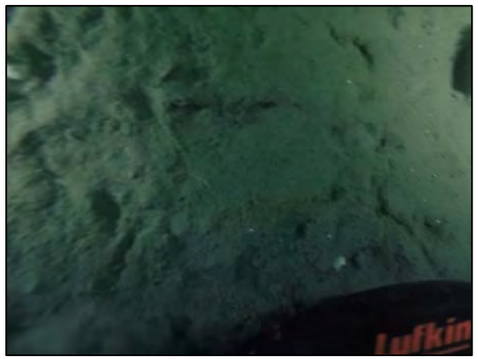
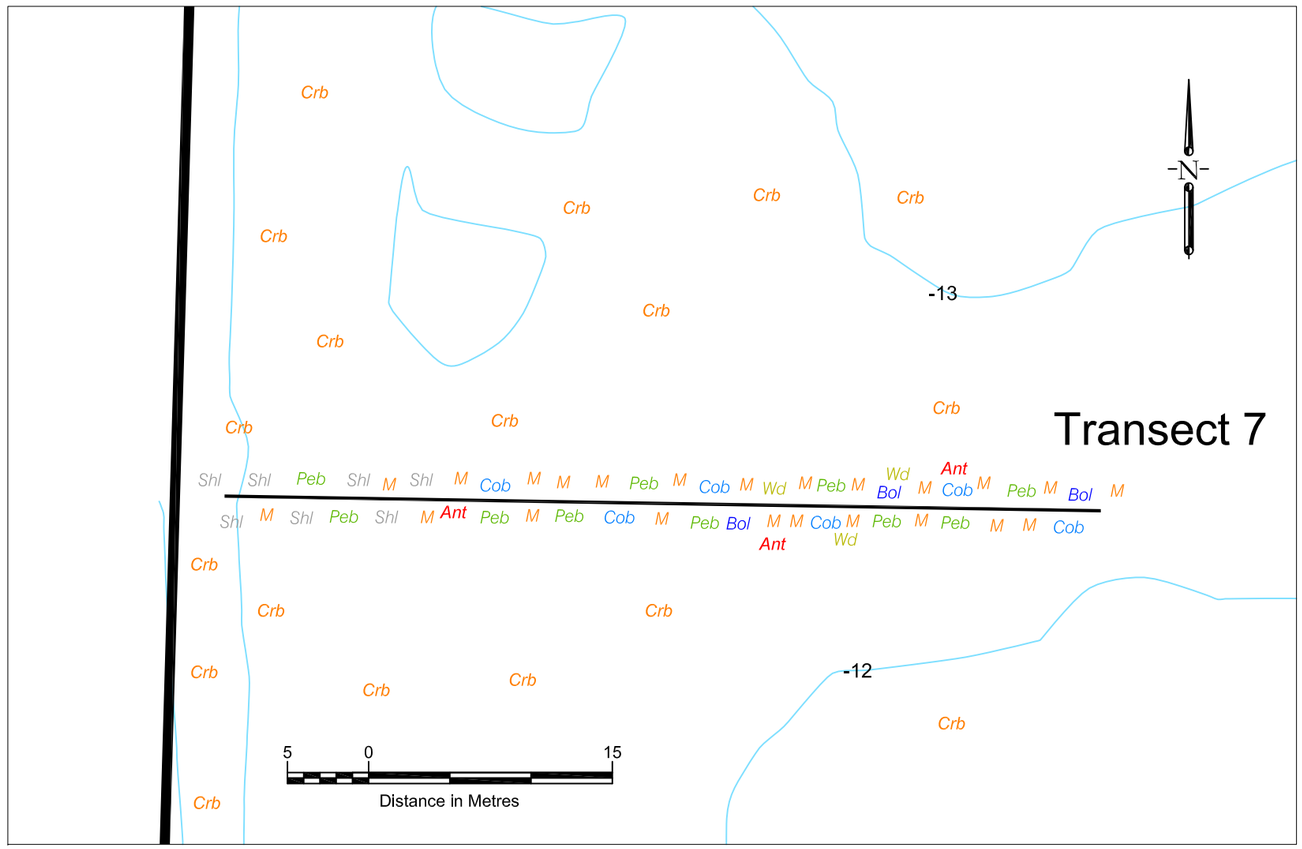


Photo 2. Mud/silt substrates typical of deeper subtidal zones surrounding Centerm.

Photo 1. Mud/silt substrates and wood debris.



DRAWING NOTES

- See Drawing 3787-D-00.1

LEGENDS

Substrate

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Wd	Woody Debris

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PROJECT

TRANSECT 7
BIOPHYSICAL SURVEY
CENTERM TERMINAL,
VANCOUVER, BRITISH COLUMBIA

DWG. No. 3787 -D-07.1

Photo 3. Uncommon boulder daylights through mud seabed with plumose anemone and barnacles attached.

Photo 4. Clam shells found mixed in with mud substrates in central areas of the berth.

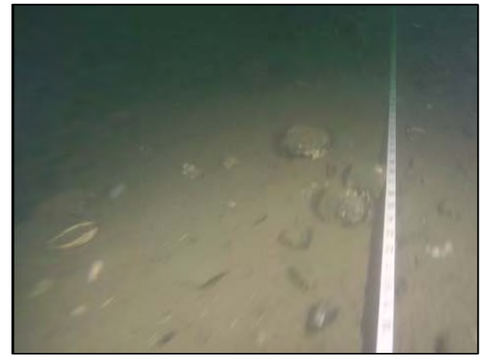


Photo 5. Substrates become siltier further from the berth face with less shel hash. Pebbles and cobbles still present.

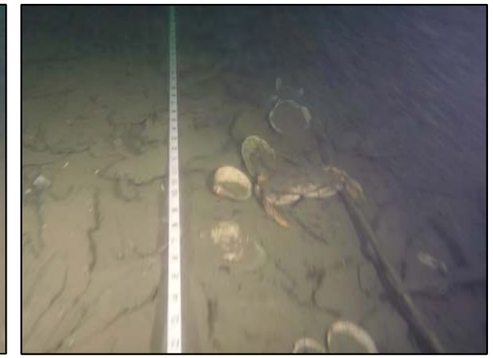


Photo 6. Dungeness crabs were found throughout the survey area.

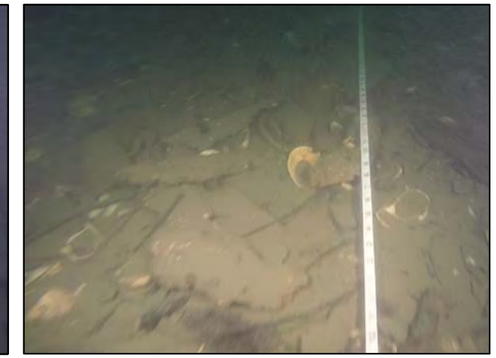


Photo 7. Wood debris covering 100% of the seabed.

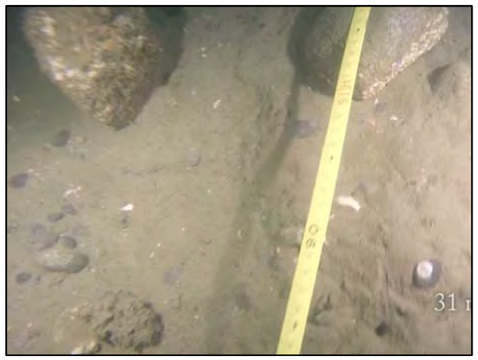


Photo 2. Mud/silt/pebble/cobble typical of areas beyond the shell hash fringe along berth face.

