FINAL

Acoustic Fish Tracking Study Field Sampling Plan

Portland Harbor Pre-Remedial Design Investigation and Baseline Sampling

Portland Harbor Superfund Site

AECOM Project Number: 60554349
Geosyntec Project Number: PNG0767A

March 30, 2018

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CERTIFICATION

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

March 30, 2018

Kenneth M. Tyrrell
PDI Project Coordinator
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Date

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ACRONYMS AND ABBREVIATIONS

AECOM	AECOM Technical Services
ASAOC	Administrative Settlement Agreement and Order on Consent
Ballard	Ballard Marine Services
BHHRA	baseline human health risk assessment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COC	contaminant of concern
CSM	Conceptual Site Model
DGPS	differential global positioning system
DO	dissolved oxygen
DQMP	Data Quality Management Plan
DQO	data quality objective
DSL	[Oregon] Department of State Lands
DUO	data use objective
EPA	United States Environmental Protection Agency
FC	Field Coordinator
FS	feasibility study
FSP	Field Sampling Plan
g	gram
Geosyntec	Geosyntec Consultants, Inc.
Gravity	Gravity Marine Services,
ID	identification number
kHz	kilohertz
km	kilometer
LWG	Lower Willamette Group
m	meter
NMFS	National Marine Fisheries Service
ODFW	Oregon Department of Fish and Wildlife
PDI	pre-remedial design investigation
PHSS	Portland Harbor Superfund Site

Pre-RD AOC Group	Pre-Remedial Design Agreement and Order on Consent Investigation Group
QA	quality assurance
QAPP	quality assurance project plan
QC	quality control
RI	remedial investigation
RM	river mile
ROD	Record of Decision
Site	Portland Harbor Superfund Site
SMB	smallmouth bass
SOW	Statement of Work
USACE	U.S. Army Corps of Engineers

1. INTRODUCTION

The Record of Decision (ROD) described a post-ROD sampling effort for the Portland Harbor Superfund Site (Site or PHSS; Figure 1) located in Portland, Oregon, to delineate and better refine the sediment management area footprints, refine the Conceptual Site Model (CSM), determine baseline conditions, and support remedial design (United States Environmental Protection Agency [EPA] 2017a). Geosyntec Consultants, Inc. (Geosyntec), and AECOM Technical Services (AECOM) submitted a Work Plan for Pre-Remedial Design Investigations (PDI) on behalf of a group of industrial parties called the Pre-Remedial Design Agreement and Order on Consent Investigation Group (Pre-RD AOC Group). On December 19, 2017, EPA entered into an Administrative Settlement Agreement and Order on Consent (ASAOC) with the Pre-RD AOC Group to conduct the PDI studies at the Site (EPA 2017b). The ASAOC includes the Statement of Work (SOW) and the PDI Work Plan (an attachment to the SOW), which generally describe the field investigation activities, data analyses, schedule, and deliverables for the PDI.

These PDI studies are a focused and foundational step in what will be a multi-phase effort to update current conditions from the collection of data during the remedial investigation (RI)/ feasibility study (FS). The RI/FS was initiated by a group of potentially responsible parties known as the Lower Willamette Group (LWG) and completed by EPA in 2016 (EPA 2016a, 2016b). The RI consisted of three rounds of data collection, including surface and subsurface sediment, bank soils, surface water, sediment traps, porewater, fish tissue, and other media from 2001 through 2007.

This Field Sampling Plan (FSP) was prepared to support the acoustic fish tracking study outlined in the PDI Work Plan (Geosyntec 2017) and the project Quality Assurance Project Plan (QAPP) (AECOM and Geosyntec 2018a).

1.1 Project Setting

The PHSS is located in Portland, Oregon, on the lower Willamette River immediately downstream of the urban downtown. The Site extends from river mile (RM) 1.9 upstream to RM 11.8 and covers 2,190 acres (Figure 1). There are two reaches located immediately upstream of the Site. The Downtown Reach, which includes the urbanized area of downtown Portland, is defined by EPA as extending from RM 11.8 to RM 16.6. EPA defines the Upriver Reach as extending from RM 16.6 to RM 28.4.

1.2 Project Overview

The RI included preparation of a baseline human health risk assessment (BHHRA), baseline ecological risk assessment, and food web model (Kennedy/Jenks 2013a; Windward Environmental 2013, 2015). The BHHRA identified several persistent lipophilic compounds, including polychlorinated biphenyls, as contaminants of concern (COC) based on their bioaccumulation into fish.

The PDI studies are designed to update the RI/FS dataset and characterize current conditions, refine the CSM for all pathways consistent with the ROD, and refine delineation of active remedial areas. In addition to updating sediment, surface water, and tissue chemistry data sets, the PDI scope of work includes a year-long acoustic fish tracking program to capture fine-scale temporal and spatial movement of Smallmouth Bass (*Micropterus dolomieu*; SMB) at the PHSS.

1.3 Study Objectives and Data Uses

The overall goal of the fish tracking study is to improve understanding of fish residency and exposure areas that affect the sediment-fish tissue relationship. The study focuses on SMB (versus other resident species) because of their abundance, more limited home range, extensive historical chemistry database, and importance in the BHHRA. The specific data quality objectives (DQOs) include the following:

- Monitor resident fish movement in the lower Willamette River over an approximately 1-year period to understand seasonal movement, habitat use/preference, and home range.

- Provide a monitoring network sufficient to characterize river mile and fine-scale movement of SMB and whether tagged fish leave the PHSS.

- Generate a dataset that supports reliable estimates of home range area and bank travel distance of SMB in the PHSS.

The results of the study will be used to support the analyses identified in the PDI Work Plan. Additionally, information collected during the fish tracking study may be used to inform the 2018 fish tissue sampling program. For example, insights gained during the fish collection portion of the tracking study may be used to inform the subsequent SMB sampling (e.g., targeting certain areas within sediment decision units/targeting certain times of day/tides/flow regimes/etc.). The 3-month data download is anticipated to be available before the fish tissue sampling commences. These data will be reviewed and considered when targeting locations for capture of SMB.

2. SAMPLING DESIGN AND APPROACH

The overall sampling design, rationale for approach, DQOs, and data use objectives (DUOs) are described in the PDI Work Plan. This FSP provides the additional details necessary to ensure that execution of the study will achieve the project-specific DQOs and DUOs set out in Section 1.3 of this FSP and Section 3.2 of the QAPP (AECOM and Geosyntec 2018a). The sampling design and approach are based on the current understanding of the river system and the target fish species; the specifications and capabilities of the acoustic telemetry equipment, which have been informed by a June 2017 pilot study; and the project-specific DQOs and DUOs. This section of the FSP presents the basis of the study design, including the location and array of receivers and the targeted number of tagged fish. A sample size of 40 tagged fish has been selected for the PDI study. This number is sufficient to generate a robust dataset, even if some fish are lost over the

course of the study. A summary of prior fish tracking studies in the PHSS is presented first for context, followed by details on the proposed 2018 fish tagging study.

2.1 Previous Studies

Two prior studies have been conducted in the PHSS that provide information useful for the design of the acoustic fish tracking study. A study conducted by Oregon Department of Fish and Wildlife (ODFW) in the lower Willamette River in early 2000s used radio tracking technology to track fish movement. In 2017, a pilot study evaluated the performance of acoustic telemetry systems in the river (AECOM 2017a). Radio tracking provides "opportunistic" measurements of fish location (e.g., weekly, bi-weekly) that are not highly refined. Acoustic tracking provides a more refined understanding of fish movement in time and space.

2.1.1 2000-2003 ODFW Radio Tracking Study

From 2000 to 2003, ODFW performed a radio tracking survey of four predator species in the lower Willamette River from RM 0 to ~RM 26 (Pribyl et al. 2004). A total of 73 fish were implanted with Lotek tags (battery life ranging from 238 to 439 days), including 8 walleye, 37 northern pikeminnow, 23 SMB, and 5 largemouth bass. Radio tracking was conducted by boat on an irregular basis, about 1 to 10 days per month from May 2000 to July 2003. A total of 53 of the 73 tagged fish were relocated during radio tracking at least once (i.e., location of tagged fish was recorded by the radio receiver), including 96% of the SMB. A total of 264 relocations were recorded over the survey period. Anglers captured four radio-tagged fish. Most tagged fish were relocated offshore (defined as greater than 10% of the measured channel width to either bank), often adjacent to a structure, such as pilings or floating structures. The distribution of radio-tagged fish across the river channel indicated a preference for areas within 20% of either shoreline. For SMB, the median total distance traveled (upstream and downstream movement) was 4.3 kilometers (km) (2.7 miles), and the 25th and 75th percentiles were 0.8 km (0.5 mile) and 8.0 km (5 miles).

2.1.2 2017 Acoustic Tracking Pilot Study

In June of 2017, an acoustic fish tracking pilot study was conducted to test the technical feasibility of acoustic tracking in the lower Willamette River environment and perform a side-by-side comparison of two different acoustic telemetry systems (HTI-Vemco and Lotek Wireless) (AECOM 2017a). The pilot study assessed and confirmed the technical feasibility of acoustic tracking in the lower Willamette River system. The experimental design involved deployment of a receiver array and fixed tags at two sites (Willamette Cove and RM 11.5 East [E]) where resident SMB had previously been caught. Each site has unique acoustic properties based on bathymetry, bottom sediment composition, anthropogenic alteration, and noise; Willamette Cove was a more quiescent location and RM 11.5E a more active location with regard to boat traffic. The pilot study design was developed with the input and assistance of Karl Gustavson of EPA's Office of Superfund Research and Technology Innovation.

Each array consisted of five autonomous receivers deployed in a pattern designed to optimize detection and two-dimensional positioning of acoustic transmissions (quadrilateral with a central node). The distances of the quadrilateral nodes were within the detection specifications of each vendor's equipment (≤ 150 meters [m]). A receiver from each vendor was installed on the same mount that was securely moored such that the receiver was located about 1 m above the river bottom. Lotek tested their model WHS 4250 datalogger/receiver, which is a 416.7 kilohertz (kHz) system. HTI-Vemco tested their model VR2 receiver, which is a 180 kHz system. Three transmitters representing "tagged fish" were also deployed in stationary positions in optimal, less optimal, and sub-optimal locations relative to the receiver array. Lotek tested their JCART model 14-12 tag (combined acoustic and radio) and HTI-Vemco tested their V9 acoustic tag. All tags were set to a transmission interval of 3 seconds. The fixed receivers and transmitters were deployed for 1 week and then recovered. Tag transmission distance and positioning from the receiver array were also tested using mobile transmitters towed behind a vessel. Based on the transmission detections recorded during the pilot study, the detection efficiency and position efficiency and accuracy of each system was determined.

Overall, the detection efficiency and position efficiency and accuracy of the HTI-Vemco system was higher (AECOM 2017b).[1] Tag detection was recorded by the HTI-Vemco system at distances up to 400 m in Willamette Cove and 250 m in the noisier RM 11.5E area. Based on the pilot study, arrays with HTI-Vemco receivers spaced between 150 to 250 m (or more, depending on the site characteristics) are expected to provide reliable detection capability for fine-scale positioning of SMB. For detection only of tagged fish passing through a gate, receiver spacing of at least 200 m is expected to provide very high levels of detectability and trackability.

2.2 Rationale for Array Locations/Layout

The positioning of individual receivers is based on the physical configuration of the lower Willamette River, water depth (Figure 2), historical knowledge of contaminated areas at the Site, and the project objectives (Section 1.2). Lessons learned from the June 2017 pilot study also contributed to the design of the receiver array (AECOM 2017b). A total of 34 HTI-Vemco VR2 acoustic receivers will be installed in the river as part of this study. The layout of the acoustic receiver array will be a combination of "gates" (designed to track fish presence/absence) and more closely spaced receiver positions designed to track fine-scale fish movement in specific areas of interest.

A series of gates consisting of transects of two to three receivers will be installed at each river mile between RM 5 and RM 9 (Figure 3). These gates will track fish movement on a river mile scale in a section of the river that is representative of conditions and SMB habitat across the PHSS. Focusing on the four mile stretch in the central part of the Site also minimizes potential for tagged fish to leave the study area especially early on in the study. Based on the 2000-2003 radio-tracking study conducted in the lower Willamette River by the Oregon Department of Fish

[1] An equipment malfunction (SD card failure) in the Lotek receiver located in the central node of the Willamette Cove array compromised the detection capability of the Lotek system in this location.

and Wildlife, the travel distance of SMB is estimated to be a few miles on average. By focusing on the central part of the Site and collecting fish when they are spawning, the potential for a tagged fish to exit the study area is minimized as it would require the tagged fish to travel 3 miles upstream or downstream to exit the study area.

Gates will also be installed at the PHSS boundaries (RM 1.9, RM 11.8, and the mouth of Multnomah Channel) to track fish that enter or leave the study area. Three receivers will be deployed along each transect, except at RM 7, RM 8, and Multnomah Channel, where two receivers are expected to be sufficient due to the smaller river width, for a total of 21 receivers at the eight transects of gates. Based on the pilot study, the receivers within each transect will be spaced approximately 200 to 250 m apart.

To capture fine-scale fish movement, receiver arrays will also be installed in three areas of interest: Willamette Cove (RM 6.8 [four receivers]), Swan Island Lagoon (RM 8 [five receivers]), and near the Cargill/Glacier terminals (RM 11.5E [four receivers]). These three focused locations provide a range of SMB habitat and acoustic environments within the PHSS and represent areas of elevated COCs in sediment and SMB. The receiver layouts at the focused locations are shown on Figure 4 (Willamette Cove), Figure 5 (Swan Island Lagoon), and Figure 6 (RM 11.5E). Based on the pilot study, the receivers within each fine-scale array will be spaced approximately 150 to 200 m apart. The proposed receiver location coordinates are presented in Table 1 (final positioning will change based on the specific locations where receivers are deployed).

The key principle of the study design is that each receiver gate will not allow a tagged fish to transit past the gate without being detected. Based on the pilot study findings, the distance between receivers along a transect provides a high degree of certainty that a passing tagged fish will be detected. After a tagged fish is released, its location will be determined via transponding. The receiver technology allows for acoustic querying to determine which tagged fish have been detected and how many detections have been received. If a tagged fish then moves out of the detection range of one gate, it cannot pass the next gate either upstream or downstream without being detected. The sequence of detections then defines the location and direction of the tagged fish to the area between the upstream and downstream gates surrounding the last gate where the tagged fish was detected. Over time, the sequence of detections at the gates and arrays will inform the fish’s movement within and across the 1-mile zones. At the study area end points, it is unlikely for a tagged fish to exit the study area without being detected, and it would be obvious which direction a fish is traveling if it is detected by the end gates. Likewise, it would not be possible for a tagged fish to re-enter the study area without being detected and its direction of movement logged.

