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Intertidal and Subtidal Conceptual Site Model and Data Gaps Report

Jensen and Sons Boatyard and Marina

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Abbreviations and Acronyms

µg/kg	micrograms per kilogram
AET	apparent effects threshold
City	City of Friday Harbor
COPC	contaminant of potential concern
County	San Juan County
cPAH	carcinogenic polycyclic aromatic hydrocarbon
CSM	Conceptual Site Model
DMMP	Dredged Material Management Program
Ecology	Washington Department of Ecology
ESA	Environmental Site Assessment
IPG	Integrated Planning Grant
LDW	Lower Duwamish Waterway
NPDES	National Pollutant Discharge Elimination System
OHW	ordinary high water
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PMA	Port Management Agreement
Port	Port of Friday Harbor
ppt	parts per thousand
RI	Rural Industrial
ROC	receptor of concern
SAP	Sampling and Analysis Plan
SCUBA	self-contained underwater breathing apparatus
SCUM II	Sediment Cleanup User's Manual II
SOPC	Sediment of Potential Concern
SQS	Sediment Quality Standards
TBT	tributyltin
TEQ	toxicity equivalent
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey
WDNR	Washington State Department of Natural Resources
WE	Whatcom Environmental Services

1.0 INTRODUCTION

This Conceptual Site Model (CSM) and Data Gaps Report focuses on subtidal and intertidal areas at the Jensen and Sons Boatyard and Marina (Jensen's) site (Project site), which was recently acquired by the Port of Friday Harbor (Port) for redevelopment. A related CSM and Data Gaps Report focusing on Jensen's upland areas has been prepared by Shannon & Wilson. This work is funded by an Integrated Planning Grant (IPG) awarded by the Washington Department of Ecology (Ecology) to the Port to facilitate potential remedial actions and adaptive reuse of the property.

The contents of this CSM are consistent with Ecology guidance provided in the Sediment Cleanup User's Manual II (SCUM II) (Ecology, 2017), which defines the goal of the CSM to concisely summarize known information for distributions of contaminants, sources, release mechanisms, migration routes, potential human and ecological receptors, and potential and complete exposure pathways for the site.

The purpose for this CSM and Data Gaps report is to present an integrated overview of the physical, ecological, and human health conceptual models for subtidal and intertidal areas at the Jensen's site, while identifying the data gaps that will inform a potential future remedial investigation, including further investigations of the extent of contamination and feasibility of remedial alternatives. The physical processes description summarizes information about hydrodynamic and physical processes, focusing specifically on sediment transport. The ecological and human health CSMs identify receptors of concern and exposure pathways.

This report identifies the proposed study area boundaries, and forms the basis for appropriate data collection in subsequent phases of the anticipated site remediation. It is anticipated that the CSMs will be refined in future efforts as new data are acquired. The outcome will be an objective, prioritized work plan that can guide Port development and necessary site remediation and restoration opportunities.

The current effort is limited to evaluating the existing information that has been collected for the site. The analytical data evaluated in this report were collected primarily by Whatcom Environmental Services (WE) as part of preliminary redevelopment planning. These data are summarized in three reports that WE prepared for the Jensen's site: *Phase I Environmental Site Assessment* (WE, 2017a), *Draft Sediment Data Report* (WE, 2018c), and the *Draft Remedial Investigation Report* (WE, 2018d). Additional data were acquired from publicly available information sources.

WE prepared a preliminary CSM for the site (WE, 2018d), which provided a cursory summary of site geology, hydrology, contaminant sources, exposure pathways and receptors; however, that CSM is focused on the uplands and does not integrate available intertidal and subtidal data.

1.1 Site Description and History

The Project site is located at 1293 Turn Point Road, on the southern shore of Shipyard Cove of the Salish Sea, on San Juan Island, San Juan County (County). Turn Point Road provides a direct connection from the City of Friday Harbor (City) to the Project site, which is located approximately 1.5 miles southeast of downtown. Turn Point Road continues to the east to Kansas Cove, and then becomes Pear Point Road as it follows the Island's southern shoreline to circle back to the City. The Project site is located entirely within Shipyard Cove, a relatively shallow embayment that faces northward on the eastern side of San Juan Island. Shipyard Cove is generally protected by Brown Island; however, the Project site is exposed to roughly 2.5 miles of fetch from a northerly direction. (Figure 1, Location & Vicinity Map)

The property encompasses one parcel (351341005000) of approximately 4.8 acres of upland with 652 linear feet of shoreline, and approximately 5 acres of aquatic lands currently managed under a Port Management Agreement (PMA) (PMA No. 20-080023) with the Washington State Department of Natural Resources (WDNR). Surrounding land uses include industrial, commercial and residential development. Shipyard Cove Marina and a barge ramp are located immediately to the northwest of Jensen's. Residential properties with private docks extend along the shoreline to the northeast of Jensen's.

The Project site is zoned as Rural Industrial (RI). This zoning designation allows for light industrial, light manufacturing, seasonal residential[1], public, and some institutional uses.

The Project site is partially developed and consists of three distinct areas: a boatyard, a marina, and an undeveloped upland and shoreline area. (Figure 2, Existing Conditions)

1.1.1 Boatyard

The existing boatyard is located in the southwestern portion of the parcel. It encompasses approximately 1.5 acres of level work areas including boat storage, a laydown area and a wash pad. Four buildings are associated with current boatyard operations: an office/retail building, a machine shop, a storage building and a water treatment building through which water from the wash pad is circulated and then discharged into an evaporating pond on site. The boatyard infrastructure also includes a 35-ton travel lift that needs maintenance or replacement in the near future. The marine services provided at the boatyard include haul-out, pressure wash, bottom paint, light mechanical, chandlery and parts, and boat storage. The boatyard area has several areas where maintenance was deferred by the prior owner. Ongoing releases from the degraded structures (e.g., visible sheen associated with the creosote pilings) have been observed. The Port anticipates that at least some of these deferred maintenance projects will need to be completed on an expedited basis to sustain current and future operations. These projects may be the subject of interim actions proposed under a subsequent remedial action grant application.

1.1.2 Marina

The existing marina includes approximately 50 slips; just over half are wood-framed, covered moorage. The structure consists of creosote-treated piles and wood floats on unwrapped Styrofoam. The structure itself, as well as the associated electrical system, is in very poor condition, and reconstruction and expansion of the marina is anticipated as part of the redevelopment of the property. Coordinating subsequent remedial actions with marina maintenance and redevelopment is a key consideration for this project.

1.1.3 Undeveloped Upland and Shoreline Areas

The undeveloped area in the eastern portion of the property consists of approximately 2 acres of open grassy field and gravel parking areas. This area slopes moderately from Turn Point Road toward the waterfront and terminates at a low bank.

A derelict boat building structure is located near the shoreline east of the current boatyard area. The marine rails waterward of this structure were originally used to launch boats and were later used to pull out boats for repair. The concrete pad at this location was added later and is not original to the marine rail system. The undeveloped area also contains the remnants of a small derelict cabin, a small oil storage building further east and a shallow dug well. The Port has not identified a final use for this area of the

[1] Vacation rental; Farmworker housing

Project site; however, it is anticipated that some of the area will be used to meet requirements associated with marina redevelopment like restrooms, parking, and other support infrastructure.

Compatibility of the ongoing boatyard operations with the planned marina improvements, public access to parts of the site, and other potentially developed businesses and facilities (especially around issues such as safety, parking, and access) will be addressed as part of the master planning effort that is currently underway. The master plan will be coordinated with Ecology and the public. Marina improvements may also be compatible and conducted co-incident with anticipated remedial actions for the site.

The site was first developed as a shipyard before 1941; anecdotal evidence suggests that operations began as early as 1910. Originally, wooden boats were manufactured at the site, but when wooden boats were phased out in the middle of the 20th century, the site use moved from shipbuilding to boat repair and maintenance.

1.2 Physical and Habitat Features

The Project site is located within Shipyard Cove, a relatively shallow embayment that faces northward on the eastern side of San Juan Island, immediately southeast of downtown Friday Harbor. Site bathymetry (San Juan Surveying, 2018) is shown in Figure 2. Shipyard Cove is generally protected by Brown Island; however, the Project site is exposed to roughly 2.5 miles of fetch from a direct northerly direction.

The shoreline along the active boatyard area is characterized by either vertical structures or steep berms. The less developed areas along the eastern side of the property, especially waterward of the old boat building structure, are more gently sloped with areas of estuarine marsh plants. The full extent of the site's low waterfront bank is composed of fill and debris, with contaminated soils known to exist in the active boatyard areas.

The undeveloped portions of the Project site are dominated by open grassy areas; other native vegetation is limited. Native trees and shrubs (a mix of evergreen and deciduous species) are found on the hillside east of the boatyard, near Turn Point Road, and in limited patches along the shoreline. Native plants present include Douglas fir *(Pseudotsuga menziesii)* and Pacific madrone (*Arbutus menziesii),* as well as native rose *(rosa sp.)* and oceanspray. Some areas of estuarine marsh vegetation, dominated by pickleweed *(Sarcocornia perennis),* were observed along the shoreline, especially waterward of the old boat building structure; however, substrate in all of these vegetated areas is highly impacted by a substantial volume of debris (typically concrete rubble, metal, plastic, wire, treated and untreated wood, etc.).

The marina occupies the deeper intertidal and subtidal areas of the Project site. Marina structures include the main pier and a system of floats and floating finger piers, three areas of piling-supported boat house structures, an offshore piling-supported pier, a concrete floating breakwater, and various standalone piles and dolphins. A substantial amount of maintenance has been deferred and the marina infrastructure is generally in poor condition. Numerous piles are in advanced states of disrepair, including many that have already failed. Many of the floats are supported by open-cell Styrofoam, which appear to be highly degraded. Floats and piers are covered with solid wooden decking (both treated and untreated) in various conditions. Within the boathouse areas, there appears to be some debris present on the seafloor, including tires that can be observed from the marina floats.

The entire shoreline area, extending from intertidal elevations out to at least shallow subtidal depths, is heavily impacted with a substantial volume of debris, including concrete, tires, metal (motors, small parts, etc.), plastic, and other general rubbish.

Patches of eelgrass *(Zostera marina)* may be present in the subtidal areas of Shipyard Cove; eelgrass beds in the vicinity of the project site were found historically to occur at depths up to minus 21 feet MLLW (WDNR, 2001). Although current observations suggest that eelgrass may grow within Shipyard Cove, no patches were observed within the Jensen's marina and a survey is needed to delineate the extent (or absence) of eelgrass within the general project area.

1.2.1 Shoreline Characteristics

The upper shoreline areas at the Jensen's site consists predominantly of fill and debris that extend above ordinary high water (OHW). Except for the central area of the shoreline below the old boat building structure, the filled areas tend to descend steeply to upper intertidal elevations, where they generally level off to more natural slopes in intertidal and subtidal areas. Throughout the boatyard area, this filled shoreline consists of berms and vertical structures (creosote-treated bulkheads, ecology block walls, etc.). The upper shoreline of the undeveloped eastern area consists of what appears to be general rubbish and fill soils. The central shoreline of the Project site, located generally below the old boat building structure and between the marina pier (western boundary) and the old oil storage building (approximate eastern boundary), is more naturally-sloped with pickleweed growing in large areas of the upper intertidal zone; however, this shoreline is highly impacted with concrete rubble, debris, and a concrete pad. There is no natural shoreline within the Project site. Immediately west of the Project site, a marina and barge landing facility operate along the shoreline. The shoreline immediately east of the Project site is a residential property. Additional descriptions of specific sections of the Project area shoreline are provided below.

