ADMIRALTY INLET PILOT TIDAL PROJECT

April, 2014

SNOHOMISH COUNTY PUD
PUBLIC UTILITY DISTRICT NO. 1

AGENDA

- ABOUT SNOHOMISH PUD
- PROJECT OVERVIEW
- SCOPE OF WORK - PHASE-1 INSTALLATION
  - QUAYSIDE INTEGRATION
  - DETAILED MARINE OPERATIONS
    a. Cable Installation
    b. Turbine Deployment
    c. Cable Connection
    d. Commissioning
- SCOPE OF WORK - PHASE-2 OPERATIONS AND ENVIRONMENTAL MONITORING

About Snohomish PUD

- Snohomish County population –approximately 723,000
- Electric System distributes power to almost 325,000 customers covering 2200 square miles
- Generation System includes the Jackson Hydroelectric Project, Youngs Creek Hydro Project and the Woods Creek Hydro Project
- Snohomish is the largest PUD in the state, 2nd largest municipal utility in the Northwest, and the 12th largest public power utility in the country
- 3-Elected commissioners serving 6-year rotating terms with rate setting authority
- Not regulated by state
- Climate change policy focuses all new energy requirements from cost effective Conservation and renewables

Why Tidal Energy?

- Clean, non-greenhouse gas-emitting and predictable renewable energy resource
- Close to our customers
- Meets Board's adopted policy focus (no greenhouse gas emissions)

- Washington State "Renewable Portfolio Standard" eligible
- Predictable Power Source
- Worldwide potential of over 1-GW, with a Puget Sound potential of 100 MW

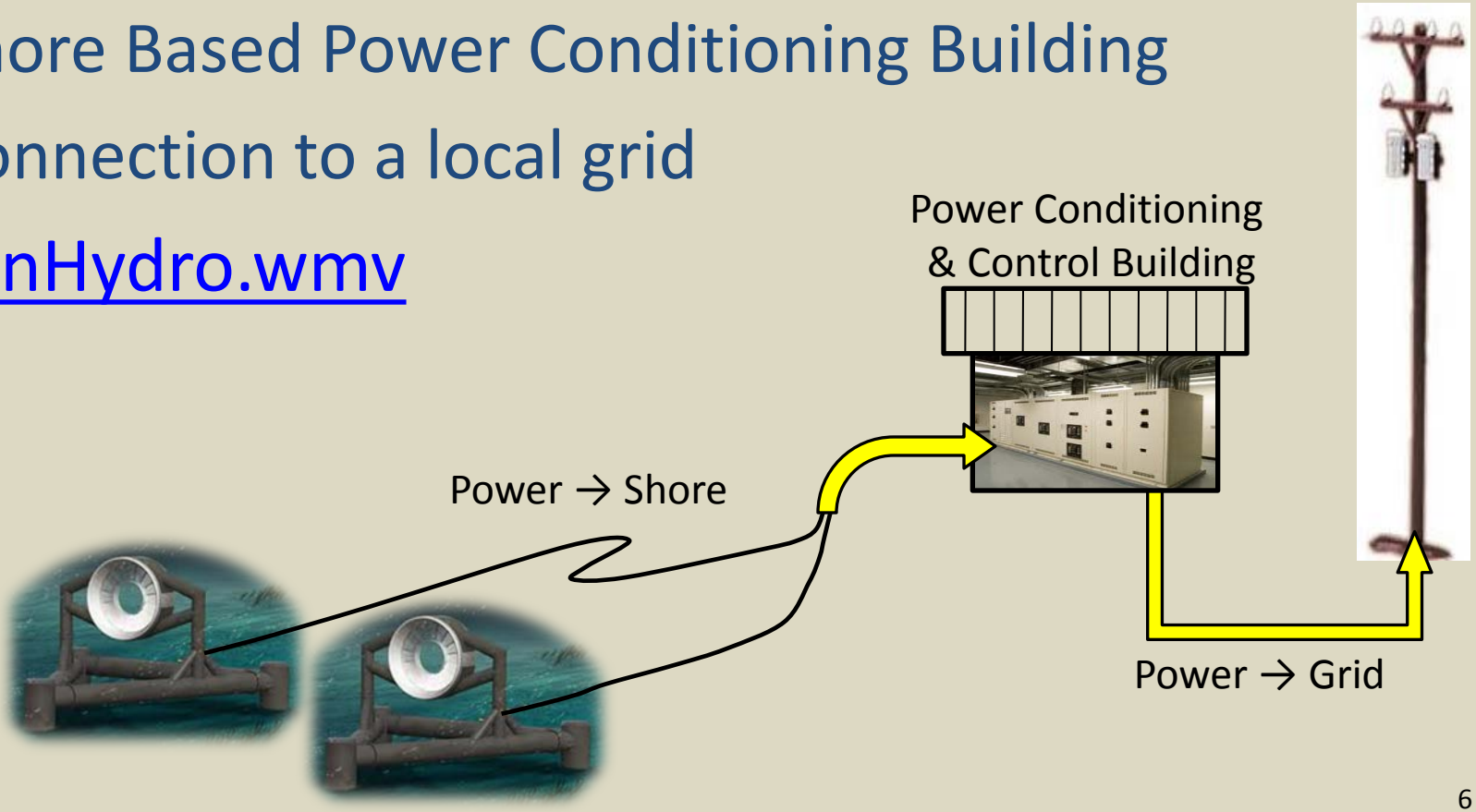
Project Objectives

To generate relevant data necessary to evaluate the technical, social, economic and environmental feasibility of tidal energy generation

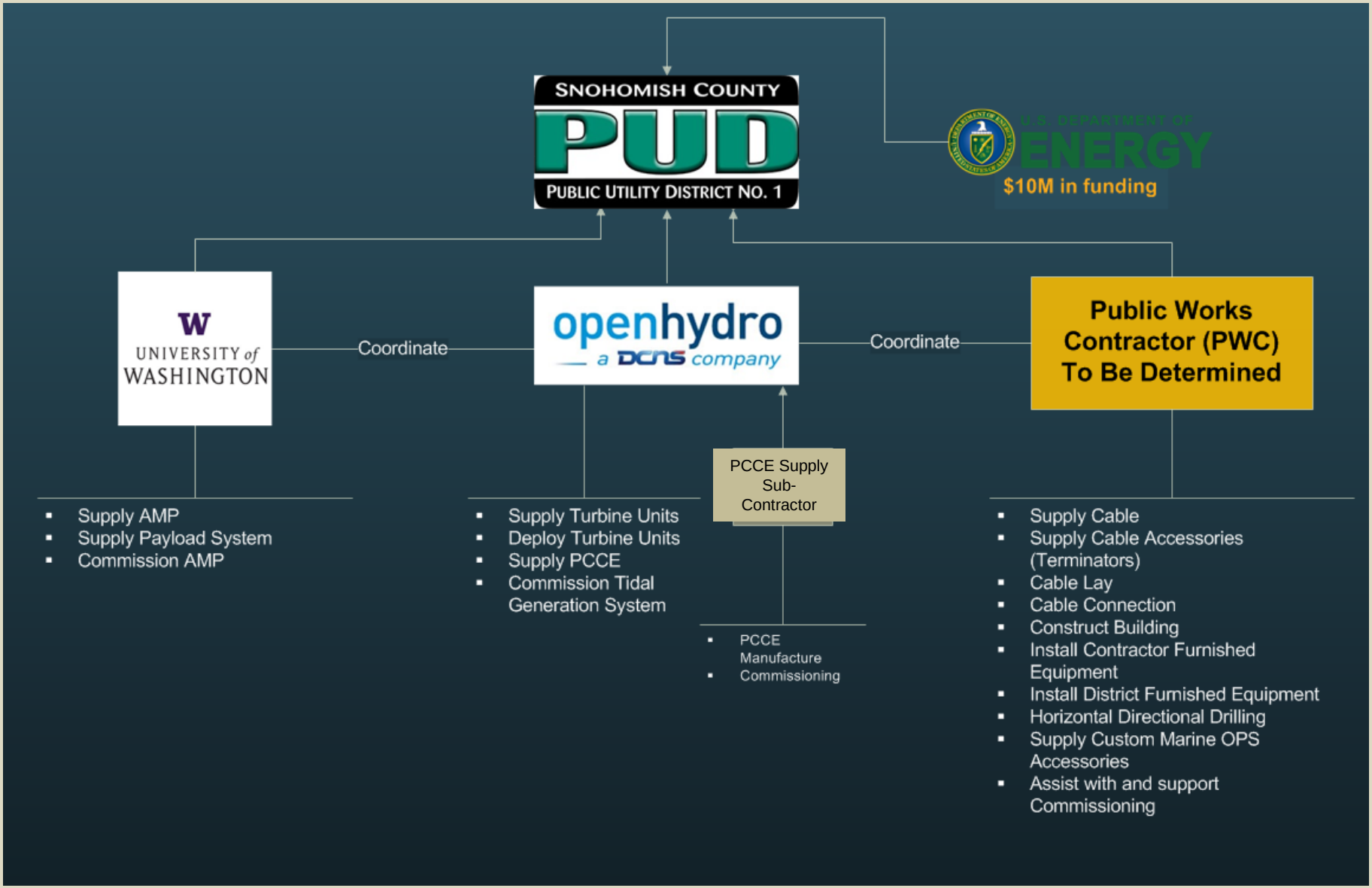
Admiralty Inlet Tidal Project

- Subsea Turbine Devices
- Trunk Cable(s) to Shore
- Shore Based Power Conditioning Building
- Connection to a local grid

[OpenHydro.wmv]

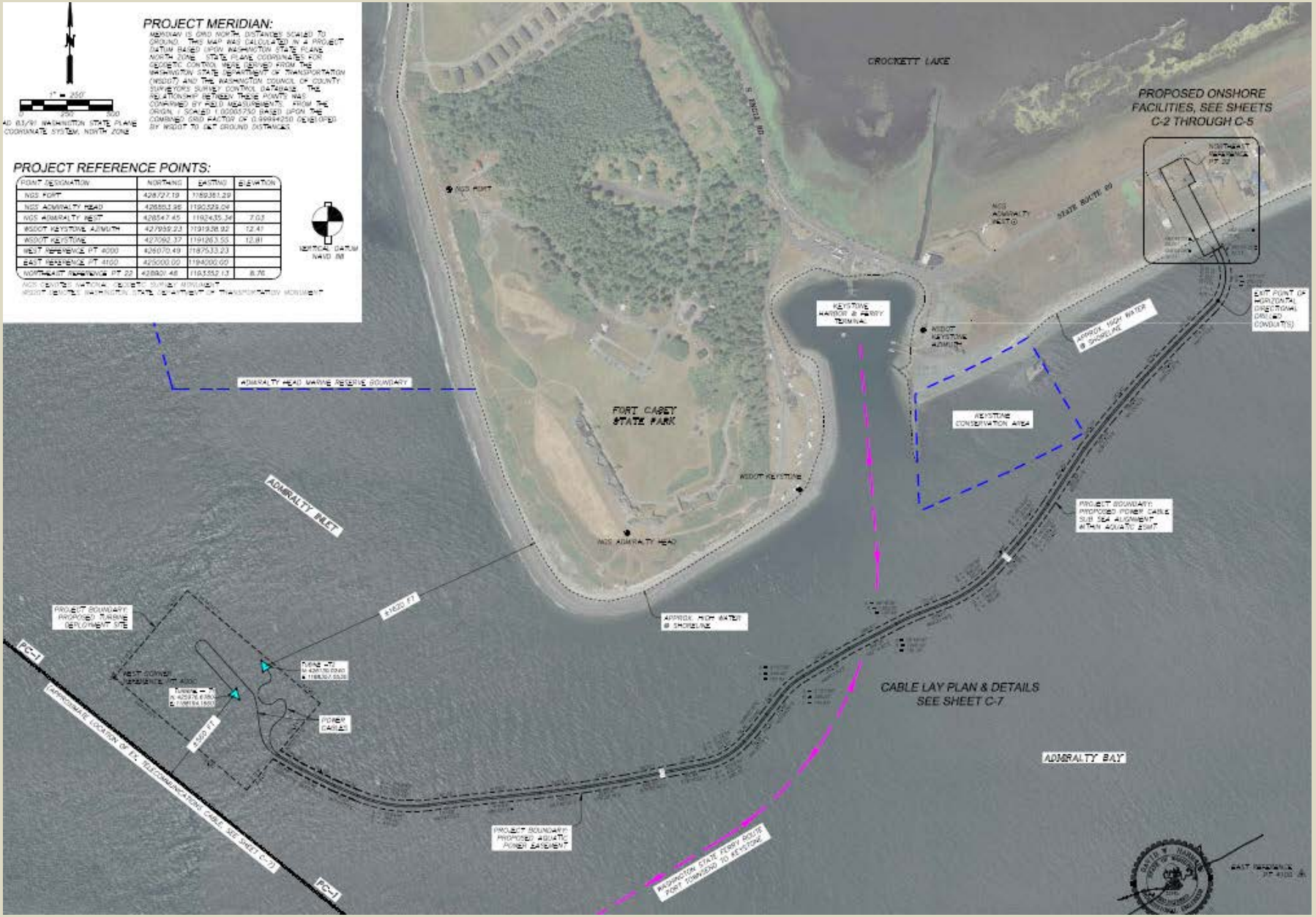


Project Implementation Partners



REGIONAL MAP

PROJECT SITE OVERVIEW



Two Phase Approach

PHASE-1

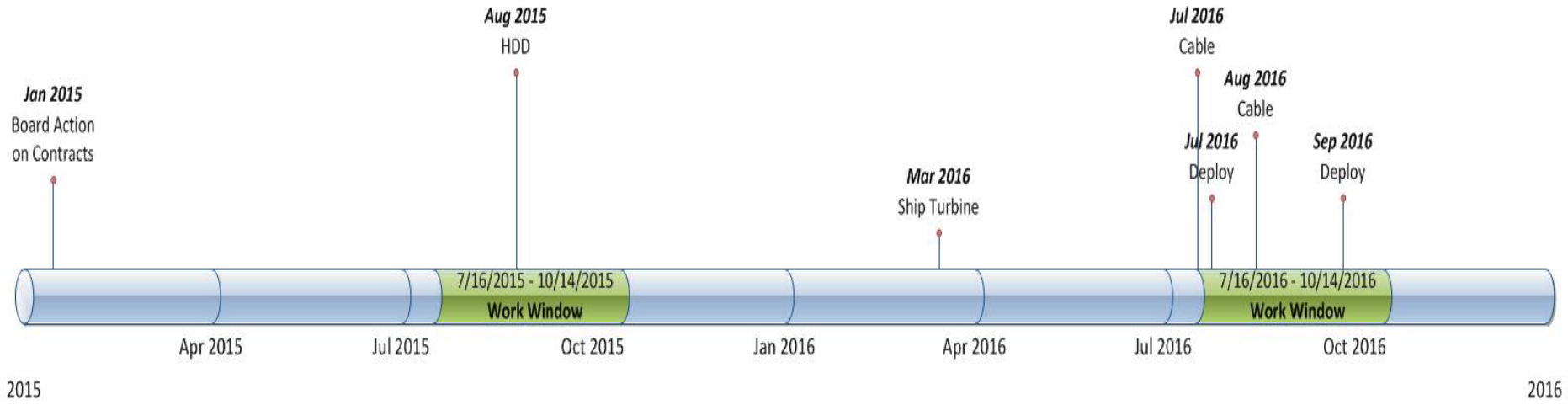
DEPLOY AND COMMISSION A GRID CONNECTED TIDAL ARRAY THROUGH THE FERC's "PILOT LICENSING PROGRAM"

On track to be the "WORLDS FIRST GRID CONNECTED TIDAL ARRAY"

PHASE-2

COLLECT OPERATIONAL AND ENVIRONMENTAL DATA THAT WILL INFORM THE INDUSTRY IN SUPPORT OF THE FUTURE COMMERCIALIZATION OF TIDAL ENERGY
AND ULTIMATELY REMOVE THE TURBINES

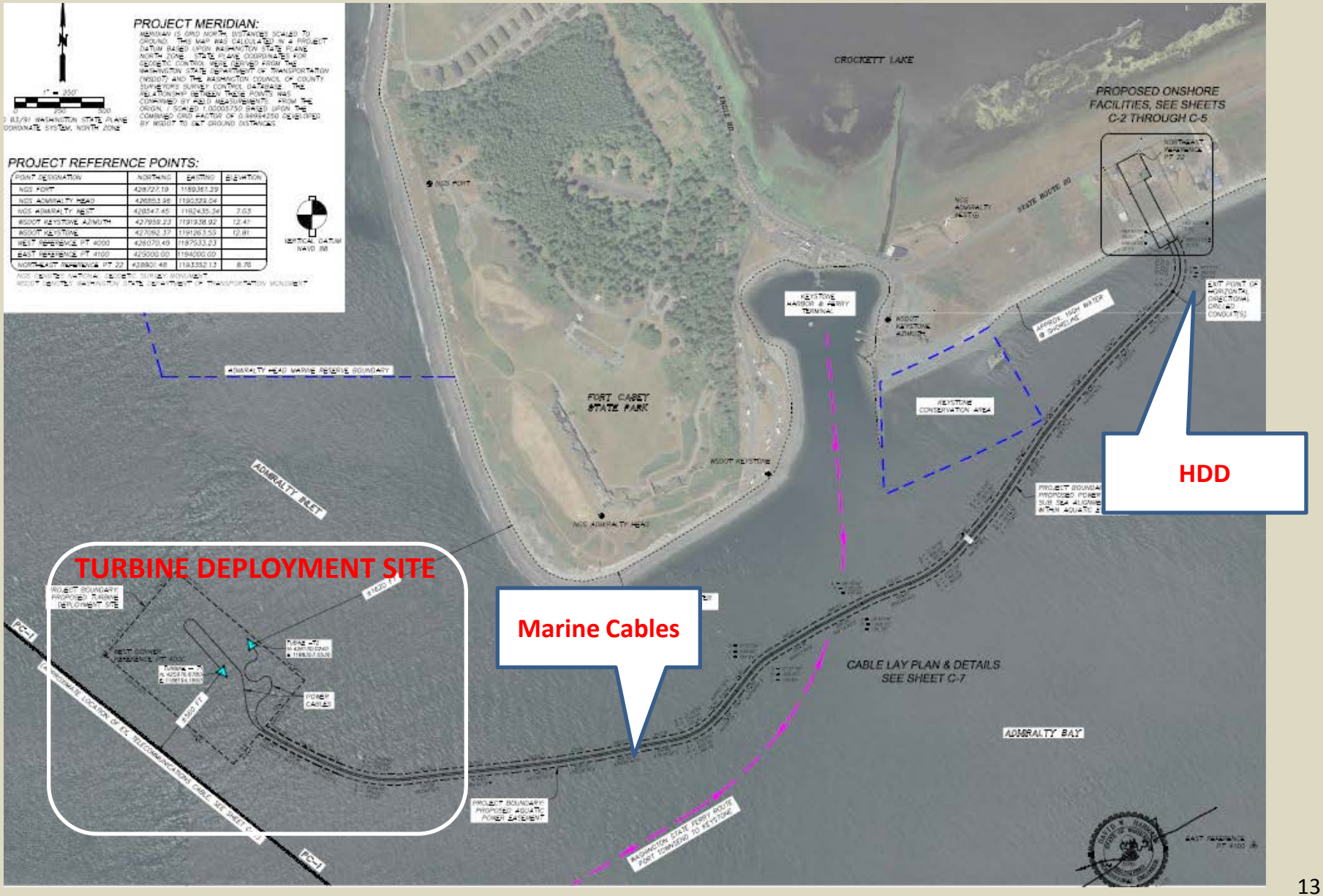
Project Schedule Overview



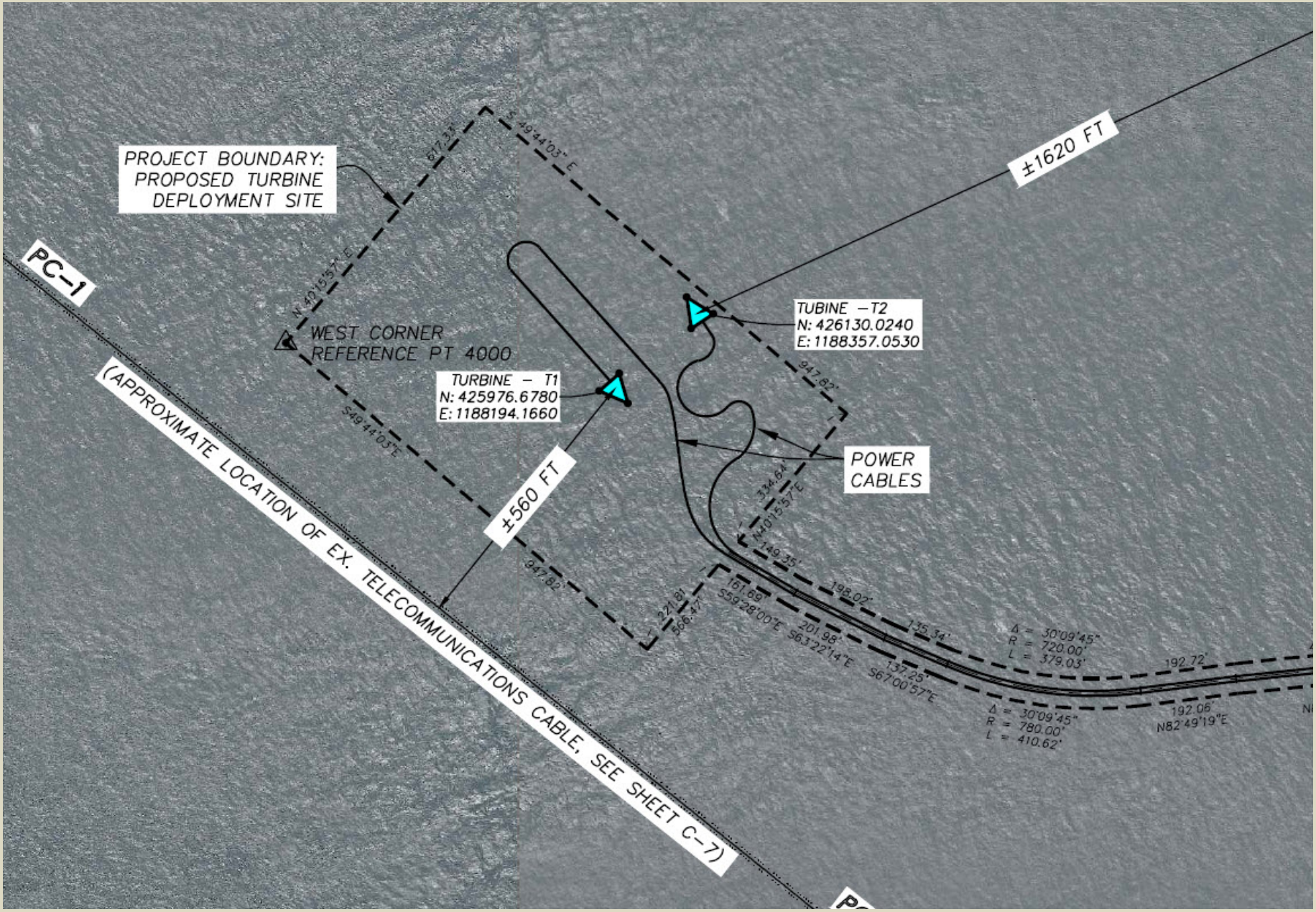
PHASE-1 SCOPE OF WORK

- OpenHydro
  - Turbine and Subsea Base furnish and install
  - Power Control and Conditioning Equipment
- University of Washington (UW) - Adaptive Monitoring Package (AMP)
- Public Works Contractor (PWC)
    - Horizontal Directional Drilling
    - Power Control and Conditioning Building
    - Procurement and Installation of:
      - Marine Cable
      - Marine Cable Terminations
      - Miscellaneous marine installation hardware
- System Integration and Testing - All

