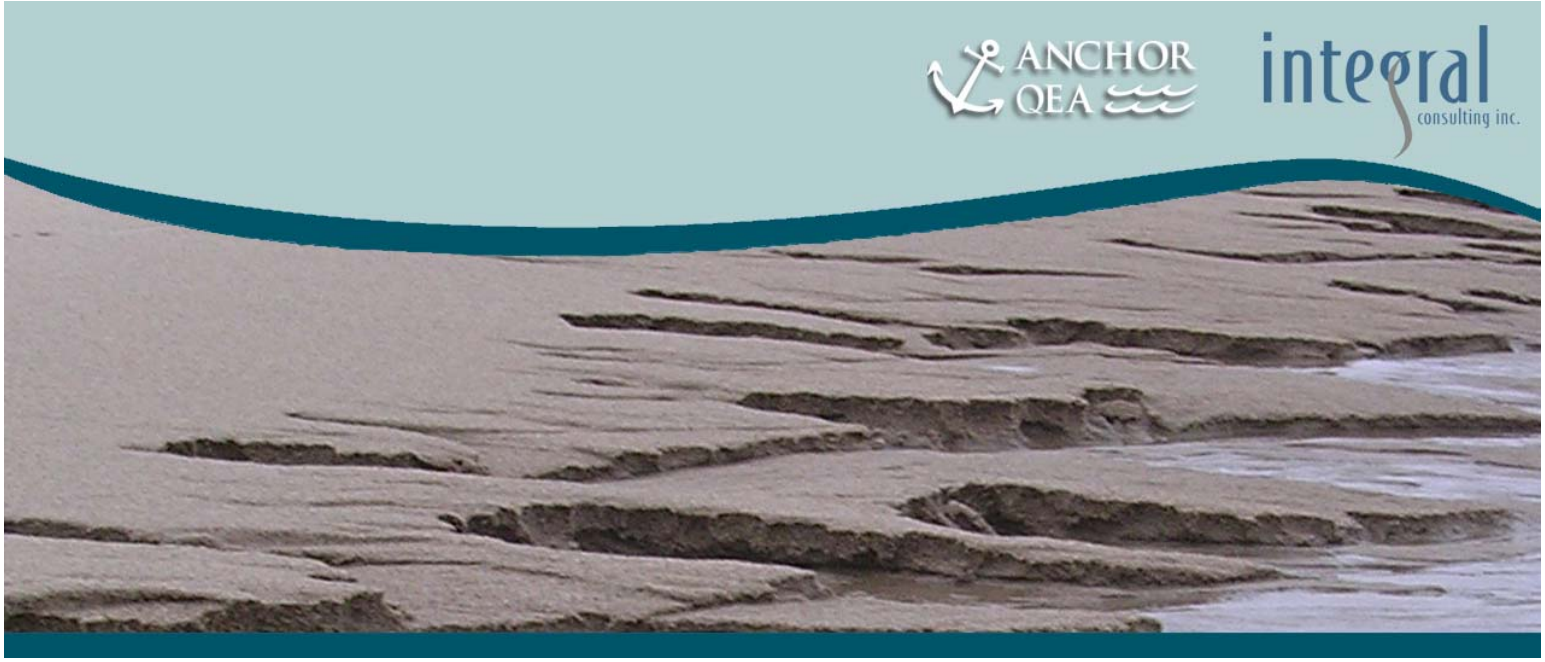

# SAMPLING AND ANALYSIS PLAN: SEDIMENT STUDY
# SAN JACINTO RIVER WASTE PITS SUPERFUND SITE

**Prepared for**

McGinnes Industrial Maintenance Corporation
International Paper Company
U.S. Environmental Protection Agency, Region 6

**Prepared by**


Integral Consulting Inc.
411 First Avenue South, Suite 550
Seattle, Washington 98104

Anchor QEA, LLC
2113 Government Street
Building D, Suite 3
Ocean Springs, Mississippi 39564


**April 2010**

9184360

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Ocean Springs, Mississippi 39564

**April 2010**

## Title and Approval Sheet

### Quality Assurance Project Plan Approvals

| | | | |
|---|---|---|---|
| EPA Remedial Project Manager: | Stephen Tzhone | _____ | Date: _____ |
| EPA Quality Assurance (QA) Reviewer: | Walter Helmick | _____ | Date: _____ |
| Respondents' Project Coordinator and Anchor QEA Project Manager: | David Keith | _____ | Date: _____ |
| McGinnes Industrial Maintenance Corp. Project Manger: | Andrew Shafer | _____ | Date: _____ |
| International Paper Co. Project Manager: | Philip Slowiak | _____ | Date: _____ |
| Integral Project Manager: | Jennifer Sampson | _____ | Date: _____ |
| Laboratory QA Coordinator: | Craig Hutchings | _____ | Date: _____ |
| Chemical Laboratory Project Manager: | To be determined | _____ | Date: _____ |
| Chemical Laboratory QA Manager: | To be determined | _____ | Date: _____ |

**Quality Assurance Project Plan Approvals**

| | | | |
|---|---|---|---|
| Geotechnical and Engineering Laboratory Project Manager: | To be determined | _____ | Date: _____ |
| Geotechnical and Engineering Laboratory QA Manager: | To be determined | _____ | Date: _____ |

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## LIST OF ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| Anchor QEA | Anchor QEA, LLC |
| ASTM | American Society for Testing and Materials |
| BERA | baseline ecological risk assessment |
| BHHRA | baseline human health risk assessment |
| CERCLA | Comprehensive Environmental Response, Compensation and Liability Act of 1980 |
| CDF | confined disposal facility |
| COC | chain-of-custody |
| COI | chemical of interest |
| COPC | chemical of potential concern |
| CLP | Contract Laboratory Program |
| CSM | conceptual site model |
| CU triax | consolidated-undrained triaxial |
| DQO | Data Quality Objective |
| EDD | electronic data deliverable |
| EDL | estimated detection limit |
| EqP | equilibrium partitioning |
| ERL | effect range low |
| FS | Feasibility Study |
| FSP | Field Sampling Plan |
| GPS | global positioning system |
| HAZWOPER | Hazardous Waste Operations and Emergency Response |
| HRGC/HRMS | high-resolution gas chromatography with high-resolution mass spectrometry |
| HASP | Health and Safety Plan |
| I-10 | Interstate Highway 10 |
| Integral | Integral Consulting Inc. |
| IPC | International Paper Company |
| $K_{oc}$ | partition coefficient of a chemical in the organic matter of soil/sediment |
| $K_{ow}$ | octanol-water partition coefficient |

| | |
|---|---|
| MIMC | McGinnes Industrial Maintenance Corporation |
| MDL | method detection limit |
| MRL | method reporting limit |
| NPL | National Priorities List |
| NTCRA | Non-Time-Critical Removal Action |
| OC | organic carbon |
| PAH | polycyclic aromatic hydrocarbon |
| PARCC | precision, accuracy or bias, representativeness, completeness, comparability |
| PCB | polychlorinated biphenyl |
| PRG | Preliminary Remediation Goal |
| PSCR | Preliminary Site Characterization Report |
| QA | quality assurance |
| QAPP | Quality Assurance Project Plan |
| QC | quality control |
| RME | reasonable maximum exposure |
| RI | Remedial Investigation |
| RPD | relative percent difference |
| SAP | Sampling and Analysis Plan |
| Site | San Jacinto River Waste Pits Superfund site |
| SJRWP | San Jacinto River Waste Pits |
| SLERA | screening level ecological risk assessment |
| SLV | screening level value |
| SOP | standard operating procedure |
| SRM | Standard Reference Material |
| SSI | screening site inspection |
| SVOC | semivolatile organic compound |
| TAL | Target Analyte List |
| TCDF | tetrachlorodibenzofuran |
| TCEQ | Texas Commission on Environmental Quality |
| TEQ | toxicity equivalent |
| TMDL | Total Maximum Daily Load |
| TOC | total organic carbon |

| | |
|---|---|
| TXDOT | Texas Department of Transportation |
| UAO | Unilateral Administrative Order |
| UCL | upper confidence limit |
| USACE | U.S. Army Corps of Engineers |
| USEPA | U.S. Environmental Protection Agency |
| VOC | volatile organic compound |
| VST | vane shear test |
| WTP | wastewater treatment plant |

# 1 PROJECT MANAGEMENT

## 1.1 Distribution List

| Title | Name |
|---|---|
| EPA Remedial Project Manager | Stephen Tzhone |
| EPA QA Reviewer | Walter Helmick |
| Respondents' Project Coordinator and Anchor QEA Project Manager | David Keith |
| McGinnes Industrial Maintenance Corp. Project Manager | Andrew Shafer |
| International Paper Co. Project Manager | Philip Slowiak |
| Integral Project Manager | Jennifer Sampson |
| Study Element 1 & 2 Task Manager | Jane Sexton |
| Study Element 3 & 4 Task Manager | John Laplante |
| Study Element 1 & 2 Field Lead | Joss Moore |
| Study Element 3 & 4 Field Lead | Jason Kase |
| Laboratory QA Coordinator | Craig Hutchings |
| Database Administrator | Dreas Nielsen |
| Chemical Testing Laboratory Project Manager | To be determined |
| Chemical Testing Laboratory QA Manager | To be determined |
| Geotechnical and Engineering Laboratory Project Manager | To be determined |
| Geotechnical and Engineering Laboratory QA Manager | To be determined |

## 1.2 Introduction and Task Organization

This Sampling and Analysis Plan (SAP) has been prepared on behalf of International Paper Company (IPC) and McGinnes Industrial Maintenance Corporation (MIMC), pursuant to the requirements of Unilateral Administrative Order (UAO), Docket No. 06-03-10, which was issued by the U.S. Environmental Protection Agency (USEPA) to IPC and MIMC on November 20, 2009 (USEPA 2009a). The 2009 UAO directs IPC and MIMC to prepare a work plan for a Remedial Investigation and Feasibility Study (RI/FS) and a SAP for the San Jacinto River Waste Pits (SJRWP) Superfund Site in Harris County, Texas (the Site). The 2009 UAO also directs IPC and MIMC to submit a screening level ecological risk assessment (SLERA).

As agreed by USEPA on March 16, 2010, the RI/FS Work Plan and SLERA will be submitted on April 9, 2010. This SAP was submitted and reviewed by USEPA prior to the RI/FS Work Plan so that information relevant to the RI can be collected as early as practical. This SAP addresses only the sampling and analysis of sediments required for the RI/FS. This document is the SAP required by the 2009 UAO, and presents the Quality Assurance Project Plan (QAPP) and the Field Sampling Plan (FSP), which is included as Appendix A. The QAPP was prepared consistent with USEPA guidance and requirements for QAPPs (USEPA 1998, 2001), as required by the 2009 UAO, and reflects input from USEPA and the Texas Commission on Environmental Quality (TCEQ) on the draft document, including written comments and a full day of discussion on technical issues (March 16, 2010). Agency comments on the draft of this document and a summary of responses are provided in Appendix B. Additional SAPs setting forth the QAPPs and FSPs for sampling of other media (e.g., biological tissue, soils) will be submitted consistent with the schedule provided in the RI/FS Work Plan.

This section reviews the organizational structure for activities associated with the sediment study, including project management and oversight, fieldwork, sample analysis, and data management. The organizational structure for this project is illustrated in Figure 1. Contact information for key personnel is provided in Section 1.3.

## 1.3 Project Organization

IPC and MIMC have retained Anchor QEA, LLC (Anchor QEA) and Integral Consulting Inc. (Integral) to perform the RI/FS. Figure 1 illustrates the organization of personnel on the project. The primary contacts for USEPA, MIMC, and IPC are provided in the following table. A description of the project organization and contacts pertaining to this QAPP are provided after the table.

**USEPA and Respondent Project Managers**

| Title | Name | Contact Information |
|---|---|---|
| USEPA Remedial Project Manager | Stephen Tzhone | U.S. Environmental Protection Agency, Region 6<br>1445 Ross Avenue<br>Dallas, TX 75202-2773<br>(214) 665-8409<br>tzhone.stephen@epa.gov |
| McGinnes Industrial Maintenance Corporation Project Manager | Andrew Shafer | 9590 Clay Road<br>Houston, TX 77080<br>(713) 772-9100, ext. 109<br>DShafer@wm.com |
| International Paper Company Project Manager | Philip Slowiak | 6400 Poplar Avenue<br>Memphis, TN 38197-0001<br>(901) 419-3845<br>philip.slowiak@ipaper.com |

The sediment study is organized into four study elements, as described in Section 1.9. These correspond to the broader Study Elements 1 through 4 described in the RI/FS Work Plan. To execute this study, Anchor QEA and Integral will conduct the fieldwork and data analysis, with Integral primarily responsible for execution of Study Elements 1 and 2, and Anchor QEA responsible for execution of Study Elements 3 and 4. The names and quality assurance (QA) responsibilities of key project personnel for Anchor QEA and Integral who will be involved in sampling and analysis activities are provided below.

**Project Personnel Quality Assurance Responsibilities**

| Title | Responsibility | Name | Contact Information |
|---|---|---|---|
| Project Coordinator | Coordination of project information and related communications on behalf of IPC and MIMC with USEPA; liaison between USEPA project managers and respondent project managers | David Keith | Anchor QEA, LLC<br>2113 Government Street<br>Building D, Suite 3<br>Ocean Springs, MS 39564<br>(228) 818-9626<br>dkeith@anchorqea.com |
| Anchor QEA Project Manager | Project planning and implementation; liaison between respective internal and external team members and project coordinator | David Keith | Anchor QEA, LLC<br>2113 Government Street<br>Building D, Suite 3<br>Ocean Springs, MS 39564<br>(228) 818-9626<br>dkeith@anchorqea.com |

| Title | Responsibility | Name | Contact Information |
|---|---|---|---|
| Integral Project Manager | Responsible for the successful completion of tasks associated with Study Elements 1 and 2 and coordination with the Anchor QEA project manager, the IPC project manager, and the MIMC project manager to execute the study described in this SAP | Jennifer Sampson | Integral Consulting Inc.<br>411 1st Avenue South<br>Suite 550<br>Seattle, WA 98104<br>(206) 957-0351<br>jsampson@integral-corp.com |
| Anchor QEA and Integral Corporate Health and Safety Managers | Oversight of health and safety program for field tasks associated with RI/FS | David Templeton | Anchor QEA, LLC<br>1423 Third Avenue, Suite 300<br>Seattle, WA 98101<br>(206) 287-9130<br>dtempleton@anchorqea.com |
| | | Eron Dodak | Integral Consulting Inc.<br>319 SW Washington Street<br>Suite 1150<br>Portland, OR 97204<br>(503) 284-5545<br>edodak@integral-corp.com |
| Study Elements 1 and 2 Integral Task Manager | Data Quality Objective (DQO) planning, QAPP development, and ensuring the project objectives for Study Elements 1 and 2 are met; liaison between project manager and project team | Jane Sexton | Integral Consulting Inc.<br>411 1st Avenue South<br>Suite 550<br>Seattle, WA 98104<br>(206) 957-0342<br>jsexton@integral-corp.com |
| Study Elements 3 and 4 Anchor QEA Task Manager | DQO planning, QAPP development, and ensuring the project objectives for Study Elements 3 and 4 are met; liaison between project manager and project team | John Laplante | Anchor QEA, LLC<br>1423 Third Avenue, Suite 300<br>Seattle, WA 98101<br>(206) 287-9130<br>jlaplante@anchorqea.com |
| Study Elements 1 and 2 Field Lead Integral | Field data collection and implementation of the Health and Safety Plan in the field for Study Elements 1 and 2 | Joss Moore | Integral Consulting Inc.<br>319 SW Washington Street<br>Suite 1150<br>Portland, OR 97204<br>(503) 284-5545<br>jmoore@integral-corp.com |
| Study Elements 3 and 4 Field Lead Anchor QEA | Field data collection and implementation of the Health and Safety Plan in the field for Study Elements 3 and 4 | Jason Kase | Anchor QEA, LLC<br>4208 Cherry Laurel Drive<br>Pensacola, FL 32054<br>(850) 912-8400<br>jkase@anchorqea.com |

| Title | Responsibility | Name | Contact Information |
|---|---|---|---|
| Project Database Administrator Integral | Database development and data management | Dreas Nielsen | Integral Consulting Inc.<br>411 1st Avenue South<br>Suite 550<br>Seattle, WA 98104<br>(206) 957-0311<br>dnielsen@integral-corp.com |
| Study Elements 1 and 2 Laboratory QA Coordinator Integral | Completeness of QA documentation and procedures; liaison between project personnel, chemical testing laboratories, and data validators and for related QA communications with USEPA | Craig Hutchings | Integral Consulting Inc.<br>1205 West Bay Dr. NW<br>Olympia, WA 98502<br>(360) 705-3534<br>chutchings@integral-corp.com |
| Study Elements 3 and 4 Laboratory QA Coordinator Anchor QEA | Completeness of QA documentation and procedures; liaison between project personnel, geotechnical laboratories, and data validators and for related QA communications with USEPA | John Laplante | Anchor QEA, LLC<br>1423 Third Avenue, Suite 300<br>Seattle, WA 98101<br>(206) 287-9130<br>jlaplante@anchorqea.com |

### *1.3.1 Laboratories*

The following responsibilities apply to the project manager and QA manager at the analytical laboratories used for this task.

The laboratory project manager is responsible for the successful and timely completion of 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 this QAPP, the cited methods, and laboratory standard operating procedures (SOPs).
- Keep the task QA coordinator apprised of the schedule and status of sample analyses and data package preparation.
- 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 this QAPP.

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 Problem Definition and Background

On March 19, 2008, USEPA added the Site to the National Priorities List (NPL), and the 2009 UAO requires that an RI be conducted at the Site. The investigation described in this SAP will address uncertainties about the following aspects of the Site:

- The nature and extent of Site-related sediment contamination
- The exposure to humans and ecological receptors that may be using the Site and may be in direct or indirect contact with contaminated sediment
- The physical characteristics of the Site and physical processes governing fate and transport of Site-related contaminated sediments
- The physical properties of sediment that are directly adjacent to the impoundments and that may provide the basis for construction of facilities for containment of the wastes in the future

The remainder of this document describes the Site history and conceptual site model (CSM), identifies the chemicals of interest (COIs) and chemicals of potential concern (COPCs), provides a design for the collection and analysis of new information to address and reduce these uncertainties, and describes the sampling procedures, sample custody, analytical procedures, data validation, reporting and management, and QA procedures. Appendix A,

the FSP, describes in detail the sampling and data gathering methods, station positioning, field documentation, and all sample handling details. It includes field SOPs and an addendum specific to this study for the project Health and Safety Plan (HASP; Anchor QEA 2009).

### *1.4.1 Site History*

The Site consists of a set of impoundments approximately 14 acres in size, built in the mid-1960s for disposal of paper mill wastes, and the surrounding areas containing sediments and soils potentially contaminated with the waste materials that had been disposed of in the impoundments. The set of impoundments is located on a 20-acre parcel on the western bank of the San Jacinto River, in Harris County, Texas, immediately north of the Interstate Highway 10 (I-10) Bridge over the San Jacinto River (Figure 2).

In 1965, the impoundments were constructed by forming berms within the estuarine marsh, just north of what was then Texas State Highway 73, and is now I-10, to the west of the main river channel. The two primary impoundments at the Site were divided by a central berm running lengthwise (north to south) through the middle, and were connected with a drain line to allow flow of excess water (including rain water) from the impoundment located to the west of the central berm, into the impoundment located to the east of the central berm (Figure 2). The excess water collected in the impoundment located to the east of the central berm was pumped back into barges and taken off-Site.

In 1965 and 1966, pulp and paper mill wastes (both solid and liquid) were reportedly transported by barge from the Champion Paper Inc. paper mill in Pasadena, Texas, and unloaded at the Site into the impoundments where the waste was stabilized and disposed. The excess water from the impoundments was pumped back into barges and taken off-Site. The Champion Paper mill used chlorine as a bleaching agent, and the wastes that were deposited in the impoundments have recently been found to be contaminated with polychlorinated dibenzo-*p*-dioxins, polychlorinated furans (dioxins and furans), and some metals (TCEQ and USEPA 2006); additional discussion of the chemical constituents typical of materials like those deposited in the impoundments is provided in Section 1.5. The impoundments were used for waste disposal from September 1965 through May 1966 until

both impoundments were filled to capacity. In a letter dated July 1966, the Texas Water Pollution Control Board stated that it was their understanding that no additional waste material would be placed in the impoundments.

Physical changes at the Site in the 1970s and 1980s, including regional subsidence of land in the area due to large scale groundwater extraction and sand mining within the river and marsh to the west of the impoundments, have resulted in partial submergence of the impoundments and exposure of the contents of the impoundments to surface waters. Based upon review of U.S. Army Corps of Engineers (USACE)-approved dredging permits, dredging by third parties has occurred in the vicinity of the perimeter berm at the northwest corner of the impoundments. Recent samples of sediment in nearby waters north and west of the impoundments (University of Houston and Parsons 2006) indicate that dioxins and furans are present in nearby sediments at levels higher than levels in background areas nationally (USEPA 2000).

Freshwater, estuarine, and marine habitats in the vicinity of the Site are shown in Figure 3. Residential, commercial, industrial, and other land use activities occur within the preliminary Site perimeter and in the surrounding area. Residential development on the eastern bank of the river is present within 0.5 mile of the Site. The impoundments are currently occupied by late successional stage estuarine riparian vegetation to the west of the central berm, and are consistently submerged even at low tide to the east of the central berm. Estuarine riparian vegetation lines the upland area that runs parallel to I-10 and the uplands west of the impoundments. A sandy intertidal zone is present along the shoreline throughout much of the Site (Figure 2).

### *1.4.2 Summary of Available Sediment Data*

Both chemical and physical data describing conditions at the Site are currently available. Each of these two types of available information is summarized below.

#### *1.4.2.1 Existing Sediment Chemistry Data*

The preliminary Site perimeter identified in the 2009 UAO is within the estuarine portion of the lower San Jacinto River, in an area from which sediments have been previously sampled

for several studies (Table 1 and Figure 4). The studies or programs providing sediment chemistry data that addresses the objectives of one or more study elements for the RI/FS include the following:

- The Screening Site Inspection (SSI) Report (TCEQ and USEPA 2006)
- Sampling for the I-10 dolphin project (Weston 2006)
- The Houston Ship Channel dioxin Total Maximum Daily Load (TMDL) study (University of Houston and Parsons 2006)
- Samples collected for TCEQ in August 2009 (URS 2010)
- Data generated by the November 1, 2009, Permit Evaluation Process initiated by USEPA, USACE, and TCEQ, and managed by TCEQ (USEPA et al. 2009); this currently includes a dataset for one permit application (Orion 2009)
- The Houston Ship Channel Toxicity Study (ENSR and EHA 1995)
- The Houston Ship Channel polychlorinated biphenyls (PCBs) TMDL study (University of Houston and Parsons 2009; Koenig 2010, Pers. Comm.)

Within the preliminary Site perimeter, surface sediment samples have been collected from 50 locations, and sediment cores have been collected from five locations for the studies listed above (Table 2 and Figure 4). In some cases, a location was sampled more than once, so more than 50 individual surface sediment samples are represented in the database. Nine of the surface sediment sample locations are within the impoundments, and an additional five are in their immediate vicinity. The highest spatial density of samples within the preliminary Site perimeter is in and adjacent to the impoundments and adjacent to the I-10 Bridge (Figures 4 and 5). Sediment samples collected within the Site upstream of the impoundments are approximately 1,000 feet (305 m) apart. Under or downstream of the I-10 Bridge, 25 samples were collected but 16 of these are not within the preliminary Site perimeter and 15 are closely spaced around the Sneed Shipbuilding facility. Louchouarn and Brinkmeyer (2009) also collected samples for analysis of dioxins and furans and organic carbon (OC) in one surface grab sediment sample, and in one 1-m (3-foot) core from within the impoundments and sectioned at 2-cm (0.8-inch) intervals, but these data could not be accessed in time for this evaluation.

Surface sediment chemistry samples from 45 of the Site locations and all of the cores (Table 2) were collected in 2000 or later (Table 2). All of these samples were analyzed for

dioxins and furans; metals and other chemicals were also analyzed in sediment from 17 surface and 4 subsurface locations within the Site, and in surface sediments at 5 locations nearby but outside the Site (Table 3). Data for pesticides, PCBs, and many semivolatile organic compounds (SVOCs) in surface sediments were generated by TCEQ and USEPA (2006), University of Houston and Parsons (2009), Koenig (2010, Pers. Comm.), and Weston (2006) (Table 3). In most of these samples, none of these chemicals (other than dioxins, furans, and metals) were detected, with very few exceptions. PCBs were measured as Aroclors by Weston (2006) and as congeners by the TMDL program (University of Houston and Parsons 2009; and Koenig 2010). PCBs were not detected in any of the samples collected by Weston (2006), which were from the vicinity of the I-10 Bridge downstream of the impoundments. Individual congeners were detected in the sediment samples collected in 2002, 2003, 2008, and 2009 by the TMDL program at a location (Station 11193) downstream of the impoundments and the I-10 Bridge.

Upstream sediments in the San Jacinto River have likely influenced sediment conditions within the Site and can be expected to continue to influence them in the future.[1]. Available sediment data for the area upstream of the Site indicates that there are dioxins and furans present in sediments upstream (University of Houston and Parsons 2006). TCEQ's TMDL data also indicated that the toxicity equivalent (TEQ) concentrations in the tidally influenced embayment upstream of the Site are higher than those further upstream in the freshwater portion of the river. TCEQ has investigated several possible sources of dioxins in this upstream area (University of Houston and Parsons 2006), including a both city and county wastewater treatment facilities, and found dioxins in both sludges and wastewaters. In addition, in October 1994, two petroleum pipelines ruptured during a flood of the San Jacinto River, igniting a fire that impacted more than 186 acres of riparian habitat and shoreline areas.[2] Therefore, upstream background areas near the Site do not reflect a pristine or natural condition. Nevertheless, measurements of regional background conditions in sediments from the San Jacinto River estuary are relevant to interpreting data from the Site and selecting appropriate remedial actions, if required. Tidal dispersion may lead to some

[1] Methods for evaluation and modeling of sediment transport between the Site and areas upstream and downstream will be addressed in a Technical Memorandum on Fate and Transport Modeling, to be submitted according to the schedule provided in the RI/FS Work Plan.
[2] http://www.fws.gov/southwest/es/contaminants/NRDAR/SiteInformation/Texas/SanJac.pdf

upstream transport and mixing, but the aggregate downstream movement of the sediment in the San Jacinto River system appears to limit the potential influence of downstream sediments on conditions within the Site (Louchouarn and Brinkmeyer 2009).[3]

Sediment samples were also collected from 26 locations near the Site. (Two locations are not shown on Figures 4 and 5 because they are farther upstream than the extent of this map.) All but two of these locations were sampled in 2000 or later (Table 2). All of these samples were analyzed for dioxins and furans. Metals and other chemicals were measured in five of them (Table 3). Finally, one dataset was generated for USEPA et al. (2009), but it does not provide concentrations of individual dioxin and furan congeners. These data are not included in this discussion because TEQ concentrations were calculated using a 1989 toxicity equivalency factor scheme, and the dioxin and furan congener data were not available in time for this evaluation. These samples were collected at a facility directly east of the Sneed Shipbuilding site (Orion 2009).

#### *1.4.2.2 Existing Physical Data*

Existing physical data include Site bathymetry and geotechnical studies that were performed for the Texas Department of Transportation (TXDOT), which were associated with the I-10 Bridge crossing at the San Jacinto River (Weston 2006). In addition, a 2009 bathymetric survey was conducted west and north of the impoundments (Hydrographic Consultants 2009). Also, there is limited TXDOT bathymetric survey data (date unknown) associated with the dolphin project in the vicinity of the I-10 Bridge.

Although the Hydrographic Consultants bathymetry provides the most recent survey coverage of bed elevations around the impoundments, some deficiencies in this dataset have been identified through visual inspection at periods of low water levels. Additional research would be required to determine the datum, age, and quality of the TXDOT bathymetric survey. The geotechnical data provided by TXDOT provides logs of three geotechnical borings (two in river) south of the I-10 Bridge. These boring logs require some interpretation because they are provided in a non-standard format as part of an engineering

[3] Additional discussion of data on the sources and movement of contaminated sediment is provided in the RI/FS Work Plan.

plan set. In addition, these borings are not in the vicinity of the historical impoundment perimeter berms. Additional geotechnical studies may be available from TXDOT; this research is ongoing.

### *1.4.3 Problem Definition and Overall CSM*

Major physical changes resulted in the exposure of the wastes deposited within the impoundments to surface waters and the distribution of contaminated materials into nearby surface sediments. Land subsidence resulting from groundwater withdrawal in the 1970s contributed to the sinking of the impoundments. As a result of this event, contaminated material was potentially distributed and became potentially accessible to ecological receptors and to people at the Site. Material from the berm and from within the impoundment was subject to mobilization and redistribution by both the dredging operations and by erosion resulting from tidal and river currents. Dredging activities in the area may have affected the Site. . Mobilization of materials by dredging may have released sediment-associated contaminants to the water column that would have settled to the bottom. Contaminants in the near-surface, biologically active and/or physically mixed zone may move between solid and aqueous phases and be remobilized from the sediment bed by sediment resuspension and porewater/surface water exchange. Once in the water column, upstream or downstream contaminant transport can occur. Direct biological uptake can also occur from surface and suspended sediments, porewater, and surface water. Determining the spatial extent of sediment contaminants from the impoundments, including in upland soils, is one issue that will be addressed in the RI/FS.

Contact with contaminated sediment within the boundary of the impoundment itself, and in other areas to which it may have been transported, creates the potential for exposure to ecological receptors and for people using the Site. Ecological receptors and people using the Site also may be exposed to contamination from global, regional, and local sources of contamination that are unrelated to the Site. Quantification of exposures to Site-related, upstream, and regional sources of contamination, and resulting risks, is another issue that will be addressed by the RI/FS. A simple CSM of the release and exposure pathways at this Site is illustrated in Figure 6.

Chemicals associated with the waste impoundments are expected to be exclusively those associated with solid wastes produced by bleached kraft pulp mill operations (Section 1.5.1). Chemistry data for sediment collections from within the area of the impoundments (Table 1) show that dioxins and furans are present in sediments in and near the impoundments at concentrations higher than other Site and regional samples, and may contribute to risks to ecological receptors and people using the Site.

The overall issue to be addressed by the RI/FS, and by sediment sampling in particular, is to determine the horizontal and vertical distribution of pulp mill compounds associated with sediment originating in the impoundments. These data will be used to evaluate the contribution of COPCs to exposure and risks to ecological receptors and people. Both the exposure and risk analyses and characterization of background conditions upstream from the Site will be used to develop Preliminary Remediation Goals (PRGs) for sediments, and to support remedy selection. In addition, uncertainty regarding the potential for transport of sediments off the Site, and for transport of upstream sediments into the Site, must be addressed to facilitate the selection of a remedy. Finally, characterization of the physical properties of the sediment surrounding the impoundments is needed to evaluate remedial alternatives at the location of the impoundments.

## 1.5 Determination of Chemicals of Interest

This section describes the basis for establishing the list of chemicals that will be considered COIs in the RI. Section 1.6 describes how COPCs for the RI are identified, and reports on an analysis of existing sediment chemistry data to define the COPCs. The COPCs will be the chemical analytes in sediments collected for this study.

USEPA guidance for performance of an RI/FS under the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA; USEPA 1988a) does not specify the methods to be used to identify COIs and COPCs, nor does it address the specific chemicals that should be evaluated, regardless of available data, at any individual site. For this project, the process for selection of COIs started with identification of all chemicals on USEPA's Target Analyte List (TAL) for metals and the standard organic analytes (SVOCs, volatile organic compounds [VOCs], pesticides, and Aroclors) and the Contract Laboratory

Program (CLP) organic compounds. The combination of these two lists was checked against the Clean Water Act priority pollutants to ensure that all of USEPA's priority analytes were included in the initial evaluation. The final list of the 173 chemicals comprising the priority pollutant list is provided in Table 4.

The primary source of contaminants associated with the Site is the pulp mill sludge deposited in the waste impoundments during operation of the mill in the mid-1960s. Consistent with the CSM, the identification of COIs includes consideration of the constituents likely to be associated with such wastes based on existing sludge sampling and analysis of results from the impoundments. A literature review was conducted relating to pulp and paper mill wastes generated prior to the point at which the paper industry moved away from the use of chlorine ions in its bleaching processes and began using chlorine dioxide.[4] The literature review is discussed in Section 1.5.1.

To identify COIs, a series of questions was addressed for each chemical individually, as illustrated in Figure 7. A total of 141 chemicals were analyzed in the sediment samples collected by TCEQ and USEPA (2006) from within the impoundments. If an individual chemical was analyzed in these sediments and was detected at least once, it is considered a COI (Figure 7). For those chemicals never detected, and for those priority pollutants never analyzed in sediment from the impoundments, both the likelihood of its presence in the source material (waste from a bleached kraft pulp mill operating in 1965) and the persistence of the chemical were evaluated. Chemical characteristics of bleached kraft pulp mill solid wastes were identified in a literature review (discussed in Section 1.5.1). The persistence of a chemical was evaluated by considering the tendency of each chemical reasonably expected in these pulp mill solid wastes to adsorb to OC in the sediment, as expressed by the $K_{oc}$ value. Chemicals were classified as "persistent" if they were identified in the Hazardous Substances Data Bank as expected to adsorb to suspended solids and sediment based on their $K_{oc}$ and other physical properties (NIH 2010). No additional metrics were used to determine persistence because half-life durations for volatilization or biodegradation of any chemicals

[4] In the 1990s, to prevent generation of dioxins and furans, mills stopped using elemental chlorine, which binds with organic materials and forms chlorinated compounds, and switched to using chlorine dioxide, which bleaches fibers and produces no new chemicals (Wiegand 2010, Pers. Comm.).

not sorbed to sediments were very short in comparison to the 44 years that have elapsed since the wastes were deposited in the estuary (NIH 2010).

As shown in Figure 7, if a chemical on the priority pollutant list was both expected in bleached kraft pulp mill wastes and persistent, it is considered a COI (Table 5). The background information leading to the selection of COIs, and the COI list, are summarized in the rest of this section.

### *1.5.1 Chemical Characteristics of Bleached Kraft Pulp Mill Wastes*

According to available historical documents about the Site, the solid waste materials that were deposited in the impoundments in 1965 had the following characteristics:

- Primarily fibrous (the dried material was reported to resemble low-grade cardboard)
- Near neutral pH
- Medium stiff to stiff
- Low permeability
- Organic base (grass could be grown on the material)

Because there are no data to describe the chemical constituents in the wastes generated by the Champion Paper mill in Pasadena, Texas, at the time the impoundments at the Site were formed, industry experts and technical papers documenting bleached kraft pulp mill waste chemistry were consulted. The description of the types of wastes generated in these mills that follows is a generalized description assembled from these sources.

Several kinds of wastes were generated by bleached kraft pulp mills (NCASI 1999):

- Liquid effluents
- Solid wastes derived from caustic residuals from the kraft recovery process (lime mud, slaker grits, and green liquor dregs)
- Solids from wastewater treatment plant (WTP) residuals
- Ash generated by burning bark, sawdust, fossil fuels, and in some cases, other waste materials from a mill site

The chemical constituents of both WTP solids and ash depended to some degree on the types of fiber used to make pulp, and the other materials burned. Generally, the broad categories of hazardous materials expected in bleached kraft pulp mill wastes from that era (Wiegand 2010, Pers. Comm.) include dioxins, furans, and chlorinated phenols. The available literature on the hazardous chemicals likely present in bleached kraft pulp mill solid wastes generated in the 1960s is limited; the specific chemicals identified through this research are summarized in Table 6. Table 6 presents those priority pollutants included in the analyses of sediment samples collected from within the impoundments by TCEQ and USEPA (2006) and that may occur in bleach kraft pulp mill wastes according to the literature.

USEPA (1988b) and NCASI (1999) confirm that dioxins and furans were generated historically by bleached kraft pulp mills. A review of available chemistry data for solid wastes generated by 26 bleached kraft and other pulp mills (NCASI 1999) consistently found several types of metals, chlorinated phenols, dioxins, and several VOCs (Table 6). NCASI (1999) also reports negligible concentrations of PCBs and chlorinated benzenes in some wastes, and trace levels of some polycyclic aromatic hydrocarbon (PAH) compounds in some ash samples. A study of the chemistry of leachates from landfills used specifically for pulp mill wastes (NCASI 1992) reported toluene (a VOC), as well as other phenolics, including three cresol isomers, and trichlorophenols. No pesticides or PCBs were found in these landfill leachates. A list of analytes provided by Suntio et al. (1988), reporting on the chemical constituents in liquid effluents of pulp mills, included chlorinated phenols, chlorinated benzenes, nitrotoluenes, and 15 VOCs.

### *1.5.2 Characteristics of Sediments in the Impoundments*

Sediment samples were collected by TCEQ and USEPA (2006) from within the impoundments and analyzed for 141 chemicals, including dioxins and furans, metals, pesticides, SVOCs, and PCBs. VOCs were not analyzed. Pesticides and PCBs were not detected in any samples from the impoundments. SVOCs were also not detected, with the exception of one phthalate compound in three samples. Most metals were detected in one or more samples, with the exceptions of beryllium, selenium, and thallium, which were never detected in sediment samples from the impoundments. Dioxins and furans were detected in all samples from the impoundments.

Louchouarn and Brinkmeyer (2009) also collected a sediment grab and a sediment core from within the eastern half of the impoundments in 2006. The only COIs analyzed in these sediments were dioxins and furans, but these investigators also reported on the depth distribution of lignins and several forms of OC within the core, which was sectioned at 2-cm (0.8-inch) intervals. The authors found the OC content of the sediment to be variable at this depth resolution, ranging from about 1 to 3 percent, with a spike in the OC content up to about 8 percent OC at the interval between 1 and 1.3 feet (30 and 40 cm). The materials in this depth appear to contain relatively high fractions of both terrestrial plant-derived lignins and other OC.

Other than dioxins and furans, there were no detectable concentrations of nearly all of the organic chemicals evaluated by TCEQ and USEPA (2006), including the chlorinated phenols, nitrotoluenes, and assorted PAHs that were determined to possibly occur in bleached kraft pulp mill wastes. The confirmed low levels of other organic chemicals, coupled with the very high dioxin and furan concentrations in the sediment and their persistence in the environment, suggest that patterns of dioxins and furans typical of the impoundments may provide a useful signal, or tracer, in the RI/FS for impacts on sediments of material derived from the impoundments.

### *1.5.3 Summary of Chemicals of Interest*

A summary of the approach to selection of COIs, and the list of COIs, are provided in Table 7; the final list of COIs is provided in Table 5. COIs are those chemicals that are among USEPA's priority pollutants, were reported by one or more technical reports as occurring in pulp mill solid wastes or leachate from solid waste landfills, and are likely to have bound to sediment OC and persist for more than 40 years in the environment. These COIs were further evaluated in each of three risk-based screens to identify COPCs, discussed in Section 1.6. Results of the COPC identification affect the sediment sampling and analysis designs, as described in Section 1.7.

## 1.6 Determination of Chemicals of Potential Concern

Because the source of the COIs to the RI/FS for the Site is the impoundments created in 1965 for the disposal of waste sludges from the Champion Paper mill in Pasadena, Texas (Section 1.4.1), the evaluation to identify COPCs for the RI was performed using chemistry data for the seven sediment samples collected by TCEQ and USEPA (2006) directly from the impoundments. Although there are chemistry data for other sediment samples collected within the preliminary Site perimeter (Section 1.4.2), the sediment samples collected from within the impoundments are expected to contain the highest concentrations of any chemicals that are associated with the wastes in the impoundments. This assumption can be verified by comparing the concentrations of dioxins and furans in sediment from the impoundments with the highest concentrations in sediment collected elsewhere from within the preliminary Site perimeter. For example, the concentration of 2,3,7,8-tetrachlorodibenzofuran (TCDF) from station 15 in the TCEQ TMDL study was 93,000 ng/kg (the higher of two replicates at this station). The highest concentration in sediment samples outside the impoundments, but still within the preliminary Site perimeter is at TMDL Station 11 (1,600 ng/kg). This concentration is a factor of nearly 60 lower than the concentration in the impoundments. Therefore, for the purposes of the selection of COPCs, chemical concentrations in sediments at the six stations (seven samples; one a field duplicate) from within the impoundments are considered to represent the highest concentrations of source-related chemicals at the Site.

The process to select COPCs for the RI involves the following two steps:

- Determination of COIs to the investigation (Figure 7)
- Performance of risk-based screens for each COI

To determine whether a COI should be the subject of the sediment investigation, other field investigations that will support the RI/FS, the baseline ecological risk assessment (BERA), and the baseline human health risk assessment (BHHRA), each COI was evaluated using three conservative risk-based screening tools, as follows:

- Human health risk screen
- Fish and wildlife risk screen
- Benthic macroinvertebrate risk screen

The objective of using these screens is to identify those COIs that can be eliminated from further consideration with a high degree of confidence that the COI plays no role in Site-related risks to human health or ecological receptors at the Site. Each of the three risk-based screens combine information on the bioaccumulation potential of each COI and risk-based screening concentrations in sediment to interpret the chemistry of samples from within the impoundments (TCEQ and USEPA 2006). Each risk-based screen results in one of the following conclusions for each COI:

1. Data are sufficient to conclude that there is an absence of risk to receptors using the Site.
2. There are insufficient data to determine whether there is a risk to receptors; more information is needed.
3. Data are sufficient to determine that the COI should be evaluated in the baseline risk assessments.

Those COIs in the first category will not be analyzed further in the RI/FS. A complete evaluation of those COIs in the second category requires additional data, and the extent to which each may contribute to risk is unknown. Additional data are required that describe these COIs in sediment and possibly other media. These chemicals are discussed further in this SAP as "secondary COPCs." COIs falling into the third category are known to be present in sediments from the impoundments at concentrations associated with the potential for adverse effects to humans, fish, wildlife, or benthic invertebrates. These COIs will be evaluated in the baseline risk assessments, and additional information is required to do so. COIs determined to be in the third category are termed "primary COPCs."

Each of the three risk-based screens is described below, followed by a summary of the primary COPCs and secondary COPCs that result in Table 8. The entire process and results are summarized for each screen in Tables 9, 10, and 11. Every chemical listed as a primary COPC will be evaluated in one or both of the baseline risk assessments.

Steps to collect and analyze additional information about primary and secondary COPCs in sediments are discussed in Section 1.7 of this SAP. Greater detail on the screening process for ecological receptors is provided in the SLERA. Additional considerations for planning

both the BERA and the BHHRA are included in greater detail in the RI/FS Work Plan. The sections below are not intended to replace those discussions.

### 1.6.1 Human Health Risk-Based Screen

The approach for evaluating COIs for human health is illustrated in Figure 8. The screening process for a COI considers comparison with its risk-based screening level values (SLVs), bioaccumulation potential, and whether the COI was ever detected in sediments from within the impoundments.

SLVs were obtained from two sources: USEPA Region 3 PRGs,[5] which were calculated consistent with USEPA (1991) guidance, and TCEQ (2006a) sediment protective concentration levels. PRGs are not available for sediment, so PRGs for residential soil were used as surrogates and are considered conservative because residential soil PRGs consider exposures through incidental ingestion, dermal contact, and inhalation of particulates, while direct sediment exposures are likely limited to incidental ingestion and dermal contact. Because human exposures at the Site may occur through ingestion of contaminated tissues, bioaccumulation potential is considered in the screening process. The list of chemicals with potential to bioaccumulate was obtained from TCEQ (2006b). PCBs were screened as total PCBs (all Aroclors summed). PCB congener data are not available for the sediment samples from within the impoundments.

Using this approach, the chemicals identified as primary COPCs for human health are arsenic, cadmium, chromium, copper, mercury, nickel, zinc, bis(2-ethylhexyl)phthalate, and 2,3,7,8-TCDD TEQ concentrations (Table 8). The chemicals identified as secondary COPCs for human health are PCBs, pentachlorophenol, hexachlorobenzene, 2,3,4,6-tetrachlorophenol, 1,2,4-trichlorobenzene, 1,2,3-trichlorobenzene, 1,2-dichlorobenzene, 1,3-dichlorobenzene, 1,4-dichlorobenzene, and chloroform. Documentation of the human health screening process is provided in Table 9.

[5] http://www.epa.gov/reg3hwmd/risk/human/index.htm

### 1.6.2 Benthic Macroinvertebrate Risk-Based Screen

The approach to evaluating each COI to determine whether it can be eliminated from further assessments of risk to benthic macroinvertebrates on the Site is illustrated in Figure 9. Benthic macroinvertebrates are assumed to be in direct contact with sediments such that chemical concentrations in sediments provide the appropriate measure of exposure for the screening evaluation. SLVs protective of benthic macroinvertebrates were used as a primary screening step in this approach. The primary source of screening values was the Long et al. (1995) Effect Range Low (ERL) values for marine sediments. These ERLs represent concentrations of chemicals in sediment that are not associated with adverse biological effects; as such, they provide a conservative screening benchmark against which Site concentrations can be evaluated, consistent with USEPA guidance for selection of screening-level benchmarks (USEPA 1997a). These values are the primary screening values provided in TCEQ ecological risk assessment guidance (TNRCC 2001; TCEQ 2006b). If no ERL was available, TCEQ's benchmarks for marine sediments were used as a secondary source of SLVs (TCEQ 2006b).[6]

One additional study was considered in identifying benthic invertebrate screening values for PCBs, because the Long et al. (1995) value for PCBs is at odds with more recent literature. Fuchsman et al. (2006) explore the differences between cause-effect studies that are used to derive benthic invertebrate no-effects levels for PCBs in sediment and the screening values derived by Long et al. (1995) and others using data for effects only, and based on sediments containing a mixture of chemicals. Fuchsman et al. (2006) demonstrate that no-effects and effects PCB concentrations in sediment estimated using the equilibrium partitioning (EqP) method are more consistent with actual effects and no-effects values from PCB toxicity studies than the derived screening values such as those of Long et al. (1995). Ideally, the EqP method uses partitioning coefficients for individual congeners, but no-effects concentrations estimated for Aroclors and for total PCBs are also provided by Fuchsman et al (2006). These values are considered conservative, because the more chlorinated PCBs are generally the more toxic, but they are also more likely to be bound to OC in sediments under ambient sediment conditions. These authors list several no-effects levels in units of mg/kg OC for

[6] The marine benchmarks provided in TCEQ (2006b) are primarily based on Long et al. (1995), as detailed in Table 10.

both marine and freshwater benthic invertebrates. Their lowest unbounded no-observed-effect level (growth) for a PCB mixture is 81 mg/kg OC for a marine clam (*Macoma nasuta*). Conservatively assuming an OC content in sediments from the impoundments of 1.5 percent (Louchouarn and Brinkmeyer 2009), the dry weight equivalent of this value is 1.2 mg/kg, which is greater than the highest non-detect for any Aroclor in sediment from the impoundments (TCEQ and USEPA 2006).

TCEQ (2006b) does not provide a dioxin screening value, so the scientific literature was reviewed for appropriate dioxin benchmark(s) that could be used to screen sediment data for the Site. Preference was given to benchmarks that were empirically derived, relevant to marine/estuarine sediments, and provided a concentration associated with no effect in the tested organism. Proposed sediment quality guidelines and benchmarks for dioxins have been promulgated by a variety of institutions and agencies and many have been compiled by Wenning et al. (2004). Several of these benchmarks are based on equilibrium partitioning and other predicted relationships between sediments and receptors and were not considered as relevant or robust as the screening value described below.

A value of 25 µg/kg from a spiked sediment 10-day toxicity test using the marine amphipod *Ampelisca abdita* was chosen for comparison to Site data (Barber et al. 1998). In this study, 25 µg/kg 2,3,7,8-TCDD was the highest concentration to which the amphipod was exposed, and no significant effects on either survival or growth were found. This study was chosen to provide the screening benchmark because it used a sensitive and representative marine benthic invertebrate species and empirically identified a no-effect concentration of dioxin at and below which effects were not observed.

Documentation of the screening process for benthic macroinvertebrates is provided in Table 10. Additional information on the benthic invertebrates, and on the toxicity of dioxins and furans to invertebrates, is provided in the SLERA and attachments, which is an appendix to the RI/FS Work Plan.

### *1.6.3 Fish and Wildlife Risk-Based Screen*

The approach to determining whether each COI is a COPC, or can safely be eliminated from further assessments of risk to fish and wildlife, is illustrated in Figure 10.

This approach differs from the approach used to identify COPCs for benthic invertebrates because, for the purposes of screening only, fish, birds, and mammals are assumed to be exposed to sediment-related chemicals primarily through ingestion of their foods, or that exposures to COIs for the purpose of evaluating risk would be assessed using whole body or other tissue concentrations, as for dioxins and furans in fish. Therefore, the potential for bioaccumulation of each chemical is considered in the first step of risk-based screening approach for fish, birds, and mammals. Potential for bioaccumulation of metals was evaluated using TCEQ guidance, which lists chemicals considered bioaccumulative (Table 3-1 in TNRCC 2001 and TCEQ 2006b). Because TCEQ guidance does not address some of the organic COIs, for all of the organic COIs the log $K_{ow}$ was used as an indicator of bioaccumulation potential. Consistent with USEPA guidance (USEPA 2008c), chemicals with log $K_{ow}$s equal to or greater than 5 were considered to have the potential to bioaccumulate in tissue.

If the chemical was potentially bioaccumulative but was never detected, it was included as a secondary COPC. If it was detected, it was included as a primary COPC. Documentation of the screening process for fish and wildlife is provided in Table 11. The chemicals identified as primary and secondary COPCs for benthic invertebrates and for fish and wildlife are summarized in Table 8.

## 1.7 Evaluation of COPCs in the Sediment Study and Its Results

The purpose of investigating chemicals in sediment is to determine the nature and extent of potential contamination, identify any unacceptable risks associated with the contamination, and to evaluate potential remedies (USEPA 2005a). Sections 1.5 and 1.6 describe a series of conservative analyses to focus the RI/FS on only those chemicals that may be present in sediments at levels that could generate unacceptable risks. This section describes how the results of these evaluations will affect the sediment study design and provides an overview of how the results of the sediment study will be analyzed to focus the risk assessments.

Figure 11 provides an overview of how the chemicals listed in Table 4 are addressed and the related analysis steps, including the following:

- Identification of COIs (Section 1.5)
- Application of conservative risk-based screening to select COPCs (Section 1.6)
- Identification of dioxins and furans as an indicator chemical group (Section 1.7.1)
- How the sediment study addresses COPCs (Section 1.7.2).

Because the risk-based screening evaluations were performed on the samples that describe the most contaminated sediments at the Site (i.e., those from the source), the selection and treatment of COPCs described in these sections are applicable to other aspects of the RI/FS. For example, these analyses also define the COPCs and analytes for the investigation of soils in upland areas. Additional information will be provided in the RI/FS Work Plan and subsequent SAPs.

### *1.7.1 Dioxins and Furans as an Indicator Chemical Group*

According to USEPA (1988a) guidance for conducting RI/FS under CERCLA, it is sometimes appropriate to select one or more indicator chemicals to focus the assessment on those chemicals likely to be of greatest concern. An indicator chemical or chemical group is one that is the most toxic, persistent, and/or mobile among those substances likely to contribute significantly to the overall risk at the Site. Selection of an appropriate indicator chemical or chemical group can serve to simplify and focus much of the investigation, the required analyses, and the evaluation of remedial alternatives. Use of an effectively selected indicator chemical reduces both the costs and the time required to develop and implement a remedial strategy, and in doing so, is considered appropriate by USEPA guidance (USEPA 1988a).

For the Site, dioxins and furans provide an appropriate indicator chemical group for the RI/FS. Their concentrations relative to risk-based screening values are very high in sediments from the impoundments, and the degree to which they exceed risk-based screening levels in these sediments relative to those of the other COPCs is also very high, indicating that they are very likely to be the most important risk driver at the Site. For these reasons, dioxins and furans are the chemicals of greatest concern to the RI/FS. Moreover,

concentrations of biologically active congeners can be expressed in a unifying metric, the TEQ concentration, providing a simple means to express exposures, evaluate risks, and to address remedial goals for a group of chemicals. The specific uses of dioxins and furans as an indicator chemical group for the sediment study are discussed in sections below. The overall importance and full range of uses of dioxins and furans as an indicator chemical group will be described in the RI/FS Work Plan and in subsequent documents.

### *1.7.2 How the Sediment Study Addresses COPCs*

Figure 11 outlines the additional analysis steps for the COPCs summarized in Table 8. The sediment study will generate new information on both primary and secondary COPCs in sediments. Primary COPCs will be analyzed in all sediment samples, and secondary COPCs will be included among the analytes in a subset of sediment samples collected for Study Element 1, Nature and Extent Evaluation. Specifically, secondary COPCs will be analyzed in samples from within the impoundments, from a subset of stations within the Site, and in all of the upstream background stations. At all of the stations for which sediments will be collected to characterize the nature and extent of contamination, enough mass of sediment will be collected for analysis of secondary COPCs in these samples, if necessary. This additional mass of sediment will be archived.

To determine whether archived sediments should be analyzed for secondary COPCs, the secondary COPCs in the nature and extent sediment samples will be evaluated using the same risk-based screens applied in Section 1.6. Because a secondary COPC has either never been measured in Site sediments, or was never detected, the detection frequency within the data generated by this sediment study will also be considered (to the extent possible, detection limits will be improved for this study relative to existing data). In some cases, secondary COPCs will be eliminated from further consideration in the RI because it passes the risk-based screen (Section 1.6). A secondary COPC will also be eliminated from further consideration in the RI if it is detected in 5 percent or fewer of the surface sediment samples collected from the Site for this study.

For each secondary COPC that does not pass one or more of the risk-based screens, the data generated by this sediment study will be evaluated to determine if the concentrations of the

secondary COPC correlates with concentrations of the indicator chemical group, dioxins and furans. If the secondary COPC does not correlate, it will be included in the baseline risk evaluation (because it did not pass the risk-based screen). If the secondary COPC does correlate with dioxins and furans, it will not be evaluated in the baseline risk assessments, unless additional information indicates that the risks should be evaluated for the chemical. A correlation with dioxins and furans, the chemicals that are likely the primary risk drivers, will be interpreted to indicate that remedial actions to address dioxins and furans will address any relatively minor risks due to secondary COPCs.

## 1.8 Uncertainties and Data Gaps

Uncertainties and data gaps currently present in the dataset related to the Site are discussed below. The sediment study proposed in this document addresses the collection and analysis of new information to supplement existing data and to address and reduce the uncertainties in the existing data.

### *1.8.1 Nature and Extent*

Surface sediment concentrations of COPCs have been measured within and near the Site; sampled locations are shown on Figures 4 and 5. The spatial resolution of these samples is fairly low; the average spacing between the samples collected in 2005 in a grid surrounding the impoundments for the TMDL program (University of Houston and Parsons 2006) is approximately 1,000 feet (305 m), and these data are only for dioxins and furans. The steepest spatial gradients of dioxin and furan concentrations are between samples collected from within the impoundment or on the shoreline of the property west of the impoundments and samples that are approximately 1,000 feet (305 m) away (Figure 4). At distances greater than approximately 1,000 feet (305 m) from these two locations, the spatial gradient of concentrations appears to be much lower on the basis of the available data (Figure 12). Sediment conditions within 1,000 feet (305 m) of the impoundments and of the shoreline of the property west of the impoundments are not well characterized.

In addition, concentrations of dioxins and furans in sediment along the eastern and northeastern perimeter of the original impoundments are not well described by the existing dataset and existing data need to be supplemented (Figure 4).

Concentrations of metals in sediment have been measured at 17 locations within the Site. Fourteen of these are in or adjacent to the impoundments, or adjacent to the I-10 Bridge to the east of the impoundments. The spatial and vertical distributions of metals are therefore not well characterized and represent data gaps.

The baseline distribution of COPCs with depth is characterized only near the I-10 Bridge. Four sediment cores were collected by Weston (2006), and one core under the bridge was collected by the TCEQ's TMDL program (University of Houston and Parsons 2006). Therefore, the depth distribution of COPCs throughout the Site is not well characterized. The paucity of sediment core data is a data gap that should be filled to complete an evaluation of the nature and extent of contamination.

The distribution of COPCs in sediments of upstream background areas for baseline is characterized by only five samples from the SSI (TCEQ and USEPA 2006). Therefore, chemistry of upstream sediments is not well characterized. The paucity of upstream sediment chemistry data is a data gap that should be filled to complete an evaluation of the nature and extent of contamination.

### *1.8.2 Receptor Exposures*

Additional data are needed to characterize exposures of humans and ecological receptors to sediment-associated contaminants, both on the Site and for upstream background.

#### *1.8.2.1 Human Exposure*

There are three human receptor groups of interest for the BHHRA to be conducted for the RI for the Site: fishers, recreational visitors, and trespassers. These receptor groups may be exposed to sediments via direct contact (ingestion and dermal) or indirectly through consumption of aquatic organisms (i.e., fish and shellfish) that are exposed to the sediments. Available data for COIs in the sediments within the impoundments (TCEQ and USEPA 2006) indicate the presence of dioxins and furans and other chemicals at levels that are of potential concern to human health (Section 1.6.1; Tables 8 and 9). Additional information on the concentrations of these chemicals in sediment at locations throughout the Site where human use activities are expected to occur is needed to reliably characterize exposures and risks to

people coming into contact with Site sediment. Additional information on the concentrations of these chemicals in intertidal sediments from upstream in background areas is needed to understand the exposures and risks in background areas.

#### *1.8.2.2 Ecological Exposure*

A number of fish and aquatic-dependent wildlife species could potentially be exposed to Site-related chemicals through direct contact with contaminated sediments, incidental ingestion of contaminated sediment, or through ingestion of prey organisms that have been exposed to contaminated sediment. The exposure pathway for fish would include exposure at both the nearshore and deeper water environs.

Benthic macroinvertebrates are prey for a wide variety of fish and aquatic-dependent wildlife. Benthic macroinvertebrates known to occur in the vicinity of the Site include crabs, shrimp, mussels, oysters, and clams. Other species adapted to the low-salinity conditions, such as euryhaline polychaetes, oligochaetes, and amphipods, may also be expected in the vicinity of the Site. Fish species that have been listed in association with or collected from the tidal portion of the lower San Jacinto River near the Site include hardhead catfish, red and black drum, Atlantic croaker, gulf killifish, spot, spotted sea trout, and flounder (Gardiner et al. 2008; Osborn et al. 1992; Usenko et al. 2009). Fish and aquatic-dependent wildlife species that have potentially complete direct contact or ingestion exposure pathways from Site-related chemicals include those that prey on benthic macroinvertebrates, or those that prey on fish that have ingested benthic macroinvertebrates and sediment.

Aquatic-dependent wildlife may nest in, forage in, and/or migrate through the vicinity of the lower San Jacinto River. Birds such as raptors, herons, rails, pelicans, gulls, ducks, and shorebirds; and mammals including raccoon, river otter, nutria, and muskrat use the types of habitats that are present on and in the vicinity of the Site (Litteer 2009; USFWS 2009). Sandpipers, egrets, and herons are wading birds that forage along shallow intertidal areas for benthic infauna, small fish, and crustaceans. Piscivorous birds foraging in the open waters of the river include terns, cormorants, osprey, and pelicans. Omnivores including gulls and dabbling ducks may forage at the river's edge, as well as in the water column and in the

shallow benthos. Nutria and muskrat may be expected in the vicinity in wetland areas with emergent vegetation and river otters may use or move through the area while foraging for prey. Additional mammal species, including opossums and raccoons, may use riparian areas adjacent to the river for foraging and as corridors for moving across territories.

Available data for COIs in the sediments within the impoundments (TCEQ and USEPA 2006) indicate the presence of dioxins and furans, and several other chemicals at levels that are of potential concern to ecological receptors (Section 1.6.2 and 1.6.3; Tables 8, 10, and 11). Additional information on the concentrations of these chemicals in sediment at locations throughout the Site where ecological receptors may be active is needed to reliably characterize exposures and risks to ecological receptors coming into contact with Site sediment. Additional information on the concentrations of COPCs in sediment from upstream background areas is also needed to understand background ecological exposures and risks.

### *1.8.3 Physical CSM*

Development of the physical CSM is required to better describe the hydrodynamics and sediment transport. Qualitative and quantitative descriptions of hydrodynamics and sediment transport, which are provided by the physical CSM, are important because these physical processes provide the foundation for understanding chemical fate and transport processes.

For the hydrodynamic component of the CSM, the primary data needs are 1) geometry and bathymetry both within the Site and upstream; 2) rates of freshwater inflow from the San Jacinto River; 3) changes in water surface elevation (e.g., tidal elevation, including storm surges); 4) current velocity data; 5) salinity and temperature measurements; and 6) wind speed and direction data. For the sediment transport component of the CSM, the primary data needs are 1) sediment load (magnitude and composition) from upstream in the San Jacinto River; 2) spatial distribution of bed type (e.g., areas of cohesive [muddy] and noncohesive [sandy] sediment); 3) bulk bed property data (e.g., grain size distribution); 4) erosion properties of cohesive sediment; 5) suspended sediment concentrations; and 6) net sedimentation rate measurements. Initially, additional information on sediment grain sizes

and dry densities of sediments within and in the vicinity of the Site is required; these data gaps are addressed by the sediment study described in this SAP. Concentrations of COPCs and the grain size of sediments in upstream background areas are also addressed by this SAP.

An evaluation of the data needs for effective sediment transport modeling is underway, and a Technical Memorandum on Chemical Fate and Transport will be developed to discuss the modeling and data requirements according to details described in the RI/FS Work Plan. The Technical Memorandum on Chemical Fate and Transport will be accompanied by an addendum to this SAP for the collection of additional data required for sediment transport modeling. The schedule and timing of this memorandum and sediment transport SAP is described in the RI/FS Work Plan.

### *1.8.4 Fate and Transport-Related Information*

Sediment transport information will be used in conjunction with chemical data developed for the nature and extent investigation, as well as from the physical CSM, to develop an understanding of chemical fate and transport processes. In addition to chemical concentration data for sediments, additional fate and transport data and information include 1) chemical loads from the San Jacinto River (e.g., upstream sources); 2) chemical loads from atmospheric deposition; 3) volatilization rates; 4) adsorption-desorption kinetics (i.e., partition coefficients for particle-associated chemicals); 5) porewater concentrations; and 6) total organic carbon (TOC) data. The data relevant to this analysis that will be collected as part of the sediment study described in this SAP include the data on the nature and extent of contamination in surface and subsurface sediments, the sediment transport information addressed in the previous subsection, and in the sediment transport SAP referenced therein.

### *1.8.5 Engineering-Related Information*

Additional information is required to address the physical properties of sediments surrounding the impoundments to support a full evaluation of remedial alternatives, including the potential construction of a confined disposal facility (CDF) within the Site or complete removal of the contents of the impoundments to be disposed of offsite.

#### *1.8.5.1 Geotechnical Data*

A component of the FS is developing an understanding of whether re-establishment of impoundment containment is feasible, either through reconstruction of the berms or by other appropriate measures, or if removal of the waste contained in the impoundments is a more appropriate remedial alternative. In addition, dredging of sediments in the river may be a potential remedial action; and therefore, the dredgability and materials-handling characteristics of the river sediments should be understood. The information used to evaluate these issues is geotechnical engineering data.

Currently, only limited existing geotechnical studies are available for the project area. As described below, supplemental geotechnical data are required in order to support assessment of the dredgability of river sediments, and to evaluate berm design and potential construction techniques. Geotechnical data will be used in conjunction with the coastal hydrodynamic modeling results to address potential erosional forces that may influence sediment and berm stability. These different uses of geotechnical data and the associated data gaps are described below.

#### *1.8.5.2 Dredgability and Dredged Materials Handling*

Physical testing data are required within areas that will potentially be dredged in order to assess the dredging methods, the appropriate dredging equipment, and handling properties of dredged materials. Conceptually, potential dredging may entail the use of hydraulic dredge methods, with placement of dredged material into geotubes staged within the footprint of the potential CDF that is proposed to be constructed at the Site. Additional data collection to support evaluation of the behavior of sediments within the geotubes and the potential CDF will be required once the prospective dredge area has been delineated by the nature and extent sampling (Section 1.9.1). Any additional studies will be described in an addendum to this SAP.

Table 12 provides a summary of the physical testing that is needed to assess dredgability and dredge material handling. Many of these tests also provide information to support the evaluation and design of sediment placement activities within the potential CDF. Data collection for dredgability and dredge materials handling will be coordinated with the data

collection to define the nature and extent of contamination to maximize efficiency of the field sampling program.

#### *1.8.5.3 Waste Impoundment Containment*

Geotechnical information is required to evaluate engineering considerations for the potential re-establishment of a containment system around the Site and to provide design information. Broadly, four categories of subsurface information are required for geotechnical engineering design: conventional geotechnical parameters, soil permeability, soil strength, and soil compressibility. Proposed containment berm side-slopes will need to be designed for static stability under various conditions (e.g., during construction and in the long term). In addition, potential settlement of the subgrade under the berm footprint and within the containment system itself will need to be considered during the FS.

## 1.9 Task Descriptions

The sediment study will address data gaps by generating new information organized into four related study elements:

- Study Element 1: Nature and Extent Evaluation. Data will be used to characterize the nature and extent of sediment contamination.
- Study Element 2: Exposure Evaluation. Data will be used to evaluate ecological and human health exposure and risks.
- Study Element 3: Physical CSM and Fate and Transport Evaluation. Data will be used to better understand the physical processes governing sediment transport, including the fate and transport of contaminants.
- Study Element 4: Engineering Construction Evaluation. Data will be used to support design of remedial actions, including removal of contaminated sediments and the potential construction of an on-site CDF or removal of contaminated sediments for offsite disposal.

The broad outlines of each study element are provided in this section. Data Quality Objectives (DQOs) for each element are discussed in Section 1.10; the detailed study design is described in Section 2.

### 1.9.1 Study Element 1: Nature and Extent Evaluation

Additional data on the horizontal and vertical distribution of COPCs needs to be collected to supplement existing Site data and to address the data gaps associated with evaluation of the nature and extent of contamination (Section 1.8). The spatial distribution of these samples should allow the boundary of any PRG exceedances in surface sediment to be determined with a high degree of confidence. The vertical distribution of COPCs in subsurface sediment should be determined with a resolution of 1 foot (30 cm), because this is the finest level of vertical control that is likely to be established in a remedial design. Temporal analysis of data from 2005 and 2010 will be carried out to evaluate whether statistically significant changes in surface sediment conditions occurred as a result of hurricane Ike. If COPC concentrations in surface sediment are found to have changed significantly over this period, the baseline condition for risk assessments will be set by the most recent data, otherwise earlier data will also be used to define the baseline condition. Definition of a remedial action boundary is expected to be made on the basis of PRG exceedances in surface sediment, because surface sediment is the primary source of contaminant exposures for ecological receptors and people; and on subsurface sediment chemistry to the extent that contamination at depth is likely to move to the surface as a result of common processes of sediment disturbance (e.g., river and tidal currents, storm events). Mixing of subsurface with surface sediment will be addressed in the RI using methods described in the Technical Memorandum on Fate and Transport Modeling, which is described in the RI/FS Work Plan.

Supplementary pre-remedial sampling may be used in the future to further refine the location of such a boundary and to design a remedy that is both effective and cost-efficient.

### 1.9.2 Study Element 2: Exposure Evaluation

Additional information is needed to characterize sediment chemistry in areas where human and ecological receptors may be exposed to sediment-associated contaminants. Surface sediment samples collected for the exposure evaluation will be analyzed for primary COPCs (Table 8), TOC, and grain size.

#### *1.9.2.1 Human Exposure*

Surface sediment samples are required for evaluation of human exposures to sediment via direct contact at locations where people could be expected to wade into the water, resulting in direct contact with contaminated sediments in shallow nearshore areas. Data generated from this study will be used in the BHHRA to characterize direct contact exposures to fishers, recreational visitors, and trespassers who may be exposed to contaminated sediments from the Site due to direct contact.