The shoreline along the western side of the Project site shoreline below the boatyard consists of an overgrown, gravel-paved filled area partially contained by a failing creosote-treated bulkhead. The aerial photographs provided in WE's Phase I Environmental Site Assessment (ESA) (WE, 2017a) suggest that the area was filled between 1941 and 1972. The bulkhead is in an advanced state of failure, allowing fill to spill into intertidal areas. At intertidal elevations, the substrate consists of pea gravel, small cobbles, sand, and debris; this area is barren of any vegetation. Additional debris (including broken creosote-treated piling, larger metal and concrete) is present at deeper intertidal elevations.

The boatyard shoreline immediately east of the bulkhead consists of a steep berm separating the upland working area of the boatyard from intertidal areas. The berm is composed of rubble, garbage and other debris (metal, concrete, etc.). A small outfall pipe (~6-inch diameter), which serves as an emergency overflow from the boatyard stormwater detention and evaporation pond, extends from the base of the berm at roughly the midpoint of this stretch of shoreline. This outfall is shown in Figure 3. A band of vegetation (pickleweed, gumweed, henstooth, and drift algae) extends roughly 10 feet to 20 feet from the top of the berm, but ends abruptly at intertidal elevations. At upper and shallow intertidal elevations, the substrate consists of pea gravel, small cobble, sand, and debris (garbage, concrete, metal, etc.). A light sheen was observed in limited areas of the intertidal substrate. Except for potential clam shows, there was no obvious benthic activity noted within the barren intertidal area during an October 8, 2018, site evaluation; however, a benthic survey is anticipated as part of the remedial investigation phase to more fully assess the status of the benthic community. Additional debris (including broken creosote-treated piling, larger metal, and concrete) is present at deeper intertidal elevations.

The boat pullout area is located between the bermed shoreline to the west and the old overwater deck to the east. The boat pullout consists of two piers supported by creosote-treated piling, ecology blocks, and a concrete wall. Each pier is covered with timber decking and a single concrete rail for a boat lift to operate. The shoreline here is a vertical bulkhead, consisting of stacked ecology blocks. Upland fill material is sloughing through the eastern side of the ecology block bulkhead into intertidal areas. The substrate beneath each pier is covered in a substantial volume of debris, including concrete, metal, wire, engine parts, and other garbage. The boat haulout area between the two piers is maintained at deeper depths than on either side. The substrate between the piers is covered in shell hash, with less debris evident than in surrounding areas. As throughout the Project site, debris extends throughout the intertidal area, with larger debris present at deeper elevations.

The shoreline immediately east of the boat pullout is completely covered by an old overwater deck and the marina pier. The overwater deck is composed of solid timber decking and supported by creosote-treated piles; however, the structure is in poor condition due to deferred maintenance. The marina pier is located immediately east of the overwater deck and is currently in operational condition. It is built with solid CCA-treated decking and supported by creosote-treated piles. The shoreline along the overwater deck and marina pier is a vertical bulkhead, consisting of stacked ecology blocks. The bulkhead is leaning waterward and requires maintenance. There is evidence that the bulkhead is being undermined, with settling observed in soils on the immediate upland side of the bulkhead. The substrate beneath the overwater deck and marina pier is covered in a substantial volume of debris that is consistent with shoreline conditions along the boatyard.

The shoreline immediately east of the marina pier and waterward of the old boat building structure features a more natural-appearing slope, but the intertidal substrate consists of cobbles, imported gravel, mud, and concrete rubble. Concrete pads located between the marina pier and the old boat building extend from intertidal elevations up to the active boatyard. Four rails (two rails per pair), which appear to be composed of 10-inch x 10-inch creosote-treated timbers, extend out to subtidal elevations. It is not clear how far the rails extend, because they dive under the sediments at approximately 85 feet from the waterward edge of the concrete pad. The upper intertidal area consists of pickleweed that extends all the way up to the old boat building. There is evidence that clams may be present at lower intertidal elevations, but similar to the entire western half of the Project site, the benthic community in this area appears relatively barren.

The shoreline along the eastern boundary of the Project site is located below the undeveloped area. The upper shoreline area appears to be composed of upland fill material and garbage (metal, plastic, concrete, wood waste, etc.), which is consistent with historical descriptions of the area being used as a dump (WE, 2017a). There appears to be a remnant shoreline timber (some treated) structure, possibly an old pier or ramp, which has left a debris pile extending from the upper shoreline down to intertidal elevations. The upper shoreline features mature vegetation (primarily native trees and shrubs, and invasive blackberries and scotch broom). The garbage and fill material from the upper shoreline are emerging from the bank as it descends to upper intertidal elevations. Bank vegetation consists of snowberry, ocean spray, blackberry, and scotch broom. Upper intertidal vegetation consists of Turkish towel and ulva, which transition to pickleweed and rockweed at lower elevations. The intertidal substrate consists of gravel and cobble at upper intertidal elevations transitioning to mud, algae, and debris at lower intertidal elevations. Consistent with the entire Project site shoreline, a substantial field of debris extends out to subtidal elevations.

1.2.2 Hydrology

The site is entirely saltwater (25 parts per thousand [ppt]) and experiences mixed semidiurnal tides, with a tidal range of 7.76 feet (NOAA, Station ID 9449880). The average annual precipitation at the property is approximately 20 to 40 inches, the average annual air temperature is approximately 48 to 50°F, and the average frost-free period is 200 to 240 days (WE, 2017a). The shoreline orientation faces northward and is entirely open to the dynamics of tides, waves, and winds from Puget Sound. No wind-wave analysis has been conducted at the Project site; however, this information has been identified as necessary to support necessary marina maintenance and improvement. Freshwater input is expected to be primarily surface runoff and seepage from storm events. With the exception of the single, 6-inch pipe extending from the berm along the boatyard area (Figure 3, Outfall photo), no other watercourses or outfalls were observed. The 6-inch pipe serves as the emergency overflow from the onsite stormwater detention and evaporation pond. The pond overflow pipe is included in Jensen's National Pollutant Discharge Elimination System (NPDES) Boatyard General Permit Coverage (WAG994386). At the time of the inspection, there was no indication that discharges have occurred from the pipe. The Port reports that no discharges have ever occurred and anticipates vacating the pond and pipe as part of future marina improvements. WE collected limited groundwater data at the Project site and identified a generally northward movement of groundwater from the uplands to and into the intertidal and subtidal areas (Figure 4, Groundwater Elevation) (WE, 2018d), but did not calculate volumes or definitively confirm interaction with marine waters. Although no detailed hydrologic study has been performed, the site is characterized by a relatively shallow groundwater table that may be influenced by the tidal cycle throughout the nearshore. The sloped shoreline is comprised of materials generally pervious to groundwater flux, and the surrounding upland ground surface consists of unpaved soils that do not limit infiltration and percolation of precipitation.

1.2.3 Site Geology

Soils in the upland area of the subject property are described in the *Soil Survey of San Juan County Area, Washington* (U.S. Department of Agriculture [USDA], 2009) and summarized in the Phase I ESA prepared by WE (WE, 2017a). The Soil Survey designates the upland soil as a mixture of Beaches-Endoaquents, tidal-Xerorthents association; Mitchellbay-Rock Outcrop-Killebrew complex; and Cady-Rock Outcrop Complex. The soil is composed of approximately 38% Beaches-Endoaquents, tidal-Xerorthents association; 26% Mitchellbay-Rock Outcrop-Killebrew complex; and 36% Cady-Rock Outcrop Complex.

1.3 Nature and Extent of Contaminants

1.3.1 Sediment Characteristics

Sediments within the Project site have been minimally characterized and additional sediment sampling is anticipated as part of a subsequent remedial investigation; however, existing data support a preliminary conclusion that contaminants originating from Jensen's operations are generally concentrated around the central boatyard area and have not migrated offsite via intertidal or subtidal pathways (WE, 2018c). A summary of grain size and other conventional sediment characteristics is provided in WE's *Draft Sediment Data Report* (WE, 2018c).

Previous sediment characterizations at the Jensen Shipyard were limited and focused only on surface conditions. Sediment samples were collected from the site by the Department of Ecology in 1997 as part of a larger study conducted to determine the occurrence and extent of toxic chemicals associated with marina activities in four harbors in the San Juan Islands. The results of sediment chemical testing were summarized in a 2001 Department of Ecology report titled *Concentrations of Selected Chemicals in Sediments from Harbors in the San Juan Islands* (Ecology, 2001). Two sediment samples collected within the aquatic area of the subject property (FR1 and FR3) exceeded the screening level of 73 micrograms per

kilogram (µg/kg) for tributyltin (TBT) at concentrations of 135.3 µg/kg and 74.8 µg/kg, respectively (Ecology, 2001).

In February 2018, upland soil and marine sediment samples were collected by WE and the results summarized in the report *Initial Investigation Report* (WES, 2018a). Fifteen soil samples and thirteen sediment samples were collected during the investigation. The soil sample results indicated that portions of the site are contaminated with metals (primarily copper and lead), petroleum compounds, and carcinogenic polycyclic aromatic hydrocarbons (cPAHs).

In August 2018, WE collected additional sediments in accordance with the *Sediment Investigation, Sediment Sampling and Analysis Plan* (SAP) (WE, 2018b) approved by the Washington State Department of Ecology. The purpose of the study was to further characterize sediment quality in the marine area of the Shipyard and Marina site. An additional seven surface sediment samples were collected. Three of the sampling stations had been previously sampled during February and were resampled to supplement the original data set with an evaluation of dioxins/furans. The results were summarized in WE's *Draft Sediment Data Report* (WE, 2018c).

Collectively, the sediment sample results indicated that marine surface sediments (particularly near the shore) contain concentrations of metals, PAHs, polychlorinated biphenyls (PCBs), phthalates, pesticides, and tributyltin that exceed regulatory thresholds. The elevated concentrations were detected in samples collected from the nearshore marine areas close to the old marine railways and the current boat travel lift. Elevated concentrations were also present to a lesser extent in samples collected further west of the lifts and beneath the covered boat moorage slips. Sediment results were compared to the Sediment Quality Standards (SQS) marine chemical criteria levels (Chapter 173-204-320 WAC), where applicable. TBT and dioxins/furans results were compared to Dredged Material Management Program (DMMP) screening levels (USACE, 2016) because they do not have established SQS numeric criteria. Chemicals with concentrations exceeding applicable target criteria and screening levels include PCBs, various PAHs, phthalates, pesticides, copper, zinc, mercury, and TBT. WE's surface sediment concentrations figures (WE, 2018c) (TBT, PCBs, mercury, and fluoranthene) are provided in this report as Figures 5 through 8. The study recommended further sediment sampling to more thoroughly delineate the presence of chemicals in sediment at the site.

The following paragraphs describe known contaminated sediment characterization of surface sediments (WE, 2018d) and offer a starting platform for additional sediment characterization during the remedial investigation phase.

1.3.2 Tributyltin (TBT)

Elevated TBT concentrations were encountered throughout nearshore areas adjacent to upland work areas at the site. TBT concentrations were particularly elevated in the intertidal zone along the base of the historic western railway. The DMMP screening level was exceeded at sample locations SED-7, SED-8, SED-9, SED-10, and SED-13. Additionally, the screening level was exceeded directly offshore from the marine railways at sample location SED-14. All other samples contained detectable concentrations of TBT below the screening level.

1.3.3 Polychlorinated Biphenyls (PCBs)

PCB concentrations (evaluated as total Aroclors) exceeded the applicable criteria levels in the nearshore area at the end of the travel lift slip (SED-9), at the intertidal zone located at base of the historic western railway (SED-10 and SED-13), and directly offshore from the marine railway (SED-14). Samples SED-10,

SED-13, and SED-14 were compared to the SQS criteria. Due to the elevated organic carbon content, sample SED-9 was compared to Apparent Effects Threshold (AET) criteria, as recommended in SCUM II Table 8-1 (Ecology, 2015). All other samples contained detectable concentrations of PCBs below applicable criteria. This evaluation compared PCB Aroclors to benthic criteria; therefore, it is anticipated that the subsequent remedial investigation will collect PCB congener data for comparison to applicable toxicity equivalent (TEQ) background criteria and human health protective levels.