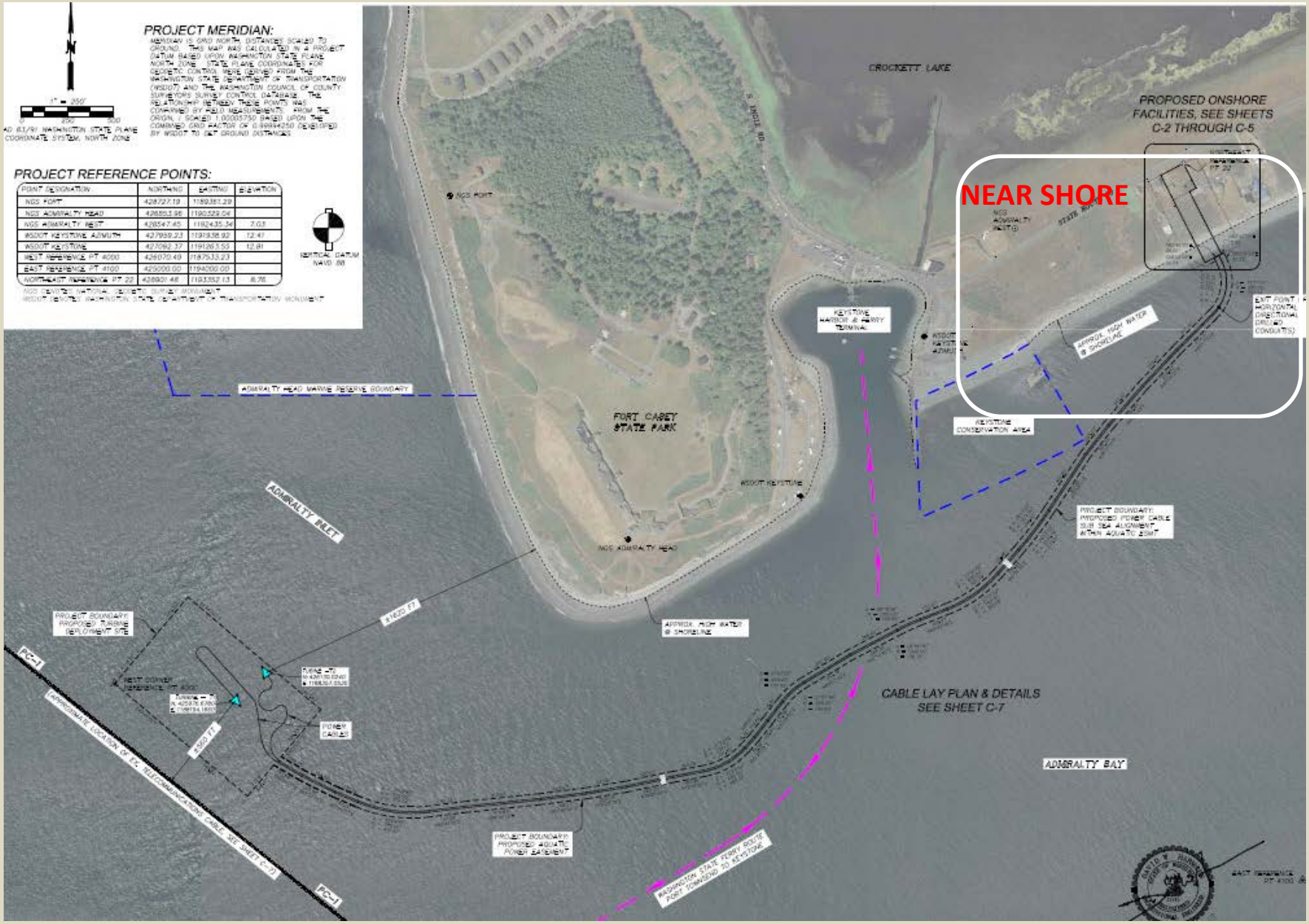
OVERVIEW MAP



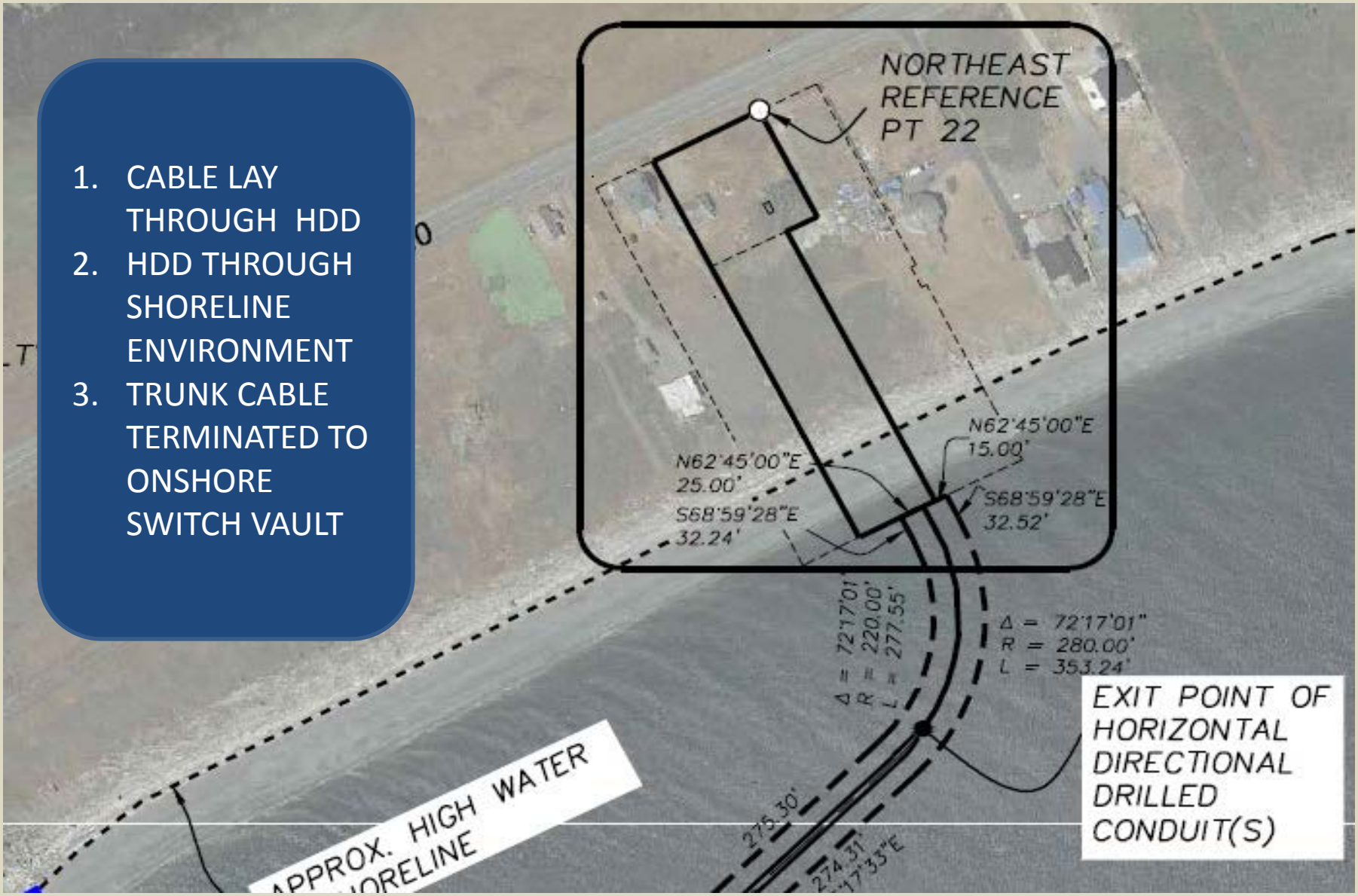
TURBINE DEPLOYMENT SITE

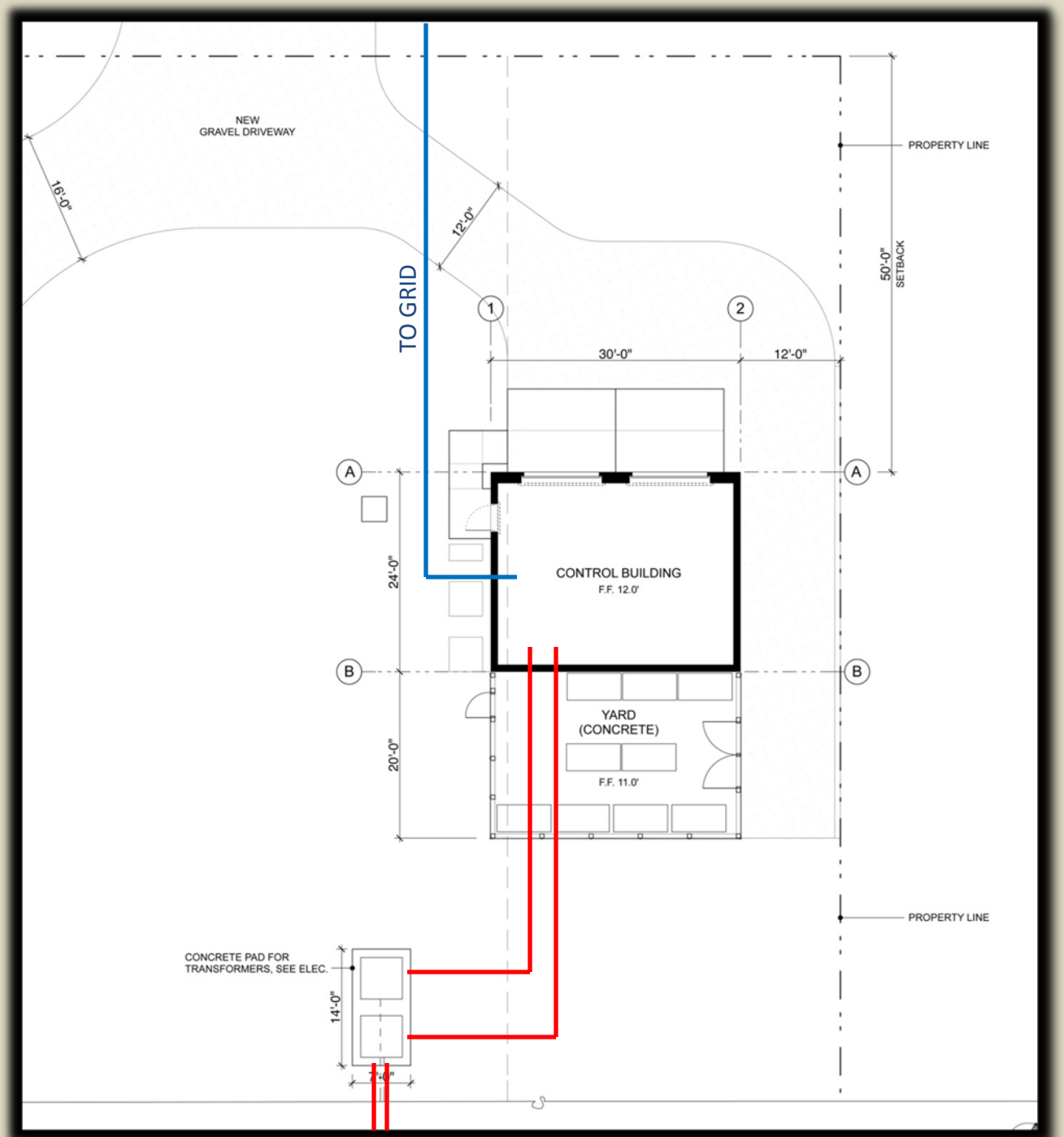


OVERVIEW MAP



NEAR SHORE


1. CABLE LAY THROUGH HDD
2. HDD THROUGH SHORELINE ENVIRONMENT
3. TRUNK CABLE TERMINATED TO ONSHORE SWITCH VAULT
NORTHEAST REFERENCE PT 22
N62°45'00"E 25.00'
S68°59'28"E 32.24'
N62°45'00"E 15.00'
S68°59'28"E 32.52'
Δ = 72°17'01" R = 220.00' L = 277.55'
Δ = 72°17'01" R = 280.00' L = 353.24'
EXIT POINT OF HORIZONTAL DIRECTIONAL DRILLED CONDUIT(S)
APPROX. HIGH WATER
275.30'
274.31'

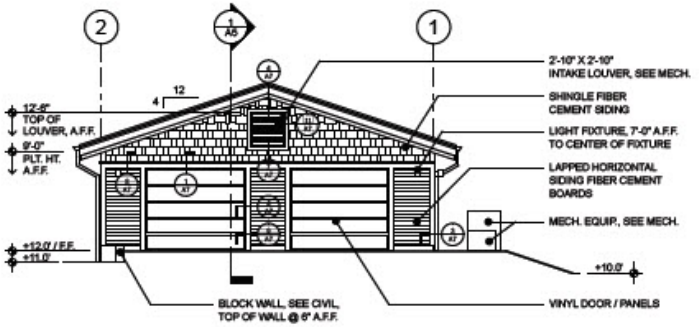


ONSHORE DETAILS

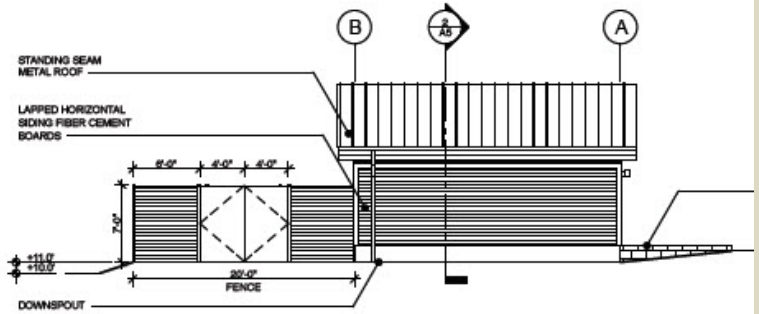
OVERVIEW

1. TRANSFORMERS
2. POWER CONTROL & CONDITIONING BLDG. (PCCB)
3. BATTERY STORAGE SYSTEM
4. GRID CONNECTION EQUIPMENT
5. CONCRETE FENCED YARD

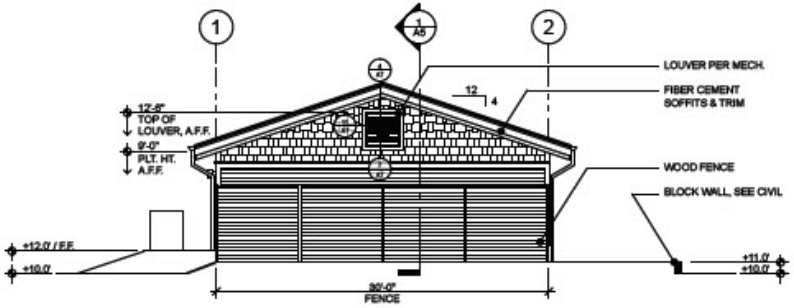
Power Conditioning and Control Building



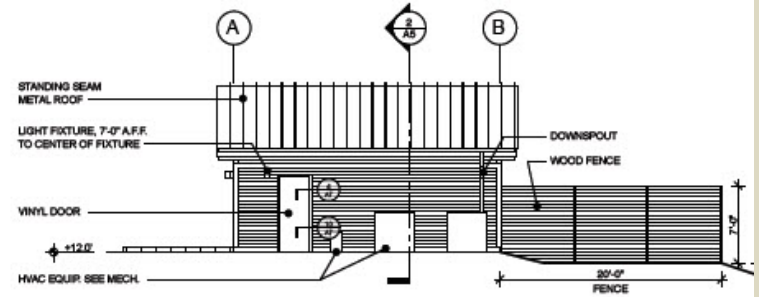
1 NORTH ELEVATION 1/8" = 1'-0"



2 EAST ELEVATION



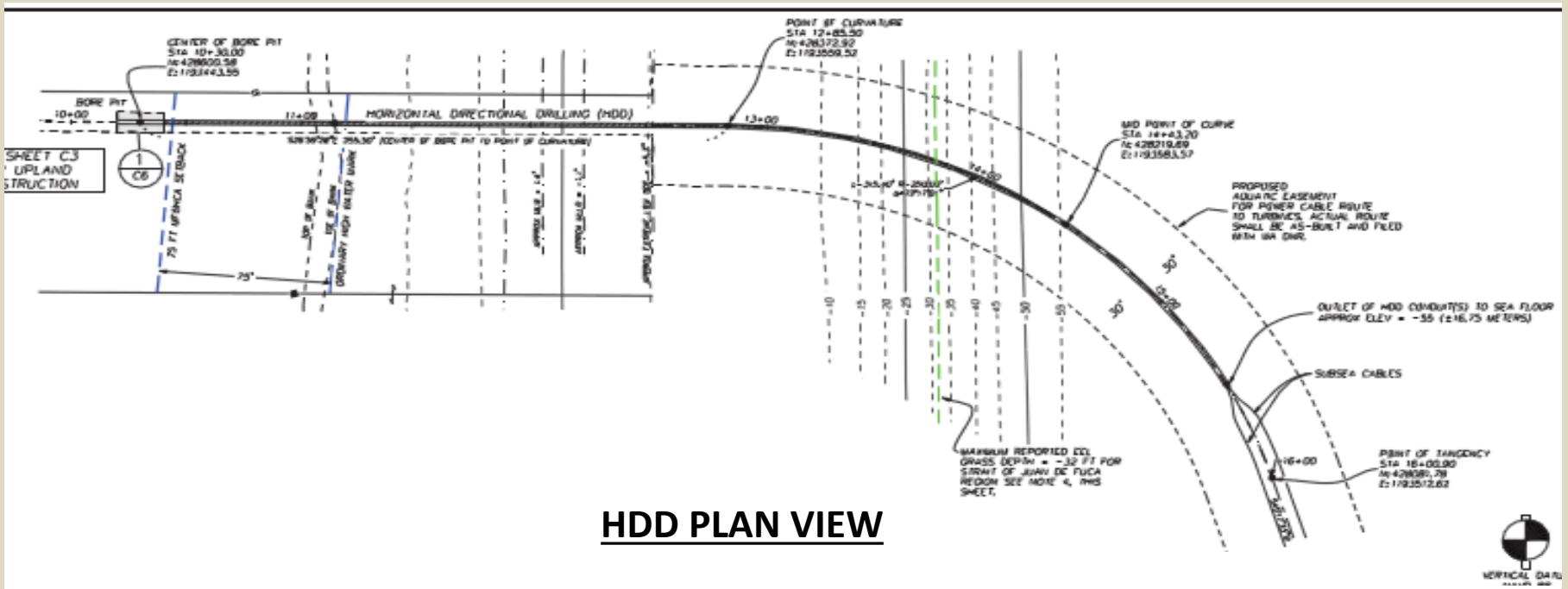
3 SOUTH ELEVATION 1/8" = 1'-0"



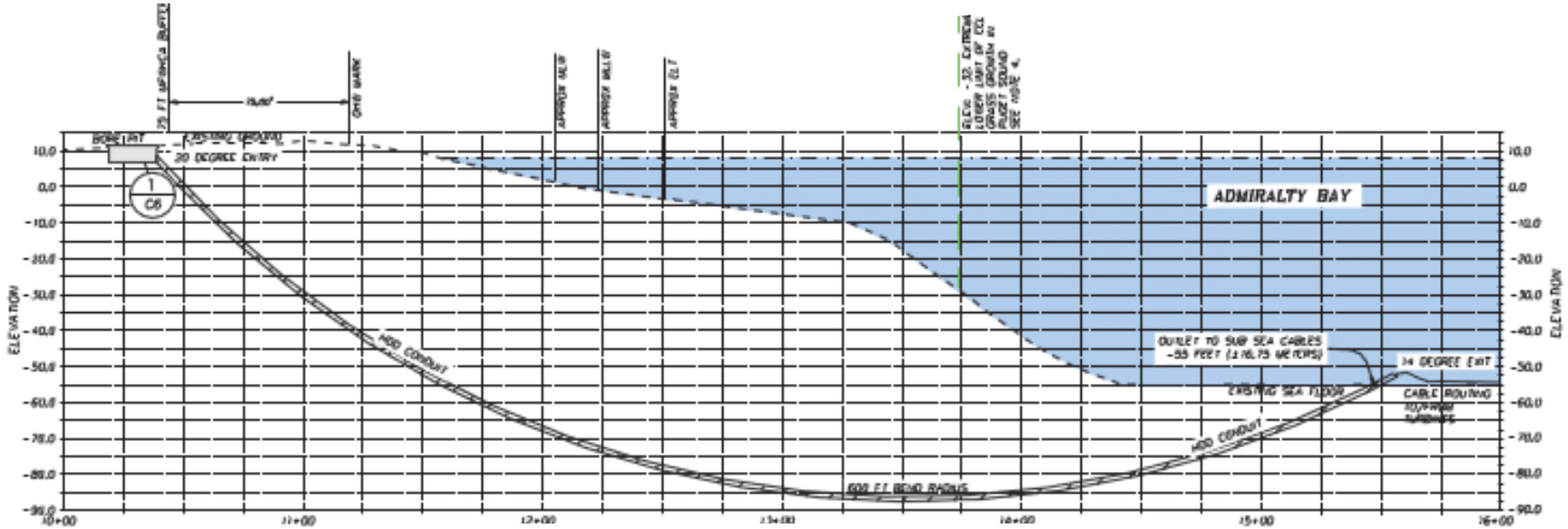
4 WEST ELEVATION

HORIZONTAL DIRECTIONAL DRILLING *(HDD)*

- 600 lineal feet under the shoreline environment
- 1-12” or 2-6” diameter conduits
- 19-meters – requiring shallow dive support
- Avoids conflicts with sensitive near-shore habitat



