

APPENDIX A

FIELD SAMPLING PLAN FOR THE 2009/2010 SURFACE WATER STUDY

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ACRONYMS AND ABBREVIATIONS

amsl	above mean sea level
COC	chain of custody
COI	chemicals of interest
DGPS	differential global positioning system
DOI	U.S. Department of the Interior
DQO	data quality objective
Eh	reduction potential
EPA	U.S. Environmental Protection Agency
FSP	field sampling plan
GIS	geographic information system
GPS	global positioning system
HDPE	high density polyethylene
Lake Roosevelt	Franklin D. Roosevelt Lake
LRNRA	Lake Roosevelt National Recreation Area
NPS	National Park Service
ORP	oxidation-reduction potential
Parametrix	Parametrix, Inc.
PCB	polychlorinated biphenyl
PUF	polyurethane foam
QA	quality assurance
QA/QC	quality assurance and quality control
QAPP	quality assurance project plan
QC	quality control
RI/FS	remedial investigation and feasibility study
RM	river mile (USGS designations unless otherwise noted)
SHSP	site health and safety plan
SiO ₂	silicon dioxide
Site	Upper Columbia River site
SOP	standard operating procedure
Teck	Teck American Incorporated
UCR	Upper Columbia River
USGS	U.S. Geological Survey

UNITS OF MEASURE

°C	degrees Celsius
ft	foot (feet)
in.	inch(es)
m	meter(s)
μm	micron(s)

1 INTRODUCTION

This document presents the field sampling plan (FSP) for the 2009/2010 surface water study of the Upper Columbia River (UCR) (Site¹), which extends from river mile (RM) 745² to RM 596 near the Grand Coulee Dam. This study is one of the tasks that will be conducted by Teck American Incorporated (Teck) as part of the remedial investigation and feasibility study (RI/FS) for the Site.

The primary objective of the 2009/2010 surface water study is to collect information on the longitudinal, lateral, vertical, and temporal variability of chemical concentrations in surface water in the UCR. Chemical of interest (COI) data will also be collected from above the border in Birchbank, B.C., and Waneta, B.C., to help interpret Site data. As discussed in the quality assurance project plan (QAPP), surface water data will be used to support site characterization and risk assessments (i.e., human health and ecological) that will be conducted as part of the RI/FS.

1.1 OVERVIEW

Surface water will be collected along eight transects in the UCR (Figure 1-1), and at a nearshore station at Black Sand Beach. In addition, limited surface water sampling in the Columbia River will occur above the Site in British Columbia to help evaluate Site data: surface water will be collected along a transect at Birchbank, B.C., and at a nearshore station at Waneta, B.C.

A summary of the rationale for sample collection at each of the proposed sampling locations is provided in Table A-12 of the QAPP. The surface water sampling locations in the UCR are as follows:

¹ The Site consists of the areal extent of hazardous substances contamination within the United States in or adjacent to the Upper Columbia River, including Franklin D. Roosevelt Lake (Lake Roosevelt), from the U.S.-Canadian border downstream to the Grand Coulee Dam and all suitable areas in proximity to such contamination necessary for implementation of the response actions described in the Settlement Agreement (USEPA 2006c).

² There is a discrepancy in river mile designations by U.S. Geological Survey (USGS) and by USEPA (2006d). USGS river miles increase from RM 680 to RM 682 over a less than 1 river mile segment when transitioning between the Inchelium and Rice USGS quadrants, whereas USEPA (2006d) river miles increase from RM 680 to RM 681 over the same segment. To remain consistent with international borders, the USGS river mile designations are used herein.

- Eight cross-channel transects (TC1–TC7 and TC9³) will be sampled in the UCR between the U.S.-Canadian border (RM 745) and RM 605⁴ near the Grand Coulee Dam (Figure 1-1). One or more transects will be located in each of the six physiographic reaches identified for the UCR and many transects coincide with focus areas delineated by EPA during its 2005 study (USEPA 2006b). Transect locations were selected based on river hydrology, proximity to potentially significant sources, and spatial patterns in sediment chemical concentrations. Between two and four (Transects TC1–TC7, and TC9) individual near-surface samples and the same number of individual near-bottom samples will be collected along each transect (Figures 1-2a through 1-2g and Figures 1-3a through 1-3h). The rationale for transect and station placement is found in the surface water QAPP.
- Two samples will be collected from undisturbed water where the water depth is 0.5 m and as close as possible to shore, including one at each end of each transect. These samples will be collected near both banks at every transect (TC1–TC7 and TC9) (Figures 1-2a through 1-2g and Figures 1-3a through 1-3h).
- Three surface water samples⁵ (triplicates) will be collected following sediment disturbance at both ends of transects TC1–TC7 (i.e., a total of six samples per transect) and at one nearshore station near the left bank (looking downstream) at what is locally referred to as Black Sand Beach (Station TC8; Figure 1-3i). These samples will be collected where water depth is 1.0 m and where the sediment has been disturbed. Disturbed-sediment surface water samples will be collected at transects along the entire length of the UCR to characterize spatial variability between samples. Temporal variability will be addressed by including disturbed sediment surface water samples in all three sampling events. Surface water samples will be collected from approximately 0.25 m below the water surface following sediment disturbance that would reflect shallow water (i.e., 1 m) play during recreation or other nearshore human activity, to support the human health risk assessment. Sampling 0.25 m below the water surface will be used in the human health risk assessment to evaluate exposures due to incidental ingestion of water during recreation (Teck 2009).
- One cross-channel transect (CAN1) will be sampled at Birchbank, B.C., which is located upriver from the Trail facility. Transect CAN1 will have two individual near-surface and two individual near-bottom samples (Figures 1-2h and 1-3i). In addition, two nearshore surface water samples will be collected at each end of the transect. One sample will be collected from undisturbed water

³ The proposed sampling location for TC9 is located in a high energy environment at close proximity to a rock outcrop. If the field crew finds that this location presents difficult sampling conditions, the transect may need to be relocated downstream.

⁴ The most downstream transect for the surface water study is located at USGS RM 605 (Plum Point).

⁵ All disturbed sediment surface water samples will be collected as unfiltered samples.

where the water depth is 0.5 m and as close as possible to each shore. The rationale for transect and station placement is found in the surface water QAPP.

- A single station (CAN2) will be sampled at Waneta, B.C., on a weekly basis for several weeks (depending on the average hydraulic residence time of water within the Site) prior to the start of each UCR surface water survey (Figure 1-3k). These data will help document the variability in water quality as water enters the Site and will be used to help interpret Site data.

The start date for each field sampling event will be determined following EPA approval of the QAPP. Sampling periods for the proposed surface water sampling program will account for annual hydrologic flow conditions into the UCR. The proposed sampling periods will be as follows:

- Sampling Event #1, Fall low flow (October 8–22, 2009): This event will occur during fall low flow conditions within the Columbia River as measured at U.S. Geological Survey (USGS) gage Station No. 12399500 and stable pool elevations within Lake Roosevelt (Figure 1-4).
- Sampling Event #2, Spring low flow (March 28–April 8, 2010): This event will occur during the descending limb of the hydrograph at spring low flow conditions and will be completed prior to infilling of Lake Roosevelt (Figure 1-4).
- Sampling Event #3, Spring high flow (May 27–June 10, 2010): This event will occur during the peak of the ascending limb of the hydrograph at spring high flow conditions and will be completed prior to infilling of Lake Roosevelt (Figure 1-4).

The following groups of analytes will be analyzed (individual analytes in these groups are listed in Table 1-1):

- Total and dissolved metals and metalloids in all samples: EPA target analyte list metals, plus molybdenum and uranium
- Total and dissolved other metals in all samples (excluding disturbed nearshore samples) collected from transects at Northport (TC1), Marcus Flats (TC3), Inchelium (TC4), and downstream of the Spokane River (TC6), as well as in all samples collected at Birchbank, B.C. (CAN1).
- Organic compounds in one near-surface and one near-bottom sample at the thalweg or mid-channel station along each Site transect, in one undisturbed nearshore sample at each Site transect (TC1–TC7 and TC9), in one disturbed nearshore sample at transects which are proximate to beach sediment sampling locations (TC1, TC2, TC3, TC6, and TC7; the disturbed-sediment sample will be

collected at the end of the transect nearest to the beach [Figures 1-2a, 1-2b, 1-2c, 1-2f, and 1-2g and Table 1-2]), and in all samples collected at Birchbank, B.C.

- Conventional parameters in all samples (excluding disturbed nearshore samples; except for total suspended solids which will be analyzed in all disturbed nearshore samples)
- Stable isotopes of water in all samples (excluding disturbed nearshore samples collected within the Site)
- Radionuclides in one of three disturbed nearshore samples collected near beach sediment sampling sites (TC1, TC2, TC3, TC6, and TC7, as discussed above for organics sampling)
- Nutrients and major ions in all samples (excluding disturbed nearshore samples)
- Field measurements at all stations
 - Water depth, temperature, pH, dissolved oxygen, conductivity, turbidity, oxidation-reduction potential (ORP). (Note: Reduction potential [Eh] will be calculated from ORP readings.)

This FSP describes the field methods that will be used to collect surface water for the 2009/2010 surface water study. The background, rationale, data quality objectives (DQOs), and overall study design for this study are described in detail in the QAPP. Section 2 of this FSP describes the field procedures that will be followed by the Teck technical team during the field study. Section 3 outlines the protocol for field documentation, including chain of custody (COC) procedures. Section 4 summarizes the laboratory analyses that are described in greater detail in the QAPP. Section 5 provides information on data management procedures. References cited in this document are listed in Section 6.

The following documents are provided as attachments to this FSP:

- **Site Health and Safety Plan (SHSP) Addendum No. 2.** This document describes the specific requirements and procedures that will be implemented to minimize the safety risk to personnel who carry out the field study program (Attachment A1). It is an addendum to the project SHSP (TCAI 2007).
- **Standard Operating Procedures (SOPs).** The SOPs describe the procedures that will be used to collect surface water (Attachment A2).

- 1 • **Field Forms.** This attachment contains examples of various forms that will be
2 used during field sampling, including a corrective action record, a field change
3 request form, a water quality log sheet, and a COC form (Attachment A3). A
4 water quality log sheet will be kept for each site to record multiple instrument
5 readings over the sampling time period to document instrument stability.

2 SAMPLE COLLECTION AND PROCESSING PROCEDURES

The following sections describe the detailed procedures and methods that will be used during the 2009/2010 surface water study, including sampling procedures, recordkeeping, sample handling, storage, and field quality control procedures. Sample collection and processing will be conducted in accordance with the SOPs provided in Attachment A2. Depending on field conditions, procedures specified in the referenced SOPs may be modified if necessary. All field activities will be conducted in accordance with the site-specific SHSP addendum that is provided in Attachment A1.

2.1 SAMPLING SCHEDULE

As discussed in the QAPP, water levels within Lake Roosevelt are controlled largely by water management activities that occur at Grand Coulee Dam. By contrast, water levels in the uppermost portions (i.e., riverine reaches) of the UCR are controlled largely by water flow across the U.S.-Canadian border, which, in turn, is a function of precipitation, snowmelt, and management of upriver dams.

Because seasonal variations in pool levels of Lake Roosevelt and flow of the UCR (Figure 1-4) may affect the temporal variability of COI concentrations in surface water, the 2009/2010 surface water study will be scheduled to evaluate the characteristics of UCR surface water during the three time periods discussed above in Section 1.1. The proposed field sampling schedule is shown in the following chart:

UCR 2009/2010 Surface Water Sampling Schedule

	2009				2010											
	OCTOBER				MARCH				APRIL				MAY			
Fall Low Flow																
Spring Low Flow																
Spring High Flow																

Collection of weekly nearshore grab samples at Waneta, B.C., will be initiated several weeks before each sampling event in the UCR. The average hydraulic residence time of water within the Site at the time of sampling will be determined using Figure 2-1. Weekly sample collection at Waneta will be initiated prior to Site sampling by approximately the same number of days as the average hydraulic residence time. For

example, if the average hydraulic residence time for water within the Site is 50 days, then weekly sampling at Waneta will be initiated approximately 50 days prior to the start of sampling within the Site, provided EPA approval for the sampling program has been received.

2.2 FIELD SURVEY AND SAMPLING METHODS

As discussed previously, surface water will be collected along eight transects and at an additional station at Black Sand Beach in the UCR (Figure 1-1). Surface water samples will also be collected along a transect at Birchbank, B.C., and at a station at Waneta, B.C. (Figure 1-1).

2.2.1 Sample Types Collected within the UCR

Three sample types will be collected within the UCR:

- **Transect Samples**—Single-point near-surface samples (i.e., 1 m below water surface) and single-point near-bottom samples (i.e., 1 m above the river bottom) (of which one will be in the thalweg or mid-channel) will be collected along each transect. Transects will have two to four near-surface and near-bottom single-point locations (four samples at TC9; six samples at TC1, TC2, and TC7 and eight samples at TC3–TC6; see Figures 1-2a through 1-2g and 1-3a through 1-3h).
- **Undisturbed, Nearshore Samples**—One undisturbed, single-point nearshore sample will be collected at each end of each Site transect at the midpoint of the water column where water depth is 0.5 m. Nearshore samples will be collected near each riverbank at each Site transect (two samples per transect; see Figures 1-2a through 1-2g).
- **Disturbed Nearshore Samples**—Three disturbed-sediment, single-point nearshore samples (triplicate samples) will be collected from each end of each transects TC1–TC7 (six samples per transect; see Figures 1-2a through 1-2g), and three disturbed, single-point nearshore samples will be collected from the left bank only (looking downstream) at Black Sand Beach (Station TC8). The samples will be collected from approximately 0.25 m below the water surface following sediment disturbance that would reflect shallow-water (i.e., 1 m) play during recreation or other nearshore human activity to support the human health risk assessment.

2.2.2 Sample Types Collected in Canada

Two sample types will be collected in Canada:

- 1 • **Transect Samples**—Two single-point near-surface samples (i.e., 1 m below
2 water surface) and two single-point near-bottom samples (i.e., 1 m above the
3 river bottom) will be collected at Birchbank, B.C. (Transect CAN1) (total of four
4 samples; see Figure 1-2h).
- 5 • **Undisturbed, Nearshore Samples**—One undisturbed, single-point nearshore
6 sample will be collected at each end of Transect CAN1 at the midpoint of the
7 water column where water depth is 0.5 m. Nearshore samples will be collected
8 near each riverbank at this transect (two samples per transect; see Figure 1-2h).
- 9 • **Nearshore Samples**—At Waneta, B.C. (CAN2; see Figure 1-3k), a single grab
10 sample will be collected from a shoreline location at the midpoint of the water
11 column where total water depth is 0.5 m. This station will be sampled on a
12 weekly basis leading up to each UCR sampling event as described above.
13 Sampling at Waneta will cease once sample collection begins at all other
14 transects.

15 Figure 2-2 provides a schematic of the different kinds of sample collection
16 configurations.

17 **2.2.3 Sampling Vessel, Field Equipment, and Supplies**

18 Surface water sampling events within the UCR and at Birchbank, B.C., will require two
19 or three sampling vessels and two or three shore-based teams (for sample transport and
20 logistics support). Each vessel will have a deck large enough to accommodate three
21 crew members, the vessel's captain, one EPA oversight individual, and the following
22 gear: either two peristaltic pumping systems (see SOP-SW4) or two water collection
23 bottles (e.g., GO-FLO™ or modified Niskin bottle) (SOP-SW5), a portable four stroke
24 2,000-watt generator, sample coolers, and multiple sampling equipment boxes
25 containing sample bottles and other ancillary equipment.

26 The deck or covered “wet-lab” area will be large enough to accommodate all necessary
27 sampling equipment and sample processing materials such as coolers, sample bottles,
28 sample labels, and filter cartridges. The sampling area should be placed preferentially at
29 the foredeck of the boat as far away as possible from potential sources of contamination,
30 such as fumes from a power generator and the boat's exhaust pipes. Moreover, the
31 sampling crew must provide means to protect the covered wet-lab area (e.g., plastic
32 walls) in order to prevent other sources of contaminants such as airborne dust from
33 falling into sample bottles while collecting surface water samples. Trace clean sampling
34 techniques, which are described in SOP-SW4, will be used to collect the surface water
35 samples. Adherence to the instructions in SOP-SW4 will ensure a high level of sample
36 integrity and minimize the potential for contamination during sample handling.

The vessel will include a capstan (minimum of 350-lb capacity davit [pulling winch]), a bow-mounted A-frame or equivalent, navigational lights, anchors, and basic sonar (e.g., fathometer). The vessel will have the capability to make headway and maneuver in the potentially turbulent, high-velocity waters of the upper UCR. One vessel must be equipped with outboard jet engines in order to navigate very shallow waters at Birchbank, B.C. (i.e., CAN1).

The sampling stations at Waneta, B.C., will be accessed by land. Sampling will occur from the shoreline.

Field equipment and supplies include sampling equipment, utensils, decontamination supplies, sample containers, coolers, shipping containers, logbooks and forms, personal protection equipment, and personal gear. Protective wear (e.g., gloves) is required to minimize the possibility of cross-contamination between sampling locations.

Surface water samples will be collected using either water bottles (e.g., Niskin or GO-FLO™ bottles) or a peristaltic pump and tubing. Both methods will provide acceptable samples and they may be used interchangeably by the field crews depending on field conditions. The preferred sampler for offshore transect samples is a water bottle because a large volume of water can be collected quickly from deep waters where anchoring is not possible and very long tubing lengths would be required. The preferred sampler for nearshore samples is a peristaltic pump with tubing. Sampling methods using water bottles and peristaltic pumps with tubing are described in SOP-SW5 and SOP-SW4, respectively.

In addition, a high volume peristaltic pump equipped with a vortex separator and polyurethane foam (PUF) cartridge will be used to collect 40 L of surface water for the detection of low levels of PCB congeners (see SOP-SW17).

A multi-probe (e.g., YSI 650/6600, or equivalent) will be deployed during collection of each sample to obtain *in situ* field measurements including water temperature, pH, dissolved oxygen, conductivity, turbidity, and ORP (Eh will be calculated from ORP readings). Information and general instructions for field measurement of water quality parameters are provided in SOP-SW6; procedures prescribed by the instrument field manual will be performed to provide quality control on field measurements of surface water quality.

Sample bottles, preservatives, distilled/deionized water, coolers, and packaging material for the samples will be supplied by the analytical laboratory. Details on the type of sample containers are provided in the QAPP and in Table 2-1 of this FSP.

Commercially available precleaned bottles will be used for the samples, and the chemical testing laboratory will maintain a record of certification from the suppliers. The bottle shipment documentation will record batch numbers for the bottles. With this documentation, bottles can be traced to the supplier, and bottle wash analysis results can be reviewed. The bottle wash certificate documentation will be archived in the Teck technical team project file. Field personnel will not obstruct these stickers with sample labels.

Sample containers will be clearly labeled at the time of sampling. Labels will include the task name, sample location and number, sampler's initials, analyses to be performed, and sample date and time. Sample labeling procedures are provided in detail in Section 3.4 and an example sample label is provided in Attachment A3.

2.2.4 Sampling Location Positioning

Latitude and longitude coordinates and water depth (to the nearest 0.5 m) will be obtained at the locations where surface water samples are collected. A differential global positioning system (DGPS) will be used to document the sample collection locations. The standard projection method to be used during field activities is Horizontal Datum: North American Datum of 1983 (NAD83), UTM Zone 11, meters. The positioning objective is to accurately determine and record the positions of all sampling locations to within ± 2 m. Proposed surface water sampling location coordinates within the Site are provided in Table 2-2. Proposed locations for samples collected in Canada are also provided in Table 2-2.

The DGPS unit consists of a global positioning system (GPS) receiver on the sampling platform and a differential receiver located at a horizontal control point. At the control point, the GPS-derived position is compared with the known horizontal location, offsets or biases are calculated, and the correction factors are telemetered to the GPS receiver. Positioning accuracies on the order of ± 1 –3 m can be achieved under optimal satellite positioning at the time of sampling. The GPS provides the operator with a listing of the time intervals during the day when accuracies are decreased. Avoidance of these time intervals, if possible, permits the operator to maintain better positioning accuracy (see SOP-AP6).

Some surface water samples will be collected in areas with a high-velocity flow regime. If maintaining position on station and successfully deploying the sampler is not possible because of high flow, samples may be collected using a drift sampling approach (LaGrangian method). Instead of having a fixed transect station where the sampling boat anchors or maintains position at a fixed point, the transect line will be expanded longitudinally along the river and the water bottle sampler closed at the desired water depth as it drifts over the station location. The location coordinates will be recorded

when the sampler is closed. If a peristaltic pump with tubing is used for sample collection, the length of drift line will be calculated as the minimum distance needed to collect the required volume of water, and location coordinates will be recorded at the beginning and end of the drift line.

2.2.5 Surface Water Sampling Methods

The equipment and procedures that will be used to collect surface water samples during the 2009/2010 surface water study are discussed in the following sections. The estimated numbers of field samples that will be collected are listed in Tables 2-3 and 2-4. Holding time requirements for the surface water samples following field collection are specified in Table 2-1.

At every Site transect (TC1–TC7 and TC9), the sampling team will first navigate to the proposed sampling location using the geographic coordinates provided in Table 2-2. The sampling team will then transverse the river channel and use the onboard fathometer to determine the approximate thalweg of the channel to correctly place the thalweg sampling location (in case the thalweg has shifted over time).

Between two and four pairs of near-surface (~1 m below the water surface) and near-bottom (~1 m above the sediment surface) samples will be collected at the Site transects to assess risk to plankton, pelagic and demersal fish, and aquatic-dependent wildlife. One sample pair will be located at the thalweg (or mid-channel if a thalweg is not present) and the remaining pairs will be located in areas where bottom topography is relatively flat (Figures 1-2a through 1-2h). If bottom topography appears significantly different from what is currently understood based on historical bathymetry, the field supervisor will adjust the sample collection locations along the transect so that samples are collected at the thalweg and from areas between the thalweg and shoreline that are relatively flat because it is assumed that these areas may accumulate more sediment than areas on steep slopes.

The water depth at each sampling location will be determined to the nearest 0.5 m using a fathometer or portable handheld sonar depth sounder. Depth sensing instrumentation comes calibrated from rental facilities. As a control measure, readings from a handheld depth sounder or multiprobe sensor will be compared side by side with a graduated lead line at the beginning of each sampling day and a conversion factor will be applied to the readings if necessary. The water depth where the sampler device is situated in the water column will also be measured by a depth sensor located on the multiprobe, which is attached to the water sampler to collect field water quality measurements.

The concentrations of certain trace metals in ambient waters are typically very low, and collecting water samples that are representative of ambient conditions requires extreme

care to prevent contamination during handling. Therefore, EPA guidance on surface water sampling techniques will be used to collect the surface water samples (see SOP-SW7 in Attachment 2 to this FSP and USEPA [1996]).

2.2.5.1 Stations within the UCR Site

Offshore, Near-Surface and Near-Bottom Single-Point Sample Collection

At each transect location (TC1–TC7 and TC9) within the Site, offshore samples will be collected to represent two depths, near-surface (approximately 1 m below surface) and near-bottom (approximately 1 m above bottom) (see Figure 2-2). A single water sample will be collected at each of two to four points at the near-surface and two to four points along the near-bottom along a transect (see Figures 1-2a through 1-2g and 1-3a through 1-3h). A total of six or eight unique offshore samples will be collected along each transect. These samples will provide information on COI concentrations at different points in the water column under different river discharge conditions.

These samples will be collected using either a peristaltic pump with Teflon™ tubing or a Teflon™ coated GO-FLO™ bottle, and a high volume peristaltic pump equipped with a vortex separator and PUF cartridges for the analyses of ultralow concentrations of organic compounds. If the peristaltic pump method is used, then the surface water samples will be collected using a peristaltic pump with an extended sampling Teflon™ tube, which will be lowered to the desired water depth. Surface water will be pumped directly into pre-cleaned sample bottles provided by the analytical laboratories (SOP-SW4). Surface water for the analyses of ultralow concentrations of organic compounds will be pumped with a high-volume peristaltic pump for a predetermined period at a predetermined rate through a PUF cartridge. The surface water will first pass through a 140 µm stainless steel mesh filter and then through a vortex separator to isolate suspended particles greater than 1µm and smaller than 140 µm, prior to entering the PUF cartridge (see SOP-SW17). Two samples will be derived from this sampling method, one or more 40 mL vials containing the suspended particles and a PUF cartridge containing the dissolved organic compounds adsorbed to the PUF. At sampling stations where the use of GO-FLO™ bottles are required, the GO-FLO™ bottle(s) will be attached to a non-metallic wire (e.g. Technora™ or Kevlar™) under a bow-mounted A-frame or on a side davit, and lowered with the help of a winch, to the predetermined water depth. A Teflon™-coated messenger will then be sent down attached to the wire to trigger the closing of the GO-FLO™ bottle at depth. Once the GO-FLO™ bottle is retrieved on deck, Teflon™ tubing is attached to the bottom manifold and water is extruded with the help of a peristaltic pump (see SOP-SW5). The outflow of the pump will be directed into individual sample bottles. Detailed sample collection procedures for these methods are provided in SOP-SW4, SOP-SW5, and SOP-SW17 which are provided in Attachment A2 to this FSP.

Nearshore, Undisturbed Single-Point Sample Collection

Surface water samples will be collected from the midpoint of the water column, at a depth of 0.25 m where the total water depth is 0.5 m, and as close as possible to shore. These samples will be collected near each bank at each transect (TC1–TC7 and TC9) within the Site. The geographic location of these samples is dependent upon the water depth and will change with each sampling event.

These samples will be collected with a peristaltic pump with Teflon™ tubing and a high-volume peristaltic pump for the analyses of ultralow concentrations of organic compounds. Dedicated sample bottles (either laboratory-cleaned or cleaned in the field; see SOP-SW1) will be used at each sampling location for sample collection. Detailed sample collection procedures are provided in SOP-SW4 and SOP-SW17, which are provided in Attachment A2 to this FSP.

Nearshore, Disturbed-Sediment Single-Point Sample Collection

Sediments will be disturbed by sampling personnel who will walk back and forth through the water at the sample collection point as the sample is being collected. Surface water samples will be collected from 0.25 m below the water surface where the water is 1 m deep. These samples will be collected near each bank at transects TC1–TC7 within the Site. This disturbance and sample collection process will be performed three times at each end of each transect resulting in a total of six samples per transect. In addition, three nearshore disturbed, single-point samples will be collected from the left bank only (looking downstream) at Black Sand Beach (Station TC8), resulting in a total of three samples from this station (see Table 1-2). The geographic location of these samples is dependent upon the water depth. Disturbed nearshore water samples will be collected at all sampling events. Detailed disturbed-sediment sample collection procedures are provided in SOP-SW16 (in Attachment 2 to this FSP).

These samples will be collected with a peristaltic pump with Teflon™ tubing. Dedicated sample bottles (either laboratory-cleaned or cleaned in the field; see SOP-SW1) and laboratory-precleaned tubing will be used at each sampling location for sample collection. Detailed sample collection procedures are provided in SOP-SW4 (in Attachment A2 to this FSP).

2.2.5.2 Stations within Canada

Offshore, Near-Surface and Near-Bottom Single-Point Sample Collection

Limited surface water sampling in the Columbia River will occur above the Site in British Columbia to help evaluate Site data. At Birchbank, B.C. (Transect CAN1), offshore samples will be collected to represent two depths: near-surface (approximately 1 m below surface) and near-bottom (approximately 1 m above bottom) (see Figure 2-1).

A single water sample will be collected at each of two points at the near-surface and two points along the near-bottom along the transect (see Figure 1-2h). A total of four unique offshore samples will be collected along this transect (Table 1-2). These samples will be used to help interpret Site data.

Nearshore, Undisturbed Single-Point Sample Collection

Surface water samples will be collected from the midpoint of the water column (0.25 m) where the water depth is 0.5 m, and as close as possible to shore. These samples will be collected near each bank at Transect CAN1 (Table 1-2). The geographic location of these samples is dependent upon the water depth and will change with each sampling event.

These samples will be collected with a peristaltic pump with Teflon™ tubing. Dedicated sample bottles (either laboratory-cleaned or cleaned in the field; see SOP-SW1) will be used at each sampling location for sample collection. Detailed sample collection procedures are provided in SOP-SW4 (in Attachment A2 to this FSP).

Shoreline Single-Point Sample Collection

Surface water samples will be collected from the midpoint of the water column (0.25 m) where the water depth is 0.5 m, and as close as possible to shore. At Station CAN2, a single grab sample will be collected from the shoreline of the Columbia River at Waneta, B.C., on a weekly basis for several weeks prior to the initiation of each sampling event within the Site. The number of weeks over which sampling will occur will vary with the average hydraulic residence time in the UCR (see Figure 2-1) during the upcoming sampling event, as explained in Section 2.1.

These samples will be collected using a peristaltic pump with Teflon™ tubing. Dedicated sample bottles (either laboratory-cleaned or cleaned in the field; see SOP-SW1) and Teflon™ tubing will be used for sample collection. The surface water samples will be collected using a peristaltic pump with an extended sampling tube, which will be lowered to the desired water depth. Surface water samples will be pumped directly into individual sample bottles for analyses. Detailed sample collection procedures are provided in SOP-SW4 (in Attachment A2 to this FSP).

2.2.5.3 Sample Analyses

Surface water samples will be used for the following analyses:

- **Total and dissolved standard metals and metalloids (i.e., aluminum, antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, molybdenum, nickel, selenium, silver, thallium, uranium, vanadium, zinc):** These analytes will be measured in all undisturbed and disturbed surface water samples.

- 1 • **Total and dissolved selected other metals (i.e., bismuth, boron, cerium,**
2 **cesium, dysprosium, erbium, europium, gadolinium, gallium, germanium,**
3 **gold, holmium, indium, lanthanum, lithium, lutetium, neodymium,**
4 **niobium, praseodymium, rubidium, samarium, scandium, strontium,**
5 **tantalum, tellurium, terbium, titanium, thorium, thulium, tin, titanium,**
6 **tungsten, ytterbium, yttrium, zirconium):** These analytes will be tested in all
7 undisturbed surface water samples at Transects TC1, TC3, TC4, and TC6, as
8 well as in all samples collected at Birchbank, B.C. (CAN1) (Table 1-2).
- 9 • **Organic compounds (i.e., pesticides, semivolatile organic compounds,**
10 **polycyclic aromatic hydrocarbons, polychlorinated biphenyl congeners, and**
11 **polybrominated diphenyl ethers):** These compounds will be analyzed at near-
12 surface and near-bottom thalweg (or mid-channel) stations at each Site transect
13 (14 samples), in one undisturbed nearshore sample at each Site transect
14 (7 samples), in one disturbed nearshore sample at transects which are
15 proximate to beach sediment sampling locations (TC1, TC2, TC3, TC6, and
16 TC7; the disturbed-sediment sample will be collected at the end of the transect
17 nearest to the beach [Figures 1-2a, 1-2b, 1-2c, 1-2f, and 1-2g and Table 1-2]), and
18 in all samples collected at Birchbank, B.C. (4 samples) (Table 1-2). A high-
19 volume peristaltic pump equipped with a PUF cartridge and vortex separator
20 will be used to collect 40 L of surface water for low levels of PCB congeners
21 (see SOP-SW17). If water depths are too deep to pump water directly from the
22 river with the high-volume peristaltic pump, then three 20 L GO-FLO™ bottles
23 will be deployed at the same time to obtain the necessary volume for all sample
24 analyses at those stations.
- 25 • **Conventional parameters (i.e., alkalinity, dissolved organic carbon, hardness,**
26 **total dissolved solids, total suspended solids, total organic carbon, pH, silica**
27 **[as dissolved SiO₂]):** These analytes will be tested in all undisturbed surface
28 water samples (see Table 1-2). Total suspended solids will be the only
29 conventional parameter analyzed in the disturbed sediment samples.
- 30 • **Stable isotopes of water (i.e., deuterium and oxygen-18):** These analytes will
31 be tested in all undisturbed surface water samples within the Site (see
32 Table 1-2).
- 33 • **Nutrients and major ions (i.e., ammonia, nitrate, nitrite, total phosphorus,**
34 **potassium, sodium, calcium, magnesium, fluoride, chloride, and sulfate):**
35 These analytes will be tested in all undisturbed surface water samples (see
36 Table 1-2).

- **Radionuclides (i.e., uranium-238 and radium-226):** These analytes will be tested in one disturbed nearshore sample at transects which are proximate to beach sediment sampling locations (TC1, TC2, TC3, TC6, and TC7; the disturbed-sediment sample will be collected at the end of the transect nearest to the beach [Figures 1-2a, 1-2b, 1-2c, 1-2f, and 1-2g and Table 1-2]).

Two types of surface water samples will be collected: unfiltered and filtered (for metals and dissolved oxygen content). For filtered water samples, a 0.45- μ m membrane filter cartridge will be placed inline near the tubing outlet to filter samples immediately before the water is discharged into the sample bottle. The filter will be flushed approximately five times its own internal volume before a sample is collected. Samples for total suspended solids and total dissolved solids will be filtered at the analytical laboratory.

The surface water samples will be placed in labeled, laboratory-cleaned sample bottles (Table 2-1). Each sample bottle will be clearly labeled with the task name, sample number, type of analysis to be performed, date and time, and initials of person(s) preparing the sample. Immediately after sample bottles are filled, the samples will be stored on ice ($4\pm 2^{\circ}\text{C}$).

For the analysis of low levels of PCB congeners, a vortex separator will be used to separate suspended particles greater than 1.0 μ m (99 percent efficiency) before surface water is passed through a PUF cartridge. The PUF will adsorb the dissolved PCB congeners at a pumping rate of 2 L/min (see SOP-SW17). Therefore, two samples will be collected, a particulate sample ($>1.0 \mu\text{m}$) and a dissolved phase sample (PUF cartridge) at each sampling station.

2.2.5.4 *In situ* Measurements

In addition to surface water collection, general water quality parameters (i.e., water temperature, pH, dissolved oxygen, conductivity, turbidity, and ORP) will be measured *in situ* at all sampling locations using a YSI 650/6600 multiprobe sensor or equivalent (see SOP-SW6 in Attachment A2; see field manual for quality control procedures). The meters used to obtain these measurements will be calibrated daily before the start of work and checked against the calibration solutions daily at the end of the sampling day (see 2.2.6 for more details). The sensor will record a continuous profile of these parameters from approximately 1 m above the sediment surface to the surface of the water column. *In situ* measurements of water temperature as a function of depth will provide the basis for temperature profile development, which can help identify if thermal stratification is occurring.

Different multiprobes have several sensors with different stability reading requirements. Therefore, to ensure that each sensing probe reaches stability at each stage (e.g., every meter) during the measurement of a vertical water column profile (particularly ORP),

the user must refer to the user manual for the specific multiprobe used at the site. Each probe has a different response time (e.g., ORP < 15 seconds; optical dissolved oxygen ~30 seconds). The rate of ascent and descent will need to be calculated according to depth at the site and specific probe response time.

Eh will be calculated from ORP readings using the instrument software to automatically add the offset voltage to the ORP readings as they are displayed or logged (YSI 2007).

2.2.6 Field Quality Control Samples

Field quality control (QC) samples will be used to assess sample variability and evaluate potential sources of contamination. The types of QC samples that will be collected for this task are described in this section. Detailed information on quality assurance and quality control (QA/QC) procedures, limits, and reporting are described in detail in the QAPP. The estimated numbers of field QC samples that will be collected are listed in Tables 2-3 and 2-4. If QC problems are encountered, they will be brought to the attention of the task quality assurance (QA) coordinator. Corrective actions, if appropriate, will be implemented to meet the laboratory's data quality indicators.

Field QC samples will include field replicates, field triplicates, split samples, and equipment rinse blanks. The following QC samples will be collected in the field and analyzed by the analytical laboratory:

- **Field Replicate Samples**—Blind field replicate samples will be collected and analyzed to assess the environmental, sample processing, and laboratory variability within a sampling location. Field replicates will be collected in the same manner as the original field sample and will be assigned a unique sample number so that the laboratory will not know it is a QC sample. Field replicates will be collected at the same water depth and same location as the parent sample and at a minimum frequency of 20 percent.

Field replicates will be collected at Transect TC6 (downstream from the Spokane River). These field replicates will be collected in the lacustrine section (i.e., below Kettle Falls to the dam). This set will consist of five field replicates; one replicate from a nearshore station (either left or right), one replicate from the near-surface thalweg (or mid-channel) station, one replicate from the near-bottom thalweg (or mid-channel) station, one replicate from either the left or right near-surface station, and one replicate from either the left or right near-bottom station.

- **Field Triplicate Samples**—Field triplicates will be used to document the short-term variability at each sample location for selected transects during the first sampling event. Triplicates will be taken at two locations: at CAN1 (Birchbank, B.C.) to document variability above the Trail facility, and at TC3 (Marcus Flats) to document variability at a location that is both below the Trail facility and at which slag deposits are known to exist (the purpose of sampling triplicates at CAN1 and TC3, and the uses of the data are explained in greater detail in Section A7.6 of the QAPP). At each sample location within a transect, triplicate samples will be collected sequentially, all from the same location. If an entire day is required to collect the first samples of a transect, replicate samples will be collected on the following days.

Field triplicates will be collected at all sampling locations along Transect TC3 and Transect CAN1 in October 2009. The decision to collect triplicates along this transect during the 2010 sampling events will be made following evaluation of data collected in 2009 and using an adaptive management approach. The necessity for triplicate sampling in subsequent sampling events will be determined by evaluating the variability of data within the triplicate sample set..

- **Field Split Samples**—Field split samples will be collected at a subset of the locations where the field replicates are collected (e.g., TC6 and CAN1), and analyzed to assess the variability associated with sample processing and laboratory variability. Field split samples will be collected from the same composited samples in the GO-FLO™ grabs using a peristaltic pump to fill the sample bottles sequentially. For PUF cartridges, split samples will be collected simultaneously as surface water is pumped directly from the river through the PUF cartridges. That is, a Y-split on the water line will direct water to two PUF cartridges mounted side by side. If surface water is collected directly from the river into sample bottles without compositing, then split samples will be collected by inserting a Y-splitter at the end of the sampling tube to collect two simultaneous split samples at each station. For filtered surface water split samples, the Y-splitter will be placed at the filter outlet. Samples will be assigned unique numbers and will not be identified as field splits to the laboratory. Blind field split samples will be collected at a minimum frequency of 5 percent of the surface water sampling locations.

- **Archived Samples**—When possible, additional surface water samples, stored in glass bottles, should be collected at each station and maintained at the field laboratory or refrigerated truck as a backup for any bottles that may break during transport to the analytical laboratories. After confirmation from the laboratories that the samples have arrived intact, the content of the bottles can be discarded and the bottles recycled.

- 1 • **Equipment Rinsate Blanks**—Equipment rinsate blanks will be collected to
2 help identify possible contamination from the sampling environment or from
3 the sampling equipment (e.g., tubing, water bottles). Equipment rinsate blanks
4 will be generated at approximately 5 percent of the surface water sampling
5 locations at a minimum. Equipment rinsate blanks will consist of running
6 distilled/deionized water through the sampling equipment after
7 decontamination.
- 8 • **Field Calibration**—Field measurements will be collected during each of the
9 surface water sampling events. The meters used to obtain these measurements
10 will be calibrated daily before the start of work and checked against the
11 calibration solutions daily at the end of the sampling day. Any instrument
12 “drift” from prior calibration will be recorded in a field notebook. Calibration
13 will be in accordance with procedures and schedules outlined in the particular
14 instrument's operations and maintenance manual. If calibration fails, a second
15 attempt will be made to calibrate the unit. If the second attempt fails, the unit
16 will be replaced with a backup.
- 17 • **Performance Evaluation Samples and Inter-laboratory Splits**—Performance
18 evaluation samples will be used during this project and inter-laboratory splits
19 may be used in this project.
- 20 • **Extra Bottles**—A set of extra bottles for each type of sample bottle (e.g., glass,
21 plastic with acid) will be kept onboard to replace any bottles that may break,
22 caps that may fall or break, or for any other reason for which a sample bottle
23 cannot be used during field sampling.

24 2.3 **SAMPLE HANDLING AND STORAGE**

25 The analytical laboratories will supply sample bottles and preservatives for surface
26 water samples. Details on types of sample bottles, sizes, preservatives, and holding
27 times are provided in Table 2-1. The estimated number of field and QC samples needed
28 is listed in Tables 2-3 and 2-4. Table 1-1 lists all analytes for each analytical group (e.g.,
29 metals and metalloids, organic compounds, conventional parameters, and nutrients and
30 major ions).

31 In general, preservatives will be added to the sample containers by the analytical
32 laboratory prior to shipment to the field. Field staff will confirm the presence or absence
33 of preservatives visually in the containers prior to filling. Any discrepancies with
34 preservatives will be noted on the field sampling records, and corrective action will be
35 initiated.

Once the sample is collected and preserved, the sample bottle will be capped, labeled, and placed on ice or refrigerated until shipped to the laboratory.

Each field storage freezer or refrigeration unit (if used) will be monitored to ensure temperature compliance. Each unit will have a separate log form containing date, time, and temperature information.

If there is any possibility of a refrigerated unit falling below freezing, glass bottles should not be filled to the brim. Unless required in the QAPP, sampled water in glass bottles should be filled to shoulder level. The space will allow for some water expansion when freezing and prevent the glass bottle from cracking and losing the sample.

2.4 SAMPLE PACKAGING AND TRANSPORT

As mentioned above, sample coolers and packing materials will be supplied by the analytical laboratory. Individual sample jars will be placed into plastic bags and sealed. Samples will then be packed in a cooler lined with a large plastic bag. Glass jars (if used) will be packed to prevent breakage and separated in the cooler by bubble wrap or other shock-absorbent material. Ice in sealed plastic bags will then be placed in the cooler to maintain a temperature of approximately 4°C ($\pm 2^\circ\text{C}$). When the cooler is full the COC form will be placed into a zip-locked bag and taped to the inside lid of the cooler. A temperature blank will be added to each cooler. Each cooler will be sealed with three COC seals—one on the front of the cooler and one on each side. On each side of the cooler a *This End Up* arrow label will be attached; and a *Fragile* label will be attached to the top of the cooler.

The shipping containers will be clearly labeled with sufficient information (i.e., name of task, time and date container was sealed, person sealing the cooler, and company name and address) to enable positive identification. These packaging and shipping procedures are in accordance with U.S. Department of Transportation regulations as specified in 49 CFR 173.6 and 49 CFR 173.24. Coolers containing samples for chemical analyses will be transported to the laboratory by courier or overnight shipping service.

After the chemistry samples have been received by the laboratory, they will be stored under refrigeration ($4\pm 2^\circ\text{C}$).

2.5 STUDY-DERIVED WASTE

All sample collection bottles and Teflon™ tubing that will be used at each sampling location will be decontaminated at the analytical laboratory prior to being transported to the field. No liquid wastes such as hydrochloric acid or methanol are expected to be

- 1 generated in the field during the surface water study. A dilute solution of Liquinox™
2 detergent will be used to decontaminate the inside of GO-FLO™ bottles followed by
3 rinse with deionized water between sampling transects.
- 4 All disposable materials used for sample collection and processing, such as paper towels
5 and gloves, will be placed in heavyweight garbage bags or other appropriate containers.
6 Disposable supplies will be removed from the site by sampling personnel and placed in
7 a normal refuse container for disposal at a solid waste landfill.

3 FIELD DOCUMENTATION

The integrity of each sample from the time of collection to the point of data reporting must be maintained. Proper recordkeeping and COC procedures will be implemented to allow samples to be traced from collection to final disposition. Representative photographs will be taken of each type of sampling activity performed during the surface water study. Site photos from various angles and views of the sampling locations will also be collected.

3.1 FIELD LOGBOOK

All field activities and observations will be noted in a field logbook. The field logbook will be a bound document containing individual field and sample log forms. Information will include personnel, date, time, station designation, sampler, types of samples collected, and general observations. Any changes that occur during sampling (e.g., personnel, responsibilities, deviations from the FSP) and the reasons for these changes will be documented in the field logbook. The logbook will identify onsite visitors (if any) and the number of photographs taken at each sampling location. The field supervisor is responsible for ensuring that the field logbook and all field data forms are correct. Requirements for logbook entries will include the following:

- Logbooks will be bound, with consecutively numbered pages
- Removal of any pages, even if illegible, will be prohibited
- 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 noted, as well as the time of the observation itself)
- Each consecutive day's first entry will be made on a new, blank page
- The date and time, based on a 24-hour clock (e.g., 0900 a.m. for 9 a.m. and 2100 for 9 p.m.), will appear on each page
- When field activity is complete, the logbook will be entered into the Teck technical team project file.

In addition to the preceding requirements, the person recording the information must initial and date each page of the field logbook. If more than one individual makes entries on the same page, each recorder must initial and date each entry. The bottom of the page must be signed and dated by the individual who makes the last entry. The

field supervisor, after reading the day's entries, also must sign and date the last page of each daily entry in the field logbook.

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.

The type of information that may be included in the field logbook and/or field data forms includes the following:

- Task name, task location, and task number
- Task start date and end date
- Weather conditions
- Name of person making entries and other field staff
- Onsite visitors, if any
- Sampling vessel, if any
- Station/transect name and location
- Date and collection time of each sample
- The sample number for each sample to be submitted for laboratory analysis
- The sampling location name, date, gear, water depth, and sampling location coordinates derived from GPS
- Specific information on each type of sampling activity
- Observations made during sample collection, including weather conditions, complications, and other details associated with the sampling effort
- Sample description (source and appearance, such as presence of sediment in sample, oil sheens, and any odor)
- Any visible debris on the water surface near any of the sampling locations
- The locations of surface water runoff or seeps that may be located near any of the sampling transects
- The number of photographs taken at the sampling location
- A record of site health and safety meetings, updates, and related monitoring
- Any deviation from the FSP and reasons for deviation.

In addition, a sampling location map will be updated during sampling and will be maintained throughout the sampling event. All logbooks must be completed at the time

any observations are made. Copies of all logbooks and forms will be retained by Teck and its technical team.

3.2 CHAIN-OF-CUSTODY PROCEDURES

Samples are in custody if they are in the custodian's view, stored in a secure place with restricted access, or placed in a container secured with custody seals. A COC record will be signed by each person who has custody of the samples and will accompany the samples at all times. Copies of the COC will be included in laboratory and QA/QC reports. Attachment A3 contains an example of the COC form that will be used during the 2009/2010 surface water study.

At a minimum, the COC form will include the following information:

- Site name
- Field supervisor's name and team members responsible for collection of the listed samples
- Collection date and time for each sample
- Sample type (i.e., sample for immediate analysis)
- Number of sample containers (i.e., coolers) shipped
- Requested analyses for each sample
- Sample preservation information (if any)
- Name of the carrier relinquishing the samples to the transporter, noting date and time of transfer and the designated sample custodian at the receiving facility.

The field supervisor, as the designated field sample custodian, will be responsible for all sample tracking and COC procedures for samples in the field. The field sample custodian will be responsible for final sample inventory and will maintain sample custody documentation. The field sample custodian will complete COC forms prior to removing samples from the field. Upon transferring samples to the laboratory sample custodian or shipping courier, the field supervisor will sign, date, and note the time of transfer on the COC form. The original COC form will be transported with the samples to the laboratories. All samples will be shipped to the testing laboratories in either coolers or shipping containers sealed with custody seals.

Each laboratory will designate a sample custodian who will be responsible for receiving samples and documenting their progress through the laboratory analytical process. The sample custodian for each laboratory will establish the integrity of the custody seals

upon sample arrival at the laboratory. The laboratory sample custodian will also ensure that the COC and sample tracking forms are properly completed, signed, and initialed upon receipt of the samples.

Upon receipt of the samples by the laboratory, the laboratory sample custodian will inventory the samples by comparing sample labels (numbers and tags) to those on the COC document. The custodian will enter the sample number into a laboratory tracking system by task code and sample designation. The custodian will assign a unique laboratory sample identifier to each sample number and will be responsible for distributing the samples to the appropriate analyst or for storing samples at the correct temperature in an appropriate secure area.

3.3 STATION/TRANSECT NUMBERING

Each distinct sampling location (station or transect) will be assigned a unique identifier. Station/transect IDs will start with the letters “TC” (Teck) or “CAN” (Canada). All station/transect IDs will be expressed with one numeric digit (e.g., TC2 or CAN1). The station/transect identifier will also include the letters “NS” and “NB” for near-surface or near-bottom. A supplemental component will be added to the station IDs when coordinates are collected at the transect sampling locations. A single letter (i.e., a suffix of “L = nearer to the left bank [looking downriver],” “M = middle stations,” and “R = nearer to the right bank”) will be used to indicate from which location the coordinate was collected (e.g., TC3-NS-M). When there are two stations between the middle station and bank, they will be labeled “L1” and “L2” or “R1” and “R2.”. The exceptions to these sample labeling rules are TC8 and CAN2, which are single-point sampling stations.

A supplemental component will also be added to the station IDs for the nearshore single-point stations. The station/transect identifier will also include the letters “NSH” for nearshore. A single letter (i.e., a suffix of “L = left bank [looking downriver]” and “R = right bank”) will be used to indicate from which shoreline the surface water sample was collected (e.g., TC4-NSH-L). Samples collected following sediment disturbance will also have the letters “DIS” as part of the station identifier (e.g., TC4-NSH-L-DIS).

3.4 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 (i.e., replicates) to ensure proper data analysis and interpretation, 2) to obscure the relationships between samples so that laboratory analysis will be unbiased by presumptive similarities between samples, and 3) to track individual sample containers to ensure that the laboratory receives all of the material

associated with a single sample. To accomplish these purposes, each container will have three different codes associated with it: the sample identifier, the sample number, and the sample tag. These codes and their uses are described as follows:

- **Sample Identifier**—The sample identifier will be a four-part code. The first component will begin with the letter abbreviation “SWNS,” “SWNB,” or “SWNSH” to designate that the surface water sample was collected from the near-surface, near-bottom, or nearshore respectively. The second part identifies the sampling event (i.e., 1 = fall low flow October 2009], 2 = spring low flow March/April 2010], and 3 = spring high flow [May/June 2010]). The third part will be the transect or station number. The location of the sample on a given transect or riverbank will be the fourth component and complete the sample identifier for most samples. Nearshore samples collected following sediment disturbance will have “DIS” at the end of the sample identifier. If appropriate, a supplemental component will be added to the sample identifier to code field duplicate samples and splits. A single letter (i.e., a suffix of “A” and “B”) will be used to indicate field duplicates or splits in the final component of the sample identifiers.

For equipment decontamination rinsate blanks, sequential numbers starting at 900 will be assigned instead of station numbers, and the code will have three instead of the typical four parts. The sample type code will correspond to the sample type for which the decontamination blank was collected. Additional codes may be adopted, if necessary, to reflect sampling equipment requirements.

Example sample identifiers are provided below:

- **SWNS-1-TC2-M:** Surface water sample collected from the near-surface during the first sampling event (fall low flow) from Transect TC2 at the thalweg or mid-channel location on the transect.
- **SWNB-3-TC4-R:** Surface water sample collected from the near-bottom during the third sampling event (spring high flow) from Transect TC4 at the station located closer to the right bank (looking downstream) on the transect.
- **SWNSH-2-TC5-L:** Surface water sample collected from the nearshore during the second sampling event (spring low flow) from Transect TC5 at the station located on the left bank (looking downstream) on the transect.
- **SWNSH-1-TC3-RDIS:** Surface water sample collected following sediment disturbance from the nearshore during the first sampling event

- 1 (fall low flow) from Transect 3 at the station located on the right bank
2 (looking downstream) on the transect.
- 3 – **SWNS-1-TC4-LA:** One of two duplicate surface water samples from the
4 near-surface during the first sampling event (fall low flow) from Transect
5 TC4 at the station located closer to the left bank (looking downstream) on
6 the transect.
- 7 – **SWBL-3-902:** Second equipment blank for the surface water samples
8 collected during the third sampling event (spring high flow).
- 9 • **Sample Number**—The sample number is an arbitrary number assigned to each
10 distinct sample or split that is shipped to the laboratory for separate analysis.
11 All aliquots of a composited field sample will have the same sample number.
12 Each field replicate of a given type will have a different sample number, and
13 the sample numbers of related field replicates will not necessarily have any
14 shared content. Each field split of a single sample will also have a different
15 sample number. The sample numbers will be assigned sequentially in the field
16 (i.e., SW0001, SW0002). The sample number appears on the sample containers
17 and the COC forms.
- 18 • **Tag Number**—A different tag number is attached to each sample container.
19 Tag numbers are pre-printed numbers on the bottom of Integral's sample
20 labels. The tag number and associated sample number should be noted in the
21 field logbook during sample collection. Sample labels will be preprinted with
22 tag numbers. If the amount of material (i.e., everything associated with a
23 single sample number) is too large for a single container, each container will
24 have the same sample number and a different sample tag. A sample will also
25 be split between containers if a different preservation technique is used for
26 each container (i.e., because different analyses will be conducted). The tag
27 number will appear on the COC forms. Tag numbers are used by laboratories
28 only to confirm that they have received all of the containers that were filled
29 and shipped. Data are reported by sample number.

4 LABORATORY ANALYSES

The surface water program includes a variety of sample types (i.e., nearshore undisturbed, nearshore disturbed, offshore) with varying suites of laboratory analyses. Only total suspended solids and the standard metals and metalloids will be measured in all samples. Table 1-2 presents the analyses to be completed on each proposed sample as well as total sample volume requirements for laboratory analysis.

Laboratory analyses will be performed according to the QAPP. Analytical methods and QA measurements and criteria are based on current SW-846 requirements and EPA guidance (USEPA 2008). Detailed laboratory methods, QA procedures, and QA/QC requirements are described in the QAPP.

All samples will be maintained according to the appropriate holding times and temperatures for each analysis, as summarized in Table 2-1. Field QC sample requirements are described above in Section 2.2.6 and summarized in Tables 2-3 and 2-4. A temperature blank will be included in each cooler containing samples for chemical analysis.

Laboratory QA will be implemented as described in the QAPP and according to the laboratories' respective QA programs, plans, and standard operating procedures. Additional information on analytical methods and laboratory QA program plans for each laboratory is provided in the QAPP.

5 DATA MANAGEMENT AND REPORTING PROCEDURES

During field, laboratory, and data evaluation operations, effective data management is critical to providing consistent, accurate, and defensible data and data products. Data management and reporting are discussed in the following sections.

5.1 FIELD DATA

Daily field records (a combination of field logbooks, field forms, and COC forms) will make up the main documentation for field activities. Upon completion of sampling, field notes, data sheets, and COC forms will be scanned to create an electronic record for use in creating the field data report. Field data will be manually entered into the project database. One hundred percent of the transferred data will be verified based on hard-copy records. Electronic QA checks to identify anomalous values will also be conducted following entry.

5.2 LABORATORY DATA

The contract laboratory will submit data in both electronic and hard-copy format, as described in Section B10.2 of the QAPP. The laboratory project managers for the respective testing laboratories will contact each of their respective laboratory QA managers prior to data delivery to discuss specific format requirements. Written documentation will also be used to clarify how field replicate and split samples, and laboratory duplicates and QA/QC samples were recorded in the data tables and to provide explanations of other issues that may arise. The data management task will include keeping accurate records of field and laboratory QA/QC samples so that Teck technical team personnel who use the data will have appropriate documentation. Data management files will be stored on a secure computer or on a removable hard drive that can be secured.

In addition to placing all data and identifiers in an electronic database, hard copies of all original analytical data or study records will be placed in a filing system. Each analytical data set (or supporting lab document) will be given a unique documentation code based on the original source of the data or information, and filed based on that code. A master list of all filed documents, sorted in order by filing code, will be maintained for easy retrieval from the document library. The laboratories will archive all hard copy and electronic instrument data for a period of 10 years.

5.3 DATA REVIEW AND REPORTING SCHEDULE

Draft data validation reports will be prepared by an independent validator following receipt of the complete laboratory data package for each round of sampling. Validated data will be provided electronically to EPA within 90 days of completion of the data validation. A field sampling report will be prepared by the Teck technical team and submitted to EPA with the data validation reports. The field sampling report will include an overview of the field event, a station location map, sample collection methods used, rationale for any deviations from the FSP and QAPP, and, if appropriate, recommendations for changes to the sampling design for upcoming surveys. Sample results will be reported in tabular format in the field sampling report.

A final data evaluation report will be prepared by the Teck technical team and submitted to EPA within 150 days following submission of the third set of validated data to EPA. The final data evaluation report will include an evaluation of surface water data relative to conservative risk benchmarks and literature-based values. Furthermore, longitudinal and temporal trends in concentrations and conservative risk estimates will be included.

