



Enabling Cost Effective Electricity from Ocean Waves - PacWave

Marine and Hydrokinetics Program

October 9, 2019

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Project Overview

Project Summary

PacWave will consists of four individual tests berths over a 2 square nautical mile area, each with a separate 5 MW cable back to shore. Each berth can accommodate multiple devices for array testing. A fifth power and data cable will use the land-based power grid to supply power to the site for associated environmental monitoring and/or other uses. Total project capacity is 20 MW and up to 20 devices. PacWave will be pre-permitted for all currently known deep-water device types.

Project Objective & Impact

Project objectives are to complete permitting, project design, construction; begin accredited operation of the facility. Given the nature of PacWave, and the fact it is a test facility, it will serve as the place where technical advances and innovations will occur by:

- 1) Advancing environmental monitoring and understanding;
- 2) Refining deployment and removal procedures;
- 3) Understanding grid integration issues; and
- 4) Offering the opportunity for WEC technology to advance performance and cost reductions from in-ocean testing.

Project Information

Project Principal Investigator(s)

Burke Hales, Chief Scientist
Justin Klure, Project Manager

WPTO Lead

Steve DeWitt

Project Partners/Subs

Pacific Energy Ventures
European Marine Energy Centre (EMEC)
Williwaw Engineering
Aquatera
3U Technologies
HDR Engineering
HT Harvey and Associates
Stoel Rives
TriAxis Engineering
HGE Architects
Siemens & Associates
TerraSond
Foundation Engineering
National Renewable Energy Lab (NREL)

Project Duration

- Project Start Date: May 1, 2017
- Project End Date: April 30, 2022

Marine and Hydrokinetics (MHK) Program Strategic Approaches

Data Sharing and Analysis

Foundational
and
Crosscutting
R&D

Technology-
Specific
Design and
Validation

Reducing
Barriers to
Testing

Reducing Barriers to Testing

- Enable access to world-class testing facilities that help accelerate the pace of technology development
 - Work with agencies and other groups to ensure that existing data is well-utilized and identify potential improvements to regulatory processes and requirements
 - Support additional scientific research as needed, focused on retiring or mitigating environmental risks and reducing costs and complexity of environmental monitoring
 - Engage in relevant coastal planning processes to ensure that MHK development interests are equitably considered
- Optimize WECs and arrays to increase their energy capture, improve their survivability and reliability, and decrease LCOE.
 - Improve deployment, recovery, operations, and maintenance procedures.
 - Collect power quality data.
 - Gather information about potential environmental effects.
 - Enable development and testing opportunities for Powering the Blue Economy (PBE) applications
 - The multi-year collaborative permitting process led to increased understanding of regulatory process and requirements, and how they could be applied to MHK projects. This will help streamline the regulatory process for other projects in the future.
 - The environmental monitoring plans focuses on the key potential environmental effects that were identified in collaboration with stakeholders.

Total Project Budget – Award Information			
DOE	Cost-share	Total	
[\$34,468,486]	[\$12,455,432]	[\$46,923,918]	

