



Wave Energy at PacWave

Burke Hales

PacWave Chief Scientist

PacWave
TESTING WAVE ENERGY FOR THE FUTURE

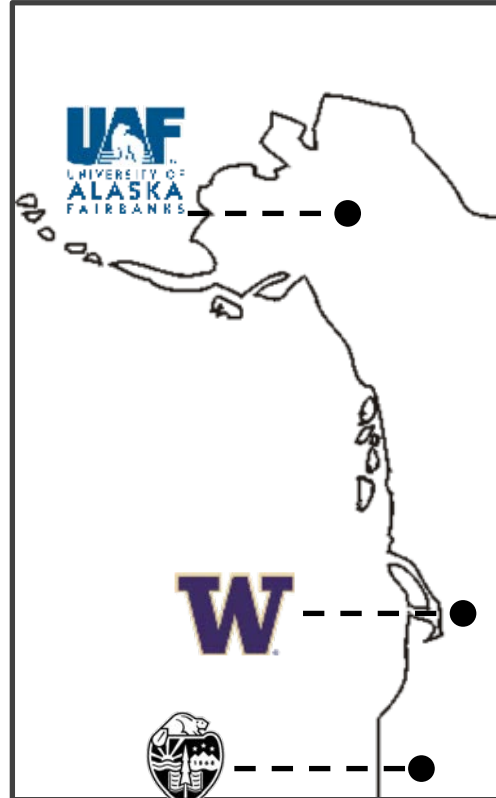


Oregon State University
College of Earth, Ocean,
and Atmospheric Sciences



New Identities: NNMREC is now P MEC P MEC-SETS is now PacWave

NNMREC, then:



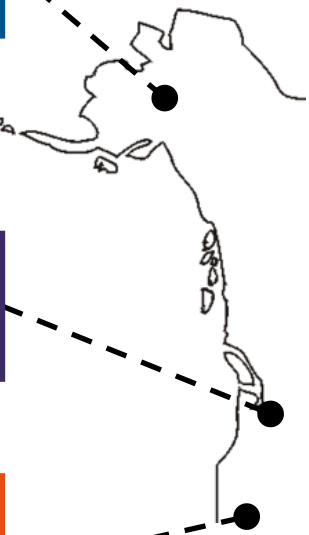
Oregon State
University



Marine renewable
energy research and
development

Marine renewable
energy testing facilities

Pacific Marine Energy Center: Now



Testing

Waves (Lab and Field)

Power Systems

Currents (Lab and Field)

Research & Development

WECs

Resources

Environmental

IO&M

Turbines

Society & Policy

Education & Outreach

Graduate Degrees

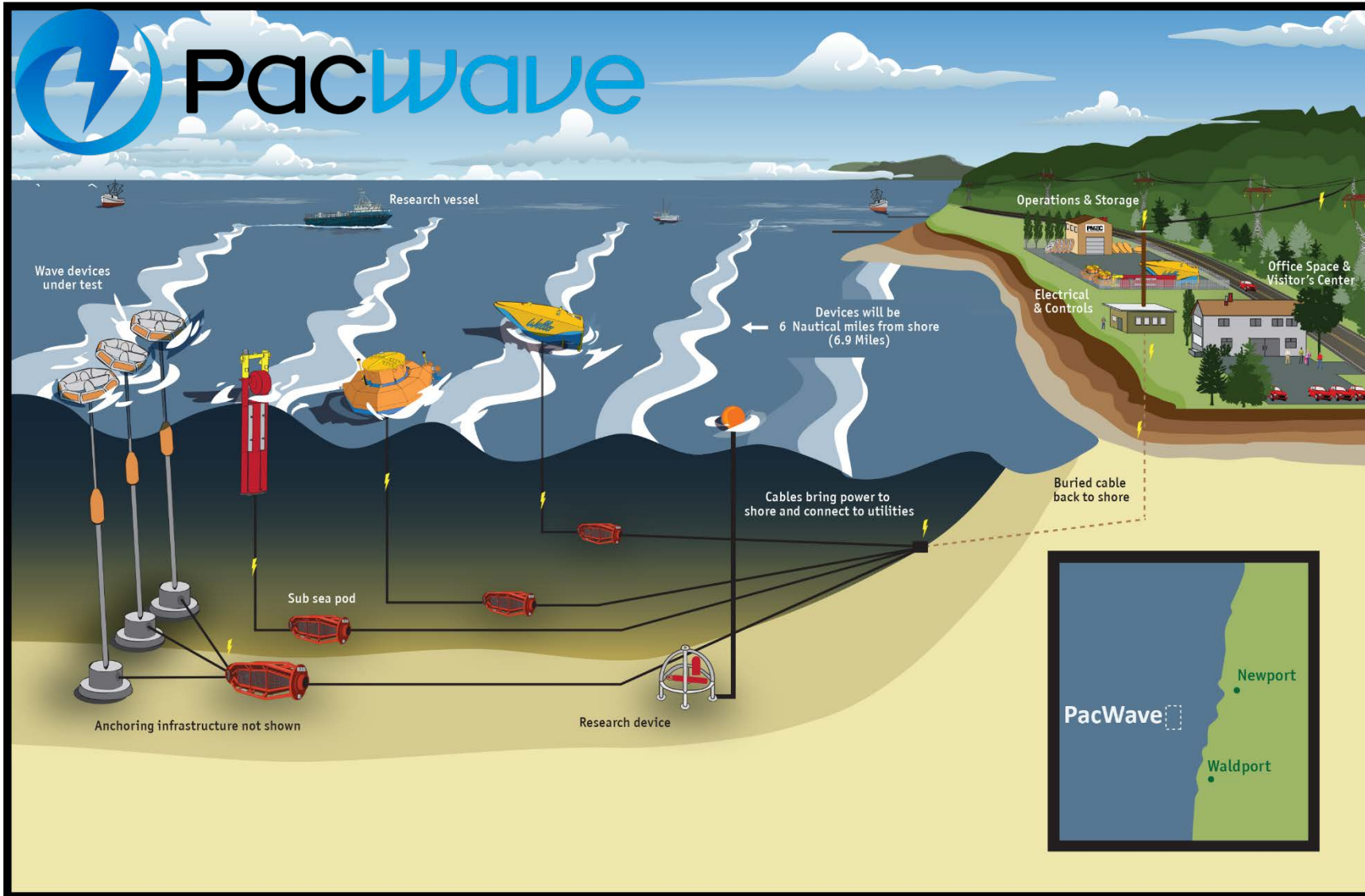
Public Seminars

Student Research

Stakeholders



What is PacWave?



