DRDC NEPTUNE HYDROPHONE ARRAY PRELIMINARY INFORMATION PACKAGE
ONC-DN-2017-02
REVISION A [2017-01-07]

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AN INITIATIVE OF University of Victoria

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TABLE OF TERMS

Acronym	Description
CTD	Instrument for measuring Conductivity, Temperature, and Depth
DI	Digital Infrastructure
JB	Junction Box
LED	Light Emitting Diode
MEWQ	Marine Environmental Water Quality
NEPTUNE	North East Pacific Time-series Undersea Networked Experiment
ONC	Ocean Networks Canada
OWI	OceanWorks International
PICC	Pacific International Cable Company
QAQC	Quality Assurance and Quality Control
PRPA	Prince Rupert Port Authority
ROV	Remotely Operated Vehicle
SIIM	Subsea Instrument Interface Module
SSMSP	Salish Sea Marine Survival Project
VENUS	Victoria Experimental Network Under the Sea

INTRODUCTION

Ocean Networks Canada (ONC) is a not-for-profit agency, created by the University of Victoria that manages and develops the world-leading VENUS and NEPTUNE observatories. VENUS and NEPTUNE represent over $200M in capital investment, and support transformative, multi-disciplinary research in coastal and deep ocean environments providing a deeper level of understanding of ocean processes and their impacts on a global scale. Since its inception, ONC has also expanded to include a community-based observatory located in the Arctic (Cambridge Bay), with additional locations along the British Columbia coast currently being installed.

ONC has also received funding under the federal Centres of Excellence in Commercialization and Research (CECR) program for the Ocean Networks Canada Innovation Centre which builds upon ONC's existing private and public sector partnerships to develop commercial, outreach, and policy applications in the areas of sensors and instruments, ocean observing system technologies, digital infrastructure, and ocean analytics. To achieve this goal, the Innovation Centre leverages the expertise and technologies developed with the ONC team and helps groups around the world who are seeking similar capabilities for their national infrastructure.

ONC by the Numbers

8 observatories
11 shore stations
900 km seafloor backbone cables
17 instrumented sites
36 instrument platforms
6 mobile instrument platforms
180 instruments producing data continuously
3400 measurement sensors producing data
2006 – the year the first observatory (VENUS) went online
250+ terabytes of data archived
290 gigabytes of data collected every day
23,000+ Oceans 2.0 users registered

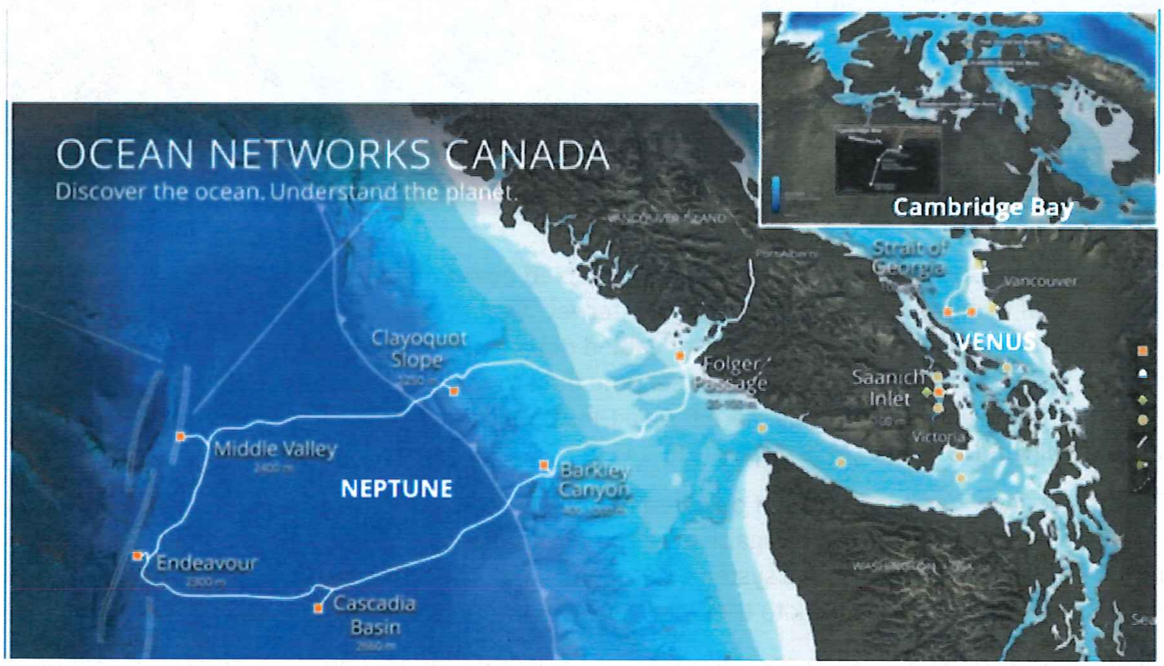


Figure 1 – ONC Observatories

ONC OBSERVATORIES

ONC's observatories represent the world's first multi-node, multi-site and regional-scale cabled ocean observing systems. They operate at depths from 20 m to 2700 m, and deliver data and analytic/ visualizations to hundreds of users around the world via the Internet.