For the fine-scale positioning arrays, the detection ranges of all receivers will be at least as great as the greatest dimension of the given fine-scale array. Therefore, upon approach, a tagged fish will be detected by one or more receivers long before it enters the bounds of the positioning array. Positioning a tagged fish can occur outside the bounds of the positioning array, although positioning error increases with increasing distance away from the array.

The combination of RM and fine-scale acoustic tracking of SMB over the year-long study duration (discussed in Section 2.6) is expected to provide a robust and representative dataset for characterizing the seasonal movement and home range of SMB throughout the PHSS.

Prior to deployment, AECOM will confirm station placement with the U.S. Army Corps of Engineers (USACE) Portland District to see if there is any potential for dredging in the monitoring locations over the course of the study. If there is potential dredging activity scheduled, these locations will be adjusted accordingly, and EPA will be notified of any changes.

2.3 Tagged Fish

The SMB has been selected as the species of interest for this study, as it is a prevalent, resident species with a smaller home range than other species included in the BHHRA (Kennedy/Jenks 2013a; Windward 2015). Further, a robust historical dataset on this species exists, making the SMB a good target for tissue monitoring (Section 2.1.1). A sample size of 40 tagged fish was selected for the PDI study. This number is sufficient to generate a robust dataset, even if some fish are lost over the course of the study. Consistent with the PDI SMB tissue study, SMB that are greater than 228 millimeters in total length (approximately 9 inches) will be targeted, with a preference for larger specimens. To the extent practicable, the weight of the tag (in air) will be in the range of 2-5% of the total fish body weight, but not exceed 10% of the total body weight (Adams, et al 1998; Brown, et al, 1999). The HTI-Vemco model V9 tag, with a weight of 3.7 grams, will be used. Achieving a tag-fish weight ratio of less than 10% is not expected to pose a challenge based on the weight of SMB specimens caught during several prior sampling programs in the Study Area, as summarized in the table below.

Study		SMB Body Weight		
	Sample Size	Minimum (g)	Maximum (g)	Mean (g)
2012 SMB Study	92	85	660	350
2011 SMB Study	68	140	790	377
2007 RI Sampling for SMB	136	134	1035	344

2.4 Targeted Fishing Locations

Collection of fish for the study will be targeted within the high resolution array areas (Willamette Cove, Swan Island Lagoon, and RM 11.5E), supplemented with fish collection in RM 5 – RM 9 as needed. Maps from historical fish sampling efforts as well as institutional knowledge of the Oregon Bass and Panfish Club will help guide sampling efforts. Angling efforts will be focused on locations that were productive in prior sampling events, as shown in Figure 7 (Integral 2008; GSI 2012; Kennedy/Jenks 2013b). It is anticipated that the fish collected for this effort will be representative of the resident population in the PHSS.

2.5 Sample Nomenclature

Both the acoustic receivers and the tagged fish will have a unique identifying sample identification number (ID) that includes the following, as described in the project-specific QAPP:

- Project phase (PDI)
- Sample matrix (AR [acoustic receiver] and AT [acoustic tagged fish])
- Sample type (A [acoustic receiver] and SMBT [tagged smallmouth bass]
- Unique, sequential station number (001 to ### per sample)

For example, acoustic receiver #32 would have the sample ID PDI-AR-A032, and the SMB implanted with tag #40 would have the sample ID PDI-AT-SMBT040.

2.6 Schedule

The fish tracking study is scheduled to begin in late April 2018 with deployment of receivers followed by fish tagging in early May over a period of approximately 2 to 3 weeks. Receivers will be checked monthly for operational status using a topside transponder. Data downloads are scheduled for 3 months, 6 months, and at the conclusion of the study in late March/early April of 2019. It is anticipated that the results of the 3-month data download (July 2018) will be used to inform the SMB sampling program scheduled for August/September 2018. Telemetry equipment retrieval will take place at the conclusion of the study in spring 2019.

3. PROJECT ORGANIZATION/FIELD TEAM

3.1 Team Organization and Responsibilities

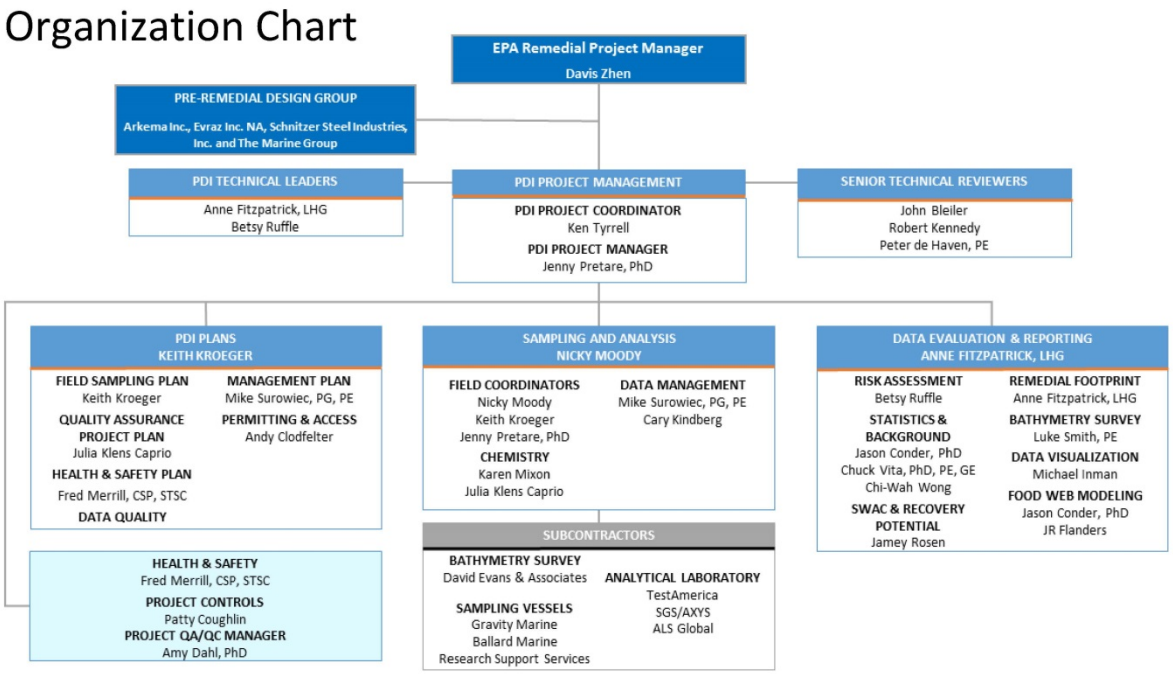
EPA is the lead agency overseeing the work. The EPA Project Manager is Mr. Davis Zhen. EPA will be assisted in the review of technical documents by an oversight contractor.

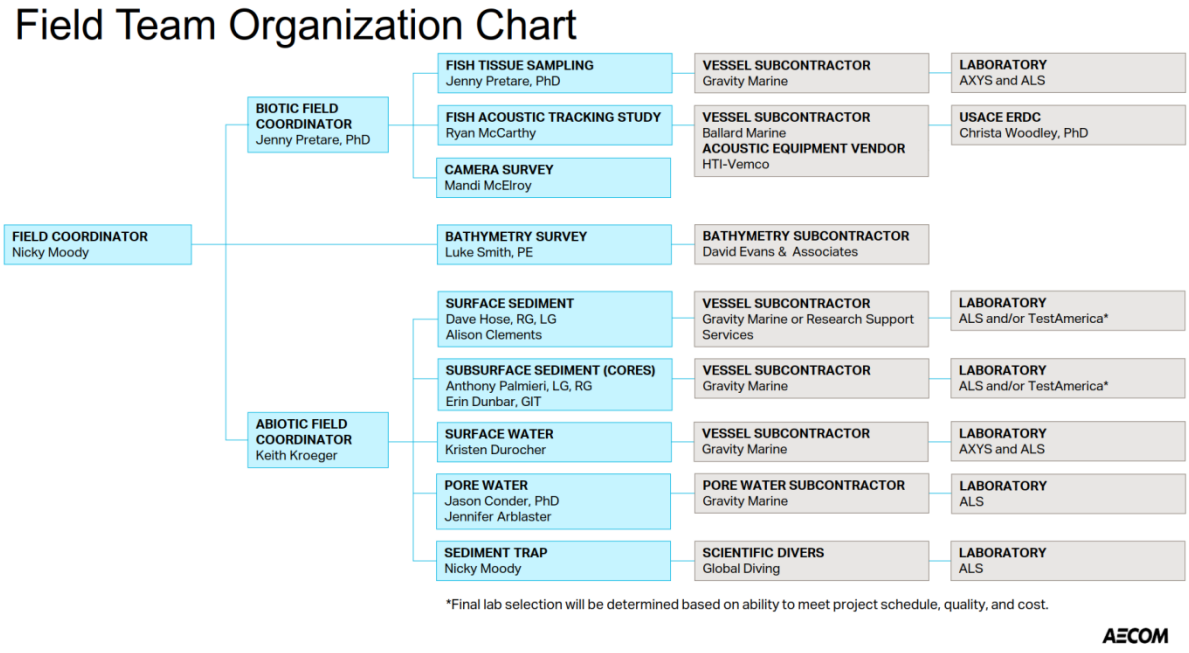
Team organization is presented in detail in the PDI Work Plan and in Section 2 of the QAPP. Project organizational charts are presented below. As it relates to this FSP, AECOM is coordinating activities, including management of all subcontractors, field sampling, analysis, and reporting scoping tasks.

The PDI Project Coordinator, Mr. Ken Tyrrell, and PDI Project Manager, Dr. Jennifer Pretare, Ph.D. (AECOM), will be responsible for overall project coordination and providing oversight on planning and coordination, work plans, all project deliverables, and performance of the administrative tasks needed to ensure timely and successful completion of the project. Ms. Betsy Ruffle (AECOM) will serve as the senior technical lead for this study.

Ms. Nicky Moody (AECOM) and Mr. Keith Kroeger (Geosyntec) will be the Project Field Coordinators (FCs) and will be responsible for managing field activities and general field quality assurance/quality control (QA/QC) oversight. The fish tracking task will be led by Mr. Ryan McCarthy (AECOM), who led the pilot study, with support from Mr. Steve Pagliughi, an AECOM senior fishery biologist with extensive experience with SMB and fish telemetry studies.

Ballard Marine Services (Ballard), of Washougal, Washington, will provide vessel support during the deployment of the acoustic moorings and monthly field checks, with Mr. Robert Stanton acting as the point of contact. Gravity Marine Services (Gravity), of Fall City, Washington, will provide vessel support during fish collection and tag implant, with Mr. Shawn Hinz acting as the point of contact. HTI-Vemco of Seattle, Washington, will provide telemetry support, including provision of telemetry equipment, supporting receiver deployment and tag implantation, and performing preliminary post-processing and data analysis. Mr. Sam Johnston will serve as the HTI-Vemco point of contact. Both Ballard and HTI-Vemco participated in the pilot study. Dr. Christa Woodley, Senior Aquatic Biologist with the USACE Engineer Research and Development Center, who also participated in the pilot study, will provide expert assistance and review.





3.2 Communication/Information Flow

The communication strategy is outlined in Section 2 of the QAPP. The FC will be the point of contact for field staff during the implementation of this FSP. Deviations from this FSP or the project-specific QAPP will be reported to the PDI Project Coordinator for consultation. Significant deviations from the FSP/QAPP will be further reported to representatives of the Pre-RD AOC Group and EPA.

3.3 Coordination with EPA

The PDI Project Coordinator will notify the EPA Project Manager 1 week prior to beginning any field activities so that EPA can schedule any oversight activities required. The PDI Project Coordinator will also notify the EPA Project Manager once field activities have been completed.

4. FIELD WORK TASKS AND PROCEDURES

The following sections describe the procedures and methods that will be used during the acoustic fish tracking study. These procedures include receiver/mooring deployment, fish collection, tag implantation, data downloading, and mooring recovery activities, as well as recordkeeping and field quality control procedures. It is currently anticipated that this work will commence in April 2018 and will be 1 year in duration. All field work will be conducted in accordance with the project-specific Health and Safety Plan (AECOM and Geosyntec 2018b). Standard Operating Procedures (SOPs) associated with the fish tracking program are provided in Appendix A.

4.1 Sampling Vessels and Equipment

Fish collection activities will be performed on vessels provided by a subcontractor (Gravity Marine, supported by the Oregon Bass and Panfish Club). These boats will be equipped with aerated livewells in order to store/transport fish between the collection site and the landside surgery station, which will be located in Swan Island Lagoon at Fred Devine Diving and Salvage facility (6211 North Ensign Street, Portland).

Receiver mooring deployment, data download, and recovery activities will be performed on research work vessels provided by Ballard. The vessels will provide a wide, stable platform and be equipped with a davit arm suitable for safely lifting and deploying heavy loads (e.g., 100 pounds). Monthly routine monitoring may be performed using smaller vessels, depending on availability and river conditions.

4.2 Permits/Notifications

The study will involve the collection of approximately 40 SMB using hook-and-line methods, surgical implant of an acoustic tag, and subsequent release back to the river following a recovery period. All non-target sized SMB or other fish incidentally captured will be immediately and safely returned back to the river.

The lower Willamette River supports five federally threatened salmonid species that could be incidentally captured during hook-and-line fishing. Section 4(d) of the Endangered Species Act directs the National Marine Fisheries Service (NMFS) to issue authorizations for scientific research projects that may result in incidental take (harm or harassment) of federally threatened species. The ODFW also requires a scientific taking permit to collect fish from the waters of the state for scientific purposes. However, Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) 121(e)(1) and the National Contingency Plan (40 CFR

300.400(e)(1)) exempt the requirement for federal, state, or local permits for on-site response actions conducted pursuant to CERCLA.

The Pre-RD AOC Group submitted a letter to EPA describing the program-wide approach to permit equivalencies on February 16, 2018. The AECOM PDI Project Coordinator and/or PDI Project Manager will continue to work with EPA on refining and implementing this approach. As described in the permit equivalencies letter, an Oregon Department of State Lands (DSL) General Authorization for Minimal Disturbance and a DSL Access Agreement will be obtained, along with an ODFW Scientific Taking Permit. The project team is coordinating with NMFS regarding Endangered Species Act listed resources in the study area.