A wave energy testing facility, consisting of:

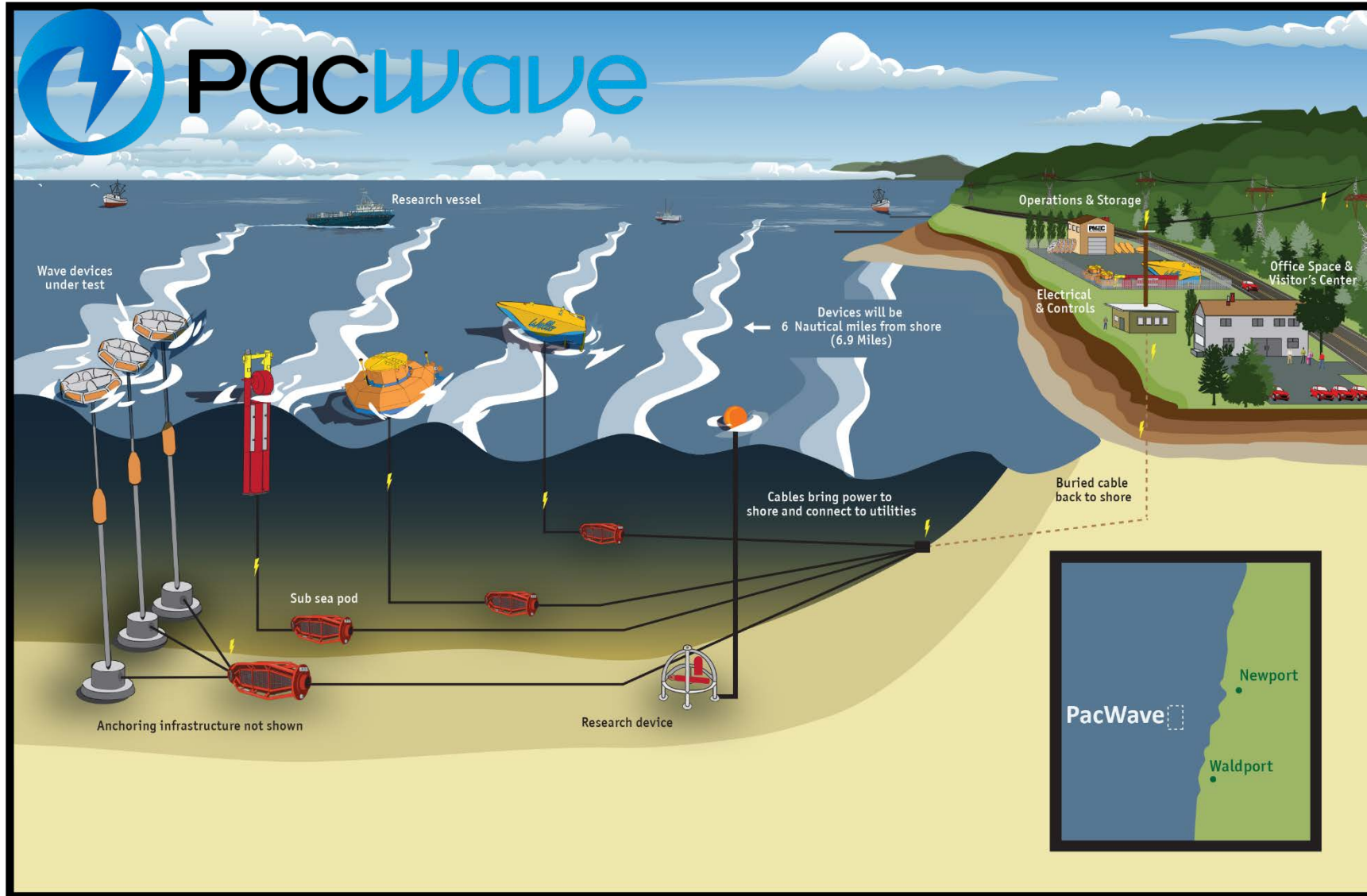
South Site

A pre-permitted, full-scale, grid-connected facility for pre-commercial testing of WEC technology in a two square-mile site 7 mi WSW offshore of Newport, Oregon. Four truly independent 5 MW-capable berths connected to a shore-side 'Utility Connection and Monitoring Facility' (UCMF).

North Site

An autonomous site for scaled and maritime-market testing in a 1 sq-mile site 5 mi NNW of Newport. Can support up to 100 kW output, or self-contained, devices.

What PacWave is NOT:



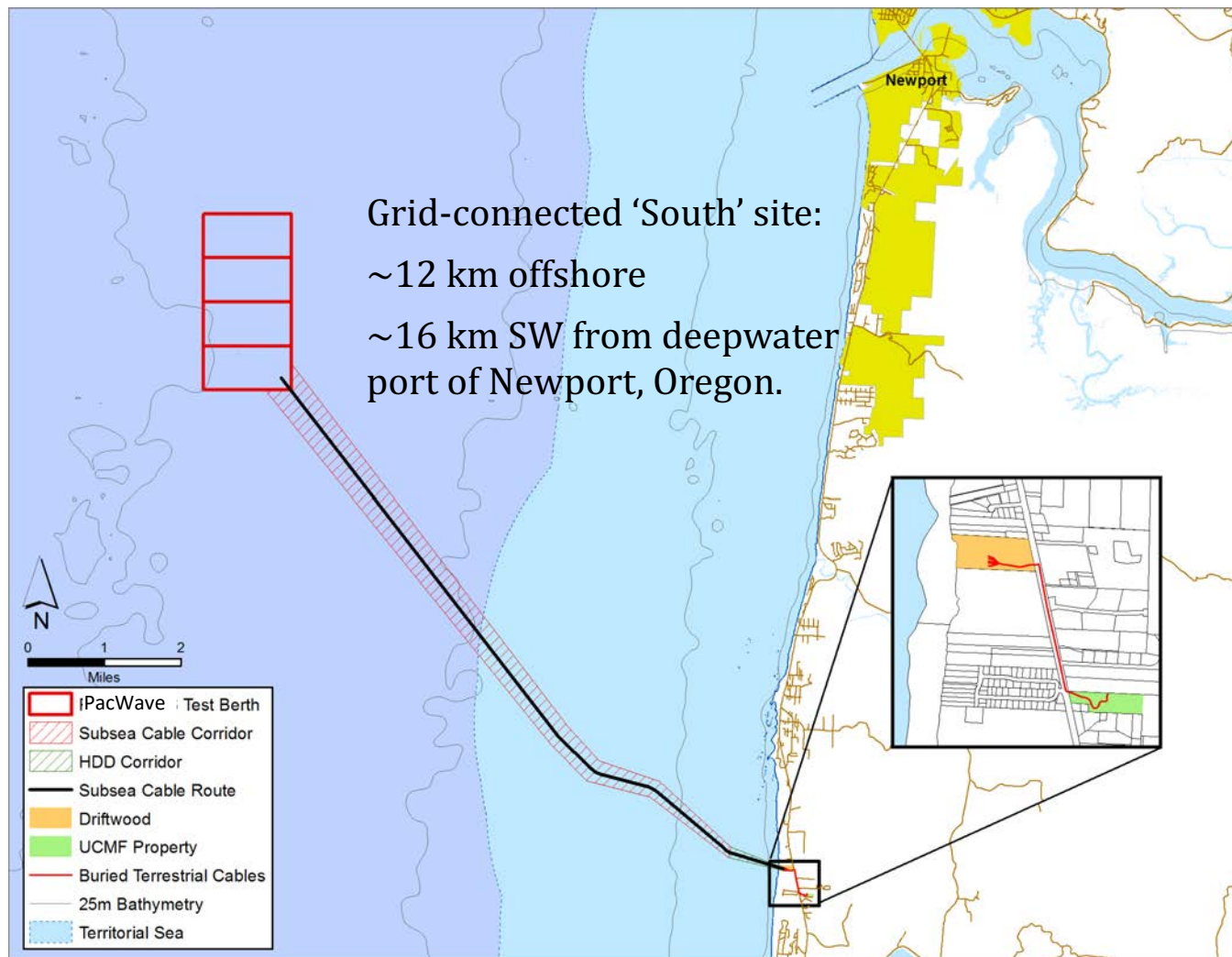
Commercial or municipal-scale energy production.