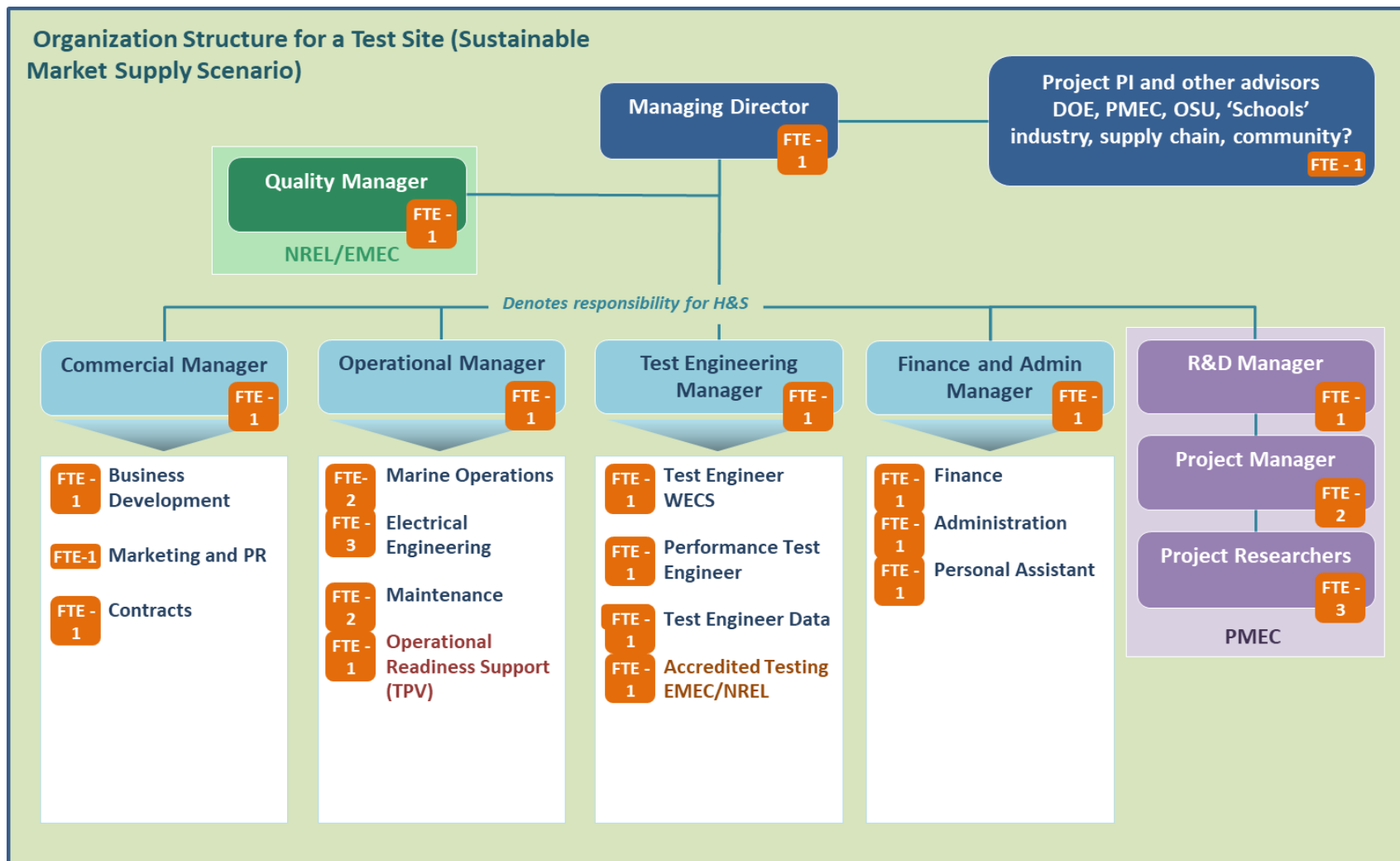
FY17	FY18	FY19 (Q1 & Q2 Only)	Total Actual Costs FY17–FY19 Q1 & Q2 (October 2017 – March 2019)
Costed	Costed	Costed	Total
[\$635,729]	[\$2,995,124]	[\$2,554,877]	[\$6,185,730]

OSU's management approach encompasses a multi-disciplinary strategy to not only deliver on project tasks, but to ensure the project will ultimately *meet the needs of the MHK industry*.