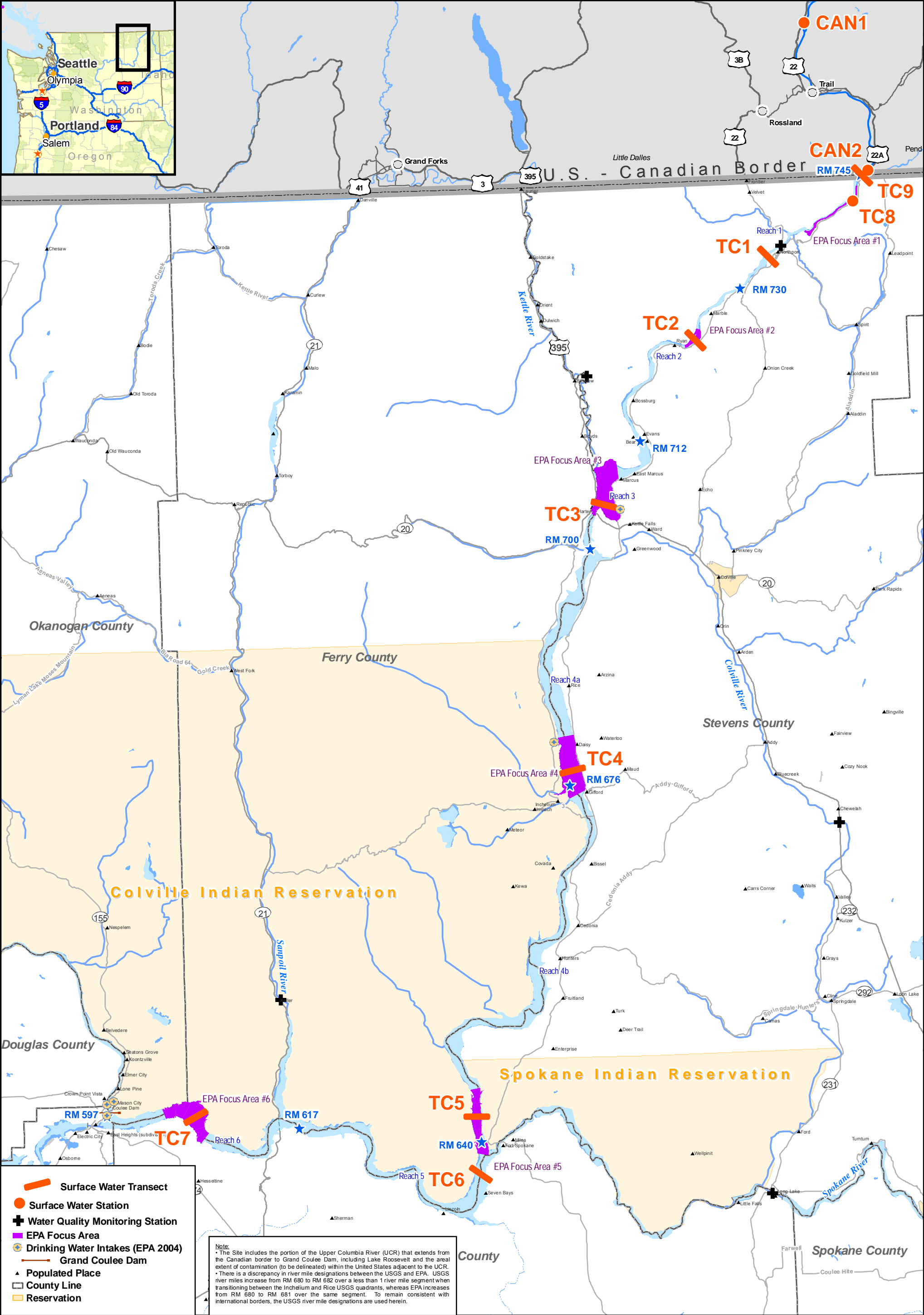
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- 5 https://www.ysi.com/DocumentServer/DocumentServer?docID=YSI_T608. YSI
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FIGURES



Integral Parametrix

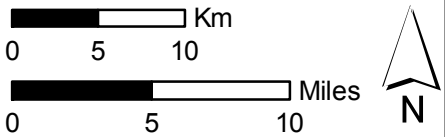
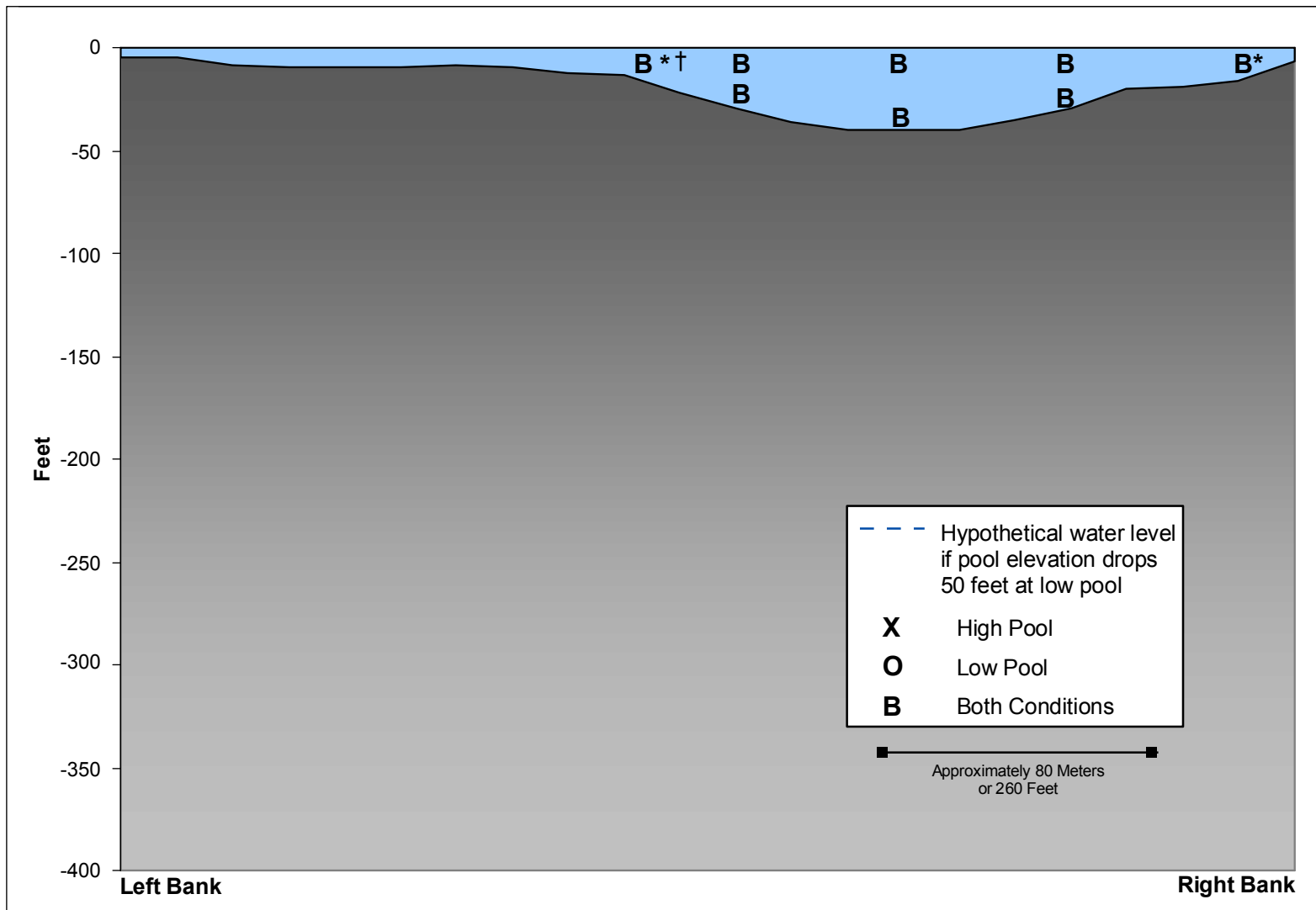


Figure 1-1. Proposed 2009/2010 Surface Water Sampling Locations

Upper Columbia River, WA

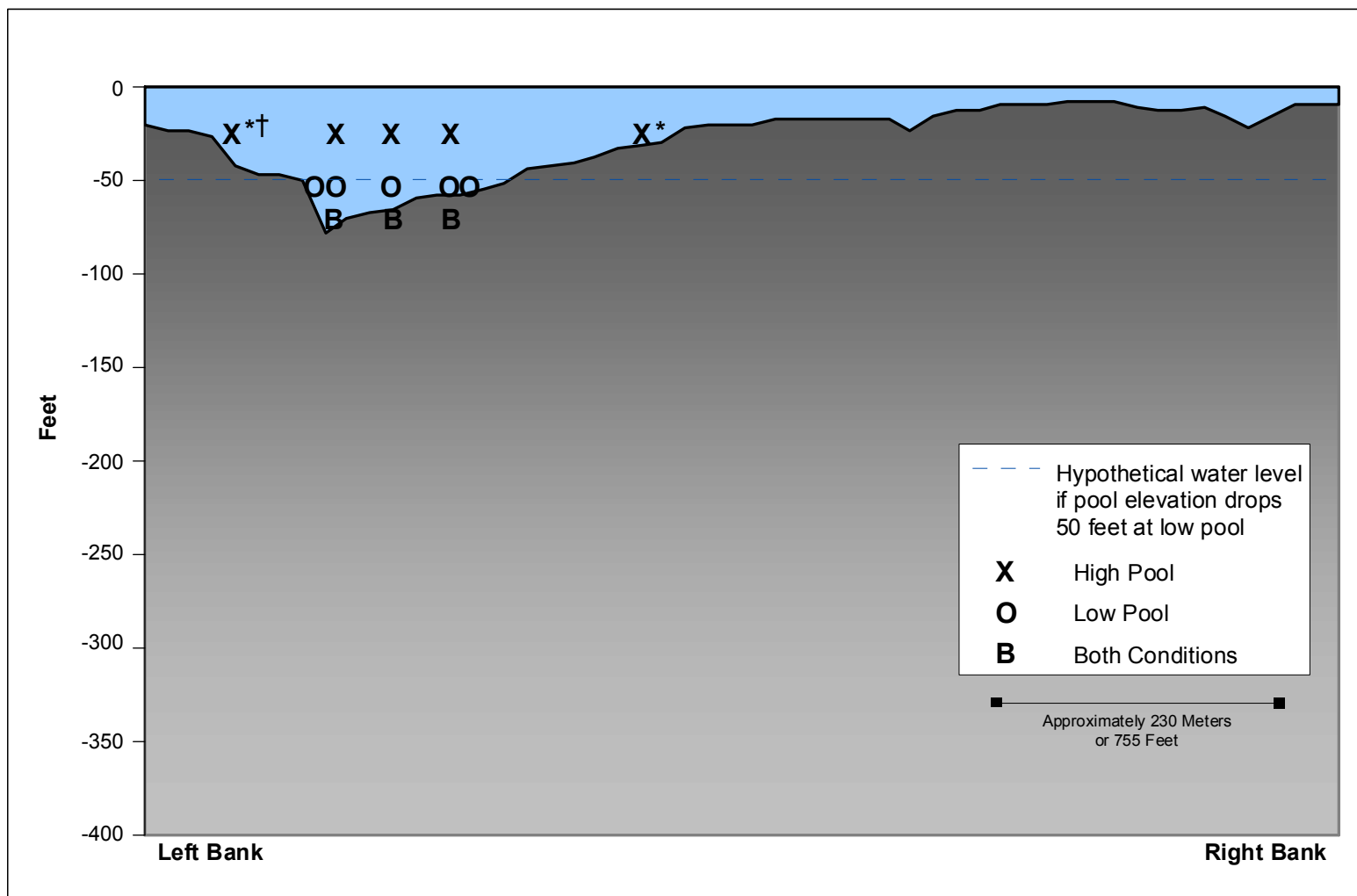


Notes: Orientation to left and right banks is based on looking down river.

* Sample locations at which disturbed-sediment surface water samples will be collected to support the human health risk assessment.

† One of the three disturbed-sediment surface water samples collected from this location will also be analyzed for the supplementary list of chemicals identified in the beach sediment study (i.e., organic compounds, radionuclides) (Teck 2009).

Figure 1-2a. Proposed Sampling Locations – Transect TC1 at River Mile 734: Northport.

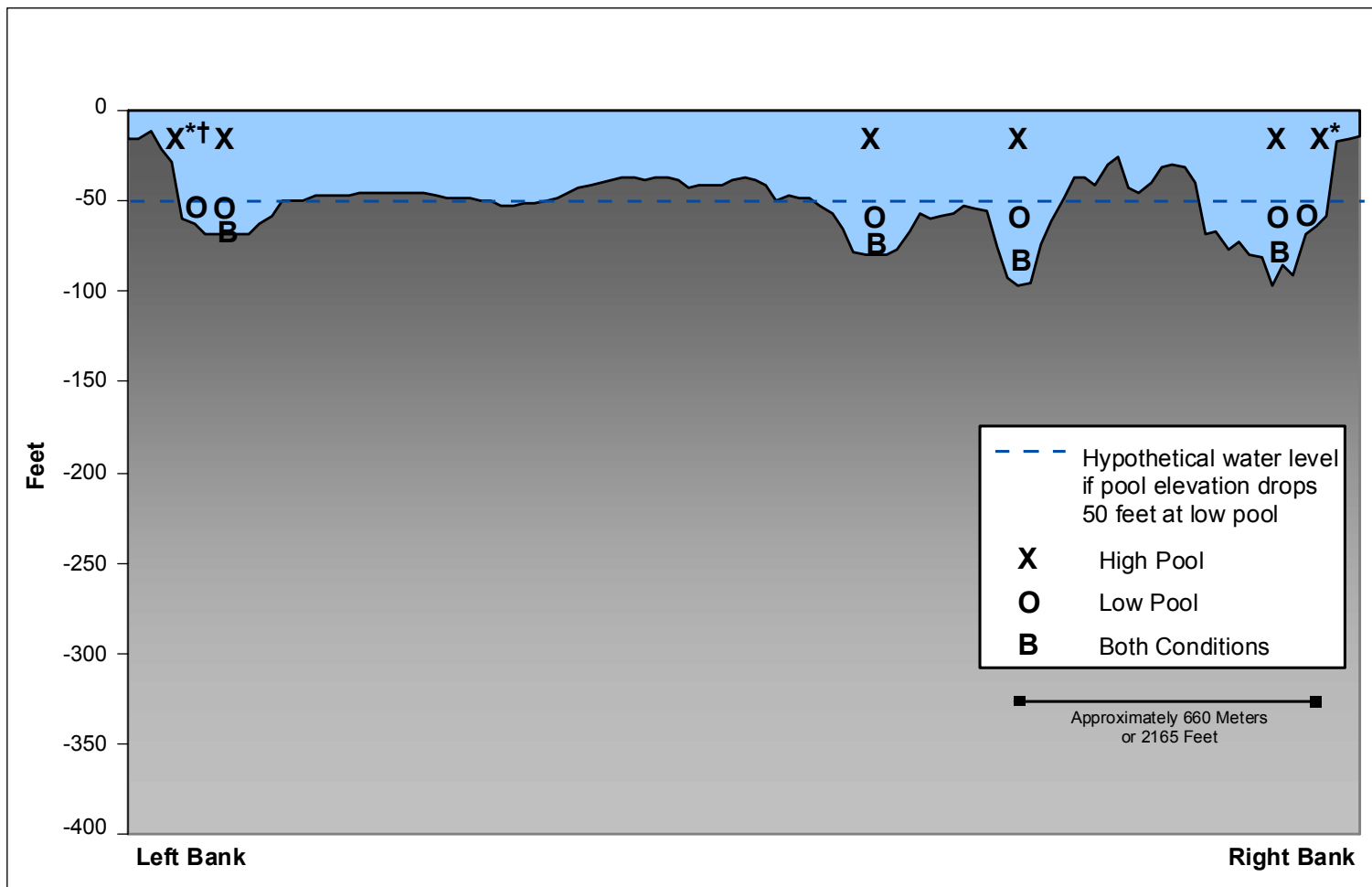


Notes: Orientation to left and right banks is based on looking down river.

* Sample locations at which disturbed-sediment surface water samples will be collected to support the human health risk assessment.

† One of the three disturbed-sediment surface water samples collected from this location will also be analyzed for the supplementary list of chemicals identified in the beach sediment study (i.e., organic compounds, radionuclides) (Teck 2009).

Figure 1-2b. Proposed Sampling Locations – Transect TC2 at River Mile 724: China Bend.

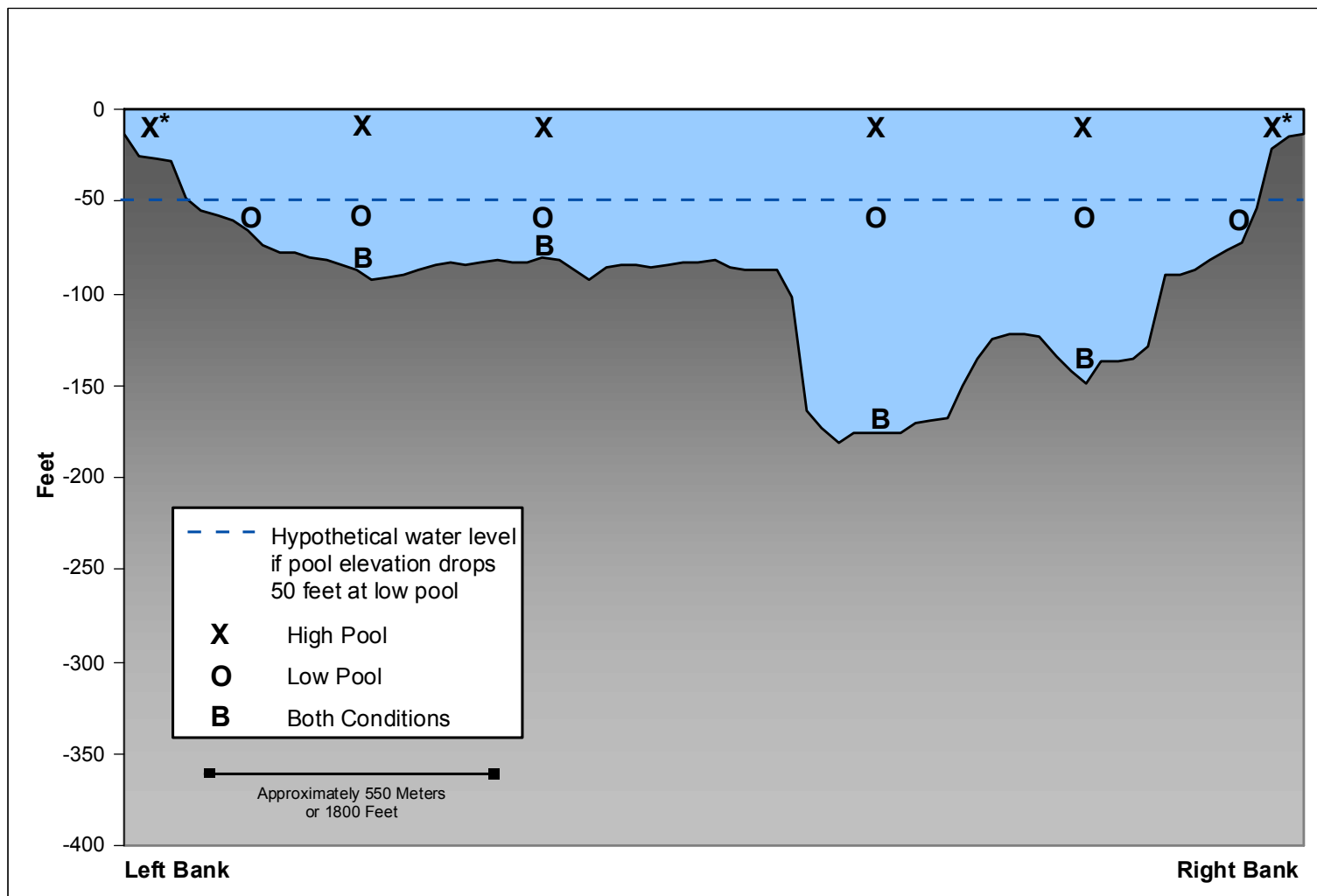


Notes: Orientation to left and right banks is based on looking down river.

* Sample locations at which disturbed-sediment surface water samples will be collected to support the human health risk assessment.

† One of the three disturbed-sediment surface water samples collected from this location will also be analyzed for the supplementary list of chemicals identified in the beach sediment study (i.e., organic compounds, radionuclides) (Teck 2009).

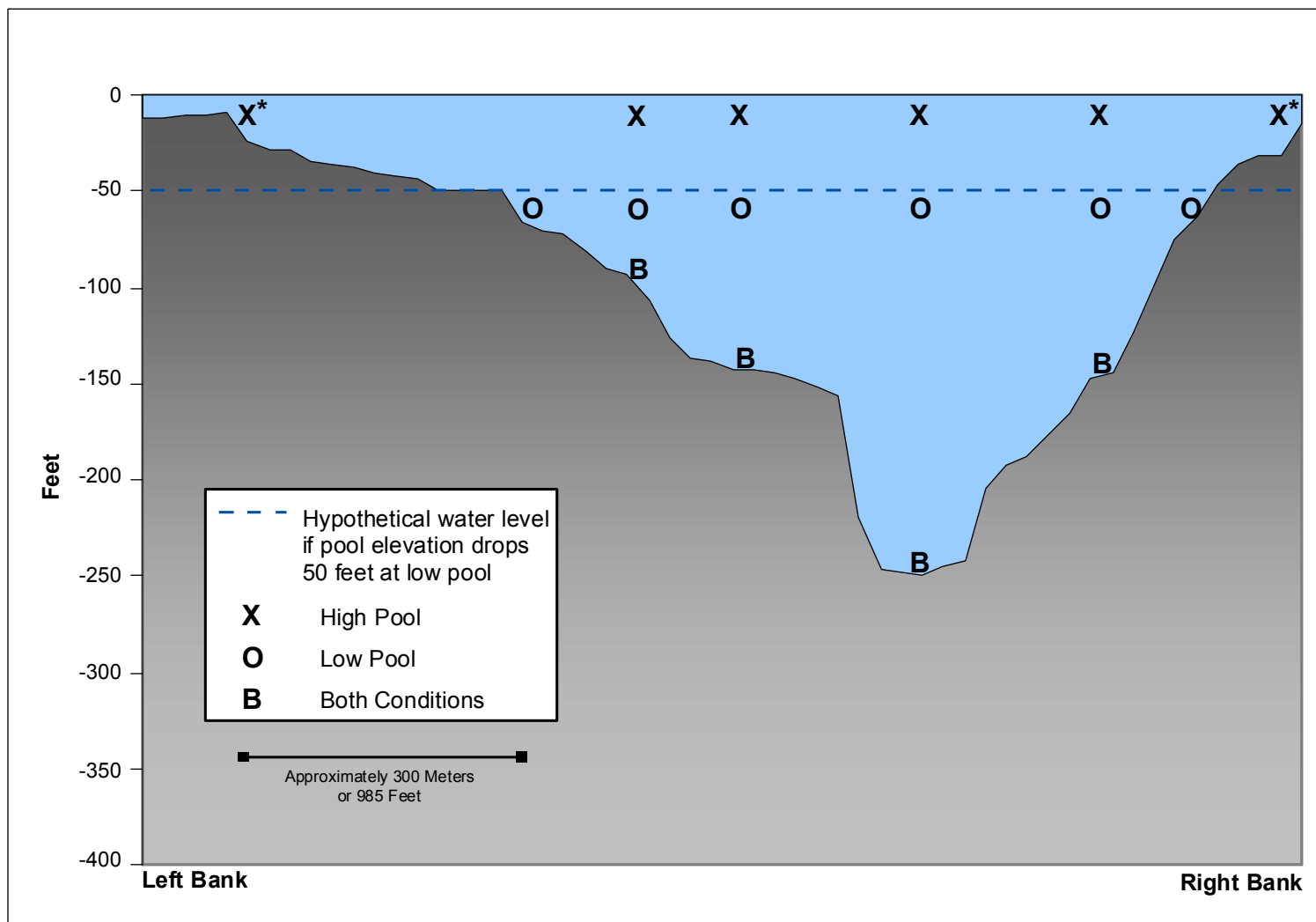
Figure 1-2c. Proposed Sampling Locations – Transect TC3 at River Mile 704: Marcus Flats.



Notes: Orientation to left and right banks is based on looking down river.

* Sample locations at which disturbed-sediment surface water samples will be collected to support the human health risk assessment.

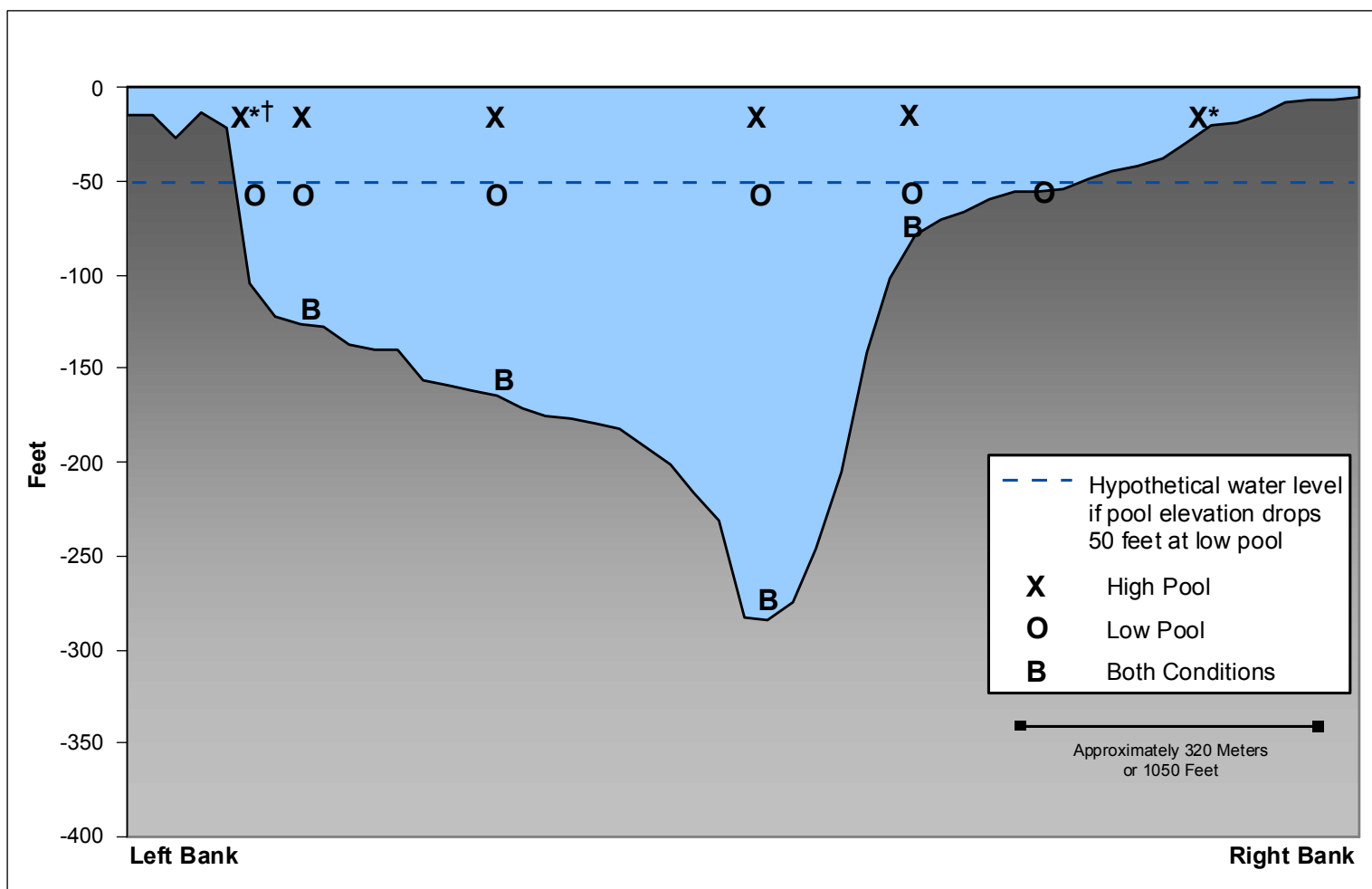
Figure 1-2d. Proposed Sampling Locations – Transect TC4 at River Mile 678: Inchelium.



Notes: Orientation to left and right banks is based on looking down river.

* Sample locations at which disturbed-sediment surface water samples will be collected to support the human health risk assessment.

Figure 1-2e. Proposed Sampling Locations – Transect TC5 at River Mile 642: Upstream of Spokane River Confluence.

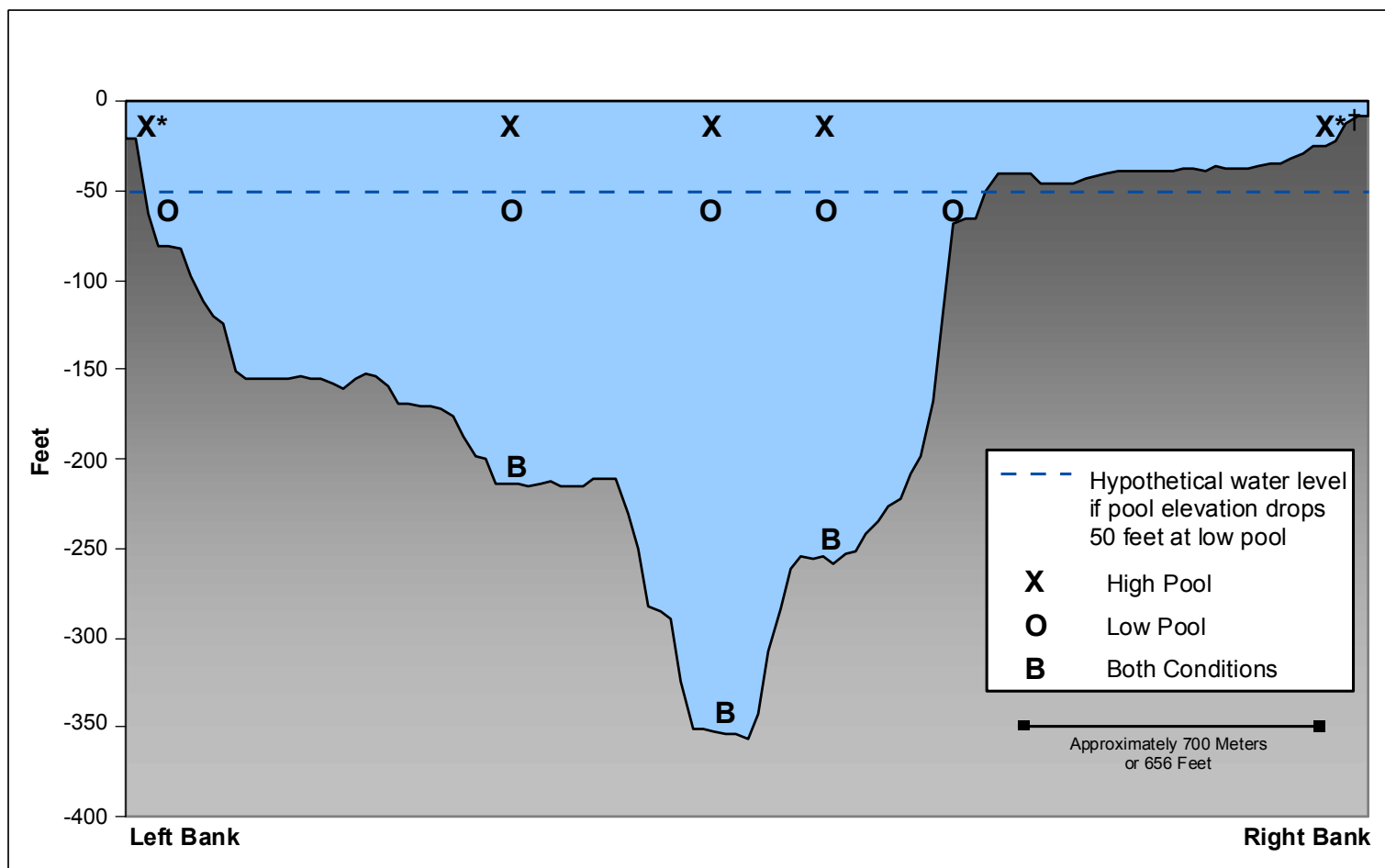


Notes: Orientation to left and right banks is based on looking down river.

* Sample locations at which disturbed-sediment surface water samples will be collected to support the human health risk assessment.

† One of the three disturbed-sediment surface water samples collected from this location will also be analyzed for the supplementary list of chemicals identified in the beach sediment study (i.e., organic compounds, radionuclides) (Teck 2009).

Figure 1-2f. Proposed Sampling Locations – Transect TC6 at River Mile 637: Seven Bays.

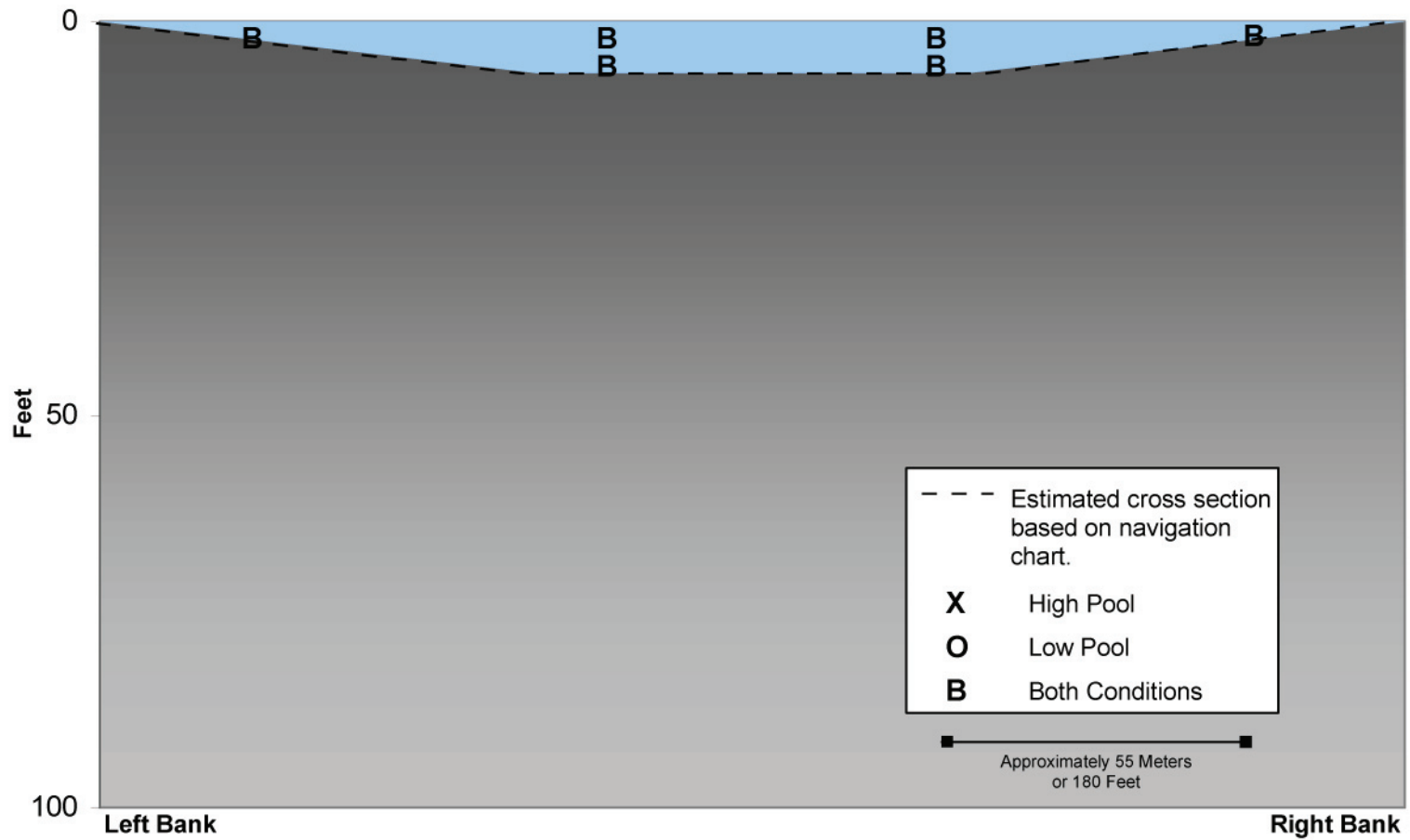


Notes: Orientation to left and right banks is based on looking down river.

* Sample locations at which disturbed-sediment surface water samples will be collected to support the human health risk assessment.

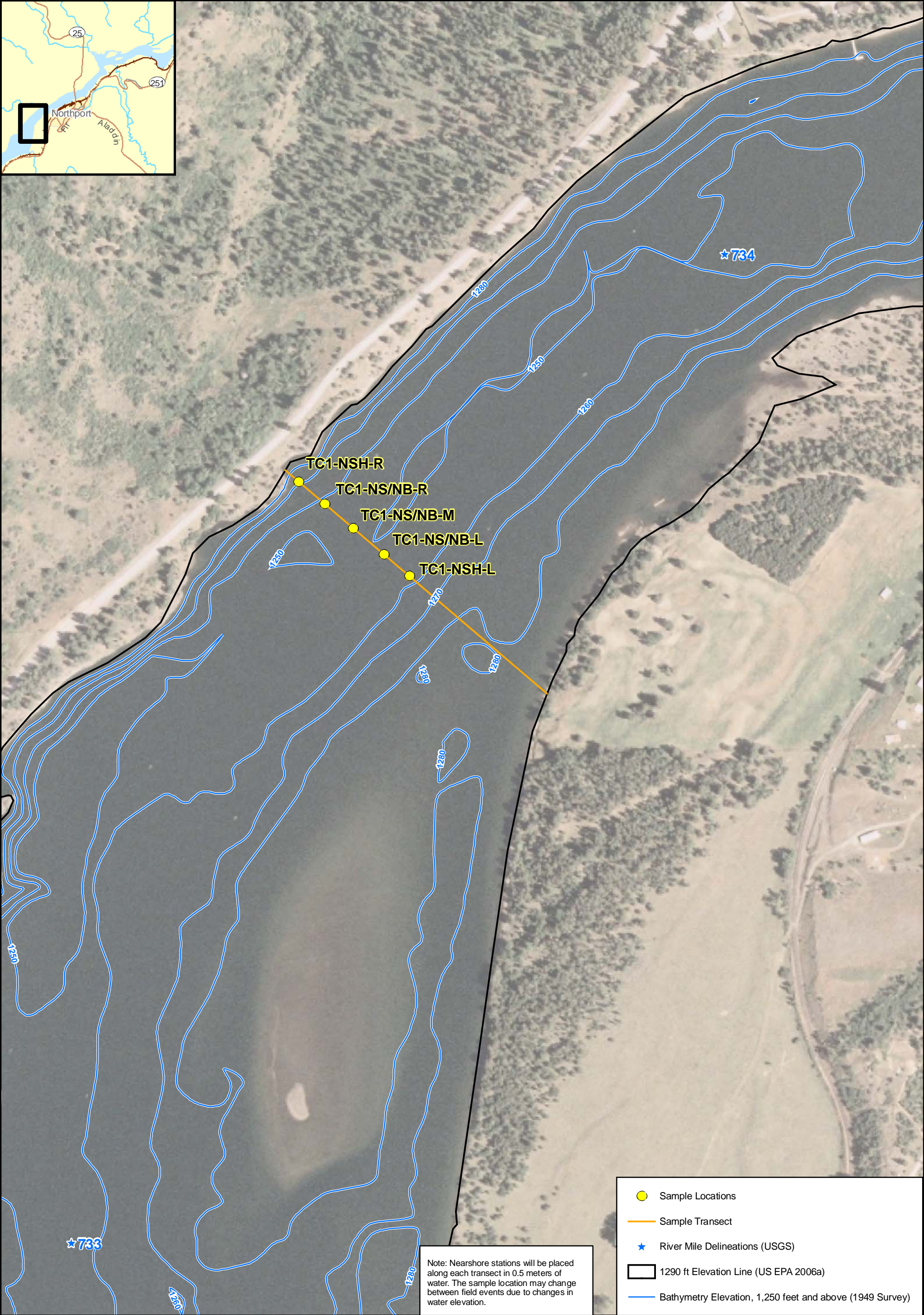
† One of the three disturbed-sediment surface water samples collected from this location will also be analyzed for the supplementary list of chemicals identified in the beach sediment study (i.e., organic compounds, radionuclides) (Teck 2009).

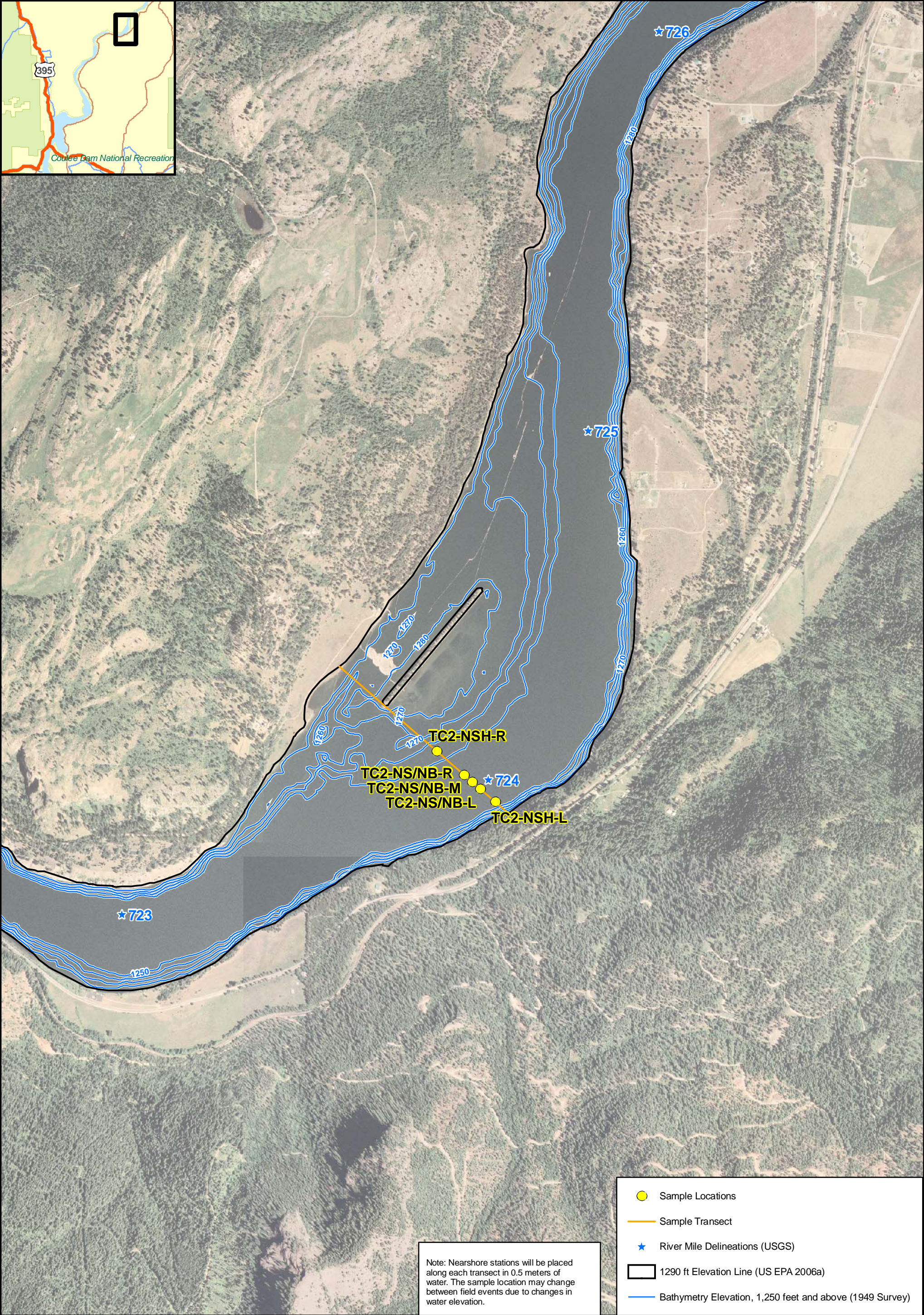
Figure 1-2g. Proposed Sampling Locations – Transect TC7 at River Mile 605: Plum Point.



Note: Orientation to left and right banks is based on looking down river.

Figure 1-2h. Proposed Sampling Locations – Transect CAN1 at USGS River Mile 762 (Birchbank).







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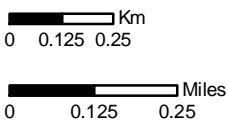
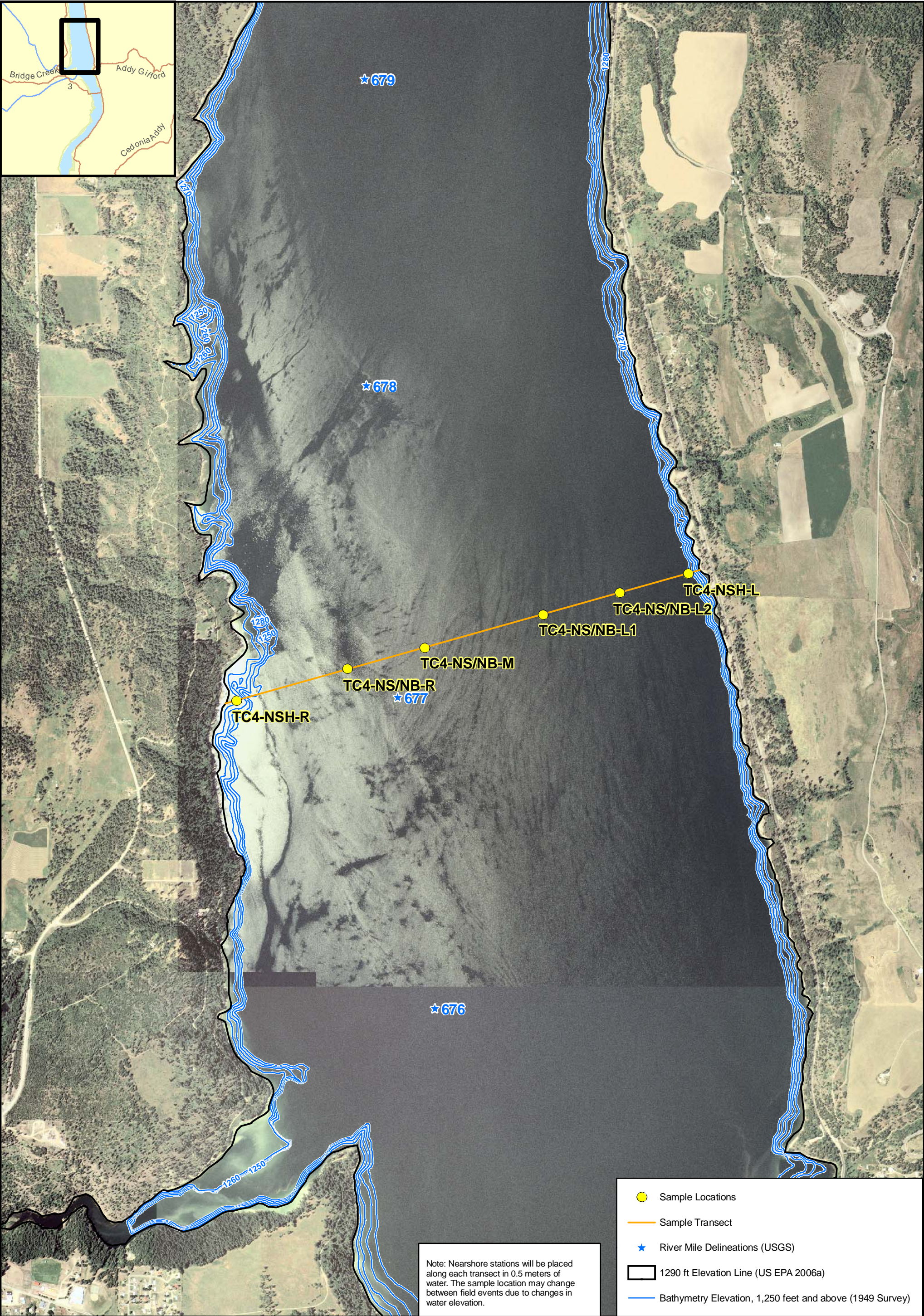
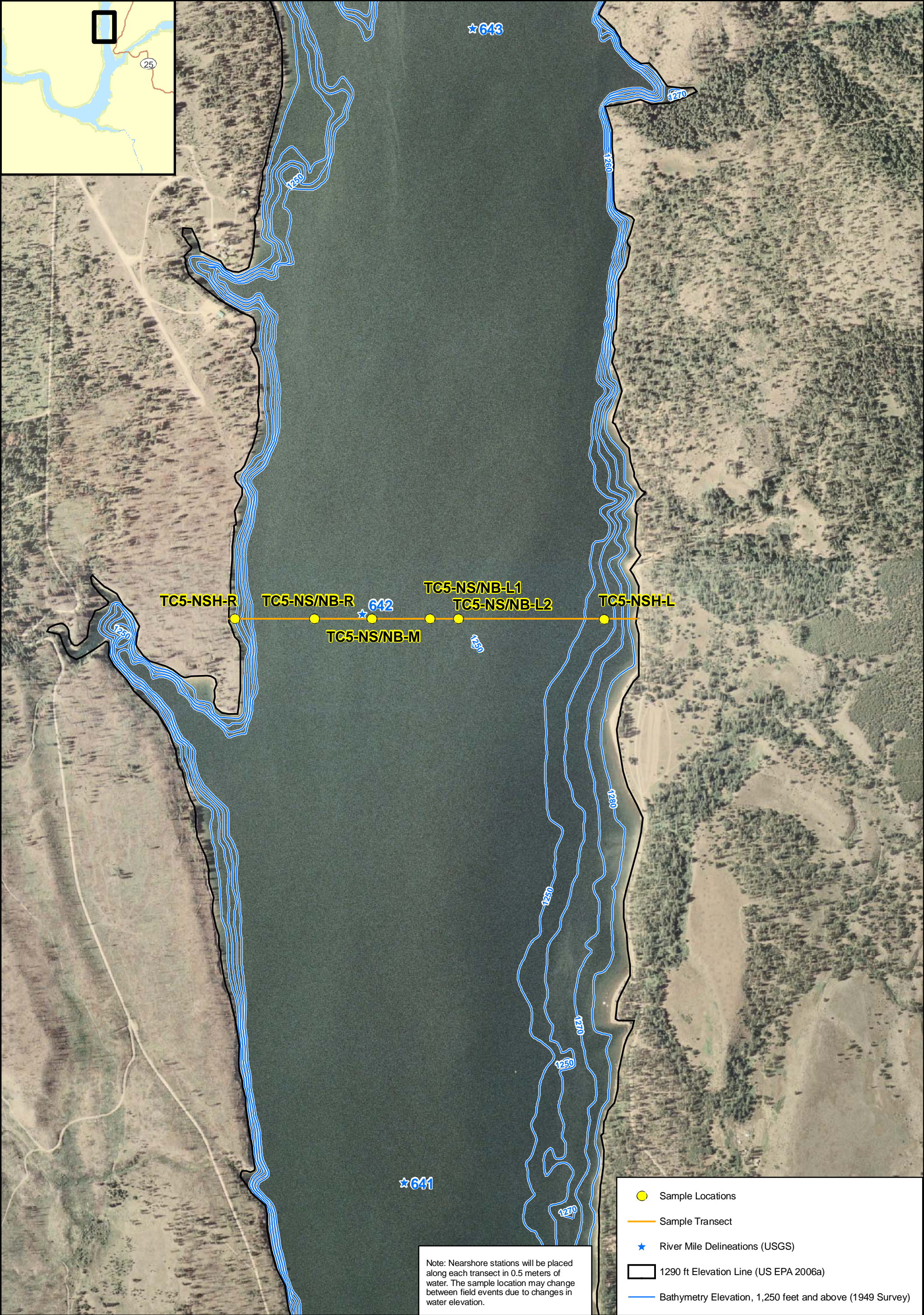


Figure 1-3c Proposed Surface Water Sampling Locations - TC3
2009/2010 Surface Water Study







Integral Parametrix

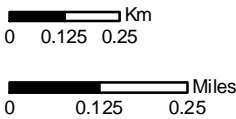
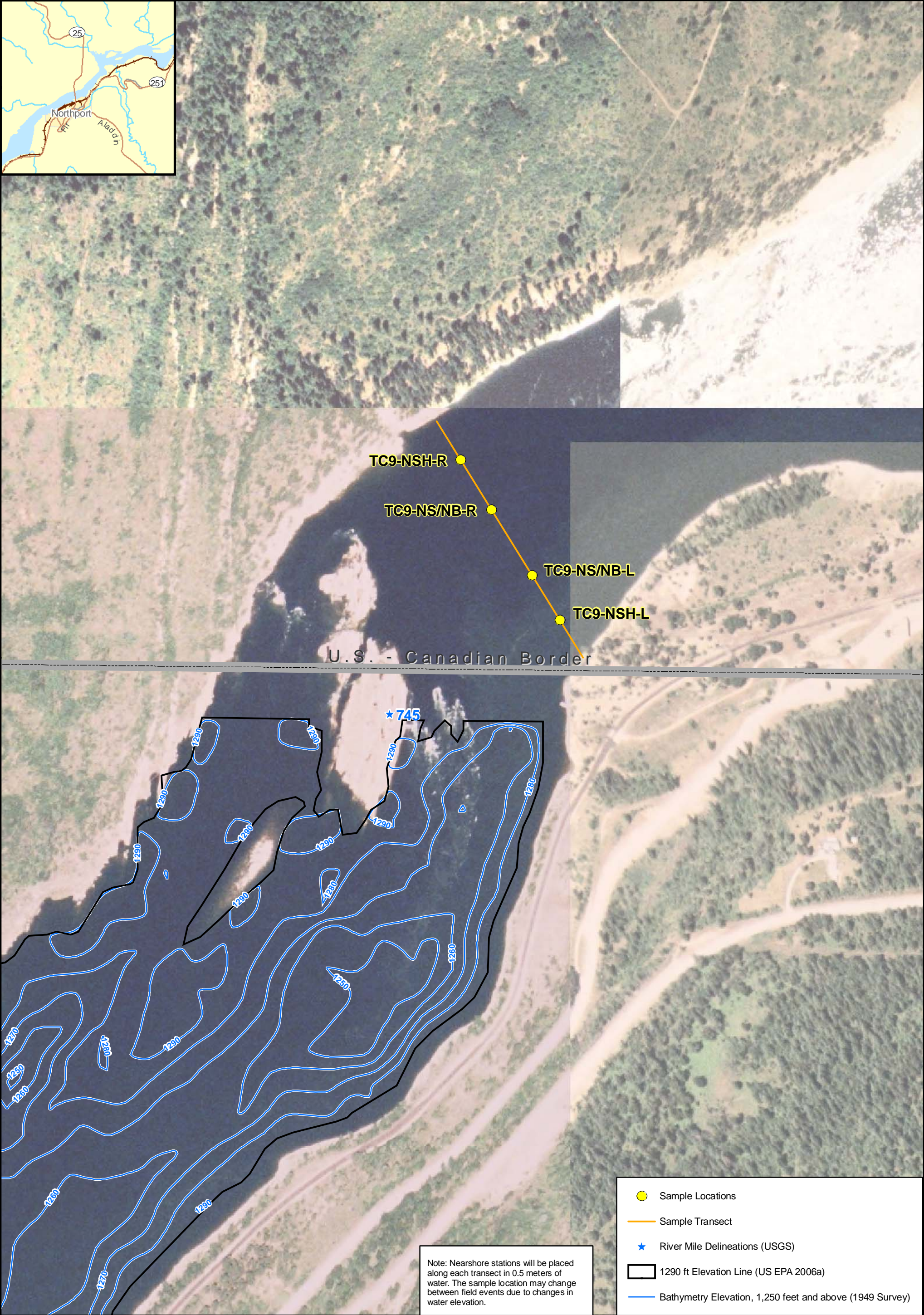


Figure 1-3f Proposed Surface Water Sampling Locations - TC6
2009/2010 Surface Water Study

Upper Columbia River, WA





Integral Parametrix

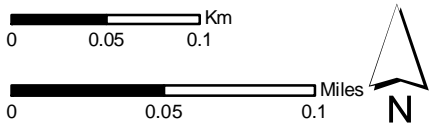
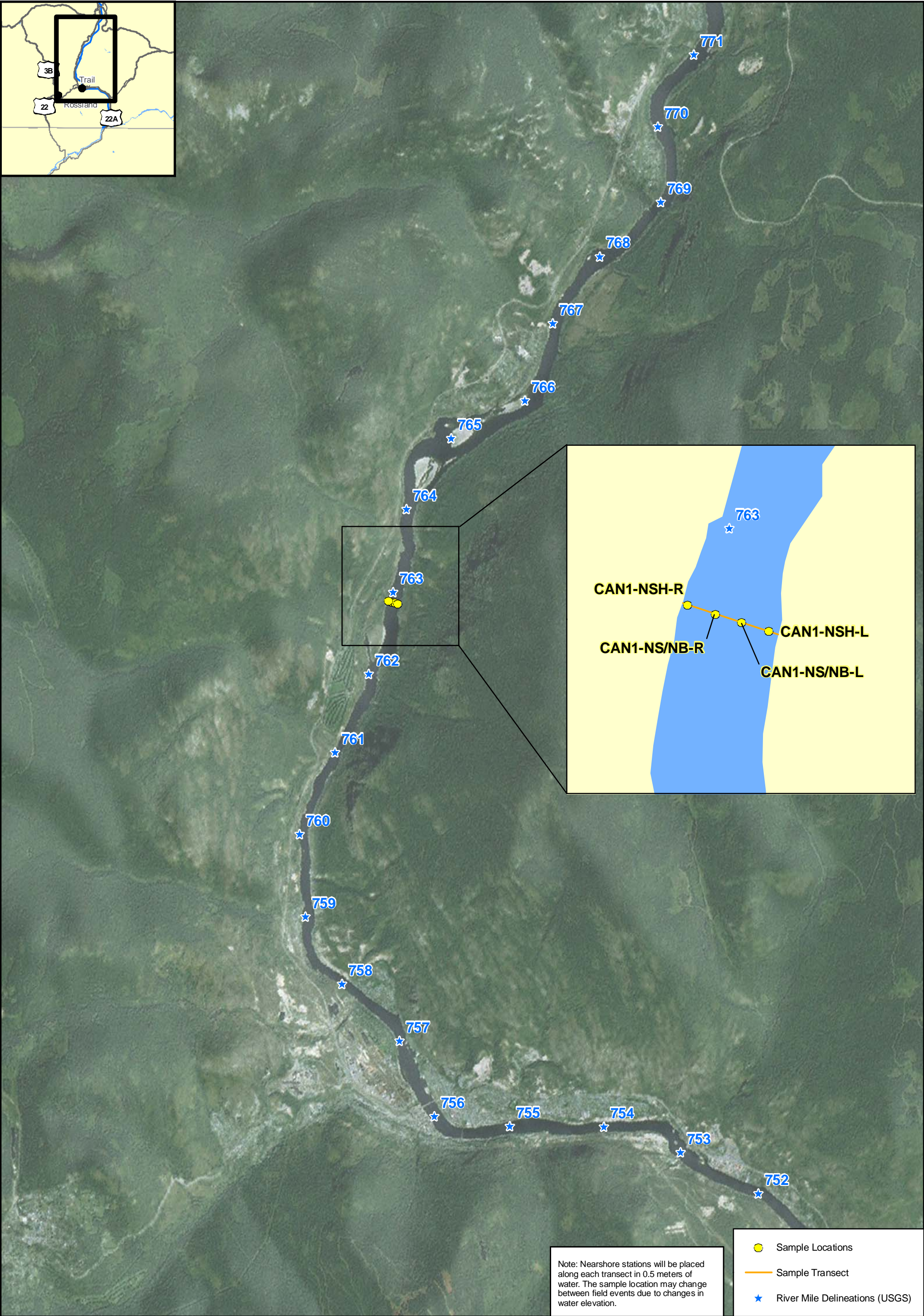


Figure 1-3h Proposed Surface Water Sampling Locations - TC9 2009/2010 Surface Water Study





Integral Parametrix

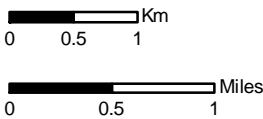


Figure 1-3j **Proposed Surface Water Sampling Locations - CAN1**
2009/2010 Surface Water Study

Upper Columbia River, WA



Integral Parametrix

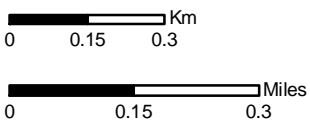


Figure 1-3k **Proposed Surface Water Sampling Locations - CAN2**
2009/2010 Surface Water Study

Upper Columbia River, WA

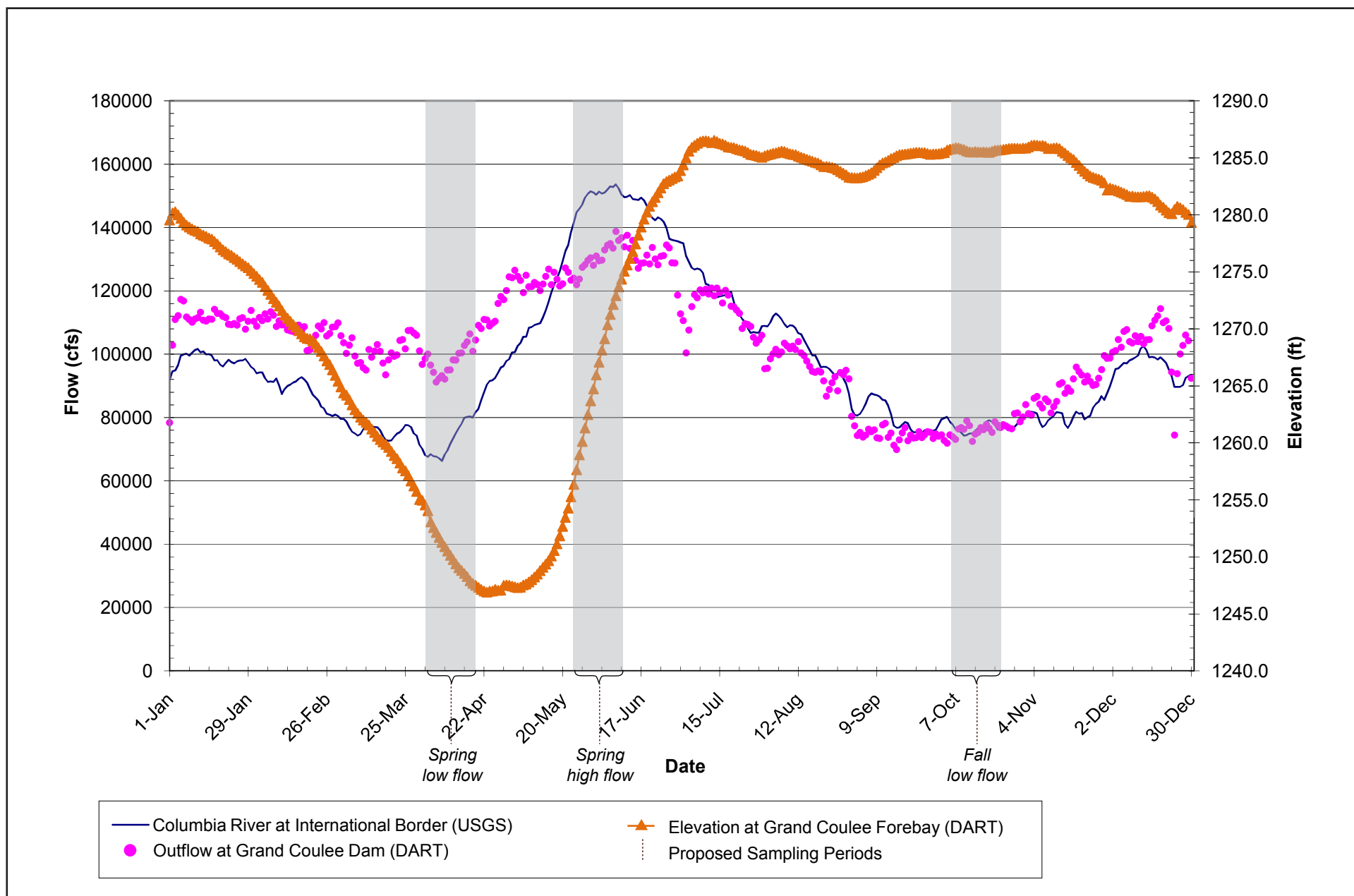


Figure 1-4. Lake Roosevelt Daily Average Inflow, Outflow and Pool Elevation: 1978–2007.