Wind, solar or other 'green' offshore energy production or testing.

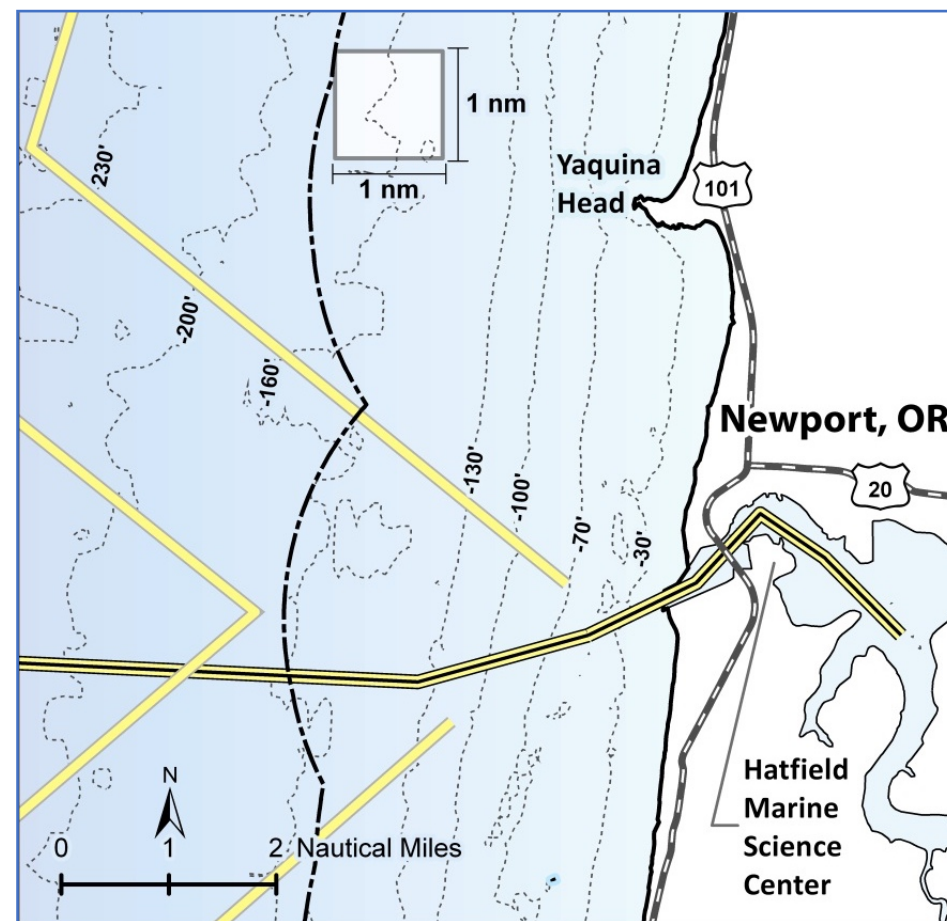
Visible, audible, or directly accessible from the beach.

An alteration of municipal power supply structure or cost.

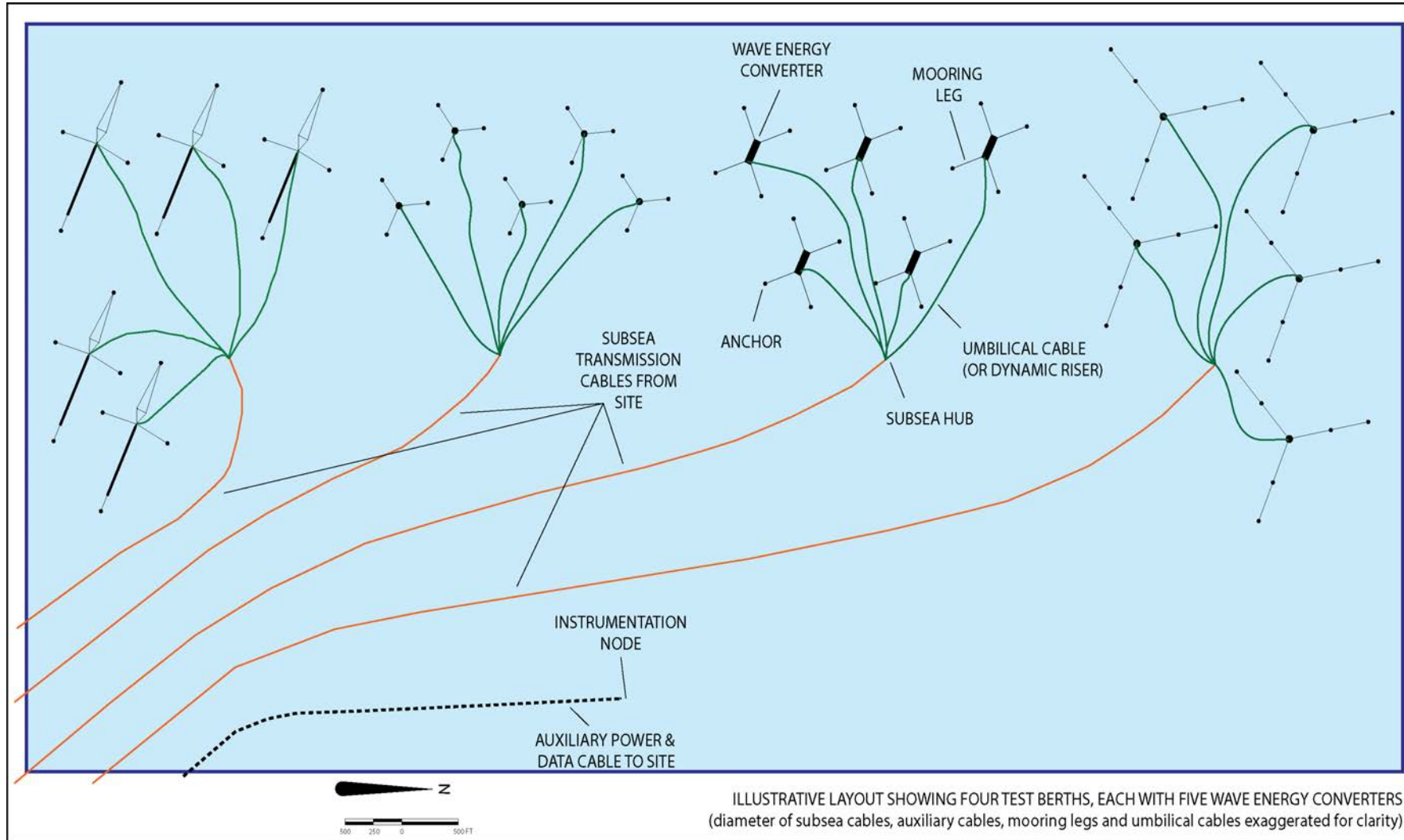
PacWave South and North Settings



Autonomous 'North' site:
~5 km offshore
~10 km NW from Newport, Oregon.