VENUS

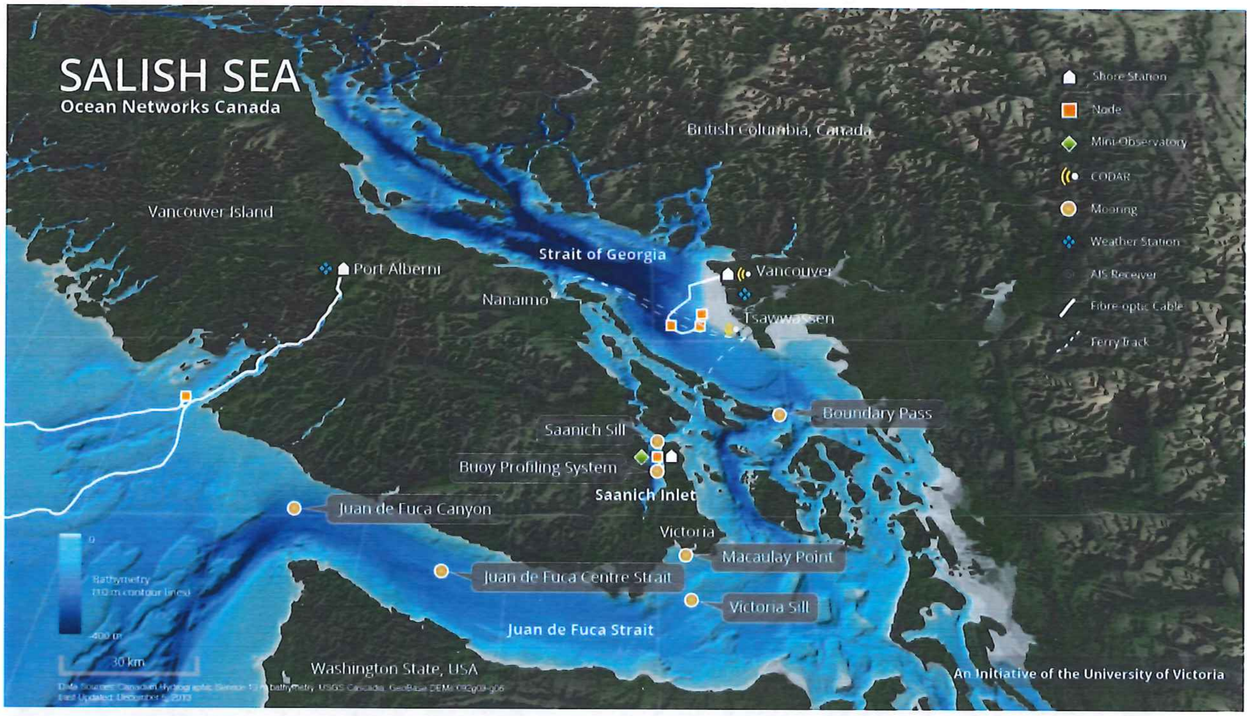


Figure 1 – VENUS Observatory in the Salish Sea

VENUS is the world's first multi-node, multi-site cabled ocean observing system, delivering data to hundreds of users around the world via the internet. Operational since 2006, VENUS has proven the fundamental concepts and technology for cabled observatories, including interactive remote control of subsea instruments and the delivery of real-time data to active research programs across the country and around the world. Currently more than a thousand users from over a dozen countries are downloading and using VENUS data.

The observatory has over 44 km of powered fibre optic cable delivering 9 kW of power to three science sites and connecting them with Gigabit data communications. Currently the three 4 tonne science nodes connect over 100 sensors systems to the Internet. The two remote shore stations transmit the data from the observatory back to the Data Centre at the University of Victoria.

Of any marine habitat, it is the coastal oceans of the world that are under the greatest threat of deterioration. The VENUS network probes two distinct environments in the complex coastal seas of southern British Columbia, Canada. A 4-km long array in Saanich Inlet near Victoria gathers data on ocean processes and seafloor ecology in a sheltered fjord. A second 40-km array near Vancouver in the

Strait of Georgia—Canada's busiest seaway—focuses on ocean currents, marine ecology, slope stability and the subsea soundscape. Current VENUS research includes: tracking of events such as storms and plankton blooms, zooplankton and fish behaviour, marine mammal communication and acoustic pollution, water currents and ocean renewal, and sediment dynamics and subsea slides.

