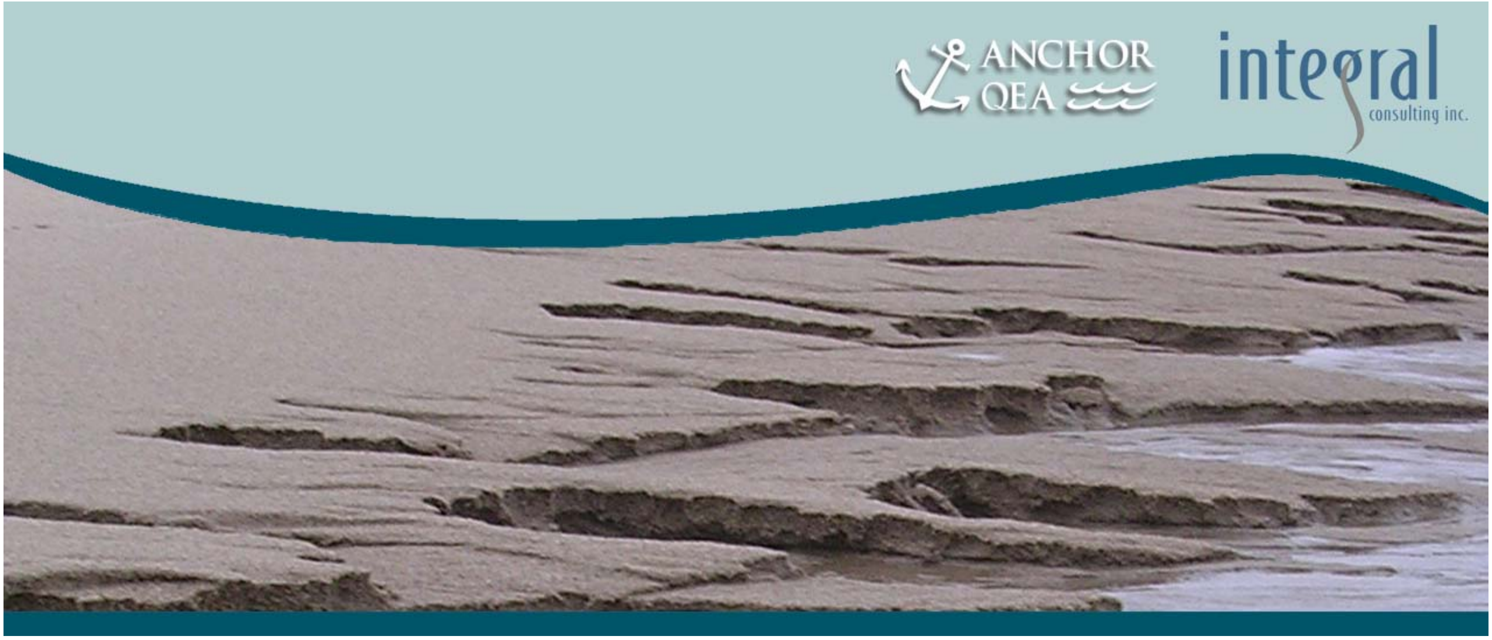

FINAL SEDFLUME STUDY
FIELD SAMPLING PLAN
SAN JACINTO RIVER WASTE PITS SUPERFUND SITE

Prepared for

McGinnes Industrial Maintenance Corporation

International Paper Company

U.S. Environmental Protection Agency, Region 6

Prepared by

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614 Magnolia Avenue
Ocean Springs, Mississippi 39564

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411 First Avenue South, Suite 550
Seattle, Washington 98104

May 2011

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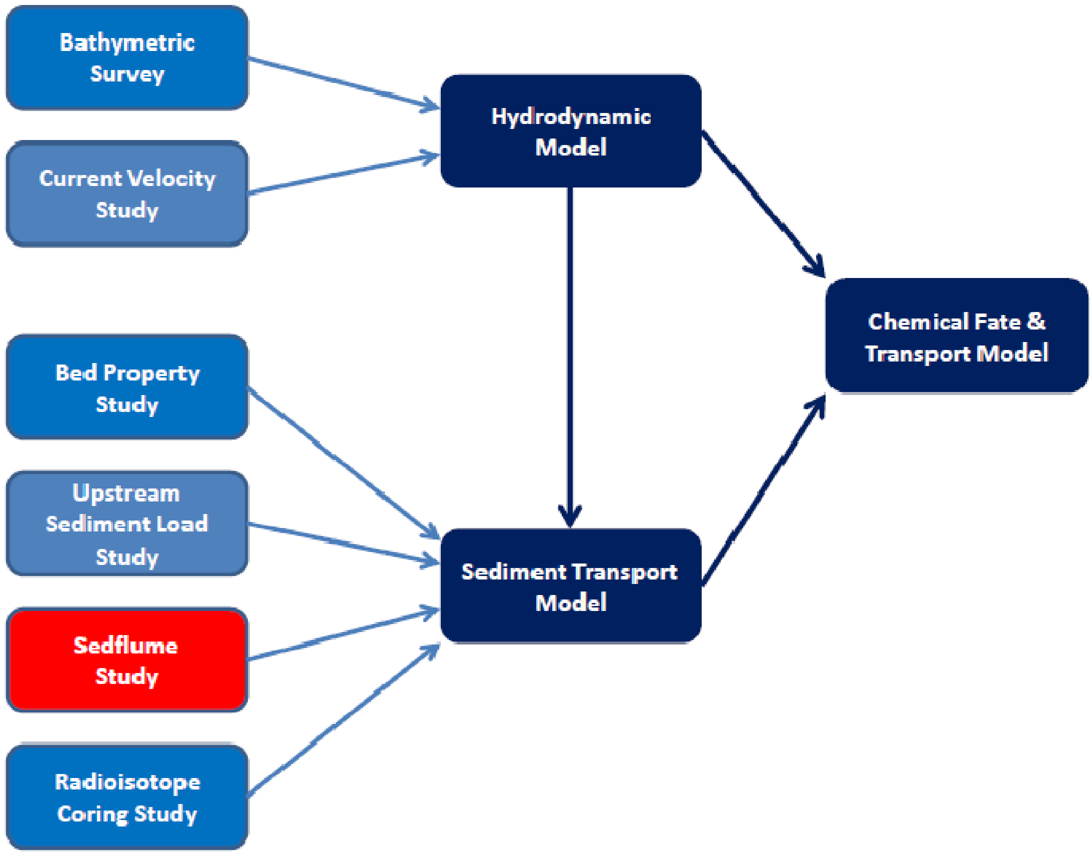
LIST OF ACRONYMS AND ABBREVIATIONS

Anchor QEA	Anchor QEA, LLC
COC	Chain-of-Custody
DGPS	Differential Global Positioning System
FSP	Field Sampling Plan
GPS	Global Positioning System
HASP	Health and Safety Plan
HDPE	high density polyethylene
IDW	investigation derived waste
Integral	Integral Consulting Inc.
MCL	Maximum Contaminant Limit
NAD83	North American Datum 1983
NOAA	National Oceanic and Atmospheric Administration
PM	Project Manager
PPE	personal protection equipment
PSD	particle size distribution
QA/QC	Quality Assurance/Quality Control
RI/FS	Remedial Investigation and Feasibility Study
SAP	Sampling and Analysis Plan
SEI	Sea Engineering, Inc.
Site	San Jacinto River Waste Pits Superfund Site
SJRWP	San Jacinto River Waste Pits
SOP	Standard Operating Procedure
TPWD	Texas Parks and Wildlife Division
UAO	Unilateral Administrative Order
USCG	U.S. Coast Guard
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey

1 INTRODUCTION

This document provides a Field Sampling Plan (FSP) for the Sedflume study at the San Jacinto River Waste Pits (SJRWP) Superfund Site (the Site) located in Harris County, Texas (Figure 1). This FSP was prepared as a supplement to the Final Sampling and Analysis Plan Addendum Chemical Fate and Transport Modeling Study (Fate and Transport Addendum; Anchor QEA and Integral 2010b), which is an Addendum to the Sampling and Analysis Plan, Sediment Study (Sediment SAP; Integral and Anchor QEA 2010). The Chemical Fate and Transport Modeling Study is required by the Remedial Investigation and Feasibility Study (RI/FS) Work Plan (Anchor QEA and Integral 2010a) and describes the sampling and fate and transport modeling efforts to be undertaken in support of achieving the overall RI/FS goals. Together with the Sediment SAP and the Fate and Transport Addendum, this FSP provides information on field activities and related documentation to meet the requirements of the U.S. Environmental Protection Agency (USEPA) guidance (USEPA 1988, 1992, 2001, and 2002) and as required by the Unilateral Administrative Order (UAO) (USEPA 2009). Additional information of the Site history and a summary of existing data are provided in the RI/FS Work Plan (Anchor QEA and Integral 2010a) and the Sediment SAP (Integral and Anchor QEA 2010). Information on the geology, physiography, hydrology, and cultural and natural resources of the Site and information on the fate and transport is provided in the RI/FS Work Plan (Anchor QEA and Integral 2010a).

Six field studies are being conducted to provide information and data for the Chemical Fate and Transport Modeling Study: 1) bathymetric survey; 2) current velocity study; 3) bed property study; 4) upstream sediment load study; 5) Sedflume study; and 6) radioisotope coring study. The flow chart shown below illustrates the relationships between the field studies and the specific models for which each field study will provide data. The hydrodynamic model provides transport information (e.g., current velocity, water depth) to both the sediment transport and chemical fate and transport models. The sediment transport model provides erosion and deposition flux information to the chemical fate and transport model.



The objective of the Sedflume study is to obtain sediment cores from representative cohesive sediment bed areas in the Study Area for Sedflume testing. Specifically, the cores will be obtained to provide sediment suitable for:

- Sedflume testing using procedures described in the Sedflume Erosion Rate Measurement Manual (Attachment 1), which will provide data related to erosion rate properties of cohesive bed sediment; and
- Particle size distribution (PSD) (using laser diffraction [Beckman Coulter LS 13 320]) and wet bulk density (indirectly calculated from percent moisture in accordance with ASTM 2216-05 (Standard Test Methods for Laboratory Determination of Water [Moisture] Content of Soil and Rock by Mass).

The results of the Sedflume study will provide input data for the sediment transport model, as described in the Fate and Transport Addendum (Anchor QEA and Integral 2010b). The

Sedflume study will measure erosion rates in cohesive sediment bed areas as a function of bed shear stress and depth in the bed.

1.1 Overview

The Sedflume study will be conducted by Sea Engineering, Inc. (SEI) to measure the erosion properties of cohesive sediments as a function of bed shear stress and depth in the bed. Sediment cores will be collected at 15 locations for the Sedflume study. The locations of these cores will be determined upon completion of the bed property study and after the cohesive sediment bed areas have been identified (i.e., only cohesive sediments will be tested during the Sedflume study). The sampling locations will be grouped into three areas: 1) in the immediate vicinity of the waste impoundments north of I-10; 2) upstream of the waste impoundments north of I-10; and 3) downstream of the waste impoundments north of I-10. Five cores will be collected from each of these three areas for Sedflume testing. In addition to the testing of cores in the Sedflume, samples will be analyzed for PSD and wet bulk density, as discussed below.

1.1.1 Testing Procedures

A schematic of the Sedflume apparatus is shown in Figure 2. The mobile laboratory is self-contained with a power generator and pumps for water intake from external sources. A detailed description of the Sedflume testing procedure is provided in the Sedflume Erosion Rate Measurement Manual included in Attachment 1. This section summarizes those procedures.

Once a sediment core obtained for Sedflume testing has been collected, it will be inspected for length and quality. If any signs of disturbance within the core are observed (e.g., showing signs of fractures in the core, uneven surfaces), the core will be discarded and another core will be collected from the same sampling location. A total of 15 undisturbed cores will be collected, with five cores in each of the three areas listed above. After a Sedflume core has been obtained, a plug that will later act as a piston will be inserted. The opposite end of the core barrel will be capped and the core will be stored on deck until the boat returns to the onshore processing site. Sedflume testing will take place in a mobile laboratory located on-site. Care will be taken to transport the cores safely in an upright position such that the core is not disturbed. During testing, the core tube will be inserted into the bottom of the straight flume, via the test section, and will be advanced through the flume as described below.

The sediment cores collected for Sedflume testing will be approximately 30-cm long and erosion rate testing will be conducted over the top 30-cm of each core. Erosion rates will be measured for bed shear stresses ranging between 0.1 and 6.4 Pa, beginning at low shear stress, and running the flume sequentially at higher stresses, with each successive shear stress run at twice the preceding one, as described in the Sediment Erosion Rate Measurement Manual (Attachment 1). Each core layer is eroded by regulating flow over the core surface. The flume is operator-controlled, so the operator selects the range of shear stresses for measuring erosion rate. The operator generally performs cycles of varying shear stress, starting at a low value and proceeding through several higher values. The cycle is repeated as the operator moves downward through the core. Erosion rate is quantified using the operator-controlled upward movement of the core and time duration of specified shear stress for each erosion test. This method provides the distribution of erosion rates as a function of depth. The end of the flume includes an exit section for removal of water and eroded sediment. The sediment core is destroyed during testing. The top of the flume is removable above the test section, allowing sediment samples to be extracted as various layers of the core are exposed during erosion tests.

1.1.2 Particle Size Distribution, Percent Moisture and Wet Bulk Density

In addition to the measurement of erosion rates, each core will be sub-sampled at 5-cm intervals for analysis of PSD and percent moisture, from which wet bulk density can be calculated. Additional information regarding sampling for these parameters is provided in Section 2.

1.2 Project Organization

Detailed project organization is provided in the Sediment SAP (Integral and Anchor QEA 2010). The names and quality assurance (QA) responsibilities of key task-specific personnel are provided below. In addition, the project manager (PM) for SEI is also indicated, and is responsible for the execution of the Sedflume field activities.

FSP Personnel Quality Assurance Responsibilities

Title	Responsibility	Name	Contact Information
Project Coordinator	Coordination of project information and related communications on behalf of IP and MIMC with USEPA; liaison between USEPA project managers and respondent project managers	David Keith	Anchor QEA, LLC 614 Magnolia Avenue Ocean Springs, MS 39564 (228) 818-9626 dkeith@anchorqea.com
Task Coordinator	Coordination of task project information and related communications with Project Coordinator	Kirk Ziegler	Anchor QEA, LLC 305 W. Grand Avenue Suite 300 Montvale, NJ 07645-1813 (201) 571-0949 kziegler@anchorqea.com
Field Lead Anchor QEA	Field data collection and implementation of the Health and Safety Plan in the field	Daleel Nangju	Anchor QEA, LLC 10707 Corporate Drive Suite 230 Stafford, TX 77477 (281) 565-1133 dnangju@anchorqea.com
SEI Task Leader	Laboratory PM and Sampling Coordinator for SEI	Craig Jones	Sea Engineering, Inc. 200 Washington Street Suite 210 Santa Cruz, CA 95060 (831) 421-0871 craig.jones@sbcglobal.net

1.3 Laboratories

The following responsibilities apply to the project manager (PM) and quality assurance (QA) manager at the analytical laboratories used for this task. The laboratory project manager is responsible for the successful and timely completion of the sample analyses, and for performing the following tasks:

- Ensure that samples are received and logged in correctly, that the correct methods and modifications are used, and that data are reported within specified turnaround times.
- Review analytical data to ensure that procedures were followed as required in the Sediment SAP (Integral and Anchor QEA 2010), the cited methods, and the laboratory standard operating procedures (SOPs).

- Keep the task QA coordinator apprised of the schedule and status of sample analyses and data package preparations.
- Notify the task QA coordinator if problems occur in sample receiving, analysis, or scheduling, or if control limits cannot be met.
- Take appropriate corrective action as necessary.
- Report data and supporting QA information as specified in the Sediment SAP (Integral and Anchor QEA 2010).

The laboratory QA manager is responsible for overseeing the QA activities in the laboratory and ensuring the quality of the data for this project. Specific responsibilities include the following:

- Oversee and implement the laboratory's QA program.
- Maintain QA records for each laboratory production unit.
- Ensure that QA and quality control (QC) procedures are implemented as required for each method and provide oversight of QA/QC practices and procedures.
- Review and address or approve nonconformity and corrective action reports.
- Coordinate response to any QC issues that affect this project with the laboratory project manager.

1.4 Document Organization

This FSP describes the field methods that will be used to collect sediment cores for the Sedflume study. The background, rationale, data quality objectives, and overall study design, are described in detail in the Chemical Fate and Transport Addendum (Anchor QEA and Integral 2010b). Section 2 of this FSP describes the field procedures and sample packaging and shipping requirements that will be followed by the technical team during the field study. Section 3 summarizes field documentation and chain-of-custody (COC) procedures. Field data management and reporting procedures are discussed in Section 4.

The following documents are provided as attachments to the FSP:

- Standard Operating Procedures (SOPs). The SOPs are provided in Attachment 1. These include the Sedflume SOP (Sedflume Erosion Rate Measurement Manual), SOPs developed for equipment decontamination, sample handling, and COC, consistent with the procedures used during the sediment and soil investigations, as applicable. All SOPs included in this document are also provided in the Sediment SAP (Integral and Anchor QEA 2010) or in the Chemical Fate and Transport Addendum. They are included here for the convenience of the field team.

- Field Forms. Attachment 2 contains examples of various forms that will be used during field sampling, including: Sediment Core Log, Field Change Request Form, Corrective Action Record, and the Chain-of Custody/Laboratory Analysis Request Form.

2 SAMPLING PROCEDURES

The following sections describe the detailed procedures and methods that will be used during the Sedflume study, including the schedule, sampling procedures, recordkeeping, sample handling, storage, and field QC procedures. All field activities will be conducted in accordance with the Health and Safety Plan (Anchor QEA 2009), which will be amended as needed to support the Sedflume FSP tasks, and Addendum 1 to the Overall HASP: Sediment HASP (Integral 2010).

2.1 Schedule

The start date for the Sedflume study will be determined following USEPA approval of this FSP as well as the completion of the bed property study data analysis. However, for planning purposes, it is anticipated that the sampling event and laboratory analysis will be conducted during May 2011. It is anticipated that core collection in the field will take place at a rate of approximately three cores per day. Thus, a total of five days is anticipated to collect all 15 cores. In addition, it is anticipated that it will take at most another five days to conduct the Sedflume experiment and process the cores at the mobile processing lab.

2.2 Sampling Methods

The following sections describe the sampling vessel and field equipment, sampling methods, sample handling, and shipping.

2.2.1 Sampling Vessel, Field Equipment, and Supplies

Access to sub-tidal and to some of the inter-tidal locations (particularly at high tide) will require the use of a boat.

2.2.1.1 Sampling Vessel

The sampling vessel will have enough space to accommodate a minimum of five people – three sampling team members, the vessel's operator, and one USEPA oversight individual (if required), and the following equipment: rectangular coring apparatus and sleeve; sample coolers modified to contain upright, undisturbed cores; and multiple sampling equipment boxes containing sample jars and other ancillary equipment. The vessel will be equipped with a mechanical winch system to be used for lowering and retrieving the sediment cores. The vessels used for sampling will have navigational lights, anchors, basic sonar, and all safety equipment (i.e., personal floatation devices, whistle or horn, and fire extinguisher), as required by the U.S. Coast Guard (USCG) and Texas Parks and Wildlife (TPWD 2006). The vessel operator will be thoroughly familiar with the area of the river to be navigated and will coordinate with the USCG Vessel Traffic System and Port of Houston security notification procedures, as applicable.

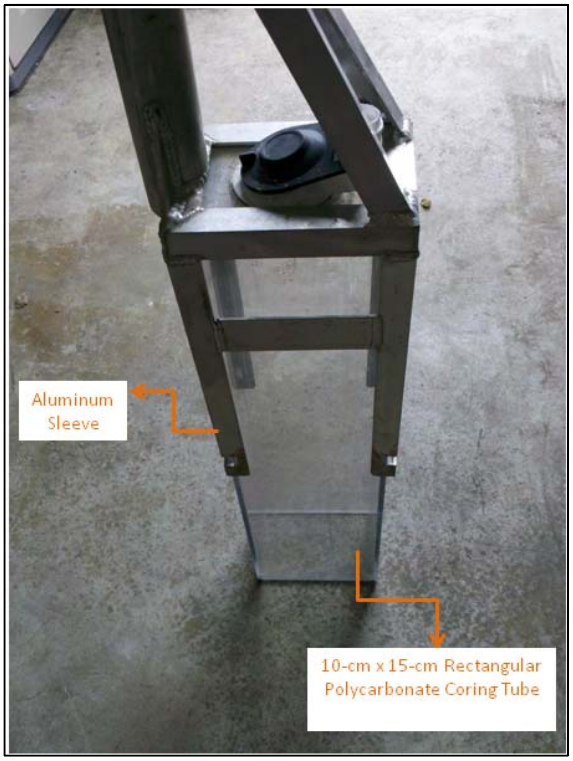
Weather, stream elevation, and tides, will be monitored using the following websites:

- Weather conditions and forecasts: National Oceanic and Atmospheric Administration (NOAA) site for the Houston/Galveston area (http://www.weather.gov/forecasts/wfo/sectors/hgx.php#tabs).
- Real-time stream elevation: U.S. Geological Survey (USGS) 08072050 San Jacinto River near Sheldon, 10 miles upstream from the Site.
- Real-time data on wind direction, wind speed, and water elevation: USGS 08077637 Clear Lake Second Outflow Channel at Kemah, 22 miles south of the Site (http://waterdata.usgs.gov/nwis/uv?site_no=08077637).
- Tides: NOAA site at Morgan's Point, TX, Station Id: 8770613, located 10 miles southeast of the Site (http://tidesandcurrents.noaa.gov/geo.shtml?location=8770613).
- If needed, supplementary tidal information may be obtained from staff gauges SG01 and SG02, located just offshore, east and west of the former impoundments. Top of gauges are 3.66 and 3.38 feet (NAVD88), respectively. Coordinates are 3216594.63 E, 13857474.61 N, and 3217261.16 E, 13857107.46 N (US State Plane 1983, Texas South Central 4204), respectively.