#### *1.9.2.2 Exposure of Ecological Receptors*

Data generated from this study will be used in the BERA to characterize exposure of ecological receptors to contaminated sediments in nearshore, shallow areas of the Site. The data generated by this study will be used to evaluate exposure to ecological receptors resulting from incidental ingestion of contaminated sediment during foraging. Sediment chemistry, TOC, and grain size data collected from nearshore ecological exposure areas will also be used for evaluation of processes resulting in the contamination of tissue of fish and invertebrates dwelling in nearshore shallow areas. Sediment chemistry, TOC, and grain size data collected from deepwater areas of the Site as part of the nature and extent evaluation will be used to evaluate processes resulting in the contamination of biological tissues from those deeper areas. Although there are two areas on the Site and one upstream at which samples are intended only for the ecological exposure evaluation, surface sediment samples (0–6 inches) collected at human exposure stations will be used to evaluate exposure of ecological receptors. Collection of tissue for the RI will be addressed in a separate SAP.

### *1.9.3 Study Element 3: Physical CSM and Fate and Transport Evaluation*

The data and information collected to support the physical CSM and chemical fate and transport evaluation will be used to develop a qualitative narrative that describes chemical fate and transport of sediment-associated contaminants. While there are numerous physical and chemical processes that affect chemical fate and transport at any contaminated sediment site, experience at other sites has shown that a relatively small number of processes are of primary importance. Identifying the primary processes that are controlling chemical fate and transport in the vicinity of the Site is the main objective of this study element. Once the primary processes are determined, the Site-specific physical and chemical data will be

integrated and synthesized to develop a coherent narrative that describes chemical fate and transport.

### 1.9.4 Study Element 4: Engineering Construction Evaluation

This study element requires geotechnical information, characterization of dredgability of sediments, and information on the physical properties of sediments adjacent to the impoundments to support design of a potential containment system, such as a CDF, within the area of the impoundments as a potential long-term remedial action.

#### 1.9.4.1 Geotechnical Evaluations

Field sampling will address the data gaps identified in Section 1.8. Geotechnical sampling locations are identified in Figure 13. Where possible, river channel sample locations are co-located with chemical sampling core locations.

#### 1.9.4.2 Dredgability and Dredge Materials Handling

To address data gaps related to dredgability and materials handling, geotechnical laboratory testing will be conducted on representative sediment samples collected from the river channel, and geotechnical borings will be taken at 8 locations within the original perimeter of the impoundments. Conventional geotechnical sediment parameters (i.e., moisture content or total solids, grain size, Atterberg limits, and specific gravity) will provide information to evaluate the behavior of sediments to be dredged. These data will be used to consider the appropriate size and types of dredge equipment, expected pumping and dredge production rates, estimated sediment bulking during dredging, and anticipated pre- and post-dredge sediment volumes. Sampling methodology to evaluate dredgability and dredge material handling is described in more detail elsewhere in this SAP and within the FSP.

#### 1.9.4.3 CDF Design

Data gaps for potential CDF and berm design will be addressed by obtaining samples and completing geotechnical laboratory tests, as proposed in Table 12. A series of borings advanced from the upland and from a barge will be used to collect samples. These borings

will be advanced at multiple locations in order to provide a representative characterization of the subsurface sediment profile.

Strength data will be used to evaluate bearing capacity and slope stability for the design and construction of the potential CDF and its containment berms. Vane shear and consolidated-undrained triaxial (CU triax) test results will be used directly as measures of sediment strength. Standard penetration test blow counts and Atterberg limits test results will be correlated to sediment strength using standard-of-practice geotechnical engineering reference sources (e.g., Federal Highway Administration and TXDOT geotechnical manuals).

Settlement data will be used to estimate the magnitude and duration of expected settlement under the footprint of the potential CDF and its containment berms. The results of this evaluation will be used for planning the crest elevation of the berms and the top elevation of the potential CDF cap. Consolidation test results will be used as a direct measure of sediment compressibility. Atterberg limits and moisture content data will be used to correlate expected compressibility parameters using similar standard-of-practice geotechnical engineering references as described above.

Permeability data will be used to evaluate potential fate and transport mechanisms within the potential CDF. Permeability will be directly measured by the permeability test. Permeability can also be correlated with data reported from the triaxial shear strength test and loosely correlated with grain size data that will be collected.

Sampling methodology and analysis depth intervals are further defined in Section 2 of this SAP and within the FSP (Appendix A).

## 1.10 Data Quality Objectives and Criteria

This section presents a summary of the DQOs for each of the four discrete study elements of the sediment study described by this SAP, prepared consistent with USEPA guidance (USEPA 2006). Establishing DQOs for each study element provides an assurance that sampling will be focused on the goals of the RI/FS and will be sufficient to address those goals. The DQO summaries in the following subsections include, for each study element, a

statement of the problem, a description of the analytical or interpretive approach to be followed, and components of the sampling design necessary to support the analytical or interpretive approach.

These DQOs will be addressed in the initial phase of sediment sampling; the sediment sampling design to meet all of the goals is presented in Section 2. In addition to the study described in this sediment SAP, a Technical Memorandum on Chemical Fate and Transport will be developed and will define additional data needs for development of the physical CSM and the fate and transport analysis. The Technical Memorandum on Chemical Fate and Transport will be accompanied by an addendum to this sediment SAP, which will define additional sediment parameters required for the sediment transport model, and the approach to collecting the required data. Depending on the results of these first phases of sediment sampling, additional sampling may subsequently be conducted to further support implementation of a selected remedial action.

### *1.10.1 DQOs for Study Element 1: Nature and Extent Evaluation*

This RI/FS is being undertaken to address contamination of San Jacinto River sediments in the vicinity of the impoundments at the Site (Figure 2), and to plan for remedial actions. The spatial and vertical extent of remedial action is anticipated to be determined, at least in part, by exceedances of concentration-based PRGs for sediments.

#### *1.10.1.1 Statement of the Problem*

The primary problem to be addressed by Study Element 1, the nature and extent investigation, is uncertainty in the spatial and vertical extent of COPC contamination in sediments. Related problems to be addressed by Study Element 1 are: 1) current data are insufficient (in both spatial extent and types of measurements) to understand the movement of sediment-associated contamination into and away from the Site; and 2) chemical characteristics of Site and background sediments need to be clearly distinguished to evaluate the relative contribution of Site wastes outside the impoundment, and the dioxin and furan concentrations along the eastern perimeter of the original impoundments. The nature and extent evaluation, including characterization of upstream background sediment conditions,

will address these problems and thereby facilitate the selection and implementation of remedial approaches.

A screening-level evaluation of the available chemical data (Section 1.6) indicates that the primary COPCs (Table 8) are present in the sediment at levels of potential concern to human and environmental health. Information on the concentrations of all of these chemicals throughout the Site will be needed to evaluate the horizontal and vertical extent of PRG exceedances. In addition, evaluation of the movement of Site-related contaminants within the river requires characterization of source materials in the impoundments (i.e., the source of contamination of Site sediments) using chemical signatures, and also characterization of sediments that are likely not influenced by the impoundments. As described in Section 1.4.2, locations upstream in the San Jacinto River are relevant for assessing sediment conditions and sediment chemistry outside of the influence of the impoundment. Although some upstream data have been previously collected (Table 3), a larger number of samples is required for quantitative comparison, given the number of COPCs (Gonzales 2007). Finally, the available data contains few measurements for COPCs other than dioxins and furans, and additional upstream samples are required to characterize local background concentrations of these COPCs relative to conditions on the Site.

#### *1.10.1.2 Analytical Approach*

Study Element 1 includes three distinct types of data analysis:

- **Characterization of the spatial extent of contamination.** Sediment data will be integrated to provide an overall evaluation of the spatial and vertical extent of contamination using kriging to interpolate throughout the Site (Myers 1997). Depending on the results of the ecological and human health risk assessments, additional kriging may be carried out to evaluate the spatial extent of risk. Indexes of risk assessment results (e.g., locations with risk higher than specified thresholds) may be mapped to support the visualization and interpretation of risk assessment results.
- **Characterization of temporal changes in contamination.** To evaluate whether changes to surface sediment conditions have occurred in the recent past—specifically, as a result of hurricane Ike in 2008—newly collected data will be compared with the data collected in the sampling grid surrounding the impoundments by TCEQ in

August 2005. Paired two-sample tests will be conducted, matching every sample collected in 2005 within the preliminary Site perimeter with the closest recent sample that is within 250 feet (for samples within the 500-foot grid) or within 500 feet (for samples within the 1,000-foot grid). A systematic difference in surface sediment concentrations of dioxins and furans (as the indicator chemical group) will be indicated by a p value of less than 0.05. If newly collected data for dioxins and furans are found to be statistically significantly different than 2005 data, baseline conditions for all COPCs will be defined by the recent data set for all COPCs. If statistically significant differences are not found, then data collected in 2000 or later will be used to define the baseline condition.

- **Evaluation of the association of contaminants in sediments outside of the impoundments, but within the Site, with the contaminated materials within in the impoundments.** Patterns of dioxin and furan congeners within a sediment sample can vary considerably depending on the source (USEPA 2004b). Therefore, a pattern-matching approach will be used to evaluate both Site and upstream background samples to identify any pattern characteristic of the impoundment, and to determine the contribution of this pattern to other previously collected samples. The pattern-matching approach will provide an estimate of the fractional contribution of different mixing end members (i.e., source types) to each sample. Assuming that end members can be interpreted as sources, this analysis will therefore provide the basis for determining the fractional contribution of the impoundment to each sediment sample.
- **Comparison of Site sediment conditions with background sediments.** Evaluation of Site data relative to background conditions requires assessment of variability in background conditions. For this analysis, a method analogous to a reference envelope approach will be used, in which an upper 95th percentile or upper tolerance limit will be derived to characterize background conditions. This approach provides a threshold value for comparing individual Site stations to background conditions.

#### *1.10.1.3 Sample Collection Design*

A design for sediment sampling that will result in the collection of additional data in a manner that that will meet the project goals is discussed below.

#### 1.10.1.3.1 On-site Chemical Distribution Samples

To characterize the nature and extent of impoundment-related contamination within the Site, sediment samples will be collected from a regular grid. Sample spacing will be based on the spatial gradient of dioxin and furan concentrations: within 1,000 to 1,500 feet (305 to 457 m) of the impoundment boundary and of the shoreline of the sand separation area on the property west of the impoundments; where concentration gradients appear to be steepest on the basis of existing data (Figure 12), surface samples will be collected on a 500-foot (152-m) grid. This grid extends to approximately 1,500 feet (457 m) from the impoundment to the east and south, where transport processes may redistribute sediments from the impoundment. At greater distances from the impoundment, samples will be collected on a 1,000-foot (305-m) grid (Figure 14), except where agencies requested that some grid stations south of I-10 and to the west of the Site be moved from near upland areas to positions more clearly in the water (stations SJNE002, SJNE007, and SJNE013). This design produces 39 sampling locations in the high-intensity area close to the impoundment, and an additional 20 locations throughout the Site, for a total of 59 Site sampling locations. In addition to the grid samples, surface sediment samples will be collected at four locations along the eastern perimeter of the impoundments, along the inside of the historical perimeter berm. These four locations correspond to the locations of four geotechnical borings in that same area (Study Element 4). One additional station not within the grid (SJNE018) is located south of I-10, within an embayment. Placement of this station was decided in consultation with EPA and TCEQ. At all of these locations, surface sediment will be collected to a depth appropriate for exposure characterization (0 to 6 inches; 0 to 15 cm) and analyzed for all primary COPCs. Physical parameters (sediment grain size, TOC, and solids) will also be analyzed in these samples.

There is a single sampling location at the center of the grid, at a central location within the impoundments. At this station, three surface samples will be collected to provide a reliable characterization of material within the impoundments. Coring will be conducted within the impoundment for Study Element 4, and related chemistry data will also be used to characterize nature and extent of contamination. Details of these samples are provided in Section 1.10.4. Finally, two samples of sediments 0 to 6 inches (0–15 cm) will be collected

within the impoundments for use in the exposure assessment (Study Element 2), but will be used for analyses related to Study Element 1. Primary and secondary COPCs will be measured in all of these samples.

Cores for nature and extent characterization will be collected at a subset of 12 of the high-intensity sampling locations, focusing on locations closest to the impoundment (Figure 14). Cores will be collected using a gravity, slide-hammer, or vibratory coring device (depending on the conditions encountered in the field) to refusal or to a maximum depth of 10 feet (3 m), and sectioned at 1-foot (30-cm) intervals. Based on historical data collected within the site, TEQ concentrations for dioxins and furans (which are an indicator chemical group for the sediment study) reach a constant level at or before a depth of 10 feet (3 m) within the site. Primary COPCs, physical parameters, and geotechnical parameters (Atterberg limits and specific gravity) will be measured in the core samples.

Secondary COPCs will be measured in all surface sediment samples collected at coring locations and within the impoundment itself. At all other surface sampling locations, sufficient sediment will be collected and archived to allow subsequent analysis of secondary COPCs if warranted.

#### 1.10.1.3.2 Background Samples

Upstream surface sediment will be collected to allow comparison of Site samples to local background conditions as part of the nature and extent investigation. Samples will be collected from transects across the river at several locations upstream of the Site. Transects will be located within the portion of the San Jacinto River below the channelized area because these conditions are likely to be more similar to sediments near the impoundment than samples farther upstream (Figure 15). Surface sediment will be sampled to a depth suitable for use in the exposure investigation (0 to 6 inches; 0 to 15 cm). A minimum of 20 total samples is necessary to accurately calculate an upper 95th percentile of the background data, or a 95 percent upper prediction limit (used by TCEQ for characterizing background); the 11 background samples shown in Figure 15, in combination with the 13 existing upstream samples, will provide more than 20 data points. The layout of upstream

samples will allow both lateral and longitudinal variations in upstream conditions to be evaluated.

It is possible that some of these locations may be sufficiently different from Site samples in physical characteristics (i.e., grain size and OC content) that they should not be included in the local background dataset; therefore, this plan will produce 24 candidate background samples, rather than just 20. In addition, although the Hazard Ranking System Documentation Record for the Site (TCEQ and USEPA 2008) indicates that "tidal influence has had little effect on the transport of source related contaminants upstream of the impoundments" (TCEQ and USEPA 2008, p. 51), additional evaluation will be performed to determine the potential for the chemicals from the Site to have influenced each of the stations upstream. Data from this sediment study will be analyzed to verify that each of the upstream stations provides representation of conditions (and risks) that would occur in the absence of influences from the Site (i.e., to determine the extent to which dioxins and furans in each upstream sample are attributable to the source material in the impoundments on Site). The method to perform this evaluation is described in Section 6.1.5 of the RI/FS Work Plan.

### *1.10.2 DQOs for Study Element 2: Exposure Evaluation*

The RI/FS will address risks to human and ecological receptors associated with contamination of San Jacinto River sediments at the Site (Figure 2). The exposure evaluation and risk assessment will support planning for remedial actions. This section presents the technical rationale and general approach for conducting the evaluation of human and ecological exposures to Site sediments.

#### *1.10.2.1 Statement of the Problem*

People visiting this portion of the San Jacinto River may be exposed to sediments via direct contact (ingestion and dermal) or indirectly through consumption of aquatic organisms (i.e., fish and shellfish) that have been exposed to the sediments. Available chemical data for Site sediment (TCEQ and USEPA 2006) indicate the presence of COPCs at concentrations greater than levels of potential concern to human health. Characterization of risk in support of selection and implementation of remedial approaches requires information on contamination

in sediments accessible by people. One problem to be addressed by the sediment study is uncertainty regarding concentrations of COPCs present in sediments directly contacted by people visiting the Site.

A related problem is the potential for ecological receptors at the Site to be exposed through direct ingestion of contaminated sediment, and exposed to bioaccumulative chemicals through ingestion of prey organisms that have been exposed to contaminated sediment. The problem to be addressed in the ecological exposure evaluation is uncertainty regarding the magnitude and spatial extent of exposures of fish and aquatic-dependent wildlife receptors to contaminants in Site sediments.

For both human and ecological receptors, there is additional uncertainty regarding the exposures to COPCs in sediment in upstream background areas. Information on exposures and risks to human and ecological receptors both at the Site and in upstream background areas are needed in the evaluation of remedial options.

#### *1.10.2.2 Analytical Approach*

Study Element 2 will include the following types of analyses:

**Characterization of exposures to human receptors using the Site.**

- Sampling of sediments for use in characterizing human exposures will be conducted to provide representation of the range of exposures possible within the Site. Five human exposure areas have been identified, and within each, samples will be collected to characterize the exposures within that area. After the characteristics of that exposure area have been established (i.e., data distribution and 95 percent upper confidence limit [UCL]), the area may be considered representative of exposures at other areas within the preliminary Site perimeter. Exposure areas were selected to represent relatively low on-Site exposure conditions through the highest exposures (i.e., within and around the impoundments).
- Within the preliminary Site perimeter, locations of probable human use are expected to occur along shoreline areas accessible by foot. The sediment zone of interest to the exposure evaluation is the intertidal sediments along the shoreline (i.e., those extending from the high tide elevation to the low tide elevation). Within this

sediment zone, five human use areas have been designated for collection of additional data (Figure 16). These human use areas are:

- The shoreline to the west of the shipping berth on the property west of the impoundments
- The eastern shoreline of the sand separation area on the property west of the impoundments
- The shoreline between the sand separation area and the west side of the impoundments
- The shoreline on both sides of the channel under the I-10 Bridge over the San Jacinto River
- The area in and around the impoundments.

At the first three of these, 10 distinct locations will be sampled. At the fourth, 15 distinct locations will be sampled. At the fifth, the existing data and two surface samples collected from within the impoundments will be used to evaluate potential human exposures.

- Sediment will be sampled at each station in each of the first four human use areas, at two sediment depths: 0 to 6 inches (0 to 15 cm) and 6 to 12 inches (15 to 30 cm). Five surface sediment samples from each of the first three of the exposure areas, 10 surface sediment samples from the fourth area, and the corresponding subsurface sediment samples from the eastern shoreline of the property west of the impoundments will be analyzed initially for primary COPCs. The remaining five surface samples from each of the four areas, five subsurface samples from the eastern shoreline of the property west of the impoundments, and all subsurface samples from the other three exposure areas will be archived.
- Analysis of the surface samples will be conducted using the following steps:
  - Because of the proximity of the two sets of samples from the sand separation area and from the shoreline between that location and the impoundments, both sets may represent a single exposure condition. A two-sample statistical test (*t*-test or Mann-Whitney U test) will be used to evaluate whether the two sets of five surface samples from these two exposure areas represent the same exposure conditions. If the null hypothesis of equivalence is rejected with a *p* value of less

than 0.05, archived surface sediment samples from both locations will be analyzed. If not, then the 10 samples collected across this area will be considered representative of one exposure area.

- The mean COPC concentration within each exposure area will be compared with the means from the other exposure areas. Data will be pooled across those exposure areas that are not statistically significantly different.
- The 95 percent UCL on the mean concentration of each COPC will be calculated for each dataset, which may consist of five samples or may be larger if some datasets were pooled. The 95 percent UCL will be used as an estimate of the reasonable maximum exposure (RME) concentration for direct contact of people with intertidal sediments (USEPA 1992). If the 95 percent UCL is greater than the maximum, it will be concluded that there is significant variation in the dataset and additional information is required. In these cases, the additional five surface samples from the appropriate human use area will be analyzed, and used to calculate the final RME. If the 95 percent UCL is less than the maximum, it will be concluded that the existing data are sufficient to characterize the central tendency and RME exposures, and the archived samples will not be analyzed. Statistical software, including ProUCL, will be used to calculate exposure point concentrations for sediments, as appropriate to the characteristics of the data and the required analysis.

- The decision whether to analyze the archived subsurface samples will be made based on the results of the surface samples from these areas. If the 95 percent UCL for the surface sediment exceeds the soil PRG, the subsurface sediment samples will be analyzed. Initially, five samples will be analyzed using the same scheme described above. If the 95 percent UCL for the surface sediment does not exceed the soil PRG, it will be concluded that exposures in that area are not significant and that additional information is not needed to evaluate that area.
- For the BHHRA, exposure point concentrations for sediment in each human use exposure area will be calculated as using the statistically appropriate measure of the central tendency and the 95 percent UCL to represent the RME.

**Characterization of exposures to ecological receptors on the Site.**

- Results of the sediment sampling will be used to evaluate exposures of fish and

aquatic-dependent wildlife receptors to contaminants in intertidal sediments. For evaluation of exposures to fish and aquatic-dependent wildlife, sediments in two wildlife use areas within the preliminary Site perimeter will be collected and analyzed. These wildlife use areas are (Figure 16):

- The shoreline of the island that is north of the impoundments
- The shoreline along the islands to the south of the I-10 Bridge over San Jacinto River, on the east side of the main channel

- Concentrations of COPCs in intertidal sediments from these areas and for samples collected for the human exposure assessment will be used to characterize the exposure profiles in each area for each bird and mammal receptor, and for nearshore-dwelling fishes. The exposure profile will consist of a measure of the central tendency concentration, and a measure of the RME concentration, but the statistics to be used for these (e.g., the mean vs. the median for the central tendency) will be determined after the chemistry data have been evaluated to identify the most appropriate representation for these areas. Calculation of exposure point values will also consider the home range or foraging range of each receptor, and the number of stations to be used in calculations may differ for different receptor species.
- For evaluation of exposure of benthic macroinvertebrates to primary COPCs, the measured concentrations at individual sampling stations throughout the Site will be used. Sediment chemistry data for the shoreline stations described above, and for samples collected for Study Element 1, will be used in this exposure evaluation.
- Sediment chemistry data will also be used in an evaluation of bioaccumulation of chemicals at the Site. This aspect of the exposure evaluation will use the results of sediment chemistry from the ecological and human exposure areas (i.e., intertidal sediments) described above, and the sediment chemistry results from Study Element 1. This analysis will involve statistical evaluations for correlations between sediment chemical concentrations with concentrations in benthic macroinvertebrate and fish tissues that will be collected as part of the Tissue SAP. If a predictive relationship is found, it may be used as one method of developing site-specific risk-based sediment PRGs.

**Comparison of exposures of human and ecological receptors to Site sediment contaminants with those of background.**

- Exposures to sediment contaminants on the Site will be compared with exposures at background locations (Figure 15), to determine the extent to which Site sediments pose an excess risk to humans, fish, and aquatic-dependent wildlife (i.e., a risk above that which would be experienced in the absence of Site contamination). To allow comparison of exposures to COPCs in Site sediments to those in upstream background areas, locations outside the Site boundary and upstream will be sampled. For the human health risk assessment, 10 stations will be sampled upstream. Five of the surface sediment samples will be analyzed initially for primary COPCs. The remaining five surface sediment samples and all of the subsurface samples will be archived for possible future analysis. These data will also be used to evaluate ecological exposures in this area. Three additional samples of sediment from a shoreline upstream will be collected and analyzed for primary COPCs for use in evaluation of exposures to ecological receptors, with additional sediment archived for possible future analysis if needed for the ecological exposure evaluation. The specific means of comparisons of Site risks with background risks will be based on the risk assessment results. Direct statistical comparisons of sediment chemistry between sediments in Site and background exposure areas may also be conducted. The specific statistical tests to be used will depend on the characteristics of the data.

#### *1.10.2.3 Sample Collection Design*

Data quality specifications, including analytical concentration goals, laboratory analytical methods, the number and type of field and laboratory QC samples, and the methods for evaluating and characterizing data quality, are specified in Section 2.5 of this document.

The sampling plan for the human health evaluation calls for 10 sampling stations in four of the five, and five stations at the fifth potential Site human exposure areas that are listed above and shown in Figure 16. Two additional surface samples will be collected within the impoundments to evaluate exposures within the impoundment area (additional information generated by cores collected for Study Element 4, and existing data will also be used to address human exposures within the impoundments). These exposure areas were selected because they are observed or likely locations where people go to fish and can contact sediments while doing so, and because they are locations that are or may have been impacted

by releases from the Site. Also, each exposure area is expected to reflect a unique exposure condition (and will be evaluated to confirm this expectation), such that the full set of exposure areas will characterize the range of possible exposure conditions, from relatively low (within the Site) to the highest exposures, at the impoundments. The 10 sampling stations identified in the upstream background area are shown on Figure 15. In each of the upstream and at the four Site exposure areas to be sampled, 10 surface (0 to 6 inches; 0 to 15 cm) and 10 subsurface (6 to 12 inches; 15 to 30 cm) sediment samples will be collected. In addition, five sampling stations are identified in the exposure area downstream of I-10 and are shown in Figure 16. Surface (0 to 6 inches; 0 to 15 cm) and subsurface (6 to 12 inches; 15 to 30 cm) sediment will be collected at each of these stations. Sampling stations will be located between the high tide mark and the low tide mark.

To evaluate ecological exposures, surface sediment samples (0 to 6 inches; 0 to 15 cm) will be collected from shallow water in two near site locations and in one background location where foraging wildlife are expected to come into contact with sediment (Figure 16). At each of these general locations, three separate samples will be collected. This design allows determination of whether risks to aquatic-dependent wildlife are uniform or variable within the Site, and allows evaluation of exposures on the Site relative to background conditions.

### *1.10.3 DQOs for Study Element 3: Physical CSM and Fate and Transport Evaluation*

The RI/FS will provide information to characterize the potential movement of sediment-associated contaminants in the vicinity of the Site (Figure 2). This information is necessary to plan for remedial actions.

#### *1.10.3.1 Statement of the Problem*

Information to support the evaluation of chemical fate and transport processes is needed to inform the evaluation of remedial alternatives. Understanding both qualitatively and quantitatively how sediment associated chemicals move into, within, and away from the Site is required for evaluation of the extent of potential impacts of materials deposited in the impoundments, the feasibility of various remedial actions, and the current and likely future sediment conditions within the Site.

The main goal of Study Element 3 is to determine the primary physical and chemical processes that are controlling chemical fate and transport. After the primary controlling processes are identified, this information will be used to design methods (e.g., computer modeling) to quantitatively analyze and evaluate chemical fate and transport within the Site. The ultimate goal of the quantitative analyses performed for Study Element 3 of the RI/FS will be to determine the efficacy of various remedial alternatives.

The immediate information needs to be addressed by Study Element 3 of the sediment study are the spatial distribution of bed types and COPC concentrations and bed sediment properties, including TOC data. The Sediment Transport Modeling Memorandum and associated SAP Addendum (Section 1.8.3) will address additional DQOs for this Study Element.

#### *1.10.3.2 Analytical Approach*

For the chemical fate and transport evaluation, the upstream boundary is located about 4 miles (6 kilometers) upstream of the Site, and the downstream area of interest extends to the confluence of the Buffalo Bayou with the San Jacinto River at the San Jacinto Monument. Analyses of the data generated for Study Element 3 by the study described in this sediment SAP will allow a qualitative description of the spatial distribution of bed types (i.e., cohesive and non-cohesive bed areas); spatial distribution of grain size distribution; net sedimentation rates; and incoming sediment load from the river.

#### *1.10.3.3 Sample Collection Design*

For this phase of the sediment transport analysis, the data collected as part of the nature and extent investigation (Study Element 1) will be used. The sampling design for that study element is described in Section 1.9.1.

### ***1.10.4 DQOs for Study Element 4: Engineering Construction Evaluation***

The RI/FS will address the nature and extent of contamination and associated risks in the vicinity of the Site, and will result in plans for remedial actions. Additional information is

needed to evaluate the feasibility of construction of a containment system, such as a CDF, within the area of the impoundments as a potential long-term remedial action.

#### *1.10.4.1 Statement of the Problem*

The former impoundment containment berms have been degraded through regional subsidence, adjacent work activities, and erosional energy from the San Jacinto River. The impoundment containment needs to be re-established. By rebuilding the containment berms, an opportunity will be created for replacement of sediments within the impoundment footprint that may have been resuspended and redistributed outside of the impoundment footprint and within the river channel. Geotechnical data are required to evaluate potential CDF and containment design and construction elements. Evaluations include dredgability of the river sediments, berm design, and potential CDF design. Geotechnical information required includes conventional parameters, sediment permeability, sediment strength, and sediment compressibility.

The goals of the engineering and construction evaluation are to obtain sufficient data to allow conceptual containment and capping structure designs to be prepared. The data collection and evaluation will support feasibility, conceptual, and design studies for the impoundment area.

#### *1.10.4.2 Analytical Approach*

The analytic approach will use the geotechnical data collected during the field and laboratory program to develop a range of expected permeability, strength, and compressibility characteristics for the variety of geologic horizons that are encountered beneath the Site. Direct measurements of permeability, strength, and compressibility as measured in the laboratory will be compared to correlated parameters from the conventional geotechnical test results.

Results of geotechnical evaluations can be highly dependent on input parameter assumptions. For berm stability, bearing capacity, and settlement evaluations, a range of strength and compressibility parameters will be considered during conceptual design based on the results of the field investigation. Stability will be modeled using limit-equilibrium

methods and if appropriate, Monte-Carlo type simulations will be performed to assess the sensitivity of the results to the input assumptions. Bearing capacity and settlement will be computed using spreadsheet implementations of standard-of-practice geotechnical equations.

#### *1.10.4.3 Sample Collection Design*

There are no specific acceptance criteria for geotechnical sampling that are independent from the acceptance criteria used for nature and extent sampling. The samples to be collected in support of Study Element 4 include sediment borings and sediment grabs for vane shear tests (VSTs), and are illustrated on Figure 13. Sediment borings will be collected at 17 locations for measurements of sediment strength and stability and will be used to support engineering design for a potential CDF. VSTs will be performed at 18 locations in the impoundment and in locations around the berm. Details of the sample collection design are presented in Section 2 of this SAP, with field procedures specified in the accompanying FSP (Appendix A).

## 1.11 Special Training and Certification

A technical team will be assembled with the requisite experience and technical skills to successfully complete the 2010 sediment study. All technical team personnel involved in sample collection will have extensive environmental sampling experience.

Sampling personnel who enter the exclusion zone and contaminant reduction zone (see Attachment A1, Sections 5.1.1 and 5.1.2 for definition and discussion of these zones) may be required to have completed the 40-hour Hazardous Waste Operations and Emergency Response (HAZWOPER) standard training course and 8-hour refresher courses (see overall HASP [Anchor QEA 2009] for further explanation). The training provides employees with knowledge and skills that enable them to perform their jobs safely and with minimum risk to their personal health. Documentation of course completion will be maintained in personnel files.

Selected laboratories will hold certification through the National Environmental Laboratory Accreditation Program for the methods which that laboratory will perform, where

applicable. Training and certification requirements for laboratory personnel will be provided in the laboratory QA plans (to be submitted under separate cover).

## 1.12 Documents and Records

Records will be maintained documenting all activities and data related to sample collection and to laboratory analyses. Results of data verification and validation activities will also be documented. Procedures for documentation of these activities are described in this section.

The QAPP, FSP (Appendix A), and the HASP Addendum 1 for this sediment study (Attachment A1) will be provided to every task participant listed in Section 1.1. Any revisions or amendments to any of the documents that make up the FSP will also be provided to these individuals.

### *1.12.1 Field Records*

Components of field documentation are discussed in Section 3 of the FSP. Integral and Anchor QEA's field leads will ensure that the field team receives the final, approved version of the QAPP (including the FSP and sediment HASP [Attachment A1]) prior to the initiation of field activities. Field records that will be maintained include the following:

- Field logbooks
- Photo documentation
- Field data and sample collection information forms
- Field change request forms (as needed)
- Sample tracking/chain-of-custody (COC) forms

Observations recorded in the field logbook will be used to provide context and aid in presentation and interpretation of analytical results. Additional details regarding the content and use of these documents are described in Section 3.1 of the FSP.

### 1.12.2 Laboratory Data Reports

All activities and results related to sample analysis will be documented at each laboratory. Internal laboratory documentation procedures are described in the laboratory QA manuals (to be submitted under separate cover).

Each laboratory will provide a data package for each sample delivery group or analysis batch that is comparable in content to a full CLP package. The format of the data may differ from CLP requirements. Each data package will contain all information required for a complete QA review, including the following:

- A cover letter discussing analytical procedures and any difficulties that were encountered
- A case narrative referencing or describing the procedures used and discussing any analytical problems and deviations from SOPs and this QAPP
- COCs and cooler receipt forms
- A summary of analyte concentrations (to two significant figures, unless otherwise justified), method reporting limits (MRLs), and method detection limits (MDLs) or estimated detection limits (EDLs)
- Laboratory data qualifier codes appended to analyte concentrations, as appropriate, and a summary of code definitions
- Sample preparation, digestion, extraction, dilution, and cleanup logs
- Instrument tuning data
- Initial and continuing calibration data, including instrument printouts and quantification summaries, for all analytes
- Results for method and calibration blanks
- Results for all QA/QC checks, including but not limited to labeled compounds, surrogate spikes, internal standards, serial dilutions, laboratory control samples, matrix spike samples, matrix spike duplicate samples, and laboratory duplicate or triplicate samples provided on summary forms
- Instrument data quantification reports for all analyses and samples
- Copies of all laboratory worksheets and standards preparation logs

Data will be delivered by the laboratories in both hard copy and electronic format to the task QA coordinator, who will be responsible for oversight of data verification and validation and for archiving the final data and data quality reports in the project file. Electronic data deliverables (EDDs) will be compatible with the project database.

### 1.12.3 Data Quality Documentation

Data verification (i.e., confirming the accuracy and completeness of field and laboratory data) will be completed by the SJRWP technical team for data generated in the field, and by each laboratory for the data that it generates. Data validation reports for chemical analyses will be prepared as described in Section 4 and provided to the task QA coordinator. All changes to data stored in the database will be recorded in the database change log. Any data tables prepared from the database for data users will include all qualifiers that were applied by the laboratory and during data validation.

### 1.12.4 Reports and Deliverables

The laboratories will keep the Laboratory QA Coordinator apprised of their progress on a weekly basis. The laboratories will provide the following information:

- Inventory and status of samples held at the laboratory in spreadsheet format by sample delivery group
- Summaries of out-of-control laboratory QC data and any corrective actions implemented
- Descriptions and justification for any significant changes in methodology or QA/QC procedures

Once all field programs for the Site are complete, a draft Preliminary Site Characterization Report (PSCR) will be prepared and submitted to USEPA. The draft PSCR will contain sample location maps, validated analytical chemistry results, and information on the extent of contaminant migration through the sediment pathway. Consistent with the 2009 UAO, the draft PSCR will be submitted to USEPA within 30 days after the completion of all laboratory and data validation work for all of the field studies that will be required for the RI/FS (a schedule will be provided in the RI/FS Work Plan). Prior to submittal of the draft

PSCR, data will be made available online within 30 days of receipt of final validated results. Interpretation of the data will be presented in the RI report.

# 2 DATA GENERATION AND ACQUISITION

## 2.1 Sampling Design

The sediment sampling design for the RI/FS incorporates a number of different components. The individual study components (as discussed in the QAPP) differ in the locations, depths, and analytes to be measured in the sediment. The sampling design can be summarized as follows:

- Surface sediment sampling and analysis of primary COPCs at 26 locations in and near the impoundments (Figure 14) on a 500-foot (152-m) grid, at 1 location in the channel immediately south of I-10 and toward the western side of the preliminary Site perimeter, and at 4 locations along the eastern perimeter of the original impoundments. Additional sediment from these 31 locations will be archived for later analysis of secondary COPCs, if necessary. Primary and secondary COPCs will be measured at an additional 13 locations on the 500-foot (152-m) grid, at 2 locations near the impoundment, and at 2 locations south of I-10. These samples will provide data for the nature and extent, exposure, and fate and transport analyses. Data from locations from within the impoundment area (seven stations), will allow characterization of waste materials and will be used for analysis of potential human exposures within the impoundments (along with existing data) as well as other objectives related to Study Element 1. Data from the two locations south of I-10 will provide information on possible prop scour or possible dredging disturbances.
- Surface sediment sampling and analysis of primary COPCs at an additional 15 locations within the Site boundary (Figure 14), on a 1,000-foot (305-m) grid (with some distance adjustments at two stations south of I-10 to place stations within the river rather than on land). These samples will provide data for the nature and extent, exposure, and fate and transport analyses. Additional sediment from these stations will also be archived for possible future analyses of secondary COPCs.
- Collection of cores and analysis of primary COPCs at 12 locations within approximately 1,000 feet (305 m) of the impoundment (Figure 14) and at 2 locations south of I-10. Additional sediment from these stations will also be archived for possible future analyses of secondary COPCs. These samples will provide data for the nature and extent evaluation and for dredgability assessments. Data from the two

locations south of I-10 will provide information on possible prop scour or possible dredging disturbances.

- Collection of surface samples and analysis of primary and secondary COPCs at 11 locations upstream of the Site but downstream of the channelized portion of the San Jacinto River (Figure 15), to allow estimation of local background conditions for the nature and extent, exposure assessments, and fate and transport analysis.
- Collection of intertidal sediment samples at 45 locations in three different human exposure areas on five beaches (Figure 16) near the Site to evaluate potential human exposure and whether the beaches represent different exposure conditions for human receptors. Surface and subsurface sediment samples will be collected at all 45 stations at each of the five beaches. Twenty-five of the surface intertidal sediment samples will be analyzed for primary COPCs, with additional sediment archived for possible future analysis of secondary COPCs. Surface sediment samples from the remaining 20 stations will be archived for future analysis of primary and/or secondary COPCs, if necessary (Section 1.10.2.2).
- In addition, half of the subsurface samples collected at Stations SJSH026 through SJSH035 will initially be analyzed for primary COPCs; the archived subsurface sediment samples from the other half of these stations and all of the subsurface samples from the other two beaches will be archived for possible future analysis of primary and/or secondary COPCs, if necessary (Section 1.10.2.2).
- Collection of intertidal sediment samples for analysis of primary COPCs at 10 locations upstream of the Site, but downstream of the channelized portion of the San Jacinto River (Figure 15), for evaluation of human exposures under upstream background conditions. Surface and subsurface sediment samples will be collected at all 10 stations at this beach. Half of the surface intertidal sediment samples will be analyzed for primary COPCs. The other half of the surface and all of the subsurface samples will be archived for possible future analysis of primary and/or secondary COPCs, if necessary (Section 1.10.2.2). Surface samples from these stations will also be used to evaluate ecological exposures.
- Collection of intertidal samples from six locations at two ecological exposure areas on the Site (Figure 16) and three locations at one ecological exposure area upstream (Figure 15) for characterization of exposure of ecological receptors such as wading birds. These samples will be analyzed for primary COPCs. Additional sediment from

these stations will be archived for possible future analyses of secondary COPCs, if necessary.

- Sediment borings at 17 locations and VSTs at 18 locations in the impoundment and in locations around the perimeter berms (Figure 13). Measurements of sediment engineering characteristics (strength and settlement behavior) will be used to support engineering design for a potential CDF.

The planned locations of these samples are shown in Figures 13, 14, 15, and 16. Some of the samples to be collected will be used for multiple elements of the overall study. Table 13 summarizes the suite of samples to be collected under this SAP in terms of placement, depth, analytes, and study element.

One surface sediment sample will be collected at each location sampled for the nature and extent evaluation, except for the location in the impoundment area: in this location, a field triplicate (i.e., three unique samples placed approximately 10 m [33 feet] apart) will be collected to assure an accurate characterization of the chemical characteristics (e.g., dioxin and furan "fingerprints") of the waste material within the impoundments. In general, surface sediment samples collected for the nature and extent evaluation will also be used to support the evaluations of exposure of aquatic receptors, sediment fate and transport, and sediment dredgability. Samples collected to support exposure assessments for humans and wildlife, and to support a potential CDF design, are more specialized in purpose and location, and will be collected in nearshore, shallow areas.

## 2.2 Sampling Methods

Sampling methods that will be used to collect the suite of samples summarized in Section 2.1 are presented in the following sections. Sampling methods are described in detail in the FSP.

### *2.2.1 Surface Sediment Samples for Chemical Analyses*

Two different kinds of surface sediment grab samples will be collected during the 2010 sediment study to address Study Elements 1 and 2:

- Intertidal sediments for exposure assessment
- Submerged San Jacinto River sediments

All surface sediment samples for characterization of nature and extent, for exposure of ecological receptors, and for characterization of human health exposure will be collected from 0-6 inches (15 cm). Sampling equipment may include stainless-steel spades or shovels, a stainless-steel hand corer, or a modified petite-Ponar grab sampler, depending on the conditions encountered in the field. One surface sediment sample will be collected at each location sampled for the nature and extent evaluation, except for the location in the impoundment area (Station SJNE022); in this location, a field triplicate will be collected to assure an accurate characterization of waste material present. Sediment from the field triplicates at Station SJNE022 will be processed as three separate and distinct samples. At all other chemical analysis stations, the sediment collected at each station will be placed into a decontaminated stainless-steel bowl and homogenized using a stainless-steel spoon until the sediment attains a visually uniform color and texture. Sediment subsamples will then be removed for the various kinds of laboratory analyses and for archiving. Sediment subsamples collected for SVOC and PCB analysis (i.e., 3 locations within the impoundment area [Station SJNE022, SJVS001, SJVS016], 12 locations on the 500-foot [152-m] grid, 2 locations south of I-10, and 11 locations upstream of the Site) will be analyzed; all other sediment subsamples for SVOC and PCB analysis will be immediately frozen upon receipt at the testing laboratory to extend holding time requirements (USEPA 1997b) for possible future analysis. Analyses of VOCs at these stations will be expedited by the laboratory, to enable a decision about analysis of VOCs at the remaining sediment stations before expiration of holding times for VOC analysis.

Submerged San Jacinto River sediments may be collected with a power grab, or a van Veen grab sampler (or equivalent type of equipment) in accordance with standard methods used by USEPA (1997b). Sample collection and processing will follow the same methodology described above.

Further details of the surface sediment sampling methods, collection, and sample processing can be found in the FSP. Locations of surface sediment sampling stations are shown in Figures 13, 14, 15, and 16.

### 2.2.2 Subsurface Sediment Samples for Chemical Analyses

Two different kinds of subsurface sediment will be collected during the 2010 sediment study:

- Intertidal sediments for exposure assessment
- Submerged San Jacinto River sediments

The subsurface intertidal sediments will be collected from 6 to 12 inches (15 to 30 cm) with a stainless-steel hand corer. Submerged San Jacinto River sediment core samples will be collected at 1-foot [30-cm] intervals to refusal or to a maximum depth of 10 feet with a gravity, slide-hammer, or vibratory coring device (depending on the conditions encountered in the field) in accordance with standard methods used by USEPA (1997b). Each core sample will be inspected for physical characteristics and described on a core profile form (see Attachment A3 of the FSP). Cores designated for chemical analysis will be sectioned into 1-foot (30-cm) intervals. The sediment from each core section will be homogenized with a decontaminated stainless-steel spoon until the sediment attains a visually uniform color and texture. Sediment touching the sides of the core tube will be excluded from each sample. Sediment subsamples will then be removed for the various kinds of laboratory analyses and for archiving. A minimum of one core will be collected at each nature and extent core station, and a minimum of three cores will be collected at each beach that is considered a human exposure area.

Further details of the subsurface sediment sampling methods, collection, and sample processing can be found in the FSP.

Locations of subsurface sediment sampling stations are shown in Figures 14, 15, and 16. Where both cores and surface sediment samples are to be collected at the same station, the surface sediment sample will be adjacent to the core, and all core intervals will be a full 1 foot (30 cm) deep.

### 2.2.3 Sediment Geotechnical Borings

Subsurface sediment will be collected by advancing borings at selected locations to obtain additional chemistry and geotechnical data. The chemistry data will be used to supplement data collected for the nature and extent evaluation (Study Element 1) and the exposure

evaluation (Study Element 2). The geotechnical data will be used for the physical CSM and fate and transport evaluation (Study Element 3) and the engineering construction evaluation (Study Element 4).

Locations of geotechnical borings are shown in Figure 13. The proposed sampling intervals and test parameters for borings in the area of a potential CDF are identified in Table 14. The subsequent sections provide details regarding sample collection methods, processing methods, and the sampling design plan.

#### *2.2.3.1 Upland and In-Water Boring Methods*

Sediment samples will be collected using upland and in-water boring methods consistent with American Society for Testing and Materials (ASTM) procedures (ASTM D 1452). The upland locations will use a track-mounted or similar limited access drill rig. The over water boring locations will be advanced from a barge-mounted drill rig. Following completion of each boring within the impoundment, the drill equipment will be decontaminated on a designated pad located within the confines of the impoundments using a hot water pressure wash.

Depending on the drill method used, the sampler will be advanced through a series of hollow stem augers, or through a steel casing. In either case, the drilling activity (drill fluid, cuttings, and sample collection) will be effectively separated from the surrounding water to minimize the potential for water quality impacts associated with the drilling. Uplands drilling will be performed within a contained enclosure such that cuttings and drill fluid will not be spread beyond the immediate boring hole, and will not enter surface water.

All cuttings generated by the drilling operation will be placed into 55 gallon drums or similar approved disposal bin. Sealed drums will be transported off site for disposal at an approved facility.

Further details of the boring methods, collection, processing, and sampling can be found in the FSP.

#### 2.2.3.2 Split-Spoon and Thin-Walled Tube Processing Methods

Split spoon samples will be logged and processed on site by the field geologist. Prior to processing, a visual description of each sample will be recorded on a standard boring log (Attachment A3 of the FSP). The following parameters will be noted:

- Sample recovery
- Physical sediment description in accordance with the Unified Soil Classification System (includes sediment type, density/consistency of sediment, color)
- Odor (e.g., hydrogen sulfide, petroleum)
- Visual stratification, structure, and texture
- Vegetation
- Debris (e.g., woodchips or fibers, paint chips, concrete, sand blast grit, metal debris)
- Evidence of biological activity (e.g., detritus, shells, tubes, bioturbation, live or dead organisms)
- Presence of oil sheen

Discrete samples will be taken out of the split spoon directly from the selected depth interval and placed into laboratory-supplied jars. Sample jars will be stored in a cooler out of direct sunlight until transportation to the testing laboratory. A COC form will be logged by the processing staff and relinquished to the courier and then to the testing laboratory staff.

Thin-walled tube samples (e.g., Shelby tubes) do not allow direct observation of the sample material. When removed from the boring, length of recovery will be measured and recorded prior to cleaning up the tube. Once the tube is clean, both the top and bottom will be sealed and the sample will be stored in a vertical position in the same alignment it was removed.

#### 2.2.3.3 Boring Design Plan

Locations for the borings are illustrated on Figure 13. Final boring locations and sampling intervals may vary depending on site access issues and based on determinations made by the field geologist. Borings will be drilled to varying depths depending on the proposed location of the berm and other components of the potential CDF. Two 120-foot (37-m) deep borings and five 60-foot (18-m) deep borings will be drilled in the vicinity of the proposed berm. Within the former waste impoundment limits of the potential CDF, two 30-foot (9-m) and

eight 10- to 20-foot (3- to 6-m) deep borings will be advanced to evaluate the thickness of the waste material. The final depth of the 10- to 20-foot deep borings will be determined in the field based on the contact elevation within the native sediments.

Geotechnical testing will include grain size, Atterberg limits, moisture content, specific gravity, permeability, CU triax compression, and one-dimensional consolidation testing. Primary and secondary COPCs will be measured on samples collected from the waste material collected in the 10- to 20-foot deep borings. The testing program is provided in Table 14.

### *2.2.4 Vane Shear Testing*

VSTs will be performed to measure the undrained shear strength of near-surface sediments. This information typically cannot be obtained using geotechnical borings due to limitations of the drilling and sampling that necessitate an initial boring sample interval that is often a few feet below the existing mudline.

VSTs will be performed at 18 locations and at up to three depths for each location in selected areas of the potential CDF footprint, which will generally coincide with the historic berm locations (Figure 13) and within the interior of the impoundment. Table 15 summarizes the depths and details of the VSTs. Grab samples will be collected at each VST location. The grab samples will be photographed, logged, and placed into 16-ounce jars for physical testing to provide sediment plasticity data that allows for correction of the field VST results. Additional VST sampling details can be found in the FSP.

## 2.3 Sample Handling and Custody

Principal documents used to identify samples and to document sample possession will be field logbooks and COC records. Custody will be documented for all samples at all stages of the analytical or transfer process. COC procedures for sample handling prior to delivery to each laboratory are outlined in Section 3.5 of the FSP.

Upon receipt of samples at each laboratory, the physical integrity of the containers and seals will be checked, and the samples will be inventoried by comparing sample labels to those on

the COC forms. Each laboratory will include the COC and shipping container receipt forms in the data package. Any breaks in the COC or non-conformances will be noted and reported in writing to the project laboratory coordinator within 24 hours of receipt of the samples. Each laboratory QA plan (to be provided under separate cover) includes procedures used for accepting custody of samples and documenting samples at the laboratory. The laboratory project manager will ensure that a sample-tracking record is maintained that follows each sample through all stages of sample processing at the laboratory.

Samples will be stored in accordance with Table 16. Samples for chemical analyses will be stored under refrigeration (4 ± 2°C). Aliquots of the samples submitted to the analytical laboratory for possible SVOC analysis and long-term archiving for future analysis will be stored at –20°C. Each laboratory will maintain COC documentation and documentation of proper storage conditions for the entire time that the samples are in its possession.

The laboratories will not dispose of the samples for this task until authorized to do so by the task QA coordinator. After authorization is obtained, each laboratory will dispose of samples, as appropriate, based on matrix, analytical results, and information received from the client.

## 2.4 Laboratory and Analytical Methods

Sediment samples collected for this study will be analyzed for a variety of chemical and physical parameters as outlined in Table 17. The proposed laboratory methods are described below and are summarized in Table 17. These methods are consistent with requirements provided in SW-846 (USEPA 2008b), ASTM (2009), and other established and widely accepted protocols. Analyte lists are provided in Table 18. Expected MRLs and MDLs will be provided following laboratory selection.

### *2.4.1 Physical Properties and Geotechnical Analyses*

All sediment samples for nature and extent evaluation will be analyzed for percent moisture, TOC, grain size, Atterberg limits, and specific gravity. In addition, some sediment samples from the geotechnical borings will be analyzed for percent moisture, grain size, Atterberg

limits, and specific gravity. Sediment samples collected for exposure assessment will be analyzed for percent moisture, TOC, and grain size.

Percent moisture for samples for nature and extent evaluation and exposure assessment will be determined according to USEPA Method 160.3, which is a method commonly used by chemistry laboratories to determine total solids. These results will be used to calculate analyte concentrations on a dry-weight basis and will also be reported in the database. Sediment moisture content for geotechnical samples will be determined according to ASTM Method D-2216. These results will be used in tandem with the Specific Gravity results to compute *in situ* void ratio, which is directly related to dry and buoyant unit weight (i.e., "density") of sediments.

TOC in sediment will be analyzed by USEPA Method 9060, modified for sediment. Samples will be pretreated with hydrochloric acid to remove inorganic carbon, dried at 70° C, and analyzed by combustion in an induction furnace.

Grain size distribution will be determined according to ASTM Methods D-422 and D-1140, with modifications described in USEPA (1986). Organic material in the samples will not be oxidized prior to analysis.

Atterberg limits and specific gravity will be determined using applicable ASTM methods (Table 12).

### 2.4.2 Sediment Chemistry

All sediments sampled for nature and extent and exposure evaluations will be analyzed for the primary COPCs (Table 8). A subset of these sediments will be analyzed for the secondary COPCs. The list of analytes that will be reported for each of these samples is provided in Table 18. Sediment analyzed for metals other than mercury will be digested with strong acid per USEPA Method 3050 and analyzed by inductively coupled plasma-atomic emission spectrometry per USEPA Method 6010B, or by inductively coupled plasma/mass spectrometry per USEPA Method 6020.

USEPA Method 7471A (USEPA 2008b) will be used for mercury analyses. Samples will be extracted with aqua regia and oxidized using potassium permanganate. Analysis will be completed by cold vapor atomic absorption spectrometry.

Dioxins and furans in sediment samples will be extracted and analyzed in accordance with either USEPA Method 1613B or USEPA Method 8290A (USEPA 1994, 2008b). All extracts will undergo silica gel cleanup. Additional cleanup procedures will be used as necessary. Samples will be analyzed by high-resolution gas chromatography with high-resolution mass spectrometry (HRGC/HRMS). Detection limits are calculated on an individual compound and sample basis and depend on the signal-to-background ratio for the specific labeled isomer.

Dioxin-like PCB congeners will be extracted and analyzed in accordance with USEPA Method 1668B (USEPA 2008d). All extracts will undergo silica gel cleanup. Additional cleanup procedures will be used as necessary. Samples will be analyzed by HRGC/HRMS. Detection limits are calculated on an individual compound and sample basis and depend on the signal-to-background ratio for the specific labeled isomer.

PCB Aroclors will be extracted by Soxhlet per USEPA Method 3450C (USEPA 2008b) and be analyzed by gas chromatography with an electron capture detector (GC/ECD) in accordance with USEPA Method 8082A (USEPA 2008b). Acid cleanup (USEPA Method 3665) and sulfur removal (USEPA Method 3660B) will be performed on the extract if necessary.

SVOCs will be extracted using Soxhlet or pressurized fluid extraction procedures, processed through gel permeation chromatography (USEPA Method 3640A), and analyzed by gas chromatography/mass spectrometry in accordance with USEPA Method 8270C (USEPA 2008b). Tentatively identified compounds will not be reported. For analysis of sediment, sample modifications such as use of selected ion monitoring or large volume injectors may be made to these methods to improve MRLs.

VOCs will be analyzed by purge and trap extraction and GC/MS in accordance with USEPA Method 8260B (USEPA 2008b). Tentatively identified compounds will not be reported.

### 2.4.3 Sediment Permeability

Permeability will be measured in the laboratory to evaluate the sediment's ability to allow water to pass through. Permeability in the laboratory will be measured either by the constant head test for coarse-grained samples (ASTM D 2434) or the falling head test for fine-grained samples (ASTM D 5084). Multiple permeability tests will be performed on samples of the waste material encountered within the potential CDF footprint.

Fine-grained samples for these tests will be obtained by taking undisturbed samples from the borings using thin-walled tubes. Special care will be taken, as noted in the FSP, when handling and transporting the thin-walled tubes so as to minimize potential sample disturbance.

### 2.4.4 Sediment Consolidation

Consolidation testing will be performed to determine the sediment's settlement behavior over time. Consolidation testing can also provide rough measurements of permeability. Consolidation in the laboratory will be measured for very soft to stiff fine-grained sediments by the one-dimensional consolidation test (ASTM D 2435). Multiple consolidation tests will be performed to evaluate potential subsurface variability across the Site.

Fine-grained samples for these tests will be obtained by collecting undisturbed samples from the borings using thin-walled tubes. Special care will be taken, as noted in the FSP, when handling and transporting the thin-walled tubes so as to minimize potential sample disturbance.

### 2.4.5 Consolidated-Undrained Triaxial Sediment Strength Test

CU triax testing will be conducted in the laboratory on undisturbed samples sediment obtained via use of a thin-walled tube (e.g., Shelby tube). This test measures the sediment's strength through a variety of loading and confining pressures (ASTM D 4767). The test measures pore pressures in the sediment to allow both total and effective stresses sediment parameters to be reported. The Technical Team Coordinator will work directly with the testing laboratory to determine the range of confining pressures at which the tests will be run. These confining pressures will be based on the depth from which the sample was

collected, and considering the future anticipated loads from the potential CDF. Multiple CU triax tests will be performed to evaluate potential subsurface variability across the Site.

Fine-grained samples for these tests will be obtained by taking undisturbed samples from the hollow-stem auger explorations using thin-walled tubes. Special care will be taken, as noted in the FSP, when handling and transporting the thin-walled tubes so as to minimize potential sample disturbance.

## 2.5 Quality Control

QC samples will be prepared in the field and at each laboratory to monitor the bias and precision of the sample collection and analysis procedures.

### *2.5.1 Field Quality Control*

Field QC samples for this study will include field split samples (homogenization duplicate), field triplicate (three unique samples at the same location), equipment filter wipes, filter blanks, and Standard Reference Material (SRM). Because field QC sampling is not standard protocol for geotechnical engineering investigations, field QC samples will not be collected for Study Element 4.

Field split samples will be collected at a frequency of one for every 20 field samples processed. A field triplicate will be collected at one station in the impoundment area. Equipment filter wipes will consist of clean, ashless filter papers supplied by the analytical laboratory. Equipment filter wipes will be collected at a frequency of one for every 20 field samples processed for each type of nondedicated equipment in direct contact with the sediments being collected. One filter blank will be collected for each lot of filter wipes used during the field effort. Where available, SRMs for sediments will be submitted from the field at a frequency of once per sampling event.

Procedures for preparing field split samples, equipment wipes, and SRMs are presented in Section 2.3 of the FSP. Validation criteria and procedures for field QC samples are described in Sections 4.1 and 4.2 of this SAP.

### 2.5.2 Laboratory Quality Control

Extensive and detailed requirements for laboratory QC procedures are provided in the methods that will be used for this investigation (Table 17). QC requirements include control limits and requirements for corrective action in many cases. QC procedures will be completed by each laboratory, as required by each protocol and as indicated in this QAPP. Laboratory QC procedures are addressed for chemical and physical laboratories below.

The overall quality objective for this task is to develop and implement procedures that will ensure the collection of representative data of known and acceptable quality. The QA procedures and measurements that will be used for this project are based on USEPA guidance (USEPA 2002b, 2008b, 1986) and on established laboratory methods from other sources (APHA 1998; ASTM 2009).

Laboratory QC procedures for geotechnical testing are defined in the relevant ASTM standard for each test. Table 12 provides the ASTM standard methods that will be applied to each test. Further detail on laboratory QC procedures per ASTM can be found within the language of the standard. The geotechnical laboratory will follow general QC procedures for personnel qualifications, quality systems, equipment calibration, and records retention as described in ASTM D 3740.

#### 2.5.2.1 Chemistry Laboratory QA

The frequency of analysis for laboratory control samples, matrix spike samples, matrix spike duplicates or laboratory duplicates, and method blanks will be one for every 20 samples or one per extraction batch, whichever is more frequent. Surrogate spikes, labeled compounds, and internal standards will be added to every field sample and QC sample, as required. Calibration procedures will be completed at the frequency specified in each method description. Performance-based control limits have been established by each laboratory. These and all other control limits specified in the method descriptions will be used by the laboratories to establish the acceptability of the data or the need for reanalysis of the samples. Laboratory control limits for recoveries of surrogate compounds, matrix spikes, and laboratory control samples, and for relative percent difference (RPD) of matrix spike

duplicates and laboratory duplicates, are provided in each laboratory's QA manual (to be submitted under separate cover).

PARCC parameters (i.e., precision, accuracy or bias, representativeness, completeness, comparability) are commonly used to assess the quality of environmental data. Bias represents the degree to which a measured concentration conforms to the reference value. The results for matrix spikes, laboratory control samples, field blanks, and method blanks will be reviewed to evaluate bias of the data. The following calculation is used to determine percent recovery for a matrix spike sample:

$$\%R = [(M-U) / C] \times 100 \qquad (1\text{-}1)$$

where:

| | | |
|---|---|---|
| %R | = | percent recovery |
| M | = | measured concentration in the spiked sample |
| U | = | measured concentration in the unspiked sample |
| C | = | concentration of the added spike |

The following calculation is used to determine percent recovery for a laboratory control sample or reference material:

$$\%R = (M / C) \times 100 \qquad (1\text{-}2)$$

where:

| | | |
|---|---|---|
| %R | = | percent recovery |
| M | = | measured concentration in the spiked sample |
| U | = | measured concentration in the unspiked sample |
| C | = | concentration of the added spike |

Results for field and method blanks can reflect systematic bias that results from contamination of samples during collection or analysis. Any analytes detected in field or method blanks will be evaluated as potential indicators of bias.

Precision reflects the reproducibility between individual measurements of the same property. Precision will be evaluated using the results of matrix spike duplicates, laboratory duplicates, field splits, and field replicates. Precision is expressed in terms of the relative standard deviation for three or more measurements and the RPD for two measurements. The following equation is used to calculate the RPD between measurements:

$$RPD = |[(C1-C2) / ((C1 + C2) / 2)]| \text{ X } 100 \qquad (1\text{-}3)$$

where:

RPD = relative percent difference

C1 = first measurement

C2 = second measurement

The relative standard deviation is the ratio of the standard deviation of three or more measurements to the average of the measurements, expressed as a percentage.

Completeness will be calculated as the ratio of usable data (i.e., unqualified data and *U*- or *J*-qualified data) to generated data, expressed as a percentage. Completeness will be calculated for each suite of analytes for each sample type and sampling event.

Additional laboratory QC results will be evaluated to provide supplementary information regarding overall quality of the data, performance of instruments and measurement systems, and sample-specific matrix effects.

QC samples and procedures are specified in each method protocol that will be used for this project. Methods are summarized in Table 17. All QC requirements will be completed by each laboratory as described in the protocols, including the following (as applicable to each analysis):

- Instrument tuning
- Initial calibration

- Initial calibration verification
- Continuing calibration verification
- Calibration or instrument blanks
- Method blanks
- Laboratory control samples
- Internal standards
- Surrogate spikes/labeled compounds
- Matrix spikes
- Matrix spike duplicates or laboratory duplicates

To alert the data user to possible bias or imprecision, data qualifiers will be applied to reported analyte concentrations when associated QC samples or procedures do not meet control limits. Laboratory control limits for the methods that will be used for this Site investigation are provided in Table 17 and in the laboratory QA manuals (to be provided under separate cover). Data validation criteria and procedures are described in Section 4.

MRLs reflect the sensitivity of the analysis. Target MRLs for this study are summarized in Table 18 where possible. Some control limits cannot be specified until a laboratory has been selected.

MDLs will be determined by each laboratory for each analyte, as required by USEPA (2008a). MDLs are statistically derived and reflect the concentration at which an analyte can be detected in a clean matrix (e.g., sand or distilled water) with 99 percent confidence that a false positive result has not been reported. MRLs are established by the laboratories at levels above the MDLs for the project analytes. The MRL values are based on the laboratories' experience analyzing environmental samples and reflect the typical sensitivity obtained by the analytical system in environmental samples. For this task, the concentration of the lowest standard in the initial calibration curve for each analysis is at the level of the MRL. This allows reliable quantification of concentrations to the MRL in the absence of matrix interferences.

Dioxin and furan analyte concentrations for this task will be reported to the sample specific EDLs as described in USEPA Method 8290A (USEPA 2008b). Other analyte concentrations

will be reported to the MDL. Analytes detected at concentrations between the MRL and the EDL or MDL will be reported with a J qualifier to indicate that the value is an estimate (i.e., the analyte concentration is below the calibration range). Non-detects will be reported at the EDL for dioxins and furan congeners, and to the MRL for all other analyses. The MRLs, EDLs, and MDLs will be adjusted by each laboratory, as necessary, to reflect sample dilution, percent moisture, and/or matrix interference.

#### *2.5.2.2 Physical Properties Laboratory QA*

Duplicate specific gravity analyses and triplicate grain size analyses will be conducted on one of every 20 samples, or one per batch if less than 20 samples are analyzed. The precision of these replicate samples will be evaluated as described in Sections 2.5.2.1 and 4.1. No other QA procedures are applicable to the physical properties analyses.

#### *2.5.2.3 Representativeness and Comparability of All Data*

Representativeness and comparability are qualitative QA/QC parameters. Representativeness is the degree to which data represent a characteristic of an environmental condition. In the field, representativeness will be addressed primarily in the sampling design by the selection of sampling sites and sample collection procedures. In the laboratories, representativeness will be ensured by the proper handling and storage of samples and initiation of analysis within holding times.

Comparability is the qualitative similarity of one dataset to another (i.e., the extent to which different datasets can be combined for use). Comparability will be addressed through the use of field and laboratory methods that are consistent with methods and procedures recommended by USEPA and are commonly used for sediment studies.

## 2.6 Instrument and Equipment Testing, Inspection, and Maintenance

Analytical instrument testing, inspection, maintenance, setup, and calibration will be conducted by each laboratory in accordance with the requirements identified in the laboratory's SOPs and manufacturer instructions. In addition, each of the specified analytical methods provides protocols for proper instrument setup and tuning, and critical operating

parameters. Instrument maintenance and repair will be documented in the maintenance log or record book.

## 2.7 Inspection and Acceptance of Supplies and Consumables

The quality of supplies and consumables used during sample collection and laboratory analysis can affect the quality of the project data. All equipment that comes into contact with the samples and extracts must be sufficiently clean to prevent detectable contamination, and the analyte concentrations must be accurate in all standards used for calibration and QC purposes.

During sample collection, the quality of laboratory water used for decontamination will be documented at the laboratory that provides that water. Precleaned sample jars (with documentation) will be provided by the laboratories. All containers will be visually inspected prior to use, and any suspect containers will be discarded.

Reagents of appropriate purity and suitably cleaned laboratory equipment will also be used for all stages of laboratory analyses. Details for acceptance requirements for supplies and consumables at the laboratories are provided in the laboratory SOPs and QA manuals (to be submitted under separate cover). All supplies will be obtained from reputable suppliers with appropriate documentation or certification. Supplies will be inspected to confirm that they meet use requirements, and certification records will be retained by Integral (i.e., for supplies used in the field) or the laboratories.

Sampling for parameters required by Study Element 4 does not require any additional inspection and acceptance of supplies beyond what is described in this section.

## 2.8 Non-Direct Measurements

Existing chemical data from previous investigations will be used for this study. As discussed in the RI/FS Work Plan, historical data will be reviewed for QA and acceptability for use in the RI/FS.

## 2.9 Data Management

During field, laboratory, and data evaluation operations, effective data management is critical to providing consistent, accurate, and defensible data and data products. Data management systems and procedures will be used to establish and maintain an efficient organization of the environmental information collected. Procedures and standards for conducting specific data management tasks (i.e., creation, acquisition, handling, storage, and distribution of data) will be documented in a project data management manual. Essential elements of data management and reporting activities associated with the sediment sampling program are discussed in the following sections.

Project data will be maintained in a relational database designed to accommodate all the types of environmental measurements that will be made during this RI/FS, as described in the data management plan, which is included as Appendix B of the RI/FS Work Plan. On-line access to the database will be provided to members of the project team and regulatory oversight bodies through a browser-based interface that provides information on the status and contents of the project database, and that allows users to create custom data tables and maps.

### *2.9.1 Field Data*

Daily field records (a combination of field logbooks, field forms, global positioning system [GPS] records, and COC forms) will make up the main documentation for field activities. Detailed guidelines for entry of information during field sampling are provided in the FSP, which is included as Appendix A to this SAP. Upon completion of sampling, hardcopy notes and forms will be scanned to create an electronic record for use in creating the draft PSCR. Information on sampling locations, dates, depths, equipment, and other conditions, and sample identifiers, will be entered into the project database. One hundred percent of hand-entered data will be verified based on hard copy records. Electronic QA checks to identify anomalous values will also be conducted following entry.

### *2.9.2 Laboratory Data*

The analytical laboratories will each submit data in both electronic and hard-copy format. The project database administrator or his designated data manager will provide the desired

format for EDDs to the laboratories, and the project data manager and laboratory coordinator will discuss these specifications with laboratory QA managers prior to data delivery and tailor them as necessary to specific laboratory capabilities. QA checks of format and consistency will be applied to EDDs received from the laboratory. After any issues have been resolved, the data will be loaded into the project database. Each dataset loaded will be linked to the electronic document of the relevant laboratory data package. Data summaries will be produced from the database for use by data validators. Validators will return edited versions of these summaries, and the edits will then be incorporated into the database. An automated change log will be maintained by the database so that the history of all such edits is maintained, and the provenance of each data value can be determined.

# 3 ASSESSMENT AND OVERSIGHT

This task will rely on the knowledge and expertise of the SJRWP technical team, as described in the RI/FS Work Plan. The field team and laboratories will stay in close verbal contact with the task manager and task QA coordinator during all phases of this task. This level of communication will serve to keep the management team informed about activities and events, and will allow for informal but continuous task oversight.