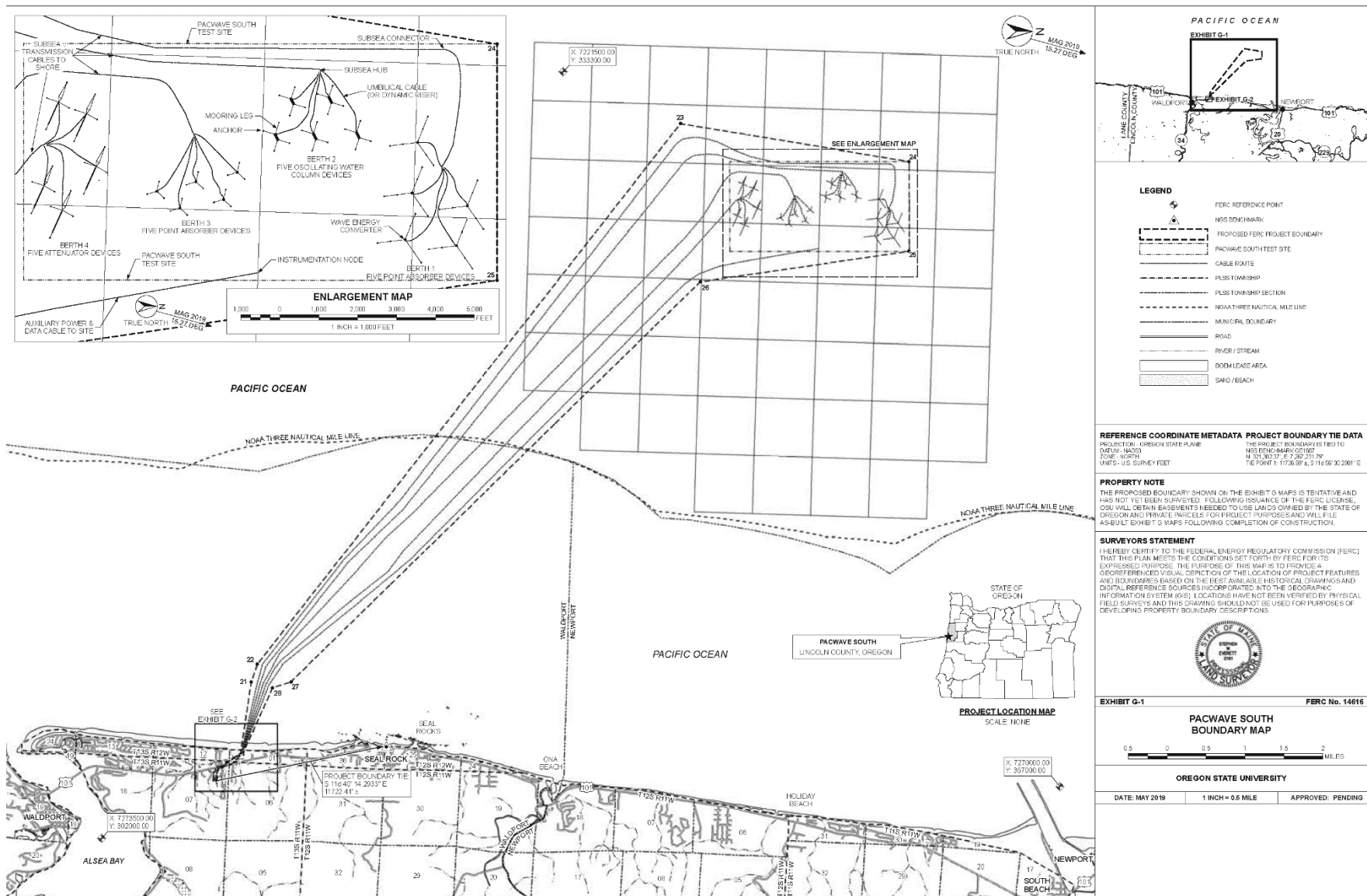
- OSU maintains on-going engagement with industry to ensure testing needs are met.
- Maintain regular communication with DOE staff and leadership
- Regular Face-To-Face Meetings with Project Team
- Extensive management oversight
- Technical review of deliverables