2.2.1.2 Field Equipment and Supplies

Field equipment and supplies include: sampling equipment, utensils, decontamination supplies, sample containers, coolers, shipping containers, log books and forms, personal protection equipment (PPE), and personal gear. Protective wear (e.g., gloves) will be used as required in the HASP (Anchor QEA 2009).

Sedflume sediment cores with a minimum length of 30-cm will be obtained using a 10-cm x 15-cm rectangular coring tube made of clear polycarbonate. The coring tube inserted into an aluminum sleeve to secure it during the coring process (see below). The neck of the sleeve is an outer rectangular tube (10-cm x 15-cm in size), while the main body is a box with dimensions such that the outer rectangular core tube fits tightly inside the tube.



Sample jars, coolers, and packaging material for the samples will be determined and supplied by SEI for shipment of PSD samples to the analytical laboratory. The field lead and field personnel in charge of sample handling in the field will use a sample matrix table (Table 1) as a QC check to ensure that all samples have been collected at a given station.

Commercially available, pre-cleaned jars will be used for the samples, and the testing laboratory will maintain a record of certification from the suppliers. The bottle shipment documentation will include batch numbers. With this documentation, jars can be traced to the supplier, and bottle-wash analysis results can be reviewed. The bottle-wash certificate documentation will be archived in the project file. The option for Whirl-Pak bags is also available to store the sediment samples. Whirl-Pak bags are transparent and sterile sample bags that are constructed of durable polyethylene and provide safe, spill-free use for liquid, semisolid, and solid samples.

Sample containers will be clearly labeled at the time of sampling. Labels will include the task name, sample number, sampler's initials, analysis to be performed, and sample date and time. Sample numbering and identification procedures are described in detail in Sections 3.3 and 3.4.

2.2.2 Station Location Positioning

The vessel position for sediment core sampling will be performed as described in SOP AP-06 (Navigation and Station Positioning). Sampling locations for the cores will be located using differential global positioning system (DGPS). The DGPS unit will be mounted on a winch arm used to collect the sediment cores. The GPS unit will receive GPS signals from satellites to produce horizontal positioning accuracy to within ±2 meters. Texas State Plane South Central FIPS 4204 coordinates (feet, North American Datum [NAD] 83) will be used for the horizontal datum.

The core sample will be collected as close to the target position as possible. The vessel will be maneuvered to within 5 feet of the pre-programmed target coordinates. Best efforts will be made to position activities at the target station coordinates. A list of the Sedflume sampling locations is provided in Table 1. A map of the Sedflume sampling locations is shown in Figure 3. The objective was to locate the Sedflume cores in areas where the sediment bed is primarily composed of cohesive sediment.

Core locations were selected based on results from the recently completed 2011 bed property study and results from grain size data collected in 2010. The sediment type descriptions of the surface grab samples as well as the sub-surface sediment type descriptions from the bed probing study were used to select areas with primarily surface and sub-surface cohesive sediments outside of the preliminary RI/FS Site perimeter. Inside the preliminary RI/FS Site perimeter, surface and sub-surface grain size distribution data were used to assess sediment type.

Field conditions may preclude accessing the planned locations. As such, latitude and longitude coordinates will be obtained at the locations where the sediment coring occurs. If the planned location is not accessible or the core is completely composed on non-cohesive sediment, then the station will be moved to within 100 feet of the original location.

Table 1

Proposed Sedflume Core Locations and Sediment Sampling Matrix

Core ID	Easting[a]	Northing[a]	Elevation (ft MSL)[b]	Sample Matrix	Sedflume	Particle Size Distribution	Percent moisture
SJSF001	3210182.88398	13866193.81362	-11.8	Sediment	X	X	X
SJSF002	3207296.09364	13861479.29005	-4.0	Sediment	X	X	X
SJSF003	3209197.33601	13862420.36606	-11.5	Sediment	X	X	X
SJSF004	3210124.47077	13859547.68242	-0.9	Sediment	X	X	X
SJSF005	3213031.34395	13861425.23688	-3.7	Sediment	X	X	X
SJSF006	3215251.26400	13860004.27000	-12.9	Sediment	X	X	X
SJSF007	3216254.07900	13861008.27000	-13.8	Sediment	X	X	X
SJSF008	3217240.06100	13859998.44000	-18.8	Sediment	X	X	X
SJSF009	3217253.68200	13858495.01000	-3.9	Sediment	X	X	X
SJSF010	3216251.80300	13854004.18000	-12.1	Sediment	X	X	X
SJSF011	3211060.73825	13853824.80553	-4.6	Sediment	X	X	X
SJSF012	3207298.93014	13852889.28209	-3.9	Sediment	X	X	X
SJSF013	3205737.69822	13846868.60751	-7.6	Sediment	X	X	X
SJSF014	3213904.74788	13851905.58096	-13.1	Sediment	X	X	X
SJSF015	3213781.76129	13849992.83546	-10.7	Sediment	X	X	X

Notes:
a Texas State Plane South Central FIPS 4204 coordinates (feet, North American Datum [NAD] 83).
b Elevation is approximate. Estimated from current bathymetry data.

2.2.3 Sediment Coring and Sedflume Testing

Sediment coring will be performed as follows. The assembled coring sleeve is lowered to the sediment bed using a boat equipped with a mechanical winch system. Pressure is applied to the top of the sleeve, causing the sleeve to penetrate into the sediment bed. The coring sleeve is pushed as far as possible into the sediment bed; the distance of penetration will vary as a result of the characteristics of the sediment (i.e., deeper penetration will occur in softer sediment than in compact sediment). The objective of this process is to obtain a relatively undisturbed core that is at least 30-cm in length. After retrieving the coring unit and bringing it onboard the sampling boat, the barrel is lifted off of the core tube. A plug is inserted into the core tube from the bottom (to act as a piston for later use in Sedflume) and the core is capped. Sediment cores are transported and stored in an upright position. After sealing, each core is stored in an ambient temperature water bath to prevent the sediment from drying.

After capping, the cores will be visually inspected for length and quality. Sediment cores that show signs of disturbance during the coring process will be discarded and another core will be taken from the sampling location. Approved cores will be capped and stored on deck until the boat returns to the onshore processing site. An onshore processing site will be provided for the mobile Sedflume field laboratory, as well as space to hold the effluent waste water disposal tank. The space will be within a reasonable distance from the Study Area, with access to electricity and freshwater. At the processing site, samples collected, as described below, from the core, for PSD and wet bulk density analysis will be placed in appropriate containers, labeled, sealed, and submitted for analysis.

The original Sedflume method, including bulk property testing procedures, has been modified and refined by Dr. Craig Jones at SEI during the last 5 to 10 years. The SEI Sedflume procedure (Sea Engineering, Inc. 2008), which is a certified laboratory procedure that will be used during this study, has been successfully applied at a number of contaminated sediment sites, including: Lower Duwamish Waterway (Washington), Lower Willamette River (Oregon), Patrick Bayou (Texas), Holston River (Tennessee), Lake Hartwell (South Carolina), San Francisco Bay (California), Newtown Creek (New York), and Pearl Harbor (Hawaii). This procedure has been shown to provide reliable data for quantifying cohesive sediment erosion rates.

Co-located cores were collected in the McNeil et al. (1996) method due to the requirement for a 500-gram sample for particle size analysis (sieve method). Laser diffraction particle size analysis, which is currently used, has allowed for smaller sub-samples (i.e., less than 10 grams) to be collected for adequate particle size analysis, eliminating the need to obtain co-located cores and substantially streamlining the process. The collection of both wet bulk density and particle size samples from the same Sedflume core is the preferred approach, eliminating possible variation and uncertainty due to separate core collection.

All sediment cores will be tested using the Sedflume apparatus at the onshore processing site. The Sedflume device is a straight flume that has a test section with an open bottom through which the rectangular coring tube containing sediment is inserted. The main components of the flume are: coring tube; test section; inlet section to create uniform, fully-developed, turbulent flow; flow outlet section; water storage tank; and pump to force water through the system. The coring tube, test section, inlet section, and exit section, are made of clear acrylic so that the sediment-water interactions can be observed. The coring tube shown in Figure 2 has a rectangular cross-section and can be up to 1 meter in length.

Prior to testing a core in Sedflume, a visual description will be recorded of the sediment in the core to document the sediment stratigraphy, and the core will be photographed through the clear polycarbonate tube. Wet bulk density and PSD sub-samples will be obtained from within each core; sub-samples will be collected at the surface (prior to starting the first shear stress cycle) and after each shear stress cycle. Two 10-gram sub-samples of sediment will be collected from the surface of the sediment core near the downstream edge of the test section. This sampling affects a small portion (i.e., less than 5 percent of the surface area) of the erosion surface of the core and, thus, has minimal impact on the test results. The interval at which wet bulk density and PSD samples are collected will be approximately 5-cm and dependent on how sediment erodes in each interval.

At the start of the Sedflume test, the core is inserted into the bottom of the test section. Water is pumped through the system from a 120-gallon storage tank, through a 5-cm diameter pipe, and then through a flow converter into the rectangular duct, as shown in Figure 2. This duct is 2-cm in height, 10-cm in width, and 120-cm in length; it connects to the test section, which has the same cross-sectional area and is 15-cm long. The flow converter changes the shape of the cross-section from circular to the rectangular duct shape, while maintaining a constant cross-sectional area. A three-way valve regulates the flow so that part of the flow goes into the duct while the remainder returns to the tank. A small valve in the duct is located immediately downstream from the test section and it is opened at higher flow rates to keep the pressure in the duct and over the test section at atmospheric conditions. The operator moves the sediment upward using a piston that is inside the core; the piston is connected to a hydraulic jack. By these means, the sediment in the core is raised and the sediment surface is positioned so that it is level with the bottom of the test section in Sedflume. The jack movement can be controlled in increments as small as 0.5 millimeters (mm).

Potable water is forced through the duct and the test section over the surface of the sediments. The shear stress produced by this flow may cause sediment to erode. As the sediment in the core erodes, the sediment core is moved upwards so that the sediment-water interface remains level with the bottom of the test section. The erosion rate is determined by measuring the amount of erosion (i.e., distance sediment is moved upward) in a specific amount of time.

In order to measure erosion rates at several different shear stresses using only one core, the following procedure is used. Starting at a low shear stress, the flume is run sequentially at increasing shear stresses with each succeeding shear stress being twice the previous one. Generally, about four shear stress values are applied sequentially during a particular shear stress cycle. Each shear stress is applied until at least 1 to 3 mm, but no more than 2-cm of sediment, are eroded, with each shear stress being applied for a minimum of 20 seconds and a maximum of 10 minutes. The amount of erosion (i.e., distance sediment is moved upward) and time are recorded for each shear stress. The time interval is recorded for each cycle with a stopwatch. The flow is increased to the next higher shear stress until the maximum shear stress in the cycle is applied. This cycle is repeated until the top 30-cm of sediment in the core is eroded or, if the core is shorter than 30-cm, the entire core is eroded. If, after three shear stress cycles, an erosion rate of less than approximately 1.7×10^{-4} cm/sec occurs for a particular shear stress, that shear stress value is dropped from the cycle. If, after multiple cycles, the erosion rates decrease significantly, a higher shear stress is included in the cycle.

2.2.4 Sediment Bulk Property Sample Processing

This section discusses standard analytical methods for bulk property analyses. Analytical methods and holding times are presented in Table 2.

Table 2

Laboratory Analytical Methods and Maximum Holding Times

Parameter	Method	Maximum Holding Time
Percent Moisture	ASTM 2216-05	6 months
Particle Size Distribution	Laser Diffraction (Beckman Coulter LS 13 320)	6 months

Two 10-gram samples from each 5-cm section of a Sedflume core will be analyzed for percent moisture and sediment particle size distribution, according to the methods in Table 2, for a total of five or six measurements of these parameters per core. The procedures in the Standard Laboratory Procedures for Measurement of Water Content (Attachment 1) will be used to analyze the samples. The equations in the SOP, however, were developed for SEI's laboratory certification process and will not be used to calculate water content or wet bulk density. Equations 1 and 2 in this field sampling plan will be used to calculate percent moisture and wet bulk density. The calculation of the wet bulk density from percent moisture is necessary because the volume of the whole sample is not known. Wet bulk density is determined in the SEI Sedflume laboratory by water content analysis using methods outlined in Hakanson and Jansson (2002) and ASTM procedures for the determination of water content (ASTM 2216-05) (Standard Test Methods for Laboratory Determination of Water [Moisture] Content of Soil and Rock by Mass)

PSD analysis will be conducted by SEI using laser diffraction analysis. Sub-samples of sediment collected from within the Sedflume core during testing are prepared and sieved at 2,000 µm in the laboratory. Any fraction over 2,000 µm is weighed and compared to total sample weight to determine the weight percentage greater than 2,000 µm. The fraction of the sample less than 2,000 µm is analyzed using a Beckman Coulter LS 13 320, which uses measurement of laser diffraction through an aqueous suspension of the sample. Each sample is analyzed in three 1-minute intervals and the results of the four analyses are averaged. The instrument is tested daily with a controlled standard and all manufacturer specifications for instrument operation are met or exceeded in the SEI laboratory. Results will be presented as a standard PSD plot with percent (%) passing by weight on the y-axis of the plot and decreasing particle diameter size on the x-axis.

The percent moisture (W) will be measured following ASTM method 2216-05 (Standard Test Methods for Laboratory Determination of Water [Moisture] Content of Soil and Rock by Mass) and calculated as follows:

$$W = \frac{M_w - M_d}{M_w} \tag{1}$$

where:

M_w = wet weight of sample

M_d = dry weight of sample

The detection limit is 0.1 grams in a sample weight ranging from 10 to 50 grams. The percent moisture value has a range between 0 and 1.

Wet bulk density is calculated based on the percent moisture using:

$$\rho_{b,wet} = \frac{\rho_w \rho_s}{\rho_w + (\rho_s - \rho_w)W} \tag{2}$$

where:

$\rho_{b,wet}$ = wet bulk density (g/cm^3)

ρ_w = density of water (g/cm^3)

ρ_s = density of sediment particles (assumed 2.65 g/cm^3)

W = percent moisture

2.2.5 Equipment Decontamination

All equipment and instruments used that are in direct contact with the sediment collected for analysis will be made of glass, stainless steel, or high density polyethylene (HDPE), and will be cleaned prior to each day's use and between sampling locations. Disposable gloves will be discarded after processing each station and replaced prior to handling decontaminated instruments or work surfaces. The decontamination procedure is as follows:

- Pre-wash rinse with potable water

- Wash with solution of potable water and Alconox soap (brush)
- Rinse with potable water
- Rinse three times with distilled water
- Cover (no contact) all decontaminated items with aluminum foil
- Store in clean, closed container for next use

2.3 Quality Control Samples and Procedures

This project will generate data of known and acceptable quality. Applicable quantitative goals for these data quality parameters are listed in Table 3. The number of field QC samples to be collected cannot be estimated until the core depths can be determined from the bed property study. If QC problems are encountered, they will be brought to the attention of the Task Coordinator. Corrective actions, if appropriate, will be implemented to meet the task's data quality indicators. Although great care will always be taken, quality control will be performed routinely during sampling and measuring.

Table 3
Data Quality Indicators for Sediment Analyses

Parameter	Precision	Accuracy	Completeness	Sensitivity (Method Detection Limit)
Wet Bulk Density	± 20%	na	95%	0.01 g/cm^3
Percent moisture	± 20%	na	95%	0.1% ww
Sediment Particle Size	± 30%	na	95%	0.1% dw

Note:
na – not applicable

Sediment erosion rates are related to shear stresses that are applied at particular flow rates in the channel of the Sedflume. The initial flow rate used will be that which sediment erosion is observed to begin. The flow rates, as measured by the flow meter, will be checked daily by directly measuring the volume of water collected over time at the outlet of the channel. If flow rates are not correct, the paddle wheel of the flow meter will be cleaned and inspected. If this does not correct the problem, a new flow meter will be installed.

All instruments used for wet bulk density analysis will be tested with standards before and after each testing period. PSD measurements will be run in duplicate to check for accuracy. Known standards will be measured before and after each testing period.

Field duplicates are generally used to evaluate the variability attributable to sample handling. Field duplicate samples will be collected according to the frequency described in Table 4, by splitting the homogenized sediment from a single sample into two identical samples.

Table 4
Quality Control Samples

Parameter	Field Duplicate	Method Blank	Matrix Replicates	Laboratory Control Standard	Matrix Spike	Matrix Spike Duplicate
Bulk Density	1/20	na	na	na	na	na
Percent Moisture	1/20	na	na	na	na	na
Sediment Particle Size	1/20	na	na	na	na	na

Note:
na – not applicable

2.4 Investigation Derived Waste Handling and Tracking

This section provides a waste management plan for handling investigation derived waste (IDW) associated with initial RIs at the Site. The IDW for this field study is expected to consist of:

- Excess sediment generated during sampling (cores and slurries)
- Effluent waste water from Sedflume
- Personal protective equipment (PPE)

2.4.1 Sediment

Generation of excess sample material is anticipated during collection of cores. Sediments and slurries will be retained and stored in 55-gallon drum(s) for later disposal at an approved solid waste handling facility. Drums will be clearly marked as to contents. A log of collection dates and times, plus approximate volume of each sample, will be maintained to facilitate off-site disposal of the material as either non-hazardous or hazardous dredge spoil material.

2.4.2 Effluent Waste Water from Sedflume

It is expected that approximately 150 gallons per core of effluent waste water per core will be generated as a result of the Sedflume testing. The water will be collected in a 6,500 gallon Baker tank that will be available at the sample processing site. Upon completion of the work, the waste water in the Baker tank will be tested. If testing results are below the dioxin/furan Federal Maximum Contaminant Limit (MCL), drinking water standard of 30 pg/L, then the waste water in entirety will be discharged to the local sewer system. However, if the concentration is above the MCL, then it will be disposed of by a sub-contractor specialized in contaminated waste removal, reflective of the type of contaminants and their expected concentrations. The sub-contractor will be required to have, at a minimum, a drum management service that provides the following:

- Proper waste identification including full analytical capability
- Pickup and disposal of a broad range of wastes
- Safe and proper transportation
- Environmentally sound treatment and disposal
- Regularly scheduled service visits with manifest and label preparation

2.4.3 Personal Protective Equipment

Any dry waste (e.g., contaminated boots, bibs, Tyvek™ suits) present at the end of the sampling event will be segregated and containerized (e.g., 55-gallon drums) and disposed of by a sub-contractor specialized in waste removal. All disposable materials used for sample collection and processing, such as paper towels and gloves, will be placed in heavyweight garbage bags or other appropriate containers. Disposable supplies that do not contain Site sediment will be removed from the Site by sampling personnel and placed in a normal refuse container.

3 FIELD DOCUMENTATION

The integrity of each sample from the time of collection to the point of data reporting will be maintained. Proper record-keeping and COC procedures will allow samples to be traced from collection to final disposition. Representative photographs will be taken of each area where samples are collected. Site photos from various angles and close-up views of the overall conditions will also be collected. A photograph will be taken to document the stratigraphy of each core. In addition, each 30-cm core will be described according to SOP SD-12.

3.1 Field Logs

Results of the Sedflume analyses will be recorded in the forms as part of the Sedflume Erosion Rate Measurement Manual (Attachment 1). These include a record of the core recovery (Sedflume Sampling Data Sheet), a record of the applied sheer stresses for each depth interval (Sedflume Laboratory Data Sheet), and a record of the wet bulk density and PSD sample weights (Bulk Density Data Sheet).

All field activities and observations will be recorded as described by SOP AP-02 and on data collection sheets, as needed. The field log book will be a bound document and will contain individual field and sample log forms (Attachment 2). 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, or deviations from the FSP) and the reasons for these changes will be documented in the log book. The log book will identify on-site visitors, in any, and the number of photographs taken at each sampling location. Each field lead is responsible for ensuring that their respective field log book and all field data forms are correct. Requirements for log book entries will include the following:

- Log books 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 recorded, 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 for 9:00 a.m., 2100 for 9:00 p.m.), will appear on each page.

In addition to the preceding requirements, the person recording the information must initial and date each page of the field log book. 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 made the last entry.

Log book 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 log book 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
- On-site visitors, if any
- Sampling vessel, if any
- Station number and location
- Data collection and time of each sample
- The sample number for each sample to be submitted for laboratory analysis
- The specific date and time with corresponding station number associated with the sampling location coordinates derived from the DGPS
- Specific information on each type of sampling activity
- The sample number, date and time of collection, equipment type, and the lot number for the box of filter papers used for field QC samples
- Observations made during sample collection, including weather conditions, complications, and other details associated with the sampling effort
- Sample description (source and appearance, such as sediment type, color, presence of anthropogenic material, and presence and type of biological structures, other debris,

oil sheens, and odor)

- Sediment penetration depth (nearest 0.25 foot)
- Any visible debris near any of the sampling locations
- Any surface vegetation that is removed from the sampling location prior to sampling
- The number of photographs taken at each sampling location
- A record of Site health and safety meetings, updates, and related monitoring
- Any deviation from the FSP and reasons for deviation

All log books must be completed at the time that any observations are made. Copies of all log books and forms will be retained by the technical team.

3.2 Chain-of-Custody Procedures

Samples for percent moisture will be analyzed in the mobile Sedflume field laboratory near the Site. Samples for particle size distribution will be sent to a laboratory off-site for analysis. 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 (see SOP AP-03). 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 2 contains an example of the COC form that will be used during this study.

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

- Site name
- Field leader'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 or archive)
- Number of sample containers shipped
- Requested analyses
- 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

Anchor QEA's field leader (or delegate) will be the designated field sample custodian for their respective sampling events and will be responsible for all sample tracking and COC procedures for the samples that their respective teams collected 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 (if a local laboratory is selected) or shipping courier (as appropriate), the field sample custodian 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.