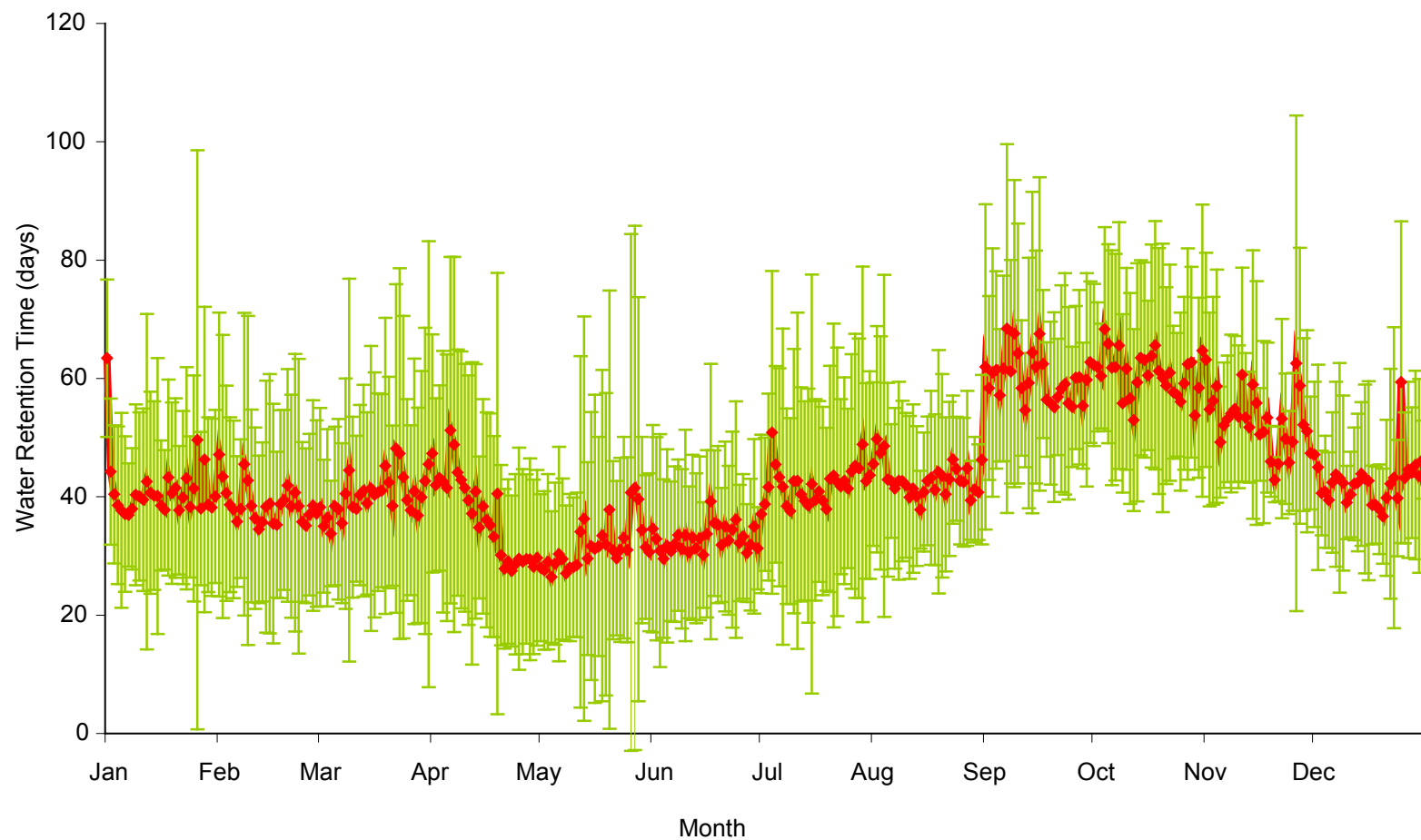
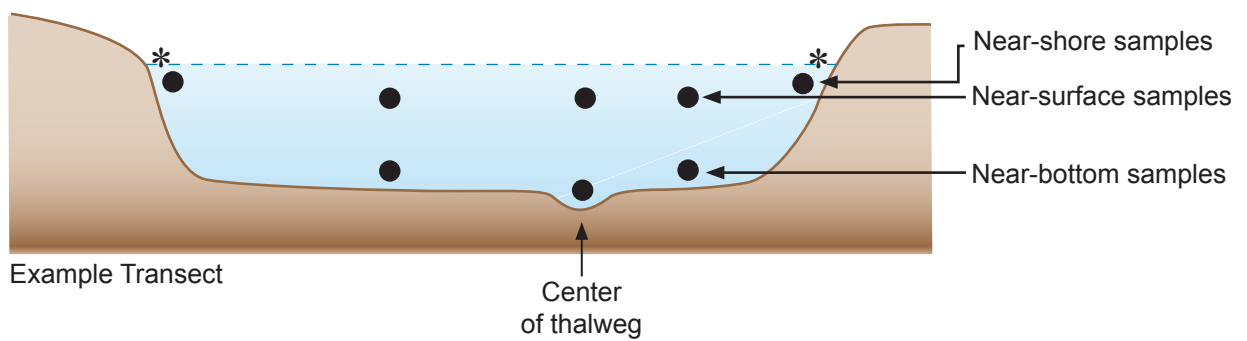


Figure 2-1. Daily Average Lake Roosevelt Water Retention Time over the Period of 1995-2005.
Source: <http://www.cbr.washington.edu/dart/dart.html> (September 2006).
Note: The shaded area around the average represents one standard deviation.



LEGEND

- - - - - Water level at time of sampling
- Single point sample
- * Location of near-shore samples will change with each sample collection period due to fluctuating river and pool elevations and will be determined based on water depth

Figure 2-2. Sample Collection Approach.

TABLES

Table 1-1. Target Analyte List for the 2009/2010 Surface Water Study

Conventional Parameters	Other Metals and Metalloids ^a	Pesticides
Alkalinity as CaCO ₃	Bismuth	2,4'-DDD
DOC	Boron	2,4'-DDE
Hardness as CaCO ₃	Cerium	2,4'-DDT
TDS/TSS	Cesium	4,4'-DDD
TOC	Dysprosium	4,4'-DDE
pH	Erbium	4,4'-DDT
Silicon dioxide (silica) (dissolved)	Europium	Aldrin
	Gadolinium	alpha-BHC
Major Ions	Gallium	alpha-Chlordane
Calcium	Germanium	beta-BHC
Chloride	Gold	cis-Nonachlor
Fluoride	Holmium	delta-BHC
Magnesium	Indium	Dieldrin
Potassium	Lanthanum	Endosulfan sulfate
Sodium	Lithium	Endosulfan I
Sulfate	Lutetium	Endosulfan II
	Neodymium	Endrin
Nutrients	Niobium	Endrin aldehyde
Ammonia	Praseodymium	Endrin ketone
Total phosphorus	Rubidium	gamma-BHC (lindane)
Nitrate	Samarium	gamma-Chlordane
Nitrite	Scandium	Heptachlor
	Strontium	Heptachlor epoxide
Common Metals and Metalloids^a	Tantalum	Hexachlorobenzene
Aluminum	Tellurium	Hexachlorobutadiene
Antimony	Terbium	Methoxychlor
Arsenic	Thorium	Oxychlordane
Barium	Thulium	Total Chlordane
Beryllium	Tin	Toxaphene
Cadmium	Titanium	trans-Nonachlor
Chromium	Tungsten	
Cobalt	Ytterbium	Polycyclic Aromatic Hydrocarbons
Copper	Yttrium	2-Methylnaphthalene
Iron	Zirconium	Acenaphthene
Lead		Acenaphthylene
Manganese	Polychlorinated Biphenyls	Anthracene
Mercury	PCB Congeners	Benz(a)anthracene
Molybdenum		Benzo(a)pyrene
Nickel		Benzo(b)fluoranthene
Selenium		Benzo(e)pyrene
Silver		Benzo(g,h,i)perylene
Thallium		Benzo(k)fluoranthene
Uranium		Carbazole
Vanadium		Chrysene
Zinc		Dibenz(a,h)anthracene
		Dibenzothiophene
		Fluoranthene
		Fluorene
		Indeno(1,2,3-cd)pyrene
		Naphthalene
		Perylene
		Phenanthrene
		Pyrene

Table 1-1. Target Analyte List for the 2009/2010 Surface Water Study

Semivolatile Organic Compounds	Polybrominated Diphenyl Ethers (PBDEs - most environmentally significant congeners)
1,1'-Biphenyl	2,2',4-TriBDE (BDE-17)
1,2,4-Trichlorobenzene	2,4,4'-TriBDE (BDE-28)
1,3-Dichlorobenzene	2,2',4,4'-TetraBDE (BDE-47)
1,4-Dichlorobenzene	2,2',4,5'-TetraBDE (BDE-49)
2,2'-Oxybis(1-chloropropane)	2,3',4,4'-TetraBDE (BDE-66)
2,4,5-Trichlorophenol	2,3',4',6-TetraBDE (BDE-71)
2,4,6-Trichlorophenol	2,2',3,4,4'-PentaBDE (BDE-85)
2,4-Dichlorophenol	2,2',4,4',5-PentaBDE (BDE-99)
2,4-Dimethylphenol	2,2',4,4',6-PentaBDE (BDE-100)
2,4-Dinitrophenol	2,2',3,3',4,4'-HexaBDE (BDE-128)
2,4-Dinitrotoluene	2,2',3,4,4',5'-HexaBDE (BDE-138)
2,6-Dinitrotoluene	2,2',4,4',5,5'-HexaBDE (BDE-153)
2-Chloronaphthalene	2,2',4,4',5,6'-HexaBDE (BDE-154)
2-Chlorophenol	2,2',3,4,4',5',6-HeptaBDE (BDE-183)
2-Methylphenol (o-cresol)	2,2',3,4,4',6,6'-HeptaBDE (BDE-184)
2-Nitroaniline	2,3,3',4,4',5,6-HeptaBDE (BDE-190)
2-Nitrophenol	2,3,3',4,4',5',6-HeptaBDE (BDE-191)
3,3'-Dichlorobenzidine	2,2',3,4,4',5,5',6-OctaBDE (BDE-203)
3-Nitroaniline	2,2',3,3',4,4',5,5',6-NonaBDE (BDE-206)
4,6-Dinitro-2-methylphenol	Decabromodiphenyl ether (BDE-209)
4-Bromophenyl phenyl ether	
4-Chloro-3-methylphenol	
4-Chloroaniline	Radionuclides
4-Chlorophenyl phenyl ether	Ra-226
4-Methylphenol (p-cresol)	U-238
4-Nitroaniline	
4-Nitrophenol	Stable Isotopes
Acetophenone	Deuterium
Benzaldehyde	Oxygen-18
Benzoic acid	
Benzyl alcohol	
Bis(2-chloroethoxy)methane	
Bis(2-chloroethyl)ether	
Bis(2-ethylhexyl)phthalate	
Butyl benzyl phthalate	
Caprolactam	
Dibenzofuran	
Diethyl phthalate	
Dimethyl phthalate	
Di-n-butyl phthalate	
Di-n-octylphthalate	
Hexachlorocyclopentadiene	
Hexachloroethane	
Isophorone	
Nitrobenzene	
N-Nitrosodi-n-propylamine	
N-Nitrosodiphenylamine	
Pentachlorophenol	
Phenol	

Notes:

^a Surface water samples will be analyzed for total and dissolved metals and metalloids.

Table 1-2. Analytes and Sample Volume Requirements for Each Transect/Station

Transect	Name	RM	Station ID ^a	Station Description	Common Metals and Metalloids ^b	Other Metals and Metalloids ^c	Organic Compounds ^d	Conventional Parameters ^e	Stable Isotopes ^f	Nutrients ^g	Major Ions ^h	Radionuclides ⁱ	Field Measurements ^j	Total Sample Volume/Station (Liters)
Site Transects/Stations														
TC1	Northport	734	TC1-NS-L	Near-surface single point sample; left	√	√		√	√	√	√		√	5.4
			TC1-NB-L	Near-bottom single point sample; left	√	√		√	√	√	√		√	5.4
			TC1-NS-M	Near-surface single point sample; middle	√	√	√	√	√	√	√		√	50.4
			TC1-NB-M	Near-bottom single point sample; middle	√	√	√	√	√	√	√		√	50.4
			TC1-NS-R	Near-surface single point sample; right	√	√		√	√	√	√		√	5.4
			TC1-NB-R	Near-bottom single point sample; right	√	√		√	√	√	√		√	5.4
			TC1-NSH-L	Near-shore single point sample; left (undisturbed)	√	√	√ ^k	√	√	√	√		√	50.4
				Near-shore single point sample; left (disturbed) ^{l,m}	√		√ ⁿ	TSS only				√ ⁿ		57.5
			TC1-NSH-R	Near-shore single point sample; right (undisturbed)	√	√		√	√	√	√		√	5.4
				Near-shore single point sample; right (disturbed) ^m	√									
TC2	China Bend	724	TC2-NS-L	Near-surface single point sample; left	√			√	√	√	√		√	4.9
			TC2-NB-L	Near-bottom single point sample; left	√			√	√	√	√		√	4.9
			TC2-NS-M	Near-surface single point sample; middle	√		√	√	√	√	√		√	49.9
			TC2-NB-M	Near-bottom single point sample; middle	√		√	√	√	√	√		√	49.9
			TC2-NS-R	Near-surface single point sample; right	√			√	√	√	√		√	4.9
			TC2-NB-R	Near-bottom single point sample; right	√			√	√	√	√		√	4.9
			TC2-NSH-L	Near-shore single point sample; left (undisturbed)	√		√ ^k	√	√	√	√		√	49.9
				Near-shore single point sample; left (disturbed) ^m	√									
			TC2-NSH-R	Near-shore single point sample; right (undisturbed)	√			√	√	√	√		√	4.9
				Near-shore single point sample; right (disturbed) ^{l,m}	√		√ ⁿ	TSS only				√ ⁿ		57.5
TC3 ^o	Marcus Flats	704	TC3-NS-L1	Near-surface single point sample; left	√	√		√	√	√	√		√	16.1
			TC3-NB-L1	Near-bottom single point sample; left	√	√		√	√	√	√		√	16.1
			TC3-NS-L2	Near-surface single point sample; left	√	√		√	√	√	√		√	16.1
			TC3-NB-L2	Near-bottom single point sample; left	√	√		√	√	√	√		√	16.1
			TC3-NS-M	Near-surface single point sample; middle	√	√	√	√	√	√	√		√	151.1
			TC3-NB-M	Near-bottom single point sample; middle	√	√	√	√	√	√	√		√	151.1
			TC3-NS-R	Near-surface single point sample; right	√	√		√	√	√	√		√	16.1
			TC3-NB-R	Near-bottom single point sample; right	√	√		√	√	√	√		√	16.1
			TC3-NSH-L	Near-shore single point sample; left (undisturbed)	√	√	√ ^k	√	√	√	√		√	151.1
				Near-shore single point sample; left (disturbed) ^{l,m}	√		√ ⁿ	TSS only				√ ⁿ		57.5
			TC3-NSH-R	Near-shore single point sample; right (undisturbed)	√	√		√	√	√	√		√	16.1
				Near-shore single point sample; right (disturbed) ^m	√									
TC4	Inchelium	678	TC4-NS-L1	Near-surface single point sample; left	√	√		√	√	√	√		√	5.4
			TC4-NB-L1	Near-bottom single point sample; left	√	√		√	√	√	√		√	5.4
			TC4-NS-L2	Near-surface single point sample; left	√	√		√	√	√	√		√	5.4
			TC4-NB-L2	Near-bottom single point sample; left	√	√		√	√	√	√		√	5.4
			TC4-NS-M	Near-surface single point sample; middle	√	√	√	√	√	√	√		√	50.4
			TC4-NB-M	Near-bottom single point sample; middle	√	√	√	√	√	√	√		√	50.4
			TC4-NS-R	Near-surface single point sample; right	√	√		√	√	√	√		√	5.4
			TC4-NB-R	Near-bottom single point sample; right	√	√		√	√	√	√		√	5.4
			TC4-NSH-L	Near-shore single point sample; left (undisturbed)	√	√	√ ^k	√	√	√	√		√	50.4

Table 1-2. Analytes and Sample Volume Requirements for Each Transect/Station

Transect	Name	RM	Station ID ^a	Station Description	Common Metals and Metalloids ^b	Other Metals and Metalloids ^c	Organic Compounds ^d	Conventional Parameters ^e	Stable Isotopes ^f	Nutrients ^g	Major Ions ^h	Radionuclides ⁱ	Field Measurements ^j	Total Sample Volume/Station (Liters)
TC5	Upstream of Spokane River	642	TC4-NSH-R	Near-shore single point sample; left (disturbed) ^m	√									5.4
				Near-shore single point sample; right (undisturbed)	√	√		√	√	√	√		√	
				Near-shore single point sample; right (disturbed) ^m	√									
			TC5-NS-L1	Near-surface single point sample; left	√			√	√	√	√		√	4.9
				TC5-NB-L1	√			√	√	√	√		√	4.9
				TC5-NS-L2	√			√	√	√	√		√	4.9
				TC5-NB-L2	√			√	√	√	√		√	4.9
				TC5-NS-M	√		√	√	√	√	√		√	49.9
				TC5-NB-M	√		√	√	√	√	√		√	49.9
				TC5-NS-R	√			√	√	√	√		√	4.9
				TC5-NB-R	√			√	√	√	√		√	4.9
				TC5-NSH-L	√		√ ^k	√	√	√	√		√	49.9
			TC5-NSH-R	Near-shore single point sample; left (disturbed) ^m	√									4.9
				Near-shore single point sample; right (undisturbed)	√			√	√	√	√		√	
				Near-shore single point sample; right (disturbed) ^m	√									
TC6 ^p	Downstream of Spokane River	637	TC6-NS-L	Near-surface single point sample; left	√ ^k	√ ^k		√ ^k	√ ^k	√ ^k	√ ^k		√	16.1
				TC6-NB-L	√ ^k	√ ^k		√ ^k	√ ^k	√ ^k	√ ^k		√	16.1
			TC6-NS-M	Near-surface single point sample; middle	√	√	√	√	√	√	√		√	151.1
				TC6-NB-M	√	√	√	√	√	√	√		√	151.1
			TC6-NS-R1	Near-surface single point sample; right	√	√		√	√	√	√		√	5.4
				TC6-NB-R1	√	√		√	√	√	√		√	5.4
			TC6-NS-R2	Near-surface single point sample; right	√	√		√	√	√	√		√	5.4
				TC6-NB-R2	√	√		√	√	√	√		√	5.4
			TC6-NSH-L	Near-shore single point sample; left (undisturbed)	√ ^k	√ ^k	√ ^k	√ ^k	√ ^k	√ ^k	√ ^k		√	151.1
				Near-shore single point sample; left (disturbed) ^{l,m}	√		√ ⁿ	TSS only				√ ⁿ		57.5
			TC6-NSH-R	Near-shore single point sample; right (undisturbed)	√	√		√	√	√	√		√	5.4
				Near-shore single point sample; right (disturbed) ^m	√									
TC7	Plum Point	605	TC7-NS-L	Near-surface single point sample; left	√			√	√	√	√		√	4.9
				TC7-NB-L	√			√	√	√	√		√	4.9
			TC7-NS-M	Near-surface single point sample; middle	√		√	√	√	√	√		√	49.9
				TC7-NB-M	√		√	√	√	√	√		√	49.9
			TC7-NS-R	Near-surface single point sample; right	√			√	√	√	√		√	4.9
				TC7-NB-R	√			√	√	√	√		√	4.9
			TC7-NSH-L	Near-shore single point sample; left (undisturbed)	√		√ ^k	√	√	√	√		√	49.9
				Near-shore single point sample; left (disturbed) ^m	√									4.9
			TC7-NSH-R	Near-shore single point sample; right (undisturbed)	√			√	√	√	√		√	
				Near-shore single point sample; right (disturbed) ^{l,m}	√		√ ⁿ	TSS only				√ ⁿ		12.5
TC8	Black Sand Beach	742	TC8-NSH-L	Near-shore single point sample: left (disturbed) ^{l,m}	√		√ ⁿ	TSS only				√ ⁿ	√	57.5
TC9	At the border	745	TC9-NS-L	Near-surface single point sample; left	√	√	√	√	√	√	√		√	50.4
				TC9-NB-L	√	√	√	√	√	√	√		√	50.4
				TC9-NS-R	√	√	√	√	√	√	√		√	50.4

Table 1-2. Analytes and Sample Volume Requirements for Each Transect/Station

Transect	Name	RM	Station ID ^a	Station Description	Common Metals and Metalloids ^b	Other Metals and Metalloids ^c	Organic Compounds ^d	Conventional Parameters ^e	Stable Isotopes ^f	Nutrients ^g	Major Ions ^h	Radionuclides ⁱ	Field Measurements ^j	Total Sample Volume/Station (Liters)
			TC9-NB-R	Near-bottom single point sample; right	√	√	√	√	√	√	√		√	50.4
			TC9-NSH-L	Near-shore single point sample; left (undisturbed)	√	√	√	√	√	√	√		√	50.4
			TC9-NSH-R	Near-shore single point sample; right (undisturbed)	√	√	√	√	√	√	√		√	50.4
Canadian Transect/Station														
CAN1 ^o	Birchbank, B.C.	762	CAN1-NS-L	Near-surface single point sample; left	√	√	√	√	√	√	√		√	50.4
			CAN1-NB-L	Near-bottom single point sample; left	√	√	√	√	√	√	√		√	50.4
			CAN1-NS-R	Near-surface single point sample; right	√	√	√	√	√	√	√		√	50.4
			CAN1-NB-R	Near-bottom single point sample; right	√	√	√	√	√	√	√		√	50.4
			CAN1-NSH-L	Near-shore single point sample; left (undisturbed)	√	√	√ ^k	√	√	√	√		√	151.1
			CAN1-NSH-R	Near-shore single point sample; right (undisturbed)	√	√		√	√	√	√		√	16.1
CAN2	Waneta, B.C.	746	CAN2-NSH-L	Near-shore single point sample; left (undisturbed)	√			√		√	√		√	4.8

^a Definitions
NSH=Nearshore station (~1 m water depth)
NS=Near-surface station
NB=Near-bottom station
L=Left side of transect
M=Middle of transect
R=Right side of transect

^b Total and dissolved metals; EPA target analyte list metals (aluminum, antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, nickel, selenium, silver, thallium, vanadium, zinc), molybdenum, and uranium

^c Total and dissolved metals; bismuth, boron, cerium, cesium, dysprosium, erbium, europium, gadolinium, gallium, germanium, gold, holmium, indium, lanthanum, lithium, lutetium, neodymium, niobium, praseodymium, rubidium, samarium, scandium, strontium, tantalum, tellurium, terbium, thorium, thulium, tin, titanium, tungsten, ytterbium, yttrium, zirconium

^d Pesticides, semivolatile organic compounds, polycyclic aromatic hydrocarbons, polychlorinated biphenyls (as congeners), polybrominated diphenyl ethers

^e Alkalinity as CaCO₃, dissolved organic carbon, hardness (as CaCO₃), total dissolved solids, total suspended solids, total organic carbon, pH, silica (as dissolved silicon dioxide [SiO₂])

^f Deuterium and oxygen-18

^g Ammonia, nitrate, nitrite, total phosphorus

^h Calcium, magnesium, potassium, sodium, chloride, fluoride, sulfate

ⁱ Ra-226 and U-238

^j Water temperature, pH, dissolved oxygen, conductivity, turbidity, oxidation-reduction potential (ORP). [Note: Reduction potential (Eh) will be calculated from ORP readings.]

^k Depending upon field conditions, the sample for organic compounds and field replicate (TC6 and CAN1 only) may be collected on the right bank instead of the left bank in the undisturbed sample.

^l One of the three disturbed sediment samples at this location will additionally be analyzed for the supplemental list of chemicals, including organic compounds and radionuclides identified for the beach sampling program (Teck 2009).

^m Disturbed, near-shore surface water samples at TC1 through TC8 will be collected at all sampling events. The total sample volume per station has been tripled to include all three samples.

ⁿ One of the three disturbed samples per sampling event will be analyzed for these compounds.

^o Field triplicates will be collected at all sampling locations along TC3 and CAN1 in October 2009. The total sample volume per station has been tripled to include the triplicate samples.

^p Five field replicates and five split samples will be collected at TC6; one replicate and split from a nearshore station (either left or right), one replicate and split from near-surface thalweg (or mid-channel) station, one replicate and split from near-bottom thalweg (or mid-channel) station, one replicate and split from near-surface either the left or right near-bottom station, and one replicate and split from either the left or right near-bottom station. The total sample volume per station has been tripled to include both the field replicate and the split samples.

Table 2-1. Sample Containers, Preservation, and Holding Time Requirements

	Container ^a		Preservation	Holding Time	Proposed Laboratory Sample Size ^b
	Type	Size			
Conventional Parameters					
Alkalinity as CaCO ₃	HDPE	250 mL	4±2°C	28 days	50 mL
Dissolved organic carbon	HDPE	250 mL	H ₂ SO ₄ to pH <2; 4±2°C	28 days	20 mL
Hardness as CaCO ₃	HDPE	250 mL	4±2°C	28 days	50 mL
Total dissolved solids	HDPE	1 L	4±2°C	7 days	200 mL
Total suspended solids	HDPE	1 L	4±2°C	7 days	200 mL
Total organic carbon	HDPE	250 mL	H ₂ SO ₄ to pH <2; 4±2°C	28 days	20 mL
pH	HDPE	1 L	4±2°C	28 days	50 mL
Silicon dioxide (silica) (dissolved)	HDPE	1 L	4±2°C	28 days	50 mL
Cations/Anions					
Calcium, magnesium, potassium, sodium	HDPE	250 mL	HNO ₃ to pH <2; 4±2°C	28 days	60 mL
Chloride, fluoride, sulfate	HDPE	250 mL	H ₂ SO ₄ to pH <2; 4±2°C	28 days	60 mL
Nutrients, Cations/Anions					
Ammonia	HDPE	250 mL	H ₂ SO ₄ to pH <2; 4±2°C	28 days	5 mL
Nitrate-nitrite	HDPE	250 mL	H ₂ SO ₄ to pH <2; 4±2°C	28 days	60 mL
Total phosphorus	HDPE	250 mL	H ₂ SO ₄ to pH <2; 4±2°C	28 days	100 mL
Common Metals and Metalloids ^c	HDPE	two 1 L two 250 mL	5 mL of 1:1 HNO ₃ ; 4±2°C	6 months	1 L
Mercury ^c	FP or G w/ FP-lined lids	two 500 mL	BrCl in lab within 28 days of collection; 4±2°C	90 days	500 mL
Other Metals and Metalloids ^c	HDPE	two 500 mL	HNO ₃ in lab within 28 days of collection; 4±2°C	6 months	250 mL
Stable Isotopes					
Deuterium Oxygen-18	HDPE	125 mL	4±2°C	N/A	100 mL

Table 2-1. Sample Containers, Preservation, and Holding Time Requirements

	Container ^a		Preservation	Holding Time	Proposed Laboratory Sample Size ^b
	Type	Size			
Pesticides	AG	1 L	4±2°C	7/40 days ^d	1 L
SVOCs	AG	1 L	4±2°C	7/40 days ^d	1 L
PAHs	AG	1 L	4±2°C	7/40 days ^d	1 L
PCB Congeners	PUF	40 L	4±2°C	7/40 days ^d	1 PUF
PBDEs	AG	1 L	4±2°C	7/40 days ^d	1 L
Radionuclides					
Ra-226	HDPE	1 L	HNO ₃ to pH<2	180 days	1 L
U-238	HDPE	1 L	HNO ₃ to pH<2	180 days	300 mL

Notes:

AG = amber glass

FP = fluoropolymer

G = glass

HDPE = high density polyethylene bottle

N/A = not available

PUF = polyurethane foam

^a Sample container sizes may be modified to meet laboratory requirements

^b Extra sample volume will be collected at a frequency of 5 percent of samples to accommodate requirements for laboratory QC samples

^c Surface water samples will be collected and analyzed for total and dissolved metals and metalloids and mercury. A total of 2 L of water will be collected for the common metals/metalloids analyses (1 L each for total and dissolved), and 500 mL will be collected for the "other" metals/metalloids analyses (250 mL each for total and dissolved). 250 mL bottles will be collected for possible arsenic analysis at Frontier GeoSciences.

^d The holding time is 7 days from collection to extraction, and 40 days from extraction to analysis

Table 2-2. Proposed Station Location Coordinates and Approximate Water Depths for UCR Surface Water Sampling

Transect/ Station ID	Station Number ^a	Sample Type	Approximate Water Depth (m)	Coordinates (NAD83) ^{a,b}		Coordinates (WGS 1984) ^{c,b}		Coordinates (in decimal-degrees) ^{d,b}	
				X	Y	Longitude	Latitude	Longitude	Latitude
TC1	TC1-NS-L	Near-surface single point sample; left	1.0	441214.4565	5418049.4728	48.91259311800	-117.80231281100	48 54.7555873	117 48.1387687
	TC1-NB-L	Near-bottom single point sample; left	9	441214.4565	5418049.4728	48.91259311800	-117.80231281100	48 54.7555873	117 48.1387687
	TC1-NS-M	Near-surface single point sample; middle	1	441178.6807	5418080.0134	48.91286442900	-117.80280543600	48 54.7718656	117 48.1683262
	TC1-NB-M	Near-bottom single point sample; middle	10	441178.6807	5418080.0134	48.91286442900	-117.80280543600	48 54.7718656	117 48.1683262
	TC1-NS-R	Near-surface single point sample; right	1	441145.1311	5418108.6537	48.91311885700	-117.80326741100	48 54.7871316	117 48.1960447
	TC1-NB-R	Near-bottom single point sample; right	10	441145.1311	5418108.6537	48.91311885700	-117.80326741100	48 54.7871316	117 48.1960447
	TC1-NSH-L	Near-shore single point sample; left	0.5	441243.9700	5418024.2781	48.91236929700	-117.80190642100	48 54.7421578	117 48.1143853
	TC1-NSH-R	Near-shore single point sample; right	0.5	441114.9619	5418134.4081	48.91334764600	-117.80368284200	48 54.8008588	117 48.2209705
TC2	TC2-NS-L	Near-surface single point sample; left	1	431760.8488	5407627.7919	48.81788417200	-117.92958235800	48 49.0730505	117 55.7749415
	TC2-NB-L	Near-bottom single point sample; left	21	431760.8488	5407627.7919	48.81788417200	-117.92958235800	48 49.0730505	117 55.7749415
	TC2-NS-M	Near-surface single point sample; middle	1	431727.3003	5407656.8516	48.81814187000	-117.93004414300	48 49.0885125	117 55.8026486
	TC2-NB-M	Near-bottom single point sample; middle	18	431727.3003	5407656.8516	48.81814187000	-117.93004414300	48 49.0885125	117 55.8026486
	TC2-NS-R	Near-surface single point sample; right	1	431692.7076	5407686.8157	48.81840758600	-117.93052030500	48 49.1044554	117 55.8312183
	TC2-NB-R	Near-bottom single point sample; right	16	431692.7076	5407686.8157	48.81840758600	-117.93052030500	48 49.1044554	117 55.8312183
	TC2-NSH-L	Near-shore single point sample; left	0.5	431821.7106	5407575.0734	48.81741666600	-117.92874462600	48 49.0449998	117 55.7246776
	TC2-NSH-R	Near-shore single point sample; right	0.5	431580.7927	5407783.7562	48.81926722200	-117.93206083000	48 49.1560333	117 55.9236498
TC3	TC3-NS-L1	Near-surface single point sample; left #1	1	418632.3907	5387520.4140	48.63545032200	-118.10442381900	48 38.1270194	118 06.2654291
	TC3-NB-L1	Near-bottom single point sample; left #1	23	418632.3907	5387520.4140	48.63545032200	-118.10442381900	48 38.1270194	118 06.2654291
	TC3-NS-L2	Near-surface single point sample; left #2	1	420315.1084	5387074.4856	48.63165610400	-118.08150240300	48 37.8993665	118 04.8901442
	TC3-NB-L2	Near-bottom single point sample; left #2	20	420315.1084	5387074.4856	48.63165610400	-118.08150240300	48 37.8993665	118 04.8901442
	TC3-NS-M	Near-surface single point sample; middle	1	418326.4772	5387601.4826	48.63613960800	-118.10859123100	48 38.1683767	118 06.5154739
	TC3-NB-M	Near-bottom single point sample; middle	24	418326.4772	5387601.4826	48.63613960800	-118.10859123100	48 38.1683767	118 06.5154739
	TC3-NS-R	Near-surface single point sample; right	1	417782.0028	5387745.7709	48.63736604300	-118.11600879700	48 38.2419627	118 06.9605278
	TC3-NB-R	Near-bottom single point sample; right	23	417782.0028	5387745.7709	48.63736604300	-118.11600879700	48 38.2419627	118 06.9605278
	TC3-NSH-L	Near-shore single point sample; left	0.5	420401.6231	5387051.5588	48.63146090600	-118.08032401900	48 37.8876545	118 04.8194412
	TC3-NSH-R	Near-shore single point sample; right	0.5	417700.8649	5387767.2728	48.63754876600	-118.11711419800	48 38.2529261	118 07.0268519
TC4	TC4-NS-L1	Near-surface single point sample; left #1	1	413477.3218	5353894.4347	48.33230778800	-118.16741748700	48 19.9384675	118 10.0450492
	TC4-NB-L1	Near-bottom single point sample; left #1	23	413477.3218	5353894.4347	48.33230778800	-118.16741748700	48 19.9384675	118 10.0450492
	TC4-NS-L2	Near-surface single point sample; left #2	1	413859.7856	5354003.9194	48.3334483500	-118.16228053900	48 20.0006899	118 09.7368323
	TC4-NB-L2	Near-bottom single point sample; left #2	24	413859.7856	5354003.9194	48.3334483500	-118.16228053900	48 20.0006899	118 09.7368323
	TC4-NS-M	Near-surface single point sample; middle	1	412883.3531	5353728.2649	48.33073152000	-118.17539557700	48 19.8438913	118 10.5237346
	TC4-NB-M	Near-bottom single point sample; middle	52	412883.3531	5353728.2649	48.33073152000	-118.17539557700	48 19.8438913	118 10.5237346
	TC4-NS-R	Near-surface single point sample; right	1	412497.9804	5353622.1990	48.32972423900	-118.18057193500	48 19.7834544	118 10.8343161
	TC4-NB-R	Near-bottom single point sample; right	43	412497.9804	5353622.1990	48.32972423900	-118.18057193500	48 19.7834544	118 10.8343161
	TC4-NSH-L	Near-shore single point sample; left	0.5	414202.1052	5354099.4954	48.33425109800	-118.15768210300	48 20.0550657	118 09.4609262
	TC4-NSH-R	Near-shore single point sample; right	0.5	411942.4574	5353464.0593	48.32822465200	-118.18803230400	48 19.6934790	118 11.2819382
TC5	TC5-NS-L1	Near-surface single point sample; left #1	1	398898.4183	5310416.0743	47.93907991100	-118.35375051700	47 56.3447945	118 21.2250310
	TC5-NB-L1	Near-bottom single point sample; left #1	43	398898.4183	5310416.0743	47.93907991100	-118.35375051700	47 56.3447945	118 21.2250310
	TC5-NS-L2	Near-surface single point sample; left #2	1	398981.4431	5310416.0732	47.93909299800	-118.35263913500	47 56.3455798	118 21.1583481
	TC5-NB-L2	Near-bottom single point sample; left #2	27	398981.4431	5310416.0732	47.93909299800	-118.35263913500	47 56.3455798	118 21.1583481
	TC5-NS-M	Near-surface single point sample; middle	1	398729.5112	5310416.0766	47.93905325300	-118.35601152900	47 56.3431955	118 21.3606917
	TC5-NB-M	Near-bottom single point sample; middle	73	398729.5112	5310416.0766	47.93905325300	-118.35601152900	47 56.3431955	118 21.3606917
	TC5-NS-R	Near-surface single point sample; right	1	398560.7518	5310416.0789	47.93902657500	-118.35827056000	47 56.3415946	118 21.4962336
	TC5-NB-R	Near-bottom single point sample; right	43	398560.7518	5310416.0789	47.93902657500	-118.35827056000	47 56.3415946	118 21.4962336

Table 2-2. Proposed Station Location Coordinates and Approximate Water Depths for UCR Surface Water Sampling

Transect/ Station ID	Station Number ^a	Sample Type	Approximate Water Depth (m)	Coordinates (NAD83) ^{a,b}		Coordinates (WGS 1984) ^{c,b}		Coordinates (in decimal-degrees) ^{d,b}	
				X	Y	Longitude	Latitude	Longitude	Latitude
TC6	TC5-NSH-L	Near-shore single point sample; left	0.5	399408.2069	5310413.6919	47.93913873000	-118.34692584600	47 56.3483239	118 20.8155508
	TC5-NSH-R	Near-shore single point sample; right	0.5	398327.5417	5310416.0821	47.93898963500	-118.36139233100	47 56.3393781	118 21.6835399
	TC6-NS-L	Near-surface single point sample; left	1	399329.2034	5302909.7631	47.87162963500	-118.34623174200	47 52.2977781	118 20.7739045
	TC6-NB-L	Near-bottom single point sample; left	35	399329.2034	5302909.7631	47.87162963500	-118.34623174200	47 52.2977781	118 20.7739045
	TC6-NS-M	Near-surface single point sample; middle	1	399166.0801	5302970.7929	47.87215299800	-118.34842674600	47 52.3291800	118 20.9056048
	TC6-NB-M	Near-bottom single point sample; middle	43	399166.0801	5302970.7929	47.87215299800	-118.34842674600	47 52.3291800	118 20.9056048
	TC6-NS-R1	Near-surface single point sample; right #1	1	398918.8168	5303063.3024	47.87294623500	-118.35175403000	47 52.3767739	118 21.1052418
	TC6-NB-R1	Near-bottom single point sample; right #1	84	398918.8168	5303063.3024	47.87294623500	-118.35175403000	47 52.3767739	118 21.1052418
	TC6-NS-R2	Near-surface single point sample; right #2	1	398784.3209	5303113.6219	47.87337766600	-118.35356390800	47 52.4026601	118 21.2138345
	TC6-NB-R2	Near-bottom single point sample; right #2	23	398784.3209	5303113.6219	47.87337766600	-118.35356390800	47 52.4026601	118 21.2138345
TC7	TC6-NSH-L	Near-shore single point sample; left	0.5	399385.3829	5302888.7443	47.87144937800	-118.34547579500	47 52.2869626	118 20.7285477
	TC6-NSH-R	Near-shore single point sample; right	0.5	398478.9900	5303227.8564	47.87435698700	-118.35767277900	47 52.4614191	118 21.4603667
	TC7-NS-L	Near-surface single point sample; left	1	362696.8833	5311871.2827	47.94543117100	-118.83872911800	47 56.7258705	118 50.3237471
	TC7-NB-L	Near-bottom single point sample; left	64	362696.8833	5311871.2827	47.94543117100	-118.83872911800	47 56.7258705	118 50.3237471
	TC7-NS-M	Near-surface single point sample; middle	1	363035.4526	5312062.6479	47.94722453700	-118.83425839700	47 56.8334723	118 50.0555038
	TC7-NB-M	Near-bottom single point sample; middle	104	363035.4526	5312062.6479	47.94722453700	-118.83425839700	47 56.8334723	118 50.0555038
	TC7-NS-R	Near-surface single point sample; right	1	363212.0974	5312162.0106	47.94815582200	-118.83192557000	47 56.8893496	118 49.9155342
	TC7-NB-R	Near-bottom single point sample; right	75	363212.0974	5312162.0106	47.94815582200	-118.83192557000	47 56.8893496	118 49.9155342
	TC7-NSH-L	Near-shore single point sample; left	0.5	361953.5030	5311455.4313	47.94153181300	-118.84854555400	47 56.4919087	118 50.9127332
	TC7-NSH-R	Near-shore single point sample; right	0.5	364371.3291	5312809.7083	47.95422692700	-118.81661291400	47 57.2536155	118 48.9967749
TC8	TC8-NSH-L	Near-shore single point sample; left (disturbed)	0.5	452556.0978	5424433.8117	48.97099400000	-117.64827600000	48 58.2596403	117 38.8965349
TC9	TC9-NS-L	Near-surface single point sample; left	ND ^e	453879.2483	5427801.8506	49.00139000000	-117.63057900000	49 00.0834002	117 37.8347594
	TC9-NB-L	Near-bottom single point sample; left	ND	453879.2483	5427801.8506	49.00139000000	-117.63057900000	49 00.0834002	117 37.8347594
	TC9-NS-R	Near-surface single point sample; right	ND	453831.9809	5427878.2022	49.00207300000	-117.63123400000	49 00.1243955	117 37.8740531
	TC9-NB-R	Near-bottom single point sample; right	ND	453831.9809	5427878.2022	49.00207300000	-117.63123400000	49 00.1243955	117 37.8740531
	TC9-NSH-L	Near-shore single point sample; left	0.5	453911.8712	5427749.1543	49.00091800000	-117.63012700000	49 00.0551060	117 37.8076403
	TC9-NSH-R	Near-shore single point sample; right	0.5	453796.0013	5427936.3207	49.00259300000	-117.63173300000	49 00.1556007	117 37.9039639
CAN1	CAN1-NS-L	Near-surface single point sample; left	1	447820.1823	5447309.3694	49.17638885900	-117.71600656300	49 10.5823995	117 42.9559914
	CAN1-NB-L	Near-bottom single point sample; left	1	447820.1823	5447309.3694	49.17638885900	-117.71600656300	49 10.5823995	117 42.9559914
	CAN1-NS-R	Near-surface single point sample; right	1	447751.3591	5447332.3104	49.17652692300	-117.71670902300	49 10.5944288	117 43.0128229
	CAN1-NB-R	Near-bottom single point sample; right	1	447751.3591	5447332.3104	49.17652692300	-117.71670902300	49 10.5944288	117 43.0128229
	CAN1-NSH-L	Near-shore single point sample; left	0.5	447867.6142	5447294.0216	49.17623931300	-117.71528046500	49 10.5743590	117 42.9168279
	CAN1-NSH-R	Near-shore single point sample; right	0.5	447709.4516	5447345.5577	49.17668940000	-117.71745705100	49 10.6013642	117 43.0474231
	CAN2 ^e	CAN2-NSH-L	Near-shore single point sample; left	1	454942.4261	5428518.6376	49.00791600000	-117.61612400000	49 00.4749654

Notes:

^a NAD83 UTM Zone 11.

^b Coordinates are provided for the spring high flow sampling event. Coordinates for actual station locations will be collected in the field.

^c GCS WGS 1984

^d Degrees Minutes Decimal Seconds

^e ND=no data, a cross-section has not been developed for this transect to estimate station depths

^f Sampling on a weekly basis for several weeks prior to the initiation of each sampling event within the Site.

The number of weeks over which sampling will occur will vary with the average hydraulic residence time in the UCR.

ATTACHMENT A1

GENERAL SITE HEALTH AND
SAFETY PLAN, ADDENDUM 2,
2008/2009 SURFACE WATER
STUDY

GENERAL SITE HEALTH AND SAFETY PLAN

ADDENDUM 2

2009/2010 SURFACE WATER STUDY

UPPER COLUMBIA RIVER RI/FS

Prepared for

Teck American Incorporated

P.O. Box 3087

Spokane, WA 99220-3087

Prepared by



411 1st Avenue S., Suite 550

Seattle, WA 98104

September 2009

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ACRONYMS AND ABBREVIATIONS

CFR	Code of Federal Regulations
COI	chemical of interest
DGPS	differential global positioning system
HAZWOPER	hazardous waste operations and emergency response
Integral	Integral Consulting Inc.
OSHA	Occupational Safety and Health Administration
PFD	personal flotation device
PPE	personal protective equipment
RI/FS	remedial investigation and feasibility study
RM	river mile
SHSP	site health and safety plan
Site	Upper Columbia River site
Teck	Teck American Incorporated
UCR	Upper Columbia River
WISHA	Washington Industrial Safety and Health Act

**SITE HEALTH AND SAFETY PLAN
ADDENDUM APPROVAL**

Addendum 2 to the general site health and safety plan (SHSP) has been reviewed and approved by Teck American Incorporated's (Teck) lead technical consultant (Integral Consulting Inc. [Integral]) for the 2009/2010 surface water study at the Upper Columbia River (UCR) site (Site) in support of the remedial investigation and feasibility study (RI/FS) for the Site.

Integral Project Manager

Date

Integral Corporate Health and Safety Officer

Date

SITE HEALTH AND SAFETY PLAN ADDENDUM ACKNOWLEDGEMENT

Addendum 2 to the general SHSP (TCAI 2007) is approved by Integral for use at the Site. The general SHSP and Addendum 2 are the minimum health and safety standard for the Site and will be strictly enforced for Integral personnel and other subcontracted personnel where applicable. Subcontracted personnel may request to adopt Addendum 2 to the general SHSP in lieu of a subcontractor-specific plan, but must obtain prior written approval by Integral and provide written concurrence from the subcontractor that the subcontractor will assume direct responsibility and liability for administering the plan for its employees.

I have reviewed Addendum 2, dated September 2009, to the general SHSP for the Site 2009/2010 surface water study. I have had an opportunity to ask any questions I may have and have been provided with satisfactory responses. I understand the purpose of the plan, and I consent to adhere to its policies, procedures, and guidelines while an employee of Integral, or their subcontractors.

Employee signature

Company

Date

Employee signature

Company

Date

Employee signature

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Date

1 INTRODUCTION

Addendum 2 to the UCR RI/FS general SHSP provides specific Site information and health and safety provisions to protect workers from potential hazards during surface water sampling at locations along the UCR.

Site background information and general health and safety provisions to protect workers from potential hazards during work at the Site are presented in the general SHSP.

Subcontractors that are contracted to perform fieldwork associated with the RI/FS will develop and follow their own SHSPs. However, subcontractor SHSPs must be consistent with the provisions outlined in Addendum 2 and the general SHSP.

It is Integral's policy to provide a safe and healthful work environment. No aspect of the work is more important than protecting the health and safety of all workers.

Integral cannot guarantee the health or safety of any person entering the Site. Because of the potentially hazardous nature of the Site and the activity occurring thereon, it is not possible to regulate personal diligence or to discover, evaluate, and provide protection for all possible hazards that may be encountered. Strict adherence to the health and safety guidelines set forth herein will reduce, but not eliminate, the potential for injury and illness at the Site. The health and safety guidelines in this plan were prepared specifically for the Site and should not be used on any other site without prior evaluation by trained health and safety personnel.

A copy of Addendum 2 and the general SHSP must be in the custody of the field crew during field activities. All individuals performing fieldwork must read, understand, and comply with this plan before undertaking field activities. Once the information has been read and understood, the individual must sign the Site Health and Safety Acknowledgment Form provided with this addendum to the general plan. The signed form will become part of Integral's project file. A copy of the form will also be provided to Teck.

Addendum 2 may be modified at any time based on the judgment of Integral's site safety officer in consultation with Integral's corporate health and safety officer and project manager or designee. Any modification will be presented to the onsite team during a safety briefing and will be recorded in the field notebook.

1.1 ORGANIZATION

Task-specific safety procedures associated with surface water sampling are presented in this addendum to the general SHSP. In addition, this addendum provides detailed field site and hospital location maps, air monitoring requirements, specific requirements for

personal protective equipment (PPE), work zone definitions, and key emergency contact information

The general SHSP provides background site information and general health and safety provisions to protect workers from potential hazards during field activities. The information includes general safety guidelines for physical hazards, a chemical hazard evaluation, health and safety training requirements, general PPE requirements, emergency planning, general decontamination procedures, vehicle and boating safety, spill containment, and shipping instructions.

1.2 SCOPE OF WORK

Surface water will be collected along eight transects and one additional nearshore sampling station in the UCR between the U.S.-Canadian border (river mile [RM] 745¹) and RM 605 near the Grand Coulee Dam (Figure 1-1). One or more transects will be located in each of the six physiographic reaches identified for the UCR.

Sampling will occur during three key time periods that may influence chemicals of interest (COI) concentrations in surface water of the UCR and its major tributaries:

- Fall low flow (i.e., mid-October)
- Spring low flow (i.e., late March to early April)
- Spring high flow (i.e., late May to early June).

Access to all of the surface water stations (except possibly a few near-shore stations during the spring drawdown (i.e., low flow) sampling event) will require the use of a boat. Depending on water levels, wading may be necessary to collect the near-shore spring drawdown surface water samples. Wading will also be necessary to cause disturbance to sediment as required for some of the near-shore disturbed surface water samples that will be collected. Depending on the sample collection requirements, surface water samples will be collected using either a non-metallic water collection bottle (e.g., GO-FLO™), a peristaltic pump with Teflon™ tubing, a depth integrated sampler, or similar device. The coordinates of each sample station location will be surveyed using a differential global positioning system (DGPS) unit.

1.3 DEFINITIONS

Contamination reduction zone:	Area between the exclusion and support zones that provides a transition between contaminated and clean zones
-------------------------------	--

¹ All river miles are U.S. Geological Survey (USGS) river miles.

1	Exclusion zone:	Any area of the Site where hazardous substances are
2		present, or are reasonably suspected to be present,
3		and pose an exposure hazard to personnel
4	HAZWOPER:	Hazardous Waste Operations and Emergency
5		Response standard, as described in 29 CFR Part
6		1910.120
7	OSHA:	Occupational Safety and Health Administration
8	Support zone:	Any area of the site, so designated, that is outside the
9		exclusion and contamination reduction zones
10	WISHA:	Washington Industrial Safety and Health Act, as
11		described in Chapter 49.17 Revised Code of
12		Washington

2 SAFETY GUIDELINES FOR PHYSICAL HAZARDS

All work will be done using the buddy system. Depending upon the time of year and the location of work, snakes, cougars (mountain lions), and insects or other animals may be an issue when accessing the sampling vessel and at near-shore sampling stations during the spring drawdown sampling event. During the fall and winter times, the field crew may be working under artificial lighting due to shorter daylight hours. Drowning and hypothermia are always concerns when working on the water, so it is required that personnel participating in surface water sample collection must wear personal flotation devices (PFDs).

The following table summarizes potential physical hazards posed by proposed site activities.

Table 2-1. Summary of Activities and Potential Hazards.

Activity	Potential Hazard
Surface water sampling	Uneven terrain/tripping, slippery walking surfaces, cold/hypothermia (depending on sampling event), heat stress (depending on sampling event), material handling, adverse weather, work in remote areas, plant and animal hazards, drowning.

The following table presents possible physical hazards that are expected to be present during surface water sampling activities.

Table 2-2. Possible Physical Hazards and Proposed Safety Procedures.

Possible Hazard	Yes	No	Proposed Safety Procedure
Uneven terrain/tripping, slippery walking surfaces	X		Use caution; wear properly fitting shoes or boots with good gripping capacity and ankle support; keep work area orderly
Above-head lifting equipment such as A-frame, winch cable, and suspended sampling equipment, pinch areas	X		Wear hard hat while working on deck when overhead activities are ongoing; listen to verbal and visual commands of boat and winch operator; do not stay underneath area of operations; watch for pinch areas near mobile A-frame, wear gloves
Cold/hypothermia	X		Keep warm and dry, bring changes of clothes; do not work in extreme conditions without proper equipment and training; follow cold stress information (Attachment 3); potential for cold/hypothermia will depend on season
Heat stress	X		Drink water frequently in hot weather; take work breaks; follow the heat-related illness policy (Attachment 2); potential for heat stress will depend on season
Material handling	X		Lift properly; seek assistance if necessary; do not overfill coolers or boxes

Possible Hazard	Yes	No	Proposed Safety Procedure
Adverse weather	X		Seek shelter during electrical storms; work in adverse weather conditions only with proper training, clothing and equipment, use of flashlights or artificial lighting at night
Drowning	X		Wear PFD at all times when working over water or when wading. Inspect the PFDs prior to use and do not use defective PFDs. Keep sampling equipment on boats organized at all times. Boats are required to be equipped with a throwable life ring, fire extinguisher, and warning horn, and each field member will be briefed on their storage location.
Work in remote areas	X		Use buddy system; carry radio, satellite phone and/or cellular phone; bring sufficient equipment in case of accident or injury (first aid kit, shelter if appropriate)
Plant/animal hazards	X		Know local hazards and take appropriate precautions (see Table 2-3).

- 1 The following table presents potential wildlife hazards that could be encountered during
- 2 field activities.

Table 2-3. Potential Wildlife and Plant Hazards

Wildlife/Plant	Location	Potential Hazard	Means of Defense
Black Bear	Selkirk Mountains	Provoke attack	If you come in contact with a black bear, stay calm and avoid eye contact. Try to stay upwind and identify yourself as a human being by standing up, talking, and waving your hands above your head. If you can not safely move away from the bear and the animal does not flee, try to scare it away by clapping your hands or yelling. If the bear attacks, fight back aggressively. As a last resort if the attack continues, protect yourself by curling into a ball or lie on the ground on your stomach playing dead.
Grizzly Bear/ Brown Bear	Selkirk Mountains and border of Canada	Provoke attack	If you are attacked by a grizzly bear, play dead. Lie flat on your stomach or curl up in a ball with your hands behind your head. Remain motionless as long as possible. Do not run.
Cougar	Everywhere	Provoke attack	If you come in contact with a cougar, stop, stand tall, and don't run. Try to appear larger than the cougar. Never take your eyes off the animal or turn your back. If the animal displays aggressive behavior, shout, waive your arms, and throw rocks. If the cougar attacks, fight back aggressively and stay on your feet.
Moose	Everywhere	Between mother/calf	If you come in contact with a moose, step back. Look for the nearest tree, fence, or building or other obstruction to hide behind. It's usually a good idea to run from a moose because it usually won't chase you far. If a moose knocks you down, curl up in a ball, protect your head with your arms and hands, and hold still. Don't move or try to get up until the moose moves a safe distance away.

Bees/Wasps	Everywhere	Allergic reaction	Avoiding wearing bright colors or scents. Use an appropriate insect repellent. Wear long-sleeved shirt, hat, and gloves. Employees must notify supervisor if they have allergies to bee/wasp stings prior to engaging in field activities. Employees with allergies may be required to carry an appropriate antidote kit.
Ticks	Everywhere	Disease transmission	Use an appropriate insect repellent. Wear long sleeved clothing and ankle length boots and try to avoid excessive contact with tall brush or grass. Personnel should change clothes and inspect their skin and scalps for ticks after every day of field work. If individuals discover a tick embedded in their skin, it should be removed as soon as possible. Grasp the tick with a blunt pair of tweezers as close to the skin as possible and remove it using slow even pressure. Do not break off head or release fluids from the tick. Gently scrub the area with soap and water after removal. Note the date of the bite and watch for symptoms such as fever, chills, aches, and rashes for a month after the bite. If these symptoms occur, consult a doctor.
Rattlesnakes	Found East of Cascades	Bites	Wear ankle high leather boots, long sleeved shirts, and long pants. Do not reach into burrows or dens, under rocks, or logs. Walk heavily through brush. Back away if a snake is encountered. Take snake bite kit with a complete set of instructions. In case of a snake bite, seek prompt medical assistance. The injured employee should rest while awaiting (or being transported to) medical assistance.
Mosquitoes	Everywhere	West Nile Virus	Use an insect repellent containing DEET. Wear long-sleeved shirts, pants, and hat; spray clothing with insect repellent containing DEET. Avoid handling dead animals. The risk of getting West Nile Virus is very low. Symptoms include fever, headache, neck stiffness, stupor, disorientation, tremors, convulsions, muscle weakness, paralysis, and body aches. If you develop any of these symptoms, contact your health care provider.
Poison Ivy	Primarily along riverbanks	Allergic reaction	Poison ivy generally has three green leaves on each stem. The color and appearance can vary throughout the year. Avoid contact with all parts of the plant. Contact with the oily resins on the plant may cause a skin rash. The rash usually appears after 24–48 hours and can last for weeks. If poison ivy is contacted, remove the affected clothing and wash the skin with soap and water to remove the oil resins as soon as possible.