## 3.1 Assessment and Response Actions

Assessment activities will include readiness reviews by the field coordinator prior to sampling, by the database administrator prior to release of the final data to the data users, and internal review while work is in progress. An informal technical systems audit may be conducted if problems are encountered during any phase of this project.

The first readiness review will be conducted by the field lead prior to field sampling to verify that all field equipment is ready for transfer to the Site. The field lead will also verify that the field team and any subcontractors have been scheduled and briefed and that the contracts for the subcontractors have been signed by both parties. Any deficiencies noted during this readiness review will be corrected prior to initiation of sampling activities.

The second readiness review will be completed by the database administrator before final data are released for use to verify that all results have been received from each laboratory, data validation and data quality assessment have been completed for all of the data, and data qualifiers have been entered into the database and verified. Any deficiencies noted during this review will be corrected by the database administrator, the task QA coordinator, or their designee. Data will not be released for final use until all data have been verified and validated. No report will be prepared in conjunction with the readiness reviews. However, the SJRWP technical team coordinator and data users will be notified when the data are ready for use.

Technical review of intermediate and final work products generated for this task will be completed throughout the course of all sampling, laboratory, data validation, data management, and data interpretation activities to ensure that every phase of work is accurate

and complete and follows the QA procedures outlined in this QAPP. Any problems that are encountered will be resolved between the reviewer and the person completing the work. Any problems that cannot be easily resolved or that affect the final quality of the work product will be brought to the attention of the SJRWP technical team coordinator and SJRWP project coordinator.

Each laboratory will be required to have implemented a review system that serves as a formal surveillance mechanism for all laboratory activities. Details are provided in the laboratory QA plans (to be submitted under separate cover).

Technical system audits may be conducted if serious problems are encountered during sampling or analysis operations. If completed, these audits will be conducted by the task QA coordinator or designee, or by the laboratory, as appropriate. These audits may consist of on-site reviews of any phase of field or laboratory activities or data management. Results of any audits will be provided in the draft PSCR.

Any task team member who discovers or suspects a nonconformance is responsible for reporting the nonconformance to the task manager, the task QA coordinator, or the laboratory project or QA manager, as applicable. The task QA coordinator will ensure that no additional work dependent on the nonconforming activity is performed until a confirmed nonconformance is corrected. Any confirmed nonconformance issues will be relayed to the SJRWP technical team coordinator.

## 3.2 Reports to Management

The laboratories will keep the task laboratory coordinator informed of their progress on a weekly basis. The laboratories will provide the following information:

- Inventory and status of samples held at the laboratory in spreadsheet format by sample delivery group
- Summaries of any laboratory QC data outside of control limits and any corrective actions implemented
- Descriptions and justification for any significant changes in methodology or QA/QC procedures

The task laboratory coordinator will provide this information to the task QA coordinator, who will provide this information to the task manager.

Each laboratory will be required to have implemented routine systems of reporting nonconformance issues and their resolution. These procedures are described in the laboratory QA manuals (to be submitted under separate cover). Laboratory nonconformance issues will also be described in the draft PSCR if they affect the quality of the data.

Data packages and EDDs will be prepared by each laboratory upon completion of analyses for each sample delivery group. The case narrative will include a description of any problems encountered, control limit exceedances (if applicable), and a description and rationale for any deviations from protocol. Copies of corrective action reports generated at the laboratory will also be included with the data package.

Data validation reports will be prepared following receipt of the complete laboratory data packages for each sample delivery group. These reports will be provided to the task QA coordinator when validation is completed for each parameter. A summary of any significant data quality issues will be provided to USEPA with the data report.

# 4 DATA VALIDATION AND USABILITY

Data generated in the field and at the laboratories will be verified and validated according to criteria and procedures described in this section. Data quality and usability will be evaluated, and a discussion will be included in the data report.

## 4.1 Criteria for Data Review, Verification, and Validation

Field and laboratory data for this task will undergo a formal verification and validation process. All entries into the database will be verified. All errors found during the verification of field data, laboratory data, and the database will be corrected prior to release of the final data.

Data verification and validation for dioxins and furans, metals, and organic compounds will be completed in accordance with Guidance on Environmental Data Verification and Validation (USEPA 2002a) and according to methods described in USEPA's National Functional Guidelines for inorganic and organic data review (USEPA 2004a, 2005b, 2008a). Performance-based control limits established by the laboratories and control limits provided in the method protocols will be used to evaluate data quality and determine the need for data qualification. Performance-based control limits are established periodically by each laboratory. Current values will be provided in the laboratory QA plans (to be submitted under separate cover), as applicable.

No guidelines are available for validation of data for physical properties analyses and physical testing. These data will be validated using procedures described in the functional guidelines for inorganic data review (USEPA 2004a), as applicable, and their respective methods.

Results for field splits will be evaluated against a control limit of 50% RPD. Data will not be qualified as estimated if this control limit is exceeded, but RPD results will be tabulated, and any exceedances will be discussed in the draft PSCR. Equipment wipe blanks will be evaluated and data qualifiers will be applied in the same manner as method blanks, as described in the functional guidelines for data review (USEPA 2004a).

Data will be rejected if control limits for acceptance of data are not met, as described in USEPA (2004a, 2005b, 2008).

## 4.2 Verification and Validation Methods

Both the chemical and conventional analyses and the results of physical properties tests for Study Element 4 will undergo verification and validation, as described below.

### *4.2.1 Chemistry and Sediment Conventionals*

Field data will be verified during preparation of samples and COC forms. Field data and COC forms will be reviewed daily by the field lead. After field data are entered into the project database, 100 percent verification of the entries will be completed by a second party to ensure the accuracy and completeness of the database. Any discrepancies will be resolved before the final database is released for use.

Data verification and validation will be completed as described in Section 4.1 by either Integral or a data validation firm. The first data package generated for each analysis method will be fully validated, equivalent to a Stage 4 validation as described in USEPA (2009b). If no major problems are encountered during validation of this package, full validation will be completed at a rate of approximately 30 percent of the dioxin and furan samples and 10 percent of the samples analyzed for other parameters. Validation for the remaining data will be based on a review of the sample and QC data, equivalent to a Stage 2B validation. If problems are encountered, the laboratory will be contacted for resolution. Additional full validation will be completed if required to fully assess the quality of the data to verify that the laboratory errors have been addressed.

The accuracy and completion of the database will be verified at each laboratory when the EDDs are prepared and again as part of data validation. Ten percent of entries to the database from laboratory EDDs will be checked against hard-copy data packages. In addition to verification of field and laboratory data and information, data qualifier entries into the database will be verified. Any discrepancies will be resolved before the final database is released for use.

Reporting limits for non-detects will be compared to the MRL goals to evaluate method sensitivity for each sample. Any exceedance of actual MRLs over the target MRLs will be discussed in the data report.

### *4.2.2 Results of Physical Properties Tests*

Data verification and validation will be completed as described in Section 4.1 by either Integral or a data validation firm. The first data package generated for each analysis method will be validated to a level similar to a Stage 3 validation as described in USEPA (2009b), as applicable to the method. If no major problems are encountered during validation of this package, Stage 3 validation will be completed at a rate of approximately 10 percent of the samples analyzed. Validation for the remaining data will be based on a review of the sample and QC data, equivalent to a Stage 2A validation, as applicable to the method. If problems are encountered, the laboratory will be contacted for resolution. Additional Stage 3 validation will be completed if required to fully assess the quality of the data to verify that the laboratory errors have been addressed.

The accuracy and completion of the database will be verified at each laboratory when the EDDs are prepared and again as part of data validation. Ten percent of entries to the database from laboratory EDDs will be checked against hard-copy data packages. In addition to verification of field and laboratory data and information, data qualifier entries into the database will be verified. Any discrepancies will be resolved before the final database is released for use.

## 4.3 Reconciliation with User Requirements

Both the chemical and conventional analyses and the results of physical properties tests for Study Element 4 will undergo reconciliation with user requirements, as described below.

### *4.3.1 Chemistry and Sediment Conventionals*

The goal of data validation is to determine the quality of each data result and to identify those that do not meet the task measurement quality objectives. Nonconforming data may be qualified as estimated (i.e., a J qualifier will be applied to the result) or rejected as unusable (i.e., an R qualifier will be applied to the result) during data validation if criteria for

data quality are not met. Rejected data will not be used for any purpose. An explanation of the rejected data will be included in the draft PSCR.

Data qualified as estimated will be used for all intended purposes and will be appropriately qualified in the final project database. However, these data are less precise or less accurate than unqualified data. Data users, in cooperation with the SJRWP technical team coordinator and the task QA coordinator, are responsible for assessing the effect of the inaccuracy or imprecision of the qualified data on statistical procedures and other data uses.

### *4.3.2 Results of Physical Properties Tests*

Protocols for data validation from geotechnical testing are not established; specific validation procedures will not be used for Study Element 4 laboratory results.

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# TABLES

# FIGURES

# APPENDIX A
# FIELD SAMPLING PLAN

# TABLES

**Table 1**
**List of Datasets and Information Evaluated for the San Jacinto River Waste Pits Site**

| Source of Sediment Chemistry Data | Media Sampled | Sampling Dates | Chemicals Analyzed | Area Sampled | Reference |
|---|---|---|---|---|---|
| TCEQ Site Sampling | Sediment[a] | Aug. 20, 2009 | Dioxins/Furans | 4 sediment stations (5 samples, of which 1 was a field duplicate) and 3 surface water samples in Site, within and adjacent to impoundments | URS (2010) |
| Sneed Shipbuilding Sediment Sampling | Sediment | May and Nov. 2009 | Dioxins/Furans | 15 sediment samples collected from waterfront adjacent to Sneed Shipbuilding, downstream of Site | Orion (2009) |
| Texas Department of Transportation Dolphin Project | Sediment | May to June 2006 | Dioxins/Furans, Metals, SVOCs, PCBs | 4 sediment cores and 8 surface sediment samples in San Jacinto River just upstream of Interstate Highway 10 | Weston (2006) |
| TCEQ Site Screening Investigation | Sediment | July 2005 | Dioxins/Furans, Metals, PAH, SVOCs, Pesticides, PCBs | 6 stations in the Impoundments (7 samples, of which 1 was a field duplicate), 3 stations downstream and within the Site, additional upstream and downstream background locations outside of the Site | TCEQ and USEPA (2006) |
| TCEQ TMDL Study | Sediment[a] | 2002 to 2005 | Dioxins/Furans | Sampling throughout the HSC; 1 station adjacent to the Site (11193) sampled for surface sediment multiple times (this is a monitoring station), and 1 core sample collected in 2004; 21 additional surface sediment samples on Site collected in August, 2005 | University of Houston and Parsons (2006) |
| HSC Toxicity Study | Sediment | Aug. and Oct. 1993; May 1994 | Dioxins/Furans | 35 Stations along the HSC and major tributaries; two stations are located in the Site, 1 in the channel adjacent to the impoundments and one upstream of waste pits | ENSR and EHA (1995) |
| TCEQ TMDL Study | Sediment | Apr. to July 2008 | PCBs | 70 stations along the HSC, in the San Jacinto River, and down to Galveston Bay. One sample was taken within the site downstream of the impoundment (11193) and one sample was taken upstream of the site (16622). | University of Houston and Parsons (2008) |
| TCEQ TMDL Study | Sediment | May to Aug. 2009 | PCBs | 35 stations along the HSC and in the San Jacinto River. One sample was taken within the site downstream of the impoundment (11193) and one sample was taken upstream of the site (16622). | Koenig (2010, Pers. Comm.) |

**Notes**

HSC = Houston Ship Channel
PAH - polycyclic aromatic hydrocarbon
PCB = polychlorinated biphenyl
SVOC = semivolatile organic compound
TCEQ = Texas Commission on Environmental Quality
TMDL = total maximum daily load
a - Tissue and/or surface water were also collected by this program. Those data are addressed in the RI/FS Work Plan.

**Table 2**
**Numbers of Surface Sediment and Core Sampling Locations at the Site by Study**

| Study | Number of Locations[a] | |
|---|---|---|
| | Surface | Core |
| ENSR and EHA (1995) | 1 | 0 |
| TCEQ and USEPA (2006) | 9 | 0 |
| URS (2010) | 4 | 0 |
| University of Houston and Parsons (2006) | 24 | 1 |
| Weston (2006) | 8 | 4 |
| University of Houston and Parsons (2008) | 1 | 0 |
| Koenig (2010, Pers. Comm.) | 1 | 0 |

**Notes**

a - The number of locations may differ from the number of samples if a location was sampled more than once.

## Table 3
## Number of Sediment Sampling Locations at the Site by Study and Analyte

| Study | Number of Locations Sampled | | | | | |
|---|---|---|---|---|---|---|
| | Dioxins and Furans | Metals | PCBs | Pesticides | PAH | SVOCs |
| ENSR and EHA (1995) | 1 | | | | | |
| TCEQ and USEPA (2006) | 9 | 9 | 9 | 9 | 9 | 9 |
| URS (2010) | 4 | | | | | |
| University of Houston and Parsons (2006)[a] | 24 | | | | | |
| Weston (2006)[b] | 12 | 12 | 12 | | 12 | 12 |
| University of Houston and Parsons (2008) | | | 2 | | | |
| Koenig (2010, Pers. Comm.) | | | 2 | | | |

**Notes**

PAH = polycyclic aromatic hydrocarbon
PCB = polychlorinated biphenyl
SVOC = semivolatile organic compound
TMDL = total maximum daily load
a - At one of these stations (11193), a core was also collected.
b - Eight of these samples are surface sediments; four are cores co-located with four of the surface sediments. Cores were analyzed at multiple depth increments.

**Table 4**
**Priority Pollutant List**

| TAL Metals, Polychlorinated Biphenyls, and Semivolatile Organic Compounds | Group | CAS RN | CLP Pesticides and Volatile Organic Compounds | Group | CAS RN |
|---|---|---|---|---|---|
| 2,3,7,8-TCDD | Dioxins/Furans | 1746-01-6 | alpha-Chlordane[a] | Pesticide | 5103-71-9 |
| Aluminum | Metals | 7429-90-5 | gamma-Chlordane[a] | Pesticide | 5103-74-2 |
| Antimony | Metals | 7440-36-0 | Endrin ketone[b] | Pesticide | 53494-70-5 |
| Arsenic | Metals | 7440-38-2 | Methoxychlor[b] | Pesticide | 72-43-5 |
| Barium | Metals | 7440-39-3 | 4,4'-DDD[b] | Pesticides | 72-54-8 |
| Beryllium[b] | Metals | 7440-41-7 | 4,4'-DDE[b] | Pesticides | 72-55-9 |
| Cadmium | Metals | 7440-43-9 | 4,4'-DDT[b] | Pesticides | 50-29-3 |
| Chromium | Metals | 7440-47-3 | Aldrin[b] | Pesticides | 309-00-2 |
| Cobalt | Metals | 7440-48-4 | alpha-BHC[b] | Pesticides | 319-84-6 |
| Copper | Metals | 7440-50-8 | Endosulfan I[b] | Pesticides | 959-98-8 |
| Iron[b] | Metals | 7439-89-6 | beta-BHC[a] | Pesticides | 319-85-7 |
| Lead | Metals | 7439-92-1 | Endosulfan II[b] | Pesticides | 33213-65-9 |
| Magnesium | Metals | 7439-95-4 | Chlordane[b] | Pesticides | 57-74-9 |
| Manganese | Metals | 7439-96-5 | delta-BHC[b] | Pesticides | 319-86-8 |
| Mercury | Metals | 7439-97-6 | Dieldrin[b] | Pesticides | 60-57-1 |
| Nickel | Metals | 7440-02-0 | Endosulfan sulfate[b] | Pesticides | 1031-07-8 |
| Potassium[c] | Metals | '7440-09-7 | Endrin[b] | Pesticides | 72-20-8 |
| Selenium[b] | Metals | 7782-49-2 | Endrin aldehyde[b] | Pesticides | 7421-93-4 |
| Sodium[c] | Metals | 7440-23-5 | gamma-BHC (Lindane)[b] | Pesticides | 58-89-9 |
| Silver | Metals | 7440-22-4 | Heptachlor[b] | Pesticides | 76-44-8 |
| Thallium | Metals | 7440-28-0 | Heptachlor epoxide[b] | Pesticides | 1024-57-3 |
| Vanadium | Metals | 7440-62-2 | Toxaphene[b] | Pesticides | 8001-35-2 |
| Zinc | Metals | 7440-66-6 | 1,2,4-Trichlorobenzene | VOC | 120-82-1 |
| Polychlorinated Biphenyls | PCBs | various | 1,2-Dichlorobenzene | VOC | 95-50-1 |
| Acenaphthene | SVOC | 83-32-9 | 1,3-Dichlorobenzene | VOC | 541-73-1 |
| Acenaphthylene[b] | SVOC | 208-96-8 | 1,4-Dichlorobenzene | VOC | 106-46-7 |
| Anthracene[b] | SVOC | 120-12-7 | 1,1,1-Trichloroethane | VOC | 71-55-6 |
| Benzo(a)anthracene[b] | SVOC | 56-55-3 | 1,1,2,2-Tetrachloroethane | VOC | 79-34-5 |
| Benzo(a)pyrene[b] | SVOC | 50-32-8 | 1,1,2-Trichloroethane [a] | VOC | 79-00-5 |
| Benzo(b)fluoranthene[b] | SVOC | 205-99-2 | 1,1-Dichloroethane [a] | VOC | 75-34-3 |

**Table 4**
**Priority Pollutant List**

| TAL Metals, Polychlorinated Biphenyls, and Semivolatile Organic Compounds | Group | CAS RN | CLP Pesticides and Volatile Organic Compounds | Group | CAS RN |
|---|---|---|---|---|---|
| Benzo(g,h,i)perylene[b] | SVOC | 191-24-2 | 1,1-Dichloroethene [a] | VOC | 75-35-4 |
| Benzo(k)fluoranthene[b] | SVOC | 207-08-9 | 1,2-Dichloroethane | VOC | 107-06-2 |
| Chrysene[b] | SVOC | 218-01-9 | 1,2-Dichloropropane | VOC | 78-87-5 |
| Dibenzo(a,h)anthracene[a] | SVOC | 53-70-3 | trans-1,2-Dichloroethene [a] | VOC | 156-60-5 |
| Fluoranthene[b] | SVOC | 206-44-0 | 1,2-dichloropropylene[a] | VOC | 542-75-6 |
| Fluorene | SVOC | 86-73-7 | 2-chloroethyl vinyl ethers[a] | VOC | 110-75-8 |
| Indeno(1,2,3-cd)pyrene[b] | SVOC | 193-39-5 | Acrolein[a] | VOC | 107-02-8 |
| Naphthalene | SVOC | 91-20-3 | Acrylonitrile[a] | VOC | 107-13-1 |
| Phenanthrene | SVOC | 85-01-8 | Benzene | VOC | 71-43-2 |
| Pyrene[b] | SVOC | 129-00-0 | Bromoform[a] | VOC | 75-25-2 |
| 2,4,6-Trichlorophenol | SVOC | 88-06-2 | Carbon tetrachloride | VOC | 56-23-5 |
| 2,4-Dichlorophenol | SVOC | 120-83-2 | Chlorobenzene | VOC | 108-90-7 |
| 2,4-Dimethylphenol[b] | SVOC | 105-67-9 | Chlorodibromomethane | VOC | 124-48-1 |
| 2,4-Dinitrophenol[b] | SVOC | 51-28-5 | Chloroethane[a] | VOC | 75-00-3 |
| 2-Chlorophenol | SVOC | 95-57-8 | Chloroform | VOC | 67-66-3 |
| 2-Nitrophenol[b] | SVOC | 88-75-5 | Ethylbenzene | VOC | 100-41-4 |
| 4-Nitrophenol[b] | SVOC | 100-02-7 | Bromomethane [a] | VOC | 74-83-9 |
| Pentachlorophenol | SVOC | 87-86-5 | Chloromethane [a] | VOC | 74-87-3 |
| Phenol | SVOC | 108-95-2 | Methylene chloride [a] | VOC | 75-09-2 |
| Bis(2-ethylhexyl)phthalate | SVOC | 117-81-7 | Tetrachloroethene | VOC | 127-18-4 |
| Butylbenzylphthalate[b] | SVOC | 85-68-7 | Toluene | VOC | 108-88-3 |
| Diethylphthalate[b] | SVOC | 84-66-2 | Trichloroethene | VOC | 79-01-6 |
| Dimethylphthalate[b] | SVOC | 131-11-3 | Vinyl chloride [a] | VOC | 75-01-4 |
| Di-n-butylphthalate[b] | SVOC | 84-74-2 | Styrene [a] | VOC | 100-42-5 |
| Di-n-octylphthalate[b] | SVOC | 117-84-0 | cis-1,3-Dichloropropene[a] | VOC | 10061-01-5 |
| 1,2-diphenylhydrazine[b] | SVOC | 122-66-7 | trans-1,3-dichloropropene [a] | VOC | 10061-02-6 |
| 2,4-Dinitrotoluene[b] | SVOC | 121-14-2 | 1,2-Dibromoethane [a] | VOC | 106-93-4 |
| 2,6-Dinitrotoluene[b] | SVOC | 606-20-2 | 4-Methyl-2-pentanone [a] | VOC | 108-10-1 |
| 2-Chloronaphthalene[b] | SVOC | 91-58-7 | Methylcyclohexane[a] | VOC | 108-87-2 |
| 3,3'-Dichlorobenzidine[b] | SVOC | 91-94-1 | Cyclohexane [a] | VOC | 110-82-7 |

**Table 4**
**Priority Pollutant List**

| TAL Metals, Polychlorinated Biphenyls, and Semivolatile Organic Compounds | Group | CAS RN | CLP Pesticides and Volatile Organic Compounds | Group | CAS RN |
|---|---|---|---|---|---|
| 4,6-Dinitro-2-methylphenol[b] | SVOC | 534-52-1 | 1,4-Dioxane [a] | VOC | 123-91-1 |
| 4-Bromophenyl-phenylether[b] | SVOC | 101-55-3 | cis-1,2-Dichloroethene [a] | VOC | 156-59-2 |
| 4-Chlorophenyl-phenyl ether[b] | SVOC | 7005-72-3 | Methyl tert-butyl ether [a] | VOC | 1634-04-4 |
| Benzidine[b] | SVOC | 92-87-5 | m,p-Xylene[a] | VOC | 179601-23-1 |
| Bis(2-chloroethoxy) methane[b] | SVOC | 111-91-1 | 2-Hexanone [a] | VOC | 591-78-6 |
| Bis(2-chloroethyl)ether[b] | SVOC | 111-44-4 | Acetone [a] | VOC | 67-64-1 |
| Bis(2-chloroisopropyl) ether[b] | SVOC | 39638-32-9 | Bromochloromethane [a] | VOC | 74-97-5 |
| Hexachlorobenzene | SVOC | 118-74-1 | Carbon disulfide [a] | VOC | 75-15-0 |
| Hexachlorobutadiene[b] | SVOC | 87-68-3 | Trichlorofluoromethane [a] | VOC | 75-69-4 |
| Hexachlorocyclo-pentadiene[b] | SVOC | 77-47-4 | Dichlorodifluoromethane [a] | VOC | 75-71-8 |
| Hexachloroethane[b] | SVOC | 67-72-1 | 1,1,2-Trichloro-1,2,2-trifluoroethane [a] | VOC | 76-13-1 |
| Isophorone[b] | SVOC | 78-59-1 | 2-Butanone [a] | VOC | 78-93-3 |
| Nitrobenzene[b] | SVOC | 98-95-3 | Methyl acetate [a] | VOC | 79-20-9 |
| N-nitrosodimethylamine[b] | SVOC | 62-75-9 | 1,2,3-Trichlorobenzene | VOC | 87-61-6 |
| N-Nitroso-di-n propylamine[b] | SVOC | 621-64-7 | o-Xylene [a] | VOC | 95-47-6 |
| N-Nitrosodiphenylamine[b] | SVOC | 86-30-6 | 1,2-Dibromo-3-chloropropane [a] | VOC | 96-12-8 |
| 4-Chloro-3-methylphenol[b] | SVOC | 59-50-7 | Isopropylbenzene [a] | VOC | 98-82-8 |
| 4-Nitroaniline[b] | SVOC | 100-01-6 | Cyanide, Total[a] | Conventionals | 57-12-5 |
| Benzaldehyde[b] | SVOC | 100-52-7 | | | |
| Caprolactam[b] | SVOC | 105-60-2 | | | |
| 4-Methylphenol | SVOC | 106-44-5 | | | |
| 4-Chloroaniline[b] | SVOC | 106-47-8 | | | |
| 2,2'-Oxybis(1-chloropropane)[b] | SVOC | 108-60-1 | | | |
| Dibenzofuran[b] | SVOC | 132-64-9 | | | |
| Atrazine[a] | SVOC | 1912-24-9 | | | |
| 2,3,4,6-Tetrachlorophenol | SVOC | 58-90-2 | | | |
| Carbazole | SVOC | 86-74-8 | | | |
| 2-Nitroaniline[b] | SVOC | 88-74-4 | | | |
| 2-Methylnaphthalene[b] | SVOC | 91-57-6 | | | |
| 1,1'-Biphenyl[b] | SVOC | 92-52-4 | | | |

**Table 4**
**Priority Pollutant List**

| TAL Metals, Polychlorinated Biphenyls, and Semivolatile Organic Compounds | Group | CAS RN | CLP Pesticides and Volatile Organic Compounds | Group | CAS RN |
|---|---|---|---|---|---|
| 2-Methylphenol | SVOC | 95-48-7 | | | |
| 1,2,4,5-Tetrachlorobenzene | SVOC | 95-94-3 | | | |
| 2,4,5-Trichlorophenol | SVOC | 95-95-4 | | | |
| Acetophenone[b] | SVOC | 98-86-2 | | | |
| 3-Nitroaniline[b] | SVOC | 99-09-2 | | | |

**Notes**

CLP = Contract Laboratory Program
COI = contaminant of interest
SVOC = semivolatile organic compound
TAL = target analyte list
VOC = volatile organic compound
a - Chemical is not associated with pulp mill waste and Site sediments were never analyzed for this chemical, so it is not moved forward as a COI.
b - Chemical is not associated with pulp mill waste and was never detected in Site sediments, so is not moved forward for evaluation as a COI.
c - Chemical is an essential nutrient and is not moved forward for evaluation as a COI.

**Table 5**
**Chemicals of Interest**

| Class | Chemical |
|---|---|
| **Dioxins/Furans** | |
| | Dioxins and Furans |
| **Metals** | |
| | Aluminum |
| | Antimony |
| | Arsenic |
| | Barium |
| | Cadmium |
| | Chromium |
| | Cobalt |
| | Copper |
| | Lead |
| | Magnesium |
| | Manganese |
| | Mercury |
| | Nickel |
| | Silver |
| | Thallium |
| | Vanadium |
| | Zinc |
| **Polychlorinated Biphenyls** | |
| | Polychlorinated Biphenyls |
| **Semivolatile Organic Compounds** | |
| | Acenaphthene |
| | Fluorene |
| | Naphthalene |
| | Phenanthrene |
| | 2,4,6-Trichlorophenol |
| | 2,4-Dichlorophenol |
| | Pentachlorophenol |
| | Phenol |
| | Hexachlorobenzene |
| | 2,3,4,6-Tetrachlorophenol |
| | Carbazole |
| | 2,4,5-Trichlorophenol |
| | Bis(2-ethylhexyl)phthalate |
| **Volatile Organic Compounds** | |
| | Chloroform |
| | 1,2,4-Trichlorobenzene |
| | 1,2-Dichlorobenzene |
| | 1,3-Dichlorobenzene |
| | 1,4-Dichlorobenzene |
| | 1,2,3-Trichlorobenzene |

**Table 6**
**Chemicals Potentially Associated with Bleached Pulp Mill Waste**

| TAL Metals, CLP Chemicals and CWA PPL | Generally in Bleached Pulp Mill Waste (Wiegand 2010) | Effluents (Suntio et al. 1998) | Solid Wastes (NCASI 1999) | Leachates (NCASI 1992) | Summary: Chemicals Potentially Associated with Bleached Pulp Mill Waste |
|---|---|---|---|---|---|
| **Dioxins/Furans** | | | | | |
| Dioxins and Furans | X | X | X | | X |
| **Metals** | | | | | |
| Aluminum | | | X | X | X |
| Antimony | | | | | |
| Arsenic | | | X | X | X |
| Barium | | | X | X | X |
| Cadmium | | | X | | X |
| Chromium | | | X | | X |
| Cobalt | | | X | | X |
| Copper | | | X | X | X |
| Lead | | | X | X | X |
| Magnesium | | | X | X | X |
| Manganese | | | X | X | X |
| Mercury | X | | X | X | X |
| Nickel | | | X | | X |
| Silver | | | | | |
| Thallium | | | | X | X |
| Vanadium | | | | | |
| Zinc | | | X | X | X |
| **Polychlorinated Biphenyls (PCBs)** | | | | | |
| Polychlorinated Biphenyls | | | X | | X |
| **Semivolatile Organic Compounds (SVOCs)** | | | | | |
| Acenaphthene | | | X | | X |
| Fluorene | | | X | | X |
| Naphthalene | | | X | | X |
| Phenanthrene | | | X | | X |
| 2,4,6-Trichlorophenol | X | X | X | X | X |
| 2,4-Dichlorophenol | X | X | X | | X |
| 2-Chlorophenol | X | X | | X | X |
| Pentachlorophenol | X | X | | X | X |
| Phenol | | | X | | X |
| Hexachlorobenzene | | X | | | X |

**Table 6**
**Chemicals Potentially Associated with Bleached Pulp Mill Waste**

| TAL Metals, CLP Chemicals and CWA PPL | Generally in Bleached Pulp Mill Waste (Wiegand 2010) | Effluents (Suntio et al. 1998) | Solid Wastes (NCASI 1999) | Leachates (NCASI 1992) | Summary: Chemicals Potentially Associated with Bleached Pulp Mill Waste |
|---|---|---|---|---|---|
| 4-Methylphenol | | | | X | X |
| 2,3,4,6-Tetrachlorophenol | X | X | | X | X |
| Carbazole | | | X | | X |
| 2-Methylphenol | | | | X | X |
| 2,4,5-Trichlorophenol | X | X | X | X | X |
| Bis(2-ethylhexyl)phthalate | | | | X | X |
| 1,2,4,5-Tetrachlorobenzene | | X | | | X |
| **Volatile Organic Compounds (VOCs)** | | | | | |
| 1,2,4-Trichlorobenzene | | X | | | X |
| 1,2-Dichlorobenzene | | X | | | X |
| 1,3-Dichlorobenzene | | X | | | X |
| 1,4-Dichlorobenzene | | X | | | X |
| 1,1,1-Trichloroethane | | X | | | X |
| 1,1,2,2-Tetrachloroethane | | X | | | X |
| 1,2-Dichloroethane | | X | | | X |
| Benzene | | X | | | X |
| Carbon tetrachloride | | X | | | X |
| Chlorobenzene | | X | | | X |
| Chloroform | | X | X | | X |
| Ethylbenzene | | X | | | X |
| Tetrachloroethene | | X | | | X |
| Toluene | | X | X | X | X |
| Trichloroethene | | X | | | X |
| 1,2-Dichloropropane | | X | | | X |
| Chlorodibromomethane | | X | | | X |
| 1,2,3-Trichlorobenzene | | X | | | X |

**Notes**

See Table 4 for chemicals not associated with pulp mill waste and never analyzed or analzyed and never detected.

CLP = Contract Laboratory Program

COI = chemical of interest

CWA PPL = Clean Water Act priority pollutant list

TAL = target analyte list

**Table 7**
**Summary of Chemicals of Interest and Steps to Evaluate Detections, Persistence, and Potential Association with Bleached Pulp Mill Waste**

| TAL Metals, CLP Chemicals and CWA PPL | Association with Pulp Mill Waste | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Analyzed in Site Sediments (TCEQ and USEPA 2006) | Ever Detected in Site Sediments (TCEQ and USEPA 2006) | Common in Bleached Pulp Mill Waste (Wiegand 2010) | Effluents (Suntio et al. 1988) | Solid Wastes (NCASI 1999) | Leachates (NCASI 1992) | Chemicals Potentially Associated with Pulp Mill Waste[a] | Potentially Associated with Bleached Pulp Mill Waste and Expected to Persist in Sediment[b] | COI |
| **Dioxins and Furans** | X | X | X | X | X | | X | X | X |
| **Metals** | | | | | | | | | |
| Aluminum | X | X | | | X | X | X | NA | X |
| Antimony | X | X | | | | | | NA | X |
| Arsenic | X | X | | | X | X | X | NA | X |
| Barium | X | X | | | X | X | X | NA | X |
| Cadmium | X | X | | | X | | X | NA | X |
| Chromium | X | X | | | X | | X | NA | X |
| Cobalt | X | X | | | X | | X | NA | X |
| Copper | X | X | | | X | X | X | NA | X |
| Lead | X | X | | | X | X | X | NA | X |
| Magnesium | X | X | | | X | X | X | NA | X |
| Manganese | X | X | | | X | X | X | NA | X |
| Mercury | X | X | X | | X | X | X | NA | X |
| Nickel | X | X | | | X | | X | NA | X |
| Silver | X | X | | | | | | NA | X |
| Thallium | X | | | | | X | X | NA | X |
| Vanadium | X | X | | | | | | NA | X |
| Zinc | X | X | | | X | X | X | NA | X |
| **Polychlorinated Biphenyls (PCBs)** | X | | | | X | | X | X | X |
| **Semivolatile Organic Compounds (SVOCs)** | | | | | | | | | |
| Acenaphthene | X | | | | X | | X | X | X |
| Fluorene | X | | | | X | | X | X | X |
| Naphthalene | X | | | | X | | X | X | X |
| Phenanthrene | X | | | | X | | X | X | X |
| 2,4,6-Trichlorophenol | X | | X | X | X | X | X | X | X |
| 2,4-Dichlorophenol | X | | X | X | X | | X | X | X |
| 2-Chlorophenol | X | | X | X | X | | X | | |
| Pentachlorophenol | X | | X | X | | X | X | X | X |
| Phenol | X | | | | X | X | X | X | X |
| Hexachlorobenzene | X | | | X | | | X | X | X |
| 4-Methylphenol | X | | | | | X | X | | |
| 2,3,4,6-Tetrachlorophenol | | | X | X | | X | X | X | X |
| Carbazole | | | | | X | | X | X | X |
| 2-Methylphenol | X | | | | | X | X | | |
| 2,4,5-Trichlorophenol | X | | X | X | X | X | X | X | X |

**Table 7**
**Summary of Chemicals of Interest and Steps to Evaluate Detections, Persistence, and Potential Association with Bleached Pulp Mill Waste**

| TAL Metals, CLP Chemicals and CWA PPL | Association with Pulp Mill Waste | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Analyzed in Site Sediments (TCEQ and USEPA 2006) | Ever Detected in Site Sediments (TCEQ and USEPA 2006) | Common in Bleached Pulp Mill Waste (Wiegand 2010) | Effluents (Suntio et al. 1988) | Solid Wastes (NCASI 1999) | Leachates (NCASI 1992) | Chemicals Potentially Associated with Pulp Mill Waste[a] | Potentially Associated with Bleached Pulp Mill Waste and Expected to Persist in Sediment[b] | COI |
| Bis(2-ethylhexyl)phthalate | X | X | | | | X | X | X | X |
| 1,2,4,5-Tetrachlorobenzene | X | | | X | | | X | | |
| **Volatile Organic Compounds (VOCs)** | | | | | | | | | |
| 1,2,4-Trichlorobenzene | | | | X | | | X | X | X |
| 1,2-Dichlorobenzene | | | | X | | | X | X | X |
| 1,3-Dichlorobenzene | | | | X | | | X | X | X |
| 1,4-Dichlorobenzene | | | | X | | | X | X | X |
| 1,1,1-Trichloroethane | | | | X | | | X | | |
| 1,1,2,2-Tetrachloroethane | | | | X | | | X | | |
| 1,2-Dichloroethane | | | | X | | | X | | |
| Benzene | | | | X | | | X | | |
| Carbon tetrachloride | | | | X | | | X | | |
| Chlorobenzene | | | | X | | | X | | |
| Chloroform | | | | X | X | | X | X | X |
| Ethylbenzene | | | | X | | | X | | |
| Tetrachloroethene | | | | X | | | X | | |
| Toluene | | | | X | X | X | X | | |
| Trichloroethene | | | | X | | | X | | |
| 1,2-Dichloropropane | | | | X | | | X | | |
| Chlorodibromomethane | | | | X | | | X | | |
| 1,2,3-Trichlorobenzene | | | | X | | | X | X | X |

**Notes**

See Table 4 for chemicals not associated with pulp mill waste and never analyzed or analzyed and never detected.
CLP = Contract Laboratory Program
COI = chemical of interest
CWA PPL = Clean Water Act priority pollutant list
Koc = partition coefficient of a chemical in the organic matter of soil/sediment
NA = not applicable
TAL = target analyte list
a - See Table 6
b - Persistence based on evaluation provided in NIH (2010): Chemicals were classified as "persistent" if the Koc value indicated that the chemical was likely to adsorb to suspended solid and sediment. Chemicals were classified as "not persistent" if the Koc value indicated that the chemical may adsorb or was not likely to adsorb to suspended solid and sediment. No additional metrics were used to determine persistence because half-life durations for volatilization from water or biodegradation were very short in comparison to the 44 years that have elapsed since the chemicals were deposited in the impoundment.

## Table 8
## Summary of Primary and Secondary COPCs

| Chemical of Interest | Baseline Human Health Risk Assessment | | Baseline Ecological Risk Assessment | | | |
|---|---|---|---|---|---|---|
| | | | Benthic Invertebrates | | Fish and Wildlife | |
| | Primary COPC | Secondary COPC | Primary COPC | Secondary COPC | Primary COPC | Secondary COPC |
| **Dioxins/Furans** | | | | | | |
| Dioxins and Furans | X | | | | X | |
| **Metals** | | | | | | |
| Aluminum | | | X | | | |
| Antimony | | | | | | |
| Arsenic | X | | | | | |
| Barium | | | X | | | |
| Cadmium | X | | | | X | |
| Chromium | X | | | | | |
| Cobalt | | | X | | | |
| Copper | X | | X | | X | |
| Lead | | | X | | | |
| Magnesium | | | X | | | |
| Manganese | | | X | | | |
| Mercury | X | | X | | X | |
| Nickel | X | | | | X | |
| Silver | | | | | | |
| Thallium | | | | X | | |
| Vanadium | | | X | | | |
| Zinc | X | | X | | X | |
| **Polychlorinated Biphenyls** | | | | | | |
| Polychlorinated Biphenyls | | X | | | | X |
| **Semivolatile Organic Compounds** | | | | | | |
| Acenaphthene | | | | X | | |
| Fluorene | | | | X | | |
| Naphthalene | | | | X | | |
| Phenanthrene | | | | X | | |
| 2,4,6-Trichlorophenol | | | | X | | |
| 2,4-Dichlorophenol | | | | X | | |

## Table 8
## Summary of Primary and Secondary COPCs

| Chemical of Interest | Baseline Human Health Risk Assessment | | Baseline Ecological Risk Assessment | | | |
|---|---|---|---|---|---|---|
| | | | Benthic Invertebrates | | Fish and Wildlife | |
| | Primary COPC | Secondary COPC | Primary COPC | Secondary COPC | Primary COPC | Secondary COPC |
| Pentachlorophenol | | X | | X | | X |
| Phenol | | | | X | | |
| Hexachlorobenzene | | X | | X | | X |
| 2,3,4,6-Tetrachlorophenol | | X | | X | | |
| Carbazole | | | | X | | |
| 2,4,5-Trichlorophenol | | | | X | | |
| Bis(2-ethylhexyl)phthalate | X | | X | | X | |
| **Volatile Organic Compounds** | | | | | | |
| 1,2,4-Trichlorobenzene | | X | | X | | |
| 1,2-Dichlorobenzene | | X | | X | | |
| 1,3-Dichlorobenzene | | X | | X | | |
| 1,4-Dichlorobenzene | | X | | X | | |
| Chloroform | | X | | X | | |
| 1,2,3-Trichlorobenzene | | X | | X | | |

**Notes**

COPC = chemical of potential concern

**Table 9**
**COPC Screening for Human Health**

| | Highest Site Concentration[a] | Frequency of Detection of Site Samples | USEPA Region 3 Soil PRG[b] | $^{Tot}Sed_{Comb}$ [c] | Does maximum site value exceed PRG or $^{Tot}Sed_{Comb}$? | Is chemical potentially bioaccumulative from sediment? | Is Chemical Detected at Least Once in Site Sediments? | Maintain as COPC for Human Health? | Revised Reason for COPC Decision, Excluding Background Consideration |
|---|---|---|---|---|---|---|---|---|---|
| **Metals (mg/kg)** | | | | | | | | | |
| Aluminum | 22,100 | 7/7 | 77,000 | 150,000 | No | No | Yes | No | Does not exceed SLV and is not potentially bioaccumulative |
| Antimony | 7.2 *U* | 1/7 | 31 | 83 | No | No | Yes | No | Does not exceed SLV and is not potentially bioaccumulative |
| Arsenic | 3 | 4/7 | 0.39 | 110 | Yes | No | Yes | Primary | Exceeds SLV, detected at least once in Site sediments |
| Barium | 244 | 7/7 | 15,000 | 23,000 | No | No | Yes | No | Does not exceed SLV and is not potentially bioaccumulative |
| Cadmium | 0.7 *U* | 4/7 | 70 | 1,100 | No | Yes | Yes | Primary | Potentially bioaccumulative, detected at least once in Site sediments |
| Chromium | 22.1 | 7/7 | 0.29/120,000 | 140/36,000 (VI / III) | Yes | No | Yes | Primary | Exceeds SLV, detected at least once in Site sediments |
| Cobalt | 6.8 *J* | 7/7 | 23 | 32,000 | No | No | Yes | No | Does not exceed SLV and is not potentially bioaccumulative |
| Copper | 62.5 | 7/7 | 3,100 | 21,000 | No | Yes | Yes | Primary | Potentially bioaccumulative, detected at least once in Site |
| Lead | 59.3 | 7/7 | 400 | 500 | No | No | Yes | No | Does not exceed SLV and is not potentially bioaccumulative |
| Magnesium | 4790 | 7/7 | NV | NV | NV | No | Yes | No | No SLV, not potentially bioaccumulative |
| Manganese | 790 | 7/7 | 1,800 | 14,000 | No | No | Yes | No | Does not exceed SLV and is not potentially bioaccumulative |
| Mercury | 1.7 | 7/7 | 24 | 34 | No | Yes | Yes | Primary | Potentially bioaccumulative, detected at least once in Site sediments |
| Nickel | 14 | 7/7 | 1,600 | 1,400 | No | Yes | Yes | Primary | Potentially bioaccumulative, detected at least once in Site sediments |
| Silver | 1.4 *U* | 2/7 | 390 | 350 | No | No | Yes | No | Does not exceed SLV and is not potentially bioaccumulative |
| Thallium | 3.5 *U* | 0/7 | NV | 43 | No | No | No | No | No SLV, never detected in Site Sediments |

**Table 9**
**COPC Screening for Human Health**

| | Highest Site Concentration[a] | Frequency of Detection of Site Samples | USEPA Region 3 Soil PRG[b] | $^{Tot}Sed_{Comb}$ [c] | Does maximum site value exceed PRG or $^{Tot}Sed_{Comb}$? | Is chemical potentially bioaccumulative from sediment? | Is Chemical Detected at Least Once in Site Sediments? | Maintain as COPC for Human Health? | Revised Reason for COPC Decision, Excluding Background Consideration |
|---|---|---|---|---|---|---|---|---|---|
| Vanadium | 34.4 | 7/7 | 390 | 330 | No | No | Yes | No | Does not exceed SLV and is not potentially bioaccumulative |
| Zinc | 244 | 7/7 | 24,000 | 76,000 | No | Yes | Yes | Primary | Potentially bioaccumulative, detected at least once in Site sediments |
| **Polychlorinated Biphenyls (µg/kg)** | | | | | | | | | |
| Total PCBs | 90 *U* | 0/7 | 220 | 2,300 | No | Yes | No | Secondary | Potentially bioaccumulative, never detected in Site sediments |
| **Dioxins/Furans (ng/kg)** | | | | | | | | | |
| 2,3,7,8-TCDD TEQ | 24,000 | 7/7 | 4.5 | 1,000 | Yes | Yes | Yes | Primary | Exceeds PRG, detected at least once in Site sediments |
| **Semivolatile Organic Compounds (µg/kg)** | | | | | | | | | |
| Acenaphthene | 455 *U* | 0/7 | 3,400,000 | 7,400,000 | No | No | No | No | Does not exceed SLV and is not potentially bioaccumulative |
| Fluorene | 455 *U* | 0/7 | 2,300,000 | 4,900,000 | No | No | No | No | Does not exceed SLV and is not potentially bioaccumulative |
| Naphthalene | 455 *U* | 0/7 | 3600 | 2,500,000 | No | No | No | No | Does not exceed SLV and is not potentially bioaccumulative |
| Phenanthrene | 455 *U* | 0/7 | NV | 3,700,000 | No | No | No | No | Does not exceed SLV and is not potentially bioaccumulative |
| 2,4,6-Trichlorophenol | 455 *U* | 0/7 | 44,000 | 1,300,000 | No | No | No | No | Does not exceed SLV and is not potentially bioaccumulative |
| 2,4-Dichlorophenol | 455 *U* | 0/7 | 180,000 | 460,000 | No | No | No | No | Does not exceed SLV and is not potentially bioaccumulative |
| Pentachlorophenol | 1,150 *U* | 0/7 | 3,000 | 56,000 | No | Yes | No | Secondary | No SLV; potentially bioaccumulative, never |
| Phenol | 455 *U* | 0/7 | 18,000,000 | 46,000,000 | No | No | No | No | Does not exceed SLV and is not potentially bioaccumulative |
| Hexachlorobenzene | 455 *U* | 0/7 | 300 | 8,900 | Yes | Yes | No | Secondary | Exceeds SLV and has potential to bioaccumulate |
| 2,3,4,6-Tetrachlorophenol | NV | NV | 1,800,000 | 4,600,000 | NV | No | NV | Secondary | No information available on which to base evaluation |
| Carbazole | 455 *U* | 0/7 | NV | 710,000 | No | No | No | No | No SLV, not potentially bioaccumulative |

**Table 9**
**COPC Screening for Human Health**

| | Highest Site Concentration[a] | Frequency of Detection of Site Samples | USEPA Region 3 Soil PRG[b] | $^{Tot}Sed_{Comb}$ [c] | Does maximum site value exceed PRG or $^{Tot}Sed_{Comb}$? | Is chemical potentially bioaccumulative from sediment? | Is Chemical Detected at Least Once in Site Sediments? | Maintain as COPC for Human Health? | Revised Reason for COPC Decision, Excluding Background Consideration |
|---|---|---|---|---|---|---|---|---|---|
| 2,4,5-Trichlorophenol | 1,150 *U* | 0/7 | 6,100,000 | 15,000,000 | No | No | No | No | Does not exceed SLV and is not potentially bioaccumulative |
| Bis(2-ethylhexyl)phthalate | 1800 | 3/7 | 35,000 | 240,000 | No | Yes | Yes | Primary | Potentially bioaccumulative, detected at least once in Site sediments |
| **Volatile Organic Compounds (µg/kg)** | | | | | | | | | |
| Chloroform | NV | not analyzed | 290 | 7,300,000 | NV | No | NV | Secondary | No information available on which to base evaluation |
| 1,2,4-Trichlorobenzene | NV | not analyzed | 22,000 | 1,500,000 | NV | No | NV | Secondary | No information available on which to base evaluation |
| 1,2-Dichlorobenzene | NV | not analyzed | 1,900,000 | 66,000,000 | NV | No | NV | Secondary | No information available on which to base evaluation |
| 1,3-Dichlorobenzene | NV | not analyzed | NV | 22,000,000 | NV | No | NV | Secondary | No information available on which to base evaluation |
| 1,4-Dichlorobenzene | NV | not analyzed | 2400 | 2,300,000 | NV | No | NV | Secondary | No information available on which to base evaluation |
| 1,2,3-Trichlorobenzene | NV | not analyzed | 49,000 | 460,000 | NV | No | NV | Secondary | No information available on which to base evaluation |

**Notes**

COPC = chemical of potential concern
NV = no value available
PCB = polychlorinated biphenyl
PCL = protective concentration level
PRG = preliminary remediation goal
SLV = screening level value
TCDD = tetrachlorodibenzo-*p* -dioxin
TEQ = toxicity equivalent
*J* = estimated
*U* = analyte not detected
a - Nondetects are provided at 1/2 the detection limit.
b - PRGs are from http://www.epa.gov/reg3hwmd/risk/human/index.htm.
c - TotSedComb values are from TCEQ (2006a) Tier 1 Sediment PCLs.

**Table 10**
**COPC Screening for Benthic Macroinvertebrate Community**

| Chemical | NOEC [a] | Highest Site Concentration (TCEQ and USEPA 2006)[b] | Frequency of Detection of Site Samples | Does Maximum Site Sample Exceed NOEC? | Maintain as COPC for Benthic Invertebrates? | Reason for COPC Decision |
|---|---|---|---|---|---|---|
| **Metals (mg/kg)** | | | | | | |
| Aluminum | NV | 22,100 | 7/7 | NSLV | Yes | No SLV, detected at least once in Site sediments |
| Antimony | NV | 7.2 *U* | 1/7 | NSLV | No | No SLV; however, there is only a single detection in Site data and this is not a chemical expected to be associated with pulp mill waste |
| Arsenic | 8.2 | 3 | 4/7 | No | No | Maximum site concentration does not exceed SLV |
| Barium | NV | 244 | 7/7 | NSLV | Yes | No SLV, detected at least once in Site sediments |
| Cadmium | 1.2 | 0.7 *U* | 4/7 | No | No | Maximum site concentration does not exceed SLV |
| Chromium | 81 | 22.1 | 7/7 | No | No | Maximum site concentration does not exceed SLV |
| Cobalt | NV | 6.8 *J* | 7/7 | NSLV | Yes | No SLV, detected at least once in Site sediments |
| Copper | 34 | 62.5 | 7/7 | Yes | Yes | Maximum site concentration exceeds SLV |
| Lead | 46.7 | 59.3 | 7/7 | No | Yes | Maximum site concentration exceeds SLV |
| Magnesium | NV | 4,790 | 7/7 | NSLV | Yes | No screening value, detected at least once in Site sediments |
| Manganese | NV | 790 | 7/7 | NSLV | Yes | No screening value, detected at least once in Site sediments |
| Mercury | 0.15 | 1.7 | 7/7 | Yes | Yes | Maximum site concentration exceeds SLV |
| Nickel | 20.9 | 14 | 7/7 | No | No | Maximum site concentration does not exceed SLV |
| Silver | 1 | 1.4 *U* | 2/7 | Yes | No | Highest concentration is close to SLV. High percentage of non-detects. Highest detected concentration is 0.29, below SLV |
| Thallium | NV | 3.5 *U* | 0/7 | NSLV | Yes (secondary) | No SLV, no detected concentrations in Site sediments |
| Vanadium | NV | 34.4 | 7/7 | NSLV | Yes | No SLV, detected at least once in Site sediments |
| Zinc | 150 | 244 | 7/7 | Yes | Yes | Maximum site concentration exceeds SLV |
| **Dioxins/Furans (ng/kg)** | | | | | | |
| 2,3,7,8-TCDD | 25,000[c] | 18,500 | 7/7 | No | No | Maximum site value does not exceed SLV |
| **Polychlorinated Biphenyls (µg/kg)** | | | | | | |
| Total PCBs | 1,200[d] | 90 *U* [e] | 0/7 | N/A | No | Highest detection limit does not exceed screening value |
| **Semivolatile Organic Compounds (µg/kg)** | | | | | | |
| Acenaphthene | 16 | 455 *U* | 0/7 | Yes | Yes (secondary) | No SLV, no detected concentrations in Site sediments |
| Fluorene | 19 | 455 *U* | 0/7 | Yes | Yes (secondary) | No SLV, no detected concentrations in Site sediments |
| Naphthalene | 160 | 455 *U* | 0/7 | Yes | Yes (secondary) | No SLV, no detected concentrations in Site sediments |
| Phenanthrene | 240 | 455 *U* | 0/7 | Yes | Yes (secondary) | No SLV, no detected concentrations in Site sediments |

**Table 10**
**COPC Screening for Benthic Macroinvertebrate Community**

| Chemical | NOEC [a] | Highest Site Concentration (TCEQ and USEPA 2006)[b] | Frequency of Detection of Site Samples | Does Maximum Site Sample Exceed NOEC? | Maintain as COPC for Benthic Invertebrates? | Reason for COPC Decision |
|---|---|---|---|---|---|---|
| 2,4,6-Trichlorophenol | NV | 455 *U* | 0/7 | NSLV | Yes (secondary) | No SLV, no detected concentrations in Site sediments |
| 2,4-Dichlorophenol | NV | 455 *U* | 0/7 | NSLV | Yes (secondary) | No SLV, no detected concentrations in Site sediments |
| Pentachlorophenol | NV | 1,150 *U* | 0/7 | NSLV | Yes (secondary) | No SLV, no detected concentrations in Site sediments |
| Phenol | NV | 455 *U* | 0/7 | NSLV | Yes (secondary) | No SLV, no detected concentrations in Site sediments |
| Hexachlorobenzene | NV | 455 *U* | 0/7 | NSLV | Yes (secondary) | No SLV, no detected concentrations in Site sediments |
| 2,3,4,6-Tetrachlorophenol | NV | NV | NV | NA | Yes (secondary) | No information available on which to base evaluation |
| Carbazole | NV | 455 *U* | 0/7 | NSLV | Yes (secondary) | No SLV, no detected concentrations |
| 2,4,5-Trichlorophenol | NV | 1,150 *U* | 0/7 | NSLV | Yes (secondary) | No SLV, no detected concentrations |
| Bis(2-ethylhexyl)phthalate | 182 | 1800 | 3/7 | Yes | Yes | Maximum site concentration exceeds SLV |
| **Volatile Organic Compounds (µg/kg)** | | | | | | |
| Chloroform | 4,300[f] | NV | NV | NA | Yes (secondary) | No information available on which to base evaluation |
| 1,2,4-Trichlorobenzene | 390 | NV | NV | NA | Yes (secondary) | No information available on which to base evaluation |
| 1,2-Dichlorobenzene | 740 | NV | NV | NA | Yes (secondary) | No information available on which to base evaluation |
| 1,3-Dichlorobenzene | 320 | NV | NV | NA | Yes (secondary) | No information available on which to base evaluation |
| 1,4-Dichlorobenzene | 700 | NV | NV | NA | Yes (secondary) | No information available on which to base evaluation |
| 1,2,3-Trichlorobenzene | NV | NV | NV | NA | Yes (secondary) | No information available on which to base evaluation |

**Notes**

DL = detection limit
EqP = equilibrium partitioning
OC = organic carbon
NA = not applicable
NOEC = no-observed-effect concentration
NV = no value
NSLV = no screening level value available
PCB = polychlorinated biphenyl
SLV = screening level value
*J* = estimated
*U* = analyte not detected

a - NOEC is from TCEQ (2006b) and is based on Long et al. (1995) unless otherwise indicated. Units of screening value match those of sediment data as given in compound class header (e.g., metals in mg/kg).
b - Nondetects are provided at 1/2 the detection limit.
c - Barber et al. (1998)
d - Fuchsman et al. (2006). Lowest unbounded NOEC (growth) for a PCB mixture of 81 mg/kg OC (*Macoma nasuta* ). Using EqP and conservative estimate of organic carbon of 1.5 percent (Louchouarn and Brinkmeyer 2009), the dry weight equivalent of this value is 1.2 mg/kg.
e - No PCBs were detected; this value is the highest reporting limit in the data set for PCBs.
f - Table 3-3 in TCEQ (2006b).

**Table 11**
**COPC Screening for Fish and Wildlife**

| Chemical | Highest Site Concentration (TCEQ and USEPA 2006)[a] | Frequency of Detection of Site Samples | Log Kow of Chemical (Organics Only)[b] | Is Chemical Potentially Bioaccumulative from Sediment?[c] | Maintain as COPC for Fish and Wildlife | Reason for COPC Decision |
|---|---|---|---|---|---|---|
| **Metals (mg/kg)** | | | | | | |
| Aluminum | 22,100 | 7/7 | NA | No | No | Not potentially bioaccumulative |
| Antimony | 7.2 *U* | 1/7 | NA | No | No | Not potentially bioaccumulative |
| Arsenic | 3 | 7/7 | NA | No | No | Not potentially bioaccumulative |
| Barium | 244 | 7/7 | NA | No | No | Not potentially bioaccumulative |
| Cadmium | 0.7 *U* | 4/7 | NA | Yes | Yes | Potentially bioaccumulative, |
| Chromium | 22.1 | 7/7 | NA | No | No | Not potentially bioaccumulative |
| Cobalt | 6.8 *J* | 7/7 | NA | No | No | Not potentially bioaccumulative |
| Copper | 62.5 | 7/7 | NA | Yes | Yes | Potentially bioaccumulative, detected at least once in Site sediments |
| Lead | 59.3 | 7/7 | NA | No | No | Not potentially bioaccumulative |
| Magnesium | 4,790 | 7/7 | NA | No | No | Not potentially bioaccumulative |
| Manganese | 790 | 7/7 | NA | No | No | Not potentially bioaccumulative |
| Mercury | 1.7 | 7/7 | NA | Yes | Yes | Potentially bioaccumulative, detected at least once in Site sediments |
| Nickel | 14 | 7/7 | NA | Yes | Yes | Potentially bioaccumulative, detected at least once in Site sediments |

**Table 11**
**COPC Screening for Fish and Wildlife**

| Chemical | Highest Site Concentration (TCEQ and USEPA 2006)[a] | Frequency of Detection of Site Samples | Log Kow of Chemical (Organics Only)[b] | Is Chemical Potentially Bioaccumulative from Sediment?[c] | Maintain as COPC for Fish and Wildlife | Reason for COPC Decision |
|---|---|---|---|---|---|---|
| Silver | 1.4 *U* | 2/7 | NA | No | No | Not potentially bioaccumulative |
| Thallium | 3.5 *U* | 0/7 | NA | No | No | Not potentially bioaccumulative |
| Vanadium | 34.4 | 7/7 | NA | No | No | Not potentially bioaccumulative |
| Zinc | 244 | 7/7 | NA | Yes | Yes | Potentially bioaccumulative, detected at least once in Site sediments |
| **Dioxins/Furans (ng/kg)** | | | | | | |
| TEQ birds at ND=1/2DL | 62,200 | NA | >5 | Yes | Yes | Potentially bioaccumulative, detected at least once in Site sediments |
| TEQ fish at ND=1/2DL | 22,300 | NA | >5 | Yes | Yes | Potentially bioaccumulative, detected at least once in Site sediments |
| TEQ mammals at ND=1/2 DL | 24,000 | NA | >5 | Yes | Yes | Potentially bioaccumulative, detected at least once in Site sediments |
| **Polychlorinated Biphenyls (µg/kg)** | | | | | | |
| Total PCBs | 90 *U*[d] | 0/7 | >5 | Yes | Yes (secondary) | Potentially bioaccumulative, no detected concentrations in Site sediments |
| **Semivolatile Organic Compounds (µg/kg)** | | | | | | |
| Acenaphthene | 455 *U* | 0/7 | 3.92 | No[e] | No | Not potentially bioaccumulative |

**Table 11**
**COPC Screening for Fish and Wildlife**

| Chemical | Highest Site Concentration (TCEQ and USEPA 2006)[a] | Frequency of Detection of Site Samples | Log Kow of Chemical (Organics Only)[b] | Is Chemical Potentially Bioaccumulative from Sediment?[c] | Maintain as COPC for Fish and Wildlife | Reason for COPC Decision |
|---|---|---|---|---|---|---|
| Fluorene | 455 *U* | 0/7 | 4.18 | No[e] | No | Not potentially bioaccumulative |
| Naphthalene | 455 *U* | 0/7 | 3.3 | No[e] | No | Not potentially bioaccumulative |
| Phenanthrene | 455 *U* | 0/7 | 4.57 | No[e] | No | Not potentially bioaccumulative |
| 2,4,6-Trichlorophenol | 455 *U* | 0/7 | 3.72 | No[e] | No | Not potentially bioaccumulative |
| 2,4-Dichlorophenol | 455 *U* | 0/7 | 3.06 | No[e] | No | Not potentially bioaccumulative |
| Pentachlorophenol | 1,150 *U* | 0/7 | 5.12 | Yes | Yes (secondary) | Potentially bioaccumulative, no detected concentrations in Site sediments |
| Phenol | 455 *U* | 0/7 | 1.46 | No[f] | No | Not potentially bioaccumulative |
| Hexachlorobenzene | 455 *U* | 0/7 | 5.73 | Yes | Yes (secondary) | Potentially bioaccumulative, no detected concentrations in Site sediments |
| 2,3,4,6-Tetrachlorophenol | NV | NV | 4.45 | No[e] | No | Not potentially bioaccumulative |
| Carbazole | 455 *U* | 0/7 | 3.72 | No[e] | No | Not potentially bioaccumulative |
| 2,4,5-Trichlorophenol | 1,150 *U* | 0/7 | 3.69 | No[e] | No | Not potentially bioaccumulative |
| Bis(2-ethylhexyl)phthalate | 1800 | 3/7 | 7.6 | Yes | Yes | Potentially bioaccumulative, detected in Site sediments |

**Table 11**
**COPC Screening for Fish and Wildlife**

| Chemical | Highest Site Concentration (TCEQ and USEPA 2006)[a] | Frequency of Detection of Site Samples | Log Kow of Chemical (Organics Only)[b] | Is Chemical Potentially Bioaccumulative from Sediment?[c] | Maintain as COPC for Fish and Wildlife | Reason for COPC Decision |
|---|---|---|---|---|---|---|
| **Volatile Organic Compounds (µg/kg)** | | | | | | |
| Chloroform | NV | NV | 1.97 | No[e] | No | Not potentially bioaccumulative |
| 1,2,4-Trichlorobenzene | NV | NV | 4.02 | No[e] | No | Not potentially bioaccumulative |
| 1,2-Dichlorobenzene | NV | NV | 3.43 | No[e] | No | Not potentially bioaccumulative |
| 1,3-Dichlorobenzene | NV | NV | 3.53 | No[e] | No | Not potentially bioaccumulative |
| 1,4-Dichlorobenzene | NV | NV | 3.44 | No[e] | No | Not potentially bioaccumulative |
| 1,2,3-Trichlorobenzene | NV | NV | 4.05 | No[e] | No | Not potentially bioaccumulative |

**Notes**

COPC = chemical of potential concern
NA = not applicable
NV = no value
PCB = polychlorinated biphenyl
TCEQ = Texas Commission on Environmental Quality
TEQ = toxicity equivalent
*J* = estimated
*U* = analyte not detected
a - Undetected values are set to 1/2 the detection limit.
b - Log Kow: Octanol-water partition coefficient, the ratio of the concentration of a chemical in octanol and water at equilibrium and at a specified temperature. Octanol is an organic solvent that is used as a surrogate for natural organic matter (e.g., lipids). Values obtained from the Hazardous Substances Data Bank (http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB) or Oak Ridge National Laboratory Risk Assessment Information System (http://rais.ornl.gov/cgi-bin/tox/TOX_select?select=chem)
c - Determination of bioaccumulative potential is based on TCEQ guidance (TCEQ 2006b) or, if chemical is not addressed in guidance, log Kow information is used to determine bioaccumulative potential (as indicated in footnote e), with those chemicals having log Kow>5 being considered potentially bioaccumulative (USEPA 2008).
d - No PCBs were detected; this value is the highest reporting limit in the dataset for PCBs.
e - Not provided in TCEQ guidance; log Kow used to determine potential for bioaccumulation as described in footnote b.

**Table 12**
**Physical Testing Data Relevant to Dredging, Materials Handling, and/or Potential Confined Disposal Facility Design**

| | Engineering Evaluations Testing | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Standard Penetration Test (ASTM D-1586) | Thin-Walled Tube Collection (ASTM D-1587) | Vane Shear Test (ASTM D-2573) | Atterberg Limits (ASTM D-4318) | Grain Size (ASTM D-422 & D-1140) | Specific Gravity (ASTM D-854) | Moisture Content (ASMT D-2216) | Visual Description (ASMT D-2488) | Permeability (ASTM D-5084) | Consolidated Undrained Triaxial Compressive Strength (ASTM D-4767) | Consolidation Test (ASTM D-2435) |
| **Dredging and Handling** | | | | | | | | | | | |
| Hydraulic Dredging and Materials Handling | -- | -- | -- | X | X | X | X | X | -- | -- | -- |
| **CDF and Berm Design** | | | | | | | | | | | |
| Soil Classification | X | X | -- | X | X | X | X | X | X | -- | -- |
| Soil Strength | X | X | X | -- | -- | -- | -- | -- | -- | X | -- |
| Soil Compressibility | -- | X | -- | -- | -- | -- | -- | -- | -- | -- | X |

**Notes**

-- = not applicable

CDF = confined disposal facility

**Table 13**
**Number of Locations Sampled[a]**

| Sample Group | Sampling Method and Depth | Number of Locations | Sample Locations | Analytes | Study Elements |
|---|---|---|---|---|---|
| Site surface sediment, primary COPCs | Grab sampler, surface 10 cm (0-4 inches) | 44 | 152-m (500-foot) grid within 305 to 457 m (1,000 to 1,500 feet) of the impoundments and property west of the impoundments, 305-m (1,000-foot) grid elsewhere[b] | Primary COPCs, organic carbon, grain size, and solids. Sediment for analysis of secondary COPCs will be archived. | Nature and extent, ecological exposure, fate and transport |
| Impoundment characterization sample | Grab sampler, surface 10 cm (0-4 inches) | 7 | Within the impoundment area | 3 stations for primary and secondary COPCs, organic carbon, grain size, and solids; 4 stations for primary COPCs, organic carbon, grain size, and solids. Sediment for analysis of secondary COPCs will be archived at these 4 stations. | Nature and extent, characterization of waste materials |
| Site surface sediment, all COPCs | Grab sampler, surface 10 cm (0-4 inches) | 14 | Selected locations on a 152-m (500-foot) grid within approximately 305 m (1,000 feet) of the impoundments (coincident with core locations) | Primary and secondary COPCs, organic carbon, grain size, solids, and specific gravity. | Nature and extent, ecological exposure, fate and transport |
| Site subsurface sediment | Cores to refusal or maximum depth of 3 m (10 feet), sectioned at 30-cm (1-foot) intervals | 14 | Selected locations on a 152-m (500-foot) grid within approximately 305 m (1,000 feet) of the impoundments | Primary COPCs, organic carbon, grain size, and solids. Sediment for analysis of secondary COPCs will be archived. (Atterberg limits and specific gravity at all core locations). | Nature and extent, dredging assessment |
| Shoreline sediment for human health risk assessment | Surface 0-15 cm (0-6 inches) and subsurface 15-30 cm (6-12 inches) | 45 | 10 per beach on four beaches; 5 on one beach downstream of Site | 5 surface sediment samples from each of the exposure areas on the five beaches and the corresponding subsurface sediment samples from the eastern shoreline of the property west of the impoundments will be analyzed initially for primary COPCs. Any remaining surface samples from each area, 5 subsurface samples from the eastern shoreline of the property west of the impoundments, and all subsurface samples from the other exposure areas will be archived. | Exposure for human health risk assessment, support ecological risk assessment |
| Shoreline sediment for ecological risk assessment | Grab sampler, surface 10 cm (0-4 inches) | 6 | 3 in each of two locations to represent ecological exposures | Primary COPCs, organic carbon, grain size, and solids. Sediment for analysis of secondary COPCs will be archived. | Exposure for ecological risk assessment |
| Upstream background surface samples | Grab sampler, surface 10 cm (0-4 inches) | 11 | Upstream in San Jacinto River on four transverse transects | Primary and secondary COPCs, organic carbon, grain size, solids, and specific gravity. | Nature and extent, ecological exposure, fate and transport |
| Upstream shoreline sediment for human health risk assessment | Surface 1-15 cm (0-6 inches) and subsurface 15-30 cm (6-12 inches) | 10 | 10 per beach on one beach | Primary COPCs, organic carbon, grain size, and solids on 5 surface samples. Remainder of surface samples and all of the subsurface samples will be archived. | Exposure for human health and ecological risk assessments |
| Upstream shoreline sediment for ecological risk assessment | Grab sampler, surface 10 cm (0-4 inches) | 3 | 3 on one beach to represent ecological exposures | Primary COPCs, organic carbon, grain size, solids, and specific gravity. Sediment for analysis of secondary COPCs will be archived. | Exposure for ecological risk assessment |
| Soil borings in the impoundment and berm | Various depths depending on location | 17 | In areas of berm reconstruction and in the impoundment area. | Atterberg limits, grain size, moisture content, specific gravity, sediment compressibility, sediment permeability, consolidated undrained triaxial compressive strength. Primary and secondary COPCs in 8 select locations from within the former impoundment | Remedial design and potential CDF evaluation |
| Vane shear tests in the impoundment and berm | Surface | 18 | In areas of berm reconstruction and in the impoundment area | Undrained shear strength | Remedial design and potential CDF evaluation |
| Sediment surface grabs associated with vane shear tests | Grab sampler, surface 10 cm (0-4 inches) | 18 | In areas of berm reconstruction and in the impoundment area | Atterberg limits, specific gravity, grain size, moisture content | Remedial design and potential CDF evaluation |

**Notes**
CDF = confined disposal facility
COPC = chemical of potential concern
a - Numbers do not include field quality control samples, and cores, which generate more than one "sample," are counted only once.
b - With some distance adjustments at three stations south of I-10 to place stations within the river rather than on land.