HDD PLAN VIEW

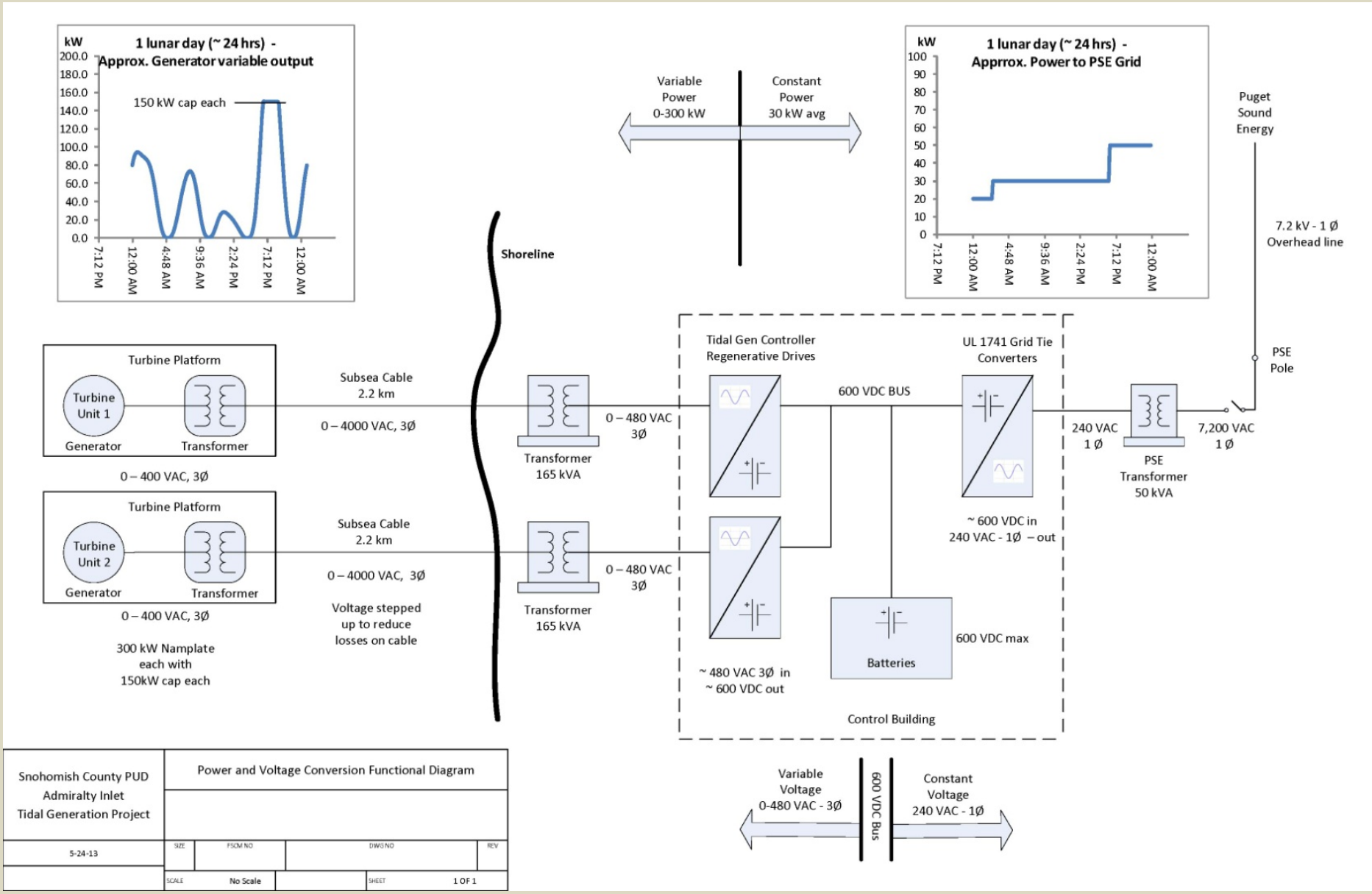


HDD PROFILE VIEW

PROJECT PERMITS

1. FEDERAL ENERGY REGULATORY COMMISSION (FERC)
2. HYDRAULIC PROJECTS APPROVAL (HPA) - WDFW
3. ISLAND COUNTY CONDITIONAL USE PERMIT (CUP)
4. ISLAND COUNTY BUILDING PERMIT
5. WASHINGTON ECOLOGY (401) – WATER QUALITY CERTIFICATE
6. NOAA FISHERIES CONCURRENCY – BIOLOGICAL ASSESSMENT
7. WASHINGTON STATE DOT (ACCESS)
8. WASHINGTON STATE DNR (AQUATIC EASEMETNS AND LEASES)

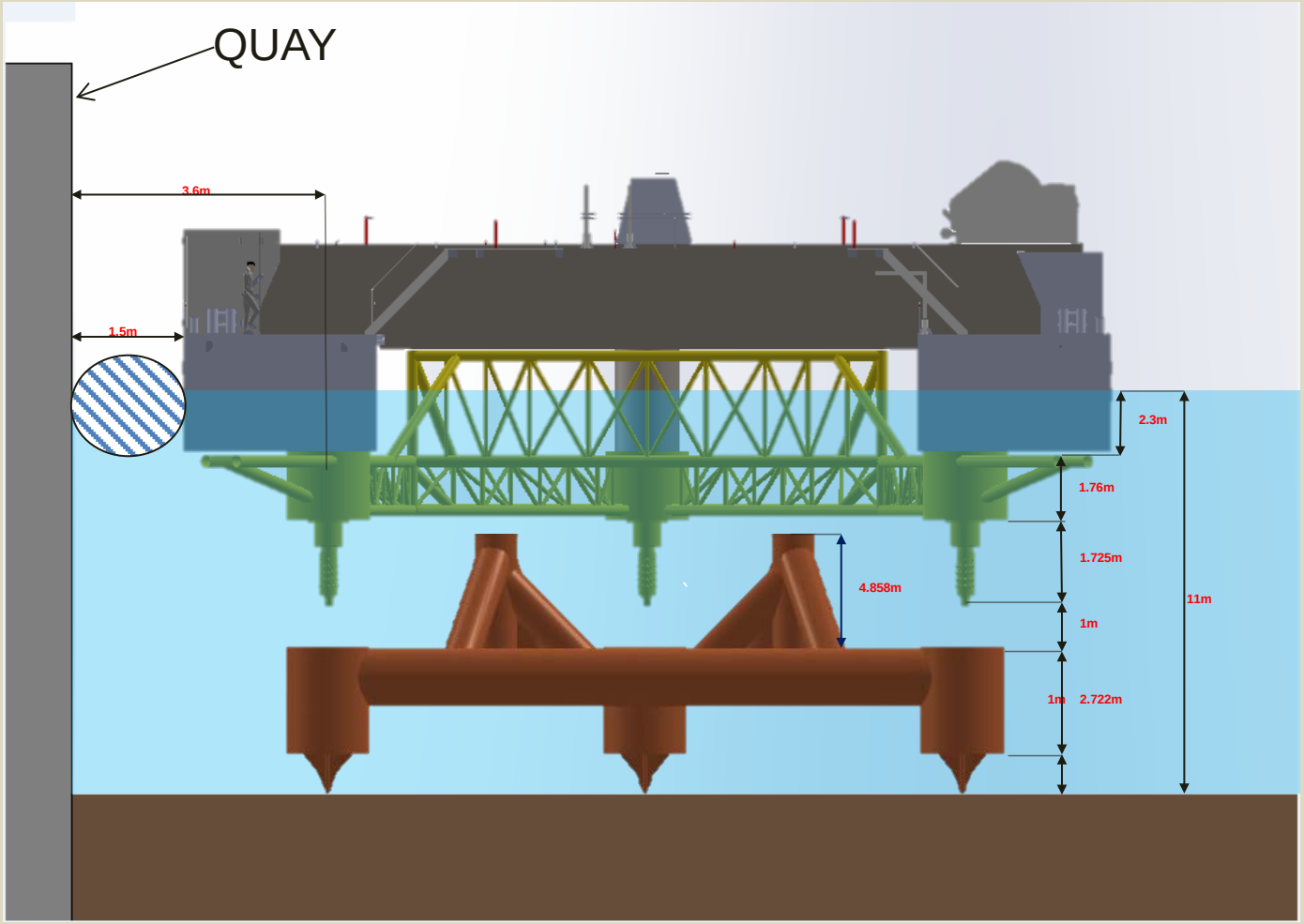
FUNCTIONAL ONE-LINE



Turbine Shipment

Quayside Integration

OpenHydro



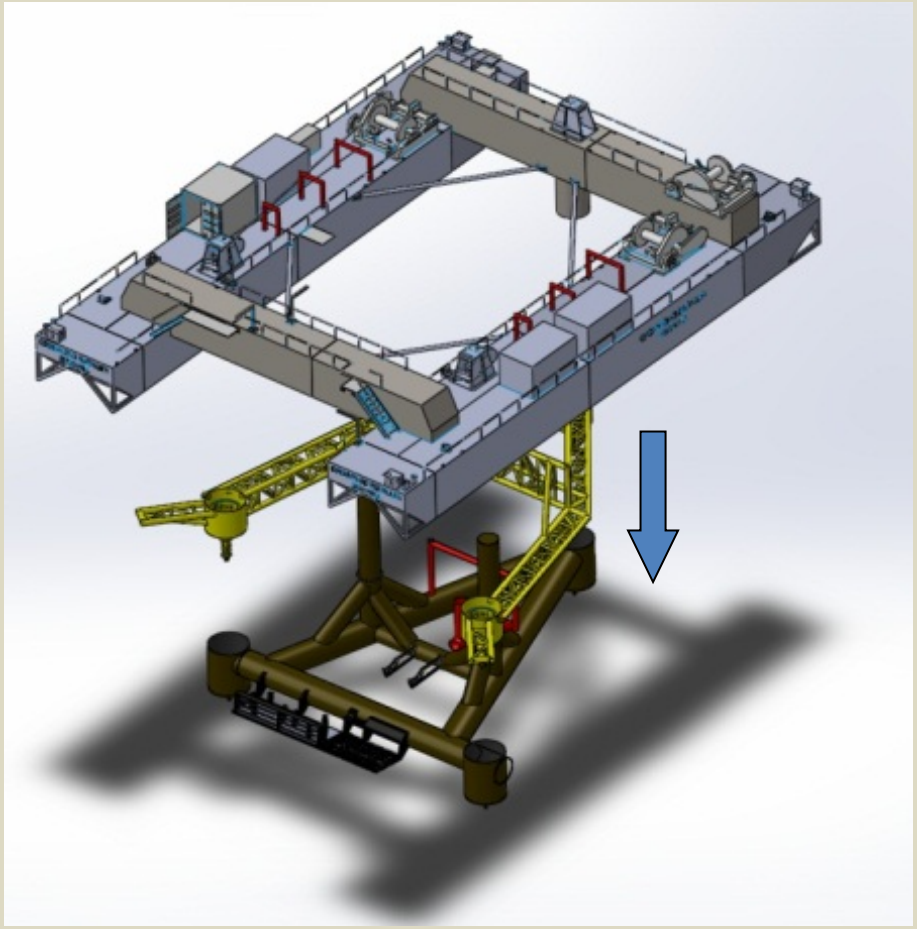
1. SPECIFIC DEPTH REQUIREMENTS NECESSARY FOR THE OPERATION.

2. ONLY A FEW OF THE COMMERCIAL SHIPYARDS IN THE PUGET SOUND ARE CAPABLE O F MEETING THIS CRITERIA.

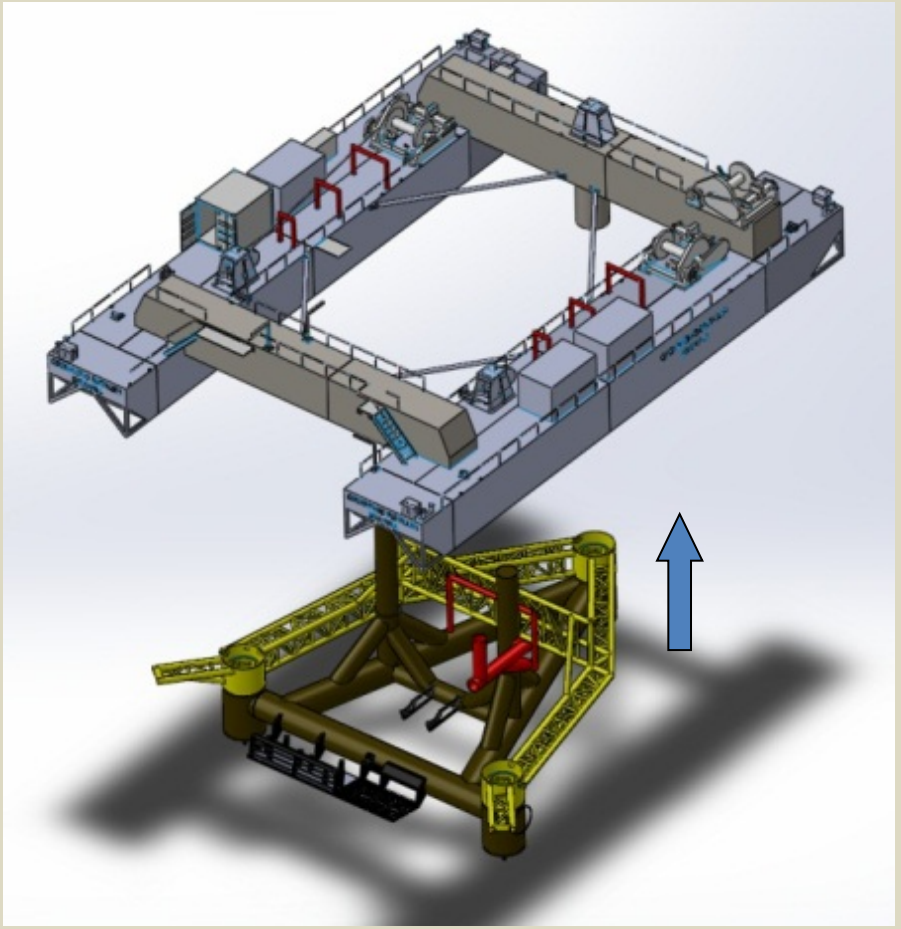
3. WITHOUT THIS DEPTH CRITERIA, A SHIPYARD WOULD BE REQUIRED TO MOBILIZE A VERY LARGE DERRICK BARGE.

Quayside Integration

OpenHydro

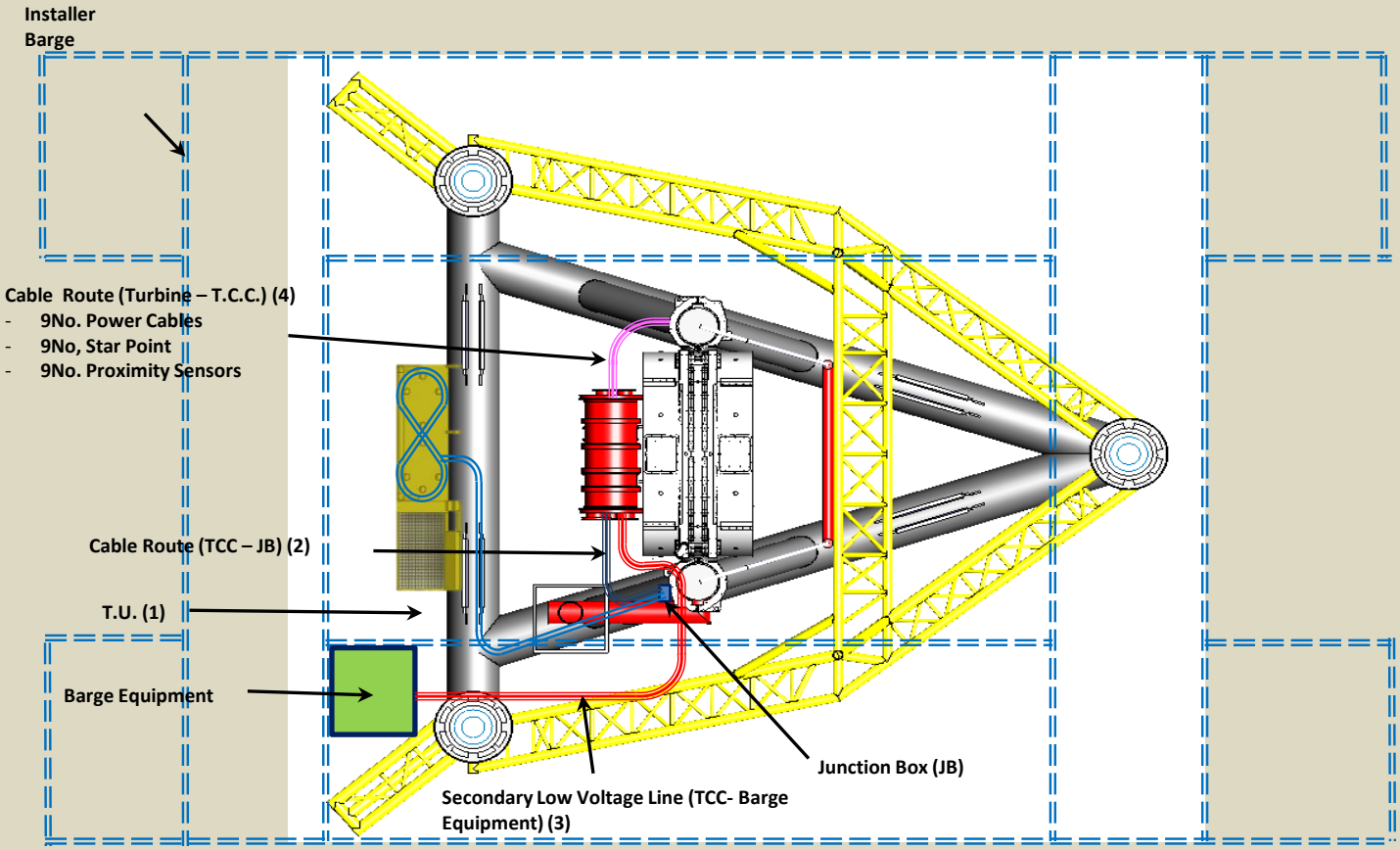


1. ONCE IN POSITION, THE RECOVERY FRAME LIFT-LOKS ARE LOWERED INTO THE SUBSEA BASE



2. UPOND SUCCESSFUL CONNECTION, THE SUBSEA BASE IS LIFTED INTO THE MOONPOOL OF THE INSTALLATION BARGE.

Quayside Integration



- Electrical Inductance Test to be completed
- Stray Capacitance Test to be completed
- Instrument functionality to be confirmed
- Data Download simulation (To relevant instruments)

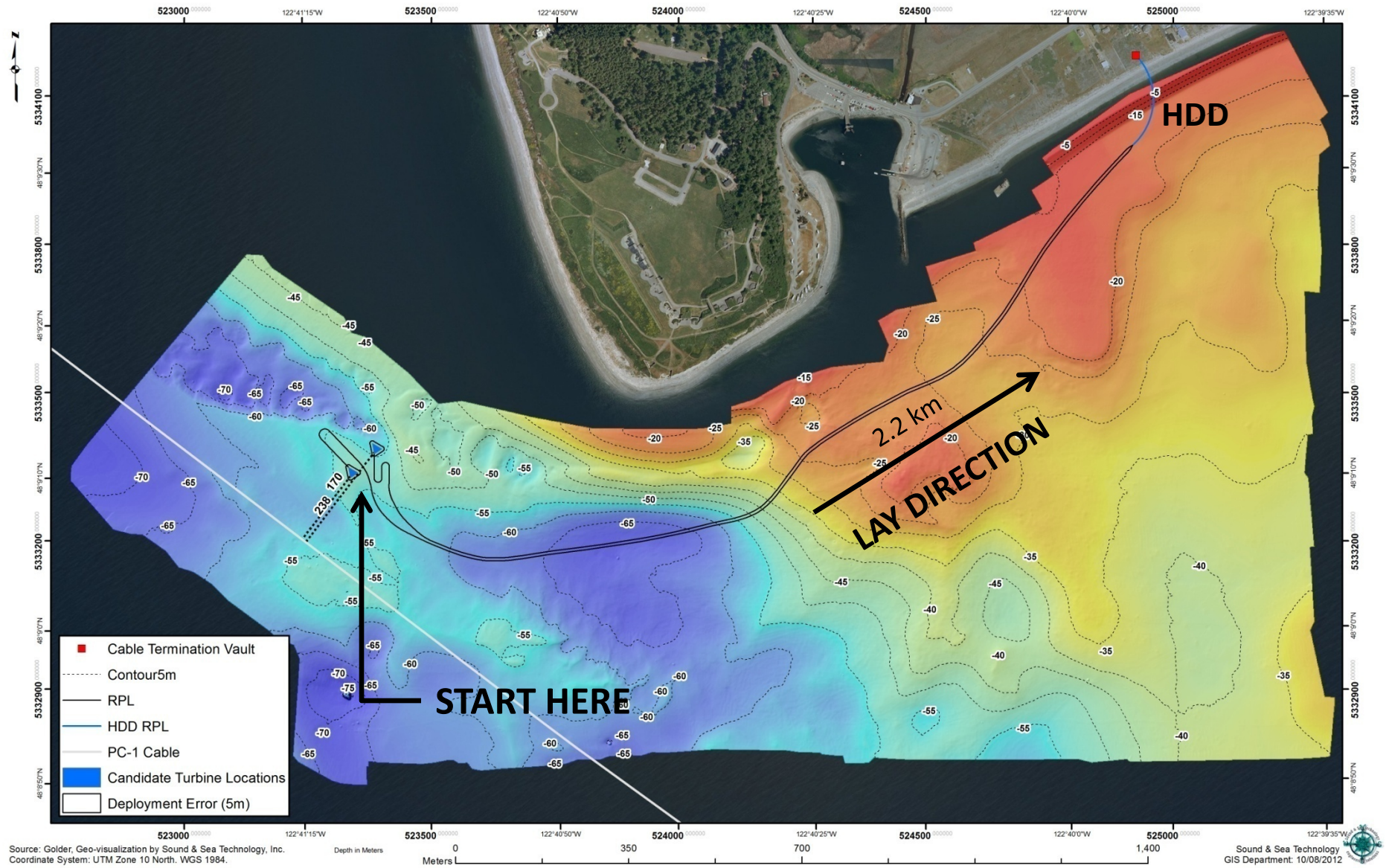
DETAILED MARINE OPERATIONS

- Marine Operations effectively separated into 3-discrete operations with limited coordination requirements:
  - Cable Installation (Qty-2) – By PWC
  - Turbine Deployment (Qty-2) – By OpenHydro
  - Cable Connection (Qty-2) – By PWC

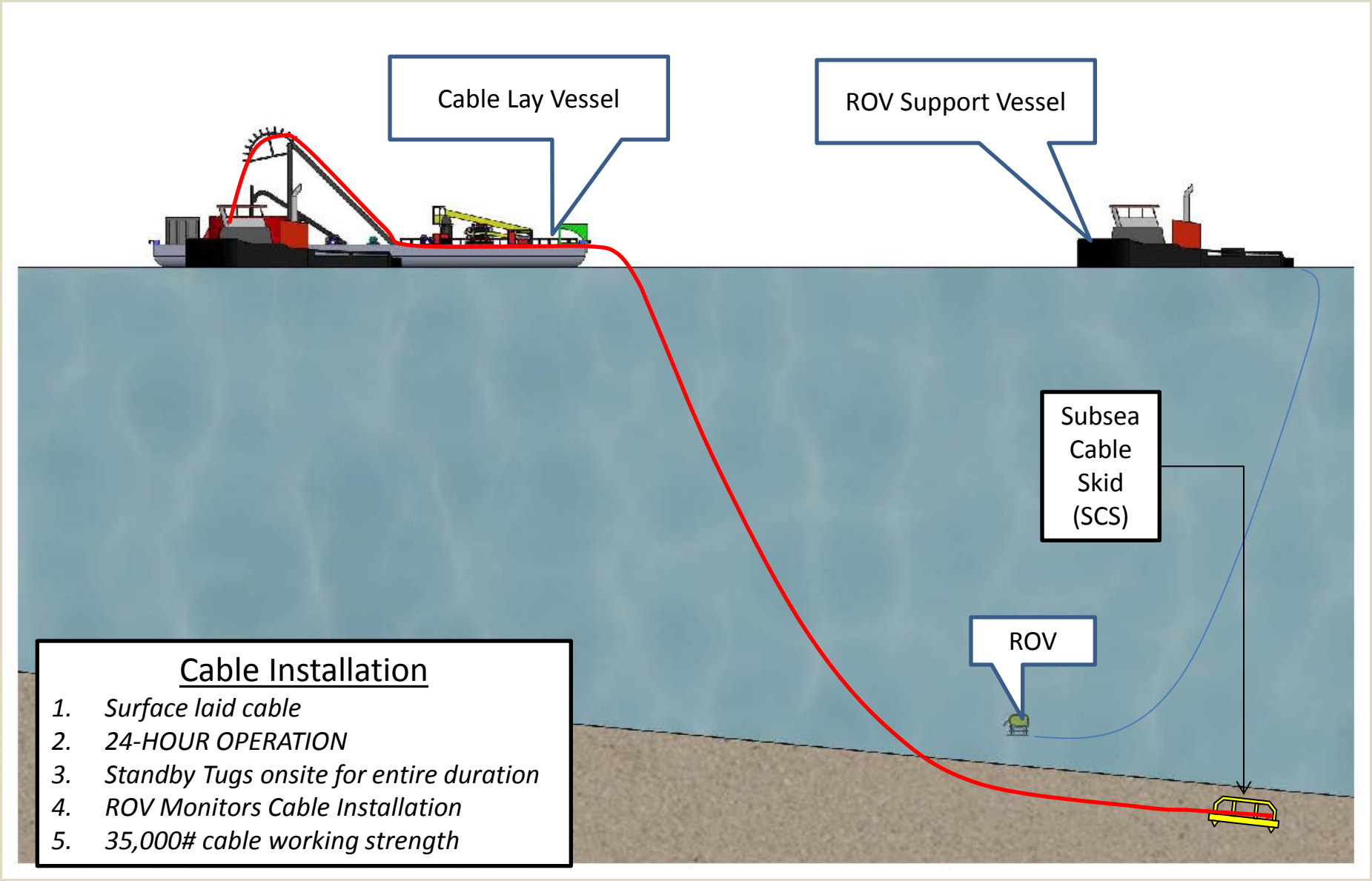
Cable Installation - PWC

- Barge of opportunity
  - PWC Leased
  - Self powered or Z-Drive tug powered
- Equipment spread
  - PWC Leased, owned or fabricated equipment