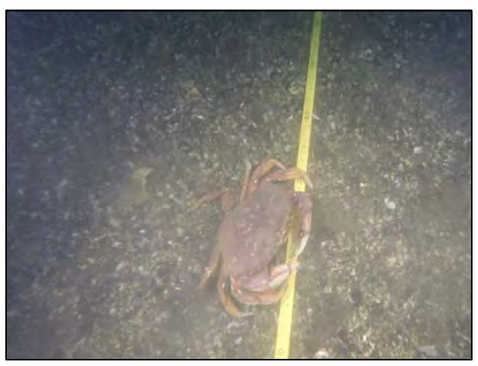
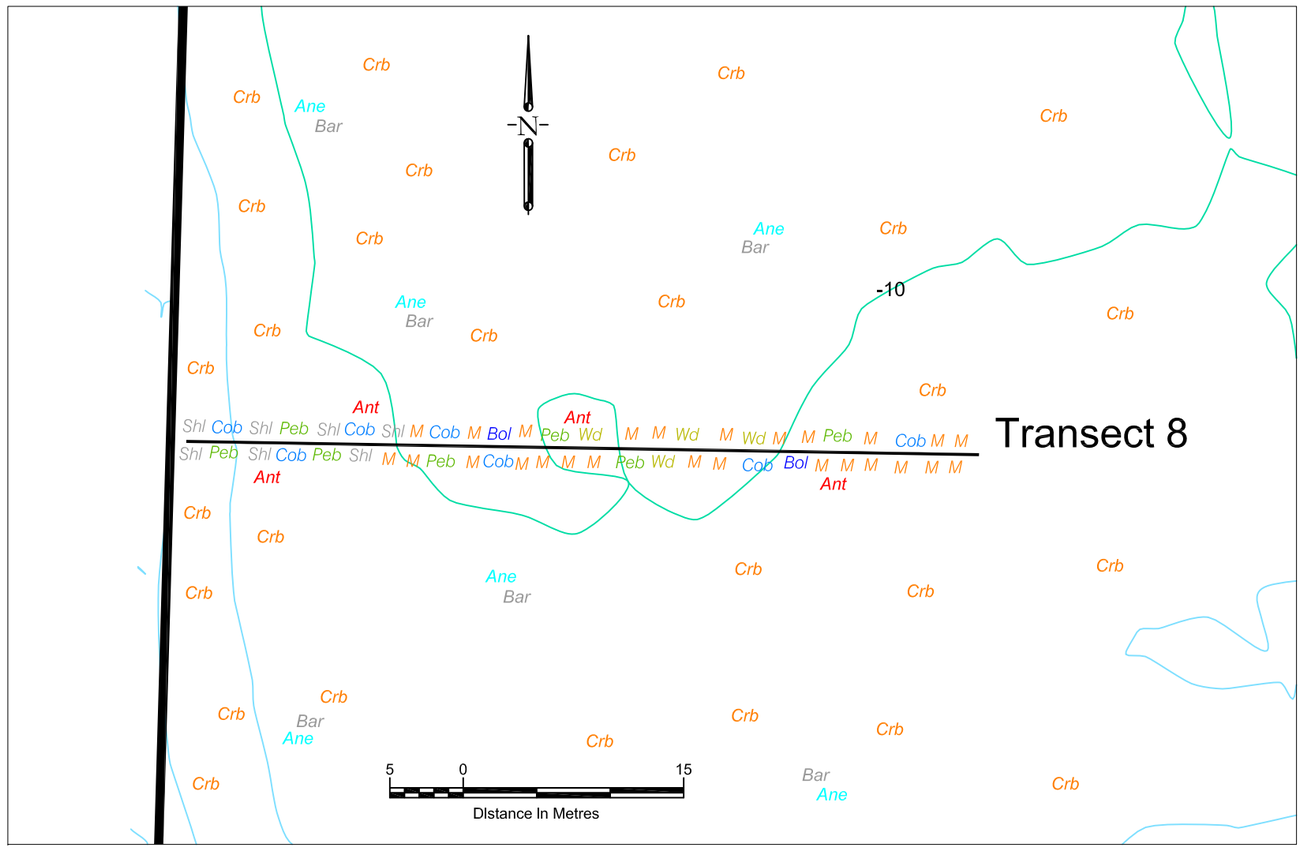


Photo 1. Red rock crab and shell hash were commonly found along the berth face.



DRAWING NOTES

- See Drawing 3787-D-00.1

LEGENDS

Substrate

Ant	Anthropogenic Materials
Bed	Bedrock
RR	Riprap (Angular rock > 64mmØ)
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PROJECT

TRANSECT 8
BIOPHYSICAL SURVEY
CENTERM TERMINAL,
VANCOUVER, BRITISH COLUMBIA

DWG. No. 3787 -D-08.1

Photo 3. Cargo habitat net hung inside Berth 2 fish refugia.

Photo 4. Baby seal at Berth 2 face.

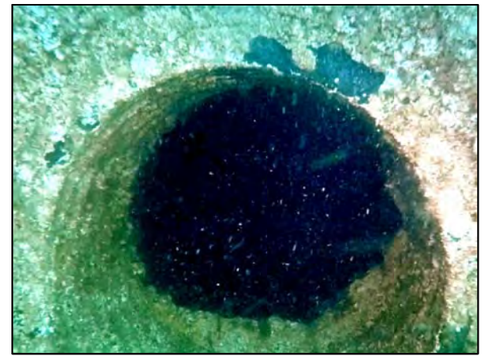

Photo 5. Typical entrance to Berth 6 fish refugia.

Photo 6. Cloudy water column typical of the lower regions of the Berth 6 fish refugia

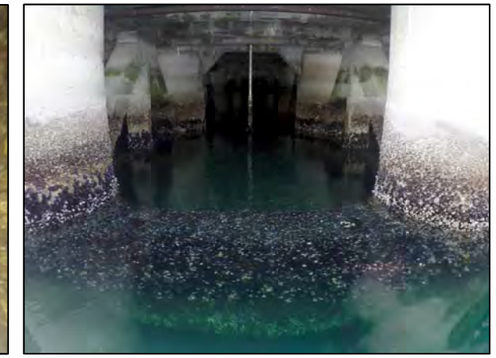

Photo 7. Berth 1 cobble tray located below the water surface inset from the berth face.

Photo 2. Entrance to Berth 2 fish refugia.

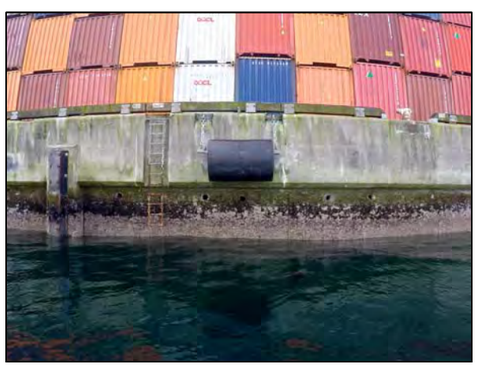

Photo 1. Berth 2 face above fish refugia.