PacWave Grid-connected South Test Site



Four truly independent berths, 1x2 km.

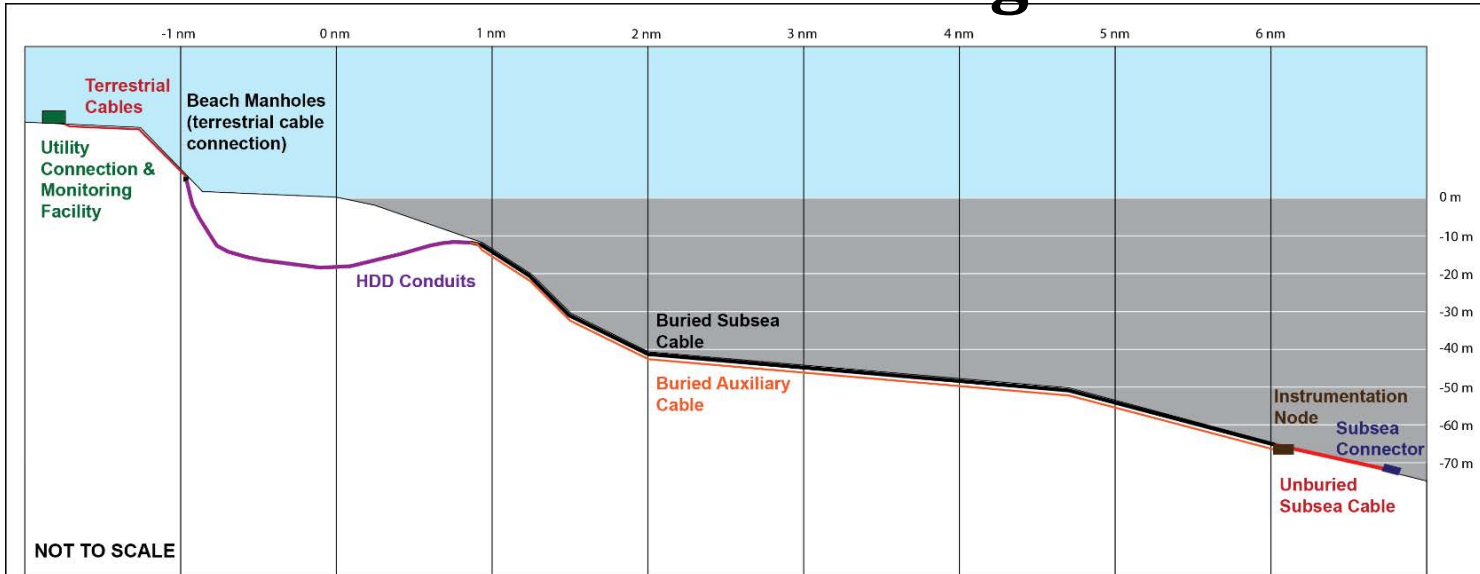
Accommodate large individual devices or arrays.

5 MW, 36 kV capable subsea cables to each berth with fiber-bundle data transmission capability.

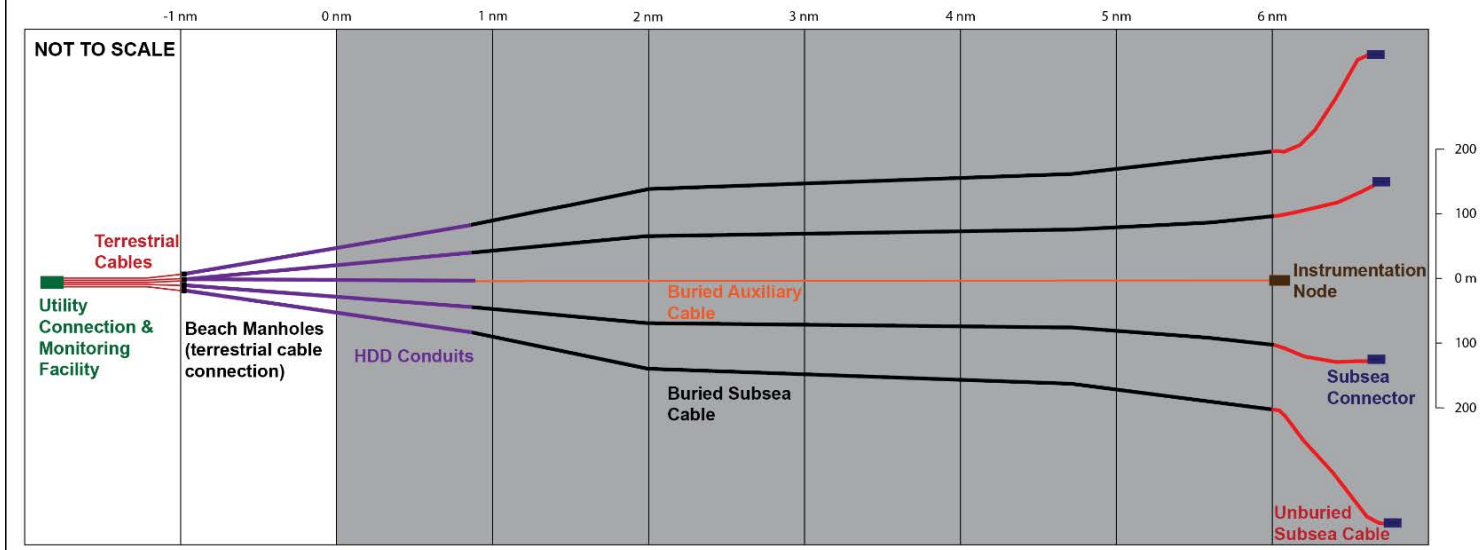
Acoustic monitoring of each berth with autonomous instrumentation package with cellular telemetry.

Auxiliary power/data cable for high-speed real-time site-representative condition monitoring.

PacWave South Sea Cable Routing



Buried seacable (~3mbsf) to 10 m isobaths; then HDD-bored cable route to landing site.

