

PNNL-29345

Operational Planning Strategy for a Sequim Bay Underwater UXO Test Site (SBU2)

December 2019

Mark E Jones
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Prepared for
Strategic Environmental Research and Development
Program

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Prepared for
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Pacific Northwest National Laboratory
Richland, Washington 99354

Executive Summary

The Department of Defense (DoD) has identified more than 400 underwater sites that are potentially contaminated with munitions. Most areas are in shallow water (0-35 m) where the munitions pose a threat to human health and the environment. The Strategic Environmental Research and Development Program (SERDP) and Environmental Security Technology Certification Program (ESTCP) held a workshop in 2018 to establish the requirements, framework, protocols, responsibilities, and time lines for development of a series of underwater UXO Standardized Demonstration sites (“test beds”) for the purpose of testing the efficacy of sensors, equipment, and technologies to detect UXO. The workshop recommended a phased approach to building test beds to capitalize on: 1) incorporation of lessons learned from existing DoD funded projects, 2) leveraging existing underwater test bed environments funded by other programs, and 3) supporting recursive learning from early phases of the test bed development (i.e. efficiently optimizing through a scaling-up approach).

This strategy document provides the framework to establish a working operational plan for the Sequim Bay Underwater UXO (SBU2) Test Bed (Phase II). Details of the plan are dependent on earlier phases of the effort as shown in Figure 1. Results from Phase I are being evaluated, and when complete, will inform the next iteration of this plan. As such, it should be considered a living document that will be informed by the lessons learned and updated as new information becomes known and requirements are refined. This approach will allow SBU2 to evolve to meet the needs of the remediation community.

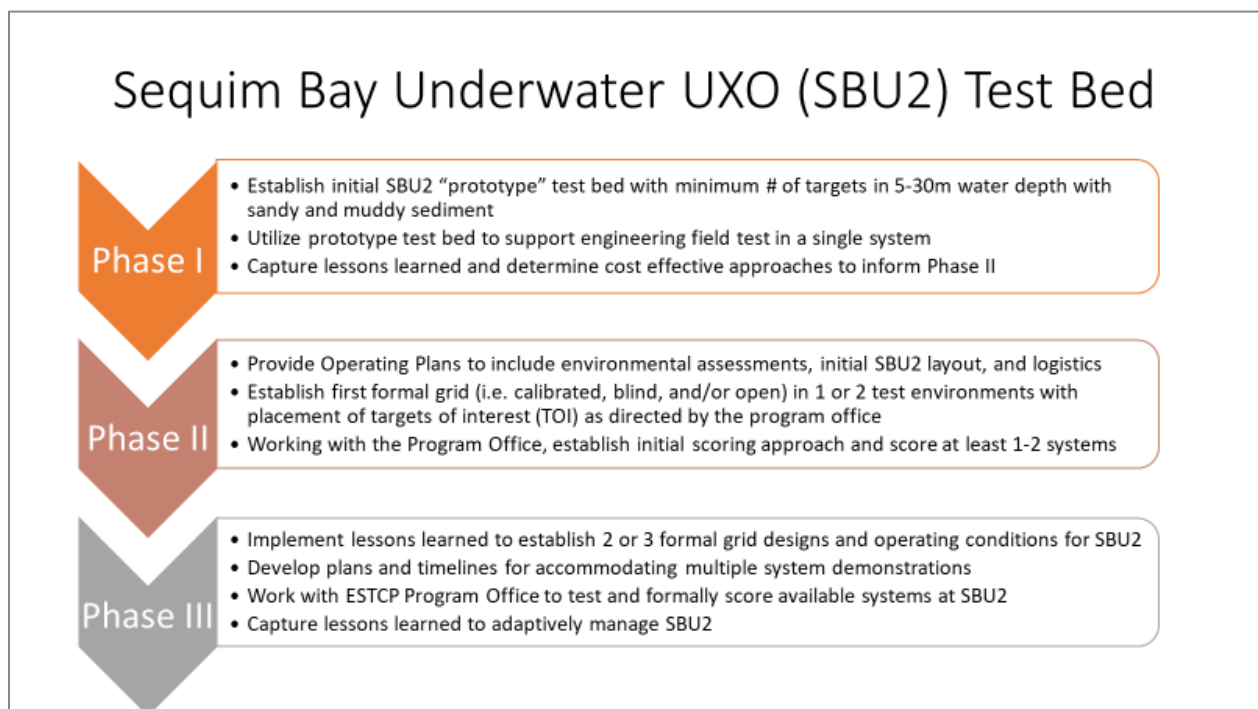


Figure 1. Test Bed development framework. Phase I will be completed by early 2020 and will included results of testing of a prototype system. This report is addressing the initial Operating Strategy that is a component of Phase II.

Acronyms and Abbreviations

ADCP	Acoustic Doppler Current Profiler
ASME	American Society of Mechanical Engineers
AZ	Azimuth
CAD	Computer Aided Design
CV	Curriculum Vitae
CTD	Conductivity, Temperature, Depth
DBrms	Decibels root mean squared
DMM	Discarded Military Munitions
DoD	Department of Defense
DOE	Department of Energy
EM	Electromagnetic
ESTCP	Environmental Security Technology Certification Program
FN	False Negative
FOUO	For Official Use Only
FP	False Positive
GPS	Global Positioning System
Hz	Hertz
IOPS	Integrated Operating System
JWM	John Wayne Marina
LAN	Local Area Network
LiDAR	Light Detection and Ranging
MLLW	Mean Lower Low Water
MR	Munitions Response
MSL	Marine Science Laboratory
ORMP	Offsite Risk Management Plan
PFD	Personal Flotation Device
PNNL	Pacific Northwest National Laboratory
QC	Quality Control
RAID	Redundant Array of Independent Disks
SB3	Sequim Bay Site #3
SBU2	Sequim Bay Underwater UXO Test Bed
SERDP	Strategic Environmental Research and Development Program
SSN	Social Security Number
TN	True Negative
TOI	Target of Interest

TP
UXO

True Positive
Unexploded Ordnance

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1.0 Introduction

The purpose of this document is to specify the operational strategy to be employed when using the Sequim Bay Underwater UXO (SBU2) Test Bed. The document is provided to establish a draft framework for specific processes to be followed once SBU2 is established and operational. PNNL is currently working on Task Order 3 (Figure 1, Phase 1) related to a prototype demonstration that will provide information relevant to the operation of the site. After completion of Task Order 3 this framework document will be revised, and an updated operational plan will be released formalizing the use and official requirements for SBU2.

1.1 Project Overview

The Pacific Northwest National Laboratory (PNNL) has been contracted by the Strategic Environmental Research and Development Program (SERDP) office to provide operational planning and support toward the development of Sequim Bay as a future test bed site for Munitions Response (MR) projects. Sequim Bay meets the requirements of the test bed location and is appropriate for systems and sensors that are ready for demonstration. Sequim Bay represents a deeper water site (between 5 and 30 meters) that is free of native UXO or DMM, with a variety of bottom types including sandy and muddy sediments. PNNL is providing the framework for test site operation in the form of this operational strategy. This strategy will be reviewed and updated as needed to reflect the status of the test bed development and the needs of the technology developers.

The main goal associated with the establishment of this Site (SBU2) is to provide a permitted venue for select activities to conduct demonstration of technologies representing a variety of testing scenarios that may include shallow water, intertidal and shore studies and in sandy and muddy bottom types. There are several sensors that are nearing the demonstration phase. The range of sensors likely to be tested in SBU2 include low and high frequency acoustics, magnetics, optical systems including Light Detection and Ranging (LIDAR), traditional and photographic systems, and cued and single pass electromagnetic sensor combinations. The deployment and testing platforms include autonomous vehicles, remotely operated vehicles, towed systems, surface systems, crawlers, and airborne platforms. The SBU2 will be permitted to operate approved systems in approximately 5 to 30 m of the bay. Additionally, SERDP will conduct additional evaluations beyond the tests conducted in Sequim using formal demonstrations at DoD facilities and within other operational settings. Performance results will be used to document and validate improved performance and cost savings that have resulted from the use of the SBU2.