**Table 14**
**Geotechnical Borings with Sample Specifications**

| Sample ID | Depth Interval[a] (feet) | SPT-N | Moisture Content | Grain Size[b] | Atterberg Limits [b] | Specific Gravity[b] | Permeability[b,c] | CuTriax[b,c] | Consolidation[b,c] | Primary and Secondary COPCs |
|---|---|---|---|---|---|---|---|---|---|---|
| **Locations SJGB003 and SJGB007: 120-foot deep boring (in-water geotech location)** | | | | | | | | | | |
| S1 | 0 - 1.5 | X | X | -- | -- | -- | -- | -- | -- | -- |
| S2 | 2.5 - 4.0 | X | X | X | -- | -- | -- | -- | -- | -- |
| S3 | 5.0 - 7.0 | -- | X | -- | X | -- | -- | X | X | -- |
| S4 | 7.5 - 9.0 | X | X | -- | -- | -- | -- | -- | -- | -- |
| S5 | 10.0 - 11.5 | X | X | -- | X | X | -- | -- | -- | -- |
| S6 | 15.0 - 16.5 | X | X | X | -- | -- | -- | -- | -- | -- |
| S7 | 20.0 - 21.5 | X | X | -- | -- | -- | -- | -- | -- | -- |
| S8 | 25.0 - 26.5 | X | X | -- | X | -- | -- | -- | -- | -- |
| S9 | 30.0 - 31.5 | X | X | X | -- | -- | -- | -- | -- | -- |
| S10 | 35.0 - 36.5 | X | X | -- | -- | -- | -- | -- | -- | -- |
| S11 | 40.0 - 42.0 | -- | X | -- | X | -- | -- | -- | X | -- |
| S12 | 45.0 - 46.5 | X | X | X | -- | -- | -- | -- | -- | -- |
| S13 | 50.0 - 51.5 | X | X | -- | -- | -- | -- | -- | -- | -- |
| S14 | 55.0 - 56.5 | X | X | -- | X | X | -- | -- | -- | -- |
| S15 | 60.0 - 61.5 | X | X | X | -- | -- | -- | -- | -- | -- |
| S16 | 65.0 - 66.5 | X | X | -- | X | -- | -- | -- | -- | -- |
| S17 | 70.0 - 71.5 | X | X | -- | X | X | -- | -- | -- | -- |
| S18 | 75.0 - 76.5 | X | X | X | -- | -- | -- | -- | -- | -- |
| S19 | 80.0 - 81.5 | X | X | -- | -- | -- | -- | -- | -- | -- |
| S20 | 85.0 - 86.5 | X | X | -- | X | -- | -- | -- | -- | -- |
| S21 | 90.0 - 91.5 | X | X | X | -- | -- | -- | -- | -- | -- |
| S22 | 95.0 - 96.5 | X | X | -- | -- | -- | -- | -- | -- | -- |
| S23 | 100.0 - 101.5 | X | X | -- | X | -- | -- | -- | -- | -- |
| S24 | 105.0 - 106.5 | X | X | X | -- | -- | -- | -- | -- | -- |
| S25 | 110.0 - 111.5 | X | X | -- | -- | -- | -- | -- | -- | -- |
| S26 | 115.0 - 116.5 | X | X | -- | X | X | -- | -- | -- | -- |
| S27 | 120.0 - 121.5 | X | X | X | -- | -- | -- | -- | -- | -- |
| **Locations SJGB001, SJGB002, SJGB004, SJGB005, and SJGB008: 60-foot deep boring (in-water/on-land geotech location)** | | | | | | | | | | |
| S1 | 0 - 1.5 | X | X | -- | -- | -- | -- | -- | -- | -- |
| S2 | 2.5 - 4.0 | X | X | X | -- | -- | -- | -- | -- | -- |
| S3 | 5.0 - 7.0 | -- | X | -- | X | -- | -- | X | X | -- |
| S4 | 7.5 - 9.0 | X | X | -- | -- | -- | -- | -- | -- | -- |
| S5 | 10.0 - 11.5 | X | X | -- | X | X | -- | -- | -- | -- |
| S6 | 15.0 - 16.5 | X | X | X | -- | -- | -- | -- | -- | -- |
| S7 | 20.0 - 21.5 | X | X | -- | -- | -- | -- | -- | -- | -- |
| S8 | 25.0 - 26.5 | X | X | -- | X | -- | -- | -- | -- | -- |
| S9 | 30.0 - 31.5 | X | X | X | -- | -- | -- | -- | -- | -- |
| S10 | 35.0 - 36.5 | X | X | -- | -- | -- | -- | -- | -- | -- |
| S11 | 40.0 - 41.5 | -- | X | -- | X | -- | -- | -- | X | -- |
| S12 | 45.0 - 46.5 | X | X | X | -- | -- | -- | -- | -- | -- |
| S13 | 50.0 - 51.5 | X | X | -- | -- | -- | -- | -- | -- | -- |
| S14 | 55.0 - 56.5 | X | X | -- | X | X | -- | -- | -- | -- |
| S15 | 60.0 - 61.5 | X | X | X | -- | -- | -- | -- | -- | -- |
| **Locations SJGB006 and SJGB009: 30-foot deep boring (former impoundment geotech location)** | | | | | | | | | | |
| S1 | 0 - 1.5 | X | X | -- | -- | -- | -- | -- | -- | -- |
| S2 | 2.5 - 4.0 | -- | X | X | X | -- | X | -- | -- | -- |
| S3 | 5.0 - 7.0 | -- | X | -- | -- | -- | -- | X | X | -- |
| S4 | 7.5 - 9.0 | -- | X | -- | X | -- | X | -- | -- | -- |
| S5 | 10.0 - 11.5 | X | X | -- | X | X | -- | -- | -- | -- |
| S6 | 15.0 - 16.5 | X | X | X | -- | -- | -- | -- | -- | -- |
| S7 | 20.0 - 21.5 | X | X | -- | -- | -- | -- | -- | -- | -- |
| S8 | 25.0 - 26.5 | X | X | -- | X | -- | -- | -- | -- | -- |
| S9 | 30.0 - 31.5 | X | X | X | -- | -- | -- | -- | -- | -- |

**Table 14**
**Geotechnical Borings with Sample Specifications**

| Sample ID | Depth Interval[a] (feet) | SPT-N | Moisture Content | Grain Size[b] | Atterberg Limits [b] | Specific Gravity[b] | Permeability[b,c] | CuTriax[b,c] | Consolidation[b,c] | Primary and Secondary COPCs |
|---|---|---|---|---|---|---|---|---|---|---|
| **Locations SJGB010 through SJGB017[d]: 10 to 20-foot deep boring (former impoundment geotech location)** | | | | | | | | | | |
| S1 | 0 - 1.5 | X | X | -- | -- | -- | -- | -- | -- | X |
| S2 | 1.5 - 3.5 | -- | X | X | X | -- | X | -- | -- | X |
| S3 | 3.5 - 5.0 | X | X | -- | -- | -- | -- | -- | -- | X |
| S4 | 5.0 - 7.0 | -- | X | -- | X | -- | X | -- | -- | X |
| S5 | 7.0 - 8.5 | X | X | -- | X | X | -- | -- | -- | X |
| S6 | 8.5 - 10.0 | X | X | X | -- | -- | -- | -- | -- | X |
| S7 | 10.0 - 11.5 | X | X | X | -- | -- | -- | -- | -- | X |
| S8 | 15.0 - 16.5 | -- | X | X | -- | -- | X | -- | -- | -- |

**Notes**

-- = not applicable
COPC = chemical of potential concern
CuTriax = consolidated undrained triaxial test
SPT-N = standard penetration test blow counts
a - Depth interval will be set in the field depending on the starting depth of the auger. All depths relative to ground surface or mudline.
b - Actual physical testing depth interval will be determined in the field based on the geologic interpretation of conditions encountered.
c - Permeability, CuTriax and consolidation testing to be performed on undisturbed Shelby tubes collected from appropriate depth intervals in the field as determined by the field geologist.

d - Locations will be continuously sampled for primary and secondary COPCs until the bottom of the waste is encountered. Actual sample interval where this transition occurs will vary based on location. Field sample numbering and total boring depths will be adjusted in the field as appropriate to ensure the boring extends into native soils at least 5 feet. Final boring depth listed as 10- to 20-feet for planning purposes only and will be determined based on the actual depth of the waste at a particular boring location.

## Table 15
## Vane Shear Test and Co-located Surface Grab Sampling Design

| Station ID | NAD 83 [a] | | Sample Method | Sampling Depth (feet)[b,c] | Sample Method | Sampling Depth (feet)[d] | Physical Tests |
|---|---|---|---|---|---|---|---|
| | Easting | Northing | | | | | |
| SJVS001 | 3216837.673 | 13857733.34 | VST | 0-1, 1-2, 2-3 | Surface grab | 0-1 | GS, MC, AL, SG |
| SJVS002 | 3216931.835 | 13857814.21 | VST | 0-1, 1-2, 2-3 | Surface grab | 0-1 | GS, MC, AL, SG |
| SJVS003 | 3217162.082 | 13857931.76 | VST | 0-1, 1-2, 2-3 | Surface grab | 0-1 | GS, MC, AL, SG |
| SJVS004 | 3217143.091 | 13857809.41 | VST | 0-1, 1-2, 2-3 | Surface grab | 0-1 | GS, MC, AL, SG |
| SJVS005 | 3217285.139 | 13857780.73 | VST | 0-1, 1-2, 2-3 | Surface grab | 0-1 | GS, MC, AL, SG |
| SJVS006 | 3217412.468 | 13857746.27 | VST | 0-1, 1-2, 2-3 | Surface grab | 0-1 | GS, MC, AL, SG |
| SJVS007 | 3217149.067 | 13857642.97 | VST | 0-1, 1-2, 2-3 | Surface grab | 0-1 | GS, MC, AL, SG |
| SJVS008 | 3217301.584 | 13857610.84 | VST | 0-1, 1-2, 2-3 | Surface grab | 0-1 | GS, MC, AL, SG |
| SJVS009 | 3217435.436 | 13857574.02 | VST | 0-1, 1-2, 2-3 | Surface grab | 0-1 | GS, MC, AL, SG |
| SJVS010 | 3217148.268 | 13857524.67 | VST | 0-1, 1-2, 2-3 | Surface grab | 0-1 | GS, MC, AL, SG |
| SJVS011 | 3217298.499 | 13857472.71 | VST | 0-1, 1-2, 2-3 | Surface grab | 0-1 | GS, MC, AL, SG |
| SJVS012 | 3217499.901 | 13857450.02 | VST | 0-1, 1-2, 2-3 | Surface grab | 0-1 | GS, MC, AL, SG |
| SJVS013 | 3217131.134 | 13857386.74 | VST | 0-1, 1-2, 2-3 | Surface grab | 0-1 | GS, MC, AL, SG |
| SJVS014 | 3217407.129 | 13857359.48 | VST | 0-1, 1-2, 2-3 | Surface grab | 0-1 | GS, MC, AL, SG |
| SJVS015 | 3217297.722 | 13857311.23 | VST | 0-1, 1-2, 2-3 | Surface grab | 0-1 | GS, MC, AL, SG |
| SJVS016 | 3217211.824 | 13857242.94 | VST | 0-1, 1-2, 2-3 | Surface grab | 0-1 | GS, MC, AL, SG |
| SJVS017 | 3217420.45 | 13857242.94 | VST | 0-1, 1-2, 2-3 | Surface grab | 0-1 | GS, MC, AL, SG |
| SJVS018 | 3217325.676 | 13857120.58 | VST | 0-1, 1-2, 2-3 | Surface grab | 0-1 | GS, MC, AL, SG |

**Notes**

Sediment surface grabs will be co-located with VST locations to facilitate standardization of the field vane shear measurements.
AL = Atterberg limits
GS = grain size
MC = moisture content
SG = specific gravity
VST = vane shear test
a - U.S. State Plane NAD 83 FT - Texas South Central Zone
b - VST to be performed at the following depth intervals below mudline: 0-1, 1-2, and 2-3 ft.
c - Both peak and residual VST strength to be measured at each depth interval.
d - Sample depth refers to surface grabs, not to the VST depth.

**Table 16**
**Sample Containers, Preservation, and Holding Time Requirements**

| Matrix | Container [a] Type | Container [a] Size | Laboratory | Parameter | Preservation | Holding Time | Sample Size [b] |
|---|---|---|---|---|---|---|---|
| **Sediment** | | | | | | | |
| | WMG | 8 oz. | TBD | Percent moisture (EPA 160.3) | 4±2°C | 6 months | 10 g |
| | | | | TOC | 4±2°C | 28 days | 1 g |
| | | | | Metals | 4±2°C | 6 months | 10 g |
| | | | | Mercury | 4±2°C | 28 days | 5 g |
| | WMG | 16 oz. | TBD | Grain size | 4±2°C | 6 months | 100 g |
| | WMG | 8 oz. | TBD | Atterberg limits | 4±2°C | NA | 225 g |
| | | | | Percent moisture (ASTM D 2216) | 4±2°C | 6 months | 10 g |
| | | | | Specific gravity | 4±2°C | NA | |
| | WMG | 8 oz. | TBD | Dioxins/furans | 4±2°C/Deep frozen (-20°C) [c]/ -10°C [d] | 1 year/1 year [e] | 50 g |
| | WMG | 8 oz. | TBD | PCB congeners, dioxin-like | 4±2°C/Deep frozen (-20°C) [c]/ -10°C [d] | 1 year/1 year [e] | 50 g |
| | WMG | 8 oz. | TBD | SVOCs (BEHP only; BEHP & secondary COPCs where analyzed) | 4±2°C | 14 days/40 days [e] | 50 g |
| | WMG | 8 oz. | TBD | SVOCs (archive for possible analysis of secondary COPCs) [f] | 4±2°C / Deep frozen (-20°C) [c] | 1 year [g] | 50 g |
| | WMG | 8 oz. | TBD | PCB Aroclors | 4±2°C / 4±2°C/Deep frozen (-20°C) [c] | 14 days/40 days [e] / 1 year [g] | 50 g |
| | WMG | 2 oz. | TBD | Volatile organic compounds | 4±2°C; do not freeze | 14 days | 5 g |
| | WMG | 8 oz. | NA | Archival | 4±2°C/ Deep frozen (-20°C) [c] | NA | N/A |
| | Thin wall sampler | -- | TBD | Sediment permeability | Airtight seal | 6 months [h] | N/A |
| | Thin wall sampler | -- | TBD | Consolidated undrained triaxial compressive strength | Airtight seal | 6 months [h] | N/A |
| | Thin wall sampler | -- | TBD | Sediment compressibility | Airtight seal | 6 months [h] | N/A |
| **Equipment Filter Wipe Blanks** | | | | | | | |
| | HDPE | 4 oz. | TBD | Metals | 4±2°C | 6 months | 1 wipe |
| | HDPE | 4 oz. | TBD | Mercury | 4±2°C | 28 Days | 2 wipe |
| | AG | 4 oz. | TBD | Dioxins/furans | 4±2°C | 1 year/1 year [e] | 3 wipe |
| | AG | 4 oz. | TBD | SVOCs | 4±2°C | 7 days/40 days [e] | 4 wipe |

**Notes**

AG = amber glass
COPC = chemical of potential concern
BEHP = bis(2-ethylhexyl)phthalate
HDPE = high density polyethylene
NA = not applicable
SVOC = semivolatile organic compound
TBD = to be determined
TOC = total organic carbon
VOC = volatile organic compound
WMG = wide mouth glass

a - The size and number of containers may be modified by the analytical laboratory.
b - Sample sizes may be modified after laboratory selection is made.
c - Samples will be shipped to the laboratory on ice at 4±2°C. Once received at the laboratory, samples will be stored at -20°C.
d - Extracts will be stored at -10°C.
e - Holding time for samples prior to extraction/ holding time for extracts.
f - Collected only for samples that are archived for possible future analysis of secondary COPCs.
g - Holding time for frozen samples is one year.
h - Published holding time does not exist. Holding time shown is based on best professional judgment.

**Table 17**
**Proposed Laboratory Methods for Sediment Samples**

| Parameter | Laboratory | Sample Preparation | | Quantitative Analysis | |
|---|---|---|---|---|---|
| | | Protocol | Procedure | Protocol | Procedure |
| **Conventional and Geotechnical** | | | | | |
| Percent moisture (nature and extent samples) | TBD | EPA 160.3 | Oven drying | EPA 160.3 | Balance/gravimetric |
| Percent moisture (geotechnical borings) | TBD | ASTM D 2216 | Oven drying | ASTM D 2216 | Balance/gravimetric |
| Total organic carbon | TBD | EPA 9060A | Acid pretreatment | EPA 9060A (modified for sediment) | Combustion |
| Grain size | TBD | NA | NA | ASTM D-422 and D-1140 with USEPA (1986) modifications | Sieves and pipette method |
| Atterberg limits | TBD | NA | NA | ASTM D-4318-00 | Wet method; moisture determination |
| Specific gravity | TBD | NA | NA | ASTM D-854-02 | Water pycnometer |
| Sediment compressibility | TBD | NA | NA | ASTM D-2435 | One-dimensional |
| Sediment permeability | TBD | NA | NA | ASTM D-5084 (fine grained samples)/ASTM D-2434 (coarse grained samples) | Flexible wall permeameter (D-5084)/rigid wall permeameter (D-2434) |
| Consolidated undrained triaxial compressive strength | TBD | NA | NA | ASTM D-4767 | Isotropic consolidation; shearing in compression |
| **Metals** | | | | | |
| Aluminum, arsenic, barium, cadmium, chromium, cobalt, copper, lead, magnesium, manganese, nickel, thallium, vanadium, zinc | TBD | EPA 3050 | Strong acid digestion | EPA 6010B/6020 | ICP/ICP/MS |
| Mercury | TBD | EPA 7471A | Acid digestion/oxidation | EPA 7471A | CVAA |

## Table 17
## Proposed Laboratory Methods for Sediment Samples

| Parameter | Laboratory | Sample Preparation | | Quantitative Analysis | |
|---|---|---|---|---|---|
| | | Protocol | Procedure | Protocol | Procedure |
| **Organics** | | | | | |
| Dioxins /furans | TBD | EPA 1613B/8290A | Soxhlet extraction | EPA 1613B/8290A | HRGC/HRMS |
| | | | Silica gel column cleanup | | |
| | | | Additional cleanup as needed | | |
| PCB Congeners, dioxin-like | TBD | EPA 1613B/8290A | Soxhlet extraction | EPA 1613B/8290A | HRGC/HRMS |
| | | | Silica gel column cleanup | | |
| | | | Additional cleanup as needed | | |
| PCB Aroclors | TBD | EPA 3540 C | Soxhhlet | EPA 8082A | GC/ECD |
| | | EPA 3665A | acid cleanup | | |
| SVOCs | TBD | EPA 3540C/3541/ 3545A | Soxhlet/automated Soxhlet/presurized fluid extraction | EPA 8270C | GC/MS |
| | | EPA 3640A | Gel permeation chromatography | | |
| VOCs | TBD | EPA 5035 | Purge and trap | EPA 8260B | GC/MS |

**Notes**

ASTM = American Society for Testing and Materials
CVAA = cold vapor atomic absorbtion spectrometry
ECD = electron capture detector
EPA = U.S. Environmental Protection Agency
GC/ECD = gas chromatograpthy/electron capture detector
GC/MS = gas chromatography/mass spectrometry
HRGC = high-resolution gas chromatography
HRMS = high-resolution mass spectrometry
ICP = inductively coupled plasma-atomic emission spectrometry
ICP/MS = inductively coupled plasma/mass spectrometry
NA = not applicable
SVOC = semivolatile organic compound
TBD = to be determined
VOC = volatile organic compound

## Table 18

## Analytes, Analytical Concentration Goals, Method Reporting Limits, and Method Detection Limits for Sediment Samples

| Analyte | CAS Number | HHRA ACG [a] | BERA ACG [b] | Method Reporting Limit | Method Detection Limit |
|---|---|---|---|---|---|
| **Conventionals** | | | | | |
| Percent moisture (percent) | -- | NA | NA | TBD | NA |
| Total organic carbon (percent) | -- | NA | NA | TBD | TBD |
| Grain size (percent retained) | -- | NA | NA | TBD | NA |
| Atterberg limits (percent moisture) | -- | NA | NA | TBD | NA |
| Specific gravity (unitless) | -- | NA | NA | TBD | NA |
| **Metals (mg/kg-dry weight)** | | | | | |
| Aluminum | 7429-90-5 | NA | 77,000 | TBD | TBD |
| Arsenic | 7440-38-2 | 0.39 | NA | TBD | TBD |
| Barium | 7440-39-3 | NA | 15,000 | TBD | TBD |
| Cadmium | 7440-43-9 | 70 | 1.2 | TBD | TBD |
| Chromium | 7440-47-3 | 0.29 | NA | TBD | TBD |
| Cobalt | 7440-48-4 | NA | 23 | TBD | TBD |
| Copper | 7440-50-8 | 3,100 | 34 | TBD | TBD |
| Lead | 7439-92-1 | NA | 46.7 | TBD | TBD |
| Magnesium | 7439-95-4 | NA | 50 | TBD | TBD |
| Manganese | 7439-96-5 | NA | 1,800 | TBD | TBD |
| Nickel | 7440-02-0 | 1,400 | 20.90 | TBD | TBD |
| Thallium | 7440-28-0 | NA | 43 | TBD | TBD |
| Vanadium | 7440-62-2 | NA | 330 | TBD | TBD |
| Zinc | 7440-66-6 | 24,000 | 150 | TBD | TBD |
| Mercury | 7439-97-6 | 24 | 0.15 | TBD | TBD |
| **Organics** | | | | | |
| Dioxins/furans (ng/kg-dry weight) | | | | | |
| 1,2,3,4,6,7,8-Heptachlorodibenzo-*p* -dioxin | 35822-46-9 | NA | NA | TBD | TBD |
| 1,2,3,4,6,7,8-Heptachlorodibenzofuran | 67562-39-4 | NA | NA | TBD | TBD |
| 1,2,3,4,7,8,9-Heptachlorodibenzofuran | 55673-89-7 | NA | NA | TBD | TBD |
| 1,2,3,4,7,8-Hexachlorodibenzo-*p* -dioxin | 39227-28-6 | NA | NA | TBD | TBD |
| 1,2,3,4,7,8-Hexachlorodibenzofuran | 70648-26-9 | NA | NA | TBD | TBD |

## Table 18

## Analytes, Analytical Concentration Goals, Method Reporting Limits, and Method Detection Limits for Sediment Samples

| Analyte | CAS Number | HHRA ACG [a] | BERA ACG [b] | Method Reporting Limit | Method Detection Limit |
|---|---|---|---|---|---|
| 1,2,3,6,7,8-Hexachlorodibenzo-*p* -dioxin | 57653-85-7 | NA | NA | TBD | TBD |
| 1,2,3,6,7,8-Hexachlorodibenzofuran | 57117-44-9 | NA | NA | TBD | TBD |
| 1,2,3,7,8,9-Hexachlorodibenzo-*p* -dioxin | 19408-74-3 | NA | NA | TBD | TBD |
| 1,2,3,7,8,9-Hexachlorodibenzofuran | 72918-21-9 | NA | NA | TBD | TBD |
| 1,2,3,7,8-Pentachlorodibenzofuran | 57117-41-6 | NA | NA | TBD | TBD |
| 1,2,3,7,8-Pentachlorodibenzo-*p* -dioxin | 40321-76-4 | NA | NA | TBD | TBD |
| 2,3,4,6,7,8-Hexachlorodibenzofuran | 60851-34-5 | NA | NA | TBD | TBD |
| 2,3,4,7,8-Pentachlorodibenzofuran | 57117-31-4 | NA | NA | TBD | TBD |
| 2,3,7,8-Tetrachlorodibenzo-*p* -dioxin | 1746-01-6 | NA | NA | TBD | TBD |
| 2,3,7,8-Tetrachlorodibenzofuran | 51207-31-9 | NA | NA | TBD | TBD |
| Octachlorodibenzo-*p* -dioxin | 3268-87-9 | NA | NA | TBD | TBD |
| Octachlorodibenzofuran | 39001-02-0 | NA | NA | TBD | TBD |
| total tetrachlorinated dioxins | 41903-57-5 | NA | NA | NA | NA |
| total pentachlorinated dioxins | 36088-22-9 | NA | NA | NA | NA |
| total hexachlorinated dioxins | 34465-46-8 | NA | NA | NA | NA |
| total heptachlorinated dioxins | 37871-00-4 | NA | NA | NA | NA |
| total tetrachlorinated furans | 30402-14-3 | NA | NA | NA | NA |
| total pentachlorinated furans | 30402-15-4 | NA | NA | NA | NA |
| total hexachlorinated furans | 55684-94-1 | NA | NA | NA | NA |
| total heptachlorinated furans | 38998-75-3 | NA | NA | NA | NA |
| 2,3,7,8-TCDD TEQ | NA | 4.5 | 25,000 | NA | NA |
| PCB Congeners, dioxin-like (ng/kg-dry weight) | | | | | |
| 3,3'-4,4'-TCB (77) | 32598-13-3 | NA | NA | TBD | TBD |
| 3,4,4',5-TCB (81) | 70362-50-4 | NA | NA | TBD | TBD |
| 2,3,3',4,4'-PeCB (105) | 32598-14-4 | NA | NA | TBD | TBD |
| 2,3,4,4',5-PeCB (114) | 74472-37-0 | NA | NA | TBD | TBD |
| 2,3',4,4',5-PeCB (118) | 31508-00-6 | NA | NA | TBD | TBD |
| 2',3,4,4',5-PeCB (123) | 65510-44-3 | NA | NA | TBD | TBD |
| 3,3',4,4',5-PeCB (126) | 57465-28-8 | NA | NA | TBD | TBD |

## Table 18

## Analytes, Analytical Concentration Goals, Method Reporting Limits, and Method Detection Limits for Sediment Samples

| Analyte | CAS Number | HHRA ACG [a] | BERA ACG [b] | Method Reporting Limit | Method Detection Limit |
|---|---|---|---|---|---|
| 2,3,3',4,4',5-HxCB (156) | 38380-08-4 | NA | NA | TBD | TBD |
| 2,3,3',4,4',5'-HxCB (157) | 69782-90-7 | NA | NA | TBD | TBD |
| 2,3',4,4',5,5'-HxCB (167) | 52663-72-6 | NA | NA | TBD | TBD |
| 3,3',4,4',5,5'-HxCB (169) | 32774-16-6 | NA | NA | TBD | TBD |
| 2,3,3',4,4',5,5'-HeCB (189) | 39635-31-9 | NA | NA | TBD | TBD |
| Aroclors (ug/kg-dry weight) | | | | | |
| Aroclor-1016 | 12674-11-2 | NA | NA | TBD | TBD |
| Aroclor-1221 | 11104-28-2 | NA | NA | TBD | TBD |
| Aroclor-1232 | 11141-16-5 | NA | NA | TBD | TBD |
| Aroclor-1242 | 53469-21-9 | NA | NA | TBD | TBD |
| Aroclor-1248 | 12672-29-6 | NA | NA | TBD | TBD |
| Aroclor-1254 | 11097-69-1 | NA | NA | TBD | TBD |
| Aroclor-1260 | 11096-82-5 | NA | NA | TBD | TBD |
| Aroclor-1262 | 37324-23-5 | NA | NA | TBD | TBD |
| Aroclor-1268 | 11100-14-4 | NA | NA | TBD | TBD |
| Total PCBs | NA | 220 | 1,200 | TBD | TBD |
| Semivolatile Organic Compounds (µg/kg-dry weight) | | | | | |
| Acenaphthene | 83-32-9 | NA | 16 | TBD | TBD |
| Fluorene | 86-73-7 | NA | 19 | TBD | TBD |
| Naphthalene | 91-20-3 | NA | 160 | TBD | TBD |
| Phenanthrene | 85-01-8 | NA | 240 | TBD | TBD |
| 2,4,6-Trichlorophenol | 88-06-2 | NA | 44,000 | TBD | TBD |
| 2,4-Dichlorophenol | 120-83-2 | NA | 180,000 | TBD | TBD |
| Pentachlorophenol | 87-86-5 | 3,000 | 3,000 | TBD | TBD |
| Phenol | 108-95-2 | NA | 18,000,000 | TBD | TBD |
| Hexachlorobenzene | 118-74-1 | 300 | 300 | TBD | TBD |
| 2,3,4,6-Tetrachlorophenol | 58-90-2 | 1,800,000 | 1,800,000 | TBD | TBD |
| Carbazole | 86-74-8 | NA | 710,000 | TBD | TBD |
| 2,4,5-Trichlorophenol | 95-95-4 | NA | 6,100,000 | TBD | TBD |

## Table 18

## Analytes, Analytical Concentration Goals, Method Reporting Limits, and Method Detection Limits for Sediment Samples

| Analyte | CAS Number | HHRA ACG [a] | BERA ACG [b] | Method Reporting Limit | Method Detection Limit |
|---|---|---|---|---|---|
| Bis(2-ethylhexyl)phthalate | 117-81-7 | 35,000 | 182 | TBD | TBD |
| Volatile Organic Compounds (µg/kg-dry weight) | | | | | |
| 1,2,4-Trichlorobenzene | 120-82-1 | 22,000 | 390 | TBD | TBD |
| 1,2,3-Trichlorobenzene | 87-61-6 | 49,000 | 49,000 | TBD | TBD |
| 1,2-Dichlorobenzene | 95-50-1 | 1,900,000 | 740 | TBD | TBD |
| 1,3-Dichlorobenzene | 541-73-1 | 22,000,000 | 320 | TBD | TBD |
| 1,4-Dichlorobenzene | 106-46-7 | 2,400 | 700 | TBD | TBD |
| Chloroform | 67-66-3 | 290 | 4,300 | TBD | TBD |

**Notes**

ACG = analytical concentration goal

BERA = baseline ecological risk assessment

HHRA = human health risk assessment

NA = not applicable

NV = no value

TBD = to be determined

TEQ = toxicity equivalent

a - HHRA ACGs are the lower of the USEPA Region 3 Soil PRG or ${}^{Tot}Sed_{Comb}$ values from Table 9.

b - BERA ACGs are the NOEC values from Table 10. The HHRA ACG is used when no NOEC value is available.

# FIGURES

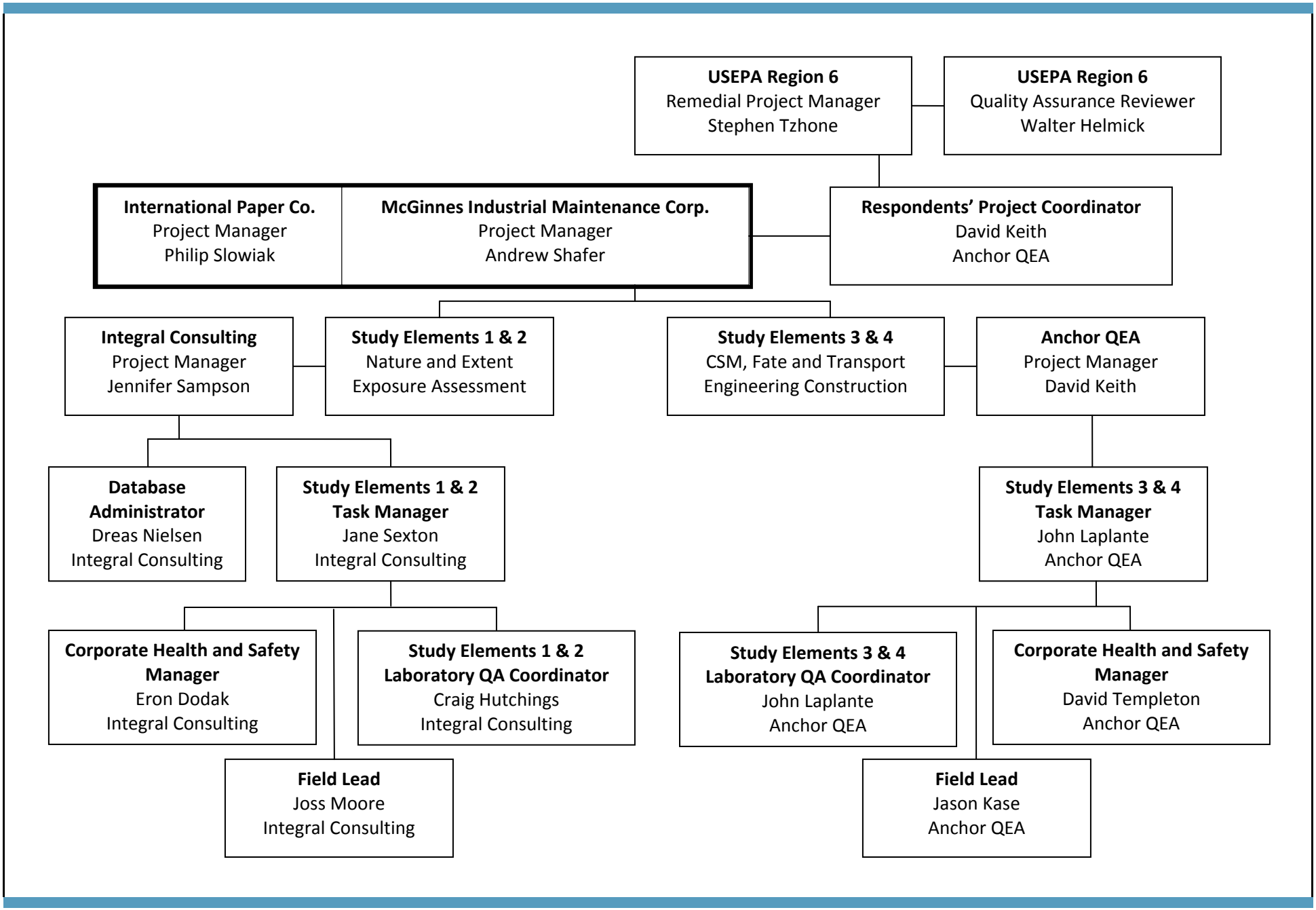



**Figure 1**
Project Organization Chart
SJRWP Sediment SAP
SJRWP Superfund/MIMC and IPC

P:\Projects\C643_SJWaste_IPC\Production_MXDs\SAP\Figure_2_Site.mxd - 3/26/2010 @ 1:53:16 PM

ANCHOR QEA

integral consulting inc.

0 800

Scale in Feet

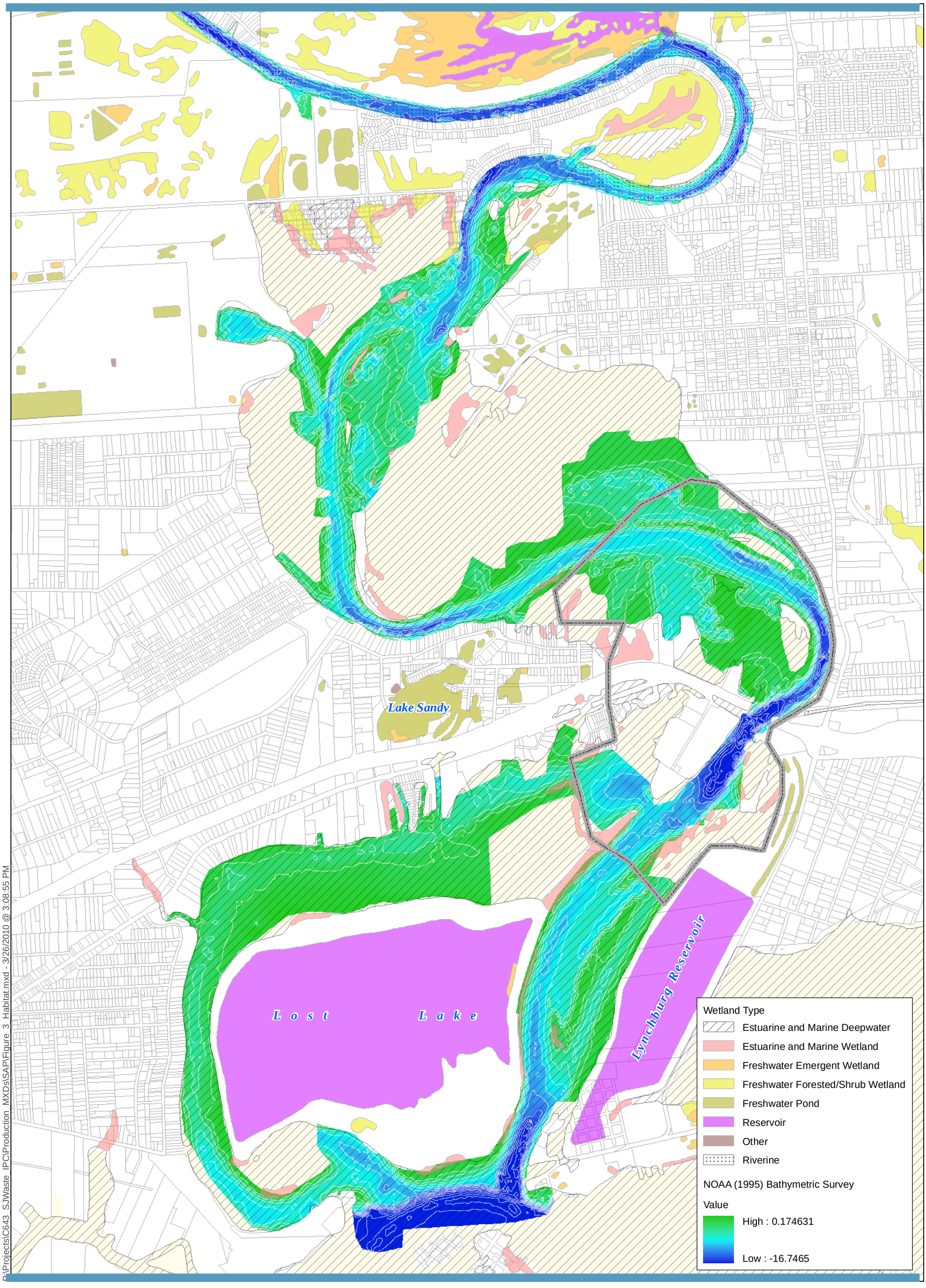
Preliminary Site Perimeter

Upland Sand Separation Area

Original (1966) Perimeter of the Impoundments

FEATURE SOURCES:
Aerial Imagery: 0.5-meter January 2009 DOQQs - Texas Strategic Mapping Program (StratMap), TNIS

**Figure 2**
Overview of Current Site
SJRWP Sediment SAP
SJRWP Superfund/MIMC and IPC

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ANCHOR QEA integral consulting inc.

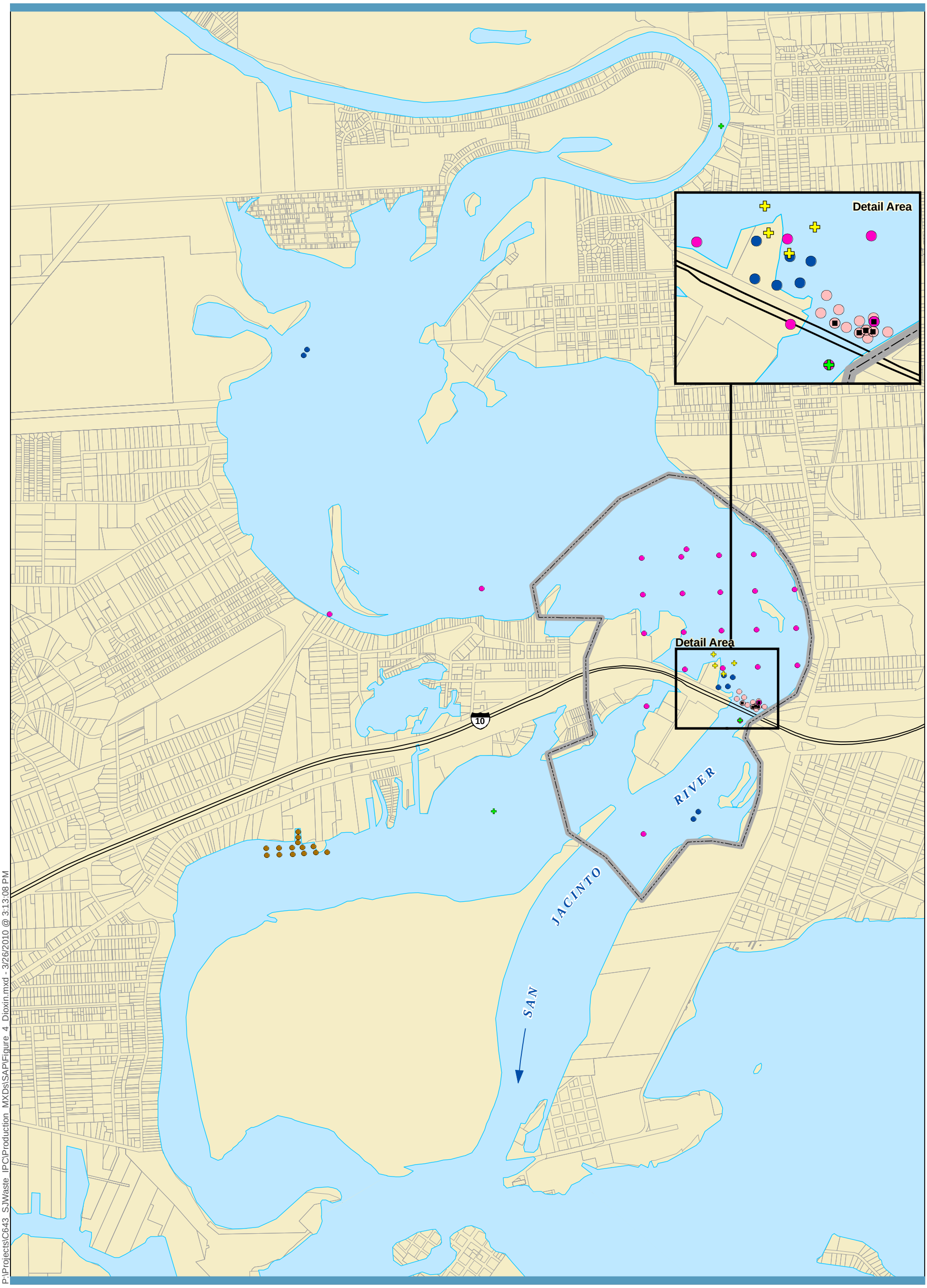
Preliminary Site Perimeter
1-Meter 1995 Bathymetric Contour
Tax Parcel Boundary

0 0.125 0.25 0.5
Miles

N

FEATURE SOURCES:
Bathymetry and Contours: NOAA. 1995. Hydrographic Survey No. H10619: in the vicinity of Lynchburg Landing to Muleshoe Lake, Texas.
Wetlands: U.S. Fish and Wildlife Service.
Parcel Boundaries: Harris County Appraisal District.

**Figure 3**
Habitats in the Vicinity of the Site
SJRWP Sediment SAP
SJRWP Superfund/MIMC and IPC




P:\Projects\C643_SJWaste_IPC\Production_MXDs\SAP\Figure_4_Dioxin.mxd - 3/26/2010 @ 3:13:08 PM

ANCHOR QEA
integral consulting inc.

0 0.5
Scale in Miles

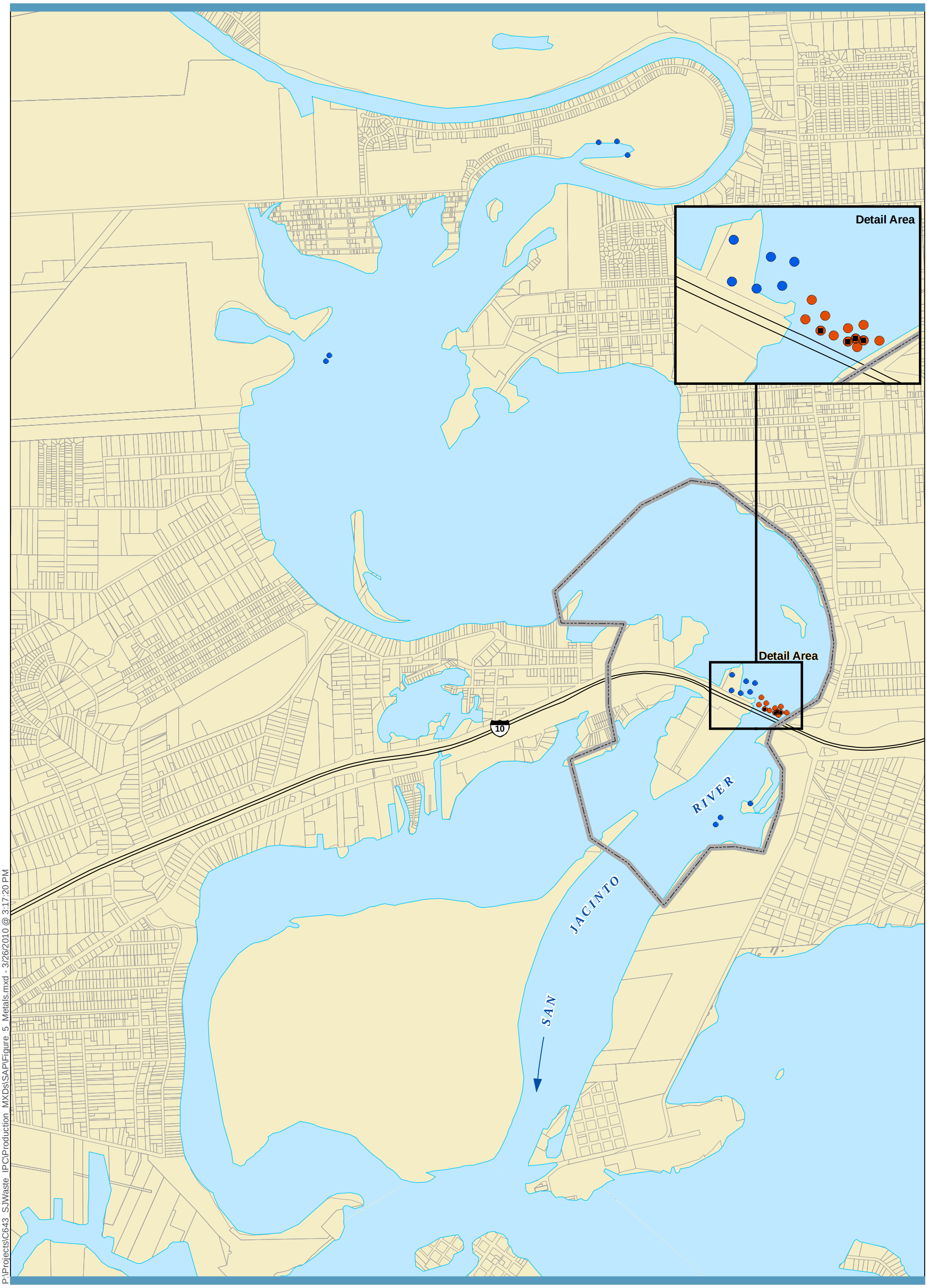
FEATURE SOURCES:
Parcel Boundaries:
Harris County Appraisal District
Hydrology:
Harris County Flood Control District

Preliminary Site Perimeter
Tax Parcel Boundary

**Dioxin/Furans Surface Sediment Sample**
- ENSR and EHA (1995)
- TCEQ and USEPA (2006)
- University of Houston and Parsons (2006)
- Weston (2006)
- URS (2010)
- Orion (2009)

**Dioxin/Furans Subsurface Sediment Sample**
- Co-located with surface sample; study listed above.

**Figure 4**
Locations of Sediment Dioxin Data
SJRWP Sediment SAP
SJRWP Superfund/MIMC and IPC




P:\Projects\C643_SJWaste_IPC\Production_MXDs\SAP\Figure_5_Metals.mxd - 3/26/2010 @ 3:17:20 PM

ANCHOR QEA
integral consulting inc.

0 0.5
Scale in Miles

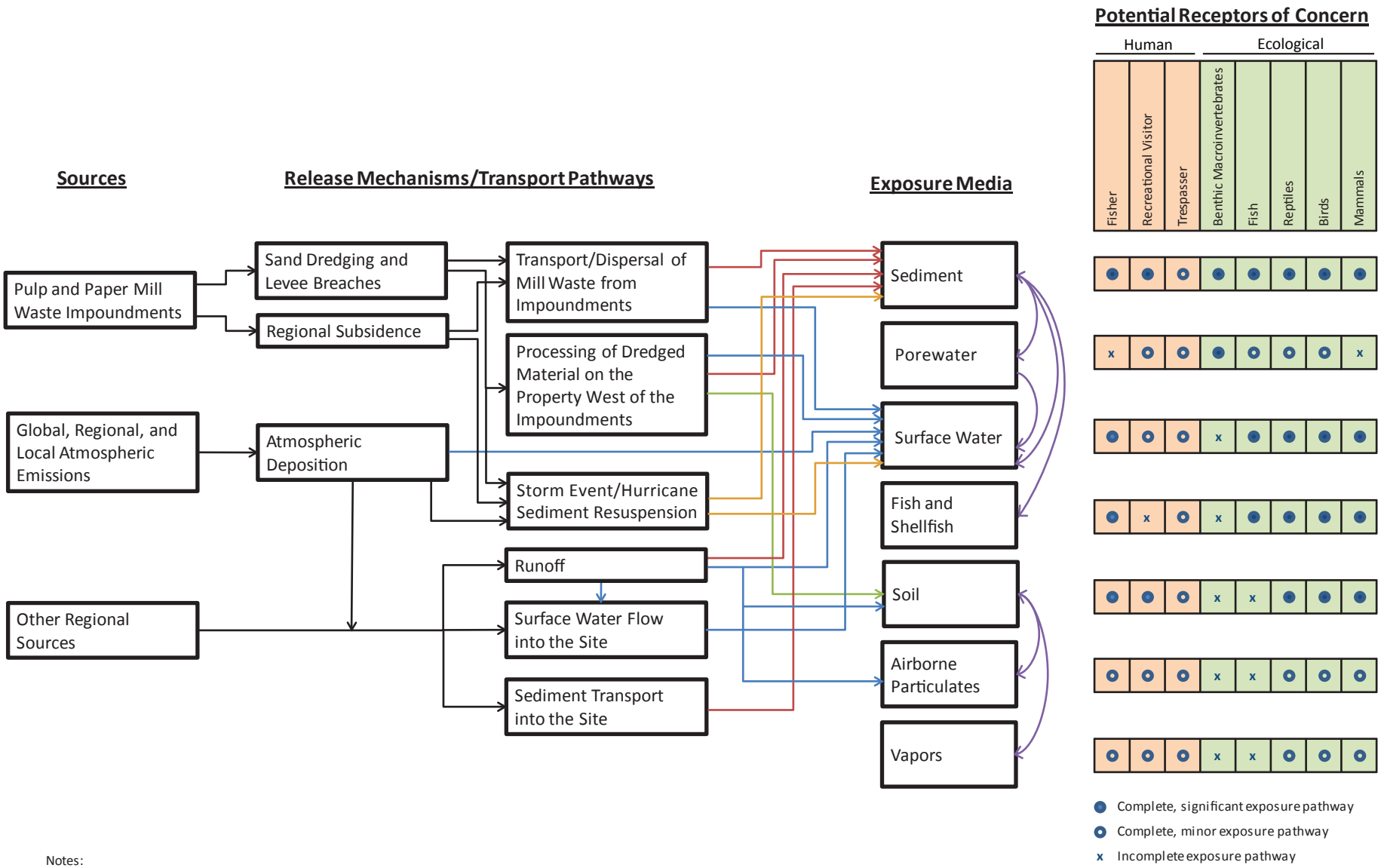
Preliminary Site Perimeter
Tax Parcel Boundary

**Metals Surface Sediment Sample**
- TCEQ and USEPA (2006)
- Weston (2006)

**Metals Subsurface Sediment Sample**
- Co-located with surface sample; study listed above.

FEATURE SOURCES:
Parcel Boundaries: Harris County Appraisal District
Hydrology: Harris County Flood Control District

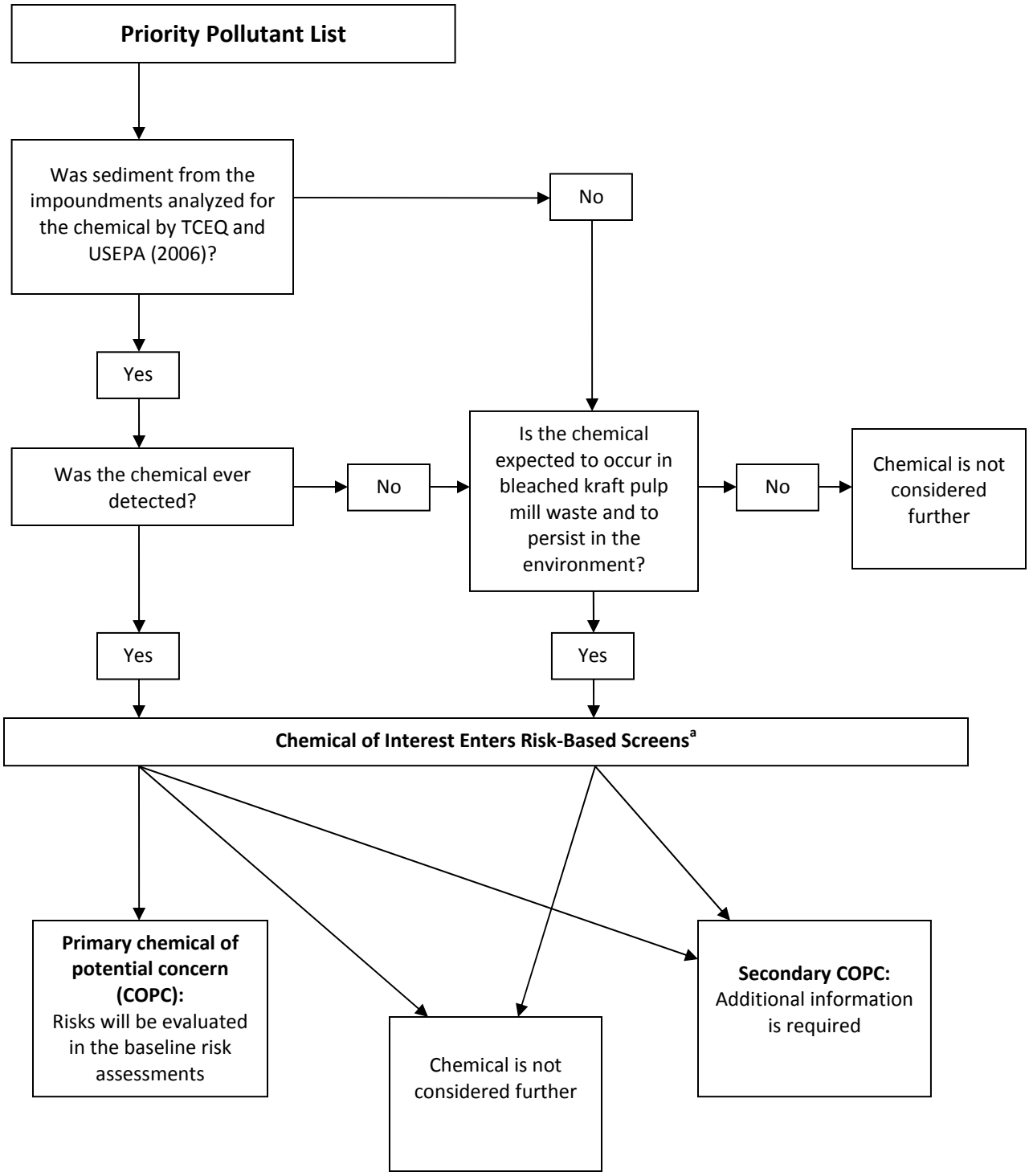
**Figure 5**
Locations of Sediment Metal Data
SJRWP Sediment SAP
SJRWP Superfund/MIMC and IPC




Notes:
Other regional sources may include industrial effluents, publicly owned treatment works, and stormwater.
Curved lines indicate potential transport pathways for chemicals of potential concern among exposure media.
Benthic invertebrates include crabs and other crustaceans and shellfish consumed by all receptors, as well as polychaetes and other infauna consumed by fish, other marine life, birds and mammals.

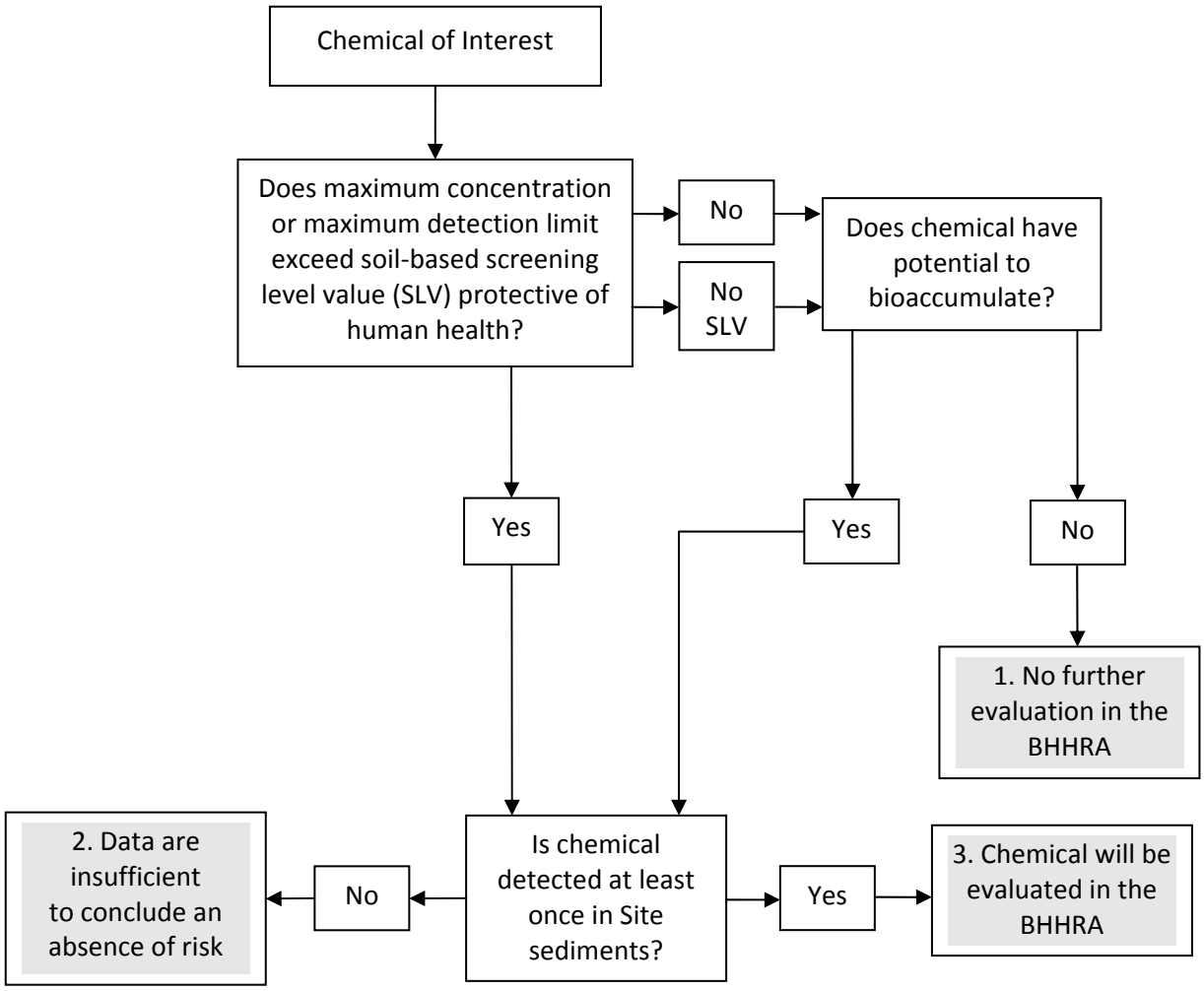
ANCHOR QEA integral consulting inc.

**Figure 6**
CSM Pathway Diagram
SJRWP Sediment SAP
SJRWP Superfund/MIMC and IPC




[a]**Chemicals of Interest** are those that will enter the risk-based screening process. Three separate risk-based screens will be used: a) fish and wildlife, b) benthic invertebrates, and c) human health.