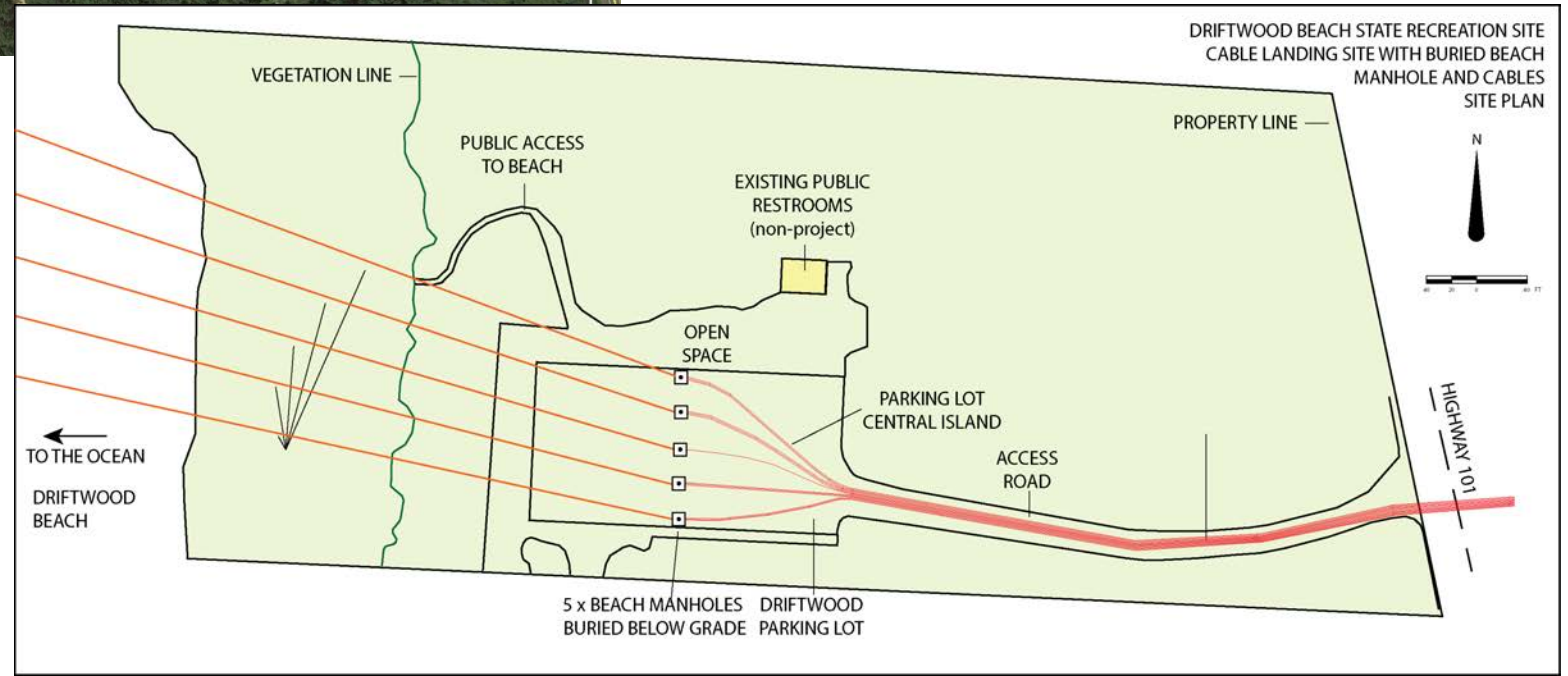


PacWave South Sea Cable Landing Site

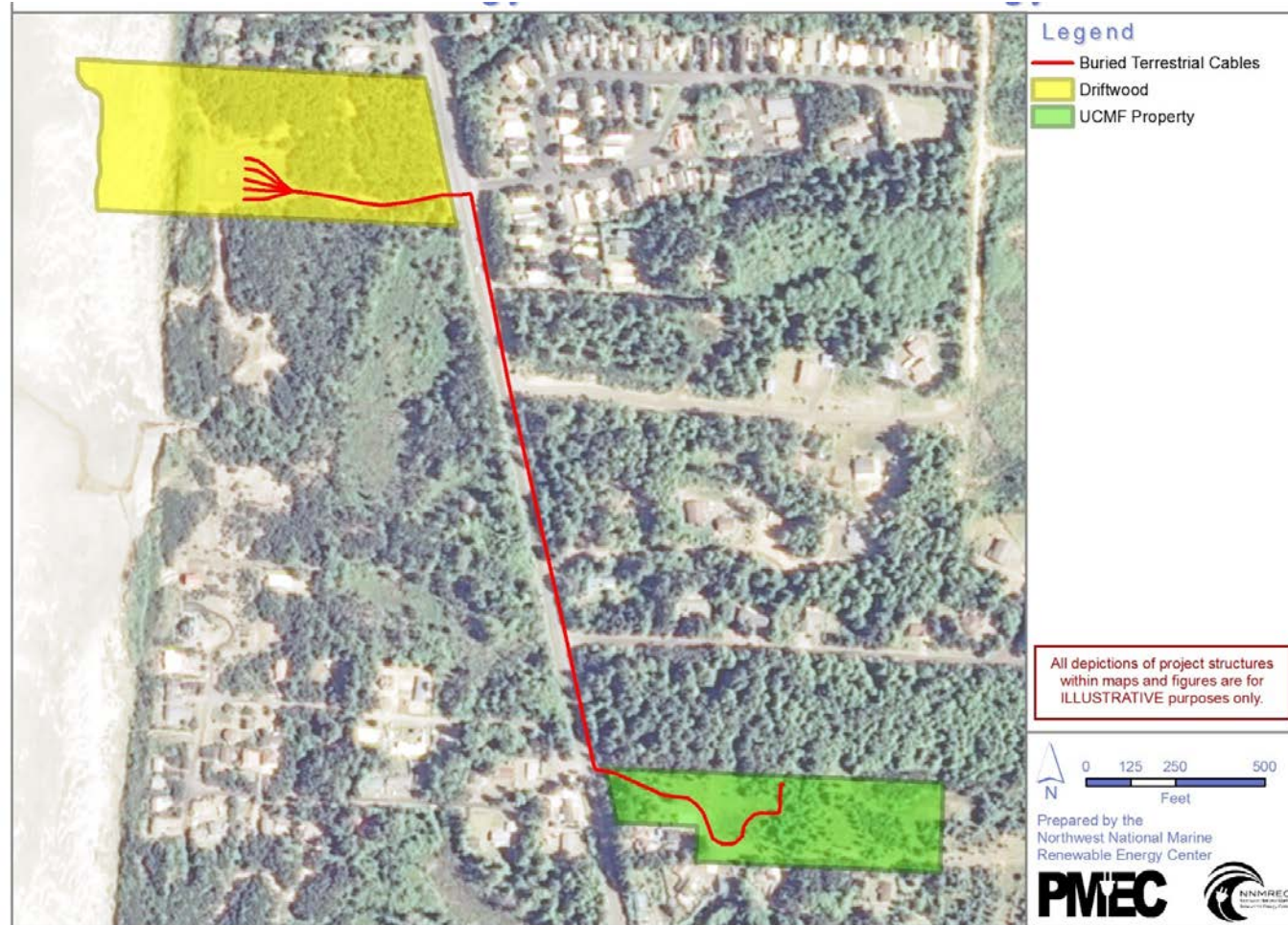
Terrestrial cable connection made via splice vaults Driftwood Beach State Recreation Area.