1.3.4 Dioxins/Furans

Dioxins/furans concentrations (evaluated as total 2,3,7,8-TCDD equivalence) exceeded the applicable DMMP screening level in the nearshore areas at the north end of the boat travel lift (SED-9d) and at the base of the historic western railway (SED-10d and SED-13d). Dioxins/Furans have not been evaluated in any other marine areas of the site.

1.3.5 Metals

Elevated metals concentrations were encountered in the nearshore area. Copper, mercury, and zinc concentrations exceeded applicable SQS criteria at sample stations located in the intertidal zone at base of the historic western railway (SED-10 and SED-13). Additionally, mercury exceeded the criteria just northeast of the railway (SED-11), and copper exceeded the AET criteria at the end of the travel lift slip (SED-9). No other metals exceeded the applicable criteria in marine sediment at the site.

1.3.6 Organic Chemicals

Benzyl alcohol concentration exceeded the SQS criteria at sample station SED-9. The result was flagged by the lab as being an estimated concentration (J-flagged) and was only slightly above the SQS criteria. The result may or may not be of concern. Detected organic chemical concentrations did not exceed applicable SQS criteria at any other sampling station. However, numerous organic chemical results were reported at elevated detection limits that are above applicable SQS (and/or AET) criteria.

1.3.7 Phthalates

Butylbenzyl phthalate and dimethyl phthalate concentrations exceeded the SQS criteria at one sample station located at the north end of the boat travel lift (sample station SED-9). No other phthalate exceedances were encountered in marine sediment at the site.

1.3.8 Polycyclic Aromatic Hydrocarbon (PAH)

Various PAH constituent concentrations exceeded the SQS criteria levels in the nearshore areas at the north end of the boat travel lift (SED-9) and at the base of the historic western railway (SED-10 and SED-13). PAH constituents detected at sample station SED-9 exceeded six of the eighteen criteria levels. PAH constituents detected at sample station SED-10 exceeded eleven of the eighteen criteria levels. PAH constituents detected at sample station SED-13 exceeded three of the eighteen criteria levels. No other PAHs exceeded the applicable criteria levels in marine sediment at the site. Evaluation of cPAH risk is anticipated in a subsequent remedial investigation.

1.3.9 Chlorinated Organics

No chlorinated organics were detected in sediment at the site above applicable SQS criteria. However, due to the dilution factors (created by converting data to dry weight and also converting to carbon normalized data), some laboratory detection limits were elevated greater than the SQS criteria.

1.3.10 Pesticides

Total chlordane exceeded the DMMP screening level at two sample stations located approximately 300 and 450 feet from shore, beneath the covered boat slips (SED-3 and SED-5). There were no other chemical criteria exceedances at those sample stations. Pesticides were not evaluated during the most recent sampling event.

1.4 Proposed Study Area Boundaries

Study area boundaries define the area where site investigations are focused primarily. A preliminary evaluation of available site information highlights areas of potential chemical concerns and probable action that define a proposed study area boundary for the Project site:

1. The intertidal and subtidal seabed where chemicals regulated under SMS were detected in surface sediments at concentrations that exceed numeric Sediment Quality Standards (SQS). This area is designated preliminarily as the Sediments of Potential Concern (SOPC) area.

2. The marina at Jensen's is likely to be reconfigured to improve habitat conditions and to optimize marina function and capacity. This area, which includes the full shoreline and extends out to the deepest subtidal areas considered for potential marina redevelopment, is designated as the Marina Footprint[2].

These areas are shown in Figure 9 (Proposed Study Area Boundaries).

Initial surface sediment data suggests that sediment contamination is generally contained within the central shoreline and shallow subtidal areas of the Project site. Existing data show that surface sediments along Jensen's lease boundary do not exceed SMS criteria. Because no obvious transport mechanisms have been identified that would cause exchange of potential contaminants between Jensen's and adjacent properties, there is no obvious rationale to expand the study area beyond the immediate Marina Footprint. For this reason, the proposed study area boundary is defined by the Marina Footprint, which also encompasses the SOPC areas and subtidal areas beyond the outer extent of Jensen's existing marina infrastructure. Subsequent sediment characterization efforts are anticipated to focus both on evaluating the depth of contamination and further refining the horizontal distribution of chemical contaminants.

[2] The Marina Footprint is loosely defined by the Port's subtidal lease with WDNR.

2.0 PHYSICAL PROCESSES CONCEPTUAL SITE MODEL

The physical processes description synthesizes what is known about important physical processes operative on and within the embayment where Jensen's is located. The twin foci include identifying the sources and transport pathways that introduced chemical contamination to the sediments, and on the processes that govern sediment transport. This information, coupled with data regarding the nature and extent of sediment contamination, will inform a prudent and cost-effective approach to address the need for and nature of remediation. In this circumstance, data collected to date is sufficient to demonstrate limited chemical contamination within the soil-groundwater matrix of the Jensen's uplands and chemical contamination in the intertidal and shallow subtidal surface sediments.

The following sections discuss likely transport pathways at Jensen's. These pathways are shown conceptually in Figure 10 (Physical Conceptual Site Model – Plan View) and Figure 11 (Physical Conceptual Site Model – Cross Section).

2.1 Hydrodynamics

Shipyard Cove is subject to a range of hydrodynamic forces that potentially affect the movement and stability of the sediments. Water circulation is primarily influenced by the open and unimpeded connection to Puget Sound, so natural tides, currents, and wind-generated waves can be expected to sort and distribute intertidal and shallow subtidal sediments. During storm events, significant discharges from surface runoff, would be expected and (depending on storm strength, duration, and direction) could further concentrate sediment contamination along the shore or disperse it. There is regular active boat traffic via the shipyard and adjacent marine based activities (i.e., a barge landing operation located immediately north of the shipyard), which are large enough that propeller-generated currents (propwash) are likely to redistribute surface sediments in the shallower locations of the shipyard.

Sediment transport and sedimentation rates in Shipyard Cove, particularly around the Project site, are unknown. Shipyard Cove is entirely open to Puget Sound, so tides, currents, and wind-generated waves are expected to be dynamic forces that influence deposition and distribution of surface sediments. However, the Project site is generally sheltered from the east, west, and south by the shoreline of Shipyard Cove. The adjacent Shipyard Cove Marina shelters Jensen's from northwest exposure, and Brown Island also shelters Jensen's from north-northwest exposure.

The sediment bed in Shipyard Cove seems to be stable under normal circumstances. The Project site is exposed primarily to wind and wave energy coming from the north, which is expected to occur only during episodic events. Bathymetry shows a shallow sill gently sloping into deeper marine waters. Because of the embayment's northern orientation, wind and wave forces are expected to concentrate sediments up the shoreline or redistribute sediments east/west along the shoreline. Given the shallow depth of the embayment and the amount of regular boat activity, it is likely that propwash is a more important factor in sediment transport and redistribution, particularly in the vicinity of the boat lift at Jensen's and the barge landing site on the adjacent property.

2.2 Water Column/Suspended Sediment

Shipyard Cove is relatively sheltered, open only to wind and wave induced forces from the north. Because there is little indication of sediment deposition across the Project site, sedimentation rates are expected to be low; however, no data has been collected for the area. Similarly, no current water velocity information is available, which would help evaluate sediment transport.

2.3 Groundwater Data

Groundwater movement was reported by WE (WE, 2018a; WE, 2018b) to be generally northward, although no rate of movement was given. The upland soils are covered in gravel and expected to be pervious, so past or ongoing discharges to intertidal and subtidal sediments through groundwater flux can be expected to be a source. Although groundwater sampling during WE's initial investigations detected an exceedance of MTCA Method A cleanup levels for only one chemical (arsenic) at one location, subsequent soil sampling suggests that groundwater samples were collected upgradient from a potential hotspot. If groundwater is flowing through chemical contamination at depth, especially along the shoreline, it would represent a potential pathway for contaminants to migrate to sediments.

2.4 Lateral Loads

A single, 6-inch pipe extends from the berm along the boatyard area (Figure 3, Outfall photo). The pipe serves as the emergency overflow from the onsite stormwater detention and evaporation pond. The pond is located in the southwest portion of the property, west of the machine shop. It is equipped with a pump and fountain to facilitate evaporation, but is emptied of water annually (WE, 2017a). The pond receives wash water from a wash pad located at the end of the boat pullout. Wash water is treated in a closed-loop system using enzymes and diverted to the pond (WE, 2017a). Although the pond has been identified as a potential area of concern for tributytins and other heavy metals (WE, 2017a), there is no indication that discharges have occurred from the emergency overflow pipe, and the Port confirms that no discharges have ever occurred. No other point source outfalls or streams have been identified as discharging to the embayment where Jensen's Shipyard is located, although a sheen was observed close to the creosote pilings supporting the travel lift during a May 9, 2019, site visit.

3.0 POTENTIAL HUMAN AND ECOLOGICAL RECEPTORS

A complete CSM includes general information about sources leading to chemical contamination of sediment, water, and biota. The model also includes pathways for human exposure to chemicals through these media. With sufficient information, for each pathway-media combination, a determination can be made as to whether the pathway is complete or incomplete. A complete exposure pathway includes an exposure medium and exposure point, a potentially exposed population, and an exposure route. Incomplete pathways do not meet these criteria. They may require assessment, but cannot be evaluated quantitatively since both exposure (a complete pathway) and toxicity are required to quantify risk. The identification of complete or incomplete pathways can be used to inform the data gaps analysis. Complete pathways expected to represent a potential exposure of health concern may need to be evaluated in a risk assessment, if potential remedial alternatives include scenarios where final surface concentrations of chemicals exceed SMS criteria. For pathways identified as having low exposure and risk potential relative to other pathways being evaluated, a determination will be made in consultation with Ecology about the utility of some type of evaluation of the pathways (e.g., comparisons to other quantified exposure pathways) for risk communication purposes or to evaluate whether a standardized remediation remedy would achieve adequate compliance with existing standards and acceptable reduction of risk. The exposure parameters and the likelihood of exposure under both current and future land use at the site may need to be evaluated for any significant exposure pathways.

3.1 Potential Human Exposure Scenarios

Potential human exposure scenarios are described qualitatively below. If required, subsequent quantitative analysis is expected to occur as part of a remedial investigation.

3.1.1 Water Recreation

Direct contact with embayment waters is a key exposure scenario to be considered for people. Recreational opportunities abound around the island and throughout the San Juan archipelago. Water recreation at Jensen's can include swimming, self-contained underwater breathing apparatus (SCUBA) diving, pleasure boating, fishing, and time spent on the marina floats. These potential exposure scenarios are focused primarily on the surface water pathway. Although sediment contact may occur during such activities, the frequency and duration of this contact is expected to be much lower than the shore recreation scenario. For this reason, any risk associated with potential sediment exposure during water recreation is addressed through the direct-contact scenario for shore recreation.

Site access, either by the upland or via boat, is not restricted to the public, but many recreational activities would be unsafe or undesirable given vessel traffic and the current debris impacts to shoreline and shallow subtidal lands.

The current frequency of swimming in the site is unknown; however, it is assumed that recreational swimming rarely occurs at or around Jensen's. Similarly, although the frequency that recreational SCUBA diving occurs around Jensen's is unknown, it is expected to be low. The most likely exposure scenarios include incidental exposure during boating, fishing, and spending time recreating on the marina's floats. Future remediation and restoration actions that could be conducted at the site could change the frequency of these recreational activities; however, a substantial increase is not anticipated.