When the laboratory receives the samples, the laboratory sample custodian will conduct an inventory by comparing sample labels 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 number to each sample 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 Numbering

All stations will be assigned a unique identification code based on a designation scheme designed to suit the needs of the field personnel, data management, and data users. Station numbers will include "SJ" to indicate San Jacinto followed by "SF" to indicate the Sedflume study, followed by a three-digit number (e.g., 001, 002). The station numbers will increase as the stations move upstream. An example station number for the Sedflume study would be SJSF007.

3.4 Sample Identifiers

A sample identifier for each sediment Sedflume station will be created as follows: the station number (e.g., SJSF007), followed by a two-letter code for the kind of sample collected at a given location (SF = Sedflume sample, PM = percent moisture sample, PS = particle size distribution sample), followed by a sequential number. This will then be followed by a one letter code designating if the sample collected was a duplicate or normal sample (D = duplicate, N = normal). An example identifier for a Sedflume sample would be SJSF007-SF1-N. Percent moisture (wet bulk density) and PSD samples will also indicate the depth interval for the sample. For example, the 0- to 5-cm section for a PSD sample would be SJSF007-PS1_0-5-N. Sedflume cores will be analyzed as a continuous unit (i.e., no discrete sampling intervals).

4 FIELD DATA MANAGEMENT AND REPORTING PROCEDURES

During field operations, effective data management is critical to providing consistent, accurate, and defensible data and data products. Field data management will be performed as described in the Sediment SAP, and in Section 6.2 of Appendix A of the RI/FS Work Plan. Daily field records (a combination of field log books, field forms, if any, and COC forms) will make up the main documentation for field activities. Upon completion of sampling, field notes, and data sheets (if any), will be scanned to create an electronic record. 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 REFERENCES

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FIGURES

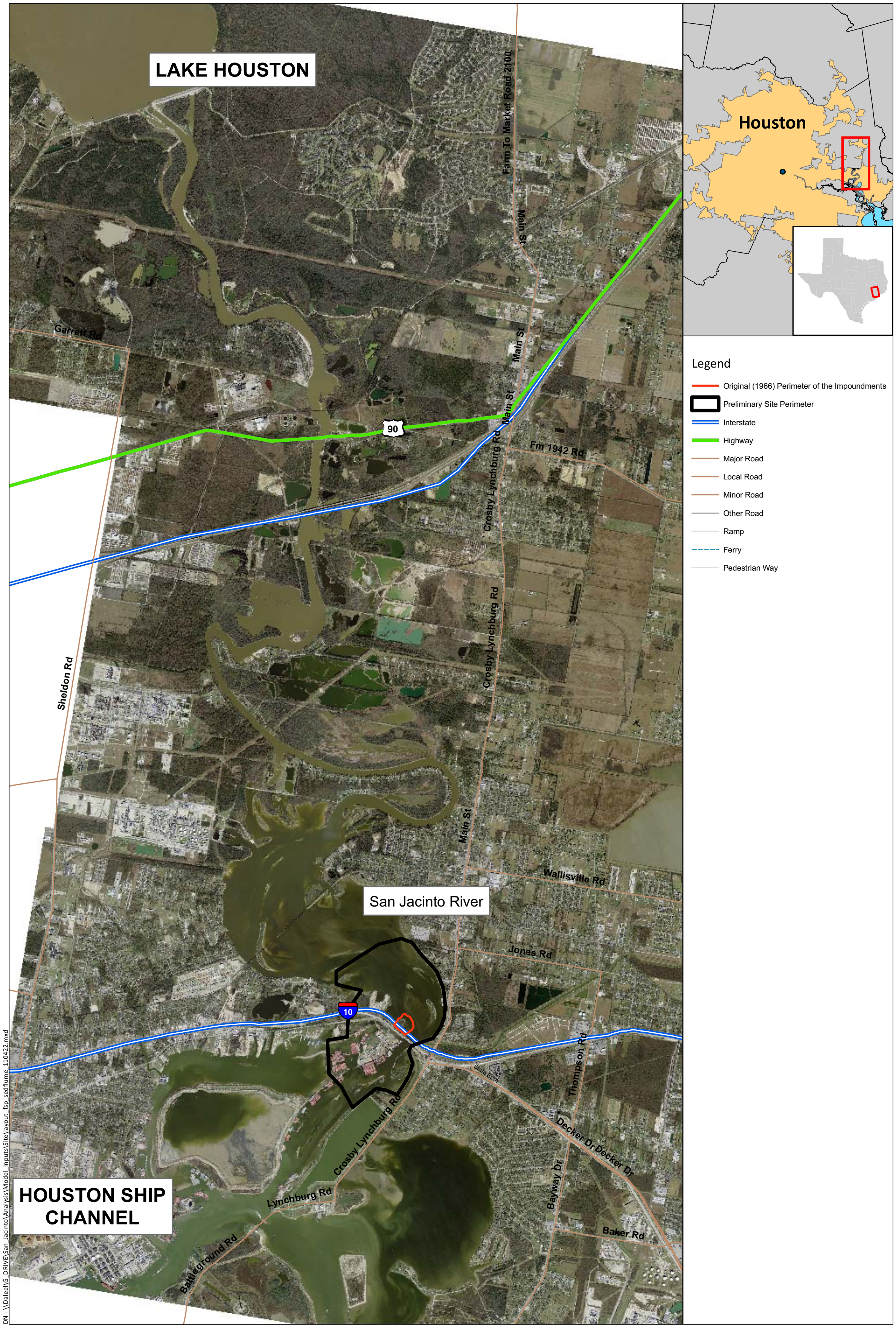

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Figure 1
Site Map
Sedflume Study Field Sampling Plan
SJRWP Superfund/ MIMC and IPC

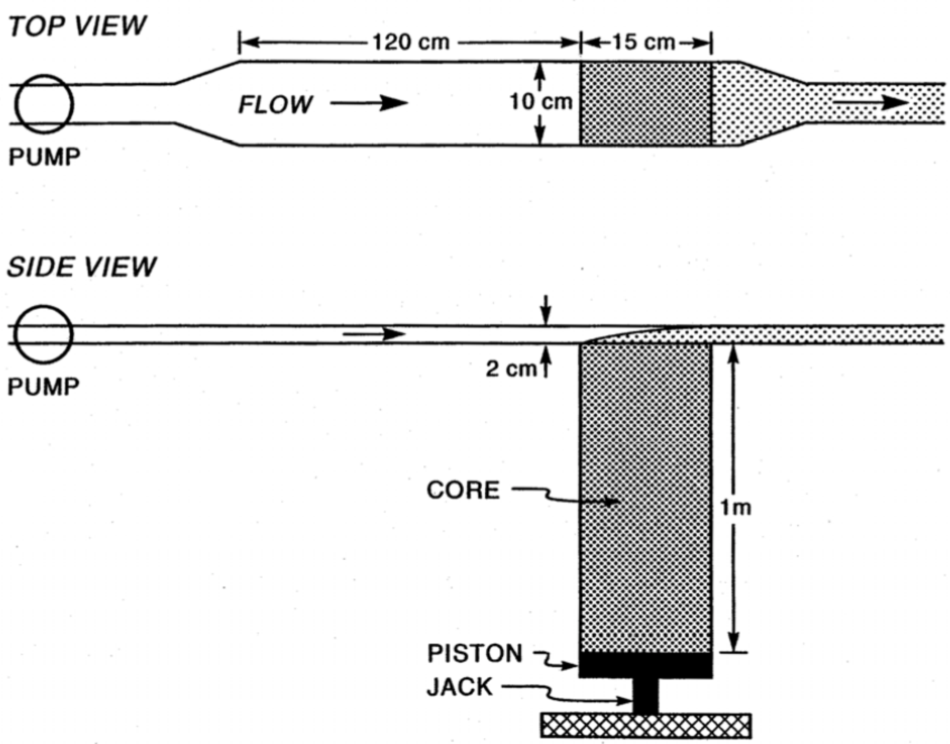

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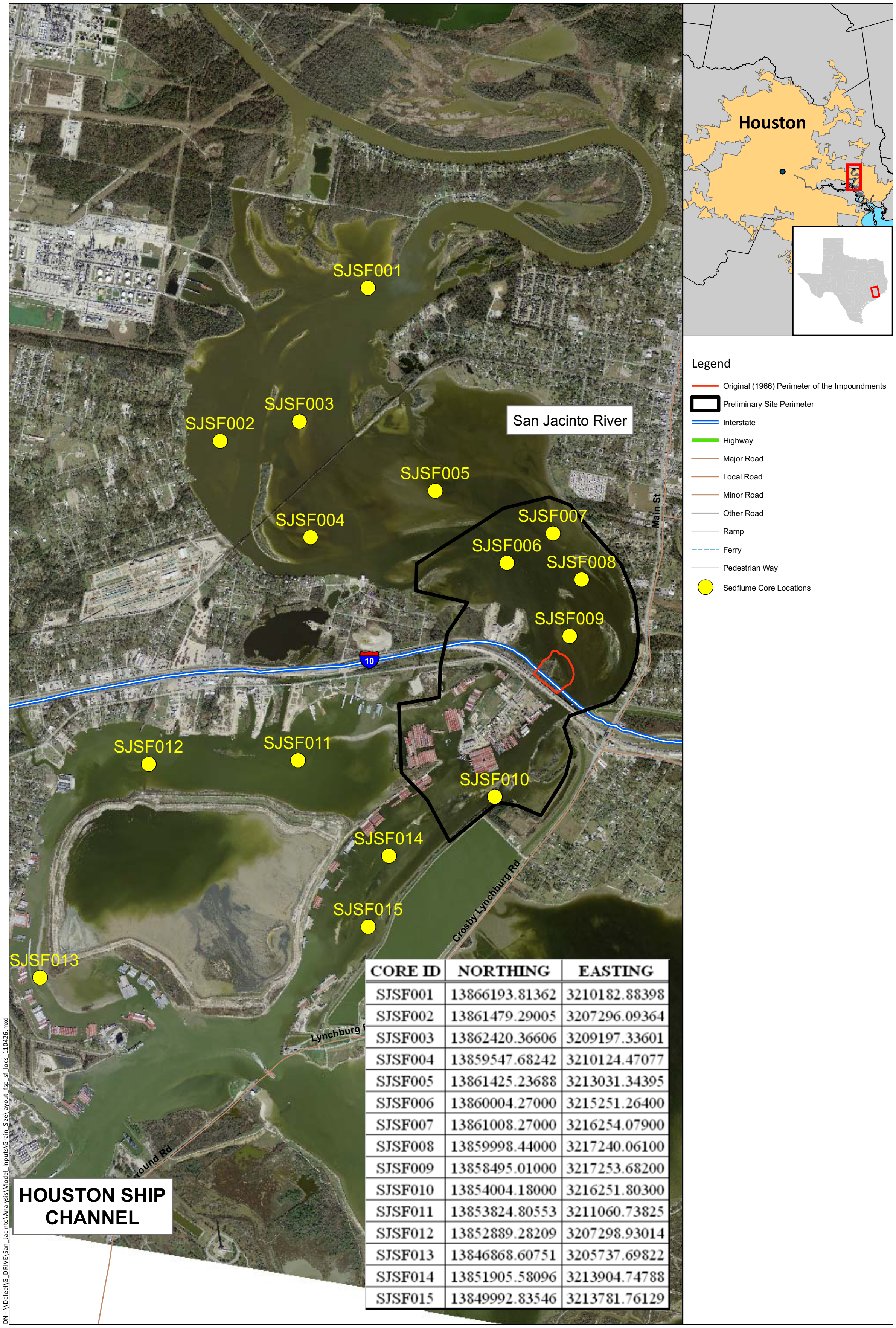
Figure 2
Schematic of Sedflume Apparatus
Sedflume Study Field Sampling Plan
SJRWP Superfund/ MIMC and IPC



CORE ID	NORTHING	EASTING
SJSF001	13866193.81362	3210182.88398
SJSF002	13861479.29005	3207296.09364
SJSF003	13862420.36606	3209197.33601
SJSF004	13859547.68242	3210124.47077
SJSF005	13861425.23688	3213031.34395
SJSF006	13860004.27000	3215251.26400
SJSF007	13861008.27000	3216254.07900
SJSF008	13859998.44000	3217240.06100
SJSF009	13858495.01000	3217253.68200
SJSF010	13854004.18000	3216251.80300
SJSF011	13853824.80553	3211060.73825
SJSF012	13852889.28209	3207298.93014
SJSF013	13846868.60751	3205737.69822
SJSF014	13851905.58096	3213904.74788
SJSF015	13849992.83546	3213781.76129

ANCHOR QEA | integral consulting inc.

0 1,500 3,000 Feet

Figure 3
Sedflume Core Locations
Sedflume Study Field Sampling Plan
SJRWP Superfund/ MIMC and IPC

ATTACHMENT 1
STANDARD OPERATING PROCEDURES

Sea Engineering, Inc.

Sedflume Erosion Rate Measurement Manual

Approved by:________________Date______
Craig A. Jones, Ph.D.
Lab Manager/ Quality Assurance Officer

Approved by:________________Date______
Ken Israel
Vice President/Technical Director

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Santa Cruz, CA 95062
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Data Quality Objectives for Measurement Data

To achieve the project's overall data quality objectives, measurements will be made to ensure sufficient characterization of sediment bulk properties and erosion rates. The bulk properties to be measured by the University of California at Santa Barbara have been chosen based on previously determined field and laboratory work (McNeil et al, 1996; Taylor et al, 1996; Jepsen et al, 1997; and Roberts et al, 1998). The parameters to be measured in this study are listed in Table A-1.

Table A-1

	Definition	Units	Detection Limit	Int. Consistency
Bulk Density, ρ_b (wet/dry weight)	$\rho_b = \frac{\rho_w \rho_s}{\rho_w + (\rho_s - \rho_w)W}$	g/cm^3	Same as water content	$\rho_w < \rho_b < 2.6\rho_w$
Grain Size	Volume weighted distribution including median and mean size	μm	Method Specific	1μm<Grain Size<2000μm
Water Content	$W = \frac{M_w - M_d}{M_w}$	none	0.1g in sample weight ranging from 10 to 50 g	$0 < W < 1$
Erosion Rate	$E = \Delta z/T$	cm/s	$\Delta z > 0.5$mm $T > 15$s	None

M_w = wet weight of sample
M_d = dry weight of sample
Δz = amount of sediment eroded
T = time
ρ_w = density of water (fresh = 1 g/cm^3)
ρ_s = density of sediment particles (2.65 g/cm^3)

All essential bulk properties will be measured or sub-sampled from the same core.

Documentation and Record

Records of data and information will be kept in a special workbook, which has been, developed to record erosion rate measurements, and a notebook computer. All data recorded by the computer notebook will also be recorded in the laboratory composition book and laboratory computer. Laboratory measurements of subsamples will be logged in the laboratory computer. All data acquired will be burned onto a compact disc and stored in archives. Appendix A contains a sample field coring sheet and laboratory analysis sheet.

During a project, data will be photocopied daily and stored separately from the originals to ensure that no loss of data occurs.

Problems encountered will be documented in the field book and reported to the project manager. QC results will also be recorded in the field book and transferred to the laboratory PC and data not meeting these requirements will be flagged.

Measurement Acquisition

Sampling Process Design

Erosion rates will be measured as a function of shear stress and depth for each core. Grain size distribution and bulk density will be measured using approximately 5-10g sub-samples from the erosion core. All essential bulk properties (including erosion rates) will be measured for the same core using the following method. All measurements to be taken (Table A-1) are classified as critical measurements.

Analytical Methods

Description of Sedflume

A detailed description of Sedflume and its application are given in McNeil et al, 1996. Sedflume is shown in Figure 1 and is essentially a straight flume that has a test section with an open bottom through which a rectangular cross-section coring tube containing sediment can be inserted. The main components of the flume are the coring tube; the test section; an inlet section for uniform, fully-developed, turbulent flow; a flow exit section; a water storage tank; and a pump to force water through the system. The coring tube, test section, inlet section, and exit section are made of clear acrylic so that the sediment-water interactions can be observed. The coring tube has a rectangular cross-section, 10 cm by 15 cm, and can be up to 1 m in length.

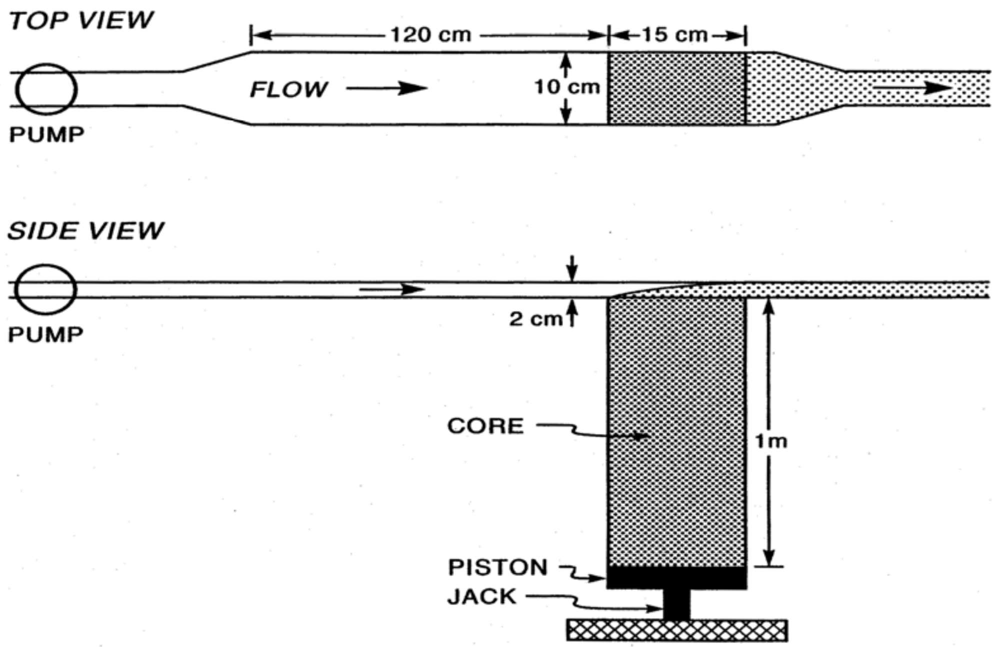

Figure 1. Schematic of Sedflume

Water is pumped through the system from a storage tank, through a 5 cm diameter pipe, and then through a flow converter into the rectangular duct shown. This duct is 2 cm in height, 10 cm in width, and 120 cm in length; it connects to the test section, which has the same cross-sectional area and is 15 cm long. A valve regulates the flow to control the flow rate through the test section. Also, there is a small valve in the duct immediately downstream from the test section that is opened at higher flow rates to keep the pressure in the duct and over the test section at atmospheric conditions.

At the start of each test, the coring tube is filled with either reconstructed or undisturbed sediments from the body of water of interest. The coring tube and the sediment it contains are then inserted into the bottom of the test section. An operator moves the sediment upward using a piston inside the coring tube. The piston is pushed upwards by a hydraulic jack with a 1 m drive. The jack is driven by the release of pressure that is regulated with a switch and valve system. By this means, the sediments can be raised and made level with the bottom of the test section. The speed of the jack movement can be controlled at a variable rate in measurable increments as small as 0.5 mm.

Water is forced through the duct and the test section over the surface of the sediments. The shear produced by this flow causes the sediments to erode. As the sediments in the core erode, they are continually moved upwards by the operator so that the sediment-water interface remains level with the bottom of the test and inlet sections. The erosion rate is recorded as the upward movement of the sediments in the coring tube over time.

Core Collection and Preparation

Sedflume sediment cores with a minimum length of 30 cm will be obtained using the following procedure. A 10 cm x 15 cm rectangular core will be used during this study. Cores are inserted into a thin stainless steel sleeve. The neck of the sleeve is an outer rectangular tube (10 cm x 15 cm in size), while the main body is a box with dimensions such that the outer rectangular core tube fits tightly inside.

The assembled coring sleeve is lowered to the sediment bed using either a pole or gravity corer, depending on water depth. Pressure is applied to the top of the sleeve, causing the sleeve to penetrate into the sediment bed. The coring sleeve is then pushed as far as possible into the sediment bed; the distance of penetration will vary as a result of the characteristics of the sediment (i.e., deeper penetration will occur in softer sediment than in compact sediment). The objective of this process is to obtain a relatively undisturbed core. After retrieving the coring unit and bringing it onboard the sampling boat, the nose cone is removed and the barrel is lifted off of the core tube. A plug is inserted into the core tube from the bottom (to act as a piston for later use in Sedflume) and the core is then capped. Sediment cores are transported and stored in an upright position. After sealing, each core is stored in an ambient temperature water bath to prevent the sediment from drying.

After capping, cores will be visually inspected for length and quality. Sediment cores that show signs of disturbance during the coring process will be discarded and another core will be taken from the sampling location. Approved cores will be capped and stored on deck until returned to the onshore processing site. At the processing site, samples taken from the core for bulk property analysis will be placed in appropriate containers, labeled, sealed, and preserved for delivery to the laboratory for analysis. The sampling procedure for the bulk property samples is described below. Appendix A contains a sample field coring sheet and laboratory analysis sheet.

Measurements of Sediment Erosion Rates

The procedure for measuring the erosion rates of the sediments as a function of shear stress and depth will be as follows. The sediment cores will be obtained as described above and then moved upward into the test section until the sediment surface is even with the bottom of the test section. A measurement is made of the depth to the bottom of the sediment in the core. Two 5-g subsamples of sediment will be collected from the surface of the sediment core near the downstream edge of the test section. This sampling affects a small portion (i.e., less than 5% of the surface area) of the erosion surface of the core and, thus, has minimal impact on the test results. These subsamples will also be obtained at depth while the core is in the Sedflume by stopping flow within the device between each shear stress cycle (see below), opening up the Sedflume, and manually collecting the samples. The samples will be analyzed for grain size distribution, using a laser grain size analyzer, and bulk density.