Cable Installation - PWC



Cable Installation – By PWC

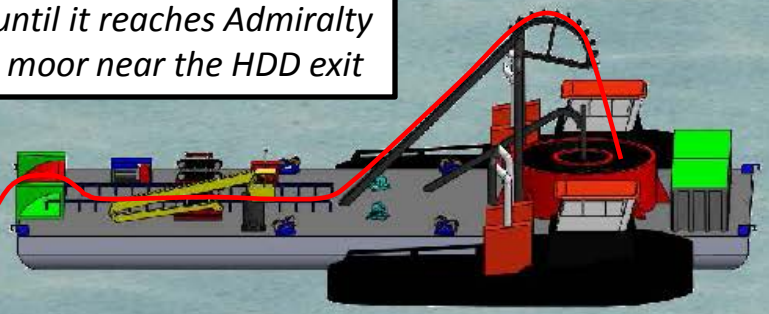


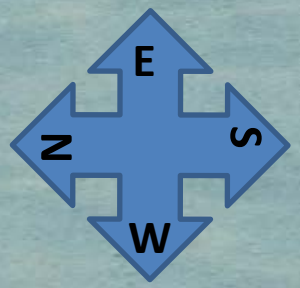
Cable Installation

1. *Surface laid cable*
2. *24-HOUR OPERATION*
3. *Standby Tugs onsite for entire duration*
4. *ROV Monitors Cable Installation*
5. *35,000# cable working strength*

Cable Installation – By PWC

Cable-Lay Vessel continues operation until it reaches Admiralty Bay. Vessel is arranged into a 4-point moor near the HDD exit



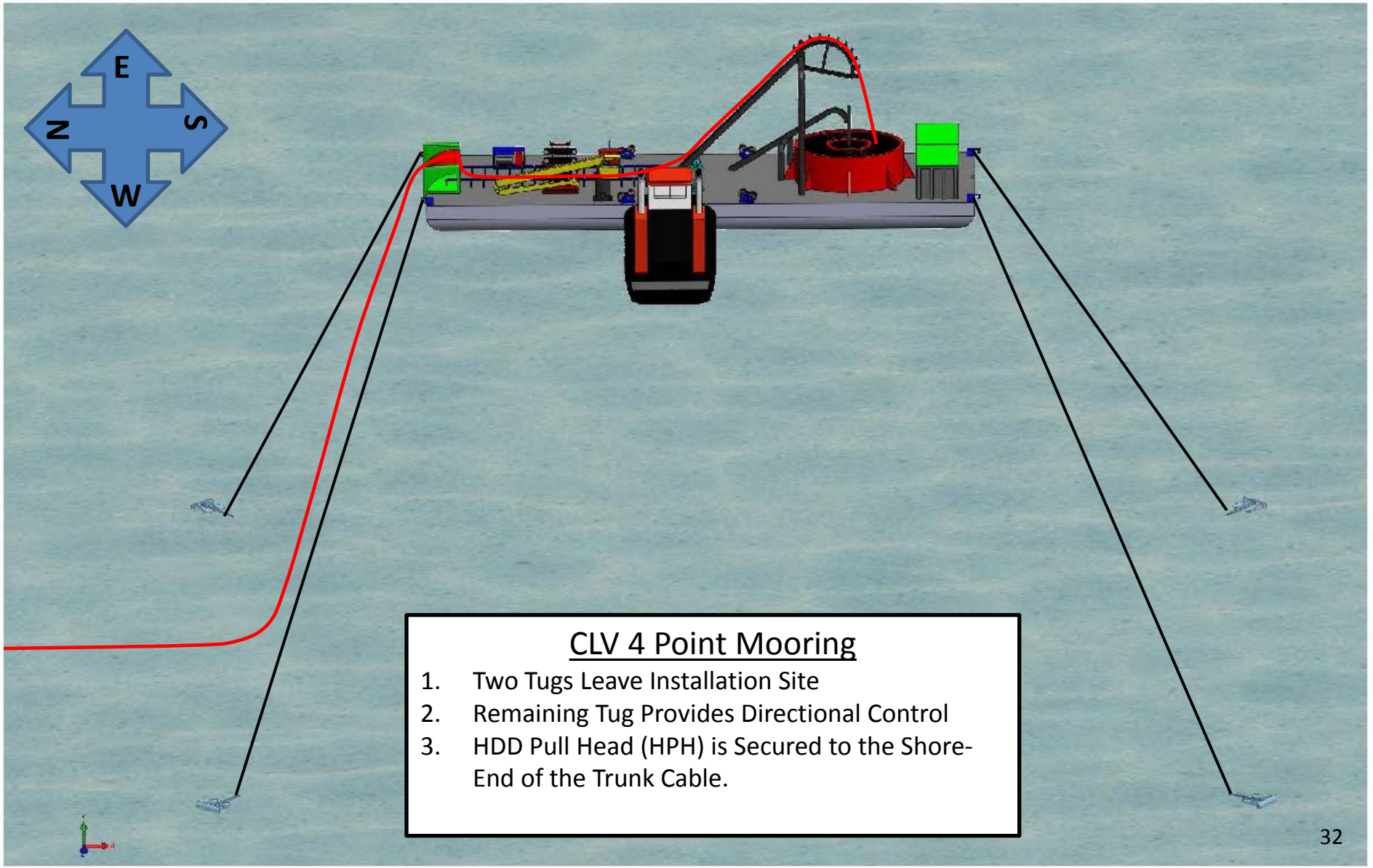


Preset 4-Point Mooring Anchors & Lines

CALM WATERS OF ADMIRALTY BAY

Acoustic Release Buoy

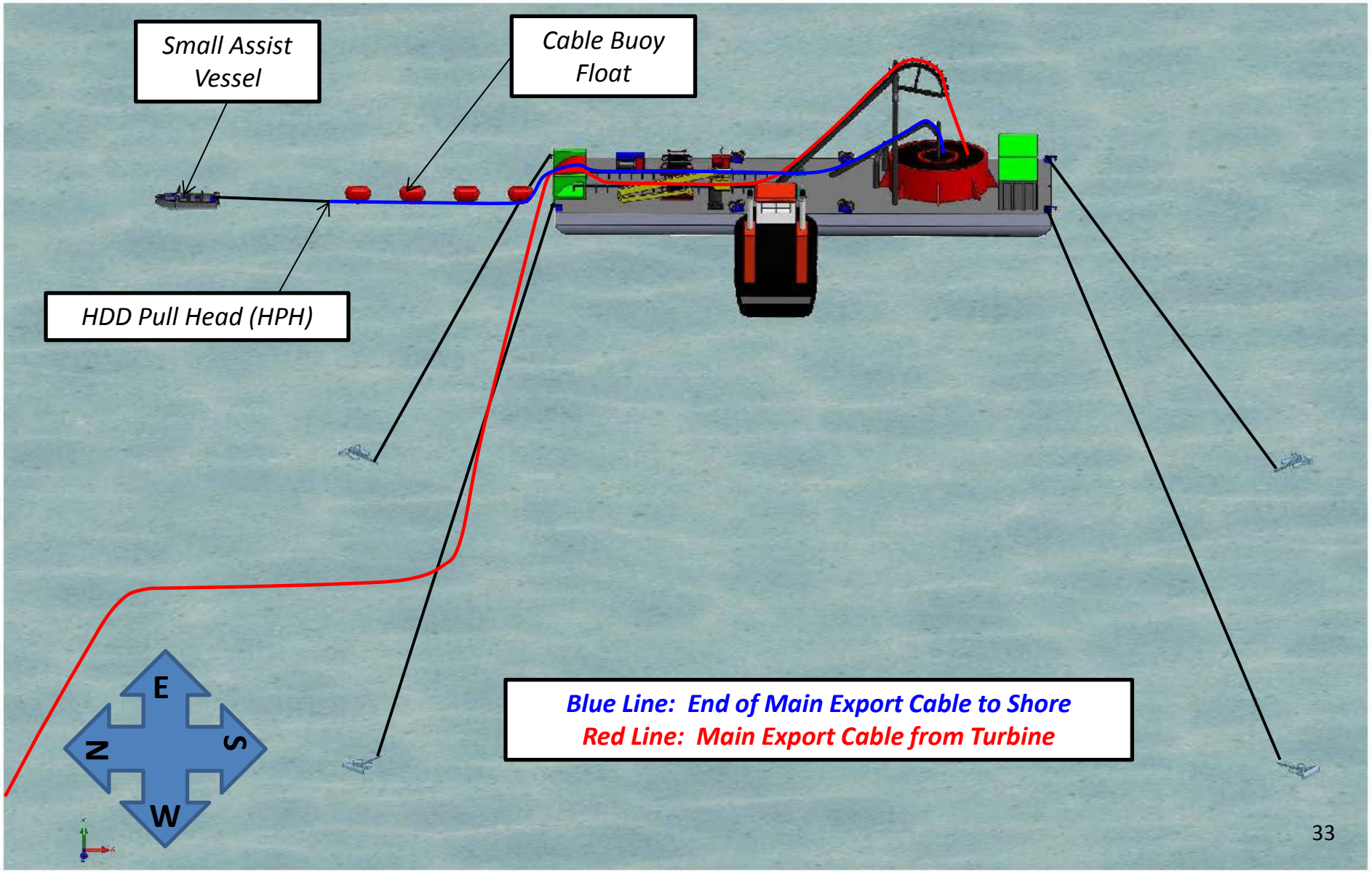
Cable Installation – By PWC



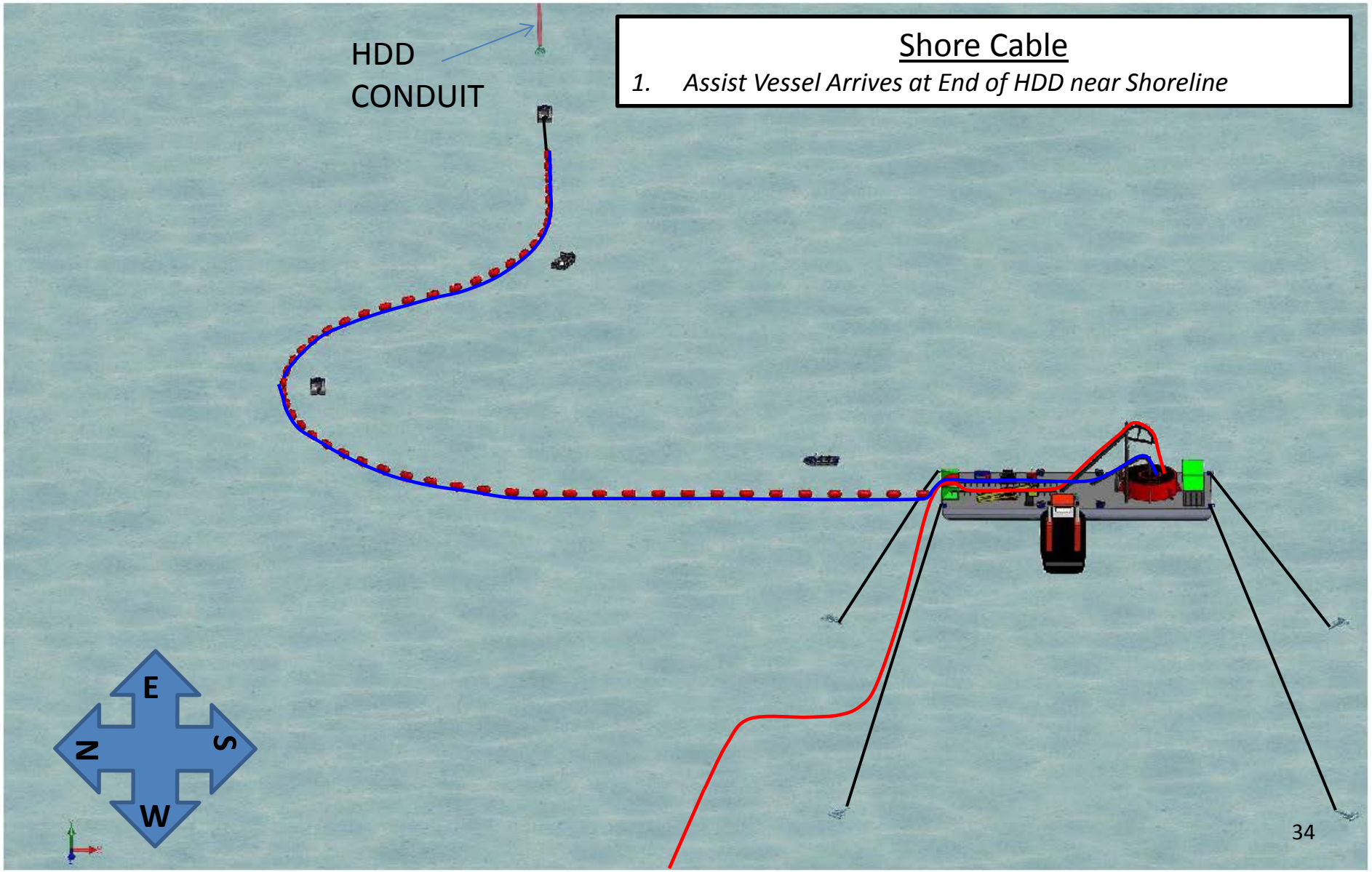
CLV 4 Point Mooring

1. Two Tugs Leave Installation Site
2. Remaining Tug Provides Directional Control
3. HDD Pull Head (HPH) is Secured to the Shore-End of the Trunk Cable.

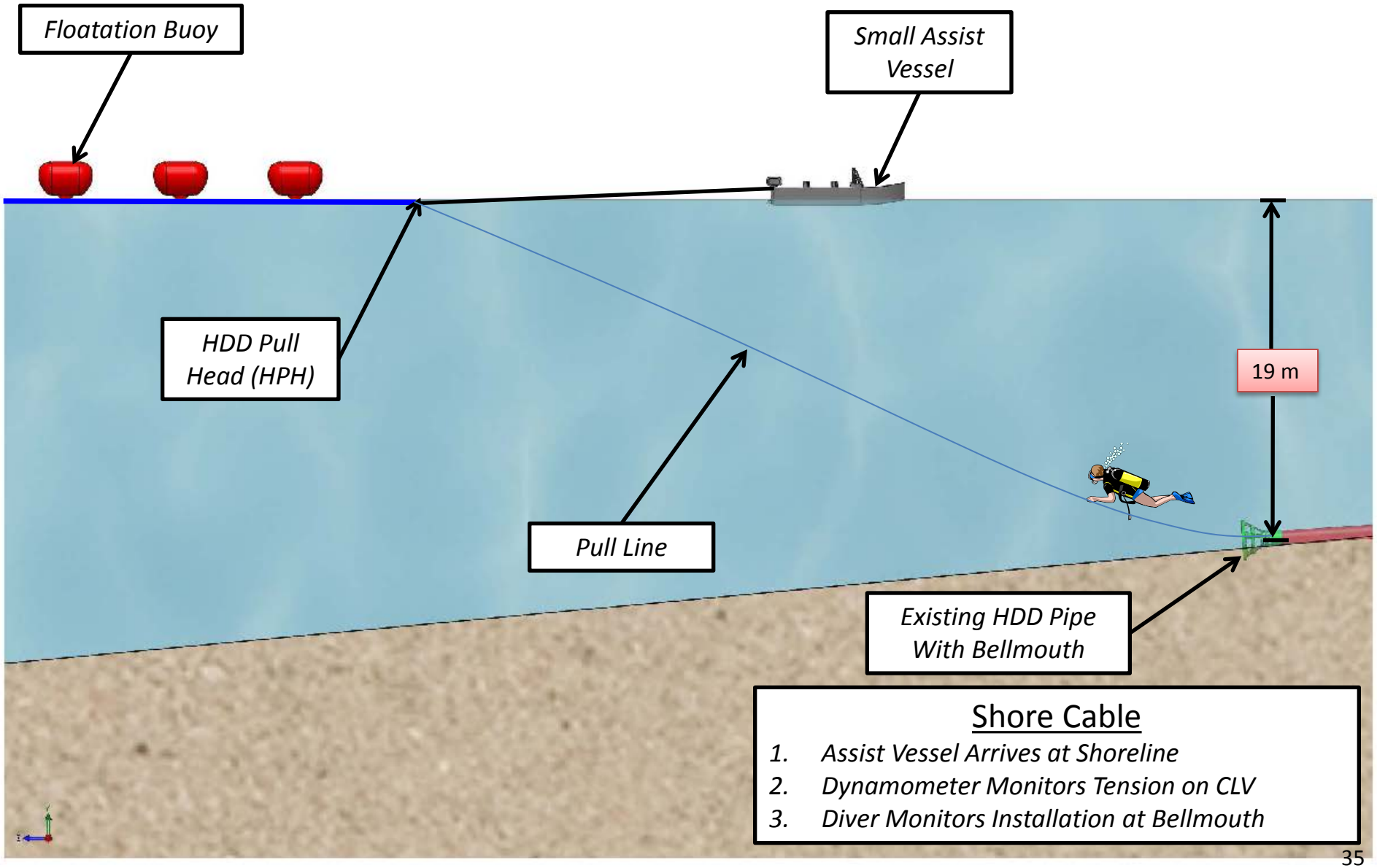
Cable Installation – By PWC



Cable Installation – By PWC



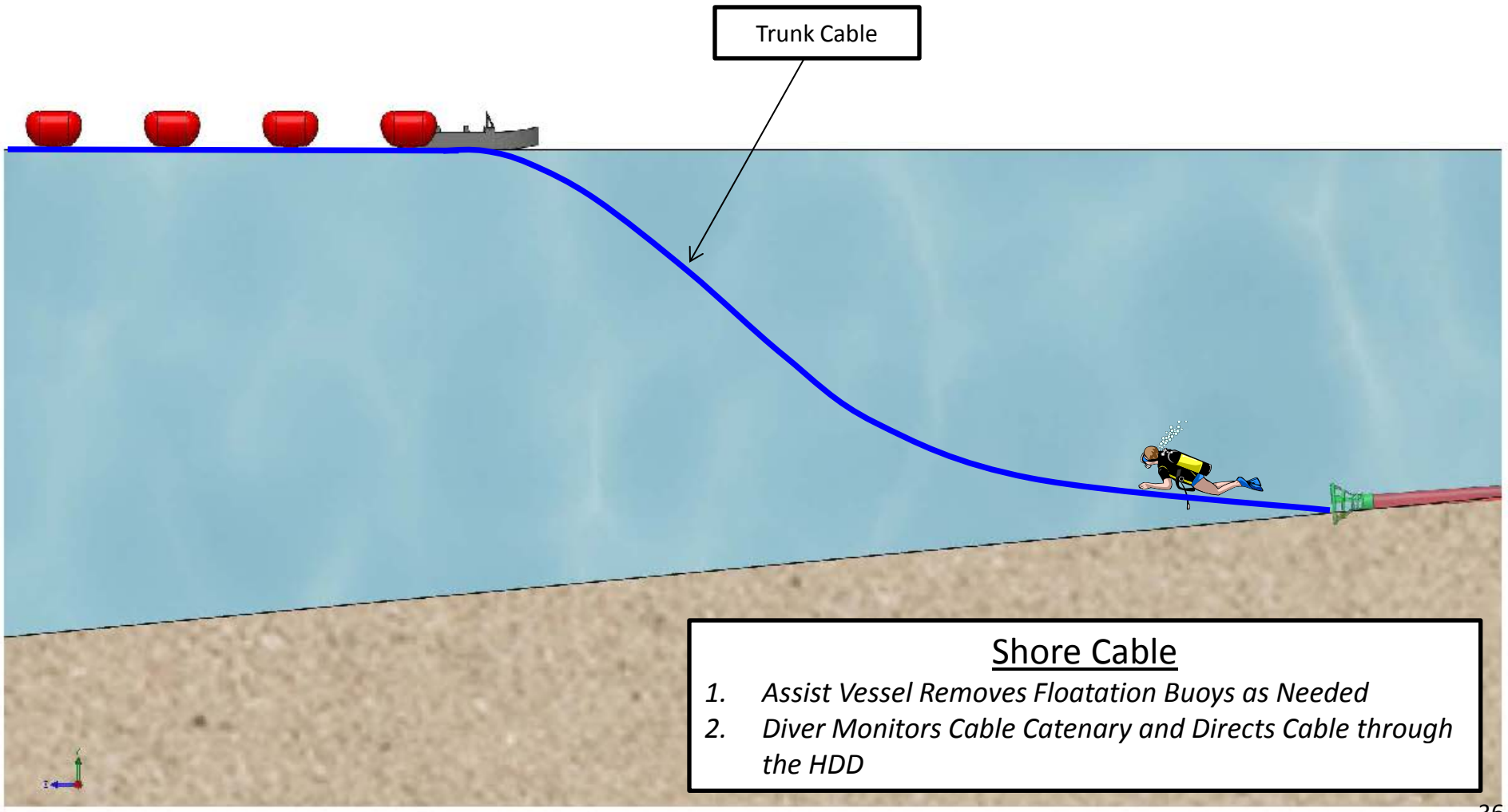
Cable Installation – By PWC



Shore Cable

1. *Assist Vessel Arrives at Shoreline*
2. *Dynamometer Monitors Tension on CLV*
3. *Diver Monitors Installation at Bellmouth*