- 1 **3 CHEMICAL HAZARD EVALUATION**
- 2 A chemical hazard evaluation is presented in the general SHSP and incorporated herein
- 3 by reference.

4 PERSONAL PROTECTIVE EQUIPMENT AND SAFETY EQUIPMENT

The following sections address PPE and safety equipment required for completing the surface water sampling activities.

4.1 PERSONAL PROTECTIVE EQUIPMENT

Based on the chemical and physical hazards associated with the surface water sampling activities, the following table identifies the personal protective equipment required for the sampling.

Table 4-1. Level of Protection Required for Site Activities.

Site Activity	Level of Protection	
	Initial	Contingency ^a
Surface water sampling	MD	Leave site, reassess situation
Sample handling	D	Leave site, reassess situation

Notes: Level D = Long pants and shirt or work coveralls, safety glasses or goggles (as appropriate), and nitrile, neoprene, or Barrier® 5 layer laminate gloves (as appropriate). Hard hat and hearing protection as needed.
Level MD = Same as Level D with modification (M) of addition of PFD and rain gear.

^a Based on unexpected change in site conditions.

Table 4-2. Levels of Protection and Personal Protective Equipment.

Protection Level	Required	Personal Protection Equipment
Level D	X	Long pants and shirt or work coveralls, safety glasses or goggles (as appropriate), and nitrile, neoprene, or Barrier® 5 layer laminate gloves (as appropriate). Hard hat and hearing protection as needed.
Level MD	X	Same as Level D with modification (M) of addition of PFD and rain gear.

Is there potential for a respirator to be donned during fieldwork?

Yes _____ No X

4.2 SAFETY EQUIPMENT

The following safety equipment will be onsite during the proposed field activities.

Air Monitoring (Check the items required for this project.)

<input type="checkbox"/> PID	<input type="checkbox"/> Air sampling pumps
<input type="checkbox"/> LEL/O ₂ meter	<input type="checkbox"/> Miniram
<input type="checkbox"/> H ₂ S meter	<input type="checkbox"/> Radiation meter
<input type="checkbox"/> Detector pump and tubes	<input type="checkbox"/> Other: _____

First Aid Kit (mandatory, including adhesive band-aids, gauze, tape, gloves, cardiopulmonary resuscitation shield, triangle bandage)

<input checked="" type="checkbox"/> Emergency blanket	<input checked="" type="checkbox"/> Sunscreen
<input checked="" type="checkbox"/> Insect repellent	<input checked="" type="checkbox"/> Other: <u>Snake bite kit</u>

Other (Check the items required for this project.)

<input checked="" type="checkbox"/> Eyewash	<input type="checkbox"/> Fit test supplies
<input checked="" type="checkbox"/> Drinking water	<input type="checkbox"/> Fire extinguisher (drill rigs)
<input type="checkbox"/> Stopwatch for monitoring heart rate	<input type="checkbox"/> Windsock
<input type="checkbox"/> Thermoscan [®] thermometer (or equivalent) for heat stress monitoring	<input checked="" type="checkbox"/> Cellular phone
<input type="checkbox"/> Survival kit	<input checked="" type="checkbox"/> Radio sets
<input checked="" type="checkbox"/> Personal flotation device	<input checked="" type="checkbox"/> Global positioning system
<input type="checkbox"/> Cool vests	<input checked="" type="checkbox"/> Other: <u>Chest waders</u>
	<input checked="" type="checkbox"/> Satellite phone

5 AIR MONITORING

The principal chemicals of interest (COIs) at the site (i.e., metals) are not volatile. In addition, the chemical hazard evaluation presented in the general SHSP concluded that, based on previous evaluations, none of the surface water chemicals are expected to pose a threat to field personnel during surface water sampling activities. If windblown dust becomes problematic to the field crew, then the field sampling team will leave the site and reassess the situation.

Site-specific air monitoring requirements are presented below.

Monitoring Instrument	Calibration Frequency	Parameters of Interest	Monitoring Frequency
Visual	N/A	Dust	Continuous

The following action levels have been established to determine the appropriate level of personal protection to be used during site investigation activities:

Instrument	Reading	Action ^a	Comments
Visual	Excessive Dust	Implement engineering controls or leave site, if necessary	

^a Examples: "upgrade to Level C" or "leave site."

6 EMERGENCY PLANNING

In case of any emergency affecting the site, all affected personnel must immediately evacuate the work area and report to the site safety officer at the following predetermined location.

DESIGNATED ASSEMBLY LOCATION: Field vehicle or boat or boat ramp

In case of injury, field personnel should take precautions to protect the victim from further harm and notify local or facility emergency services. In remote areas, it will be necessary to have first aid-trained personnel on the field team. The victim may require decontamination prior to treatment—requirements will vary based on site conditions.

Emergency medical care will be provided by:

- ☒ Local emergency medical provider (i.e., fire department)
- ☐ Facility emergency medical provider
- ☒ First aid-trained field staff (for remote areas only)

Table 6-1. Emergency Telephone Numbers.

Local Resources	Name	Telephone	Notified Prior to Work (Yes/No)?
Fire	Varies by location	911	Yes. Notify the E911 coordinator for Stevens County (Debby McCanna; 509-684-2555) of the schedule and location of work.
Police	Varies by location	911	Yes (see above)
Ambulance	Varies by location	911	Yes (see above)
Main Hospital	Mount Carmel Hospital, Colville, WA	(509) 684-2561	No
Alternative Hospitals	Coulee Community Hospital, Grand Coulee, WA	(509) 633-1753	No
	Ferry County Memorial Hospital, Republic, WA	(509) 775-3333	No
	Lincoln Hospital, Davenport, WA	(509) 725-7101	No
	St Joseph's Hospital, Chewelah, WA	(509) 935-8211	No
	Deer Park Hospital, Deer Park, WA	(509) 276-5061	No

Local Resources	Name	Telephone	Notified Prior to Work (Yes/No)?
	Deaconess Medical Center-Spokane, Spokane, WA	(509) 473-7178	No
	Holy Family Hospital, Spokane, WA	(509) 482-0111	No
	Sacred Heart Medical Center, Spokane, WA	(509) 474-3131	No
	Veterans Affairs Medical Center, Spokane, WA	(509) 434-7032	No
Site phone	Field cell phone. Cell phone coverage is spotty in the vicinity of the sampling areas. If cell phone coverage is lost due to a mountain/ hill, drive a little further to get coverage. If cell phone coverage is available, the 911 system will work. A satellite phone may be necessary for areas with limited cell phone coverage. A time line schedule for satellite availability must be at hand with emergency contact.	TBD	NA
Directions to Mount Carmel Hospital (from Highway 395):	Begin traveling SE on Highway 395. Highway 395 becomes Main Street in Colville. Turn LEFT on E. Columbia Ave. Go 0.6 miles. Arrive at 982 E. Columbia Ave. Hospital is on right. (See detailed hospital location maps in Attachment 1)		

1

Corporate Resources	Name	Work/Cell Telephone	Home Telephone
Integral Corporate Health and Safety Officer	Eron J. Dodak	Work: (503) 284-5545 Cell: (503) 407-2933 (425) 806-5700	(503) 293-5471
Medical consultant	Dr. Calvin Jones (HealthForce Partners)		----

2

3 In case of serious injuries, death, or other emergency, the Integral corporate health and
4 safety officer must be notified immediately. To contact the Integral corporate health and
5 safety officer (or delegate), try calling the phone numbers listed above.

1 Table 6-2. Washington State Hospital Information.

Facility Name	Hours of Operation	Phone Number	Address	City
Coulee Community Hospital	24 hour emergency	509-633-1753	411 Fortuyn Road	Grand Coulee
Ferry County Memorial Hospital	24 hour emergency	509-775-3333	36 Klondike Road	Republic
Lincoln Hospital	24 hour emergency	509-725-7101	10 Nichols Street	Davenport
St Joseph's Hospital	24 hour emergency	509-935-8211	500 East Webster Street	Chewelah
Mount Carmel Hospital	24 hour emergency	509-684-2561	982 East Columbia Street	Colville
Deer Park Hospital	24hour emergency	509-276-5061	East 1015 'D' Street	Deer Park
Deaconess Medical Center-Spokane	24 hour emergency	509-473-7178	800 West Fifth Avenue	Spokane
Holy Family Hospital	Dependent on case	509-482-0111	North 5633 Lidgerwood Avenue	Spokane
Sacred Heart Medical Center	24 hour emergency	509-474-3131	West 101 Eighth Avenue	Spokane
Veterans Affairs Medical Center	7:30am-4:00 pm	509-434-7032	North 4815 Assembly Street	Spokane

2

3

7 WORK ZONES

The following work zones are defined for the surface water sampling activities.

Exclusion zone: The aft deck of the sampling vessel will be considered to be the exclusion zone. Sample collection and processing will occur in this area. Only properly equipped and trained (i.e., wearing modified D protective clothing) personnel will be allowed in this area.

Contamination reduction zone (CRZ): The rest of the deck will be the contamination reduction zone. Sample storage and other support functions will occur in these areas.

Support zone: The cabin or pilot house will be the support zone. Personnel will be required to rinse off rain gear with potable or river water before entering this area.

Controls to be used to prevent entry by unauthorized persons: No unauthorized personnel will be allowed on the sampling vessel.

8 DECONTAMINATION

1

2 Decontamination procedures for the surface water sampling activities will occur at the
3 analytical laboratory prior to equipment deployment. Otherwise decontamination
4 procedures will follow those presented in the general SHSP and are incorporated herein.

9 VEHICLE SAFETY, SPILL CONTAINMENT, AND SHIPPING INSTRUCTIONS

Vehicle safety, spill containment, and shipping instructions are presented in the general SHSP and are incorporated herein.

10 TASK-SPECIFIC SAFETY PROCEDURES

Slips, trips, and falls and head injuries are anticipated to be the greatest hazards to field personnel during the surface water sampling event. When working on the sampling vessel, always be aware of slippery areas or uneven terrain. When accessing the sampling vessel or near-shore sampling stations by foot, always proceed with caution, watching footfalls in slippery areas or uneven terrain and avoid contact with thorny vegetation. Wear properly fitting shoes or boots with non-slip soles and good ankle support. Wear a hard hat while working on deck when overhead activities are ongoing; listen to verbal and visual commands of boat and winch operator; do not stay underneath area of operations; watch for pinch areas near mobile A-frame and retractable bow platform, wear gloves. If steep slopes need to be traversed to access the near-shore stations during the spring drawdown (i.e. Low flow) sampling event, take the time to look for a safe route to the beach and proceed with caution. If safe access to a sample station is not possible, the field crew will assess alternative options before proceeding.

Access to all of the surface water stations (except possibly a few near-shore stations during the spring drawdown sampling event) will require the use of a boat. Depending on water levels, wading may be necessary to collect the near-shore spring drawdown surface water samples. Wading will also be necessary to disturb near-shore sediments as needed. Wear a PFD at all times when working over water. Inspect the PFDs prior to use and do not use defective PFDs. Keep sampling equipment on boats organized at all times. Boats are required to be equipped with a throwable life ring, fire extinguisher, first aid kit, eyewash bottle and water (if acids are taken on the boat), drinking water (for long trips), alternate propulsion mechanism (e.g., paddles), rope, and warning horn, and each field member will be briefed on their storage location. Additional information on boating safety is presented in the general SHSP (Section 9.2).

All of the areas that will be sampled are accessible to the public. Always be aware of your surroundings. Use the buddy system and keep in line-of-sight contact with other sampling personnel at all times. Do not leave samples or sampling equipment unattended. If you feel threatened, or if the situation feels unpredictable, leave the area immediately.

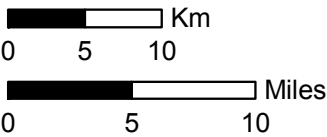
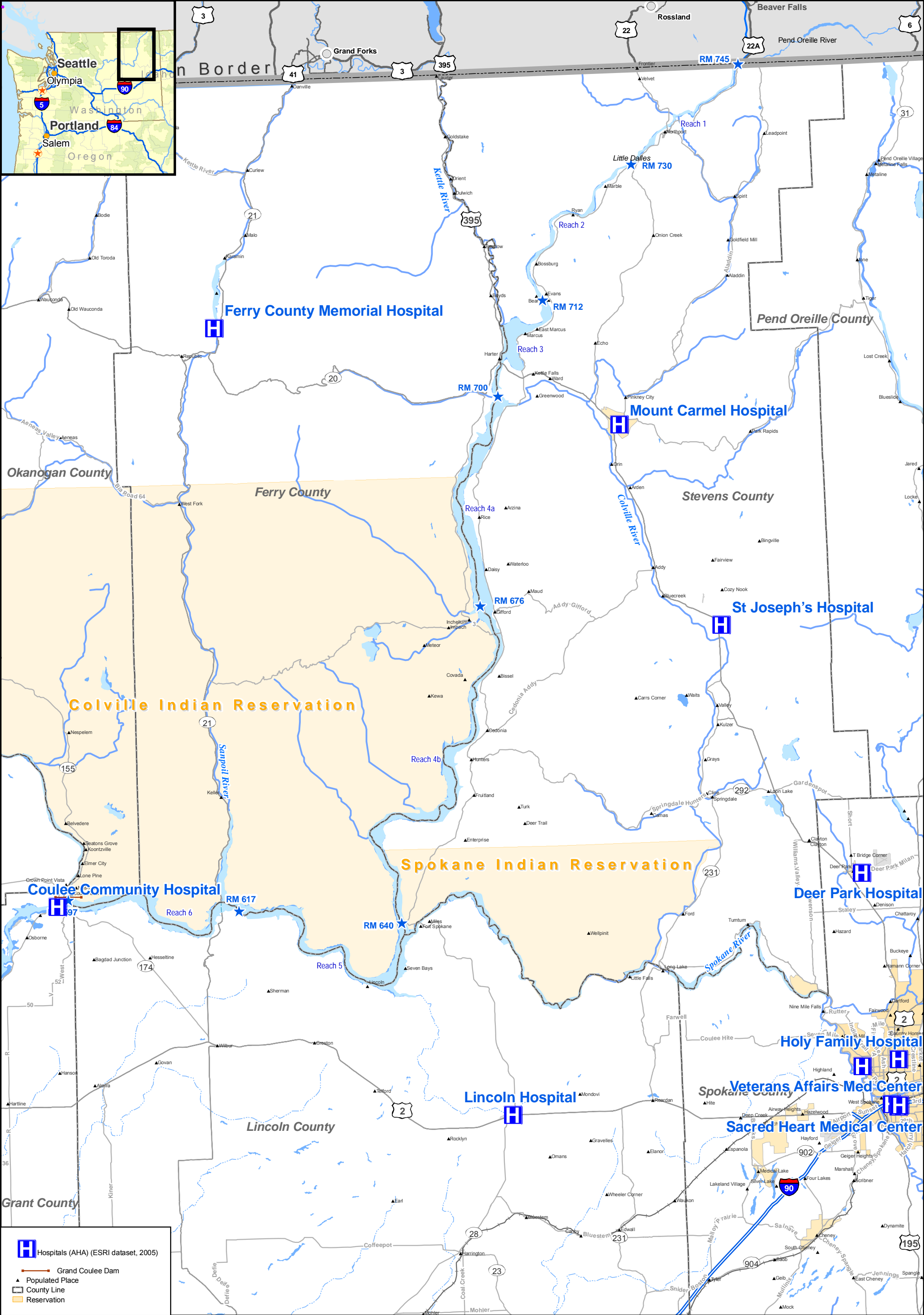
Always wear appropriate chemical-resistant gloves and safety glasses or goggles when handling sampling equipment, samples, or preservative chemicals. Keep a 1-L eye wash bottle accessible during all fieldwork. Avoid getting preservatives on your skin or clothes. If any preservatives are spilled or splashed on your skin or clothes, immediately rinse the affected area with potable water and get medical attention, if warranted. If any preservative is splashed in the eye, flush the eye with the eye wash solution and get immediate medical attention.

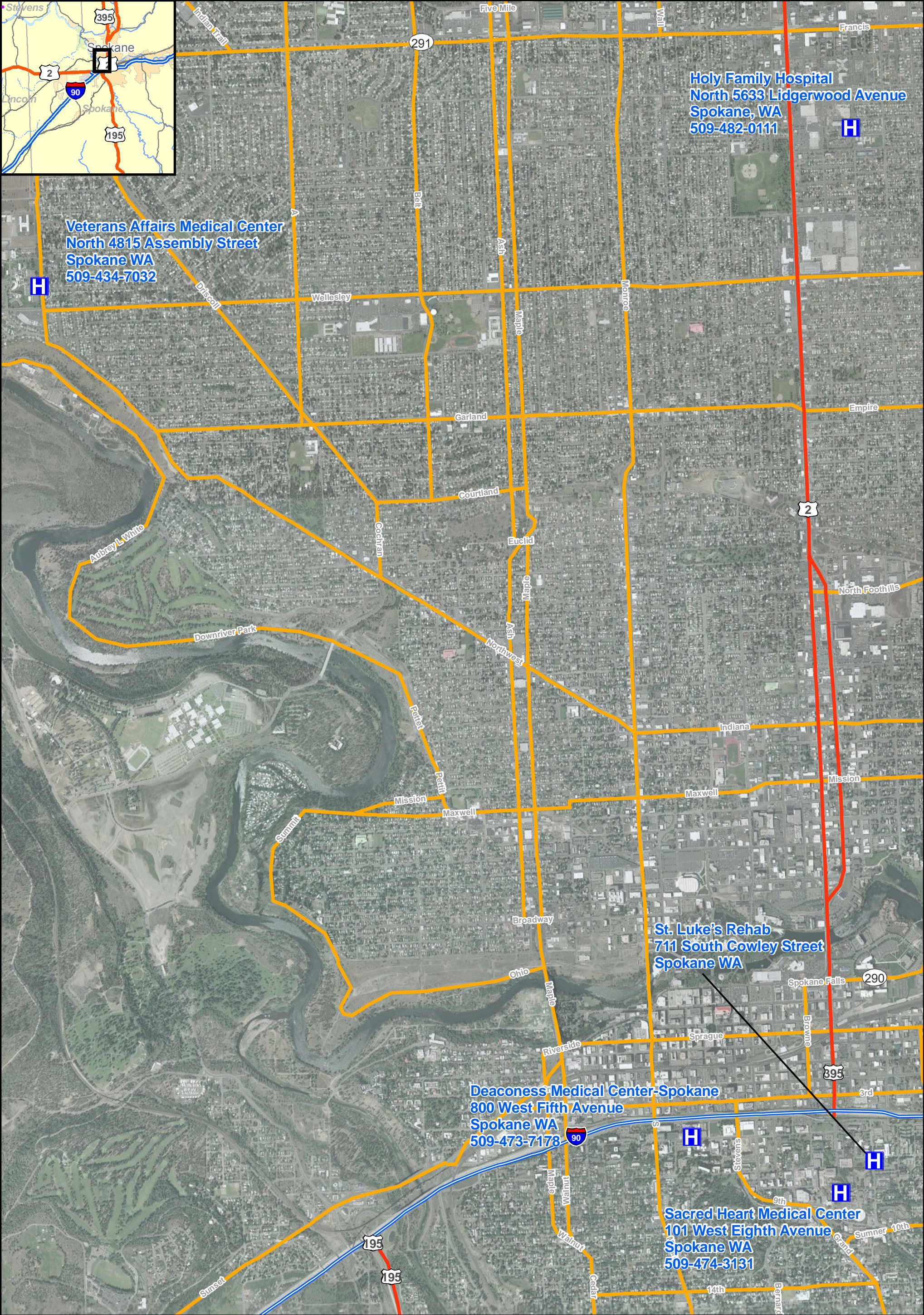
11 REFERENCE

TCAI. 2007. Upper Columbia River: Draft general health and safety plan for the remedial investigation and feasibility study. Prepared for Teck Cominco American Incorporated. Integral Consulting Inc., Mercer Island, WA, and Parametrix, Bellevue, WA.

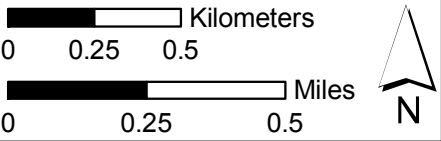
ATTACHMENT 1

SITE MAP AND HOSPITAL LOCATION MAPS



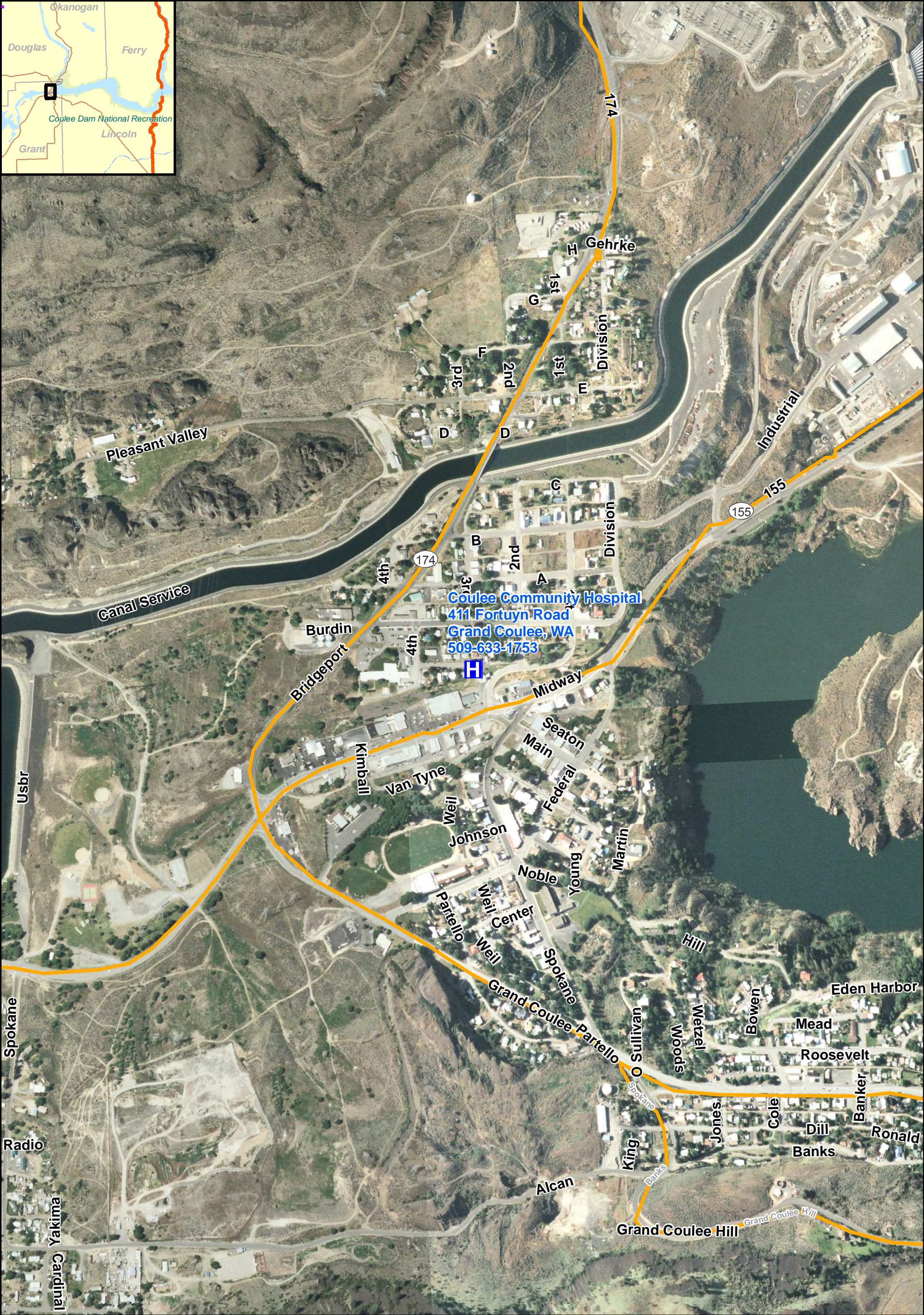


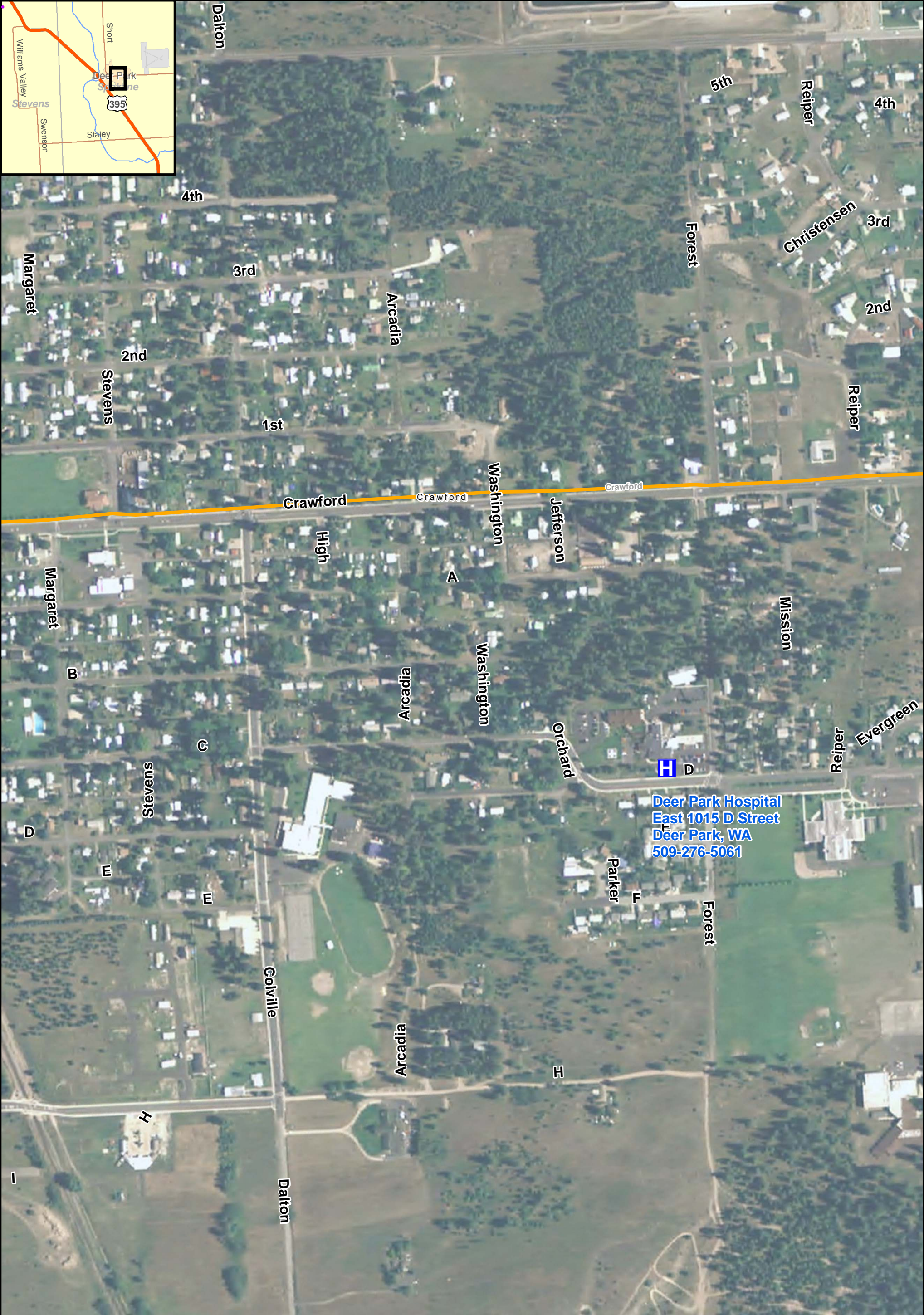
Integral Parametrix



Spokane Area Hospital Locations

Upper Columbia River, WA







Ferry County Memorial Hospital
36 Klondike Road
Republic, WA
509-775-3333

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Willow

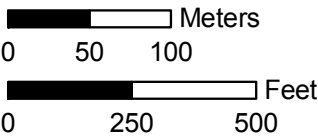
21

Fish Hatchery

Torboy

21

Integral Parametrix

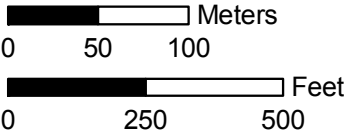


Ferry County Memorial Hospital Location

Upper Columbia River, WA

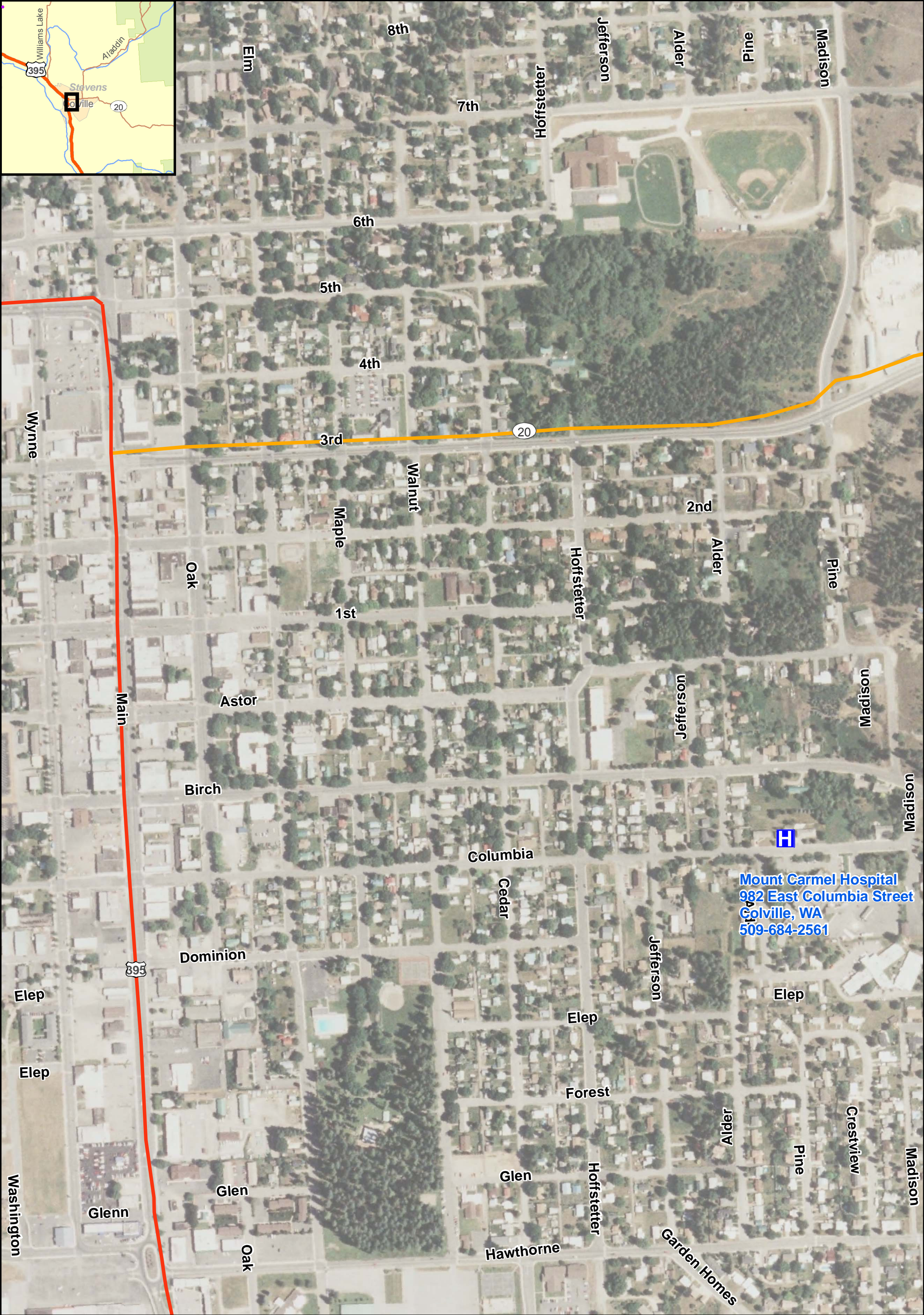


Integral Parametrix



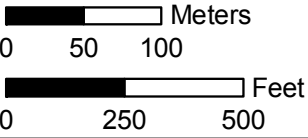
Lincoln Hospital Location

Upper Columbia River, WA



Mount Carmel Hospital
982 East Columbia Street
Colville, WA
509-684-2561

Integral Parametrix



Mount Carmel Hospital Location

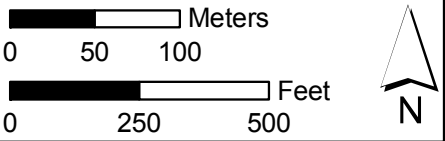
Upper Columbia River, WA



St. Joseph's Hospital
500 East Webster Street
Chewelah, WA
509-935-8211



Integral Parametrix



St. Joseph's Hospital Location

Upper Columbia River, WA

ATTACHMENT 2

HEAT-RELATED ILLNESS PREVENTION POLICY

Instructions:

The following document has been provided to assist your company in developing a written Heat Related Illness (HRI) Prevention Policy for Outdoor Work activities per WAC 296-62-095 through WAC 296-62-09570, Heat Related Illnesses in the Outdoor Environment.

The program outline follows the recommendations found in DOSH Directive (WRD) 18.50, Heat Related Illness in the Outdoor Environment.

You must tailor these procedures to meet your specific work site conditions. Simply printing off the procedures would not comply with the provisions of the HRI Rule.

The underlined areas and tables must be filled in to tailor this program to meet your needs.

To assist you in tailoring these sample procedures to your work site conditions the following documents are available for reference:

Appendix A: Heat and Humidity Chart

Appendix B: Examples of Workload Activities

Appendix C: Sample HRI First Aid and Emergency Response Procedures

“Protecting Employees Working Outdoors from Heat-Related Illnesses”

“Training Guide for Heat-Related Illnesses”

DOSH Directive (WRD) 18.50: Heat Related Illness in the Outdoor Environment (June 5, 2007)

You can find these documents and other helpful tools by visiting the Department of Labor and Industries website at:

<http://www.lni.wa.gov/safety/topics/atoz/heatstress/default.asp>

Heat-Related Illness (HRI) Prevention Outdoor Work Policy

⇒ _____ is committed to preventing Heat Related Illnesses—HRI that can occur to employees working in the outdoor environment.

⇒ _____ recognizes that exposure to extreme temperature, humidity and other environmental factors can lead to serious illnesses including heat fatigue, heat rash, fainting, heat cramps, heat exhaustion, and heat stroke. The following formal policy has been developed to protect employees from the hazards posed by working in the outdoor environment and to comply with the written procedures as required by WAC 296-62-095 through WAC 296-62-09570, Heat Related Illnesses in the Outdoor Environment. Outdoor work includes any employee assigned to work in the outdoor environment on a regular basis.

I. HRI Training Plan

Prior to assignment of any outdoor work activities, employees and supervisors of

⇒ _____ will be trained on our HRI procedures and the elements outlined below.

(See “Training Guide for Heat-Related Illness”-Found on DOSH website)

A. Employee Training

- Recognizing the environmental causes of HRI and personal factors that can increase the risk
- How our company identifies, evaluates, and controls HRI exposure
- Removal of Personal Protective Equipment during all breaks
- Frequently consuming water when HRI hazards are present
- Importance of acclimatization (Getting used to hot weather)
- Different types of HRI and the common signs and symptoms
- Importance of immediately reporting HRI symptoms of themselves or co-workers
- How our company will respond to HRI symptoms and emergencies
- The purpose and requirements of the HRI rules

B. Supervisor Training

- How to implement the provisions of the HRI rule
- What to do when an employee exhibits signs or symptoms of HRI, including emergency response
- How to safely move employees to a place that is easily reached by emergency medical providers
- How to provide clear directions to emergency medical providers so they can find the work site

II. Evaluation of HRI Hazards

⇒ _____ will evaluate HRI hazards based on a combination of factors including temperature, humidity, and other environmental conditions in

all workplaces where outdoor work is performed. ⇒ _____ will routinely evaluate potential HRI hazards by checking one or more of the following:

(See Appendix A: Heat Index Chart as an evaluation option)

Air Temperature and Humidity *(list your source of information)*

- Local weather report predictions from:

- On-site temperature and humidity measuring equipment (and location):

- Historical area weather data to approximate work site conditions from:

Other Environmental Factors *(list what may be present and increase HRI risk)*

- **Radiant Heat** *(Example: Reflection of heat from asphalt, rocks, or composite roofing material; or work in direct sunlight)*

- **Air Movement** *(Example: Wind blowing and temperature above 95 degrees F)*

- **Conductive Heat Sources** *(Example: Operating orchard tractor for mowing)*

- **Workload Activity and Duration** *(Example: Hand sawing wood, carrying masonry blocks, digging with a shovel)*

- **Personal Protective Equipment/Clothing** *(Example: Wearing respirator, chemical resistant suit, and gloves for pesticide application or HAZMAT clean-up; or leathers and gloves for welding)*

III. Procedures for Controlling Environmental Factors

⇒ _____ will control HRI environmental factors at the worksite to reduce HRI risks. Depending on the environmental factors present, we will use one or more of the following methods for controlling HRI risks to protect employees:

List your control methods, when they will be used, and what the expected outcome is.

Control Method	When Used	Expected Outcome
<i>Example 1: Use water hose to wet towels or clothing and place on the body; use cooling vest or cooling headbands</i>	<i>When temperature is going to reach 95 degrees or more; or Heat Index reaches 90</i>	<i>Cool the body temperature</i>
<i>Example 2: Take breaks in shaded area (house, garage, canopy, under trees)</i>	<i>When working in direct sun light (e.g. roofers, asphalt pavers, berry pickers)</i>	<i>Cool the body temperature</i>
<i>Example 3: Start work shift early (when daylight begins) and end shift early, or do not work during hottest parts of day</i>	<i>When temperature expected to reach 90 degrees or more</i>	<i>Reduce time exposed to heat and keep body temperature cooler</i>
<i>Example 4: Remove respirator, chemical suit and gloves, or welding leathers during breaks</i>	<i>When temperature is going reach 80 degrees or more</i>	<i>Cool the body temperature and all reduce humidity close to body</i>

IV. Drinking Water

Sufficient potable drinking water will be provided and made accessible to employees.

⇒ _____ is responsible for ensuring sufficient water is available. At least **one quart of water per employee per hour** will be available when HRI hazards are present. **If you notice water is not present notify your supervisor immediately.** Water can be found in the following locations: *(List your water sources and locations)*

- _____
- _____
- _____

V. Adjusting Rest Breaks for Increased Work Load and Duration

⇒ _____ will use an adjusted rest break schedule to minimize employees risk when there is an increased risk of HRI hazards due to work loads. Supervisors will adjust rest breaks as follows:

(See Appendix B: Examples of Work Load Activities)

Work Activity	Adjusted Rested Breaks and When Used
<i>Example: Thinning apples 8-hours, roofing a residential house 6-hours, carrying masonry blocks 4-hours, shoveling hot asphalt for 8-hours</i>	<i>Example: An additional break before and after lunch when. . . -temperature reaches 90 degrees and humidity is 50% -performing heavy work in direct sunlight or on hot surfaces</i>

VI. Procedures for Responding to Heat-Related Illnesses

⇒ _____ will respond to HRI in a quick and safe manner. The table below outlines the potential types of heat-related illnesses, signs and symptoms, and specific First Aid and HRI Emergency procedures. The information will be present at all work sites where outdoor work activities are present.

- Emergency medical phone number: _____
- Specific work site address: _____
- Driving directions from a major roadway to the work site: _____

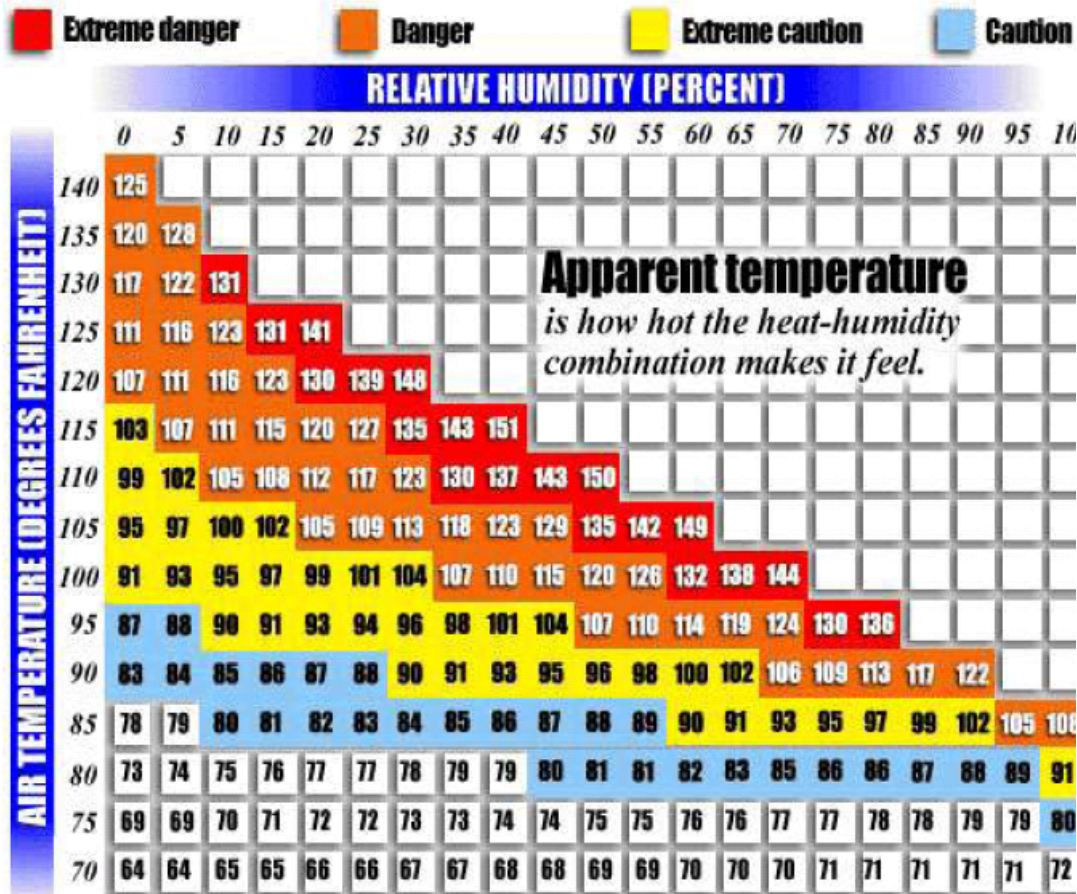
Procedures for Responding to Heat-Related Illnesses

(See Appendix C: Sample First Aid and Emergency Response Procedures)

Heat-Related Illness	Signs and Symptoms	First Aid and Emergency Response Procedures
Sunburn		
Heat Rash		
Heat Cramps		
Heat Exhaustion		
Heat Stroke		

APPENDIX A

Heat and Humidity Chart



<http://www.crh.noaa.gov/dvn/tools/heatindex.pdf>

Heat Index	General Effect of Heat Index on People in Higher Risk Groups
80 - 89 <i>Caution</i>	Fatigue possible with prolonged exposure and physical activity.
90 - 104 <i>Extreme Caution</i>	Sunstroke, heat cramps, and heat exhaustion possible.
105 - 129 <i>Danger</i>	Sunstroke, heat cramps, and heat exhaustion likely, and heat stroke possible.
130 or higher <i>Extreme Danger</i>	Heat Stroke highly likely with continued exposure.

APPENDIX B

Examples of Workload Activities

Categories	Example Activities
Resting	Sitting quietly
	Sitting with moderate arm movements
Light	Sitting with moderate arm and leg movements
	Standing with light work at machine or bench while using mostly arms
	Using a table saw
	Standing with light or moderate work at machine or bench and some walking about
Moderate	Scrubbing in a standing position
	Walking about with moderate lifting or pushing
	Walking on level at 6 Km/hr while carrying 3 kg weight load
Heavy	Carpenter sawing by hand
	Shoveling dry sand
	Heavy assembly work on a non-continuous basis
	Intermittent heavy lifting with pushing or pulling (e.g. pick-and-shovel work)
Very Heavy	Shoveling wet sand

APPENDIX C:
Sample HRI First Aid and Emergency Response Procedures

Heat-Related Illness	Signs and Symptoms	First Aid and Emergency Response Procedures
Sunburn	<ul style="list-style-type: none"> • Red, hot skin • May blister 	<ul style="list-style-type: none"> • Move to shade, loosen clothes to reduce temperature • Apply cool compress or water to cool burn • Get medical evaluation if severe
Heat Rash	<ul style="list-style-type: none"> • Red, itchy skin • Bumpy skin • Skin infection 	<ul style="list-style-type: none"> • Apply cool water or compress to cool rash • Keep affected area dry to minimize infection • Control itching and infection with prescribed medication
Heat Cramps	<ul style="list-style-type: none"> • Muscle cramps or spasms • Grasping the affected area • Abnormal body posture 	<ul style="list-style-type: none"> • Drink water or sports drinks to re-hydrate body • Rest, cool down in shaded area • Massage affected muscle to release body toxins • Get medical evaluation if cramps persist
Heat Exhaustion	<ul style="list-style-type: none"> • High pulse rate • Extreme sweating • Pale face • Insecure gait • Headache • Clammy and moist skin • Weakness • Fatigue • Dizziness 	<ul style="list-style-type: none"> • Move to shade and loosen clothing to cool down • Initiate rapid cooling with fan, water mister, or ice packs • Lay flat and elevate feet to reduce heart rate and blood pressure • Monitor recovery (is body cooling?) • Drink small amounts of water to cool body and re-hydrate • Evaluate mental status (ask Who? Where? When? Q's) • If no improvement call 911
Heat Stroke	<ul style="list-style-type: none"> • Any of the above but more severe • Hot, dry skin (25-50% of cases) • Altered mental status with confusion and agitation • Can progress to loss of consciousness and seizures • Can be fatal 	<ul style="list-style-type: none"> • Call 911 • Provide EMS with directions to work site • Immediately remove from work activity to slow/stop body temp rise • Start rapid cooling with fan, water mister, or ice packs • Lay flat and elevate feet to reduce heart rate and blood pressure • If conscious give sips of water to cool body and re-hydrate • Monitor airway and breathing-administer CPR if needed

ATTACHMENT 3

COLD-STRESS FACT SHEET

FROSTBITE

What happens to the body:

Freezing in deep layers of skin and tissue; pale, waxy-white skin color; skin becomes hard and numb; usually affects fingers, hands, toes, feet, ears, and nose.

What to do: (land temperatures)

- Move the person to a warm, dry area. Don't leave the person alone.
- Remove wet or tight clothing that may cut off blood flow to the affected area.
- **Do not** rub the affected area because rubbing damaged the skin and tissue.
- Gently place the affected area in a warm water bath (105°) and monitor the water temperature to **slowly** warm the tissue. Don't pour warm water directly on the affected area because it will warm the tissue too fast, causing tissue damage. Warming takes 25-40 minutes.
- After the affected area has been warmed, it may become puffy and blister. The affected area may have a burning feeling or numbness. When normal feeling, movement, and skin color have returned, the affected area should be dried and wrapped to keep it warm.
Note: If there is a chance the affected area may get cold again, do not warm the skin. If the skin is warmed and then becomes cold again, it will cause severe tissue damage.
- Seek medical attention as soon as possible.

How to Protect Workers

- Recognize the environmental and workplace conditions that lead to potential cold-induced illnesses and injuries.
- Learn the signs and symptoms of cold-induced illnesses/injuries and what to do to help the worker.
- Train workers about cold-induced illnesses and injuries.
- Select proper clothing for cold, wet, and windy conditions. Layer clothing to adjust to changing environmental temperatures. Wear a hat and gloves, in addition to underwear that will keep water away from the skin (polypropylene.)
- Take frequent short breaks in warm, dry shelters to allow the body to warm up.
- Perform work during the warmest part of the day.
- Avoid exhaustion or fatigue because energy is needed to keep muscles warm.
- Use the buddy system (work in pairs.)
- Drink warm, sweet beverages (sugar water, sports-type drinks.)
Avoid drinks with caffeine (coffee, tea, or hot chocolate) **or alcohol.**
- Eat warm, high-calorie foods like hot pasta dishes.

Workers are at increased risk when...

- They have predisposing health conditions such as cardiovascular disease, diabetes, and hypertension.
- They take certain medications. Check with your doctor, nurse, or pharmacy and ask if medicines you take affect you while working in cold environments.
- They are in poor physical condition, have a poor diet, or are older.

HYPOTHERMIA - (Medical Emergency)

What happens to the body:

Normal body temperature (98.6°F/37°C) drops to or below 95°F/35°C; fatigue or drowsiness; uncontrolled shivering; cool, bluish skin; slurred speech; clumsy movements; irritable, irrational, or confused behavior.

What to do: (land temperatures)

- Call for emergency help (i.e., ambulance or 911).
- Move the person to a warm, dry area. Don't leave the person alone.
- Remove wet clothing and replace with warm, dry clothing or wrap the person in blankets.
- Have the person drink warm, sweet drinks (sugar water or sports-type drinks) if he is alert. **Avoid drinks with caffeine** (coffee, tea, or hot chocolate) **or alcohol.**
- Have the person move his arms and legs to create muscle heat. If he is unable to do this, place warm bottles or hot packs in the armpits, groin, neck, and head areas. **Do not** rub the person's body or place him in a warm water bath. This may stop his heart.

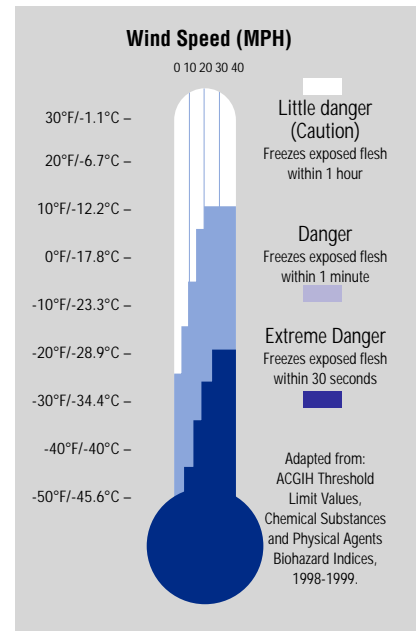
What to do: (water temperatures)

- Call for emergency help (i.e., ambulance or 911). Body heat is lost up to 25 times faster in water.
- **Do not** remove any clothing. Button, buckle, zip, and tighten any collars, cuffs, shoes, and hoods because the layer of trapped water closest to the body provides a layer of insulation that slows the loss of heat. Keep the head out of the water and put on a hat or hood.
- Get out of the water as quickly as possible or climb on anything floating. **Do not** attempt to swim unless a floating object or another person can be reached because swimming or other physical activity uses body heat and reduces survival time by about 50 percent.
- If getting out of the water is not possible, wait quietly and conserve body heat by folding arms across the chest, keeping thighs together, bending knees, and crossing ankles. If another person is in the water, huddle together with chests held closely.

THE COLD STRESS EQUATION

LOW TEMPERATURE + WIND SPEED + WETNESS = INJURIES & ILLNESS

When the body is unable to warm itself, serious cold-related illnesses and injuries may occur, and permanent tissue damage and death may result. **Hypothermia** can occur when *land temperatures are above freezing or water temperatures are below 98.6°F/37°C*. Cold-related illnesses can slowly overcome a person who has been chilled by low temperatures, brisk winds, or wet clothing.



ATTACHMENT A2

STANDARD OPERATING PROCEDURES

SOP-AP1.	SAMPLE PACKAGING AND SHIPPING
SOP-AP2.	FIELD DOCUMENTATION
SOP-AP3.	SAMPLE CUSTODY
SOP-AP4.	SAMPLE LABELING
SOP-AP6.	NAVIGATION AND STATION POSITIONING
SOP-SW1.	DECONTAMINATION OF SURFACE WATER SAMPLING EQUIPMENT
SOP-SW4.	SURFACE WATER SAMPLING USING A PERISTALTIC PUMP
SOP-SW5.	SURFACE WATER SAMPLING USING GRAB SAMPLERS
SOP-SW6.	MEASUREMENT OF SURFACE WATER FIELD PARAMETERS
SOP-SW7.	CLEAN-HANDS TECHNIQUE FOR SURFACE WATER SAMPLING
SOP-SW15.	LABORATORY DECONTAMINATION PROCEDURES
SOP-SW16.	COLLECTION OF DISTURBED-SEDIMENT NEAR- SURFACE, NEARSHORE SURFACE WATER SAMPLES
SOP-SW17.	HIGH-VOLUME SURFACE WATER SAMPLING FOR ANALYSIS OF ORGANIC COMPOUNDS WITH LOW DETECTION LIMITS

STANDARD OPERATING PROCEDURE SOP-AP1

SAMPLE PACKAGING AND SHIPPING

Scope and Application

Specific requirements for sample packaging and shipping must be followed to ensure the proper transfer and documentation of environmental samples collected during field operations. Procedures for the careful and consistent transfer of samples from the field to the laboratory are outlined herein. This SOP presents the method to be used when packing samples that will either be hand delivered or shipped by commercial carrier to the laboratory.

Equipment and Supplies Required

Specific equipment or supplies necessary to properly pack and ship environmental samples include the following:

- Project-specific sampling and analysis plan (SAP)
- Project-specific field logbook
- Sealable airtight bags (assorted sizes) (e.g., Ziplocs®)
- Wet ice in doubled, sealable bags; frozen Blue Ice®; or dry ice
- Coolers
- Bubble wrap
- Fiber reinforced packing tape and duct tape
- Clear plastic packing tape
- Scissors or knife
- Chain-of-custody (COC) forms
- Chain-of-custody seals
- Large plastic garbage bags (preferably 3 mil [0.003 inch] thick)

- Paper towels
- “Fragile,” “This End Up,” or “Handle With Care” labels
- Mailing labels
- Airbills for overnight shipment

Procedure

The logistics for sample packaging and shipping should be specifically tailored to each study. In some cases, samples may be transferred from the field to a local storage facility where they can be either frozen or refrigerated. Depending on the logistics of the operation, field personnel may transport samples to the laboratory themselves or utilize a commercial courier or shipping service. If a courier service is used, then Integral field personnel need to be aware of any potentially limiting factors to timely shipping (e.g., availability of overnight service and weekend deliveries to specific areas of the country, shipping regulations “restricted articles” [e.g., dry ice, formalin]) prior to shipping the samples.

Sample Preparation

The following steps should be followed to ensure the proper transfer of samples from the field to the laboratories:

At the sample collection site:

1. Appropriately document all samples using the proper logbooks or field forms (see SOP-AP2), required sample container identification (i.e., sample labels with tag numbers), and chain-of-custody (COC) form (example provided in SOP-AP3). Fill out the COC form as described in SOP-AP3, and use the sample labeling techniques provided in SOP-AP4.
2. Make sure all applicable laboratory quality control sample designations have been made on the COC forms. Samples that will be archived for future possible analysis should be clearly identified on the COC form and should be also be labeled as “Do Not Analyze: Hold and archive for possible future analysis” as some laboratories interpret “archive” to mean continue holding the residual sample after analysis.
3. Notify the laboratory contact and the Integral project quality assurance/quality control (QA/QC) coordinator that samples will be shipped and the estimated arrival time. Send copies of all COC forms

to Integral's project QA/QC coordinator or project manager, as appropriate.

4. Samples will remain in the possession of the sampling personnel at all times. Any temporary onsite sample storage areas will be locked and secured to maintain sample integrity and chain-of-custody requirements.
5. Clean the outside of all dirty sample containers to remove any residual material that may lead to cross-contamination.
6. Fill out the chain-of-custody form as described in SOP-AP3, and retain the back (pink) copy of the form for the project records prior to sealing the cooler. Check sample containers against the chain-of-custody form to ensure all of the samples that were collected are in the cooler.
7. Store each sample container in an individual sealable plastic bag that allows the sample label (example provided in SOP-AP3) to be read. Volatile organic analyte (VOA) vials must be encased in a foam sleeve or in bubble wrap before being sealed in bags.
8. If the samples have a required storage temperature, place a sufficient amount of ice in the sample cooler to maintain the temperature inside the cooler (e.g., 4°C) throughout the sampling day.

At the sample processing area (immediately after sample collection):

1. If the samples have a required storage temperature, then the samples should be cooled to and maintained at that temperature prior to shipping. For example, a sufficient amount of ice must be present in each sample cooler to maintain the temperature inside the cooler at 4°C until processing begins to ship the samples to the testing laboratory.
2. Be aware of holding time requirements for project-specific analytes and arrange the sample shipping schedule accordingly.
3. Samples will be placed in secure storage (i.e., locked room or vehicle) or remain in the possession of Integral sampling personnel before shipment. Any sample storage areas will be locked and secured to maintain sample integrity and chain-of-custody requirements.
4. Samples should be stored in the dark (e.g., coolers kept shut).

At the sample processing area (just prior to shipping):

1. Check sample containers against the COC form to ensure all samples intended for shipment are accounted for.
2. Choose the appropriate size cooler (or coolers) and make sure that the outside and inside of the cooler is clean of gross contamination. If the cooler has a drain on the outside at the bottom of the cooler, the drain should be capped and thoroughly taped shut with duct tape.
3. The cooler should be lined with bubble wrap and a large plastic bag (preferably a bag with a thickness of 3 mil) should be opened and placed inside the cooler.
4. Individually wrap each glass container (which at the sample collection site had already been placed in an individual sealable plastic bag) in bubble wrap using either tape or a rubber band to hold the bubble wrap in place. Place the wrapped samples into the large plastic bag in the cooler, leaving sufficient room for ice to keep the samples cold (i.e., 4°C).
5. If temperature blanks have been provided by the testing laboratory, include one temperature blank in each sample cooler.
6. If the samples have a required storage temperature, add enough wet ice or Blue Ice® to keep the samples refrigerated during overnight shipping (i.e., 4°C). Always over-estimate the amount of ice that you think will be required. Ice should be enclosed in a sealable plastic bag and then placed in a second sealable plastic bag to prevent leakage. Avoid separating the samples from the ice with excess bubble wrap because it will insulate the containers from the ice. After all samples and ice have been added to the cooler, use bubble wrap (or other available clean packing material) to fill any empty space to keep the samples from shifting during transport.
7. If possible, consolidate all VOA samples in a single cooler and ship them with (a) trip blank(s) if the project-specific quality assurance project plan calls for one.
8. Sign, date, and include any tracking numbers provided by the shipper on the COC form. Remove the back (pink) copy of the original COC form and retain this copy for the project records.
9. Place the rest of the signed COC form in a sealable bag and tape the bag containing the form to the inside of the cooler lid. Each cooler should contain an individual COC form for the samples contained in each respective cooler. If time constraints impact sample shipping and it

becomes necessary to combine all of the samples onto a single set of COC forms and the shipment contains multiple coolers, indicate on the outside of the respective cooler "Chain-of-Custody Inside."