NEPTUNE

NEPTUNE is the world's first regional scale cabled ocean observing system. Located off the west coast of Vancouver Island in British Columbia, Canada, the network spans from the coast, across the continental shelf and covers an entire tectonic plate from subduction zone to spreading ridge. The Juan de Fuca tectonic plate is one of the most active on the planet and serves as an exceptional natural laboratory for ocean observation. The observatory has over 800km of powered fiber optic cable delivering 160kW of power to five or more science sites and connecting them with up to 40Gbit data communications. Currently five 13 tonne science nodes connect over 500 sensors systems to the network. A shore station in Port Alberni, Canada transmits the data from the system back to the Data Centre at the University of Victoria.

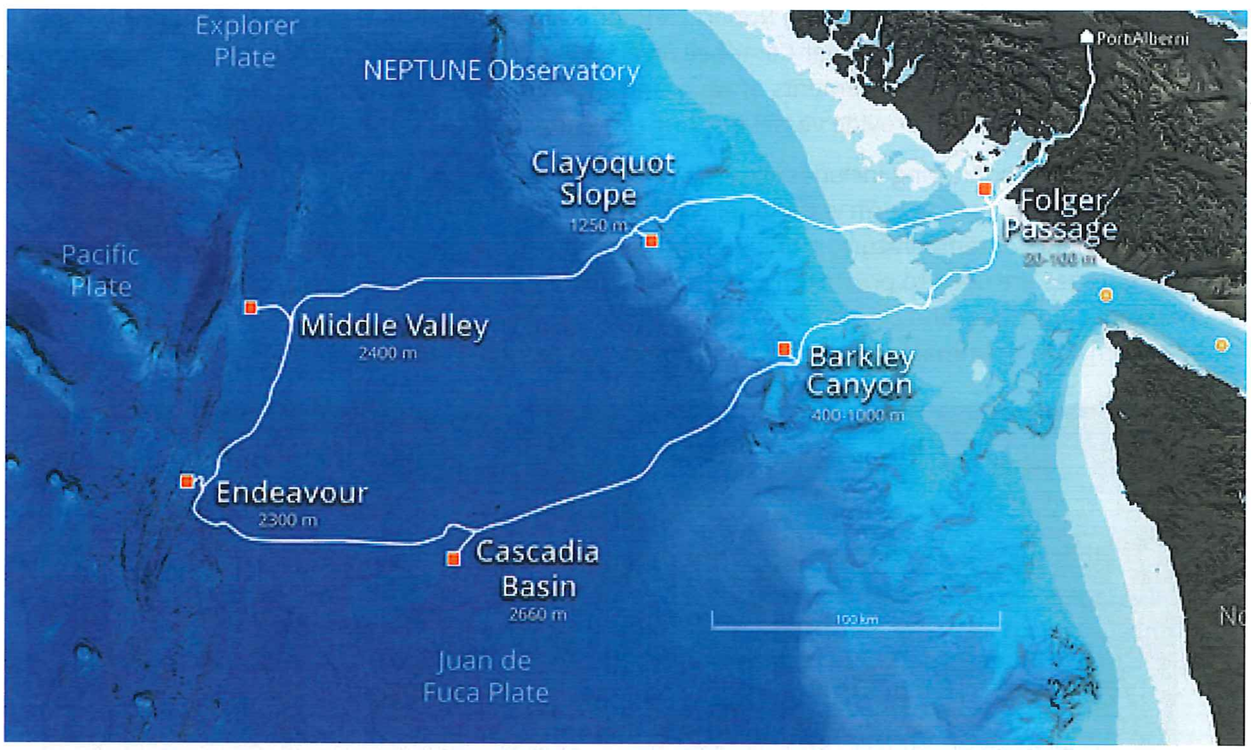


Figure 3 – NEPTUNE Observatory

NEPTUNE nodes are located in a variety of ecological and geological settings. Locations vary from the 20-metre shallows of coastal Folger Passage, which is strongly influenced by inshore oceanographic processes, land use activity, and water and nutrients from the watershed, to the depths of Juan de Fuca Ridge (Endeavour Site) at 2,300 metres. Here, new seafloor is being formed with volcanic activity that also creates 350°C hydrothermal vents. NEPTUNE instruments at several sites create a tsunami monitoring and earthquake detection network. NEPTUNE's five major research themes include: plate tectonic processes and earthquake dynamics, fluids in the ocean crust and gas hydrates, ocean climate change and its effects on marine life, the dynamics of deep sea ecosystems, and engineering and computational research.

Smart Ocean Systems™

Ocean Networks Canada is expanding research infrastructure along the BC coast, targeting sites that may see increased vessel traffic and major future marine development projects, including Liquified Natural Gas (LNG) terminals. The goal of the program is to install infrastructure for marine safety, public safety and environmental monitoring near potential development sites to provide public accessible scientific data and analytic information products that can provide a basis for science based decision making.