1.2 Objectives

The overall objective of this program is to provide a standardized marine test site that will support the SERDP mission to test technologies that have been developed to detect UXO in shallow marine environments. The test site will be developed collaboratively between PNNL and SERDP using input received at the test bed workshop in Washington DC during November of 2018. PNNL staff have engaged in planning meetings with SERDP staff and potential platform/sensor developers that may utilize Sequim Bay as an underwater test site. This operational strategy document describes the needs and options for developing Sequim Bay as a test bed facility (e.g. permitting, infrastructure, operational requirements) based on the input from the workshop and subsequent discussions with SERDP and the technology developers.

1.3 Site Description

Sequim Bay is a protected embayment toward the eastern end of the Strait of Juan de Fuca. Prevailing longshore sediment transport created and maintains a sand spit (Travis Spit; see Figure 2) that almost completely seals the mouth of the bay, leaving a narrow navigation channel through which all water exchange between the Strait and Sequim Bay occurs. Because there is relatively limited freshwater input from the few streams that contribute to Sequim Bay basin, compared to other areas of the peninsula, most of the circulation is driven by tidal exchange.

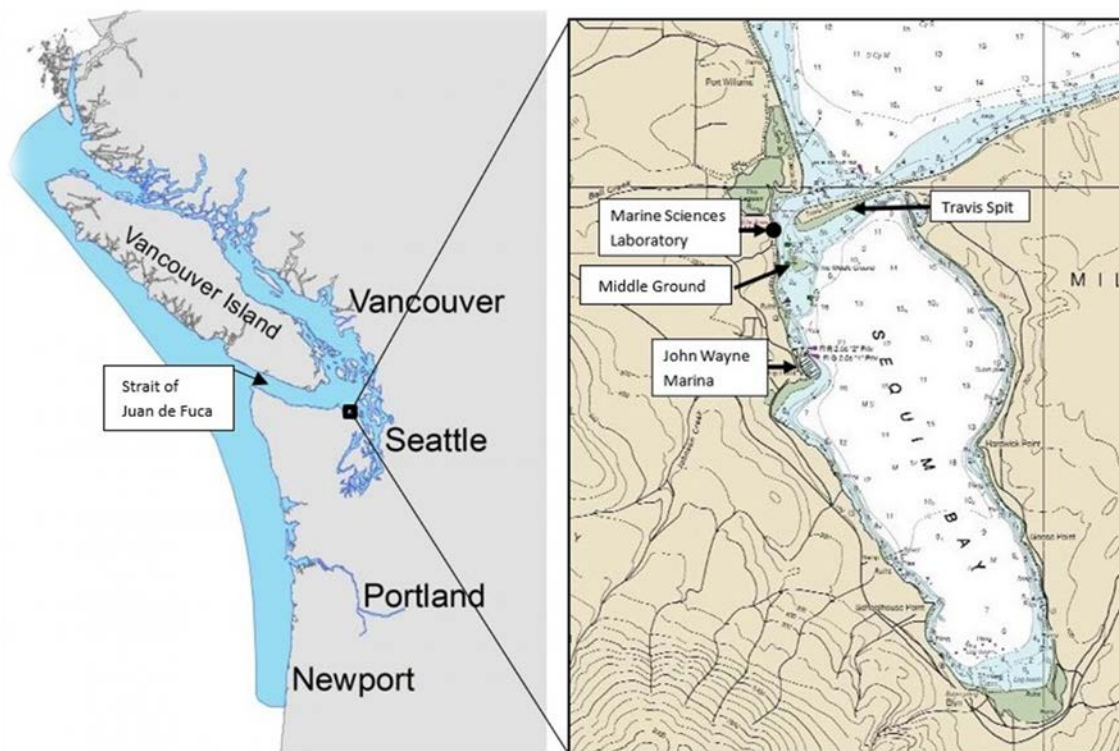


Figure 2. Sequim Bay location at the eastern edge of the Strait of Juan de Fuca

Sequim Bay experiences mixed semidiurnal tides (Figure 3). The result of this tidal pattern is that the two high tides (and low tides) are uneven during the course of the day. During neap tides this will often mean that the exchange is more limited between the two high tides and there is only one larger lower low tide in the tidal cycle. The average tidal exchange (i.e., between Mean Lower Low Water [MLLW] and Mean Higher High Water) is 2.41 m although the most extreme tidal exchanges can be greater than 3.5 m.

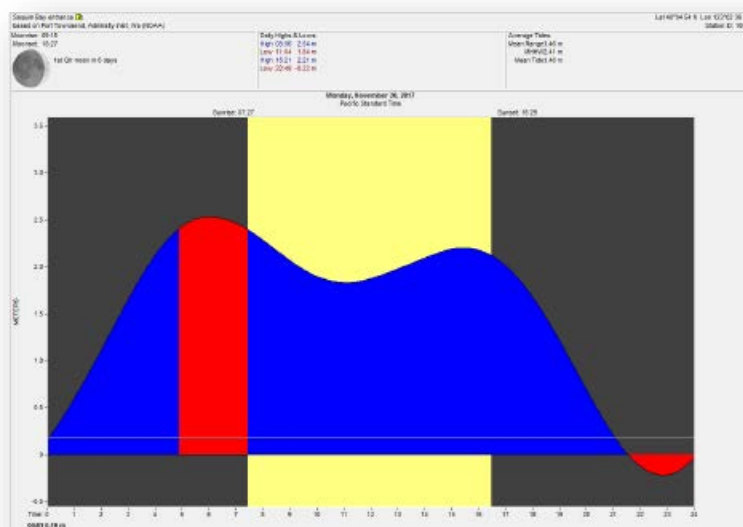


Figure 3. Example of the mixed semidiurnal tide pattern in Sequim Bay.

These tides can create strong tidal currents in more constrained parts of Sequim Bay and drive most of the circulation throughout the bay. As water enters Sequim Bay, it is funneled into a channel created by Travis Spit and the mainland at velocities approaching 2 m/s. A sand shoal called the Middle Ground (Figure 2) further constrains flow in the channel and directs most of the water south toward John Wayne Marina. While some of the incoming flow passes between the Middle Ground and Travis Spit, especially during lower low tides, the primary flow is along the primary channel, west of Middle Ground. Once the water leaves the constraints of the channel to the south, the velocity decreases by an order of magnitude (Figure 5) and the water can move throughout the bay creating slow eddies inside Sequim Bay.

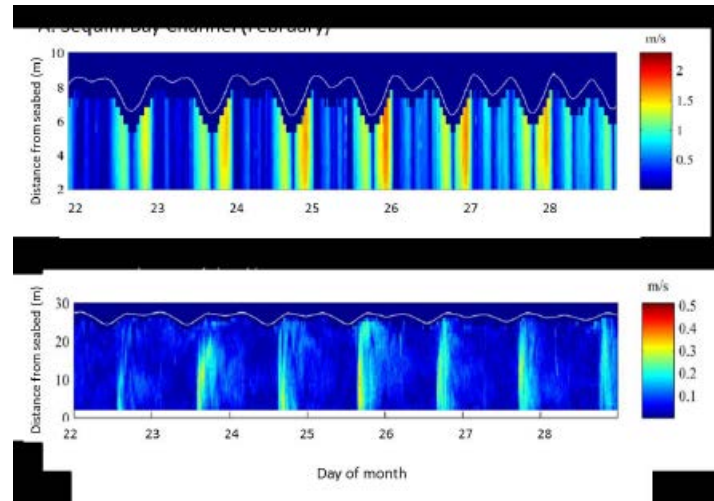


Figure 4. Excerpts from previous 2017 ADCP deployments (a) in the Sequim Bay Channel and (b) in the center of Sequim Bay showing velocity magnitude and water depth over a typical spring tide week (adapted from Harding and Harker-Klimes 2017 a,b). Yellow line indicates the sea surface. Note the velocity and depth scale differences between the sites.