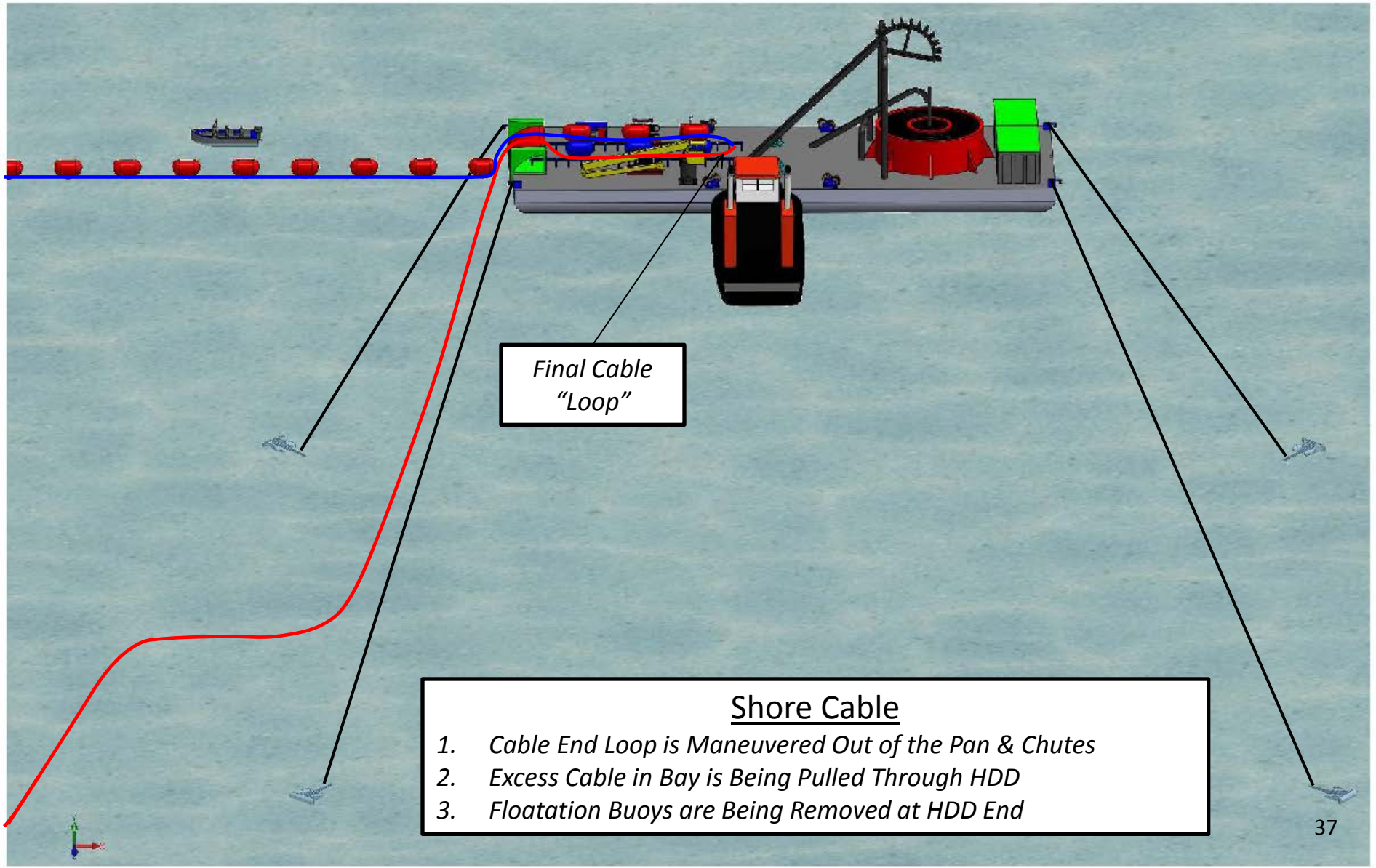
Cable Installation – By PWC



Shore Cable

1. *Assist Vessel Removes Floatation Buoys as Needed*
2. *Diver Monitors Cable Catenary and Directs Cable through the HDD*

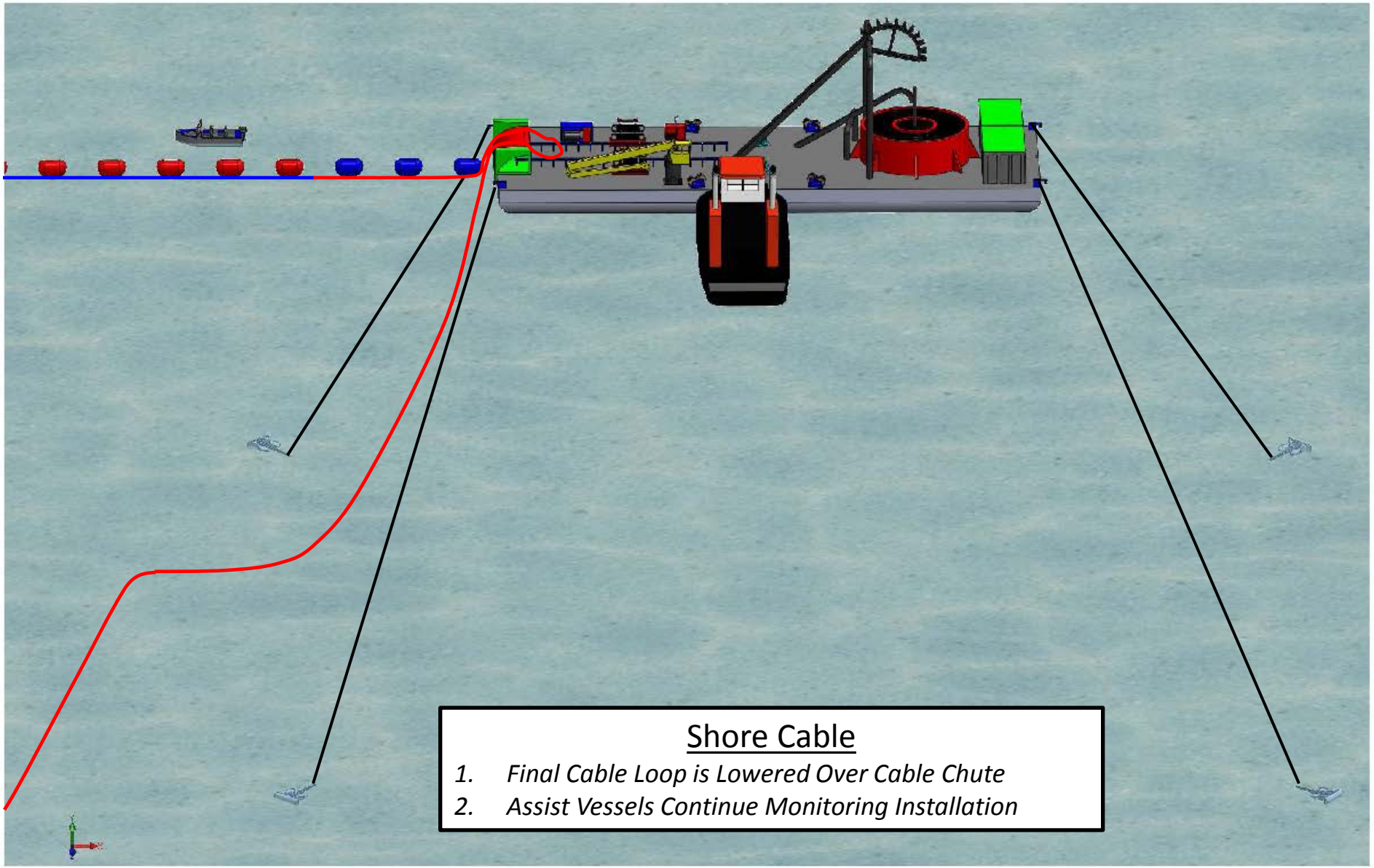
Cable Installation – By PWC



Shore Cable

1. *Cable End Loop is Maneuvered Out of the Pan & Chutes*
2. *Excess Cable in Bay is Being Pulled Through HDD*
3. *Floatation Buoys are Being Removed at HDD End*

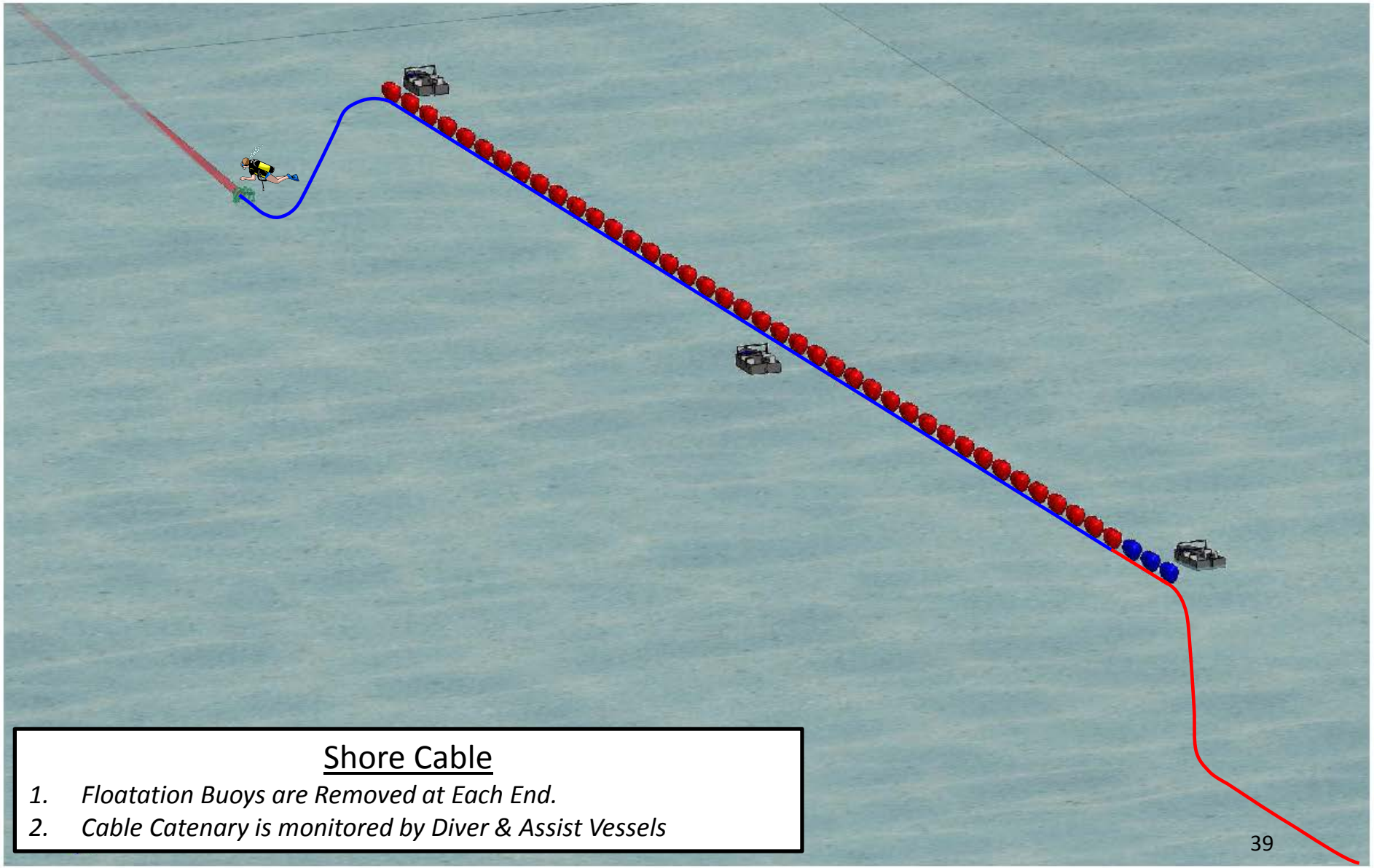
Cable Installation – By PWC



Shore Cable

1. *Final Cable Loop is Lowered Over Cable Chute*
2. *Assist Vessels Continue Monitoring Installation*

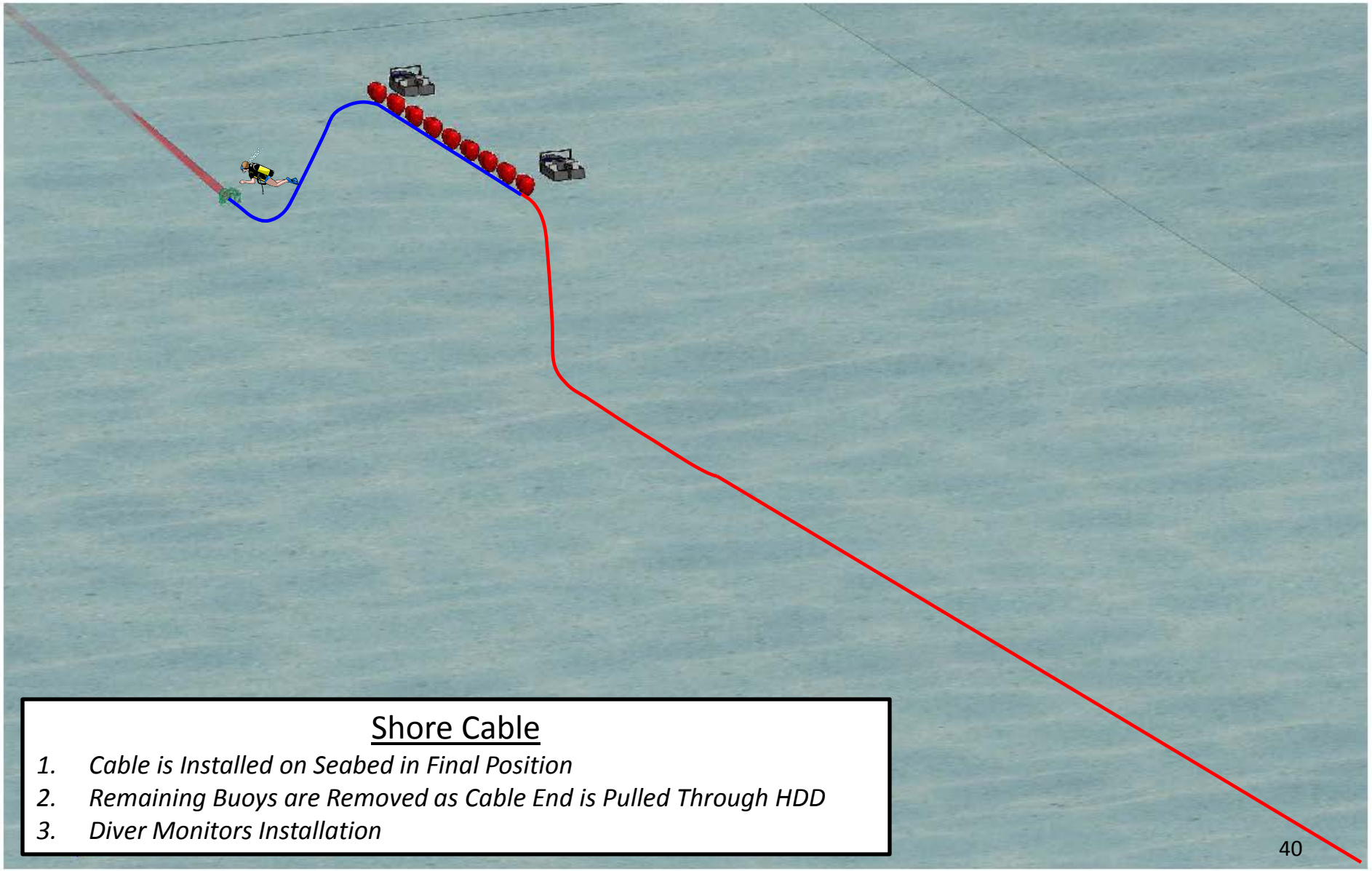
Cable Installation – By PWC



Shore Cable

1. *Floatation Buoys are Removed at Each End.*
2. *Cable Catenary is monitored by Diver & Assist Vessels*

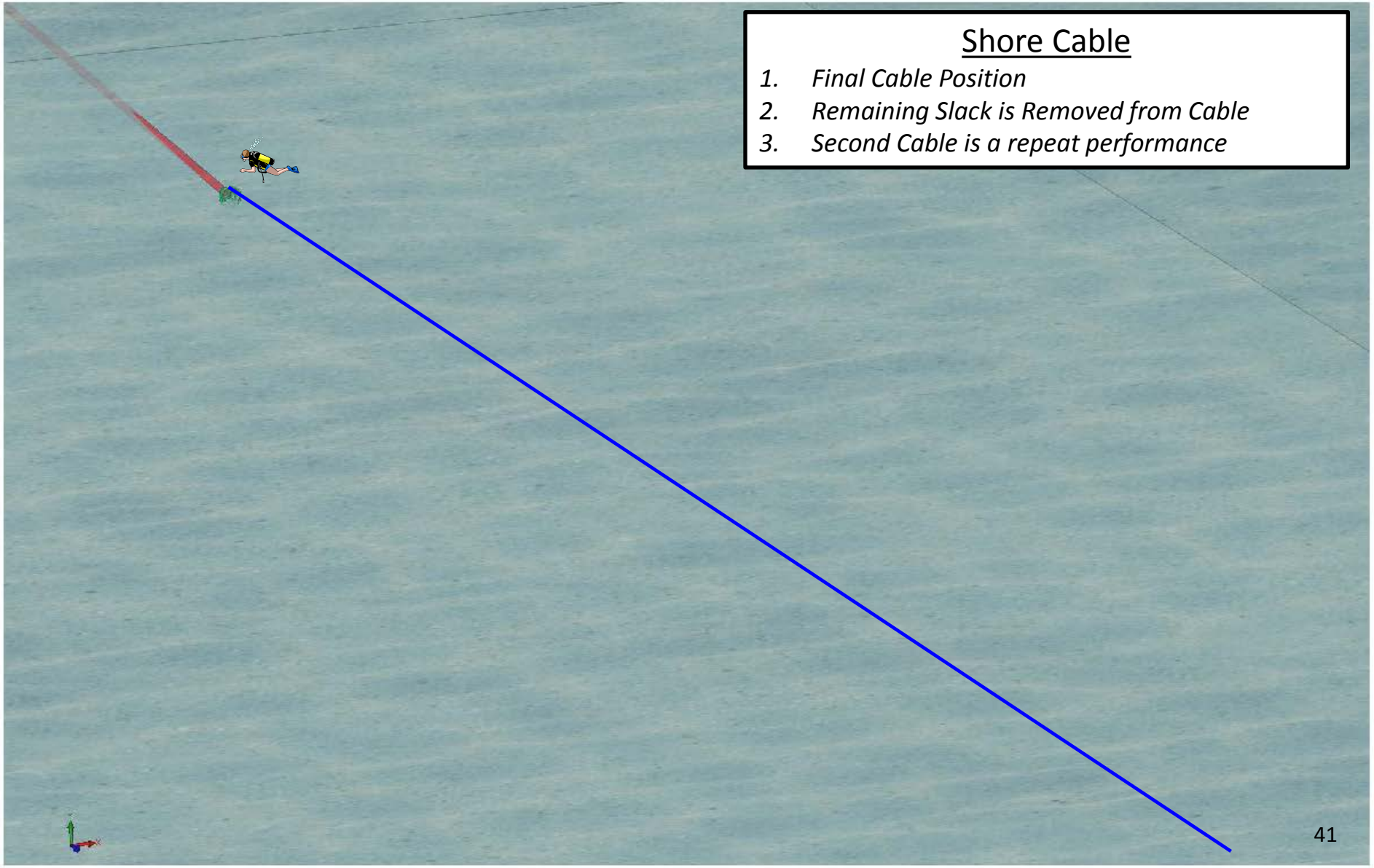
Cable Installation – By PWC



Shore Cable

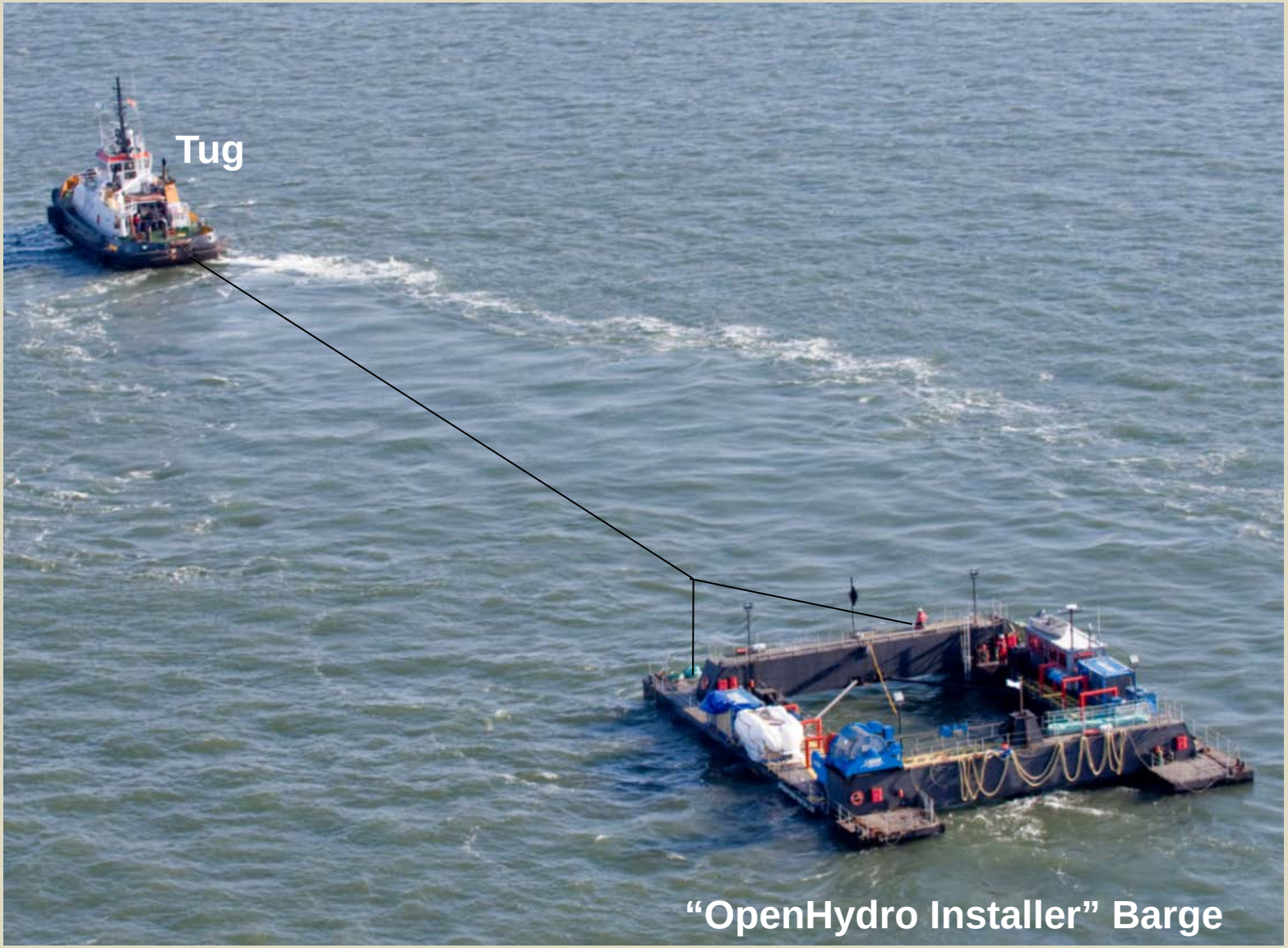
1. *Cable is Installed on Seabed in Final Position*
2. *Remaining Buoys are Removed as Cable End is Pulled Through HDD*
3. *Diver Monitors Installation*