Park access limited during 6-9 month construction phase.

Fully restored park following construction.



PacWave South Terrestrial Cable Routing



Underground cable installed between Driftwood Beach and power connection and monitoring facility at Wenger Lane

PacWave South Utility Conversion and Monitoring Facility



PacWave Project Team

US Department of Energy (DOE); project funding and technical advising.

Oregon State University; project implementation and funding.

- College of Earth, Ocean & Atmospheric Sciences
- College of Engineering
- Hatfield Marine Science Center
- Hinsdale Wave Research Laboratory

Contractors; Task execution and technical advising.

- Pacific Energy Ventures (PEV)
- European Marine Energy Centre (EMEC)
- Aquatera
- National Renewable Energy Lab (NREL)
- 3U Technologies
- Williwaw Engineering

Contractors; permitting.

- Stoel Rives
- HDR Engineering
- H. T. Harvey & Associates



Contacts:

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PacWave Project Developments

Funding: Initial \$5M from DOE for Phase I, May 2017
Additional \$30M appropriated for Phases II & III (after Go/No-Go, October 2019)
\$800K of State funding (2017)
\$3M of State funding (2018)
Estimated total project cost = \$50M (fundraising underway)

Reorganization: College of Earth, Ocean & Atmospheric Sciences takes lead role; Hales as Chief Scientist

Permitting: FERC Draft License Application (DLA) submitted Apr. 20, 2018
http://elibrary.FERC.gov/idmws/file_list.asp?accession_num=20180420-5237
90-day public comment period closed 20 July 2018
FERC Final License Application (FLA) to be submitted late 2018
State applications to be submitted late 2018

Next steps:

Coastal community re-engagement	Final property acquisition, October 2018
Terrestrial surveys, Fall 2018	Marine surveys, completed September 2018
Final designs Spring 2019	Final cost estimates Fall 2019

PacWave—College of Earth Ocean and Atmospheric Sciences

The screenshot shows two browser windows. The left window displays the Oregon State University homepage with the URL 'College of Earth, Ocean, and Atmospheric Sciences | Oregon State University'. The right window shows a news article on 'ceoas.oregonstate.edu' with the title 'CEOAS to oversee wave energy testing facility'. The article is dated June 4, 2018, and mentions a partnership with the U.S. Department of Energy. A quote from Cynthia Sagers, Vice President for Research at Oregon State, is also visible.

Wave energy testing facility

CEOAS to oversee wave energy testing facility

Posted June 4, 2018

Oregon State University has partnered with the U.S. Department of Energy and other stakeholders to build a wave energy test facility located off the Oregon Coast, between Newport and Waldport, called PacWave.

PacWave, the project formerly known as P MEC-SETS, recently transitioned to the College of Earth, Ocean, and Atmospheric Sciences (CEOAS), an internationally recognized, comprehensive earth science center with an extensive history of world-class research in marine geology, oceanography, and atmospheric science.

Support for PacWave

Cynthia Sagers, Vice President for Research at Oregon State:
"CEOAS is uniquely positioned to support the test facility."

<http://ceoas.oregonstate.edu/features/pacwave/>



Ocean Observatories Initiative



Photo by Andy Cripe, Corvallis Gazette Times

- Initiated 2007 with \$32.3M construction&operations budget
- Led conceptual design of Endurance Cabled Array
- \$8M annual operating budget; \$20M of managed equipment
- Developed siting requirements with affected stakeholders
- 12 Full-Time Equivalent personnel
- Lead semi-annual cruises on Global-Class research vessels

Ships

<http://ceoas.oregonstate.edu/ships/>



- 40 years as operator of Ocean research vessels, pier and port
- Vessels: 175' *Oceanus*; 84' *Pacific Storm*; 54' *Elakha*, 29' *Kalipi*
- ~\$4M annual operating budget
- 20 full time and many relief personnel
- Support operations by NSF, ONR, NOAA, ACE, ODFW, State
- Manage UNOLS West Coast Van Pool
- Significant subcontracting activities (shipyard etc)
- Global logistical operations support

Regional Class Research Vessel (RCRV)

Leading the design and construction of the next class of ocean-going research vessels for the National Science Foundation

The coastal ocean encompasses the most complex range of oceanic phenomena on the globe, and ships are as vital as ever to observing and understanding these phenomena. Oregon State University is leading the charge in designing and delivering the next generation of ships to advance coastal science.

With more modern technology and abilities than previous generations of ocean research ships, these Regional Class Research Vessels (RCRV) will be cutting-edge platforms that provide scientists and educators access to the marine realm. The RCRV's environmentally conscious and acoustically quiet design, robust on-board sensor suite, and advanced overboard-

<http://ceoas.oregonstate.edu/ships/rcrv/>



Watch [video on YouTube](#)

-Design and construction of 3 193' 1760 LT research vessels

-\$354M total budget

-Team personnel ~12 in '18, ramping to 17 in '20, then to 0 by '23

- \$272M in major subcontractors (Gulf Island, Glosten...)

- \$26M in project management (OSU)

\$56M in contingency

Community Engagement

- Feasibility Analysis of Oregon Coast (2011)
- Community Site Selection Teams (2012)
- FERC Collaborative Work Group (2013-2018)
- NEPA Scoping Meeting, July 2014 (Newport, OR)
- Draft License Application (2018)
- Newport Conditional Use Permit, 2018
- Various Media and other Public Meetings 2018 (OPAC, OPRD, SurfRider, HMSC Volunteers, etc.)