10. After the cooler is sufficiently packed to prevent shifting of the containers, close the lid and seal it shut with fiber-reinforced packing tape. The cooler should be taped shut around the opening between the lid and the bottom of the cooler and around the circumference of the cooler at both hinges.
11. As security against unauthorized handling of the samples, apply two chain-of-custody seals across the opening of the cooler lid (example provided in Attachment 2-1). One seal should be placed on the front right portion of the cooler and one seal should be placed on the back left portion of the cooler. Be sure the seals are properly affixed to the cooler so they are not removed during shipment. Additional tape across the seal may be necessary if the outside of the cooler is wet.

Sample Shipping

Hand-Delivery to the Testing Laboratory

1. Notify the laboratory contact and the Integral project QA/QC coordinator that samples will be delivered to the laboratory and the estimated arrival time.
2. All environmental samples that are hand-delivered to the testing laboratory will be received by the laboratory on the same day that they were packed in the coolers.
3. Fax or scan and email copies of all COC forms to the Integral project QA/QC coordinator. Note: Prior to faxing, it may be necessary to photocopy the COC form on a slightly darker setting so that the form is readable after it has been faxed. Never leave the original COC form in the custody of non-Integral staff.

Shipped by Commercial Carrier to the Laboratory

1. Use a mailing label and label the cooler with destination and return addresses, and add other appropriate stickers, such as "This End Up," "Fragile," and "Handle With Care." If the shipment contains multiple coolers, indicate on the mailing label the number of coolers that the testing laboratory should expect to receive (e.g., 1 of 2; 2 of 2). Place clear tape over the mailing label to firmly affix it to the outside of the cooler and to protect it from the weather. This is a secondary label in case the airbill is lost during shipment.

2. Fill out the airbill as required and fasten it to handle tags provided by the shipper (or the top of the cooler if handle tags are not available).
3. If samples need to be frozen (-20°C) during shipping, then dry ice will need to be placed in the sample cooler. Be aware of any additional shipping, handling, and special labeling requirements that may be required by the shipper for these samples.
4. Benthic infauna samples will need to be preserved with formalin in the field prior to shipping. Be aware of any additional shipping, handling, and special labeling requirements that may be required by the shipper for these samples.
5. Notify the laboratory contact and the Integral project QA/QC coordinator that samples will be shipped and the estimated arrival date and time. All environmental samples that are shipped at 4°C or -20°C will be shipped overnight for next morning delivery. Fax or scan and email copies of all COC forms to the Integral project QA/QC coordinator. Note: Prior to faxing, it may be necessary to photocopy the COC form on a slightly darker setting so that the form is readable after it has been faxed. Never leave the original COC form in the custody of non-Integral staff.

STANDARD OPERATING PROCEDURE SOP-AP2

FIELD DOCUMENTATION

Scope and Application

The integrity of each sample from the time of collection to the point of data reporting must be maintained throughout the study. Proper record keeping will be implemented in the field to allow samples to be traced from collection to final disposition.

All information relevant to field operations must be properly documented to ensure that activities are accounted for and can be reconstructed from written records to the extent that someone not present at the site can reconstruct the activity without relying on the memory of the field crew. Several types of field documents will be used for this purpose and should be consistently used by field personnel. Field documentation should include only a factual description of site-related activities and observations made. Field personnel should not include superfluous comments or speculation regarding the field activities or observations made.

Field Logbooks

During field sampling events, field logbooks are used to record all daily field activities. The purpose of the field logbook is to document events that occur and record data measured in the field to the extent that someone not present at the site can reconstruct the activity without relying on the memory of the field crew.

The field logbook is issued by the Project Manager (or designee) to the appropriate site personnel for the direction of onsite activities (e.g., Reconnaissance Survey Team Leader, Sampling Team Leader). It is the responsibility of this person (or designee) to keep the site logbook current while in his or her possession, and return it to the Project Manager or turn it over to another field team.

A separate bound, waterproof field logbook with consecutively numbered pages will be completed using indelible ink for each sampling event. All daily field activities will be documented in indelible ink in this logbook and no erasures will be made. All corrections should consist of a single line-out deletion, followed by the author's initials and the date. The author will initial and date each page of the field logbook. The author will sign and

date the last page at the end of each day, and a line will be drawn through the remainder of the page.

The project name, dates of the field work, site name and location (city and state), and Integral contract number should be written on the cover of the field logbook. If more than one logbook is used during a single sampling event, then the upper right hand corner of the logbook will be annotated (e.g., Volume 1 of 2, 2 of 2) to indicate the number of logbooks used during the field event. Field logbooks will be stored in a secure manner when not in use in the field. At a minimum, the sampler will record the following information in the field logbook:

- Project name, project location, and contract number
- Purpose and description of the field task
- Project start date and end date
- Date and time of entry (24-hour clock)
- Time and duration of daily sampling activities
- Weather conditions at the beginning of the field work and any changes that occur throughout the day, including the approximate time of the change (e.g., wind speed and direction, rain, thunder, wave action, current, tide, vessel traffic, temperature of both the air and water, thickness of ice if present)
- Name and affiliation of person making entries and other field personnel and their duties, including the times that they are present
- The location and description of the work area, including sketches, map references, and photograph log, if appropriate
- Level of personal protection being used
- Onsite visitors (names and affiliations), if any, including the times that they are present
- The name, agency, and telephone number of any field contacts
- Notation of the coordinate system used to determine the station location information
- The sample identifier and analysis code for each sample to be submitted for laboratory analysis, if not included on separate field data sheets
- All field measurements made (or reference to specific field data sheets used for this purpose), including the time that the measurement was collected and the date of calibration, if appropriate
- The sampling location name, date, gear, water depth (if applicable), and sampling location coordinates, if not included on separate field data sheets
- The type of vessel used (e.g., size, power, type of engine) (for aquatic sampling only)
- Specific information on each type of sampling activity

- The sample type (e.g., groundwater, soil, surface sediment), sample number, sample tag number, and preservatives used (if any), if not included on separate field data sheets
- Sample storage methods
- Cross-references of numbers for duplicate samples
- A description of the sample [source and appearance, such as soil or sediment type, color, texture, consistency, presence of biota or debris, presence of oily sheen, changes in sample characteristics with depth, presence/location/thickness of the redox potential discontinuity (RPD) layer, and odor] and penetration depth, if not included on separate field data sheets
- Estimate of length and appearance of recovered cores, if not included on separate field data sheets
- Photographs (uniquely identified) taken at the sampling location, if any
- Details of the work performed
- Variations, if any, from the project-specific sampling and analysis plan (SAP) or standard operating protocols and reasons for deviation
- Details pertaining to unusual events which might have occurred during sample collection (e.g., possible sources of sample contamination, equipment failure, unusual appearance of sample integrity, control of vertical descent of the sampling equipment)
- References to other logbooks or field forms used to record information (e.g., field data sheets, health and safety log)
- Any field results not appearing the field data sheets (if used), including station identification and location, date, and time of measurement
- Sample shipment information (e.g., shipping manifests, COC form numbers, carrier, air bill numbers, time addresses)
- A record of quantity of investigation derived wastes (if any) and storage and handling procedures.

During the field day, as listed above, a summary of all site activities should be recorded in the logbook. The information need not duplicate anything recorded in other field logbooks or field forms (e.g., Site Health and Safety Officer's logbook, calibration logbook, field data sheets), but should summarize the contents of the other logbooks and refer to the page locations in these logbooks for detailed information.

If measurements are made at any location, the measurements and equipment used must either be recorded in the field logbook or reference must be made to the logbook and page number(s) on which they are recorded. All maintenance and calibration records for equipment should be traceable through field records to the person using the instrument and to the specific piece of instrumentation itself.

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

Field Data Forms

Occasionally, additional field data forms are generated during a field sampling event (e.g., groundwater monitoring form, sediment core profile form, water quality measurement form) to record the relevant sample information collected during a sampling event. For instructions regarding the proper identification of field data forms, sampling personnel should consult the project-specific SAP.

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

Photographs

In certain instances, photographs (print or digital) of sampling stations may be taken using a camera-lens system with a perspective similar to the naked eye. Photographs should include a measured scale in the picture, when practical. Photographs may also be taken of sample characteristics and routine sampling activities. Telephoto or wide-angle shots will not be used because they cannot be used in enforcement proceedings. The following items should be recorded in the field logbook for each photograph taken:

1. The photographer's name or initials, the date, the time of the photograph, and the general direction faced (orientation)
2. A brief description of the subject and the field work portrayed in the picture
3. For print photographs, the sequential number of the photograph and the roll number on which it is contained
4. For digital photographs, the sequential number of the photograph, the file name, the file location, and back-up disk number (if applicable).

Upon completion of the field sampling event, the sampling team leader will be responsible for submitting all photographic materials to be developed (prints) or to be copied (disks), as appropriate. The prints or disks (as appropriate) and associated negatives will be placed in the project files (at the Integral Project Manager's location). Photo logs and any supporting documentation from the field logbooks will be photocopied and placed in the project files with the prints or disks.

Equipment Calibration Records

Equipment calibration records, including instrument type and serial number, calibration supplies used, calibration methods and calibration results, date, time, and personnel performing the calibration, should be recorded in the field logbook. At a minimum, equipment used during the investigation should be calibrated daily in accordance with the manufacturers' recommendations.

Distribution of Copies

Two copies of all field logbooks and additional field data forms will be made at Integral. The first copy will be stamped with a "COPY" stamp. This copy will be placed in the project file and will be available for general staff use. The second copy will be stamped with a "FILE" stamp. This copy will be placed in the data management file with the laboratory data packages and will be used by the data management and quality assurance staff only. The original field logbooks and forms will be placed in a locked file cabinet.

Set-up of Locking File Cabinet

Each project will have its own file folder in a locking file cabinet. The folder label will include the project name and contract number. As many as six kinds of files will be included in this folder for each project:

- Field logbook(s)
- Additional field data forms
- Photographs
- COC forms
- Acknowledgment of Sample Receipt forms
- Archive Record form (to be completed only if samples are archived at an Integral field storage facility or Integral laboratory).

STANDARD OPERATING PROCEDURE SOP-AP3

SAMPLE CUSTODY

Scope and Application

This SOP describes Integral procedures for custody management of environmental samples.

A stringent, established program of sample chain-of-custody will be followed during sample storage and shipping activities to account for each sample. The procedure outlined herein will be used with SOP-AP1, which covers sample packaging and shipping; SOP-AP2, which covers the use of field logbooks and other types of field documentation; and SOP-AP4, which covers sample labeling. Chain-of-custody (COC) forms (see attached example) ensure that samples are traceable from the time of collection through processing and analysis until final disposition. A sample is considered to be in a person's custody if any of the following criteria are met:

1. The sample is in the person's possession
2. The sample is in the person's view after being in possession
3. The sample is in the person's possession and is being transferred to a designated secure area
4. The sample has been locked up to prevent tampering after it was in the person's possession.

At no time is it acceptable for samples to be outside of Integral personnel's custody unless the samples have been transferred to a secure area (i.e., locked up). If the samples cannot be placed in a secure area, then an Integral field team member must physically remain with the samples (e.g., at lunch time one team member must remain with the samples).

Chain-of-Custody Forms

The COC form is the critical because it documents sample possession from the time of collection through the final disposition of the sample. The form also provides information to the laboratory regarding what analyses are to be performed on the samples that are shipped.

The COC form will be completed after each field collection activity and before the samples are shipped to the laboratory. Sampling personnel are responsible for the care and custody of the samples until they are shipped. When transferring possession of the samples, the individuals relinquishing and receiving the samples must sign the COC form(s), indicating the time and date that the transfer occurs.

The COC forms each consist of 3-part carbon-less paper with white, yellow, and pink copies. The pink copy is kept by the sampling team leader. The white sheet and the yellow sheet will be placed into a plastic sealable bag and secured to the inside top of each transfer container (e.g., cooler). The pink sheet will be retained by the field staff for filing at the Integral Project Manager's location. Each COC form has a unique 4-digit number. This number and the samples on the form shall be recorded in the field logbook. Integral also uses computer-generated COC forms. If computer-generated forms are used, then the forms must be printed in triplicate and all three sheets signed so that two sheets can accompany the shipment to the laboratory and one sheet can be retained on file at the Integral Project Manager's location. Alternatively, if sufficient lead time is available, the computer-generated forms will be printed on 3-part carbon-less paper.

The project-assigned sample number and the unique tag number at the bottom of each sample label will be recorded on the COC form. The COC form will also identify the sample collection date and time, the type of sample, the project, and the sampling personnel. In addition, the COC form provides information on the preservative or other sample pretreatment applied in the field and the analyses to be conducted by referencing a list of specific analyses or the statement of work for the laboratory. The COC form will be sent to the laboratory along with the sample(s).

Procedures

The following guidelines will be followed to ensure the integrity of the samples:

1. Each COC form must be appropriately signed and dated by the sampling personnel. The person who relinquishes custody of the samples must also sign this form.
2. At the end of each sampling day and prior to shipping or storage, chain-of-custody entries will be made for all samples. Information on the labels and tags will be checked against field logbook entries.
3. The COC form should not be signed until the information has been checked for inaccuracies by the sampling team leader. All changes should be made by drawing a single line through the incorrect entry and initialing and dating it. Revised entries should be made in the space below the entries. Any blank lines remaining

on the COC form after corrections are made should be marked out with single lines that are initialed and dated. This procedure will preclude any unauthorized additions.

4. At the bottom of each COC form is a space for the signatures of the persons relinquishing and receiving the samples and the time and date that the transfer occurred. The time that the samples were relinquished should match exactly the time they were received by another party. Under no circumstances should there be any time when custody of the samples is undocumented.
5. If samples are sent by a commercial carrier not affiliated with the laboratory, such as Federal Express (FedEx) or United Parcel Service (UPS), the name of the carrier should be recorded on the COC form. Any tracking numbers supplied by the carrier should be also entered on the COC form. The time of transfer should be as close to the actual drop-off time as possible. After the COC forms are signed and the "pink" copy has been removed, they should be sealed inside the transfer container.
6. If errors are found after the shipment has left the custody of sampling personnel, a corrected version of the forms must be made and sent to all relevant parties. Minor errors can be rectified by making the change on a copy of the original with a brief explanation and signature. Errors in the signature block may require a letter of explanation.
7. Samples that are archived internally at Integral must be accompanied by a COC form and an Archive Record form.
8. Upon completion of the field sampling event, the sampling team leader will be responsible for submitting all COC forms to be copied. A discussion of copy distribution is provided in SOP-AP2.

Custody Seal

As security against unauthorized handling of the samples during shipping, two custody seals will be affixed to each sample cooler (example provided in Attachment GEN-03-1). The custody seals will be placed across the opening of the cooler (front right and back left) prior to shipping. Be sure the seals are properly affixed to the cooler so they cannot be removed during shipping. Additional tape across the seal may be prudent.

Shipping Air Bills

When samples are shipped from the field to the testing laboratory via a commercial carrier (e.g., Federal Express, UPS), an air bill or receipt is provided by the shipper. Upon completion of the field sampling event, the sampling team leader will be responsible for submitting the sender's copy of all shipping air bills to be copied. A discussion of copy distribution is provided in SOP-AP2. The air bill number (or tracking number) should be noted on the applicable COC forms or alternatively the applicable COC form number should be noted on the air bill to enable the tracking of samples if a cooler becomes lost.

Acknowledgement of Sample Receipt Forms

In most cases, when samples are sent to a testing laboratory, an Acknowledgment of Sample Receipt form is faxed to the project QA/QC coordinator the day the samples are received by the laboratory. It is the responsibility of the person receiving this form to review the form and make sure that all the samples that were sent to the laboratory were received by the laboratory and that the correct analyses were requested. If an error is found, the laboratory must be called immediately. Decisions made during the telephone conversation should be documented in writing on the Acknowledgment of Sample Receipt Form. In addition, corrections should be made to the COC form and the corrected version of the COC form should be faxed to the laboratory.

The Acknowledgment of Sample Receipt form (and any modified COC forms) will then be submitted to be copied. A discussion of copy distribution is provided in SOP-AP2.

Archive Record Forms

On rare occasions, samples are archived at an Integral office. If samples are to be archived at Integral, it is the responsibility of the project manager to complete an Archive Record form. This form is to be accompanied by a copy of the COC form for the samples, and will be placed in a locked file cabinet. The original COC form will remain with the samples in a sealed Ziploc bag.

STANDARD OPERATING PROCEDURE SOP-AP4

SAMPLE LABELING

Scope and Application

This SOP describes the general Integral procedures for sample labeling and the three different kinds of labels that could be used on a project (i.e., sample labels, sample tags, and internal sample labels). The project-specific sampling and analysis plan (SAP) should be consulted to determine the exact sample identifiers and sample labels are required for a given project. If they are not specified in the SAP, the designations listed below should be followed.

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 (i.e., replicates) to ensure proper data analysis and interpretation, 2) to obscure the relationships between samples so that laboratory analysis will be unbiased by presumptive similarities between samples, and 3) to track individual sample containers to ensure that the laboratory receives all of the material associated with a single sample. To accomplish these purposes, each container may have three different codes associated with it: the sample identifier, the sample number, and the sample tag number. These codes and their uses are described as follows:

- **Sample Identifier**—The sample identifier is a unique designation that identifies where and how the sample was collected. The sample identifier is recorded in the field logbook *only* and is not provided on the sample label or chain-of-custody form. The sample identifier is a multiple-part code. The first component will begin with the letter abbreviation; for example, “SWNS” or “SWNB” to designate the surface water sample was collected from the near-surface or near-bottom of the water column. The second part could identify the sampling event; for example, “1” to designate Round 1 sampling. The third part could contain an abbreviation for whether the station is a single point (SP), a transect (TR), a composite (CO), or a vertically integrated station (VI). The station number would be the final component and complete the sample

identifier. Leading zeros will be used for stations with numbers below 100 for ease of data management and correct data sorting.

If appropriate, a supplemental component will be added to the sample identifier to code field duplicate samples and splits. A single letter (i.e., a suffix of “A” and “B”) will be used to indicate field duplicates or splits in the final component of the sample identifiers. For equipment decontamination blanks, sequential numbers starting at 900 will be assigned instead of station numbers. The sample type code will correspond to the sample type for which the decontamination blank was collected. Additional codes may be adopted, if necessary, to reflect sampling equipment requirements (see project-specific SAP).

Example sample identifiers are:

- **SWNS-1-SP-002:** Surface water sample collected from the near-surface at a single point during Round 1 from Station 2.
- **SWNB-1-TR-010-A:** Duplicate surface water sample from the near-bottom transect during Round 1 from Station 10.
- **Sample Number**—The sample number is an arbitrary number assigned to each distinct sample or split that is shipped to the laboratory for separate analysis. The sample number appears on the sample containers and the COC forms. Each sample will be assigned a unique sample number. All aliquots of a composited field sample will have the same sample number. Note that in cases where samples consist of multiple bottles from the same location, each bottle will be assigned the same sample number and time. Replicates from the same location, however, will be assigned a different sample number and time, and the sample numbers of related field replicates will not necessarily have any shared content. Each field split of a single sample will also have a different sample number and time.

The sample number is a unique number that is generally assigned six digits, including a two-digit media code and a four-digit number. The media code may be site-specific, but the Integral default codes are as follows:

- SS – Surface soil
- BH – Subsurface soil or rock (typically from borehole)
- GW – Groundwater
- SW – Surface water

- PW – Pore water
- SD – Sediment
- BT – Biota or biological tissue

The exact sample numbering scheme may vary from project to project. Variances in the sample numbering scheme will be described in the project-specific SAP for the field event.

Example sample numbers would be: PW0001, PW0002, PW0003, etc.

- **Tag Number**—A different tag number is attached to each sample container. If the amount of material (i.e., everything associated with a single sample number) is too large for a single container, each container will have the same sample number and a different sample tag. A sample will also be split between containers if a different preservation technique is used for each container (i.e., because different analyses will be conducted).

The sample tag number is a unique five- or six-digit number assigned to each sample label (or “tag”) for multiple bottles per sample. Integral sample labels come with a pre-printed sample tag number. The purpose of the tag number is to provide a unique tracking number to a specific sample bottle. This allows for greater flexibility in tracking sample bottles and assists in field quality control when filling out documentation and shipping. Sample tags are not used by many other consultants, and there may be resistance from such firms during teaming situations. However, experience has shown that tags can be very valuable, both in the field and while processing data from field efforts.

The tag number will appear on the COC forms. Tag numbers are used by laboratories only to confirm that they have received all of the containers that were filled and shipped. Data are reported by sample number.

Sample numbers will be assigned sequentially in the field; sample labels will be preprinted with sequential tag numbers.

Sample Labels

Integral sample labels are designed to uniquely identify each individual sample container that is collected during a sampling event. Field sampling teams will be provided with preprinted sample labels, which must be affixed to each sample container used. The labels should be filled out at the time the samples are collected and should consist of the following information:

1. Sample number
2. Site name or project number
3. Date and time sample is collected
4. Initials of the samplers
5. Preservatives used, if any
6. A unique number (commonly referred to as the "Tag Number") that is preprinted on the label consisting of five or six digits; used to identify individual containers.

Sample Tags

Integral sample tags are designed to be affixed to each container that is used for a sample. Sample tags are only required for environmental samples collected in certain U.S. Environmental Protection Agency (EPA) regions (i.e., EPA Region 5). Field crews will be provided with preprinted sample tags. Sample tags must be attached to each individual sample container with a rubber band or wire through a reinforced hole in the tag. All sample tag entries will be made with indelible ink. The tags should be filled out at the time the samples are collected and should consist of the following information:

1. Sample number
2. Site name or project number
3. Date and time sample is collected
4. Initials of the samplers
5. Preservatives used, if any
6. Type of analysis.

A space for the laboratory sample number (provided by the laboratory at log-in) will also be provided on the sample tag.

Internal Sample Labels

For benthic infaunal samples, the sediment is washed away from the sample and the remaining benthic infauna are collected into a sample container. A sample label as discussed above is affixed to the outside of the sample container. In addition, an internal sample label is placed inside the sample container. This internal sample label is made of

water-proof paper and all internal sample label entries will be made with pencil. The internal sample labels should be filled out at the time the samples are collected and should consist of the following information:

1. Sample number
2. Site name or project number
3. Date and time sample is collected
4. Initials of the samplers
5. Preservative used (i.e., formalin).

STANDARD OPERATING PROCEDURE SOP-AP6

NAVIGATION AND STATION POSITIONING

Scope and Application

Accurate station positioning is required to help 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, allowing a user to reoccupy a station location (e.g., long-term monitoring programs).

This SOP describes the most commonly used station positioning method, Differential Global Positioning System (DGPS). Integral owns the following DGPS hardware and software systems for station positioning at many of their field efforts.

- Trimble Pathfinder™ Pro XRS system (TSC1 handheld unit, GPS receiver and GPS antenna)
- Trimble GeoXT
- Trimble Pathfinder Office (Version 4.0)
- Trimble TerraSync Professional (Version 3.05)
- ESRI ArcPad 7.1

The Trimble DGPS offers post-processing sub-meter accuracy often required for documenting sampling station locations and for relocating previously sampled stations. A thorough and comprehensive discussion of the Trimble DGPS is provided in attachments to this SOP.

Summary of Method

Global positioning system (GPS) navigation is used to navigate and position the sampler at the desired location. GPS is a satellite-based system that receives positioning data at 1-second intervals from multiple satellites at known positions in space. Standard GPS is calculated to an accuracy of about ± 50 m.

A higher accuracy of approximately 2 m may be obtained by applying differential corrections to the standard GPS positioning data using DGPS. These differential corrections are applied by sending GPS differential corrections to the GPS receiver via radio

transmission. If the sampling location is near the coastal United States, the U.S. Coast Guard generates differential corrections that are transmitted via radio link to the GPS receiver. If a Coast Guard station is out of range of the sampling area, then a receiver may be set up at a known (i.e., surveyed) reference point on land or real-time satellite differential signals can be purchased from a private company (e.g., OmniSTAR).

With the Trimble GeoXT and Pro XRS systems, GPS data can be gathered to sub-meter accuracy using a choice of differential correction sources (i.e., free beacon differential signals [e.g., Coast Guard or U.S. Forest Service beacons] or OmniSTAR) without establishing a reference station. Correction of data is required to gain sub-meter accuracy. Free beacon or base station signals allow differential corrections to be performed after data collection by using a nearby beacon or base station logging data files. (Note: Station must be within 150 km (93.2 miles) of the data collection location.) For satellite-based signals, a built-in virtual base station allows for real-time data correction, eliminating the need for post-processing data in some cases. However, post-processing data corrections can obtain accuracies in the range of 30–50 cm. These accuracies are for the horizontal (northing and easting) component only. The vertical component (elevation) accuracy ranges from sub meter to three times larger than the horizontal accuracy.

The GPS receiver transmits differentially corrected positioning data to the computer and displays it on the screen using an integrated navigation software package (e.g., HYPACK, TerraSync). The computer data are typically displayed and recorded in World Geodetic System of 1984 (WGS-1984) geographic coordinates (latitude/longitude). However, the integrated navigation system can display and record information in other datums (e.g., UTM, NAD83, etc.). The integrated navigation system, acting as a data manager, displays the sampler's position relative to a target station location in plan view on a video screen. The resulting pictorial screen presentation, as well as numeric navigation data (e.g., range and bearing to the target sampling location) assists the vessel operator (when sampling on-water) in approaching and maintaining the station position while sampling.

Supplies and Equipment

- Cables (antenna to receiver, receiver to computer)
- Trimble Pro XRS GPS antenna
- Trimble Pro XRS GPS receiver with battery charger and batteries
- Trimble TSC1 handheld data logger unit with Asset Surveyor software
- Trimble GeoXT handheld GPS unit (antenna, receiver and computer all-in-one unit) with battery charger/docking station and cables

- Trimble® GeoBeacon™ receiver for precision of real-time differential GPS (use with GeoXT)
- Laptop computer and additional navigational monitor (if needed)
- Navigation software (e.g., Terrasync and Pathfinder Office)
- Laser range finder (use TruPulse™ 200 or 360 Laser Rangefinder - Blue Tooth™ enabled)
- Logbook or log sheets.

Procedures

Latitude and longitude coordinates will be obtained at the locations where surface water samples are collected. An average positioning objective is to accurately determine and record the positions of all sampling locations to within ± 2 m. Positioning accuracies on the order of ± 1 – 3 m can be achieved by avoiding the few minutes per day when the satellites are not providing the same level of signal. The GPS provides the operator with a listing of the time intervals during the day when accuracies are decreased. Avoidance of these time intervals permits the operator to maintain better positioning accuracy.

On-Land Sampling Event

A Trimble Pro XRS backpack or a handheld Trimble GeoXT (equipped with a GeoBeacon™ receiver) DGPS unit may be used to direct the sampling team to the proposed sampling location. To expedite field activities, the target station coordinates may be entered in the navigation system database prior to beginning sampling. The DGPS antenna is located as close as possible to where the sampling will occur. Once the sample(s) have been collected at the appropriate location, the horizontal coordinates of the station are recorded in the field logbook. If necessary, the vertical elevation may be recorded as well.

On-Water Sampling Event

When collecting samples from a boat, the GPS Pathfinder Pro XRS system is used. The receiver is a real-time GPS mapping receiver combining a GPS receiver, an minimum shift keying (MSK) beacon differential receiver, and a satellite differential receiver in a single housing, the GPS Pathfinder Pro XRS receiver offers the flexibility for choosing a source for real-time differential corrections.

The GPS antenna is mounted right above the location where the sample will be collected. That is, the antenna is mounted vertically at the outboard end of the vessel's boom, at the top middle of an A-frame or at the outboard end of a davit. If this is not possible, the navigator must measure the distance between the sampler location and the antenna and enter an offset in the navigation program (e.g. TerraSync) to correct for that distance. The GPS antenna

cable extends along the boom into the cabin where it is connected to the GPS receiver and a laptop. If available, an additional video screen is installed to allow the vessel operator to observe on-screen positioning data from the helm.

Alternatively, if sampling will be done from a different vessel, such as a drilling barge, a backpack or handheld DGPS unit may be used to position the sampling vessel over a proposed sampling location. The DGPS antenna is located as close as possible to where the drilling will occur (i.e., over the moon pool). The person operating the DGPS unit directs the sampling vessel operator to the sample station location.

Once the sampling vessel is at the appropriate location and is anchored, the horizontal coordinates of the station are recorded in the field logbook. To expedite field activities, the target station coordinates may be entered in the navigation system database prior to beginning sampling.

Positioning System Verification

GPS requires no calibration, as all signal propagation is controlled by the U.S. 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. If possible, GPS accuracy should be verified at the beginning or at the end of each sampling day.

Station Positioning Activities

A consistent routine is used for each day's positioning activities. After successful reception of differential signals, the computer turned on, and the software booted. The accuracy of the system is verified at a horizontal control point, as described in the previous section.

At the beginning of a sampling day, the team leader defines the order in which each sampling station will be visited. The station locations are then selected one at a time from a number of pre-selected station locations that have been entered into the integrated navigation system database. Upon selection of a target station, the positioning data of the sampler is displayed on the computer screen or hand-held unit to assist the operator in proceeding to the station, and if on water work, in maintaining the station position during sampling. A confirmed position is recorded electronically each time a sample collection is attempted (this means that during sediment grab sampling and coring from a boat, the locations of both accepted and rejected grabs or cores are recorded). Upon recovery of the sampling device, the station position coordinates (i.e. northing (y) and easting (x) or latitude and longitude) are read from the archived computer file and recorded in the field logbook or

on log sheets as a backup to the computer record. Time and water depth (if applicable) are also recorded. Ancillary information recorded in the field logbook may include personnel operating the GPS system, tidal phase or river stage for on-water work, elevation for on-land work, type of sampling activity, and time when coordinates were collected.

References

Trimble Navigation Limited. 2007. GPS tutorial. Accessed on January 12, 2007.
<http://www.trimble.com/gps/index.shtml>

Trimble Navigation Limited. 2001. TSC1 Asset Surveyor operation manual. Version 5.20. <http://trl.trimble.com/dscgi/ds.py/Get/File-8145/Oper.pdf>

ATTACHMENT 1

TRIMBLE PRO XRS AND TSC1 DESCRIPTION

The Trimble Pathfinder™ Pro XRS combines a high-performance GPS receiver and antenna, beacon differential receiver, and satellite differential receiver (Wide Area Augmentation System [WAAS]) capabilities in one compact unit. The Pro XRS also includes Trimble's advanced Everest™ technology, which allows users to collect accurate position data near walls, water, vehicles, or other surfaces that reflect satellite signals. Reflected signals, also called multipath signals, make it difficult for GPS receivers to accurately determine position. Everest uses a patented technique to remove multipath signals before measurements are used to calculate position.

Equipment Required

The GPS Pro XRS with a TSC1 data logger consists of the following:

- GPS receiver in backpack casing (with system batteries and cables)
- Hand-held data logger (TSC1) and cable, OR Laptop with Terrasync software installed and cable. (Note: Terrasync procedures are covered under Attachment 4.)
- Pro XRS antenna, range poles, and cable
- Compass and tape measure
- Spare 12-volt camcorder and 9-volt batteries (minimum of 2 each) (use only Kodak, Duracell, or Energizer 9-volt batteries)
- Battery charger and power cord.

Pro XRS and TSC1 Setup

Follow these procedures for the proper setup of the Pro XRS:

1. Ensure connections between batteries, receiver and data logger are correct and secure. The coaxial antenna cable connects from the GPS receiver port "ANT" to the base of the antenna. The TSC1 cable (a "pig-tail"-type cable) connects from the bottom or top of the TSC1 to the receiver port "B", where a 9-pin serial port dongle is attached. The dual Y-clip cables should be connected from the receiver to the batteries. Alternatively, if AC power is available (e.g., aboard a vessel), then the power cable for the battery charger can be attached directly to the receiver on some models.
2. Screw the three long antenna poles together (the shorter pole may be added if necessary for taller users). Screw on the antenna and connect its cable.
3. Put backpack and/or shoulder strap on. The pouch for the data logger should be

in place around the waist strap/in backpack.

4. Screw antenna to the attachments on the top of the back-pack. Wind cord around pole, and use ensure the antenna is secure. Please be aware of overhead hazards, especially if working near low hanging power lines. Severe injury or death can result.

Basic Operation of the Pro XRS

Recording a Feature

Before beginning field use, ensure that all GPS configurations and settings are set correctly for the particular use of the Pro XRS and that an appropriate data dictionary is loaded onto the TSC1 (See Attachments GEN-04-1 and GEN-04-2 for typical settings). These steps outline the basic use of the GPS to document a sample position or any other defined "feature." Note that the TSC1 has both hard-keys and soft-keys that allow for its operation. The hard-keys are all the keys (e.g., letters and numbers) on its surface. The soft-keys are the F1 through F5 hardkeys. The function of these changes depending upon the context. These keys will be referred to with arrows around them (<soft-key>).

1. Turn data logger on outside in an open area. Wait for antenna to receive satellite signals. The display will read "Recording Almanac," "Too few SVs," and "PDOP too high." Continue to wait until enough satellites (a minimum of 4) are acquired, and the PDOP is below 5.0.
2. Ensure that the real-time settings are correct according to the parameters listed in Attachment 1.
3. Select DATA COLLECTION, and create a new rover file or open an existing file. This file should be named according to the format specified by the project GIS analyst. Note: If opening an existing file press <NEW> to access the "Antenna options" menu and "Start Feature" menu.
4. Enter the height of the antenna from the ground to the "Measurement Method" reference point shown in the "Antenna Options" menu and then press ENTER to bring up the "Start Feature" menu.
5. Pick the appropriate data dictionary to use with the rover file. Only one dictionary can be used with a rover file. Please consult with the project GIS analyst to formulate the most appropriate data dictionary for the type of sampling you wish to perform. The data dictionary entitled "Generic," contains only a comment field, and is appropriate for simple navigation tasks. If using a data dictionary, make sure to become familiar with its attributes before recording information in the field.
6. Move to the location of the first feature for which you want to record the GPS position. Select the appropriate feature and press ENTER to begin logging. Log data points in accordance with the feature type. Point features should have at least

10 points collected at a stationary location. Line features should be collected while moving. If movement is stopped, press the <PAUSE> key. When movement starts again, press the <RESUME> key. Area features should be collected with enough points to define the outline of the area (e.g., a square building would have four single points, collected on each corner, and the <PAUSE> key would be used between each of the points).

7. Depending on the setup of the data dictionary, each feature may have one or more feature attributes. An attribute is used to record additional data associated with the feature. For example, the attributes assigned to a sediment sampling station could be sample number, station ID, sampling gear, sediment color, odor, etc. (The <PAUSE> key should be used while recording feature attributes to avoid too many data points being collected at one point feature. [Body movements while logging attributes for an extended time can decrease the accuracy of collection.] The <PAUSE> key must be used when recording attributes of a line or area feature because only one data point should be collected in a single location.) Once all attributes are entered and the feature data points are logged, press ENTER to complete and save the feature and move on to a new feature. Pressing ESC instead of ENTER will allow the user to abandon the logged feature without saving.
8. When all features in a given area have been recorded, from the "Data Collection" menu press ESC to exit data capture and then press <YES> to close the file. Features are appended and saved to the file after each collection, so there is no need to "save" the file. When the Pro XRS system is not in use, it should be turned off. If you need to come back to the same rover file later in the day, the rover file may be reopened at that time. Rover files may not be edited after 7 days from the first feature was created. Please consult the project GIS analyst for the best way to handle multi-week sampling projects. Ideally, files should be saved and sent to the GIS daily for differential corrections. Files older than a week will require access to archived base station files for differential corrections and will require additional GIS time for post-processing. Post-processing may be done in the field if the appropriate software and internet connections are available.
9. At the end of each day, the rover file should be downloaded to a PC by using Pathfinder Office software and if possible, sent to the GIS team for post-processing and QA/QC checks.

Feature Collection Options

Offsets—The TSC1 can collect a point or line feature while standing at a set distance away from the feature. This option may be necessary because of obstructions such as tree cover, buildings, or car traffic. For a point feature, measure the distance between the object you want recorded and the Pro XRS antenna. Use the compass to determine the bearing (e.g., west is 270°). The bearing is the direction the point should be moved for it to be located in the correct place (e.g., if you are due north of the feature, the bearing is south

or 180°; i.e., the position you want recorded is south of where you are standing). Estimate the inclination from the feature to the GPS antenna (if height determination is critical, a clinometer should be used). The inclination is the degree angle up from the feature to the antenna (e.g., if the feature is 5° below the antenna position, -5° would be entered). During data capture, from within the feature, press the <OFFSET> button, and enter the distance, bearing, and inclination. Press OK to complete the feature.

Note: This procedure describes an offset of a single feature. A constant offset may be applied to all features collected as well.

Nesting—While recording a line feature or an area feature, a point feature may be collected to avoid backtracking. While recording the line or area feature, press <PAUSE> and then <NEST>. The TSC1 will prompt for collection of a new feature. Move to the feature, and collect data as for any other point feature. When the feature is complete, press OK. The Pro XRS is ready to resume collecting data as part of the line/area feature: press <RESUME>. (Remember to continue moving before pressing resume to avoid having multiple positions recorded in the same place in the line or area feature.)

Segmenting—While moving along a line feature, changing the attributes of that line may be necessary (e.g., because of a change in surface type from paved to dirt road, dropping a benthic sled at the bottom of a river and marking when the benthic tow starts). This change may be done without having to begin a new feature by pressing <PAUSE> and then <SEGMENT>. Change the appropriate attributes and then press <RESUME> to continue recording.

Repeat—The function allows the collection of a new feature with the same feature attributes as the previous feature. If features are not exactly the same, it also allows editing of the attributes.

Quickmark—Allows collection of point features while moving (e.g., from a car or a boat) by estimating the exact location. The use of this feature will not result in positionally accurate locations and is not recommended for most sampling operations.

Reviewing and Editing Features

It is possible to review or edit features collected in the field while still in the data capture mode. For example, it may be necessary to document the GPS location in the field logbook or to edit one of the feature's attributes. Without exiting data capture, press <REVIEW>. (If data capture is already complete, just press REVIEW and then select the appropriate rover file.) This step will display a list of data points including each feature collected. Scroll to the appropriate feature, and follow the steps below depending on the required action:

- To view the GPS location (e.g., lat/long), press <POS>
- To edit the attributes, press ENTER. Make any necessary edits to the attributes by scrolling through.
- To change or add an offset, press <POS>, then press <OFFSET>. Make any necessary changes.
- To delete a feature collected in error, press .

Navigating to an Existing Location

Waypoints

To use the Pro XRS to navigate to a previously established position, this position must be loaded into the TSC1 data logger as a waypoint, be present as a feature position in the data files, or must be generated in the field using the GPS unit. Waypoints may be entered into the TSC1 by:

- Manually entering coordinates
- Choosing previously recorded locations and importing them into the TSC1 by using Pathfinder Office
- Defining a location stored in a rover file saved to the TSC1 as a waypoint (see *Reviewing/Editing Features*, above)
- Creating a way point from the current position being shown by the operating GPS unit in the field.

Navigating

Usually the *Navigation* module (accessed by pressing MENU followed by Navigation) will be used to guide yourself to a target (waypoint or feature). You can also use the *Map* module (accessed by pressing MENU followed by Map) to:

- Orient yourself in the area you are working in
- Get a general indication of the location of a feature or waypoint that you want to find
- Find or select features or waypoints that you want to navigate to
- Plot a course from one place to another.

While in the Map screen, the GPS cursor x shows the current position reported by the receiver and is always shown on the Map screen (note: it may not always be within the visible part of the screen when panning or scrolling). The <OPTIONS> key can be used to hide or display the GPS trail (line of dots showing up to 60 previous positions), the heading showing the direction of travel, and other options on the map display.

A feature can be selected by pressing MENU, Data Collection to reach the “Start Feature” screen, and then REVIEW to access all features contained in the data file. The desired feature can then be highlighted and selected by pressing the <Target> key which adds a crossed flag to the feature. The Map screen can be re-accessed by selecting MENU, then Map, which will now show the highlighted feature with a crossed flag symbol on the Map screen. The user can then start moving toward the feature and the current position (shown by the x) will move closer to the target position as the user approaches.

There are two graphical modes of navigation with the Pro XRS in the TSC1 *Navigation* module. On both modes text information appears on the right of the screen in the *Info* panels, which can be configured by the user. The graphic modes available are the *Directional Dial* screen or the *Road* screen, which can be toggled between using the <Mode> key.

To navigate you need to select a target and then a start position. Each of these positions can be features from an open data file or a waypoint. A list of available features or waypoints can be accessed by pressing <TARGET> or <START>. Once the item has been chosen as a target it will show the crossed flags symbol in the list. Once a target has been selected, the Distance to Go appears at the bottom of the Navigation screen, which indicates the distance from the current GPS position to the target. Select a start position (not required but useful for calculating crosstrack error and other navigation information) by pressing <START>. A waypoint of the current GPS position can be created for use as the Start point by selecting <CREATE>. Once the Start position is selected, a flag symbol will appear next to the item in the list.

In the *Directional Dial* mode an arrow will appear that will always point at the target. This is the bearing to go (Note: you need to be moving for this to be accurate as it will lock if you are moving too slowly or are stopped). The triangle at the top of the circle represents the direction that you are going or heading. This triangle never moves, but by changing directions you can line up the arrow with the triangle. When the two are aligned you are heading in the direction of the target. When you are close to the target a bull’s-eye (two concentric circles) will appear at the edge of the screen. This is warning you that the unit will be switching to the close up screen. A proximity alarm will sound and the directional arrow will be replaced by the bull’s-eye on the close up screen. Your current position will

be shown by an x and the target by the bull's-eye. Move so that the x is in the same location as the bull's-eye.

In the *Road* mode you navigate by walking down a road. Your position is shown by a stick figure and is always positioned in the center of the screen. The target (crossed flags) shows the point that you are navigating to. Your heading is shown by the top center of the screen and the bearing to go is shown by the direction of the road, which will rotate as you change your heading. Change your heading until the road is pointing at the top of the screen (Target is also at the top of the screen) and the edges are parallel to the sides of the screen. As you move toward the target the screen zooms in, so the road appears to get wider.

Downloading Rover Files

Upon returning to the office, all rover files should be downloaded from the TSC1 to a PC for post-processing. You will need the Trimble Pathfinder Office software installed on your computer. If not using a field laptop that already has the program installed, please contact your project GIS analyst for instructions on how to install the software.

Connect the TSC1 to your computer using the appropriate cables. In addition to the "pigtail" cable, you will also need a null modem, which is a 9-pin female to female cable, in order to plug into a PC serial port. Once connected, power up the TSC1 unit and navigate to MENU, File Manager, File Transfer. Then, open the Pathfinder software and navigate to the *Utilities>Data Transfer...* window from the menu bar. Select GIS Datalogger on COM1 (for most computer systems), and press the green connect button. Files can be downloaded from the TSC1 by selecting the Receive tab and choose the data file type from the Add pulldown menu. After downloading, all rover files and waypoints should be removed from the TSC1 to conserve memory. Rover files may be deleted from the File Manager menu.

1. Select MENU, File Manager, then delete file(s).
2. Select the rover file to be deleted, and press <ENTER>.
3. Confirm the deletion of this file by pressing <YES>.

Data dictionaries can be deleted in the same manner by selecting Data dictionaries from the File Manager menu. Waypoints may be deleted by selecting Utilities from the Main menu and then by selecting Waypoints followed by .

ATTACHMENT 2 TSC1 SETTINGS

The following are lists of menus that can be accessed through the TSC1 keypad. Please ensure that settings are correct before proceeding. Please do not make changes to the settings unless necessary. Each menu will list all available subheadings, the correct setting, and the available <soft-keys> to access additional menus. Comments are included only where necessary.

GPS Rover Options

Access this menu by selecting Configuration from the main menu and then select GPS Rover Options.

Logging Options	Setting	Comment
<u>Logging intervals</u>		
Point feature	1s	
Line/area feature	2s–5s	depending upon speed of movement
Not in feature	None	
Velocity	None	
Confirm end feature	No	
Minimum pos	10	
Carrier Mode	Off	
Carrier phase min time	10 min	
Dynamics code	Land	may be changed to sea or air, as appropriate
Audible click	Yes	
Log DOP data	Yes	
Log PPRT data	Yes	
Log QA/QC data	Yes	
Allow GPS update	Warn First	
Warning Distance	Any	
Position Mode Manual	3D	
Elevation Mask	15°	Should not go below 15° (accuracy decreases)
SNR Mask	6.0	Can raise to 7 if multi-path filtering is poor
PDOP Mask	5.0	Can be raised up to 8 – reduces accuracy
PDOP Switch	6.0	

Real-Time Input Options

This menu can be accessed from the GPS Rover options menu by selecting real-time input.

	Setting	Comment
Preferred Correction Source	Choice 1	Integrated Beacon
	Choice 2	Integrated WAAS
	Choice 3	Use uncorrected GPS
Correction age limit	20s	

Antenna Options

This menu can be accessed from the GPS Rover options menu by selecting Antenna Options.

	Setting	Comment
Height (from ground)	in m or ft	Enter correct user antenna height using measurement method indicated below
Measure Type	Uncorrected Integrated GPS/Beacon/Satellite	
Confirm	Per file	
		Can be changed to "Per feature" if antenna height varies and elevation is critical
Part Number	33580-50	Auto selected based on TYPE selected
Measurement Method	Bottom of Antenna Mount	

ATTACHMENT 3

Additional Settings for the TSC1

Additional TSC1 settings can be found in the configuration menu. Items of particular importance are indicated in *italics*.

Configuration

This menu can be accessed by selecting Configuration from the main menu.

	Description
GPS base station options	For using a land base station or beacon for real time corrections
NMEA/TSIP output	Consult manual
Coordinate system	Changes coordinate system among latitude/longitude, UTM, and other coordinate systems. System can be converted, if necessary, after data capture by using Pathfinder Office software.
Map Display options	Change layers, scale, background files and items shown on the TSC1 screen during data collection
Navigation options	Changes Navigation parameters
Units and display	Changes various units, for example: length (e.g., feet, meters), elevation reference (e.g., MSL), <i>North reference</i> (i.e., true or magnetic). Units can be converted, if necessary, after data capture by using Pathfinder Office software.
Time and date	Changes to <i>local time</i> , 24 hour clock, date format, etc.
Quickmarks	Set-up parameters for use with quickmarks.
Constant offset	Set-up parameters for use with a constant offset.
External sensors	Connections with external sensors.
Hardware (TSC1)	TSC1 settings such as beep volume, contrast, <i>internal and external battery status</i> , software version, free space.

Contrast and Backlighting

The TSC1 display can be viewed in various light settings. Pressing FUNC, then L turns on the display backlight for viewing in dim lighting. In addition, the contrast can be adjusted by pressing FUNC, then E or F.

ATTACHMENT 3

Pre-Sampling Activities Before Use of the Pro XRS DGPS Unit

Determination of Optimal Satellite-Use Time

Positioning accuracies on the order of $\pm 1-3$ m can be achieved by avoiding the few minutes per day when the satellites are not providing the same level of signal. The GPS provides the operator with a listing of the time intervals during the day when accuracies are decreased. Avoidance of these time intervals using Trimble's Mission Planning software permits the operator to maintain better positioning accuracy.

Mission Planning

Trimble's Planning software is a stand-alone software tool supporting any form of analysis to determine visibility for GPS and geostationary satellites. It can be downloaded for free at:

http://www.trimble.com/planningsoftware_ts.asp

The location can be picked from a list of cities from all over the world, select a location from the world map or type in the local WGS84 position to do more precise mission planning.

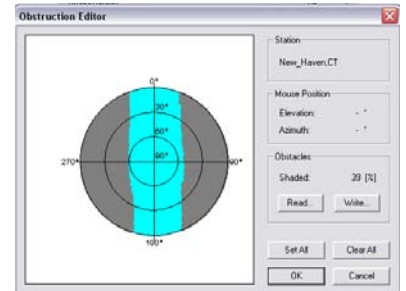
- Put in multiple station locations to determine the best time to observe these stations simultaneously.
- Get detailed sky plots (including obstructions) of the site for any time of the day to aid in determining the best available occupation times.
- Chart out the different DOP values by time
- Get a quick overview on the number of satellites available for the site, for any time of the day.

Using the Mission Planning Software

1. First, download the latest version of the Trimble Planning Software from the web site listed above. Be sure to download the latest Ephemeris file from the same page.
2. Install the software to a computer on which you have the appropriate permissions.
3. Start the Trimble Planning Software.
4. On the Main Menu, go to Almanac > Import > SSF...
5. Browse through the same folder where the Ephemeris file was saved. Select it and click Open.

Setting the GPS Survey Parameters

1. On the Main Menu, go to File>Station.
2. Click on the City name button to open the City Selector.
There are a number of options for selecting the area to survey. Depending upon the area to be surveyed, it may be more appropriate to manually enter Latitude/Longitude coordinates, or to use the Map Button to search for a station visually.
3. Select the city that is closest to the area to where the survey will be conducted.
4. If there are significant obstacles that will be confronted in the survey, click on the obstacles button and use the Obstruction Editor to define any obstructions that will be a factor in the survey (will the survey be in a canyon, the shadow of a mountain, etc?...).
5. Define the starting date/time and duration of the survey work.
6. Set the time zone for report format

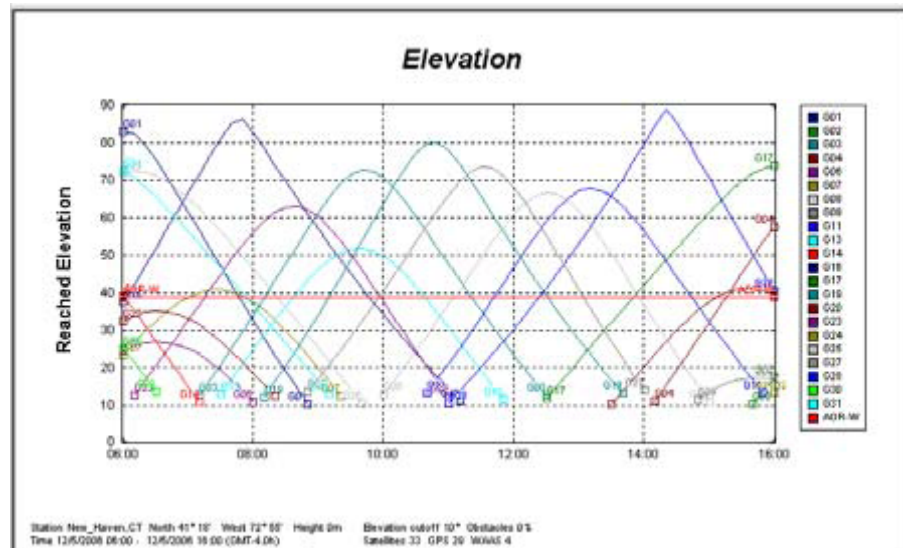


Creating Planning Graphs

Once the survey parameters have been entered use the Toolbar to produce all the graphs created by the planning survey.

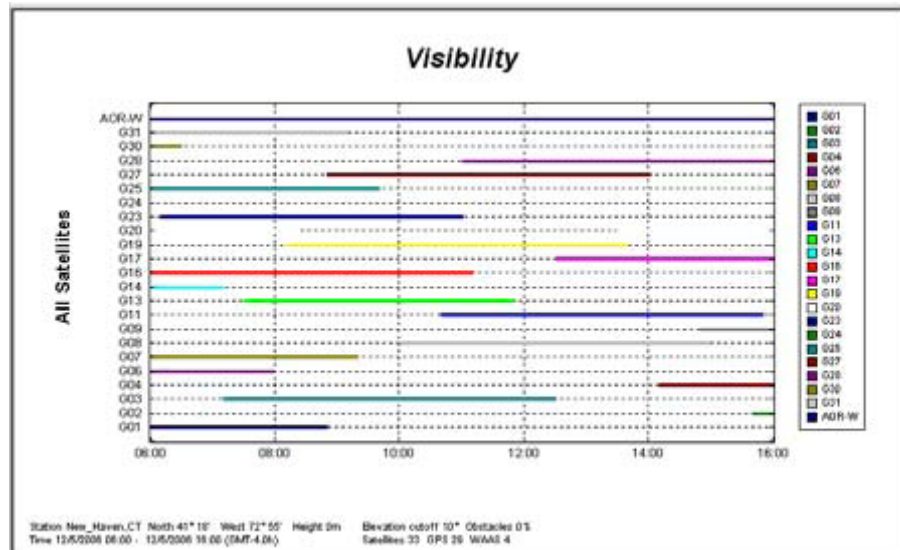
Elevation Graphs

The elevation graph will show satellites at very low elevations that do not significantly contribute to positioning calculations because of atmospheric interferences. It will also show the elevation in the sky for each satellite visible by the GPS receiver in the area across the time period defined. Note that this graph may be the most important for planning surveys in vertically developed urban environments.



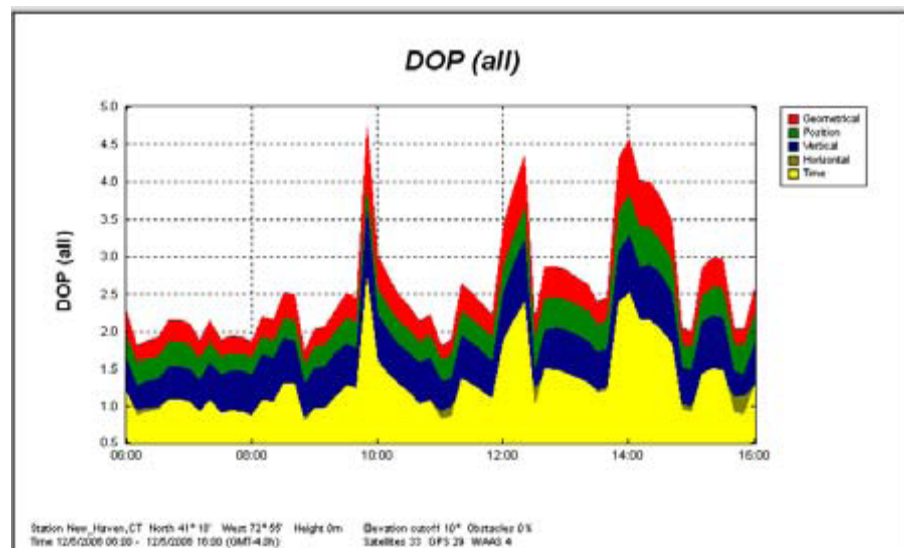
Visibility Graphs

This graph displays the visibility of satellites as a function of time.



DOP Graphs

Dilution of Precision (DOP) maps shows the satellite signal quality in relation to the number of satellites and their position in the sky and relative to each other. The lower the DOP value the better signal quality and the higher the positioning precision. This map is probably the best to use for a survey planning.



ATTACHMENT 4

Managing GPS Data from TerraSync—A Tutorial

Introduction

Currently, positional data collected in the field is most often done with a Trimble GPS unit (see Integral's equipment list at the beginning of the SOP-AP6) interfaced with a laptop via Trimble's TerraSync software. This short tutorial is meant to serve as a guide to field personnel who need to understand how to retrieve and collect geographic data in the most efficient way possible with existing software.

Scope

This document is intended to be a reference for procedures involving:

- 1) Fixing files containing target stations that are more than 7 days old so that they can be updated
- 2) Adding features in GPS Pathfinder software (companion to TerraSync) and then importing them as base files in TerraSync.

This document is **not** intended to be a comprehensive manual for using Terrasync or Pathfinder software. It is assumed that the reader has received at least some training on how to use the basic features of Terrasync and is comfortable using MS Windows.

The Basics

GPS data collection at Integral currently utilized two pieces of complementary software: Terrasync – the interface for GPS navigation and data collection; and Pathfinder Office – a multi-use piece of software that acts as a conduit between GIS data files (shape files) and Terrasync GPS files. Pathfinder can also be used as a simple map editor in a pinch.

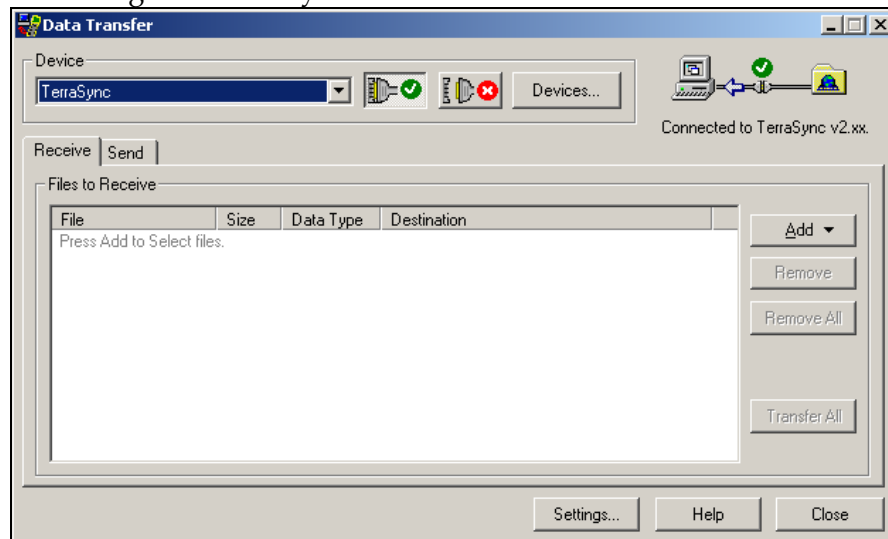
Installing the Correct Versions of Terrasync and Pathfinder

**** Important note *** : This tutorial uses Pathfinder Office version 4.00 and TerraSync version 3.05. It is very important to use the proper versions of this software due to compatibility issues. Licenses for TerraSync are reserved to one per computer or handheld GPS device. A floating license is available for Pathfinder Office and can be installed in several office computers .Please obtain installation instructions from GIS staff.*

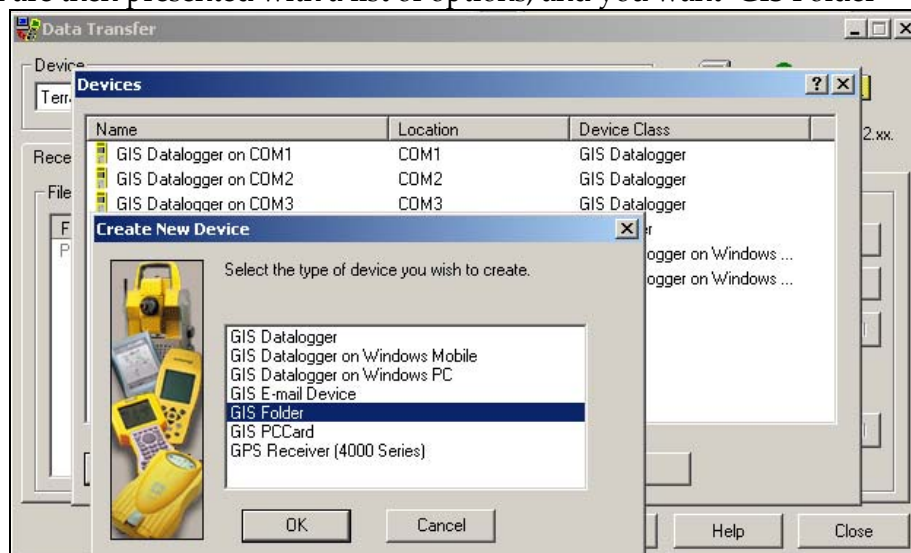
Initial Setup of TerraSync and Pathfinder Office

There are certain settings and configuration setups that are needed before Pathfinder Office can talk to Terrasync. Whether you are newly installing this software or have an existing installation, it is good to check to make sure these settings are in place.