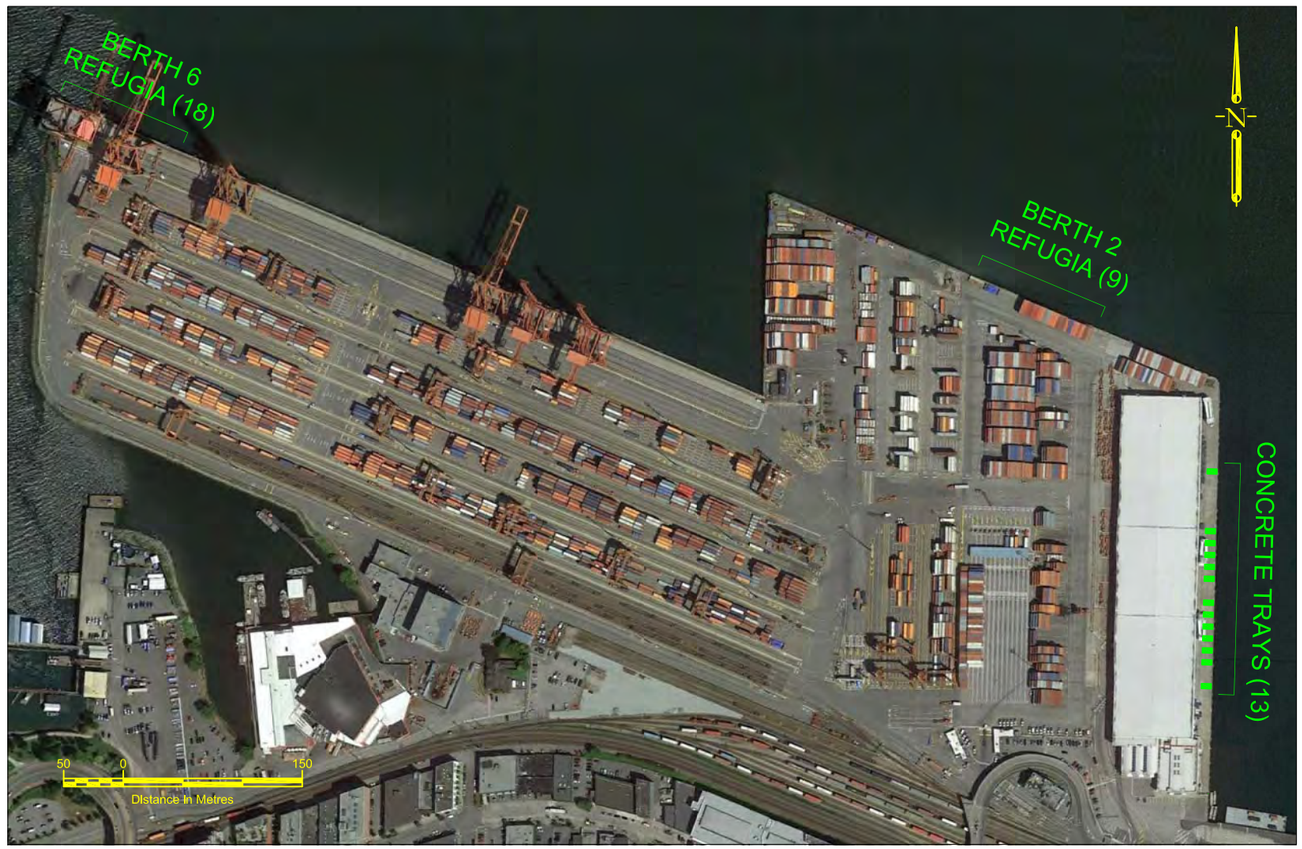

Photo 8. Cobble/pebble substrate located on upper surfaces of concrete trays.

Photo 9. Shell hash debris (typical) and a Green Urchin (rare) found on cobble tray.

Ref. No.	REFERENCE

Client

AECOM

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Checked by	XIE
Drawn by	DB
Date	08-NOV-15
Scale	1:250
Inspectors	DV, TB, DV
Paper	11 x 17

PROJECT

BIOPHYSICAL SURVEY OF
BERTHS 2 & 6 FISH REFUGIA AND
BERTH 1 COBBLE TRAYS, CENTERM TERMINAL,
VANCOUVER, BRITISH COLUMBIA

DWG. No. 3787 -D-09.1

APPENDIX 3

Table 1 - Transect 1 Abundance Estimates for Selected Biota Groups

Biota Type/Group	Highest Level of Abundance		Elev. Range (m) Chart Datum	
	Amount	% Areal Coverage or No. of Individuals	Upper	Lower
Plants				
Bladed Brown Algae	Few	26% to 50%	-1.0	-5.0
Bull Kelp	Common	11 to 30	-2.0	-6.0
Green Algae	Few	26% to 50%	2.0	-3.0
Red Algae	Common	51% to 75%	0.5	-7.0
Rockweed	Sparse	5% to 25%	3.8	1.0
Animals				
Barnacles	Common	51% to 75%	2.0	-15.0
Dungeness Crabs	Sparse	2 to 5	-5.0	-25.0
Lingcod	Sparse	2 to 5	-6.0	-12.0
Perch	Abundant	>30	-3.0	-8.0
Rockfish	Sparse	2 to 5	-5.0	-10.0
Sea Stars	Few	6 to 10	1.0	-20.0
Shrimp	Abundant	>30	-10.0	-20.0

Table 2 - Transect 2 Abundance Estimates for Selected Biota Groups

Biota Type/Group	Highest Level of Abundance		Elev. Range (m) Chart Datum	
	Amount	% Areal Coverage or No. of Individuals	Upper	Lower
Plants				
Bladed Brown Algae	Abundant	>75%	0.5	-8.5
Bull Kelp	Sparse	2 to 5	-3.0	-6.0
Green Algae	Few	26% to 50%	2.0	-1.0
Red Algae	Few	26% to 50%	1.0	-8.5
Rockweed	Few	26% to 50%	3.8	0.9
Animals				
Barnacles	Common	51% to 75%	3.9	-8.5
Dungeness Crabs	Abundant	>30	-3.0	-12.5
Sea Stars	Few	6 to 10	-1.0	-8.0
Shrimp	Abundant	>30	-3.0	-8.0
Perch	Abundant	>30	-2.0	-7.0

Table 3 - Transect 3 Abundance Estimates for Selected Biota Groups

Biota Type/Group	Highest Level of Abundance		Elev. Range (m) Chart Datum	
	Amount	% Areal Coverage or No. of Individuals	Upper	Lower
Plants				
Bladed Brown Algae	Common	51% to 75%	0.4	-4.5
Bull Kelp	Common	11 to 30	-1.0	-4.5
Green Algae	Sparse	5% to 25%	2.0	-1.0
Red Algae	Sparse	5% to 25%	0.5	-4.5
Rockweed	Few	26% to 50%	3.5	1.0
Animals				
Barnacles	Abundant	>75%	3.5	-4.0
Dungeness Crabs	Common	11 to 30	-4.0	-5.0
Sea Stars	Common	11 to 30	-1.0	-4.0
Shrimp	Abundant	>30	-2.0	-5.0
Perch	Abundant	>30	1.0	-5.0

Table 4 - Transect 4 Abundance Estimates for Selected Biota Groups

Biota Type/Group	Highest Level of Abundance		Elev. Range (m) Chart Datum	
	Amount	% Areal Coverage or No. of Individuals	Upper	Lower
Plants				
Bladed Brown Algae	Few	26% to 50%	0.4	-6.5
Bull Kelp	Common	11 to 30	-1.0	-6.5
Green Algae	Sparse	5% to 25%	2.0	-1.0
Red Algae	Common	51% to 75%	0.5	-6.5
Rockweed	Common	51% to 75%	3.8	0.9
Animals				
Barnacles	Common	51% to 75%	3.9	-15.0
Dungeness Crabs	Sparse	2 to 5	-2.0	-15.0
Perch	Abundant	>30	-1.0	-10.0
Rockfish	Sparse	2 to 5	-5.0	-10.0
Sea Stars	Sparse	2 to 5	1.7	-12.0
Shrimp	Abundant	>30	-1.0	-10.0

Table 5 - Transect 5 Abundance Estimates for Selected Biota Groups

Biota Type/Group	Highest Level of Abundance		Elev. Range (m) Chart Datum	
	Amount	% Areal Coverage or No. of Individuals	Upper	Lower
Plants				
Bladed Brown Algae	Few	26% to 50%	0.4	-6.0
Bull Kelp	Common	11 to 30	-1.0	-7.0
Green Algae	Few	26% to 50%	2.0	-1.0
Red Algae	Sparse	5% to 25%	0.5	-6.0
Rockweed	Sparse	5% to 25%	3.8	0.9
Animals				
Anemones	Few	6 to 10	-3.0	-9.0
Barnacles	Common	51% to 75%	3.9	-20.0
Dungeness Crabs	Sparse	2 to 5	-2.0	-25.0
Lingcod	Rare	1	-5.0	-10.0
Perch	Abundant	>30	-1.0	-10.0
Sea Stars	Common	11 to 30	1.7	-18.0
Shrimp	Abundant	>30	-1.0	-25.0

Table 6 - Transect 6 Abundance Estimates for Selected Biota Groups

Biota Type/Group	Highest Level of Abundance		Elev. Range (m) Chart Datum	
	Amount	% Areal Coverage or No. of Individuals	Upper	Lower
Animals				
Anemones	Few	6 to 10	-15.0	-30.0
Barnacles	Sparse	5% to 25%	-15.0	-20.0
Dungeness/Red Rock Crabs	Common	11 to 30	-15.0	-30.0