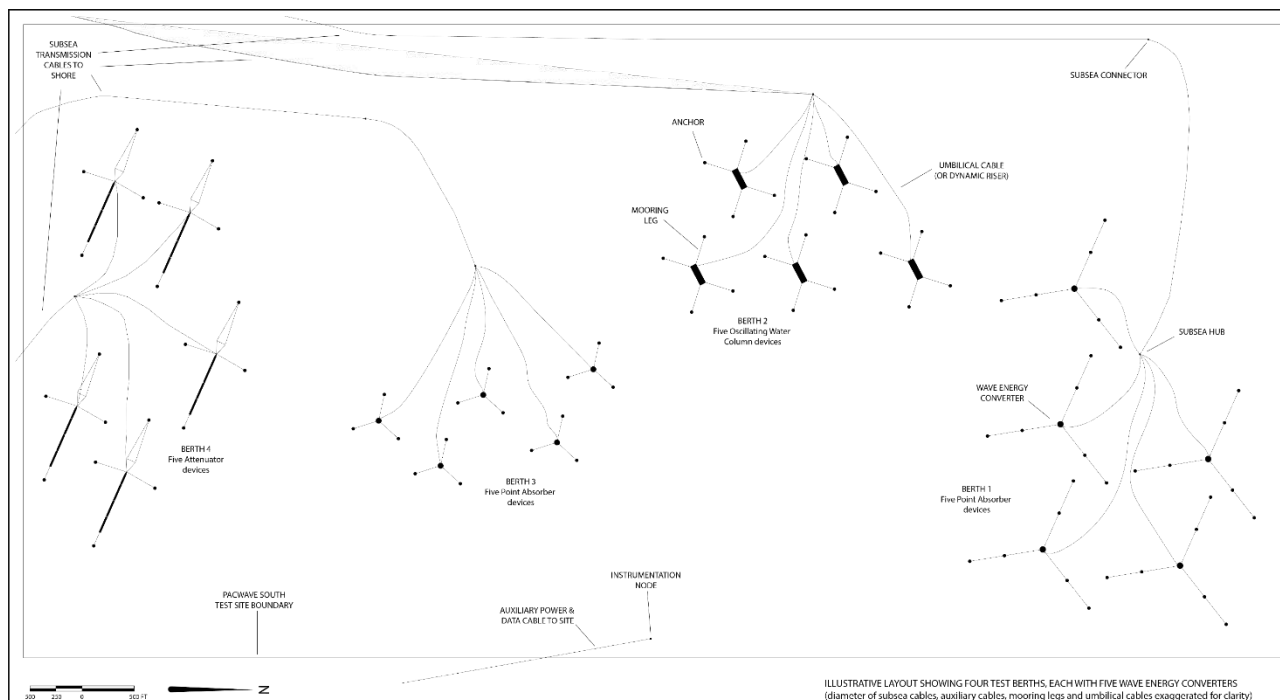
Management Approach – Future Org Structure



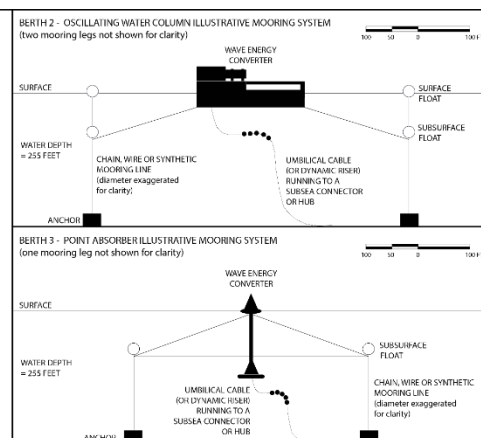
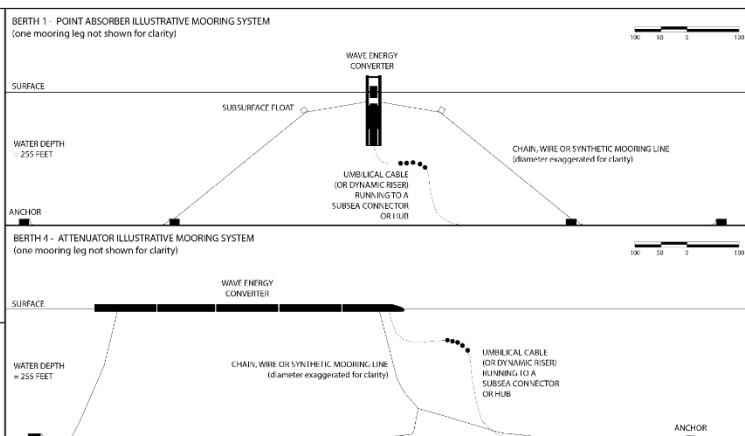
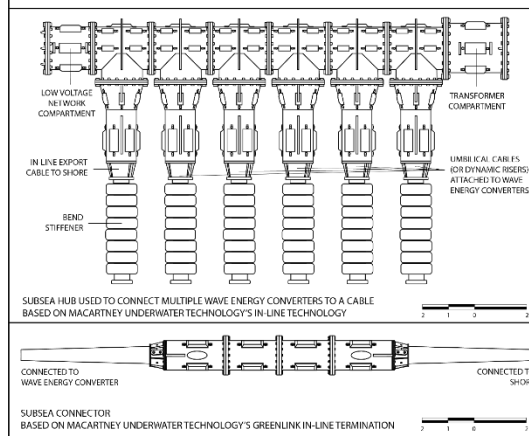
Technical Approach - Siting