A water recreation scenario could be developed for the site, but the utility is expected to be low. A risk assessment conducted by King County (King County, 1999)[3] found that risks associated with swimming in the Duwamish river and Elliott Bay due to water exposure were small. Because risk associated with water recreation exposure scenarios is expected to be low, these scenarios are not proposed for subsequent evaluation.

3.1.2 Shore Recreation

Activities with the potential for sediment exposure include beach play, clamming, launching small vessels, and shoreline fishing. Direct contact with sediments can be either incidental (e.g., sinkers and fishing lines coming into contact with bedded or suspected sediment during normal activity and fishers contacting this sediment incidentally upon retrieval) or more extreme (e.g., sunbathing or being partly buried in sand as part of the beach experience). These same fishers and other recreationalists may also make additional incidental contact with surface water and suspended sediment while wading; however, risk associated with suspended sediments is expected to be low, and surface water exposure is addressed above in the water recreation scenario. The shore recreation scenario focuses on sediment pathway exposures, including dermal contact and incidental ingestion.

Shore recreation exposure to sediments is not expected to be prominent on intertidal areas along the western half of the property in front of the active boatyard; however, the eastern half of the property is likely to serve as a primary place for the public to access intertidal habitat at Jensen's. Currently, many recreational activities would be unsafe or undesirable given the current debris-impacted shoreline, but future remediation of the Project site is expected to address these impacts and encourage more public access.

A beach play scenario was developed to assess risks to young children (i.e., up to 6 years of age) from playing in intertidal sediments at publicly accessible beaches on the Lower Duwamish Waterway (LDW) that have public access from the shore (Windward, 2007). Assumptions in this study included unlimited public access from the shore, including from residential areas directly adjacent to the shore. The exposure parameters for this scenario, which were based on a survey of recreational lake use in King County (Parametrix, 2003), evaluated significant sediment exposure to children's bodies occurring 65 days/year. Other recreational exposure scenarios evaluated in this study focused on adult recreation are expected to be less protective than the child exposure scenario. As part of the anticipated remedial investigation for Jensen's, the LDW shore recreation exposure scenarios will be compared to conditions at Jensen's.

3.1.3 Occupational Exposure

Much of the work around piers and water craft necessarily involves some incidental exposure to site water and sediment. Work performed on piers, pilings, and boat bottoms occurs on site, resulting in more than incidental exposure to water and sediment, although such activities are expected to be relatively infrequent. Occupational exposures may also occur during marina improvements/ maintenance planned by the Port. Workers on moored vessels and on dock structures could potentially come into contact with sediment, but are more likely to contact surface waters. Most workers are typically aboard the vessels and well above the water surface. Accordingly, worker exposure to Project site waters and sediments

[3] The King County risk assessment (King County 1999) estimated health risks (both water and sediment exposure) associated with swimming. The report concluded that chemical exposure risks during swimming are generally considered acceptable by EPA. Exposure scenarios included a duration of 2.6 hours/day at a frequency of 24 days/year. The greatest health risks for the King County study were associated with arsenic and PCBs, which also appear to be COPCs at Jensen's.

would be relatively infrequent, resulting in potentially complete, but low, exposure. Other occupational exposure, such as a biologist conducting field investigations for marina maintenance or restoration work, is likely, but expected to be of low risk due to a lower exposure frequency and duration. Overall, occupational exposure to water and sediments is expected to be much lower than in the shore recreation and shellfish collection exposure scenarios; however, the need to evaluate occupational scenarios will be established in consultation with Ecology.

3.1.4 Fish, Crab, and Shellfish Collection

The extent and frequency of recreational collection of fish, crab, and shellfish within the embayment and specifically from the Jensen Shipyard property is unknown. It is known that various fishes, crab, and shellfish (clams and oysters) are present at this location; however, the Port indicates[4] that long-term residents have reported that there is no history of fishing, clamming, or crabbing in the tidal or shallow bedland areas of Jensen's. For the purposes of this CSM, it is assumed that there are no recreational or commercial fisheries that operate within the Project area. This assumption must be validated as part of the anticipated remedial investigation. The potential for shellfish collection in the future is anticipated to be evaluated in a subsequent phase of work.

3.1.5 Fish, Crab, and Shellfish Consumption

Likewise, the extent and frequency of any subsequent consumption of fish, crabs, and shellfish collected from the Jensen Shipyard area (or within the shallow embayment) are unknown; however, existing evidence suggests that seafood consumption does not occur. For the purposes of this CSM, it is assumed that no shellfish consumption from the Jensen's shoreline is occurring; however, the potential for shellfish consumption in the future is anticipated to be evaluated in a subsequent phase of work.

3.1.6 Selection of Exposure Scenarios for Additional Evaluation

Specific exposure assumptions will be developed in consultation with Ecology to identify complete pathways, which must include an exposure medium, exposure point, a potential exposed population, and an exposure route. Complete pathways will be subsequently evaluated to determine whether site-specific risk calculations are required, versus comparing a qualitative site-specific risk evaluation against risk quantified at similar sites.

Potential exposure scenarios are summarized in Table 1.

[4] Email correspondence with Todd Nicholson, Port of Friday Harbor. March 22, 2019.

Table 1. Potential Exposure Scenarios

Exposure Scenario	Exposure Point	Exposure Medium	Exposed Population	Exposure Route	Anticipated Analysis	Comment
Water Recreation	Project Site	Sediment	Resident	Dermal, Ingestion[1]	Qualitative	Exposure via swimming is lower than exposure via other pathways.
		Surface Water	Resident	Dermal, Ingestion[2]	Qualitative	King County study (King County, 1999) suggests that risks associated with water recreation are within accepted levels. Anticipated RI will validate King County conclusions against site-specific data.
Shore Recreation	Shoreline and Intertidal	Sediment	Resident	Dermal, Ingestion[1]	Qualitative	To be further evaluated.
		Surface Water	Resident	Dermal, Ingestion[2]	Qualitative	Exposure attributable to resuspended sediment in water column is insignificant compared to that from direct contact with bedded sediment. Exposure is expected to be much lower than in the swimming scenario.
Occupational	Boatyard	Sediment	Worker	Dermal, Ingestion[1]	Qualitative	Exposure is expected to be much lower than that evaluated in the shore recreation and shellfish collection exposure scenarios.
		Surface Water	Worker	Dermal, Ingestion[2]	Qualitative	Exposure is expected to be less than in the swimming scenario.
	Habitat Restoration	Sediment	Worker	Dermal, Ingestion[1]	Qualitative	Workers engaged in habitat restoration or site cleanup projects may come in contact with sediment. Further evaluation will help to identify what level of PPE is appropriate.
		Surface Water	Worker	Dermal, Ingestion[2]	Qualitative	Exposure is expected to be less than in the swimming scenario.
Fish, Crab and Clam Collection	Shoreline and Intertidal	Sediment	Resident	Dermal, Ingestion[1]	Qualitative	Sediment exposure will occur during shellfish collection. Exposure is expected to be similar to shoreline recreation.
		Surface Water	Resident	Dermal, Ingestion[2]	Qualitative	Exposure attributable to resuspended sediment in water column is insignificant compared to that from bedded sediment.
	Project Site	Sediment	Resident	Dermal, Ingestion[1]	Qualitative	Incidental exposure during fishing and crabbing is insignificant.
		Surface Water	Resident	Dermal, Ingestion[2]	Qualitative	Incidental exposure is less than the swimming scenario.
Fish, Crab and Clam Consumption	N/A	Tissue	Resident	Ingestion	Qualitative	To be further evaluated.

Notes:

1. Incidental sediment ingestion associated with dermal contact.
2. Incidental water ingestion associated with dermal contact.

3.2 Potential Ecological Receptors

Ecological values include those roles and processes vital to ecosystem function, those providing critical resources such as habitat and fisheries, and the regulatory status of the populations (e.g., threatened or endangered species). Although no site-specific studies have been performed, it is known that several receptor groups occur in and throughout the San Juan Islands and would be expected to use the uplands and or aquatic environs of the Jensen Shipyard. Species that could directly or indirectly be exposed to contaminated sediments include the benthic invertebrate community, fish, birds, and mammals. Reptiles and amphibians are unlikely to be present on site because there is no persistent freshwater habitat present. Further evaluation will be done to determine whether the group or a representative species should be identified as a Receptor(s) of Concern.

3.2.1 Benthic Assemblages

Benthic invertebrate communities in the San Juan Islands are composed of a diverse set of phyla (*Mollusca*, *arthropoda*, *annelida*, and *Echinodermata*), and can be classified as infaunal (living in sediment) and epifaunal (living on the sediment or other substrate). Benthic invertebrates are in contact with sediment during some or all of their life cycles, and tend to have limited mobility (particularly as adults).

The benthic community can be an indicator of ecosystem health and performs several important ecological functions. Burrowing benthic invertebrates support nutrient cycling and bioturbation, and the benthic community is an important food source for other invertebrates, fish, birds, and mammals.

No benthic community sampling has occurred at the Project site; however, it is likely that some benthic invertebrates that humans consume are present within the study area. There is evidence that bivalves (clams, mussels, oysters, etc.) may be present at intertidal and subtidal elevations within the Project site, while crustaceans (crab and shrimp) and other benthic invertebrates are likely present around subtidal areas of Shipyard Cove.

3.2.2 Fish

Fish can be classified as demersal (living on or near the sediment and feeding on benthic organisms), benthopelagic (living and feeding near the sediment as well as in the water column), and pelagic (living and feeding in open water). Fish species within the proposed study area are generally expected to be mobile predators and thus exposed to chemicals through the ingestion of prey, incidental ingestion while consuming prey, and direct contact with sediments (particularly demersal species).

Fish are a food source for other fish, larger invertebrates, birds, and mammals, including people. They also provide important recreation value.

No fish surveys have been performed in the proposed study area, nor has an extensive review of other information sources been performed; however, it is likely that fish species that humans consume or that serve other important ecosystem functions are present within the study areas.

3.2.3 Birds

The Project site consists of habitat that numerous bird species are expected to utilize. The Project site and surrounding areas are known to support numerous species, including those that depend on the diverse riparian, intertidal, and subtidal habitat present at Jensen's. Birds that are expected to utilize the Project site include passerine and upland bird species, raptors, shorebirds and wading birds, waterfowl, and seabirds. Bird species would be exposed to chemicals through similar mechanisms as fish, including

ingestion of prey (benthic invertebrates, fish, small mammals, etc.), incidental ingestion of sediments while consuming prey, and direct contact with sediments.

No bird surveys have been performed in the proposed study area, nor has an extensive review of other information sources been performed.

3.2.4 Mammals

The proposed study area includes habitat that is expected to be utilized by marine mammal species like harbor seal, California sea lion, harbor porpoise, and killer whale. Marine mammals would be expected to consume fish, squid, octopus, and crustaceans. Additionally, semi-aquatic terrestrial mammals like raccoon, muskrat, and river otter may be present on site or in the vicinity. These species consume fish, crustaceans, and bivalves. In addition to ingesting prey, mammals are also expected to be exposed to chemicals through incidental ingestion of and direct contact with sediments.

No mammal surveys have been performed in the proposed study area, nor has an extensive review of other information sources been performed.

3.2.5 Selection of Receptors of Potential Concern (ROCs)

Specific receptors of concern (ROCs) will be identified in consultation with Ecology based on subsequent work, anticipated to include identification of key species that utilize the Project site and exposure assessments to evaluate whether a direct pathway exists and is significant. For the purposes of this CSM, sediments are assumed to be the principal source of chemicals for all exposure scenarios, regardless of the actual exposure medium (sediment, tissue, surface water, porewater).