Proposed sites for the Smart Ocean Systems™ program are the Strait of Georgia, Alberni Inlet, Campbell River, Kitimat, Douglas Channel and Prince Rupert.

Public safety infrastructure includes a prototype earthquake early warning system and a prototype near-field tsunami detection system.

Marine safety infrastructure includes RADAR systems that expand ONC's Coastal High Frequency (HF) RADAR (CODAR) to measure surface currents in the Strait of Georgia covering the approaches to the port of Vancouver and the port of Prince Rupert. X Band RADAR (similar to ones used on marine vessels) will be placed in critical locations near Campbell River, Prince Rupert and Douglas Channel. These RADARs will provide real time measurements of wave and currents and have the capability of tracking oil slicks. Additional analytics will provide vessel tracking tools and tools for vessel/marine mammal deconfliction.

Environmental monitoring includes small scale community based underwater monitoring systems to provide baseline an long term water quality data sets. Measurement systems include standard water measurements of temperature, salinity and water depth, turbidity, chlorophyll, and dissolved oxygen. Hydrophones are used to provide measures of ambient noise, vessel noise signatures, and marine mammal detections, and classifications (where partner hydrophone networks can be integrated into the system marine mammal locations and tracking will be possible). Underwater video is being recorded to

Figure 4 – BC Smart Ocean Systems™ Infrastructure

observe seafloor life. On shore systems monitor marine weather and vessel traffic in addition to recording surface conditions and vessel traffic on video.

Data from this extensive network is publicly available for non-commercial use through Oceans 2.0 on the ONC website.

Oceans 2.0

Providing user interface, operations, and data management to the VENUS, NEPTUNE and other ONC ocean observing systems is the Oceans 2.0. The Oceans 2.0 is a scalable operational software system specifically designed to efficiently collect, archive and redistribute data from underwater sensor networks. Oceans 2.0 includes the tools necessary to manage and monitor both the sensors and the observatory infrastructure. Oceans 2.0 can support hundreds of instruments and is designed to keep track of any change and events occurring anywhere within the infrastructure. The archiving system is flexible and extensible, supporting the wide variety of data types found in oceanographic instrumentation. The infrastructure is based on a modern service-oriented architecture and all of the tools (data access, system management, configuration) are Web-based and the system serves over 23,000 users in 160 countries.

DRDC NEPTUNE HYDROPHONE ARRAY SITE

DRDC has issued and RFP for a horizontal hydrophone array under PW-HAL-309-9997. This document outlines the interface of this system with Ocean Networks Canada infrastructure.

The deployment site is at the ONC NEPTUNE Clayoquot Slope site (background information can be found at http://www.oceannetworks.ca/observatories/pacific/clayoquot-slope). Connection will be made to Junction Box#8 located at the ODP CORK borehole 1364A (48 41.9962N, 126 52.3291W) at a depth of 1315m. The area for array deployment relatively flat (within 5m for the length of the array). Bathymetric data for the site is shown in the figures below.

The DRDC hydrophone array will be connected to a NEPTUNE Junction Box using a Teledyne ODI wet mate connector on a 70m hose (provided by ONC).