Table 7 - Transect 7 Abundance Estimates for Selected Biota Groups

Biota Type/Group	Highest Level of Abundance		Elev. Range (m) Chart Datum	
	Amount	% Areal Coverage or No. of Individuals	Upper	Lower
Animals				
Dungeness/Red Rock Crabs	Common	11 to 30	-11.0	-13.0

Table 8 - Transect 8 Abundance Estimates for Selected Biota Groups

Biota Type/Group	Highest Level of Abundance		Elev. Range (m) Chart Datum	
	Amount	% Areal Coverage or No. of Individuals	Upper	Lower
Animals				
Anemones	Few	6 to 10	-9.0	-10.0
Barnacles	Sparse	5% to 25%	-9.0	-10.0
Dungeness/Red Rock Crabs	Common	11 to 30	-9.0	-10.0

Table 12. Observed Biota, Port Metro Vancouver Centerm Terminal

		Transects								Refugia		Trays
Common Name	**Scientific Name**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**Berth 2**	**Berth 6**	**Berth 1**
Algae												
Argarum	*Agarum fimbriatum*	✓	✓	✓	✓	✓						
Branched Red	*Unidentified*	✓	✓	✓	✓	✓						
Bull Kelp	*Nereocystis luetkeana*	✓	✓	✓	✓	✓						
Crustose Coraline	*Various species*	✓	✓	✓	✓	✓						
Japanese Weed	*Sargassum muticum*	✓	✓	✓	✓	✓						
Red Blade	*Neodilsea borealis*	✓	✓	✓	✓	✓						
Rockweed	*Fucus gardneri*	✓	✓	✓	✓	✓						
Sea Lettuce	*Ulva spp.*	✓	✓	✓	✓	✓						
Split Kelp	*Saccharina groenlandica*	✓	✓	✓	✓	✓						
Sugar Wrack Kelp	*Saccharina latissima*	✓	✓	✓	✓	✓						
Crustaceans												
Shrimp	*Pandalus spp.*	✓	✓	✓	✓	✓				✓	✓	
Dungeness Crab	*Cancer magister*	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓
Hermit Crab	*Pagurus sp.*	✓										
Kelp Crab	*Pugettia gracillis*	✓										
Red Rock Crab	*Cancer productus*					✓	✓	✓	✓			
Echinoderms												
Leather Star	*Dermasterias imbricata*	✓	✓	✓		✓						
Mottled Star	*Evasterias troschelii*	✓										
Ochre Star	*Pisaster ochraceus*	✓		✓	✓	✓				✓	✓	
Giant Pink Star	*Pisaster brevispinus*					✓						
Green Urchin	*Strongylocentrotus droebachiensis*											✓
California Sea Cucumber	*Parastichopus californicus*					✓						
Fish												
Bay Gobey	*Lepidogobius lepidus*	✓										
Copper Rockfish	*Sebastes caurinus*	✓			✓							
Pile Perch	*Rhacochilus vacca*	✓			✓							
Shiner Perch	*Cymatogaster aggregata*	✓	✓	✓								
Kelp Perch	*Brachyistius frenatus*	✓	✓	✓	✓	✓						
Ling Cod	*Ophiodon elongatus*	✓				✓						
Striped Perch	*Embiotoca lateralis*	✓	✓	✓		✓						
Mammals												
Harbour Seal	*Phoca vitulina richardsi*									✓		
Molluscs												
Acorn Barnacle	*Balanus glandula*	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓
Bay Mussel	*Mytilus trossulus*									✓		✓
Chiton	*Tonicella and Mopalia spp.*									✓	✓	
Limpet	*Tectura spp.*	✓				✓						
Sea Lemon Nudibranch	*Doris montereyensis*		✓									
Sea Anemones												
Painted	*Urticina crassicornis*						✓					
Plumose	*Metridium senile*			✓		✓	✓		✓			
Tube-dwelling	*Pachycerianthus fimbriatus*					✓						
Tunicates												
Shiny Orange Sea Squirt	*Cnemidocarpa finmarkiensis*									✓	✓	
Tube Worms												
Calcareous	*unidentified*	✓	✓	✓	✓	✓				✓	✓	
Feather Duster	*Eudistylia vancouveri*									✓		

AECOM

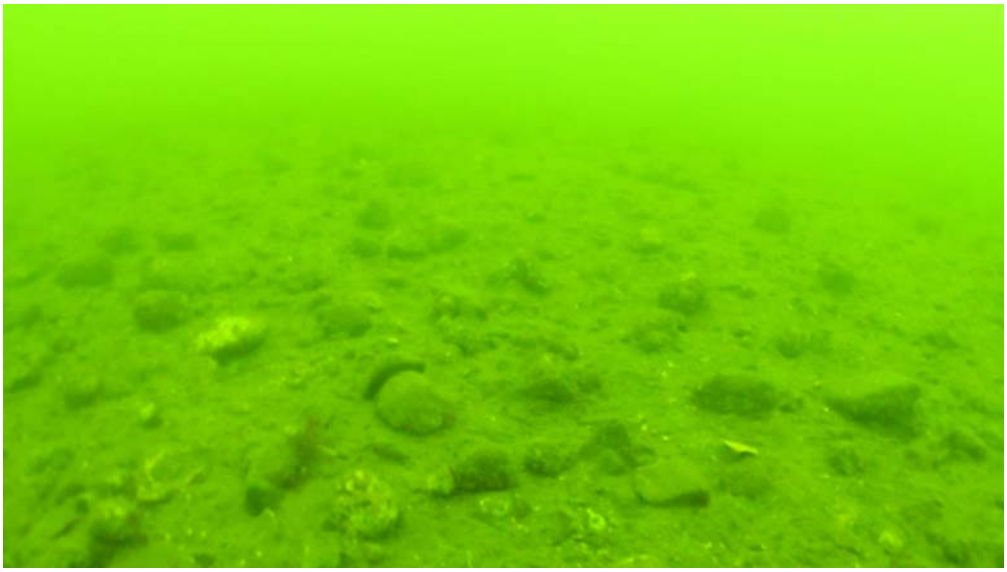
Appendix G2

Biophysical Assessment September 2016 (Foreshore Technologies)

Report Number: 3841-R-01.0

BIOPHYSICAL ASSESSMENT

BIOPHYSICAL SURVEY RESULTS OF SELECTED SEABED AREAS
FRONTING THE VANCOUVER SEABUS TERMINAL, VANCOUVER, B.C.
SEPTEMBER 14, 2016



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SUMMARY OF PROJECT SCOPE

Foreshore Technologies Inc. (Foreshore) has been secured by AECOM (Proponent) to perform a biophysical survey (the Project) of the seabed fronting the Vancouver SeaBus Terminal. The scope of work includes the collection and reporting on habitat conditions found in the subtidal zones including macro biota and seabed substrates.

CLARIFICATIONS REGARDING SERVICES/FINDINGS

Foreshore Technologies Inc. (Foreshore) prepared this report for the exclusive use of AECOM and the Vancouver Fraser Port Authority (VFPA). The contents, implied or written, of this document and its related media may not be utilized in whole or in part by any party other than AECOM and the VFPA without the signed written authorization of AECOM, VFPA or Foreshore.

This report has been duly prepared by qualified environmental professionals with knowledge and experience relevant to the Project and the scope of work.

Foreshore prepared this report in a manner consistent with generally accepted Qualified Environmental Professional (QEP) practices, and in a manner consistent with that level of care normally exercised by QEPs currently practicing under similar conditions. The information presented in this report is accurate and complete to the best of Foreshore's knowledge. The information contained within this report reflects the opinion and best judgment of Foreshore in light of the information available to it at the time the report was prepared.

This report has been prepared by Foreshore Technologies Inc.

Foreshore Technologies Inc.

Scott Christie, R.P.Bio
Senior Biologist/Principal

SECTION 0 TABLE OF CONTENTS

BIOPHYSICAL SURVEY RESULTS OF SELECTED SEABED AREAS FRONTING THE VANCOUVER SEABUS TERMINAL, VANCOUVER, BRITISH COLUMBIA

SECTION 1 INTRODUCTION

1.1 Project Overview

This biophysical survey was conducted in order to identify macro biophysical features and provide general condition statements regarding habitat conditions found on the seabed north of the Vancouver SeaBus Terminal.