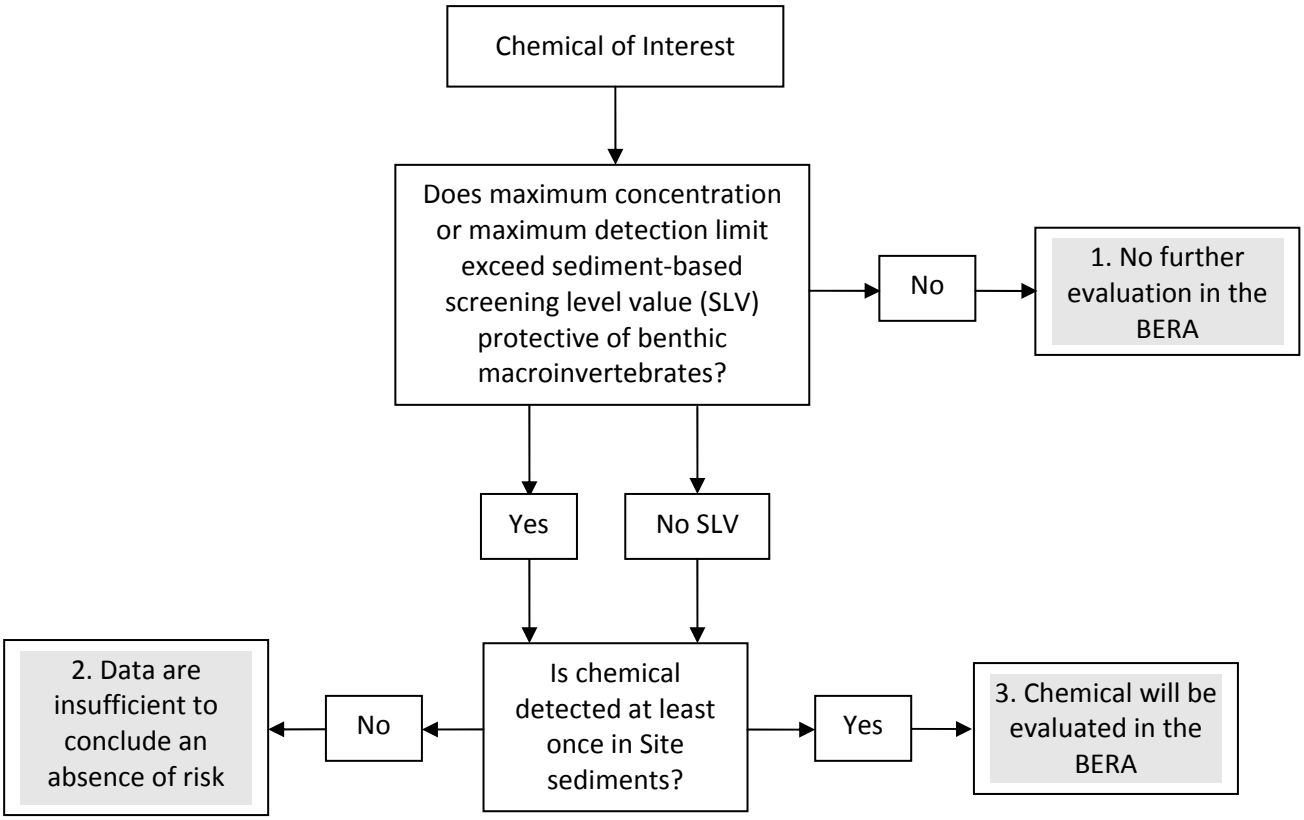
**Figure 7**
Process for Selection of Chemicals of Interest to the RI/FS
SJRWP Sediment SAP
SJRWP Superfund/MIMC and IPC




**Outcomes**:

1. Data are sufficient to conclude that there is an absence of risk to human health. **Chemical will not be evaluated further in the baseline human health risk assessment (BHHRA)**.
2. Data are insufficient to conclude an absence of risk to human health. **Chemical is retained as a secondary chemical of potential concern (COPC)**.
3. Data are sufficient to conclude that the chemical must be evaluated in the BHHRA. **Chemical is retained as a primary COPC.**

**Figure 8**
Process for COI Screening Evaluation of Risk to Human Health
SJRWP Sediment SAP
SJRWP Superfund/MIMC and IPC

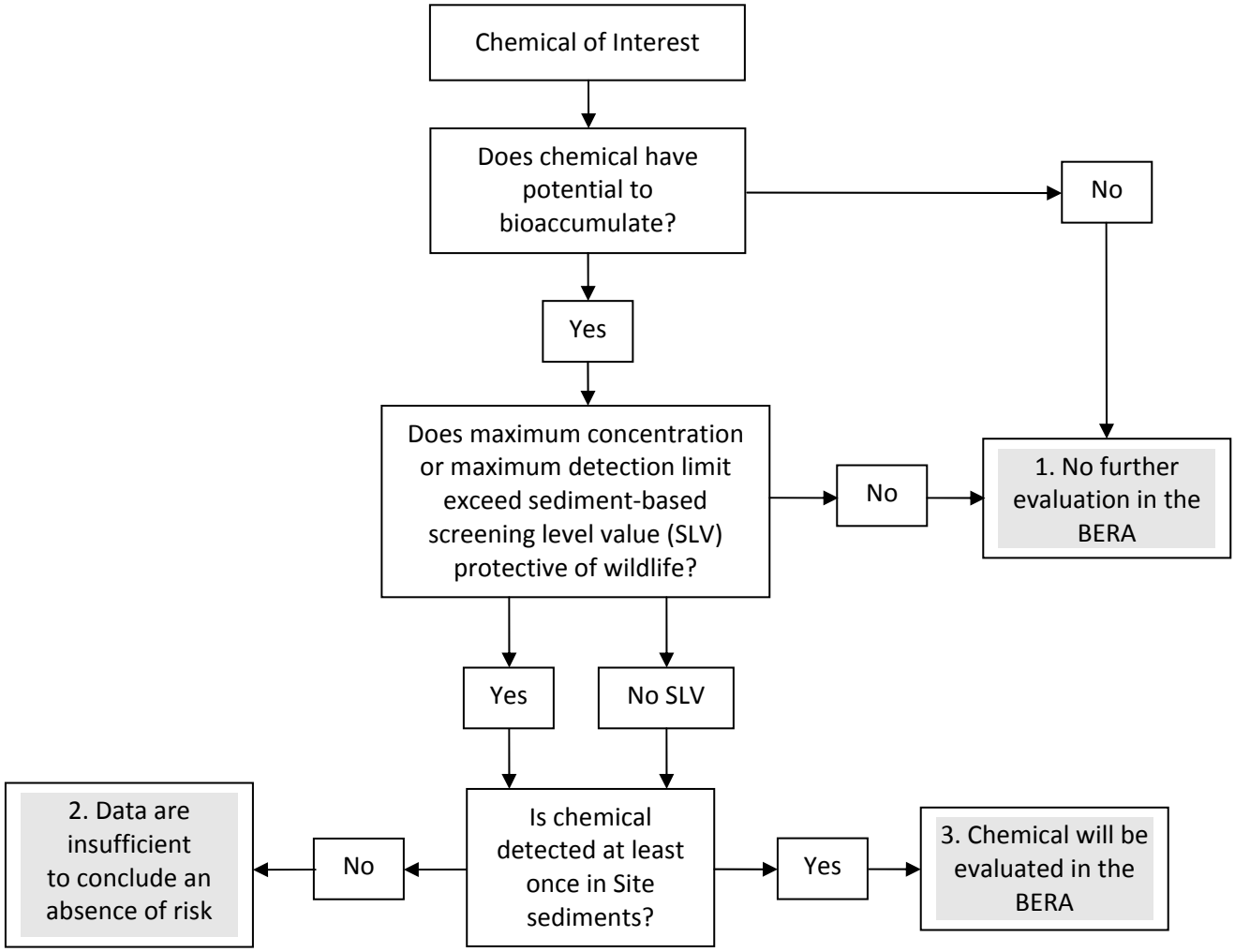



**Outcomes**:

1. Data are sufficient to conclude that there is an absence of risk to benthic macroinvertebrates. **Chemical will not be evaluated further in the baseline ecological risk assessment (BERA)**.
2. Data are insufficient to conclude an absence of risk to benthic macroinvertebrates. **Chemical is retained as a secondary chemical of potential concern (COPC)**.
3. Data are sufficient to conclude that the chemical must be evaluated in the BERA. **Chemical is retained as a primary COPC.**



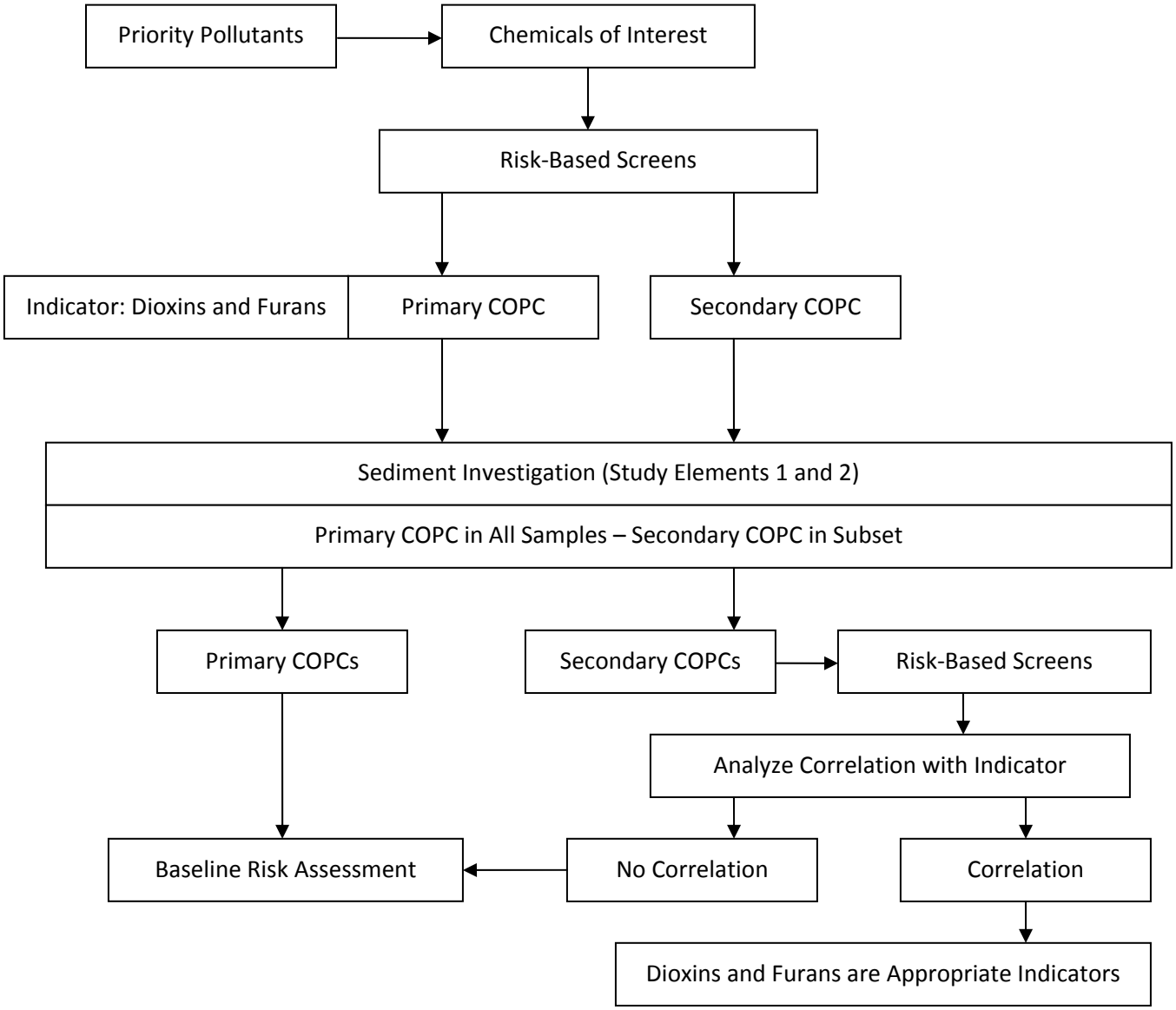
**Figure 9**
Process for Screening Evaluation of Risk to Benthic Macroinvertebrates
SJRWP Sediment SAP
SJRWP Superfund/MIMC and IPC




**Outcomes**:

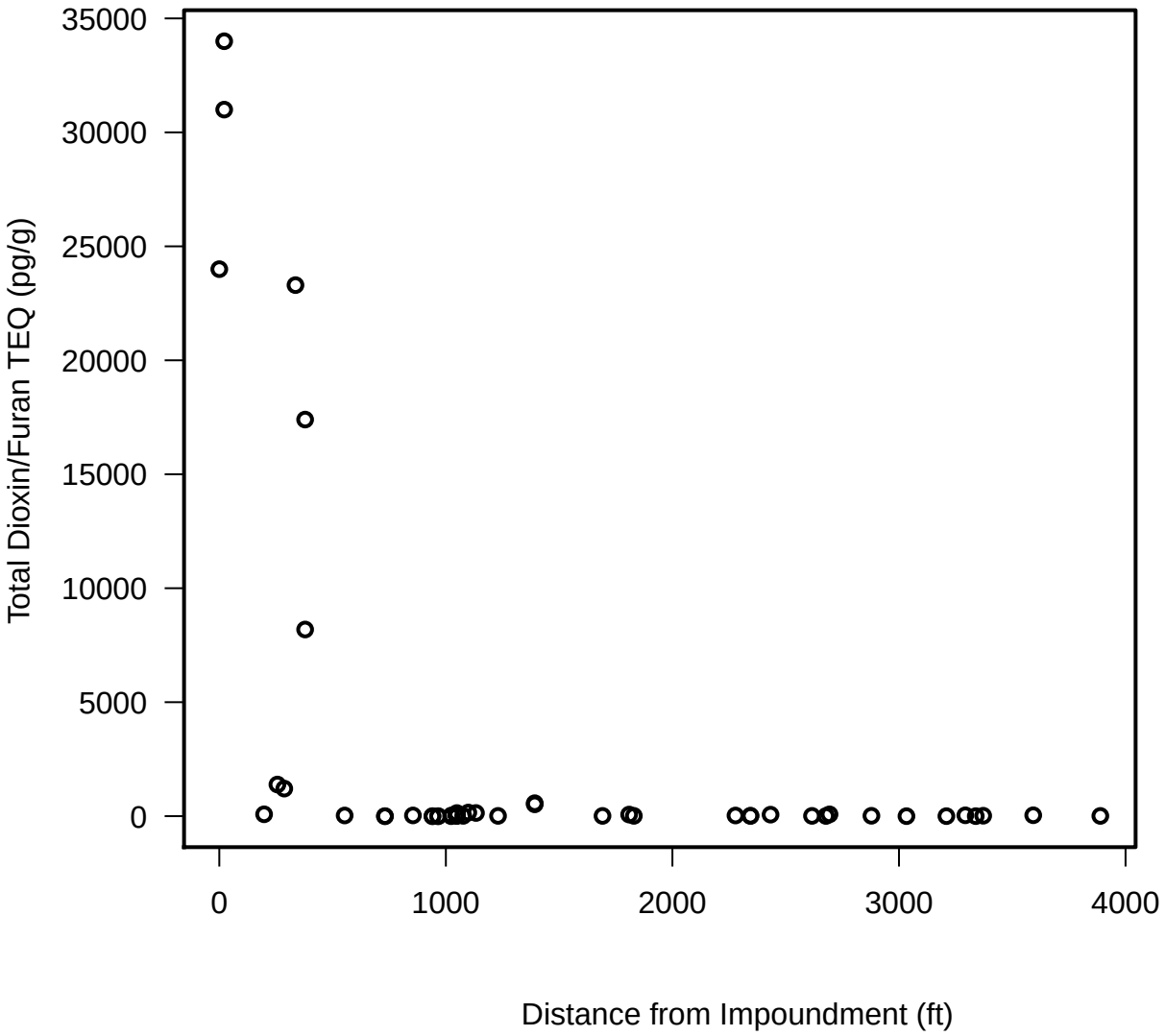
1. Data are sufficient to conclude that there is an absence of risk to fish and wildlife. **Chemical will not be evaluated further in the baseline ecological risk assessment (BERA)**.
2. Data are insufficient to conclude an absence of risk to fish and wildlife. **Chemical is retained as a secondary chemical of potential concern (COPC)**.
3. Data are sufficient to conclude that the chemical must be evaluated in the BERA. **Chemical is retained as a primary COPC.**

**Figure 10**
Process for Screening Evaluation of Risk to Fish and Wildlife
SJRWP Sediment SAP
SJRWP Superfund/MIMC and IPC



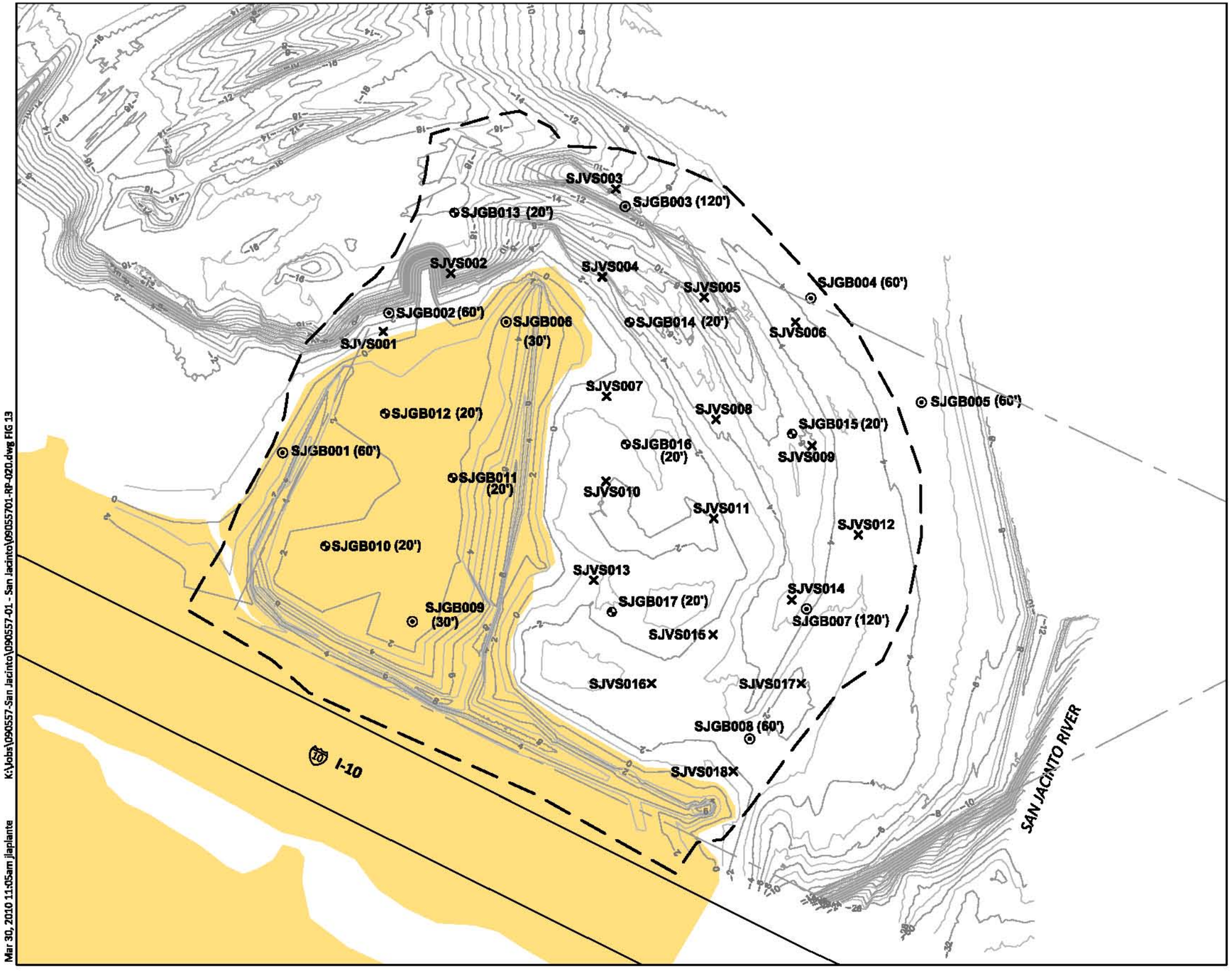

COPC – chemical of potential concern

**Figure 11**
Process for COPC Selection and Analysis
SJRWP Sediment SAP
SJRWP Superfund/MIMC and IPC




TEQ – toxicity equivalent

**Figure 12**
Change in Toxicity Equivalent Concentration with Distance from the San Jacinto Impoundment
SJRWP Sediment SAP
SJRWP Superfund/MIMC and IPC




**LEGEND:**

| | |
|---|---|
| SJGB001 (60') | Boring location and depth below mudline - geotechnical sampling (Proposed) |
| SJGB016 (20') | Boring location and depth below mudline - geotechnical and chemistry sampling (Proposed) |
| SJVS001 × | Vane shear test (VST) location (Proposed) |
| | Approximate 1966 alignment of perimeter berms (EPA) |
| | Property Line |
| | Approximate limit of vegetated area |

**NOTES:**

1. Boring and VST locations approximate and subject to change in the field depending on access constraints.
2. Final depth of borings within the impoundments shown as (20') deep will be based on actual contact elevation with native soils so that the boring extends into native material at least 5 feet. The 20-foot depth shown on the plan view is for planning purposes only. Actual depth will vary from location to location based on the thickness of the waste deposit.

0 150
Scale in Feet

**SOURCE:** Drawing prepared from COE.
**HORIZONTAL DATUM:** Texas South Central, NAD83. US Survey Feet.
**VERTICAL DATUM:** NAVD 88.

K:\Jobs\090557-San Jacinto\090557-01 - San Jacinto\09055701-RP-020.dwg FIG 13
Mar 30, 2010 11:05am jlapiante

ANCHOR QEA
integral consulting inc.

**Figure 13**
**Proposed Geotechnical Borings and Vane Shear Test Locations**
SJRWP Sediment SAP
SJRWP Superfund/MIMC and IPC

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ANCHOR QEA

integral consulting inc.

0 800
Scale in Feet

FEATURE SOURCES:
Aerial Imagery: 0.5-meter 2008/2009 DOQQs - Texas Strategic Mapping Program (StratMap), TNRIS
Contours: NOS Survey H1016 (1995)

Preliminary Site Perimeter
1-Meter 1995 Bathymetric Contour
Field Triplicate

**Proposed Locations**

Surface Sediment (Primary and Secondary COPCs)
Surface Sediment (Primary COPCs)
Surface Sediment (Primary and Secondary COPCs) and Core (Primary COPCs)
Additional Geotechnical Samples From Core

**Figure 14**
Nature and Extent Sediment Sampling Locations Within the Preliminary Site Perimeter
SJRWP Sediment SAP
SJRWP Superfund/MIMC and IPC

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ANCHOR QEA

integral consulting inc.

0 800
Scale in Feet

Preliminary Site Perimeter
1-Meter 1995 Bathymetric Contour
Sampling Transect

**Proposed Locations**

Human Health Surface Sediment (Primary COPCs)
Human Health Surface Sediment and Subsurface Sediment (Primary COPCs)
Upstream Background (Primary and Secondary COPCs)
ERA Surface Sediment (Primary COPCs)

FEATURE SOURCES:
Aerial Imagery: 0.5-meter 2008/2009 DOQQs - Texas Strategic Mapping Program (StratMap), TNRIS; Contours: NOS Survey H1016 (1995)

**Figure 15**
Upstream Sediment Sampling Locations
SJRWP Sediment SAP
SJRWP Superfund/MIMC and IPC

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ANCHOR QEA

integral consulting inc.

0 800
Scale in Feet

Preliminary Site Perimeter

1-Meter 1995 Bathymetric Contour

**Proposed Locations**

Human Health Surface Sediment (Primary COPCs)

Human Health Surface Sediment and Subsurface Sediment (Primary COPCs)

ERA Surface Sediment (Primary COPCs)

**Figure 16**
Human Health and Ecological Exposure Sediment Sampling Locations Within the Preliminary Site Perimeter
SJRWP Sediment SAP
SJRWP Superfund/MIMC and IPC

FEATURE SOURCES:
Aerial Imagery: 0.5-meter 2008/2009 DOQQs - Texas Strategic Mapping Program (StratMap), TNRIS; Contours: NOS Survey H1016 (1995)

# APPENDIX A
# SEDIMENT FIELD SAMPLING PLAN
# SAN JACINTO RIVER WASTE PITS SUPERFUND SITE

# SEDIMENT 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**

Integral Consulting Inc.
411 First Avenue South, Suite 550
Seattle, Washington 98104

Anchor QEA, LLC
2113 Government Street
Building D, Suite 3
Ocean Springs, Mississippi 39564

**April 2010**

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## List of Attachments


| | |
|---|---|
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| Attachment A2 | Standard Operating Procedures |
| Attachment A3 | Field Forms |
| Attachment A4 | USEPA Risk Assessment Guidance Forms (per the Unilateral Administrative Order Statement of Work) |

# LIST OF ACRONYMS AND ABBREVIATIONS

| Abbreviation | Definition |
|---|---|
| Anchor QEA | Anchor QEA, LLC |
| ASTM | American Society for Testing and Materials |
| ATV | all terrain vehicle |
| CDF | confined disposal facility |
| COC | chain-of-custody |
| COPC | chemical of potential concern |
| CU | consolidated undrained |
| DGPS | differential global positioning system |
| FSP | Field Sampling Plan |
| GPS | global positioning system |
| HASP | Health and Safety Plan |
| I-10 | Interstate Highway 10 |
| Integral | Integral Consulting Inc. |
| NOAA | National Oceanic and Atmospheric Administration |
| QA | quality assurance |
| QA/QC | quality assurance and quality control |
| QC | quality control |
| RI/FS | Remedial Investigation and Feasibility Study |
| SAP | Sampling and Analysis Plan |
| Site | San Jacinto River Waste Pits Superfund Site |
| SJRWP | San Jacinto River Waste Pits |
| SOP | standard operating procedure |
| SOW | statement of work |
| SPT | standard penetration test |
| UAO | Unilateral Administrative Order |
| USCS | Unified Soil Classification System |
| USEPA | U.S. Environmental Protection Agency |
| USGS | U.S. Geological Service |
| VST | vane shear test |

# 1 INTRODUCTION

This document presents the Field Sampling Plan (FSP) that has been prepared for the 2010 sediment study at the San Jacinto River Waste Pits (SJRWP) Superfund site (the Site). This FSP was prepared consistent with U.S. Environmental Protection Agency (USEPA) guidance (USEPA 1988, 1992) and as required by the USEPA 2009 Unilateral Administrative Order (UAO) (USEPA 2009). Additional information on the Site history and a summary of existing data are provided in the Sampling and Analysis Plan (SAP). Information on geology, physiography, hydrology, and cultural and natural resources of the Site and information on fate and transport will be provided in the Remedial Investigation and Feasibility Study (RI/FS) Work Plan (in preparation).

The Site is located on the western bank of the San Jacinto River, immediately north of the Interstate Highway 10 (I-10) Bridge, in Harris County, Texas. The property was acquired for the disposal of paper mill waste sludge from the Champion Paper Company in Pasadena, Texas. The on-site impoundments are believed to have been used in the mid-1960s for disposal of paper mill waste sludge, which were reportedly brought to the Site by barges (TCEQ and USEPA 2006). The sediment study is one of the tasks that will be conducted as part of the RI/FS for the Site.

The primary objective of the 2010 sediment study is to collect information on chemical concentrations and geotechnical properties of the sediment at the Site. Data on the chemicals of potential concern (COPCs) will also be collected from areas upstream of the Site. As discussed in the SAP, sediment data will be used to support Site characterization, risk assessments (i.e., human health and ecological), and remedial actions that will be conducted as part of the RI/FS.

To execute this study, Integral Consulting Inc. (Integral) and Anchor QEA, LLC (Anchor QEA) will conduct the fieldwork and data analysis, with Integral responsible for execution of Study Elements 1 and 2, and Anchor QEA responsible for execution of Study Elements 3 and 4 (as discussed in the SAP). The names and quality assurance (QA) responsibilities of key project personnel for Anchor QEA and Integral who will be involved in sampling and analysis activities are provided in Figure 1 of the SAP.

## 1.1 Overview

The sediment sampling design for the RI/FS incorporates a number of different components. The individual study components (as discussed in the SAP) differ in the locations, depths, and analytes to be measured in the sediment. The sampling design can be summarized as follows:

- Surface sediment sampling and analysis of primary COPCs at 26 locations in and near the impoundments (Figure A-1) on a 500-foot (152-m) grid, at 1 location in the channel immediately south of I-10 and toward the western side of the preliminary Site perimeter, and at 4 locations along the eastern perimeter of the original impoundments. Additional sediment from these 31 locations will be archived for later analysis of secondary COPCs, if necessary. Primary and secondary COPCs will be measured at an additional 13 locations on the 500-foot (152-m) grid, at 2 locations near the impoundment, and at 2 locations south of I-10. Additional sediment from the 27 locations will be archived for later analysis of secondary COPCs, if necessary. These samples will provide data for the nature and extent, exposure, and fate and transport analyses. Data from locations from within the impoundment area (seven stations) will allow characterization of waste materials and will be used for analysis of potential human exposures within the impoundments (along with existing data) as well as other objectives related to Study Element 1. Data from the two locations south of I-10 will provide information on possible prop scour or possible dredging disturbances.
- Surface sediment sampling and analysis of primary COPCs at an additional 19 locations within the Site boundary (Figure A-1), on a 1,000-foot (305-m) grid (with some distance adjustments at two stations south of I-10 to place stations within the river rather than on land). These samples will provide data for the nature and extent, exposure, and fate and transport analyses. Additional sediment from these stations will also be archived for possible future analyses of secondary COPCs.
- Collection of cores and analysis of primary COPCs at 12 locations within approximately 1,000 feet (305 m) of the impoundment (Figure A-1) and at 2 locations south of I-10. Additional sediment from these stations will also be archived for possible future analyses of secondary COPCs. These samples will provide data for the

nature and extent evaluation and for dredgability assessments. Data from the two locations south of I-10 will provide information on possible prop scour or possible dredging disturbances.

- Collection of surface samples and analysis of primary and secondary COPCs at 11 locations upstream of the Site, but downstream of the channelized portion of the San Jacinto River (Figure A-2), to allow estimation of local background conditions for the nature and extent, exposure assessments and fate and transport analysis.
- Collection of intertidal sediment samples at 45 locations in different human exposure areas on five beaches (Figure A-3) near the Site to evaluate potential human exposure and whether the beaches represent different exposure conditions for human receptors. Surface and subsurface sediment samples will be collected at all 45 stations at each of the five beaches. Twenty-five of the intertidal surface sediment samples will be analyzed for primary COPCs, with additional sediment archived for possible future analysis of secondary COPCs. Surface sediment samples from the remaining 20 stations will be archived for future analysis of primary and/or secondary COPCs, if necessary.

  In addition, half of the subsurface samples collected at Stations SJSH026 through SJSH035 will initially be analyzed for primary COPCs; the archived subsurface sediment samples from the other half of these stations and all of the subsurface samples from the other four beaches will be archived for possible future analysis of primary and/or secondary COPCs, if necessary.
- Collection of intertidal sediment samples for analysis of primary COPCs at 10 locations upstream of the Site, but downstream of the channelized portion of the San Jacinto River (Figure A-2), for evaluation of human exposures under upstream conditions. Surface and subsurface sediment samples will be collected at all 10 stations at this beach. Half of the surface intertidal sediment samples will be analyzed for primary COPCs. The other half of the surface and all of the subsurface samples will be archived for possible future analysis of primary and/or secondary COPCs, if necessary. Surface samples from these stations will also be used to evaluate ecological exposures.
- Collection of intertidal samples from six locations at two ecological exposure areas near the Site (Figure A-3) and three locations at one ecological exposure area upstream (Figure A-2) for characterization of exposure of ecological receptors such as

wading birds. These samples will be analyzed for primary COPCs. Additional sediment from these stations will be archived for possible future analyses of secondary COPCs, if necessary.

- Sediment borings at 17 locations and vane shear tests (VSTs) at 18 locations in the impoundment and in locations around the perimeter impoundments (Figure A-4). Measurements of sediment engineering characteristics (strength and settlement behavior) will be used to support engineering design for a potential confined disposal facility (CDF).

Some of the samples to be collected will be used for multiple elements of the overall study. Table A-1 summarizes the location to be sampled in terms of placement, depth, analytes, and study element. In general, surface sediment samples collected for the nature and extent evaluation will also be used to support the evaluations of exposure of aquatic receptors, sediment fate and transport, and sediment dredgability. Samples collected to support exposure assessments for humans and wildlife, and to support potential CDF design, are more specialized in purpose and location.

To accomplish the objective of the 2010 sediment study, two field sampling teams will be deployed, one team each from Integral and Anchor QEA. The following tasks will be performed autonomously by the two teams (Table A-1):

- Integral team
  - Collection of surface and subsurface sediment for chemical analyses within the San Jacinto River
  - Collection of surface and subsurface intertidal sediment (to the lowest low water level at time of sampling) along the shoreline of the San Jacinto River.
- Anchor QEA team:
  - Collection of sediment borings for measurements of geotechnical and engineering properties within the Site and also from the San Jacinto River
  - Collection of VST information.

## 1.2 Document Organization

This FSP describes the field methods that will be used to collect sediment for the 2010 sediment study. The background, rationale, data quality objectives, and overall study design are described in detail in the SAP. 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 reporting and field custody procedures are discussed in Section 4.

The following documents are provided as attachments to this FSP:

- Sediment Health and Safety Plan (HASP) Addendum 1. This document describes the specific requirements and procedures that will be implemented to minimize the safety risk to personnel who carry out the field study program for sediment collection (Attachment A1). It is an addendum to the project's overall HASP (Anchor QEA 2009).
- Standard Operating Procedures (SOPs). The SOPs describe the procedures that will be used to collect surface and subsurface sediments (Attachment A2). Attachment A2 is separated into two components: Integral SOPs and Anchor QEA SOPs.
- Field Forms. This attachment contains examples of various forms that will be used during field sampling, including a corrective action record, a field change request form, and a COC form (Attachment A3).
- USEPA Risk Assessment Guidance Forms (per the UAO Statement of Work [SOW]). This attachment contains the risk assessment guidance forms from USEPA (1992) that were stipulated in Item 17a of the UAO SOW (Attachment A4).

# 2 SAMPLING PROCEDURES

The following sections describe the detailed procedures and methods that will be used during the 2010 sediment study, including sampling procedures, recordkeeping, sample handling, storage, and field quality control (QC) procedures. Sample collection and processing will be conducted in accordance with the SOPs provided in Attachment A2. Depending on field conditions, procedures specified in the referenced SOPs may be modified if necessary. All field activities will be conducted in accordance with the sediment HASP addendum that is provided as Attachment A1.

## 2.1 Schedule

The start date for the sediment study will be determined following USEPA approval of the SAP. However, for planning purposes, it is anticipated that the first field sampling event will begin in late April/May 2010.

## 2.2 Field Survey and Sampling Methods

As mentioned above, it is anticipated that two field teams will implement this FSP. The Integral team will be responsible for collection of sediment samples for chemical analyses, and the Anchor QEA team will be responsible for collection of all borings and samples associated with the geotechnical and engineering properties analyses (Table A-1). The Anchor QEA team will also conduct the *in situ* VSTs for the study.

As discussed previously, surface and subsurface sediment chemistry samples will be collected from within the preliminary Site perimeter (Figures A-1, A-3, and A-4) and from upstream areas (Figure A-2). The following sections describe the sampling equipment, sampling methods, sample handling, and shipping.

### *2.2.1 Sampling Vessel, Field Equipment, and Supplies*

Access to river sediments and to some of the intertidal stations (particularly at high tide) may require the use of either a boat or a barge. Some of the intertidal stations will be sampled at low tide, and accessed by land; a truck or van will be required in these cases. Any upland

stations that need to be accessed for geotechnical borings will require the use of a truck or all terrain vehicle (ATV)-mounted drilling equipment.

#### *2.2.1.1 Sampling Vessel*

The sampling boat or barge 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 gear: sediment collection and compositing equipment, sample coolers, and multiple sampling equipment boxes containing sample jars and other ancillary equipment. The vessels used for sampling will have navigational lights, anchors, and basic sonar (e.g., fathometer). The vessel operator will be thoroughly familiar with the area of the river to be navigated.

Weather, river gauge height, and tides will be monitored using the following web sites:

- 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 Service (USGS) 08072050 San Jacinto River near Sheldon, 10 miles upstream from the Site (http://waterdata.usgs.gov/nwis/uv?site_no=08072050)
- 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 Battleship Texas State Park, Station Id: 8770743, 3 miles southwest of the Site (http://tidesandcurrents.noaa.gov/noaatidepredictions/viewDailyPredictions.jsp?Stationid=8770743).

#### *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, and personal gear. Protective wear (e.g., gloves) is required to

minimize the possibility of cross-contamination between sampling locations. Additional information on protective wear required for this project is provided in Attachment A1.

Surface sediment samples (6 inches; 15 cm) for characterization of nature and extent, for exposure of ecological receptors, and for characterization of human health exposure will be collected using stainless-steel spades, shovels, or hand-held corers; a modified petite-Ponar grab sampler, or a van Veen grab sampler (or equivalent type of equipment). A coring device (e.g., vibracorer from a boat, slide-hammer corer, gravity corer, thin-walled tubes, split-spoon sampler, or equivalent type of equipment) will be used for subsurface sediment collection.

Sample jars, preservatives, distilled/deionized water, coolers, and packaging material for the samples will be supplied by the analytical laboratory. Details on the numbers and type of sample containers are provided in the SAP and in Table A-2 of this FSP. The field lead and field personnel in charge of sample handling in the field will use a sample matrix table (Table A-3) as a QC check to ensure that all samples have been collected at a given station. This table includes the total number and type of sample jars required for each analysis at each sampling station.

Commercially available, pre-cleaned jars will be used for the samples, and the testing laboratories 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 Integral's project file.

Sample containers will be clearly labeled at the time of sampling. Labels will include the task name, sample number, sampler's initials, analyses to be performed, and sample date and time. Sample numbering and identification procedures are described in detail in Sections 3.6 and 3.7.

### 2.2.2 Sample Location Positioning

Latitude and longitude coordinates will be obtained at the locations where sediment samples are collected. A differential global positioning system (DGPS) will be used to document the sample collection locations. The standard projection method to be used during field activities is Horizontal Datum: NAD1983_StatePlane, Texas South Central, FIPS 4204, US feet. The positioning objective is to accurately determine and record the positions of all sampling locations to within ±2 m. Proposed sediment sampling location coordinates are provided in Table A-4.

The DGPS unit consists of a global positioning system (GPS) receiver and a differential receiver located at a horizontal control point. At the control point, the GPS-derived position is compared with the known horizontal location, offsets or biases are calculated, and the correction factors are telemetered to the GPS receiver. Positioning accuracies on the order of ±1 to 3 m can be achieved by avoiding the few minutes per day when the satellites are not providing the appropriate quality of signal (SOP AP-06). The GPS unit provides the operator with a listing of the time intervals during the day when accuracies are decreased. Avoidance of these time intervals permits the operator to maintain better positioning accuracy (SOP AP-06).

### 2.2.3 Surface Sediment Sample Collection

The equipment and procedures that will be used to collect surface sediment samples during the 2010 sediment study are discussed in the following sections. The estimated numbers of field locations that will be sampled are listed in Table A-1. The holding time requirements for the sediment samples following field collection are specified in Table A-2.

Surficial sediment samples (0 to 6 inches; 0 to 15 cm) for characterization of nature and extent, for exposure of ecological receptors and for characterization of human health exposure may be collected with a variety of sampling equipment depending upon the conditions encountered in the field: stainless-steel spades or shovels, a stainless-steel hand corer, a modified petite-Ponar grab sampler, a power grab, or a van Veen grab sampler (or equivalent type of equipment), in accordance with standard methods used by USEPA (1997). Methods for surface sediment sampling are provided in SOPs SD-04, SD-13, and SL-05, respectively.

One surface sediment sample will be collected at each location sampled for the nature and extent evaluation, except for the location in the impoundment area. In this location, three field replicates will be collected to ensure an accurate characterization of waste material present. The samples will be analyzed for primary COPCs and primary and secondary COPCs will be analyzed at Station SJNE022 (field triplicate station; see Section 2.3). Additional sediment from each station will be archived for possible future analysis, if necessary.

Three intertidal sampling areas will be sampled for human health: 1) the shoreline on both sides of the channel under the I-10 Bridge over the San Jacinto River; 2) the eastern shoreline of the sand separation area on the property west of the impoundment; and 3) the shoreline to the west of the shipping berth on the property west of the impoundment. Sediment will be sampled at ten stations from 0 to 6 inches (0 to 15 cm) at each of these areas. Sampling stations will be located between the high tide mark and the low tide mark. Five surface sediment samples from each of the exposure areas will be analyzed initially for primary COPCs. The remaining five surface samples from each area will be archived for possible future analysis, if necessary. Care will be taken to ensure that samples collected from Stations SJSH007, SJSH009, SJSH010, SJSH012, and SJSH015 (stations located on the shoreline near the I-10 Bridge) are sent for analysis rather than archived. A minimum of three grab samples will be collected within 1 foot (30 cm) from each other. Any vegetative material will be removed from the surface prior to sample collection and from the sample. Removal of material from the sample will be documented in the field log book.

At each of the intertidal sampling stations for ecological receptors, a minimum of three grab samples will be collected within 1 foot (30 cm) from each other. Sampling stations will be located between the high tide mark and the low tide mark. All of the surface sediment samples from each of the ecological exposure areas will be analyzed initially for primary COPCs. Additional sediment from each sampling location will be archived for possible future analysis of secondary COPCs, if necessary. Any vegetative material will be removed from the surface prior to sample collection and from the sample. Removal of material from the sample will be documented in the field log book.

Material collected with the sampling device will be evaluated by the Integral field lead for acceptability using the following criteria:

- The sampler is not overfilled
- Overlying water is present (may not be applicable to exposed intertidal sediment samples collected at low tide)
- The overlying water (if present) is not excessively turbid
- The sediment surface is relatively undisturbed
- An adequate penetration depth is attained (i.e., to enable sampling of the undisturbed surface sediment).

If a sample fails to meet any of the above criteria, it will be rejected and discarded away from the station.

After a sediment sample is judged to be acceptable, any overlying water will be siphoned off and the upper 6 inches (15 cm) of sediment will be collected in accordance with (USEPA 1997) guidelines. If a grab sampler is used, then decontaminated stainless-steel spoons will be used to collect the sediment from the grab sampler. A stainless-steel ruler will be used with all sampling devices to ensure that the sampling criterion for adequate penetration depth has been met and that the correct amount (i.e., 6 inches [15 cm]) of sediment has been removed.

Surface sediments from the grab samples will be placed into a decontaminated, stainless-steel bowl and homogenized using a stainless-steel spoon or other stainless-steel mixing implement until the sediment attains a visually uniform color and texture. The sediment sample in the bowl will be covered with aluminum foil until a sufficient volume of sediment (approximately 2 L per station) is collected. Sediment subsamples will then be removed for the various kinds of laboratory analyses and for archiving. Sediment subsamples collected at 3 locations within the impoundment area (Station SJNE022, SJVS001, and SJVS016), 12 locations on the 500-foot (152-m) grid, 2 locations south of I-10, and 11 locations upstream of the Site will be analyzed for semivolatile organic compounds (SVOCs) and polychlorinated biphenyls (PCBs); all other sediment subsamples for SVOC and PCB analysis will be immediately frozen upon receipt at the testing laboratory to extend holding time requirements (USEPA 1997b) for possible future analysis. Analyses of VOCs at these stations

will be expedited by the laboratory, to enable a diction about analysis of VOCs at the remaining sediment stations before expiration of holding times for VOC.

The surface sediment composite samples will be placed in labeled, laboratory-cleaned sample containers with Teflon-lined lids (Table A-2). Each sample container will be clearly labeled with the task name, sample number, type of analysis to be performed, date and time, and initials of person(s) preparing the sample. Containers that will be frozen (i.e., archived samples) will have 0.5 to 1 inch (1.3 to 2.6 cm) of headspace above the sediment to prevent the jars from breaking during storage at the laboratory. Immediately after sample containers are filled, the samples will be stored on ice (4±2°C).

As stated above, the sample matrix table (Table A-3) shows the total number of sample jars for each analysis needed at each sampling station. Integral's field lead and field personnel in charge of sample handling will use this table as a QC check to ensure that all samples at a given station are collected and that the appropriate sample container is used for each sample.

### *2.2.4 Subsurface Sediment Sample Collection*

The equipment and procedures used to collect subsurface sediment samples during the 2010 sediment study are discussed in the following sections. The estimated numbers of field locations that will be sampled are listed in Table A-1. The holding time requirements for the sediment samples following field collection are specified in Table A-2.

The Integral team will collect a minimum of one core at each nature-and-extent station and a minimum of three cores at each intertidal station for human health exposure. If sample volume requirements dictate the need for additional sediment, then additional co-located core(s) will be collected and the sediment from the cores will be composited at 1-foot (30-cm) intervals. Any separate sediment horizons that are observed in the core will be noted on the field form (Attachment A3), but will not alter the collection interval of 1 foot (30 cm).

The Anchor QEA team will collect geotechnical-specific borings to address data gaps for geotechnical engineering analyses. The Anchor QEA team will also collect additional cores

for geotechnical analyses at six of the nature and extent coring stations. These geotechnical core samples will not be composited but sent as a whole, undisturbed core segment to the testing laboratory. VSTs will also be conducted by the Anchor QEA team to supplement surficial data that might be missed during the boring program in the area of the potential CDF. The Anchor QEA team will also collect grab samples that will be co-located with the VST locations to characterize the sediments and provide for VST correction factors.

#### *2.2.4.1 Nature and Extent Cores*

Sediment cores will be collected by the Integral team using a coring device (e.g., vibracorer with Lexan® liner and core catcher, an impact coring device, piston core, or equivalent type of equipment). Sampling methods for subsurface sediment sampling are provided in SOPs SD-08, SD-12, and SD-13, respectively.

A minimum diameter of 3 inches (7.6 cm) will be used for all cores. Cores will be collected in 1-foot (30-cm) intervals to refusal or to a maximum depth of 10 feet (3 m). Sediment will be collected from the entire sediment interval (i.e., 1 foot [30 cm]), and a discrete sample from the composited, homogenized sediment will be collected. Shorter core lengths will be accepted if native materials are encountered, based on visual inspection of the core, or if multiple attempts (i.e., two attempts) at coring a given sampling location do not provide the anticipated core length.

For cores that are collected from a sampling vessel, the core's position will be monitored by observing the angle of the winch line while the corer is being lowered in the water column. When the inlet of the corer is approximately 2 m above the sediment, the corer will stop being lowered, the boat location confirmed, and the angle of the hydrowire determined. When the angle of the hydrowire is less than 5 degrees, the corer will be lowered into the sediment at a rate of 30 cm/s or less. If the weather is windy or tidal conditions warrant it, the boat will be anchored before the core is lowered. Cable will be released through the winch until there is slack in the line. If the boat drifts significantly (e.g., because of wind or tidal conditions), slack in the line will be permitted only briefly to prevent pulling the corer out at an angle.

The corer will be retrieved at a controlled rate to minimize agitation of the core. Retrieval will be stopped as soon as the top of the corer reaches the water surface. If a core catcher is not installed at the bottom end of the core, a plug may be inserted in the bottom end of the corer to prevent the core from slipping out when the corer is raised out of the water. The corer will be brought on board the sampling vessel and immediately stabilized to prevent it from tipping or falling. Care will be taken at all times to keep the corer in a vertical position. After the corer is secured onboard the sampling vessel, the polyethylene liner that contains the sample will be removed from the corer barrel and inspected.

Each core will be evaluated by Integral's field lead for acceptability using the following criteria:

- The sediment surface is relatively undisturbed
- Any overlying water is not excessively turbid
- At least 80 percent core recovery relative to penetration is achieved.

If a sediment core fails to meet any of the above criteria, it will be rejected.

If less than 80 percent core recovery versus penetration is achieved, the recovered core will be retained but considered insufficient, and another attempt to recover a sediment core at the same location will be conducted. If the specified penetration depth is not achieved after two attempts, the station may be relocated slightly. If the slight relocation of the station does not improve the penetration depth, the station may be temporarily abandoned and Integral's project manager will be notified.

After the cores have been collected, both ends of the cores designated for chemical analysis will be securely capped; labeled with the station identifier, core section, and sediment orientation; and fastened in an upright position. The overlying water will be siphoned or drained off.

Processing of the core may occur either on the sampling vessel or at a specified location onshore. At the processing area, the core liner will be laid out horizontally on a clean work surface. The content of the core will be extruded with a plunger onto a clean sheet of aluminum foil. If the core contains a liner that cannot be extruded, the core liner will be cut

lengthwise and the core split open. Split cores and hand cores collected without a liner will be placed next to a tape measure and a station identifier and photographed. Cores will be inspected for physical characteristics and described on a core profile form (see Attachment A3).

Cores designated for chemical analysis will be sectioned into 1-foot (30-cm) intervals. Sediment touching the sides of the core tube will be excluded from each sample. The sediment from each core section will be homogenized with a decontaminated stainless-steel mixing implement (e.g., spoon) until the sediment attains a visually uniform color and texture. The sediment sample in the bowl will be covered with aluminum foil until a sufficient volume of sediment (approximately 2 L per station) is collected. Sediment subsamples will then be removed for the various kinds of laboratory analyses and for archiving.

The subsurface sediment composite samples will be placed in labeled, laboratory-cleaned sample containers with Teflon-lined lids (Table A-2). Each sample container will be clearly labeled with the task name, sample number, type of analysis to be performed, date and time, and initials of person(s) preparing the sample. Containers that will be frozen (i.e., archived samples) will have 0.5 to 1 inch (1.3 to 2.6 cm) of headspace above the sediment to prevent the jars from breaking during storage at the laboratory. Immediately after sample containers are filled, the samples will be stored on ice (4±2°C).

As stated above, the sample matrix table (Table A-3) shows the total number of sample jars for each analysis needed at each sampling station. Integral's field lead and field personnel in charge of sample handling in the field will use this table as a QC check to ensure that all samples at a given station are collected and that the appropriate sample container is used for each sample.

#### *2.2.4.2 Human Health Exposure Cores*

Sampling stations will be located between the high tide mark and the low tide mark. Sediment cores for human health exposure will be collected using a hand-held stainless steel corer. The subsurface sample of intertidal sediment for human health exposure will be

collected from a depth of 6 to 12 inches (15 to 30 cm) and collocated with the surface sediment samples discussed above in Section 2.2.3. A minimum of three cores will be collected at each location, and sediment will be collected from the entire sediment interval. Care will be taken at all times to keep the corer in a vertical position.

Five subsurface sediment samples from the same locations where surface sediment samples were collected from the eastern shoreline of the property west of the impoundment (see above) will be analyzed initially for primary COPCs. All of the remaining subsurface samples will be archived for possible future analysis, if necessary.

Each core will be evaluated by Integral's field lead to ensure that the sediment surface is relatively undisturbed. If the specified penetration depth (1 foot; 30 cm) is not achieved after two attempts, the station will be relocated slightly. If the slight relocation of the station does not improve the penetration depth, the station may be temporarily abandoned and Integral's project manager will be notified.

Processing of the core will occur in the field. The core will be laid out horizontally on a clean work surface. The content of the core will be extruded with a plunger onto a clean sheet of aluminum foil. Extruded hand cores will be placed next to a tape measure and a station identifier and photographed. Cores will be inspected for physical characteristics and described on a core profile form (see Attachment A3).

The sediment from the 6 to 12-inch (15 to 30-cm) core section will be homogenized with a stainless-steel mixing implement (e.g., spoon) until the sediment attains a visually uniform color and texture. Sediment touching the sides of the core tube will be excluded from each sample. The sediment sample in the bowl will be covered with aluminum foil until a sufficient volume of sediment (approximately 2 L per station) is collected. Sediment subsamples will then be removed for the various kinds of laboratory analyses and archiving.

The subsurface sediment composite samples will be placed in labeled, laboratory-cleaned sample containers with Teflon-lined lids (Table A-2). Each sample container will be clearly labeled with the task name, sample number, type of analysis to be performed, date and time, and initials of person(s) preparing the sample. Containers that will be frozen (i.e., archived

samples) will have 0.5 to 1 inch (1.3 to 2.6 cm) of headspace above the sediment to prevent the jars from breaking during storage at the laboratory. Immediately after sample containers are filled, the samples will be stored on ice (4±2°C).

As stated above, the sample matrix table (Table A-3) shows the total number of sample jars for each analysis needed at each sampling station. Integral's field lead and field personnel in charge of sample handling in the field will use this table as a QC check to ensure that all samples at a given station are collected and that the appropriate sample container is used for each sample.

#### *2.2.4.3 Geotechnical Borings*

Subsurface sediment will be collected by advancing borings at selected locations to obtain geotechnical data using the standard penetration test (SPT) with a split-spoon sampler and thin-walled tube sampling. Locations of the borings are shown in Figure A-4.

The proposed sampling intervals and test parameters for borings are identified in Table A-5. Final sampling locations and depth intervals may vary depending on updated survey data, access, and the determinations of the field geologist. Borings will be drilled to varying depths based on the proposed location of the impoundment so that the exploration program provides a representative characterization of subsurface conditions across the Site.

Additional sediment from the geotechnical borings will be collected to supplement data collected for the nature and extent evaluation (Study Element 1) and the exposure evaluation (Study Element 2). The geotechnical data will be used for the physical conceptual site model and fate and transport evaluation (Study Element 3) and the engineering construction evaluation (Study Element 4).

The boring program consists of two 120-foot-deep (below mudline) borings and five 60-foot (18-m)-deep borings around the perimeter of the potential CDF. Within the potential CDF footprint, two 30-foot (9-m)-deep borings will be advanced. Samples will be collected continuously from 0 to 10-foot and at 5-foot (1.5-m) depth intervals below 10 feet in each boring. The actual depth interval for thin-walled tube sampling will be selected in the field

by the geologist depending on the subsurface conditions encountered during drilling, so that the thin-walled tube will target fine-grained materials and/or depth intervals that are proposed for either triaxial or consolidation testing.

Undisturbed thin-walled tube samples will be collected following American Society for Testing and Materials (ASTM) D1587 *Standard Practice for Thin-Walled Tube Sampling of Soils for Geotechnical Purposes* and will be handled following ASTM D3213 *Standard Practice for Handling, Storing, and Preparing Soft Undisturbed Marine Soil*. These standards cover the methods for project/cruise reporting, collecting, handling, transporting, and storing soft cohesive undisturbed marine sediment. Geotechnical testing will include grain size (ASTM D422), Atterberg limits (ASTM D4318), moisture content (ASTM D2216), specific gravity (ASTM D854), permeability (ASTM D5084), consolidated undrained (CU) triaxial compression (ASTM D4767), and consolidation testing (ASTM D2435). Table A-6 summarizes the uses of the geotechnical laboratory testing that will be performed and provides the applicable ASTM standard that will be applied to each test (ASTM 2003).

The subsequent sections provide details regarding split-spoon and thin-walled tube sample collection methods, processing methods, and the boring design plan.

#### 2.2.4.3.1 Split-Spoon and Thin-Walled Tube Sample Collection Methods

Sediment samples will be collected by advancing a series of borings around the Site. Depending on drill rig availability, either hollow-stem auger or mud rotary methods will be used. The over-water boring locations will be advanced from a barge.

The hollow-stem auger or mud rotary casing will be advanced into the sediment to the top of the depth interval of interest. After the target depth is reached, sediment will be collected by advancing a split-spoon or thin-walled tube. For split-spoon sampling, a 2-inch (5 cm) outside diameter split spoon will be driven 18 inches. Field conditions may require a 3-inch (7.6 cm) outside diameter split spoon. Undisturbed samples will be obtained by pushing a 3-inch (7.6 cm) diameter thin-walled tube 2 feet using a constant push from hydraulics reacting off the drill rig (per ASTM D1587).

A lead line measurement of depth to the mudline will be taken prior to sampling or drilling over the water. The measurement will be cross checked by recording the lengths of hollow-stem auger or casing used to reach the mudline surface below the water. Where soft sediment is present at the sampling location, this method of cross check will be closely reviewed by the field geologist to evaluate whether the auger/casing has penetrated below the mudline under its own weight.

During split-spoon sampling, the number of hammer blows required to advance the spoon in 6-inch (15-cm) increments will be recorded as a measure of sediment density using the SPT (see Section 3.2 for detailed information on boring logs). This test is an approximate measure of sediment density and consistency. As described in ASTM D 1586, this test employs a standard 2-inch (5-cm) outside diameter split-spoon sampler. Using a 140-pound (64-kg) hammer free falling 30 inches (76 cm), the sampler is driven into the sediment for 18 inches (46 cm). The number of blows required to drive the sampler the last 12 inch (30 cm) is the standard penetration resistance. This resistance, or blow count, measures the relative density of granular sediments and the consistency of cohesive solids.

If dense materials (i.e., more than 50 blows per 6-inch [15-cm] drive) preclude driving the total 18-inch (46-cm) sample, the penetration resistance is entered in one of two ways. For sample sizes less than 6 inches (15 cm), the total number of blows over the number of inches of penetration on the boring log (e.g., "50/3") is entered. For samples larger than 6 inches, the number of blows completed after the first 6 inches of penetration are summed. This sum is expressed over the number of inches driven that exceed the first 6 inches (e.g., "50/9"). In determining the final SPT blow count, the number of blows needed to drive the first 6 inches is not reported, because this first interval is considered potentially disturbed by the drilling action.

The tube ends of the undisturbed thin-walled tube samples will be sealed in the field, per SOP 6.3 (see Attachment A2) to prevent leakage of porewater. The tubes will be maintained in a vertical orientation and transported to the laboratory with minimal disturbance. The undisturbed thin-walled tubes will be sealed and submitted to the analytical laboratory for further testing. The sample intervals for laboratory testing will be determined by the Anchor QEA field lead based on review of the field logs. Fine-grained sediment subsamples

will undergo consolidation testing and CU triaxial shear testing and will be analyzed for grain size distribution, water content, permeability, specific gravity, and Atterberg limits. The laboratory will also record the Unified Soil Classification System (USCS) classification of the undisturbed samples.

Depending on the analyses, the geotechnical boring will either be placed in new, labeled clean plastic or glass jars, labeled zip-lock bags (double bagged), or will be maintained as an intact core (e.g., thin-walled tube). Each sample container will be clearly labeled with the task name, sample number, depth interval, type of analysis to be performed, date and time, and initials of person(s) preparing the sample. Geotechnical samples will be stored at room temperature out of direct sunlight.

As stated above, a sample matrix table (which will be prepared prior to initiating the sampling event) will show the kinds of geotechnical samples needed at each station. Anchor QEA's field lead and field personnel in charge of sample handling in the field will use this table as a QC check to ensure that all samples and field tests at a given station are collected and that the appropriate container is used for each sample.

#### 2.2.4.3.2 Split-Spoon Sample and Thin-Walled Tube Processing Methods

Split-spoon samples will be logged on Site by an experienced field geologist or geotechnical engineer (see Section 3.3 for detailed information on split-spoon logs). Discrete samples will be taken directly from the selected depth interval and spooned into laboratory-supplied jars for geotechnical physical testing. The samples will be placed in a cooler out of direct sunlight until transported to the testing laboratory. A COC form will be logged by the processing staff and relinquished to the courier and then to laboratory staff.

Thin-walled tube samples do not allow for direct observation or logging in the field. When recovered from the boring, the tubes will be measured for amount of recovery and checked to ensure the tube was not dented or damaged while being driven or removed. The tubes will then be quickly cleaned, sealed with a plastic cap and duct tape on both ends, and labeled with boring name, sample name, date, approximate depth, and the location of the top of the sample with respect to the orientation at which it was removed from the subsurface.

Every effort will be made to store and transport the thin-walled tubes with minimal disturbance in the upright, vertical position.

### *2.2.4.4 Vane Shear Tests*

Six VSTs are planned for the potential CDF area. Figure A-4 depicts proposed vane shear sampling locations; the sampling scheme is summarized in Table A-7. At each location, tests will be performed at the 1-foot (30-cm), 2-foot (60-cm), and 3-foot (90-cm) depth intervals below mudline. Peak and residual strength measurements will be made for each location and depth interval.

*In situ* strength of the near surface sediments will be measured using field vane shear equipment. This information will be used to supplement surficial data that will potentially be missed in the first sample interval during the boring program. Test results will be corrected using geotechnical index parameters measured on surface grab samples collected at each VST location. The subsequent sections provide details regarding vane shear collection methods and the sampling design plan.

At each VST location, a lead line measurement of depth to the mudline will be taken prior to testing. Where water is too deep to complete the test (e.g., approximately more than 12 to 15 feet [3.7 to 4.6 m] of water), the field geologist may elect to field-adjust the VST location. After the water depth has been measured, the time of testing will be marked on the field log. This time, combined with the date, will be used to estimate river stage elevation during the test using the nearest tide gage. The mudline elevation of each VST will be computed by subtracting the depth to mudline from the water level elevation.

#### 2.2.4.4.1 Vane Shear Collection Methods

Vane shear data will be collected from a shallow draft boat or the drill barge using VST equipment. VSTs will be performed in accordance with ASTM D2573 and the manufacturers' recommended SOP. The VST equipment will be operated by pushing the vane into the sediment to the required depth and making sure that the scale-ring is set to the zero position. The handle is turned clockwise slowly until the lower part of the scale follows the upper part around, indicating failure. Peak undrained shear strengths are obtained in the

sediment at the vane and will be recorded on field forms (Attachment A3; see Section 3.4 for detailed information on VST logs).

Once peak strength has been measured, the VST will be rotated 360 degrees relatively quickly several times. The scale will be re-zeroed, and another strength measurement will be completed. After recording the data for each test, the handle will be held firmly and allowed to return to the zero position.

Surface grabs will be co-located with vane shear locations in order to characterize the material and to standardize the field VST results using laboratory tests. Surface sediment will be collected using a van Veen grab sampler, Ekman grab sampler, or box grab sampler.

As stated above, a sample matrix table (which will be prepared prior to initiating the sampling event) will show the kinds of VST samples needed at each station. Anchor QEA's field lead and field personnel in charge of sample handling in the field will use this table as a QC check to ensure that all samples and field tests at a given station are collected and that the appropriate sample container is used for each sample.

### *2.2.5 Equipment Decontamination*

Before sampling begins at a location, the grab sampler will be scrubbed with a standard detergent (e.g., Alconox® or Liquinox®), rinsed with water (river, tap, or deionized water), air-dried, and rinsed with river water. Equipment used for compositing the sediment samples (i.e., stainless-steel bowls and spoons) will follow the same basic decontamination sequence, except that the final rinse will be with laboratory-grade distilled/deionized water. After cleaning, the decontaminated sample homogenizing equipment will be covered with aluminum foil to protect it from possible contamination.

Prior to subsurface sampling, all core liners will be washed in sequence with a standard detergent (e.g., Alconox® or Liquinox®), rinsed with laboratory grade distilled/deionized water, and then air-dried. During storage and transport, decontaminated Lexan® core liners will be capped at both ends to prevent contamination.

All non-dedicated sampling equipment that comes into contact with the sediment samples (e.g., core catchers, grab samplers, core liners, stainless-steel bowls, and utensils) will be decontaminated prior to use and between samples. Non-dedicated sampling equipment will be decontaminated following procedures in SOP SD-01 (Attachment A2), except that no solvent rinse will typically be used. If samples are collected that include obvious oily contamination, the sampling equipment used to collect and process them will be decontaminated using a separate decontamination station dedicated to heavily impacted equipment. This equipment will be wiped with a solvent following the initial decontamination, and it will undergo a second decontamination sequence using the standard decontamination procedures used for the non-oil-impacted equipment.

## 2.3 Field Quality Control Samples

Field QC samples will be used to assess sample variability and evaluate potential sources of contamination. The types of QC samples that will be collected for the 2010 sediment study are described in this section. Detailed information on quality assurance and quality control (QA/QC) procedures, limits, and reporting are described in detail in the SAP. The estimated numbers of field QC samples to be collected are listed in the sample matrix table (Table A-3). If QC problems are encountered, they will be brought to the attention of Integral's QA coordinator. Corrective actions, if appropriate, will be implemented to meet the task's data quality indicators.

Field QC samples will include field split samples, field triplicate samples, standard reference materials, equipment filter wipe blanks, and filter blanks. The following QC samples will be collected in the field and analyzed by the analytical laboratory:

- Field split samples will be collected and analyzed to assess the variability associated with sample processing and laboratory variability. Blind field split samples will be collected at a minimum frequency of 1 field split sample per 20 sediment sampling stations. Samples will be assigned unique numbers and will not be identified as field splits to the laboratory. Field split samples will be collected from both surface and subsurface sediment samples for chemical analysis. A minimum of one field split sample will be collected for each kind of sample collected. A field split sample will be collected at every 20th station.

- Field triplicate 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 triplicate samples will be prepared by collecting three completely separate samples from the same station and submitting them for analysis as separate samples. During the 2010 sediment study, field triplicate samples will be collected at one station (SJNE022) and will be placed approximately 33 feet (10 m) apart, roughly in the shape of a triangle.
- Standard reference materials are samples of known concentration that have typically undergone multilaboratory analyses using a standard method. Reference materials provide a measure of analytical performance and/or analytical method bias. Where available, reference materials for sediments will be submitted from the field at a frequency of once per sampling event.
- Equipment filter wipe blanks will be collected to help identify possible contamination from the sampling environment or from the sampling equipment (e.g., stainless-steel spade, coring device, spoons, and bowls). Equipment filter wipe blanks will be generated at approximately 5 percent of the sediment sampling stations at a minimum. Field equipment filter wipe blanks will be collected from both surface and subsurface sediment samples for chemical analysis. All equipment wipe samples will be clearly noted in the field log (e.g., sample identifier, equipment type, date and time of collection, analysis, and filter lot number).
- A minimum of one field equipment filter wipe blank will be collected for each kind of sampling equipment used for chemical analyses. A filter wipe blank will be collected at every 20th station. One equipment wipe will be prepared for each analysis type. If multiple analyses are requested, separate sets of filter wipes will be collected for each analysis type for each kind of sampling equipment used, as the equipment can be wiped down only once for each piece of filter paper. This ensures that the filter wipe result represents the most conservative estimate of cross contamination for each analysis type. (*Note*: Filter papers must be stored in their original box, wrapped carefully in three layers of aluminum foil, or contained in a glass jar. The filter paper box cannot be stored in plastic bags or containers.)
- Filter blanks are prepared in the field to evaluate potential background concentrations present in filter paper used for the equipment filter wipe blank. Filter blanks will be

collected at a minimum frequency of one for each lot number of filter papers used for collecting the equipment wipe blanks.

## 2.4 Sample Packaging and Transport

As mentioned above, sample coolers and packing materials will be supplied by the analytical laboratories. Individual sample jars will be labeled and placed into plastic bags and sealed. Samples will then be packed in a cooler lined with a large plastic bag. Glass jars will be packed to prevent breakage and separated in the cooler by bubble wrap or other shock-absorbent material. Ice in sealed plastic bags will then be placed in the cooler to maintain a temperature of approximately 4°C (±2°C). When the cooler is full, the COC form will be placed into a zip-locked bag and taped to the inside lid of the cooler. A temperature blank will be added to each cooler. Each cooler will be sealed with two COC seals, one each on the front and side of the cooler. Labels indicating "This End Up"with an arrow and "Fragile" will be attached to each cooler.

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

After the chemistry samples have been received by the laboratory, they will be stored under refrigeration (4±2°C). Archive sediment samples collected from each composite sample for possible future analysis will be stored frozen at –20°C.

## 2.5 Study-Derived Wastes

Any excess phosphate-free, detergent-bearing liquid wastes from decontamination or any sample remaining after processing will be deposited in the vicinity of the collection area. Any dry waste (e.g., contaminated boots, bibs, Tyvek™ suits, contaminated sediments) present at the end of the sampling event will be segregated and containerized (e.g., 50-gallon drums) and disposed of by a subcontractor specialized in hazardous waste removal. The

subcontractor 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 hazardous wastes
- Safe and proper transportation
- Environmentally sound treatment and disposal
- Regularly scheduled service visits with manifest and label preparation.

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 for disposal at a solid waste landfill.

# 3 FIELD DOCUMENTATION

The integrity of each sample from the time of collection to the point of data reporting must be maintained. Proper 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 (e.g., near the impoundment, downstream of the I-10 Bridge, upstream of the preliminary Site perimeter, and at each intertidal and upland station). A photograph will be taken of each subsurface sediment interval collected for nature and extent evaluation and for geotechnical testing. Site photos from various angles and close-up views of the overall conditions will also be collected.

## 3.1 Field Log Book

All field activities and observations will be noted in a log book. The field log book will be a bound document and may contain individual field and sample log forms (depending on the sampling activity). 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. The log book will identify on-site visitors (if 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. and 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 makes 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 and/or field data forms includes the following:

- Task name, task location, and task number
- Task start date and end date
- Weather conditions
- Name of person making entries and other field staff
- On-site visitors, if any
- Sampling vessel, if any
- Station number and location
- Date and collection 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 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 0.5 cm) based on sediment depth at the center of the excavation
- Any visible debris near any of the sampling locations

- Any surface vegetation that is removed from the sampling location prior to sampling
- The locations of any surface water runoff or seeps that are located near any of the sampling stations
- The number of photographs taken at the sampling location
- A record of Site health and safety meetings, updates, and related monitoring
- Any deviation from the FSP and reasons for deviation.

In addition, a sampling location map will be updated during sampling and will be maintained throughout the sampling event. All 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 Boring Logs

The blow counts that occur during thin-walled tube collection will be plotted on boring logs at their respective sample depths. The field geologist will record field conditions and drive notes on a standard boring log (Attachment A3). Logs will include the following information:

- Date and time of collection of each sediment core sample
- Names of field personnel collecting and handling the samples
- Type of sampling equipment used (e.g., split-spoon diameter, hammer weight, free fall height, and hammer deployment method)
- Observations made during sample collection, including weather conditions, complications, and other details associated with the sampling effort
- The sample station identification
- Length and depth intervals of each core section and estimated recovery
- Qualitative notation of apparent resistance during driving
- Any deviation from the approved FSP.

## 3.3 Split-Spoon Logs

Prior to subsampling from either the split-spoon or the thin-walled tube, a sediment description of each sample will be recorded on a standard boring log (Attachment A3) by an

experienced field geologist or geotechnical engineer. The following parameters will be noted in the logs:

- Sample recovery
- Physical sediment description in accordance with the USCS (includes sediment type, moisture, density/consistency of sediment, and color)
- Odor (e.g., hydrogen sulfide, or petroleum)
- Visual stratification, structure, and texture
- Vegetation
- Debris (e.g., woodchips or fibers, concrete, or metal debris)
- Evidence of biological activity (e.g., detritus, shells, tubes, bioturbation, or live or dead organisms)
- Presence of oil sheen.

## 3.4 Vane Shear Test Logs

The following parameters will be noted in the VST logs:

- Peak undrained shear strengths
- Peak undrained strength (recorded as the residual undrained shear strength)
- Values on the graduated scale
- Position of the hole
- Depth.

## 3.5 Chain-of-Custody Procedures

Samples are in custody if they are in the custodian's view, stored in a secure place with restricted access, or placed in a container secured with custody seals (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 A3 contains an example of the COC form that will be used during the 2010 sediment study.

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

- Site name
- Field lead'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.

Integral's field lead or Anchor QEA's field lead (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.

## 3.6 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 a two-letter code for the type of sample to be collected at a given location (NE = nature and extent, SH = shoreline, GB = geotechnical boring, and VS = vane shear). The letters will be followed by a three-digit number (e.g., 001, 002, or 003). The station numbers will increase as the stations move upstream. An example station number for the 2010 sediment study would be SJNE033.

Station numbers will not be recorded on sample labels or COC forms to prevent analytical laboratories from seeing the relationships between samples and stations.

## 3.7 Sample Identifiers

Each sediment sample from a given station will also have a unique label identifier. Sample identifiers will be established before field sampling begins and assigned to each sample as it is collected. Sample identifiers consist of codes designed to fulfill three purposes: 1) to identify related samples (i.e., field split samples) to ensure proper data analysis and interpretation; 2) to obscure the relationships between samples so that laboratory analysis will be unbiased by presumptive similarities between samples; and 3) to track individual sample containers to ensure that the laboratory receives all of the material associated with a single sample. To accomplish these purposes, each container is assigned a sample number and a tag number. These codes and their uses are described below:

- A sample identifier for each surface sample will be created as follows: the station number (e.g., SJNE033), followed by a two-letter code for the kind of sample collected at a given location (GR = grab sample, CR = core, GB = geotechnical boring, and VS = vane shear). In addition, subsurface core samples for chemical analyses will also have a final alpha character attached to the sample identifier that will distinguish between the different sample intervals of the core (e.g., A = 0 to 1 foot [0 to 30 cm], B = 1 to 2 feet [30 to 60 cm], C = 2 to 3 feet [60 to 90 cm], and so on, to refusal or to a

maximum depth of 10 feet [3 m]). Example identifiers for a surface sediment sample and a co-located coring station would be SJNE033-GR1 and SJNE033-CR1A, SJNE033-CR1B, SJNE033-CR1C, and so on. If a second core were required at a given station to obtain the required sample volume, then example sample identifiers for this second core would be SJNE033-CR2A, SJNE033-CR2B, SJNE033-CR2C, and so on.

- The sample number is an arbitrary number assigned to each sediment sample collected (e.g., SD0001, SD0002) for chemical analysis. All subsamples of a composited field sample will have the same sample number. Each field split sample and each field triplicate will have a different sample number, and the sample numbers of related field QC samples may not share any content. The sample number appears on the sample containers and the COC forms.
- Sample numbering for geotechnical borings will consist of the boring location number, followed by a dash, followed by a sequential sample number in the form of S and a digit. Thus, at location SJGB001, the samples would be numbered SJGB001-S1, SJGB001-S2, and so on.
- The test number at a vane shear location will consist of the test location followed by a dash, followed by the test depth (in feet below mudline), and ending in P or R (P = peak shear strength, R = residual shear strength). Thus for location SJVS001, the tests would be reported as SJVS001-1P, SJVST001-1R, SJVS001-2P, and so on.
- A unique numeric sample tag number will be attached to each sample container. If the amount of material (i.e., everything associated with a single sample number) is too large for a single container, each container will have the same sample number and a different sample label with a unique sample tag number. 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 will appear on the COC forms. Tag numbers are used by laboratories only to confirm that they have received all of the containers that were filled and shipped. Data are reported by sample number.