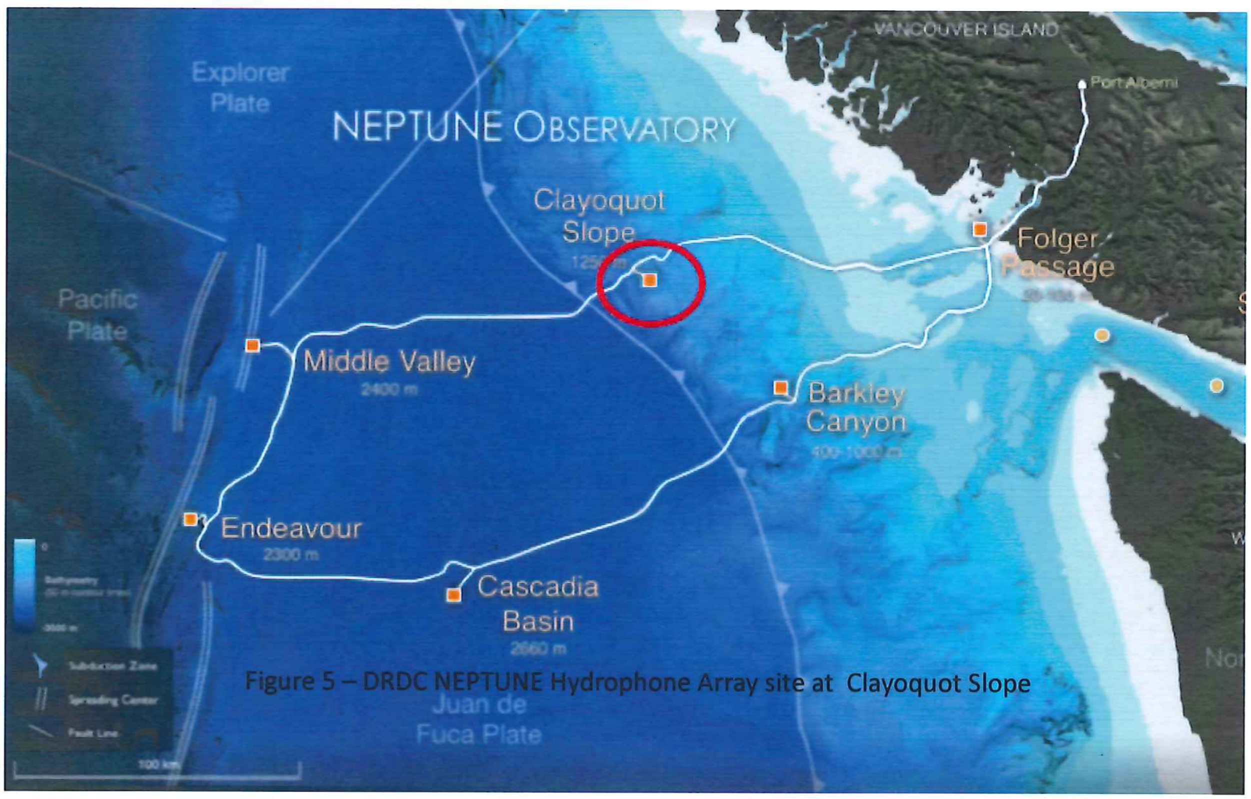
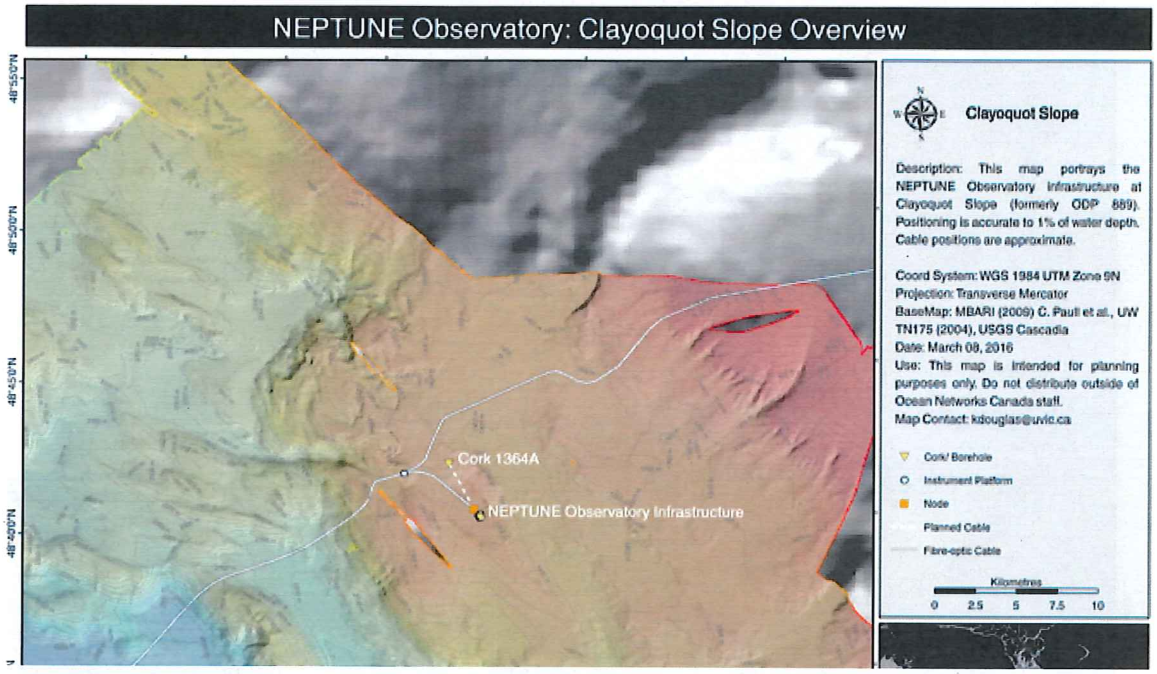
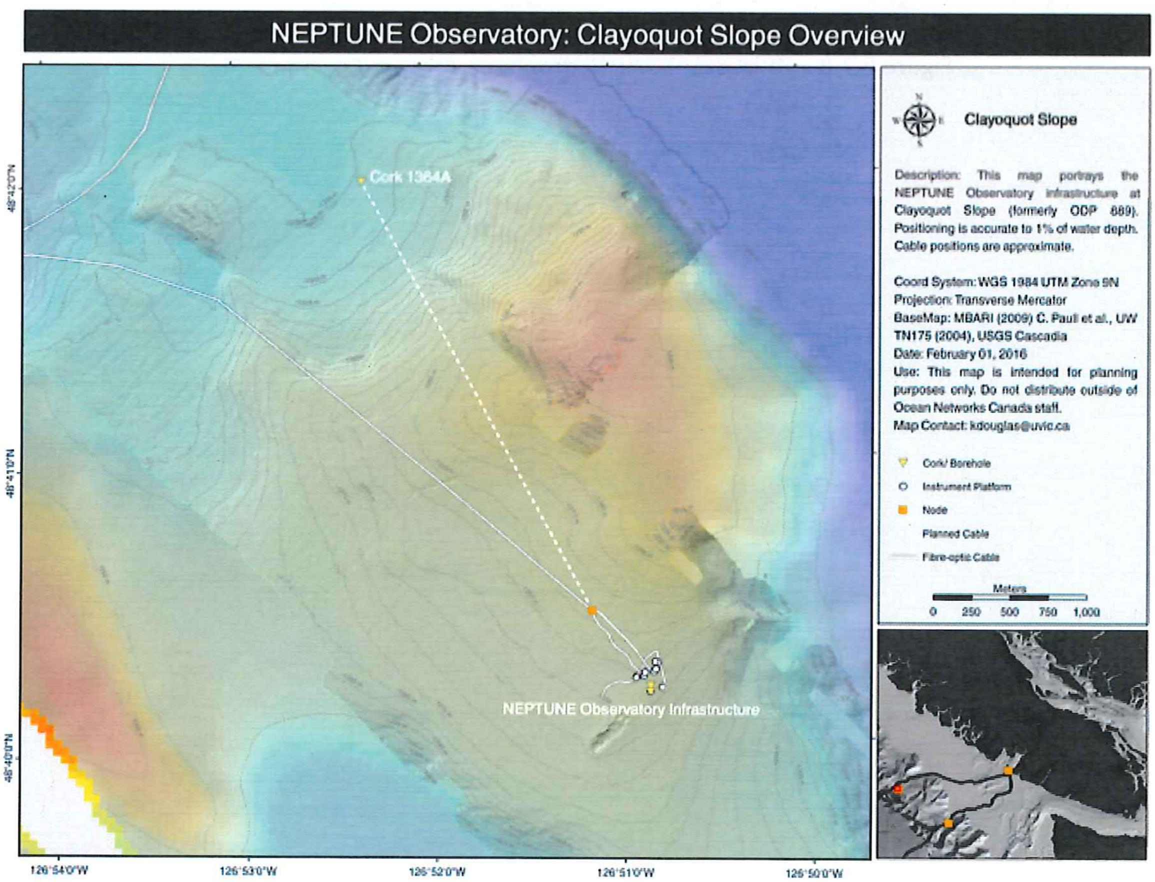