1.2 Project Location

The Vancouver SeaBus Terminal is located on the south side of Vancouver's Inner Harbour in Burrard Inlet, east of the Vancouver Trade and Convention Centre/Cruise Ship Terminal and, west of the Heliport, see Drawing 3841-D-01.1 Location Maps in Appendix 1. The UTM and latitude/longitude coordinates for the site are generally:

Easting:	492067.21 m E	Latitude:	49° 17' 13.14" N
Northing:	5459365.68 m N	Longitude:	123° 6' 32.72" W
Zone:	10 U		

The facility operates a passenger only ferry service that connects Vancouver with the North Shore, departing every 15 minutes during the day and every 30 minutes in the evening.

The biophysical survey covers an area within the navigational channel of the ferries north of the Vancouver SeaBus Terminal. The survey site is irregular in shape and approximately 200m long and 80m wide covering a seabed area of almost 10,000 m^2, see Drawings 3841-D-2.1 and 03.1 in Appendix 2.

SECTION 2 BIOPHYSICAL SURVEY METHODOLOGY

2.1 General

The biophysical survey was conducted by SCUBA equipped Qualified Environmental Professionals (QEPs) operating from a boat on July 19, 2016. The large survey area coupled with the limited "safe" onsite dive time between SeaBus sailings, approximately six to nine minutes, required the use of the TOAD Sled in order to provide enough time onsite while effectively characterizing the biophysical conditions of the seabed, see Image 1 at right. The QEP Diver was towed along four Tow transects (Tows 6, 7, 8 and 9) during which the QEP communicated to the surface technician the seabed biophysical conditions.

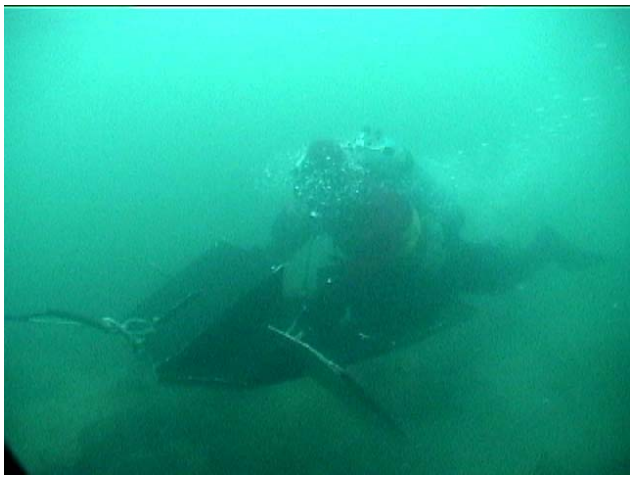


Image 1: TOAD Sled.

In addition to the Tow transects, five bounce dives were employed to collect specific site details, including photographs and video, and to confirm biophysical observations made during the Tow transects.

Substrate conditions were identified on the basis of the following guidelines:

Substrate Type	Diameter (mm)
▪ rip rap (angular rock)	> 64
▪ boulders	>255
▪ cobble	64 to <255
▪ pebble	2 to <64
▪ sand	0.0625 to <2
▪ mud	<0.0625

Additional substrate conditions noted during the survey included any significant build-up of shell hash, woody debris and/or anthropogenic materials.

Species and biota groups chosen for surveying and mapping purposes were selected by the QEPs at the time of the survey. Species and biota groups were selected that best represented the environmental and habitat conditions. A list of all species observed was also developed. The abundance levels of selected species or biota groups were based on the following criteria:

Abundance		
Amount	**% Areal Coverage**	**Individuals Along Transect**
Rare	<5%	1
Sparse	5% to 25%	2 to 5
Few	26% to 50%	6 to 10
Common	51% to 75%	11 to 30
Abundant	>75%	> 30

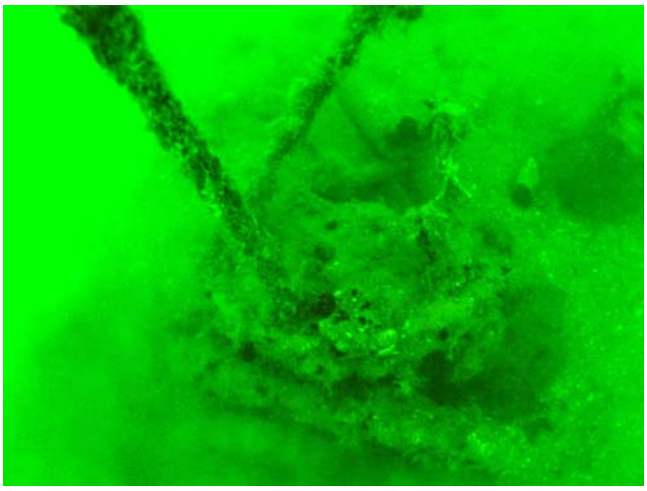
SECTION 3 BIOPHYSICAL OBSERVATIONS

3.1 Substrate Conditions – see Drawing 3841-D-02.1 Substrate Conditions

The dominant feature within the survey area is a “Rise” in the seabed that runs in a northeasterly direction from the SeaBus Terminal and along the western edge of the Seabus navigation route. The side slopes and upper reaches of the Rise are predominantly covered in granular materials (pebbles, cobbles and boulders) with patches of sand/mud/silt.

Seabed areas beyond the western, eastern and northern slopes of the Rise were dominated by mud/silt with harder substrates daylighting through in areas (see Drawing 3841-D-02.1 for photographs of the substrate conditions).

Shell hash was found mixed in with seabed substrates where populations of invertebrates, such as barnacles, were found. The highest concentrations of shell hash were found in the southwestern areas where anthropogenic materials were common. Anthropogenic materials common to marine industrial areas were observed including pile stubs, derelict dimensioned timbers and piles, bottles, tires, construction debris, cables and metal.



Images 2 and 3: Anthropogenic materials typical of the southwestern regions within the survey area.

3.2 Biota Conditions – see Drawing 3841-D-03.1 Biota Conditions

Biota densities and diversities within the offshore reaches of the survey area were low with the occasional boulder or cobble providing opportunities for encrusting species. Seastars, anemones or Dungeness crab were the dominant species observed. Higher densities and diversity of plants and animals were seen in the southwestern regions of the survey area where an increase in stable anthropogenic materials and larger cobbles/boulders provided opportunities for colonization, see Images 4 and 5 below.

Images 4 and 5: Biota opportunistically colonizing hard stable substrates including cobbles and anthropogenic debris.

A list of observed macro species is provided in Table 1 below:

TABLE 1: List of Macro Species and Relative Abundance Observed

Date of survey: July 19, 2016

Common Name	Scientific Name	Chart Datum Range (m)		Abundance*	
		Upper	Lower	Description	Method
Sea Anemones					
Giant Plumose	*Metridium farcimen*	-6.2	-10.5	Rare	IOT
Crab					
Dungeness	*Cancer magister*	-5.8	-10.5	Sparse	IOT
Sea Stars					
Giant Pink	*Pisaster brevispinus*	-5.9	-5.9	Rare	IOT
Ochre Star	*Pisaster ochraceus*	-5.9	-5.9	Rare	IOT
Leather	*Dermasterias imbricata*	-5.6	-5.8	Rare	IOT
Rainbow	*Orthasterias koehleri*	-5.9	-5.9	Rare	
Mottled	*Evasterias troschelii*	-5.8	-10.1	Rare	

Abundance Category	Percent Areal Coverage (PAC)	Individuals On or AlongTransect (IOT)	Individuals per Square Metre (IPM)
Rare	<5%	1	1
Sparse	5% to 25%	2 to 5	2 to 5
Few	26% to 50%	6 to 10	6 to 10
Common	51% to 75%	11 to 30	11 to 30
Abundant	>75%	> 30	> 30

SECTION 4 QEP COMMENTS

Species abundance and habitat productive capacities observed in the survey area are typical of those found in waterfront areas of like substrate and depth in Burrard Inlet.