1. Open Pathfinder Office and go to the **>Utilities>Data Transfer...** menu. A dialog box similar to Figure 1 should greet you. This is the interface for communicating with Terrasync.

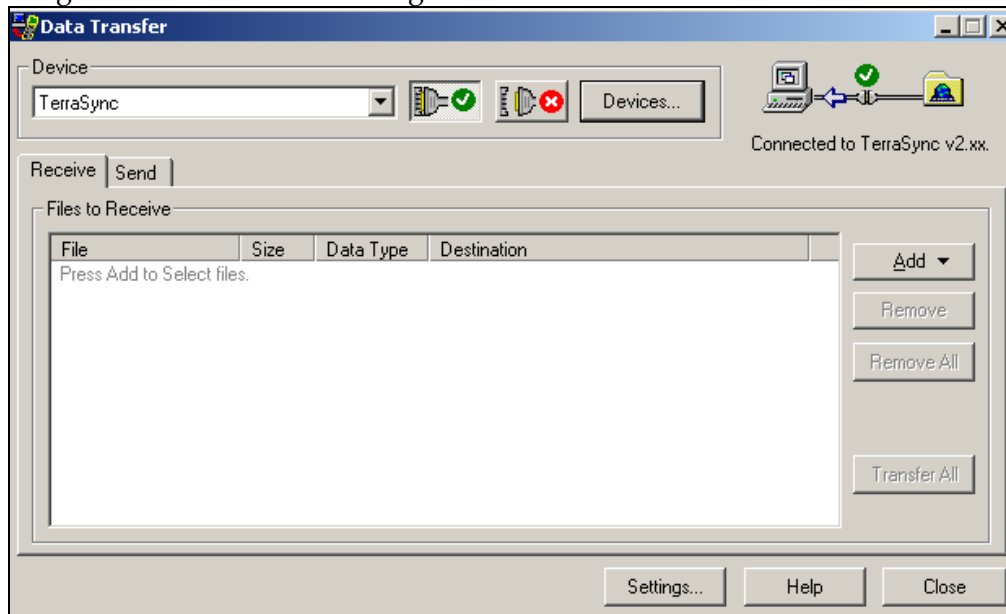


2. Click the **Devices** button, and then **New...**
3. You are then presented with a list of options, and you want 'GIS Folder'



4. Browse to the Terrasync data folder on your computer, which in most cases will be **C:\My Documents\TerraSync**
5. In the next box, 'Type' will be **TerraSync**, and 'Version' will be **v. 3.05**.

6. The next box prompts you for a name that will display in the device list. Shorten it to simply say **TerraSync**.
7. Now you should be able to go back to the Data Transfer dialog box, select TerraSync from the dropdown menu, press the 'connect' icon, and get a rewarding green check mark indicating success.



If this procedure does not work for you, it is likely that you have the wrong version of Pathfinder or TerraSync. For some reason, with each version upgrade of Pathfinder, connectivity to older versions of Terrasync is lost. You can check what version of Pathfinder you have installed by going to the **>Help>About GPS Pathfinder Office...** menu. To find out what version of Terrasync you have, you need to go to **C:\Program Files\TerraSync**, right-click on TerraSync.exe, and choose the version tab.

Common Issues

Handling Expired Files in Terrasync

One of the most common things that field personnel will have to deal with is the one week expiration date when trying to collect data with Terrasync (Figure 1). This is a safety feature of Terrasync to prevent too many days of logged in data being saved in a single file, and unfortunately there is no solution that we know of. The following instructions will guide you through the process to make the files useable.

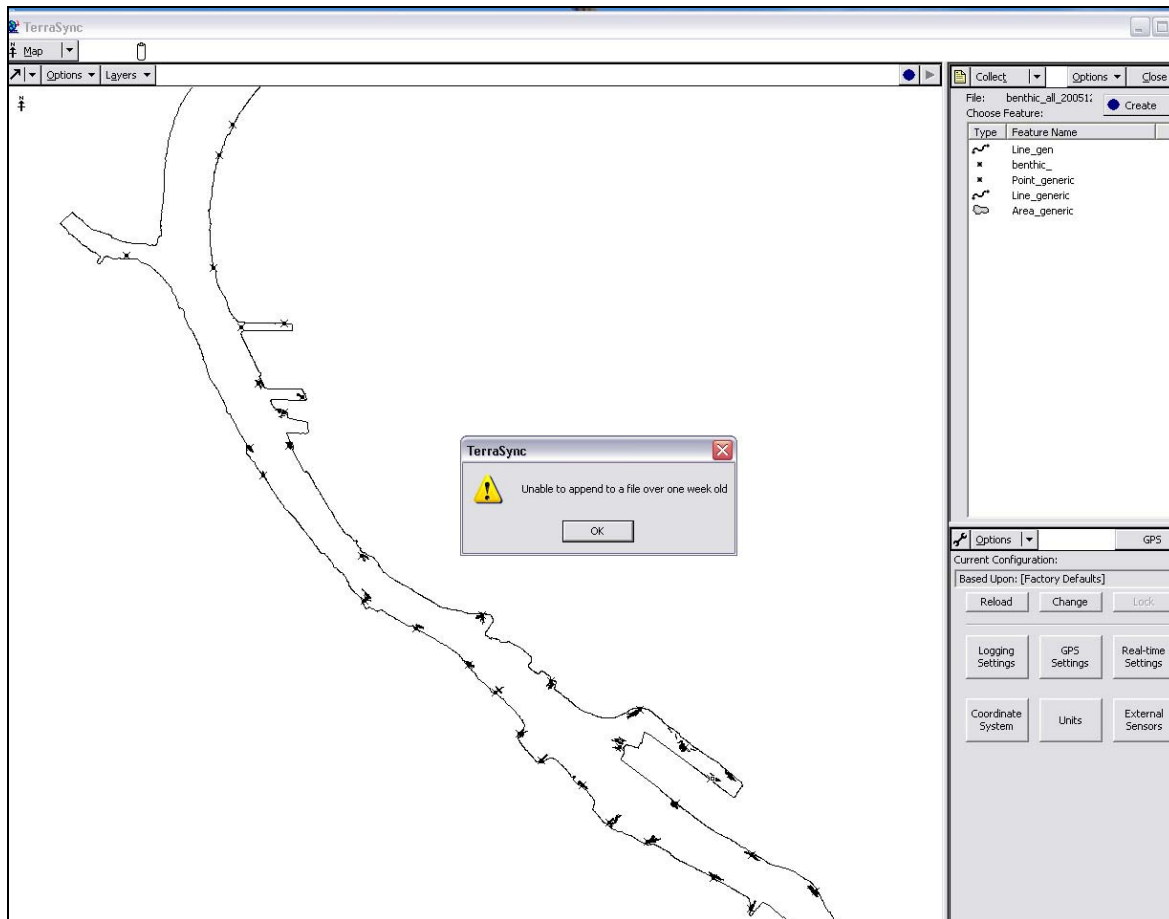


Figure 1: TerraSync file that is over one week old will not allow user to collect features. Note, the clock starts ticking when you collect your first feature in the field (not when the file was created)

Basically, there are two options depending on your needs. If you don't need to see your previously logged locations and just need to see the targets, you can use the original files provided by GIS staff (option 1). If you need to see previously occupied locations in order to make decisions about where to go next, then you will need to transfer the file to Pathfinder and back again (option 2).

- Option 1: Move and replace logged files with original targets.

At the beginning of the field effort, you should receive a set of files with your target locations, most likely in a zip archive (.zip file extension). There will be six to eight files with the same name but with different extensions (see Figure 2).

These files will have to go into the C:\My Documents\TerraSync\ folder in order to be available to Terrasync.

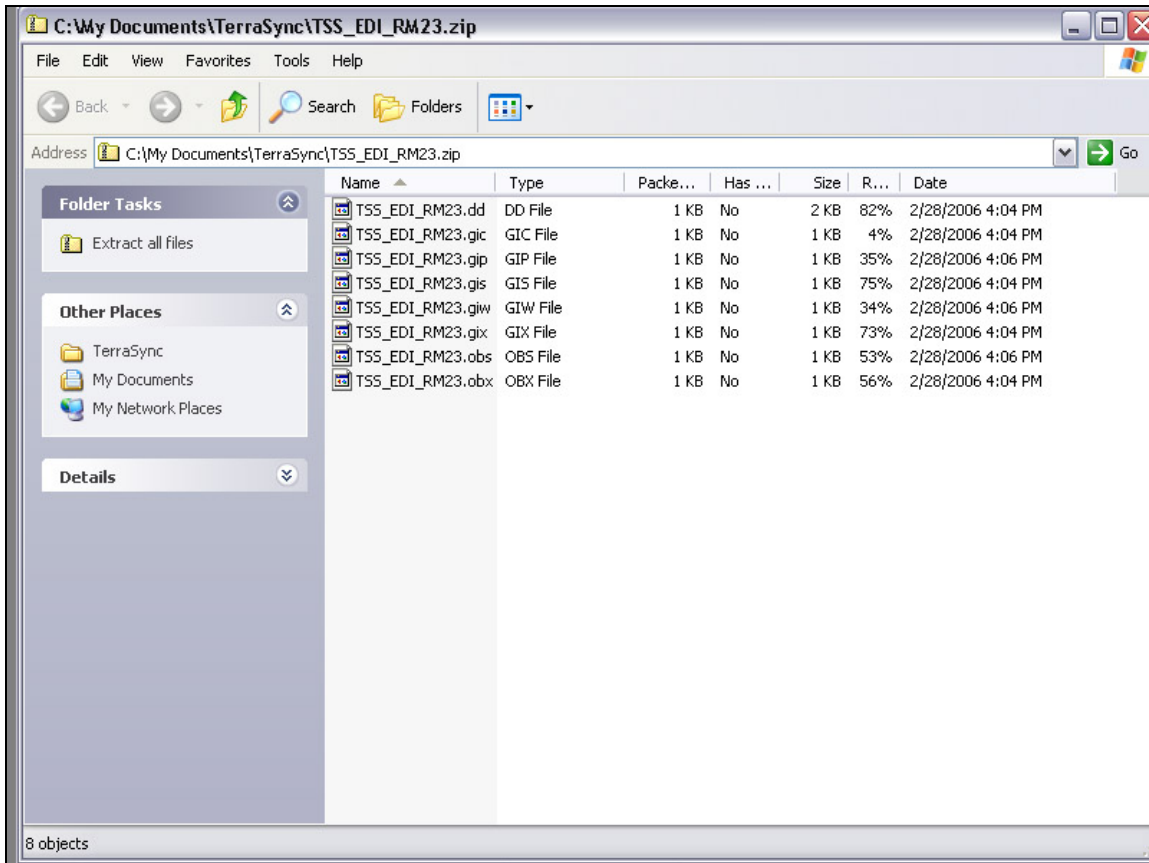


Figure 2: Example of file set to be unzipped into the TerraSync folder.

After you unzip these files to Terrasync, keep this zip archive around in an easy to find place (i.e. the Desktop or project GPS folder). The reason for this is that the one week clock does not start ticking until you begin collecting your first point in the field. Therefore, you can use this unadulterated file again, so long as you make a copy of the work you did the previous week. Here are the detailed steps to take:

1. Make sure you have the original files with the target locations available in a handy place. This will probably be the original zip archive. Also, **be sure to close TerraSync** while performing this process.
2. Navigate to C:\My Documents\TerraSync\ in Windows Explorer. Locate the files that you have been using the previous week. Make sure to get all the little files associated with the dataset. Note, that while it is useful to sort the files by

date modified, you can miss some of the little files – it is highly recommended that you sort the files alphabetically.

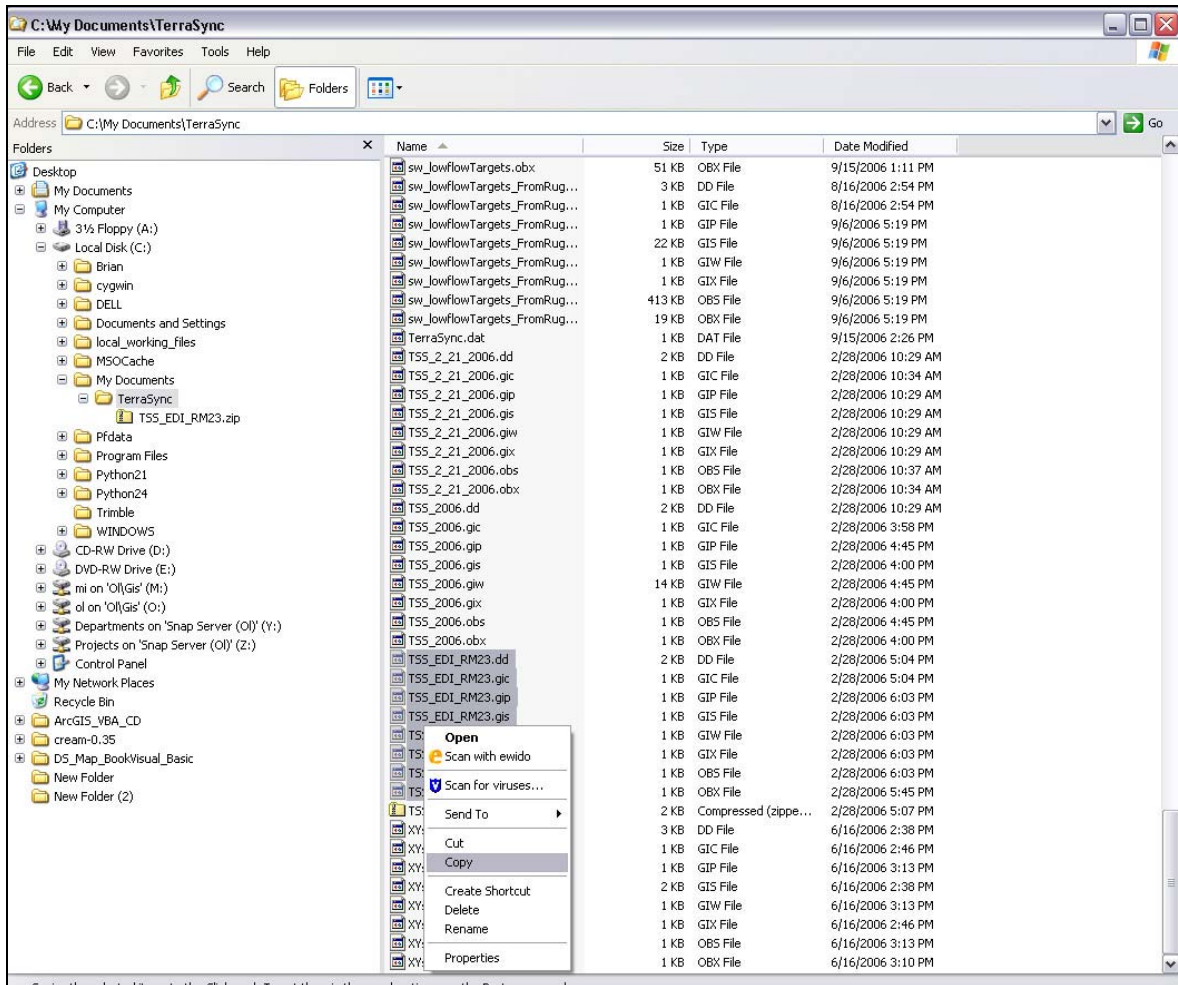


Figure 3: Selecting files to copy to a different directory

3. Copy all of these files to a different directory, preferably one that is named appropriately to reflect the data and time period that you were collecting. For example C:\Documents and Settings\bpointer\Desktop\lampreyTargets_20060925. These files contain the data you have collected the previous week and should be backed up and/or emailed to the appropriate project manager or GIS staff.
4. First, make sure you have made a copy of the original files. You can now safely replace the files you just copied with the ones from the original zip file. Simply right-click the zip archive, click “Extract All...”, and when prompted to “Select a folder to extract files to”, browse to C:\My

Documents\TerraSync. If prompted about replacing existing files, select yes to all.

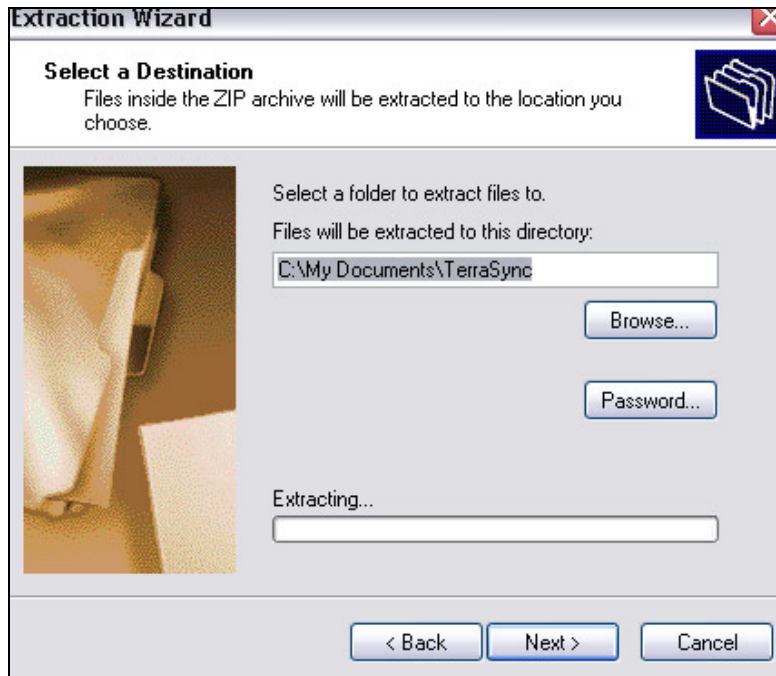


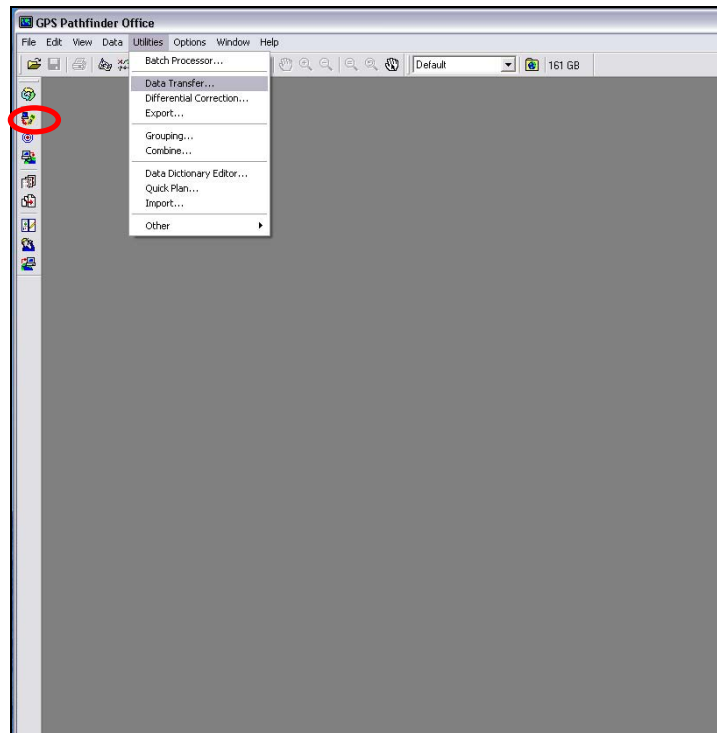
Figure 4: Extract (or copy) original target files into the TerraSync directory.

5. You should now be able to open the file in TerraSync and begin logging as normal.

- **Option 2: Transfer files back and forth from TerraSync.**

If you need to be able to see the previously occupied positions from last week while positioning this week, you need to use Pathfinder to reset the file. This process will essentially combine the targets and actuals from last week into one file. This has it's drawbacks though – once converted the actuals from last week will not be able to be corrected, so a backup procedure similar to the one in the previous option should be carried out to maintain data integrity. Here are the details.

1. For good data management, please backup the data files from the previous week using the procedure laid out in steps 1-3 in Option 1 above.
2. Close TerraSync and open up Pathfinder Office.
3. Go to the >Utilities>Data Transfer menu or just click the icon on the left.



4. Ensure that the device listed is TerraSync. If not, follow the initial setup instructions at the beginning of this document. Most of the computers used for GPS logging are already setup for this.

There are two tabs, Receive and Send. Make sure that Receive is selected and then go to Add>Data File. Select the file(s) that you are using and select Open. The file should now be in the "Files to Receive" box. Click Transfer All and wait for the transfer to take place. If you have made the recommended backups, it is fine to replace any files.

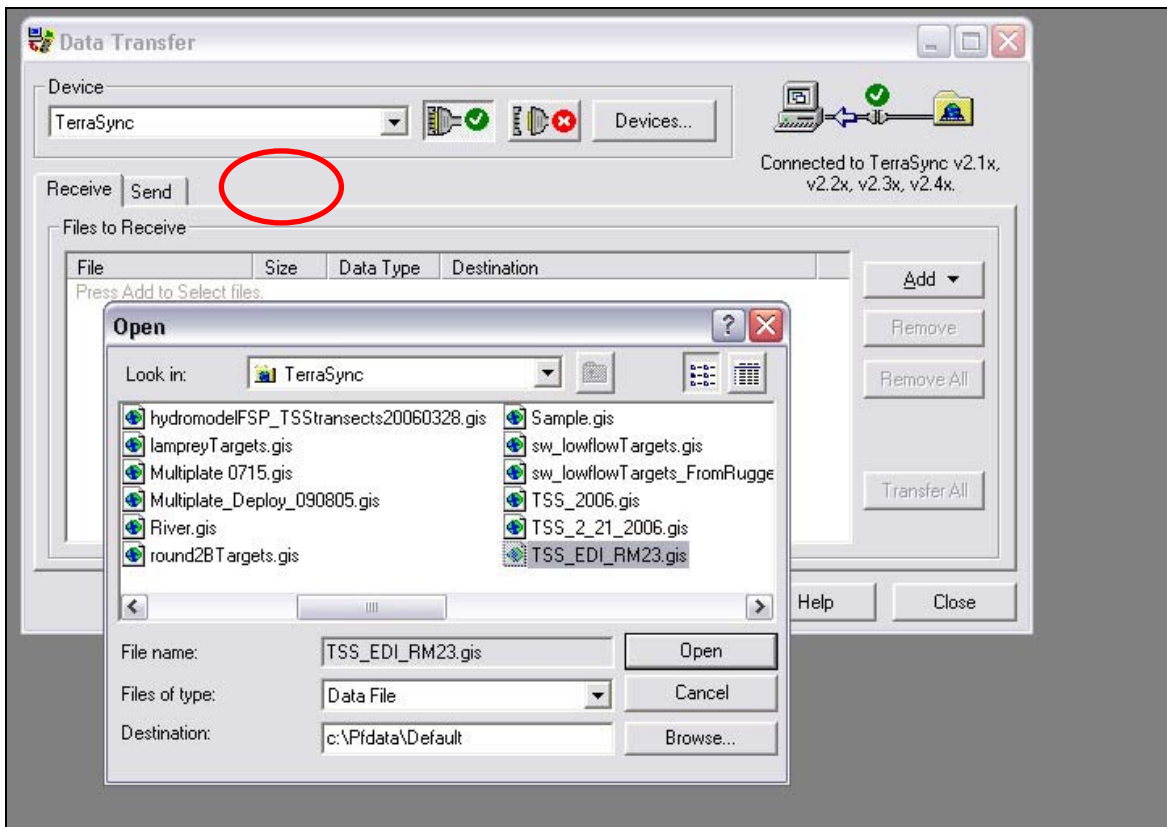
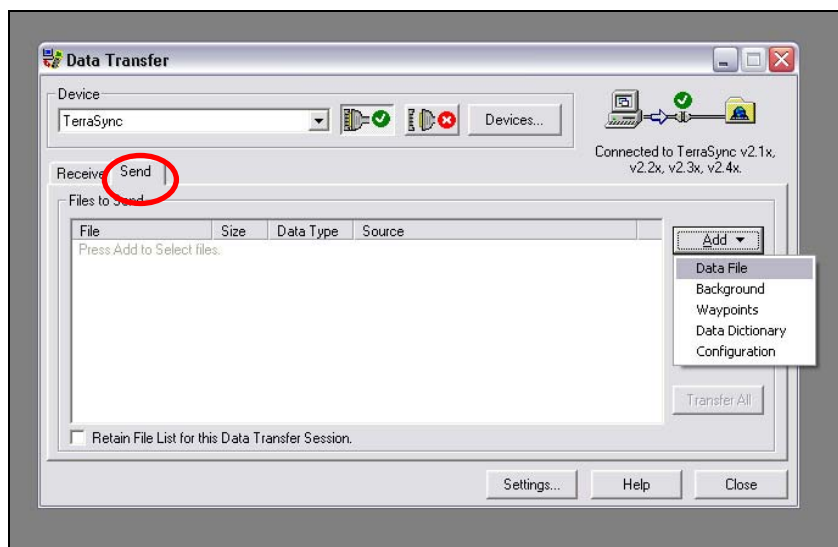


Figure 5: Transferring file from TerraSync.

5. Now select the Send tab, and go to Add>Data File. Select the file you just transferred (it will have the same name as the TerraSync file) and click Open. Now click Transfer All to move the file back to TerraSync.



By transferring the file back and forth from Terrasync to Pathfinder you have “reset the clock” and you may now update the file for an additional 7 days. This file will have your targets and actual positions from the last week, so it is important to be aware of the features you are selecting for navigation.

STANDARD OPERATING PROCEDURE SOP-SW1

DECONTAMINATION OF SURFACE WATER SAMPLING EQUIPMENT

This SOP defines and standardizes the methods for decontamination of field sampling equipment for the collection of surface water samples to ensure sample integrity and minimize contamination during sample handling.

This SOP utilizes and augments the procedures outlined in the in the San Francisco Estuary Institute's *Field Sampling Manual for the Regional Monitoring Program for Trace Substances* (David et al. 2001), *Interagency Field Manual for the Collection of Water-Quality Data* (USGS variously dated) and U.S. Environmental Protection Agency (EPA) Method 1669, *Sampling Ambient Water for Trace Metals at EPA Water Quality Criteria Levels* (USEPA 1996), and *Standard Operating Procedure for Mercury Analysis* (Mason and Sullivan 1996). Clean sampling techniques designed for trace metals will be used for the collection of filtered and unfiltered water samples.

Samples may be analyzed for organic compounds, metals, nutrients and conventionals for the surface water sampling events, according to the project-specific sampling and analysis plan (SAP).

Scope and Application

To prevent potential cross-contamination of samples, all reusable surface water sampling equipment will be decontaminated before each use. Decontamination of field sampling equipment can be done in the field or in a commercial laboratory. Depending on the level of project complexity and if low analytical reporting limits are required (see project-specific SAP), then sampling equipment must be decontaminated at a qualified laboratory. It is strongly discouraged to decontaminate sampling equipment in the field due to the high risk of contamination. Thorough decontamination procedures should be done under controlled conditions at the laboratory. However, certain decontamination steps are necessary to be performed in the field.

A decontamination station can be set up onsite in a clean location, or decontamination can be done in the field office, under a laboratory hood if available. Decontaminated equipment will be stored away from contaminated areas and in a manner that will prevent recontamination prior to use.

When handling decontamination chemicals, field personnel will follow all relevant procedures outlined in the site-specific health and safety plan.

Equipment and Reagents Required

Equipment required for decontamination includes one or more of the following, depending on the target analyte and sampling equipment:

- Plastic brushes with rigid bristles
- Properly labeled squirt bottles
- 5-gal plastic bucket
- 30L polyethylene bags
- Tap water
- Alconox®, Liquinox® detergent or equivalent
- Pesticide-grade decontamination solvents (e.g., ethanol and methanol according to the project-specific sampling and analysis plan [SAP], as the solvents may vary by EPA region or state)
- Nitric acid (5 percent)
- Hydrochloric acid (0.05 and 10 percent) if nutrients are being analyzed
- DI water (analyte-free; received from testing laboratory)
- Sealable waste container equipped with a funnel
- 1-gal sealable plastic bags
- 2.5-L amber glass bottles for organic waste storage.

Laboratory Decontamination Procedures

Decontamination methods vary depending on whether the sampling equipment is used for collecting samples to be analyzed for conventional analytes, organic chemicals, or trace metals. Each participating laboratory is responsible for preparing the equipment prior to the sampling cruise. Pre-designated commercial laboratories will decontaminate sample tubing, mixing containers, and sample collection bottles according to steps described below. Additional field equipment will be cleaned and decontaminated by Integral, as described below.

Conventional Analytes and First Time Use

The following procedure should be used when sampling for conventional analytes such as chloride, sulfate, sodium, and calcium. It should also be used for new equipment and for equipment that is being used for the first time at a site. Conventional analytes have the simplest decontamination procedure because they tend to be very soluble in water and detergent solutions, and do not tend to sorb significantly to the surface of the sampling

equipment. For sampling in lake water at different depths at the same location, equipment needs only to be rinsed three times with site water between stations following an initial decontamination. Similarly for rivers where stations are close together, spatially and temporally, only a site-water rinse is necessary. However, some projects may dictate that decontamination be performed at every single sampling cast. For example, water samples collected at three locations within a near-bottom transect may require decontamination of a Go-Flo™ bottle between locations.

1. Rinse the equipment thoroughly with tap water.
2. Pour a small amount of Liquinox® (or similar product) into a 5-gal bucket and fill it with tap water. Using a plastic brush with rigid bristles, scrub each piece in the detergent solution.
3. Rinse the equipment with tap water to remove all detergent (some detergents contain surfactants that are analytes) and set aside to drain.
4. Rinse the equipment three times with site water immediately prior to collecting the sample.

Summary of Method for Decontamination of Peristaltic Pump Equipment

Preparation of the Teflon™ sample tubing will be completed in the laboratory 3-4 weeks before the start of a sampling event. All sample tubing, filters and containers will be decontaminated, pre-assembled and packed for the field in double bagged polyethylene bags.

Decontamination of tubing, filters, stir bars, and containers consists of soaking the sampling equipment in cleaning solutions for a pre-determined amount of time and then rinsing it with DI water. A peristaltic pump is used to fill the Teflon™ sample tubing with cleaning solutions and to flush with DI water between cleanings. In similar fashion, sampling filters are also attached in series with C-flex™ tubing, filled with cleaning solutions and flushed with DI water between cleanings. The Teflon™ tubing ends and in-line filters are joined together with C-flex™ tubing for transport to the field.

Procedures

The procedure that will be used for each type of sampling equipment is provided below. Selected equipment (e.g., tubing) will be used for collection of all target parameters. However, selected equipment (containers, filter units) will be processed separately for metals and organics.

Teflon™ and C-Flex™ Pump Tubing and Teflon™ Coated Stir Bars for Intake Water

The Teflon™ and C-Flex™ tubing used for the intake of site water and Teflon coated stir bars used in the containers will be cleaned for all target parameters. Cleaning procedures are as follows:

- Completely fill sample tubing with reagent grade methanol and let it soak for 24 hours.
- Soak the appropriate number of stir bars in reagent grade methanol for 24 hours.
- Drain methanol solution from the tubing and stir bars and flush with approximately 10 liters (L) of DI water.
- Completely fill sample tubing with dilute reagent grade hydrochloric acid (HCl) and let soak for 24 hours. Soak the appropriate number of stir bars in reagent grade HCl for 24 hours.
- Drain acid and flush tubing and stir bars with DI water. Fill tubing with DI water, and soak stir bars with DI water and let set for 24 hours.
- Double bag clean tubing and stir bars, label outside bag identifying cleaning process used, and store in double-bagged polyethylene bags until assembly.

Teflon™ and C-Flex™ Pump Tubing From Filtration Units to Sample Jars

The Teflon™ and C-Flex™ tubing used from the filtration units to the sample jars will be cleaned for metals or for organic and conventional parameters, as described below:

Metals, Nutrients, and Conventional Analysis

- Completely fill sample tubing with dilute reagent grade HCl and let soak for 24 hours.
- Drain acid and flush tubing with DI water, fill with DI water, and let set for 24 hours. Drain, rinse with DI water, and drain.
- Double bag clean tubing, label outside bag identifying cleaning process used, and store in double-bagged polyethylene bags until assembly.

Organic Analysis

- Completely fill sample tubing with reagent grade methanol and let it soak for 24 hours.
- Drain methanol solution from the tubing and flush with approximately 10 L of DI water.
- Double bag clean tubing, label outside bag identifying cleaning process used, and store in double-bagged polyethylene bags until assembly.

Filter Cartridges

The 0.45 µm Teflon™ filter cartridges will be used for the collection of dissolved trace metal samples and DOC in water. The following procedures are used for cleaning the 0.45 µm filter cartridges for metals, DOC, and conventionals:

- The 0.45 µm Teflon™ filters are hydrophobic and need to be “wetted” with methanol prior to rinsing with a water-based solution.
- Pump methanol through the filter unit to wet the filter
- Drain the methanol and flush the filter with DI water for approximately 10 minutes
- Fill the filter unit with dilute HCl and allow it to soak for 24 hours
- Drain the acid and flush with DI water.
- Fill the unit with DI water and allow to soak for 24 hours
- Followed by a series of draining and rinsing procedures with DI water, the filter units are dried in a laminar flow hood and double-bagged in polyethylene bags.

Glass and Polycarbonate 10 - 20 Liter Containers

The glass and polycarbonate containers will be used to composite the sample prior to distribution to the sample containers. The cleaning procedure for metals and for organic and conventional parameters is described below:

Polycarbonate Container (metals, nutrients and conventionals)

- Half-fill the container with dilute reagent-grade HCl. Secure the lid and place the container on its side for 12 hours
- Rotate the container to the other side for an additional 12 hours
- Drain the acid and rinse with DI water
- Drain the DI water and let it dry in a laminar flow hood
- Double-bag the polycarbonate container in polyethylene bags.

Glass Container (organics)

- Rinse the glass container three times with methanol using a squeeze bottle and thoroughly coat all inner surfaces
- Drain the methanol and rinse with DI water

- Drain the DI water and let it dry in a laminar flow hood
- Double-bag the glass container in polyethylene bags.

Assembly

After all the components have been cleaned, the peristaltic pump collection and filtration units will be assembled by the laboratory performing the sample equipment decontamination. The assembled units will be double-bagged in polyethylene bags, labeled for identification on the outside bag, and sent to the field laboratory.

Laboratory and Decontamination Blanks

Laboratory and decontamination blanks will be collected for each sampling event. A cooler will be sent to the laboratory performing the decontamination with pre-labeled bottles, along with chain-of-custody forms, custody seals, and a temperature blank. The two types of blanks are described below.

- **Laboratory Blank**. A laboratory blank is a sample of analyte-free water that is supplied by the laboratory. The laboratory blank is generated by transferring the analyte-free water to another laboratory-supplied sample container. Laboratory blank results are used to measure and document any possible laboratory contamination.
- **Decontamination Blank**. Prior to the start of sample collection activities for each sampling event, a decontamination blank will be generated by the laboratory that conducts decontamination of the peristaltic pump sampling equipment (i.e. containers, filters, tubing and tubing connectors) to ensure that the decontamination procedure is adequate.

The blanks will then be sent back to the analytical laboratory for analyses of all pertinent target analytes within 1-2 days of collection. Samples must be received by the laboratory at or around $4 \pm 2^{\circ}\text{C}$.

Organic Chemicals

The following procedures should be used for decontaminating equipment (e.g., Go-Flo™ sampler) used to collect surface water samples that will be analyzed for organic chemicals. Two organic solvents are used in the procedure, the first is miscible with water (e.g., ethanol) and is intended to scavenge water from the surface of the sampling equipment and allow the equipment to dry quickly. Make sure that the solvent ordered is anhydrous or has a very low water content (i.e., < 1 percent). The second organic solvent is hydrophobic (e.g., methanol) and is intended to dissolve any organic chemicals that are on the surface of the equipment.

The exact solvents used for a given project may vary by EPA region or state (see project specific SAP). The choice of solvents is also dependent on the kind of material the equipment is made from (e.g., acetone cannot be used on polycarbonate), and the ambient temperature (e.g., hexane is too volatile in hot climates). In addition, although methanol and hexane are sometimes slightly more effective than other solvents, their use is discouraged because of toxicity to sampling personnel.

1. Rinse the equipment thoroughly with tap or site water.
2. Pour a small amount of Liquinox® (or similar product) into a 5-gal bucket and fill it with tap or site water. Using a plastic brush with rigid bristles, scrub each piece in the detergent solution.
3. Rinse the equipment with tap or site water and set aside to drain.
4. Rinse the equipment with ethanol dispensed from a squirt bottle and let the excess solvent drain into a waste container equipped with a funnel (ethanol acts primarily as a drying agent, but also works as a solvent for some organic contamination). Rinse the inside of the sampling equipment that comes in contact with sample water. Set the equipment in a clean location and allow it to air dry. In cold temperatures it may take a long time for equipment to dry prior to using the second solvent. In this case it is important to remove all water from the surface by thoroughly rinsing with a more volatile solvent such as acetone. In hotter temperatures, a less volatile water solvent (e.g., isopropanol) can be used.
5. Rinse the air-dried equipment with methanol dispensed from a squirt bottle and let the excess solvent drain into the waste container. Methanol acts as the primary solvent, but it is insoluble with water. If water beading occurs, it means that the equipment was not thoroughly rinsed with ethanol or the equipment was not given sufficient time to dry completely. Rinse the inside of sampling equipment that comes in contact with site water. In hotter climates a less-volatile solvent such as methanol should be used. When the equipment has been thoroughly rinsed, set it in a clean location and allow the solvent to evaporate before storing or using it for sampling.
6. When not in use, close the solvent waste container and store in a secure area.
7. The waste should be transferred to empty solvent bottles and disposed of at a licensed facility.

Trace Metals

In addition to the following decontamination procedures, sampling personnel collecting water samples must be aware of other sources of contamination. Sources commonly encountered in the field include lead batteries used to power pumps, metal objects such as tools, and gasoline cans. As much as possible, these items should be removed from the sample collection area and the sampling equipment and collecting the samples should

avoid handling these items prior to sampling. Wear vinyl clean-room gloves (e.g., Oak class 100, powder free) when handling sampling equipment that will be used to collect surface water samples for trace metals analysis. Gloves should be discarded between stations or if materials known or likely to be contaminated come into contact with sampling personnel's gloves at a given station.

The following procedures should be used for decontaminating equipment used to collect surface water samples for trace metals (e.g., Teflon™ churn splitter, connectors and adapters made of Teflon™ or other similar material, and plastic stands used for holding sample tubing). This procedure is not intended for containers in which samples will be stored and/or shipped to the laboratory for analysis.

1. Rinse the equipment thoroughly with tap or site water.
2. Pour a small amount of Liquinox® (or similar product) into a 5-gal bucket and fill it with tap or site water. Using a plastic brush with rigid bristles, scrub each piece in the detergent solution. For bottles, fill them about half way with detergent solutions and shake for a few minutes. For tubing, pump the detergent solution through it for a few minutes. Small parts can be placed in large mouth jars that have tight lids and shaken with the detergent solution.
3. Rinse the equipment with tap water to remove all detergent (detergents will neutralize the nitric acid) and set aside to drain.
4. Surfaces of equipment that contacts water samples should be cleaned with 5 percent nitric acid solutions for at least ½ hour. Small items, such as Teflon™ water intakes, can be placed in plastic containers filled with 5 percent nitric acid. Sampling containers/bottles should be filled with 5 percent nitric acid solutions and allowed to stand. The containers should be located away from potential contamination sources and covered with lids.
5. Note: Replace nitric acid with hydrochloric acid if samples will be analyzed for nutrients.
6. Acid solution can be either pumped through or left static in tubing for the same duration.
7. Drain all equipment thoroughly and flush with at least three volumes of laboratory DI water (not DI water from the grocery store).
8. Drain thoroughly and flush with at least three volumes of site water before collecting sample.

Procedures Used to Decontaminate Sampling Diaphragm Pumps

The following procedure is for samples to be analyzed for trace metals and conventional analytes. Two types of pumps are commonly used for collecting water samples, peristaltic and diaphragm. For peristaltic pumps, only the tubing needs to be cleaned according to

the above procedure. It is best to have precleaned short lengths of tubing for each station when using the peristaltic pump. For diaphragm pumps, the procedure is as follows:

1. Using two short pieces of tube on the pump, place both ends in a 1-gal container with detergent solution and circulate the solution through the system for 2 minutes.
2. Purge the system with about 1 gal of laboratory DI water keeping the outflow tubing over a waste bucket. Do not recirculate this solution. Repeat the 1-gal DI purge.
3. Connect the two ends of the short tubes with a decontaminated plastic coupler and keep it sealed until sampling time.
4. When ready to sample, remove the short tubing protecting the inlet of the pump and connect the tubing used for sampling to the pump and purge the system with site water for 2 minutes, or with enough water volume to rinse the entire system (i.e. pump head and tubing) immediately before collecting the sample.

Procedures Used to Decontaminate Specific Depth Interval Samplers

If surface water samples are required from a specific depth, a standard Go-Flo™ sampler may be used.

CAUTION: Niskin and Kemerer discrete sampler bottles are to be avoided, as, under even the best of conditions they are often found to contaminate samples at the part-per-trillion level. In the event that deep sampling is required, the only discrete sampler which is known to be cleanable is the Teflon-coated, Go-Flo™ “(General Oceanics, FL) bottle. All metal components attached to the bottles must be coated with epoxy or silicone (CALFED 2000).

The following procedures should be used for decontaminating equipment used to collect surface water samples for trace metals analysis (Mason and Sullivan 1996). This procedure is not intended for containers in which samples will be stored and/or shipped to the laboratory for analysis.

Laboratory Preparation

1. Go-Flo™ bottle received from manufacturer
2. Test that all parts are in good working condition
3. Disassemble unit
4. Soap all parts with Liquinox®
5. DI rinse
6. Reassemble all parts
7. Soak entire bottle in dilute acid (0.05% HCl) including internal cavity for **one week** under clean room conditions

8. The ball valves are rotated periodically to ensure that all parts of the ball valve that could contact the sample water after the bottles are closed is cleaned.
9. DI rinse
10. DI soak for 6 hours and take a sample for “lab decon blank”
 - If no hits on blank – send it to the field for sampling
 - If hits – re-decontaminate and resample “lab decon blank”

[Note: All Go-Flo™ bottles decontaminated at the analytical laboratory must have acceptable blanks before being sent to the field for sampling.]
11. Cover Go-Flo™ bottles with polyethylene bags and place it in shipping container (i.e. wooden or plastic box)

Field Preparation

1. Go-Flo™ bottles received from the analytical laboratory will be ready for deployment.
2. Wear vinyl clean-room gloves (e.g., Oak class 100, powder free) when handling sampling equipment that will be used to collect surface water samples for trace metals analysis. Gloves should be discarded between stations or if materials known or likely to be contaminated come into contact with sampling personnel's gloves at a given station.

Onboard Decontamination of Go-Flo™ Bottles

Onboard decontamination will be performed every time a new station will be sampled. The onboard decontamination procedures must be done in a dedicated clean room area only.

1. Rinse inside bottles with dilute acid solution (0.05% HCl)
2. Rinse inside bottles with DI water three times
3. Rinse inside bottles with methanol and let the excess solvent drain into the waste container.
4. Rinse inside bottles with DI water three times
5. Close bottles and cover with polyethylene bags
6. Go-Flo™ bottles are stored in dedicated clean areas and will only be carried out on deck when ready for deployment.

Field Equipment Blank Sample Collection

1. Rinse inside bottles with dilute acid solution (0.05% HCl)
2. Rinse inside bottles with DI water three times
3. Rinse inside bottles with methanol and let the excess solvent drain into the waste container.
4. Rinse bottles with DI water three times

5. Soak bottles for at least 0.5 hour (period comparable to the deployment time before the sample water is decanted from the bottle) and sample DI water for “on board decon blank” [Note: This step may be done at the end of the day and sample collected the next morning.]
6. Send blank samples for analysis

The waste should be transferred to empty solvent bottles and disposed of at a licensed facility. When not in use, close the solvent waste container and store in a secure area.

The sample containers should be located away from potential contamination sources and covered with lids. Prior to filling the containers in which samples will be stored and/or shipped to the laboratory for analysis, flush the out-take nozzle with at least three volumes of site water before collecting sample.

References

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STANDARD OPERATING PROCEDURE SOP-SW4

SURFACE WATER SAMPLING USING A PERISTALTIC PUMP

Scope and Application

This SOP defines and standardizes the methods for collecting surface water samples from freshwater or marine environments using a peristaltic pump and Teflon™ tubing.

This SOP utilizes and augments the procedures outlined in the San Francisco Estuary Institute's *Field Sampling Manual for the Regional Monitoring Program for Trace Substances* (David et al. 2001), the *Interagency Field Manual for the Collection of Water-Quality Data* (USGS variously dated), and U.S. Environmental Protection Agency (EPA) Method 1669, *Sampling Ambient Water for Trace Metals at EPA Water Quality Criteria Levels* (USEPA 1996). A goal of this SOP is to ensure that the highest quality, most representative data be collected, and that these data are comparable to data collected by different programs that follow EPA guidelines.

While sampling filtered and unfiltered water for trace metals, trace clean sampling techniques will also be used for the collection of water for analyses of organic compounds and conventionals, such as total suspended solids, dissolved organic carbon, and total dissolved solids. By following this SOP, the collection of other samples besides trace metals guarantees a high level of sample integrity and minimizes contamination during sample handling.

Station Access

Prior to entering select areas such as private beaches, embayments or proximity to docks, it may be necessary to acquire property access permission from the landowner. Access permission must be acquired in advance of the sampling program and may require a written agreement.

Station Location

Near-bottom surface water samples must be collected in a manner that avoids resuspending sediments into the sample being collected or samples that will be collected

at other downstream stations. Therefore, care must be taken to avoid resuspending sediment into the water column. To avoid resuspended sediment interference in the sample being collected, stations should always be approached from downstream. Avoid sampling near eddies that may circulate water from the sampling location to upstream of the sampling location. To avoid interference from resuspended sediment at other stations, samples should be collected beginning with the most downstream station and continuing in an upstream direction.

Near-surface water samples must be collected at least six inches below the surface/air interface or surface water microlayer in order to avoid collecting non-representative compounds such as transient dust particles and thin oil films unless otherwise instructed.

Water samples should be collected in areas that are representative of the surface water body conditions. A station that is located away from immediate point sources (e.g., tributaries, and industrial and municipal effluents) is preferred for collecting surface water samples unless sampling is designed to assess these sources. Representative samples can usually be collected in portions of the surface water body that have a uniform cross-section and flow rate. Because mixing is influenced by turbulence and water velocity, the selection of a site immediately downstream of a riffle area (e.g., fast flow zone) will ensure good vertical mixing.

Tributaries should be sampled as near the mouth as is feasible. However, it is important to select the sample location taking into consideration the impact that the downstream receiving water body has on the tributary flow and sediments. The downstream body may affect the tributary by decreasing water velocity (causing suspended solids to settle) or by eddies (causing mixing of the two waters). The downstream water body may change the water quality (e.g., salinity), temperature, or turbidity in the tributary near its mouth. It is important to determine how far upstream the tributary is influenced by the downstream water body and then establish a sampling point with a reasonable distance upstream from that boundary.

Attention must be given to identifying intakes and outflows within lagoons or settling ponds, which may cause localized concentrations that are not representative of general conditions. Sample locations adjacent to structures (e.g., banks, piers) may also have biased characteristics as a result of flow or release of substances from the structure. These kinds of possible confounding factors should be noted in the field logbook. For ponds and lakes that may be vertically stratified, a multi-parameter water quality meter can be used to collect depth profiles throughout the water body to aid in the selection of appropriate sampling points and depths.

Summary of Method

Surface water samples for standard chemical and conventional analyses will be collected using a peristaltic pump with an extended sampling tube lowered to the desired depths (see project-specific sampling and analysis plan [SAP]). Two different kinds of sampling devices may be used to obtain the water samples depending upon the project-specific needs. The near-surface water polyvinyl chloride (PVC) sampling structure (water sampler) has a polyurethane-coated weight suspended from the bottom of the structure to maintain it in an upright position (Figure 1a).

A near-bottom water sampler has a weighted landing base designed to keep the sampling tube at a predetermined fixed distance from the bottom (e.g. 30 cm or 12 inches) and preventing the intake from coming in contact with the sediment (Figure 1b). Both types of water samplers keep the tubing intake pointing into the current with the help of a vane. The vane can be removed if the water is quiescent. Additional equipment, such as a multi probe or underwater video camera may be mounted on the PVC structure.

At each station, when either a near-surface or a near-bottom water sampler is deployed, the Teflon™ tubing will be attached to the vane with zip ties and the water intake will be placed approximately 10 feet away from the bow of the boat with the aid of an A-frame or davit. While keeping the boat facing the current, the water sampler unit will then be lowered to the appropriate depth with the help of a hydraulic or electric winch. Using a peristaltic pump, the outflow from the sampling tube is directed into either a polycarbonate (for inorganic analyses) or glass or stainless-steel (for organic analyses) composite mixing container (Figure 2). Equal volumes of water will be pumped into each large, pre-cleaned 10-liter or 20-liter mixing container (depending upon the project-specific needs) that is equipped with a Teflon™-coated magnetic stirring bar and placed over a magnetic stir table. The containers are used for mixing and compositing samples for subsequent chemical analysis.

Following sample compositing in the mixing container, appropriate sample bottles (see project-specific SAP) are filled using a second peristaltic pump, with the outflow directed into the sample bottle. If enough water volume is available, the sample bottle is held near the pump outlet, and the sample container is rinsed one or two times, the “rinsate” discarded, and then the sample bottle is filled. However, laboratory bottles already come pre-cleaned and this rinsing option is not mandatory if water volume is an issue. Field rinsate blanks are collected to assure that sampling containers are not a source of contaminants. If preservatives are present in the sample bottle, then the rinsing step is to be omitted. The sample containers are capped, labeled, and placed inside a cooler and stored at approximately $4^{\circ}\pm 2^{\circ}\text{C}$.

Two types of surface water samples may be collected: unfiltered and filtered. For filtered metals and dissolved organic carbon samples, the 0.45- μ m filter (or project-specific pore size filter; see project-specific SAP) is placed inline near the tubing outlet to filter samples immediately before the water is discharged into the sample bottle (Figure 2). Samples for total suspended solids (TSS) and total dissolved solids (TDS) are generally filtered at the laboratory (see project-specific SAP).

Surface water collected at horizontally integrated near-surface and near-bottom stations will be composited by collecting water using the same technique described above.

Equipment and Reagents Required

The general types of equipment that are required are described in this section. A detailed supply and equipment list is provided in Attachment 1 to this SOP. Additional equipment may be required depending upon project-specific needs.

One or two peristaltic pumps will be used at each sampling station (near-surface and near-bottom) for collecting surface water samples. The same pump that is used to fill the mixing containers will be used to collect unfiltered and filtered split samples from the mixing containers. A sample processing and preservation chamber (i.e., workbox) made of PVC pipes and 6-mil plastic sheeting is used to house stir plate(s), a peristaltic pump, sampling bottles and ancillary equipment. A polycarbonate, glass, or stainless-steel mixing container (10 or 20-liters) is placed on the stir plate. Each mixing container is equipped with a 3-inch-long TeflonTM-coated stir bar at the bottom and a lid containing an inflow, outflow, and vent TeflonTM spouts (Figure 2). For each sampling station, a filtering kit (laboratory pre-cleaned 0.45- μ m filter with C-FlexTM and TeflonTM tubing placed in a double ZiplocTM bag) is assembled and attached to a peristaltic pump and mixing containers. A pre-cleaned 10- μ m pre-filter may be attached in-line to prolong the filtering capacity of the 0.45- μ m filter.

- Peristaltic pump
- Surface water parameter multi-meter capable of measuring pH, reduction/oxidation (redox) potential, temperature, specific conductance, turbidity, and dissolved oxygen
- PVC pipes and plastic sheeting
- Polycarbonate (inorganic analyses) and/or glass or stainless-steel (organic analyses) mixing containers (see project-specific SAP for analyte list)
- Sample tubing (type and length are site dependent)
- Stir plate with TeflonTM-coated stir bar

- 0.45-µm filter with C-Flex™ and Teflon™ tubing (if needed; see project-specific SAP to determine if filtered samples are required)
- Water Sampling Log forms
- Sample tags/labels and appropriate documentation (e.g., chain-of-custody forms)
- Insulated cooler(s), chain-of-custody seals, Ziploc® bags
- Sample containers with preservative, coolers, and blue ice or equivalent.

Procedures

The sampling team should be comprised of three people. Two persons are needed to conduct the sampling and a third person is required to keep track of sample logging and sample processing. In addition, the third person may be responsible for collecting the surface water quality parameters.

Equipment Preparation

A sufficient amount of decontaminated sampling tubing and filtering kits will be brought to the field to avoid performing decontamination procedures between stations. Each participating laboratory is responsible for preparing their equipment prior to the sampling cruise. Pre-designated commercial laboratories will decontaminate sample tubing, mixing containers, and sampling bottles according to their specific SOPs.

Decontamination of large amounts of sampling equipment require several days, if not weeks to be ready for sampling. Contract agreements with commercial laboratories and scheduling decontamination work may require several weeks to months. This is a critical step that needs to be initiated as soon as possible.

The main components of the peristaltic pump sample collection system are as follows:

- **Processing and Preservation Chamber**—A workbox is built with ¾-inch PVC tubing and covered with a 6-mil plastic sheet in order to contain the peristaltic pump sampling equipment and conduct the subsampling from the carboys. One side of the workbox is left open for placing sampling equipment and sample containers. All components are washed with Alconox™, tap-water rinsed. Stands and clamps used to secure the receiving Teflon™ tubing and filter cartridge are made of non-metallic components or resin-coated stainless steel and will be soap washed, tap-water rinsed, acid washed, and distilled/deionized water (DI) rinsed.

- **Water Sampler**—The water sampler device for near-surface sampling is made of PVC tubing with a polyurethane-coated 50 lb weight at the bottom to keep the sampler in the vertical position (Figure 1a) (Note: To reduce the potential drag at the water surface, a base is not included on the near-surface sampling device.) The near-bottom sampling device is also made of PVC tubing and has a polypropylene vane, which is constructed with a weighted base (Figure 1b). Both of these sampling devices are attached to the boat by a Technora™ or Kevlar™ rope. Figure 1b shows the sampling device with a YSI water quality multi meter and underwater camera attached to it. Figure 1b also shows how the Teflon™ tubing is positioned on the vane and the relationship of the inlet to the water sampler. The vane works to keep the water intake into the flow and elevated at a constant height from the bottom. Prior to commencement of sampling activities, all components will be washed with Alconox™ and tap-water rinsed,.
- **Water Quality Meter**—A YSI 650/6600 multi-probe (newer model or similar) will be used for measuring surface water parameters, such as temperature, pH, dissolved oxygen (DO), conductivity, oxidation-reduction potential (ORP) and turbidity and will be attached to the water samplers as shown in Figures 1a and 1b. The unit will come pre-calibrated from the laboratory and will be checked daily for proper functioning and drift. However, certain parameters such as pH, conductivity, ORP and DO will be calibrated daily. If possible, a YSI unit will be installed on each water sampler (i.e. near-surface and near-bottom) if both are deployed at the same time. However, a YSI unit installed on near-bottom water sampler can also take an initial near-surface measurement at the beginning and at the end of the sampling event, therefore avoiding the cost of having an additional YSI unit installed on the near-surface water sampler. The proper handling of the multi probe is described in detail in SOP-SW6. Except for the probe sensor, all components are soap washed (Alconox™) and tap-water rinsed. Since this equipment will not be in the pathway with the surface water being collected, there is no need for a thorough decontamination.

The following steps are taken to set up the surface water collection system:

1. Assemble and secure the water samplers to either the A-frame or a davit.
2. Determine the correct position of the sampling station, have the captain anchor the vessel into the current at the sample site and switch off the engines. If anchoring is not possible and engine must be on, care should be taken that the water intake tubing is always facing the current.

3. Set up a clean area for the workboxes. Set workboxes on a secure table or bench top onboard the sampling vessel to house stir plate(s) and a small peristaltic pump in each workbox. Provide enough space inside the workboxes for a stand to hold the outlet tubing and filter (if necessary; see project-specific SAP) and to collect surface water and processing sample bottles (Figure 3).
4. Place stirring plate(s) inside the workbox and the mixing container(s) on top of the plate. Each mixing container (a polycarbonate container for inorganic analytes and a glass or stainless-steel container for organics) will be checked to ensure:
 - Containers were properly wrapped by the labs and do not contain rips or holes that may have occurred during shipment to the field
 - Each container contains a 3-inch stir-bar at the bottom
 - All components, such as inflow and outflow tubing have been properly assembled in the lab (e.g. one end of the outflow tubing should be touching the bottom inside the container), and that they are intact and securely placed on the cap.
5. Attach the outlet tubing “kits” (i.e. Unit # 3) to the mixing containers (Figure 2). The kits are composed of 10-cm C-Flex™ tubing, 0.5-m Teflon™ tubing, 30-cm C-Flex™ tubing, and 30-cm Teflon™ tubing, placed sequentially.
6. Place the small peristaltic pump inside each of the workboxes.
7. Place a stand inside the workboxes and secure each tubing outlet from both mixing containers with clamps (Figure 3).
8. Attach Teflon™ tubing (collecting end) to 30-cm C-Flex™ tubing and a 1-m Teflon™ tubing, sequentially, and then connect these interconnected pieces of tubing to a mixing container (polycarbonate for inorganics and glass or stainless steel for organics). Clamp the C-Flex™ tubing section firmly into place inside the large peristaltic pump head, which is placed outside the workbox. (Note: The length of the Teflon™ tubing will vary depending on project-specific requirements and water depth at a given station. For example, a 4-m (near surface sampling) and 25-m [for near bottom sampling] Teflon™ tubing could be used.)

9. Attach the intake part of the Teflon™ tubing to the vane of the near-surface sampler (Figure 1a) or to the vane of the near-bottom sampler (Figure 1b). Care must be taken not to remove the protective cap from the tip of the sample collecting tube until the sampling device is ready for submersion.
10. Secure the pump and pump speed controller and connect them to the vessel's power source with an extension cord. If vessel power is not available, the pump can be operated under its own battery power supply.
11. To limit sediment suspension during near-bottom sampling, a submersible, underwater video camera tethered to the boat can be attached to the sampling device vane to show sampling personnel when the sampling device touches bottom.