Cable Installation – By PWC

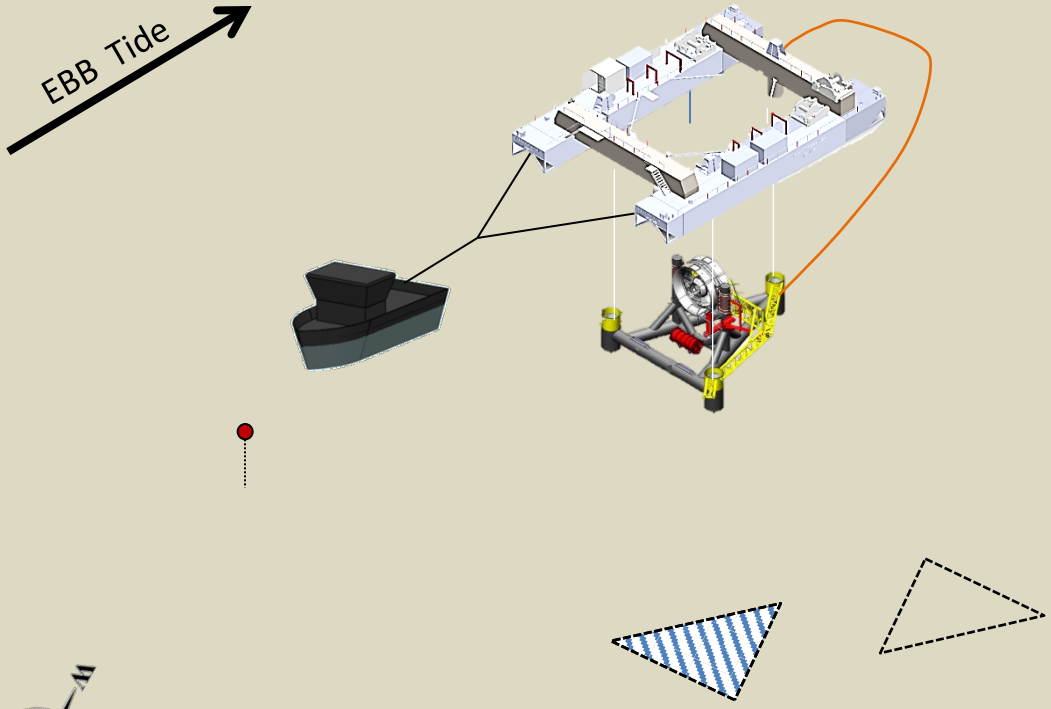


Turbine Deployment

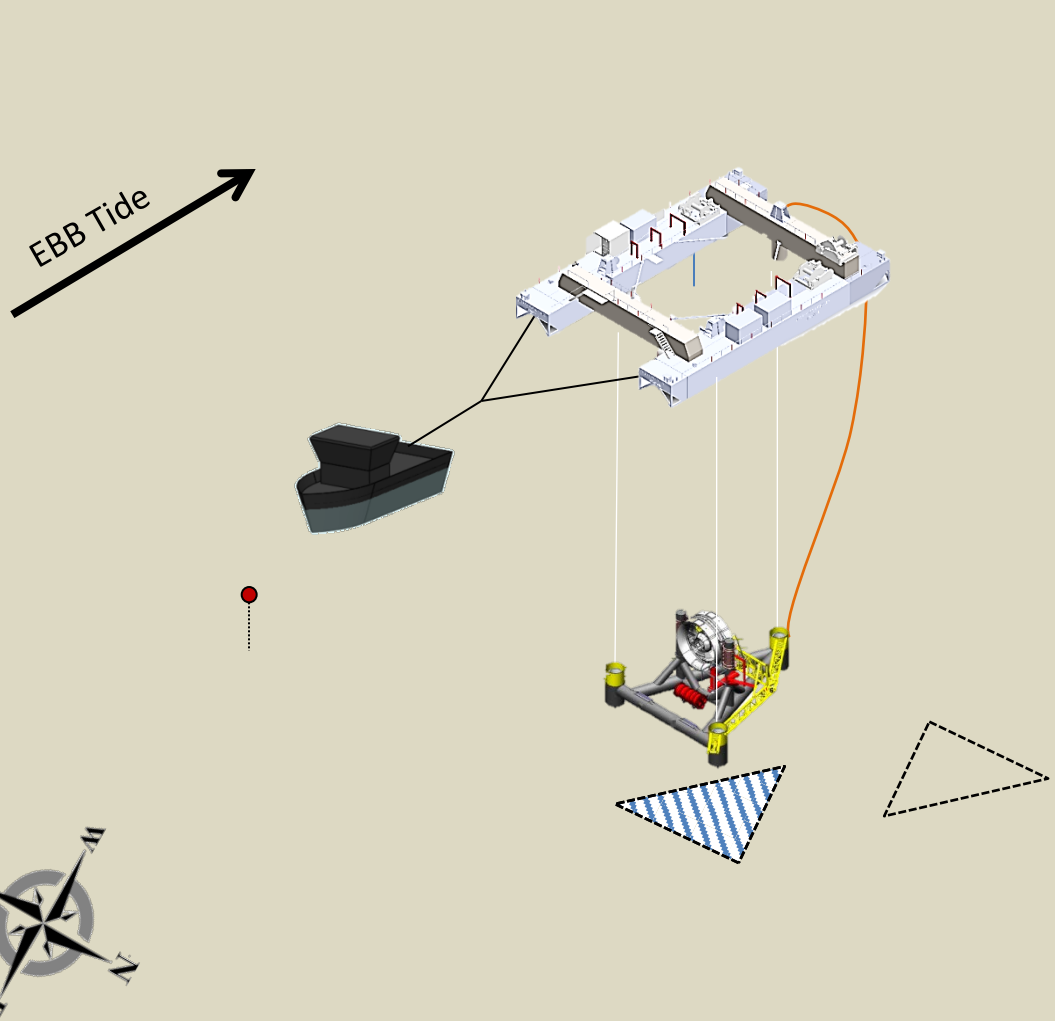
By OpenHydro



OpenHydro Turbine Deployment

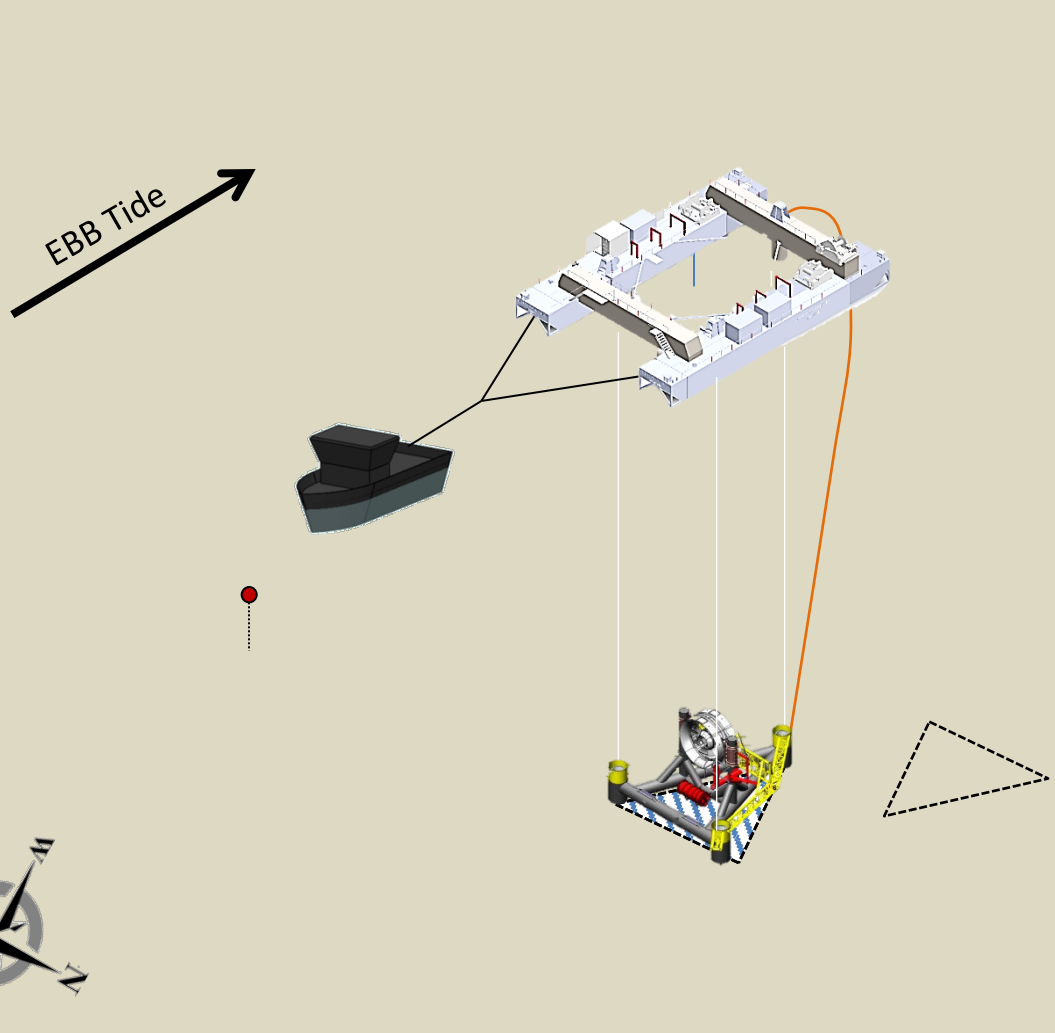


OpenHydro Turbine Deployment



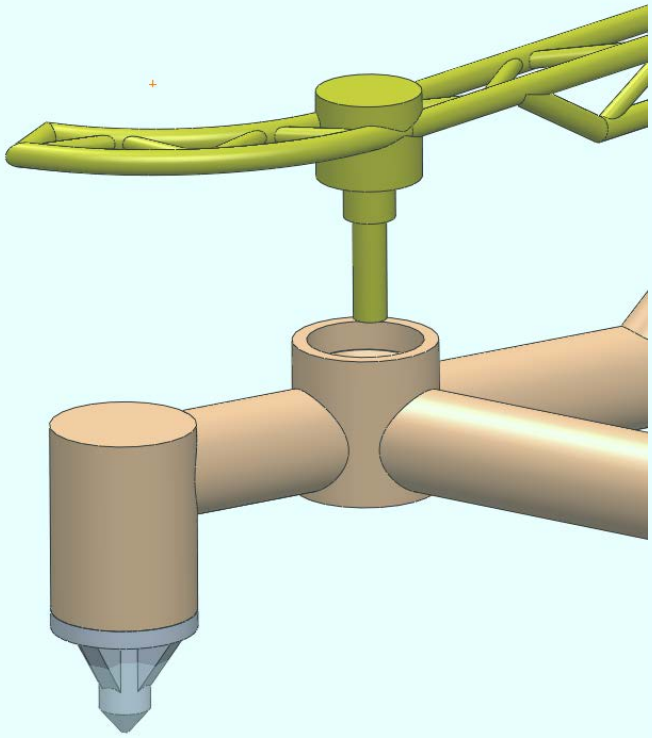
Fine timing of positions using tug tow line & 2-drives. Direction of tide & flow is measured & monitored closely as assembly approaches sea floor.

OpenHydro Turbine Deployment

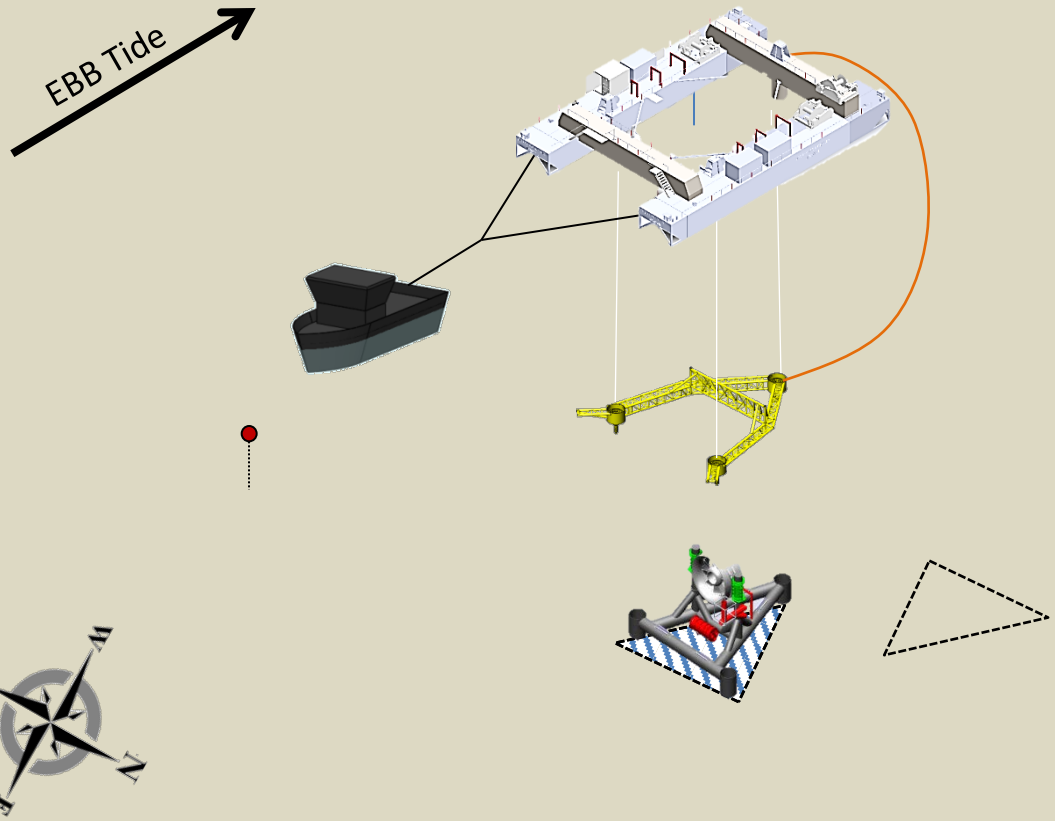


On bottom – Confirmation of positions, ensure unit is level & feet have not sunk. Release of hydraulics.

OpenHydro Turbine Deployment



OpenHydro Turbine Deployment



Legend

- Umbilical
- Barge Winch
- Marker Buoy

Recovery frame is now disconnected from the subsea base & raised back up to the barge.

Cable Connection

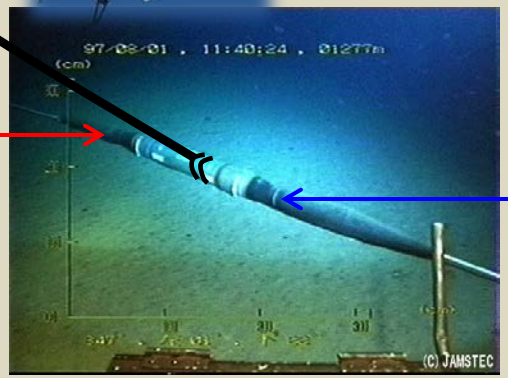
By PWC

Cable Lay Vessel

- Winch recovers each end
- Performs system health check
- Completes umbilical and cable connection
- Deploys connected in-line pressure vessel

Support Vessel

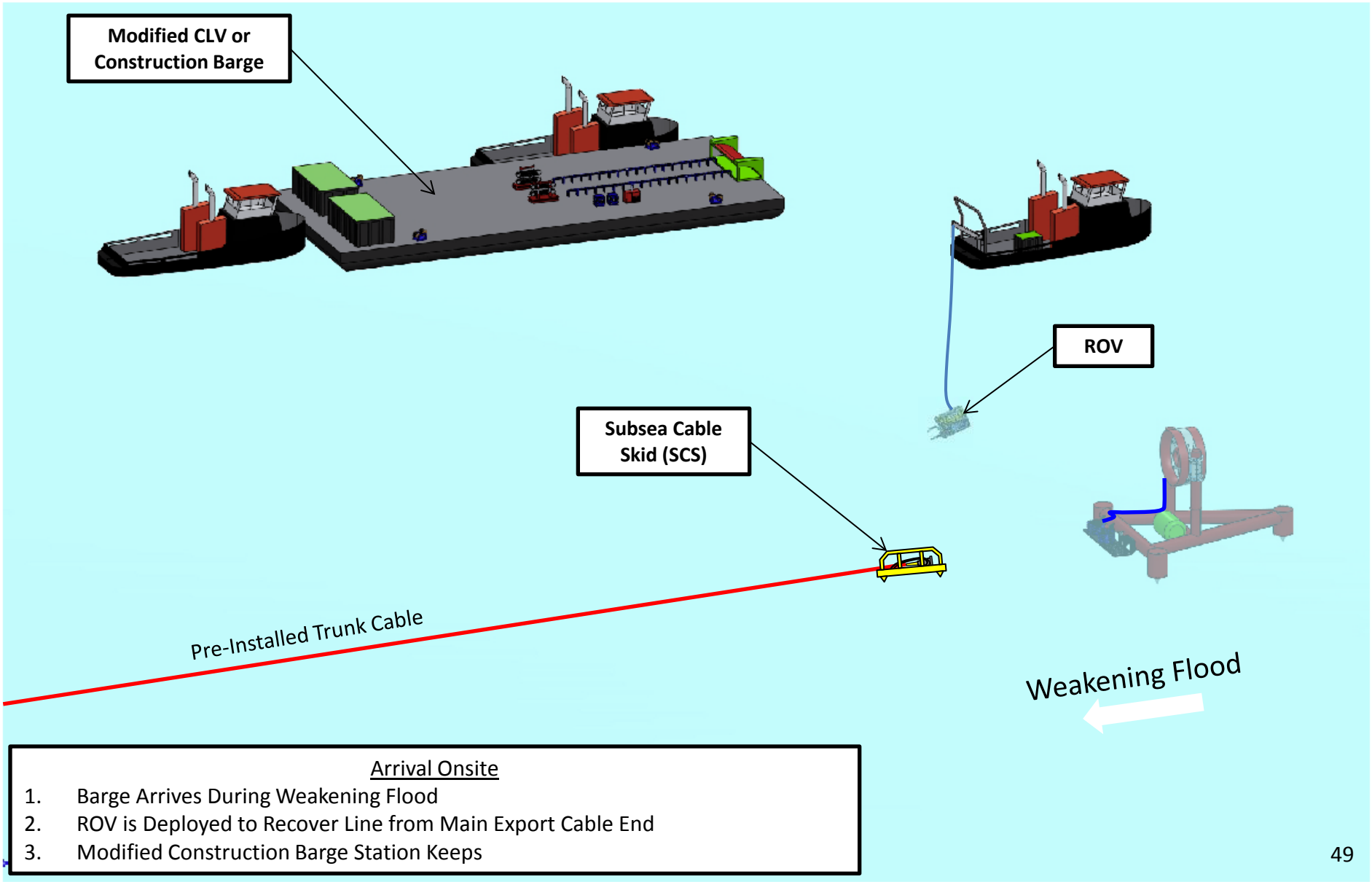
- Operates ROV
- Monitors operations
- Records final locations



Trunk Cable

Umbilical Cable

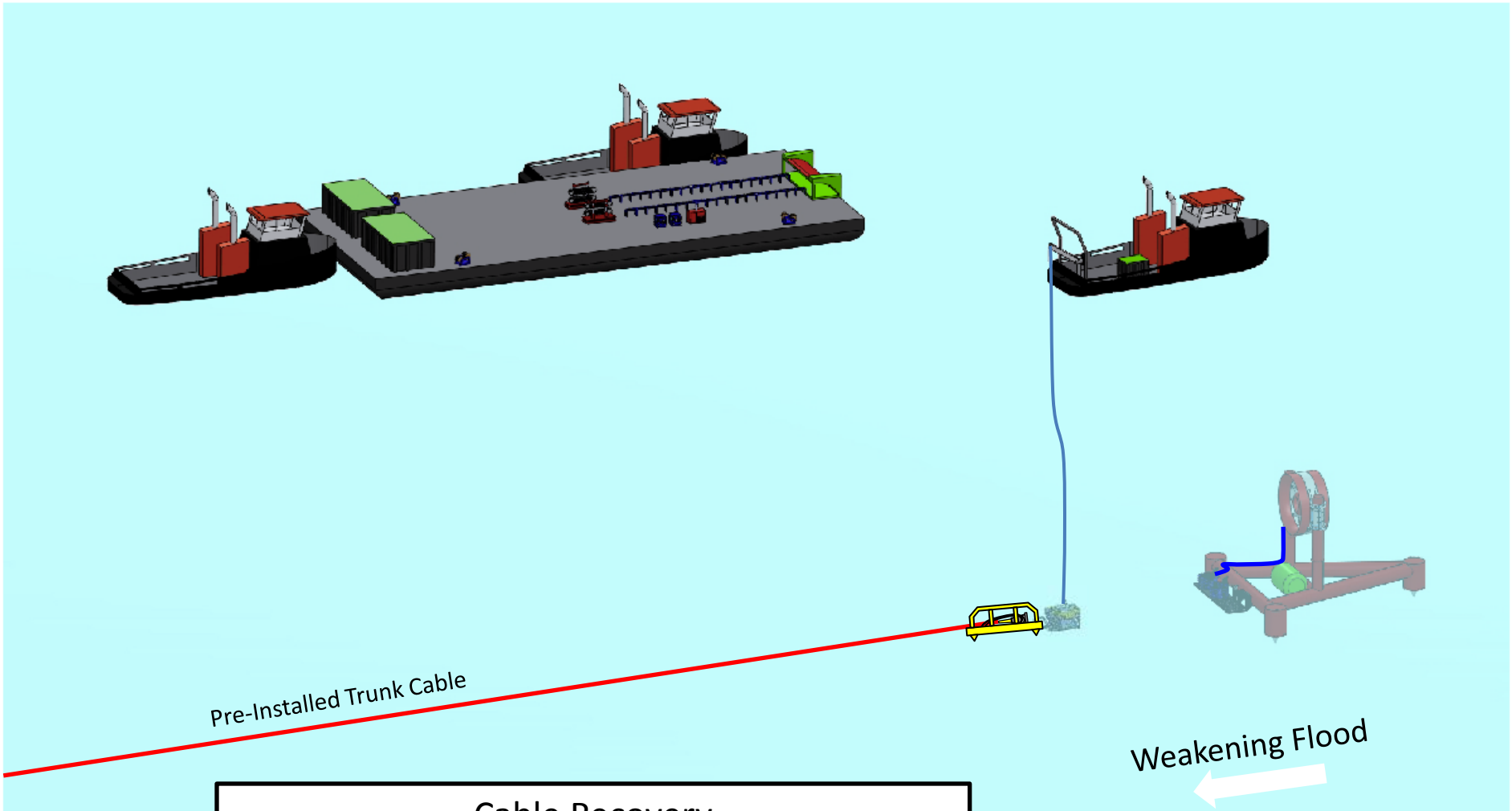
Cable Connection – By PWC



Arrival Onsite

1. Barge Arrives During Weakening Flood
2. ROV is Deployed to Recover Line from Main Export Cable End
3. Modified Construction Barge Station Keeps