4.3 Station Positioning/Navigation

The Ballard research vessel will navigate to each proposed mooring location using a differential global positioning system (DGPS) unit with an accuracy of 1 to 2 m (SOP-05, Recording Sample Collection Locations). The DGPS accuracy will be confirmed each morning and evening to a known land-based survey point. Confirmed deployment locations will be recorded to the nearest whole international foot in North American Datum 1983 (NAD83), National Spatial Reference System (NSRS) 2007. Once the vessel has navigated to the proposed deployment location, the field team will visually confirm the location and surroundings against the proposed receiver array maps (Figures 3 through 6) prior to deployment. The locations depicted on the figures are approximate, as actual deployment locations will be dictated by conditions encountered in the field.

4.4 Acoustic System Components

The major components of the acoustic system are the HTI-Vemco Model HR2 receiver and the Model V9 tag (180 kHz). The internal clocks in receivers will all be synchronized to an external GPS receiver prior to deployment. The HTI-Vemco HR2 receivers are expected to have sub-meter positional accuracy.

The acoustic receivers will be mounted to fixed moorings placed on the bottom of the lower Willamette River (Figure 8). The bottom mounts will be fabricated prior to the commencement of the study. The mooring platforms will consist of a purpose-built metal frame that has been designed for easy deployment and retrieval of the system (Figure 9). A ground line will be attached as a backup in the event that an acoustic release fails or is damaged. If determined to be practical, the ten bottom mounts that were used for the 2017 Pilot Study may be reused for this study. These moorings will be outfitted with an acoustic release for periodic downloading and maintenance.

According to the tag manufacturer (HTI-Vemco), fine suspended particulates do not significantly affect detection ranges at 180 kHz until the concentration is very high, and/or the particles are

relatively large (similar to sand grains).[2] During the course of the study, the signal strength of transmissions between receivers at each detection gate and at the positioning arrays will be measured every 30 seconds. If there is significant reduction of detection range due to attenuation caused by increased turbidity, it can be quantified and time periods when detection ranges are reduced can be characterized. There may be times of reduced detectability when special events occur (e.g., a large tug passing nearby); however, it is expected that these times will be limited in duration.

In the three focus areas (Willamette Cove, Swan Island Lagoon, and RM 11.5E), the receivers in each array will be anchored to the bottom and have a tethered cable to shore, given the proximity to shore and assuming property access agreements are obtained. The final locations of the cabled receivers will be confirmed after a Site visit and final approval(s) of property access.

4.5 Mooring/Receiver Deployment

Receivers will be attached directly to the moorings and configured to have the receiver submerged approximately 1 m above the river bottom such that it will not be damaged by vessel traffic or impede navigation. Each mooring will have a submerged float, which will aid in retrieval. The on-deck davit on the research vessel will be used to hoist the mooring and gently place it on the river bottom. The receiver mount system was successfully used in the 2017 pilot study and was effective in terms of performance, security, and safe deployment/retrieval.

The Vemco HR2 180 kHz receivers planned for this study transmit a unique ID code every 25-35 seconds. It is anticipated that at least one receiver will be in close enough proximity for the receivers to detect each other's regular transmissions. During deployment and set-up of the stationary receiver array, transponding will be performed using a boat-mounted VR100 receiver to determine which receiver(s) are within range and how many detections have been stored for each one. Within the fine-scale positioning arrays, each receiver's transmissions will be used with the other receivers in each array to position each receiver in two dimensions. Tag drags will be conducted to verify maximum detection ranges and coverage. A fixed "beacon" or sentinel tag may be added at locations where transponding or tag drags indicate that receiver reception is challenged (e.g., higher noise areas) to provide a continuous time series of positioning error measurement and assess any change in receiver detectability over the course of the study. Additionally, the receiver moorings will be checked for tilt, to ensure that they are sitting flat on the river bottom and have not been deployed on a slope or fallen over. Receiver locations will be modified as needed in order to achieve the desired coverage and to optimize detection resolution in specific areas.

The location of each receiver will be surveyed using a DGPS when deployed. These station positions will be recorded on the pre-deployment checklist (included in Appendix B). Each time

[2] For over 18 years, HTI has used 307 kHz acoustic tag tracking systems (which should be much more susceptible to changes in absorption due to turbidity than 180 kHz) with no reduction in detectability throughout the highest flow periods (spring and early summer) on the Columbia, Sacramento, and other rivers.

a receiver is recovered for download or replaced, the field team will resurvey the receiver's location.

4.5.1 Monthly Field Checks

Acoustic receivers will be checked for presence, maintenance, and functionality approximately once every month. A Ballard vessel will be used for this task. The receiver's internal transponder allows for remote monitoring of tilt, temperature, battery level, available storage space, and noise levels, reducing the number of times the receiver needs to be hauled to the surface for operational checks and redeployed with new GPS coordinates. A surface communication deck box will be used for remote communications with the deployed receivers.

4.5.2 Data Downloading

Acoustic receivers will be manually retrieved, and acoustic data from the receiver will be downloaded directly via USB cable to a field computer. The receivers will be evaluated for functionality and cleared of any biofouling growth. Acoustic receivers will also be visually examined for any obvious defects or necessary repairs, and batteries will be replaced. Data downloading will be performed at 3 months, 6 months, and at the conclusion of the study (12 months). Upon re-deployment, a new GPS station position will be recorded. Once the maintenance check has been performed and the data have been downloaded, the field team will proceed to the next acoustic receiver until all receivers have been visited. Once data has been retrieved, it will be managed according to the project Data Quality Management Plan (DQMP; AECOM and Geosyntec 2018c).

4.5.3 Mooring/Receiver Recovery

At the conclusion of the study, all receiver/moorings will be collected from the river bottom. It is not anticipated that any equipment will be left behind. If the acoustic releases do not actuate, a grapple hook will attempt to snag the ground/back-up line attached to the receiver mooring.

4.5.4 Receiver Contingency Plan

Regular transponding efforts will verify that receivers are functioning properly and detecting tagged fish and other receivers. If during the course of the study, a receiver is observed to be damaged or non-functional, all practical attempts will be made to promptly retrieve it, recover the data, and restore receiver function. If the receiver is determined to be missing or irreparable, it may be replaced dependent on discussions with the Pre-RD AOC Group and EPA. Factors to consider for replacement may include the following:

1) How much time is left in the proposed study period?

2) Has this array been productive from a data perspective (i.e., many observations of SMB)?

3) Is it likely that this receiver may be damaged/vandalized again if deployed at the same location?

4) Would there be significant impacts to overall DQOs?

The Seattle, Washington, office of HTI-Vemco has a pool of Vemco HR2 180 kHz receivers that could be deployed to the Site within a few days should it be necessary to replace a receiver.

4.6 Fish Collection and Tagging

4.6.1 Fish Collection

Fish for acoustic tagging will be collected by hook-and-line angling techniques using artificial lures (SOP-04, Fish Collection). Contract anglers from the Oregon Bass and Panfish Club will be employed to capture SMB. Each subcontracted angler vessel will be outfitted with a GPS to record capture locations and an onboard or side-mounted tank or "livewell" for transporting/holding caught SMB. A maximum of four SMB will permitted to be held in livewells at any given time. Each livewell will be filled with river water that is kept aerated, cleared of all potential snags, and cooled (if necessary). This will keep the fish alive after capture so the fish can be safely transported to the surgery station. Fish will be carefully handled and cared for prior to and after surgeries.

A fish collection datasheet will be filled out immediately after a candidate specimen is captured (sheets are presented in Appendix B). A GPS coordinate will be electronically collected (SOP-05, Recording Sample Collection Locations). Each fish will be given a unique sample ID on the fish collection datasheet, and this number will be used to name the capture location point file. Sample identification nomenclature will follow the guidelines detailed in Section 2.5 of this FSP and the SOPs in Appendix A (SOP-03, Field Documentation; SOP-06, Sample Labeling). After a fish is surgically implanted with an acoustic tag at the surgery station (Section 4.6.2), the tag code and sample ID will be recorded on the fish collection datasheet in order to link the tag code to the collection location. Therefore, it will be necessary to be able to identify each captured individual between the time of capture and the time of acoustic tag implantation. Maximum total length, fork length, (in millimeters) and weight (in pounds [0.00]) will also be recorded on the fish collection datasheets immediately after capture to identify individuals. This approach will allow identification of individuals and eliminate having to mark or attach a numbered culling buoy to each individual, thus avoiding potential marking injuries that may affect post-release survival and behavior. Pre- and post-surgery livewells will also have unique IDs so the fish can be accurately tracked through the surgery and eventual release.

Landing nets will not be used to land fish in order to avoid potential injuries to captured fish and maintain tagging candidates in the best possible condition. Captured SMB having hooking or other injuries and/or displaying obvious abnormal behavior (e.g., sluggishness, erratic swimming) will not be implanted with an acoustic tag. Abnormal behavior will be determined by the best professional judgement of the on-site fisheries biologists. If at any point abnormal behavior is observed, the fish will be sacrificed and the fish will be retained for potential chemical analysis (Section 4.6.4 below).

4.6.2 Acoustic Tag Implantation

Surgical implantation will be performed by HTI-Vemco field biologists experienced in acoustic fish tag implantation procedures with assistance from AECOM biologists in accordance with SOP-07 (Appendix A). A secure, sterile, land-based surgical station will be established prior to the commencement of the study and will be assembled and disassembled each day (SOP-01, Decontamination). The surgery station will be located at the moorage location at Fred Devine Diving and Salvage facility at 6211 North Ensign Street, which has ready access to the river. Holding pens/livewells will be on-site to retain fish prior to surgery, during recovery, and before release.

A portable electronarcosis system will be utilized by HTI-Vemco field biologists to anesthetize SMB during surgical implantation procedures. The electronarcosis system consists of a modified 153 liter marine cooler, fish cradle, and a variable power generation system. The electronarcosis system is based on designs described in Hudson et al. 2011. Prior to being placed in the electronarcosis system, each SMB will be photographed (SOP-02, Digital Camera Use and Documentation Procedures) and have scales removed for age dating. Scales will be removed from the area posterior to the pectoral fin and slightly below the lateral line (DeVries and Frie 1996); scale samples will be placed in wax paper, and placed in a coin envelope with the sample date and associated sample identification number clearly written on the outside of the envelope.

Each SMB will be placed ventral side up in the cradle within the electronarcosis system with the anterior end of the fish pointed towards the anode. SMB will be submerged deep enough in the water to cover the gills. Multiple aquarium bubblers will provide and maintain adequate dissolved oxygen (DO) levels during surgery. An on-site fisheries biologist will monitor DO levels in the livewells and will record this information on the datasheets. Maintaining the oxygen level near saturation in the surgery station livewell potentially results in higher blood oxygen levels during anesthesia, which aids in post-surgery recovery (Itazawa and Takeda 1982). Using a DC power supply, voltage will be slowly increased until induction (surgical anesthesia) is achieved (Coyle et al. 2004; Hudson et al. 2011).

Prior to and after each surgery, acoustic tags, hemostats, sutures, and scalpels will be disinfected. Following a small incision in the midline area, a pre-programmed HTI-Vemco Model V9 acoustic tag will be activated and inserted through the incision and into the abdominal cavity. Each acoustic tag will be programmed with a unique code/number in order to identify the individual fish, and the acoustic tag code/number will be recorded on the fish collection datasheet. After tag insertion, the incision will be closed with two simple interrupted sutures. A small external tag (T-bar tag or equivalent) will be attached to the SMB just behind the dorsal fin, and the SMB will be removed from the electronarcosis system, placed in a well oxygenated recovery livewell, and carefully observed for post-surgery behavior. SMB should fully recover within 2 minutes after being removed from the electronarcosis system; each surgical procedure will take approximately 30 minutes.

4.6.3 Fish Recovery/Release

Tagged fish will be placed in an aerated recovery tank for at least 2 hours and up to 1 day prior to release to ensure that there are not any post-surgery complications or mortalities. Tagged fish that regain equilibrium and exhibit controlled movement will be released. To the extent practicable, fish will be released back into the river in the vicinity of where they were originally caught. The coordinates of the release location for each fish will be recorded on the field data sheet.

4.6.4 Fish Mortality

To the extent practicable, every attempt will be made to prevent any inadvertent mortalities of SMB captured and/or tagged during the study. However in the event that a mortality does occur, the fish may be considered for tissue chemistry analysis as part of the baseline fish tissue sampling described in the Fish Tissue FSP (AECOM and Geosyntec 2018d). In this case, the individual fish will be wrapped in aluminum foil, labeled, and placed in a gallon-sized, zip top bag. Fish collected in this manner will be submitted to the project selected analytical laboratory for cold storage (+/- 4°C) until a decision can be made regarding analysis. The data necessary for including the fish as a future tissue chemistry sample (e.g., location captured, size, age, etc. per the Fish Tissue FSP) will be recorded in order to ensure that DQOs are met.

4.6.5 Contingency Fish Tagging Event

The sample size of 40 tagged fish was selected assuming that some loss, due to mortality or leaving the study area, would occur over the year-long study duration. As few as 20 to 30 tagged fish are expected to provide the data needed to characterize SMB movement and home range.[3] The data from the June and July monthly monitoring and the 3-month data download in early August will be evaluated to determine the total number of tagged fish residing in the 10-mile study area and the number of detections of each tagged fish. A second tagging event will be performed in conjunction with the late August/early September 2018 SMB tissue sampling if the total number of tagged fish that have been detected at least monthly falls below 20. A minimum of 10 and up to 20 additional SMB will be tagged and tracked for the remainder of the study period. Consistent with the initial tagging event, the additional SMB will be targeted within the high resolution array areas, supplemented with fish collection in RM 5 to RM 9 as needed.

4.7 Decontamination

The physical environment implantation surgeries are performed in is an important consideration that determines the quality and success of the procedure. The surgical environment will be maintained in a sterile condition throughout all procedures. The surgical station will be intermittently cleaned and wiped down with a solution of disinfectant; reusable surgical instruments will be placed in a disinfectant bath before and after surgical procedures. Surgical

[3] A total of 23 SMB were tagged during the 2000-2003 radio-tracking study of the lower Willamette River from RM 0 to Willamette Falls (Pribyl et al. 2004). A total of 11 SMB were tagged in 2000, nine were tagged in 2002, and three were tagged in 2003. The results of this study were used by EPA to determine the 1-mile exposure areas for SMB in the Portland Harbor RI/FS.

instruments will be transferred to a freshwater rinse bath before surgery. All equipment used for capture, holding, anesthesia, surgery, recovery, and movement of fish during the project will be thoroughly cleaned and disinfected to minimize the potential for any biological interferences.

4.8 Management of Investigation-Derived Waste

Fish collected but not retained for surgery will be returned to the lower Willamette River area from which they were collected or sacrificed and retained for potential chemical analysis. Water used for decontaminating the sample processing equipment will be collected and then returned to the lower Willamette River. Only biodegradable, phosphate free detergents will be used for decontamination (e.g., Liquinox®). Other consumables such as disposable sampling equipment, fish surgical tools, and gloves will be bagged for disposal and managed as a solid waste and discarded as general municipal waste. A disposable sharps container will be on-site for safe collection/disposal of any sharps waste.