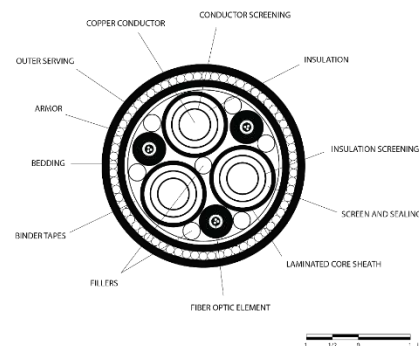
Technical Management – Project Scope



ILLUSTRATIVE LAYOUT SHOWING FOUR TEST BERTHS, EACH WITH FIVE WAVE ENERGY CONVERTERS (diameter of subsea cables, auxiliary cables, mooring legs and umbilical cables exaggerated for clarity)

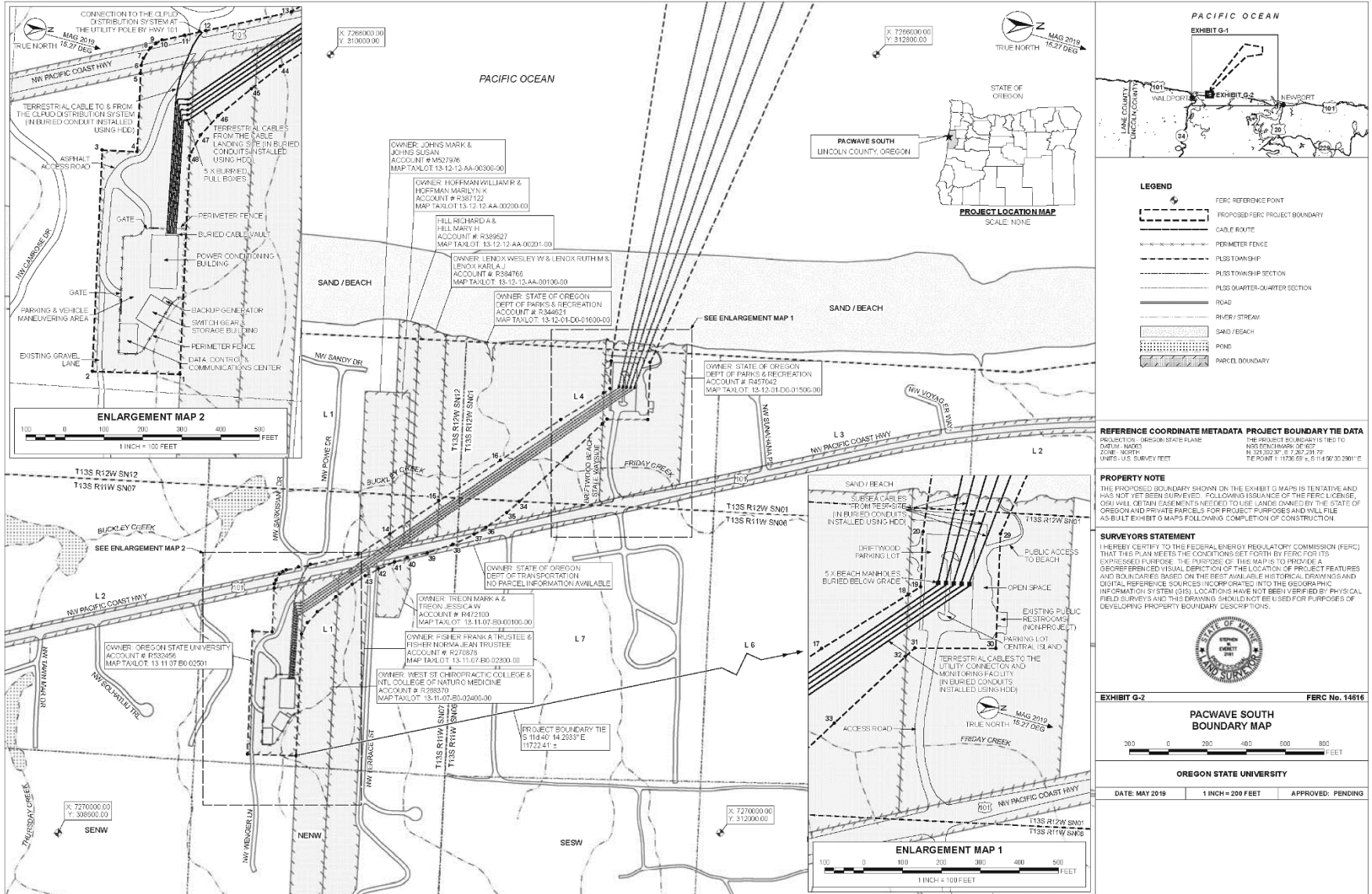


GENERAL DESIGN OF INSULATED A/C MEDIUM-VOLTAGE SUBSEA CABLE WITH FIBER OPTICS

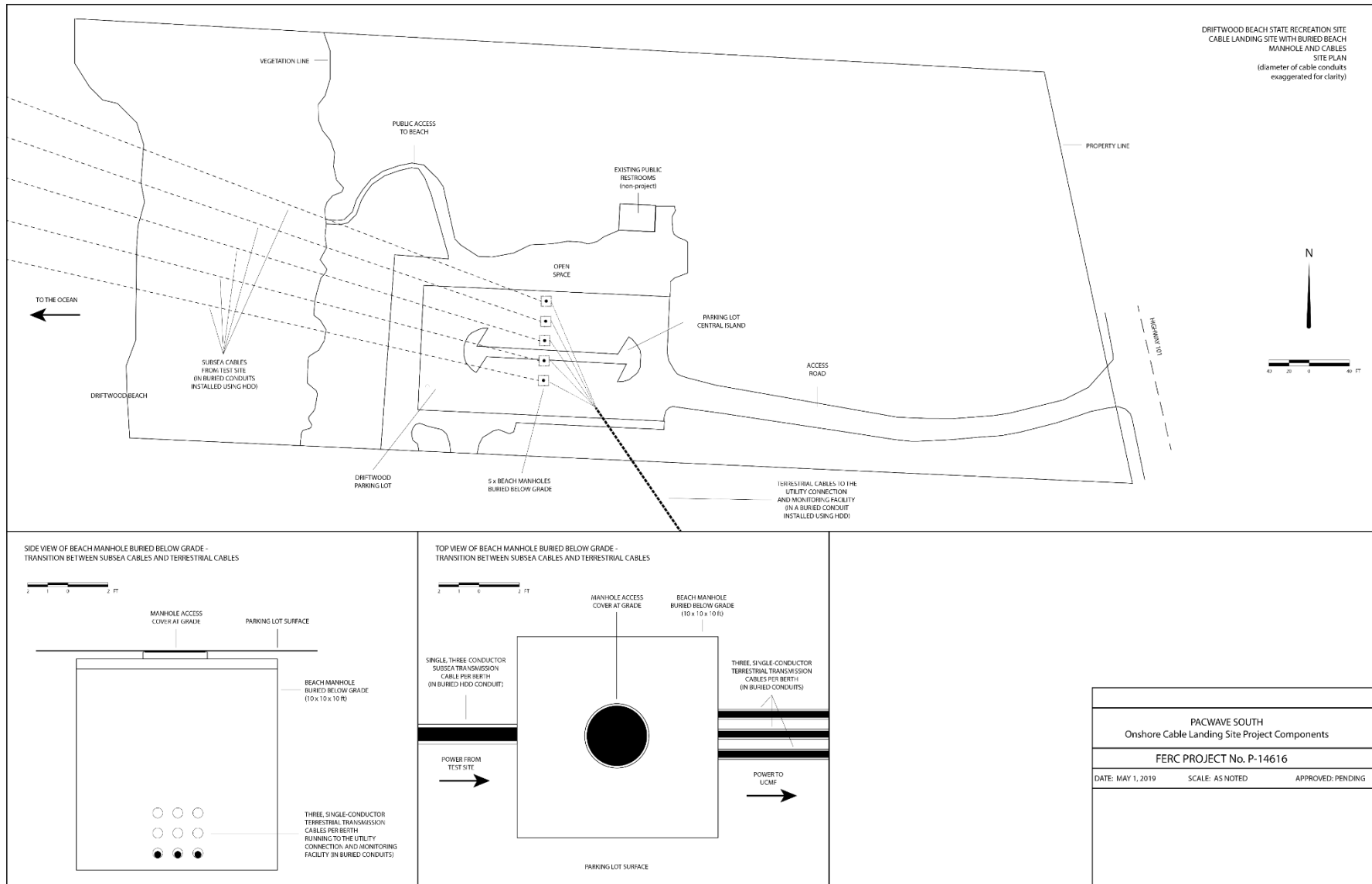


PACWAVE SOUTH Offshore Project Components		
FERC PROJECT No. P-14616		
DATE: MAY 1, 2019	SCALE: AS NOTED	APPROVED: PENDING