The bathymetry of Sequim Bay is largely maintained by interactions with these tidal currents and is relatively stable on average. Normally, for field work conducted in Sequim Bay, PNNL uses all depths referenced at the MLLW, which is essentially the average lowest tide mark. For SERDP programs, visiting Users may take advantage of the changing tide to provide varying depths at test locations; therefore, we reference the depths in the figures using elevations from mid tide. Tidal elevation at mid tide represents the average water surface elevation relative to MLLW; depths will increase at high tide or decrease at low tide. Average depths shown in the bathymetric figures are the depths below the average water surface or level at the mid tide average.

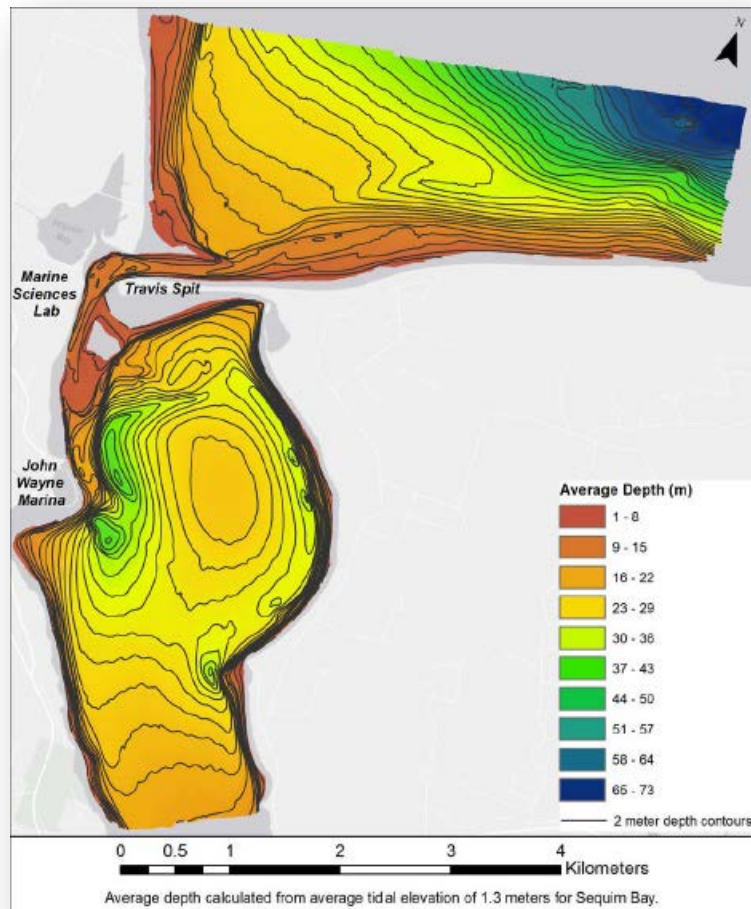


Figure 5. Bathymetry of Sequim Bay and areas north of the bay (from Integral Inc., unpublished data).

Feeder bluffs line parts of Sequim Bay and contain sedimentary deposits ranging from porous gravels and sands to hard till containing clay, silt, and coarser particles.



Figure 6. Bluffs on the northwest shore of Sequim Bay, near the Marine Sciences Laboratory.

Substrate bottom type in Sequim Bay is dominated by mud, with some sandier areas around Travis Spit, the Middle Ground, and along the nearshore of the bay. Harder substrate (large gravel) is located primarily in the channel between the Marine Sciences Laboratory (MSL) and

Travis Spit where water currents scour away finer sediments. A multibeam survey performed by Solmar Hydro applied acoustic algorithms to the acoustic backscatter to partition Sequim Bay sediments into broad categories. In Figure 7, muddy substrates are shown as blue. Generally, yellows are very fine sand, orange is fine sand, and red is slightly gravelly and/or shelly fine sand.

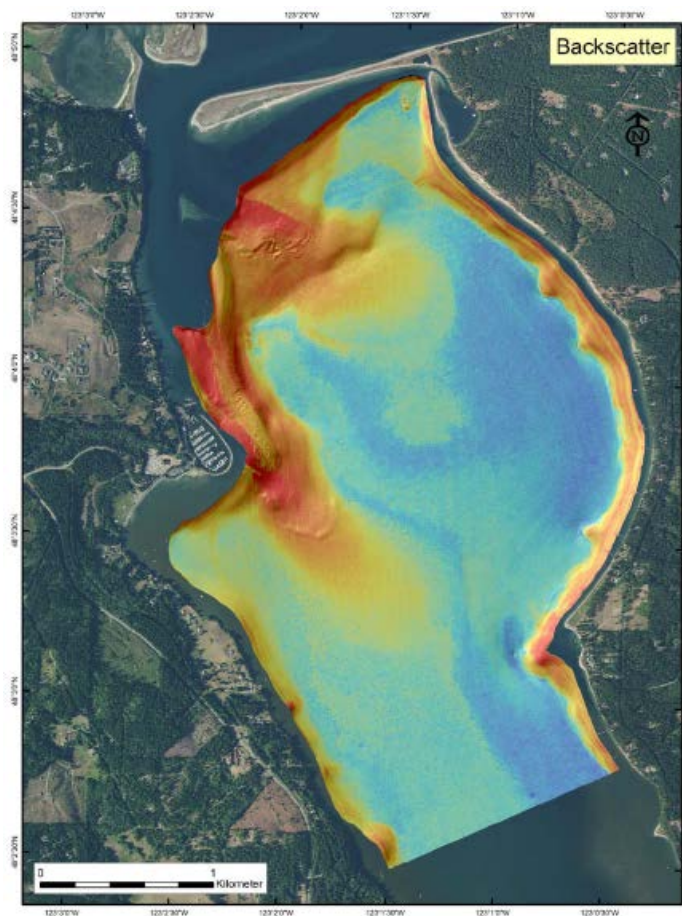


Figure 7. Multibeam survey performed by Solmar Hydro. Unpublished data.

Salinity in Sequim Bay is slightly lower than open ocean water ranging between 31 and 33 psu. Water temperatures are temperate and generally in the low 50's (Fahrenheit) in summer and upper 40's in the winter. CTD (Conductivity, Temperature, Depth sensor) casts indicate water can show some stratification toward the surface, especially in the summer, but it is generally well mixed to depth (D. Woodruff, unpublished data).