At the start of each test, the core is inserted into the bottom of the test section. An operator moves the sediment upward using a piston that is inside the core; the piston is connected to a hydraulic jack. By these means, the sediment in the core is raised and the sediment surface is positioned so that it is level with the bottom of the test section in Sedflume. The jack movement can be controlled in increments as small as 0.5 mm. Water is forced through the duct and the test section over the surface of the sediments. The shear stress produced by this flow may cause sediment to erode. A relationship between flow rate and shear stress in the test section has been developed (McNeil et al. 1996). As the sediment in the core erodes, the sediment core is moved upwards so that the sediment-water interface remains level with the bottom of the test section. The erosion rate is determined by measuring the amount of erosion (i.e., distance sediment is moved upward) in a specific amount of time.

In order to measure erosion rates at several different shear stresses using only one core, the following procedure is used. The most commonly used shear stress intervals used are 1, 2, 4, 8, 16, 32, 64, and 128 dynes/cm^2. The use of these pre-specified intervals facilitate the development of a mathematical relationship for erosion as a function of shear stress and will be used in most cases. Starting at a low shear stress, the flume is run sequentially at higher shear stresses with each succeeding shear stress being twice the previous one. Generally, four shear stresses are run sequentially during a particular shear stress cycle. Each shear stress is applied until at least 1 to 3 mm, but no more than 2 cm, of sediment are eroded, with each shear stress being applied for a minimum of 20 seconds and a maximum of 10 minutes. The amount of erosion (i.e., distance sediment is moved upward) and time are recorded for each shear stress. This procedure defines the minimum and maximum erosion rates to be 1.67 x 10^{-4} and 0.1 cm/s, respectively. The time interval is recorded for each cycle with a stopwatch. The flow is then increased to the next higher shear stress until the highest shear stress in the cycle is applied. After a cycle is completed the flume is opened and grain size and bulk density sub-samples are collected.

This procedure is repeated until the amount of sediment in the core is eroded. If after three shear stress cycles, an erosion rate of less than approximately 1.67 x 10^{-4} cm/s (i.e. less than 1 mm of erosion in 10 minutes) occurs for a particular shear stress, that shear stress value is dropped from the cycle; if after multiple cycles the erosion rates decrease significantly, a higher shear stress is included in the cycle. Figures 2 and 3 show a picture of a typical Sedflume core and associated data.

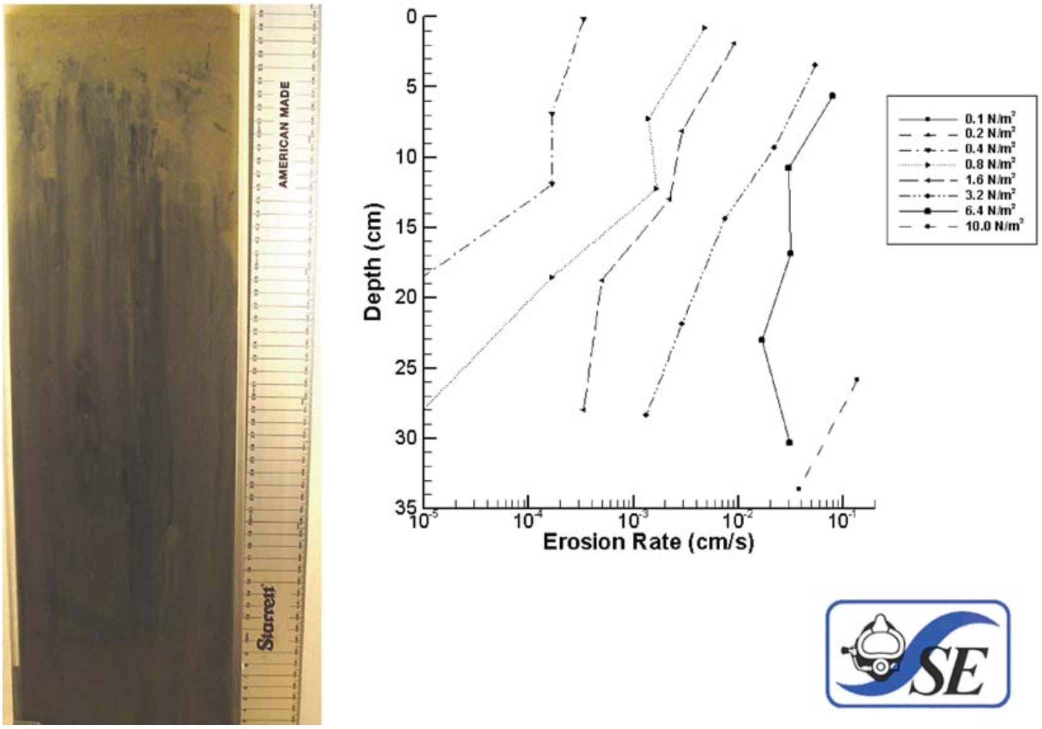

Figure 2. Erosion rate variation with depth and shear stress for a sample San Francisco Bay location.

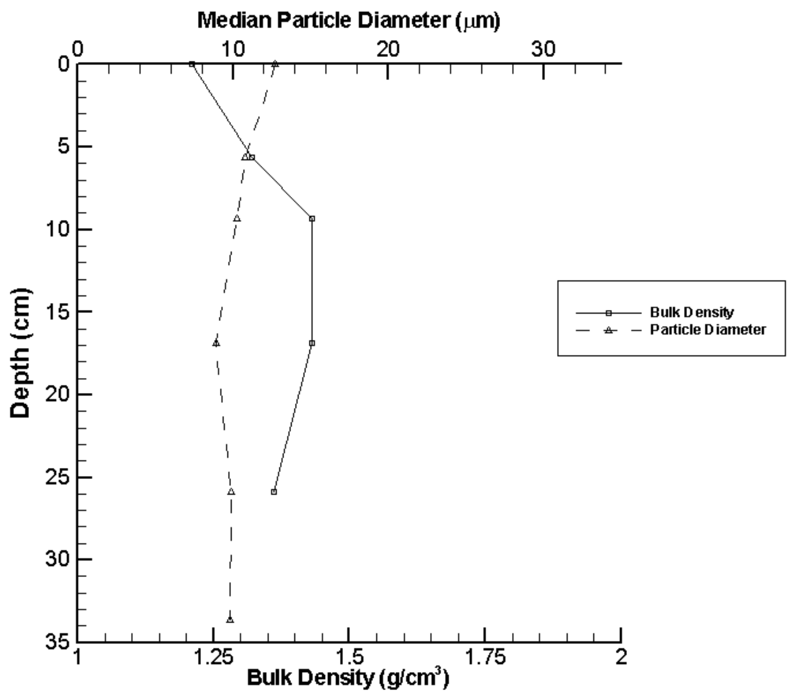

Figure 3. Variation of particle size and bulk density with depth for a sample San Francisco Bay location.

Measurements of Critical Shear Stress for Erosion

A critical shear stress can be quantitatively defined as the shear stress at which a very small, but accurately measurable, rate of erosion occurs. In the present study, this rate of erosion is chosen to be 10^{-4} cm/s; this represents 1 mm of erosion in approximately 15 minutes. Since it would be difficult to measure all critical shear stresses at exactly 10^{-4} cm/s, erosion rates are generally measured above and below 10^{-4} cm/s at shear stresses which differ by a factor of two. The critical shear stress is then linearly interpolated to an erosion rate of 10^{-4} cm/s. Critical shear stresses will be measured as a function of depth for both the field and the laboratory sediment cores.

Description of Consolidation Studies

Wet sediments obtained from various field sites will be mixed separately into homogeneous mixtures. These well-mixed sediments will be poured into several 20 cm cores and then allowed to consolidate for time periods up to 60 days. Typically 1, 7, and 14 days are used. All bulk properties for each sediment mixture will remain constant except for bulk density. Bulk density as a function of depth will be measured periodically during the test and some cores will be sacrificed and tested in the Sedflume for erosion rates. This method gives erosion rates as a function of bulk density for each sediment mixture.

Sample Handling and Custody Requirements

Samples will be collected, handled, and analyzed by SEI personnel. Chain of custody will be recorded as required by project specifications.

All samples are uniquely labeled and logged by the sampler. Samples designated for Sedflume study will be under the continuous custody of SEI personnel so the sample integrity can be assured. Dr. Craig Jones of SEI will supervise all Sedflume operations.

Quality Control Requirements/Method Performance

Although great care will always be taken, quality control will be performed routinely during sampling and measuring.

Sediment erosion rates are related to shear stresses that are applied at particular flow rates in the channel of the Sedflume. The initial flow rate used will be that which sediment erosion is observed to begin. The flow rates, as measured by the flow meter, will be checked daily by directly measuring the volume of water collected over time at the outlet of the channel. The flow rate (gal/min), volume (g)/time (sec), and the calculated flow rate (gal/min) are documented in the Sedflume log sheets located in the Sedflume Logbook at the beginning of each day of use. If the flow rates are not correct, the paddle wheel of the flow meter will be cleaned and inspected. If this does not correct the problem, a new flow meter will be installed. The pump will also be checked daily prior to every analysis to make sure it is working properly by opening the pump and cleaning out the filter. Every core run through the sedflume is logged in the Sedflume Core Log Sheets found in the Sedflume Logbook. This log sheet includes date, time, analyst, core ID number and any notes. Every 20 cores a proficiency test is run with a control core made of Quartz. This core is also logged on the Sedflume Core Log Sheet and highlighted.

No reagents are needed for this analysis. The standards are the shear stresses that are applied at particular flow rates. As stated previously these are checked at the beginning of each day the Sedflume is in use.

Detection limits are as follows: 0.5mm depth, time 1sec, flow rate 1gal/min. The erosion rates should be between $1x10^{-5}$ – 1 cm/sec to be acceptable for quality control measures.

Prior to issuing the final report the raw data goes through a second level check which is initialed and dated by the analyst.

Instrument/Equipment Testing, Inspection and Maintenance Requirements

As stated previously, the Sedflume flow rates will be tested daily before each test run. Sedflume is designed as a field device and as such is a fairly robust system. Spare parts for Sedflume and for the coring operation are either available at any hardware store, or may be made by any competent machine shop.

Equipment, materials and supplies that are necessary to complete analytical testing are provided by Sea Engineering, Inc. The purchase of materials, equipment and supplies which impact data quality is to be accomplished in such a way that a preset of defined quality and/or performance specifications is included as part of the bid package.

Equipment that has been subjected to overloading, mishandling or otherwise thought to be defective is taken out of service until the appropriate measures/repairs are completed and the instrument has been tested and calibrated to perform satisfactorily. Preventive maintenance procedures are to be prepared for each new piece of equipment acquired.

Inventory procedures

Who ever notices supplies running low in the lab it is their responsibility to order more supplies. A general supply check takes place before any analysis begins to make sure that SEI has the supplies needed.

Safety

Safety in the laboratory is the responsibility of every employee. All laboratory personnel are to familiarize themselves with the contents of this section and police other employees to be sure the procedures are being followed. Authorized visitors in the laboratory are also expected to be aware of and follow the procedures.

Under no circumstance are persons in the possession of or under the influence of mind altering drugs or alcohol permitted in the Sea Engineering office or its laboratory. Being under the influence of or in the possession of such drugs and/or the failure to report anyone under their influence or in their possession constitutes grounds for immediate dismissal. Details of this procedure are defined in the employees Employment Contract.

Drug and alcohol testing may be required by client companies. Employees are subject to the requirements and rules of client companies when working on client sites. These may include but are not limited to pre project drug testing, random testing and post accident investigation testing. Employees are expected to give full cooperation to client representatives conducting testing under their programs. Failure to cooperate with clients will be deemed as grounds for dismissal.

The proper choice of attire will enhance the effectiveness of safety equipment in the event of an accident. Bare feet or any form of open-topped shoes are not acceptable laboratory attire. Personnel are to wear gloves when handling contaminated sediments. Disposable gloves are provided by Sea Engineering.

The cleanliness of offices and laboratories is the responsibility of individuals working in those areas. Floors are to be kept free of filth and trash. The placement of supplies, equipment and personal items on the floor is to be avoided. Access to emergency equipment such as fire extinguishers shall not be obstructed. Waste and scrap shall be discarded in the appropriate provided containers.

Pollution Prevention/Waste Management

When dealing with contaminated sediments great care is taken to prevent spillage. If some spillage occurs it is cleaned up immediately using the proper cleaning agents. All contaminated sediments and water are dumped into large water containers on the outside of the laboratory. These containers are emptied when the job is completed and/or when the containers are full. A designated pollution/waste management company is called to pick up these contaminated wastes.

Non-contaminated waste materials are simply thrown into designated trash bins and emptied when full.

Corrective Action

Whenever an out of control situation has been detected, the analyst should notify his supervisor and together try to resolve the problem which caused the situation. After resolution, the analyst should continue with the corrective action to bring the analysis back in control. Usually this means repreparing and/or reanalyzing the samples. When sample or time limitations (rush work) preclude correcting the situation, discuss with the QAU, notify client and flag the out of control data. For every situation that requires a corrective action, the analyst will fill out a corrective action form found in the Quality Assurance Manual.

Once the corrective action has been put in place and the form has been signed and filed the corrective action must be monitored for its effectiveness.

The client will immediately be notified of any errors in our reports. They will receive a detailed description of the error with the appropriate correction.

Correcting erroneous reports

The client will immediately be notified of any errors in our reports. They will receive a detailed description of the error with the appropriate correction.

Complaint Resolution

Anytime a serious complaint is received, it is recorded for a permanent record, tracked to insure resolution, and brought to the attention of senior managers. A serious complaint is one that questions the validity of our results. In general, the nature of the complaint is documented on a form which is given to the Vice President/Technical Director or Laboratory Manager. Someone is assigned to resolve the issues and monitor for its effectiveness. The progress of the complaint resolution is discussed and tracked during weekly staff meetings. Finally, after resolution, the client is contacted for final comments, and the complaint form is signed off by a second senior manager. A permanent record is kept by the Quality Assurance Manager. A Client Complaint Record or similar form will be used to record the complaint which can be found in the Quality Assurance Manual.

Data Validation and Usability

Data Review, Validation and Verification Requirements

This section describes the statistical assessment procedures that are applied to the data and the general assessment of the data quality accomplishments. This is only performed on replicate cores.

Precision

The precision will be evaluated by performing duplicate analyses and will be assessed by the following three methods:

1) Difference

Difference = $X_1 - X_2$
Where: X_1 = larger of the two observed values
X_2 = smaller of the two observed values

2) Relative Percent Difference (RPD)

$$\text{RPD} = \frac{(X_1 - X_2) * 100}{(X_1 - X_2)/2}$$

3) Relative Standard Deviation (RSD)

$$\text{RSD} = (s/\bar{y})*100$$

Where: s = standard deviation
$\bar{y}$ = mean replicate analyses

This formula is used for three or more replicate values and may be used when reporting precision on aggregated data.

Standard deviation is defined as follows:

$$s = \sqrt{\sum_{n=1}^{n} \frac{(y_i - \bar{y})^2}{(n-1)}}$$

Where: y_i = measured value of the ith replicate
$\bar{y}$ = mean of replicate analyses
n = number of replicates

Accuracy

Accuracy will be based upon known samples or reference. Field and laboratory blank samples can also be used in the assessment of accuracy.

Accuracy will be evaluated by determining whether the samples are within the required acceptance windows. Bias for a particular sample is defined:

$$Bias = \frac{\sum (Y_{ik} - R_i)}{n}$$

Where: Y_{ik} = the average observed value for the ith audit sample and k observations
R_i = the theoretical reference value
n = the number of reference samples used in the assessment

Comparability

Comparability will be assessed through the evaluation of precision and accuracy estimates of samples. Replicates of at least four samples will be taken from each of four sites to demonstrate comparability.

Detectability

An important factor to consider in data quality evaluations is the detection limit, which is defined as the lowest value of a characteristic that a measurement process, or a method specific procedure can reliably discern. Detection limits are identified in table A-1 and can also be defined in general as:

$$\text{Detection Limit} = t_{(n-1,1-\alpha=.99)} * s$$

Where: $t_{(n-1,1-\alpha=.99)}$ = researcher's t-value for a one sided 99% confidence level and standard deviation estimate with n-1 degrees of freedom.
s = standard deviation

Sedflume field data is not amenable to statistical analysis. Erosion rates vary both aerially and with depth and thus no two measurements should be necessarily similar. Note that erosion rates can vary by as much as five orders of magnitude for a given core. The same applies to bulk density and to grain size. In each case there is no theoretically achievable value and as such, accuracy is an unsuitable criterion. Precision is a proper criterion only when evaluating replicates and split duplicates. Split duplicates may be obtained for bulk parameters; however, split duplicates are not possible for erosion rates. Table A-1 summarizes other acceptance criteria for the proposed measurements as relating to detection limits and internal consistency.

Completeness will be assessed for each variable upon completion of the measurements. There is ample time in the field for obtaining a second core from a given site if there are problems with processing the initial core.

Data that is determined to be inaccurate, incomplete, or non-detectable will either be rejected or presented with clear notification of data deficiency.

References

Jepsen, R., J. Roberts, and W. Lick, 1997, Effects of Bulk Density on Sediment Erosion Rates, Water, Air, and Soil Pollution, Vol. 99, pp. 21-31.

McNeil, J., C. Taylor, and W. Lick, 1996, Measurements of Erosion of Undisturbed Bottom Sediments with Depth, J. Hydraulic Engineering, pp. 316-324.

Roberts, J., R. Jepsen, and W. Lick, 1998, Effects of Grain size and Bulk Density on the Erosion of Quartz Particles, J. Hydraulic Engineering, in press.

Taylor, C. and W. Lick, 1996, Erosion Properties of Great Lakes Sediments, UCSB Report.

Appendix A
Sampling Forms

Sea Engineering, Inc.

Standard Laboratory Procedures for Measurement of Water Content

Revisions to 1.3:
Balance verification is conducted with 1g and 50g.

Approved by:____________________
Craig A. Jones, Ph.D.
Lab Manager / Quality Assurance Officer

Approved by:____________________
Ken Israel
Vice President/Technical Director

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Materials
Drying oven
Balance
Disposable metal sampling trays
Tongs

Sampling Procedure

1. Determine and record the mass of a clean and dry disposable metal sampling tray (to 3 decimal places) on the Bulk Density Datasheet found in the Sedflume Logbook
2. Place moist sample (5-10g) on the tray and determine the mass of the tray and sample using the balance and record this value (to 3 decimal places)
3. Place the tray with the sample in the drying oven at 110 ± 5°C for a minimum of 12 hours
4. After the sample has dried remove the tray from the oven with tongs and place on the counter next to the oven to cool
5. Allow to cool to room temperature or until the try can be handled comfortably with bare hands and the operation of the balance will not be affected by convection currents and/or being heated
6. Determine the mass of the tray and oven-dried sample using the same balance used in step 1 & 2 and record this value (to 3 decimal places)
7. Repeat steps 3-6 two more times to make sure the sample has reached a constant dry mass

*Record all weights onto the Bulk Density Datasheet found in the Sedflume Logbook

Calculations

1. Calculate the water content of the samples as follows:

$$w = [(M_{tms} - M_{tds})/(M_{tds} - M_t)] \text{ X } 100 = M_w/M_s$$

w = water content, %
M_{tms} = mass of tray and moist sample, g
M_{tds} = mass of tray and oven dry sample, g
M_t = mass of tray, g
M_w = mass of water ($M_w = M_{tms} - M_{tds}$), g
M_s = mass of oven dry sample ($M_s = M_{tds} - M_t$), g

2. Calculate bulk density of the samples as follows:

$$\rho_{sed} (\rho_{water}) / \rho_{sed} - [(\rho_{sed} - \rho_{water})\, w] = \text{bulk density}$$

ρ_{sed} = density of Quartz, 2.65 g/cm3 (assume as a constant)
ρ_{water} = density of water, 1.00 g/cm3

w = water content, % (determined from calculation 1 for each sample)

Identification of the test method/ Summary of test methods

A sediment sample is dried in an oven at a temperature of 110 ± 5°C to a constant mass. The loss of mass due to drying is considered to be water. The water content is calculated using the mass of water and the mass of the dry sediment sample.

Scope and application including components to be analyze
The scope of this application is to determine the water content and bulk density of various sediment samples. This data is used in the analysis and reporting of sediment cores.

Method Performance/ Data assessment and acceptance criteria for control measures

Detection limits are as follows; oven temperature 110 ± 5°C and balance ± 0.0003g of certified standards. If all detection limits are met and equipment is calibrated and verified properly then acceptance criteria for control measures are verified.

Definitions

Water content by mass (of a sediment sample) - the ratio of the mass of water contained in the pore spaces of the sediment, to the solid mass particles of that sediment, expressed as a percentage. A standard temperature of 110 ± 5°C is used to determine these masses.

Constant dry mass (of sediment sample) – the state that a water content sample has attained when further heating causes, or would cause, less that 1% additional loss in mass. The time required to obtain constant dry mass will vary depending on numerous factors. The influence of these factors generally can be established by good judgment, and experience with the materials being tested and the apparatus being used.

Bulk density – weight of a unit volume of a loose material (such as a powder or soil) to the same volume of water. Expressed in grams per cubic centimeters (g/cm3)

Safety

Safety in the laboratory is the responsibility of every employee. All laboratory personnel are to familiarize themselves with the contents of this section and police other employees to be sure the procedures are being followed. Authorized visitors in the laboratory are also expected to be aware of and follow the procedures.

Under no circumstance are persons in the possession of or under the influence of mind altering drugs or alcohol permitted in the Sea Engineering office or its laboratory. Being under the influence of or in the possession of such drugs and/or the failure to report anyone under their influence or in their possession constitutes grounds for immediate dismissal. Details of this procedure are defined in the employees Employment Contract.

Drug and alcohol testing may be required by client companies. Employees are subject to the requirements and rules of client companies when working on client sites. These may include but are not limited to pre project drug testing, random testing and post accident investigation testing. Employees are expected to give full cooperation to client representatives conducting testing under their programs. Failure to cooperate with clients will be deemed as grounds for dismissal.