5. DATA MANAGEMENT AND REPORTING

All data management will be performed according to the QAPP and DQMP.

5.1 Field Documentation and Reporting

A bound field logbook will be assigned to and maintained by AECOM field team members to provide daily records of significant events, observations, and measurements during the field effort. Each page will be numbered, signed, and dated. These logbooks will be kept as permanent records. Complete field record keeping details can be found in the project QAPP (AECOM and Geosyntec 2018a).

A brief activity log will be filed with the FC at the completion of each working day. This log will summarize the work activities undertaken/completed each day, progress, personnel on-site, hours worked, health and safety concerns, and any technical issues encountered. Field logbooks and field data sheets completed during fish collection and implantation activities will be scanned and emailed to the Technical Lead at the conclusion of each working day (or as soon as practically possible).

5.2 Data Processing

The fish tracking data collected from the acoustic receivers during the study will be provided in raw and data-processed formats. The data will be compiled and processed using HTI's software (Acoustic Tag Software Suite and MarkTags) in order to identify valid tag returns within the raw data. The valid detections will then be compiled into a single detection history for each fish. This detection history will be further processed to identify false/erroneous events to remove spurious data points. Once the data are processed and proofed, the data will be used to create fish tracks/positions (where possible). The gated portion of the system can only provide a presence/absence data point and indicate whether a fish was within the receiver detection range.

The post-processed data sets from the high-resolution and gated receivers will be combined and imported into a Microsoft Access database.

5.3 Quality Review

A series of QA/QC steps will be implemented to ensure data integrity. Monthly checks of the receiver network will be performed to ensure system functionality and proper data collection. The data will be processed on HTI's software (Acoustic Tag Software Suite and MarkTags) to evaluate the data for accuracy/usability. If problems with the systems are detected/identified during the monthly checks, they will be corrected using remote access to the collection equipment, or field crews will be dispatched as soon as possible to visit the site and correct the problems.

The monthly transponding will allow for determining data collection continuity for each receiver, as well as the number of detections received for each tagged fish. These data will be compiled and reviewed monthly to assess overall system performance, including receiver performance. The 3-month and 6-month data downloads will also be evaluated to assess the detection range and efficiency and any changes over time. If a tagged fish is not detected by any receiver for some time, the VR100 transponder may be used as a mobile receiver to locate tagged fish in areas not near the detection gates or the fine-scale positioning arrays. The need to conduct any mobile transponding to locate "missing" tagged fish over the course of the study would be discussed with EPA.

5.4 Reporting Frequency

Brief field summary reports will be provided to EPA following the 3-, 6-, and 12-month data downloads. Equipment specifications including system and tag operating parameters, calibrations, and results of pre-installation testing will be included in the summary reports. Methods, analyses, and results for all testing procedures including establishing range and efficiency calculations will be documented and presented in standard scientific reporting format.

The overall results of the study will be discussed and presented in a final report that will specifically address the key questions identified in the study objectives in Section 1.2, identify plan deviations, and summarize field collection activities.

5.5 Plan Deviations

Deviations to this FSP potentially include the monitoring of alternate stations or scope reductions/enhancements related to site conditions or real-time information. Safety will be given the highest priority in all aspects, and the Field Coordinator will be responsible for documenting all plan deviations and contacting the Project Technical Lead or PDI Project Manager to discuss these at the earliest convenience, preferably before deviations are undertaken, if possible.

5.6 Data Management and Retention

All related documentation is to be maintained in the project file either in electronic or hardcopy form. All hardcopy records will be maintained in the project file; all electronic records will be maintained in project-specific directories within AECOM's network and a final Electronic Data Deliverable will be provided to EPA at the conclusion of the PDI study.

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TABLES

Table 1. Coordinates of Proposed Receiver Locations

	Proposed Location Coordinates (NAD 1983, Intl Feet) [a]	
Receiver ID	**Easting**	**Northing**
PDI-AR-A01	7617785	725573
PDI-AR-A02	7617159	725997
PDI-AR-A03	7616627	726410
PDI-AR-A04	7613373	720491
PDI-AR-A05	7613329	720241
PDI-AR-A06	7620316	711291
PDI-AR-A07	7619786	710986
PDI-AR-A08	7619351	710760
PDI-AR-A09	7623346	707348
PDI-AR-A10	7622976	706944
PDI-AR-A11	7622675	706598
PDI-AR-A12	7626823	705692
PDI-AR-A13	7626771	705455
PDI-AR-A14	7627349	705607
PDI-AR-A15	7627114	705360
PDI-AR-A16	7627510	704330
PDI-AR-A17	7627033	703825
PDI-AR-A18	7631922	701400
PDI-AR-A19	7631107	700551
PDI-AR-A20	7630513	699906
PDI-AR-A21	7632710	701760
PDI-AR-A22	7633412	701735
PDI-AR-A23	7633178	701324
PDI-AR-A24	7633956	701070
PDI-AR-A25	7635076	697378
PDI-AR-A26	7634788	696950
PDI-AR-A27	7634459	696383
PDI-AR-A28	7644382	688077
PDI-AR-A29	7644821	688359
PDI-AR-A30	7645142	687911
PDI-AR-A31	7644791	687638
PDI-AR-A32	7645511	687193
PDI-AR-A33	7645322	687027
PDI-AR-A34	7645129	686858

Notes:

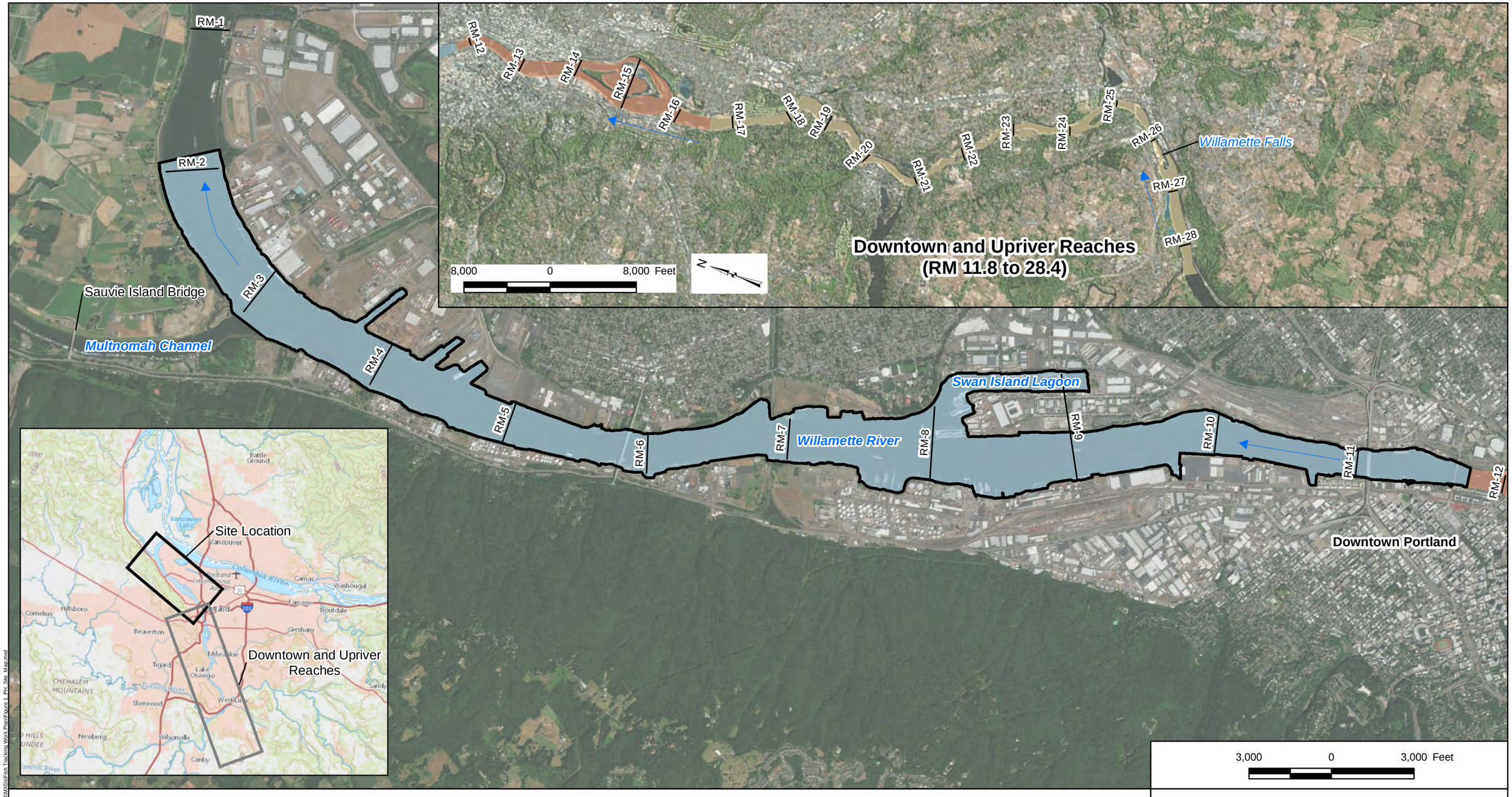
a) Horizontal Projection: NAD 1983 Oregon State Plane North (Intl Feet)

Acronyms:

ID = identification number

NAD = North American Datum

FIGURES



Legend

- Flow Direction
- River Mile Marker
- Superfund Site Boundary (RM 1.9 to 11.8)

Study Area

- Site Area (RM 1.9 to 11.8)
- Downtown Reach (RM 11.8 to 16.6)
- Upriver Reach (RM 16.6 to 28.4)

Note:
1. Aerial Imagery provided by ESRI Basemaps 2016

Portland Harbor Site Map

Portland Harbor Superfund Site
PDI Fish Tracking FSP

AECOM Geosyntec consultants

MI/SEA	March 30, 2018	Figure 1

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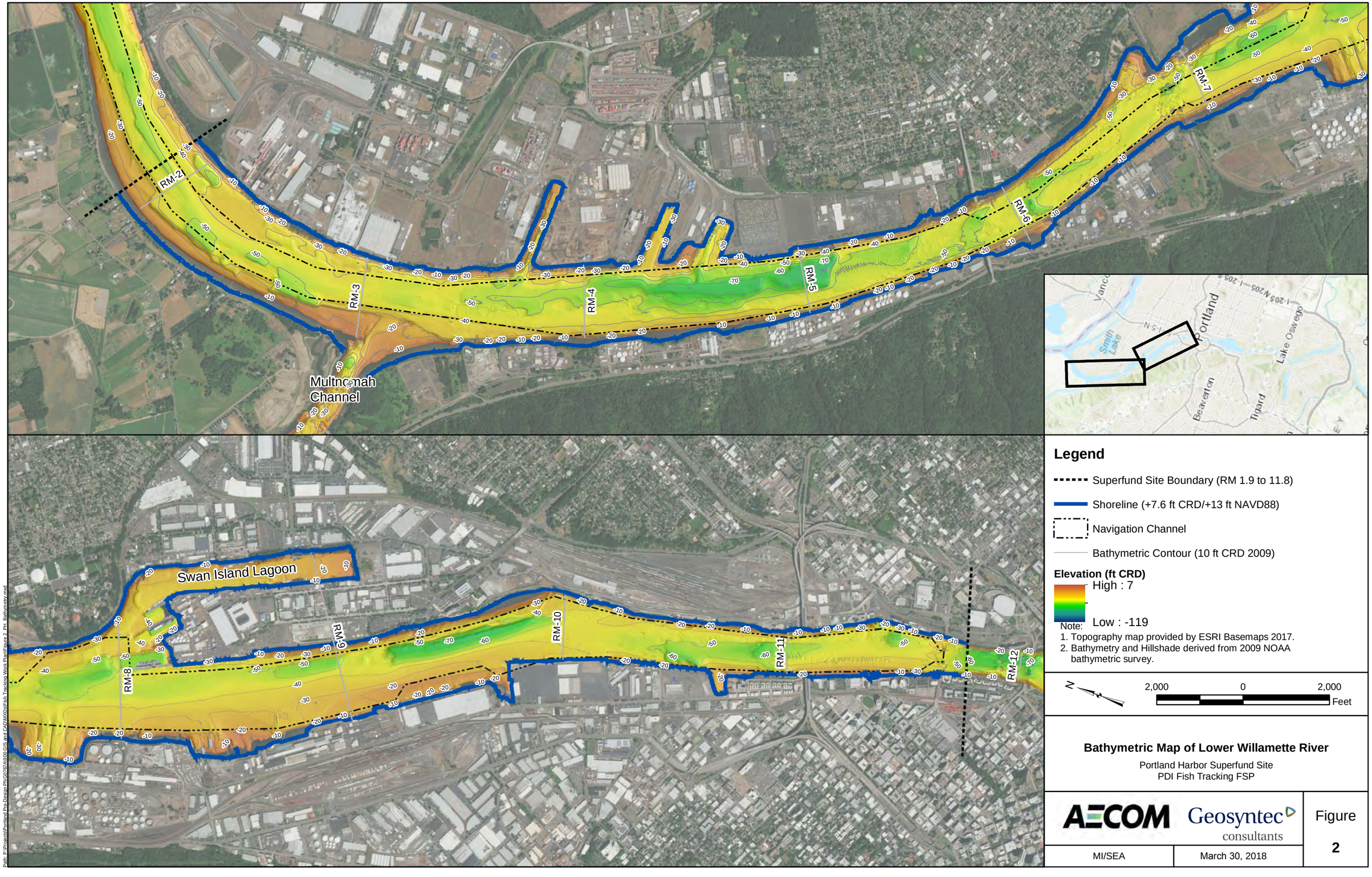

Legend

- Superfund Site Boundary (RM 1.9 to 11.8)
- Shoreline (+7.6 ft CRD/+13 ft NAVD88)
- Navigation Channel
- Bathymetric Contour (10 ft CRD 2009)

Elevation (ft CRD)

High : 7

Low : -119

Note:

1. Topography map provided by ESRI Basemaps 2017.
2. Bathymetry and Hillshade derived from 2009 NOAA bathymetric survey.

N

2,000 0 2,000 Feet

Bathymetric Map of Lower Willamette River

Portland Harbor Superfund Site
PDI Fish Tracking FSP

AECOM Geosyntec consultants

MI/SEA	March 30, 2018	Figure 2

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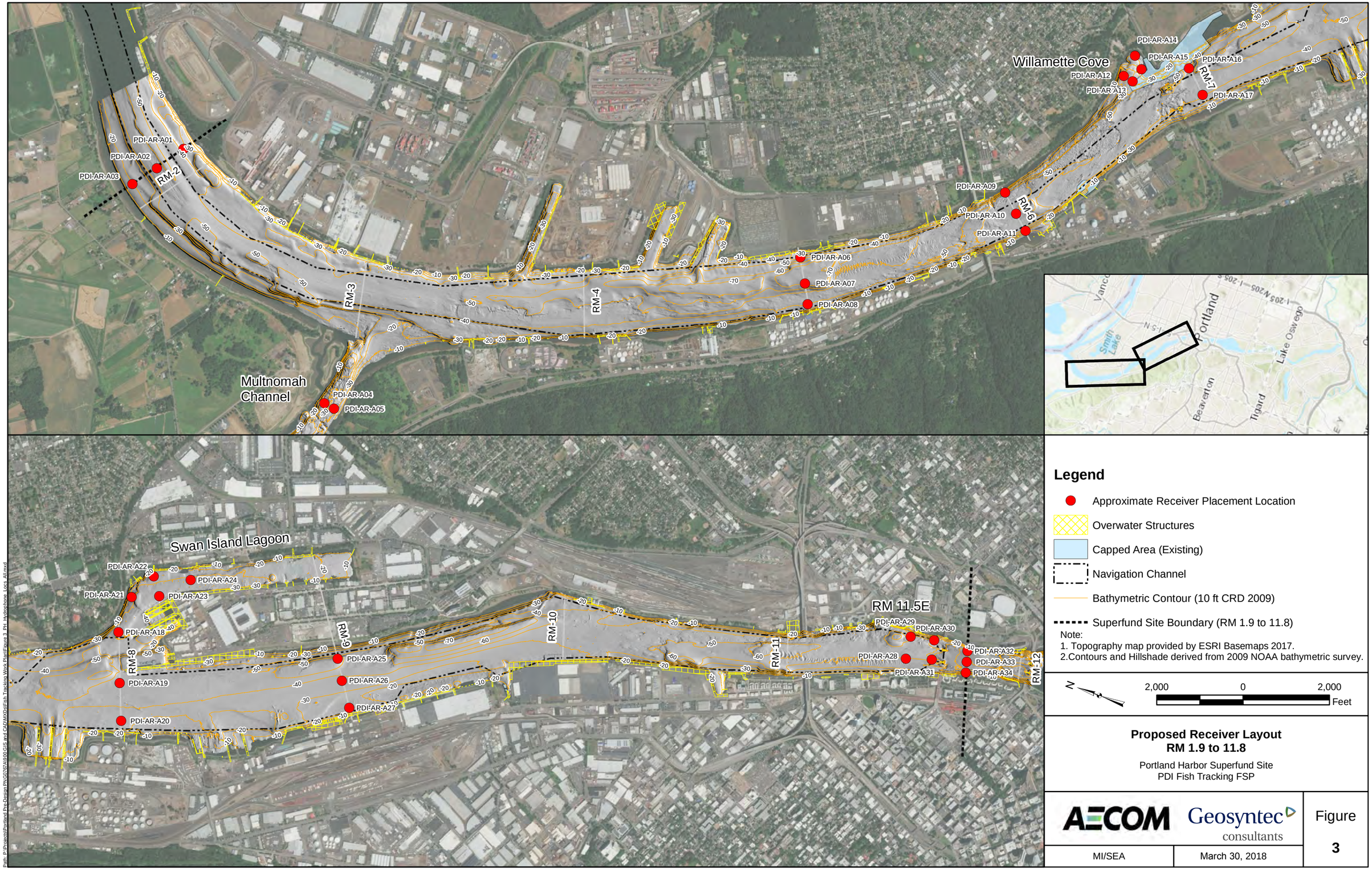

Legend

- Approximate Receiver Placement Location
- Overwater Structures
- Capped Area (Existing)
- Navigation Channel
- Bathymetric Contour (10 ft CRD 2009)
- Superfund Site Boundary (RM 1.9 to 11.8)

Note:
1. Topography map provided by ESRI Basemaps 2017.
2.Contours and Hillshade derived from 2009 NOAA bathymetric survey.

N

2,000 0 2,000 Feet

Proposed Receiver Layout
RM 1.9 to 11.8

Portland Harbor Superfund Site
PDI Fish Tracking FSP

AECOM Geosyntec consultants

MI/SEA	March 30, 2018	Figure 3

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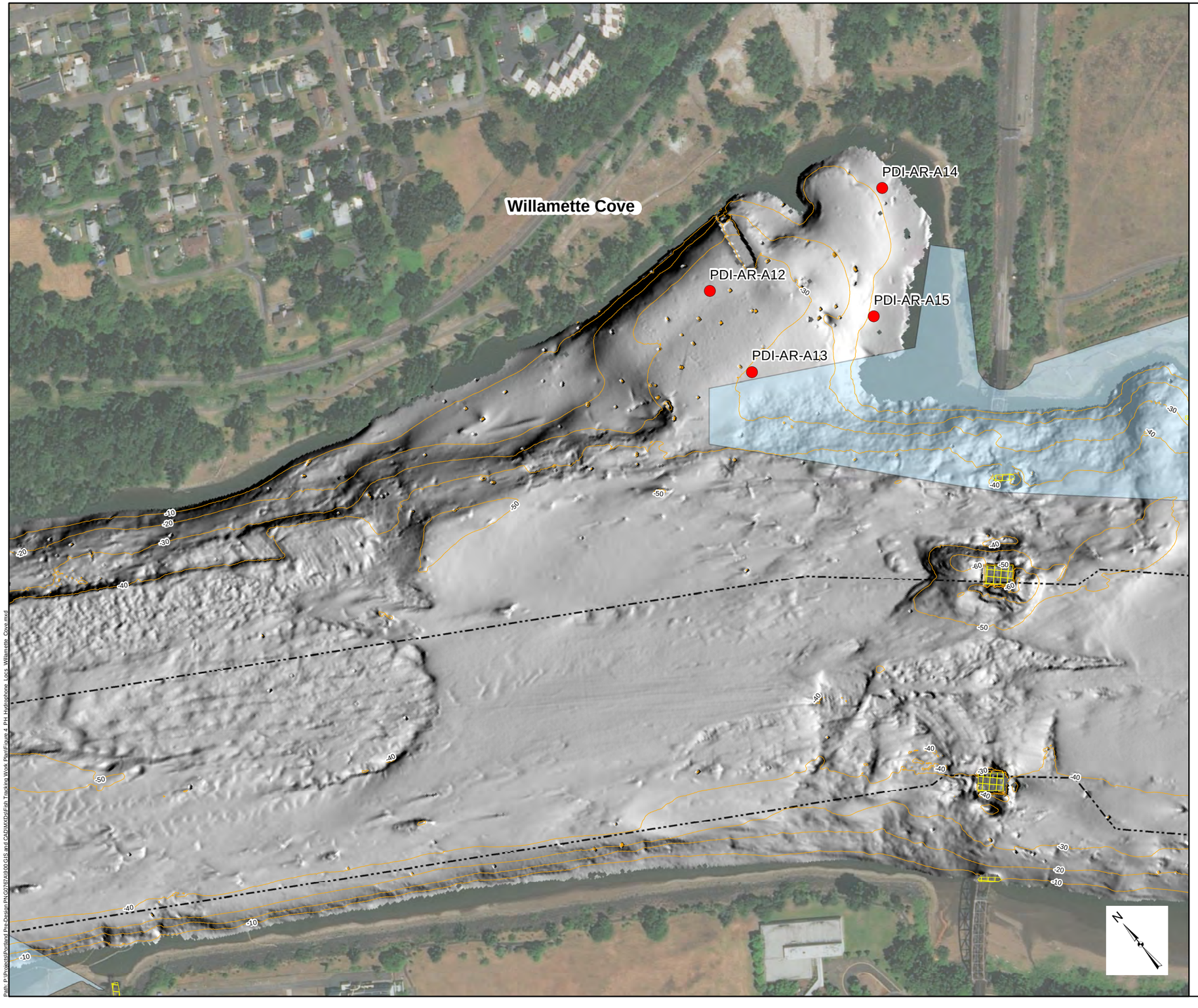


Legend

- Approximate Receiver Placement Location
- Overwater Structures
- Capped Area (Existing)
- Navigation Channel
- Bathymetric Contour (10 ft CRD 2009)

Note:
1. Topography map provided by ESRI Basemaps 2017.
2. Contours and Hillshade derived from 2009 NOAA bathymetric survey.

200 0 200
Feet

Proposed Receiver Array Layout
Willamette Cove

Portland Harbor Superfund Site
PDI Fish Tracking FSP

AECOM Geosyntec consultants

MI/SEA	March 30, 2018	Figure 4

Path: P:\Projects\Portland Pre-Design PN\G7674\900\GIS and CAD\MXD\Fish Tracking Work Plan\Figure 4 PH Hydrophone Locs Willamette Cove.mxd

Swan Island Lagoon

PDI-AR-A22

PDI-AR-A24

PDI-AR-A21

PDI-AR-A23

PDI-AR-A18

PDI-AR-A19

RM-8

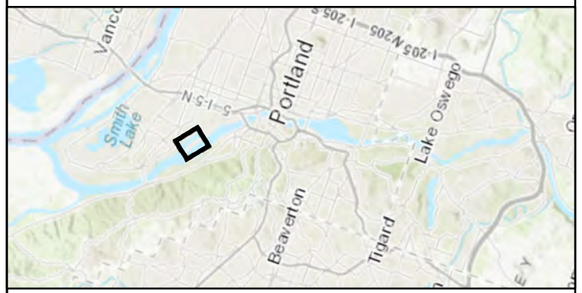
RM-9

PDI-AR-A25

PDI-AR-A26

PDI-AR-A27

PDI-AR-A20



Legend

- Approximate Receiver Placement Location
- Overwater Structures
- Navigation Channel
- Bathymetric Contour (10 ft CRD 2009)

Note:
1. Topography map provided by ESRI Basemaps 2017.
2. Contours and Hillshade derived from 2009 NOAA bathymetric survey.

200 0 200
Feet

Proposed Receiver Array Layout
Swan Island Lagoon

Portland Harbor Superfund Site
PDI Fish Tracking FSP

AECOM Geosyntec consultants

Figure 5

MI/SEA | March 30, 2018

Path: P:\Projects\Portland Pre-Design PN\G0767A\900 GIS and CAD\MXD\Fish Tracking Work Plan\Figure 5_PH_Hydrophone_Locs_Swan_Island.mxd

RM 11.5 E

PDI-AR-A29

PDI-AR-A30

PDI-AR-A28

PDI-AR-A31

PDI-AR-A32

PDI-AR-A33

PDI-AR-A34

Legend

- Approximate Receiver Placement Location
- Overwater Structures
- Navigation Channel
- Bathymetric Contour (10 ft CRD 2009)
- Superfund Site Boundary (RM 1.9 to 11.8)

Note:
1. Topography map provided by ESRI Basemaps 2017.
2. Contours and Hillshade derived from 2009 NOAA bathymetric survey.

200 0 200
Feet

Proposed Receiver Array Layout
RM 11.5E

Portland Harbor Superfund Site
PDI Fish Tracking FSP

AECOM Geosyntec consultants

MI/SEA	March 30, 2018	Figure 6

Path: P:\Projects\Portland Pre-Design PN\60767AI\900 GIS and CAD\MXD\Fish Tracking Work Plan\Figure 6_PH Hydrophone Locs_RM11_5E.mxd

RM-0
RM-1
RM-2
RM-3
RM-4
RM-5
RM-6
RM-7
RM-8
RM-9
RM-10
RM-11
RM-12
RM-12
RM-13
RM-14
RM-15
RM-16
RM-17
RM-18
RM-19
RM-20

Legend

- 2012 Fish Tissue Sampling Location
- 2011 Fish Tissue Sampling Location
- 2007 Fish Tissue Sampling Location
- Superfund Site Boundary (RM 1.9 to 11.8)
- Alternative F Mod SMA Footprint

Note:
1. Aerial Imagery provided by ESRI Basemaps 2017
2. n - sample count, RM - River Mile, SMA - Sediment Management Area
3. Site defined as RM 1.9 to 11.8
4. The Downtown Reach is defined by EPA as extending from RM 11.8 to RM 16.6 and Upriver Reach is defined by EPA as extending from RM 16.6 to RM 28.4
5. The 2007 locations represent a central point for the individual specimens included in each composite

2,000 0 2,000 Feet

N

Smallmouth Bass Catch Locations from Prior Sampling Events (RM 1.9 to 20)

Portland Harbor Superfund Site
PDI Fish Tracking FSP

AECOM Geosyntec consultants

MI/SEA | March 30, 2018

Figure 7

Path: P:\Projects\Portland Pre-Design PN\60707A\900\GIS and CAD\MXDs\Fish Tracking Work Plan\Figure 7_PH_FishTissueHistoric.mxd