PacWave Environmental Studies

1. Site Characterization

2. Pre- and Post-installation Monitoring

3. Opportunities for Research

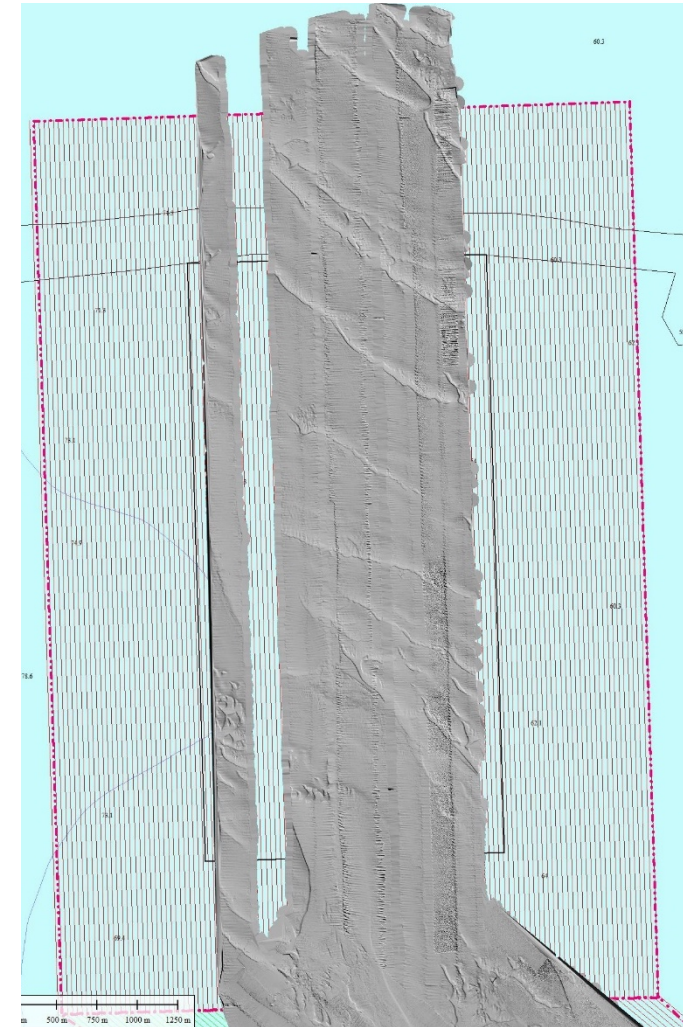
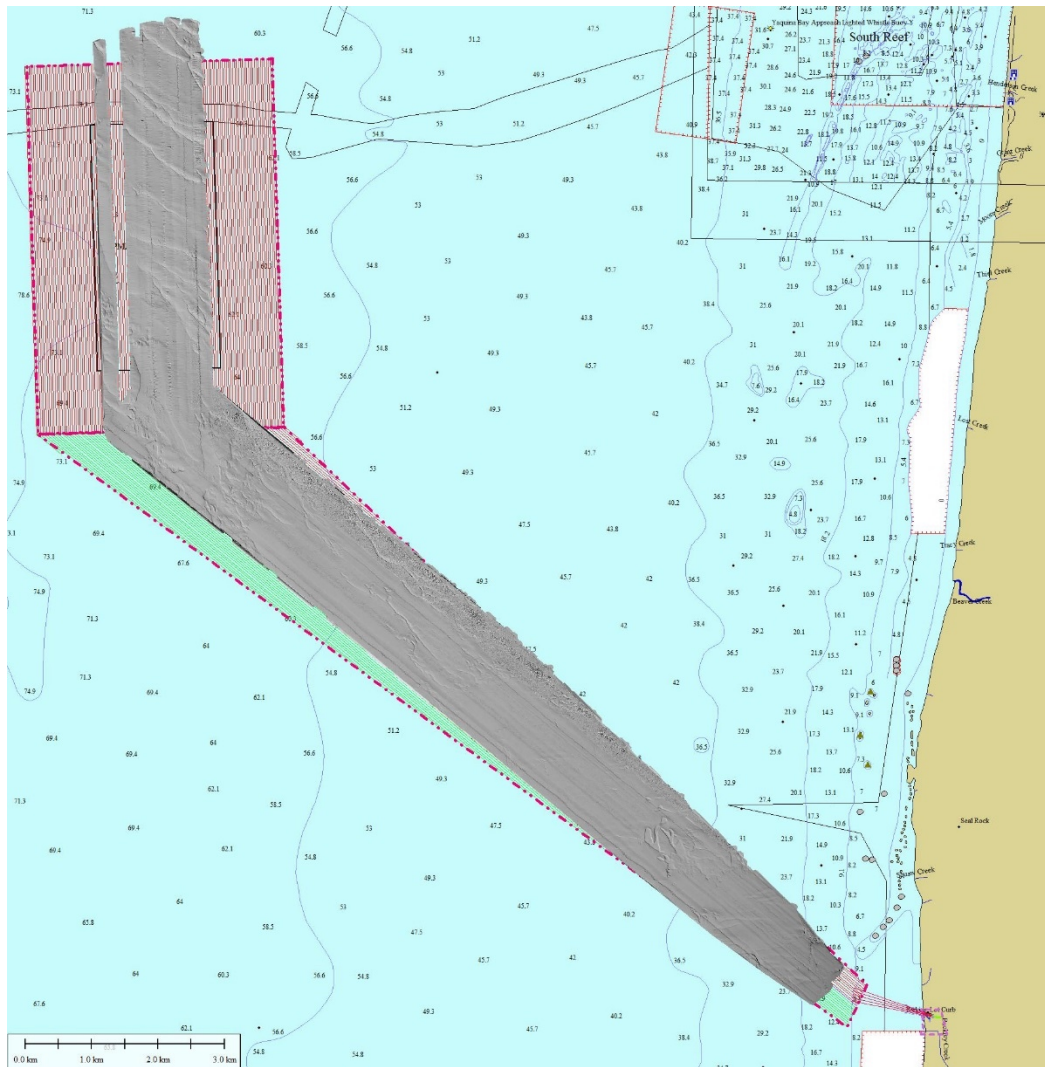
Purpose of Site Characterization

- Characterize spatial and temporal variability in habitat characteristics and species distributions in the project areas
- Identify species potentially unknown to the area
- Inform the design and implementation of future pre-installation and post-installation surveys
- Collect data to inform future monitoring results and adaptive management actions

Site Characterization and Monitoring Studies for PacWave

- *Seafloor bathymetry and character*
- *Sediment & Macrofaunal Invertebrates*
- *Dungeness Crabs*
- *Seabirds & Marine Mammals*
- *Ambient Ocean Noise*