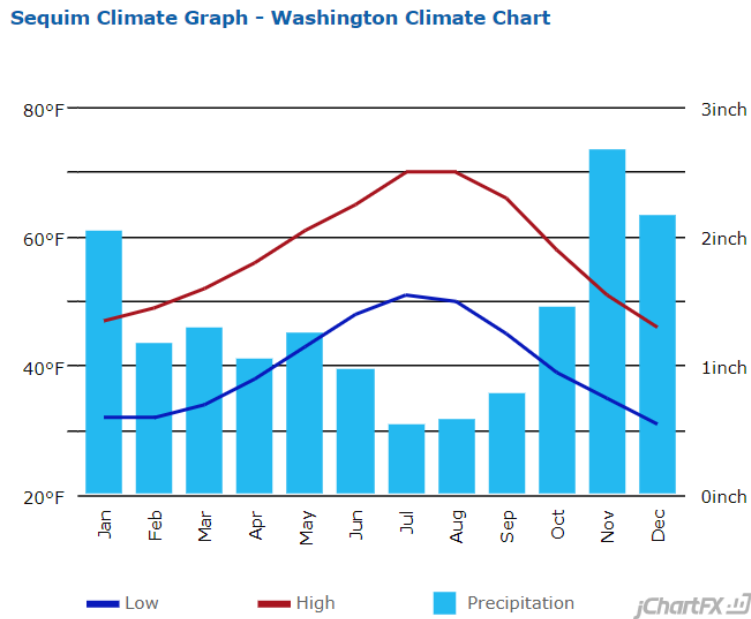
The clarity of the waters in Sequim Bay can be quite variable. At certain times of the year, the water can be relatively clear with visibility up to 6 m (pers. obs. from PNNL divers).. This typically occurs in winter when there are few phytoplankton blooms. In spring and summer, plankton blooms can severely reduce the local visibility for divers to 1.8 m or less. Stratification of the plankton in a thin layer near the water surface can exacerbate the poor visibility. The plankton also dramatically increases the attenuation of light in the water. Under these conditions the deeper layers can have better visibility than near the surface although the amount of ambient light is much lower at depth (J. Vavrinc, pers. obs.). Clarity of the water can also be affected in central areas of Sequim Bay near the bottom where the substrate is dominated by silt and clay. If this sediment is disturbed (e.g. when objects are placed or retrieved), visibility is

greatly reduced. Visibility is important when considering diver safety and efficiency when working with objects on the bottom of the Bay. Secchi depths off the MSL dock has indicated an average visibility depth of 4.4 m, although extremes have ranged between 0.8 m and over 6.5 m (D. Woodruff, unpublished data). Subsequent versions of the operational strategy will be updated as additional quantitative measurements are obtained.

1.4 Weather

A summary of annual Sequim climate is shown in the graphs in Figure 8. In spring and summer, the climate is driven by maritime effects. Afternoon wind is typical, and over the eastern strait around Sequim and Clallam Bay it is particularly gusty. In the early morning there is usually an inversion layer of fog that burns off later in the day. The fall is a relatively brief transitional period in October and part of November, with hard-to-anticipate weather. Winter encompasses late November, December, and January. The sun is lower in the horizon, and storms can frequently occur. These storms can be very strong and windy during this period. (www.olympicrainshadow.com).

(a)



(b)

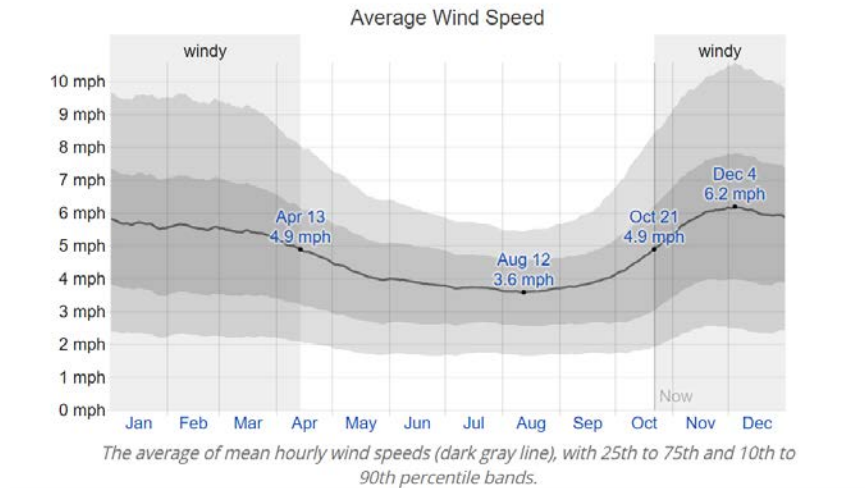


Figure 8. Sequim climate (a) Monthly rain and temperature and (b) average wind (Weatherspark.com)

2.0 Available Resources

A structured, systematic approach will be taken for all operational SBU2 projects and activities. These will be documented in an Operations Manual that may be updated yearly based on the input received from developers (i.e. Users test plans) and the likely testing schedule for that year. The general areas to be covered in the manual are briefly described below.

2.1 Environmental Characterization

Proposed test site locations were fully evaluated through underwater video, diver surveys, and substrate coring to find flat bottom areas that have a consistent substrate type for a linear distance of at least 100 m. Locations surveyed covered approximately 8 hectares of bottom area. Researchers documented the presence of mud/silt/flocculent in central Sequim Bay, silt and sand along Travis Spit, gravel and sand near the MSL facility at the entrance to Sequim Bay, and mixed substrate (sand and gravel) near Middle Ground. This information was recorded and mapped. Additional video surveys documented sandy substrates outside Sequim Bay. The size of the currently proposed test location (SB3) (Figure 9) allows for calibration, blind, and open grid testing opportunities.

PNNL scientists identified six areas of varying sizes, depths, and substrate types as potential test site areas in a previous report (SERDP Report, MR-2735.) The test site design, number and type of objects, specific locations of objects, the methods of emplacement of objects, monitoring for movement, and retrieval of objects must all be addressed. SERDP reviewed the proposed areas and based on discussions with SERDP and several preliminary studies made test area recommendations for deeper sandy and muddy locations (SB3) described below. The SB3 location may be refined or modified based on lessons learned from the Phase 1 prototype testing.

2.2 Pre-permitted Activities

PNNL has permits and authorizations to perform *select activities* for pre-defined research in portions of Sequim Bay:

- National Environmental Protection Act (NEPA) – DOE Categorical Exclusion for Aquatic Research
 - Section 106 National Historical Preservation Act, Cultural Resources Review – Washington State Historic Preservation Officer
 - Endangered Species, Section 7 – US Fish and Wildlife Service
 - Endangered Species, Section 7 – National Marine Fisheries Service
 - Essential Fish Habitat – National Marine Fisheries Service
 - Marine Mammal Protection Act (MMPA) – National Marine Fisheries Service
 - US Army Corps of Engineers Individual Permit
 - Hydraulic Project Approval – Washington State Department of Fish and Wildlife
 - Coastal Zone Management Act – Washington Dept. of Ecology
 - Clallam County Shoreline Exemption
 - Aquatic Right of Entry License – Washington State Department of Natural Resources
- US Coast Guard Private Aids to Navigation requirements are determined on a case-by-case basis.