Sample Collection

The following steps are taken to collect and process the surface water samples:

1. Remove the protective cap from the sampling tube and lower the sampler gently below the water surface.
2. To sample water near-surface, submerge the sample tubing inlet approximately 1 m (3 ft) below the surface of the water column (consult project-specific SAP for exact sampling water depth).
3. To sample water near-bottom, submerge the sample tubing inlet approximately 3 m (9 ft) above the bottom (consult project-specific SAP for required distance above the bottom) with the help of the A-frame or davit. If sampling surface water at a fixed depth from near bottom is necessary, the vane height on the sampler can be adjusted between 30 cm (12 in) to 1 m (3 ft) above bottom while the sampler rests on the bottom surface. The vane will maintain the sample tubing inlet into the current and at a constant depth above the sediment-water interface.
4. Begin collection of water quality parameters at each depth using the water quality meter (e.g., YSI, Hydrolab, Horiba). Data collection intervals should be set to collect water quality measurements according to data needs. If a vertical water column profile is needed, the multi probe should be set to collect data every 1 second for a high resolution profile. If sampling a vertically integrated water column with several round trips to the bottom, the multi probe should be reset to collect data at time intervals relative to the sampling time period after the initial high resolution profile. For example, if a vertically integrated water column will be sampled during a period of two

hours, the multi probe is set to record data at every 1 second for the first round trip to the bottom and then reset to record data at every 5 minutes for the subsequent round trips until sampling is completed. If surface water is to be collected at stationary location for more than one hour, the multi probe should be set to collect data at every 15 minutes, if no major changes in water quality are expected.

Note: Failure to adjust the multi probe for data collection according to sampling periods could result in data loss. That is, if the multi probe memory bank is quickly filled at the initial part of a long sampling period, no additional data will be stored in the multi probe memory bank for the remaining sampling time.

Sampling personnel should record the water quality measurements on the Water Sampling Log Forms every 15 minutes during sample collection. If the surface water sample collection is completed within 15 minutes, then at a minimum water quality parameters should be collected three times; at the beginning, middle, and end of sample collection.

5. Switch the pump on and pump surface water through the sample tubing and into the mixing containers. Once the water reaches one-third the container's volume, turn on the stir plates.
6. Turn off the pump once the mixing containers have been filled to 1 inch below the inflow spout or when sufficient volume has been collected to fill all of the sample bottles at a given station.
7. Place the C-Flex section of the outflow tubing kit from the first container to be sampled inside the small peristaltic pump head and clamp firmly.
8. Before the small pump is turned on, make final adjustments to the stand holding the outflow spout as close to the sample bottle opening, but without touching the inside of the bottle.
9. Fill container up to the "neck" with unfiltered sample water.
10. After the unfiltered samples are collected, attach the 0.45- μ m filter cartridge (or appropriate pore size filter) to the sample tubing outlet and secure it to the stand with a clamp (consult project-specific SAP to determine if filtered samples are required). Drain the storage solution inside the filter, and flush the entire sample tubing and filter assembly with sample water. Discard this first "rinse" of sample water.

11. After filter and sample tubing have been rinsed, then the sample bottle is filled. Fill container up to the “neck” with filtered sample water. (Note: If dissolved constituents are being analyzed [per the project-specific SAP], then the 0.45- μ m filtration cartridge will be discarded after each sampling site.)
12. As soon as a sample container is filled, the peristaltic pump is turned off, and the container is labeled. The sampling label should contain the date, time, project name or number, sample ID, type of analysis required, and sampler initials (see SOP-AP4).

Once a surface water sample container is properly closed and labeled, it is placed inside a cooler containing wet or blue ice and stored at approximately 4°C. All samples are stored in coolers with ice on board the vessel and transferred to the field laboratory (if applicable) at the conclusion of the sampling day.

Water Quality Measurements

If specified in the project-specific SAP, physical and chemical water parameters may need to be collected at surface water stations. Several physical and chemical water parameters are best measured in the field because of the unstable nature of the parameter or because the information is needed to direct further sampling. It is frequently preferable to perform these analyses in the field, especially if the samples will not be immediately transported to the analytical laboratory (pH, in particular, should be measured in the field if feasible). In addition, measurements of temperature and transparency can only be collected accurately in the field.

It is always best if the water quality meter is placed directly into the surface water body at the station location at the desired water depth instead of collecting a sample and measuring parameters in a container. However, if this is not possible, a plastic bucket can be used to collect samples for water quality analyses (e.g., pH, temperature, and conductivity). A clean bucket should be rinsed twice with the water from the station prior to measuring water quality parameters.

The name(s) of the person(s) making the measurement and the field equipment used to make that measurement must be recorded in the field logbook and on any field forms used during the sampling event. Equipment maintenance and calibration records must be kept in logbooks and field records so that the procedures are traceable.

Sample Handling

Gloved hands are required for sample collection and handling, as described above. Field staff will wear appropriate non-contaminating, disposable, powderless nitrile gloves

during the entire sampling operation. Gloves will be changed frequently; usually with each change in task (wearing multiple layers of gloves allows rapid glove changes).

Gloved hands are required for all operations that involve equipment that comes into contact with the sample, including the following responsibilities:

- Handling the sample bottle
- Handling the discharge end of the sample tube or line
- Setting up working space inside the processing and preservation chambers
- Setting up the equipment (i.e., the sample bottles, mixing containers, and the filtration and preservation equipment) inside the chambers
- Working inside the chambers during collection, processing, and preservation
- Handling the filter (if needed)
- Changing the chamber covers as needed.

Ungloved hands take care of all operations that involve contact with potential sources of contamination, including the following responsibilities:

- Works exclusively exterior to the processing and preservation chambers
- Preparing a clean workspace (inside boat)
- Prepares and operates the sampling equipment, including the pumps and discrete samplers, peristaltic pump switch, pump controller, and manifold system
- Handles the generator or other power supply for samplers
- Handles the tools, such as hammers, wrenches, keys, locks, and sample-flow manifolds
- Handles the single or multi-parameter instruments for field measurements
- Sets up and checks the field-measurement instruments
- Measures and records the water depths and field measurements.

All samples are stored in coolers with ice at approximately 4°C on board the vessel and transferred to the field laboratory (if applicable) at the conclusion of the sampling day. The sampling team leader is responsible for maintaining sample integrity throughout the sampling event.

If storage freezers or refrigeration units are available at the field laboratory, these units will be monitored daily to ensure temperature compliance. Each unit will have a separate log form containing date, time, and temperature information.

Sample contamination will be avoided by handling the sample containers with clean gloves, and transferring the samples into clean refrigerators (or clean coolers) immediately after samples have been brought back from the field. Sample bottles will

always be handled by personnel wearing disposable powderless nitrile gloves. This includes any and all sample handling that may occur during sample packing and shipping (see SOP-AP1).

Related SOPs

- All surface water samples will be packaged and shipped in accordance with procedures outlined in SOP-AP1.
- Field activities will be recorded in accordance with procedures outlined in SOP-AP2.
- Sample custody will be maintained in accordance with procedures outlined in SOP-AP3.

References

David, N., D. Bell, and J. Gold. 2001. Field Sampling Manual for the Regional Monitoring Program for Trace Substances. San Francisco Estuarine Institute, San Francisco, CA.

USEPA. 1996. Method 1669 - Sampling Ambient Water for Trace Metals at EPA Water Quality Criteria Levels. U.S. Environmental Protection Agency, Office of Water Engineering and Analysis Division (4303). Washington, DC.

U.S. Geological Survey. [various dates]. National field manual for the collection of water-quality data: U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, chaps. A1-A9, available online at <http://pubs.water.usgs.gov/twri9A>. Accessed February 5, 2008 at <http://water.usgs.gov/owq/FieldManual/index.html#Citation>.

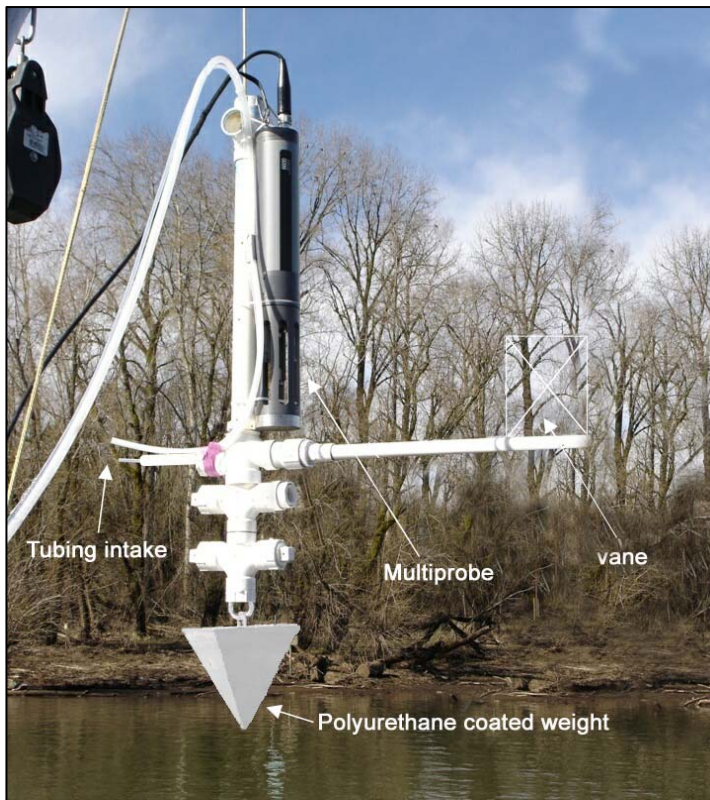


Figure 1a. Near surface water sampler.

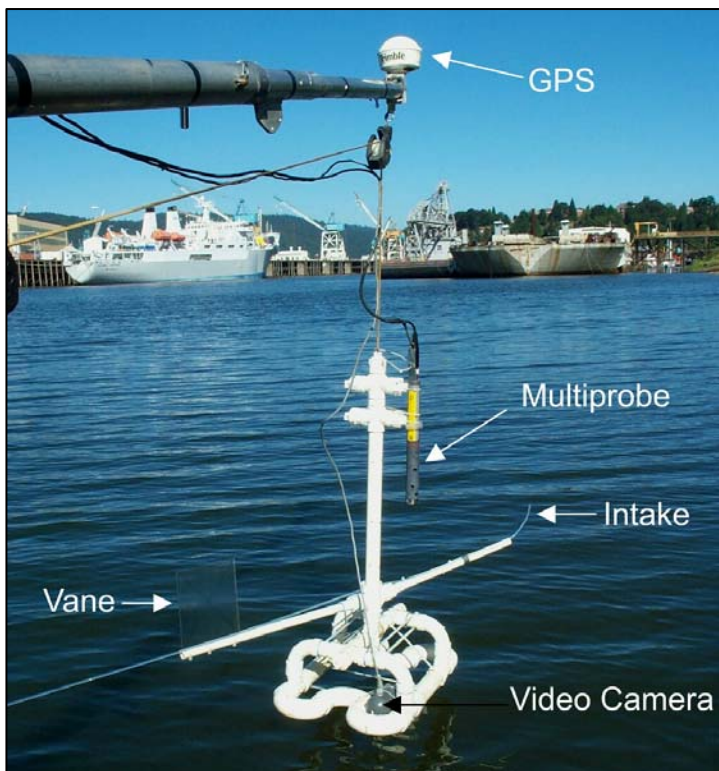
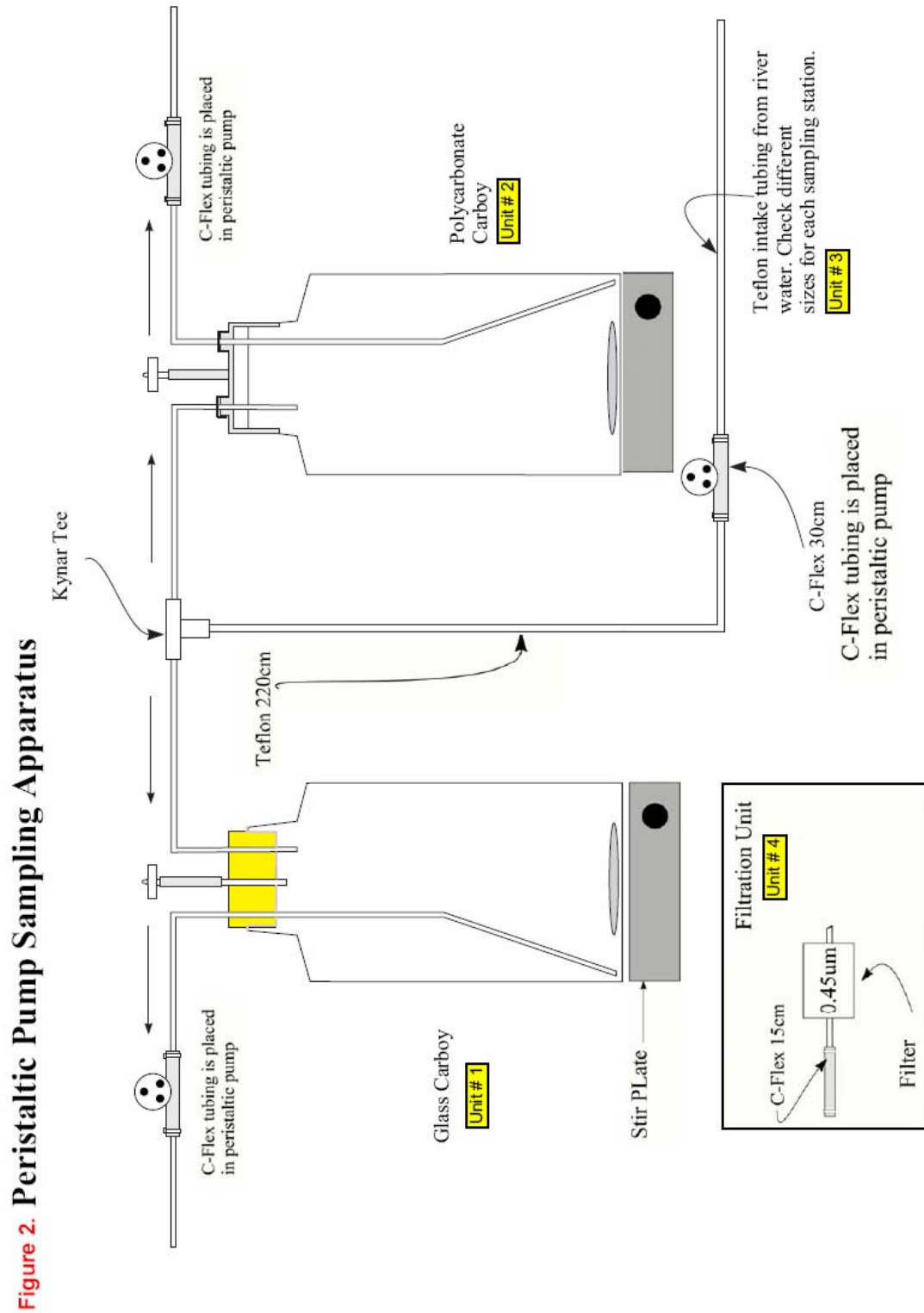


Figure 1b. Near bottom water sampler.



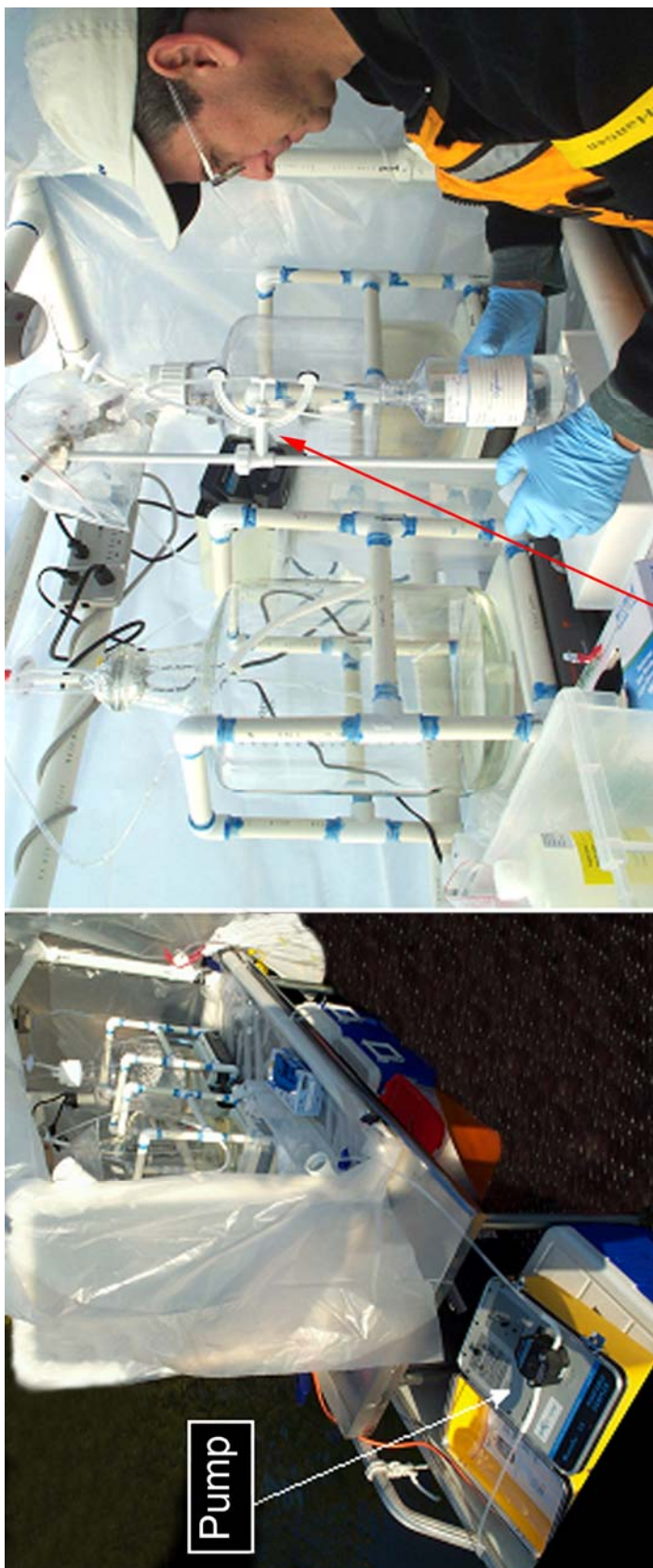


Figure 3. Peristaltic pump setup in workbook.

ATTACHMENT 1 CHECKLIST OF SUPPLIES FOR SURFACE WATER SAMPLING WITH PERISTALTIC PUMP

All sampling equipment described here will be sent to Battelle Marine Laboratories at Sequim, WA, or other approved laboratory for decontamination and assembly prior to sampling. Each unit below shall be wrapped in plastic bags and clearly labeled on the outside with a large font.

UNIT # 1

For polycarbonate carboys:

Teflon:

- 1 x 50 cm for inflow from Kynar tee into carboy
- 1 x 140cm for outflow from carboy to small peristaltic pump
- 1 x 60cm for outflow from small peristaltic pump to sample bottle

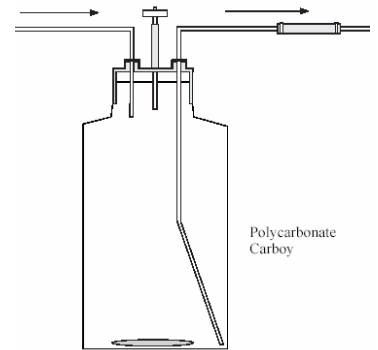
C-Flex:

- 1 x 6cm for connecting air filter on carboy (**additional internal tubing is not needed**)
- 1 x 30cm for connecting outflow tubing from carboy to tubing for filling sample bottles

Other:

- 1 x 3" stir bar
- 1 x Vacu-guard filter
- 2 x small plastic zip-ties for C-Flex tubing

The total number of bags labeled UNIT # 1 will depend on the number of sampling stations per each specific sampling event.



UNIT # 2

From sample intake tubing to large peristaltic pump to carboys:

Teflon:

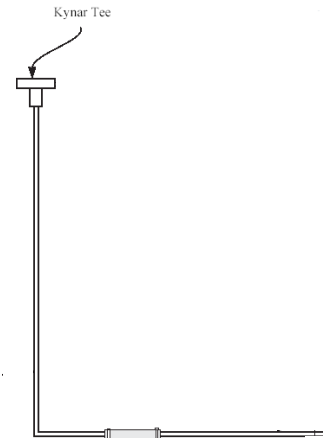
1 x 220cm for inflow from large peristaltic pump to Kynar tee

C-Flex:

1 x 30cm for connecting Kynar tee and inflow tubing to variable lengths of sampling intake tubing.

Other:

1 Kynar tee for connecting carboys to intake tubing
Variable lengths of sampling intake tubing (station dependent) to large peristaltic pump



Teflon:

40 to 100m for near bottom sampling at transect stations

8m for near surface water sampling at any station

15m for near bottom sampling at shallow stations

The total number of bags labeled UNIT # 2 will depend on the number of sampling stations per each specific sampling event.

UNIT # 3

Set of one filter in line:

C-Flex:

1 x 15cm for connecting the filter to the outflow from small peristaltic pump to sample bottle

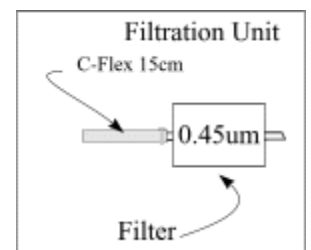
Filter

1 x 0.45- μ m Whatman POLYCAP 36 TF

Other:

1 x small plastic zip-tie for C-Flex tubing

1 x loose small plastic zip-tie (extra zip-tie to be placed in bag to connect to carboy outflow)



The total number of bags labeled UNIT # 3 will depend on the number of sampling stations per each specific sampling event.

[illegible]

STANDARD OPERATING PROCEDURE SOP-SW5

SURFACE WATER SAMPLING USING GRAB SAMPLERS

Scope and Application

Procedures for sampling surface water from freshwater bodies (e.g., creeks, rivers, lakes, ponds) or from estuarine and marine systems (e.g., estuaries, embayments, open-ocean) are presented in this SOP. These methods were developed based on Greenberg et al. (1985) and USEPA (1991). Not all of the sampling methodologies discussed in this SOP may be required for a given project. The specific sample collection techniques and associated sampling equipment will be specified in the project-specific sampling and analysis plan (SAP).

Station Access

Prior to entering select areas it may be necessary to acquire property access permission from the landowner. Access permission must be acquired in advance of the sampling program and may require a written agreement. Surface water stations may be accessed by boat, wading, standing on the shore or other structure (e.g., bridge) and extending a sampling device into the water body, or by boat.

Station Location

When sampling in close proximity to the bottom, surface water samples must be collected in a manner that avoids resuspending sediments into the sample being collected or samples that will be collected at other downstream or down current stations. Therefore, if it is necessary to enter the water to sample (i.e., wade), care must be taken to avoid resuspending sediment into the water column. To avoid resuspended sediment interference in the sample being collected, stations should always be approached from downstream. Avoid sampling near eddies that may circulate water from the sampling location to upstream of the sampling location. To avoid interference from resuspended sediment at other stations, samples should be collected beginning with the most downstream station and continuing in an upstream direction.

Water samples should be collected in areas that are representative of the surface water body conditions. A station that is located away from immediate point sources (e.g.,

tributaries, and industrial and municipal effluents) is preferred for collecting surface water samples unless sampling is designed to assess these sources. Representative samples can usually be collected in portions of the surface water of a river that have a uniform cross-section and flow rate. Because mixing is influenced by turbulence and water velocity, the selection of a site immediately downstream of a riffle area (e.g., fast flow zone) will ensure good vertical mixing.

Whenever possible, a depth-integrated sample (as well as a width-integrated sample) should be collected from flowing water bodies. This is particularly true for data that will be used in mass balance calculations. When sampling is performed to assess the effects of a tributary or discharge on receiving water chemistry, some calculations may be needed prior to sampling to estimate appropriate distances downstream and across the stream to characterize concentrations. It is common for streams to be incompletely laterally mixed for downstream distances of 50 times the stream width, or more. Guidance on mixing rates can be found in *Mixing in Inland and Coastal Waters* (Fischer et al. 1979).

Tributaries should be sampled as near the mouth as is feasible. However, it is important to select the sample location taking into consideration the impact that the downstream receiving water body has on the tributary flow and sediments. The downstream body may affect the tributary by decreasing water velocity (causing suspended solids to settle) or by eddies (causing mixing of the two waters). The downstream water body may change the water quality (e.g., salinity), temperature, or turbidity in the tributary near its mouth.

Attention must be given to identifying intakes and outflows within lagoons or settling ponds, which may cause localized concentrations that are not representative of general conditions. Sample locations adjacent to structures (e.g., banks, piers) may also have biased characteristics as a result of flow or release of substances from in water structures. These kinds of possible confounding factors should be noted in the field logbook. For ponds, lakes, and large rivers that may be vertically stratified, a multi-parameter water quality meter can be used to collect depth profiles throughout the water body to aid in the selection of appropriate sampling points and depths.

Surface Water Sample Collection

Appropriate surface water sampling techniques and equipment are designed to minimize effects on the chemical and physical integrity of the sample. Different kinds of surface water sampling techniques and equipment are discussed in the following sections. The project-specific SAP should be consulted to determine the appropriate surface water sampling techniques and associated sampling equipment.

In general, surface water samples should always be collected first if sediment samples are to be collected at the same location. Every attempt should be made to keep floating debris from entering the sample bottles, which could result in unrepresentative analytical data. Sample collection when the flow depth is minimal (i.e., less than a few inches) will require special consideration to prevent sediment disturbance. If water depth is shallow and sampling equipment will come into contact with the sediment surface, then a small excavation in the stream bed to create a “sump” for sample collection may be permissible, but should be prepared well in advance of the sample collection event to allow sediment to settle. This technique should be considered very carefully because digging a depression may expose the surface water to other possible contaminants and natural compounds such as sulfides, phosphates and ammonium. In addition, certain sediment types will crumble as a hole is dug up and will not support enough depth for bottle dipping. A peristaltic pump may be needed (consult project-specific SAP and field conditions).

As mentioned above, surface water samples shall be collected moving in an upstream or up-current direction and utilizing the following procedure:

1. Immediately after collecting the sample, record the temperature, dissolved oxygen, pH, turbidity, and specific conductance using a water quality meter (e.g., YSI, Horiba®, or equivalent) and following the manufacturer’s specifications.
2. If stipulated in the project-specific SAP, a water depth measurement should be collected at every surface water station.
3. Target analytes, container types, and preservatives are specified in the project-specific SAP. In general, surface water samples collected for multiple compounds should be collected in the following order (USEPA 1992):

➤ Volatile organic compounds (VOCs)

(Note: When collecting samples for VOCs, let the water flow down the side of the sample container to minimize aeration. Hold caps in hand to minimize contamination of sample. Fill all VOC sample containers to the top. A positive meniscus at the top of the container will help ensure that no air is trapped inside when cap is screwed down on the container. No air bubbles should be trapped in the sample when the container is sealed. VOC sample bottles must be checked after filling to ensure no air bubbles are present. Invert the bottle and lightly tap it to release any bubbles beneath the cap. If an air bubble is present, the VOC sample must be retaken using a fresh bottle.)

➤ Dissolved gases and total organic carbon (TOC)

- SVOCs
 - Metals and cyanide
 - Major water quality cations and anions
 - Radionuclides.
4. Collect quality assurance and quality control (QA/QC) samples (i.e., duplicate, equipment rinsate, trip blank, laboratory matrix spike, and laboratory matrix spike duplicate, as applicable) at the same time by filling all bottles from the same flow. The number and types of QA/QC samples are specified in the project-specific SAP.
 5. Sample bottles must be labeled with date, sample number, time, sampler's name, and type of preservative, as described in the project-specific SAP and in accordance with SOP-AP4. Sample bottles must be placed in a cooler and on ice to keep the sample cool (4°C). Samples must be cooled continuously from time of collection to time of receipt at the laboratory, as described in SOP-AP1.
 6. Complete sample logs, labels, custody seals, and chain of custody forms. Record sample information in the field notebook. The depth in the water column where the sample is collected must be recorded in the field logbook.

Dipping Using Sample Analysis Bottle

In this case, water is collected directly from the water body into the bottle that is sent to the laboratory for analysis. This surface water sampling technique is only appropriate if a composite sample is not required for analysis (i.e., only filling one sample bottle per station). If compositing is required, then a decontaminated churn splitter or mixing container will need to be used (see discussion below).

When collecting samples in a riverine environment, the sampler should approach the station from downstream of the sampling location and should face upstream and collect the sample without disturbing the sediment. Using a bottle attached to a dip stick or wearing nitrile gloves to hold the bottle, quickly immerse the inverted sample bottle through the surface of the water to the desired sampling depth and then tilt the opening of the bottle upstream to fill. If possible, samples should be collected approximately one-third of the distance from the surface to the bottom, and the sample bottle should be completely submerged. Note: If done slowly, the sampler will be collecting the film at surface of the water; water must be collected from below the air/water interface.

The sampler should be careful not to displace the preservative from a pre-preserved sample container (e.g., VOC vial). If water is needed to fill bottles that contain preservative, then collect water with a clean bottle and pour this water into the sample bottle that contains the preservatives.

Specific Depth Interval Sampler

If surface water samples are required from a specific depth, a standard Kemmerer, GO-FLO™, Niskin bottle, or Van Dorn sampler, or plastic tubing with a peristaltic pump may be used. The Kemmerer, GO-FLO™, and Niskin bottle samplers are a stainless steel or acrylic cylinders with closures at each end that leave the ends of the sampler open while being lowered in a vertical position through the water column to allow free passage of the water through the cylinder. The Van Dorn sampler is similar in construction, but is lowered in a horizontal position through the water column. In each case, the sampler is lowered to the desired depth and a messenger is sent down a rope or cable that causes the sampler to close. The sampler is then raised to the surface. Water is removed through a valve to fill sample bottles. If the sampler needs to be reused during the sampling event (i.e., at different stations), then the sampler must be decontaminated between stations.

Note: The analyte list in the project-specific SAP should be reviewed prior to sample collection to determine if a Teflon™-coated sampler is required.

Methods for operating the GO-FLO™ bottle sampler are described in the following section.

GO-FLO™ Bottle Sampler

GO-FLO™ bottle samplers are fabricated by General Oceanics Inc. 1295 N.W. 163rd Street, Miami, Florida 33169 USA. The specific model depicted here is a 20 L GO-FLO™ 1080 series (General Oceanics, <http://www.generaloceanics.com/genocean/1080.htm>).

Description: Close-open-close operation. Opens automatically (hydrostatic pressure activated) at approximately 10 m (33 ft), then flushes until closed by standard GO Devil messengers (Model 1000-MG) individually, serially, or sequentially by remote command with model 1015 Rosette® multi-bottle array, or with model AR1015 Acoustic Command Control. (See data sheet 1015-12/85). Inert gas can be injected into bottle to force retrieved sample out of sampling valve, directly through filter system. The GO-FLO™ sampling bottle avoids sample contamination at the surface, internal spring contamination, loss of sample on deck (internal seals), and exchange of water from different depths.

Material: Rigid PVC tube section, ball valve, handles and cable clamp blocks. Delrin stopcocks and push rod. Stainless steel cable clamp bolts. Latex external spring, Viton and silicone O-ring seals. Monofilament nylon and Kevlar lanyards. Inert Gas Connection: Dual-purpose air vent pressure release valve with standard 9/16-18 thread for connecting inert gas line. (Operation requires additional fitting - part S1080-AFIT).

Closure: Ball valve with Viton and silicone seals.

Health and Safety: All hands on deck must be wearing appropriate personal protective equipment (i.e., hard hats, personal flotation device, steel-toed boots, and gloves) (Figure 1). People in charge of handling the GO-FLO™ bottle must have read the instruction manual and be familiar with the proper use of the sampling equipment, must have read the project-specific health and safety plan and participated in a safety meeting debrief on the hazards associated with sampling equipment of the specific research vessel used for that project.



Figure 1. Proper Personal Protective Equipment

Trace Metal Analyses: If trace metal analyses are required, the interior of the GO-FLO™ bottle must be Teflon™ coated. Decontamination procedures for trace metals are described in Mason and Sullivan (1996) and are outlined in SOP-SW15 for laboratory decontamination and SOP-SW1 for field decontamination. Decontaminated GO-FLO™ bottles must be wrapped in plastic bags to prevent any contamination from airborne dust particles or exhaust fumes from power generators and boat engines. Additional plastic bag or clean nitrile gloves must be wrapped around the sampling spigots and only removed at the last minute before deployment. A non-metallic wire (e.g., Technora™, Kevlar™), must be spooled on a winch that will deploy the GO-FLO™ bottle. The non-metallic wire must be rated to safely support the weight of a bottle filled with water plus ancillary equipment such as bottom weight, water quality multiprobe meter, underwater

video camera, and stainless steel frame if multiple bottles are deployed at the same time. Prior to the collection of water samples, GO-FLO™ bottles are checked over for defects and the closing and opening mechanisms are checked.

Pre-deployment Checks: The bottle must be secured in a transport box or shipping crate that can also be used as a secure platform for deployment and retrieval of the unit. The GO-FLO™ bottles are pre-cocked before deployment. During the cocking procedure, the GO-FLO™ is either placed on a clean plastic sheet/bag on the floor or handheld if it is a small volume GO-FLO™ bottle (i.e., less than 20 L). The cocking procedure consists of the following:

- The bungee cord attached to the ball valve is rotated so that the plastic ball string is loose. Figure 2 shows how the bungee cord is wrapped around the ball valve wheel in order to loosen tension on plastic ball string. In this instance, residual water flows out of the bottle.

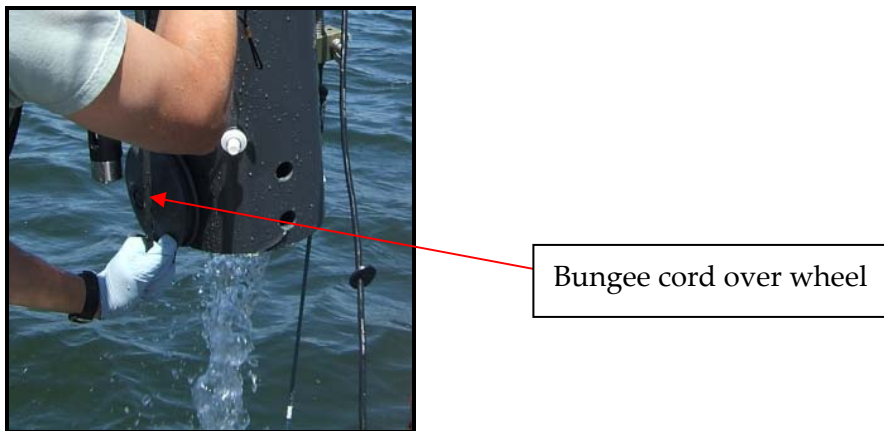


Figure 2. Release tension on ball valve

- The plastic balls on the string are positioned around the pressure release valve and the pressure release valve is pulled outward locking the two plastic balls between the valve and the U-sapped stainless steel wire located on the middle of the bottle just below one of the PVC handles (Figure 3).

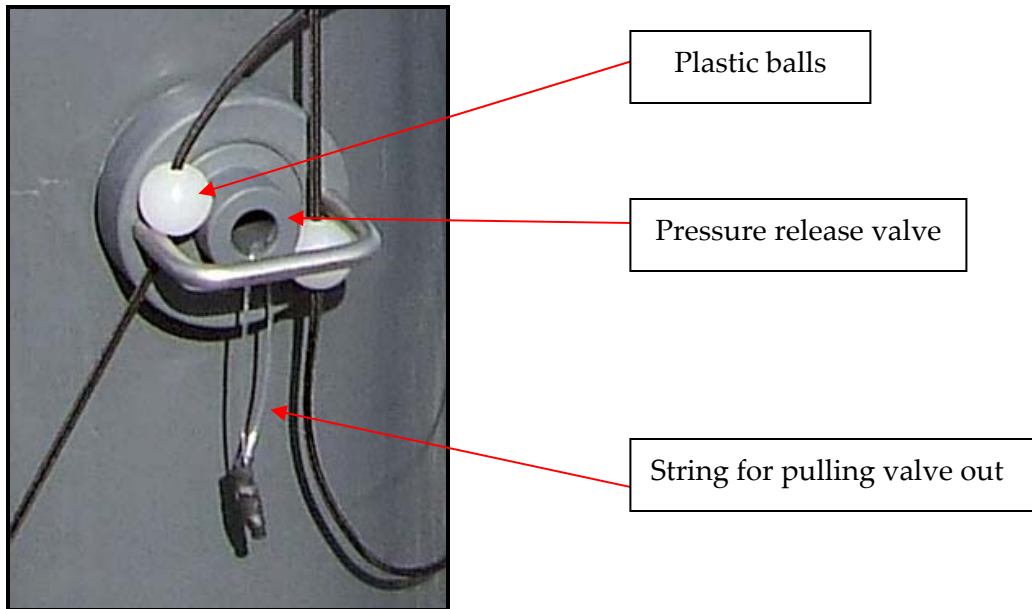


Figure 3. Pressure release valve in cocked position

- The bungee cord attached to the ball valve is then rotated back so that both the string and the cord are under tension (Figure 4).

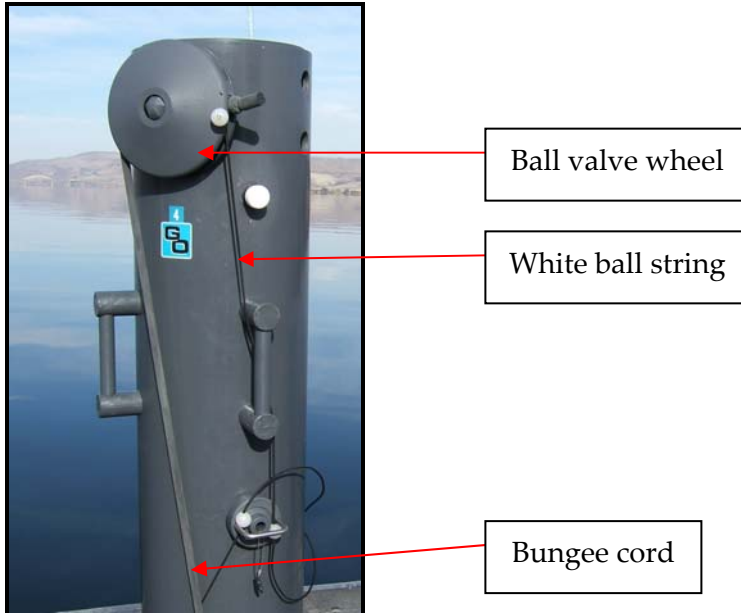


Figure 4. Bungee cord on cocked position

- The following checks can be conducted to ensure the GO-FLO™ sampler has been properly cocked.
 - Pushing the pressure release valve should cause the balls' valves to move to the open position.

- Pressing the push rod release mechanism should then release the string and result in the closure of the bottle (Figure 5).

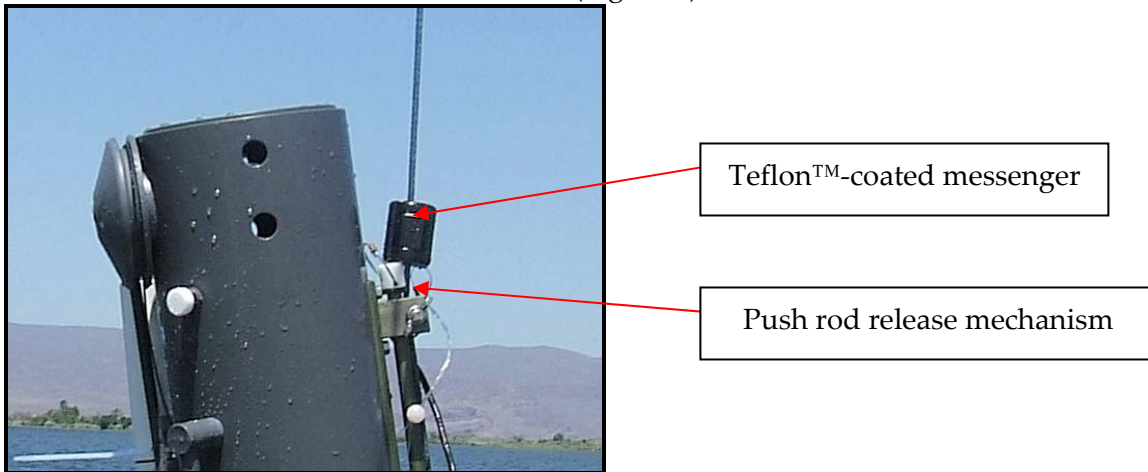


Figure 5. Push rod triggering mechanism with messenger deployed

- Recock the bottle after this check as described earlier.
- Check that vent valve is turned all the way in and that sampling spigots are pulled out and white flange twisted away from release pin before deployment (Figure 6).

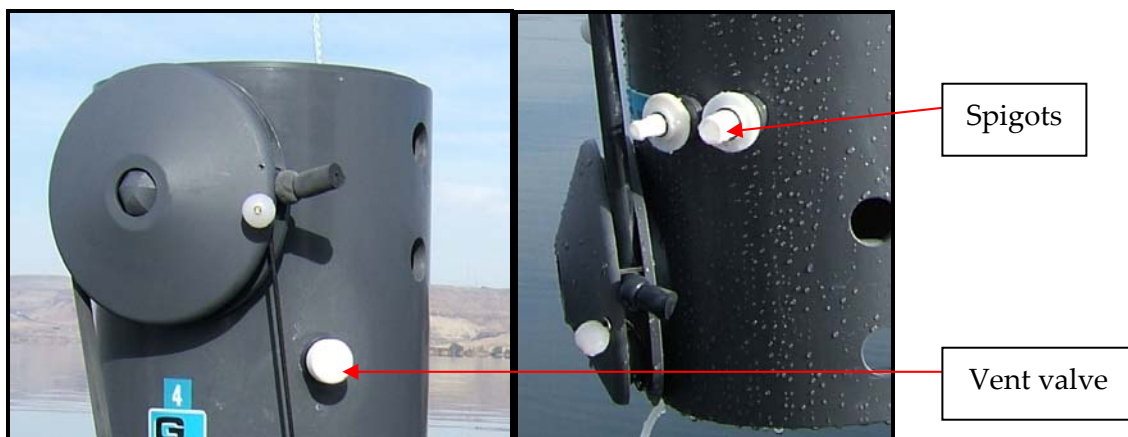


Figure 6. Vent valve at top end of bottle and sampling spigots at bottom end of bottle.

Deployment: Before deploying the sampler, make sure any ancillary equipment such as multiprobe (Figure 7) and underwater video camera are attached to the bottle and a non-metallic or polyurethane-coated weight (approximately 100 lb) is attached to the end of the Kevlar line. The weight is lifted overboard and at least 10 m of line is let out prior to the GO-FLO™ bottle attachment depending on water depth. If near bottom sampling is required, the distance between the GO-FLO™ bottle and the bottom weight must be adjusted.



Multiprobe

Figure 7. GO-FLO bottle with multiprobe attached to handle prior to deployment

The bottle is then quickly lowered down into the water to about 15 m so that the pressure valve is activated to open the two ball valves at each end of the bottle when the bottle reaches a water depth of 10 m. If the bottle is lowered too slowly, water will seep into the bottle and the pressure gradient between the inside of the bottle and the outside water column will not be sufficient to trigger the valves open. Bubbles should rise to the surface as the pressure release valve opens the GO-FLO™ underwater. Bubbles rising to the surface are indicative that the bottle is in the open position. If bubbles are not seen, this can mean that the bottle has not opened. Sometimes bubbles cannot be seen because of light scattering or choppy water surface. The bottle can be raised slowly to just beneath the water surface so that personnel looking over the side can see if the bottle has opened. If the bottle is not visible, do not bring it above the surface. If it is in the open position then contact with air or surface water oily microlayer can contaminate the lining of the bottle. If the water is rough or turbid, then it is better to assume the bottle is open. After verifying that the bottle is open, it is then lowered to the desired sampling depth. The messenger is attached to the line and released. The messenger will trigger the bottle closed. Adequate time, based on the time required for the messenger to reach the bottle must be allowed before retrieval of the GO-FLO™ bottle. When the bottle is retrieved to deck level, the person who attached the bottle to the line will disengage it and carry it or slide it with the help of the winch and secure it to the designated clean workspace. Once in the clean work space, the GO-FLO™ bottle is placed upright and the air release valve is

opened and the sample is decanted or pumped into the sample containers (Figure 8). Trace metal clean sampling procedures will follow the EPA clean-hands technique (USEPA 1996) and SOP-SW4 instructions.

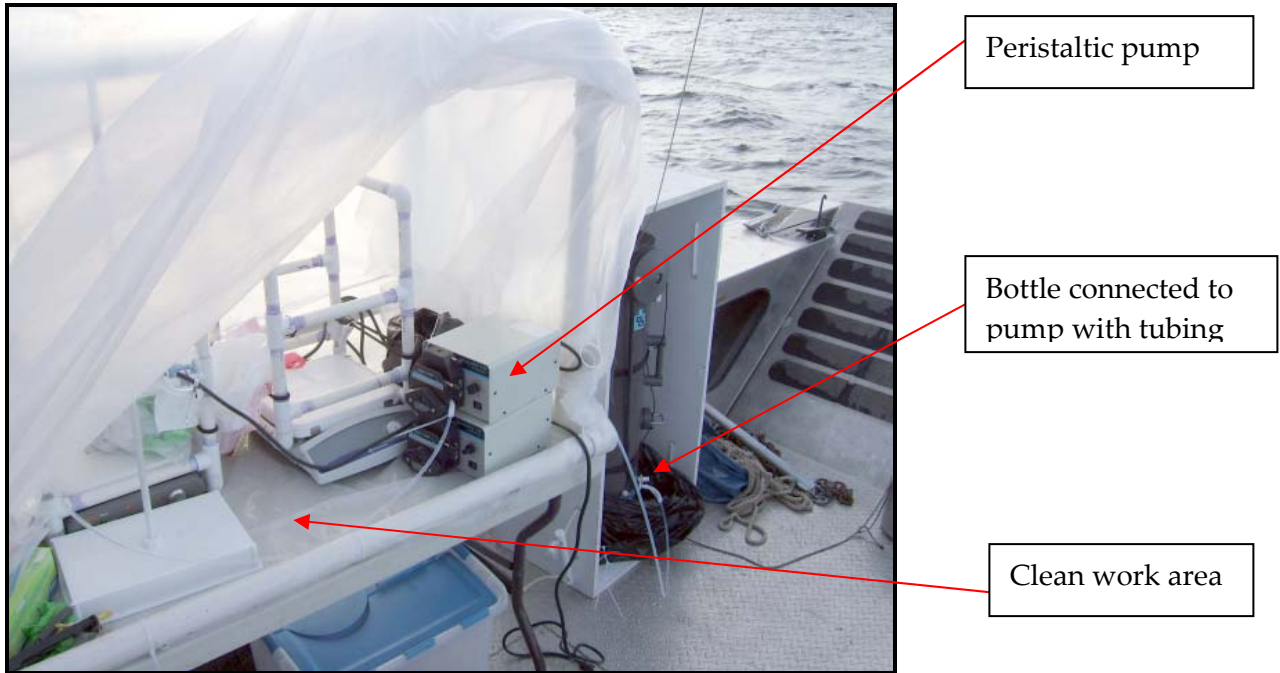


Figure 8. Typical setup for sampling with peristaltic pump

Field Filtration

In some cases, field filtration may be required (recommended for inorganics). If applicable, attach a new, disposable filter cartridge (typically $0.45\ \mu\text{m}$) to the discharge line. Filtered water should be introduced directly into the appropriate sample container. Alternate field filtration methods may be specified in project-specific SAP. *Although not recommended, the laboratory can filter the samples if the samples are NOT preserved and are filtered within 24–48 hours of collection.*

Water Quality Measurements

If specified in the project-specific SAP, physical and chemical water parameters may need to be collected at surface water stations. Several physical and chemical water parameters are best measured in the field because of the unstable nature of the parameter or because the information is needed to direct further sampling. It is frequently preferable to perform these analyses in the field, especially if the samples will not be immediately transported to the analytical laboratory (pH, in particular, should be measured in the field if feasible). In addition, measurements of temperature and transparency can only be collected accurately

in the field. The standard operating procedures for surface water quality measurements using a multiprobe can be found in SOP-SW6.

It is always best if the water quality meter is placed directly into the surface water body at the station location at the desired water depth instead of collecting a sample and measuring parameters in a container. However, if this is not possible, a clean plastic bucket can be used to collect samples for water quality analyses (e.g., pH, temperature, and conductivity). The bucket should be rinsed twice with the water from the station prior to measuring water quality parameters.

The name(s) of the person(s) making the measurement and the field equipment used to make that measurement must be recorded in the field logbook. Equipment maintenance and calibration records must be kept in logbooks and field records so that the procedures are traceable.

Related Integral SOPs

- SOP-AP1. Sample Packaging and Shipping
- SOP-AP2. Field Documentation
- SOP-AP3. Sample Custody
- SOP-AP4. Sample Labeling
- SOP-SW1. Decontamination of Surface Water Sampling Equipment
- SOP-SW4. Surface Water Sampling Using a Peristaltic Pump
- SOP-SW6. Measurement of Surface Water Field Parameters
- SOP-SW7. Clean-Hands Technique for Surface Water Sampling
- SOP-SW15. Laboratory Decontamination Procedures

References

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STANDARD OPERATING PROCEDURE SOP-SW6

MEASUREMENT OF SURFACE WATER FIELD PARAMETERS

This SOP utilizes the procedures outlined in Wilde, F.D. (variously dated), *Field Measurements: U.S. Geological Survey Techniques of Water-Resources Investigations*.

Scope and Application

Information and general instructions for field measurement of water quality parameters (pH, Eh [ORP], specific conductance, dissolved oxygen, and temperature) are presented below. Due to the variety and complexity of water quality meters available, calibration and measurement procedures should be conducted in accordance with manufacturer's recommendations for specific meters used. The following information describes general procedures for the measurement of water quality parameters. Where possible, sampling should be conducted first in areas least affected by constituents of interest, followed by increasingly affected areas.

Equipment and Reagents Required

- Water quality parameter multimeter or meters specific to parameters of interest (i.e., temperature, dissolved oxygen, pH, transparency, turbidity, salinity, specific conductance, and oxidation-reduction potential)
- Calibration solutions and deionized distilled water.

Procedures

Before any calibration takes place, the probe has to be acclimated to the ambient field temperature along with all calibration solutions for at least one hour.

Calibrate meter(s) in the field at the beginning of each day of field or laboratory work when water quality parameters will be measured. If feasible, meters must be checked for drift with calibration standards after every 4 hours of continuous use. Otherwise, a final check must be done at the end of the sampling event. If drift is evident, recalibrate.

1. Calibrate meter(s) in accordance with manufacturer's instructions using fresh (unused) calibration buffers and standards for each sensor.
2. Check slope reading with specifications (in operating manual) to verify slope is within the manufacturer's specified range.
3. Thoroughly rinse a 500-mL beaker or 8-ounce jar with sample water. Discard sample water.
4. Rinse electrodes with sample water to acclimate them.
5. Fill beaker with fresh sample water.
6. Immerse electrodes in sample while swirling the sample, if needed, to provide thorough mixing. Turn on meter(s). If a flow-through cell is used, install probes and connect sample water to bottom port of flow-through cell, directing sample water up through the cell, exiting through the top port. Direct effluent tubing back in the water or into an appropriate container for storage and handling.
7. When the readings have stabilized, record the measurements displayed on the meter. It is important to determine that the correct units and unit scale are displayed on the meter and recorded for each parameter measured. Record and correct any problems encountered during measurement.
8. If available, field measurement results should be compared to previous measurements for quality control.

Several physical and chemical water parameters are best measured in the field because of the unstable nature of the parameter or because the information is needed to direct further sampling. It is frequently preferable to perform these analyses in the field, especially if the samples will not be immediately transported to the analytical laboratory (pH, in particular, should be measured in the field, if feasible). In addition, measurements of temperature and transparency can only be collected accurately in the field. Eight parameter measurements for water are described in the following sections of this SOP.

Temperature

Water temperature may be measured with either an alcohol or digital thermometer. It is recommended that mercury thermometers not be used to avoid possible breakage and introduction of mercury into the environment and to remove a source of possible contamination to samples collected for the analysis of mercury. Temperature should be measured as soon as the sample is collected to obtain a measurement that is an accurate

representation of the *in situ* sample temperature. All instruments used to measure temperature should be traceable to a NIST temperature reference. In the case of digital thermometers, if there is a calibration procedure recommended by the manufacturer, it should be followed. Multi probes in general contain a temperature probe and these should be checked against a calibrated thermometer before use. For more detailed procedures, see discussion in Wilde (2006).

Dissolved Oxygen

Dissolved oxygen may be measured in the field by either a dissolved oxygen polarographic-membrane type sensor or a luminescent type sensor. Dissolved oxygen can also be measured by a field-portable Winkler titration kit.

It is recommended that calibration be done at temperatures that are at least within 10°C of the ambient water temperature. The smaller the temperature difference is between the environmental water and the calibration chamber a more accurate calibration will be attained.

When using static samples (i.e. water sample collected in a container), samples should be protected from absorbing oxygen from the atmosphere by using a low or zero-headspace container. In using a meter and probe, the system should be calibrated according to the manufacturer's procedure prior to use with a zero oxygen standard and a second standard of known oxygen content. The second standard should be checked by performing a Winkler titration. Other probes are calibrated by percent oxygen saturation in an enclosed container with a small amount of water. When measuring dissolved oxygen with certain polarographic-membrane probe in water samples held inside a zero-headspace containers, samples should be swirled or stirred constantly until the reading stabilizes and the measurement is recorded. Stirring of the sample is not necessary if a luminescent-sensor is used. Other probes are immersed in the water column and a constant measurement (dynamic measurement) is monitored until the readings are stabilized. Once the readings stabilize, the oxygen concentration readings can be recorded manually or digitally. For more detailed procedures, see discussion in Lewis (2006).

pH

The pH of a water column sample may be measured in the field using a pH meter. The meter should be calibrated according to manufacturer's specifications with at least two standards of known pH. The pH of these standards should bracket the expected pH at the sampling site. For example, if the pH at the sampling site is expected to be basic (pH 7 to 14), standards of pH 7.00 and 10.00 should be used to calibrate the meter. The pH of the buffer solution is temperature dependent. That is, pH 10 buffers change more per unit change in temperature than do pH 4 buffers. The temperature of buffer solutions must be

measured, and temperature-correction factors must be applied before calibration adjustments are made. Calibration and operating procedures differ with instrument systems— check the manufacturer's instructions. If pH measurements at the sampling site do not fall within the initial calibration range, the meter should be recalibrated with appropriate standards and sample pH remeasured for those samples that fell outside the calibration range. For more detailed procedures, see discussion in Wilde et al. (2006).

Transparency

Water column transparency is measured with a Secchi disk, which is a weighted, black-and white or all-white disk that is lowered into the water body on a calibrated rope or line.

Measurement should be performed from the side of the boat that faces away from the sun. The disk is lowered slowly until it is no longer visible and then raised until it is visible again. The depth, measured from the water surface, is recorded in feet or meters. The all-white disk may be preferable when the water transparency is high. Either disk, however, is acceptable to use.

Turbidity

Turbidity may be measured in the field on static water samples contained in jars with a field-portable nephelometer (turbidity meter) or *in situ* with a turbidity probe mounted in a multi probe device. The meter should be calibrated prior to use with at least two standards of different but known turbidity (in nephelometric turbidity units or NTUs). The two standards should bracket the range of turbidity measurements expected at the sampling site.

When performing field analysis for turbidity on static water samples, samples should be analyzed as soon as possible after collection. If immediate analysis is not possible, the sample should be agitated prior to analysis to resuspend any settled solid material. If the sample temperature increases, air bubbles may form and cause erroneous values.

When performing field analysis for turbidity *in situ*, the turbidity probe is constantly monitored with a remote display and data can be recorded manually or digitally. For more detailed procedures, see Anderson (2005).

Conductivity or Salinity

Salinity may be measured in the field with a salinometer, and conductivity with a conductivity meter. There are two types of conductivity sensors as described below.

- **Contacting-type sensors with electrodes.** Electrodes contained in a dip cell can be suspended in the sample. The cell constant is the distance between electrodes (in centimeters) divided by the effective cross-sectional area of the conducting path (in square centimeters). A cell constant is chosen on the basis of the expected conductivity. The greater the cell constant, the greater the conductivity that can be measured.
- **Electrodeless-type sensors.** Conductivity is measured by inducing an alternating current in a closed loop of solution, and measuring the magnitude of the current. Measuring errors in this type of electrode are minimized because sensors do not have issues with electrode polarization or electrode fouling.

The conductivity meter should be calibrated prior to use according to the manufacturer's directions using a standard of known conductivity. The conductivity of the standard should be close to the expected value at the sampling site. When measuring a sample for conductivity, the sample should be swirled or stirred until the meter is stabilized and a measurement is recorded. For more detailed procedures, see Radtke et al. (2005).

Salinity can be automatically calculated from conductivity, temperature and barometric pressure readings in the same multi probe and displayed on the meter of most models. Salinity may also be calculated from the measured conductivity and temperature of a sample according to Standard Method 2520B (APHA 1998). Gross salinity measurements may also be taken with a field-portable refractometer. This instrument will provide salinity measurements with an accuracy of 1 to 2 parts per thousand. For more detailed procedures, see APHA (1998).

ORP or Eh

Oxidation-Reduction Potential or Eh may be measured in the field with an inert metal electrode and read relative to a reference electrode that is immersed in the same medium. For most multi probe units, the inert metal electrode is a button or ring made of platinum and the Ag/AgCl reference electrode is the same one connected to the pH probe. The readout of the sensor is a voltage (relative to the reference electrode), with positive values (e.g., + 300 mV) indicating an oxidizing environment (ability to accept electrons) and negative values (e.g. -300 mV) indicating a reducing environment (ability to donate electrons) (YSI 2005).

ORP and Eh are the same parameters in that both measure the potential of the medium to transfer electrons. However, the ORP reference electrode is made of different material than the Eh standard reference hydrogen electrode (SHE) and therefore, there is a voltage

offset that needs to be taken into account when converting ORP measurements to Eh values.

More detailed explanation on the theoretical concept, voltage offset conversions, method limitations and interferences can be found in the attached YSI Tech Note (2005) and in Nordstrom and Wilde (2005).

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STANDARD OPERATING PROCEDURE SOP-SW7

CLEAN-HANDS TECHNIQUE FOR SURFACE WATER SAMPLING

Scope and Application

The concentration of many metals in ambient waters is typically very low ($<1 \mu\text{g/L}$), and collecting water samples that are representative of ambient conditions requires extreme care to prevent contaminating the sample during handling. This standard operating procedure (SOP) utilizes and augments the procedures outlined in the San Francisco Estuary Institute's *Field Sampling Manual for the Regional Monitoring Program for Trace Substances* (David et al. 2001), the *Interagency Field Manual for the Collection of Water-Quality Data* (USGS 2000), and U.S. Environmental Protection Agency (EPA) Method 1669, *Sampling Ambient Water for Trace Metals at EPA Water Quality Criteria Levels* (USEPA 1996). The following technique is commonly called the "clean-hands technique." It employs two people, one designated as the "clean-hands person" and the other designated as the "dirty-hands person."