The deeper mud/silt subtidal areas surrounding the Rise are typical of undeveloped areas of similar elevation and substrate within Burrard Inlet having lower productive capacities than areas with hard substrates. Where the occasional stable boulder or anthropogenic material were found, macro biota diversity and abundance increased.

The most diverse and abundant biota located during the survey was found in the southern region of the survey area and associated with submerged derelict timber pile structures and associated debris. These anthropogenic materials provide a stable surface on which encrusting plants and animals can colonize providing opportunities for more motile species.

APPENDIX 1

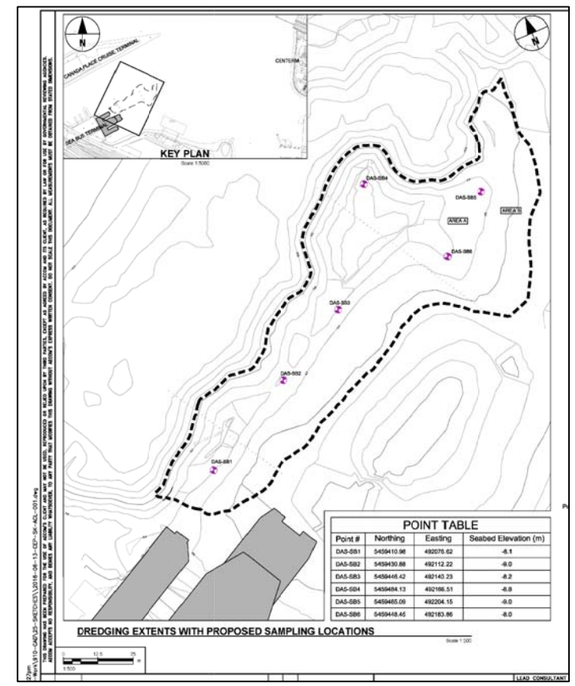
BIOPHYSICAL DRAWINGS AND PHOTOGRAPHS

Drawing 3841-D-01.1 Location Map

Drawing 3841-D-02.1 Substrate Conditions

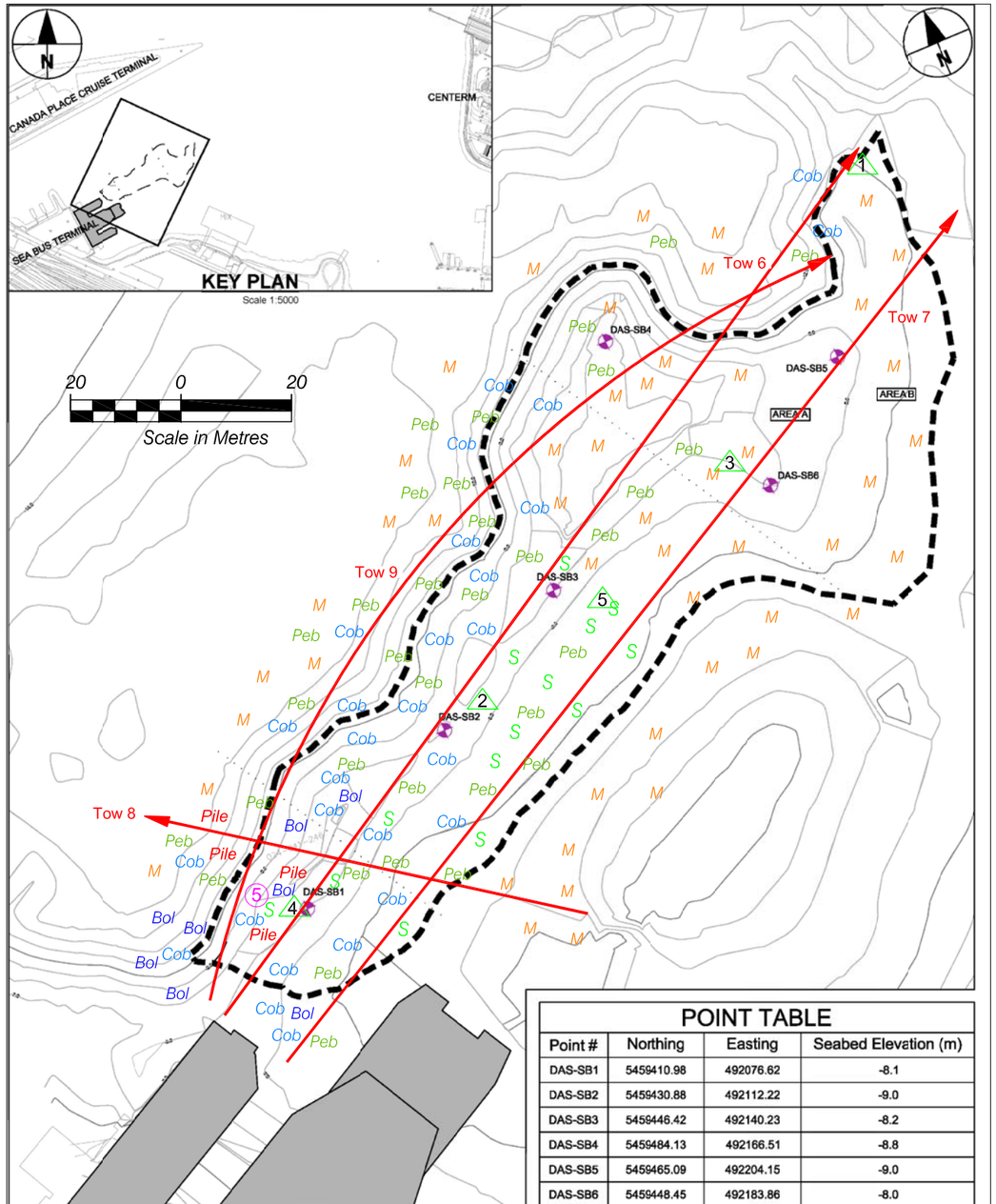
Drawing 3841-D-03.1 Biota Conditions

Project Site Northeast of Seabus Terminal



Survey Area
- taken from AECOM Drawing
2016-06-13-CEP-SK-ACL-001

	Images Courtesy of Google Earth / Digital Globe.	Client	This document contains restricted and/or privileged information and has been prepared solely for use by the party with whom Foreshore Technologies Inc. has entered into a contract. This document is to be used only for the purpose to which it refers and none of the information in this document may be used, reproduced or transmitted, in any form or by any means, electronic or mechanical, without written permission of Foreshore Technologies Inc.	Author	Checked by SC	PROJECT
		AECOM		FORESHORE Technologies Inc.	Drawn by xie	Biophysical Survey of Seabed, Vancouver SeaBus Terminal, Vancouver, British Columbia
				120 Garden Ave. North Vancouver, B.C. CANADA V7P 3H2 Tel: 604.983.3111 Fax: 604.983.3454	Date Sept. 14, 2016	
					Scale	
					Inspectors GM/WP/SC	
Ref. No.	REFERENCE				Paper 11x17	DWG. No. 3841-D-01.1 Location Maps



DREDGING EXTENTS WITH PROPOSED SAMPLING LOCATIONS

POINT TABLE

Point #	Northing	Easting	Seabed Elevation (m)
DAS-SB1	5459410.98	492076.62	-8.1
DAS-SB2	5459430.88	492112.22	-9.0
DAS-SB3	5459446.42	492140.23	-8.2
DAS-SB4	5459484.13	492166.51	-8.8
DAS-SB5	5459465.09	492204.15	-9.0
DAS-SB6	5459448.45	492183.86	-8.0

LEGEND

Substrate

- Pile — Derelict Piles
- Bol — Boulder (>255mmØ)
- Cob — Cobble (64mm to 255mmØ)
- Peb — Pebble (2mm to 64mmØ)
- S — Sand (0.0625mm to 2mmØ)
- M — Mud/Silt (<0.0625mmØ)
- Towed Diver Transects
- Bounce Dive Locations

Observed Substrates

The survey area is characterized by a "rise" in the seabed that runs in a northeasterly direction from the seabus terminal (south). The side slopes and upper reaches of the rise are predominantly covered with more granular materials including boulders, cobbles, pebbles and sand. Larger cobbles and boulders were found in the southern regions of the survey area nearer the seabus terminal. Mud/silt was the predominant substrate in the lower reaches of the survey area beyond the toe of the "rise". Mud/silt/sand was also commonly found distributed amongst the coarser substrates.