Figure 5 – DRDC NEPTUNE Hydrophone Array site at Clayoquot Slope


NEPTUNE Observatory: Clayoquot Slope Overview
48°55'0"N
48°50'0"N
48°45'0"N
48°40'0"N
Cork 1364A
NEPTUNE Observatory Infrastructure
Clayoquot Slope
Description: This map portrays the NEPTUNE Observatory infrastructure at Clayoquot Slope (formerly ODP 889). Positioning is accurate to 1% of water depth. Cable positions are approximate.
Coord System: WGS 1984 UTM Zone 9N
Projection: Transverse Mercator
BaseMap: MBARI (2009) C. Paull et al., UW TN175 (2004), USGS Cascadia
Date: March 08, 2016
Use: This map is intended for planning purposes only. Do not distribute outside of Ocean Networks Canada staff.
Map Contact: kdouglas@uvic.ca
Cork/ Borehole
Instrument Platform
Node
Planned Cable
Fibre-optic Cable
Kilometres
0 2.5 5 7.5 10


NEPTUNE Observatory: Clayoquot Slope Overview
48°42'0"N
48°41'0"N
48°40'0"N
Cork 1364A
NEPTUNE Observatory Infrastructure
126°54'0"W
126°53'0"W
126°52'0"W
126°51'0"W
126°50'0"W
Clayoquot Slope
Description: This map portrays the NEPTUNE Observatory infrastructure at Clayoquot Slope (formerly ODP 889). Positioning is accurate to 1% of water depth. Cable positions are approximate.
Coord System: WGS 1984 UTM Zone 9N
Projection: Transverse Mercator
BaseMap: MBARI (2009) C. Paull et al., UW TN175 (2004), USGS Cascadia
Date: February 01, 2016
Use: This map is intended for planning purposes only. Do not distribute outside of Ocean Networks Canada staff.
Map Contact: kdouglas@uvic.ca
Cork/ Borehole
Instrument Platform
Node
Planned Cable
Fibre-optic Cable
Meters
0 250 500 750 1,000