Sequim Bay Permit Areas

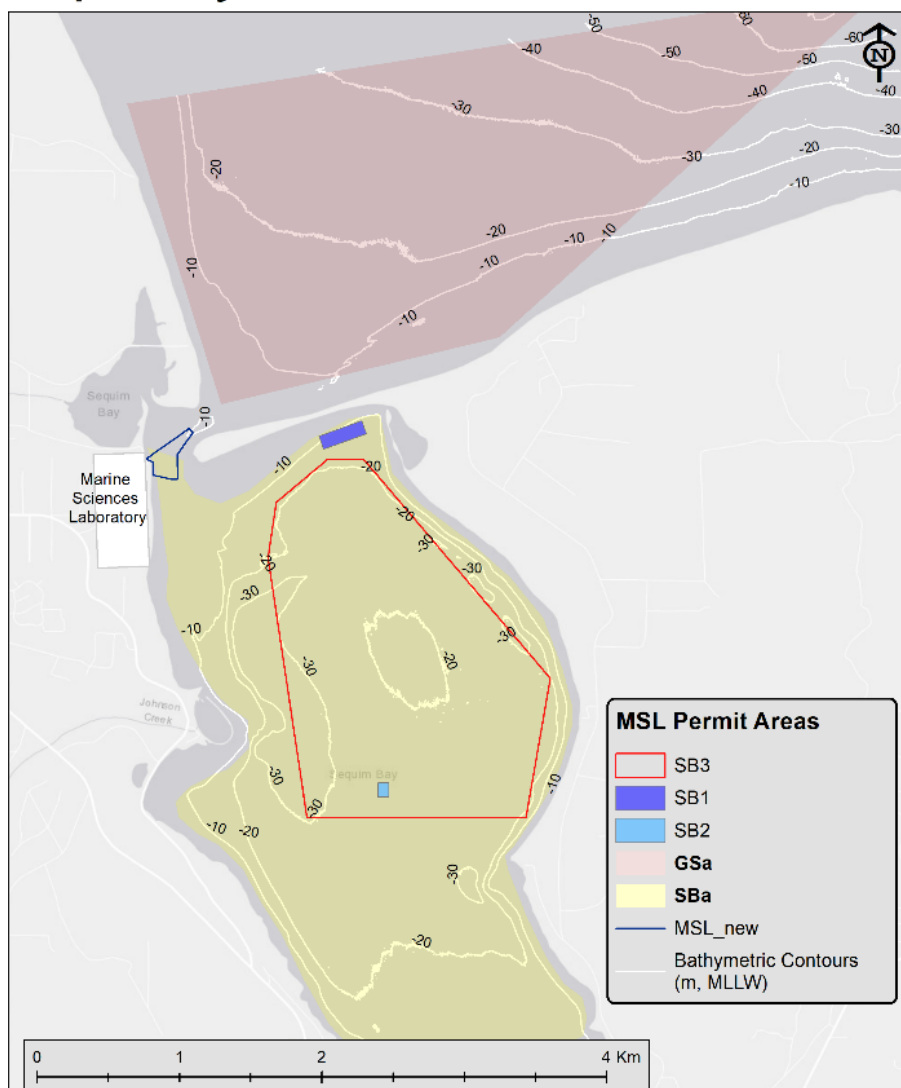


Figure 9. Sequim Bay permitted study areas. SB3 was permitted for the 2019 Phase 1 testing and is being considered for Phase 2 testing as part of the Sequim Bay Test Site (SBU2).

Examples of research activities currently permitted inside the SB3 area include:

- Diver surveys
- Seabed installation of scientific equipment for periods up to 12 months at a time. This includes deployment of targets (to include items such as aluminum cylinders, scuba tanks, inert and replica munitions, cement blocks, boat anchors and crab traps).
- Sediment sampling (up to 200 gallons per year)
- Operation of acoustic devices at frequencies outside of marine mammal hearing ranges (below 7 Hz or above 180 kHz), or at sound level pressures that are below the Level B harassment thresholds for marine mammals ($160 \text{ dB}_{\text{rms}}$ for impulsive; $120 \text{ dB}_{\text{rms}}$ for non-impulsive) and behavior effects for fish ($150 \text{ dB}_{\text{rms}}$).

A detailed test plan will be required from each developer that will be reviewed to determine compliance with existing permits and to determine if new permits, authorizations, or permit amendments are required.

Before research activities can occur within the permitted area, a detailed test plan must be submitted to the PNNL permit review team. It is strongly recommended that plans be submitted at least 6 months in advance of proposed testing. The review team examines test plans to determine compliance with existing authorizations and permits. If proposed activities do not fall within existing authorizations, recommendations for amendments or new authorizations/permits are made.

2.3 Test Objects

Test objects will consist of inert and surrogate munitions, science targets and clutter objects. Clutter objects will include cement blocks, scuba tanks, and crab pots. A catalog of targets will be kept. Targets will be kept on location with additional targets for placement held in storage. For emplaced objects, diver surveys will be performed prior to site access to confirm conditions. For emplaced targets and where possible, the Test Bed Supervisor site manager will supply:

- Material type
- Material properties (e.g. conductivity, density, etc.)
- Size (e.g. caliber)
- Description (e.g. rotating bands and objects that affect signal scatter)
- Orientation – az/pitch
- Lat/long location to within range determined in consultation with SERDP office
 - Note smaller ranges will cost more to site target locations
- Burial condition/slant angle
- Photos

This documentation will enable Users to better understand their system performance and results.

2.4 Spaces

PNNL's Marine Science Laboratory is the only marine laboratory in the Department of Energy National Laboratory system and it is dedicated to research and development focused on helping the nation meet needs for sustainable energy, a sustaining environment, and robust security in coastal environments. The laboratory is situated on 140 acres of land at the mouth of Sequim Bay (Figure 10) and has approximately 1400 m² of laboratory space, half of which is connected to a system that provides flowing seawater to laboratory space or to outdoor tanks. The facility also has a shop, electronics/optics laboratory, and pier with floating dock to support operations on land.



Figure 10. Aerial photograph of the PNNL's Marine Sciences Laboratory located at the mouth of Sequim Bay.

2.5 Offices

A turnaround office will be made available (In addition to conference space) for computational work. Desk space, phones, and an ethernet connection to PNNL's Visitor LAN will be provided so Users can perform necessary onsite data analysis or share data with researchers within their own organization who are not on site. For security purposes, there will not be any connectivity provided behind the PNNL firewall.

2.6 Laboratories

To address hardware repairs or refinements onsite, PNNL has electronics and fabrication laboratories available to Users with appropriate PNNL-supplied training and hazard awareness review. PNNL staff can also be made available to perform hands-on work with prior notification/request. The laboratories available for sensor system development, platform development, and field operations command and control, contain the following available equipment:

- Oscilloscopes
- Power Supplies
- Signal Generators
- Function Generators
- Frequency Counters
- Multimeters
- Soldering/Desoldering stations
- Small hand tools

In addition, these laboratories contain PNNL engineering capabilities such as Solidworks 3D mechanical CAD and multi-layer electronic circuit board design that can be utilized by PNNL engineers to support User needs.

Local machine shops provide contract services, precision machining, and fabrication capabilities. There is conditioned guest space in the server room with high speed internet connections. There is also room for guest servers and a desk for visiting Users. If test instruments, chemical products, or specific equipment is needed for onsite repair, the request to bring this equipment and/or the chemical products onto PNNL property must be made when scheduling the test site and approval will be subject to a hazards review.

2.7 Conference Rooms

A PNNL conference room will be made available for daily briefings. Additionally, the rooms can be scheduled for necessary coordination of activities. Conference rooms are equipped with collaboration-ready features and work seamlessly with Skype for Business meetings. Each room is standardized with a high-definition web camera and audio device, as well as a large video display for presenting. Built-in table top connections are available. The conference room located on the shoreline can hold up to 50 individuals.

2.8 Dock/Pier/Marina

The MSL has a fixed pier and floating dock at the shoreline facility. MSL Research boats tie off to the floating dock for transfer of personnel and equipment. Boats are not typically moored at the floating dock overnight.

John Wayne Marina (JWM), run by the Port of Port Angeles, is located inside Sequim Bay south of the MSL (Figure 11). JWM is a full-service marina that offers permanent and transient moorage, fuel, and a boat ramp. Vessels can be moored at the marina at night to facilitate operations so there is no need to launch and trailer vessels each day.



Figure 11. Aerial of John Wayne Marina in Sequim Bay (from marinas.com).

2.9 Boat Operations

To support operations on the water PNNL operates research vessels (Figure 12), including:

- 33-ft SAFE Boat with davit and optional gantry system (Desdemona)
- 28-ft Aluminum vessel with A-frame and davit (Strait Science)
- 23-ft SAFE Boat (SAFE Boat)
- 17-ft- Alumaweld Super-Vee LS (Tenacious-A)
- Sun Tracker 20 Fun Fish (Sun Tracker)



Figure 12. MSL vessels available to support operations in Sequim Bay. From the upper left moving clockwise: Desdemona, Strait Science, Sun Tracker, Tenacious A., and SAFE Boat.