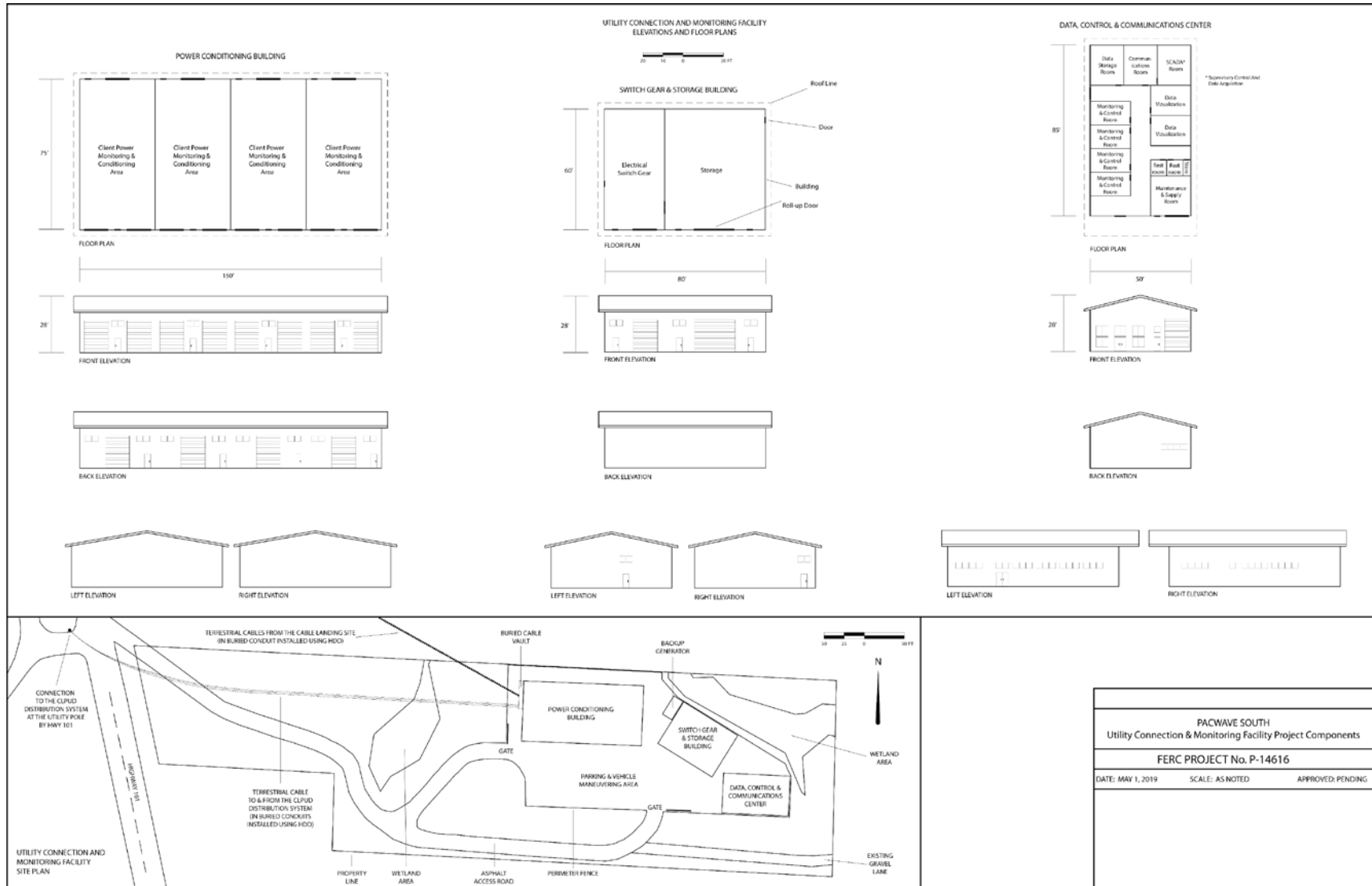
Technical Approach – Cable Route



Technical Approach – Cable Landing



Technical Approach - UCMF



End-User Engagement

The primary beneficiaries of the PacWave project will be the *MHK industry itself*