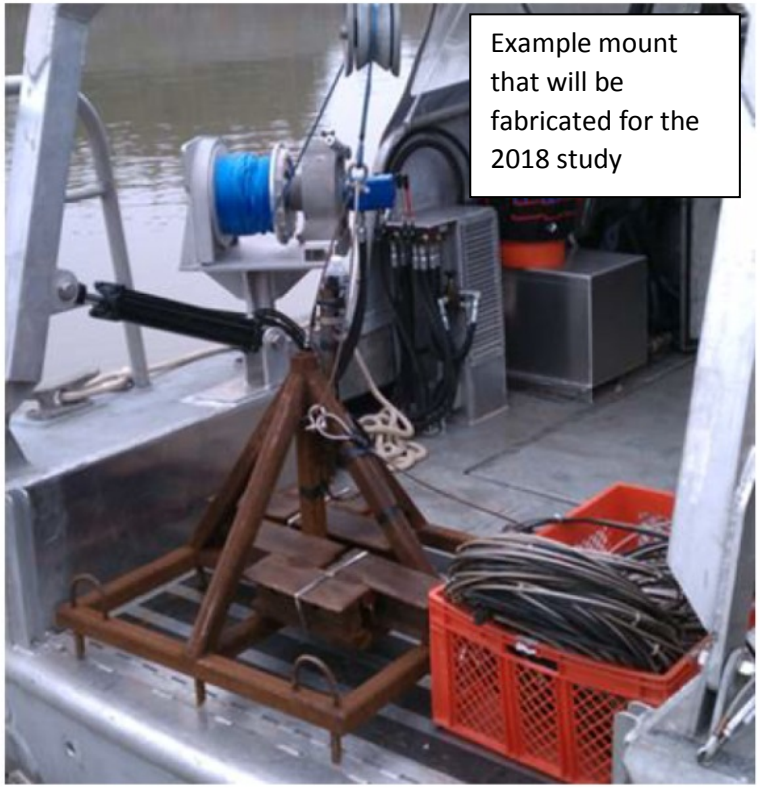


Figure 8. Acoustic Equipment Mount

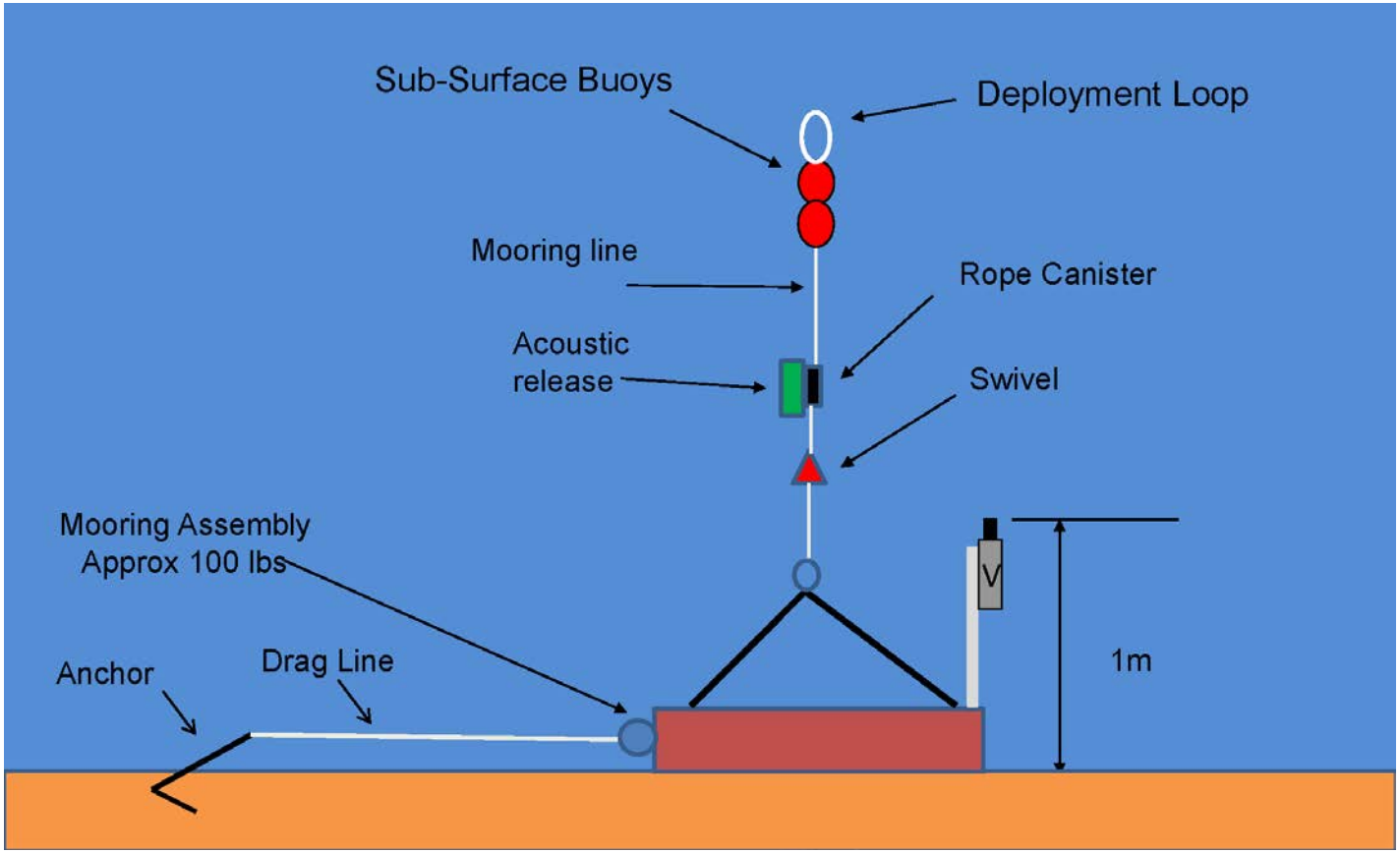


Figure 9. Acoustic Equipment Schematic

APPENDIX A

Standard Operating Procedures

- Decontamination
- Digital Camera Use and Documentation Procedures
- Field Documentation
- Fish Collection
- Recording Sample Collection Locations
- Sample Labeling
- Surgical Implantation of Acoustic Tags

STANDARD OPERATING PROCEDURE SOP-01

DECONTAMINATION

Scope and Applicability

This standard operating procedure (SOP) describes procedures for decontaminating sampling and processing equipment contaminated by inorganic and organic materials. To prevent potential cross-contamination of samples, all reusable sampling and processing equipment will be decontaminated before each use. Decontaminated equipment will be stored away from areas that may cause recontamination. When handling decontamination chemicals, field personnel will follow all relevant procedures and will wear protective clothing as stipulated in the project health and safety plan (HASP).

Equipment and Materials

Equipment and materials for this task include the following:

- Plastic bucket(s) (e.g., 5-gallon bucket)
- Properly labeled squirt bottles (or large spray bottles if needed)
- Long-handled, hard-bristle brushes
- Plastic sheeting, garbage bags, and aluminum foil
- Tap water or river water
- Personal protective equipment, as specified in the HASP

Decontamination Procedures

When necessary, reusable sampling equipment should be decontaminated before and after the sampling effort, between sampling stations, and at any other times specified by the field sampling plan (FSP). The specific procedures for decontaminating reusable sampling equipment are as follows:

1. Rinse the equipment thoroughly with tap or river water to remove any visible sediment or debris.
2. Pour a small amount of concentrated laboratory detergent (e.g., Alconox) into a bucket (e.g., about 1/2 tablespoon per 5-gallon bucket) and fill it halfway with tap or river water. If the detergent is in crystal form, all crystals should be completely dissolved prior to use.
3. Scrub the equipment in the detergent solution using a long-handled brush with rigid bristles, using a back-and-forth motion. Be sure to clean the outside of samplers,

bowls, and other tools that may be covered with sediment or tissue. Remove all particulate matter and surface films.

4. Rinse with tap or river water. Equipment does not need to be dried before use.
5. If the decontaminated sampling equipment is not to be used immediately, wrap small items in aluminum foil (dull side facing the cleaned area).
6. If the sample collection or processing equipment is cleaned at the field laboratory and transported to the sampling site, then the decontaminated equipment will be wrapped in aluminum foil (dull side facing the cleaned area) and stored and transported in a clean plastic bag (e.g., a trash bag) until ready for use, unless the FSP lists special handling procedures.

STANDARD OPERATING PROCEDURE SOP-02

DIGITAL CAMERA USE AND DOCUMENTATION PROCEDURES

Purpose

The purpose of this standard operating procedure (SOP) is to describe the use of digital cameras and procedures for digital camera data management.

Scope and Applicability

This SOP is applicable to taking digital photographs and placing the digital data in a database. Digital photographs may be taken to document field activities, site conditions and features, and sampling locations.

Equipment and Materials

Equipment and materials for taking digital photographs include the following:

- Digital camera
- Spare batteries
- Digital camera-carrying case and manual
- Photo log form
- Dry-erase board
- Dry-erase marker
- Personal computer
- Black waterproof pen

Typical Camera Features

- Save photographs (in standard mode) directly to a memory stick or comparable device
- Auto focus; manual focus available if required
- Zoom
- Brightness control
- Playback of photographs on camera screen
- Display of photograph number, date, and time
- Flash
- Timer

- Display showing time remaining on battery and remaining disk capacity
- Ability to protect and delete images that have been taken

Camera Use

Digital cameras will be used by the field team to document field activities. Each field team will be directly responsible for the camera to ensure that it is not exposed to excessive heat, cold, or moisture. The field team leader will be responsible for digital photograph documentation or for assigning documentation duties to a team member.

Digital photographs will be taken to document field activities and locations. Examples of field activities for which photo documentation will be useful include 1) individual samples; 2) sampling location; and 3) field sampling techniques used, such as equipment use and operation.

Each individual sample and each sample location will be photographed. A minimum of three photographs of each field sampling technique will also be photographed.

Digital photographs will be collected at a high-pixel setting such that enlargements can be made with minimal degradation in picture quality.

Photograph Documentation

Field Team Responsibilities

Each field team will keep a daily hard copy log of all photographs. The following digital photograph data will be collected:

- Date and time—as provided by the camera display.
- Team members—list each team member.
- Camera identifier (type, model, equipment number).
- Sample Location ID, if applicable. This information is obtained from the field team leader and/or Data Quality Management Plan (DQMP). This ID should be written onto a dry erase board and included in the photo frame.
- Sample ID, if applicable. This ID should be written onto a dry erase board and included in the photo frame.
- Photograph ID—record the number of the photograph and the photograph file name (as coded below).
- Description—the target of the photograph.

Digital Photograph File Name

At the end of each field day, the member of the field team who is responsible for the camera will transfer the electronic data from the camera to the field operations computer. The folder structure will be as follows (or as specified in the DQMP):

\\DATA\PHOTOS\YYYYMMDD\SAMPLE AREA\file\[1, 2, 3, ...N]

The notation YYYYMMDD represents the year, month, and day. The sample area is the sampling area name (e.g., Willamette River). The individual files for the day (e.g., file 1, file 2, file N) will be placed within this folder using the default file identifier provided by the camera.

Transfer of Information and Archive

After the photograph disks have been uploaded, the original hard copy of the photograph log will be initialed and dated by the team member who downloaded the photographs, then archived by the field team leader.

Sample Processing Coordinator Responsibilities

The field team leader will be responsible for 1) reviewing electronic photographs and the logs as they are made available to ensure consistency and completeness of annotations; 2) collecting and archiving the hard copies of the photograph logs; 3) reviewing electronic photographs and the logs as they are made available to ensure consistency and completeness of annotations; and 4) notifying the sampling team leader of apparent inconsistencies and making recommendations for corrective action.

Key Checks and Items

Important checks for digital camera management include the following:

- Make sure the camera's battery is fully charged on a daily basis.
- Keep extra memory sticks available.
- To save battery life, use flash only when necessary.
- Make sure the camera quality level is set at "best" or equivalent (high pixel).
- Review photograph records periodically to ensure that the electronic photographs, dry erase board information, and the Specimen Tally and Location Form agree.
- Leave enough time at the end of the field day to transfer the data.

STANDARD OPERATING PROCEDURE SOP-03

FIELD DOCUMENTATION

Scope and Applicability

This standard operating procedure (SOP) presents the general information that will be documented for all sampling activities conducted by field personnel. Proper record keeping will be implemented in the field to allow samples to be traced from collection to final disposition. All information pertaining to field operations during sample collection must be properly documented to ensure transparency and reproducibility of methods and procedures. Several types of field documents will be used for this purpose by field personnel.

Equipment and Materials

Equipment and materials used for this SOP include the following:

- Field logbook, preferably Rite-in-the-Rain 8.5 x 11 inch spiral-side notebook
- Field forms
- Black-ink waterproof pen
- Digital camera

Field Logbooks

During field sampling events, field logbooks and field forms are used to record all daily field activities. The purpose of the field logbook is to thoroughly document the sampling event to ensure transparency and reproducibility. The field logbook will contain sampling-related information supplemental to the field forms. Any deviations from the project-specific field sampling plan (FSP) that occur during sampling (e.g., personnel, responsibilities, sample station locations) and the reasons for these changes will be documented in the field logbook. Other types of information, as applicable, that should be documented in the field logbook include the following:

- Project sampling name and type
- Name of person making entries and other field staff
- On-site visitors, if any
- Observations made during sample collection, including collection complications and other details not entered onto the field form
- A record of health and safety meetings, updates, and related monitoring
- Presence of vessel traffic, construction and maintenance activities, or man-made features that may influence sampling

- Specific measured characteristics of collected samples

The field supervisor will maintain the field logbook and is responsible for ensuring that the field logbook and all field data forms are correct. Requirements for logbook entries will include the following:

- Entries will be made legibly with black (or dark) waterproof ink.
- Unbiased, accurate language will be used.
- Entries will be made while activities are in progress or as soon afterward as possible (the date and time that the notation is made should be documented, as well as the time of the observation itself).
- Each consecutive day's first entry will be made on a new, blank page.
- The field supervisor must sign and date the last page of each daily entry in the field logbook.
- Logbooks will be photographed daily and copied or scanned weekly, and backups of data will be generated as specified in the Data Quality Management Plan.
- When field activity is complete, the logbook will be scanned into the project file, and originals will be retained by the Project Manager.

All logbook entries must be completed at the time any observations are made. Logbook corrections will be made by drawing a single line through the original entry, allowing the original entry to be read. The corrected entry will be written alongside the original. Corrections will be initialed and dated and may require a footnote for explanation.

Upon completion of the field sampling event, the field supervisor will be responsible for submitting all field logbooks to be copied. A discussion of copy distribution is provided below.

Field Forms

Field data forms will be used to record the relevant sample information collected during a sampling event. These forms will be filled out completely by the sampling team during sampling.

The Fishing Effort and Tally Form will be used to record data on all fish caught and shall include the following:

- Sampling date (YYYY-MM-DD)
- Sampling location
- Angler initials
- Fishing start and stop times (24-hour Pacific Standard Time)
- Total duration of fishing effort; this will used to calculate catch per unit effort

- Catch time (24-hour Pacific Standard Time)
- Catch species, Abbreviations: BB= brown bullhead, BC= black crappie, BG= bluegill, CC= common carp, LS= largescale sucker, LMB= largemouth bass, NP= northern pikeminnow, PS= pumpkinseed, SC= sculpin, SMB= smallmouth bass, WC= white crappie, YP= yellow perch; for ESA species: CHK=Chinook salmon, CM= chum salmon, CO= coho salmon, STH= steelhead
- Health examination will include general condition, injuries, survivability after release.
    - Good: Rapid swimming away on release, usually with a vigorous splash.
    - Fair: Slow but strong swimming away on release.
    - Poor: Short recovery time (up to 30 seconds) required; once recovered, slow but sometimes atypical swimming away on release.
    - Very poor: Long recovery time (more than 30 seconds); once recovery, limited or no swimming observed on release but respiration functional.
    - Dead: Dead on removal from gear or does not recover following removal from gear.

For any SMB that are caught, the Smallmouth Bass Specimen Tally and Location Form will be used and data to be recorded shall include:

- Collection date and time (YYYY-MM-DD and 24-hour Pacific Standard Time)
- Sample ID
- Fork and total length in millimeters
- Weight in grams
- Health examination, including gill condition, fin condition, visible parasites, and presence/absence of lesions
- Retained for analysis or tagging?
- Sample location depth to mudline in feet
- Sample location coordinates

Upon completion of the field sampling event, the field supervisor will be responsible for submitting all field data forms to be copied. A discussion of copy distribution is provided below.