PNNL provides the boat operators when PNNL boats are used. Depending on experience level, Users may act as boat crew, assisting with on-water operations. However, only PNNL staff may operate on-board hydraulic equipment (davits and A-frame). Users will receive PNNL Floating Dock training and a safety briefing before boarding any PNNL vessel. Personal Flotation Devices (PFD's) will be provided. Each day before on water activities, the lead PNNL boat operator will supply a mandatory safety brief. *Any individual will have the authority to call a stop work for any perceived unsafe condition (e.g. water/weather conditions are too rough).* There are also limits to the weights and dimensions individual PNNL boats can handle. If a larger vessel is required for an application, PNNL (or the User) may contract another vessel. PNNL currently has a standing contract in place with the University of Washington's *R/V Jack Robertson*, a 56-ft vessel with A-frame and utility hoist (Figure 13).



Figure 13. The R/V Jack Robertson operated by the Applied Physics Laboratory University of Washington.

All operations using PNNL vessels will be managed by qualified PNNL staff. If a User brings their own vessel, it must comply with PNNL's standards and, at a minimum, adhere to PNNL's safety practices.

2.10 Dive Operations

The PNNL MSL is home to a Scientific Research Dive Team. The divers are scientists, adept at accomplishing scientific tasks in a variety of underwater environments. The team reports to a PNNL Diving Control Board, which advises the PNNL Laboratory Director, monitors ongoing diving activities, and reviews past and proposed dive work. The team has advanced standardized equipment including full-face masks with wireless communications, closed-circuit rebreathers, and a variety of underwater scientific and video-/photographic equipment. The divers have an intimate knowledge of Sequim Bay and are an invaluable resource when assessing habitats and other underwater features. The PNNL divers may be scheduled to assist with deploying and retrieving objects in Sequim Bay's Test Site. It is also possible for Users to supply their own divers. A letter of reciprocity must be provided in advance to the PNNL Diving Safety Officer to ensure that the non-PNNL divers have the medical clearance, training, and dive experience required to safely perform dives in the conditions typical of SBU2 (i.e., cold water, depths between 60 and 100 ft, and low visibility). The PNNL Diving Safety Officer will make the final determination.

3.0 Roles and Responsibilities

This section provides a brief overview of the roles and responsibilities for PNNL and for Users of the site.

3.1 PNNL Involvement

The following PNNL roles and responsibilities have or will be established to ensure safe access to the testbed.

Table 1. PNNL Site Roles and Responsibilities

Role	Responsibilities
Test Bed Supervisor	Primary point of contact responsible for range scheduling and deconfliction; maintaining tools, permitting and overall facility access. Final go/no go decision on test readiness.
Field Operations Lead	Oversees daily operation on the PNNL campus and field-testing activities within SBU2. Provides technical expertise and access to facilities and ensures environmental and safety compliance. Holds daily planning meeting and end of day outbriefing.
Dive Safety Office	Responsible for any underwater activities including surveying of site prior to testing
Permitting Officer	Responsible for maintaining permitting at site. Point of contact should additional permitting needs be identified
Safety Officer	Authority for safe use of site. Provides daily safety briefs and determines readiness to operate. Note: Anybody has authority to stop work if unsafe conditions are a concern.
Boating Lead	Responsible for PNNL boat operations. If Users bring their own vessels, insures operations are compliant with PNNL safe boat operations. Maintains equipment on PNNL vessels
Shipping and Receiving	Point of contact to receive equipment shipped to MSL site.
Site Maintenance Lead	Responsible for sensors used to characterize site
Quality Assurance Officer	Provides a practical methodology for grading and tailoring quality work controls

3.2 User Involvement

A User is an individual or a member of a research team who is granted access to resources at the MSL test range through an approved SERDP/ESTCP-reviewed proposal.

The project Users will be separated into two functions:

- Those who use the facilities and expertise to support the development, testing and validation of detection technologies that have been funded through competitive solicitations by SERDP/ESTCP.
- Those who undertake funded development for environmental monitoring technologies and test methods, including other National Laboratories, industry and academia. Engagement will be done through a SERDP/ESTCP-reviewed process.

When a project is selected for a test campaign, the User will need to file a Demonstration Plan. Requirements for a Munitions Response ESTCP demonstration plan can be found at <https://www.serd-estcp.org/Investigator-Resources/ESTCP-Resources/Demonstration-Plans>.

4.0 Planning, Procedures, and Controls

This section provides the necessary steps and schedule that will determine when activities will occur. The dependencies and required participants are shown in the following Gantt chart:

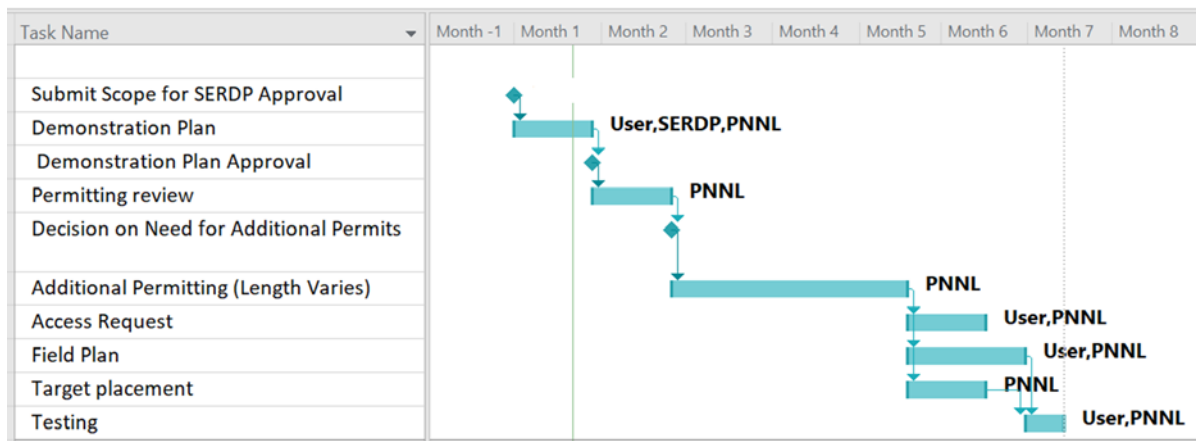


Figure 14. Schedule to access facilities. Dependent on additional permitting.

Prior to accessing the facilities, Users will be required to supply a detailed field plan (project scope) for the system to be tested including any specialized equipment needs. While not limited to what is outlined, the plan must include the following information:

- Detection methodologies and limitations (e.g. EM, acoustic, and so forth)
- Target footprint (e.g. Limited to proud objects?)
- Projected number of days in the field
- Integration time/time on target
- Deployment needs
- Vessel
- Maneuverability
- Onboard power
- Access to additional sensors (e.g. GPS)
- Calibration requirements
- Onsite assembly requirements
- Number of persons required to deploy and operate the technology (beyond test bed operations)
- Target/grid details where applicable (Calibration, Blind, Open) and # and type of objects

4.1 Project Scope

PNNL must receive a clearly defined project scope from each intended User in a timely manner to ensure there is time for additional environmental permitting (if necessary), object placement or object location confirmation, hazard identification and mitigation planning, project-specific training, and site access (badging). Last-minute changes may not be able to be accommodated. It is strongly recommended that project scope be provided to PNNL no less than six months before field activities to ensure that adequate time is available for permitting, scheduling the field site and for logistical considerations related to object placement and to ensure staff and vessel resources are available. Prior to officially submitting a well-defined project scope, it is recommended that project PIs have preliminary discussions with PNNL's Test Bed Supervisor and Permitting Officer. These preliminary discussions will provide a basis for matching scoping needs to facilities and permitting requirements and will ultimately help to establish realistic timelines for executing work.