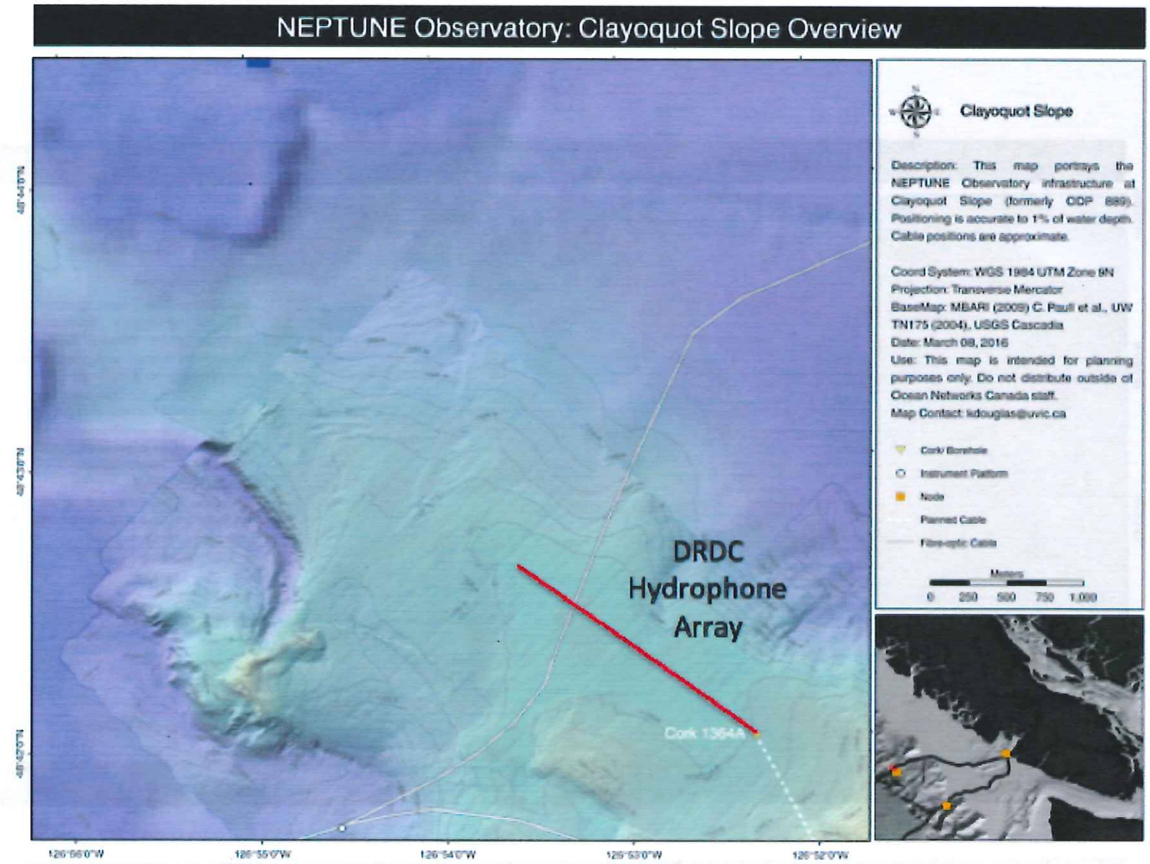


Figure 6,7,8 – DRDC NEPTUNE Hydrophone Array at Clayoquot Slope

USER INTERFACE REQUIREMENTS - PROVISIONS FOR THE DRDC NEPTUNE HYDROPHONE ARRAY PROJECT

Provided by Ocean Networks Canada:

- An interface cable from the Junction Box to the customer's instrument package, 70 m, 1048184 PBOF (oil filled) with ODI plug to MINK10CCPL connector.
- The array will be connected to **Junction Box #8 (JB-8), Port 1** which is 48 VDC, 75 W max. Note the power has some power supply switching noise, 200 mVpp max and the frequency is variable with load, typically 70 kHz. Communications format is 100BaseT Ethernet.
- ONC can loan a Test Junction Box and test cable with MINK10CCPL connector.
- Final testing of the hydrophone array will require delivery to the ONC test facilities at the Marine Technology Centre (9865 West Saanich Road, North Saaanich, BC V8L 5Y8) at least 3 months before deployment (deployment date is TBD). Contact person is Dr. Tom Dakin (tdakin@uvic.ca).