Sample numbers will be assigned sequentially in the field, and sample labels will be preprinted with tag numbers.

For equipment filter wipe blanks, sequential numbers starting at 900 will be assigned instead of station numbers. For example, the first filter wipe blank for a surface sediment sample collected with a stainless steel spoon and stainless steel bowl will be labeled as SDFW-901S, whereas the second filter wipe blank for a subsurface sediment sample collected with a coring device will be labeled as SDFW-902C (SD = sediment, FW = filter wipe, S = stainless steel spoon and bowl, and C = core).

# 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. 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, data sheets (if any), and COC forms 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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# TABLES

**Table A-1**
**Number of Locations Sampled[a]**

| Sample Group | Sampling Method and Depth | Number of Locations | Sample Locations | Analytes | Study Elements |
|---|---|---|---|---|---|
| Site surface sediment, primary COPCs | Grab sampler, surface 10 cm (0-4 inches) | 44 | 152-m (500-foot) grid within 305 to 457 m (1,000 to 1,500 feet) of the impoundments and property west of the impoundments, 305-m (1,000-foot) grid elsewhere[b] | Primary COPCs, organic carbon, grain size, and solids. Sediment for analysis of secondary COPCs will be archived. | Nature and extent, ecological exposure, fate and transport |
| Impoundment characterization sample | Grab sampler, surface 10 cm (0-4 inches) | 7 | Within the impoundment area | 3 stations for primary and secondary COPCs, organic carbon, grain size, and solids; 4 stations for primary COPCs, organic carbon, grain size, and solids. Sediment for analysis of secondary COPCs will be archived at these 4 stations. | Nature and extent, characterization of waste materials |
| Site surface sediment, all COPCs | Grab sampler, surface 10 cm (0-4 inches) | 14 | Selected locations on a 152-m (500-foot) grid within approximately 305 m (1,000 feet) of the impoundments (coincident with core locations) | Primary and secondary COPCs, organic carbon, grain size, solids, and specific gravity. | Nature and extent, ecological exposure, fate and transport |
| Site subsurface sediment | Cores to refusal or maximum depth of 3 m (10 feet), sectioned at 30-cm (1-foot) intervals | 14 | Selected locations on a 152-m (500-foot) grid within approximately 305 m (1,000 feet) of the impoundments | Primary COPCs, organic carbon, grain size, and solids. Sediment for analysis of secondary COPCs will be archived. (Atterberg limits and specific gravity at all core locations). | Nature and extent, dredging assessment |
| Shoreline sediment for human health risk assessment | Surface 0-15 cm (0-6 inches) and subsurface 15-30 cm (6-12 inches) | 45 | 10 per beach on four beaches; 5 on one beach downstream of Site | 5 surface sediment samples from each of the exposure areas on the five beaches and the corresponding subsurface sediment samples from the eastern shoreline of the property west of the impoundments will be analyzed initially for primary COPCs. Any remaining surface samples from each area, 5 subsurface samples from the eastern shoreline of the property west of the impoundments, and all subsurface samples from the other exposure areas will be archived. | Exposure for human health risk assessment, support ecological risk assessment |
| Shoreline sediment for ecological risk assessment | Grab sampler, surface 10 cm (0-4 inches) | 6 | 3 in each of two locations to represent ecological exposures | Primary COPCs, organic carbon, grain size, and solids. Sediment for analysis of secondary COPCs will be archived. | Exposure for ecological risk assessment |
| Upstream background surface samples | Grab sampler, surface 10 cm (0-4 inches) | 11 | Upstream in San Jacinto River on four transverse transects | Primary and secondary COPCs, organic carbon, grain size, solids, and specific gravity. | Nature and extent, ecological exposure, fate and transport |
| Upstream shoreline sediment for human health risk assessment | Surface 1-15 cm (0-6 inches) and subsurface 15-30 cm (6-12 inches) | 10 | 10 per beach on one beach | Primary COPCs, organic carbon, grain size, and solids on 5 surface samples. Remainder of surface samples and all of the subsurface samples will be archived. | Exposure for human health and ecological risk assessments |
| Upstream shoreline sediment for ecological risk assessment | Grab sampler, surface 10 cm (0-4 inches) | 3 | 3 on one beach to represent ecological exposures | Primary COPCs, organic carbon, grain size, solids, and specific gravity. Sediment for analysis of secondary COPCs will be archived. | Exposure for ecological risk assessment |
| Soil borings in the impoundment and berm | Various depths depending on location | 17 | In areas of berm reconstruction and in the impoundment area. | Atterberg limits, grain size, moisture content, specific gravity, sediment compressibility, sediment permeability, consolidated undrained triaxial compressive strength. Primary and secondary COPCs in 8 select locations from within the former impoundment | Remedial design and potential CDF evaluation |
| Vane shear tests in the impoundment and berm | Surface | 18 | In areas of berm reconstruction and in the impoundment area | Undrained shear strength | Remedial design and potential CDF evaluation |
| Sediment surface grabs associated with vane shear tests | Grab sampler, surface 10 cm (0-4 inches) | 18 | In areas of berm reconstruction and in the impoundment area | Atterberg limits, specific gravity, grain size, moisture content | Remedial design and potential CDF evaluation |

**Notes**

CDF = confined disposal facility
COPC = chemical of potential concern
a - Numbers do not include field quality control samples, and cores, which generate more than one "sample," are counted only once.
b - With some distance adjustments at three stations south of I-10 to place stations within the river rather than on land.

**Table A-2**
**Sample Containers, Preservation, and Holding Time Requirements**

| Matrix | Container [a] Type | Container [a] Size | Laboratory | Parameter | Preservation | Holding Time | Sample Size [b] |
|---|---|---|---|---|---|---|---|
| **Sediment** | | | | | | | |
| | WMG | 8 oz. | TBD | Percent moisture (EPA 160.3) | 4±2 °C | 6 months | 10 g |
| | | | | TOC | 4±2 °C | 28 days | 1 g |
| | | | | Metals | 4±2 °C | 6 months | 10 g |
| | | | | Mercury | 4±2 °C | 28 days | 5 g |
| | WMG | 16 oz. | TBD | Grain size | 4±2 °C | 6 months | 100 g |
| | WMG | 8 oz. | TBD | Atterberg limits | 4±2 °C | NA | 225 g |
| | | | | Percent moisture (ASTM D 2216) | 4±2 °C | 6 months | 10 g |
| | | | | Specific gravity | 4±2 °C | NA | |
| | WMG | 8 oz. | TBD | Dioxins/furans | 4±2 °C/Deep frozen (-20 °C) c/ -10 °C d | 1 year/1 year [e] | 50 g |
| | WMG | 8 oz. | TBD | PCB Congeners, dioxin-like | 4±2 °C/Deep frozen (-20 °C) c/ -10 °C d | 1 year/1 year [e] | 50 g |
| | WMG | 8 oz. | TBD | SVOCs (BEHP only; BEHP & secondary COPCs where analyzed) | 4±2 °C | 14 days/40 days [e] | 50 g |
| | WMG | 8 oz. | TBD | SVOCs (archive for possible analysis of secondary COPCs) [f] | 4±2 °C / Deep frozen (-20 °C) c | 1 year [g] | 50 g |
| | WMG | 8 oz. | TBD | PCB Aroclors | 4±2 °C / 4±2 °C/Deep frozen (-20 °C) c | 14 days/40 days [e] / 1 year [g] | 50 g |
| | WMG | 2 oz. | TBD | VOCs | 4±2 °C; do not freeze | 14 days | 5 g |
| | WMG | 8 oz. | NA | Archival | 4±2 °C/ Deep frozen (-20 °C) c | NA | N/A |
| | Thin wall sampler | -- | TBD | Sediment permeability | Airtight seal | 6 months [h] | N/A |
| | Thin wall sampler | -- | TBD | Consolidated undrained triaxial compressive strength | Airtight seal | 6 months [h] | N/A |
| | Thin wall sampler | -- | TBD | Sediment compressibility | Airtight seal | 6 months [h] | N/A |
| **Equipment Filter Wipe Blanks** | | | | | | | |
| | HDPE | 4 oz. | TBD | Metals | 4±2 °C | 6 months | 1 wipe |
| | HDPE | 4 oz. | TBD | Mercury | 4±2 °C | 28 days | 2 wipe |
| | AG | 4 oz. | TBD | Dioxins/furans | 4±2 °C | 1 year/1 year [e] | 3 wipe |
| | AG | 4 oz. | TBD | SVOCs | 4±2 °C | 7 days/40 days [e] | 4 wipe |

**Notes**

AG = amber glass
COPC = chemical of potential concern
BEHP = bis(2-ethylhexyl)phthalate
HDPE = high density polyethylene
NA = not applicable
PCB = polychlorinated biphenyl
SVOC = semivolatile organic compound
TBD = to be determined
VOC = volatile organic compound
WMG = wide mouth glass

a - The size and number of containers may be modified by the analytical laboratory.
b - Sample sizes may be modified one laboratory selection is made.
c - Samples will be shipped to the laboratory on ice at 4±2 °C. Once received at the laboratory, samples will be stored at -20 °C.
d - Extracts will be stored at -10 °C.
e - Holding time for samples prior to extraction/ holding time for extracts.
f - Collected only for samples that are archived for possible future analysis of secondary COPCs.
g - Holding time for frozen samples is 1 year.
h - Published holding time does not exist. Holding time shown is based on best professional judgment.

**Table A-3**
**Field Sample Collection Matrix**

| | | | | | Chemistry Grab and Core Samples | | | | | | | | Geotechnical Boring | | | | | | Blank Filter Wipes (Whatman Grade 42 filters ) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Primary | | | | Secondary | | | | | | | | | | | | | |
| | | | | | TOC, Metals, Mercury, and Percent Moisture (EPA 160.3) | Grain Size | ☐ BEHP ❍ All SVOCs + PCB Aroclors | ☐ PCDD/F ❍ PCDD/F + PCB congeners[f] | Archive SVOCs and PCB Aroclors | VOCs HOLD | VOCs RUSH | Archival ☐ 32 oz ❍ 8 oz | Atterberg limits (ASTM D-4318), Specific gravity (ASTM D-854), Percent moisture (ASTM D 2216) | Grain Size | Sediment permeability (ASTM D-5084) | CU Triax, Compressive Strength (ASTM D-4767) | Consolidation Test (ASTM D-2435) | Vane Shear Test (ASTM D-2573) | Metals | Mercury | Dioxins/ Furans | SVOCs |
| | | | | | 8 oz WMG[a] | 16 oz WMG[a] | 8 oz WMG[a] | 8 oz WMG[a] | 8 oz WMG[a] | 2 oz WMG[a] | 2 oz WMG[a] | WMG[a] | 8 oz WMG[a] | 16 oz WMG[a] | Shelby tube | Shelby tube | Shelby tube | Vane | 4 oz WMG[a] | 4 oz WMG[a] | 4 oz WMG[a] | 4 oz WMG[a] |
| Station | Sample ID | Sample Type | Approximate Number of Subsamples | Sample Group | 4±2 ºC | 4±2 ºC | 4±2 °C | 4±2 °C/ Deep frozen (-20°C)[b]/-10 °C[c] | 4±2 °C/ Deep frozen (-20 °C)[b] | 4±2 ºC; do not freeze; HOLD lab analysis[e] | 4±2 ºC; do not freeze; RUSH lab analysis[e] | 4±2 °C/ Deep frozen (-20°C)[b] | 4±2 ºC | 4±2 ºC | Airtight seal, store vertically | Airtight seal, store vertically | Airtight seal, store vertically | - in situ - | 4±2ºC | 4±2ºC | 4±2ºC | 4±2ºC |
| ☐ SJGB001 | SJGB001-S__ | Geotech 60-foot boring[d] | 15 | Source station | | | | | | | | | ☐ | ☐ | ☐ | ☐ | ☐ | | | | | |
| ☐ SJGB002 | SJGB002-S__ | Geotech 60-foot boring[d] | 15 | Source station | | | | | | | | | ☐ | ☐ | ☐ | ☐ | ☐ | | | | | |
| ☐ SJGB003 | SJGB003-S__ | Geotech 60-foot boring[d] | 27 | Source station | | | | | | | | | ☐ | ☐ | ☐ | ☐ | ☐ | | | | | |
| ☐ SJGB004 | SJGB004-S__ | Geotech 60-foot boring[d] | 15 | Source station | | | | | | | | | ☐ | ☐ | ☐ | ☐ | ☐ | | | | | |
| ☐ SJGB004 | SJGB004-GR1 | Surface grab | 1 | Additional characterization | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ❍ | | | | | | | | | | |
| ☐ SJGB005 | SJGB005-S__ | Geotech 60-foot boring[d] | 15 | Source station | | | | | | | | | ☐ | ☐ | ☐ | ☐ | ☐ | | | | | |
| ☐ SJGB005 | SJGB005-GR1 | Surface grab | 1 | Additional characterization | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ❍ | | | | | | | | | | |
| ☐ SJGB006 | SJGB006-S__ | Geotech 30-foot boring[d] | 9 | Source station | | | | | | | | | ☐ | ☐ | ☐ | ☐ | ☐ | | | | | |
| ☐ SJGB007 | SJGB007-S__ | Geotech 120-foot boring[d] | 27 | Source station | | | | | | | | | ☐ | ☐ | ☐ | ☐ | ☐ | | | | | |
| ☐ SJGB007 | SJGB007-GR1 | Surface grab | 1 | Additional characterization | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ❍ | | | | | | | | | | |
| ☐ SJGB008 | SJGB008-S__ | Geotech 60-foot boring[d] | 15 | Source station | | | | | | | | | ☐ | ☐ | ☐ | ☐ | ☐ | | | | | |
| ☐ SJGB008 | SJGB008-GR1 | Surface grab | 1 | Additional characterization | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ❍ | | | | | | | | | | |
| ☐ SJGB009 | SJGB009-S__ | Geotech 30-foot boring[d] | 9 | Source station | | | | | | | | | ☐ | ☐ | ☐ | ☐ | ☐ | | | | | |
| ☐ SJGB010 | SJGB010-S__ | Geotech 20-foot boring[d] | 8 | Source station | ☐ | ☐ | ❍ | ❍ | | | ☐ | ❍ | ☐ | ☐ | ☐ | ☐ | ☐ | | | | | |
| ☐ SJGB011 | SJGB011-S__ | Geotech 20-foot boring[d] | 8 | Source station | ☐ | ☐ | ❍ | ❍ | | | ☐ | ❍ | ☐ | ☐ | ☐ | ☐ | ☐ | | | | | |
| ☐ SJGB012 | SJGB012-S__ | Geotech 20-foot boring[d] | 8 | Source station | ☐ | ☐ | ❍ | ❍ | | | ☐ | ❍ | ☐ | ☐ | ☐ | ☐ | ☐ | | | | | |
| ☐ SJGB013 | SJGB013-S__ | Geotech 20-foot boring[d] | 8 | Source station | ☐ | ☐ | ❍ | ❍ | | | ☐ | ❍ | ☐ | ☐ | ☐ | ☐ | ☐ | | | | | |
| ☐ SJGB014 | SJGB014-S__ | Geotech 20-foot boring[d] | 8 | Source station | ☐ | ☐ | ❍ | ❍ | | | ☐ | ❍ | ☐ | ☐ | ☐ | ☐ | ☐ | | | | | |
| ☐ SJGB015 | SJGB015-S__ | Geotech 20-foot boring[d] | 8 | Source station | ☐ | ☐ | ❍ | ❍ | | | ☐ | ❍ | ☐ | ☐ | ☐ | ☐ | ☐ | | | | | |
| ☐ SJGB016 | SJGB016-S__ | Geotech 20-foot boring[d] | 8 | Source station | ☐ | ☐ | ❍ | ❍ | | | ☐ | ❍ | ☐ | ☐ | ☐ | ☐ | ☐ | | | | | |
| ☐ SJGB017 | SJGB017-S__ | Geotech 20-foot boring[d] | 8 | Source station | ☐ | ☐ | ❍ | ❍ | | | ☐ | ❍ | ☐ | ☐ | ☐ | ☐ | ☐ | | | | | |
| ☐ SJVS001 | SJVS001-1P/R | Vane shear | 1 | Source station | | | | | | | | | ☐ | | | | | ☐ | | | | |
| ☐ SJVS001 | SJVS001-GR1 | Surface grab | 1 | Additional characterization | ☐ | ☐ | ❍ | ❍ | | | ☐ | ❍ | | | | | | | | | | |
| ☐ SJVS002 | SJVS002-1P/R | Vane shear | 1 | Source station | | | | | | | | | ☐ | | | | | ☐ | | | | |

**Table A-3**
**Field Sample Collection Matrix**

| | | | | | Chemistry Grab and Core Samples | | | | | | | | Geotechnical Boring | | | | | | Blank Filter Wipes (Whatman Grade 42 filters ) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Primary | | | | Secondary | | | | | | | | | | | | | |
| | | | | | TOC, Metals, Mercury, and Percent Moisture (EPA 160.3) | Grain Size | ☐ BEHP ❍ All SVOCs + PCB Aroclors | ☐ PCDD/F ❍ PCDD/F + PCB congeners[f] | Archive SVOCs and PCB Aroclors | VOCs HOLD | VOCs RUSH | Archival ☐ 32 oz ❍ 8 oz | Atterberg limits (ASTM D-4318), Specific gravity (ASTM D-854), Percent moisture (ASTM D 2216) | Grain Size | Sediment permeability (ASTM D-5084) | CU Triax, Compressive Strength (ASTM D-4767) | Consolidation Test (ASTM D-2435) | Vane Shear Test (ASTM D-2573) | Metals | Mercury | Dioxins/ Furans | SVOCs |
| | | | | | 8 oz WMG[a] | 16 oz WMG[a] | 8 oz WMG[a] | 8 oz WMG[a] | 8 oz WMG[a] | 2 oz WMG[a] | 2 oz WMG[a] | WMG[a] | 8 oz WMG[a] | 16 oz WMG[a] | Shelby tube | Shelby tube | Shelby tube | Vane | 4 oz WMG[a] | 4 oz WMG[a] | 4 oz WMG[a] | 4 oz WMG[a] |
| Station | Sample ID | Sample Type | Approximate Number of Subsamples | Sample Group | 4±2 ºC | 4±2 ºC | 4±2 °C | 4±2 °C/ Deep frozen (-20°C)[b]/-10 °C[c] | 4±2 °C/ Deep frozen (-20 °C)[b] | 4±2 ºC; do not freeze; HOLD lab analysis[e] | 4±2 ºC; do not freeze; RUSH lab analysis[e] | 4±2 °C/ Deep frozen (-20°C)[b] | 4±2 ºC | 4±2 ºC | Airtight seal, store vertically | Airtight seal, store vertically | Airtight seal, store vertically | - in situ - | 4±2ºC | 4±2ºC | 4±2ºC | 4±2ºC |
| ☐ SJVS003 | SJVS003-1P/R | Vane shear | 1 | Source station | | | | | | | | | ☐ | | | | | ☐ | | | | |
| ☐ SJVS004 | SJVS004-1P/R | Vane shear | 1 | Source station | | | | | | | | | ☐ | | | | | ☐ | | | | |
| ☐ SJVS005 | SJVS005-1P/R | Vane shear | 1 | Source station | | | | | | | | | ☐ | | | | | ☐ | | | | |
| ☐ SJVS006 | SJVS006-1P/R | Vane shear | 1 | Source station | | | | | | | | | ☐ | | | | | ☐ | | | | |
| ☐ SJVS007 | SJVS007-1P/R | Vane shear | 1 | Source station | | | | | | | | | ☐ | | | | | ☐ | | | | |
| ☐ SJVS008 | SJVS008-1P/R | Vane shear | 1 | Source station | | | | | | | | | ☐ | | | | | ☐ | | | | |
| ☐ SJVS009 | SJVS009-1P/R | Vane shear | 1 | Source station | | | | | | | | | ☐ | | | | | ☐ | | | | |
| ☐ SJVS010 | SJVS010-1P/R | Vane shear | 1 | Source station | | | | | | | | | ☐ | | | | | ☐ | | | | |
| ☐ SJVS011 | SJVS011-1P/R | Vane shear | 1 | Source station | | | | | | | | | ☐ | | | | | ☐ | | | | |
| ☐ SJVS012 | SJVS012-1P/R | Vane shear | 1 | Source station | | | | | | | | | ☐ | | | | | ☐ | | | | |
| ☐ SJVS013 | SJVS013-1P/R | Vane shear | 1 | Source station | | | | | | | | | ☐ | | | | | ☐ | | | | |
| ☐ SJVS014 | SJVS014-1P/R | Vane shear | 1 | Source station | | | | | | | | | ☐ | | | | | ☐ | | | | |
| ☐ SJVS015 | SJVS015-1P/R | Vane shear | 1 | Source station | | | | | | | | | ☐ | | | | | ☐ | | | | |
| ☐ SJVS016 | SJVS016-1P/R | Vane shear | 1 | Source station | | | | | | | | | ☐ | | | | | ☐ | | | | |
| ☐ SJVS016 | SJVS016-GR1 | Surface grab | 2[g] | Additional characterization | ☐ | ☐ | ❍ | ❍ | | | ☐ | ❍ | | | | | | | | | | |
| ☐ SJVS017 | SJVS017-1P/R | Vane shear | 1 | Source station | | | | | | | | | ☐ | | | | | ☐ | | | | |
| ☐ SJVS018 | SJVS018-1P/R | Vane shear | 1 | Source station | | | | | | | | | ☐ | | | | | ☐ | | | | |
| ☐ SJNE001 | SJNE001-GR1 | Surface grab | 1 | Within Site Perimeter | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ❍ | | | | | | | | | | |
| ☐ FW Blank | SDFW-901S | Equipment filter wipe blank | NA | Within Site Perimeter | | | | | | | | | | | | | | | ☐ | ☐ | ☐ | ☐ |
| ☐ SJNE002 | SJNE002-GR1 | Surface grab | 1 | Within Site Perimeter | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ❍ | | | | | | | | | | |
| ☐ SJNE003 | SJNE003-GR1 | Surface grab | 1 | Within Site Perimeter | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ❍ | | | | | | | | | | |
| ☐ SJNE004 | SJNE004-GR1 | Surface grab | 1 | Within Site Perimeter | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ❍ | | | | | | | | | | |
| ☐ SJNE005 | SJNE005-GR1 | Surface grab | 1 | Within Site Perimeter | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ❍ | | | | | | | | | | |
| ☐ SJNE006 | SJNE006-GR1 | Surface grab | 1 | Within Site Perimeter | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ❍ | | | | | | | | | | |

**Table A-3**
**Field Sample Collection Matrix**

| | | | | | Chemistry Grab and Core Samples | | | | | | | | Geotechnical Boring | | | | | | Blank Filter Wipes (Whatman Grade 42 filters ) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Primary | | | | Secondary | | | | | | | | | | | | | |
| | | | | | TOC, Metals, Mercury, and Percent Moisture (EPA 160.3) | Grain Size | ☐ BEHP ❍ All SVOCs + PCB Aroclors | ☐ PCDD/F ❍ PCDD/F + PCB congeners[f] | Archive SVOCs and PCB Aroclors | VOCs HOLD | VOCs RUSH | Archival ☐ 32 oz ❍ 8 oz | Atterberg limits (ASTM D-4318), Specific gravity (ASTM D-854), Percent moisture (ASTM D 2216) | Grain Size | Sediment permeability (ASTM D-5084) | CU Triax, Compressive Strength (ASTM D-4767) | Consolidation Test (ASTM D-2435) | Vane Shear Test (ASTM D-2573) | Metals | Mercury | Dioxins/ Furans | SVOCs |
| | | | | | 8 oz WMG[a] | 16 oz WMG[a] | 8 oz WMG[a] | 8 oz WMG[a] | 8 oz WMG[a] | 2 oz WMG[a] | 2 oz WMG[a] | WMG[a] | 8 oz WMG[a] | 16 oz WMG[a] | Shelby tube | Shelby tube | Shelby tube | Vane | 4 oz WMG[a] | 4 oz WMG[a] | 4 oz WMG[a] | 4 oz WMG[a] |
| Station | Sample ID | Sample Type | Approximate Number of Subsamples | Sample Group | 4±2 ºC | 4±2 ºC | 4±2 °C | 4±2 °C/ Deep frozen (-20°C)[b]/-10 °C[c] | 4±2 °C/ Deep frozen (-20 °C)[b] | 4±2 ºC; do not freeze; HOLD lab analysis[e] | 4±2 ºC; do not freeze; RUSH lab analysis[e] | 4±2 °C/ Deep frozen (-20°C)[b] | 4±2 ºC | 4±2 ºC | Airtight seal, store vertically | Airtight seal, store vertically | Airtight seal, store vertically | - in situ - | 4±2ºC | 4±2ºC | 4±2ºC | 4±2ºC |
| ☐ SJNE007 | SJNE007-GR1 | Surface grab | 1 | Within Site Perimeter | ☐ | ☐ | ❍ | ❍ | | | ☐ | ❍ | | | | | | | | | | |
| ☐ SJNE007 | SJNE007-CR1 | Core | 10 (max) | Within Site Perimeter | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ❍ | ☐ | | | | | | | | | |
| ☐ SJNE008 | SJNE008-GR1 | Surface grab | 1 | Within Site Perimeter | ☐ | ☐ | ❍ | ❍ | | | ☐ | ❍ | | | | | | | | | | |
| ☐ SJNE008 | SJNE008-CR1 | Core | 10 (max) | Within Site Perimeter | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ❍ | ☐ | | | | | | | | | |
| ☐ SJNE009 | SJNE009-GR1 | Surface grab | 1 | Within Site Perimeter | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ❍ | | | | | | | | | | |
| ☐ SJNE010 | SJNE010-GR1 | Surface grab | 1 | Within Site Perimeter | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ❍ | | | | | | | | | | |
| ☐ SJNE011 | SJNE011-GR1 | Surface grab | 1 | Within Site Perimeter | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ❍ | | | | | | | | | | |
| ☐ SJNE012 | SJNE012-GR1 | Surface grab | 1 | Within Site Perimeter | ☐ | ☐ | ❍ | ❍ | | | ☐ | ❍ | | | | | | | | | | |
| ☐ SJNE012 | SJNE012-CR1 | Core | 10 (max) | Within Site Perimeter | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ❍ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | | | |
| ☐ FW Blank | SDFW-902C | Equipment filter wipe blank | NA | Within Site Perimeter | | | | | | | | | | | | | | | ☐ | ☐ | ☐ | ☐ |
| ☐ SJNE013 | SJNE013-GR1 | Surface grab | 1 | Within Site Perimeter | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ❍ | | | | | | | | | | |
| ☐ SJNE014 | SJNE014-GR1 | Surface grab | 1 | Within Site Perimeter | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ❍ | | | | | | | | | | |
| ☐ SJNE015 | SJNE015-GR1 | Surface grab | 1 | Within Site Perimeter | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ❍ | | | | | | | | | | |
| ☐ SJNE016 | SJNE016-GR1 | Surface grab | 1 | Within Site Perimeter | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ❍ | | | | | | | | | | |
| ☐ SJNE017 | SJNE017-GR1 | Surface grab | 1 | Within Site Perimeter | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ❍ | | | | | | | | | | |
| ☐ SJNE018 | SJNE018-GR1 | Surface grab | 1 | Within Site Perimeter | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ❍ | | | | | | | | | | |
| ☐ SJNE019 | SJNE019-GR1 | Surface grab | 1 | Within Site Perimeter | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ❍ | | | | | | | | | | |
| ☐ SJNE020 | SJNE020-GR1 | Surface grab | 1 | Within Site Perimeter | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ❍ | | | | | | | | | | |
| ☐ SJNE020 | SJNE020-GR1 | Surface grab | 1 | Within Site Perimeter | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ❍ | | | | | | | | | | |
| ☐ FW Blank | SDFW-903S | Equipment filter wipe blank | NA | Within Site Perimeter | | | | | | | | | | | | | | | ☐ | ☐ | ☐ | ☐ |
| ☐ SJNE021 | SJNE021-GR1 | Surface grab | 1 | Within Site Perimeter | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ❍ | | | | | | | | | | |
| ☐ SJNE022-1 | SJNE022-GR1 | Surface grab | 1 | Within Site Perimeter | ☐ | ☐ | ❍ | ❍ | | | ☐ | ❍ | | | | | | | | | | |
| ☐ SJNE022-2 | SJNE022-GR2 | Surface grab | 1 | Within Site Perimeter | ☐ | ☐ | ❍ | ❍ | | | ☐ | ❍ | | | | | | | | | | |
| ☐ SJNE022-3 | SJNE022-GR3 | Surface grab | 1 | Within Site Perimeter | ☐ | ☐ | ❍ | ❍ | | | ☐ | ❍ | | | | | | | | | | |

**Table A-3**
**Field Sample Collection Matrix**

| | | | | | Chemistry Grab and Core Samples | | | | | | | | Geotechnical Boring | | | | | | Blank Filter Wipes (Whatman Grade 42 filters ) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Primary | | | | Secondary | | | Archival | | | | | | | | | | |
| | | | | | TOC, Metals, Mercury, and Percent Moisture (EPA 160.3) | Grain Size | ☐ BEHP ◐ All SVOCs + PCB Aroclors | ☐ PCDD/F ◐ PCDD/F + PCB congeners[f] | Archive SVOCs and PCB Aroclors | VOCs HOLD | VOCs RUSH | ☐ 32 oz ◐ 8 oz | Atterberg limits (ASTM D-4318), Specific gravity (ASTM D-854), Percent moisture (ASTM D 2216) | Grain Size | Sediment permeability (ASTM D-5084) | CU Triax, Compressive Strength (ASTM D-4767) | Consolidation Test (ASTM D-2435) | Vane Shear Test (ASTM D-2573) | Metals | Mercury | Dioxins/ Furans | SVOCs |
| | | | | | 8 oz WMG[a] | 16 oz WMG[a] | 8 oz WMG[a] | 8 oz WMG[a] | 8 oz WMG[a] | 2 oz WMG[a] | 2 oz WMG[a] | WMG[a] | 8 oz WMG[a] | 16 oz WMG[a] | Shelby tube | Shelby tube | Shelby tube | Vane | 4 oz WMG[a] | 4 oz WMG[a] | 4 oz WMG[a] | 4 oz WMG[a] |
| Station | Sample ID | Sample Type | Approximate Number of Subsamples | Sample Group | 4±2 ºC | 4±2 ºC | 4±2 °C | 4±2 °C/ Deep frozen (-20°C)[b]/-10 °C[c] | 4±2 °C/ Deep frozen (-20 °C)[b] | 4±2 ºC; do not freeze; HOLD lab analysis[e] | 4±2 ºC; do not freeze; RUSH lab analysis[e] | 4±2 °C/ Deep frozen (-20°C)[b] | 4±2 ºC | 4±2 ºC | Airtight seal, store vertically | Airtight seal, store vertically | Airtight seal, store vertically | - in situ - | 4±2ºC | 4±2ºC | 4±2ºC | 4±2ºC |
| ☐ SJNE023 | SJNE023-GR1 | Surface grab | 1 | Within Site Perimeter | ☐ | ☐ | ◐ | ◐ | | | ☐ | ◐ | | | | | | | | | | |
| ☐ SJNE023 | SJNE023-CR1 | Core | 10 (max) | Within Site Perimeter | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ◐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | | | |
| ☐ SJNE024 | SJNE024-GR1 | Surface grab | 1 | Within Site Perimeter | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ◐ | | | | | | | | | | |
| ☐ SJNE025 | SJNE025-GR1 | Surface grab | 1 | Within Site Perimeter | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ◐ | | | | | | | | | | |
| ☐ SJNE026 | SJNE026-GR1 | Surface grab | 1 | Within Site Perimeter | ☐ | ☐ | ◐ | ◐ | | | ☐ | ◐ | | | | | | | | | | |
| ☐ SJNE026 | SJNE026-CR1 | Core | 10 (max) | Within Site Perimeter | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ◐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | | | |
| ☐ SJNE027 | SJNE027-GR1 | Surface grab | 1 | Within Site Perimeter | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ◐ | | | | | | | | | | |
| ☐ SJNE028 | SJNE028-GR1 | Surface grab | 1 | Within Site Perimeter | ☐ | ☐ | ◐ | ◐ | | | ☐ | ◐ | | | | | | | | | | |
| ☐ SJNE028 | SJNE028-CR1 | Core | 10 (max) | Within Site Perimeter | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ◐ | ☐ | | | | | | | | | |
| ☐ SJNE029 | SJNE029-GR1 | Surface grab | 1 | Within Site Perimeter | ☐ | ☐ | ◐ | ◐ | | | ☐ | ◐ | | | | | | | | | | |
| ☐ SJNE029 | SJNE029-CR1 | Core | 10 (max) | Within Site Perimeter | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ◐ | ☐ | | | | | | | | | |
| ☐ SJNE030 | SJNE030-GR1 | Surface grab | 1 | Within Site Perimeter | ☐ | ☐ | ◐ | ◐ | | | ☐ | ◐ | | | | | | | | | | |
| ☐ SJNE030 | SJNE030-CR1 | Core | 10 (max) | Within Site Perimeter | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ◐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | | | |
| ☐ SJNE031 | SJNE031-GR1 | Surface grab | 1 | Within Site Perimeter | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ◐ | | | | | | | | | | |
| ☐ SJNE032 | SJNE032-GR1 | Surface grab | 1 | Within Site Perimeter | ☐ | ☐ | ◐ | ◐ | | | ☐ | ◐ | | | | | | | | | | |
| ☐ SJNE032 | SJNE032-CR1 | Core | 10 (max) | Within Site Perimeter | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ◐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | | | |
| ☐ SJNE033 | SJNE033-GR1 | Surface grab | 1 | Within Site Perimeter | ☐ | ☐ | ◐ | ◐ | | | ☐ | ◐ | | | | | | | | | | |
| ☐ SJNE033 | SJNE033-CR1 | Core | 10 (max) | Within Site Perimeter | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ◐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | | | |
| ☐ SJNE034 | SJNE034-GR1 | Surface grab | 1 | Within Site Perimeter | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ◐ | | | | | | | | | | |
| ☐ SJNE035 | SJNE035-GR1 | Surface grab | 1 | Within Site Perimeter | ☐ | ☐ | ◐ | ◐ | | | ☐ | ◐ | | | | | | | | | | |
| ☐ SJNE035 | SJNE035-CR1 | Core | 10 (max) | Within Site Perimeter | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ◐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | | | |
| ☐ SJNE036 | SJNE036-GR1 | Surface grab | 1 | Within Site Perimeter | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ◐ | | | | | | | | | | |
| ☐ SJNE037 | SJNE037-GR1 | Surface grab | 1 | Within Site Perimeter | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ◐ | | | | | | | | | | |
| ☐ SJNE038 | SJNE038-GR1 | Surface grab | 1 | Within Site Perimeter | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ◐ | | | | | | | | | | |

**Table A-3**
**Field Sample Collection Matrix**

| | | | | | Chemistry Grab and Core Samples | | | | | | | | Geotechnical Boring | | | | | | Blank Filter Wipes (Whatman Grade 42 filters ) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Primary | | | | Secondary | | | | | | | | | | | | | |
| | | | | | TOC, Metals, Mercury, and Percent Moisture (EPA 160.3) | Grain Size | ☐ BEHP ❍ All SVOCs + PCB Aroclors | ☐ PCDD/F ❍ PCDD/F + PCB congeners[f] | Archive SVOCs and PCB Aroclors | VOCs HOLD | VOCs RUSH | Archival ☐ 32 oz ❍ 8 oz | Atterberg limits (ASTM D-4318), Specific gravity (ASTM D-854), Percent moisture (ASTM D 2216) | Grain Size | Sediment permeability (ASTM D-5084) | CU Triax, Compressive Strength (ASTM D-4767) | Consolidation Test (ASTM D-2435) | Vane Shear Test (ASTM D-2573) | Metals | Mercury | Dioxins/ Furans | SVOCs |
| | | | | | 8 oz WMG[a] | 16 oz WMG[a] | 8 oz WMG[a] | 8 oz WMG[a] | 8 oz WMG[a] | 2 oz WMG[a] | 2 oz WMG[a] | WMG[a] | 8 oz WMG[a] | 16 oz WMG[a] | Shelby tube | Shelby tube | Shelby tube | Vane | 4 oz WMG[a] | 4 oz WMG[a] | 4 oz WMG[a] | 4 oz WMG[a] |
| Station | Sample ID | Sample Type | Approximate Number of Subsamples | Sample Group | 4±2 ºC | 4±2 ºC | 4±2 °C | 4±2 °C/ Deep frozen (-20°C)[b]/-10 °C[c] | 4±2 °C/ Deep frozen (-20 °C)[b] | 4±2 ºC; do not freeze; HOLD lab analysis[e] | 4±2 ºC; do not freeze; RUSH lab analysis[e] | 4±2 °C/ Deep frozen (-20°C)[b] | 4±2 ºC | 4±2 ºC | Airtight seal, store vertically | Airtight seal, store vertically | Airtight seal, store vertically | - in situ - | 4±2ºC | 4±2ºC | 4±2ºC | 4±2ºC |
| ☐ SJNE039 | SJNE039-GR1 | Surface grab | 1 | Within Site Perimeter | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ❍ | | | | | | | | | | |
| ☐ SJNE040 | SJNE040-GR1 | Surface grab | 1 | Within Site Perimeter | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ❍ | | | | | | | | | | |
| ☐ FW Blank | SDFW-904C | Equipment filter wipe blank | NA | Within Site Perimeter | | | | | | | | | | | | | | | ☐ | ☐ | ☐ | ☐ |
| ☐ SJNE041 | SJNE041-GR1 | Surface grab | 1 | Within Site Perimeter | ☐ | ☐ | ❍ | ❍ | | | ☐ | ❍ | | | | | | | | | | |
| ☐ SJNE041 | SJNE041-CR1 | Core | 10 (max) | Within Site Perimeter | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ❍ | ☐ | | | | | | | | | |
| ☐ SJNE042 | SJNE042-GR1 | Surface grab | 1 | Within Site Perimeter | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ❍ | | | | | | | | | | |
| ☐ SJNE042 | SJNE042-GR1 | Surface grab | 1 | Within Site Perimeter | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ❍ | | | | | | | | | | |
| ☐ SJNE043 | SJNE043-GR1 | Surface grab | 1 | Within Site Perimeter | ☐ | ☐ | ❍ | ❍ | | | ☐ | ❍ | | | | | | | | | | |
| ☐ SJNE043 | SJNE043-CR1 | Core | 10 (max) | Within Site Perimeter | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ❍ | ☐ | | | | | | | | | |
| ☐ SJNE044 | SJNE044-GR1 | Surface grab | 1 | Within Site Perimeter | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ❍ | | | | | | | | | | |
| ☐ SJNE045 | SJNE045-GR1 | Surface grab | 1 | Within Site Perimeter | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ❍ | | | | | | | | | | |
| ☐ SJNE046 | SJNE046-GR1 | Surface grab | 1 | Within Site Perimeter | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ❍ | | | | | | | | | | |
| ☐ SJNE047 | SJNE047-GR1 | Surface grab | 1 | Within Site Perimeter | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ❍ | | | | | | | | | | |
| ☐ SJNE048 | SJNE048-GR1 | Surface grab | 1 | Within Site Perimeter | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ❍ | | | | | | | | | | |
| ☐ SJNE049 | SJNE049-GR1 | Surface grab | 1 | Within Site Perimeter | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ❍ | | | | | | | | | | |
| ☐ SJNE050 | SJNE050-GR1 | Surface grab | 1 | Within Site Perimeter | ☐ | ☐ | ❍ | ❍ | | | ☐ | ❍ | | | | | | | | | | |
| ☐ SJNE050 | SJNE050-CR1 | Core | 10 (max) | Within Site Perimeter | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ❍ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | | | |
| ☐ SJNE051 | SJNE051-GR1 | Surface grab | 1 | Within Site Perimeter | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ❍ | | | | | | | | | | |
| ☐ SJNE052 | SJNE052-GR1 | Surface grab | 1 | Within Site Perimeter | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ❍ | | | | | | | | | | |
| ☐ SJNE053 | SJNE053-GR1 | Surface grab | 1 | Within Site Perimeter | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ❍ | | | | | | | | | | |
| ☐ SJNE054 | SJNE054-GR1 | Surface grab | 1 | Within Site Perimeter | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ❍ | | | | | | | | | | |
| ☐ SJNE055 | SJNE055-GR1 | Surface grab | 1 | Within Site Perimeter | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ❍ | | | | | | | | | | |
| ☐ SJNE056 | SJNE056-GR1 | Surface grab | 1 | Within Site Perimeter | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ❍ | | | | | | | | | | |
| ☐ SJNE057 | SJNE057-GR1 | Surface grab | 1 | Within Site Perimeter | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ❍ | | | | | | | | | | |

**Table A-3**
**Field Sample Collection Matrix**

| | | | | | Chemistry Grab and Core Samples | | | | | | | | Geotechnical Boring | | | | | | Blank Filter Wipes (Whatman Grade 42 filters ) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Primary | | | | Secondary | | | | | | | | | | | | | |
| | | | | | TOC, Metals, Mercury, and Percent Moisture (EPA 160.3) | Grain Size | ☐ BEHP ❍ All SVOCs + PCB Aroclors | ☐ PCDD/F ❍ PCDD/F + PCB congeners[f] | Archive SVOCs and PCB Aroclors | VOCs HOLD | VOCs RUSH | Archival ☐ 32 oz ❍ 8 oz | Atterberg limits (ASTM D-4318), Specific gravity (ASTM D-854), Percent moisture (ASTM D 2216) | Grain Size | Sediment permeability (ASTM D-5084) | CU Triax, Compressive Strength (ASTM D-4767) | Consolidation Test (ASTM D-2435) | Vane Shear Test (ASTM D-2573) | Metals | Mercury | Dioxins/ Furans | SVOCs |
| | | | | | 8 oz WMG[a] | 16 oz WMG[a] | 8 oz WMG[a] | 8 oz WMG[a] | 8 oz WMG[a] | 2 oz WMG[a] | 2 oz WMG[a] | WMG[a] | 8 oz WMG[a] | 16 oz WMG[a] | Shelby tube | Shelby tube | Shelby tube | Vane | 4 oz WMG[a] | 4 oz WMG[a] | 4 oz WMG[a] | 4 oz WMG[a] |
| Station | Sample ID | Sample Type | Approximate Number of Subsamples | Sample Group | 4±2 ºC | 4±2 ºC | 4±2 °C | 4±2 °C/ Deep frozen (-20°C)[b]/-10 °C[c] | 4±2 °C/ Deep frozen (-20 °C)[b] | 4±2 ºC; do not freeze; HOLD lab analysis[e] | 4±2 ºC; do not freeze; RUSH lab analysis[e] | 4±2 °C/ Deep frozen (-20°C)[b] | 4±2 ºC | 4±2 ºC | Airtight seal, store vertically | Airtight seal, store vertically | Airtight seal, store vertically | - in situ - | 4±2ºC | 4±2ºC | 4±2ºC | 4±2ºC |
| ☐ SJNE058 | SJNE058-GR1 | Surface grab | 1 | Within Site Perimeter | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ❍ | | | | | | | | | | |
| ☐ SJNE059 | SJNE059-GR1 | Surface grab | 1 | Within Site Perimeter | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ❍ | | | | | | | | | | |
| ☐ FW Blank | SDFW-905S | Equipment filter wipe blank | NA | Within Site Boundary | | | | | | | | | | | | | | | ☐ | ☐ | ☐ | ☐ |
| ☐ SJNE060 | SJNE060-GR1 | Surface grab | 1 | Upstream background | ☐ | ☐ | ❍ | ❍ | | | ☐ | ❍ | | | | | | | | | | |
| ☐ SJNE061 | SJNE061-GR1 | Surface grab | 1 | Upstream background | ☐ | ☐ | ❍ | ❍ | | | ☐ | ❍ | | | | | | | | | | |
| ☐ SJNE062 | SJNE062-GR1 | Surface grab | 1 | Upstream background | ☐ | ☐ | ❍ | ❍ | | | ☐ | ❍ | | | | | | | | | | |
| ☐ SJNE062 | SJNE062-GR1 | Surface grab | 1 | Upstream background | ☐ | ☐ | ❍ | ❍ | | | ☐ | ❍ | | | | | | | | | | |
| ☐ SJNE063 | SJNE063-GR1 | Surface grab | 1 | Upstream background | ☐ | ☐ | ❍ | ❍ | | | ☐ | ❍ | | | | | | | | | | |
| ☐ SJNE064 | SJNE064-GR1 | Surface grab | 1 | Upstream background | ☐ | ☐ | ❍ | ❍ | | | ☐ | ❍ | | | | | | | | | | |
| ☐ SJNE065 | SJNE065-GR1 | Surface grab | 1 | Upstream background | ☐ | ☐ | ❍ | ❍ | | | ☐ | ❍ | | | | | | | | | | |
| ☐ SJNE066 | SJNE066-GR1 | Surface grab | 1 | Upstream background | ☐ | ☐ | ❍ | ❍ | | | ☐ | ❍ | | | | | | | | | | |
| ☐ SJNE067 | SJNE067-GR1 | Surface grab | 1 | Upstream background | ☐ | ☐ | ❍ | ❍ | | | ☐ | ❍ | | | | | | | | | | |
| ☐ SJNE068 | SJNE068-GR1 | Surface grab | 1 | Upstream background | ☐ | ☐ | ❍ | ❍ | | | ☐ | ❍ | | | | | | | | | | |
| ☐ SJNE069 | SJNE069-GR1 | Surface grab | 1 | Upstream background | ☐ | ☐ | ❍ | ❍ | | | ☐ | ❍ | | | | | | | | | | |
| ☐ FW Blank | SDFW-906G | Equipment filter wipe blank | NA | Upstream background | | | | | | | | | | | | | | | ☐ | ☐ | ☐ | ☐ |
| ☐ SJNE070 | SJNE070-GR1 | Surface grab | 1 | Upstream background | ☐ | ☐ | ❍ | ❍ | | | ☐ | ❍ | | | | | | | | | | |
| ☐ SJSH001 | SJSH001-CR1A | Core | 1 | HHRA shoreline 0 - 6.0 inch | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ❍ | | | | | | | | | | |
| ☐ SJSH001 | SJSH001-CR1B | Core | 1 | HHRA shoreline 6.0 - 12.0 inch | | | | | | | | ☐ | | | | | | | | | | |
| ☐ FW Blank | SDFW-907C | Equipment filter wipe blank | NA | HHRA shoreline | | | | | | | | | | | | | | | ☐ | ☐ | ☐ | ☐ |
| ☐ SJSH002 | SJSH002-CR1A | Core | 1 | HHRA shoreline 0 - 6.0 inch | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ❍ | | | | | | | | | | |
| ☐ SJSH002 | SJSH002-CR1B | Core | 1 | HHRA shoreline 6.0 - 12.0 inch | | | | | | | | ☐ | | | | | | | | | | |
| ☐ SJSH003 | SJSH003-CR1A | Core | 1 | HHRA shoreline 0 - 6.0 inch | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ❍ | | | | | | | | | | |
| ☐ SJSH003 | SJSH003-CR1B | Core | 1 | HHRA shoreline 6.0 - 12.0 inch | | | | | | | | ☐ | | | | | | | | | | |
| ☐ SJSH004 | SJSH004-CR1A | Core | 1 | HHRA shoreline 0 - 6.0 inch | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ❍ | | | | | | | | | | |

**Table A-3**
**Field Sample Collection Matrix**

| | | | | | Chemistry Grab and Core Samples | | | | | | | | Geotechnical Boring | | | | | | Blank Filter Wipes (Whatman Grade 42 filters ) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Primary | | | | Secondary | | | | | | | | | | | | | |
| | | | | | TOC, Metals, Mercury, and Percent Moisture (EPA 160.3) | Grain Size | ☐ BEHP ❍ All SVOCs + PCB Aroclors | ☐ PCDD/F ❍ PCDD/F + PCB congeners[f] | Archive SVOCs and PCB Aroclors | VOCs HOLD | VOCs RUSH | Archival ☐ 32 oz ❍ 8 oz | Atterberg limits (ASTM D-4318), Specific gravity (ASTM D-854), Percent moisture (ASTM D 2216) | Grain Size | Sediment permeability (ASTM D-5084) | CU Triax, Compressive Strength (ASTM D-4767) | Consolidation Test (ASTM D-2435) | Vane Shear Test (ASTM D-2573) | Metals | Mercury | Dioxins/ Furans | SVOCs |
| | | | | | 8 oz WMG[a] | 16 oz WMG[a] | 8 oz WMG[a] | 8 oz WMG[a] | 8 oz WMG[a] | 2 oz WMG[a] | 2 oz WMG[a] | WMG[a] | 8 oz WMG[a] | 16 oz WMG[a] | Shelby tube | Shelby tube | Shelby tube | Vane | 4 oz WMG[a] | 4 oz WMG[a] | 4 oz WMG[a] | 4 oz WMG[a] |
| Station | Sample ID | Sample Type | Approximate Number of Subsamples | Sample Group | 4±2 ºC | 4±2 ºC | 4±2 °C | 4±2 °C/ Deep frozen (-20°C)[b]/-10 °C[c] | 4±2 °C/ Deep frozen (-20 °C)[b] | 4±2 ºC; do not freeze; HOLD lab analysis[e] | 4±2 ºC; do not freeze; RUSH lab analysis[e] | 4±2 °C/ Deep frozen (-20°C)[b] | 4±2 ºC | 4±2 ºC | Airtight seal, store vertically | Airtight seal, store vertically | Airtight seal, store vertically | - in situ - | 4±2ºC | 4±2ºC | 4±2ºC | 4±2ºC |
| ☐ SJSH004 | SJSH004-CR1B | Core | 1 | HHRA shoreline 6.0 - 12.0 inch | | | | | | | | ☐ | | | | | | | | | | |
| ☐ SJSH005 | SJSH005-CR1A | Core | 1 | HHRA shoreline 0 - 6.0 inch | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ❍ | | | | | | | | | | |
| ☐ SJSH005 | SJSH005-CR1A | Core | 1 | HHRA shoreline 0 - 6.0 inch | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ❍ | | | | | | | | | | |
| ☐ SJSH005 | SJSH005-CR1B | Core | 1 | HHRA shoreline 6.0 - 12.0 inch | | | | | | | | ☐ | | | | | | | | | | |
| ☐ SJSH005 | SJSH005-CR1B | Core | 1 | HHRA shoreline 6.0 - 12.0 inch | | | | | | | | ☐ | | | | | | | | | | |
| ☐ SJSH006 | SJSH006-CR1A | Core | 1 | HHRA shoreline 0 - 6.0 inch | | | | | | | | ☐ | | | | | | | | | | |
| ☐ SJSH006 | SJSH006-CR1B | Core | 1 | HHRA shoreline 6.0 - 12.0 inch | | | | | | | | ☐ | | | | | | | | | | |
| ☐ SJSH007 | SJSH007-CR1A | Core | 1 | HHRA shoreline 0 - 6.0 inch | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ❍ | | | | | | | | | | |
| ☐ SJSH007 | SJSH007-CR1B | Core | 1 | HHRA shoreline 6.0 - 12.0 inch | | | | | | | | ☐ | | | | | | | | | | |
| ☐ SJSH008 | SJSH008-CR1A | Core | 1 | HHRA shoreline 0 - 6.0 inch | | | | | | | | ☐ | | | | | | | | | | |
| ☐ SJSH008 | SJSH008-CR1B | Core | 1 | HHRA shoreline 6.0 - 12.0 inch | | | | | | | | ☐ | | | | | | | | | | |
| ☐ SJSH009 | SJSH009-CR1A | Core | 1 | HHRA shoreline 0 - 6.0 inch | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ❍ | | | | | | | | | | |
| ☐ SJSH009 | SJSH009-CR1B | Core | 1 | HHRA shoreline 6.0 - 12.0 inch | | | | | | | | ☐ | | | | | | | | | | |
| ☐ SJSH010 | SJSH010-CR1A | Core | 1 | HHRA shoreline 0 - 6.0 inch | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ❍ | | | | | | | | | | |
| ☐ SJSH010 | SJSH010-CR1B | Core | 1 | HHRA shoreline 6.0 - 12.0 inch | | | | | | | | ☐ | | | | | | | | | | |
| ☐ FW Blank | SDFW-908C | Equipment filter wipe blank | NA | HHRA shoreline | | | | | | | | | | | | | | | ☐ | ☐ | ☐ | ☐ |
| ☐ SJSH011 | SJSH011-CR1A | Core | 1 | HHRA shoreline 0 - 6.0 inch | | | | | | | | ☐ | | | | | | | | | | |
| ☐ SJSH011 | SJSH011-CR1B | Core | 1 | HHRA shoreline 6.0 - 12.0 inch | | | | | | | | ☐ | | | | | | | | | | |
| ☐ SJSH012 | SJSH012-CR1A | Core | 1 | HHRA shoreline 0 - 6.0 inch | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ❍ | | | | | | | | | | |
| ☐ SJSH012 | SJSH012-CR1B | Core | 1 | HHRA shoreline 6.0 - 12.0 inch | | | | | | | | ☐ | | | | | | | | | | |
| ☐ SJSH013 | SJSH013-CR1A | Core | 1 | HHRA shoreline 0 - 6.0 inch | | | | | | | | ☐ | | | | | | | | | | |
| ☐ SJSH013 | SJSH013-CR1B | Core | 1 | HHRA shoreline 6.0 - 12.0 inch | | | | | | | | ☐ | | | | | | | | | | |
| ☐ SJSH014 | SJSH014-CR1A | Core | 1 | HHRA shoreline 0 - 6.0 inch | | | | | | | | ☐ | | | | | | | | | | |
| ☐ SJSH014 | SJSH014-CR1B | Core | 1 | HHRA shoreline 6.0 - 12.0 inch | | | | | | | | ☐ | | | | | | | | | | |

**Table A-3**
**Field Sample Collection Matrix**

| | | | | | Chemistry Grab and Core Samples | | | | | | | | Geotechnical Boring | | | | | | Blank Filter Wipes (Whatman Grade 42 filters ) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Primary | | | | Secondary | | | | | | | | | | | | | |
| | | | | | TOC, Metals, Mercury, and Percent Moisture (EPA 160.3) | Grain Size | ☐ BEHP ◐ All SVOCs + PCB Aroclors | ☐ PCDD/F ◐ PCDD/F + PCB congeners[f] | Archive SVOCs and PCB Aroclors | VOCs HOLD | VOCs RUSH | Archival ☐ 32 oz ◐ 8 oz | Atterberg limits (ASTM D-4318), Specific gravity (ASTM D-854), Percent moisture (ASTM D 2216) | Grain Size | Sediment permeability (ASTM D-5084) | CU Triax, Compressive Strength (ASTM D-4767) | Consolidation Test (ASTM D-2435) | Vane Shear Test (ASTM D-2573) | Metals | Mercury | Dioxins/ Furans | SVOCs |
| | | | | | 8 oz WMG[a] | 16 oz WMG[a] | 8 oz WMG[a] | 8 oz WMG[a] | 8 oz WMG[a] | 2 oz WMG[a] | 2 oz WMG[a] | WMG[a] | 8 oz WMG[a] | 16 oz WMG[a] | Shelby tube | Shelby tube | Shelby tube | Vane | 4 oz WMG[a] | 4 oz WMG[a] | 4 oz WMG[a] | 4 oz WMG[a] |
| Station | Sample ID | Sample Type | Approximate Number of Subsamples | Sample Group | 4±2 ºC | 4±2 ºC | 4±2 °C | 4±2 °C/ Deep frozen (-20°C)[b]/-10 °C[c] | 4±2 °C/ Deep frozen (-20 °C)[b] | 4±2 ºC; do not freeze; HOLD lab analysis[e] | 4±2 ºC; do not freeze; RUSH lab analysis[e] | 4±2 °C/ Deep frozen (-20°C)[b] | 4±2 ºC | 4±2 ºC | Airtight seal, store vertically | Airtight seal, store vertically | Airtight seal, store vertically | - in situ - | 4±2ºC | 4±2ºC | 4±2ºC | 4±2ºC |
| ☐ SJSH015 | SJSH015-CR1A | Core | 1 | HHRA shoreline 0 - 6.0 inch | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ◐ | | | | | | | | | | |
| ☐ SJSH015 | SJSH015-CR1A | Core | 1 | HHRA shoreline 0 - 6.0 inch | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ◐ | | | | | | | | | | |
| ☐ SJSH015 | SJSH015-CR1B | Core | 1 | HHRA shoreline 6.0 - 12.0 inch | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ◐ | | | | | | | | | | |
| ☐ SJSH015 | SJSH015-CR1B | Core | 1 | HHRA shoreline 6.0 - 12.0 inch | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ◐ | | | | | | | | | | |
| ☐ SJSH016 | SJSH016-CR1A | Core | 1 | HHRA shoreline 0 - 6.0 inch | | | | | | | | ☐ | | | | | | | | | | |
| ☐ SJSH016 | SJSH016-CR1B | Core | 1 | HHRA shoreline 6.0 - 12.0 inch | | | | | | | | ☐ | | | | | | | | | | |
| ☐ SJSH017 | SJSH017-CR1A | Core | 1 | HHRA shoreline 0 - 6.0 inch | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ◐ | | | | | | | | | | |
| ☐ SJSH017 | SJSH017-CR1B | Core | 1 | HHRA shoreline 6.0 - 12.0 inch | | | | | | | | ☐ | | | | | | | | | | |
| ☐ SJSH018 | SJSH018-CR1A | Core | 1 | HHRA shoreline 0 - 6.0 inch | | | | | | | | ☐ | | | | | | | | | | |
| ☐ SJSH018 | SJSH018-CR1B | Core | 1 | HHRA shoreline 6.0 - 12.0 inch | | | | | | | | ☐ | | | | | | | | | | |
| ☐ SJSH019 | SJSH019-CR1A | Core | 1 | HHRA shoreline 0 - 6.0 inch | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ◐ | | | | | | | | | | |
| ☐ SJSH019 | SJSH019-CR1B | Core | 1 | HHRA shoreline 6.0 - 12.0 inch | | | | | | | | ☐ | | | | | | | | | | |
| ☐ SJSH020 | SJSH020-CR1A | Core | 1 | HHRA shoreline 0 - 6.0 inch | | | | | | | | ☐ | | | | | | | | | | |
| ☐ SJSH020 | SJSH020-CR1B | Core | 1 | HHRA shoreline 6.0 - 12.0 inch | | | | | | | | ☐ | | | | | | | | | | |
| ☐ FW Blank | SDFW-909C | Equipment filter wipe blank | NA | HHRA shoreline | | | | | | | | | | | | | | | ☐ | ☐ | ☐ | ☐ |
| ☐ SJSH021 | SJSH021-CR1A | Core | 1 | HHRA shoreline 0 - 6.0 inch | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ◐ | | | | | | | | | | |
| ☐ SJSH021 | SJSH021-CR1B | Core | 1 | HHRA shoreline 6.0 - 12.0 inch | | | | | | | | ☐ | | | | | | | | | | |
| ☐ SJSH022 | SJSH022-CR1A | Core | 1 | HHRA shoreline 0 - 6.0 inch | | | | | | | | ☐ | | | | | | | | | | |
| ☐ SJSH022 | SJSH022-CR1B | Core | 1 | HHRA shoreline 6.0 - 12.0 inch | | | | | | | | ☐ | | | | | | | | | | |
| ☐ SJSH023 | SJSH023-CR1A | Core | 1 | HHRA shoreline 0 - 6.0 inch | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ◐ | | | | | | | | | | |
| ☐ SJSH023 | SJSH023-CR1B | Core | 1 | HHRA shoreline 6.0 - 12.0 inch | | | | | | | | ☐ | | | | | | | | | | |
| ☐ SJSH024 | SJSH024-CR1A | Core | 1 | HHRA shoreline 0 - 6.0 inch | | | | | | | | ☐ | | | | | | | | | | |
| ☐ SJSH024 | SJSH024-CR1B | Core | 1 | HHRA shoreline 6.0 - 12.0 inch | | | | | | | | ☐ | | | | | | | | | | |
| ☐ SJSH025 | SJSH025-CR1A | Core | 1 | HHRA shoreline 0 - 6.0 inch | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ◐ | | | | | | | | | | |

**Table A-3**
**Field Sample Collection Matrix**

| | | | | | Chemistry Grab and Core Samples | | | | | | | | Geotechnical Boring | | | | | | Blank Filter Wipes (Whatman Grade 42 filters ) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Primary | | | | Secondary | | | | | | | | | | | | | |
| | | | | | TOC, Metals, Mercury, and Percent Moisture (EPA 160.3) | Grain Size | ☐ BEHP ◐ All SVOCs + PCB Aroclors | ☐ PCDD/F ◐ PCDD/F + PCB congeners[f] | Archive SVOCs and PCB Aroclors | VOCs HOLD | VOCs RUSH | Archival ☐ 32 oz ◐ 8 oz | Atterberg limits (ASTM D-4318), Specific gravity (ASTM D-854), Percent moisture (ASTM D 2216) | Grain Size | Sediment permeability (ASTM D-5084) | CU Triax, Compressive Strength (ASTM D-4767) | Consolidation Test (ASTM D-2435) | Vane Shear Test (ASTM D-2573) | Metals | Mercury | Dioxins/ Furans | SVOCs |
| | | | | | 8 oz WMG[a] | 16 oz WMG[a] | 8 oz WMG[a] | 8 oz WMG[a] | 8 oz WMG[a] | 2 oz WMG[a] | 2 oz WMG[a] | WMG[a] | 8 oz WMG[a] | 16 oz WMG[a] | Shelby tube | Shelby tube | Shelby tube | Vane | 4 oz WMG[a] | 4 oz WMG[a] | 4 oz WMG[a] | 4 oz WMG[a] |
| Station | Sample ID | Sample Type | Approximate Number of Subsamples | Sample Group | 4±2 ºC | 4±2 ºC | 4±2 °C | 4±2 °C/ Deep frozen (-20°C)[b]/-10 °C[c] | 4±2 °C/ Deep frozen (-20 °C)[b] | 4±2 ºC; do not freeze; HOLD lab analysis[e] | 4±2 ºC; do not freeze; RUSH lab analysis[e] | 4±2 °C/ Deep frozen (-20°C)[b] | 4±2 ºC | 4±2 ºC | Airtight seal, store vertically | Airtight seal, store vertically | Airtight seal, store vertically | - in situ - | 4±2ºC | 4±2ºC | 4±2ºC | 4±2ºC |
| ☐ SJSH025 | SJSH025-CR1A | Core | 1 | HHRA shoreline 0 - 6.0 inch | | | | | | | | ☐ | | | | | | | | | | |
| ☐ SJSH025 | SJSH025-CR1B | Core | 1 | HHRA shoreline 6.0 - 12.0 inch | | | | | | | | ☐ | | | | | | | | | | |
| ☐ SJSH025 | SJSH025-CR1B | Core | 1 | HHRA shoreline 6.0 - 12.0 inch | | | | | | | | ☐ | | | | | | | | | | |
| ☐ SJSH026 | SJSH026-CR1A | Core | 1 | HHRA shoreline 0 - 6.0 inch | | | | | | | | ☐ | | | | | | | | | | |
| ☐ SJSH026 | SJSH026-CR1B | Core | 1 | HHRA shoreline 6.0 - 12.0 inch | | | | | | | | ☐ | | | | | | | | | | |
| ☐ SJSH027 | SJSH027-CR1A | Core | 1 | HHRA shoreline 0 - 6.0 inch | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ◐ | | | | | | | | | | |
| ☐ SJSH027 | SJSH027-CR1B | Core | 1 | HHRA shoreline 6.0 - 12.0 inch | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ◐ | | | | | | | | | | |
| ☐ SJSH028 | SJSH028-CR1A | Core | 1 | HHRA shoreline 0 - 6.0 inch | | | | | | | | ☐ | | | | | | | | | | |
| ☐ SJSH028 | SJSH028-CR1B | Core | 1 | HHRA shoreline 6.0 - 12.0 inch | | | | | | | | ☐ | | | | | | | | | | |
| ☐ SJSH029 | SJSH029-CR1A | Core | 1 | HHRA shoreline 0 - 6.0 inch | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ◐ | | | | | | | | | | |
| ☐ SJSH029 | SJSH029-CR1B | Core | 1 | HHRA shoreline 6.0 - 12.0 inch | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ◐ | | | | | | | | | | |
| ☐ SJSH030 | SJSH030-CR1A | Core | 1 | HHRA shoreline 0 - 6.0 inch | | | | | | | | ☐ | | | | | | | | | | |
| ☐ SJSH030 | SJSH030-CR1B | Core | 1 | HHRA shoreline 6.0 - 12.0 inch | | | | | | | | ☐ | | | | | | | | | | |
| ☐ SJSH031 | SJSH031-CR1A | Core | 1 | HHRA shoreline 0 - 6.0 inch | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ◐ | | | | | | | | | | |
| ☐ SJSH031 | SJSH031-CR1B | Core | 1 | HHRA shoreline 6.0 - 12.0 inch | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ◐ | | | | | | | | | | |
| ☐ SJSH032 | SJSH032-CR1A | Core | 1 | HHRA shoreline 0 - 6.0 inch | | | | | | | | ☐ | | | | | | | | | | |
| ☐ SJSH032 | SJSH032-CR1B | Core | 1 | HHRA shoreline 6.0 - 12.0 inch | | | | | | | | ☐ | | | | | | | | | | |
| ☐ SJSH033 | SJSH033-CR1A | Core | 1 | HHRA shoreline 0 - 6.0 inch | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ◐ | | | | | | | | | | |
| ☐ SJSH033 | SJSH033-CR1B | Core | 1 | HHRA shoreline 6.0 - 12.0 inch | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ◐ | | | | | | | | | | |
| ☐ SJSH034 | SJSH034-CR1A | Core | 1 | HHRA shoreline 0 - 6.0 inch | | | | | | | | ☐ | | | | | | | | | | |
| ☐ SJSH034 | SJSH034-CR1B | Core | 1 | HHRA shoreline 6.0 - 12.0 inch | | | | | | | | ☐ | | | | | | | | | | |
| ☐ SJSH035 | SJSH035-CR1A | Core | 1 | HHRA shoreline 0 - 6.0 inch | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ◐ | | | | | | | | | | |
| ☐ SJSH035 | SJSH035-CR1A | Core | 1 | HHRA shoreline 0 - 6.0 inch | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ◐ | | | | | | | | | | |
| ☐ SJSH035 | SJSH035-CR1B | Core | 1 | HHRA shoreline 6.0 - 12.0 inch | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ◐ | | | | | | | | | | |