Photographs

Reference SOP-02 of the FSP for procedures regarding digital photographs.

Distribution of Copies

Electronic scans of the field logbooks and field data forms will be made after completion of the field sampling event and stored electronically in the project files for use by project staff. The original field logbooks and forms will be placed in a locked file cabinet at the Project Manager's location.

Set-up of Locking File Cabinet

Each field event will have its own dedicated section in a locking file cabinet. The section label will include the project name and work order number. The following documents may be included in this cabinet for each field event:

- Original field logbook(s)
- Original field data forms
- Original signed chain-of-custody forms

STANDARD OPERATING PROCEDURE SOP-04

FISH COLLECTION

Scope and Applicability

This standard operating procedure (SOP) describes the procedures for fish collection associated with the acoustic tracking study at the Portland Harbor Superfund Site were previously described in the U.S. Environmental Protection Agency-approved Portland Harbor Fish Tissue Sampling SOP (SEA et al. 2002), incorporated here by reference. This SOP focuses on smallmouth bass (*Micropterus dolomieu*) collection using angling (hook and line).

Equipment and Materials

Equipment and materials for this task include the following:

- Personal protective equipment as specified in the project Health and Safety Plan (HASP)
- HASP and scientific collection permits (as needed)
- Field location maps
- Bait-casting or spinning rod, with medium action and rated for an 8- to 12-pound line and 1/4- to 3/4-ounce lure or similar.
- Monofilament line (6-12 pound line)
- Lures: plastic worms, crankbaits (diving plugs), spinnerbaits, jigs, top-water lures, swimbaits
- Decontamination supplies
- Resealable plastic bags, black permanent markers, waterproof labels, and aluminum foil
- Appropriately sized fish measuring board
- Hanging fish scale/ lab balance
- Plastic bucket(s) (e.g., 5-gallon bucket)
- Sample containers/coolers and ice
- Rite-in-the-rain field notebooks
- White board and dry erase markers
- Boat-mounted GPS or handheld GPS device

Target Species, Species Length, and Number of Specimens

The target species for this SOP is smallmouth bass. The target size is approximately 9 inches (228 millimeters) in total length, with a preference for larger specimens. Specimens that do not meet the target range will be released. The targeted number of specimens for acoustic tagging is 40.

Fish Sampling Techniques

Fish collection will be exclusively by angling. Bass fishing techniques tend to be based on the type of lure utilized. As described in previous sampling plans, smallmouth bass can be caught with a variety of lures, depending on the desired sampling depth. Lead-weighted hooks with attached green-rubber tube jigs can be used to fish the bottom, while plastic crank baits resembling small fish or crayfish can be used to fish the shallower surface waters (zero to 20 feet). Landing nets will not be used to land fish in order to avoid potential injuries to captured fish and maintain tagging candidates in the best possible condition. Electric trolling motors will be used to more accurately access specific smallmouth angling locations and enable the complete coverage of selected areas. Angling for smallmouth bass will be conducted primarily from 7:00 a.m. to 7:00 p.m.

Fish Processing and Identification

Qualified biologists will be a part of each team to oversee fish collection efforts. All buckets, measuring boards, handheld scales, and coolers used to retrieve and store fish will be washed with Alconox^{TM} soap and rinsed in river water before the sampling effort is initiated at each sampling location.

Once caught, fish will be handled using nitrile gloves, unhooked, and identified. A GPS coordinate will be collected and stored electronically when the fish is brought on-board. Non-target species will be released. Retained smallmouth bass specimens will be measured for both total length and fork length (mm) by placing them on a measuring platform. The total length of a fish will be measured from the anterior-most part of the fish to the tip of the longest caudal fin ray (when the lobes of the caudal fin are compressed dorsoventrally). The fork length of a fish will be measured from the anterior most part of the fish to the center of the fork in the tail. If the total length requirement is not met, the specimen will be returned to the river. All data will be recorded on the field sheets. Smallmouth bass that have met the target size will be rinsed with river water to remove any foreign material from the external surface, and a general fish health examination will be conducted.

Retained fish will be weighed using a handheld hanging scale (in pounds [0.00]), and placed into aerated on-board livewells for holding/ transport. The project logbook and field sheet will record the date, time, specimen identification (ID), and initials of the sampler. Each retained fish will be photographed along with the habitat conditions at each sampling location. Photographs of fish and sampling location will contain the sample ID written on a

white board included in the frame. Sample ID, date, time and other pertinent information will be recorded in the field logbook.

No more than four fish will be in the livewell at any given time. When four fish have been caught, the capture boat will transport the SMB to the on shore surgery station at Swan Island Lagoon. The fish will be transferred to the on shore surgery team for acoustic tag implantation.

References

SEA, Windward, and Kennedy/Jenks. 2002. Fish Tissue Sampling SOP Round 1A Portland Harbor RI/FS. Prepared for Lower Willamette Group, Portland, OR. Striplin Environmental Associates, Inc., Olympia, WA.

STANDARD OPERATING PROCEDURE SOP-05

RECORDING SAMPLE COLLECTION LOCATIONS

Scope and Applicability

This standard operating procedure (SOP) describes procedures recording sampling stations across the Portland Harbor Pre-Remedial Design Investigation and Baseline Sampling (PDI) Site (hereafter the Site). Accurate station positioning is required to ensure quality and consistency in collecting samples and in data interpretation and analysis. Station positioning must be both absolutely accurate in that it correctly defines a position by latitude and longitude, and relatively accurate in that the position must be repeatable.

Latitude and longitude coordinates will be obtained using a global positioning system (GPS) on the vessels operated by Gravity and supplemented by a hand-held differential GPS unit.

The methods described in this SOP should be usable for any hand-held differential GPS unit; however, the owner's manual for any GPS unit used should be consulted and used to support this SOP.

Equipment and Materials

The following is a list of equipment and materials needed by the field sampling team:

- Hand-held differential GPS unit (e.g., Trimble GeoXH or R1)
- Spare batteries
- Charging unit

A GPS hardware system, such as a Trimble GeoXH, R1, or equivalent device, should be used for recording the location of each sample. The standard projection method to be used during field activities is specified in the Data Quality Management Plan.

Positioning System Verification

GPS requires no calibration because all signal propagation is controlled by the United States government (the Department of Defense for satellite signals and the U.S. Coast Guard and U.S. Forest Service for differential corrections). Verification of the accuracy of the GPS requires that coordinates be known for one (or more) horizontal control points within the study area. The GPS position reading at any given station can then be compared to the known control point. GPS accuracy verification shall be conducted at least daily and performed in accordance with equipment manufacturer recommendations.

Station Location Procedures

Sampling area boundaries and other applicable geographic information systems (GIS) data layers (e.g., aerial photographs, topography) will be uploaded into the hand-held GPS unit(s)

prior to the sampling effort. A position will be recorded electronically at each sample location where fish are collected. Ancillary information will be recorded in the field logbook and should include the name of the personnel operating the GPS system and the time samples were collected. Water depth of the sample collection location will be recorded using the research vessel's depth transducer, when available. In shallow water, a visual estimate or lead line measurement of depth may be used.

A brief summary of procedures to locate a specific sampling location using a hand-held GPS unit are as follows:

- Turn on the unit.
- Wait for it to acquire the location of satellites.
- Save the location into the GPS memory (site coordinates may also be noted on field forms or in the field logbook).
- Charge unit and batteries when not in use.

Upon completion of the sampling effort, all data points will be downloaded from the GPS unit and displayed on a GIS map. Any sampling locations outside of the originally defined sampling areas will be mapped and described with supporting documentation in the field sampling report.

STANDARD OPERATING PROCEDURE SOP-06

SAMPLE LABELING

Scope and Applicability

This standard operating procedure (SOP) describes the general procedures for completing sample labels that will be used for all sampling. The project-specific field sampling plan (FSP) should be consulted regarding the rationale behind the sample labeling protocol.

Equipment and Materials

Equipment and materials for this task include the following:

- Sample labels
- Indelible marker
- Copy of the FSP and DQMP

Sample Identifiers

Sample identifiers will be established before field sampling begins and assigned to each sample as it is collected. Sample identifiers consist of codes designed to fulfill three purposes: 1) to identify related samples to ensure proper data analysis and interpretation, 2) to clearly connect sample results to sampling locations, and 3) to track individual samples to ensure that the laboratory receives all of the material associated with a single sample. The Data Quality Management Plan (DQMP) contains details of the location and sample nomenclature to be used in this study.

Sample Labels

Sample ID information will be entered onto the sample label with an indelible marker. Other information that will be entered onto the sample label includes the following:

- Samplers' initials
- Date
- Time

The format for the date and time will be specified as YYYY-MM-DD and 24-hour, Pacific Time. If necessary, corrections will be made on the sample labels by drawing a single line through the error and entering the correct information with an indelible marker. All corrections will be initialed and dated by the person performing the correction (i.e., the individual who made the error).

For fish samples, a weatherproof label will be filled out and adhered to the inside of a smaller resealable plastic bag. The plastic bags containing the fish and the label then will be placed inside a third resealable plastic bag. Sample packaging is discussed in SOP-07.

STANDARD OPERATING PROCEDURE SOP-07

SURGICAL IMPLANTATION OF ACOUSTIC TAGS

Scope and Applicability

This standard operating procedure describes procedures associated with administering electroanesthesia on smallmouth bass and instructions for performing surgery to implant an acoustic tag. This highly specialized surgical procedure is necessary to implant the acoustic tag and monitor the fish during recovery. The methods described herein may be modified in the field based on actual field conditions.

Equipment and Materials

Equipment and materials required by the field surgery team include the following:

- Gloves
- Hemostats
- Forceps
- Scalpel
- Scalpel blades
- Surgical scissors
- Sutures (multiple sizes)
- Salt
- Nolvasan (chlorohexidine diacetate)
- Two approximately 739-milliliter (mL) Tupperware containers for sterilizing instruments
- Acoustic tags (HTI-Vemco V9 tags)
- Surgery platform
- 153-liter Cooler with aquarium pump(s) and bubbler(s) for recovery
- Power supply
- Nylon mesh fish cradle
- Two metal aluminum plates
- Anode and cathode to attach to DOC power supply
- Measuring board
- Scale
- Dip net

- Sharps container
- 10 mL and 20 mL syringes

Electroanesthesia

After the fish has been captured, it will be kept in an aerated holding tank (Figure 1). Prior to being anesthetized, each fish is weighed and measured, and fish scales are removed for aging. Individual fish are then placed into the electronarcosis unit. The electronarcosis system is based on designs described in Hudson et al. 2011. The unit consists of a modified 153-liter marine cooler, fish cradle, and a variable power generation system. Aquarium bubblers are used to maintain dissolved oxygen levels during surgery.

Figure 1. Fish being handled prior to surgery

The HTI-Vemco V9 tag has been selected for this project, and it will not exceed 10% of the weight of the fish. Once the fish is returned to the cooler with its head pointed toward the

positive anode, the electronarcosis unit is turned on to begin acoustic surgery. Simultaneously, another staff member will begin a timer for recording surgery time.

Using the DC power supply, the voltage is increased or decreased until the fish reaches sedation. Prior to anesthesia, V9 tags, hemostats, sutures, and scalpel are disinfected in Nolvasan (Figure 2). Then, before use, the tools and tags are placed into a saline mixture.

Figure 2 – Surgical tools being sterilized

Tagging Procedure

Make an incision 1.5 times the diameter of the ceramic side of the tag (it may need to be larger depending on the batteries in the tag). Locate incision point (Figure 3) as follows (can depend on fish species):

- Find the pelvic girdle. Make incision approximately 3 millimeters (mm) toward the head and 3 mm away from the mid-ventral line, near where the color changes from the mid-ventral line.
- Insert scalpel until you feel you have entered the body cavity and then slide scalpel toward the posterior end of the fish until the incision is 2-3 centimeters in length.

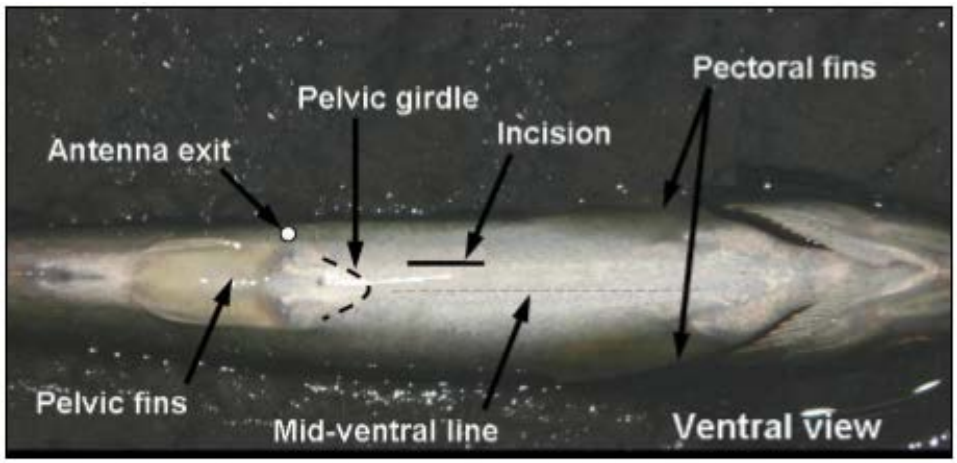


Figure 3. Example schematic of fish anatomy depicting surgery site

1) Insert the ceramic side of tag at an angle and pop inside incision (Figure 4).

Figure 4. Acoustic tag being inserted in fish

2) Make two evenly spaced sutures (Figure 5). Add a third suture if a larger incision is necessary.