PacWave Marine Survey: Bathymetry Overall, and Site Detail



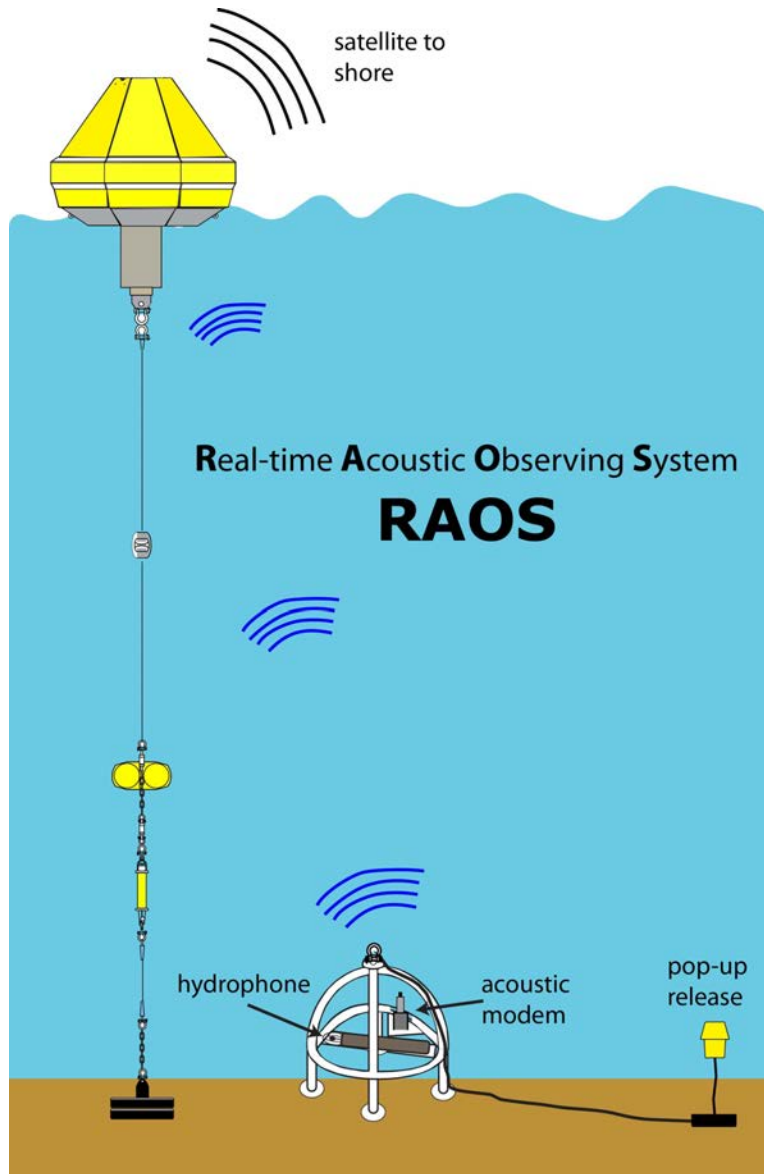
3U Proprietary 1/13/19

Area of Interest: Nearshore End of Cable Corridor

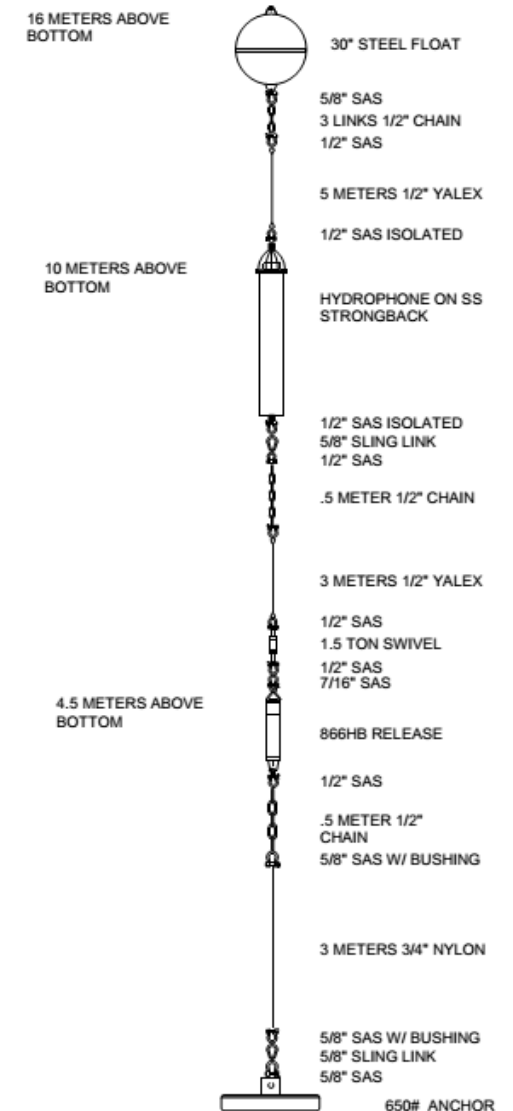
- Magnetic anomaly detected on all survey lines crossing this area
- Shows on side scan imagery
- Shows on bathymetry data



Noise Monitoring

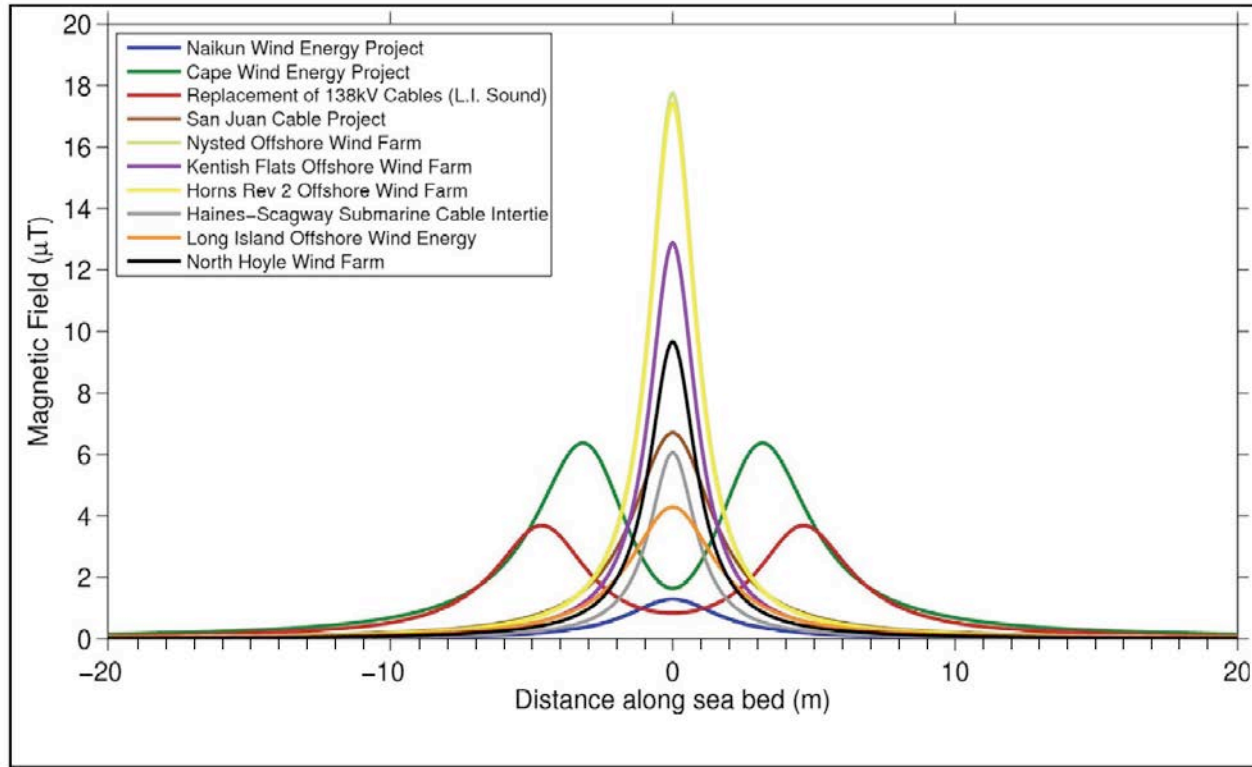


- One real-time acoustic observing system in each of the four berths
- Perimeter array of 4 hydrophones at 2 k, spacing swapped every 6 months
- Drifting hydrophones within first 10 days of deployment of each WEC



EMF Modeling/Monitoring

- Once specific WEC device(s) are committed to be deployed we will run models to determine the magnetic field levels at a distance of 45 m from the energized cables.



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F does not
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- Within 45 m of the field survey state to provide a baseline for comparison.
- If field more than 45 m from the field survey state to provide a baseline for comparison.
- If field more than 45 m from the field survey state to provide a baseline for comparison.

studied or plans to operate more WECs per berth than previously studied.

PacWave-Questions?