Derelict and broken off piling were found in the southwest region of the survey area.

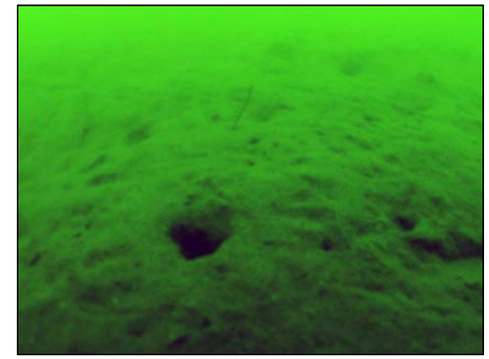


Photo 1. Typical silt conditions found in lower reaches of survey area.

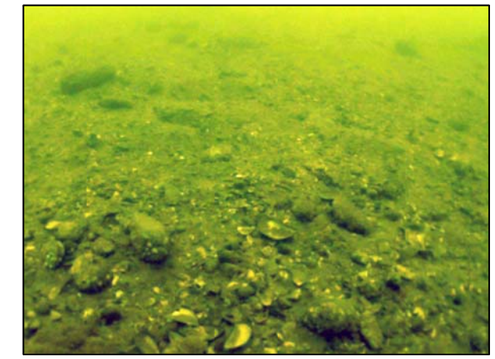


Photo 2. Sand and pebbles typical of the upper reaches of the eastern side slopes of the rise.

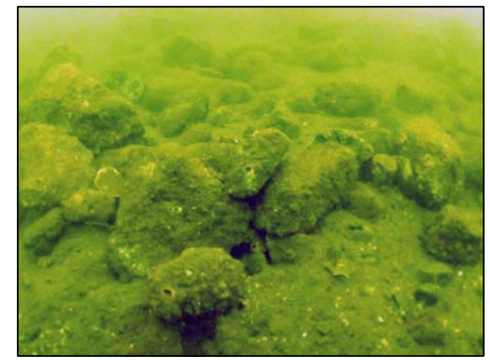


Photo 3. Cobbles/pebbles typical of the upper side slopes of the rise.

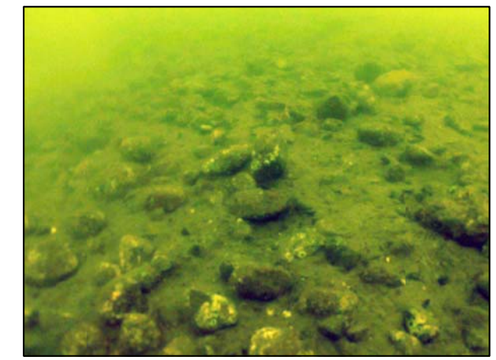


Photo 4. Pebbles mixed in with mud/silt commonly found on eastern side slopes of the rise.

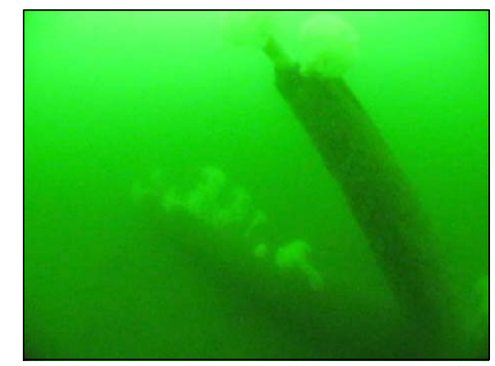


Photo 5. Derelict piles common at southern end of survey area.

DRAWING NOTES

- Transect location are approximated and based on local geographical features.
- The biophysical survey was conducted July 19th, 2016.
- The information, including bathymetric and survey data, presented on the drawings may vary from current conditions due to the passage of time or seasonal changes in substrate and biota.
- The data presented on the drawings represents, in general terms, the substrate and biota types.
- Substrate and biota are mapped on the basis of "presence" (not density), however, the number of tags/symbols present in a given area can provide, in relative terms, an indication of abundance and uniformity. Where tags/symbols are grouped together in an area, the tagged substrate or biota can be assumed to be contiguous.

Background drawing taken from AECOM Drawing: 2016-06-13-CEP-SK-ACL-001

REFERENCE

Client

AECOM

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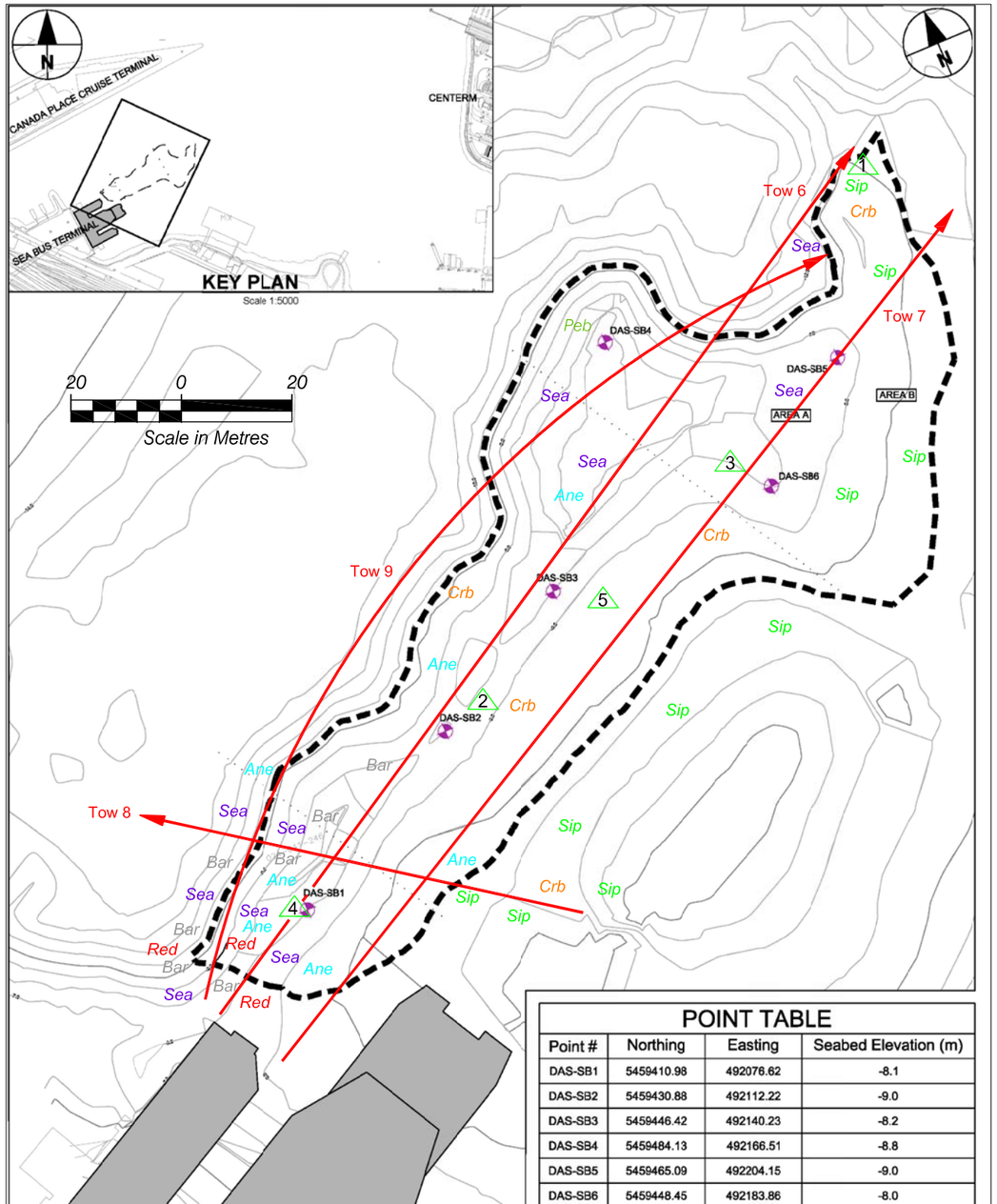
Checked by	SC
Drawn by	xie
Date	Sept. 14, 2016
Scale	See barscale
Inspectors	SC, WP, GM, MT
Paper	