The proper choice of attire will enhance the effectiveness of safety equipment in the event of an accident. Bare feet or any form of open-topped shoes are not acceptable laboratory attire. Personnel are to wear gloves when handling contaminated sediments. Disposable gloves are provided by Sea Engineering.

The cleanliness of offices and laboratories is the responsibility of individuals working in those areas. Floors are to be kept free of filth and trash. The placement of supplies, equipment and personal items on the floor is to be avoided. Access to emergency equipment such as fire extinguishers shall not be obstructed. Waste and scrap shall be discarded in the appropriate provided containers.

Equipment and supplies

Equipment, materials and supplies that are necessary to complete analytical testing are provided by Sea Engineering, Inc. The purchase of materials, equipment and supplies which impact data quality is to be accomplished in such a way that a preset of defined quality and/or performance specifications is included as part of the bid package.

Equipment that has been subjected to overloading, mishandling or otherwise thought to be defective is taken out of service until the appropriate measures/repairs are completed and the instrument has been tested and calibrated to perform satisfactorily. Preventive maintenance procedures are to be prepared for each new piece of equipment acquired. This includes checking the calibration of each piece of equipment before each daily use. There are four logbooks, one for each piece of equipment, where before each daily use the analyst must log that they have calibrated the equipment.

Reagents and Standards

No reagents are needed for this procedure. The oven has a NIST traceable thermometer and the balance has a certified 1g and 50g weight. The standard temperature the oven should be set at is 110 ± 5^{o}C.

Sample collection, preservation, storage, handling and chain of custody

Samples will be collected, handled, and analyzed by SEI personnel. However sometimes the client will send us samples they have collected and want us to analyze. Chain of custody will be recorded as required by project specifications.

All samples will be uniquely labeled and logged by the sampler. Sediment samples are placed into small plastic bags and labeled with a unique ID number. It is this ID number that is logged onto the various datasheets. Samples designated for particle size analysis will be under the continuous custody of SEI personnel so the sample integrity can be assured. Dr. Craig Jones of SEI will supervise all Sedflume operations. Holding time before analysis of samples is 28 days unless otherwise discussed between SEI employees and the client. After analysis samples will be stored in the lab until the final report has been sent to the client.

Quality control/ Calibration/Record keeping and record storage (archives)

Although great care will always be taken, quality control will be performed routinely during sampling and measuring.

Before each daily use the analyst will calibrate the balance with the certified 1g and 50g weight and record the date, time and weight displayed on the screen onto the Balance Log Sheet found in the Balance Logbook. Before each daily use the analyst will calibrate the oven with the NIST certified thermometer and record the date, time and temperature onto the Oven Log Sheet found in the Oven Logbook.

The water content data is recorded onto the Bulk Density Datasheet found in the Sedflume Logbook. These datasheets are kept in the appropriate job file found in the Sedflume filing cabinet in the SEI office.

Inventory procedures

Who ever notices supplies running low in the lab it is their responsibility to order more supplies. A general supply check takes place before any analysis begins to make sure that SEI has the supplies needed.

Data Review, Validation and Verification Requirements

This section describes the statistical assessment procedures that are applied to the data and the general assessment of the data quality accomplishments. This is only performed on replicate cores.

Precision

The precision will be evaluated by performing duplicate analyses and will be assessed by the following three methods:

1) Difference

$$\text{Difference} = X_1 - X_2$$

Where: X_1 = larger of the two observed values
X_2 = smaller of the two observed values

2) Relative Percent Difference (RPD)

$$\text{RPD} = \frac{(X_1 - X_2) * 100}{(X_1 - X_2)/2}$$

3) Relative Standard Deviation (RSD)

$$\text{RSD} = (s/\bar{y})*100$$

Where: s = standard deviation
$\bar{y}$ = mean replicate analyses

This formula is used for three or more replicate values and may be used when reporting precision on aggregated data.

Standard deviation is defined as follows:

$$s = \sqrt{\sum_{n=1}^{n} \frac{(y_i - \bar{y})^2}{(n-1)}}$$

Where: y_i = measured value of the ith replicate
$\bar{y}$ = mean of replicate analyses
n = number of replicates

Accuracy

Accuracy will be based upon known samples or reference. Field and laboratory blank samples can also be used in the assessment of accuracy.

Accuracy will be evaluated by determining whether the samples are within the required acceptance windows. Bias for a particular sample is defined:

$$Bias = \frac{\sum (Y_{ik} - R_i)}{n}$$

Where: Y_{ik} = the average observed value for the ith audit sample and k observations
R_i = the theoretical reference value
n = the number of reference samples used in the assessment

Comparability

Comparability will be assessed through the evaluation of precision and accuracy estimates of samples. Replicates of at least four samples will be taken from each of four sites to demonstrate comparability.

Detectability

An important factor to consider in data quality evaluations is the detection limit, which is defined as the lowest value of a characteristic that a measurement process, or a method specific procedure can reliably discern. Detection limits are defined in general as:

$$\text{Detection Limit} = t_{(n-1,1-\alpha=.99)} * s$$

Where: $t_{(n-1,1-\alpha=.99)}$ = researcher's t-value for a one sided 99% confidence level and standard deviation estimate with n-1 degrees of freedom.
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Sedflume field data is not amenable to statistical analysis. Bulk densities vary both aerially and with depth and thus no two measurements should be necessarily similar. Note that bulk density can vary by as much as five orders of magnitude for a given core. In each case there is no theoretically achievable value and as such, accuracy is an unsuitable criterion. Precision is a proper criterion only when evaluating replicates and split duplicates. Split duplicates may be obtained for bulk parameters; however, split duplicates are not possible for erosion rates.

Completeness will be assessed for each variable upon completion of the measurements. There is ample time in the field for obtaining a second core from a given site if there are problems with processing the initial core.

Data that is determined to be inaccurate, incomplete, or non-detectable will either be rejected or presented with clear notification of data deficiency.

Pollution Prevention/Waste Management/Management of laboratory wastes and hazardous materials

When dealing with contaminated sediments great care is taken to prevent spillage. If some spillage occurs it is cleaned up immediately using the proper cleaning agents. All contaminated sediments and water are dumped into large water containers on the outside of the laboratory. Disposable metal trays that contained contaminated sediments are rinsed with water before being thrown away. This water goes into the large water containers. These containers are emptied by a designated pollution/waste company when the job is completed and/or when the containers are full.

Non-contaminated liquid and sediment waste materials are simply washed down the sink. Non-contaminated solid wastes (i.e. paper towels) are thrown into designated trash bins and emptied when full.

Corrective Action

Whenever an out of control situation has been detected, the analyst should notify his supervisor and together try to resolve the problem which caused the situation. After resolution, the analyst should continue with the corrective action to bring the analysis back in control. Usually this means repreparing and/or reanalyzing the samples. When sample or time limitations (rush work) preclude correcting the situation, discuss with the QAU, notify client and flag the out of control data. For every situation that requires a corrective action, the analyst will fill out a corrective action form found in the Quality Assurance Manual. Once the corrective action has been put in place and the form has been signed and filed the corrective action must be monitored for its effectiveness.

Correcting erroneous reports

The client will immediately be notified of any errors in our reports. They will receive a detailed description of the error with the appropriate correction.

Complaint Resolution

Anytime a serious complaint is received, it is recorded for a permanent record, tracked to insure resolution, and brought to the attention of senior managers. A serious complaint is one that questions the validity of our results. In general, the nature of the complaint is documented on a form which is given to the Vice President/Technical Director or Laboratory Manager. Someone is assigned to resolve the issues and monitor for its effectiveness. The progress of the complaint resolution is discussed and tracked during weekly staff meetings. Finally, after resolution, the client is contacted for final comments, and the complaint form is signed off by a second senior manager. A permanent record is kept by the Quality Assurance Manager. A Client Complaint Record or similar form will be used to record the complaint which can be found in the Quality Assurance Manual.

Reference

ASTM 2216-05 Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass

STANDARD OPERATING PROCEDURE (SOP) AP-01

SAMPLE PACKAGING AND SHIPPING

SCOPE AND APPLICATION

This SOP describes specific requirements for sample packaging and shipping 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 also 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

Make sure that you have the equipment and supplies necessary to properly pack and ship environmental samples, including the following:

- Project-specific sampling and analysis plan (SAP)
- Project-specific field logbook
- Sealable airtight bags in assorted sizes (e.g., Ziploc®)
- Wet ice in doubled, sealed bags; frozen Blue Ice®; or dry ice
- Cooler(s)
- Bubble wrap
- Fiber-reinforced packing tape, clear plastic packing tape, and duct tape
- Scissors or knife
- Chain-of-custody (COC) forms
- COC seals
- Large plastic garbage bags (preferably 3 mil [0.003 in.] thick)
- Paper towels
- “Fragile,” “This End Up,” or “Handle With Care” labels
- Mailing labels
- Air bills for overnight shipment

PROCEDURE

Customize the logistics for sample packaging and shipping to each study. If necessary, transfer samples from the field to a local storage facility where they can be frozen or refrigerated. Depending on the logistics of the operation, field personnel may transport samples to the laboratory or use a commercial courier or shipping service. In the latter case, Integral field personnel must be aware of any potentially limiting factors to timely shipping, such as availability of overnight service and weekend deliveries to specific areas, and shipping regulations regarding "restricted articles" (e.g., dry ice, formalin) prior to shipping the samples.

SAMPLE PREPARATION

Take the following steps to ensure the proper transfer of samples from the field to the laboratories:

At the sample collection site:

1. Document all samples using the proper logbooks or field forms (see SOP AP-02), required sample container identification (i.e., sample labels with tag numbers), and COC form (example provided in SOP AP-03). Fill out the COC form as described in SOP AP-03, and use the sample labeling techniques provided in SOP AP-04.
2. Make all applicable laboratory quality control sample designations on the COC forms. Clearly identify samples that will be archived for future possible analysis. Label these samples as follows: "Do Not Analyze: Hold and archive for possible future analysis." Some laboratories interpret "archive" to mean that they should 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. Keep the samples in the possession of the sampling personnel at all times. Lock and secure any temporary onsite sample storage areas to maintain sample integrity and COC requirements.
5. Clean the outside of all dirty sample containers to remove any residual material that may lead to cross-contamination.
6. Complete the COC form as described in SOP AP-03, and retain the back (pink) copy for project records prior to sealing the cooler. Check sample containers against the COC form to ensure all the samples that were collected are in the cooler.

7. Store each sample container in a sealed plastic bag that allows the sample label (example provided in SOP AP-03) to be read. Before sealing the bags, ensure that volatile organic analyte (VOA) vials are encased in a foam sleeve or in bubble wrap.
8. If the samples require storage at a specific temperature, place enough ice in the sample cooler to maintain the temperature (e.g., 4°C) throughout the sampling day.

At the sample processing area (immediately after sample collection) take the following steps:

1. If the samples require a specific storage temperature, then cool the samples and maintain the temperature prior to shipping. For example, place enough ice in each sample cooler to maintain the temperature at 4°C until processing begins at the testing laboratory.
2. Be aware of holding time requirements for project-specific analytes and arrange the sample shipping schedule accordingly.
3. Place samples in secure storage (i.e., locked room or vehicle) or keep them in the possession of Integral sampling personnel before shipment. Lock and secure any sample storage areas to maintain sample integrity and COC requirements.
4. Store samples in the dark (e.g., keep coolers shut).

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

1. Check sample containers against the COC form to account for all samples intended for shipment.
2. Choose cooler(s) of appropriate size and make sure they are clean of gross contamination inside and out. If the cooler has a drain, close the drain and secure it with duct tape.
3. Line the cooler with bubble wrap and place a large plastic bag (preferably with a thickness of 3 mil), open, inside the cooler.
4. Individually wrap each glass container (which was sealed in a plastic bag at the collection site) in bubble wrap and secure with tape or a rubber band. Place the wrapped samples in the large plastic bag in the cooler, leaving room for ice to keep the samples cold (i.e., 4°C).
5. If temperature blanks have been provided by the testing laboratory, place one temperature blank in each sample cooler.
6. If the samples require a specific storage temperature, add enough wet ice or Blue Ice® to maintain that temperature during overnight shipping (i.e., 4°C). Always overestimate the amount of ice that will be required. Keep ice in a sealed plastic bag, which is placed in a second sealed plastic bag to prevent leakage. Avoid separating the samples from the ice with excess bubble wrap because it may insulate the samples from the ice. After adding all samples and ice to the cooler, use bubble wrap (or other

available clean packing material) to fill any empty space and prevent 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 QA project plan calls for them.

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. Seal the rest of the signed COC form in a bag and tape the bag to the inside of the cooler lid. Each cooler should contain an individual COC form for the samples contained inside it. If time is short and it becomes necessary to combine all the samples onto a single set of COC forms and ship multiple coolers together, then indicate on the outside of the appropriate cooler, "Chain-of-Custody Inside."

10. After the cooler is sufficiently packed to prevent shifting of the containers, close the lid and seal it with fiber-reinforced packing tape. Tape the cooler around the opening, joining the lid to the bottom, and around the circumference of the cooler at both hinges.

11. As security against unauthorized handling of the samples, apply two COC seals across the opening of the cooler lid (provided with example field forms). Place one seal on the front right portion of the cooler and one on the back left. Be sure the seals are properly affixed to the cooler to prevent removal 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. When hand-delivering environmental samples, make sure the testing laboratory receives them on the same day that they were packed in the coolers.

3. Fax or scan and e-mail copies of all COC forms to the Integral project QA/QC coordinator. Note: It may be necessary to photocopy the COC form on a slightly darker setting so 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. Apply a mailing label to 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 cooler and to protect it from the weather. This is a secondary label in case the air bill is lost during shipment.
2. Fill out the air bill and fasten it to the handle tags provided by the shipper (or the top of the cooler if handle tags are not available).
3. If samples must be frozen (–20°C) during shipping, make sure that dry ice has been placed in the sample cooler. Be aware of any additional shipping, handling, and special labeling requirements that the shipper may require.
4. Make sure that benthic infauna samples have been preserved with formalin in the field prior to shipping. Be aware of any additional shipping, handling, and special labeling requirements that the shipper may require 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. If environmental samples must be shipped at 4°C or –20°C, choose overnight shipping for delivery next morning. Fax or scan and e-mail copies of all COC forms to the Integral project QA/QC coordinator. Note: It may be necessary to photocopy the COC form on a slightly darker setting so the form is readable after faxing. Never leave the original COC form in the custody of non-Integral staff.

STANDARD OPERATING PROCEDURE (SOP) AP-02

FIELD DOCUMENTATION

SCOPE AND APPLICATION

This SOP describes the Integral procedure for accurate record-keeping in the field for the purposes of ensuring that samples can be traced from collection to final disposition.

Document all information relevant to field operations properly to ensure that activities are accounted for in written records to the extent that someone not present at the site could reconstruct the activity without relying on the memory of the field crew. Several types of field documents are 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. Field personnel should not include superfluous comments or speculation regarding the field activities or observations.

FIELD LOGBOOKS

During field sampling events, field logbooks must be used to record all daily activities. The purpose of the field logbook is to document events and record data measured in the field to the extent that someone not present at the site could reconstruct the activity without relying on the memory of the field crew. The project manager (or designee) should issue a field logbook to the appropriate site personnel for the direction of onsite activities (e.g., reconnaissance survey team leader, sampling team leader). It is this designee's responsibility to maintain the site logbook while it is in his or her possession and return it to the project manager or turn it over to another field team.

Make entries in the field logbook as follows:

1. Document all daily field activities in indelible ink in the logbook and make no erasures. Make corrections with a single line-out deletion, followed by the author's initials and the date. The author must initial and date each page of the field logbook. The author must sign and date the last page at the end of each day, and draw a line through any blank space remaining on the page below the last entry.

2. Write the project name, dates of the field work, site name and location (city and state), and Integral job number on the cover of the field logbook. If more than one logbook is used during a single sampling event, then annotate the upper right-hand corner of the logbook (e.g., Volume 1 of 2, 2 of 2) to indicate the number of logbooks used during the field event. Secure all field logbooks when not in use in the field. The following is a list of the types of information that is appropriate for entry in the field notebook:

   – 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, air and water temperature, thickness of ice if present)

   – Name and affiliation of person making entries and other field personnel and their duties, including what times 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 what times they are present

   – The name, agency, and telephone number of any field contacts

   – Notation of the coordinate system used to determine the station location

   – 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 of collection 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

   – For aquatic sampling, the type of vessel used (e.g., size, power, type of engine)

   – Specific information on each type of sampling activity

   – The sample type (e.g., groundwater, soil, surface sediment), sample number, sample tag number, and any preservatives used, 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 that 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 on the field data sheets (if used), including station identification and location, date, and time of measurement
- Sample shipment information (e.g., shipping manifests, chain-of-custody (COC) form numbers, carrier, air bill numbers, time addresses)
- A record of quantity of investigation-derived wastes (if any) and storage and handling procedures.

3. During the field day, as listed above, record in the logbook a summary of all site activities. Provide a date and time for each entry. 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 pages in these logbooks for detailed information.

4. If measurements are made at any location, record the measurements and equipment used, or refer to the logbook and page number(s) or field forms 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.

5. 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. 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 cases, photographs (print or digital) of sampling stations may be taken using a camera-lens system with a perspective similar to the naked eye. Ensure that photographs include a measured scale in the image, when practical. If you take photographs of sample characteristics and routine sampling activities, avoid using telephoto or wide-angle shots, because they cannot be used in enforcement proceedings. Record the following items 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 shown 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 is responsible for submitting all photographic materials to be developed (prints) or copied (disks). Place the prints or disks and associated negatives in the project files (at the Integral project manager's location). Make photocopies of photo logs and any supporting documentation from the field logbooks, and place them in the project files with the prints or disks.

EQUIPMENT CALIBRATION RECORDS

Record in the field logbook all equipment calibration records, including instrument type and serial number, calibration supplies used, calibration methods and calibration results, date, time, and personnel performing the calibration. Calibrate all equipment used during the investigation daily, at a minimum, in accordance with the manufacturers' recommendations.

DISTRIBUTION OF COPIES

At Integral offices, make two copies of all field logbooks and additional field data forms. Stamp the first copy with a "COPY" stamp, and place it in the project file to be available for general staff use. Stamp the second copy with a "FILE" stamp, and place it in the data management file with the laboratory data packages, to be used by the data management and quality assurance staff only. Place the original field logbooks and forms in a locked file cabinet.

SET-UP OF LOCKING FILE CABINET

Place each project in its own file folder in a locking file cabinet. On the folder label, include the project name and contract number. Each project folder will include up to six kinds of files:

- 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) AP-03

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 AP-01, which covers sample packaging and shipping; SOP AP-02, which covers the use of field logbooks and other types of field documentation; and SOP AP-04, which covers sample labeling. Chain-of-custody (COC) forms 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 his or her 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 critical because it documents sample possession from the time of collection through final disposition. The form also provides information to the laboratory regarding what analyses are to be performed on the samples that are shipped.

Complete the COC form after each field collection activity and before shipping the samples to the laboratory. Sampling personnel are responsible for the care and custody of the samples until they are shipped. The individuals relinquishing and receiving the samples must sign the

COC form(s), indicating the time and date of the transfer, when transferring possession of the samples.

A COC form consists of three-part carbonless paper with white, yellow, and pink copies. The sampling team leader keeps the pink copy. The white and yellow sheets are placed in a sealed plastic bag and secured inside the top of each transfer container (e.g., cooler). Field staff retain the pink sheet for filing at the Integral project manager's location. Each COC form has a unique four-digit number. This number and the samples on the form must 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. Alternatively, if sufficient time is available, the computer-generated forms will be printed on three-part carbonless paper.

Record on the COC form the project-assigned sample number and the unique tag number at the bottom of each sample label. The COC form also identifies the sample collection date and time, type of sample, project name, and 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 is sent to the laboratory along with the sample(s).

PROCEDURES

Use the following guidelines to ensure the integrity of the samples:

1. Sign and date each COC form. Have the person who relinquishes custody of the samples also sign this form.
2. At the end of each sampling day and prior to shipping or storage, make COC entries for all samples. Check the information on the labels and tags against field logbook entries.
3. Do not sign the COC form until the team leader has checked the information for inaccuracies. Make corrections by drawing a single line through any incorrect entry, and then initial and date it. Make revised entries in the space below the entries. After making corrections, mark out any blank lines remaining on the COC form, using single lines that are initialed and dated. This procedure will prevent any unauthorized additions.

   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 of the transfer. The time 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.

4. If samples are sent by a commercial carrier not affiliated with the laboratory, such as FedEx or United Parcel Service (UPS), record the name of the carrier on the COC form. Also enter on the COC form any tracking numbers supplied by the carrier. The time of transfer should be as close to the actual drop-off time as possible. After signing the COC forms and removing the pink copy, seal them inside the transfer container.
5. If errors are found after the shipment has left the custody of sampling personnel, make a corrected version of the forms and send it to all relevant parties. Fix minor errors 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.
6. Provide a COC form and an Archive Record form for any samples that are archived internally at Integral.

Upon completion of the field sampling event, the sampling team leader is responsible for submitting all COC forms to be copied. A discussion of copy distribution is provided in SOP AP-02.

CUSTODY SEAL

As security against unauthorized handling of the samples during shipping, affix two custody seals to each sample cooler. Place the custody seals 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., FedEx, UPS), the shipper provides an air bill or receipt. 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 at an Integral office. A discussion of copy distribution is provided in SOP AP-02. Note the air bill number (or tracking number) on the applicable COC forms or, alternatively, note the applicable COC form number on the air bill to enable the tracking of samples if a cooler becomes lost.

ACKNOWLEDGMENT 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. The person receiving this form is responsible for reviewing it, making sure that the laboratory has received all the samples that were sent, and verifying that the correct analyses were requested. If an error is found, call the laboratory immediately, and document any decisions made during the telephone conversation, in writing, on the Acknowledgment of Sample Receipt form. In addition, correct the COC form and fax the corrected version to the laboratory.

Submit the Acknowledgment of Sample Receipt form (and any modified COC forms) to be copied. A discussion of copy distribution is provided in SOP AP-02.