4.2 Permitting Review

As described in 4.1, projects must provide a clear, concise, and complete scope of work that will allow PNNL's permitting team to determine if the project activities are already covered under existing environmental permits that PNNL/DOE hold with federal, state, and local agencies. Information is needed that defines specific activities (refer to Section 4.0). Figures that show equipment and specifications (i.e., materials, dimensions, and operating parameters) are required. Projects that fall outside the pre-permitted activities and/or spatial extent of permitted areas will be required to prepare permit applications to obtain permission to do the proposed work. Activities that fall within the authorizations of permitted activities may still need a consultation with agencies for concurrence on activities. The authorization and permitting process, which includes preparation of the documents and applications, coordination with external regulatory agencies, and review and determinations by these agencies can take weeks to months. The timeline is dependent on a variety of factors, many of which are external to PNNL:

- Permits or authorizations that require prior approval / permits from other federal agencies prior to application submission
- Permitting agencies' internal permit-review schedules

4.3 Health and Safety Planning

An Offsite Risk Management Plan, or ORMP, will be prepared by PNNL in advance of each User visit. This document identifies and evaluates the risks and hazards that Users and PNNL staff may encounter while performing the proposed work in areas outside of MSL (i.e., on the pier and dock, on boats, underwater, and at the marina). Guidance on mitigating the risks and hazards will be provided. Training may be required. Most training may be completed online before the site visit except for in-person safety briefings regarding access to the floating dock and research vessels. Emergency contacts and nearby hospital facilities are identified. It is clearly indicated in the plan that all staff and visitors have stop-work authority and may halt any

activity they deem unsafe. All PNNL staff and Users must review and sign the document indicating that they have read the ORMP and understand the risk sources and hazards, controls/mitigations associated with the work and will implement the controls/mitigations as indicated.

Currently, a separate process is used at PNNL to identify and mitigate hazards inside laboratory spaces. Users needing to work with potential hazards (e.g., electrical diagnostics, chemical use, soldering) in lab spaces at the MSL will be granted online access to a program called Lab Assist that will provide the user with information about the activities they may perform in a particular laboratory. The program provides an overview of the hazards they may encounter and how those hazards are mitigated. Online training modules are linked to this system. All reading requirements and trainings identified must be completed before the user will be allowed to work on the activity in the lab. Some of these training activities can be performed online prior to Users arrival at the Site.

4.4 Scheduling

The site will be operational throughout the year. However, availability will be influenced by seasonal recreational and commercial fisheries (e.g. crabbing) schedules and weather. Projects are most likely to have unrestricted access to the site April-June, and August-October. July, the peak of recreational crabbing season in Sequim Bay, is planned as a maintenance month where there will be no scheduled User activities. Open dates will be re-evaluated based on SBU2 usage.

4.5 Approval Process

Per section 4.1, once the User has been approved by SERDP to conduct testing in Sequim, the User submits a request via email to the Test Bed Supervisor at least six months in advance of the requested testing dates. The request should contain full contact information, dates requested, as well as the following:

- **Demonstration plan:** The plan should include type of instrument, (physics, characteristics, dimensions) and any emissions. PNNL will work with Users to determine information needed for permitting requirements. The anticipated operational limitations should also be outlined (e.g. penetration depth into sediment type). This is the plan described in Section 4.1.
- **General Collection Procedure:** Data collection and storage will be the responsibility of the User unless otherwise requested. Vessel operational requirements should be defined (e.g. vessel speed and maneuverability requirements) and any special handling requirements for the sensor.

When the initial request package is received, SERDP will review the package along with PNNL. Once the request is approved, the Test Bed Supervisor will coordinate with the User to arrange dates for conducting the test.

4.6 Resource Allocation

For U.S citizens, thirty days prior to the test date (45 days if researchers include Foreign Nationals), the demonstrator is responsible for supplying following information to PNNL and the Test Range Supervisor for review and comment:

- Project Field Plan. The demonstrator's description of detection/sensor equipment and a summary of how data are collected:
- Quality Control (QC) Plan. A description of how systems checks are conducted to maintain proper operation
- Site Personnel List. Provides the names, cell phone numbers and e-mail addresses of individuals the demonstrator plans to bring on-site. This information is required so that PNNL-specific training may be completed in advance of the site visit. Site Access Requirements below describes additional requirements for site access (i.e., badging).
- Support Equipment List. A list of all demonstrators' equipment being used to conduct the test. This information is used to determine storage facility and other on-site requirements.
- After the User receives approval to utilize the site, the User and Test Bed Supervisor will finalize scheduling, security, and logistics issues. Changes or issues arising in scheduling by the User need to be coordinated with the Test Site Supervisor.
-

4.7 Site Access Requirements

SBU2 will be accessed from within a restricted area at PNNL's Marine Sciences Laboratory. Federal regulations require that visitors receive authorization prior to arrival at PNNL, and that they obtain a visitor's badge upon arrival on campus. Please note the following badging procedures for U.S. citizens and foreign nationals.

4.8 U.S. Citizens

A request to visit the site needs to be submitted two weeks prior to testing and availability of the range needs to be confirmed by the Host. The following information will need to be provided for each individual coming on site:

- Full name including middle initial
- U.S. citizenship status
- Last 4 digits of SSN:
- Employer:
- Dates on Site:

U.S. citizens must present valid, government-issued photo identification such as a U.S. passport or state-issued driver's license upon arrival. State driver's licenses and identification cards must

meet the REAL-ID ACT OF 2005 standards established by the Department of Homeland Security.

Visitors with state driver's licenses or identification cards that do not comply with REAL ID standards will be permitted access to facilities only when escorted by a PNNL employee.

4.9 Foreign Nationals

Foreign national visitors are required to fill out and submit a Visitor Pre-Visit Questionnaire and Visitor Information form to their host at PNNL. These forms cover:

- all science and technology specialties
- all work positions, city, state, and country with dates providing a brief explanation where there are **gaps** in time (from age 18)
- current/accurate names of all academic institutions attended with city, state, and country (from age 18)
- a Curriculum Vitae (CV) – a brief account of a person's education, qualifications, and previous experience, typically sent with a job application
- Lawful Permanent Residents (LPR) of the United States must present a valid LPR card or evidence of lawful status if waiting for an LPR card to be issued. Non-U.S. citizens who are not LPRs must provide valid passports and visa documentation, including an I-94 Departure Record or an applicable passport admission stamp.

The PNNL host will submit the information to PNNL's Foreign National Visitor Program personnel for review and approval. Processing timelines begin when the host signs/submits the information. A minimum of 15 business days are required to obtain approval for visits for non-sensitive visits/assignments. However, at least 35 business days are required prior to the start date for sensitive visits/ assignments.

4.10 Technology Handling

Users will be responsible for the operation and maintenance of their equipment while on site. Basic electronic laboratory space will be made available for limited repair and refinement of equipment and will include oscilloscopes, function generators, and solder stations.

All procedures undertaken within the laboratory buildings will be governed by PNNL's Integrated Operations System (IOPS) and/or Lab Assist and monitored through the existing systems. Users looking to do hands-on work onsite will be required to take PNNL-specific training.

To address power needs a Power (120 V AC) and data lines (Cat5) provide power and data connection to the end of the MSL dock, with the option for 220 V to be provided. A private local area network (LAN) will be established for data collection purposes, with one or more PNNL servers providing access to that LAN via the PNNL intranet.

Data storage will be provided by networked storage devices, using RAID¹ to protect against hardware failure. Data are backed up to the uplands facility (MSL5) via the PNNL LAN, in order to protect it against facility damage at the beach location. Separation between projects can be achieved by adding separate, networked storage devices, and using virtual machines to provide access.

The process to allow external PNNL personnel to access the data systems is currently being developed so that users can easily access the project information they need, while preventing access to other projects and systems, and maintaining cyber security.