In order for a chemical to pose a risk to a ROC, a complete exposure pathway must exist and be significant. A complete exposure pathway consists of a direct pathway between a source and the ecological receptor via one or more exposure routes. To focus future evaluations, four exposure pathway designations have been defined:

- **Complete and significant:** A direct link between the ROC and chemical exists and is considered to be a potentially significant exposure. Additional qualitative evaluation is recommended to determine whether quantitative risk evaluation is warranted.

- **Complete and significance unknown:** A direct link between the ROC and chemical exists, but insufficient information exists to determine whether the pathway is significant. Additional qualitative evaluation is recommended to determine whether quantitative risk evaluation is possible or if the pathway must be addressed in subsequent uncertainty analyses.

- **Complete and insignificant:** A direct link between the ROC and chemical exists; however, the overall exposure is considered to be low. No further analysis is proposed for these pathways.

- **Incomplete:** There is no direct link between the ROC and the chemical. No further evaluation of these pathways is proposed.

Complete and significant pathways for the benthic invertebrate community include sediment contact, sediment ingestion, prey ingestion, and surface water contact. For fish, key exposure pathways include prey ingestion and water contact. Sediment contact and incidental ingestion are complete pathways for

some fish species, but are insignificant for others. Ingestion of prey, surface water, and sediments are all complete and significant exposure pathways for birds and mammals. Sediment and water contact are also considered complete pathways for birds and mammals; however, they are insignificant in comparison to other pathways because feathers and fur limit direct dermal contact.

Table 2 illustrates exposure pathways for potential ROCs. ROCs are general, because insufficient information has been collected to identify specific species.

Table 2. Exposure Pathways for Potential ROCs

Receptor	Exposure Pathway					
	Sediment Contact	Sediment Ingestion	Water Contact	Benthic Ingestion	Fish Ingestion	Other Ingestion
Infaunal Benthic Community					X	
Crabs	?	?				?
Fish	?	?				
Birds						
Mammals						

	Pathway Key
	Complete, significant
?	Complete, significance unknown
	Complete, insignificant
X	Incomplete

If additional risk analysis is required subsequently, a food web highlighting the connections between ROCs may be appropriate for the Project site. Given the simplicity of the Project site, however, a qualitative risk evaluation for ROCs may be appropriate.

4.0 DATA GAPS ANALYSIS

The paragraphs below summarize our conclusions regarding identified data gaps that need to be addressed to complete the Remedial Investigation phase.

4.1 Sediment Data

At this time, only a limited number of surface sediment samples (22) have been collected for this location, and no data quality review has been completed. While these data provide a useful starting point for identifying a preliminary list of Contaminants of Potential Concern (COPCs), the dataset is not sufficiently robust to definitively establish the nature and extent of the contamination, or to allow identification of or elimination of other potential sources of the contamination; this therefore precludes definitive identification of Potential Cleanup Units. While the chemistry data indicate chemical exceedances of regulatory criteria, no biological testing of the sediments for toxicity or bioaccumulation potential has been conducted, which could confirm or override chemical concerns. All samples collected were restricted to surface sediments only (top 10 cm) and were generally within the immediate vicinity of Jensen's marina. Although dioxins/furans were evaluated at the north end of the travel lift and at the base of the historic western railway, they represent a data gap in other marine areas.

Several samples collected in intertidal areas (SRWA-1, SRWA-2, SRWA-3, SRWA-4, SRWA-5, and SRWA-6) were evaluated only as part of the upland dataset (WE, 2018d). These samples should also be included in the aquatic dataset and evaluated against marine sediment quality standards.

Historic wasting of debris and other material onto the uplands and directly into the water, and erosion of soils and material from the uplands via stormwater events, are visually evident as potential sources. WE established (WE, 2018a; WE, 2018b) that contamination exists in the upland soils; therefore, past or ongoing discharges to intertidal and subtidal sediments through groundwater flux may be a source, but have not been investigated. The presence of chemical contamination at depth, especially along the shoreline, can be inferred, but will require investigation to confirm. Accordingly, in addition to a quality review of the data, we recommend supplemental characterization of intertidal and subtidal sediments employing a mix of surface grabs and cores to establish the nature and extent of COPCs and to estimate the volume of material that may need to be remediated. The effort would also include the standard suite of biological toxicity tests.

Finally, the current segregation of upland data from aquatic data represents a data gap along the land/water interface. Integration of these data sets will present a more complete understanding of the nature and extent of COPCs across the land/water interface.

As part of the future remedial investigation, a supplemental sediment characterization is anticipated to address identified data gaps and refine the nature and extent of sediment contamination at the site. This effort is expected to:

- Establish vertical contamination profiles in areas where surface sediments exceed SQS.
- Include additional samples (depth and surface) along the eastern shoreline area.
- Delineate the vertical and horizontal extent of dioxins/furans beyond the surface concentrations measured along the central marina shoreline, which may correlate with observed PCB surface exceedances.

- Focus PCB congener analysis on areas showing benthic exceedances in surface sediments to facilitate subsequent background/human health evaluations.
- Delineate the vertical and horizontal extent of pesticides measured in surface sediments.

4.2 Tissue Data

Although tissue concentrations for fish and shellfish have been collected at other Puget Sound sites, no similar data have been collected at Jensen's. Previous sediment characterizations at the project site did not include bioaccumulation or toxicity testing, which could be useful in gauging the present level of risk to human and ecological health. As part of the supplemental sediment characterization, studies that could evaluate the bioavailability of selected COPCs include bioaccumulation studies and/or tissue sampling, which could be incorporated into a benthic survey. Data collected could be compared with tissue concentrations at other sites and inform decision-making regarding the need for additional collections; however, it is anticipated that final site conditions will meet SMS, which is considered to be sufficiently protective. If subsequent site evaluation suggests that SMS cannot be achieved, supplemental tissue analysis may be necessary.

4.3 Surface Water Data

A single outfall pipe was observed on the Project site, but there is no evidence of discharge or seepage. No other point source outfalls have been identified as discharging to the embayment where Jensen's Shipyard is located. Marine water quality throughout the San Juan archipelago is generally considered to be good, although no water quality studies have been conducted for this embayment associated with the marina operation of other shoreline activities outside of the project site property. Anticipated maintenance improvements to the marina and potential moorage space reconfigurations are expected to require establishment of baseline water quality parameters as part of the regulatory process, so although this is technically a data gap, it is a minor one. The need for collection of surface water quality data will be discussed with Ecology as part of the identification of required studies for remedial investigation or regulatory process.

4.4 Sediment Transport Data

Sediment transport and sedimentation rates in Shipyard Cove, particularly around the Project site, also represent a known data gap. Shipyard Cove is entirely open to Puget Sound, so tides, currents, and wind-generated waves are expected to be dynamic forces, which influence deposition and distribution of surface sediments. However, the Project site is generally sheltered from the east, west, and south by the shoreline, the adjacent Shipyard Cove Marina, and Brown Island. The Project site is exposed primarily to wind and wave energy coming from the north, which is expected to occur only during episodic events. Given the shallow depth of the embayment and the amount of regular boat activity, it is likely that propwash is an important factor in sediment transport and redistribution, particularly in the vicinity of the boat lift at Jensen's and the barge landing site on the adjacent property.

Wind-wave analysis is anticipated as part of the marina redevelopment planning process. This analysis will provide information about the magnitude and dominant direction of wind-generated waves and currents. As part of the supplemental sediment characterization effort, grain-size and contaminant patterns in surface samples will be evaluated, but at this time no additional studies are proposed to measure bedload velocity. If, in consultation with Ecology, additional characterization of sediment deposition and transport are determined to be necessary, potential studies could include investigating propwash scour, numeric modeling to predict sediment movement, placement of current meters to measure current velocity along the sediment bed, and deployment of sediment traps to measure sedimentation rates.

4.5 Groundwater Data

WE established (WE, 2018a; WE, 2018b) that contamination is present in the upland soils requiring remedial action. Groundwater movement was reported by WE to be generally northward, although no rate of movement was given. The upland soils are covered in gravel and expected to be pervious, so past or ongoing discharges to intertidal and subtidal sediments through groundwater flux can be expected to be a source. Although groundwater sampling during WE's initial investigations detected an exceedance of MTCA Method A cleanup levels for only one chemical (arsenic) at one location, subsequent soil sampling suggests that groundwater samples were collected upgradient from a potential hotspot. If groundwater is flowing through chemical contamination at depth, especially along the shoreline, it would represent a potential pathway for contaminants to migrate to sediments. Supplemental investigations could include evaluating whether groundwater data between upland hotspots and the shoreline is needed to quantify the extent of potential contaminant transport via groundwater.

4.6 Historic and Cultural Resources

The San Juan archipelago is very well known to have been utilized by native peoples. The presence of known or unknown cultural resources along this area of shoreline is a critical, but anticipated data gap that will require a literature review and survey.

4.7 Preliminary Proposed Work Plan

Based on data gaps in the existing CSM, we propose the following priorities in preparing a work plan for the anticipated remedial investigation (Table 3).

Table 3. Preliminary Proposed Work Plan

Data Gap	Proposed Activity	Description
General	Literature search	Conduct a literature review for relevant studies and data to inform the CSM. An example is the Friday Harbor Lab, which maintains a library of marine studies in the San Juan Islands.
Sediments	Existing data	Complete data validation of existing sediment data. Integrate the upland CSM with the intertidal/subtidal CSM.
	Sediment cores	Collect sediment cores from 10 - 14 locations to delineate the horizontal and vertical extent of COPCs.
Tissue	Tissue sampling	It is assumed that final site conditions will meet SMS, which is considered sufficiently protective. If tissue data are subsequently deemed necessary, bivalve tissue analysis is recommended.
Surface Water	Water sampling	No surface water sampling is proposed.
Sediment Transport	Wind-wave analysis	Wind-wave analysis required for marina infrastructure redevelopment will inform sediment transport analyses.
	Sedimentation	If natural recovery is a component of the preferred remedial alternative, sediment traps can be deployed to measure sedimentation rates. At this time, no additional data is recommended.
	Propwash scour	Complete a qualitative evaluation of the extent that vessel operations redistribute sediments.
Groundwater	Groundwater sampling	If subsequent evaluation of existing soil and groundwater data suggests that groundwater is a complete pathway to sediments, supplemental groundwater samples downgradient from known soil hotspots may be necessary.
Cultural Resources	Cultural Resources Assessment	A cultural resources assessment is required.

4.8 Schedule

The immediate project schedule is likely to be driven by interim actions, which we propose to associate with required maintenance actions. As described previously, a substantial amount of required

maintenance was deferred by the previous owner. Several components of the existing marina infrastructure are likely to fail if maintenance is deferred much longer. Failure of this infrastructure will not only handicap marina operations, but will also exacerbate the spread of COPCs in the aquatic environment through the accelerated deterioration of creosote-treated structures and sloughing of contaminated upland soils into intertidal areas.

The existing travel lift pier required to haul vessels in and out of the water is at immanent risk of failure (Figure 12, Travel Lift Pier). Although an engineering condition assessment has not been performed on this structure, the creosote-treated piling that support the structure are in an advanced state of decay and the ecology-block shoreline revetment is failing. Several piles have already failed and substantial deterioration is visually evident in many others. The existing revetment is being undermined and upland soils are beginning to spill into the intertidal zone. The travel lift pier is located in an area where preliminary surface sediment sampling (WE, 2018c) detected several COPCs that exceed regulatory criteria (TBT, PCBs, metals, PAHs, dioxins/furans). The required infrastructure replacement provides a timely and cost-effective opportunity to reduce site risks by addressing known COPCs.