PROJECT

Biophysical Survey of Seabed,
Vancouver SeaBus Terminal,
Vancouver, British Columbia

DWG. No. 3841-D-02.1 Substrate Conditions



DREDGING EXTENTS WITH PROPOSED SAMPLING LOCATIONS

Scale 1:500

POINT TABLE

Point #	Northing	Easting	Seabed Elevation (m)
DAS-SB1	5459410.98	492076.62	-8.1
DAS-SB2	5459430.88	492112.22	-9.0
DAS-SB3	5459446.42	492140.23	-8.2
DAS-SB4	5459484.13	492166.51	-8.8
DAS-SB5	5459465.09	492204.15	-9.0
DAS-SB6	5459448.45	492183.86	-8.0

LEGENDS

- *Ane* Anemone
- *Bar* Barnacles
- *Sip* Siphon Holes
- *Crb* Crabs
- *Sea* Sea Star
- *Red* Red Algae
- Towed Diver Transects
- 3 Bounce Dive Locations

Observed Species

Plumose Anem.	*Metridium farcimen*
Dungeness Crab	*Cancer magister*
Giant Pink Star	*Pisaster brevispinus*
Ochre Star	*Pisaster ochraceus*
Leather Star	*Demasterias imbricata*
Rainbow Star	*Orthasterias koehleri*
Mottled Star	*Evasterias troschelii*
Red Algae	*Unidentified*

Highest species' presence and diversity was located on hard stable substrates including boulders, cobbles, derelict piles and anthropogenic debris located in the southwest region of the survey area.

Burrows (likely clam siphon holes) were commonly found in areas where seabed substrates were predominantly mud/silt.

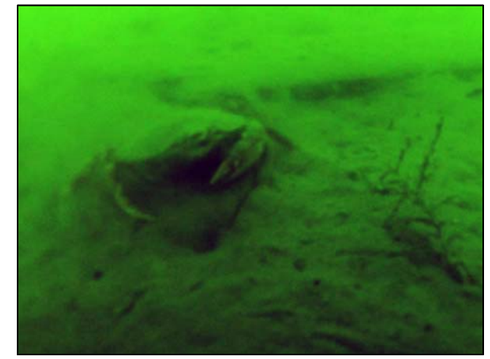


Photo 1. Dungeness crab on mud/silt sea bed.

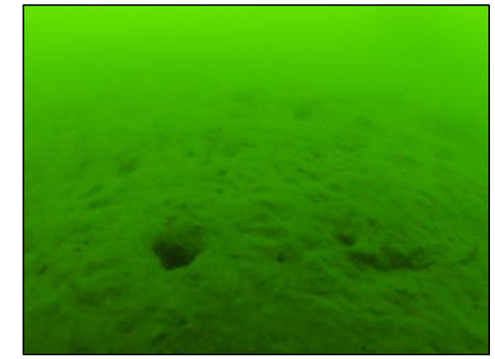


Photo 2. Burrows were commonly observed in areas where mud/silt was the dominant substrate.

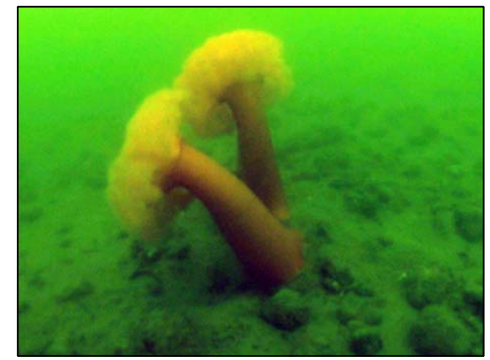


Photo 3. Plumose anemones attached to larger stable cobbles underlying mud/silt layer.

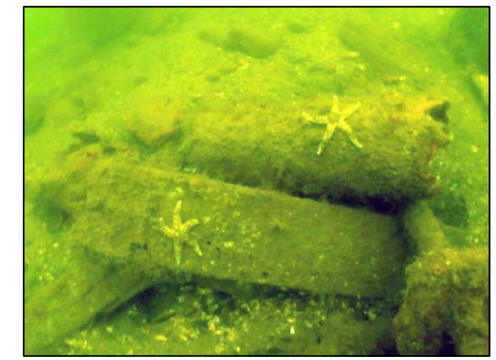


Photo 4. Sea stars on anthropogenic debris including large dimensioned timbers and piles.

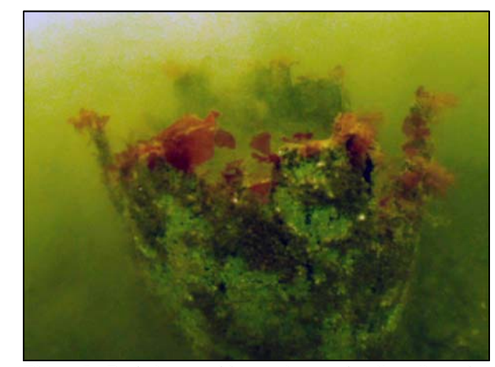


Photo 5. Red algae and barnacles on derelict pile stub located near the SeaBus terminal.

DRAWING NOTES

- Transect locations are approximated and based on local geographical features.
- Biophysical survey was conducted July 19th, 2016.
- The information, including bathymetric and survey data, presented on the drawings may vary from current conditions due to the passage of time or seasonal changes in substrate and biota.
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PROJECT

Biophysical Survey of Seabed,
Vancouver SeaBus Terminal,
Vancouver, British Columbia

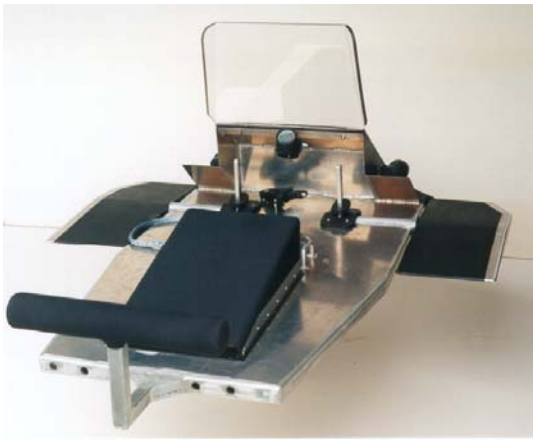
DWG. No. 3841-D-03.1 Biota Conditions

APPENDIX 2

TOAD SLED

TOAD SLED

UNDERWATER HABITAT MAPPING VEHICLE



BENEFITS

- Expands survey capabilities for population studies of targeted species
- Allows for large scale habitat mapping of substrate and biota
- Provides detailed hydrographic data including depth and contour profiles
- Increases speed and effectiveness of surveys
- Eliminates diver fatigue associated with conventional dive surveys.
- Permits complete coverage of a survey area eliminating the need to make habitat predictions based on limited transect studies.

PERFORMANCE

- Successfully operated in depths ranging from 3m (10 ft.) to 37m (120 ft.) and currents in excess of 9 knots.
- Rides comfortably at speeds of up to 10 km/hr (6 mph) underwater and 30 km/hr (18 mph) on the surface
- Highly responsive controls for searching rugged bottom contours and avoiding submerged objects
- Used to map 400 kms (250 miles) of Vancouver Harbour at depths ranging from 3m (10 ft.) to 20m (65 ft.)

SPECIFICATIONS

- Made of welded heavy duty aluminum and Lexan®
- Dimensions: 1.6m long x 1.3m wide (5.5 ft. x 4.3 ft.)
- Weight: 25 kilograms (55 lbs)
- Positively buoyant at surface - slightly negative at depth
- Diver communications is wireless or hard wired through the tow/line umbilical
- Tow/line umbilical may be modified for use with surface supply air or hot water
- Optional equipment includes lights, depth gauge, video support system, sonar and Global Positioning System