ARCHIVE RECORD FORMS

On the rare occasion that samples are archived at an Integral office, 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 remains with the samples in a sealed Ziploc® bag.

STANDARD OPERATING PROCEDURE (SOP) AP-04

SAMPLE LABELING

SCOPE AND APPLICATION

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

SAMPLE IDENTIFIERS

Before field sampling begins, establish sample identifiers to be 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 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 use are described as follows:

- **Sample Identification Code—**The sample identification code (Sample ID) 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 (COC) form. The sample identifier is a multiple-part code. The first component begins 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 of the sample identifier. Use leading zeros for stations with numbers below 100 for ease of data management and correct data sorting.

  If appropriate, add a supplemental component to the sample identifier to code field duplicate samples and splits. Use a single letter (i.e., a suffix of "A" and "B") to indicate field duplicates or splits in the final component of the sample identifiers. For equipment decontamination blanks, assign sequential numbers starting at 900 instead of station numbers. Use a sample type code that corresponds 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).

Examples of sample IDs are as follows:

- 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. In cases where samples consist of multiple bottles from the same location, assign each bottle the same sample number and time. However, assign replicates from the same location different sample numbers and times. 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 generally a unique six-digit number that includes 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 are PW0001, PW0002, PW0003, etc.

- **Tag Number—**Attach a different tag number 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, assign each container 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 preprinted sample tag number. The tag number provides 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.

  Record tag numbers on the COC form. Laboratories use tag numbers only to confirm that they have received all of the containers that were filled and shipped. Data are reported by sample number.

Assign sample numbers sequentially in the field; sample labels are 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 are provided with preprinted sample labels, which must be affixed to each sample container used. Fill out the labels at the time the samples are collected, documenting the following information:

- Sample number
- Site name or project number
- Date and time sample is collected
- Initials of the samplers
- Preservatives used, if any
- 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 required only for environmental samples collected in certain U.S.

Environmental Protection Agency (EPA) regions (e.g., EPA Region 5). Field crews are provided with preprinted sample tags. Attach sample tags to each individual sample container with a rubber band or wire through a reinforced hole in the tag. Mark all sample tag entries with indelible ink. Fill out the tags at the time the samples are collected, documenting the following information:

- Sample number
- Site name or project number
- Date and time sample is collected
- Initials of the samplers
- Preservatives used, if any
- 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, wash away the sediment from the sample and collect the remaining benthic infauna into a sample container. Affix sample label (as discussed above) to the outside of the sample container. In addition, place an internal sample label inside the sample container. This internal sample label is made of waterproof paper; be sure to make all internal sample label entries with pencil. Fill out the internal sample labels at the time the samples are collected, documenting the following information:

- Sample number
- Site name or project number
- Date and time sample is collected
- Initials of the samplers
- Preservative used (e.g., formalin).

STANDARD OPERATING PROCEDURE (SOP) AP-05

INVESTIGATION-DERIVED WASTE HANDLING

SCOPE AND APPLICATION

This SOP presents the method to be used for handling wastes generated during field sampling activities that could be hazardous. These wastes are referred to as investigation-derived waste and are subject to specific regulations.

All disposable materials used for sample collection and processing, such as paper towels and gloves, are not considered investigation-derived wastes and will be placed in heavyweight garbage bags or other appropriate containers. Disposable supplies will be removed from the site by sampling personnel and placed in a normal refuse container for disposal at a solid waste landfill.

EQUIPMENT AND REAGENTS REQUIRED

- 55-gallon drums (or appropriately sized waste container)
- Paint markers
- Tools (to open and close drum)
- Ziploc® bags
- Drum labels.

PROCEDURES

1. Place solid wastes that need to be containerized in properly labeled, DOT- approved, 55-gallon drums.
2. Properly close, seal, label, and stage all filled or partially filled drums before demobilization. Properly profile full drums and have them shipped off site to a RCRA Subtitle C facility.

3. Sampling activities generate personal protective equipment and miscellaneous debris that require disposal. Remove gross contamination from these items, and place the items in plastic bags. It is acceptable to store these items in plastic bags as an interim measure. At the end of each day, dispose of the bags at an appropriate solid waste facility dumpster.

STANDARD OPERATING PROCEDURE (SOP) AP-06

NAVIGATION AND STATION POSITIONING

SCOPE AND APPLICATION

This SOP describes procedures for accurate station positioning required to ensure quality and consistency in collecting samples and in data interpretation and analysis. Station positioning must be both absolutely accurate in that it correctly defines a position by latitude and longitude, and relatively accurate in that the position must be repeatable, allowing field crew to reoccupy a station location in the future (e.g., for long-term monitoring programs).

This SOP describes the most commonly used station positioning method, differential global positioning system (DGPS). Integral uses a Trimble Pathfinder™ Pro XRS DGPS for station positioning for many field efforts. The Pro XRS offers the submeter accuracy often required for documenting sampling station locations and for re-locating previously sampled stations. A comprehensive discussion of the Trimble Pathfinder™ Pro XRS DGPS is provided in Attachments 1, 2, and 3 of this SOP.

SUMMARY OF METHOD

Global positioning system (GPS) navigation is used to 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 10 m.

One can obtain a higher accuracy of approximately 2 m 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 U.S, 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 Pro XRS, GPS data can be gathered to submeter accuracy using a choice of differential correction sources (i.e., free beacon differential signals such as Coast Guard beacons or OmniSTAR) without establishing a reference station. Data must be corrected to gain submeter 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: The station must be within 300 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, postprocessing 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 submeter to 3 times larger than the horizontal accuracy.

The GPS receiver displays and transmits differentially corrected positioning data to the computer 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). 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

- Cable
- GPS antenna
- Telemetry antenna (for differential corrections)
- GPS receiver
- Differential corrections receiver
- Computer and monitor
- Navigation software (e.g., Terrasync)
- Logbook or log sheets.

PROCEDURES

Obtain latitude and longitude coordinates at the locations where 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. Avoiding these times allows for better positioning accuracy.

On-Land Sampling Event

A backpack DGPS unit may be used to direct the sampling team to the proposed sampling location. To expedite field activities, enter the target station coordinates into the navigation system database prior to beginning sampling. Place the DGPS antenna as close as possible to where the sampling will occur. Once the sample(s) have been collected at the appropriate location, record the horizontal coordinates of the station in the field logbook.

On-Water Sampling Event

Mount the GPS antenna vertically at the outboard end of the vessel's boom, with the GPS antenna cable extended along the boom into the cabin. Mount the telemetry antenna for receiving differential corrections on a convenient fixture outside the cabin. Locate the GPS receiver, the differential corrections receiver, and the computer in the cabin. Orient the video screen for the computer to allow the vessel operator to observe on-screen positioning data from the helm.

Alternatively, use a backpack DGPS unit to position the sampling vessel (e.g., barge) over a proposed sampling location. Place the DGPS beacon as close as possible to where the drilling will occur (i.e., moon pool). Using the DGPS unit, direct the sampling vessel operator to the sample station location.

Once the sampling vessel is anchored at the appropriate location, record the horizontal coordinates of the station in the field logbook. To expedite field activities, enter the target station coordinates 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 for differential corrections). Verifying the accuracy of the GPS requires coordinates to be known for one (or more) horizontal control point within the study area. The GPS position reading at any given station can then be compared to the known control point. Verify the GPS accuracy at the beginning and end of each sampling day.

Station Positioning Activities

Use a consistent routine for each day's positioning activities. After confirming successful reception of differential signals, turn on the computer on, and the boot the software. Verify the accuracy of the system at a horizontal control point, as described in the previous section.

The sampling team proceeds to a target station location selected by the team leader. That station location is then selected from a number of preselected station locations that have been entered into the integrated navigation system database. Once the station has been selected, the positioning data are displayed on the computer screen or hand-held unit to assist in proceeding to the station and 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, the locations of both accepted and rejected grabs or cores are recorded.) Upon recovery of the sampling device, read the station position northing (y) and easting (x) coordinates from the archived computer file and record them in the field logbook or on log sheets as a backup to the computer record. Also record time and water depth, if applicable. Ancillary information recorded in the field logbook may include personnel operating the GPS, tidal phase, type of sampling activity, and time when coordinates were collected.

REFERENCES

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

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

ATTACHMENT 1
PRO XRS DESCRIPTION

The Pro XRS combines a high-performance GPS receiver and antenna, beacon differential receiver, and satellite differential receiver in one compact unit. It 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 Pathfinder™ Pro XRS consists of the following:

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

Pro XRS Setup

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

1. Ensure that 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 or in the backpack.

4. Screw antenna to the attachments on the top of the backpack. Wind cord around pole, and 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 2 and 3 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 and soft keys that allow for its operation. The hard keys comprise all of the keys (e.g., letters and numbers) on its surface. The soft keys are the F1 through F5 hard keys. The function of these changes depending upon the context. These keys will be referred to with brackets 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 (four) 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 2.
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. 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 titled *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 the sample number, station ID, sampling gear, sediment color, odor, etc.

8. Use the **<PAUSE>** key 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.

9. 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.

10. 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 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.

11. At the end of each day, download the rover file to a PC using Pathfinder Office software.

Feature Collection Options

Offsets—The Pro XRS 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 altitude 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, enter −5°). 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 Pro XRS 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). 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—This 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/lon), 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>** and then **<OFFSET>**. Make any necessary changes.
- To delete a feature collected in error, press **<DEL>**.

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 data logger as a waypoint, present as a feature position in the data files, or generated in the field using the GPS unit. Waypoints may be entered into the TSC1 by:

- Entering coordinates manually
- 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 you will use the *Navigation* module (accessed by pressing **MENU** followed by **Navigation**) to guide yourself to a target (waypoint or feature). You can also use the *Map* module (accessed by pressing **MENU** followed by **Map**) to:

1. Orient yourself in the area where you are working.
2. Get a general indication of the location of a feature or waypoint that you want to find.
3. Find or select features or waypoints to which you wish to navigate toward.
4. Plot a course from one place to another.
    a. 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.
    b. Select a feature by pressing **MENU**, Data Collection to reach the *Start Feature* screen, and then **<REVIEW>** to access all features contained in the data file. Highlight and select the desired feature by pressing the **<Target>** key, which adds a crossed flag to the feature. Reaccess the *Map* screen by selecting **MENU**, then **Map**, which will now show the highlighted feature with a crossed flag symbol on the Map screen. You 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.

c. 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 graphical modes available are the *Directional Dial* screen or the *Road* screen, which can be toggled between using the **<Mode>** key.

d. To navigate, select a target and then a start position. Each of these positions can be features from an open data file or a waypoint. Access a list of available features or waypoints 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, *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.

e. 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 have stopped.) The triangle at the top 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.

f. In the *Road* mode, 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 to which you are navigating toward. 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, download all rover files from the TSC1 to a PC for post-processing. You will need the Trimble Pathfinder software installed on your computer. If you are not using a field laptop that already has the program installed, 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 (a 9-pin female-to-female cable) 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. Download files from the TSC1 by selecting the **Receive** tab and choosing the data file type from the *Add* pulldown menu (Figure 1).

After downloading, remove all rover files and waypoints from the TSC1 to conserve memory. Rover files may be deleted from the *File Manager* menu as follows:

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

Delete data dictionaries in the same manner by selecting **Data Dictionaries** from the *File Manager* menu. Delete waypoints by selecting **Utilities** from the *Main* menu and then by selecting **Waypoints,** followed by **<DEL>**.

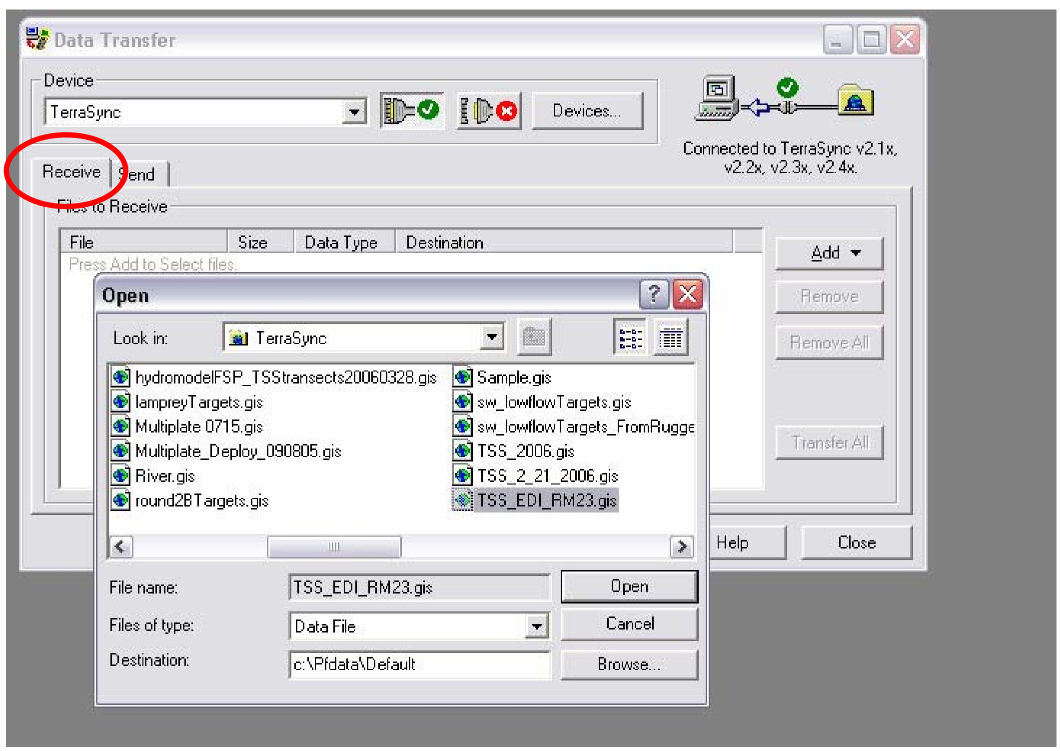

Figure 1. Transferring File from Terrasync

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. 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

To access this menu, select **Configuration** from the main menu and then select **GPS Rover Options**. The table below lists logging options and settings.

Logging Options	Setting	Comment
Logging intervals		
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 minutes	
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 13° (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

Access this menu from the GPS Rover *Options* menu by selecting **Real-Time Input**. The table below shows options and settings for real-time input.

Options	Setting	Comment
Preferred Correction Source		
	Choice 1	Integrated Beacon
	Choice 2	Integrated WAAS
	Choice 3	Use uncorrected GPS
Correction Age Limit	20s	

Antenna Options

Access this menu from the GPS rover *Options* menu by selecting **Antenna Options**. The table below shows antenna options and settings.

Option	Setting	Comment
Height	6 ft	Enter correct user antenna height using measurement method indicated below
Measure	Uncorrected	
Type	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	Bottom of Antenna	
Method	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. The table below lists options and descriptions for the *Configuration* menu.

Options	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), altitude reference (e.g., MSL), *North reference* (i.e., true or magnetic). Units can be converted, if necessary, after data capture by using Pathfinder Office software.
Time and date	Changes to *local time*, 24-hour clock, date format, and other options
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, *internal and external battery status*, software version, free space.

Contrast and Backlighting

The TSC1 display can be viewed in various light settings. Press **FUNC,** then **L** to turn on the display backlight for viewing in dim lighting. Adjust the contrast by pressing **FUNC**, then **E** or **F**.

ATTACHMENT 4
PRE-SAMPLING ACTIVITIES BEFORE USE OF THE PRO XRS

Determination of Optimal Satellite-Use Time

Positioning accuracies on the order of ±1 to 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 unit provides the operator with a listing of the time intervals during the day when accuracies are decreased. Avoiding these time intervals permits the operator to maintain better positioning accuracy.

ATTACHMENT 5
MANAGING GPS DATA FROM TERRASYNC—A TUTORIAL

Currently, positional data collected in the field is most often done with a Trimble GPS unit (usually rented) interfaced with a laptop via Trimble's Terrasync software. The Terrasync software sometimes exhibits quirks that interfere with the smooth operation of data collection in otherwise stressful field conditions. This tutorial is meant to supplement the Terrasync software documentation and serve as a guide to field personnel to help them retrieve and collect geographic data as efficiently as possible with existing software.

Scope

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

- Fixing files that are more than 7 days old so that they can be updated
- 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 competent at using MS Windows.

The Basics

GPS data collection currently relies on two pieces of complementary software:

- Terrasync—the interface for GPS navigation and data collection.
- Pathfinder Office—a multiuse 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.

Installing the Correct Versions of Terrasync and Pathfinder

Important Note: This tutorial uses Pathfinder Office v. 3.00 and Terrasync v. 2.50. It is very important to use the proper versions of this software to avoid compatibility issues. These software versions should be included in the same folder as this tutorial, or can be obtained from GIS staff.

http://www.trimble.com/terrasync_ts.asp?Nav=Collection-4576

Key code for TerraSync
499043-00110-05273-EDD049BC

Pathfinder v.3.00
001533-00300-04152-0ee4d11f

Initial Setup of Terrasync/Pathfinder

Certain settings and configuration setups are needed before Pathfinder can talk to Terrasync. Whether you are installing this software for the first time or have an existing installation, check to make sure that these settings are in place.

1. Open Pathfinder Office and go to the *Utilities>Data Transfer...* menu. A dialog box should appear. This is the interface for communicating with Terrasync.
2. Click the **Devices** button, and then **New…** (Figure 1).
3. Click on **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. 2.1x, v.2.2x, v.2.3x,** and **v2.4x**.
6. At the prompt for a name that will display in the device list, enter **Terrasync**.
7. Go back to the Data Transfer dialog box, select **Terrasync** from the dropdown menu, press the **Connect** icon, and look for a green check mark indicating success.

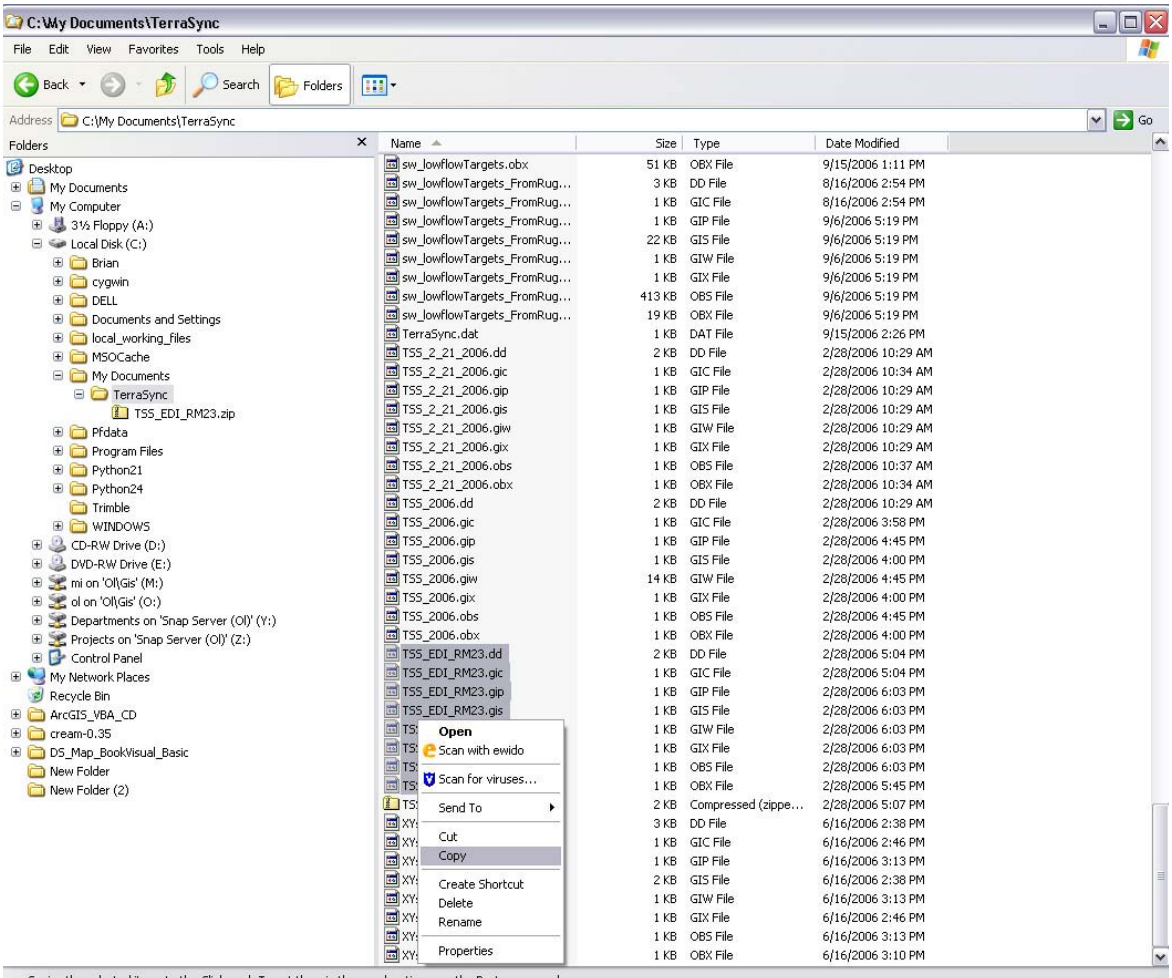

Figure 2. Selecting Files To Copy to a Different Directory

If this procedure does not work for you, you may have the wrong version of Pathfinder. For some unknown 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, go to *C:\Program Files\TerraSync*, right-click on **Terrasync.exe**, and choose the **Version** tab.

Handling Expired Files in Terrasync

One of the most common problems that field personnel will have to deal with is the 1-week expiration date when trying to collect data with Terrasync. This is a built-in function of Terrasync, and there is no simple way to work around it. The following instructions will guide you through the process to make the files usable. See Figure 3.