**Table A-3**
**Field Sample Collection Matrix**

| | | | | | Chemistry Grab and Core Samples | | | | | | | | Geotechnical Boring | | | | | | Blank Filter Wipes (Whatman Grade 42 filters ) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Primary | | | | Secondary | | | | | | | | | | | | | |
| | | | | | TOC, Metals, Mercury, and Percent Moisture (EPA 160.3) | Grain Size | ☐ BEHP ◐ All SVOCs + PCB Aroclors | ☐ PCDD/F ◐ PCDD/F + PCB congeners[f] | Archive SVOCs and PCB Aroclors | VOCs HOLD | VOCs RUSH | Archival ☐ 32 oz ◐ 8 oz | Atterberg limits (ASTM D-4318), Specific gravity (ASTM D-854), Percent moisture (ASTM D 2216) | Grain Size | Sediment permeability (ASTM D-5084) | CU Triax, Compressive Strength (ASTM D-4767) | Consolidation Test (ASTM D-2435) | Vane Shear Test (ASTM D-2573) | Metals | Mercury | Dioxins/ Furans | SVOCs |
| | | | | | 8 oz WMG[a] | 16 oz WMG[a] | 8 oz WMG[a] | 8 oz WMG[a] | 8 oz WMG[a] | 2 oz WMG[a] | 2 oz WMG[a] | WMG[a] | 8 oz WMG[a] | 16 oz WMG[a] | Shelby tube | Shelby tube | Shelby tube | Vane | 4 oz WMG[a] | 4 oz WMG[a] | 4 oz WMG[a] | 4 oz WMG[a] |
| Station | Sample ID | Sample Type | Approximate Number of Subsamples | Sample Group | 4±2 ºC | 4±2 ºC | 4±2 °C | 4±2 °C/ Deep frozen (-20°C)[b]/-10 °C[c] | 4±2 °C/ Deep frozen (-20 °C)[b] | 4±2 ºC; do not freeze; HOLD lab analysis[e] | 4±2 ºC; do not freeze; RUSH lab analysis[e] | 4±2 °C/ Deep frozen (-20°C)[b] | 4±2 ºC | 4±2 ºC | Airtight seal, store vertically | Airtight seal, store vertically | Airtight seal, store vertically | - in situ - | 4±2ºC | 4±2ºC | 4±2ºC | 4±2ºC |
| ☐ SJSH035 | SJSH035-CR1B | Core | 1 | HHRA shoreline 6.0 - 12.0 inch | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ◐ | | | | | | | | | | |
| ☐ FW Blank | SDFW-910C | Equipment filter wipe blank | NA | HHRA shoreline | | | | | | | | | | | | | | | ☐ | ☐ | ☐ | ☐ |
| ☐ SJSH036 | SJSH036-CR1A | Core | 1 | HHRA shoreline 0 - 6.0 inch | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ◐ | | | | | | | | | | |
| ☐ SJSH036 | SJSH036-CR1B | Core | 1 | HHRA shoreline 6.0 - 12.0 inch | | | | | | | | ☐ | | | | | | | | | | |
| ☐ SJSH037 | SJSH037-CR1A | Core | 1 | HHRA shoreline 0 - 6.0 inch | | | | | | | | ☐ | | | | | | | | | | |
| ☐ SJSH037 | SJSH037-CR1B | Core | 1 | HHRA shoreline 6.0 - 12.0 inch | | | | | | | | ☐ | | | | | | | | | | |
| ☐ SJSH038 | SJSH038-CR1A | Core | 1 | HHRA shoreline 0 - 6.0 inch | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ◐ | | | | | | | | | | |
| ☐ SJSH038 | SJSH038-CR1B | Core | 1 | HHRA shoreline 6.0 - 12.0 inch | | | | | | | | ☐ | | | | | | | | | | |
| ☐ SJSH039 | SJSH039-CR1A | Core | 1 | HHRA shoreline 0 - 6.0 inch | | | | | | | | ☐ | | | | | | | | | | |
| ☐ SJSH039 | SJSH039-CR1B | Core | 1 | HHRA shoreline 6.0 - 12.0 inch | | | | | | | | ☐ | | | | | | | | | | |
| ☐ SJSH040 | SJSH040-CR1A | Core | 1 | HHRA shoreline 0 - 6.0 inch | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ◐ | | | | | | | | | | |
| ☐ SJSH040 | SJSH040-CR1A | Core | 1 | HHRA shoreline 0 - 6.0 inch | | | | | | | | ☐ | | | | | | | | | | |
| ☐ SJSH040 | SJSH040-CR1B | Core | 1 | HHRA shoreline 6.0 - 12.0 inch | | | | | | | | ☐ | | | | | | | | | | |
| ☐ SJSH040 | SJSH040-CR1B | Core | 1 | HHRA shoreline 6.0 - 12.0 inch | | | | | | | | ☐ | | | | | | | | | | |
| ☐ SJSH041 | SJSH041-CR1A | Core | 1 | HHRA shoreline 0 - 6.0 inch | | | | | | | | ☐ | | | | | | | | | | |
| ☐ SJSH041 | SJSH041-CR1B | Core | 1 | HHRA shoreline 6.0 - 12.0 inch | | | | | | | | ☐ | | | | | | | | | | |
| ☐ SJSH042 | SJSH042-CR1A | Core | 1 | HHRA shoreline 0 - 6.0 inch | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ◐ | | | | | | | | | | |
| ☐ SJSH042 | SJSH042-CR1B | Core | 1 | HHRA shoreline 6.0 - 12.0 inch | | | | | | | | ☐ | | | | | | | | | | |
| ☐ SJSH043 | SJSH043-CR1A | Core | 1 | HHRA shoreline 0 - 6.0 inch | | | | | | | | ☐ | | | | | | | | | | |
| ☐ SJSH043 | SJSH043-CR1B | Core | 1 | HHRA shoreline 6.0 - 12.0 inch | | | | | | | | ☐ | | | | | | | | | | |
| ☐ SJSH044 | SJSH044-CR1A | Core | 1 | HHRA shoreline 0 - 6.0 inch | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ◐ | | | | | | | | | | |
| ☐ SJSH044 | SJSH044-CR1B | Core | 1 | HHRA shoreline 6.0 - 12.0 inch | | | | | | | | ☐ | | | | | | | | | | |
| ☐ SJSH045 | SJSH045-CR1A | Core | 1 | HHRA shoreline 0 - 6.0 inch | | | | | | | | ☐ | | | | | | | | | | |
| ☐ SJSH045 | SJSH045-CR1B | Core | 1 | HHRA shoreline 6.0 - 12.0 inch | | | | | | | | ☐ | | | | | | | | | | |

**Table A-3**
**Field Sample Collection Matrix**

| | | | | | Chemistry Grab and Core Samples | | | | | | | | Geotechnical Boring | | | | | | Blank Filter Wipes (Whatman Grade 42 filters ) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Primary | | | | Secondary | | | | | | | | | | | | | |
| | | | | | TOC, Metals, Mercury, and Percent Moisture (EPA 160.3) | Grain Size | ☐ BEHP ◐ All SVOCs + PCB Aroclors | ☐ PCDD/F ◐ PCDD/F + PCB congeners[f] | Archive SVOCs and PCB Aroclors | VOCs HOLD | VOCs RUSH | Archival ☐ 32 oz ◐ 8 oz | Atterberg limits (ASTM D-4318), Specific gravity (ASTM D-854), Percent moisture (ASTM D 2216) | Grain Size | Sediment permeability (ASTM D-5084) | CU Triax, Compressive Strength (ASTM D-4767) | Consolidation Test (ASTM D-2435) | Vane Shear Test (ASTM D-2573) | Metals | Mercury | Dioxins/ Furans | SVOCs |
| | | | | | 8 oz WMG[a] | 16 oz WMG[a] | 8 oz WMG[a] | 8 oz WMG[a] | 8 oz WMG[a] | 2 oz WMG[a] | 2 oz WMG[a] | WMG[a] | 8 oz WMG[a] | 16 oz WMG[a] | Shelby tube | Shelby tube | Shelby tube | Vane | 4 oz WMG[a] | 4 oz WMG[a] | 4 oz WMG[a] | 4 oz WMG[a] |
| Station | Sample ID | Sample Type | Approximate Number of Subsamples | Sample Group | 4±2 ºC | 4±2 ºC | 4±2 °C | 4±2 °C/ Deep frozen (-20°C)[b]/-10 °C[c] | 4±2 °C/ Deep frozen (-20 °C)[b] | 4±2 ºC; do not freeze; HOLD lab analysis[e] | 4±2 ºC; do not freeze; RUSH lab analysis[e] | 4±2 °C/ Deep frozen (-20°C)[b] | 4±2 ºC | 4±2 ºC | Airtight seal, store vertically | Airtight seal, store vertically | Airtight seal, store vertically | - in situ - | 4±2ºC | 4±2ºC | 4±2ºC | 4±2ºC |
| ☐ SJSH046 | SJSH046-CR1A | Core | 1 | HHRA background 0 - 6.0 inch | | | | | | | | ☐ | | | | | | | | | | |
| ☐ SJSH046 | SJSH046-CR1B | Core | 1 | HHRA background 6.0 - 12.0 inch | | | | | | | | ☐ | | | | | | | | | | |
| ☐ SJSH047 | SJSH047-CR1A | Core | 1 | HHRA background 0 - 6.0 inch | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ◐ | | | | | | | | | | |
| ☐ SJSH047 | SJSH047-CR1B | Core | 1 | HHRA background 6.0 - 12.0 inch | | | | | | | | ☐ | | | | | | | | | | |
| ☐ SJSH048 | SJSH048-CR1A | Core | 1 | HHRA background 0 - 6.0 inch | | | | | | | | ☐ | | | | | | | | | | |
| ☐ SJSH048 | SJSH048-CR1B | Core | 1 | HHRA background 6.0 - 12.0 inch | | | | | | | | ☐ | | | | | | | | | | |
| ☐ SJSH049 | SJSH049-CR1A | Core | 1 | HHRA background 0 - 6.0 inch | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ◐ | | | | | | | | | | |
| ☐ SJSH049 | SJSH049-CR1B | Core | 1 | HHRA background 6.0 - 12.0 inch | | | | | | | | ☐ | | | | | | | | | | |
| ☐ SJSH050 | SJSH050-CR1A | Core | 1 | HHRA background 0 - 6.0 inch | | | | | | | | ☐ | | | | | | | | | | |
| ☐ SJSH050 | SJSH050-CR1B | Core | 1 | HHRA background 6.0 - 12.0 inch | | | | | | | | ☐ | | | | | | | | | | |
| ☐ SJSH051 | SJSH051-CR1A | Core | 1 | HHRA background 0 - 6.0 inch | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ◐ | | | | | | | | | | |
| ☐ SJSH051 | SJSH051-CR1B | Core | 1 | HHRA background 6.0 - 12.0 inch | | | | | | | | ☐ | | | | | | | | | | |
| ☐ SJSH052 | SJSH052-CR1A | Core | 1 | HHRA background 0 - 6.0 inch | | | | | | | | ☐ | | | | | | | | | | |
| ☐ SJSH052 | SJSH052-CR1B | Core | 1 | HHRA background 6.0 - 12.0 inch | | | | | | | | ☐ | | | | | | | | | | |
| ☐ SJSH053 | SJSH053-CR1A | Core | 1 | HHRA background 0 - 6.0 inch | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ◐ | | | | | | | | | | |
| ☐ SJSH053 | SJSH053-CR1B | Core | 1 | HHRA background 6.0 - 12.0 inch | | | | | | | | ☐ | | | | | | | | | | |
| ☐ SJSH054 | SJSH054-CR1A | Core | 1 | HHRA background 0 - 6.0 inch | | | | | | | | ☐ | | | | | | | | | | |
| ☐ SJSH054 | SJSH054-CR1B | Core | 1 | HHRA background 6.0 - 12.0 inch | | | | | | | | ☐ | | | | | | | | | | |
| ☐ SJSH055 | SJSH055-CR1A | Core | 1 | HHRA background 0 - 6.0 inch | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ◐ | | | | | | | | | | |
| ☐ SJSH055 | SJSH055-CR1B | Core | 1 | HHRA background 6.0 - 12.0 inch | | | | | | | | ☐ | | | | | | | | | | |
| ☐ FW Blank | SDFW-911C | Equipment filter wipe blank | NA | HHRA background | | | | | | | | | | | | | | | ☐ | ☐ | ☐ | ☐ |
| ☐ SJSH056 | SJSH056-GR1 | Surface grab | 1 | ERA shoreline | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ◐ | | | | | | | | | | |
| ☐ SJSH057 | SJSH057-GR1 | Surface grab | 1 | ERA shoreline | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ◐ | | | | | | | | | | |
| ☐ SJSH058 | SJSH058-GR1 | Surface grab | 1 | ERA shoreline | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ◐ | | | | | | | | | | |

**Table A-3**
**Field Sample Collection Matrix**

| | | | | | Chemistry Grab and Core Samples | | | | | | | | Geotechnical Boring | | | | | | Blank Filter Wipes (Whatman Grade 42 filters ) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Primary | | | | Secondary | | | | | | | | | | | | | |
| | | | | | TOC, Metals, Mercury, and Percent Moisture (EPA 160.3) | Grain Size | ☐ BEHP ❍ All SVOCs + PCB Aroclors | ☐ PCDD/F ❍ PCDD/F + PCB congeners[f] | Archive SVOCs and PCB Aroclors | VOCs HOLD | VOCs RUSH | Archival ☐ 32 oz ❍ 8 oz | Atterberg limits (ASTM D-4318), Specific gravity (ASTM D-854), Percent moisture (ASTM D 2216) | Grain Size | Sediment permeability (ASTM D-5084) | CU Triax, Compressive Strength (ASTM D-4767) | Consolidation Test (ASTM D-2435) | Vane Shear Test (ASTM D-2573) | Metals | Mercury | Dioxins/ Furans | SVOCs |
| | | | | | 8 oz WMG[a] | 16 oz WMG[a] | 8 oz WMG[a] | 8 oz WMG[a] | 8 oz WMG[a] | 2 oz WMG[a] | 2 oz WMG[a] | WMG[a] | 8 oz WMG[a] | 16 oz WMG[a] | Shelby tube | Shelby tube | Shelby tube | Vane | 4 oz WMG[a] | 4 oz WMG[a] | 4 oz WMG[a] | 4 oz WMG[a] |
| Station | Sample ID | Sample Type | Approximate Number of Subsamples | Sample Group | 4±2 ºC | 4±2 ºC | 4±2 °C | 4±2 °C/ Deep frozen (-20°C)[b]/-10 °C[c] | 4±2 °C/ Deep frozen (-20 °C)[b] | 4±2 ºC; do not freeze; HOLD lab analysis[e] | 4±2 ºC; do not freeze; RUSH lab analysis[e] | 4±2 °C/ Deep frozen (-20°C)[b] | 4±2 ºC | 4±2 ºC | Airtight seal, store vertically | Airtight seal, store vertically | Airtight seal, store vertically | - in situ - | 4±2ºC | 4±2ºC | 4±2ºC | 4±2ºC |
| ☐ SJSH059 | SJSH059-GR1 | Surface grab | 1 | ERA shoreline | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ❍ | | | | | | | | | | |
| ☐ SJSH060 | SJSH060-GR1 | Surface grab | 1 | ERA shoreline | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ❍ | | | | | | | | | | |
| ☐ SJSH061 | SJSH061-GR1 | Surface grab | 1 | ERA shoreline | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ❍ | | | | | | | | | | |
| ☐ FW Blank | SDFW-912S | Equipment filter wipe blank | NA | ERA shoreline | | | | | | | | | | | | | | | ☐ | ☐ | ☐ | ☐ |
| ☐ SJSH062 | SJSH062-GR1 | Surface grab | 1 | ERA background | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ❍ | | | | | | | | | | |
| ☐ SJSH063 | SJSH063-GR1 | Surface grab | 1 | ERA background | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ❍ | | | | | | | | | | |
| ☐ SJSH064 | SJSH064-GR1 | Surface grab | 1 | ERA background | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ❍ | | | | | | | | | | |
| ☐ SJSH064 | SJSH064-GR1 | Surface grab | 1 | ERA background | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | | ❍ | | | | | | | | | | |
| | | | | | 154 | 154 | 154 | 154 | 115 | 115 | 39 | 233 | 49 | 25 | 25 | 25 | 25 | 26 | 12 | 12 | 12 | 12 |

**Definitions**

AG = amber glass
BEHP = bis(2-ethylhexyl)phthalate
HDPE = high density polyethylene sample bottle
NA = not applicable
PCDD/F = polychlorinated dibenzo-*p* -dioxin and polychlorinated dibenzofuran
SVOC = semivolatile organic compound
VOC = volatile organic compound
WMG = wide mouth glass

a - The size and number of containers may be modified by the analytical laboratory.
b - Samples will be shipped to the laboratory on ice at 4±2 °C. Once received at the laboratory, samples will be stored at -20 °C.
c - Extracts will be stored at -10 °C.
d - Refer to Table 14 of the Sampling and Analysis Plan for details on geotechnical core processing.
e - Rush VOC analysis. Turn around time of 72 hours.
f - Dioxin-like PCB congeners only.
g - One sample will be collected for Study Elements 1 and 2 and one sample will be collected for Study Elements 3 and 4.

Station ID

SD = surface grabs
CR = sediment cores
Rinsate Blanks ending in C = Lexan cores
Rinsate Blanks ending in S = SS bowls & spoons

SN = sample number
TG = tag number

Station ID = split sample
Station ID = triplicate sample; three separate and unique samples from three different grabs in three different locations.

**Table A-4**
**Station Coordinates, Sample Type, Sampling Interval, and Corresponding Analysis**

| Station Number | Sample Type | Sampling Interval[a] | Analysis | Coordinates[b,c] | |
|---|---|---|---|---|---|
| | | | | X | Y |
| **Source Stations** | | | | | |
| SJGB001 | Geotechnical boring | 5-ft intervals. Starting elevation will be based on initial penetration of auger or casing below mudline | Atterberg limits, grain size, moisture content, specific gravity, sediment compressibility, sediment permeability, consolidated undrained triaxial compressive strength | 3216697.5 | 13857564.5 |
| SJGB002 | Geotechnical boring | 5-ft intervals. Starting elevation will be based on initial penetration of auger or casing below mudline | Atterberg limits, grain size, moisture content, specific gravity, sediment compressibility, sediment permeability, consolidated undrained triaxial compressive strength | 3216845.615 | 13857759.22 |
| SJGB003 | Geotechnical boring | 5-ft intervals. Starting elevation will be based on initial penetration of auger or casing below mudline | Atterberg limits, grain size, moisture content, specific gravity, sediment compressibility, sediment permeability, consolidated undrained triaxial compressive strength | 3217175.12 | 13857907.52 |
| SJGB004 | Geotechnical boring | 5-ft intervals. Starting elevation will be based on initial penetration of auger or casing below mudline | Atterberg limits, grain size, moisture content, specific gravity, sediment compressibility, sediment permeability, consolidated undrained triaxial compressive strength; primary COPCs | 3217433.736 | 13857779.76 |
| SJGB005 | Geotechnical boring | 5-ft intervals. Starting elevation will be based on initial penetration of auger or casing below mudline | Atterberg limits, grain size, moisture content, specific gravity, sediment compressibility, sediment permeability, consolidated undrained triaxial compressive strength; primary COPCs | 3217588.147 | 13857634.82 |
| SJGB006 | Geotechnical boring | 5-ft intervals. Starting elevation will be based on initial penetration of auger or casing below mudline | Atterberg limits, grain size, moisture content, specific gravity, sediment compressibility, sediment permeability, consolidated undrained triaxial compressive strength | 3217009.085 | 13857746.5 |
| SJGB007 | Geotechnical boring | 5-ft intervals. Starting elevation will be based on initial penetration of auger or casing below mudline | Atterberg limits, grain size, moisture content, specific gravity, sediment compressibility, sediment permeability, consolidated undrained triaxial compressive strength; primary COPCs | 3217427.729 | 13857346.82 |
| SJGB008 | Geotechnical boring | 5-ft intervals. Starting elevation will be based on initial penetration of auger or casing below mudline | Atterberg limits, grain size, moisture content, specific gravity, sediment compressibility, sediment permeability, consolidated undrained triaxial compressive strength; primary COPCs | 3217348.582 | 13857165.75 |
| SJGB009 | Geotechnical boring | 5-ft intervals. Starting elevation will be based on initial penetration of auger or casing below mudline | Atterberg limits, grain size, moisture content, specific gravity, sediment compressibility, sediment permeability, consolidated undrained triaxial compressive strength | 3216878.366 | 13857329.24 |
| SJGB010 | Geotechnical boring | 5-ft intervals. Starting elevation will be based on initial penetration of auger or casing below mudline | Atterberg limits, grain size, moisture content, specific gravity, sediment compressibility, sediment permeability, consolidated undrained triaxial compressive strength; primary and secondary COPCs | 3216757.058 | 13857434.53 |
| SJGB011 | Geotechnical boring | 5-ft intervals. Starting elevation will be based on initial penetration of auger or casing below mudline | Atterberg limits, grain size, moisture content, specific gravity, sediment compressibility, sediment permeability, consolidated undrained triaxial compressive strength; primary and secondary COPCs | 3216934.356 | 13857529.67 |
| SJGB012 | Geotechnical boring | 5-ft intervals. Starting elevation will be based on initial penetration of auger or casing below mudline | Atterberg limits, grain size, moisture content, specific gravity, sediment compressibility, sediment permeability, consolidated undrained triaxial compressive strength; primary and secondary COPCs | 3216840.356 | 13857619.17 |
| SJGB013 | Geotechnical boring | 5-ft intervals. Starting elevation will be based on initial penetration of auger or casing below mudline | Atterberg limits, grain size, moisture content, specific gravity, sediment compressibility, sediment permeability, consolidated undrained triaxial compressive strength; primary and secondary COPCs | 3216936.924 | 13857899.05 |

**Table A-4**
**Station Coordinates, Sample Type, Sampling Interval, and Corresponding Analysis**

| Station Number | Sample Type | Sampling Interval[a] | Analysis | Coordinates[b,c] | |
|---|---|---|---|---|---|
| | | | | X | Y |
| SJGB014 | Geotechnical boring | 5-ft intervals. Starting elevation will be based on initial penetration of auger or casing below mudline | Atterberg limits, grain size, moisture content, specific gravity, sediment compressibility, sediment permeability, consolidated undrained triaxial compressive strength; primary and secondary COPCs | 3217181.224 | 13857746.29 |
| SJGB015 | Geotechnical boring | 5-ft intervals. Starting elevation will be based on initial penetration of auger or casing below mudline | Atterberg limits, grain size, moisture content, specific gravity, sediment compressibility, sediment permeability, consolidated undrained triaxial compressive strength; primary and secondary COPCs | 3217407.69 | 13857590.85 |
| SJGB016 | Geotechnical boring | 5-ft intervals. Starting elevation will be based on initial penetration of auger or casing below mudline | Atterberg limits, grain size, moisture content, specific gravity, sediment compressibility, sediment permeability, consolidated undrained triaxial compressive strength; primary and secondary COPCs | 3217175.906 | 13857576.18 |
| SJGB017 | Geotechnical boring | 5-ft intervals. Starting elevation will be based on initial penetration of auger or casing below mudline | Atterberg limits, grain size, moisture content, specific gravity, sediment compressibility, sediment permeability, consolidated undrained triaxial compressive strength; primary and secondary COPCs | 3217156.406 | 13857342.68 |
| SJVS001 | Vane shear | 1, 2, 3 feet depths below mudline | Vane shear | 3216837.673 | 13857733.34 |
| SJVS002 | Vane shear | 1, 2, 3 feet depths below mudline | Vane shear | 3216931.835 | 13857814.21 |
| SJVS003 | Vane shear | 1, 2, 3 feet depths below mudline | Vane shear | 3217162.082 | 13857931.76 |
| SJVS004 | Vane shear | 1, 2, 3 feet depths below mudline | Vane shear | 3217143.091 | 13857809.41 |
| SJVS005 | Vane shear | 1, 2, 3 feet depths below mudline | Vane shear | 3217285.139 | 13857780.73 |
| SJVS006 | Vane shear | 1, 2, 3 feet depths below mudline | Vane shear | 3217412.468 | 13857746.27 |
| SJVS007 | Vane shear | 1, 2, 3 feet depths below mudline | Vane shear | 3217149.067 | 13857642.97 |
| SJVS008 | Vane shear | 1, 2, 3 feet depths below mudline | Vane shear | 3217301.584 | 13857610.84 |
| SJVS009 | Vane shear | 1, 2, 3 feet depths below mudline | Vane shear | 3217435.436 | 13857574.02 |
| SJVS010 | Vane shear | 1, 2, 3 feet depths below mudline | Vane shear | 3217148.268 | 13857524.67 |
| SJVS011 | Vane shear | 1, 2, 3 feet depths below mudline | Vane shear | 3217298.499 | 13857472.71 |
| SJVS012 | Vane shear | 1, 2, 3 feet depths below mudline | Vane shear | 3217499.901 | 13857450.02 |
| SJVS013 | Vane shear | 1, 2, 3 feet depths below mudline | Vane shear | 3217131.134 | 13857386.74 |

**Table A-4**
**Station Coordinates, Sample Type, Sampling Interval, and Corresponding Analysis**

| Station Number | Sample Type | Sampling Interval[a] | Analysis | Coordinates[b,c] | |
|---|---|---|---|---|---|
| | | | | X | Y |
| SJVS014 | Vane shear | 1, 2, 3 feet depths below mudline | Vane shear | 3217407.129 | 13857359.48 |
| SJVS015 | Vane shear | 1, 2, 3 feet depths below mudline | Vane shear | 3217297.722 | 13857311.23 |
| SJVS016 | Vane shear | 1, 2, 3 feet depths below mudline | Vane shear | 3217211.824 | 13857242.94 |
| SJVS017 | Vane shear | 1, 2, 3 feet depths below mudline | Vane shear | 3217420.45 | 13857242.94 |
| SJVS018 | Vane shear | 1, 2, 3 feet depths below mudline | Vane shear | 3217325.676 | 13857120.58 |
| **Stations within the Preliminary Site Perimeter** | | | | | |
| SJNE001 | Surface sediment | 0-6 inches (0-15 cm) | Primary COPCs | 3215250 | 13853000 |
| SJNE002 | Surface sediment | 0-6 inches (0-15 cm) | Primary COPCs | 3214750 | 13854000 |
| SJNE003 | Surface sediment | 0-6 inches (0-15 cm) | Primary COPCs | 3215250 | 13854000 |
| SJNE004 | Surface sediment | 0-6 inches (0-15 cm) | Primary COPCs | 3216250 | 13854000 |
| SJNE005 | Surface sediment | 0-6 inches (0-15 cm) | Primary COPCs | 3217250 | 13854000 |
| SJNE006 | Surface sediment | 0-6 inches (0-15 cm) | Primary COPCs | 3214250 | 13855000 |
| SJNE007 | Surface sediment | 0-6 inches (0-15 cm) | All COPCs (primary and secondary) | 3214750 | 13855000 |
| SJNE007 | Subsurface sediment (core) | 1 ft intervals to 10 feet | Primary COPCs + additional samples for geotechnical | 3214750 | 13855000 |
| SJNE008 | Surface sediment | 0-6 inches (0-15 cm) | All COPCs (primary and secondary) | 3216250 | 13855000 |
| SJNE008 | Subsurface sediment (core) | 1 ft intervals to 10 feet | Primary COPCs + additional samples for geotechnical | 3216250 | 13855000 |
| SJNE009 | Surface sediment | 0-6 inches (0-15 cm) | Primary COPCs | 3217250 | 13855000 |
| SJNE010 | Surface sediment | 0-6 inches (0-15 cm) | Primary COPCs | 3216250 | 13855500 |
| SJNE011 | Surface sediment | 0-6 inches (0-15 cm) | Primary COPCs | 3216750 | 13855500 |
| SJNE012 | Surface sediment | 0-6 inches (0-15 cm) | All COPCs (primary and secondary) | 3217250 | 13855500 |
| SJNE012 | Subsurface sediment (core) | 1 ft intervals to 10 feet | Primary COPCs + additional samples for geotechnical | 3217250 | 13855500 |
| SJNE013 | Surface sediment | 0-6 inches (0-15 cm) | Primary COPCs | 3214250 | 13855500 |
| SJNE014 | Surface sediment | 0-6 inches (0-15 cm) | Primary COPCs | 3216750 | 13856000 |
| SJNE015 | Surface sediment | 0-6 inches (0-15 cm) | Primary COPCs | 3217250 | 13856000 |
| SJNE016 | Surface sediment | 0-6 inches (0-15 cm) | Primary COPCs | 3215250 | 13856500 |
| SJNE017 | Surface sediment | 0-6 inches (0-15 cm) | Primary COPCs | 3217250 | 13856500 |
| SJNE018 | Surface sediment | 0-6 inches (0-15 cm) | Primary COPCs | 3215495.131 | 13856863.02 |
| SJNE019 | Surface sediment | 0-6 inches (0-15 cm) | Primary COPCs | 3215750 | 13857000 |
| SJNE020 | Surface sediment | 0-6 inches (0-15 cm) | Primary COPCs | 3217750 | 13857000 |
| SJNE021 | Surface sediment | 0-6 inches (0-15 cm) | Primary COPCs | 3218250 | 13857000 |
| SJNE023 | Surface sediment | 0-6 inches (0-15 cm) | All COPCs (primary and secondary) | 3217750 | 13857500 |
| SJNE023 | Subsurface sediment (core) | 1 ft intervals to 10 feet | Primary COPCs + additional samples for geotechnical | 3217750 | 13857500 |
| SJNE024 | Surface sediment | 0-6 inches (0-15 cm) | Primary COPCs | 3218250 | 13857500 |
| SJNE025 | Surface sediment | 0-6 inches (0-15 cm) | Primary COPCs | 3218750 | 13857500 |
| SJNE026 | Surface sediment | 0-6 inches (0-15 cm) | All COPCs (primary and secondary) | 3216250 | 13858000 |
| SJNE026 | Subsurface sediment (core) | 1 ft intervals to 10 feet | Primary COPCs + additional samples for geotechnical | 3216250 | 13858000 |
| SJNE027 | Surface sediment | 0-6 inches (0-15 cm) | Primary COPCs | 3216750 | 13858000 |

**Table A-4**
**Station Coordinates, Sample Type, Sampling Interval, and Corresponding Analysis**

| Station Number | Sample Type | Sampling Interval[a] | Analysis | Coordinates[b,c] | |
|---|---|---|---|---|---|
| | | | | X | Y |
| SJNE028 | Surface sediment | 0-6 inches (0-15 cm) | All COPCs (primary and secondary) | 3217250 | 13858000 |
| SJNE028 | Subsurface sediment (core) | 1 ft intervals to 10 feet | Primary COPCs + additional samples for geotechnical | 3217250 | 13858000 |
| SJNE029 | Surface sediment | 0-6 inches (0-15 cm) | All COPCs (primary and secondary) | 3217750 | 13858000 |
| SJNE029 | Subsurface sediment (core) | 1 ft intervals to 10 feet | Primary COPCs + additional samples for geotechnical | 3217750 | 13858000 |
| SJNE030 | Surface sediment | 0-6 inches (0-15 cm) | All COPCs (primary and secondary) | 3218250 | 13858000 |
| SJNE030 | Subsurface sediment (core) | 1 ft intervals to 10 feet | Primary COPCs + additional samples for geotechnical | 3218250 | 13858000 |
| SJNE031 | Surface sediment | 0-6 inches (0-15 cm) | Primary COPCs | 3218750 | 13858000 |
| SJNE032 | Surface sediment | 0-6 inches (0-15 cm) | All COPCs (primary and secondary) | 3216250 | 13858500 |
| SJNE032 | Subsurface sediment (core) | 1 ft intervals to 10 feet | Primary COPCs + additional samples for geotechnical | 3216250 | 13858500 |
| SJNE033 | Surface sediment | 0-6 inches (0-15 cm) | All COPCs (primary and secondary) | 3216750 | 13858500 |
| SJNE033 | Subsurface sediment (core) | 1 ft intervals to 10 feet | Primary COPCs + additional samples for geotechnical | 3216750 | 13858500 |
| SJNE034 | Surface sediment | 0-6 inches (0-15 cm) | Primary COPCs | 3217250 | 13858500 |
| SJNE035 | Surface sediment | 0-6 inches (0-15 cm) | All COPCs (primary and secondary) | 3217750 | 13858500 |
| SJNE035 | Subsurface sediment (core) | 1 ft intervals to 10 feet | Primary COPCs + additional samples for geotechnical | 3217750 | 13858500 |
| SJNE036 | Surface sediment | 0-6 inches (0-15 cm) | Primary COPCs | 3218250 | 13858500 |
| SJNE037 | Surface sediment | 0-6 inches (0-15 cm) | Primary COPCs | 3218750 | 13858500 |
| SJNE038 | Surface sediment | 0-6 inches (0-15 cm) | Primary COPCs | 3214250 | 13859000 |
| SJNE039 | Surface sediment | 0-6 inches (0-15 cm) | Primary COPCs | 3215250 | 13859000 |
| SJNE040 | Surface sediment | 0-6 inches (0-15 cm) | Primary COPCs | 3215750 | 13859000 |
| SJNE041 | Surface sediment | 0-6 inches (0-15 cm) | All COPCs (primary and secondary) | 3216250 | 13859000 |
| SJNE041 | Subsurface sediment (core) | 1 ft intervals to 10 feet | Primary COPCs + additional samples for geotechnical | 3216250 | 13859000 |
| SJNE042 | Surface sediment | 0-6 inches (0-15 cm) | Primary COPCs | 3216750 | 13859000 |
| SJNE043 | Surface sediment | 0-6 inches (0-15 cm) | All COPCs (primary and secondary) | 3217250 | 13859000 |
| SJNE043 | Subsurface sediment (core) | 1 ft intervals to 10 feet | Primary COPCs + additional samples for geotechnical | 3217250 | 13859000 |
| SJNE044 | Surface sediment | 0-6 inches (0-15 cm) | Primary COPCs | 3217750 | 13859000 |
| SJNE045 | Surface sediment | 0-6 inches (0-15 cm) | Primary COPCs | 3218250 | 13859000 |
| SJNE046 | Surface sediment | 0-6 inches (0-15 cm) | Primary COPCs | 3218750 | 13859000 |
| SJNE047 | Surface sediment | 0-6 inches (0-15 cm) | Primary COPCs | 3215250 | 13859500 |
| SJNE048 | Surface sediment | 0-6 inches (0-15 cm) | Primary COPCs | 3215750 | 13859500 |
| SJNE049 | Surface sediment | 0-6 inches (0-15 cm) | Primary COPCs | 3216250 | 13859500 |
| SJNE050 | Surface sediment | 0-6 inches (0-15 cm) | All COPCs (primary and secondary) | 3216750 | 13859500 |
| SJNE050 | Subsurface sediment (core) | 1 ft intervals to 10 feet | Primary COPCs + additional samples for geotechnical | 3216750 | 13859500 |
| SJNE051 | Surface sediment | 0-6 inches (0-15 cm) | Primary COPCs | 3217250 | 13859500 |
| SJNE052 | Surface sediment | 0-6 inches (0-15 cm) | Primary COPCs | 3214250 | 13860000 |
| SJNE053 | Surface sediment | 0-6 inches (0-15 cm) | Primary COPCs | 3215250 | 13860000 |
| SJNE054 | Surface sediment | 0-6 inches (0-15 cm) | Primary COPCs | 3216250 | 13860000 |
| SJNE055 | Surface sediment | 0-6 inches (0-15 cm) | Primary COPCs | 3217250 | 13860000 |
| SJNE056 | Surface sediment | 0-6 inches (0-15 cm) | Primary COPCs | 3218250 | 13860000 |
| SJNE057 | Surface sediment | 0-6 inches (0-15 cm) | Primary COPCs | 3215250 | 13861000 |
| SJNE058 | Surface sediment | 0-6 inches (0-15 cm) | Primary COPCs | 3216250 | 13861000 |

**Table A-4**
**Station Coordinates, Sample Type, Sampling Interval, and Corresponding Analysis**

| Station Number | Sample Type | Sampling Interval[a] | Analysis | Coordinates[b,c] | |
|---|---|---|---|---|---|
| | | | | X | Y |
| SJNE059 | Surface sediment | 0-6 inches (0-15 cm) | Primary COPCs | 3217250 | 13861000 |
| **Stations within the Preliminary Site Perimeter for Additional Characterization of the Impoundment Area** | | | | | |
| SJNE022-1 | Surface sediment | 0-6 inches (0-15 cm) | All COPCs (primary and secondary) | 3217250 | 13857514 |
| SJNE022-2 | Surface sediment | 0-6 inches (0-15 cm) | All COPCs (primary and secondary) | 3217234 | 13857486 |
| SJNE022-3 | Surface sediment | 0-6 inches (0-15 cm) | All COPCs (primary and secondary) | 3217267 | 13857486 |
| SJVS001 | Surface sediment | 0-6 inches (0-15 cm) | All COPCs (primary and secondary) | 3216837.673 | 13857733.34 |
| SJVS016 | Surface sediment | 0-6 inches (0-15 cm) | All COPCs (primary and secondary) | 3217211.824 | 13857242.94 |
| SJGB004 | Surface sediment | 0-6 inches (0-15 cm) | Primary COPCs | 3217415.283 | 13857775.2 |
| SJGB005 | Surface sediment | 0-6 inches (0-15 cm) | Primary COPCs | 3217496.069 | 13857603.34 |
| SJGB007 | Surface sediment | 0-6 inches (0-15 cm) | Primary COPCs | 3217427.729 | 13857346.82 |
| SJGB008 | Surface sediment | 0-6 inches (0-15 cm) | Primary COPCs | 3217348.582 | 13857165.75 |
| **Upstream Background Stations** | | | | | |
| SJNE060 | Surface sediment | 0-6 inches (0-15 cm) | All COPCs (primary and secondary) | 3211685.476 | 13859209.22 |
| SJNE061 | Surface sediment | 0-6 inches (0-15 cm) | All COPCs (primary and secondary) | 3211965.424 | 13860868.17 |
| SJNE062 | Surface sediment | 0-6 inches (0-15 cm) | All COPCs (primary and secondary) | 3212345.697 | 13863121.63 |
| SJNE063 | Surface sediment | 0-6 inches (0-15 cm) | All COPCs (primary and secondary) | 3207033.213 | 13860925.82 |
| SJNE064 | Surface sediment | 0-6 inches (0-15 cm) | All COPCs (primary and secondary) | 3208153.686 | 13861627.39 |
| SJNE065 | Surface sediment | 0-6 inches (0-15 cm) | All COPCs (primary and secondary) | 3209970.905 | 13862765.22 |
| SJNE066 | Surface sediment | 0-6 inches (0-15 cm) | All COPCs (primary and secondary) | 3208406.851 | 13866335.44 |
| SJNE067 | Surface sediment | 0-6 inches (0-15 cm) | All COPCs (primary and secondary) | 3209933.519 | 13865308.09 |
| SJNE068 | Surface sediment | 0-6 inches (0-15 cm) | All COPCs (primary and secondary) | 3210363.371 | 13865018.83 |
| SJNE069 | Surface sediment | 0-6 inches (0-15 cm) | All COPCs (primary and secondary) | 3211619.353 | 13868396.73 |
| SJNE070 | Surface sediment | 0-6 inches (0-15 cm) | All COPCs (primary and secondary) | 3211946.202 | 13868073.08 |
| **Human Health Shoreline Stations** | | | | | |
| SJSH001 | Surface sediment | 0-6 inches (0-15 cm) | Primary COPCs | 3217585.809 | 13854772.3 |
| SJSH001 | Subsurface sediment (core) | 6-12 inches (15-30 cm) | Archive for possible future analysis | 3217585.809 | 13854772.3 |
| SJSH002 | Surface sediment | 0-6 inches (0-15 cm) | Archive for possible future analysis | 3217646.738 | 13854921.58 |
| SJSH002 | Subsurface sediment (core) | 6-12 inches (15-30 cm) | Archive for possible future analysis | 3217646.738 | 13854921.58 |
| SJSH003 | Surface sediment | 0-6 inches (0-15 cm) | Primary COPCs | 3217767.366 | 13855040.31 |
| SJSH003 | Subsurface sediment (core) | 6-12 inches (15-30 cm) | Archive for possible future analysis | 3217767.366 | 13855040.31 |
| SJSH004 | Surface sediment | 0-6 inches (0-15 cm) | Archive for possible future analysis | 3217859.231 | 13855178.72 |
| SJSH004 | Subsurface sediment (core) | 6-12 inches (15-30 cm) | Archive for possible future analysis | 3217859.231 | 13855178.72 |
| SJSH005 | Surface sediment | 0-6 inches (0-15 cm) | Primary COPCs | 3217931.61 | 13855331.34 |
| SJSH005 | Subsurface sediment (core) | 6-12 inches (15-30 cm) | Archive for possible future analysis | 3217931.61 | 13855331.34 |
| SJSH006 | Surface sediment | 0-6 inches (0-15 cm) | Archive for possible future analysis | 3216929.526 | 13856475.1 |
| SJSH006 | Subsurface sediment (core) | 6-12 inches (15-30 cm) | Archive for possible future analysis | 3216929.526 | 13856475.1 |
| SJSH007 | Surface sediment | 0-6 inches (0-15 cm) | Primary COPCs | 3217006.859 | 13856595.72 |
| SJSH007 | Subsurface sediment (core) | 6-12 inches (15-30 cm) | Archive for possible future analysis | 3217006.859 | 13856595.72 |
| SJSH008 | Surface sediment | 0-6 inches (0-15 cm) | Archive for possible future analysis | 3217082.273 | 13856701.38 |
| SJSH008 | Subsurface sediment (core) | 6-12 inches (15-30 cm) | Archive for possible future analysis | 3217082.273 | 13856701.38 |

**Table A-4**
**Station Coordinates, Sample Type, Sampling Interval, and Corresponding Analysis**

| Station Number | Sample Type | Sampling Interval[a] | Analysis | Coordinates[b,c] | |
|---|---|---|---|---|---|
| | | | | X | Y |
| SJSH009 | Surface sediment | 0-6 inches (0-15 cm) | Primary COPCs | 3217164.295 | 13856804.86 |
| SJSH009 | Subsurface sediment (core) | 6-12 inches (15-30 cm) | Archive for possible future analysis | 3217164.295 | 13856804.86 |
| SJSH010 | Surface sediment | 0-6 inches (0-15 cm) | Primary COPCs | 3217251.264 | 13856912.76 |
| SJSH010 | Subsurface sediment (core) | 6-12 inches (15-30 cm) | Archive for possible future analysis | 3217251.264 | 13856912.76 |
| SJSH011 | Surface sediment | 0-6 inches (0-15 cm) | Archive for possible future analysis | 3217448.184 | 13856253.65 |
| SJSH011 | Subsurface sediment (core) | 6-12 inches (15-30 cm) | Archive for possible future analysis | 3217448.184 | 13856253.65 |
| SJSH012 | Surface sediment | 0-6 inches (0-15 cm) | Primary COPCs | 3217531.119 | 13856353.35 |
| SJSH012 | Subsurface sediment (core) | 6-12 inches (15-30 cm) | Archive for possible future analysis | 3217531.119 | 13856353.35 |
| SJSH013 | Surface sediment | 0-6 inches (0-15 cm) | Archive for possible future analysis | 3217619.462 | 13856453.3 |
| SJSH013 | Subsurface sediment (core) | 6-12 inches (15-30 cm) | Archive for possible future analysis | 3217619.462 | 13856453.3 |
| SJSH014 | Surface sediment | 0-6 inches (0-15 cm) | Archive for possible future analysis | 3217707.865 | 13856542.17 |
| SJSH014 | Subsurface sediment (core) | 6-12 inches (15-30 cm) | Archive for possible future analysis | 3217707.865 | 13856542.17 |
| SJSH015 | Surface sediment | 0-6 inches (0-15 cm) | Primary COPCs | 3217802.719 | 13856643.99 |
| SJSH015 | Subsurface sediment (core) | 6-12 inches (15-30 cm) | Archive for possible future analysis | 3217802.719 | 13856643.99 |
| SJSH016 | Surface sediment | 0-6 inches (0-15 cm) | Primary COPCs | 3216431.807 | 13857496.92 |
| SJSH016 | Subsurface sediment (core) | 6-12 inches (15-30 cm) | Archive for possible future analysis | 3216431.807 | 13857496.92 |
| SJSH017 | Surface sediment | 0-6 inches (0-15 cm) | Archive for possible future analysis | 3216380.266 | 13857582.68 |
| SJSH017 | Subsurface sediment (core) | 6-12 inches (15-30 cm) | Archive for possible future analysis | 3216380.266 | 13857582.68 |
| SJSH018 | Surface sediment | 0-6 inches (0-15 cm) | Primary COPCs | 3216278.053 | 13857580.32 |
| SJSH018 | Subsurface sediment (core) | 6-12 inches (15-30 cm) | Archive for possible future analysis | 3216278.053 | 13857580.32 |
| SJSH019 | Surface sediment | 0-6 inches (0-15 cm) | Archive for possible future analysis | 3216200.11 | 13857620.11 |
| SJSH019 | Subsurface sediment (core) | 6-12 inches (15-30 cm) | Archive for possible future analysis | 3216200.11 | 13857620.11 |
| SJSH020 | Surface sediment | 0-6 inches (0-15 cm) | Primary COPCs | 3216101.293 | 13857623.89 |
| SJSH020 | Subsurface sediment (core) | 6-12 inches (15-30 cm) | Archive for possible future analysis | 3216101.293 | 13857623.89 |
| SJSH021 | Surface sediment | 0-6 inches (0-15 cm) | Archive for possible future analysis | 3216007.504 | 13857648.29 |
| SJSH021 | Subsurface sediment (core) | 6-12 inches (15-30 cm) | Archive for possible future analysis | 3216007.504 | 13857648.29 |
| SJSH022 | Surface sediment | 0-6 inches (0-15 cm) | Primary COPCs | 3215932.393 | 13857711.49 |
| SJSH022 | Subsurface sediment (core) | 6-12 inches (15-30 cm) | Archive for possible future analysis | 3215932.393 | 13857711.49 |
| SJSH023 | Surface sediment | 0-6 inches (0-15 cm) | Archive for possible future analysis | 3215846.177 | 13857751.35 |
| SJSH023 | Subsurface sediment (core) | 6-12 inches (15-30 cm) | Archive for possible future analysis | 3215846.177 | 13857751.35 |
| SJSH024 | Surface sediment | 0-6 inches (0-15 cm) | Primary COPCs | 3215750.339 | 13857811.7 |
| SJSH024 | Subsurface sediment (core) | 6-12 inches (15-30 cm) | Archive for possible future analysis | 3215750.339 | 13857811.7 |
| SJSH025 | Surface sediment | 0-6 inches (0-15 cm) | Archive for possible future analysis | 3215660.933 | 13857796.56 |
| SJSH025 | Subsurface sediment (core) | 6-12 inches (15-30 cm) | Archive for possible future analysis | 3215660.933 | 13857796.56 |
| SJSH026 | Surface sediment | 0-6 inches (0-15 cm) | Primary COPCs | 3215964.204 | 13858103.65 |
| SJSH026 | Subsurface sediment (core) | 6-12 inches (15-30 cm) | Primary COPCs | 3215964.204 | 13858103.65 |
| SJSH027 | Surface sediment | 0-6 inches (0-15 cm) | Archive for possible future analysis | 3215984.431 | 13858197.5 |
| SJSH027 | Subsurface sediment (core) | 6-12 inches (15-30 cm) | Archive for possible future analysis | 3215984.431 | 13858197.5 |
| SJSH028 | Surface sediment | 0-6 inches (0-15 cm) | Primary COPCs | 3216017.938 | 13858285.93 |
| SJSH028 | Subsurface sediment (core) | 6-12 inches (15-30 cm) | Primary COPCs | 3216017.938 | 13858285.93 |

**Table A-4**
**Station Coordinates, Sample Type, Sampling Interval, and Corresponding Analysis**

| Station Number | Sample Type | Sampling Interval[a] | Analysis | Coordinates[b,c] | |
|---|---|---|---|---|---|
| | | | | X | Y |
| SJSH029 | Surface sediment | 0-6 inches (0-15 cm) | Archive for possible future analysis | 3216078.173 | 13858350.31 |
| SJSH029 | Subsurface sediment (core) | 6-12 inches (15-30 cm) | Archive for possible future analysis | 3216078.173 | 13858350.31 |
| SJSH030 | Surface sediment | 0-6 inches (0-15 cm) | Primary COPCs | 3216160.313 | 13858391.68 |
| SJSH030 | Subsurface sediment (core) | 6-12 inches (15-30 cm) | Primary COPCs | 3216160.313 | 13858391.68 |
| SJSH031 | Surface sediment | 0-6 inches (0-15 cm) | Archive for possible future analysis | 3216165.738 | 13858483.69 |
| SJSH031 | Subsurface sediment (core) | 6-12 inches (15-30 cm) | Archive for possible future analysis | 3216165.738 | 13858483.69 |
| SJSH032 | Surface sediment | 0-6 inches (0-15 cm) | Primary COPCs | 3216129.516 | 13858569.21 |
| SJSH032 | Subsurface sediment (core) | 6-12 inches (15-30 cm) | Primary COPCs | 3216129.516 | 13858569.21 |
| SJSH033 | Surface sediment | 0-6 inches (0-15 cm) | Archive for possible future analysis | 3216100.593 | 13858654.87 |
| SJSH033 | Subsurface sediment (core) | 6-12 inches (15-30 cm) | Archive for possible future analysis | 3216100.593 | 13858654.87 |
| SJSH034 | Surface sediment | 0-6 inches (0-15 cm) | Primary COPCs | 3216069.058 | 13858742.79 |
| SJSH034 | Subsurface sediment (core) | 6-12 inches (15-30 cm) | Primary COPCs | 3216069.058 | 13858742.79 |
| SJSH035 | Surface sediment | 0-6 inches (0-15 cm) | Archive for possible future analysis | 3216023.195 | 13858821.01 |
| SJSH035 | Subsurface sediment (core) | 6-12 inches (15-30 cm) | Archive for possible future analysis | 3216023.195 | 13858821.01 |
| SJSH036 | Surface sediment | 0-6 inches (0-15 cm) | Primary COPCs | 3215073.274 | 13858888.07 |
| SJSH036 | Subsurface sediment (core) | 6-12 inches (15-30 cm) | Archive for possible future analysis | 3215073.274 | 13858888.07 |
| SJSH037 | Surface sediment | 0-6 inches (0-15 cm) | Archive for possible future analysis | 3215009.754 | 13858862.52 |
| SJSH037 | Subsurface sediment (core) | 6-12 inches (15-30 cm) | Archive for possible future analysis | 3215009.754 | 13858862.52 |
| SJSH038 | Surface sediment | 0-6 inches (0-15 cm) | Primary COPCs | 3214944.409 | 13858841.97 |
| SJSH038 | Subsurface sediment (core) | 6-12 inches (15-30 cm) | Archive for possible future analysis | 3214944.409 | 13858841.97 |
| SJSH039 | Surface sediment | 0-6 inches (0-15 cm) | Archive for possible future analysis | 3214879.12 | 13858821.24 |
| SJSH039 | Subsurface sediment (core) | 6-12 inches (15-30 cm) | Archive for possible future analysis | 3214879.12 | 13858821.24 |
| SJSH040 | Surface sediment | 0-6 inches (0-15 cm) | Primary COPCs | 3214817.508 | 13858791.46 |
| SJSH040 | Subsurface sediment (core) | 6-12 inches (15-30 cm) | Archive for possible future analysis | 3214817.508 | 13858791.46 |
| SJSH041 | Surface sediment | 0-6 inches (0-15 cm) | Archive for possible future analysis | 3214756.239 | 13858760.82 |
| SJSH041 | Subsurface sediment (core) | 6-12 inches (15-30 cm) | Archive for possible future analysis | 3214756.239 | 13858760.82 |
| SJSH042 | Surface sediment | 0-6 inches (0-15 cm) | Primary COPCs | 3214690.833 | 13858746.95 |
| SJSH042 | Subsurface sediment (core) | 6-12 inches (15-30 cm) | Archive for possible future analysis | 3214690.833 | 13858746.95 |
| SJSH043 | Surface sediment | 0-6 inches (0-15 cm) | Archive for possible future analysis | 3214622.403 | 13858749.87 |
| SJSH043 | Subsurface sediment (core) | 6-12 inches (15-30 cm) | Archive for possible future analysis | 3214622.403 | 13858749.87 |
| SJSH044 | Surface sediment | 0-6 inches (0-15 cm) | Primary COPCs | 3214553.983 | 13858753.16 |
| SJSH044 | Subsurface sediment (core) | 6-12 inches (15-30 cm) | Archive for possible future analysis | 3214553.983 | 13858753.16 |
| SJSH045 | Surface sediment | 0-6 inches (0-15 cm) | Archive for possible future analysis | 3214485.569 | 13858756.6 |
| SJSH045 | Subsurface sediment (core) | 6-12 inches (15-30 cm) | Archive for possible future analysis | 3214485.569 | 13858756.6 |
| **Human Health Upstream Background Stations** | | | | | |
| SJSH046 | Surface sediment | 0-6 inches (0-15 cm) | Primary COPCs | 3211913.425 | 13867187.14 |
| SJSH046 | Subsurface sediment (core) | 6-12 inches (15-30 cm) | Archive for possible future analysis | 3211913.425 | 13867187.14 |
| SJSH047 | Surface sediment | 0-6 inches (0-15 cm) | Archive for possible future analysis | 3211870.023 | 13867360.74 |
| SJSH047 | Subsurface sediment (core) | 6-12 inches (15-30 cm) | Archive for possible future analysis | 3211870.023 | 13867360.74 |
| SJSH048 | Surface sediment | 0-6 inches (0-15 cm) | Primary COPCs | 3211870.023 | 13867571.55 |

**Table A-4**
**Station Coordinates, Sample Type, Sampling Interval, and Corresponding Analysis**

| Station Number | Sample Type | Sampling Interval[a] | Analysis | Coordinates[b,c] | |
|---|---|---|---|---|---|
| | | | | X | Y |
| SJSH048 | Subsurface sediment (core) | 6-12 inches (15-30 cm) | Archive for possible future analysis | 3211870.023 | 13867571.55 |
| SJSH049 | Surface sediment | 0-6 inches (0-15 cm) | Archive for possible future analysis | 3211888.624 | 13867763.75 |
| SJSH049 | Subsurface sediment (core) | 6-12 inches (15-30 cm) | Archive for possible future analysis | 3211888.624 | 13867763.75 |
| SJSH050 | Surface sediment | 0-6 inches (0-15 cm) | Primary COPCs | 3211981.627 | 13867931.16 |
| SJSH050 | Subsurface sediment (core) | 6-12 inches (15-30 cm) | Archive for possible future analysis | 3211981.627 | 13867931.16 |
| SJSH051 | Surface sediment | 0-6 inches (0-15 cm) | Archive for possible future analysis | 3212093.23 | 13868024.16 |
| SJSH051 | Subsurface sediment (core) | 6-12 inches (15-30 cm) | Archive for possible future analysis | 3212093.23 | 13868024.16 |
| SJSH052 | Surface sediment | 0-6 inches (0-15 cm) | Primary COPCs | 3212254.434 | 13868067.56 |
| SJSH052 | Subsurface sediment (core) | 6-12 inches (15-30 cm) | Archive for possible future analysis | 3212254.434 | 13868067.56 |
| SJSH053 | Surface sediment | 0-6 inches (0-15 cm) | Archive for possible future analysis | 3212428.039 | 13868086.16 |
| SJSH053 | Subsurface sediment (core) | 6-12 inches (15-30 cm) | Archive for possible future analysis | 3212428.039 | 13868086.16 |
| SJSH054 | Surface sediment | 0-6 inches (0-15 cm) | Primary COPCs | 3212595.444 | 13868154.37 |
| SJSH054 | Subsurface sediment (core) | 6-12 inches (15-30 cm) | Archive for possible future analysis | 3212595.444 | 13868154.37 |
| SJSH055 | Surface sediment | 0-6 inches (0-15 cm) | Archive for possible future analysis | 3212775.249 | 13868247.37 |
| SJSH055 | Subsurface sediment (core) | 6-12 inches (15-30 cm) | Archive for possible future analysis | 3212775.249 | 13868247.37 |
| **Ecological Risk Assessment Shoreline Stations** | | | | | |
| SJSH056 | Surface sediment | 0-6 inches (0-15 cm) | Primary COPCs | 3217541.593 | 13854996.94 |
| SJSH057 | Surface sediment | 0-6 inches (0-15 cm) | Primary COPCs | 3217670.955 | 13855163.26 |
| SJSH058 | Surface sediment | 0-6 inches (0-15 cm) | Primary COPCs | 3217750 | 13855500 |
| SJSH059 | Surface sediment | 0-6 inches (0-15 cm) | Primary COPCs | 3218393.432 | 13858467.41 |
| SJSH060 | Surface sediment | 0-6 inches (0-15 cm) | Primary COPCs | 3218250.671 | 13858778.06 |
| SJSH061 | Surface sediment | 0-6 inches (0-15 cm) | Primary COPCs | 3217970.303 | 13858999.89 |
| **Ecological Risk Assessment Upstream Background Stations** | | | | | |
| SJSH062 | Surface sediment | 0-6 inches (0-15 cm) | Primary COPCs | 3208771.905 | 13860774.23 |
| SJSH063 | Surface sediment | 0-6 inches (0-15 cm) | Primary COPCs | 3208743.828 | 13860946.22 |
| SJSH064 | Surface sediment | 0-6 inches (0-15 cm) | Primary COPCs | 3208755.2 | 13861098.4 |

**Notes**

COPC = chemical of potential concern

a - 30 cm = 1 feet; 60 cm = 2 feet; 90 cm = 3 feet; 150 cm = 5 feet

b - NAD 1983; State Plane Texas South Central FIPS 4204; US feet

c - Coordinates provided correspond to proposed station locations represented on Figures A-1, A-2, A-3, and A-4. Coordinates for actual station locations will be collected in the field.

**Table A-5**
**Geotechnical Borings with Sample Specifications**

| Sample ID | Depth Interval[a] (feet) | SPT-N | Moisture Content | Grain Size[b] | Atterberg Limits [b] | Specific Gravity[b] | Permeability[b,c] | CuTriax[b,c] | Consolidation[b,c] | Primary and Secondary COPCs |
|---|---|---|---|---|---|---|---|---|---|---|
| **Locations SJGB003 and SJGB007: 120-foot deep boring (in-water geotech location)** | | | | | | | | | | |
| S1 | 0 - 1.5 | X | X | -- | -- | -- | -- | -- | -- | -- |
| S2 | 2.5 - 4.0 | X | X | X | -- | -- | -- | -- | -- | -- |
| S3 | 5.0 - 7.0 | -- | X | -- | X | -- | -- | X | X | -- |
| S4 | 7.5 - 9.0 | X | X | -- | -- | -- | -- | -- | -- | -- |
| S5 | 10.0 - 11.5 | X | X | -- | X | X | -- | -- | -- | -- |
| S6 | 15.0 - 16.5 | X | X | X | -- | -- | -- | -- | -- | -- |
| S7 | 20.0 - 21.5 | X | X | -- | -- | -- | -- | -- | -- | -- |
| S8 | 25.0 - 26.5 | X | X | -- | X | -- | -- | -- | -- | -- |
| S9 | 30.0 - 31.5 | X | X | X | -- | -- | -- | -- | -- | -- |
| S10 | 35.0 - 36.5 | X | X | -- | -- | -- | -- | -- | -- | -- |
| S11 | 40.0 - 42.0 | -- | X | -- | X | -- | -- | -- | X | -- |
| S12 | 45.0 - 46.5 | X | X | X | -- | -- | -- | -- | -- | -- |
| S13 | 50.0 - 51.5 | X | X | -- | -- | -- | -- | -- | -- | -- |
| S14 | 55.0 - 56.5 | X | X | -- | X | X | -- | -- | -- | -- |
| S15 | 60.0 - 61.5 | X | X | X | -- | -- | -- | -- | -- | -- |
| S16 | 65.0 - 66.5 | X | X | -- | X | -- | -- | -- | -- | -- |
| S17 | 70.0 - 71.5 | X | X | -- | X | X | -- | -- | -- | -- |
| S18 | 75.0 - 76.5 | X | X | X | -- | -- | -- | -- | -- | -- |
| S19 | 80.0 - 81.5 | X | X | -- | -- | -- | -- | -- | -- | -- |
| S20 | 85.0 - 86.5 | X | X | -- | X | -- | -- | -- | -- | -- |
| S21 | 90.0 - 91.5 | X | X | X | -- | -- | -- | -- | -- | -- |
| S22 | 95.0 - 96.5 | X | X | -- | -- | -- | -- | -- | -- | -- |
| S23 | 100.0 - 101.5 | X | X | -- | X | -- | -- | -- | -- | -- |
| S24 | 105.0 - 106.5 | X | X | X | -- | -- | -- | -- | -- | -- |
| S25 | 110.0 - 111.5 | X | X | -- | -- | -- | -- | -- | -- | -- |
| S26 | 115.0 - 116.5 | X | X | -- | X | X | -- | -- | -- | -- |
| S27 | 120.0 - 121.5 | X | X | X | -- | -- | -- | -- | -- | -- |
| **Locations SJGB001, SJGB002, SJGB004, SJGB005, and SJGB008: 60-foot deep boring (in-water/on-land geotech location)** | | | | | | | | | | |
| S1 | 0 - 1.5 | X | X | -- | -- | -- | -- | -- | -- | -- |
| S2 | 2.5 - 4.0 | X | X | X | -- | -- | -- | -- | -- | -- |
| S3 | 5.0 - 7.0 | -- | X | -- | X | -- | -- | X | X | -- |
| S4 | 7.5 - 9.0 | X | X | -- | -- | -- | -- | -- | -- | -- |
| S5 | 10.0 - 11.5 | X | X | -- | X | X | -- | -- | -- | -- |
| S6 | 15.0 - 16.5 | X | X | X | -- | -- | -- | -- | -- | -- |
| S7 | 20.0 - 21.5 | X | X | -- | -- | -- | -- | -- | -- | -- |
| S8 | 25.0 - 26.5 | X | X | -- | X | -- | -- | -- | -- | -- |
| S9 | 30.0 - 31.5 | X | X | X | -- | -- | -- | -- | -- | -- |
| S10 | 35.0 - 36.5 | X | X | -- | -- | -- | -- | -- | -- | -- |
| S11 | 40.0 - 41.5 | -- | X | -- | X | -- | -- | -- | X | -- |
| S12 | 45.0 - 46.5 | X | X | X | -- | -- | -- | -- | -- | -- |
| S13 | 50.0 - 51.5 | X | X | -- | -- | -- | -- | -- | -- | -- |
| S14 | 55.0 - 56.5 | X | X | -- | X | X | -- | -- | -- | -- |
| S15 | 60.0 - 61.5 | X | X | X | -- | -- | -- | -- | -- | -- |

## Table A-5
## Geotechnical Borings with Sample Specifications

| Sample ID | Depth Interval[a] (feet) | SPT-N | Moisture Content | Grain Size[b] | Atterberg Limits [b] | Specific Gravity[b] | Permeability[b,c] | CuTriax[b,c] | Consolidation[b,c] | Primary and Secondary COPCs |
|---|---|---|---|---|---|---|---|---|---|---|
| **Locations SJGB006 and SJGB009: 30-foot deep boring (former impoundment geotech location)** | | | | | | | | | | |
| S1 | 0 - 1.5 | X | X | -- | -- | -- | -- | -- | -- | -- |
| S2 | 2.5 - 4.0 | -- | X | X | X | -- | X | -- | -- | -- |
| S3 | 5.0 - 7.0 | -- | X | -- | -- | -- | -- | X | X | -- |
| S4 | 7.5 - 9.0 | -- | X | -- | X | -- | X | -- | -- | -- |
| S5 | 10.0 - 11.5 | X | X | -- | X | X | -- | -- | -- | -- |
| S6 | 15.0 - 16.5 | X | X | X | -- | -- | -- | -- | -- | -- |
| S7 | 20.0 - 21.5 | X | X | -- | -- | -- | -- | -- | -- | -- |
| S8 | 25.0 - 26.5 | X | X | -- | X | -- | -- | -- | -- | -- |
| S9 | 30.0 - 31.5 | X | X | X | -- | -- | -- | -- | -- | -- |
| **Locations SJGB010 through SJGB017[d]: 10 to 20-foot deep boring (former impoundment geotech location)** | | | | | | | | | | |
| S1 | 0 - 1.5 | X | X | -- | -- | -- | -- | -- | -- | X |
| S2 | 1.5 - 3.5 | -- | X | X | X | -- | X | -- | -- | X |
| S3 | 3.5 - 5.0 | X | X | -- | -- | -- | -- | -- | -- | X |
| S4 | 5.0 - 7.0 | -- | X | -- | X | -- | X | -- | -- | X |
| S5 | 7.0 - 8.5 | X | X | -- | X | X | -- | -- | -- | X |
| S6 | 8.5 - 10.0 | X | X | X | -- | -- | -- | -- | -- | X |
| S7 | 10.0 - 11.5 | X | X | X | -- | -- | -- | -- | -- | X |
| S8 | 15.0 - 16.5 | -- | X | X | -- | -- | X | -- | -- | -- |

**Notes**

-- = NA
CuTriax = consolidated undrained triaxial test
SPT-N = standard penetration test blow counts
a - Depth interval will be set in the field depending on the starting depth of the auger. All depths are relative to ground surface or mudline.
b - Actual physical testing depth interval will be determined in the field based on the geologic interpretation of conditions encountered.
c - Permeability, CuTriax, and consolidation testing to be performed on undisturbed Shelby tubes collected from appropriate depth intervals in the field as determined by the field geologist.
d - Locations will be continuously sampled for primary and secondary COPCs until the bottom of the waste is encountered. Actual sample interval where this transition occurs will vary based on location. Field sample numbering and total boring depths will be adjusted in the field as appropriate to ensure the boring extends into native soils at least 5 feet. Final boring depth listed as 10- to 20-feet for planning purposes only and will be determined based on the actual depth of the waste at a particular boring location.