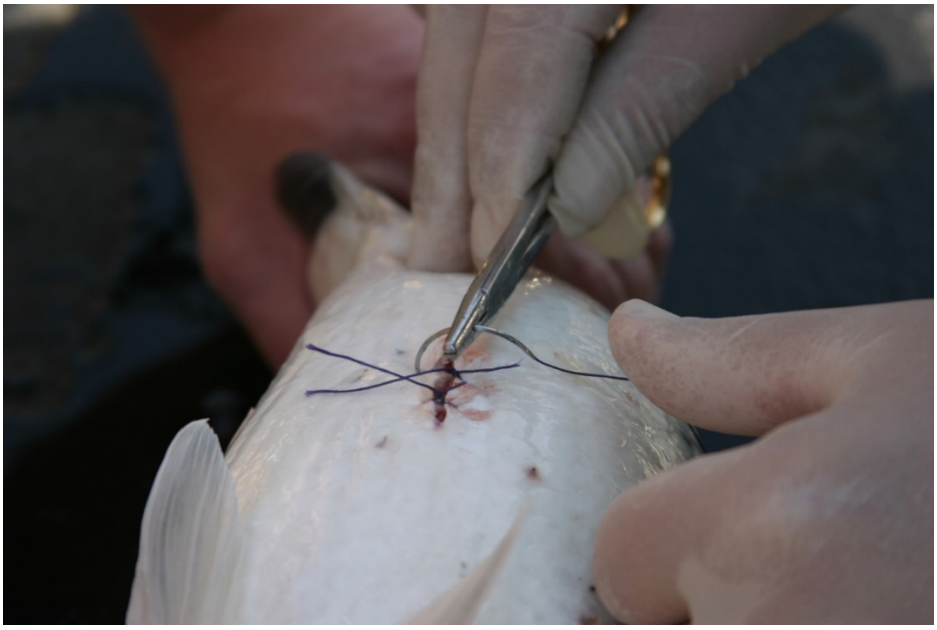


Figure 5. Incision being sutured

4) Tie surgical knot (Figures 6 and 7).

- Run the surgical needle through both sides of the incision and leave a tail of approximately 1 inch.

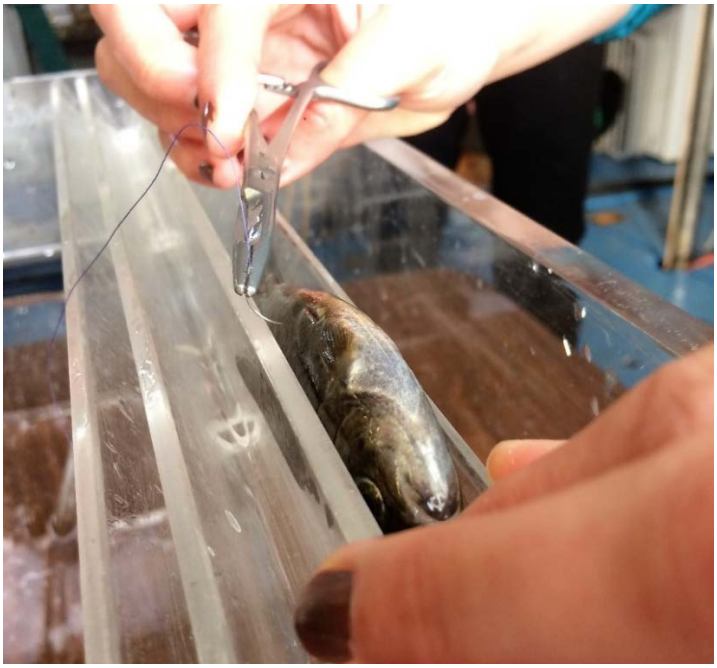


Figure 6. Incision being sutured post tag insertion

Figure 7. Incision with suture

- Wrap the suture around the hemostat three times toward yourself, grab the end of the tail with the hemostat, and holding the hemostat over the suture location, gently pull the loops over the end of the hemostat and tighten the knot.
- Wrap around hemostats two times away from yourself and repeat the knot (Figure 8).

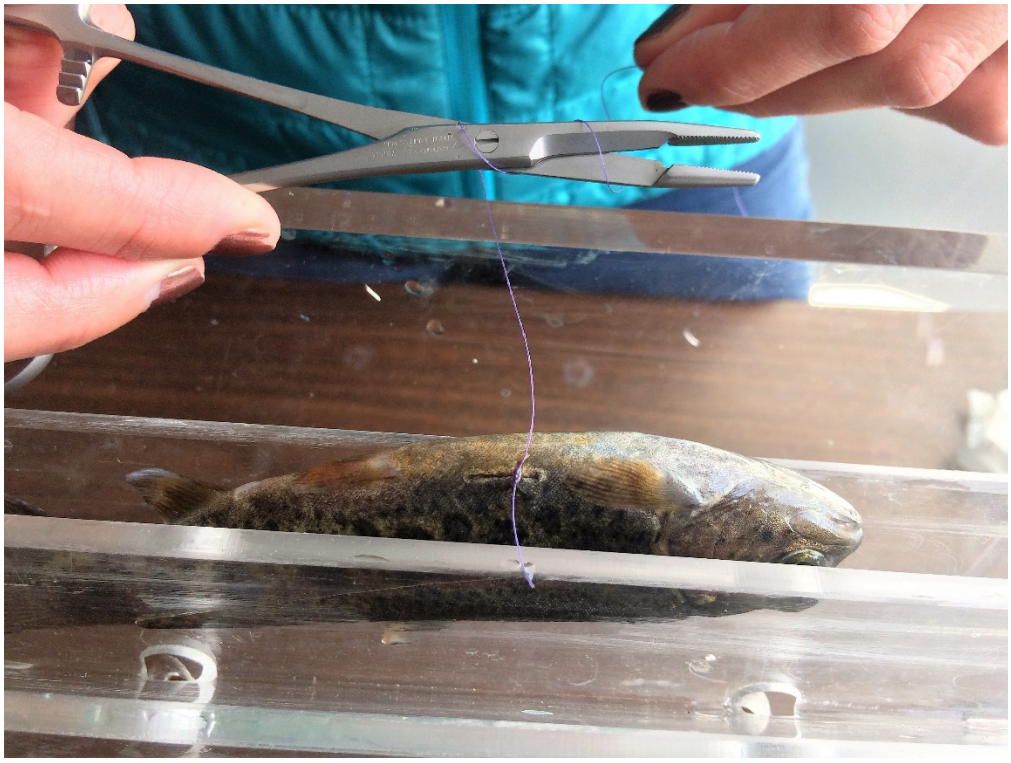


Figure 8. Suture after knot being tied

- Wrap around hemostats two times toward yourself and repeat the knot (or think of it as three times over, two times under, two times over).
- Clip thread ends of your stitch (Figure 9).

Figure 9. Two sutures complete with knots tied

3) When finished, turn of off the electronarcosis unit. The fish should recover within the next minute or so.

Post-surgery, the individual fish will be kept in an aerated recovery tank until they exhibit behavior consistent with pre-surgery observations. It is anticipated that the fish will be held for approximately 2 hours, but hold times may be longer or shorter. Once the fish have recovered, they will be released back in the river. To the extent practicable, fish will be released back into the river in the vicinity of where they were originally caught.

References

Hudson, J. M., J. R. Johnson, and B. Kynard. 2011. A Portable Electronarcosis System for Anesthetizing Salmonids and Other Fish. North American Journal of Fisheries Management 31:335-339.

APPENDIX B

Field Forms and Checklists

- Fishing Effort and Tally Form
- SMB Specimen Tally and Location Form
- Fish Tracking Field Form
- Acoustic Receiver Deployment Form
- Acoustic Fish Tracking Equipment and Materials Checklist
- HTI Data Sheet

FISHING EFFORT AND TALLY FORM

Portland Harbor PDI Studies – 2018 Fish Tissue Study or 2018 Fish Tracking Study (circle one)

Field Crew Initials:

Fishing Technique:

Boat Name:

Sampling Date	Sampling Location (RM, Array)	Angler Initials	Fishing Start Time	Fishing Stop Time	Total Duration (minutes)	Catch Time	Catch Species*	Health	Comments

* Catch Species Abbreviations: BB= brown bullhead, BC= black crappie, BG= bluegill, CC= common carp, LS= largescale sucker, LB= largemouth bass, NP= northern pikeminnow, PS= pumpkinseed, SC= sculpin, SMB= smallmouth bass, WC= white crappie, YP= yellow perch; for ESA species: CHK=Chinook salmon, CM= chum salmon, CO= coho salmon, SWT= steelhead

SMALLMOUTH BASS SPECIMEN TALLY AND LOCATION FORM

Portland Harbor PDI Studies – 2018 Fish Tissue Study or 2018 Fish Tracking Study (circle one)

Field Crew Initials:

Fishing Technique:

Boat Name:

Collection Date	Collection Time	Sample ID*	Fork Length (mm)	Total Length (mm)	Weight	Health	Retained for Analysis or Tagging?	Sample Location Depth to Mudline (ft)	X Coordinate Easting (ft)	Y Coordinate Northing (ft)	Comments

*Sample ID nomenclature is as follows: SMB Tissue Study = PDI-TF-SMB001; Acoustic Tracking Study = PDI-AT-SMBT01.

FISH TRACKING FIELD FORM

Portland Harbor PDI Studies – 2018 Fish Tracking Study

Field Crew Initials:

Fishing Technique:

SMB Sample ID:

Collection		Surgery		Release	
Collection Date:		**Surgery Date:**		**Release Date:**	
Collection Time:		**Surgery Time:**		**Release Time:**	
Species:		**Surgeon:**		**Release Location:**	
Total Length (mm) :		**Vemco Tagcode:**		**Release By:**	
Fork Length (mm) :		**Pre-Surgery Livewell Number:** **Time In:**		**Post-Surgery Livewell Number:** **Time In:**	
Weight (lbs. 0.00) :		**Pre-Surgery Livewell Number:** **Time Out:**		**Post-Surgery Livewell Number:** **Time Out:**	
Water Depth (ft):		**Dissolved Oxygen (mg/L):**			
Floy Tag ID:					
Comments:					

ACOUSTIC RECEIVER DEPLOYMENT FORM

Portland Harbor PDI Studies – 2018 Fish Tracking Study

Field Crew Initials:

Boat Name:

Date	Receiver Location (e.g. PDI-AR-A01)	Receiver Serial Number	Deployment Start Time	X Coordinate Easting (ft)	Y Coordinate Northing (ft)	Deployment End Time	Receiver Mean Depth (ft)	Comments

ACOUSTIC FISH TRACKING EQUIPMENT AND MATERIALS CHECKLIST

- ☐ Personal protective equipment (PPE) as specified in the project Health and Safety Plan (HASP; PPE to include life vests, eye protection, knee pads, etc.)
- ☐ HASP and project-specific HASP Addendum (i.e., Task Hazard Assessment)
- ☐ Scientific collection permits
- ☐ Field location maps
- ☐ Field data sheets/clipboards
- ☐ Bait-casting or spinning rods, with medium action and rated for an 8- to 12-pound line and 1/4- to 3/4-ounce lure or similar (including backups)
- ☐ Monofilament line (6-12 pound line)
- ☐ Lures: plastic worms, crankbaits (diving plugs), spinnerbaits, jigs, top-water lures, swimbaits
- ☐ Decontamination supplies (e.g., Liquinox)
- ☐ Nitrile gloves
- ☐ Gallon-size zip top plastic bags, black permanent markers, waterproof labels, and aluminum foil
- ☐ Appropriately sized fish measuring board (in millimeters [mL])
- ☐ Hanging fish scale (in pounds [0.00])
- ☐ Three tournament fish weigh bags
- ☐ Plastic bucket(s) (e.g., 5-gallon buckets with lids)
- ☐ Recirculating 150-quart cooler livewells and associated batteries eight
- ☐ Air stones
- ☐ Eight in-river livewells (32-gallon brute black plastic trash cans, polyvinyl chloride [PVC] collars, PVC glue, carabiners, small diameter rope, screw-in eye hooks)
- ☐ Medium-sized soft mesh nets
- ☐ YSI™ (or equivalent) multi-parameter water quality sonde and calibration supplies

- Rite-in-the-rain field notebooks
- White board and dry erase markers
- Boat-mounted global positioning system (GPS) or handheld differential GPS device
- Digital camera with spare batteries
- Hemostats
- Forceps
- Scalpel
- Scalpel blades
- Surgical scissors
- Sutures (multiple sizes)
- Salt
- Nolvasan (chlorohexidine diacetate)
- Two approximately 739-milliliter Tupperware containers for sterilizing instruments
- Acoustic tags (HTI-Vemco V9 tags)
- Surgery station
- Nylon mesh fish cradle
- Two metal aluminum plates
- Anode and cathode to attach to DOC power supply
- Sharps container
- 10 mL and 20 mL syringes

Release:
Species:
Program Date:

For Tagging Ops Use

Recorder : _____
Tagger : _____
Crew: _____
Time start : _____
Time end : _____

Anesthesia : _____
DO (mg/L) : _____
River temp: _____
(°C)

For HTI use

Tag Type : PW : Encoding :
Programmed by : _____
Program file : _____
Delivered by : _____
Coded-out by : _____
Code-out file : _____
Entered in DB : _____

Tagcode								Fish						Release	
Box #	Type	Mfg Lot #	Period	Sub	Verification			Species	Characteristics		Air Time	Tagging Sample #	Comments	Release Date/Time	Comments
					Prog.	Sniffer	Code-out		Length (TL)	Weight					
091	H		2435	9	☐	☐	☐								
092	H		4941	9	☐	☐	☐								
093	H		2197	9	☐	☐	☐								
094	H		2323	9	☐	☐	☐								
095	H		2519	9	☐	☐	☐								
096	H		3275	9	☐	☐	☐								
097	H		4675	9	☐	☐	☐								
098	H		4087	9	☐	☐	☐								
099	H		2057	9	☐	☐	☐								
100	H		4759	9	☐	☐	☐								
101	H		3541	9	☐	☐	☐								
102	H		3933	9	☐	☐	☐								
103	H		2981	9	☐	☐	☐								
104	H		4871	9	☐	☐	☐								
105	H		3247	9	☐	☐	☐								

Additional Comments:

Release: **PR004**
Species: **Various**
Program Date: **3/30/2014**

For Tagging Ops Use

Recorder : _____
Tagger : _____
Crew: _____
Time start : _____
Time end : _____

Anesthesia : _____
DO (mg/L) : _____
River temp: _____ (°C)

For HTI use

Tag Type : PW : Encoding :
Programmed by : _____
Program file : _____
Delivered by : _____
Coded-out by : _____
Code-out file : _____
Entered in DB : _____

Tagcode								Fish						Release	
Box #	Type	Mfg Lot #	Period	Sub	Verification			Species	Characteristics		Air Time	Tagging Sample #	Comments	Release Date/Time	Comments
					Prog.	Sniffer	Code-out		Length (TL)	Weight					
106	H		3023	9	☐	☐	☐								
107	H		4731	9	☐	☐	☐								
108	H		2687	9	☐	☐	☐								
109	H		4353	9	☐	☐	☐								
110	H		4003	9	☐	☐	☐								
111	H		2575	9	☐	☐	☐								
112	H		3597	9	☐	☐	☐								
113	H		4591	9	☐	☐	☐								
114	H		2631	9	☐	☐	☐								
115	H		4073	9	☐	☐	☐								
116	H		3415	9	☐	☐	☐								
117	H		2029	9	☐	☐	☐								
118	H		4451	9	☐	☐	☐								
119	H		3527	9	☐	☐	☐								

Additional Comments:

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