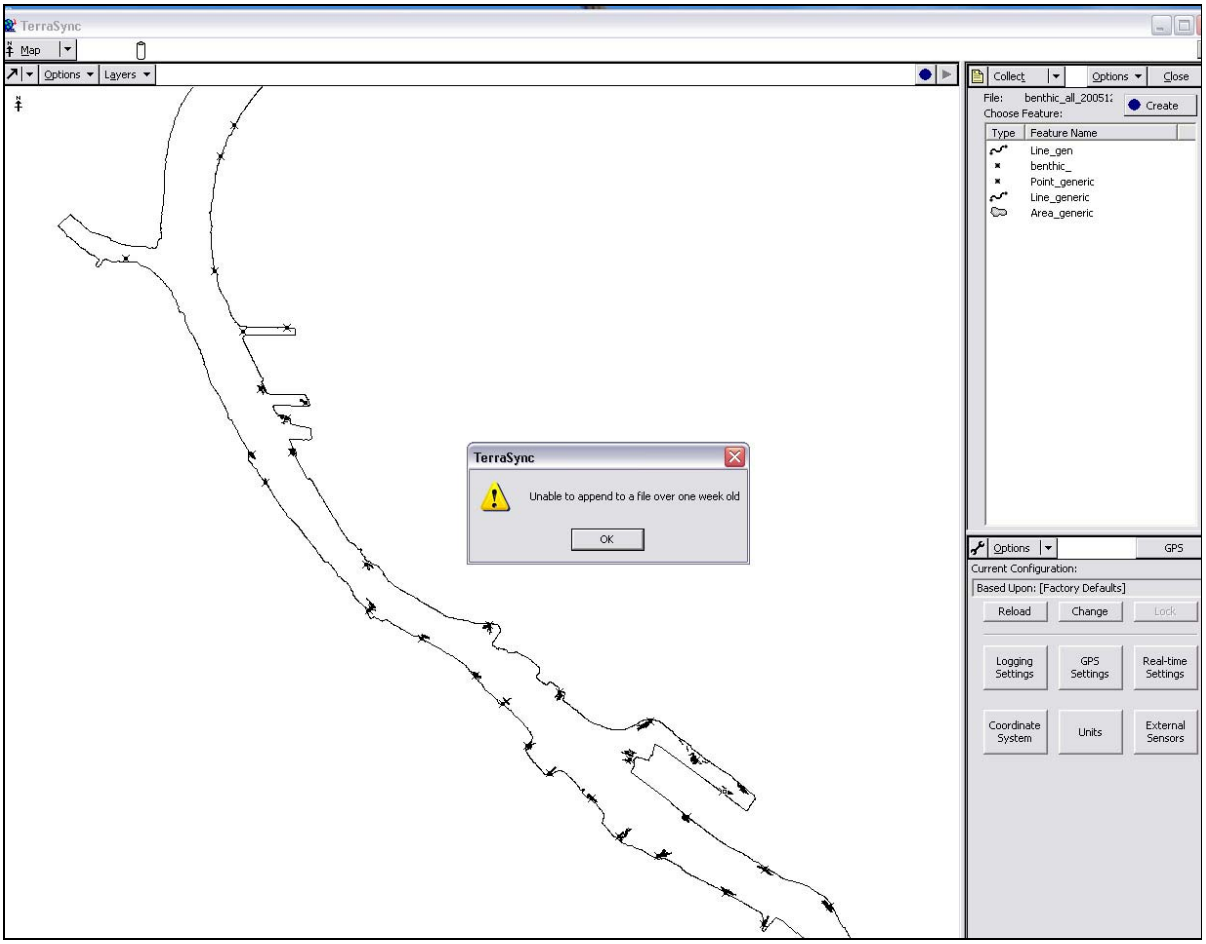

Figure 3. Notice That Terrasync File Older Than 1 Week Will Not Allow User To Collect Features (time begins to elapse when first feature is collected in the field, not when file is created)

Two options are available, depending on your needs. If you do not need to see the previously logged locations and need only to see the targets, 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 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 the 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 (Figure 4). These files will have to go into the *C:\My Documents\TerraSync* folder in order to be available to Terrasync.

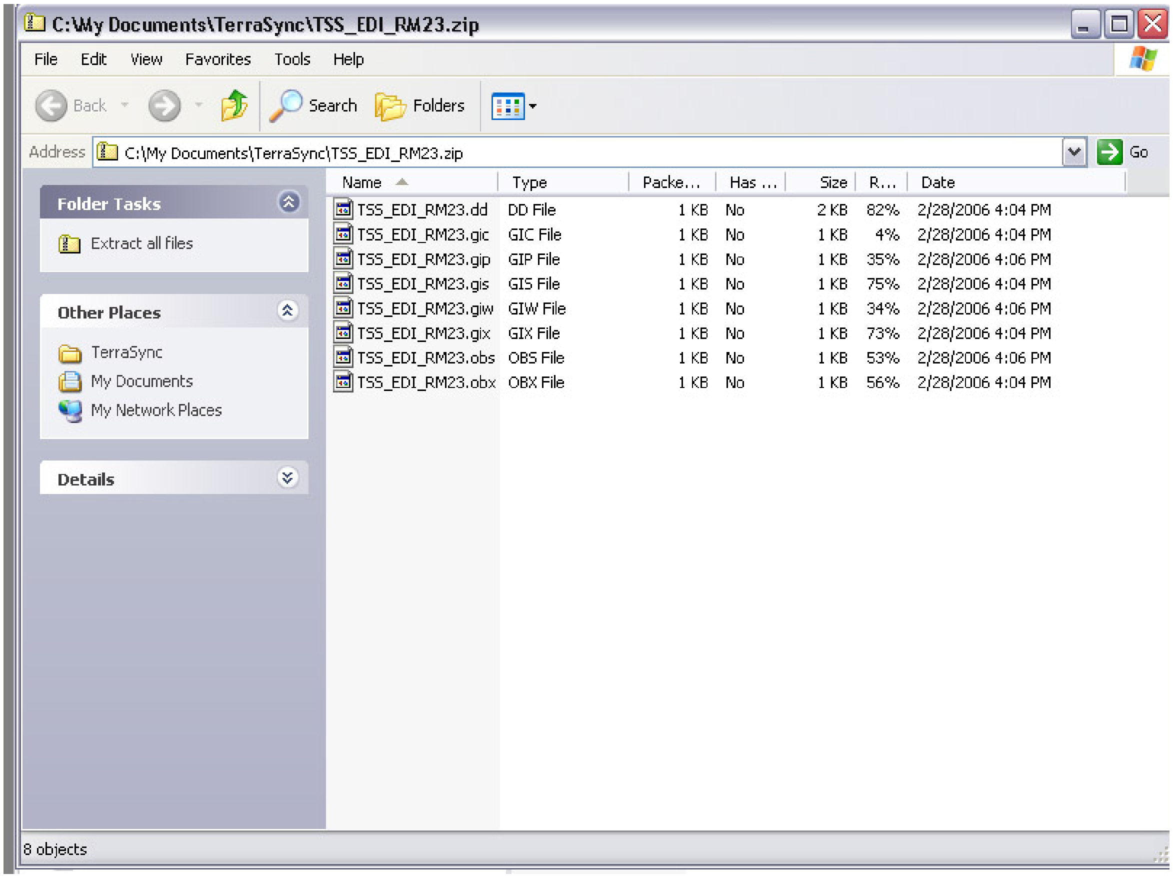

Figure 4. Example of File Set To Be Unzipped into the Terrasync Folder

After you unzip these files to Terrasync, keep this zip archive around in an easy-to-find place, such as your computer desktop, because the 1-week clock does not start until you begin collecting your first point in the field. You can use this unadulterated file again, as long as you make a copy of the work you did the previous week. The detailed steps are as follows:

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. Note: It is crucial to get all of the small files associated with the data set. While it is useful to sort the files by date modified, you can miss some of the small files—it is highly recommended that you sort the files alphabetically.

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. You can now safely replace the files you just copied with the ones from the original zip file. Right-click the zip archive, and click Extract All. When prompted to Select a folder to extract files to, browse to C:\My Documents\TerraSync. (Figure 5). If prompted about replacing existing files, select Yes to All. Note: It is crucial to make copies of the files first (see Step 3 above)—otherwise, you may lose the data.

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

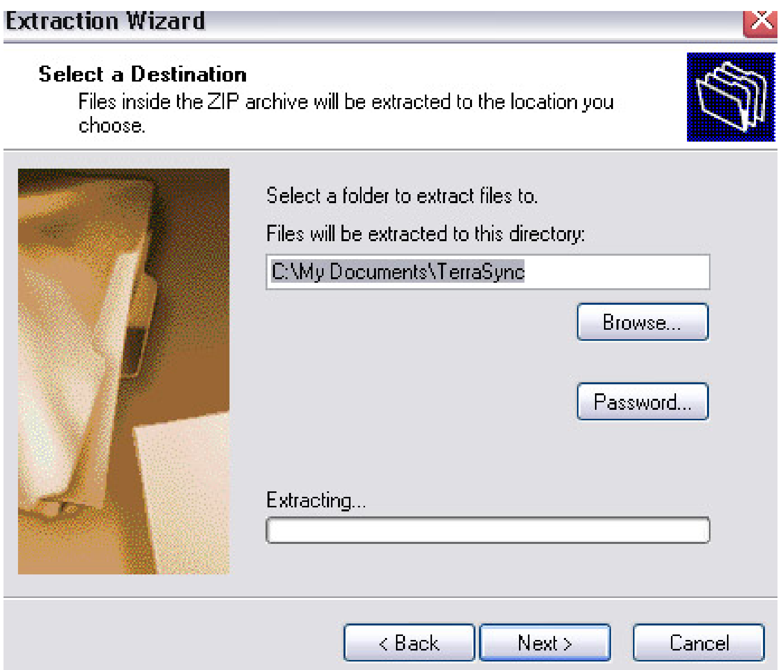

Figure 5. Extract (or copy) Original Target Files into the Terrasync Directory

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. However, this method has its drawbacks; 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.

The steps for file transfer are as follows:

1. For good data management, back up the data files from the previous week using the procedure laid out in steps 1 through 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 (Figure 6).
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.
5. 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.
6. Now select the Send tab (Figure 7), 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 can 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.

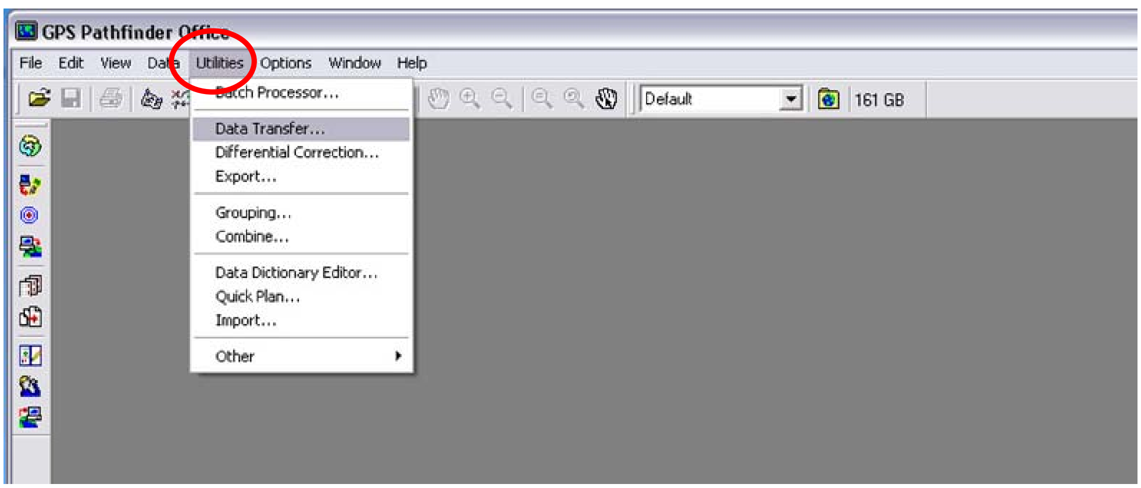

Figure 6. Data Transfer Menu

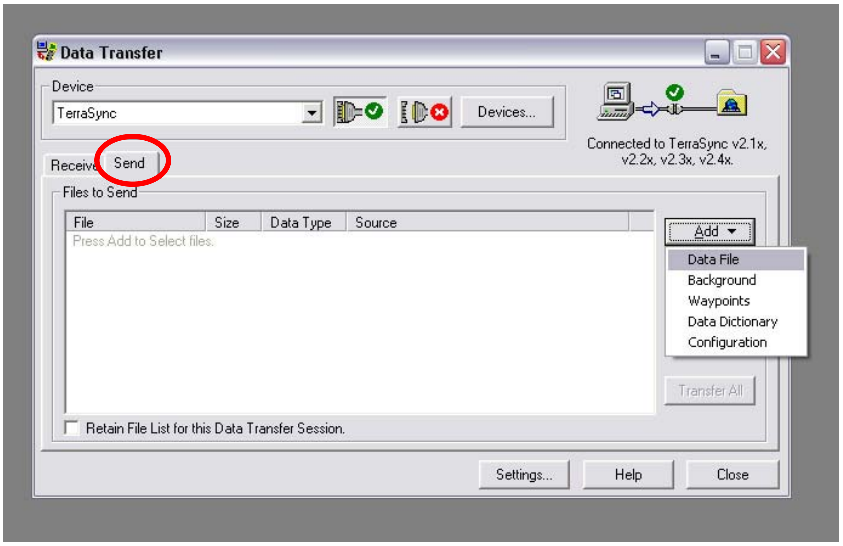

Figure 7. Sending Data File

STANDARD OPERATING PROCEDURE (SOP) SD-01

DECONTAMINATION OF SEDIMENT SAMPLING EQUIPMENT

SCOPE AND APPLICATION

This SOP describes procedures for decontaminating sampling and processing equipment contaminated by either inorganic or organic materials. To prevent potential cross contamination of samples, all reusable sediment sampling and processing equipment is decontaminated before each use. At the sample collection site, a decontamination area is established in a clean location that is upwind of actual sampling locations, if possible. All sediment sampling and processing equipment is cleaned in this location. Decontaminated equipment is stored away from areas that may cause recontamination. When handling decontamination chemicals, field personnel must follow all relevant procedures and wear protective clothing as stipulated in the site-specific health and safety plan (HSP).

Sampling equipment (e.g., van Veen, Ekman, Ponar, core tubes) may be used to collect samples that will 1) undergo a full-suite analysis (organics, metals, and conventional parameters) or 2) be analyzed for metals and conventional parameters only. Decontamination of sampling equipment used for both analyte groups should follow the order of a detergent wash, site water rinse, organic solvent rinses, and final site water rinse. Sample processing equipment (e.g., bowls, spoons) has a final rinse with distilled/deionized water rinse instead of site water. If the surface of stainless steel equipment appears to be rusting (possibly due to prolonged contact with organic-rich sediment), it should undergo an acid rinse and a site-water rinse at the end of each sampling day to minimize corrosion.

EQUIPMENT AND REAGENTS REQUIRED

Equipment required for decontamination includes the following:

- Polyethylene or polypropylene tub (to collect solvent rinsate)
- Plastic bucket(s) (e.g., 5-gal bucket)
- Tap water or site water
- Carboy, distilled/deionized water (analyte-free; received from testing laboratory or other reliable source)
- Properly labeled squirt bottles

- Funnels
- Alconox®, Liquinox®, or equivalent industrial detergent
- Pesticide-grade acetone and hexane (consult the project-specific field sampling plan [FSP], as the solvents may vary by EPA region or state)
- 10 percent (v/v) nitric acid (reagent grade) for inorganic contaminants
- Baking soda
- Long-handled, hard-bristle brushes
- Extension arm for cleaning core liners
- Plastic sheeting, garbage bags, and aluminum foil
- Core liner caps or plastic wrap and rubber bands
- Personal protective equipment as specified in the health and safety plan.

PROCEDURES

Decontamination Procedures for Full Suite Analysis (Organic, Metal, or Conventional Parameters)

Two organic solvents are used in this 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. This allows the second solvent to fully contact the surface of the sampler. Make sure that the solvent ordered is anhydrous or has a very low water content (i.e., < 1 percent). If ethanol is used, make sure that the denaturing agent in the alcohol is not an analyte in the samples. The second organic solvent is hydrophobic (e.g., hexane) 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 FSP). Integral uses ethanol and hexane as preferred solvents for equipment decontamination. If specified in the project-specific FSP, isopropanol or acetone can be substituted for ethanol, and methanol can be substituted for hexane in the decontamination sequence. The choice of solvents is also dependent on the kind of material from which the equipment is made (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 is sometimes slightly more effective than other solvents, its use is discouraged due to potential toxicity to sampling personnel.

The specific procedures for decontaminating sediment sampling equipment and sediment compositing equipment are as follows:

1. Rinse the equipment thoroughly with tap or site water to remove visible sediment. Perform this step onsite for all equipment, including core liners that will not be used again until the next day of sampling. After removing visible solids, set aside sampling equipment that does not need to be used again that day; this equipment should be thoroughly cleaned in the field laboratory at the end of the day.

2. Pour a small amount of concentrated laboratory detergent into a bucket (i.e., about 1–2 tablespoons per 5-gal bucket) and fill it halfway with tap or site water. If the detergent is in crystal form, make sure all crystals are completely dissolved prior to use.

3. Scrub the equipment in the detergent solution using a long-handled brush with rigid bristles. For the polycarbonate core liners, use a round brush attached to an extension arm to reach the entire inside of the liners, scrubbing with a back-and-forth motion. Be sure to clean the outside of core liners, bowls, and other pieces that may be covered with sediment.

4. Double rinse the equipment with tap or site water and set right-side-up on a stable surface to drain. The more completely the equipment drains, the less solvent will be needed in the next step. Do not allow any surface that will come in contact with the sample to touch any contaminated surface.

5. If the surface of stainless steel equipment appears to be rusting (this will occur during prolonged use in anoxic marine sediments), passivate[1] the surface as follows (if no rust is present, skip to next step). Rinse with a 10 percent (v/v) nitric acid solution using a squirt bottle, or wipe all surfaces using a saturated paper towel. Areas showing rust may require some rubbing with the paper towel. If using a squirt bottle, let the excess acid drain into the waste container (which may need to be equipped with a funnel). Double-rinse equipment with tap or site water and set right-side-up on a stable surface to drain thoroughly.

6. Carefully rinse the equipment with ethanol from a squirt bottle, and let the excess solvent drain into a waste container (which may need to be equipped with a funnel). Hold core liners over the waste container and turn them slowly so the stream of solvent contacts the entire surface. Turn the sample apparatus (e.g., grab sampler) on its side and open it to wash it most effectively. Set the equipment in a clean location and allow it to air dry. Use only enough solvent to scavenge all of the water and flow off the surface of the equipment (i.e., establish sheet flow) into the waste container. Allow equipment to drain as much as possible. Ideally, the equipment will be dry. The more thoroughly it drains, the less solvent will be needed in the next step.

[1] Passivation is the process of making a material less reactive relative to another material. For example, before sediment is placed in a stainless-steel container, the container can be passivated by rinsing it with a dilute solution of nitric acid and deionized water.

7. Carefully rinse the drained or air-dried equipment with hexane from a squirt bottle, and let the excess solvent drain into the waste container (which may need to be equipped with a funnel). If necessary, widen the opening of the squirt bottle to allow enough solvent to run through the core liners without evaporating. (Hexane acts as the primary solvent of organic chemicals. Ethanol is soluble in hexane but water is not. If water beading occurs, it means that the equipment was not thoroughly rinsed with acetone or that the acetone that was purchased was not free of water.) When the equipment has been rinsed with hexane, set it in a clean location and allow the hexane to evaporate before using the equipment for sampling. Use only enough solvent to scavenge all of the acetone and flow off the surface of the equipment (i.e., establish sheet flow) into the waste container.

8. Do a final rinse with site water for the sampling equipment (i.e., van Veen, Ekman, Ponar, core tubes) and with distilled/deionized water for processing equipment (i.e., stainless-steel bowls and spoons). Equipment does not need to be dried before use.

9. If the decontaminated sampling equipment is not to be used immediately, wrap small stainless-steel items in aluminum foil (dull side facing the cleaned area). Seal the polycarbonate core liners at both ends with either core caps or cellophane plastic and rubber bands. Close the jaws of the Ekman and Ponar grab samplers and wrap in aluminum foil.

   If the sample collection or processing equipment is cleaned at the field laboratory and transported to the site, then the decontaminated equipment will be wrapped in aluminum foil (dull side facing the cleaned area) and stored and transported in a clean plastic bag (e.g., a trash bag) until ready for use, unless the project-specific FSP lists special handling procedures.

10. Rinse or wipe with a wetted paper towel all stainless-steel equipment at the end of each sampling day with 10 percent (v/v) normal nitric acid solution. Follow with a freshwater rinse (site water is okay as long as it is not brackish or salt water).

11. After decontaminating all of the sampling equipment, place the disposable gloves and used foil in garbage bags for disposal in a solid waste landfill. When not in use, keep the waste solvent container closed and store in a secure area. The waste should be transferred to empty solvent bottles and disposed of at a licensed facility per the procedures listed in the project-specific FSP. When not in use, keep the waste acid container closed and store in a secure area. The acid waste should be neutralized with baking soda and disposed of per the procedures listed in the project-specific FSP.