Additionally, a substantial amount of the existing subtidal marina infrastructure is in a similar state of disrepair as the travel lift pier. Creosote-treated piling are in an advanced state of decay, including several that have already failed. Many of the walkways are supported by degraded open-cell Styrofoam floats. The Port is currently developing plans to complete substantial maintenance and redevelopment of the existing marina infrastructure.

To inform an interim action associated with required maintenance of the travel lift pier, priority investigations include integration of the upland and aquatic data sets, additional sediment sampling to define the nature and extent of contamination, and completion of a cultural resources assessment. In order to meet anticipated timelines associated with federal permitting requirements, we recommend that these priority investigations be expedited by August 2019. In addition to the sediment sampling that would facilitate travel lift maintenance, completion of marina redevelopment plans also requires an expedited wind-wave analysis. We recommend initiating this priority analysis by June 2019.

We do not anticipate that the remaining work plan elements must be expedited with the same degree of urgency. We proposed to develop a detailed Work Plan Schedule in consultation with Ecology, with a focus on the availability and schedule for MTCA funding.

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FIGURES

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Port of Friday Harbor
Jensen and Sons Boatyard and Marina

Conceptual Site Model and Data Gaps Report

Figure 1. Location and Vicinity Map

Data Sources: FEMA (2018), Leon Environmental, LLC (2018), San Juan County (2016), San Juan Surveying (2018), Whatcom Environmental (2018)

0 200 400 800 Feet

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Port of Friday Harbor
Jensen and Sons Boatyard and Marina

Conceptual Site Model and Data Gaps Report

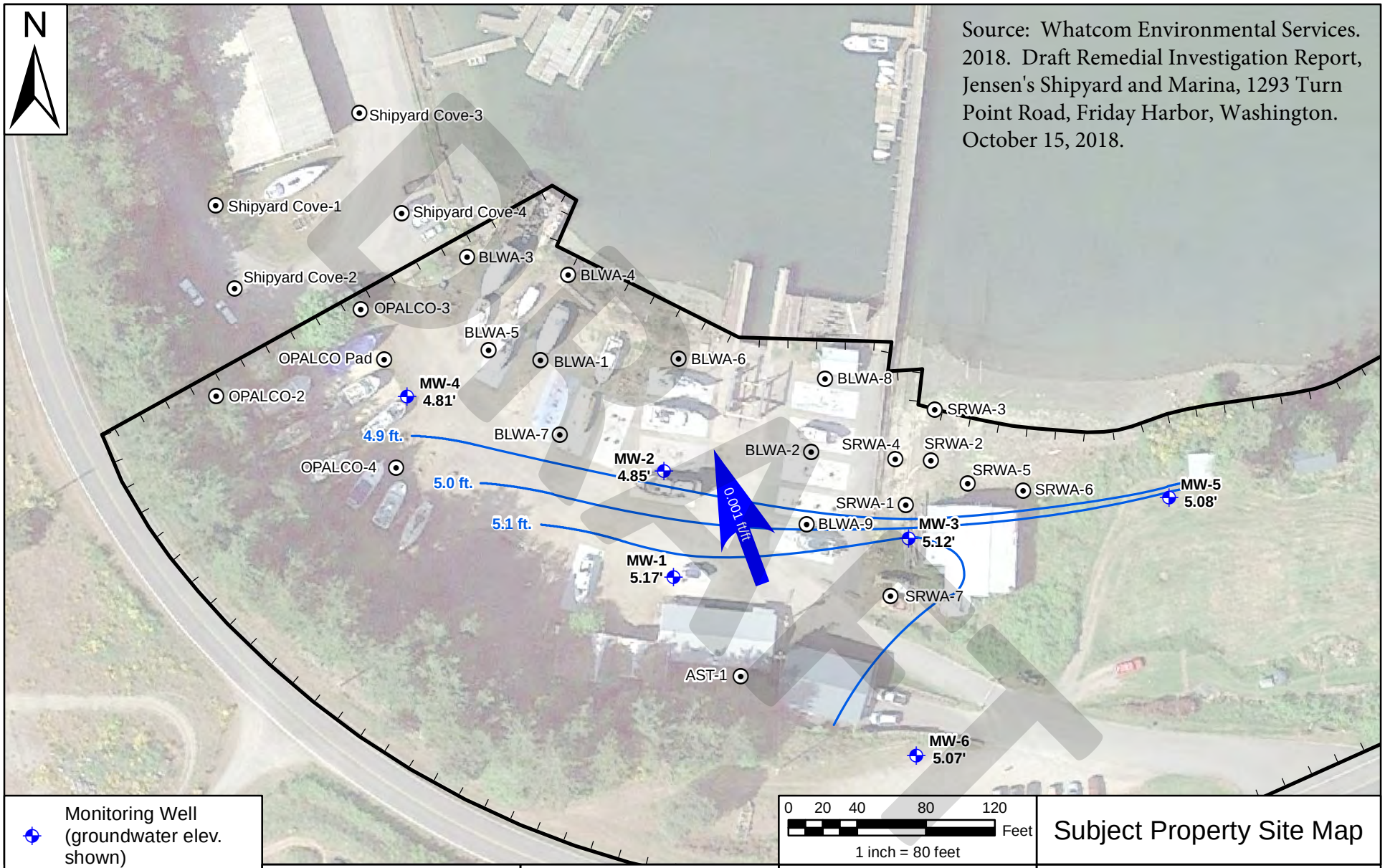
Figure 2. Existing Conditions

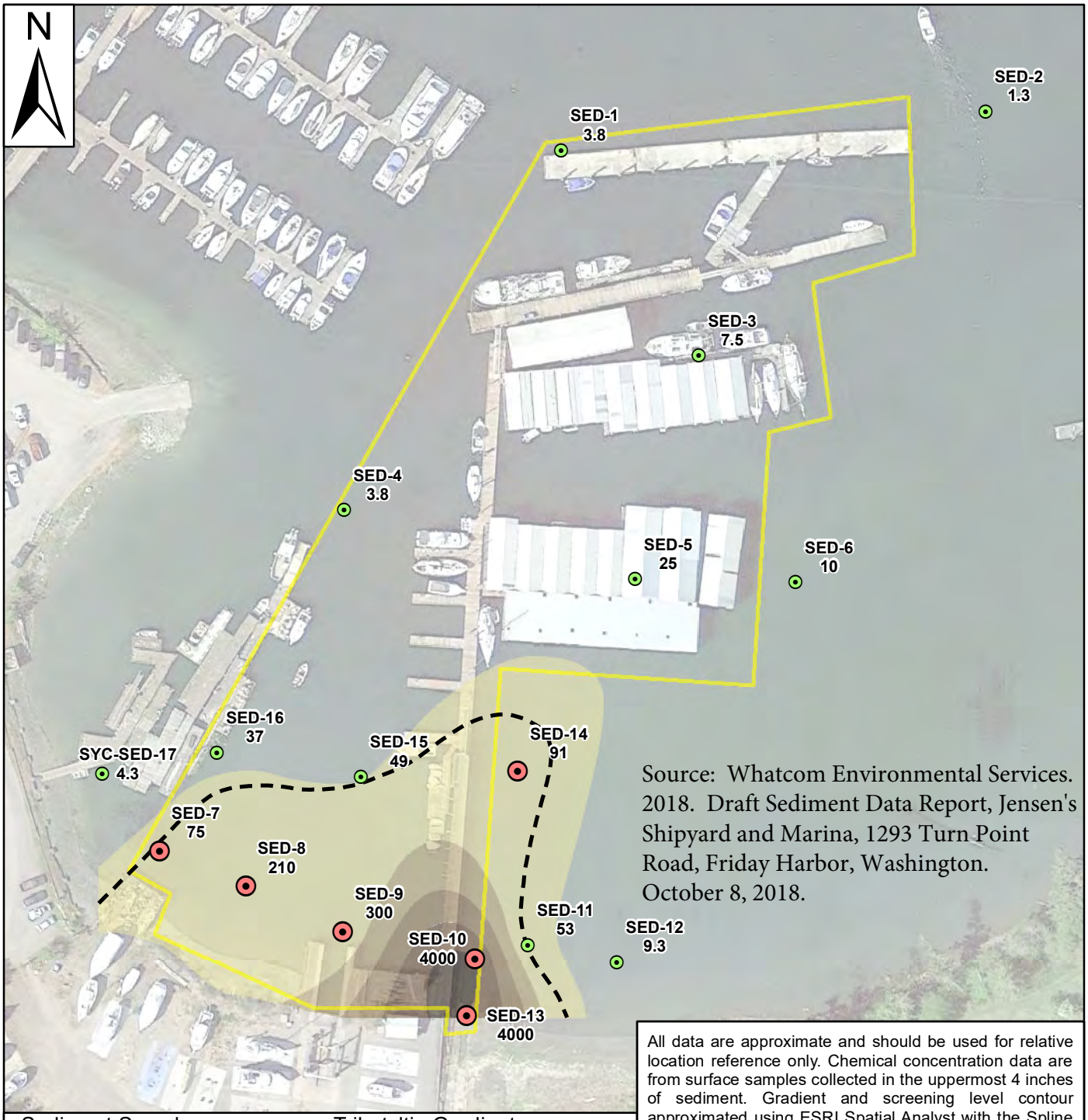
Data Sources: FEMA (2018), Leon Environmental, LLC (2018), San Juan County (2016), San Juan Surveying (2018), Whatcom Environmental (2018)

Feet
0 50 100 200

LEON Environmental, LLC

Figure 3. Outfall Photo


N
Source: Whatcom Environmental Services. 2018. Draft Remedial Investigation Report, Jensen's Shipyard and Marina, 1293 Turn Point Road, Friday Harbor, Washington. October 15, 2018.
Shipyard Cove-3
Shipyard Cove-1
Shipyard Cove-4
BLWA-3
Shipyard Cove-2
BLWA-4
OPALCO-3
BLWA-5
OPALCO Pad
BLWA-1
BLWA-6
BLWA-8
OPALCO-2
MW-4
4.81'
SRWA-3
4.9 ft.
BLWA-7
BLWA-2
SRWA-4
SRWA-2
MW-2
4.85'
OPALCO-4
SRWA-5
5.0 ft.
SRWA-6
MW-5
5.08'
0.001 ft/ft
SRWA-1
5.1 ft.
BLWA-9
MW-3
5.12'
MW-1
5.17'
SRWA-7
AST-1
MW-6
5.07'
DRAFT
Monitoring Well (groundwater elev. shown)
Soil Sample
Groundwater Elev. Contour (2018-08-29)
Subject Property
0 20 40 80 120
Feet
1 inch = 80 feet
All data are approximate and should be used for relative location reference only.
2015 aerial obtained from Google Earth.
Prepared for:
PORT OF FRIDAY HARBOR
Prepared by:
whatcom ENVIRONMENTAL
Subject Property Site Map
1293 Turn Point Road
Friday Harbor, WA 98250
Jensen's Shipyard
10/12/18
Figure 4



Source: Whatcom Environmental Services. 2018. Draft Sediment Data Report, Jensen's Shipyard and Marina, 1293 Turn Point Road, Friday Harbor, Washington. October 8, 2018.

Sediment Sample

- ≤ 73 (ug/kg dw)
- > 73 (ug/kg dw)
- DMMP Screening Level (73 ug/kg dw)
- 2001 DNR Lease Boundary

Tributyltin Gradient (ug/kg dw)

- 50 - 1,000
- 1,000 - 2,000
- 2,000 - 3,000
- 3,000 - 4,000
- 4,000 - 5,000

All data are approximate and should be used for relative location reference only. Chemical concentration data are from surface samples collected in the uppermost 4 inches of sediment. Gradient and screening level contour approximated using ESRI Spatial Analyst with the Spline and Natural Neighbor interpolation methods.