Customer package requires:

- MINK10FCRL Ti bulkhead connector as the power/communications interface The MINK pinout is shown in the table below.
- Input power: 48 VDC with 75W maximum
- Communications: 100BaseT Ethernet capability
- Operating Depth: 1320m

MINK10CCPL to 12 Way ODI Plug Pin Allocation Table

MINK	ODI 12WAY	ODI 7WAY	ODI HYBRID	CAT5 PIN	COLOUR	POWER	ETHERNET MDI	ETHERNET MDI-X	EIA-485	EIA-422	EIA-232	DB-9 PIN ON MOXA NPORT
1	9	4	5	N/A	RED	V+						
2	7	2		1	WHITE/ORANGE		TX+	RX+		TD A(-)	DCD	1
3	3			3	WHITE/GREEN		RX+	TX+		PPS	RTS	7
4	8	1		2	ORANGE		TX-	RX-		TD B(+)	RXD	2
5	6	3		5	WHITE/BLUE				GND	GND	GND	5
6	1	6		7	WHITE/BROWN				DATA B(+)	RD B(+)	TXD	3
7	4			6	GREEN		RX-	TX-			DSR	6
8	5			4	BLUE						CTS	8
9	2	7		8	BROWN				DATA A(-)	RD A(-)	DTR	4
10	10	5	6	N/A	BLACK	V-(GND)						
			Fibre 1	Px-1Tx	RED							
			Fibre 2	Px-1Rx	GREEN							
			Fibre 3	Px-2Tx	BLUE							
			Fibre 4	Px-2Rx	YELLOW							

NEPTUNE NODE AND JUNCTION BOX INTERFACE INFORMATION

NEPTUNE Node

- 400 VDC 15A
- Fibre link 1000baseT Ethernet to Junction Boxes
- 12 Way ODI receptacle out to Junction Boxes, instrument platforms

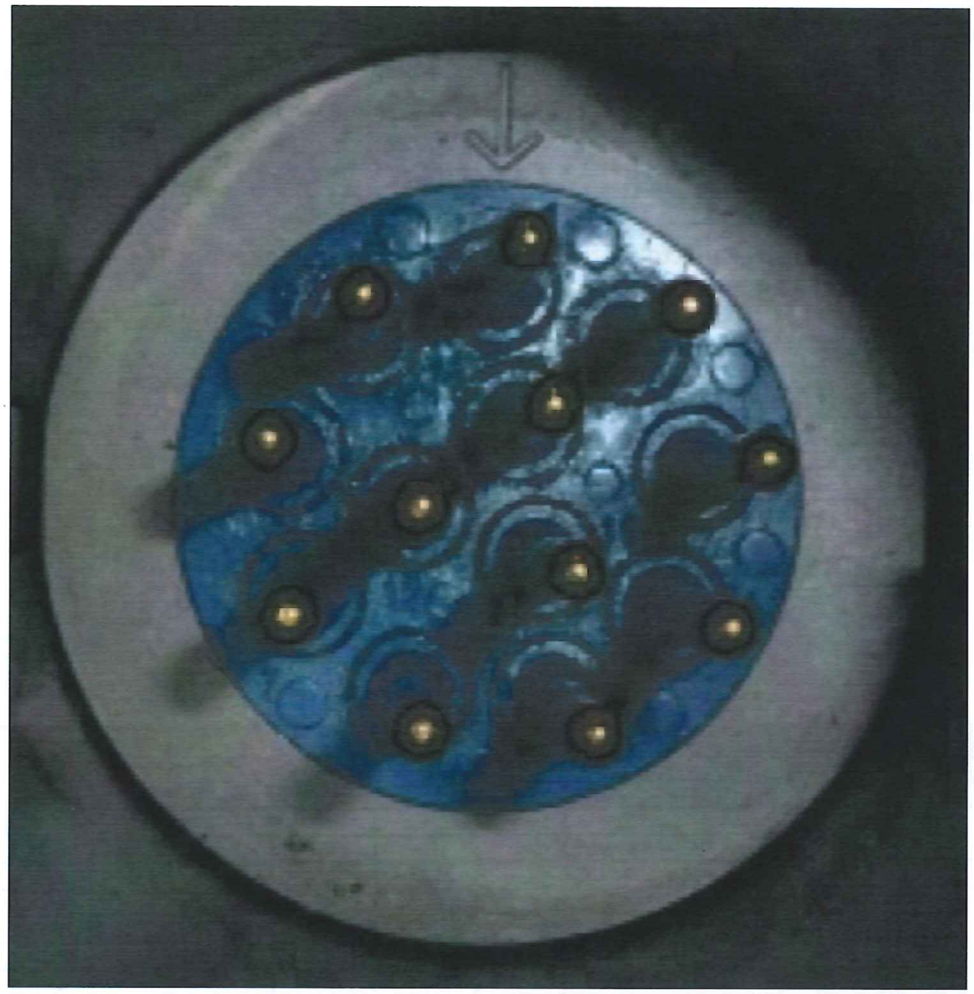


Figure 9 – ODI wet mate connector

Junction Box MKI

- JB-8 Port J1 dedicated to DRDC array, 48 VDC, 75 W
- 1000baseT into Junction Box, 100baseT Ethernet out to instrument ports
- MINK10FCRL Ti input connector
- MINK10FCRL Ti output connector
- Interconnect cable 1048181 (3 m) MINK10CCPL to 12 WAY receptacle mounted on platform