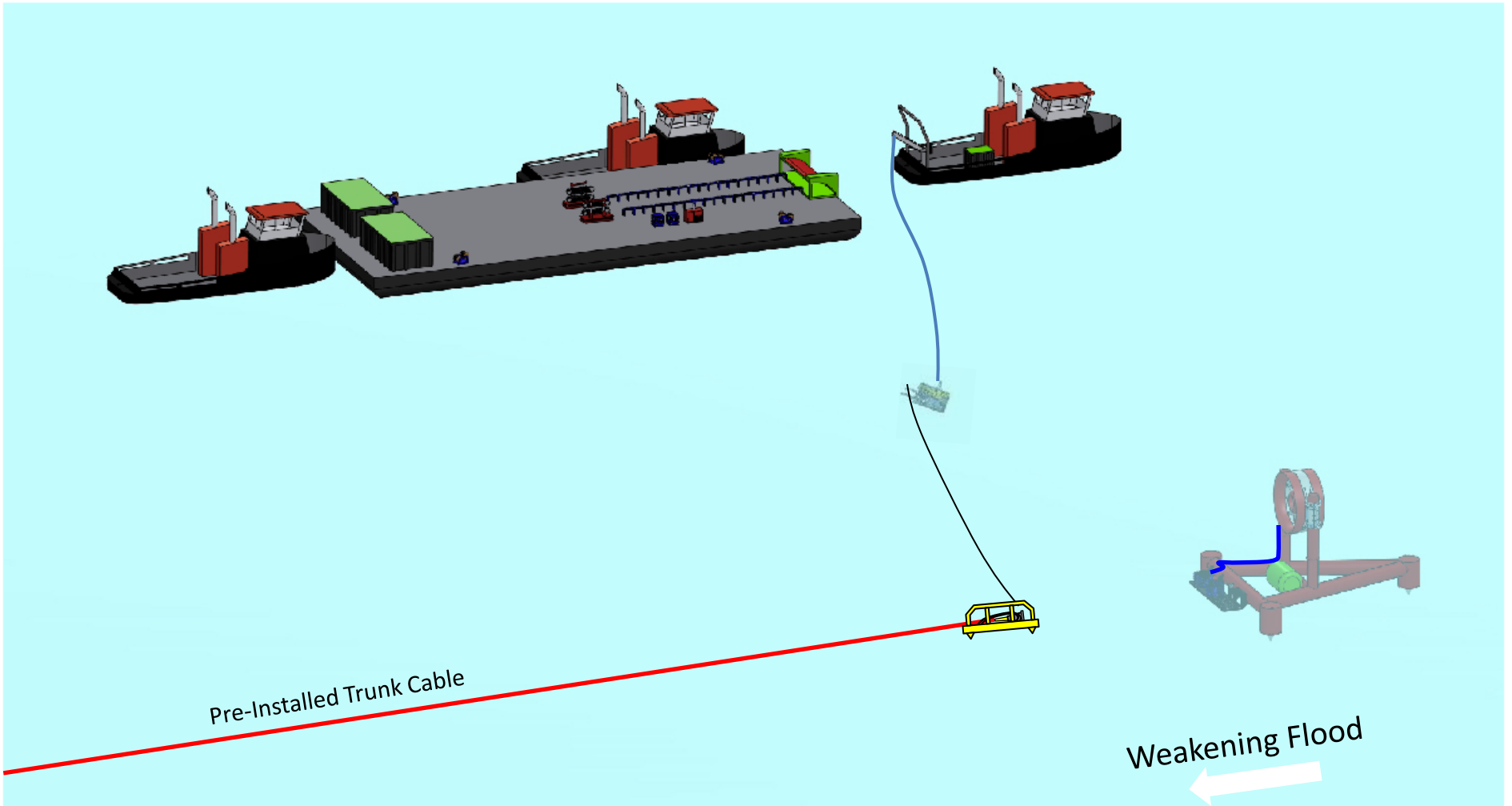
Cable Connection – By PWC



Cable Recovery

1. ROV Docks on Seafloor Next to Subsea Skid
2. ROV Recovers Line from Main Export Cable End
3. ROV Releases Dry Mate Housing from Skid

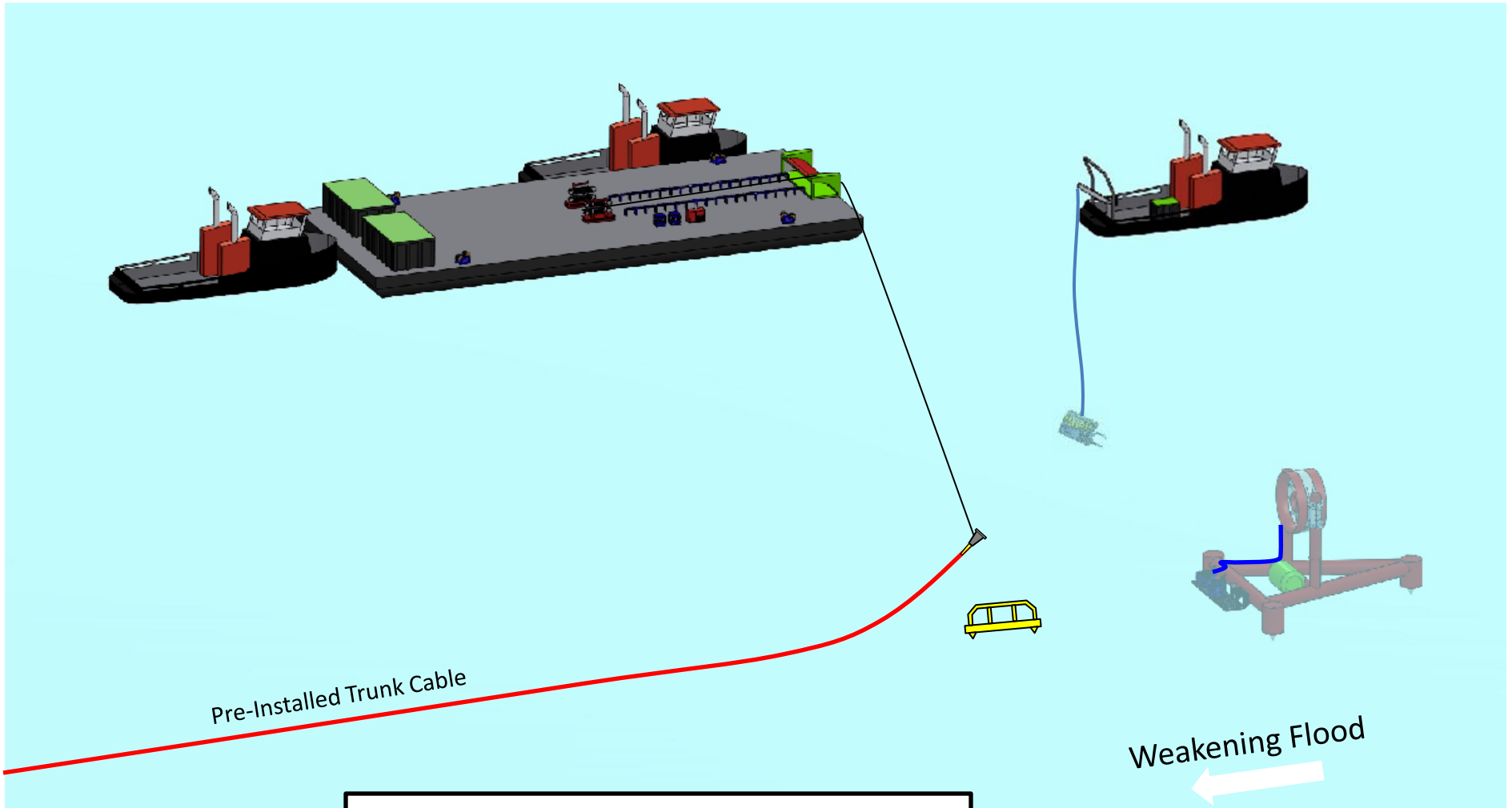
Cable Connection – By PWC



Cable Recovery

1. ROV Maneuvers Towards Construction Barge

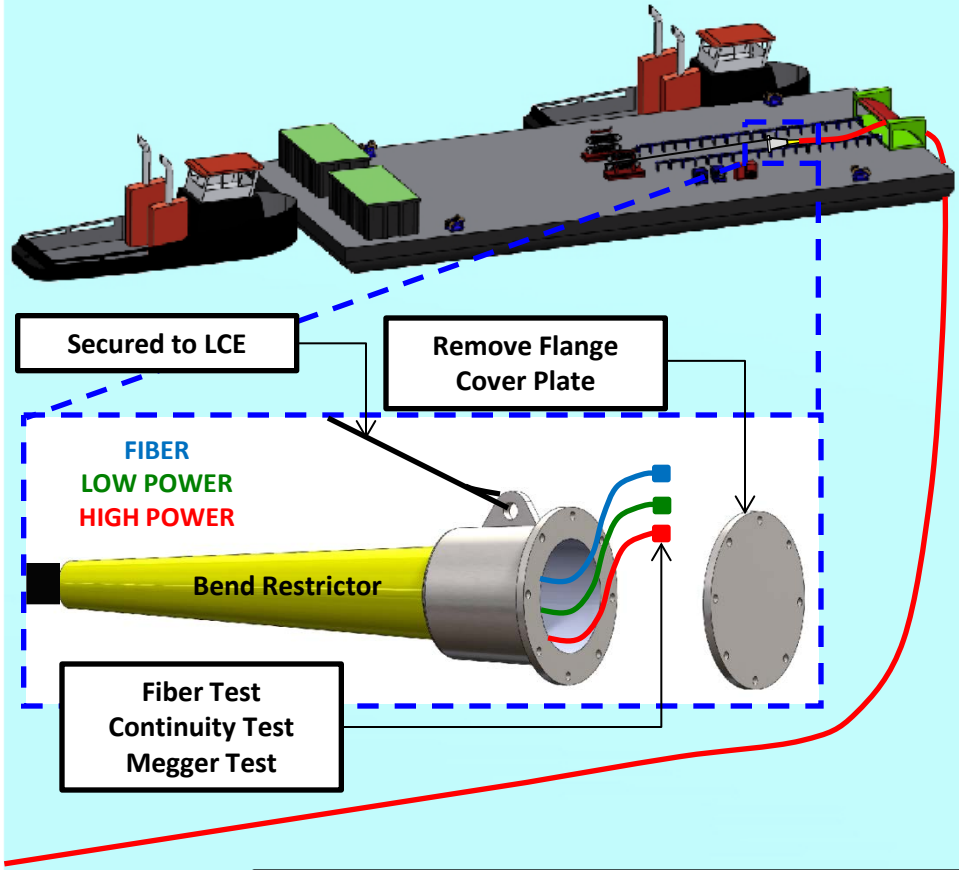
Cable Connection – By PWC

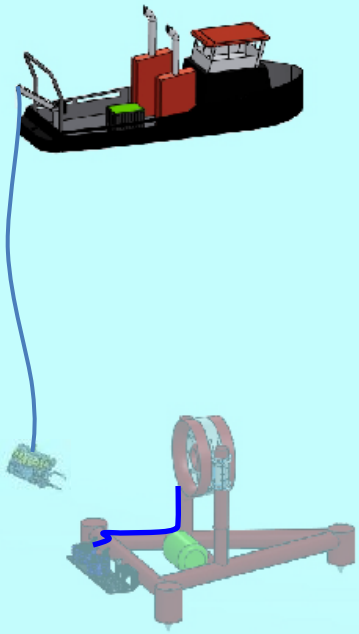


Cable Retrieval

1. Linear Cable Engine (LCE) Winches in Cable End to the barge platform.
2. ROV Maneuvers Towards Subsea Base

Cable Connection – By PWC



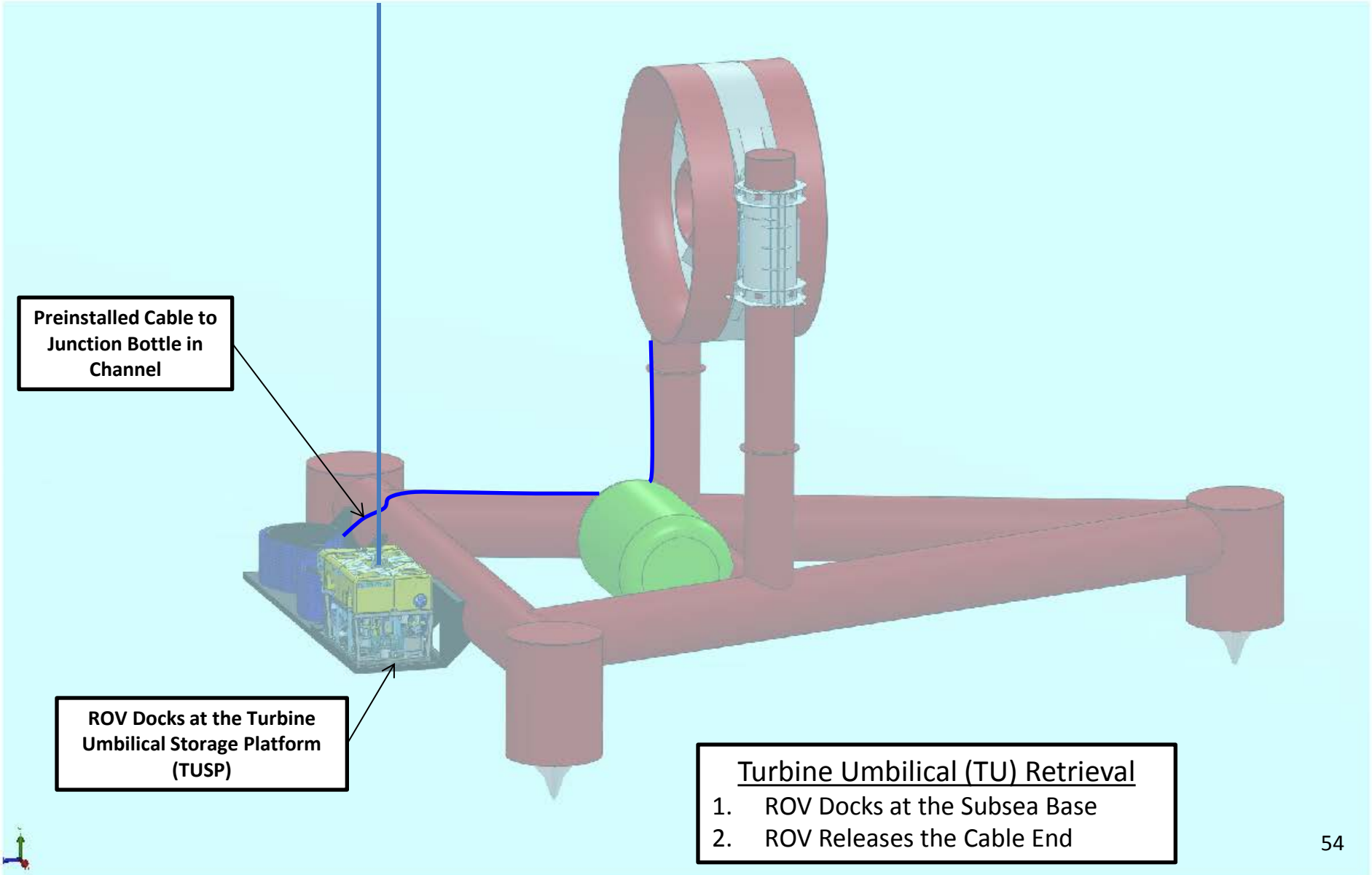


Weakening Flood

Cable Retrieval

1. LCE Secures Cable End Aboard the Barge
2. System Health Check is Performed on Main Export Cable
3. Subsea Skid Remains on Seafloor for Future Use