2015 aerial obtained from Google Earth.

0 50 100 150 200 250 Feet

1 inch = 100 feet

Surface Sediment Concentration Gradient - Tributyltin

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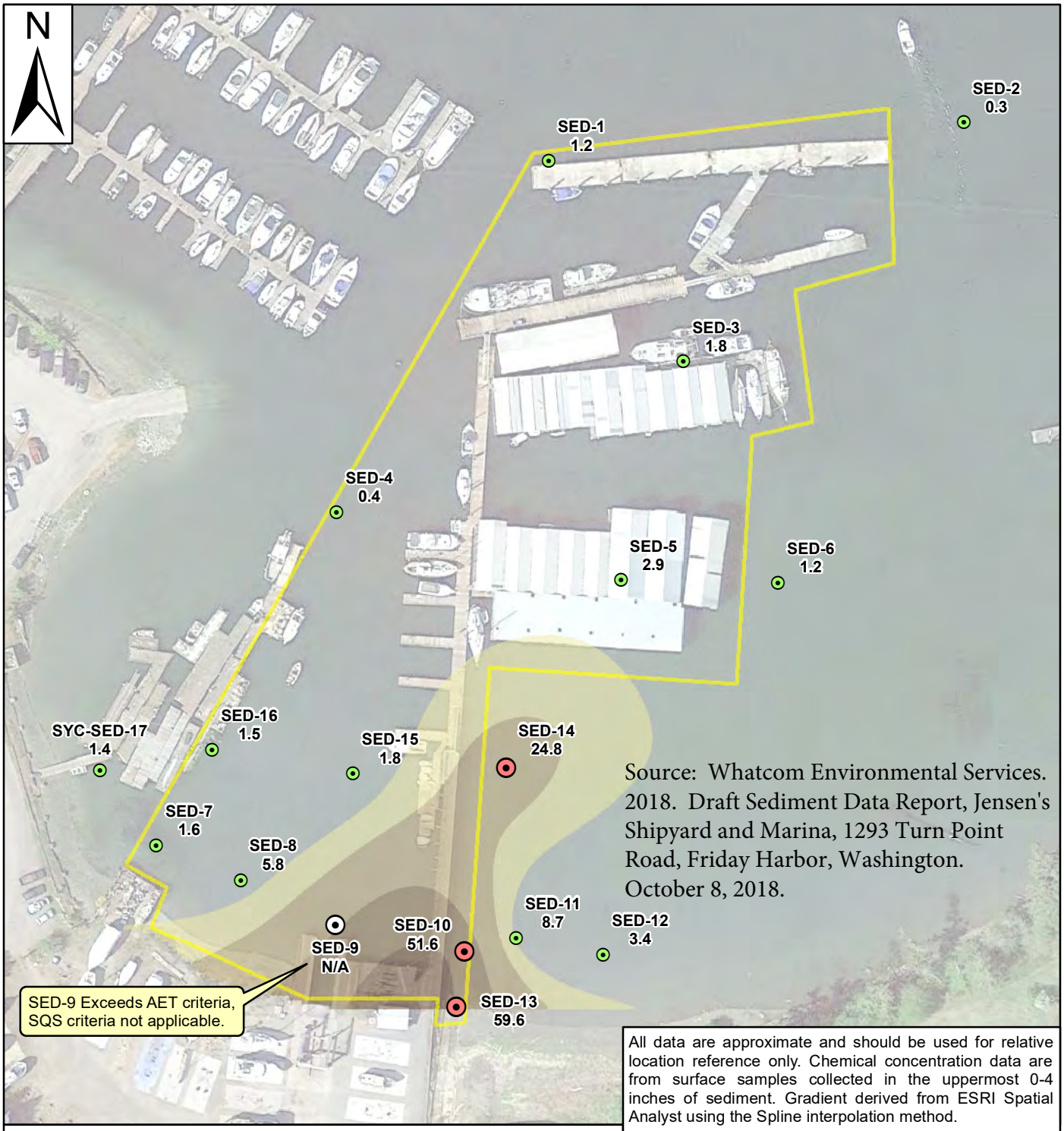
Jensen's Shipyard

10/05/18

Figure 5



Sediment Sample

- ≤ 12 (mg/kg OC)
- > 12 (mg/kg OC)
- SQS Marine Criteria (12 mg/kg OC)
- 2001 DNR Lease Boundary

PCB Gradient (mg/kg OC)

- 10 - 20
- 20 - 40
- 40 - 60
- 60 - 80

All data are approximate and should be used for relative location reference only. Chemical concentration data are from surface samples collected in the uppermost 0-4 inches of sediment. Gradient derived from ESRI Spatial Analyst using the Spline interpolation method.

2015 aerial obtained from Google Earth.

0 50 100 150 200 250 Feet

1 inch = 100 feet

Surface Sediment Concentration Gradient - PCBs

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Prepared by: whatcom ENVIRONMENTAL

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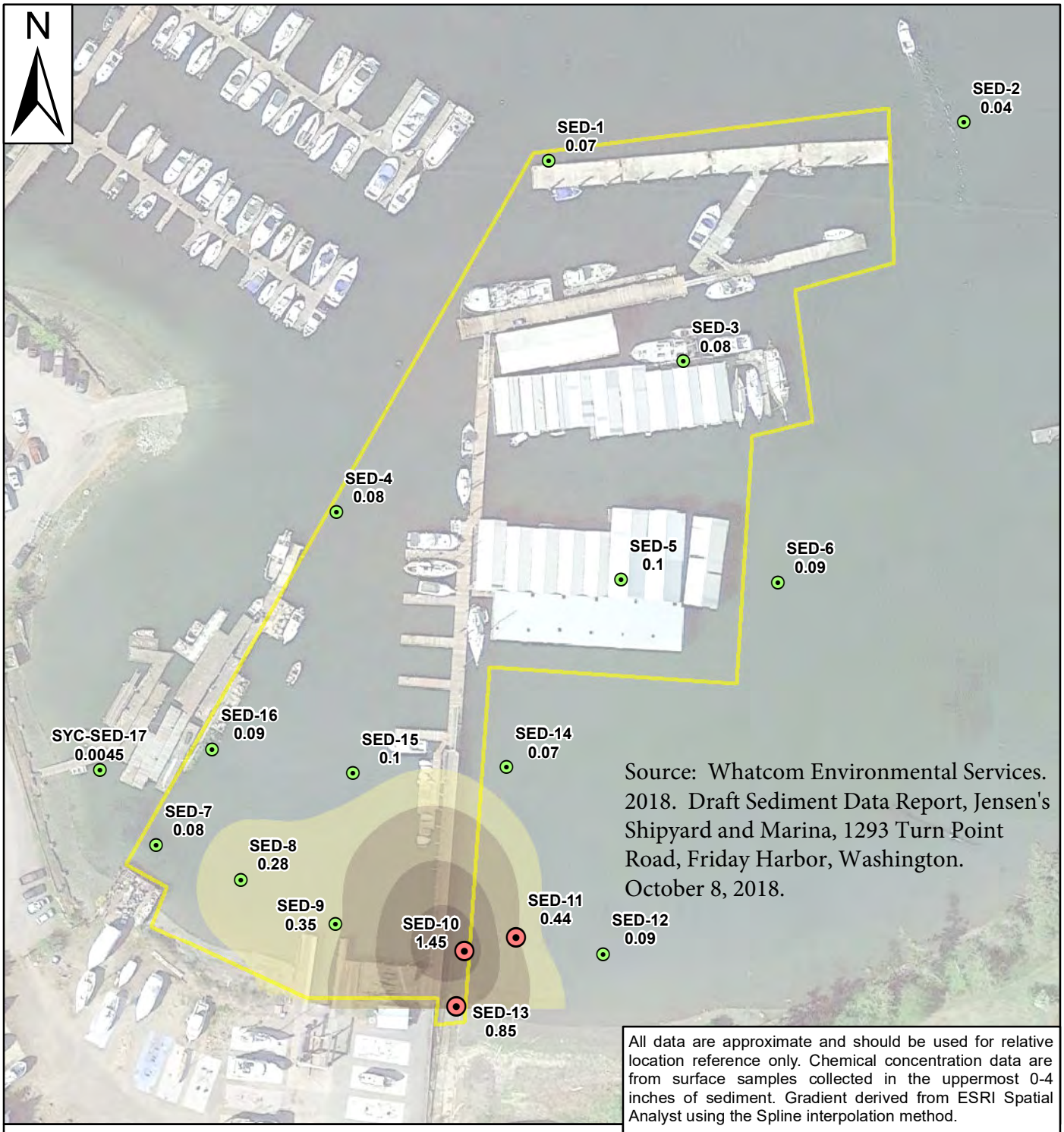
Friday Harbor, WA 98250

Jensen's Shipyard

10/05/18

Figure 6



Source: Whatcom Environmental Services. 2018. Draft Sediment Data Report, Jensen's Shipyard and Marina, 1293 Turn Point Road, Friday Harbor, Washington. October 8, 2018.

All data are approximate and should be used for relative location reference only. Chemical concentration data are from surface samples collected in the uppermost 0-4 inches of sediment. Gradient derived from ESRI Spatial Analyst using the Spline interpolation method.

2015 aerial obtained from Google Earth.

Sediment Sample

- ≤ 0.41 (mg/kg dw)
- > 0.41 (mg/kg dw)
- SQS Marine Criteria (0.41 mg/kg dw)
- 2001 DNR Lease Boundary

Mercury Gradient (mg/kg dw)

- 0.2 - 0.4
- 0.4 - 0.8
- 0.8 - 1.2
- 1.2 - 1.6

0 50 100 150 200 250 Feet

1 inch = 100 feet

Surface Sediment Concentration Gradient - Mercury

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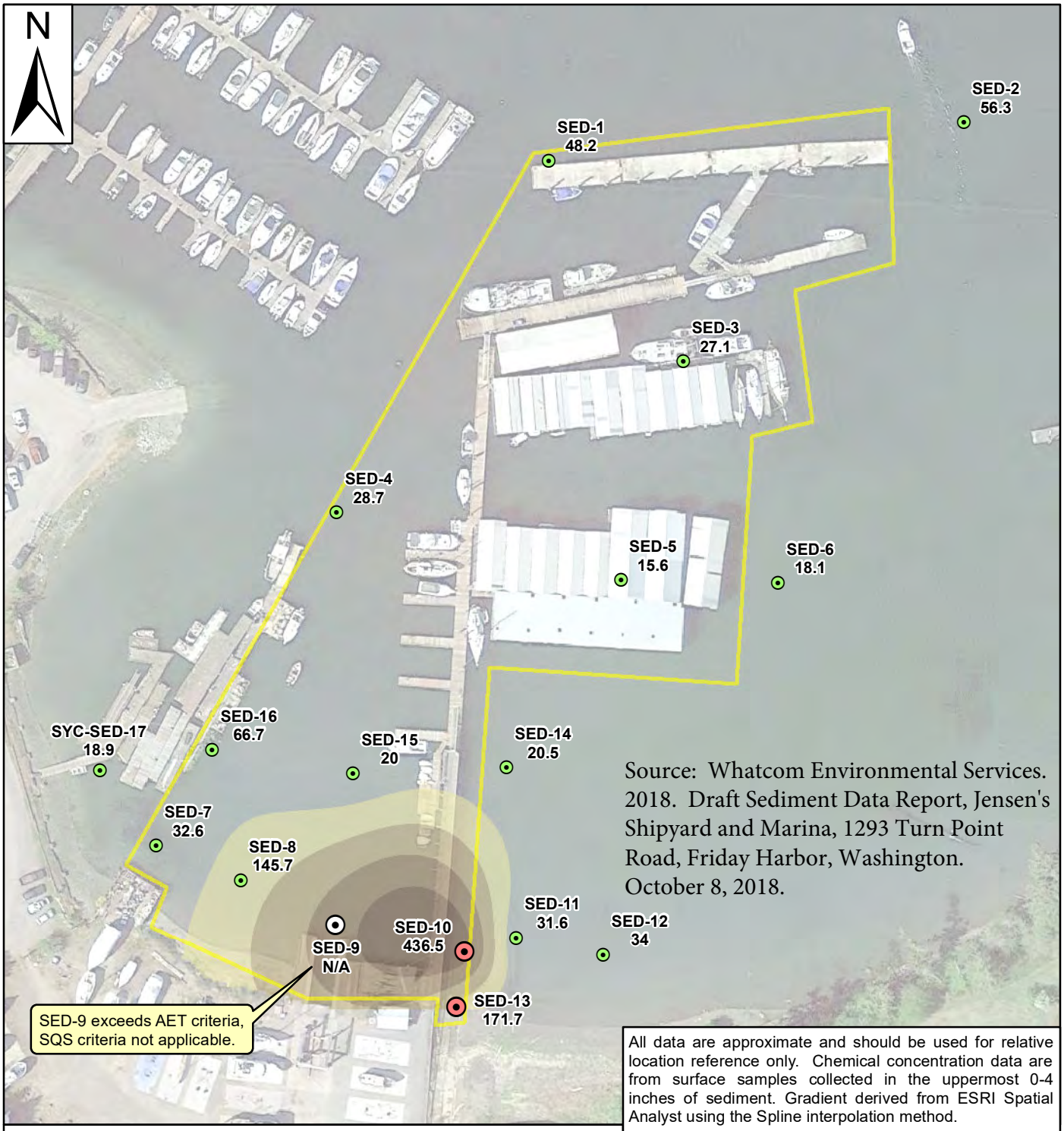
Figure 7