4.11 Data Collection & Management Planning

Field Plans will be developed for individual projects but will also cover all work activities to be conducted through the SBU2. Standard operating procedures developed by PNNL will be followed for any of the work activities that are routinely conducted at MSL. The testing protocols will be used to understand reported results and assess whether deviations are tied to the technology, how the site was utilized, or issues with the site that need to be corrected.

When it is determined that an external project will test at Sequim Bay, the goals and metrics defining a successful outcome will be summarized, and the testing protocols will be specific to those outcomes. These testing protocols will be developed according to PNNL's Quality Assurance Program, which provides a practical methodology for grading and tailoring quality work controls to projects conducting work at various stages of technological readiness.

The Quality Assurance Program at PNNL is based in part upon the requirements as defined in the United States Department of Energy (USDOE) Order 414.1D and implements the Graded Approach Application of Quality Assurance Requirements for Research and Development (ASME NQA-1-2000, Part IV, Subpart 4.2) consensus standard. In addition to the PNNL Quality Assurance Program, MSL maintains a quality program accredited to the NELAC Institute (TNI) standard (based on the ISO/IEC 17025:2005 standard) which can be applied to projects where appropriate. MSL also has a Quality Assurance Officer available to manage project quality when needed with credentials that include Lean Six Sigma Green Belt, Lead Auditor, Quality Auditor, Software Quality Engineer and Environmental Manager certifications.

5.0 Field Operations & Oversight

This section provides a summary of activities to prepare the test site for technology testing and evaluation.

¹ Redundant array of independent disks

5.1 Site Preparation

Test objects will be placed in SBU2 at least one month in advance of any User's visit. The objects will remain in place for up to one calendar year before being retrieved and moved to new locations. The details associated with timelines and locations for object deployment will ultimately be executed according to permit authorizations as well as overarching project goals and objectives. Initially, it is assumed that the permitted area will be divided into sections. One section will contain objects whose identification, location, and positioning are shared with the User, and placed in a systematic configuration determined by the Test Bed Manager and agreed upon by the User to best calibrate/refine their testing equipment. This grid will in effect be a calibration area where Users can test their equipment and ensure they are able to detect known objects in a known location prior to formal testing.

Additional test objects will be placed in other permitted sections as part of "blind" or "open" gridded test areas. For blind grids, Users will be provided potential locations but the presence or absence of targets at those locations are unknown. For open grids, the locations will not be provided to the Users. In all cases a list of potential targets from the standardized target repository will be provided to the User prior to testing.

PNNL boat operators and divers will initially position the objects within the permitted areas and will confirm the locations and orientation of the objects on a regular basis. Generally, it is expected that the object locations will be confirmed just prior to or immediately following a User visit to the SBU2. Divers may hold a taut line on the object and use dGPS at the surface to mark each object's location. Alternative methods will be considered including acoustic long baseline positioning systems that can achieve 0.5 m placement accuracy. Compass bearings are used to describe orientation. Comments made by divers underwater about the objects' state of burial and other relevant information may be recorded by surface crew on the boat. Execution of blind tests with untethered objects may require additional technologies to mitigate issues of potential and permanent loss of objects. The use of equipment such as the technologies specified in target siting will provide a more accurate means of retrieving objects following the close of the project and ensure compliance with authorizations and permit requirements.

5.2 Security Procedures

A project may prepare and maintain certain unclassified information that should be protected because of sensitive governmental, commercial, or private interests. Any information generated by PNNL will be treated as FOUO until it is derivatively classified and then marked appropriately. No information will be released without a review. All FOUO information shall be maintained in accordance with DOE requirements for controlled unclassified information. FOUO information should be secured in locked files or in a locked office when not in use. FOUO information should not be read or displayed in public places. Electronic files containing FOUO information shall be protected in accordance with PNNL requirements for Unclassified Cyber Security. FOUO files should be password protected or other file access controls implemented to prevent unauthorized access (i.e. Entrust encryption).

5.3 Classification

Staff supporting the project shall follow all DOE requirements pertaining to classified matter handling. In addition, all staff are required to receive a project classification briefing from the PM and lead derivative classifier. This program will follow SERDP/ESTCP classification guidance.

5.4 Scored Testing

The following section describes an example of how a formal test could be conducted. Per the workshop, scoring will be done by an independent contractor. The various levels or steps in the scoring process will be undertaken by a joint effort between PNNL and an independent contractor, with specific roles determined by SERDP. Note that the test bed will also be made available for use without the rigors of the included testing procedures. In its role supporting DOE, PNNL cannot endorse specific instruments or technologies, and therefore validation is restricted to stating that the successful outcomes of a specific technology development process were met. The following criteria will be used, and results supplied to SERDP and Users for determination of technology efficacy.

Scoring of the User's technology will be based on results from a blind test where the boundaries of the test location are provided *a priori* to the User. Because of the nature of clutter and the reduced ability to control background in an underwater setting, testing and scoring will adopt protocols used at live terrestrial test sites and will require two runs. The first test will focus on object detection for:

- sited surrogate munition targets,
- sited clutter objects (e.g. crab pots, cement blocks, scuba tanks),
- native clutter objects identified in advance by the site manager

The User will submit a matrixed table for grading. Each row will contain latitude and longitude of a detected object, and whether the object is buried or proud. The list will be compared to site ground truth and four values will be calculated:

- The number of detected locations that were truly Objects (True Positives, TP). For an Object to be considered it must fall within a predetermined distance of the sited latitude/longitude location.
- The number of detected locations that do not correspond to known Objects (False Positives, FP),
- The number of known Objects that were not identified (False Negatives, FN).
- and (True Negatives, TN) where the blind test site will be sectioned into a grid and areas of no Objects correlated with no detections from the performer

Note: A scoring criteria will be provided to performers prior to coming on site and will include scoring decisions for special cases. Examples cases include multiple Objects falling within single detection latitude/longitude provided by performer or single objects counted twice.

The second test will focus on correlated TP objects and address classification. The performer will be able to revisit locations of known detected objects and asked to decide whether the object is a sited surrogate munition or clutter. Binary scoring will be applied based upon the correct classification.

5.5 Reporting and Validation

At the conclusion of scoring, PNNL personnel will report the detection results (for the four values) to the Users and SERDP. PNNL will provide two copies of the report. As described in Section 5.3, PNNL will not provide an overall pass/fail conclusion and will leave this determination to SERDP. Scoring results presented at the PNNL site will be considered final when reported at the out briefing – no rework of data or reporting will be included in this assessment. Should Users question the result of the findings, SERDP will determine next steps that could include reanalysis of data or additional collection at the test site. If additional testing is needed, the same scheduling procedure will be used. SERDP can grant priority for testing based on their requirements.

5.6 Incoming Data

Data that users bring with them will be protected by a non-disclosure agreement between PNNL and the user. Data generated during project activities would be protected per SERDP guidance.

Data provided to PNNL will be deemed non-proprietary unless identified as governed by an existing non-disclosure agreement and properly marked according to the terms and conditions therein. Items provided under a non-disclosure agreement will be treated under the terms and conditions of that agreement.

Data generated under the agreement and any new instruments or software arising thereunder will be treated consistent with the terms of contract W74RDV83044655, and in the case of any patentable material, United States patent law. The U.S. government has unlimited rights in all generated data; i.e., no restrictions on use or dissemination is allowed unless approved by the SERDP. The terms will therefore be agreed within the user agreement before collaboration begins.

6.0 Conclusions

This draft report provides a high-level strategy to operate the Sequim Bay Test Site (SBU2). As this site is developed in collaboration with the SERDP office, the plan will be updated and formalized as needed to ensure the safe operation of the test bed; Additionally, the goal of this test bed will be to provide a User facility that will promote the development of munitions technologies that will further the SERDP mission of removal of underwater UXO from selected Department of Defense installations.

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