While sampling for trace metals, clean sampling techniques will be used for the collection of unfiltered organic compounds and conventionals, such as total suspended solids (TSS), filtered dissolved organic carbon (DOC), and dissolved suspended solids (DSS). By following this SOP, the collection of other samples besides trace metals guarantees a high level of sample integrity and minimizes contamination during sample handling.

Equipment Decontamination

If required in the project-specific field sampling plan, the analytical laboratory may be in charge of providing decontaminated sampling equipment prior to the sampling event. The analytical laboratory will decontaminate sample tubing, mixing carboys, and sampling jars according to their specific laboratory SOPs (see project-specific quality assurance plan). Additional field equipment will be cleaned and decontaminated by Integral Consulting Inc. (Integral), as described below.

Equipment and Reagents Required

A workbox will be built with $\frac{3}{4}$ -inch PVC tubing and covered with a 6-mil plastic sheet in order to contain the sampling equipment (e.g., peristaltic pump or Go-Flo™ bottle) and conduct the sample processing. One side of the workbox will be left open for placing sampling equipment and sample carboys. All components will be washed with Alconox™, tap-water rinsed, acid washed, and deionized water rinsed.

Initially, stands and clamps used to secure the receiving Teflon™ tubing and filter cartridge are made of nonmetallic components or resin-coated stainless-steel and will be soap washed, tap-water rinsed, dilute 10 percent acid (nitric or HCl) washed, and deionized water rinsed. At the beginning of each subsequent sampling day, the stands and clamps will be soap washed and tap-water rinsed.

Procedures

Initial Steps and Precautions

Before water samples are collected, the following steps or precautions must be taken to avoid sample contamination:

1. Prior to collecting the sample or handling the sampling equipment or sample bottles, a quick survey of the sampling area should be performed to identify sources of potential contamination to the sample (e.g., sources of dust, engines running, batteries). If there is an obvious source, it should be removed, cleaned, or isolated from the sample handling area.
2. Both the clean-hands and dirty-hands persons will wear lint-free clothing, which reduces the amount of airborne dust in the immediate vicinity of the sample. These clothes can be made of nylon, Tyvek, or a plastic-coated material (e.g., Saranex). These suits should be kept isolated from dust and contamination (in plastic bags) until ready for use and should be discarded after they have been used once. Other appropriate clothing includes coated or plastic rain suits, and suits worn for hazardous waste site investigations.
3. After the samplers are dressed in the appropriate sampling clothing, care should be taken to avoid bumping into potentially contaminated surfaces.
4. Two pairs of nitrile gloves will be worn by sampling personnel while working. The sampler will put on one pair of nitrile gloves and then while wearing the first pair of gloves, the sampler will put on a second pair of gloves over the first pair. The gloves are powder-free, clean-room gloves

(e.g., Oak Class 100 or nitrile, powder-free). These gloves come in vacuum-sealed plastic bags containing 50 pairs. Once opened, the entire pack is potentially exposed to contamination. To minimize this potential, open only the end of the bag at the wrist end of the glove (not the fingertip end), and remove only one pair at a time. Keep the unused gloves in the original bag inside a large Ziploc® bag. When handling the clean gloves, do not touch the fingertips; handle the gloves only around the wrist.

4. At all times, the clean-hands person must avoid touching surfaces that are not known to be clean, including their suit. The clean-hands person should only touch the inner bag and the sample bottle used during sample collection. While sampling, both samplers must be conscious of the potential chains of contamination that can occur. A chain of contamination could involve handling an object that touched another object that touched something contaminated. Unless it is known whether an object is clean (i.e., was cleaned appropriately and isolated from contaminants from the time of cleaning until the time of use), it should be assumed that it is dirty.

Sample Collection

The following procedure assumes that properly cleaned and packaged bottles have been shipped from the analytical laboratory. After the initial steps have been taken, the clean-hands person and the dirty-hands person will use the following procedure to collect the samples:

1. To remove the sample bottle from the plastic bags, the dirty-hands person will remove the double-bagged bottle from the ice chest and open the outer bag. While the dirty-hands person is holding the outer bag open, the clean-hands person will reach inside, lift the inner bag (but not remove it), open it, remove the sample bottle, and push the inner bag back down inside the outer bag. The dirty-hands person will close the outer bag. See Consideration 1 below.
2. In some cases, the caps on sample bottles are closed so tightly that they cannot be opened by hand. If this occurs, set the bottle aside and use another bottle. [Note: the laboratory may need to be promptly informed to send more bottles if this is a persistent problem during the sampling event.]
3. The clean-hands person will remove the cap and, while filling the bottle, will hold the cap in the upright position so that particles cannot land inside the cap. If the cap must be set down, lay down a clean vinyl glove and place the cap upright on it.

4. While the clean-hands person is filling the sample bottle, the dirty-hands person will keep the outer bag closed and prepare the sample tag. When the sample bottle is full, the clean-hands person will replace the cap and tighten it.
5. The dirty-hands person will open the outer bag, and the clean-hands person will reach inside, lift the inner bag, place the bottle in the inner bag, and seal it. Before lowering the bagged bottle into the outer bag, the dirty-hands person will place the sample tag on the inner bag. The clean-hands person will then lower the inner bag into the outer bag, and the dirty-hands person will close the outer bag and place the bagged bottle in the ice chest.

Note: Despite the fact that the person handling the outside plastic bag is called the dirty hands, the dirty hands person will maintain the same level of care as the clean hands person to avoid any cross contamination of the sample.

Additional Considerations

1. Sample bottles for mercury are made of either fluorinated ethylene propylene (FEP) Teflon®, FEP Teflon®-lined polyethylene bottles, or glass and are double-bagged in Ziploc® bags. Because labels do not stick to Teflon®, each sample bottle has a unique identifier etched on the outside. If FEP Teflon®-lined polyethylene bottles are used, then each sample bottle will be labeled with an Integral sample label affixed to the outside of the bottle. It is assumed that the exterior of the outer bag is contaminated and that its contents are clean. Therefore, only the dirty-hands person is allowed to handle the outer bag, and only the clean-hands person its contents.
2. It is common for the caps on Teflon® bottles not to seal well, and they will frequently leak if tightened only by hand. Strips of parafilm can be wrapped around the cap to keep it from leaking. The strips of parafilm can be prepared prior to going into the field. The strips of parafilm should be cut with ceramic scissors and the pre-cut strips can be placed in a separate doubled- Ziploc® bag (CETAC 2007).
3. Rain has elevated concentrations of mercury relative to most surface water samples and may contaminate a sample. Sampling will be done inside a processing chamber consisting of a PVC structure covered in 6-mil plastic sheathing. This will protect the sampling bottles from rain water or airborne dust particles during sample collection.
4. If there is any question as to whether gloves are clean, change gloves.

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STANDARD OPERATING PROCEDURE SOP-SW15

LABORATORY DECONTAMINATION PROCEDURES

Scope and Application

If low analytical reporting limits are required (see project-specific sampling and analysis plan), then sampling equipment must be decontaminated at a qualified laboratory. Each participating laboratory is responsible for preparing the equipment prior to the sampling event. Pre-designated commercial laboratories will decontaminate sample tubing, mixing containers, and sampling jars according to steps described below.

Summary of Method

Preparation of the Teflon™ sample tubing will be completed in the laboratory 3–4 weeks before the start of a sampling event. All sample tubing, filters and containers will be decontaminated, pre-assembled and packed for the field in double bagged polyethylene bags.

Decontamination of tubing, filters, stir bars, and containers consists of soaking the sampling equipment in cleaning solutions for a pre-determined amount of time and then rinsing it with distilled/deionized water (DI) water. A peristaltic pump is used to fill the Teflon™ sample tubing with cleaning solutions and to flush with DI water between cleanings. In similar fashion, sampling filters are also attached in series with C-flex™ tubing, filled with cleaning solutions and flushed with DI water between cleanings. The Teflon™ tubing ends and in-line filters are joined together with C-flex™ tubing for transport to the field.

Procedures

The procedure that will be used for each type of sampling equipment is provided below. Selected equipment (e.g., tubing) will be used for collection of all target parameters. However, selected equipment (containers, filter units) will be processed separately for metals and organics.

Teflon™ and C-Flex™ Pump Tubing and Teflon™ Coated Stir Bars for Intake Water

The Teflon™ and C-Flex™ tubing used for the intake of site water and Teflon coated stir bars used in the containers will be cleaned for all target parameters. Cleaning procedures are as follows:

- Completely fill sample tubing with reagent grade methanol and let it soak for 24 hours.
- Soak the appropriate number of stir bars in reagent grade methanol for 24 hours.
- Drain methanol solution from the tubing and stir bars and flush with approximately 10 liters (L) of DI water.
- Completely fill sample tubing with dilute reagent grade hydrochloric acid (HCl) and let soak for 24 hours. Soak the appropriate number of stir bars in reagent grade HCl for 24 hours.
- Drain acid and flush tubing and stir bars with DI water. Fill tubing with DI water, and soak stir bars with DI water and let set for 24 hours.
- Double bag clean tubing and stir bars, label outside bag identifying cleaning process used, and store in double-bagged polyethylene bags until assembly.

Teflon™ and C-Flex™ Pump Tubing From Filtration Units to Sample Jars

The Teflon™ and C-Flex™ tubing used from the filtration units to the sample jars will be cleaned for metals or for organic and conventional parameters, as described below:

Metals, Nutrients, and Conventional Analysis

- Completely fill sample tubing with dilute reagent grade HCl and let soak for 24 hours.
- Drain acid and flush tubing with DI water, fill with DI water, and let set for 24 hours. Drain, rinse with DI water, and drain.
- Double bag clean tubing, label outside bag identifying cleaning process used, and store in double-bagged polyethylene bags until assembly.

Organic Analysis

- Completely fill sample tubing with reagent grade methanol and let it soak for 24 hours.
- Drain methanol solution from the tubing and flush with approximately 10 L of DI water.

- Double bag clean tubing, label outside bag identifying cleaning process used, and store in double-bagged polyethylene bags until assembly.

Filter Cartridges

The 0.45 µm Teflon™ filter cartridges will be used for the collection of dissolved trace metal samples and DOC in water. The following procedures are used for cleaning the 0.45 µm filter cartridges for metals, DOC, and conventionals:

- The 0.45 µm Teflon™ filters are hydrophobic and need to be “wetted” with methanol prior to rinsing with a water-based solution.
- Pump methanol through the filter unit to wet the filter
- Drain the methanol and flush the filter with DI water for approximately 10 minutes
- Fill the filter unit with dilute HCl and allow it to soak for 24 hours
- Drain the acid and flush with DI water.
- Fill the unit with DI water and allow to soak for 24 hours
- Followed by a series of draining and rinsing procedures with DI water, the filter units are dried in a laminar flow hood and double-bagged in polyethylene bags.

Glass and Polycarbonate 10–20 Liter Containers:

The glass and polycarbonate containers will be used to composite the sample prior to distribution to the sample containers. The cleaning procedure for metals and for organic and conventional parameters is described below:

- **Polycarbonate container (metals, nutrients and conventionals)**
 - Half-fill the container with dilute reagent-grade HCl. Secure the lid and place the container on its side for 12 hours
 - Rotate the container to the other side for an additional 12 hours
 - Drain the acid and rinse with DI water
 - Drain the DI water and let it dry in a laminar flow hood
 - Double-bag the polycarbonate container in polyethylene bags.

- **Glass Container (organics)**
 - Rinse the glass container three times with methanol using a squeeze bottle and thoroughly coat all inner surfaces
 - Drain the methanol and rinse with DI water
 - Drain the DI water and let it dry in a laminar flow hood
 - Double-bag the glass container in polyethylene bags.

Assembly

After all the components have been cleaned, the peristaltic pump collection and filtration units will be assembled by the laboratory performing the sample equipment decontamination. The assembled units will be double-bagged in polyethylene bags, labeled for identification on the outside bag, and sent to the field laboratory.

Laboratory and Decontamination Blanks

Laboratory and decontamination blanks will be collected for each sampling event. A cooler will be sent to the laboratory performing the decontamination with pre-labeled bottles, along with chain-of-custody forms, custody seals, and a temperature blank. The two types of blanks are described below.

- **Laboratory Blank.** A laboratory blank is a sample of analyte-free water that is supplied by the laboratory. The laboratory blank is generated by transferring the analyte-free water to another laboratory-supplied sample container. Laboratory blank results are used to measure and document any possible laboratory contamination.
- **Decontamination Blank.** Prior to the start of sample collection activities for each sampling event, a decontamination blank will be generated by the laboratory that conducts decontamination of the peristaltic pump sampling equipment (i.e., containers, filters, tubing and tubing connectors) to ensure that the decontamination procedure is adequate.

The blanks will then be sent back to the analytical laboratory for analyses of all pertinent target analytes within 1–2 days of collection. Samples must be received by the laboratory at or around $4\pm 2^{\circ}\text{C}$.

STANDARD OPERATING PROCEDURE SOP-SW16

COLLECTION OF DISTURBED-SEDIMENT NEAR-SURFACE, NEARSHORE SURFACE WATER SAMPLES

Scope and Application

This standard operating procedure (SOP) defines and standardizes the methods used to collect surface water samples from areas where recent sediment disturbance has occurred in freshwater or marine environments.

A goal of this SOP is to ensure that the highest quality, most representative data be collected, and that these data are comparable to data collected by different programs that follow U.S. Environmental Protection Agency guidelines. Water samples associated with disturbed sediment will be used to assess risk associated with accidental ingestion of water during in-water activity.

Trace clean sampling techniques, which are described in SOP-SW4, will be used to collect the surface water samples. Adherence to the instructions in SOP-SW4 will ensure a high level of sample integrity and minimize the potential for contamination during sample handling.

Station Access

Prior to entering select areas such as private beaches, it may be necessary to acquire property access permission from the landowner. Access permission must be acquired in advance of the sampling program and may require a written agreement.

Station Location

Near-surface, nearshore surface water samples must be collected in a manner that actively resuspends sediments into the water column prior to samples being collected.

If undisturbed surface water samples are to be collected at the same proposed sampling location as disturbed-sediment surface water samples, they must be collected first. Also, to avoid interference from resuspended sediment at other undisturbed surface water stations, samples should be collected beginning with the most downstream station and continuing in an upstream direction.

Water samples should be collected in areas that are representative of the surface water body conditions. A station that is located away from immediate point sources (e.g., tributaries, and industrial and municipal effluents) is preferred for collecting surface water samples unless sampling is designed to assess these sources.

Attention must be given to identifying intakes and outflows within lagoons or settling ponds, which may cause localized concentrations that are not representative of general conditions. Sample locations adjacent to structures (e.g., banks, piers) may also have biased characteristics as a result of flow or release of substances from the structure. These kinds of possible confounding factors should be noted in the field logbook.

Summary of Method

Surface water samples will be collected following sediment disturbance that simulates the type of disturbance that would be expected to occur as a result of shallow water play during recreation, in-water work such as fishing, or other near-shore human activity. Sediments will be disturbed by a sampling staff member wearing chest waders and a personal flotation device (Person A) who will walk back and forth through the water just upstream of where the sample is collected. Surface water samples for standard chemical and conventional analyses will be collected by a second sampling staff member (Person B) downstream of Person A conducting the sediment disturbance. Person B will collect water from approximately 0.25 m below the water surface where total water depth is approximately 1 m. Sampling at approximately 0.25 m below the water surface allows for a sample to be collected at the depth most likely associated with incidental ingestion. Sampling at this depth, which is below the surface–air interface and the surface water microlayer, also prevents the collection of non-representative compounds such as transient dust particles and thin oil films. (Note: These depths are recommended water depths and should be confirmed in the project-specific sampling and analysis plan [SAP] prior to sample collection).

Two different kinds of sampling devices may be used to obtain the water samples depending on the project-specific needs: 1) a peristaltic pump with an extended sampling tube placed at the desired water depth or 2) a Teflon™ or high density polyethylene (HDPE) bottle on an extension pole. A dedicated, laboratory-cleaned bottle or tubing will be used at each sampling location for sample collection. Detailed sample surface water collection procedures are described herein and in SOP-SW1 and SOP-SW4.

Procedures

There should be three people on the sampling team in addition to the boat crew. Two people are needed to conduct the sampling and a third person is required to keep track of sample logging and sample processing.

At each station, Person A, wearing chest waders, will enter the river to a depth of approximately 1 m, and will walk parallel to the shoreline for approximately 10 m (unless otherwise stipulated in the project-specific SAP). A marker (e.g., wire stem colored flag) will be placed on the beach marking the upstream and downstream sampling area limits. A water depth of approximately 1 m can be determined using a lead line or digital handheld depth sounder or by simply marking the waders being worn by Person A with tape. Person A will walk back and forth along the shoreline actively disturbing the bottom sediment during sample collection. This walk and active sediment disturbance will be repeated for as long as is necessary, within a 5 or 10 m span of shoreline as described below, to obtain the required sample volume.

The water sample can then be collected by Person B in one of two ways:

1. **If Person B can enter the water to follow Person A:** Person B, wearing chest waders, will enter the water approximately 10 ft downstream of the area where the sediment is to be disturbed and walk perpendicularly out from the shore until the water depth is approximately 1 m. Approximately 10 m (33 ft) of tubing will be attached with plastic ties to a 2.54 cm (1 in.) diameter polyvinyl chloride (PVC) or aluminum pipe with a handle. The Teflon™ tubing intake will be lowered by Person B to approximately 0.25 m (10 in.) below the water surface or 1 m (3 ft) off of the sediment surface. Person B will follow Person A, holding the intake opening approximately 30 cm (12 in.) away from Person A. Persons A and B will repeat this procedure back and forth along the length of the shore until the necessary volume for all required chemical analyses is collected.
2. **If Person B cannot enter the water to follow Person A:** Person B will remain on the boat deck. The intake opening on the Teflon™ tubing will be covered by a cap and the cap will be removed just before sampling. The Teflon™ tubing will be attached with plastic ties to a 2.4 m (8 ft) long, 2.54 cm (1 in.) diameter PVC or aluminum pipe, extending 30 cm (12 in.) from the end of the pipe. Person B will remain on deck, holding the tubing intake approximately 25 cm (10 in.) below the water surface. While facing the current, the boat will remain anchored between the beach and a safe distance from person A in the water. The disturbed-sediment surface water sample will be collected by placing the intake tubing on the path where the river current transports the disturbed-sediment water downstream. Person A will walk back and forth along the shore over a distance of 5 m until the necessary volume for all required chemical analyses is collected. Person B will use the length of PVC pipe (8 ft) and the walkable surface of the boat deck to keep the intake opening of the tubing within 30 cm (12 in.) away from Person A during the sediment disturbance activity to collect the necessary volume of sample needed for all chemical analyses.

Onboard the boat or on the beach, a third field sampling member (Person C) will be control the peristaltic pump, monitor surface water movement into the carboys, and take notes. Person C will also set up the multi-probe for measuring the water quality parameters while the peristaltic pump is active.

Using a peristaltic pump, the outflow from the sampling tube is directed into either a polycarbonate (for inorganic analyses including tributyltin), HDPE (for inorganic analyses), or glass or stainless-steel (for organic analyses) composite mixing container as described in the SOP for surface water sampling using a peristaltic pump (SOP-SW4). Equal volumes of water will be pumped into each large, pre-cleaned 10-L or 20-L mixing container (depending upon the project-specific needs) that is equipped with a Teflon™-coated magnetic stirring bar and placed over a magnetic stir table. The containers are used for mixing and compositing samples for subsequent chemical analysis.

Following sample compositing in the mixing container, appropriate sample bottles (see project-specific SAP) are filled using a second peristaltic pump, with the outflow directed into the sample bottle. If enough water volume is available and the project-specific SAP requires it, the sample bottle is held near the pump outlet, and the sample container is rinsed one or two times, the rinsate is discarded, and then the sample bottle is filled. However, because laboratory bottles come pre-cleaned, this rinsing option is not mandatory if water volume is an issue. Field rinsate blanks are collected to ensure that sampling containers are not a source of contaminants. If preservatives are present in the sample bottle, then the rinsing step is to be omitted. The sample containers are capped, labeled, and placed inside a cooler and stored at approximately $4^{\circ}\pm 2^{\circ}\text{C}$.

Only one type of surface water sample may be collected when the bottom sediment has been disturbed, namely unfiltered. Samples for total suspended solids (TSS) are generally filtered at the laboratory (see project-specific SAP).

At the end of the sampling event, Person C, who is in charge of taking field notes, will be responsible for the following tasks:

1. Recording the midpoint of the sampling location with a GPS unit
2. Recording the surface water quality parameters
3. Labeling all jars and fill the sample bottles with composited surface water samples from the carboys
4. Completing all chain of custody forms.

Equipment Preparation

A sufficient amount of decontaminated sampling tubing or sample collection bottles should be brought to the field to avoid performing decontamination procedures between stations. Each participating laboratory is responsible for preparing its equipment prior to the sampling cruise. Pre-designated commercial laboratories will decontaminate sample tubing, sample collection bottles, and mixing containers according to their specific SOPs.

The chest wader used for disturbing the river bottom should be decontaminated with Alconox™ and a plastic brush and thoroughly rinsed with site water. A new pair of waders will be purchased for this type of sampling to ensure that they have not been previously worn at contaminated sites.

A workbox built with ¾-in. PVC tubing and covered with a 6-mil plastic sheet will be supplied to contain the peristaltic pump sampling equipment and conduct the subsampling from the carboys. One side of the workbox is left open for placing sampling equipment and sample containers. All components are washed with Alconox™ and rinsed with tap-water. Stands and clamps used to secure the receiving Teflon™ tubing must be made of non-metallic components or resin-coated stainless steel and will be soap washed with soap, rinsed with tap water, washed in an acid solution, and rinsed with distilled/deionized water.

A water quality multi-probe will be used for measuring surface water parameters, such as temperature, pH, dissolved oxygen, conductivity, oxidation-reduction potential (ORP), and turbidity. The unit will come pre-calibrated from the laboratory or leasing company, and will be checked daily for proper functioning and drift. It will also be calibrated daily for certain parameters such as pH, conductivity, ORP, and dissolved oxygen. The multi-probe unit will be deployed as close as possible to the time of sample collection. The proper handling of the multi-probe is described in detail in SOP-SW6. Except for the probe sensor, all components are washed with soap washed (Alconox™) and rinsed with tap water.

Take the following steps to set up the surface water collection system and follow the procedures in SOP-SW4:

1. Determine the correct position of the sampling station and have the captain anchor the vessel downstream from the sampling station and into the current near the sampling site and switch off the engines.
2. Set up a clean area for the workbox. Set the workbox on a secure table or bench top onboard the sampling vessel to house stir plate(s) and a small peristaltic pump. Provide enough space inside the workbox for a stand to hold the outlet tubing and to collect surface water and processing sample bottles.
3. Place stirring plate(s) inside the workbox and the mixing container(s) on top of the plate. Each mixing container (a polycarbonate container for inorganic analytes and a glass or stainless-steel container for organics) will be checked to ensure:
 - Containers were properly wrapped by the laboratories and do not contain rips or holes that may have occurred during shipment to the field
 - Each container contains a 3-in. stir-bar at the bottom

- All components, such as inflow and outflow tubing have been properly assembled in the laboratory (e.g., one end of the outflow tubing should be touching the bottom inside the container) and are intact and securely placed on the cap.
4. Attach the outlet tubing “kits” (i.e., Unit #3) to the mixing containers. The kits are composed of 10-cm C-Flex™ tubing, 0.5-m Teflon™ tubing, 30-cm C-Flex™ tubing, and 30-cm Teflon™ tubing, placed sequentially.
 5. Place the small peristaltic pump inside of the workbox.
 6. Place a stand inside the workbox and secure each tubing outlet from both mixing containers with clamps.
 7. Attach Teflon™ tubing (collecting end) to 30-cm C-Flex™ tubing and a 1-m Teflon™ tubing, sequentially, and then connect these interconnected pieces of tubing to a mixing container (polycarbonate for inorganic chemicals and glass or stainless steel for organic chemicals). Clamp the C-Flex™ tubing section firmly into place inside the large peristaltic pump head, which is placed outside the workbox. Note: The length of the Teflon™ tubing will vary depending on project-specific requirements and water depth at a given station.
 8. Attach the intake part of the Teflon™ tubing to the sampling PVC or aluminum pipe. Care must be taken not to remove the protective cap from the tip of the sample collecting tube until the sampling device is ready for submersion.
 9. Secure the pump and pump speed controller and connect them to the vessel’s power source with an extension cord. If vessel power is not available, use a pump that can be operated under its own battery power supply.

Sample Collection

Take the following steps to collect and process the surface water samples:

1. Persons A and B enter the water¹ to approximately 1 m water depth and begin walking parallel to the shoreline, with Person B approximately 10 ft downstream of Person A, and Person A kicking sediment while walking.
2. Person B removes the protective cap from the sampling tube

¹ Unless conditions prohibit Person B from entering the water, in which case Person B will remain on deck while collecting the sample as described above.

3. Person C switches the pump on and pumps surface water through the sample tubing and into the mixing containers. Once the water reaches one-third the container's volume, the stir plates are turned on.
4. Turn off the pump once the mixing containers have been filled to 1 in. below the inflow spout or when sufficient volume has been collected to fill all of the sample bottles at a given station.
5. Place the C-Flex section of the outflow tubing kit from the first container to be sampled inside the small peristaltic pump head and clamp firmly.
6. Before the small pump is turned on, make final adjustments to the stand holding the outflow spout as close to the sample bottle opening, but without touching the inside of the bottle.
7. Fill container up to the neck with unfiltered sample water.
8. As soon as a sample container is filled, turn off the peristaltic pump, and label the container. The sampling label should contain the date, time, project name or number, sample ID, type of analysis required, and sampler initials (see SOP-AP4).
9. Once a surface water sample container is properly closed and labeled, place it inside a cooler containing wet or blue ice and store at approximately 4°C. All samples are stored in coolers with ice on board the vessel and transferred to the field laboratory (if applicable) at the conclusion of the sampling day.

Equipment and Reagents Required

The general types of equipment that are required are described in this section. Additional equipment may be required depending upon project-specific needs.

- Peristaltic pump and sample tubing (type and length are site dependent) or water sample collection bottle (type is site dependent; consult project-specific SAP)
- Surface water parameter multi-meter capable of measuring pH, reduction/oxidation (redox) potential, temperature, specific conductance, turbidity, and dissolved oxygen
- PVC pipes and plastic sheeting
- Polycarbonate or HDPE (inorganic analyses) and/or glass or stainless-steel (organic analyses) mixing containers (see project-specific SAP for analyte list)
- Stir plate
- TeflonTM-coated stir bars

- Water Sampling Log forms
- Sample tags/labels and appropriate documentation (e.g., chain-of-custody forms)
- Insulated cooler(s), chain-of-custody seals, Ziploc® bags
- Sample containers with preservative, coolers, and blue ice or equivalent.
- Measuring tape or laser rangefinder
- Plastic ties

One peristaltic pump may be used at each sampling station for collecting surface water samples. The same pump that is used to fill the mixing containers will be used to collect unfiltered samples from the mixing containers. Depending on project-specific needs (see SAP), a water collection bottle may be used instead of the tubing and peristaltic pump.

If ultra-low detection limits need to be obtained during laboratory analysis (see project-specific SAP), then a sample processing and preservation chamber (i.e., workbox) made of PVC pipes and 6-mil plastic sheeting used to house stir plate(s), a peristaltic pump, sampling bottles, and ancillary equipment should be used. A polycarbonate, HDPE, glass, or stainless-steel mixing container (10 or 20-L) is placed on the stir plate. Each mixing container is equipped with a 3-in.-long Teflon™-coated stir bar at the bottom and a lid containing an inflow, outflow, and vent Teflon™ spouts (see SOP-SW4).

Water Quality Measurements

If specified in the project-specific SAP, physical and chemical water parameters may need to be collected at surface water stations. Several physical and chemical water parameters are best measured in the field because of the unstable nature of the parameter or because the information is needed to direct further sampling. It is often preferable to perform these analyses in the field, especially if the samples will not be immediately transported to the analytical laboratory (pH, in particular, should be measured in the field if feasible). In addition, measurements of temperature and transparency can be collected accurately only in the field.

Collection of water quality parameters should begin immediately after sample collection has been completed at the collection location using the water quality meter (e.g., YSI, Hydrolab, Horiba). Data collection intervals should be set according to data needs.

Sampling personnel should record the water quality measurements on the Water Sampling Log forms.

It is best if the water quality meter is placed directly into the surface water body at the station location at the desired water depth instead of collecting a sample and measuring parameters in a container. However, if this is not possible, a plastic bucket can be used to

collect samples for water quality analyses (e.g., pH, temperature, and conductivity). A clean bucket should be rinsed twice with the water from the station prior to measuring water quality parameters.

The name(s) of the person(s) making the measurement and the field equipment used to make that measurement must be recorded in the field logbook and on any field forms used during the sampling event. Equipment maintenance and calibration records must be kept in logbooks and field records so that the procedures are traceable.

Sample Handling

Gloved hands are required for sample collection and handling, as described above. Field staff will wear appropriate non-contaminating, disposable, powderless nitrile gloves during the entire sampling operation. Gloves will be changed frequently, usually with each change in task (wearing multiple layers of gloves allows rapid glove changes).

Gloved hands are required for all operations that involve equipment that comes into contact with the sample, including the following activities:

- Handling the sample bottle
- Handling the discharge end of the sample tube or line
- Setting up working space inside the processing and preservation chambers
- Setting up the equipment (i.e., the sample bottles, mixing containers, and the filtration and preservation equipment) inside the chambers
- Working inside the chambers during collection, processing, and preservation

Ungloved hands take care of all operations that involve contact with potential sources of contamination, including the following activities:

- Working exclusively exterior to the processing and preservation chambers
- Preparing a clean workspace (inside boat)
- Preparing and operating the sampling equipment, including the pumps and discrete samplers, peristaltic pump switch, pump controller, and manifold system
- Handling the generator or other power supply for samplers
- Handling the tools, such as hammers, wrenches, keys, locks, and sample-flow manifolds
- Handling the single or multi-parameter instruments for field measurements
- Setting up and checking the field-measurement instruments
- Measuring and recording the water depths and field measurements
- Changing the chamber covers as needed.

All samples are stored in coolers with ice at approximately 4°C onboard the vessel and are transferred to the field laboratory (if applicable) at the conclusion of the sampling day. The sampling team leader is responsible for maintaining sample integrity throughout the sampling event.

If storage freezers or refrigeration units are available at the field laboratory, these units will be monitored daily to ensure temperature compliance. Each unit will have a separate log form containing date, time, and temperature information.

Sample contamination will be avoided by handling the sample containers with clean gloves, and transferring the samples into clean refrigerators (or clean coolers) immediately after samples have been brought back from the field. Sample bottles will always be handled by personnel wearing disposable powderless nitrile gloves. This includes any and all sample handling that may occur during sample packing and shipping (see SOP-AP1).

Related SOPs

- All surface water samples will be packaged and shipped in accordance with procedures outlined in SOP-AP1.
- Field activities will be recorded in accordance with procedures outlined in SOP-AP2.
- Sample custody will be maintained in accordance with procedures outlined in SOP-AP3.
- Surface water samples using the peristaltic pump will follow procedures in SOP-SW4.

STANDARD OPERATING PROCEDURE SOP-SW17

HIGH-VOLUME SURFACE WATER SAMPLING FOR ANALYSIS OF ORGANIC COMPOUNDS WITH LOW DETECTION LIMITS

Scope and Application

This standard operating procedure (SOP) describes the protocol for collecting high-volume water samples using TeflonTM-lined polypropylene tubing with a MasterFlexTM PR2900 pump system, or equivalent, coupled with a polyurethane foam (PUF) cartridge and a vortex separator. High volumes of surface water samples are collected to quantify surface water concentrations of targeted organic chemicals (e.g., dioxins, PCBs, and pesticides) that could be present at levels too low to be detected using conventional sampling methods.

Sampling unfiltered water for hydrophobic organic compounds may yield quantities too low to be detected by standard analytical measurement techniques. High-volume surface water sampling techniques make it possible to obtain enough mass from the water column to allow quantitation of these compounds by conventional analytical techniques. A high-volume of water is collected with a pump and is passed through a vortex separator and then through a cartridge containing solid phase extraction PUF that binds the dissolved forms of the compound in question. The compounds that bind to adsorbent foam material are later extracted in the laboratory and measured on a gas chromatograph/mass spectrometer. Once the mass of the compound on the adsorbent material has been determined, the concentration of the compound in water can be calculated.

Trace metal clean sampling techniques are also used for the collection of water samples to be analyzed for organic compounds and conventional parameters, such as total suspended solids, dissolved organic carbon, and total dissolved solids. Using these techniques guarantees a high level of sample integrity and minimizes the potential for contamination during sample handling.

This SOP utilizes and augments the procedures outlined in the San Francisco Estuary Institute's *Field Sampling Manual for the Regional Monitoring Program for Trace Substances* (David et al. 2001), the *Interagency Field Manual for the Collection of Water-Quality Data* (USGS, various dates), and U.S. Environmental Protection Agency (EPA) Method 1669, *Sampling Ambient Water for Trace Metals at EPA Water Quality Criteria Levels* (USEPA 1996).

A goal of this SOP is to ensure that the highest quality, most representative data are collected, and that these data are comparable to data collected by different programs that follow EPA guidelines.

Station Access

Prior to entering select areas such as private beaches, embayments or proximity to docks, it may be necessary to acquire permission from the landowner to access the property. Access permission must be acquired in advance of the sampling program and may require a written agreement.

Station Location

Near-bottom surface water samples must be collected in a manner that prevents resuspension of sediments into the sample being collected or samples that will be collected at other downstream stations. Therefore, care must be taken to avoid resuspending sediment into the water column and stations should always be approached from downstream. Sampling near eddies should be avoided so that water does not circulate from the sampling location to upstream of the sampling location. To avoid interference from resuspended sediment at other stations, samples should be collected beginning with the most downstream station and continuing in an upstream direction.

Near-surface water samples must be collected at least 15 cm (6 in.) below the surface–air interface or surface water microlayer to avoid collecting non-representative compounds such as transient dust particles and thin oil films unless otherwise instructed.

Water samples should be collected in areas that are representative of the surface water body conditions. A station that is located away from immediate point sources (e.g., tributaries, and industrial and municipal effluents) is preferred for collecting surface water samples unless sampling is designed to assess these sources. Representative samples can usually be collected in portions of the surface water body that have a uniform cross-section and flow rate. Because mixing is influenced by turbulence and water velocity, the selection of a site immediately downstream of a riffle area (e.g., fast flow zone) will ensure good vertical mixing.

Tributaries should be sampled as near the mouth as is feasible. However, it is important to select the sample location taking into consideration the impact that the downstream receiving water body has on the tributary flow and sediments. The downstream body may affect the tributary by decreasing water velocity (causing suspended solids to settle) or by eddies (causing mixing of the two waters). The downstream water body may change the water quality (e.g., salinity), temperature, or turbidity in the tributary near its mouth. It is important to determine how far upstream the tributary is influenced by the

downstream water body and then establish a sampling point with a reasonable distance upstream from that boundary.

Attention must be given to identifying intakes and outflows within lagoons or settling ponds, which may cause localized concentrations that are not representative of general conditions. Sample locations adjacent to structures (e.g., banks, piers) may also have biased characteristics as a result of flow or release of substances from the structure. These kinds of possible confounding factors should be noted in the field logbook. For ponds and lakes that may be vertically stratified, a multi-parameter water quality meter can be used to collect depth profiles throughout the water body to aid in the selection of appropriate sampling points and depths.

Summary of Method

Surface water samples to be analyzed for ultra-low concentrations of organic compounds will be collected using a high-volume peristaltic pump with an extended Teflon™-lined polypropylene sampling tube lowered to the desired depths (see project-specific sampling and analysis plan [SAP]). Water pumped at a rate of 2 liters per minute will be drawn through the Teflon™ tubing, passing sequentially through a high vortex separator and then through a PUF cartridge.

Three different kinds of sampling devices may be used to obtain the water samples depending upon the project-specific needs.

1. The near-surface water polyvinyl chloride (PVC) sampling structure (water sampler) has a polyurethane-coated weight suspended from the bottom of the structure to maintain it in an upright position (Figure 1a). The Teflon™-lined tubing is connected from the high volume peristaltic pump to the tip of the vane facing the current.
2. The near-bottom water PVC sampling structure has a weighted landing base designed to keep the sampling tube at a predetermined fixed distance from the bottom and prevent the intake from coming in contact with the sediment (Figure 1b). The Teflon™-lined tubing is connected from the high volume peristaltic pump to the tip of the vane facing the current.

Both types of water samplers keep the tubing intake pointing into the current with the help of a vane. The vane can be removed if the water is quiescent; if the vane is removed, the tubing can be attached to the sampler PVC shaft at the same location where the vane is normally located making sure that the intake tip extends 3 to 4 in. away from the shaft. Additional equipment, such as a multiprobe or underwater video camera, may be mounted on the PVC structure.

3. If the water column is too deep for sampling with tubing, one or more GO-FLO™ bottles may be deployed to collect surface water at the desired depth and bring it back to the boat deck where it can be pumped out by connecting the high-volume peristaltic pump to the sampling spigot of the bottle(s). For instructions on how to use a GO-FLO™ bottle system, see SOP-SW5.

At each station, when either a near-surface or a near-bottom water sampler is deployed, the Teflon™ tubing will be attached to the vane with zip ties and the water intake will be placed approximately 10 ft away from the bow of the boat with the aid of an A-frame or davit. While the boat is kept facing the current, the water sampler unit will be lowered to the appropriate depth with the help of a hydraulic or electric winch. Additional weight may need to be added to the base of the sampler to prevent it from going underneath the boat. Using a peristaltic pump, the outflow from the sampling tube is directed into an intake tube, which leads to a high vortex separator. The high vortex separator is able to separate suspended sediments by forcing the water in a centrifugal fashion before exiting towards the PUF cartridge. Water is then drawn through the PUF cartridge which contains solid phase extraction resins that bind dissolved forms of the compounds in question (e.g., PCBs). A constant rate of water, 2 L/min, is pumped through this system. Every one-half hour the rate of water pumped is checked to ensure that water is flowing at a constant rate. To check that the pump is accurately delivering the desired rate of volume, the pump outflow must be calibrated with a 2 L graduated plastic cylinder and a timer. If the pump is not delivering the correct flow rate, fine adjustments must be made until the optimum flow is achieved.

After the desired volume has passed through the PUF cartridge, the high volume peristaltic pump is turned off and the PUF cartridge is removed. Two stainless steel nuts that cap each end of the PUF cartridge are reattached. The cartridge is then labeled, taped, placed in resealable bags and then placed in a cooler with wet or blue ice. The vials from the vortex separator containing the suspended particles sample will also be capped, labeled, and wrapped in bubble wrap before being placed in a cooler with ice.

At the analytical laboratory, the cartridges and vials containing the particulate samples will be analyzed individually to determine, respectively, the apparent dissolved and particulate concentrations of analytes in the samples. These analytical results can be combined at a later date, to determine the total analyte concentration in surface water.

Equipment and Reagents Required

The general types of equipment that are required are described in this section. Additional equipment may be required depending upon project-specific needs.

A high-volume peristaltic pump will be used for collecting surface water samples. A sample processing and preservation chamber (i.e., workbox) made of PVC pipes and 6-

mil plastic sheeting is used to house the high-volume peristaltic pumps and ancillary equipment.

A detailed supply and equipment list is provided in Attachment 1 to this SOP.

Procedures

The sampling team should comprise three people. Two people are needed to conduct the sampling and a third person is required to keep track of sample logging and sample processing. In addition, the third person may be responsible for recording the surface water quality parameters.

Equipment Preparation

A sufficient amount of decontaminated sampling equipment (e.g., 20 L GO-FLO™ bottles, Teflon-line polyethylene tubing) will be brought to the field to minimize the amount of decontamination procedures that need to be performed between stations. Each participating laboratory is responsible for preparing its equipment prior to the sampling cruise. Pre-designated commercial laboratories will decontaminate sample tubing, 20L GO-FLO™ bottles, and sampling bottles according to their specific SOPs.

Decontamination of large amounts of sampling equipment requires several days, if not weeks to be ready for sampling. Contract agreements with commercial laboratories and scheduling decontamination work may require several weeks to months. This is a critical step that needs to be initiated well in advance of the sampling schedule.

The ancillary components of the high-volume peristaltic pump sample collection system are as follows:

Processing and Preservation Chamber—A workbox is built with ¾-in. PVC tubing and covered with a 6-mil plastic sheet in order to contain the high-volume peristaltic pump sampling equipment. One side of the workbox is left open for placing sampling equipment and sample containers. All components are washed with dilute solution of Liquinox™ and rinsed with deionized water. Clamps used to secure the receiving Teflon™ tubing are made of non-metallic components or resin-coated stainless steel and will be washed with soap, rinsed in tap water, washed in an acidic solution, and rinsed with distilled, deionized water.

Water Samplers—The water sampler device for near-surface sampling is made of PVC tubing with a polyurethane-coated 50 lb weight or heavier at the bottom to keep the sampler in the vertical position (Figure 1a) (Note: To reduce the potential drag at the water surface, a base is not included on the near-surface sampling device.) The near-

bottom sampling device is also made of PVC tubing and has a polypropylene vane, which is constructed with a weighted base (Figure 1b). Both of these sampling devices are attached to the boat by a Technora™ or Kevlar™ rope. Figure 1b shows the sampling device with a YSI water quality multi-meter and underwater camera attached to it. Figure 1b also shows how the Teflon™ tubing is positioned on the vane and the relationship of the inlet to the water sampler. The vane works to keep the water intake into the flow and elevated at a constant height from the bottom. Prior to commencement of sampling activities, all components will be washed with Liquinox™ and rinsed with potable water.

20 L GO-FLO™ Bottles—The GO-FLO™ sampling bottle avoids sample contamination at the surface, internal spring contamination, loss of sample on deck (internal seals), and exchange of water from different depths. It opens automatically (hydrostatic pressure activated) at approximately 10 m (33 ft), and then flushes until closed by standard GO Devil messengers. It is made of rigid PVC tube section, ball valve, handles and cable clamp blocks, Delrin stopcocks and push rod, stainless steel cable clamp bolts, latex external spring, Viton and silicone O-ring seals, monofilament nylon and Kevlar lanyard, ball valve with Viton, and silicone seals. See SOP-SW5 for operation details.

Water Quality Meter—A YSI 650/6600 multi-probe (newer model or similar) will be used for measuring surface water parameters, such as temperature, pH, dissolved oxygen, conductivity, oxidation-reduction potential (ORP), and turbidity, and will be attached to the water samplers as shown in Figures 1a and 1b. The unit will come pre-calibrated from the laboratory and will be checked daily for proper functioning and drift. However, certain parameters such as pH, conductivity, ORP, and dissolved oxygen will also be calibrated daily. If possible, a YSI unit will be installed on each water sampler (i.e., near-surface and near-bottom) if both are deployed at the same time. However, a YSI unit installed on a near-bottom water sampler can also take an initial near-surface measurement at the beginning and at the end of the sampling event, thereby avoiding the cost of having an additional YSI unit installed on the near-surface water sampler. The proper handling of the multi probe is described in detail in SOP-SW6. Except for the probe sensor, all components are washed with soap (Liquinox™) and rinsed with tap water. Because this equipment will not be in the pathway with the surface water being collected, there is no need for a thorough decontamination.

The following steps are taken to set up the surface water collection system:

1. Assemble and secure the water samplers to either the A-frame or a davit.
2. Determine the correct position of the sampling station, have the captain anchor the vessel into the current at the sample site and switch off the engines. Allow sufficient time for sediments that may be resuspended by the anchor to settle before starting to collect the sample. If anchoring is not

possible and the engine must be on, care should be taken that the water intake tubing is always facing the current.

3. Set up a clean area for the workboxes. Set workboxes on a secure table or bench top onboard the sampling vessel to house a high-volume peristaltic pump sampling device.
4. Place the high volume peristaltic pump with vortex separator inside each of the workboxes.
5. Attach Teflon™ tubing (collecting end) to 30-cm C-Flex™ tubing and a 1-m Teflon™ tubing, sequentially, and then connect the C-Flex™ part of these interconnected pieces of tubing firmly into place inside the large peristaltic pump head. The outlet tubing should be directed outside of the boat gunnel. (Note: The length of the Teflon™ tubing will vary depending on project-specific requirements and water depth at a given station. For example, a 4-m (near surface sampling) and 25-m [for near bottom sampling] Teflon™ tubing could be used.)
6. Attach the intake part of the Teflon™ tubing to the vane of the near-surface sampler (Figure 1a) or to the vane of the near-bottom sampler (Figure 1b). Care must be taken not to remove the protective cap from the tip of the sample collecting tube until the sampling device is ready for submersion.
7. Secure the pump and pump speed controller and connect them to the vessel's power source with an extension cord. If vessel power is not available, the pump can be operated by a generator.
8. To limit sediment suspension during near-bottom sampling, a submersible, underwater video camera tethered to the boat can be attached to the sampling device vane to show sampling personnel when the sampling device touches bottom and disturbance subsides.

Sample Collection

The following steps are taken to collect and process the high-volume surface water samples:

1. Remove the protective cap from the sampling tube and lower the sampler gently below the water surface.
2. To sample water near-surface, submerge the sample tubing inlet approximately to the required depth below the surface of the water column (consult project-specific SAP for exact sampling water depth).

3. To sample water near-bottom, submerge the sample tubing inlet to the required distance above the bottom (consult project-specific SAP for required distance above the bottom) with the help of the winch-assisted A-frame or davit. If sampling surface water at a fixed depth from near bottom is necessary, the vane height on the sampler can be adjusted between 30 cm (12 in) to 1 m (3 ft) above bottom while the sampler rests on the bottom surface. The vane will maintain the sample tubing inlet into the current and at a constant depth above the sediment-water interface. If near-bottom station is in deep waters, use a GO-FLO™ (see SOP-SW5).
4. Begin collecting water quality parameters at each depth using the water quality meter (e.g., YSI, Hydrolab, Horiba). Set data collection intervals according to project data needs. If a vertical water column profile is needed, set the multi-probe to collect data every 5 seconds or slower depending on probe sensitivity (consult probe user manual) for a high resolution profile. If sampling a vertically integrated water column with several round trips to the bottom, reset the multi-probe to collect data at time intervals relative to the sampling time period after the initial high resolution profile. For example, if a vertically integrated water column will be sampled during a period of 2 hours, set the multi-probe to record data at every 1 second for the first round trip to the bottom and then reset to record data at every 5 minutes for the subsequent round trips until sampling is completed. If surface water is to be collected at a stationary location for more than 1 hour and no major changes in water quality are expected, set the multi-probe to collect data every 15 minutes, (see SOP-SW6).

Note: Failure to adjust the multi-probe for data collection according to sampling periods could result in data loss. That is, if the multi-probe memory bank is quickly filled at the initial part of a long sampling period, no additional data will be stored for the remaining sampling time.

Sampling personnel should record the water quality measurements on the Water Sampling Log forms every 15 minutes during sample collection. If the surface water sample collection is completed within 15 minutes, then at a minimum, water quality parameters should be collected three times; at the beginning, middle, and end of sample collection.

5. Switch the pump on and pump surface water through the sample tubing into the vortex separator and through the PUF cartridge at a rate of 2 L/min.

6. Every half hour, record pump rate to ensure that the target rate of 2 L/min is maintained by calibrating with a 2 L graduated plastic cylinder and a timer. If the pump rate falls outside this range, adjust the speed of the pump.
7. Turn off the pump once the desired volume of surface water has been pumped through the PUF cartridge.
8. Remove the PUF cartridge and cap each end with stainless steel nuts.
9. Remove the vial from the vortex separator and cap it.
10. Attach sampling label, which contains the date, time, project name or number, sample ID, type of analysis required, and sampler initials (see SOP-AP4)

Once the PUF cartridge and vortex separator vial are properly closed and labeled, place them inside a cooler containing wet or blue ice and stored at approximately 4°C. All samples are to be stored in coolers with ice on board the vessel and transferred to the field laboratory (if applicable) at the conclusion of the sampling day.

Water Quality Measurements

If specified in the project-specific SAP, physical and chemical water parameters may need to be collected at surface water stations. Several physical and chemical water parameters are best measured in the field because of the unstable nature of the parameter or because the information is needed to direct further sampling. It is frequently preferable to perform these analyses in the field, especially if the samples will not be immediately transported to the analytical laboratory (pH, in particular, should be measured in the field if feasible). In addition, measurements of temperature and transparency can be collected accurately only in the field. See details of operating a water quality meter in SOP-SW6.

It is best to place the water quality meter directly into the surface water body at the station location at the desired water depth instead of collecting a sample and measuring parameters in a container. However, if this is not possible, a plastic bucket can be used to collect samples for water quality analyses (e.g., pH, temperature, and conductivity). A clean bucket should be rinsed twice with the water from the station prior to measuring water quality parameters.

The name(s) of the person(s) making the measurement and the field equipment used to make that measurement must be recorded in the field logbook and on any field forms used during the sampling event. Equipment maintenance and calibration records must be kept in logbooks and field records so that the procedures are traceable.

Sample Handling

Gloved hands are required for sample collection and handling, as described above. Field staff will wear appropriate non-contaminating, disposable, powderless nitrile gloves during the entire sampling operation. Gloves will be changed frequently; usually with each change in task (wearing multiple layers of gloves allows rapid glove changes).

Gloved hands are required for all operations that involve equipment that comes into contact with the sample, including the following activities:

- Handling the PUF column and vortex separator vial
- Handling the intake end of the sample tube or line
- Setting up working space inside the processing chambers
- Setting up the equipment (i.e., high volume sampler and PUF cartridges) inside the chambers
- Working inside the chambers during collection, and processing
- Handling the vortex separator
- Changing the chamber covers as needed.

Ungloved hands take care of all operations that involve contact with potential sources of contamination, including the following activities:

- Working exclusively exterior to the processing and preservation chambers
- Preparing a clean workspace (inside boat)
- Preparing and operating the sampling equipment, including the pumps and discrete samplers
- Handling the generator or other power supply for samplers
- Handling the tools, such as hammers, wrenches, keys, locks, and sample-flow manifolds
- Handling the single or multi-parameter instruments for field measurements
- Setting up and checking the field-measurement instruments
- Measuring and recording the water depths and field measurements.

All samples are stored in coolers with ice at approximately 4°C on board the vessel and transferred to the field laboratory (if applicable) at the conclusion of the sampling day. The sampling team leader is responsible for maintaining sample integrity throughout the sampling event.

If storage freezers or refrigeration units are available at the field laboratory, these units will be monitored daily to ensure temperature compliance. Each unit will have a separate log form containing date, time, and temperature information.

Sample contamination will be avoided by handling the sample containers with clean gloves, and transferring the samples into clean refrigerators (or clean coolers)

immediately after samples have been brought back from the field. Sample bottles will always be handled by personnel wearing disposable, powderless nitrile gloves. This includes any and all sample handling that may occur during sample packing and shipping (see SOP-AP1).

Related SOPs

- All surface water samples will be packaged and shipped in accordance with procedures outlined in SOP-AP1.
- Field activities will be recorded in accordance with procedures outlined in SOP-AP2.
- Sample custody will be maintained in accordance with procedures outlined in SOP-AP3.
- Sample labeling will be recorded in accordance with procedures outlined in SOP-AP4.
- Surface water samples in deep waters will be collected using a GO-FLO™ bottle in accordance with procedures outlined in SOP-SW5.
- Water quality parameters will be measured using a water quality multi-meter in accordance with procedures outlined in SOP-SW6.

References

David, N., D. Bell, and J. Gold. 2001. Field Sampling Manual for the Regional Monitoring Program for Trace Substances. San Francisco Estuarine Institute, San Francisco, CA.

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USGS. [various dates]. National field manual for the collection of water-quality data: U.S. Geological Survey techniques of water-resources investigations, Book 9, Chap. A1-A9. Available online at <http://pubs.water.usgs.gov/twri9A>. U.S. Geological Survey. Accessed February 5, 2008, at <http://water.usgs.gov/owq/FieldManual/index.html#Citation>.

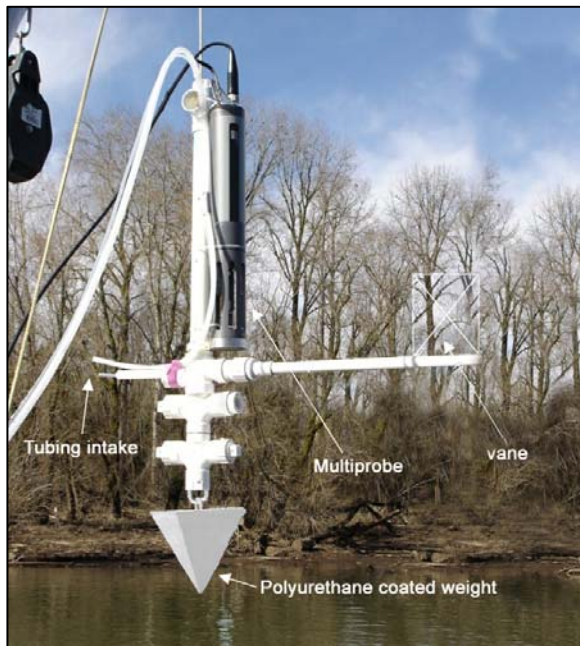


Figure 1a. Near Surface Water Sampler

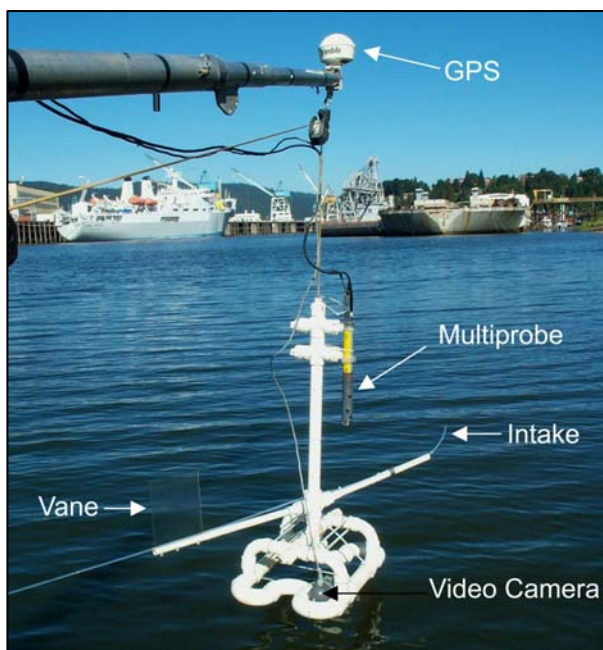


Figure 1b. Near Bottom Water Sampler

ATTACHMENT 1

Field Equipment List

- High volume peristaltic pump with vortex separator
- Viton® tubing
- Surface water parameter multi-meter capable of measuring pH, reduction/oxidation (redox) potential, temperature, specific conductance, turbidity, and dissolved oxygen
- PVC work box and 6-mil plastic sheeting
- PVC surface water samplers (near-surface and/or near-bottom water setups)
- Teflon-lined polyethylene sample tubing (length is site dependent)
- C-Flex tubing
- Plastic zip-ties
- Water Sampling Log forms
- Sample tags/labels and appropriate documentation (e.g., chain-of-custody forms)
- Insulated cooler(s), chain-of-custody seals, Ziploc® bags
- Sample containers (PUF cartridges, vortex separator vials)
- Coolers
- Blue ice or wet ice
- 20L GO-FLO™ bottle if deep water sampling is required.
- Teflon-coated messenger for GO-FLO™ bottle
- Powder-free nitrile gloves
- First aid kit
- Eye wash kit
- Duct tape
- Clear tape
- Packing tape dispenser
- Tool box
- Polyurethane-coated weights for water samplers
- Technora™ or Kevlar™ rope for winch spool

- 2000 watt power generator
- Paper towels
- Dilute solution of Liquinox
- Deionized water
- Extension cord
- Power strip
- Resealable plastic bags (i.e., 1 gallon and 1 quart)

ATTACHMENT A3

FIELD FORMS

CORRECTIVE ACTION RECORD

Page ____ of ____ Audit Report No.: _____ Date: _____

Report
Originator: _____

Task QA
Coordinator: _____

DESCRIPTION OF PROBLEM:

Date and Time
Problem Recognized: _____ By: _____

Date of
Actual Occurrence: _____ By: _____

Analyte: _____ Analytical
Method: _____

Cause of Problem:

CORRECTIVE ACTION PLANNED:

Person Responsible
for Corrective Action: _____

Date of
Corrective
Action: _____

Task QA Coordinator
Approval: _____ Date: _____

DESCRIPTION OF FOLLOW-UP ACTIVITIES:

Person Responsible
for Follow-up Activities: _____

Date of
Follow-up
Activity: _____

Task QA Coordinator
Approval: _____ Date: _____

FIELD CHANGE REQUEST

Page ____ of ____ Field Change No.: _____ Project Number: _____

Project Name: _____

CHANGE REQUEST

Applicable

Reference: _____

Description of Change:

Reason for Change:

Impact on Present and Completed Work:

Requested by: _____ Date: _____
(Field Scientist)

Acknowledged by: _____ Date: _____
(Field Task Leader)

FIELD SUPERVISOR RECOMMENDATION

Recommended Disposition:

Recommendation by: _____ Date: _____

TASK QA COORDINATOR APPROVAL

Teck Notification Required: Yes / No

Final Disposition:

Approved/Disproved by: _____ Date: _____

Sample Label

Site: _____	integral <small>consulting inc.</small>
Sample No.: _____	
Matrix: _____	Date: _____
Filtered (Y/N): _____ (if applicable)	Time: _____
Analysis: _____ (optional)	Pres: _____
Sampler: _____	
Tag Number: <u>1813</u>	

Custody Seal

CUSTODY SEAL		integral <small>consulting inc.</small>
Date: _____	Time: _____	
Sampler Signature: _____		

SAMPLE ALTERATION OR ISSUE FORM

DATE OF ALTERATION OR ISSUE:

Description of Alteration from QAPP or Project Guidance Document or Issue (Completed by Initiator):

Sample Collection Date / Occurrence Date (Completed by Initiator):

Responsible Contacts and Their Affiliation (Completed by Initiator):

Reference Document Citation (Completed by Initiator):

Investigation Notes (Completed by Task QA Coordinator or Designate):

SAMPLE ALTERATION OR ISSUE FORM

Root Cause of Alteration or Issue (Completed by Task QA Coordinator or Designate):

Alteration or Issue Warrants Corrective Action? (Yes/No):

Party/Individual Corrective Action Will be Issued to:

Initiator and Contact Information:

Date:

Non-Conformance or Issue Form Sent to: TCAI Project Coordinator, Task QA Coordinator, Project File, and all entities involved in the Alteration or Issue.

WATER SAMPLE LOG

Survey _____ Crew _____ Date _____

[illegible]