Source: Whatcom Environmental Services. 2018. Draft Sediment Data Report, Jensen's Shipyard and Marina, 1293 Turn Point Road, Friday Harbor, Washington. October 8, 2018.

Sediment Sample
- ≤ 160 (mg/kg OC)
- > 160 (mg/kg OC)
- SQS Marine Criteria (160 mg/kg OC)
- 2001 DNR Lease Boundary

Fluoranthene Gradient (mg/kg OC)
- 100 - 200
- 200 - 300
- 300 - 400
- 400 - 500

All data are approximate and should be used for relative location reference only. Chemical concentration data are from surface samples collected in the uppermost 0-4 inches of sediment. Gradient derived from ESRI Spatial Analyst using the Spline interpolation method.

2015 aerial obtained from Google Earth.

0 50 100 150 200 250 Feet

1 inch = 100 feet

Surface Sediment Concentration Gradient - Fluoranthene

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Prepared by: whatcom ENVIRONMENTAL

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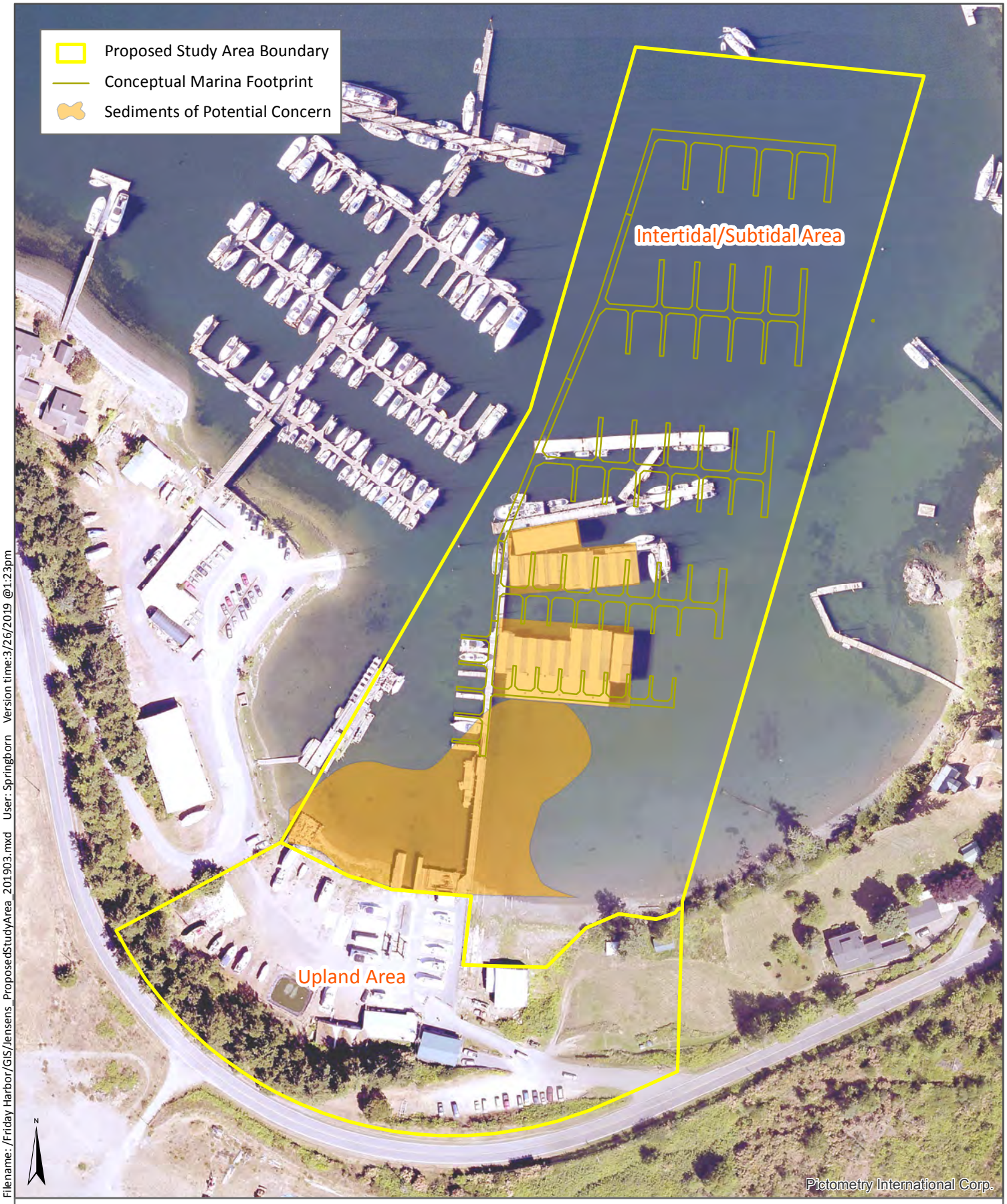
Jensen's Shipyard

10/05/18

Figure 8



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Port of Friday Harbor
Jensen and Sons Boatyard and Marina

Conceptual Site Model and Data Gaps Report

Figure 9. Proposed Study Area Boundary

Data Sources: Leon Environmental, LLC (2018), Reid Middleton (2019), Whatcom Environmental (2018)

0 50 100 200 Feet

LEON Environmental, LLC

Filename: /Friday Harbor/GIS/Jensens_PhysicalConceptualSiteModel_201903.mxd User: Springborn Version time:3/26/2019 @12:30am

Port of Friday Harbor
Jensen and Sons Boatyard and Marina

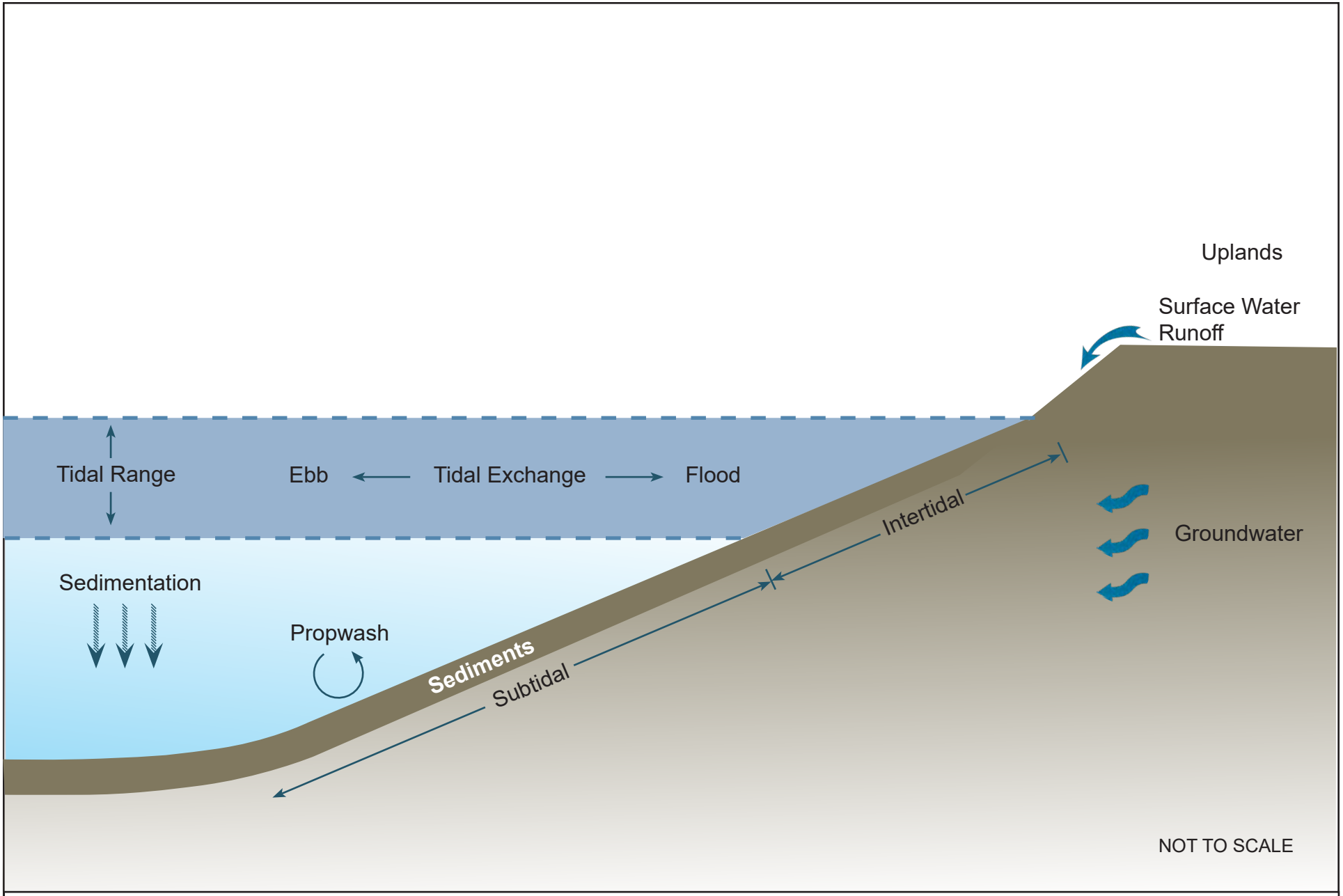
Conceptual Site Model and Data Gaps Report

Figure 10. Physical Conceptual Site Model – Plan View

Data Sources: FEMA (2018), Leon Environmental, LLC (2018), San Juan County (2016), San Juan Surveying (2018), Whatcom Environmental (2018)

0 50 100 200 Feet

LEON Environmental, LLC



Port of Friday Harbor
Jensen and Sons Boatyard and Marina

LEON Environmental, LLC

Conceptual Site Model and Data Gaps Report
Figure 11. Physical Conceptual Site Model - Cross Section

Figure 12. Travel Lift Pier