Engaged specific developers, test site operators, the national labs, supporting industries, equipment manufacturers, and other stakeholders in multiple ways including: industry surveys, industry partner networks/advisory boards, face-to-face meetings, site visits and workshops.

The goal of OSU's engagement strategy is to *ensure the PacWave project meets both the short-term and long-term needs of the MHK industry*. OSU has collected specific technical information from end-users that was used to design PacWave, while sharing specifics about various technical requirements WEC developers will need to understand and ultimately comply with to test at the site.

Local Community Engagement for over a decade.

Dissemination Strategies

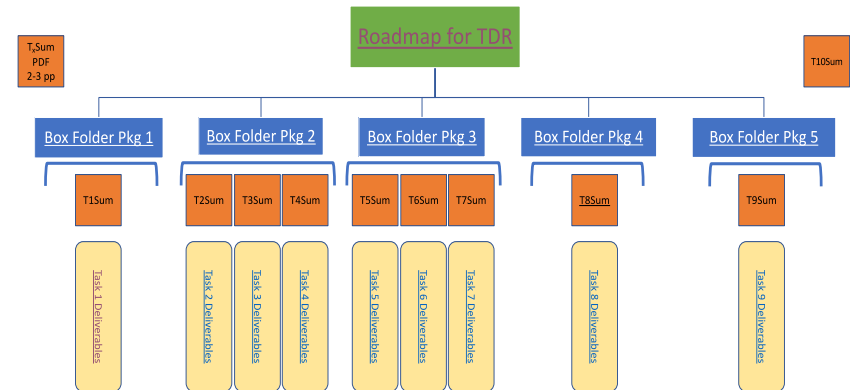
- Outreach at Conferences and Workshops
- One-on-One meetings with industry
- Public information from permitting process

- **Permitting:** FERC License other State and Federal Authorizations expected in 2019.
Significance: First of its kind in the US and will provide needed infrastructure for MHK industry.
- **Cable Design:** Final design and specifications for terrestrial and subsea cables.
Significance: Balancing needs of long-term operations with technical requirements of grid and WEC developers, as well as cable installation challenges.
- **UCMF Design:** Final design and specification for Utility Connection and Monitoring Facility.
Significance: Provide WEC clients with infrastructure and facilities to collect and analyze all aspects of performance and associated data.
- **Quality Standards:** Accredited quality standards for performance testing, quality systems and safety procedures. *Significance:* Offers WEC developers accreditation status from US entity.
- **Facility O&M Protocols:** Facility operations and maintenance, protocols, guidance and testing best practices. *Significance:* Offers WEC developers proper procedures and protocols for all aspects of ocean deployment.
- **Business Development:** Marketing, commercialization plan, and operational structure.
Significance: Establishes business plans and market assessment to attract national and international client base and develop a functioning operational structure to meet project and industry needs.

Progress Since Project Summary Submittal

- 1) OSU has initiated the Technical Design Review (TDR) and Go/No-Go process with DOE since the submission of the Peer Review narrative. All milestones have been delivered and are currently under review.

PacWave Technical Design Review Structure



Horizontal directional drilling (HDD) operations

- 2) OSU continues to work on critical contracting and procurement strategies to ensure the project stays on schedule as the project transitions from the design phase to the construction phase.

Future project phases include construction (BP2) and preparing for operation (BP3). Key construction and operational preparation activities include:

- Terrestrial and Marine HDD
- UCMF Construction
- Cable Procurement and Installation
- Organizational Structure and Business Plans
- Finalize Protocols and Procedures
- Accreditation



Subsea cable laying operations



Architectural rendering of the PacWave Utility Connection and Monitoring Facility