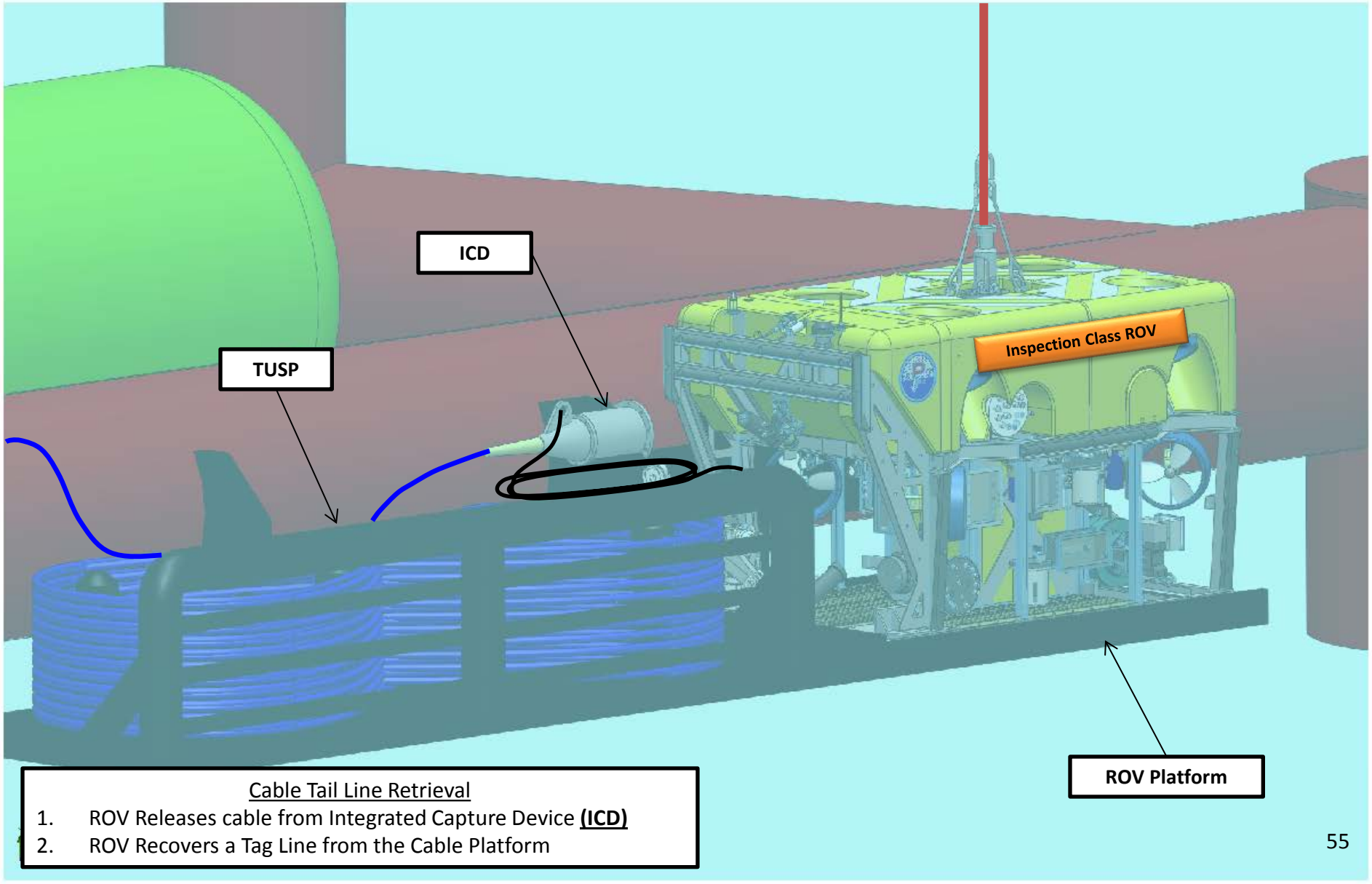
Cable Connection – By PWC



Turbine Umbilical (TU) Retrieval

1. ROV Docks at the Subsea Base
2. ROV Releases the Cable End

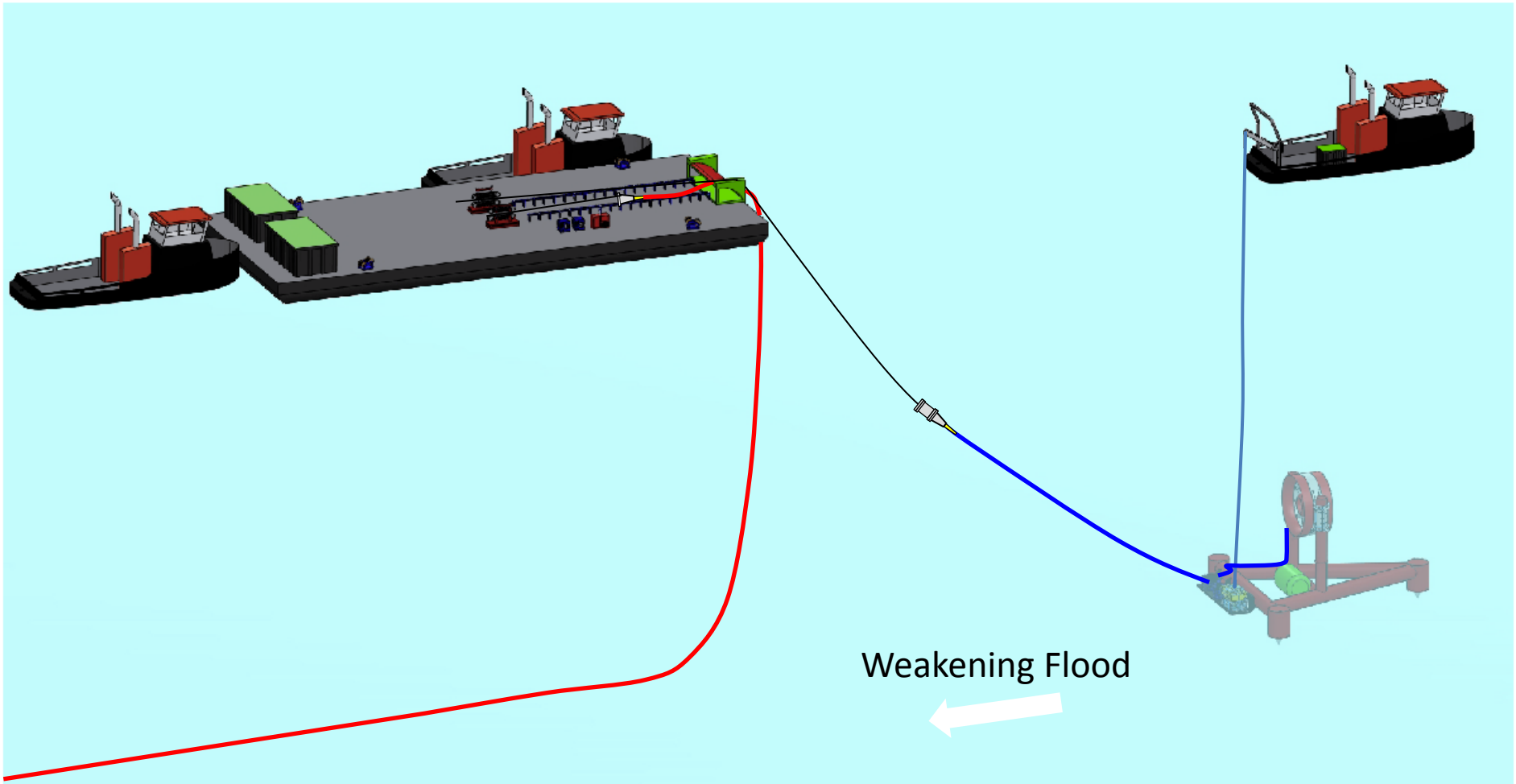
Cable Connection – By PWC



Cable Tail Line Retrieval

1. ROV Releases cable from Integrated Capture Device **(ICD)**
2. ROV Recovers a Tag Line from the Cable Platform

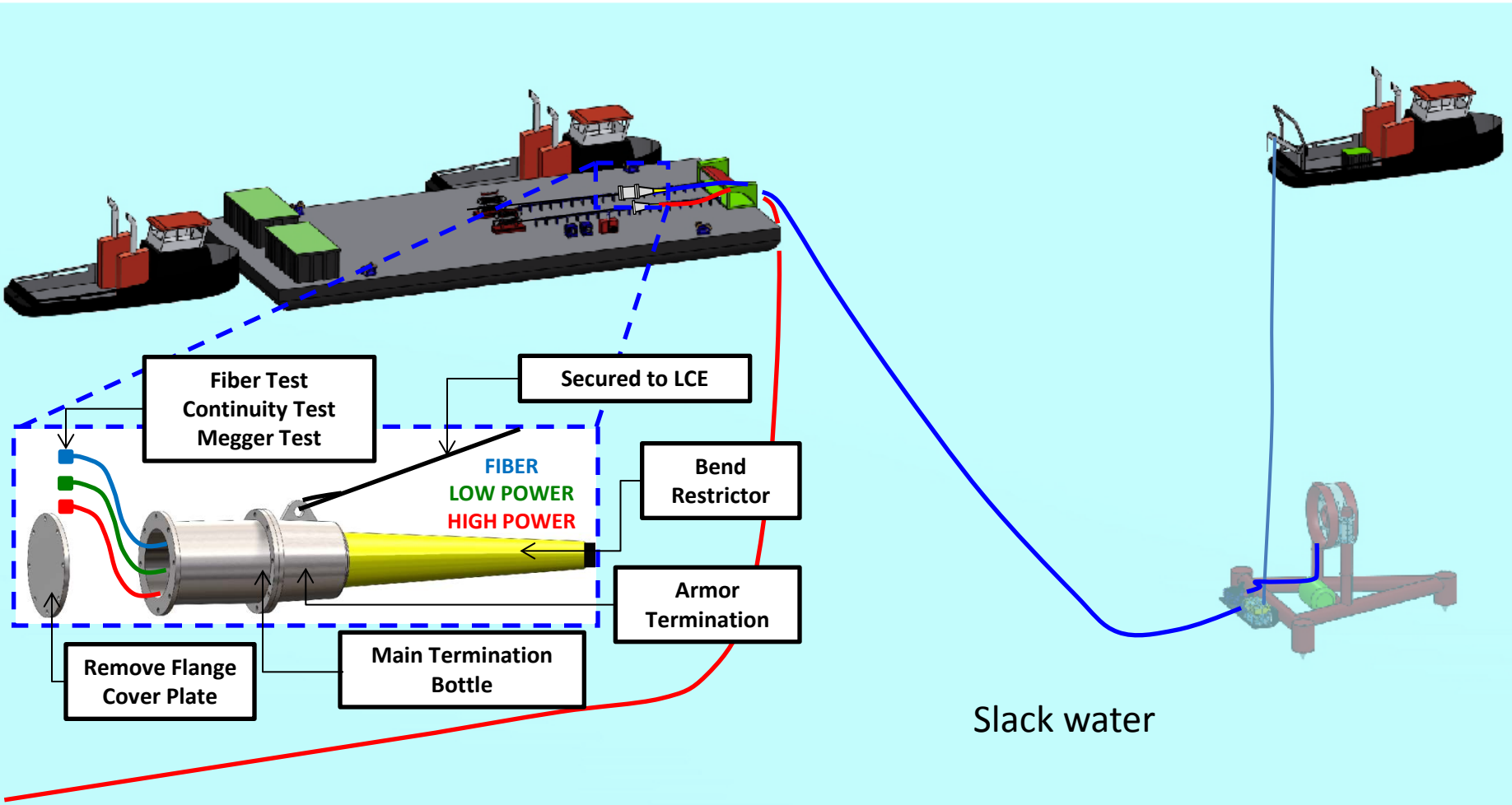
Cable Connection – By PWC



Cable Tail Line Retrieval

1. Linear Cable Engine Winches Cable Tail Towards Barge
2. ROV Docks at Subsea Base & Monitors the Cable Recovery

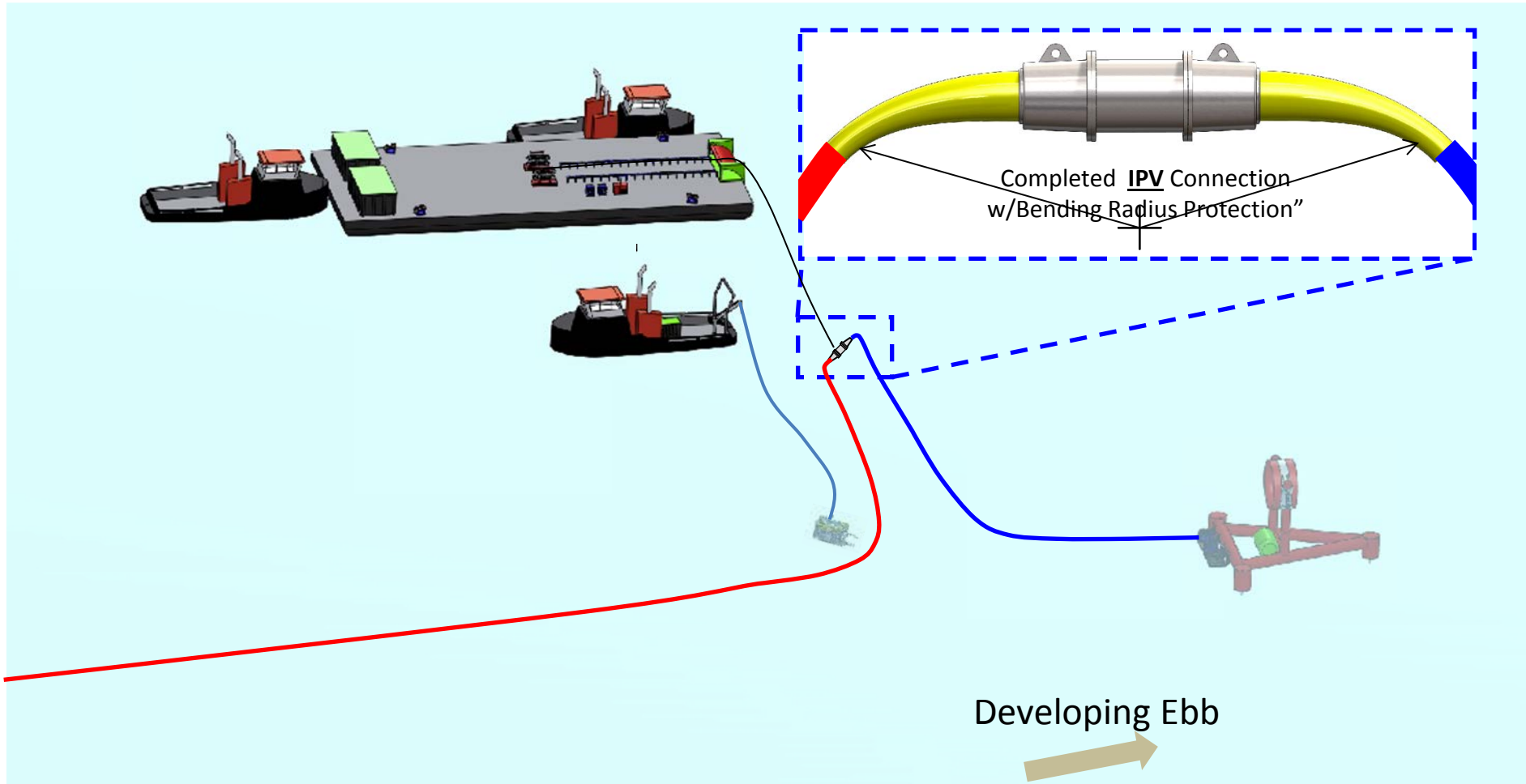
Cable Connection – By PWC



Cable Tail Line Retrieval

1. Cable Tail is Brought Aboard the Barge
2. System Health Check is Performed on Cable Tail

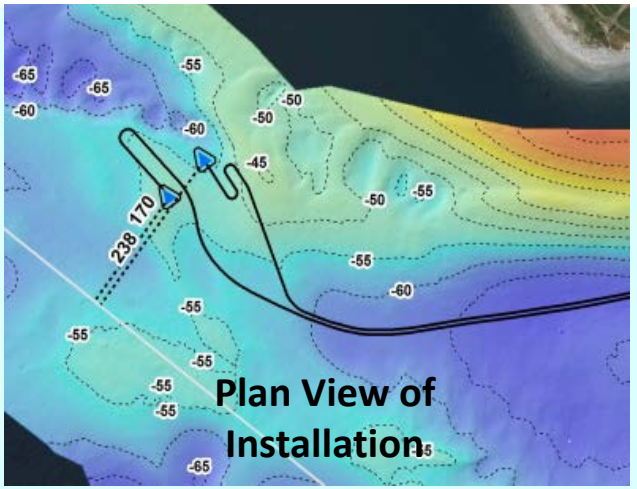
Cable Connection – By PWC



Cable Redeployment

1. Barge Begins Lowering Cable in "S" Pattern
2. ROV Monitors Cable Placement on the Seafloor

Cable Connection – By PWC



Developing Ebb

Cable Redeployment

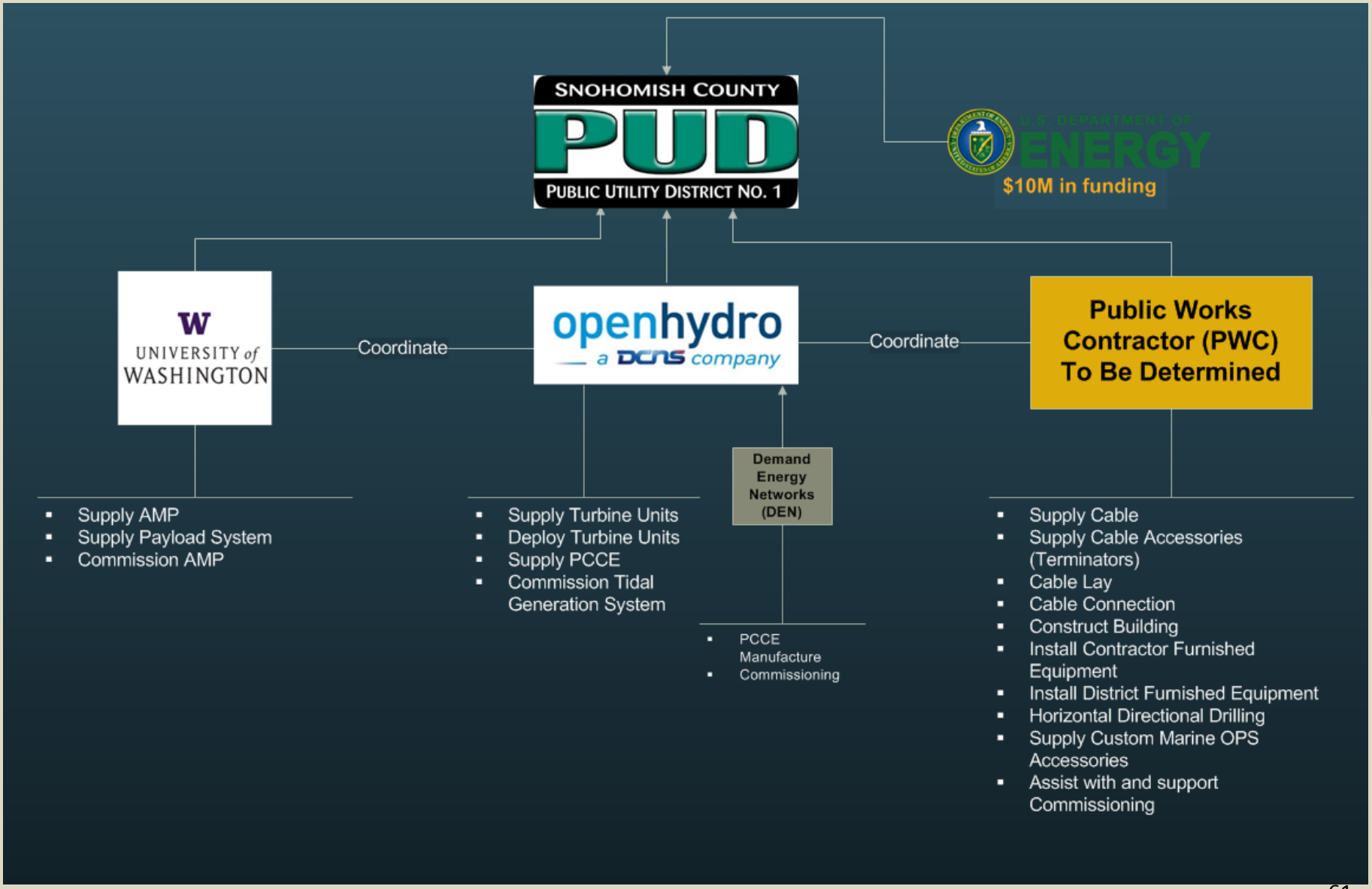
1. Connector Housing is Deployed on Seafloor
2. ROV Monitors Final Placement

PWC Cable Connection

Risk Mitigation and Safety

- Conventional Marine Cable Connection Installation
- 2- Cable Connections in separate operations
- Marine contractors with relevant subsea cable experience within the region
- No real time operational coordination with other marine operations are required.
- Hazard Identification and Risk Assessment
  - Developed by the District, PWC and OpenHydro
  - Consultation with the USCG, USACE and PC Landing required

Commissioning Team



Commissioning Effort

- Coordinated Effort
  - Turbine System
  - Battery Storage System
  - Grid Connection System
  - Supervisory Control and Data Acquisition

SCOPE OF WORK – PHASE-2

- Operate the tidal energy system
- Gather relevant data to inform the proposed studies

University of Washington (UW) Scope of Work

Pilot-Scale Monitoring Objectives

- **Gather information about device performance**
- **Gather information about environmental interactions**
  - Basis for refinements to device design
- **Address regulatory and stakeholder concerns**

Dr. Brian Polagye, University of Washington
Co-Director, Northwest National Marine Renewable Energy Center

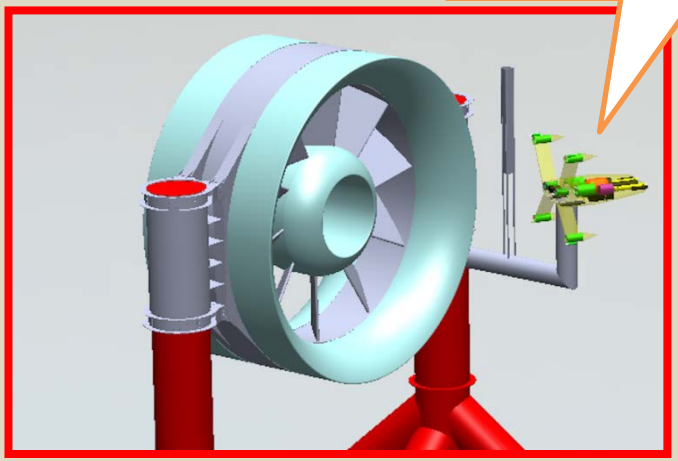
Pilot-Scale Monitoring Objectives

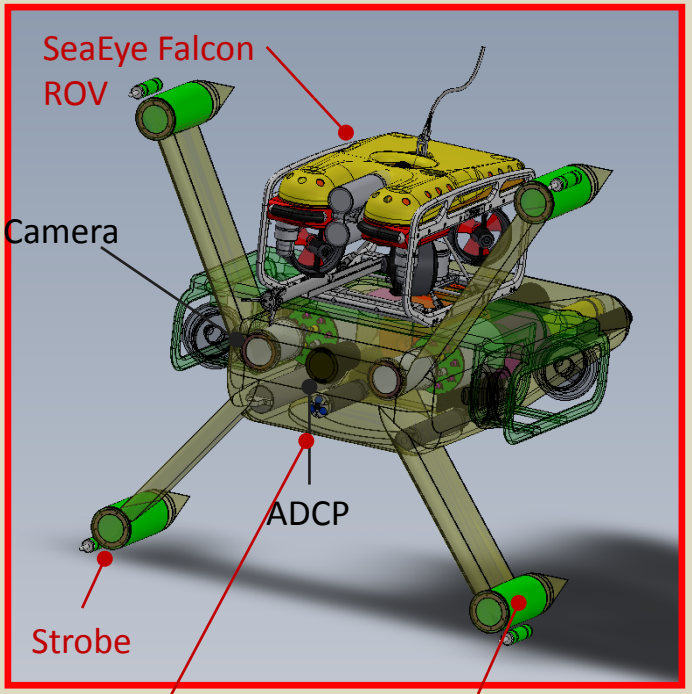
Acoustic Characterization – turbine sound

Benthic Habitat – artificial reef development, scour or sedimentation around subsea base

Near-turbine – interactions between aquatic species and turbine rotor

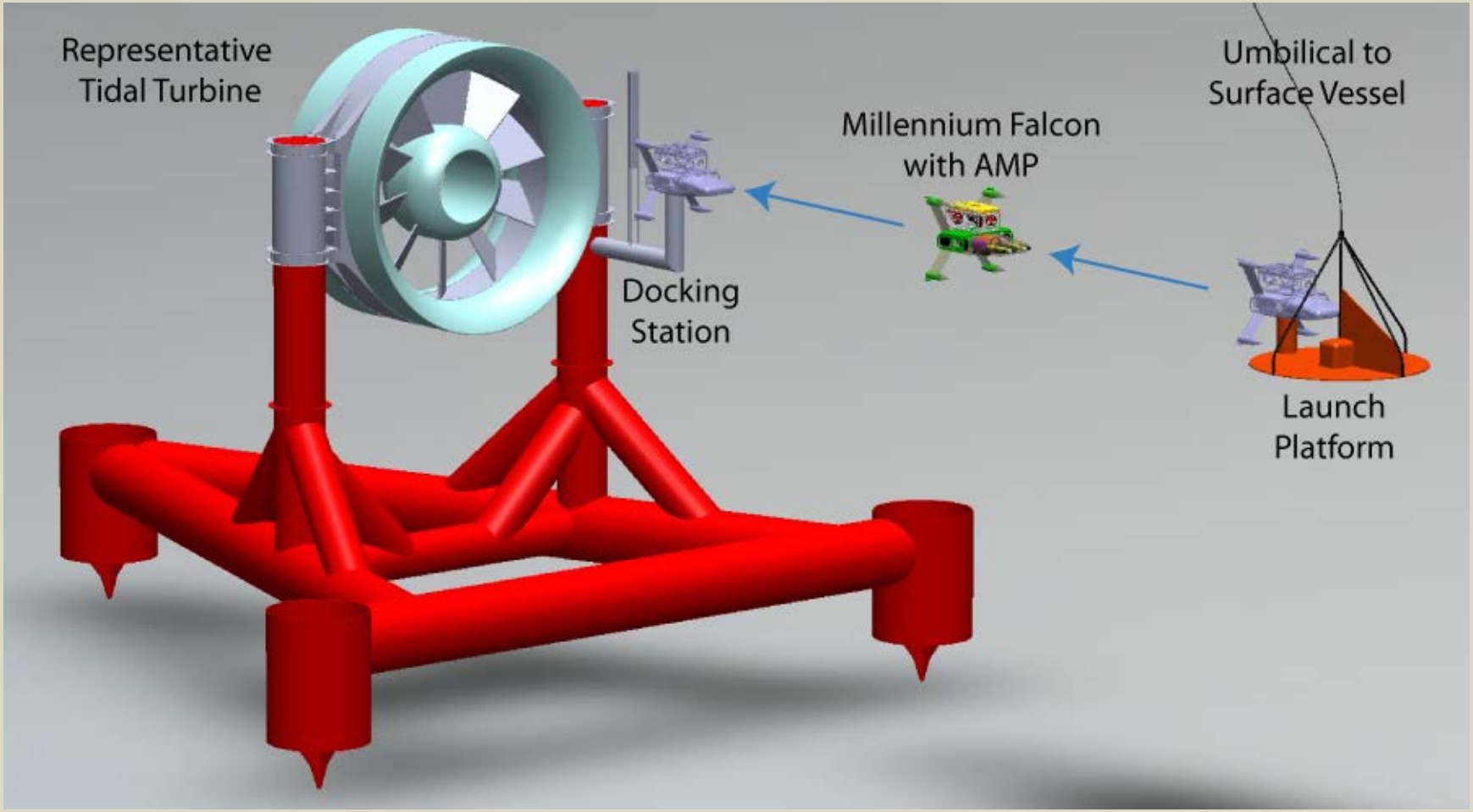
Marine Mammals – behavioral changes for seals, harbor porpoise, and Southern Resident killer whales in response to turbine sound





UNIVERSITY OF WASHINGTOM

RECOVERABLE AMP DEVELOPMENT



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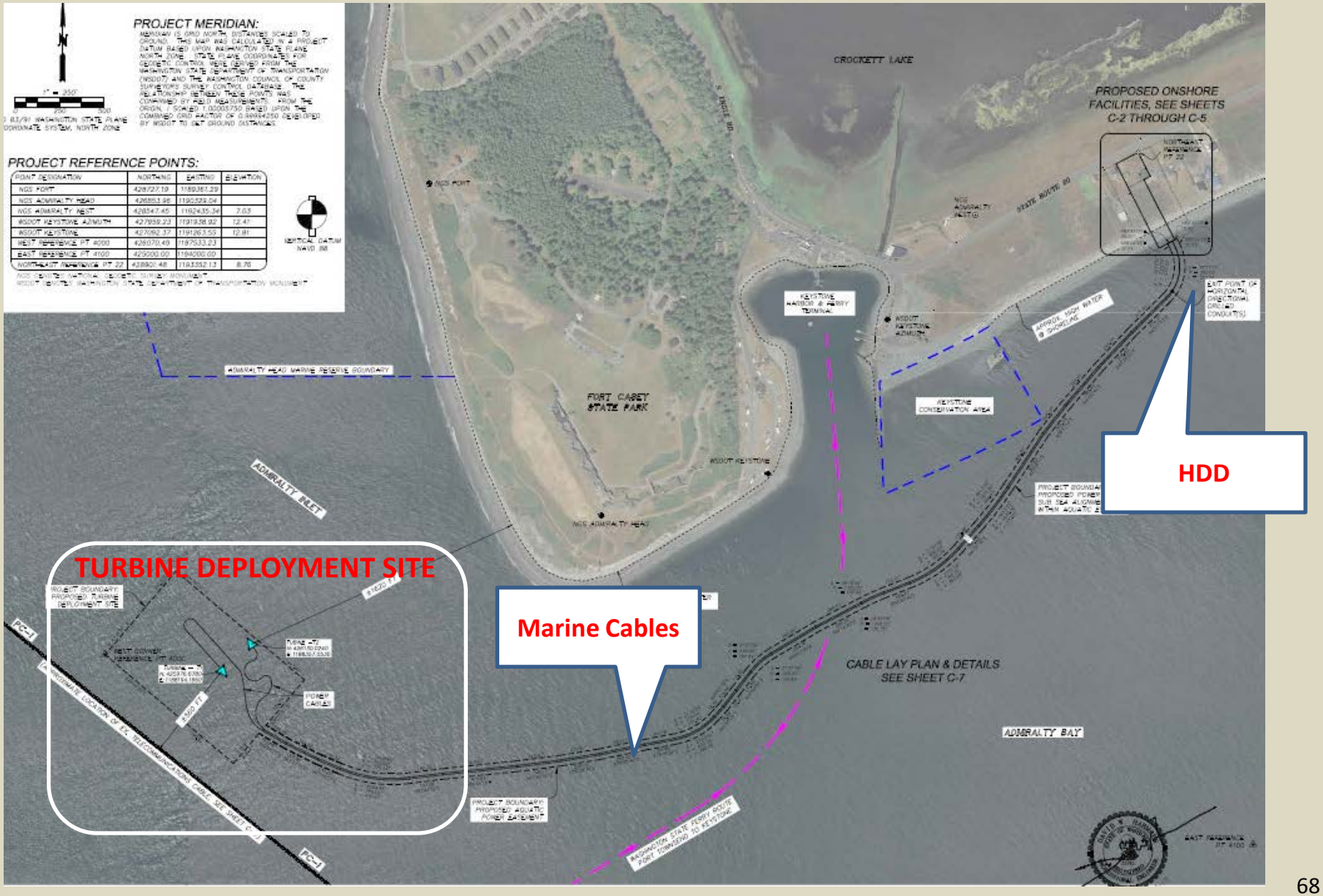
OVERVIEW MAP



6m EMEC Deployment

6m EMEC Deployment

QUESTIONS?