Decontamination Procedures for Metals and Conventional Parameters Only

The specific procedures for decontaminating sediment sampling equipment and sediment processing equipment are as follows:

1. Rinse the equipment thoroughly with tap or site water to remove the visible sediment. Perform this step onsite for all equipment, including core liners that will not be used again until the next day of sampling. Set aside pieces that do not need to be used again that day; these pieces should be and thoroughly cleaned in the field laboratory at the end of the day.
2. Pour a small amount of concentrated laboratory detergent into a bucket (i.e., about 1–2 tablespoons per 5-gal bucket) and fill it halfway with tap or site water. If the detergent is in crystal form, make sure all crystals are completely dissolved prior to use.
3. Scrub the equipment in the detergent solution using a long-handled brush with rigid bristles. For the polycarbonate core liners, use a round brush attached to an extension arm to reach the entire inside of the liners, scrubbing with a back-and-forth motion. Be sure to clean the outside of core liners, bowls, and other pieces that may be covered with sediment.
4. Double-rinse the equipment with tap or site water and set right-side-up on a stable surface to drain. Do not allow any surface that will come in contact with the sample to touch any contaminated surface.
5. If the surface of stainless steel equipment appears to be rusting (this will occur during prolonged use in anoxic marine sediments), passivate[2] the surface as follows (if no rust is present, skip to next step). Rinse with a 10 percent (v/v) nitric acid solution using a squirt bottle, or wipe all surfaces using a saturated paper towel. Areas showing rust may require some rubbing with the paper towel. If using a squirt bottle, let the excess acid drain into the waste container (which may need to be equipped with a funnel). Double-rinse sampling equipment with tap or site water and set right-side-up on a stable surface to drain. Double-rinse processing equipment with distilled/deionized water and allow to drain.
6. If the decontaminated sampling equipment is not to be used immediately, wrap small stainless-steel items in aluminum foil (dull side facing the cleaned area). Seal the polycarbonate core liners at both ends with either core caps or cellophane plastic and rubber bands. Close the jaws of the Ekman and Ponar grab samplers and wrap in aluminum foil.

   If the sample collecting or processing equipment is cleaned at the field laboratory and transported to the site, then the decontaminated equipment will be wrapped in aluminum foil (dull side facing the cleaned area) and stored and transported in a clean plastic bag until ready for use, unless the project-specific FSP lists special handling procedures.

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[2] Passivation is the process of making a material less reactive relative to another material. For example, before sediment is placed in a stainless-steel container, the container can be passivated by rinsing it with a dilute solution of nitric acid and deionized water.

7. After decontaminating all of the sampling equipment, place the disposable gloves and used foil in garbage bags for disposal in a solid waste landfill. When not in use, keep the waste acid container closed and store in a secure area. The acid waste should be neutralized with baking soda and disposed of per the procedures listed in the project-specific FSP.

STANDARD OPERATING PROCEDURE (SOP) SD-02

PREPARATION OF FIELD QUALITY CONTROL SAMPLES FOR SEDIMENTS

SCOPE AND APPLICATION

This SOP describes the purpose, preparation, and collection frequency of field duplicate samples, field replicate samples, matrix spike/matrix spike duplicates, equipment rinsate blanks, bottle blanks, trip blanks, temperature blanks, environmental blanks, and reference materials (i.e., a standard reference material, a certified reference material, or other reference material; for the purposes herein, all types of reference materials are referred to as standard reference material, or SRM) for sediment sampling efforts. Not all of the field quality control samples discussed in this SOP may be required for a given project. The specific field quality control samples will be identified in the project-specific field sampling plan (FSP) and quality assurance project plan (QAPP). For most projects, Integral's recommended field quality control samples are an equipment rinsate blank, a field duplicate, and trip blanks if samples are to be analyzed for volatile organic compounds (VOCs). Definitions of all potential quality control samples are described below.

As part of the quality assurance/quality control (QA/QC) program, all field quality control samples will be sent to the laboratories "blind." To accomplish this, field quality control samples will be prepared and labeled in the same manner as regular samples, with each quality control sample being assigned a unique sample number that is consistent with the numbering for regular samples. All of the containers with preservatives that are required to complete the field quality control sample for the applicable analyte list shall be labeled with the same sample number. The sample ID for field quality control samples should allow data management and data validation staff to identify them as such and should be recorded only in the field logbook. Under no circumstances should the laboratory be allowed to use reference materials, rinsate blanks, or trip blanks for laboratory quality control analysis (i.e., duplicates, matrix spike, and matrix spike duplicates). To prevent such an occurrence, regular samples should be selected and marked on the chain-of-custody/sampling analysis request (COC/SAR) form or the laboratory should be instructed to contact the project QA/QC coordinator to select appropriate samples for each sample group.

Field quality control samples will be prepared at least once per sampling event, and certain types will be prepared more often at predetermined frequencies. If the number of samples taken does not equal an integer multiple of the intervals specified in this SOP, the number of field quality control samples is specified by the next higher multiple. For example, if a frequency of 1 quality control sample per 20 is indicated and 28 samples are collected, 2 quality control samples will be prepared. Field quality control samples for sediment sampling activities should be prepared consistent with the requirements discussed below and at the frequency indicated unless different frequency requirements are listed in the FSP and QAPP.

The following table lists the quality control sample types and suggested frequencies for sediment sampling programs. Because sediment quality control sampling may require assessment of site cross-contamination, additional blanks may be required. A detailed explanation of each quality control sample type with the required preparation follows.

Table 1. Field Quality Control Sample Requirements

Quality Control Sample Name	Abbreviation	Preparation		Frequency[a]
		Location	Method	
Duplicate	DUP	Sampling site	Additional natural sample	One per 20 samples. May not be applicable if REP is being collected.
Replicate	REP	Sampling site	Additional natural sample	One replicate per 20 samples. May not be applicable if DUP is being collected.
Matrix spike/matrix spike duplicate	MS/MSD	Sampling site	Additional sample bottles filled for laboratory quality control requirements	One per 20 samples.
Equipment rinsate blank	ER	Sampling site	Deionized water collected after pouring through and over decontaminated equipment	Minimum of one per sampling event per type of sampling equipment used and then 1 per 20 thereafter.
Bottle blank	BB	Field	Unopened bottle	One per sample episode or one per bottle type.
Trip blank	TB	Laboratory	Deionized water with preservative	One pair per each VOC sample cooler shipment.
Temperature blank	TMB	Laboratory	Deionized water	One per sample cooler.
Environmental blank	EB	Field	Bottle filled at sample site with deionized water	One per 20 samples.
Standard reference material	SRM	Field laboratory or sampling site	SRM ampules or other containers for each analyte group	One set per 50 samples or one per episode.

[a] Frequencies provided here are general recommendations; specific frequencies should be provided in the project-specific FSP or QAPP.

FIELD DUPLICATE SAMPLES

Field duplicate (or split) samples are collected to assess the homogeneity of the samples collected in the field and the precision of the sampling process. Field duplicates will be prepared by collecting two aliquots for the sample and submitting them for analysis as separate samples. Field duplicates will be collected at a minimum frequency of 1 per 20 samples or once per sampling event, whichever is more frequent. The actual number of field duplicate samples collected during a sampling event will be determined on a case-by-case basis by the project QA/QC coordinator (consult the project-specific FSP and QAPP, as the requirements on frequency of field duplicate collection may vary by EPA region or state).

FIELD REPLICATE SAMPLES

Field replicate samples are co-located samples collected in an identical manner over a minimum period of time to provide a measure of the field and laboratory variance, including variance resulting from sample heterogeneity. Field replicates will be prepared by collecting two completely separate samples from the same station and submitting them for analysis as separate samples. Field replicates will be collected at a minimum frequency of 1 per 20 samples or once per sampling event, whichever is more frequent. If field duplicate samples are collected, then it is unlikely that field replicate samples will also be collected during a sampling event. The actual number of field replicate samples collected during a sampling event will be determined on a case-by-case basis by the project QA/QC coordinator (consult the project-specific FSP and QAPP, as the requirements on frequency of field duplicate collection may vary by EPA region or state).

MATRIX SPIKE/MATRIX SPIKE DUPLICATES

The matrix spike/matrix spike duplicate (MS/MSD) analyses provide information about the effect of the sample matrix on the design and measurement methodology used by the laboratory. To account for the additional volume needed by the laboratory to perform the analyses, extra sample volumes may be required to be collected from designated sediment stations. MS/MSDs may be collected at a minimum frequency of 1 per 20 samples or once per sampling event, whichever is more frequent. The actual number of extra bottles collected during a sampling event will be determined on a case-by-case basis by the project QA/QC coordinator (consult the project-specific FSP and QAPP, as the requirements may vary by analyte group).

EQUIPMENT RINSATE BLANKS

Equipment rinsate blanks will be used to help identify possible contamination from the sampling environment and/or from decontaminated sampling equipment. Equipment rinsate blanks will be prepared by pouring laboratory distilled/deionized water through, over, and into the decontaminated sample collection equipment, and then transferring the water to the appropriate sample containers and adding any necessary preservatives. Equipment rinsate blanks will be prepared for all inorganic, organic, and conventional analytes at least once per sampling event per the type of sampling equipment used. The actual number of equipment rinsate blanks prepared during an event will be determined on a case-by-case basis by the project QA/QC coordinator (consult the project-specific FSP and QAPP, as the requirements on frequency of equipment rinsate blank collection may vary by EPA region or state).

BOTTLE BLANKS

The bottle blank is an unopened sample bottle. Bottle blanks are submitted along with sediment samples to ensure that contaminants are not originating from the bottles themselves because of improper preparation, handling, or cleaning techniques. If required, one bottle blank per lot of prepared bottles will be submitted for analysis. If more than one type of bottle will be used in the sampling (e.g., high-density polyethylene or glass), then a bottle blank should be submitted for each type of bottle and preservative. The actual number of bottle blanks analyzed during a project will be determined on a case-by-case basis by the project QA/QC coordinator (consult the project-specific FSP and QAPP as the requirements on frequency of bottle blank analysis may vary by EPA region or state).

To prepare a bottle blank in the field, set aside one unopened sample bottle from each bottle lot sent from the testing laboratory. Label the bottle as "Bottle Blank" on the sample label (and in the "Remarks" column on the COC/SAR form), and send the empty bottle to the laboratory with the field samples.

TRIP BLANKS

Trip blanks will be used to help identify whether contaminants may have been introduced during the shipment of the sediment samples from the field to the laboratory for VOC analyses only. Trip blanks are prepared at the testing laboratory by pouring distilled/deionized water into two 40-mL VOC vials and tightly closing the lids. Each vial will be inverted and tapped lightly to ensure no air bubbles exist.

The trip blanks will be transported unopened to and from the field in the cooler with the VOC samples. A trip blank is labeled and placed inside the cooler that contains newly collected VOC samples and it remains in the cooler at all times. A trip blank must accompany samples at all times in the field. One trip blank (consisting of a pair of VOC vials) will be sent with each cooler of samples shipped to the testing laboratory for VOC analysis.

TEMPERATURE BLANKS

Temperature blanks will be used by the laboratory to verify the temperature of the samples upon receipt at the testing laboratory. Temperature blanks will be prepared at the testing laboratory by pouring distilled/deionized water into a vial and tightly closing the lid. The blanks will be transported unopened to and from the field in the cooler with the sample containers. A temperature blank shall be included with each sample cooler shipped to the testing laboratory.

FIELD BLANKS

The field blank is prepared in the field to evaluate potential background concentrations present in the air and in the distilled/deionized water used for the final decontamination rinse. If unpreserved bottles are to be used, then the appropriate preservative (i.e., for metals samples use a 10 percent nitric acid solution to bring sample pH to 2 or less) must be added, as may be required. Field blanks should be collected at a minimum frequency of 1 in 20 samples. The actual number of field blanks analyzed during a project will be determined on a case-by-case basis by the project QA/QC coordinator (consult the project-specific FSP and QAPP, as the requirements on frequency of field blank analysis may vary by EPA region or state).

To prepare a field blank in the field, open the laboratory-prepared sample bottle while at a sample collection site, fill the sample bottle with distilled/deionized water, and then seal it. Assign the field blank a unique sample number, label the bottle, and then send the bottle to the laboratory with the field samples.

REFERENCE MATERIALS

SRMs are samples containing known analytes at known concentrations that have been prepared by and obtained from EPA-approved sources. The SRMs have undergone multi-laboratory analyses using a standard method that provides certified concentrations. When available for a specific analyte, SRMs provide a measure of analytical performance and/or analytical method bias (i.e., accuracy) of the laboratory. Several SRMs may be required to cover all analytical parameters. For all analytes where available, one SRM will be analyzed at a frequency of one per 50 samples. The actual number of SRMs analyzed during a project will be determined on a case-by-case basis by the project QA/QC coordinator (consult the project-specific FSP and QAPP, as the requirements on frequency of SRM analysis may vary by EPA region or state).

STANDARD OPERATING PROCEDURE (SOP) SD-12

LOGGING OF SEDIMENT CORES

SCOPE AND APPLICATION

The following procedures for completing the Field Sediment Core Form establish the minimum information that must be recorded in the field to adequately document sediment coring activities. The field sediment core form must be filled out completely. Depending upon project specific requirements, some of the items listed below can be recorded in the observing scientist's field logbook and/or on the Station Core Log. All field forms must be filled out completely.

All of the information addressed in this standard operating procedure (SOP) should be included in the observing scientist's field documentation. Additionally, standards presented may need to be supplemented with additional technical descriptions or field test results (see project specific field sampling plan [FSP]).

ACTIVITIES OF THE OBSERVING SCIENTIST DURING CORING

1. Record the name of the coring contractor and personnel performing the coring (lead person and any support staff)
2. Record the type and make of the coring equipment being used
3. Note the weather or any special external conditions that influence the coring
4. Be certain that the coring contractor is informed about the nature of the daily records that the contractor will keep
5. Check the coring contractor's daily records to verify their accuracy
6. Note date and time of all activities associated with the coring
7. Make certain that the coring contractor follows all required procedures
8. The observing scientist's daily record shall include, but may not be limited to, the following items:

   – Date and depth of core
   – Depth of start and finish of each sampled interval
   – Depth and size of any casing or core tubing used
   – Time required to advance the core
   – Loss of water, mud, or air during sample retrieval

- Depth of overlying water
- Simplified description of strata
- Total sample recovery (in inches or centimeters)
- Details of delays and breakdowns.

The observing scientist should also record the coring start and finish dates and times. For consecutive sheets, provide, at a minimum, the project number, the station number, and the sheet number. This list excludes any special items that may be required for contractual record purposes or for special tests (see project-specific FSP).

Data on Field Sediment Core Form

Core Type/Method: Provide the sampler type (e.g., GC = gravity corer, PC = piston corer, DRCV = drive rod check valve corer, VC = vibracorer, BC = box corer).

Sample Number/Tag Number: Provide the sample number. The sample numbering scheme should be established before sampling begins. Consult the project-specific FSP for the sample numbering scheme. The depth of the sample is the depth to the top of the recovered sample to the nearest centimeter. Samples should be obtained from the entire recovered core (depending upon the sampling intervals specified in the project-specific FSP). The tag number(s) and respective sample number(s) of the sample container(s) should also be recorded in the field logbook.

Photograph Number: Provide the number of the film roll and the photograph number.

Odor: Provide information on presence of any odor associated with the sediment. Document each interval in the core at which an odor is present. Describe the odor in the *Sediment Description* section of the field sediment core form.

Sheen: Provide information on presence of any sheen associated with the sediment. Document each interval in the core at which sheen is present. Also note if sheen is present on the water surface during coring activities.

Blank Columns: Two blank columns are provided on the field sediment core form. These columns can be used for site-specific information, usually related to the contaminants of concern (e.g., sheen, air quality measurements).

Water Breaks: Record the location of any observed breaks in the sediment core.

Depth Scale: Enter the depth of the core below sediment surface. Match the sediment descriptions with the depth scale.

Unified Symbol: If a geologist is providing the sediment descriptions of the core, then the unified symbol code (USC) for different sediment types (e.g., silt, clay, sand) should be placed in this column. The USC name should be identical to the ASTM D-2488-84 Group Name with the appropriate modifiers.

Table SD-12(1) presents the USC classification system. The USC system is an engineering properties system that uses grain size to classify soils, it can however also be used by a geologist to characterize the sediment in a core.

Table SD-12(1). USC Classification System

Major Divisions			Group Symbol	Group Name
Coarse-grained soils More than 50 percent retained by No. 200 sieve	**Gravel** More than 50 percent of coarse fraction retained on No. 4 sieve	Clean Gravel	GW	Well-graded gravel, fine to coarse gravel
			GP	Poorly graded gravel
		Gravel with fines	GM	Silty gravel
			GC	Clayey gravel
	Sand More than 50 percent of coarse fraction passes No. 4 sieve	Clean Sand	SW	Well-graded sand, fine to coarse sand
			SP	Poorly graded sand
		Sand with fines	SM	Silty sand
			SC	Clayey sand
Fine-grained soils More than 50 percent passes No. 200 sieve	**Silt and clay** Liquid limit < 50	Inorganic	ML	Silt
			CL	Clay
		Organic	OL	Organic silt, organic clay
	Silt and clay Liquid limit ³ 50	Inorganic	MH	Silt of high plasticity, elastic silt
			CH	Clay of high plasticity, fat clay
		Organic	OH	Organic clay, organic silt
Highly organic soils			PT	Peat

Note: Field classification is based on visual examination of soil in general accordance with ASTM D-2488-84.

Soil classification using laboratory tests is based on ASTM D-2487-83.

Descriptions of soil density or consistency are based on interpretation of blow count data, visual appearance of soils, and/or test data.

Liquid limit is the water content of soil-water where the consistency changed from plastic to liquid.

Sediment Description: The sediment description should follow the format described in SOP SD-13, *Field Classification of Sediment*. Information on sediment should include sediment type, percent moisture with depth through the core, color, and presence or absence of vegetation or biota. The surface conditions within the core (i.e., overlying water is present, undisturbed sediment/water interface, presence of any vegetation or biota) should also be described. The project-specific FSP should be consulted for any special descriptive items that may be required.

Comments: Include all pertinent observations. Coring observations might include coring chatter, core-bounce (hard object hit by corer during penetration), sudden differences in coring speed, damaged coring equipment, and malfunctioning equipment. Information provided by the coring contractor should be attributed to the coring contractor.

Data on Station Core Log

Cast Number: Record the number of coring attempts at each station.

Start/End Time: The time should be recorded during coring to determine coring speed. Time should be recorded in 24- hour mode (e.g., 3:00 p.m. = 1500 hours).

Water Depth: Record the overlying water depth at the station. Note: The overlying water depth can change between coring attempts and therefore must be measured prior to each attempt.

Core Penetration Depth: Record the depth that the core was pushed into the sediment. Note: If this information is not readily apparent, it can be obtained from the coring contractor.

Retrieved Core Length: While the sediment core is vertical, record the length of the retrieved core.

Overlying Water: Record whether or not there is water on top of the sediment core once the core has been retrieved. This is necessary to determine measurable sediment/water interface.

Coordinates: Record the latitude and longitude (or geographic) of the station location. The datum used to collect the station location coordinates (e.g., WGS84) must also be recorded in the field notes.

ATTACHMENT 2
FIELD FORMS

integral consulting inc.

SEDIMENT CORE LOG

PROJECT: **San Jacinto River Waste Pits** **Core ID:** ________ pg ___of ____

Collected:			**Processed:**	
Date: __/__/____	Drive Length: ________		Date: __/__/____	
Time: ________	Tide Level (CRD): ________		Time: ________	
Recovery Length: _____	Mudline Depth: ________		Core Length: ________	
Recovery Efficiency: _____	Vessel: ________		Location: ________	
Crew: ________			Crew: ________	

Depth in Core (cm)	Lithologic Description: (Grainsize, color, density/consistency, odor, organics, debris)	Grain Size (%)			Photo ID	Sample ID
		G	S	Si/Cl		

Core segment breaks at (cm): ________

014602

	FIELD CHANGE REQUEST	Project Number:

Field Change No.
Page ______ to

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 OPERATIONS MANAGER RECOMMENDATION

Recommended Disposition:

Recommendation by:
Date: ____/____/

(Sampling and Analysis Coordinator)

PROJECT MANAGER APPROVAL

Final Deposition:

Approved/Disapproved by:
Date: ____/____/

(CERCLA Coordinator)

CORRECTIVE ACTION RECORD

Page ___ of

Audit Report No. :______________________________ Date:

Report Originator:

Person Responsible for Response:

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:

Corrective Action Plan Approval: ________________________ Date:

DESCRIPTION OF FOLLOW-UP ACTIVITIES:

Person Responsible for Follow-up Activities:

Date of Follow-up Activity:

Final Corrective Action Approval: ________________________ Date:

Any Lab

Address:

Chain of Custody Record

Client Information	Sampler:	Lab PM:	Carrier Tracking No(s):	COC No:
Client Contact:	Phone:	E-Mail:		Page: Page 1
Company: Anchor QEA LLC				Job #:

Address:	**Due Date Requested:**
City: Seattle	**TAT Requested (days):**
State, Zip: WA, 98101	
Phone: 206-287-9130(Tel)	PO #:
Email: dpeterson@anchorqea.com	WO #:
Project Name:	Project #:
Site:	SSOW#:

Analysis Requested

Preservation Codes:

A - HCL	M - Hexane
B - NaOH	N - None
C - Zn Acetate	O - AsNaO2
D - Nitric Acid	P - Na2O4S
E - NaHSO4	Q - Na2SO3
F - MeOH	R - Na2S2SO3
G - Amchlor	S - H2SO4
H - Ascorbic Acid	T - TSP Dodecahydrate
I - Ice	U - Acetone
J - DI Water	V - MCAA
K - EDTA	W - ph 4-5
L - EDA	Z - other (specify)

Other:

Sample Identification	Sample Date	Sample Time	Sample Type (C=comp, G=grab)	Matrix (W=water, S=solid, O=waste/oil, BT=Tissue, A=Air)	Field Filtered Sample (Yes or No)	Perform MS/MSD (Yes or No)														Total Number of containers	Special Instructions/Note:
			Preservation Code:																		
			G		N																
			G		N																
			G		N																
			G		N																
			G		N																
			G		N																
			G		N																
			G		N																
			G		N																
			G		N																
			G		N																

Possible Hazard Identification

☐ *Non-Hazard* ☐ *Flammable* ☐ *Skin Irritant* ☐ *Poison B* ☐ *Unknown* ☐ *Radiological*

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)

☐ *Return To Client* ☐ *Disposal By Lab* ☐ *Archive For __________ Months*

Deliverable Requested: I, II, III, IV, Other (specify)

Special Instructions/QC Requirements:

Empty Kit Relinquished by:	Date:	Time:	Method of Shipment:

Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company
Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company
Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company
Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company

Custody Seals Intact: Δ Yes Δ No	Custody Seal No.:	Cooler Temperature(s) °C and Other Remarks:

014605