**Table A-6**
**Physical Testing Data Relevant to Dredging, Materials Handling, and/or Potential Confined Disposal Facility Design**

| | Engineering Evaluations Testing | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Standard Penetration Test (ASTM D-1586) | Thin-Walled Tube Collection (ASTM D-1587) | Vane Shear Test (ASTM D-2573) | Atterberg Limits (ASTM D-4318) | Grain Size (ASTM D-422 & D-1140) | Specific Gravity (ASTM D-854) | Moisture Content (ASTM D-2216) | Visual Description (ASMTD-2488) | Permeability (ASTM D-5084) | Consolidated Undrained Triaxial Compressive Strength (ASTM D-4767) | Consolidation Test (ASTM D-2435) |
| **Dredging and Handling** | | | | | | | | | | | |
| Hydraulic Dredging and Materials Handling | -- | -- | -- | X | X | X | X | X | -- | -- | -- |
| **Potential CDF and Berm Design** | | | | | | | | | | | |
| Soil Classification | X | X | -- | X | X | X | X | X | X | -- | -- |
| Soil Strength | X | X | X | -- | -- | -- | -- | -- | -- | X | -- |
| Soil Compressibility | -- | X | -- | -- | -- | -- | -- | -- | -- | -- | X |

**Notes**

-- = NA

CDF = confined disposal facility

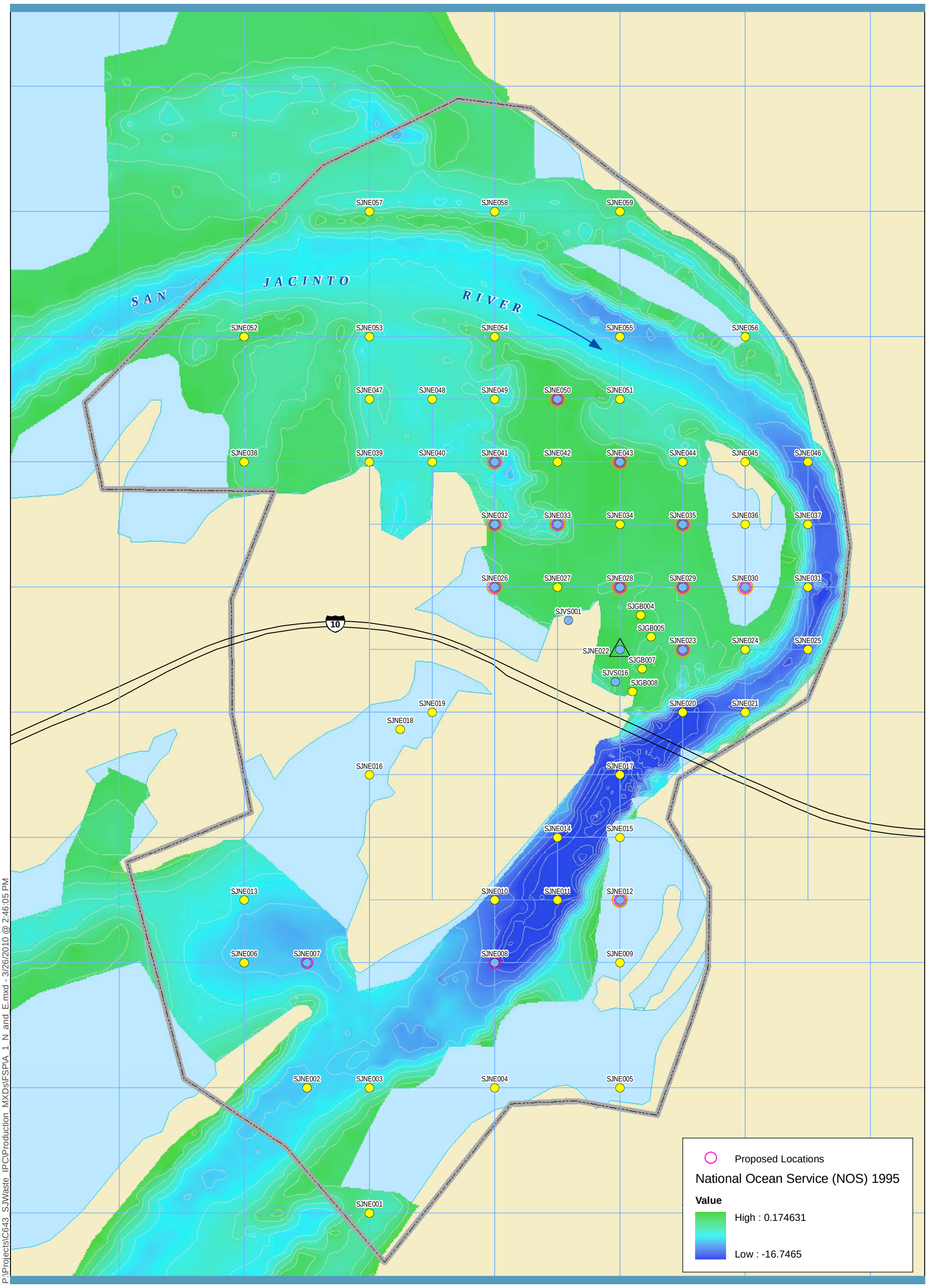
## Table A-7
## Vane Shear Test and Co-located Surface Grab Sampling Design

| Station ID | NAD 83 [a] | | Sample Method | Sampling Depth (feet)[b,c] | Sample Method | Sampling Depth (feet)[d] | Physical Tests |
|---|---|---|---|---|---|---|---|
| | Easting | Northing | | | | | |
| SJVS001 | 3216837.673 | 13857733.34 | VST | 0-1, 1-2, 2-3 | Surface grab | 0-1 | GS, MC, AL, SG |
| SJVS002 | 3216931.835 | 13857814.21 | VST | 0-1, 1-2, 2-3 | Surface grab | 0-1 | GS, MC, AL, SG |
| SJVS003 | 3217162.082 | 13857931.76 | VST | 0-1, 1-2, 2-3 | Surface grab | 0-1 | GS, MC, AL, SG |
| SJVS004 | 3217143.091 | 13857809.41 | VST | 0-1, 1-2, 2-3 | Surface grab | 0-1 | GS, MC, AL, SG |
| SJVS005 | 3217285.139 | 13857780.73 | VST | 0-1, 1-2, 2-3 | Surface grab | 0-1 | GS, MC, AL, SG |
| SJVS006 | 3217412.468 | 13857746.27 | VST | 0-1, 1-2, 2-3 | Surface grab | 0-1 | GS, MC, AL, SG |
| SJVS007 | 3217149.067 | 13857642.97 | VST | 0-1, 1-2, 2-3 | Surface grab | 0-1 | GS, MC, AL, SG |
| SJVS008 | 3217301.584 | 13857610.84 | VST | 0-1, 1-2, 2-3 | Surface grab | 0-1 | GS, MC, AL, SG |
| SJVS009 | 3217435.436 | 13857574.02 | VST | 0-1, 1-2, 2-3 | Surface grab | 0-1 | GS, MC, AL, SG |
| SJVS010 | 3217148.268 | 13857524.67 | VST | 0-1, 1-2, 2-3 | Surface grab | 0-1 | GS, MC, AL, SG |
| SJVS011 | 3217298.499 | 13857472.71 | VST | 0-1, 1-2, 2-3 | Surface grab | 0-1 | GS, MC, AL, SG |
| SJVS012 | 3217499.901 | 13857450.02 | VST | 0-1, 1-2, 2-3 | Surface grab | 0-1 | GS, MC, AL, SG |
| SJVS013 | 3217131.134 | 13857386.74 | VST | 0-1, 1-2, 2-3 | Surface grab | 0-1 | GS, MC, AL, SG |
| SJVS014 | 3217407.129 | 13857359.48 | VST | 0-1, 1-2, 2-3 | Surface grab | 0-1 | GS, MC, AL, SG |
| SJVS015 | 3217297.722 | 13857311.23 | VST | 0-1, 1-2, 2-3 | Surface grab | 0-1 | GS, MC, AL, SG |
| SJVS016 | 3217211.824 | 13857242.94 | VST | 0-1, 1-2, 2-3 | Surface grab | 0-1 | GS, MC, AL, SG |
| SJVS017 | 3217420.45 | 13857242.94 | VST | 0-1, 1-2, 2-3 | Surface grab | 0-1 | GS, MC, AL, SG |
| SJVS018 | 3217325.676 | 13857120.58 | VST | 0-1, 1-2, 2-3 | Surface grab | 0-1 | GS, MC, AL, SG |

**Notes**

Sediment surface grabs will be co-located with VST locations to facilitate standardization of the field vane shear measurements.
AL = Atterberg limits
GS = grain size
MC = moisture content
SG = specific gravity
VST = vane shear test
a - U.S. State Plane NAD 83 FT - Texas South Central Zone
b - VST to be performed at the following depth intervals below mudline: 0-1, 1-2, and 2-3 feet.
c - Both peak and residual VST strength to be measured at each depth interval.
d - Sample depth refers to surface grabs, not to the VST depth.

# FIGURES

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ANCHOR QEA

integral consulting inc.

0 800
Scale in Feet

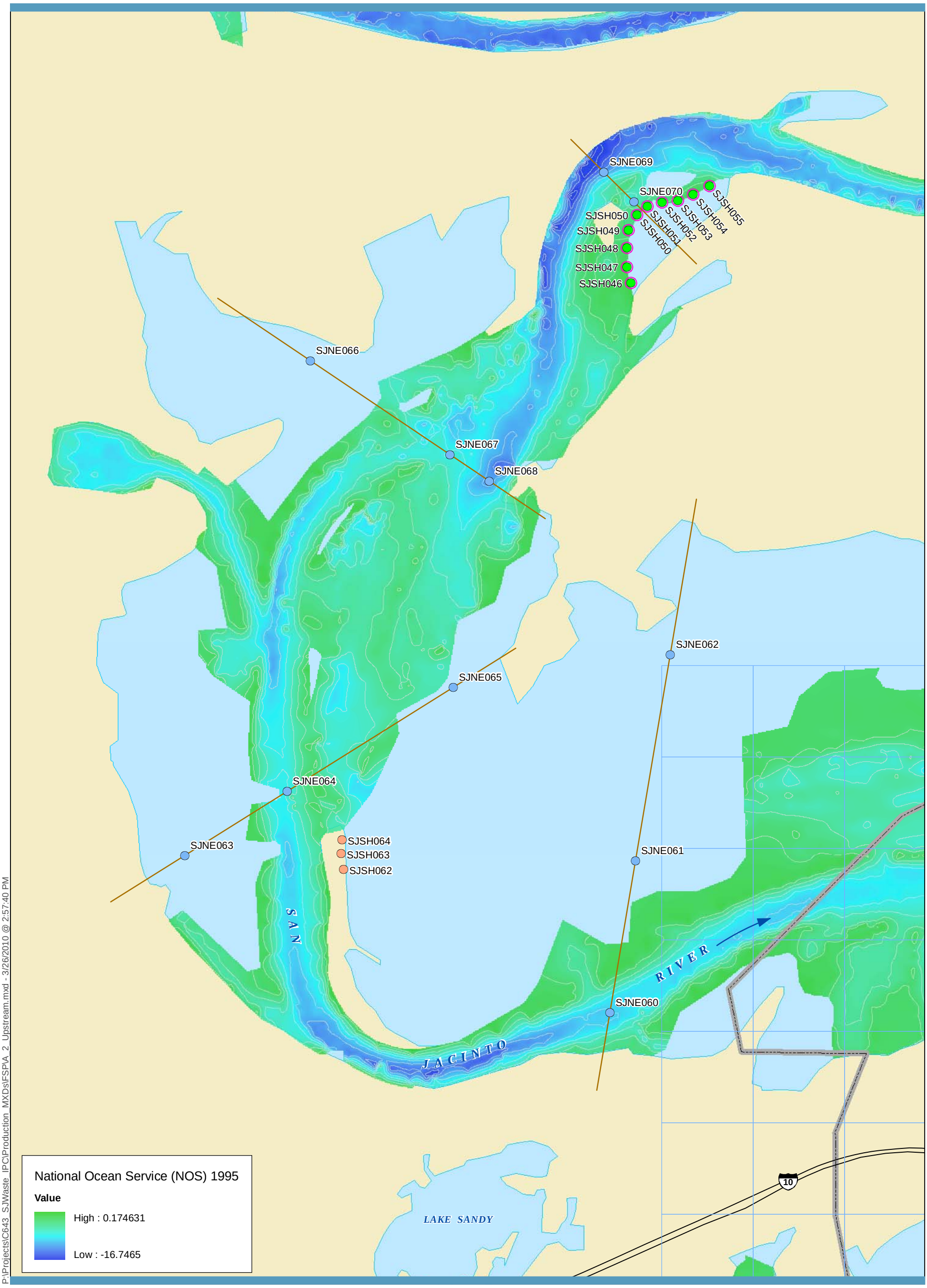
Preliminary Site Perimeter
1-Meter 1995 Bathymetric Contour
Field Triplicate

**Proposed Locations**

Surface Sediment (Primary and Secondary COPCs)
Surface Sediment (Primary COPCs)
Surface Sediment (Primary and Secondary COPCs) and Core (Primary COPCs)
Additional Geotechnical Samples From Core

FEATURE SOURCES:
Bathymetry and Contours: NOS Survey H10619 (1995)

**Figure A-1**
Nature and Extent Sediment Sampling Locations Within the Preliminary Site Perimeter
SJRWP Sediment FSP
SJRWP Superfund/MIMC and IPC

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ANCHOR QEA

integral consulting inc.

0 800
Scale in Feet

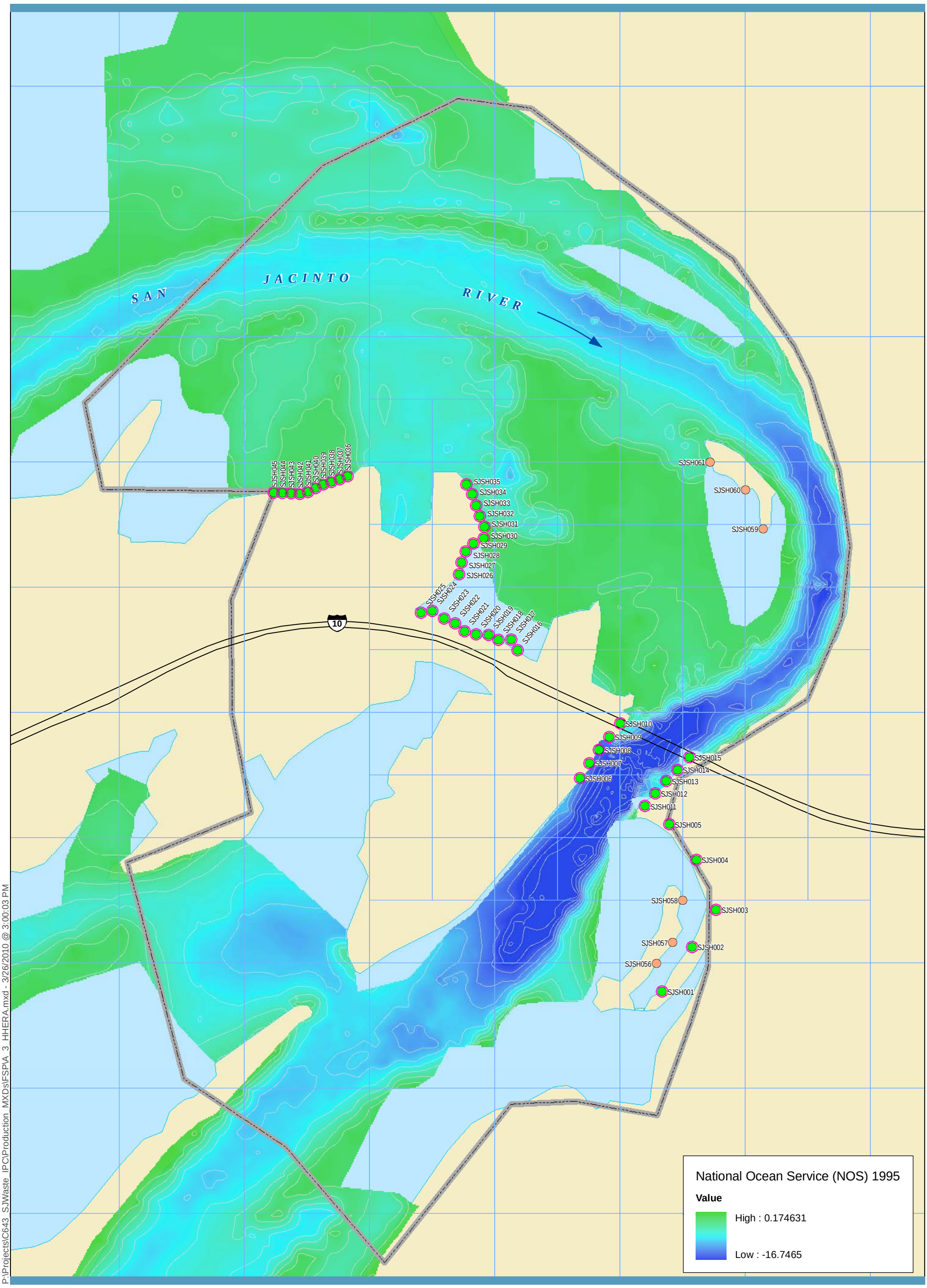
Preliminary Site Perimeter
1-Meter 1995 Bathymetric Contour
Sampling Transect

**Proposed Locations**

Human Health Surface Sediment (Primary COPCs)
Human Health Surface Sediment and Subsurface Sediment (Primary COPCs)
Upstream Background (Primary and Secondary COPCs)
ERA Surface Sediment (Primary COPCs)

FEATURE SOURCES:
Bathymetry and Contours: NOS Survey H10619 (1995)

**Figure A-2**
Upstream Sediment Sampling Locations
SJRWP Sediment FSP
SJRWP Superfund/MIMC and IPC

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ANCHOR QEA

integral consulting inc.

Preliminary Site Perimeter

1-Meter 1995 Bathymetric Contour

**Proposed Locations**

Human Health Surface Sediment (Primary COPCs)

Human Health Surface Sediment and Subsurface Sediment (Primary COPCs)

ERA Surface Sediment (Primary COPCs)

0 800

Scale in Feet

FEATURE SOURCES:
Bathymetry and Contours: NOS Survey H10619 (1995)

**Figure A-3**

Human Health and Ecological Exposure Sediment Sampling Locations Within the Preliminary Site Perimeter

SJRWP Sediment FSP

SJRWP Superfund/MIMC and IPC

**LEGEND:**

| | |
|---|---|
| SJGB001 (60') | Boring location and depth below mudline - geotechnical sampling (Proposed) |
| SJGB016 (20') | Boring location and depth below mudline - geotechnical and chemistry sampling (Proposed) |
| SJVS001 × | Vane shear test (VST) location (Proposed) |
| | Approximate 1966 alignment of perimeter berms (EPA) |
| | Property Line |
| | Approximate limit of vegetated area |

**NOTES:**

1. Boring and VST locations approximate and subject to change in the field depending on access constraints.
2. Final depth of borings within the impoundments shown as (20') deep will be based on actual contact elevation with native soils so that the boring extends into native material at least 5 feet. The 20-foot depth shown on the plan view is for planning purposes only. Actual depth will vary from location to location based on the thickness of the waste deposit.

0 150
Scale in Feet

**SOURCE:** Drawing prepared from COE.
**HORIZONTAL DATUM:** Texas South Central, NAD83. US Survey Feet.
**VERTICAL DATUM:** NAVD 88.

Mar 30, 2010 11:04am jlaplante K:\Jobs\090557-San Jacinto\090557-01 - San Jacinto\09055701-RP-020.dwg FIG A-5

ANCHOR QEA integral consulting inc.

**Figure A-4**
Geotechnical Borings and Vane Shear Test Locations
**SJRWP Sediment FSP**
SJRWP Superfund/MIMC and IPC

# ATTACHMENT A1
# ADDENDUM 1 TO THE OVERALL HEALTH AND SAFETY PLAN:
# SEDIMENT SAMPLING HEALTH AND SAFETY PLAN

**Prepared for**

McGinnes Industrial Maintenance Corporation

International Paper Company

**Prepared by**

Integral Consulting Inc.

411 First Avenue South, Suite 550

Seattle, Washington 98104

**April 2010**

## CERTIFICATION PAGE

Addendum 1 to the overall health and safety plan (HASP; Anchor QEA 2009) for the San Jacinto River Waste Pits Superfund Site (the Site) has been reviewed and approved by Integral Consulting Inc. (Integral) for the 2010 sediment study at the Site in support of the remedial investigation and feasibility study (RI/FS) for the Site.

| | |
|---|---|
| Jennifer Sampson | Joss Moore |
| Project Manager | Field Lead |
| Integral Consulting Inc. | Integral Consulting Inc. |
| Date: _____ | Date: _____ |

## HEALTH AND SAFETY PLAN ACKNOWLEDGEMENT FORM

Project Name: San Jacinto River Waste Pits Superfund Site

Addendum 1 to the overall HASP (Anchor QEA 2009) is approved by Integral for use at the San Jacinto River Waste Pits Superfund Site (the Site). The overall HASP and Addendum 1 are the minimum health and safety standard for the Site and will be strictly enforced for Integral personnel and other consulting personnel including subcontractors where applicable.

I have reviewed Addendum 1, dated April 9, 2010, to the overall HASP for the 2010 sediment study. I have had an opportunity to ask any questions I may have and have been provided with satisfactory responses. I understand the purpose of the plan, and I consent to adhere to its policies, procedures, and guidelines while an employee of Integral, or its subcontractors.

| Date | Name (print) | Signature | Company |
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# SITE EMERGENCY PROCEDURES

## Emergency Contact Information

**Table A**

**Site Emergency Form and Emergency Phone Numbers**

| Category | Information | |
|---|---|---|
| Chemicals of Potential Concern | Dioxins/Furans, aluminum, magnesium, mercury, and copper | |
| Minimum Level of Protection | Level D | |
| Site(s) Location Address | (No formal address, see Figure A)<br>Channelview, TX 77530<br>Coordinates [29° 47' 38.49"N, 95° 3' 49.55"W] | |
| **Emergency Phone Numbers** | | |
| Ambulance | 911 | |
| Fire | 911 | |
| Police | 911 | |
| Poison Control | 911 and then 1-800-222-1212 if appropriate | |
| **Project-Specific Health and Safety Officers' Phone Numbers** | | |
| Integral Field Lead (FL) and Integral Site Safety Officer (SSO) | Joss Moore | Office: (503) 284-5545 ext. 17<br>Cell: (503) 320-1796 |
| Integral Corporate Health and Safety Manager (CHSM) | Eron Dodak | Office: (503) 284-5545 ext. 14<br>Cell: (503) 407-2933 |
| Integral Project Manager (PM) | Jennifer Sampson | Office: (206) 957-0351<br>Cell: (360) 286-7552 |
| Anchor QEA PM | David Keith | Office: (228) 818-9626<br>Cell: (228) 224-2983 |
| Anchor QEA FL and SSO | Jason Kase | Office: (850) 912-8400<br>Cell: (251) 259-7196 |
| Anchor QEA CHSM | David Templeton | Office: (206) 287-9130<br>Cell: (206) 910-4279 |
| Client Contact – McGinnes Industrial Maintenance Corporation (MIMC) | Andrew Shafer | Office: (713) 647-5460<br>Cell: (832) 724-3802 |
| Client Contract – International Paper Company (IPC) | Phil Slowiak | Office: (901) 419-3845<br>Cell: (901) 214-9550 |
| **Reporting Oil and Chemical Spills** | | |
| National Response Center | 1-800-424-8802 | |
| State Emergency Response System | (512) 424-2138 | |
| EPA Environmental Response Team | (201) 321-6600 | |

Note: In the event of any emergency, contact both the Integral and Anchor QEA PMs and FLs.

**Figure A**

**Site Location Map**

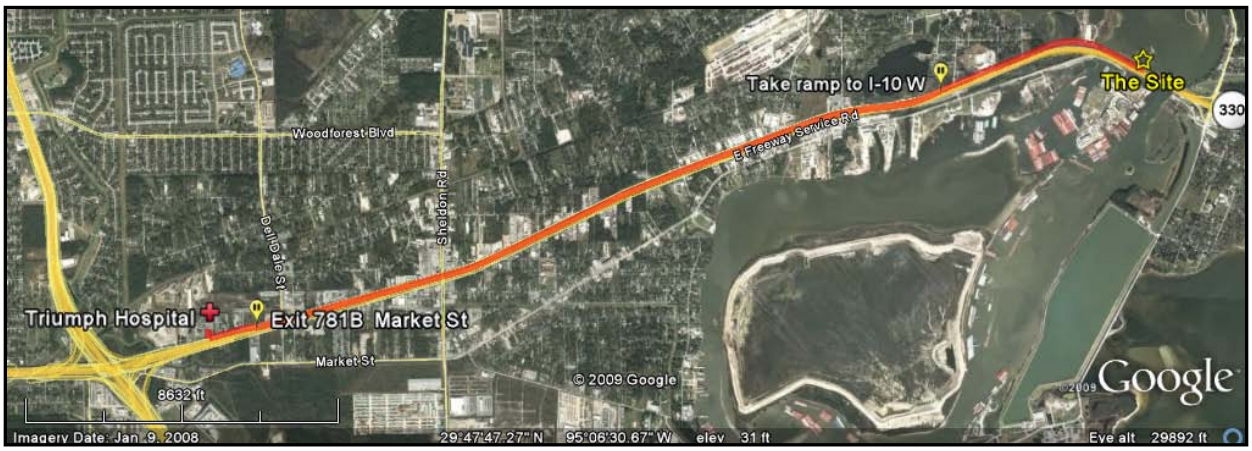
**Table B**

**Hospital Information**

| Category | Information |
|---|---|
| Hospital Name | Triumph Hospital – East Houston |
| Address | 15101 East Freeway |
| City, State | Channelview, TX 77530-41041 |
| Phone | (713) 691-6556 |
| Emergency Phone | (713) 691-6556 |

**Figure B**

**Hospital Route Map**




## DRIVING DIRECTIONS FROM SITE TO HOSPITAL

1. Head west on East Freeway Service Road toward Monmouth Street (approximately 0.9 mile).
2. Take the ramp on the left to I-10 West.
3. Proceed on I-10 West to Exit 781B (approximately 3.7 miles).
4. Exit freeway at Exit 781B onto East Freeway Service Road.
5. Continue heading west on East Freeway Service Road (approximately 0.2 mile).
6. Triumph Hospital will be on the right (total distance approximately 5 miles).

**Figure C**

**Access from Site to I-10 West**

**Figure D**

**Hospital Detail (Egress from I-10 West)**

## Emergency Response Procedures

**In the event of an emergency, refer to the procedures in the San Jacinto River Waste Pits Superfund Site Overall HASP (Anchor QEA 2009).**

A copy of this Addendum must be included with the overall HASP, and both copies must be available in the field at all times during field work.

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## List of Exhibits

Exhibit 1 Health and Safety Forms

# LIST OF ACRONYMS AND ABBREVIATIONS

| Abbreviation | Definition |
|---|---|
| °F | degrees Fahrenheit |
| ACGIH | American Conference of Governmental Industrial Hygienists |
| Anchor QEA | Anchor QEA, LLC |
| AWG | American Wire Gauge |
| CHSM | Corporate Health and Safety Manager |
| COPC | chemical of potential concern |
| CRZ | contamination reduction zone |
| FL | Field Lead |
| HASP | Health and Safety Plan |
| Integral | Integral Consulting Inc. |
| IPC | International Paper Company |
| JHA | Job Hazard Analysis |
| MIMC | McGinnes Industrial Maintenance Corporation |
| $mg/m^3$ | milligrams per cubic meter |
| MSDS | Material Safety Data Sheets |
| NIOSH | National Institute for Occupational Safety and Health |
| OSHA | Occupational Safety and Health Act or Administration |
| PEL | Permissible Exposure Limit |
| PFD | personal flotation device |
| PM | Project Manager |
| PPE | personal protective equipment |
| ppm | parts per million |
| RI/FS | remedial investigation and feasibility study |
| Site | San Jacinto River Waste Pits Superfund Site |
| SJRWP | San Jacinto River Waste Pits |
| SSO | Site Safety Officer |
| STEL | Short Term Exposure Limit |
| TLV | Threshold Limit Values |
| TWA | Time Weighted Average |
| USEPA | U.S. Environmental Protection Agency |

# 1 INTRODUCTION

Integral Consulting Inc. (Integral) has prepared Addendum 1 to the San Jacinto River Waste Pits Superfund (SJRWP) Site (the Site) overall Health and Safety Plan (HASP; Anchor QEA 2009). This addendum provides study-specific information and health and safety provisions to protect workers from potential hazards during sediment sampling activities at locations in the impoundment area and within the San Jacinto River. Site background information and general health and safety provisions to protect workers from potential hazards during work at the Site are presented in the overall HASP.

The provisions of this Sediment Sampling HASP are mandatory for all Integral, Anchor QEA, and any contractor personnel assigned to the project. Other contractors that will be working at the Site are also expected to follow the provisions of this Sediment Sampling HASP unless they have their own HASP that covers their specific activities related to this study and such HASPs have been approved by Integral. Any other contractor HASPs must include the requirements set forth in this Sediment Sampling HASP and the overall HASP (Anchor QEA 2009), at a minimum. All visitors to the work Site, including U.S. Environmental Protection Agency (USEPA) personnel; state and local government personnel; or employees, representatives, or contractors of McGinnes Industrial Maintenance Corporation (MIMC) and International Paper Company (IPC) must also abide by the requirements of this Sediment Sampling HASP and will attend a pre-work briefing where the contents of this Sediment Sampling HASP and the overall HASP (Anchor QEA 2009) will be presented and discussed.

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

Integral cannot guarantee the health or safety of any person entering the Site. Because of the potentially hazardous nature of the Site and the activity occurring thereon, it is not possible to regulate personal diligence or to discover, evaluate, and provide protection for all possible hazards that may be encountered. Strict adherence to the health and safety guidelines set forth herein and in the overall HASP (Anchor QEA 2009) will reduce, but not eliminate, the potential for injury and illness at the Site. The health and safety guidelines in this plan were

prepared specifically for the Site and should not be used on any other site without prior evaluation by trained health and safety personnel.

A copy of this Sediment Sampling HASP (Addendum 1) and the overall HASP (Anchor QEA 2009) must be in the custody of the field crew during field activities. All individuals performing field work must read, understand, and comply with these plans before undertaking field activities. Once the information has been read and understood, the individual must sign the Site Health and Safety Acknowledgment Form provided with this Sediment Sampling HASP. The signed form will become part of Integral and Anchor QEA, LLC (Anchor QEA) project files (as applicable to each company).

Addendum 1, this Sediment Sampling HASP, may be modified at any time based on the judgment of either Integral's or Anchor QEA's Site Safety Officer (SSO) in consultation with Integral's or Anchor QEA's Corporate Health and Safety Manager (CHSM) and Project Manager or designee. Any modification will be presented to the on-site team during a safety briefing and will be recorded in the field notebook.

## 2 SCOPE OF WORK

To perform the field work required for the 2010 sediment study, two field sampling teams will be deployed: one team from Integral and one team from Anchor QEA. The following tasks will be performed by the two teams using this Sediment Sampling HASP:

- Integral team:
  - Collection of surface and subsurface sediment for chemical analyses within the San Jacinto River
  - Collection of surface and subsurface nearshore, intertidal sediment (to the lowest low water level at time of sampling) along the shoreline of the San Jacinto River.
- Anchor QEA team:
  - Collection of sediment borings for measurements of geotechnical and engineering properties within the Site and also from the San Jacinto River
  - Collection of vane shear test information.

The Integral team will collect surface sediment samples in the nearshore, intertidal areas using a decontaminated, stainless-steel spade, shovel, or a modified Petit Ponar grab (or equivalent kind of equipment). Subsurface sediment in the nearshore, intertidal areas will be collected with a stainless steel hand corer. Submerged surface sediments in the San Jacinto River will be collected from a boat using either a power grab or a van Veen grab (or equivalent kind of equipment). Subsurface surface sediment cores in the San Jacinto River will be collected using a decontaminated coring device (e.g., vibracorer when sampling from a boat, with Lexan™ liner and core catcher).

The Anchor QEA team will collect sediment borings using Shelby tubes and split-spoon samplers. They will also use vane shear test equipment.

Access to the majority of the stations will require the use of a boat (Integral team) or barge (Anchor QEA team). Depending on water levels, intertidal sediment samples may be collected by sampling personnel equipped with hip- or chest waders, mudders strapped to their boots to prevent sinking while walking in soft sediments, and personal flotation devices (PFDs). Samples at the intertidal area will be collected as safely as possible from the lowest

low water level at time of sampling. If sampling of intertidal stations is not feasible at low tide, then a boat may also be used to collect the nearshore, intertidal samples during high tide.

# 3 AUTHORITY AND RESPONSIBILITIES OF KEY PERSONNEL

This section describes the authority and responsibilities of key Integral and Anchor QEA project personnel.

Because the Integral and Anchor QEA teams will be working autonomously, each team will have an SSO. To maintain adequate Site control, each SSO will have the authority to enforce the rules of the overall HASP and the Sediment Sampling HASP Addendum 1 to any individual present at the Site, whether that individual is an employee or an outside contractor who is working with his or her team.

Because there is more than one HASP (i.e., overall HASP [Anchor QEA 2009] and the Sediment Sampling HASP [Addendum 1]), the Occupational Safety and Health Act or Administration (OSHA) (OSHA 1997) considers it essential that the plans be integrated and enforced consistently to ensure that on-site personnel have a clear understanding of health and safety expectations, lines of authority, and emergency response actions.

The names and contact information for key safety personnel are listed in the Emergency Site Procedures section at the beginning of this HASP (Table A). Should key Site personnel change during the course of the project, a new list will be established and given immediately to the field teams. The emergency phone number for the Site is **911**, and should be used for all medical, fire, and police emergencies.

Joss Moore and Jason Kase (proposed Integral and Anchor QEA Field Leads [FLs] and SSOs, respectively) have oversight responsibility for all safety and health activities and the authority to discontinue or modify Site operations when unsafe conditions are detected. FLs will be in direct contact with their respective CHSMs (Eron Dodak for Integral and David Templeton for Anchor QEA) and Project Managers (PMs; Jennifer Sampson for Integral and David Keith for Anchor QEA).

The PMs will be in regular contact with their respective FL/SSOs and CHSMs to ensure that appropriate health and safety procedures are implemented during the 2010 sediment study.

Subcontractors that will provide a boat or barge for in-water work will be identified at a later date, and their names and contact information will be distributed with an updated contact list table to all participants.

# 4 JOB HAZARD ANALYSIS

The OSHA standard (29 CFR 1910.120) mandates that Site safety and health programs require that task- and operation-specific hazard analyses be conducted at the Site. These analyses are intended to ensure a comprehensive and systematic approach to hazard anticipation, recognition, and evaluation at hazardous waste sites.

The kinds of potential hazards associated with sediment sampling are summarized in the Job Hazard Analysis (JHA) that is provided in Table 1 (located at the end of this section of the Sediment Sampling HASP) for the sediment sampling task. The JHA lists a task or operation required during Site activity and the location(s) where that task or operation is performed. A single JHA may be used for a task performed in multiple locations if the hazards, potential exposures, and controls are the same in each location.

The JHA lists the chemical hazards associated with that task and their known or anticipated airborne concentrations during performance of the task. Each JHA also identifies anticipated physical and biological hazards and potential exposure levels or the likelihood of exposure. The final section of each JHA lists the control measures implemented to protect employees from exposure to the identified hazards. The information provided here is designed to satisfy OSHA's hazardous waste operations and emergency response JHA requirements of 1910.120(b)(4)(ii)(A) and the workplace hazard assessment requirements of 1910.132(d).

Health hazard information for all chemicals of potential concern (COPCs) identified in Site JHAs appears in the material safety data sheets (MSDS) of the overall HASP (Anchor QEA 2009).

Integral and Anchor QEA's FL will modify the study-specific JHA when:

- The scope of work is changed by adding, eliminating, or modifying tasks
- New methods of performing study tasks are selected
- Observation of the performance of study tasks results in a revised characterization of the hazards
- New chemical, biological, or physical hazards are identified
- Exposure data indicate changes in the concentration and/or likelihood of exposure

- New/different control measures are selected.

If the JHA is modified, then related provisions in other sections of this Sediment Sampling HASP will also be modified as needed.

The overall hazard level associated with the activities described in Section 2 is low. Hazards encountered during these sampling programs are due to physical safety hazards associated with the field operations, exposure to chemicals used to decontaminate sampling gear and preserve samples, and potential exposure to hazardous materials present within the sediments. Potential hazards while working at the Site include, but are not limited to, the following:

- Exposure to toxic and/or hazardous chemicals
- Physical hazards from use of sampling equipment and operations on a vessel and on land areas
- Physical hazards from working conditions (e.g., hypothermia, slips/trips/falls, or drowning).

As described below, protective equipment and safe working procedures will help prevent accidents caused by these hazards. All workers are required to use the buddy system, and no one will be allowed to work alone.

## 4.1 Definitions

Chemical hazards are defined by the following terms:

**Time-weighted Average (TWA):** The recommended exposure limits for a hazardous chemical in the workplace, typically during an 8-hour work day over a 40-hour work week. TWAs are recommended by the National Institute for Occupational Safety and Health (NIOSH) under the authority of OSHA.

**Permissible Exposure Limit (PEL):** The legal maximum air concentration of a hazardous chemical to which workers may be exposed on an 8-hour basis as established by OSHA. The

PEL is a time-weighted average value (PEL-TWA), and for all chemicals discussed below, the corresponding PEL-TWA is the same for OSHA.

**Threshold Limit Value (TLV):** The recommended maximum air concentration of a hazardous chemical to which workers may be exposed on an 8-hour basis. TLVs are time-weighted average values (TLV-TWA) and are recommended by the American Conference of Governmental Industrial Hygienists (ACGIH).

**Short-term Exposure Limit (STEL):** A 15-minute TWA exposure that should not be exceeded at any time during a workday.

**Ceiling Limit:** Employee's exposure, which should not be exceeded during any part of the workday.

**Buddy system:** "Buddy system" means that an employee is designated to be observed by at least one other employee in the work group. The purpose of the buddy system is to provide rapid assistance to employees in the event of an emergency.

## 4.2 Chemical Hazards

Table 1 presents a summary of health-based chemical exposure information for the primary COPCs for the 2010 sediment sampling. Additional information (including MSDSs and occupational health guidelines) is provided in Appendix B of the overall HASP (Anchor QEA 2009).

### *4.2.1 Potential Hazards of COPCs in Sediments*

A summary of the COPCs for health and safety and their concentrations in the Site sediments is provided in Table 1. This list includes chemicals that were detected in surface sediment samples: dioxins/furans, aluminum, copper, and mercury. During the sediment sampling, these COPCs will be bound in a wet solid matrix (i.e., the sediment) and pose a low risk for inhalation. Personnel will also be working in an open-air environment. Nonetheless, these compounds are potentially hazardous and exposure by all routes should be minimized. There is no evidence of significant concentrations of volatile chemicals in

sediment or surface water (Anchor QEA 2009). Therefore, respiratory protection is not expected to be needed, and either Level D (off-site sampling handling) or Modified Level D personal protective equipment (PPE) should be appropriate for the entire investigation. MSDSs for these compounds are provided in Appendix B of the general HASP overall (Anchor QEA 2009).

## 4.3 Physical Hazards

As stated in Section 2 above, it will be necessary to use a variety of boats, barges, and vehicles to access the proposed sediment sampling locations. The sections below provide safety guidelines for the use of boats and vehicles. The different physical hazard that may be associated with each of these operations is discussed below.

### *4.3.1 Sampling Vessel Operations*

The physical hazards associated with the deployment and retrieval of surface and subsurface sampling equipment result from their weight and the method of deployment. Only appropriate personnel whose presence is required will be deploying and retrieving sampling gear. Under circumstances of potentially dangerous waves or winds, the vessel (i.e., boat or barge) operator and FL/SSO will employ best professional judgment to ensure safe field operations.

To avoid injuries from heavy equipment, personnel will wear steel-toed boots when working on the work deck or loading/unloading heavy equipment from the vessel. Due to the proximity of overhead gear, hard hats will be worn when personnel are present on the work deck. Sample handling equipment, containers, deck lines, hydraulic cables, and water hoses not in immediate use will be kept clear of walkways and work areas until needed. Each time operations at a given location have been completed, excess sediment on the deck will be washed overboard to prevent slipping, minimize personnel exposure to potentially contaminated sediment, and limit cross-contamination between sample locations.

PFDs (i.e., life vests) will be provided for and worn by all personnel working on the deck, or as directed by the FL/SSO or vessel operator. The vessel will also be equipped with

throwable life rings, fire extinguishers, and warning horns, and each crew member will be briefed on their storage location.

### 4.3.2 Small Craft Operation

Safety procedures on small boats (i.e., length 20 feet or less) may necessitate an increased level of protection, depending on boat size and location in the river. Small boat procedures will include all the requirements listed above. In addition, all personnel onboard will be required to wear PFDs at all times. Any subcontractors operating small watercraft in the San Jacinto River during sediment sampling must have taken a Coast Guard Auxiliary boating safety course or equivalent and a demonstrated knowledge of the safe handling of these craft.

### 4.3.3 Man Overboard

While any team is working over water on the sampling vessel there is a potential for a man-overboard situation. The danger of this situation is increased if the water is flowing swiftly or if there is debris in the water. All personnel working over water will wear a PFD.
If a man-overboard situation occurs, all vessel engines will be stopped immediately.

Flotation devices (e.g., life rings) attached to lines will be thrown to the victim from the vessel. The victim will then be brought aboard the sampling vessel; wet clothes will be removed and replaced with dry clothing. The victim may need to be treated for cold stress (Section 4.3.5). No other person should enter the water unless the victim is unconscious or seriously injured. If required, rescuers must wear PFDs, and be tethered to the sampling vessel or shore.

### 4.3.4 Motor Vehicle Operation

Motor vehicles will be used to transport field personnel, equipment, and supplies to the nearshore, intertidal sampling locations that will be accessed during low tide. Motor vehicles will also be used to transport field personnel, equipment, and supplies to the sampling vessels and sample processing/shipping locations. Only sampling team personnel with valid driver's licenses and liability insurance (per local state laws) will operate motor vehicles required for work activities. All field staff will use best professional judgment at all times to ensure safe operation of motor vehicles, including:

- Operators are to practice defensive driving and drive in a courteous manner
- Operators are to be aware of pedestrians and give them the right-of-way
- All vehicles are to be operated in a safe manner and in compliance with statutory traffic regulations and ordinances
- Operators are to verify that safety seat belts are in proper operating order
- Seat belts are to be worn by the driver and all passengers whenever the vehicle is in motion
- No persons are allowed to ride in the back of any vehicles, unless equipped with seat belts
- Vehicles are to be driven in conformance with local speed limits
- Operators are to avoid excessively long driving periods
- Personnel who are impaired by fatigue, illness, alcohol, illegal or prescription drugs, or who are otherwise physically unfit, are not allowed to drive
- Personnel are to avoid using cellular phones or engaging in other distractions while driving
- Motor vehicle accidents are to be reported to the responsible law enforcement agency, Integral's human resources manager, and Integral's CHSM.

### *4.3.5 Physical Exposure*

Exposure to the elements and fatigue are two major causes of accidents while working outside. The individual task activities may include long work days and unpredictable weather. Working in cold, rough, or swift-moving waters can lead to fatigue, seasickness, and/or overexposure. The combination of vessel motion and fatigue increases the risk for a man-overboard situation.

To prevent fatigue and overexposure in adverse weather conditions, field personnel will take regular work breaks. Extra clothing will be brought to accommodate changes in weather. Cold stress can be manifested as hypothermia (discussed further in Section 12.2.2 of the overall HASP; Anchor QEA 2009). Heat-related illnesses can occur at any time when protective clothing is worn. When air temperatures average 70 to 75°F, the risk of heat-related illnesses increases. Heat stress can be manifested as both heat stroke and heat exhaustion (discussed further in Section 12.2.1 of the overall HASP; Anchor QEA 2009).

Personnel should monitor their own conditions and capabilities and are responsible for taking appropriate measures to relieve fatigue, exposure, or heat stress. Because fatigue and extreme heat/cold stress may impair an individual's judgment, the FL/SSO is also responsible for monitoring workers' apparent condition in relation to physical exposure. The FL/SSO and vessel operator may direct any crew member to cease working if conditions indicate the potential for overexposure or if overexposure.

### 4.3.6 Other Physical Hazards

Incorporating the following basic safety procedures can prevent many of the most common causes of injury or accident during field sampling:

- Implement good housekeeping practices, including immediate cleanup of spills and safe storage of all materials. All equipment or materials not in current use will be removed from the immediate work area.
- Use proper lifting and moving techniques to prevent back or muscle strain or injury. Any heavy equipment, boxes, coolers, or other items should be tested before lifting. If a piece of equipment is too heavy, the equipment should be broken into smaller components or assistance requested. Lifting should be done with the legs, not the back.
- Use extra caution when handling sharp tools or sampling devices and when possible, wear protective gloves.
- Use hearing protection when working with or near a power generator, and when using a circular saw to cut sediment cores.
- Use the following safety procedures when employing extension cords:
  - Always inspect cords before using them. Use only cords in good condition to avoid electrical shocks.
  - Extension cords used in wet and/or outdoor locations have to be protected by ground fault circuit interrupters.
  - Extension cords should be a minimum of 16 American Wire Gauge size (AWG) and be rated for the equipment in use. Example: To connect an impact corer to a 2000-watt power generator, a 12 AWG (25 amps) extension cord is needed to carry the necessary current to start up the unit.

- Avoid running extension cords across walkways. Instead, run them overhead if possible and place flagging tape on the extension cord to warn of possible overhead hazard.
- An extension cord that is hot to the touch is overloaded and should be replaced.

## 4.4 Employee Notification of Hazards and Overall Site Information Program

The information in the JHA and the MSDSs will be made available to all employees who could be affected by it prior to the time they begin their work activities. Modifications to JHAs and the accompanying data sheets will be communicated during routine briefings.

Consistent with paragraph 1910.120 (i) of Hazardous Waste Operations and Emergency Response (HAZWOPR) (OSHA 1994), the FL/SSO will also inform other contractors and subcontractors working on this study about the nature and level of hazardous substances at the Site, the likely degree of exposure to workers who participate in Site operations, and any modifications to this Sediment Sampling HASP to other contractors and subcontractors working on this Site.

Daily safety briefings will take place before work begins. The daily briefing form provided in Exhibit 1 will be used to record the daily meetings.

**Table 1**

**Job Hazard Analysis for Sediment Sampling – Types of Potential Hazards**

| **Operational Phase: SJRWP RI/FS** | | | | **Location: On water and impoundment area at SJRWP** | | |
|---|---|---|---|---|---|---|
| **Chemical Hazards** | | | | | | |
| **Chemical of Potential Concern** | **PEL - TWA1 mg/m$^3$** | **TLV - TWA2 mg/m$^3$** | **STEL mg/ m$^3$** | **Ceiling Limit mg/m$^3$** | **Exposure Routes** | **Symptoms** |
| 2,3,7,8-TCDD | - | - | - | - | Inh, Abs, Ing, Con | Irritation to eyes, chloracne, dermatitis |
| Mercury | 0.01 | 0.025 | 0 | 0.1 | Inh, Ing, Con | Irritation to eyes, skin, cough, chest pain, dyspnea, bronchitis, pneumonitis; tremor, insomnia, irritability, indecision, headache, lassitude; stomatitis, salivation; gastrointestinal disturbance, anorexia, weight loss; proteinuria |
| Copper (fume) | 0.1 | 0.2 | - | - | Inh, Con | Fever, chills, muscle ache, nausea, dry throat, weakness |

| **Physical Hazards** | | | |
|---|---|---|---|
| **Name of Physical Hazard** | **Source** | **Exposure Level/ Potential** | **Exposure Limit** |
| Boating operations | Boat deck | Likely | N/A |
| Pinch and crush zones | Boat winch and crane | Likely | N/A |
| Drowning | Boat/intertidal area | Likely | N/A |
| Heat (ambient) | Sun | Likely | N/A |
| Cold weather operations | Boat deck area | Likely | N/A |
| Heavy manual lifting/moving | Sediment cores, anchor weights | Likely | N/A |
| Oxidizers – storage and use | Decontamination solution | Likely | N/A |
| Slips/trips/falls/person overboard | Boat deck area | Likely | N/A |
| Inclement weather – rain, wind | Boat deck area | Likely | N/A |
| Sharp objects – machete | Clearing impoundment area vegetation | Likely | N/A |
| Sharp objects – broken glass | Boat deck/impoundment area | Likely | N/A |

**Table 1**

**Job Hazard Analysis for Sediment Sampling – Types of Potential Hazards**

| | | | |
|---|---|---|---|
| Corrosives - storage and use | Decontamination solution | Likely | N/A |
| Flammable liquids – storage and use | Decontamination solution | Likely | N/A |
| Material handling | Sediment | Likely | N/A |
| Vehicular travel | Van shuttle | Likely | N/A |
| Working over water | Boat deck area | Likely | N/A |
| Operational Phase: SJRWP RI/FS | Location: On water and impoundment area at SJRWP | | |
| **Biological Hazards** | | | |
| **Name of Biological Hazard** | **Source** | **Exposure Level/Potential** | **Exposure Limit** |
| Ragweed | Beach area | Likely | N/A |
| Insect bites and stings | Boat and beach area | Likely | N/A |
| Operational Phase: SJRWP RI/FS | Location: On water and impoundment area at SJRWP | | |
| **Control Measures Used** | | | |
| **Engineering Controls:** see the FSP (Appendix A of this document). **In addition:**<br>1. Anchor weights of sampling boat are such that the use of the boat's winch should be employed.<br>2. Weights of coolers are such that two persons should lift the units to prevent back injuries.<br>3. To avoid insect bites, insect repellents may be applied.<br>4. Field staff must bring allergy medications if allergic to ragweed.<br>5. The weight of the impact corer is such that careful lifting and position handling must be observed.<br>6. To mitigate poisoning from a snake bite, a snake bite kit will be available on Site.<br>7. To avoid sinking in mud, mudders will be strapped to boots or pieces of plywood will be used. | | | |
| Level of PPE: D<br>Location: On boat deck | PPE Equipment: Chemical-resistant steel-toed boots, PVC bib-style overalls and jacket with hood, splash-proof safety goggles, nitrile gloves, hardhat, PFD Type III. | | |
| Location: Intertidal area, impoundment area | PPE Equipment: Chemical-resistant steel toe boots, PVC Bib-style overalls (and jacket with hood as necessary), splash-proof safety goggles, nitrile gloves, chest or hip waders, mudders, PFD Type III. | | |
| Work Practices: | Change disposable nitrile gloves frequently.<br>Wash hands and face with soap and water after each sampling event.<br>Take shower at end of workday. | | |

Notes:
[1] PEL-TWA values from NIOSH Pocket Guide to Chemical Hazards (1997).
[2] TLV-TWA values from American Conference of Governmental Industrial Hygienists (ACGIH1996).
[3] PEL and TLV values for coal tar pitch volatiles include anthracene, benzo(a)pyrene, chrysene, and pyrene.
*Naphthalene: 50 mg/m$^3$ = 10 ppm (NIOSH 1997).
Inh = Inhalation, Abs = Absorption, Con = Contact, Ing = Ingestion
NA = Not applicable.
NE = Not established.

# 5 SITE CONTROL ZONES

The definitions of the Site control zones are discussed in Section 7.3 of the overall HASP (Anchor QEA 2009). The use of Site control zones is designed to reduce the spread of hazardous substances from contaminated areas to clean areas, to identify and isolate contaminated areas of the Site, to facilitate emergency evacuation and medical care, to prevent unauthorized entry to the Site, and to deter vandalism and theft.

## 5.1 Sediment Sampling

### *5.1.1 Exclusion Zone*

Exclusion zones will be established wherever exposed sediment is handled:

**Sampling Vessel:** During intrusive sampling on a sampling vessel, the exclusion zone includes the area of the vessel in which sediments collected from the river bottom are handled. This part of the vessel is designated as the exclusion zone only when sediment samples are being handled on the vessel.

**Nearshore Intertidal Sampling:** When sampling nearshore intertidal sediments, the exclusion zone will be the area within a 6-foot radius around the sampling point. The same area will apply when homogenizing sediments on Site. A designated member of the field team will be tasked with preventing unauthorized individuals from entering the exclusion zone.

**Field Processing Area:** Onshore facilities may be used for all sediment core processing activities, including a mobile facility that may be used for subsurface sediment sample processing. Otherwise, a canopy with plastic walls and ground plastic cover may be used as a field processing area. Each sediment processing facility or field processing area under a canopy will be identified by a clearly marked exclusion zone where all sediment handing will occur. The exclusion zone boundaries will be marked with caution tape, orange traffic safety cones, or equivalent. A designated member of the field team will be tasked with preventing unauthorized individuals from entering the field processing area.

### *5.1.2 Contamination Reduction Zone*

Contamination reduction zones (CRZs) will be established wherever decontamination of sampling equipment and personnel exposed to sediment is conducted:

**Sampling Vessel:** The CRZ during on-water sediment handling is the same area on the vessel deck after intrusive sampling has occurred. Decontamination of both personnel and equipment will take place in this zone to prevent the transfer of COPCs to the support zone.

**Nearshore Intertidal Sampling:** When sampling nearshore intertidal sediments, field personnel may carry the sampling equipment and sampling bowls containing sediment samples back to the field processing area (if one is used). The CRZ zone will be the reserved area outside the exclusion zone of the field processing area where decontamination of both personnel and field equipment will take place and prevent the transfer of COPCs to the support zone.

**Field Processing Area:** A reserved area outside the exclusion zone where decontamination of both personnel and equipment will occur to prevent the transfer of COPCs to the support zone. As appropriate, the boundaries of the field processing area will be marked with caution tape, orange traffic safety cones, or equivalent.

## 5.2 Support Zone

The support zone will be located wherever exposed contaminated sediments are not present. In general, the support zone is where sample processing occurs after sediment samples have been sealed in sample jars and inserted into resealable plastic bags. It is also the area where chain-of-custody forms are completed, sample jar labels are prepared, and sample jars are packed for shipping.

**Sampling Vessel:** The support zone is the cabin area of the vessel or on the vessel deck where contaminated sediments are not present.

**Nearshore Intertidal Sampling:** The support zone will be located adjacent to the field processing area and may consist of a separate room in a field lab (if used), the inside space of

a cargo van or trailer, or an area under another canopy with clean tables and chairs where sediments are not being processed.

**Field Processing Area:** The support zone will be located adjacent to the field processing area and may consist of a separate room in a field lab (if used), the inside space of a cargo van or trailer or, an area under another canopy with clean tables and chairs where sediments are not being processed.

## 5.3 Project Air Monitoring Requirements

Section 11 of the overall HASP (Anchor QEA 2009) provides general requirements for air monitoring during the 2010 sediment study, including information on air monitoring equipment. Previous investigations of the Site indicate that the main chemicals of interest for worker health and safety during the sampling event(s) are dioxins and furans. There is no evidence of significant concentrations of volatile chemicals in sediment or surface water. Therefore, respiratory protection is not expected to be needed and either Level D (off-site sample handling) or Level Modified D PPE (sampling activities) will be used.

## 5.4 Decontamination of Sampling Equipment

Decontamination of sampling equipment will follow procedures in Section 2.2.5 of the field sampling plan for this study HASP. No chemical solvents will be required for decontamination of sampling equipment.

All vehicles, vessels, and equipment that have entered potentially contaminated areas will be visually inspected and, if necessary, decontaminated prior to leaving the area by rinsing tires and wheel wells with Alconox® detergent and water. An effort will be made to keep vehicles away from contaminated soil and sediment by parking on the service road and carrying field sampling equipment to the Site on foot or by using carts or sleds. Large tools will be cleaned in the same manner. Small reusable sampling equipment, including bowls, spoons, and knives, will be rinsed, washed in phosphate-free detergent, and rinsed again. All personnel walking over the impoundment area will have their boots decontaminated as well. Rinsate from all decontamination activities will be collected for proper disposal. Decontamination of equipment and tools will take place within the CRZ.

The following supplies will be available to perform decontamination activities:

- Wash and rinse buckets
- Tap water and phosphate-free detergent (i.e., Alconox® or Liquinox®)
- Scrub brushes
- Distilled/deionized water
- Deck pump with pressurized water hose (aboard the vessel)
- Pressure washer/steam cleaner, if appropriate
- Paper towels and plastic garbage bags
- 50-gallon drums with labels and lids or 5-gallon plastic buckets with labels and lids to segregate rinsed waste water and solid waste derived from sediment sampling and processing activities.

# 6 REFERENCES

ACGIH. 1996. Threshold Limit Values (TLV) for Chemical Substances and Physical Agents Biological Exposure Indices (BEIs). American Conference of Governmental Industrial Hygienists, Cincinnati, OH.

Anchor QEA. 2009. Health and Safety Plan San Jacinto River Waste Pits Superfund Site. Prepared for McGinnes Industrial Maintenance Corporation, International Paper Company, and U.S. Environmental Protection Agency, Region 6. Anchor QEA, LLC, Ocean Springs, MS.

NIOSH. 1997. National Institute for Occupational Safety and Health (NIOSH) Pocket Guide to Chemical Hazards. Keller & Associates, Neenah, WI.

OSHA. 1994. 29 CFR Parts 1910 and 1926. Hazardous Waste Operations and Emergency Response. Department of Labor, Occupational Safety and Health Administration. Accessed web site on January 8, 2010. http://www.osha.gov/pls/oshaweb/owasrch.search_form?p_doc_type=STANDARDS&p_toc_level=1&p_keyvalue=1910

OSHA. 1997. EPA/Labor Superfund Health & Safety Task Force: OSHA Audits of Superfund Sites From 1993 to 1996. Department of Labor, Occupational Safety and Health Administration. August 25, 1997. Accessed web site on January 8, 2010. http://www.osha.gov/SLTC/hazardouswaste/sftaskrpt.html

# EXHIBIT 1
# HEALTH AND SAFETY FORMS

# EXHIBIT 1

## HEALTH AND SAFETY FORMS

ANCHOR QEA

DATE: _____

PROJECT NAME: _____

PROJECT NO: _____

# DAILY SAFETY BRIEFING

**PERSON CONDUCTING MEETING:** _____ **HEALTH & SAFETY OFFICER:** _____ **PROJECT MANAGER:** _____

**TOPICS COVERED:**

- ☐ Emergency Procedures and Evacuation Route
- ☐ Directions to Hospital
- ☐ HASP Review and Location
- ☐ Safety Equipment Location
- ☐ Proper Safety Equipment Use
- ☐ Employee Right-to-Know/MSDS Location
- ☐ Fire Extinguisher Location
- ☐ Eye Wash Station Location
- ☐ Buddy System
- ☐ Self and Coworker Monitoring
- ☐ Lines of Authority
- ☐ Communication
- ☐ Site Security
- ☐ Vessel Safety Protocols
- ☐ Work Zones
- ☐ Vehicle Safety and Driving/Road Conditions
- ☐ Equipment Safety and Operation
- ☐ Proper Use of PPE
- ☐ Decontamination Procedures
- ☐ Other:
- ☐ Lifting Techniques
- ☐ Slips, Trips, and Falls
- ☐ Hazard Exposure Routes
- ☐ Heat and Cold Stress
- ☐ Overhead and Underfoot Hazards
- ☐ Chemical Hazards
- ☐ Flammable Hazards
- ☐ Biological Hazards
- ☐ Eating/Drinking/Smoking

**WEATHER CONDITIONS:** _____

**DAILY WORK SCOPE:** _____

**SITE-SPECIFIC HAZARDS:** _____

**SAFETY COMMENTS:** _____

**ATTENDEES**

| PRINTED NAME | SIGNATURE |
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# Integral Consulting Inc.
# Employee Exposure/Injury/Illness Incident Report

Employee: _____ Employee ID No._____

Sex: M ____ F ____ Office location: _____

Incident:

Possible exposure: _____ Known exposure: _____

Physical injury/illness: _____

Check only **one** below for **illness**:

____ Occupational skin diseases or disorders ____ Disorders due to physical agents

____ Dust diseases of the lungs ____ Disorders associated with repetitive motion

____ Respiratory conditions due to toxic agents ____ All other occupational illnesses

Location: _____ Contract or Overhead No. _____

Date of incident: _____ Time of incident: _____

Date incident reported: _____ Person to whom incident was reported: _____

Date of initial medical diagnosis: _____

Weather condition during incident: Temperature: _____ Humidity: _____

Wind speed and direction: _____ Cloud cover: _____

Clear: _____ Precipitation: _____

Name of materials potentially encountered:

Chemical (liquid, solid, gas, vapor, fume, mist): _____

_____

Radiological: _____

_____

Biological or Other: _____

_____

Describe the exposure/injury/illness in detail, the parts of the body affected, and how the incident occurred (attach extra sheets if necessary):

_____

_____

_____

_____

_____

_____

Was medical treatment given? Yes ___ No ____ If so, when? _____

By whom? Name of paramedic: _____

Name of physician: _____

Other: _____

Where? Onsite ___ Offsite ___

If offsite, name of hospital or clinic: _____

Length of inpatient stay (dates): _____

Was corporate management notified? No ___ Yes ___ When? _____

Name and title of manager(s) notified: _____

Did the exposure/injury/illness result in death? No ___ Yes ___ Date: _____

Did the exposure/injury/illness result in permanent disability? No ___ Yes ___ If yes, explain:

_____

Days away from work: _____ Days of restricted work activity: _____

Has the employee returned to work? No ____ Yes ____ If yes, date: _____

Name of other persons affected during the incident:

_____ _____

_____ _____

Names of persons who witnessed the incident:

_____ _____

_____ _____

Name and title of field team leader or immediate supervisor at the site:

_____

Was the operation being conducted under an established safety plan? No ____ Yes ____

If yes, attach a copy. If no, explain: _____

_____

Were protective equipment and clothing used by the employee? No ___ Yes ___ If yes, list items:

_____

Did any limitations in safety equipment or protective clothing affect or contribute to exposure? If so, explain:

_____

_____

What was the employee doing when the exposure/injury/illness occurred? (Describe briefly as site reconnaissance, site categorization, sampling, etc.):

_____

_____

_____

_____

_____

_____

Describe exact onsite or offsite location where the incident occurred:

_____

_____

How did the incident occur? Describe fully the factors that led to or contributed to the incident:

_____

_____

_____

_____

_____

Attachments to this report: ___ Medical report(s) if not confidential ___ Site safety plan ___
Other relevant information ____

_____ _____
Employee's signature Date

_____ _____
Project Manager's signature Date

_____ _____
Site safety officer's signature Date

_____ _____
Corporate health and safety officer's signature Date

Management review and comments:

Medical consultant's comments:

Physician's signature Date

Corporate health and safety officer review and comments

Action required? No ____ Yes ____ If yes, what action?

Follow-up action carried out:

Corrective actions to be taken to prevent similar incidents:

Corporate health and safety officer's signature Date

| | |
|---|---|
| Employee's signature | Date |
| Field team leader's signature | Date |
| Site safety officer's signature | Date |
| Project manager's signatures | Date |
| Supervisor's signature | Date |

# ATTACHMENT A2

## STANDARD OPERATING PROCEDURES

# LIST OF STANDARD OPERATING PROCEDURES

## Integral Consulting Inc.

| | |
|---|---|
| SOP AP-01 | Sample Packaging and Shipping |
| SOP AP-02 | Field Documentation |
| SOP AP-03 | Sample Custody |
| SOP AP-04 | Sample Labeling |
| SOP AP-05 | Investigation-Derived Waste Handling |
| SOP AP-06 | Navigation and Station Positioning |
| SOP SD-01 | Decontamination of Sediment Sampling Equipment |
| SOP SD-02 | Preparation of Field Quality Control Samples for Sediments |
| SOP SD-04 | Surface Sediment Sampling |
| SOP SD-06 | Hollow-Stem Auger Drilling/Sediment Sampling |
| SOP SD-08 | Subsurface Sediment Core Collection Using a Vibracorer |
| SOP SD-12 | Logging of Sediment Cores |
| SOP SD-13 | Field Classification of Sediment |
| SOP SL-05 | Surface Soil Sampling |
| SOP SL-06 | Logging of Soil Boreholes |

## Anchor QEA

| | |
|---|---|
| SOP 2.1 | Sediment Grab Sampling |
| SOP 6.2 | SPT and Split Spoon Sampling |
| SOP 6.3 | Thin Wall Sampling |
| SOP 6.6 | Instruction Manual, Field Inspection Vane Tester (Model H-60) |

INTEGRAL CONSULTING INC.

# 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 ****. 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>**.

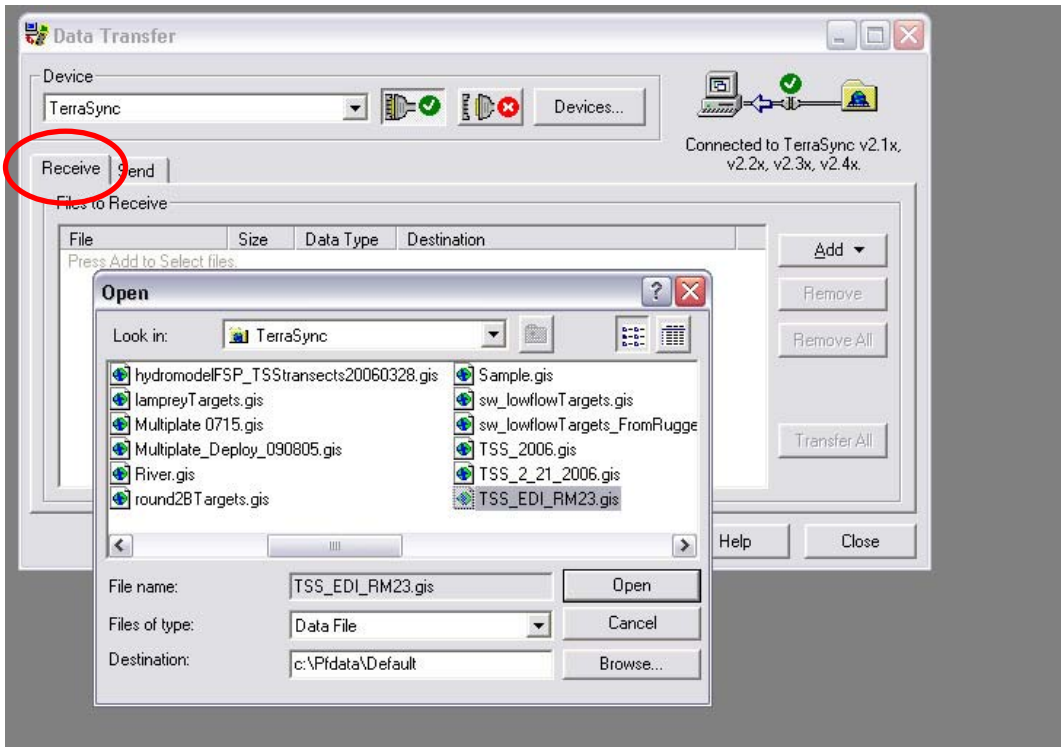


Figure 1. Transferring File from Terrasync

# 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.

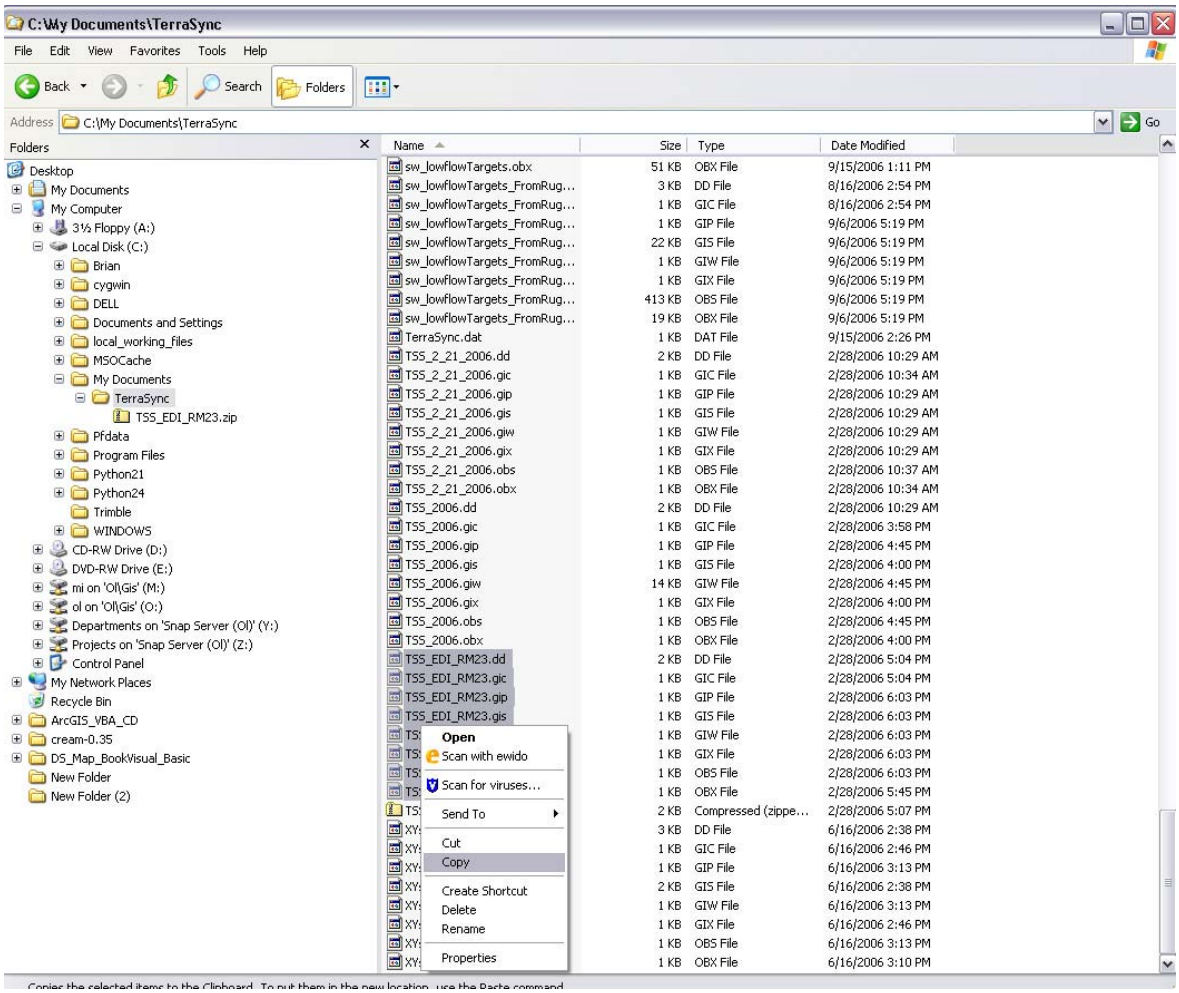


Figure 2. Selecting Files To Copy to a Different Directory

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.

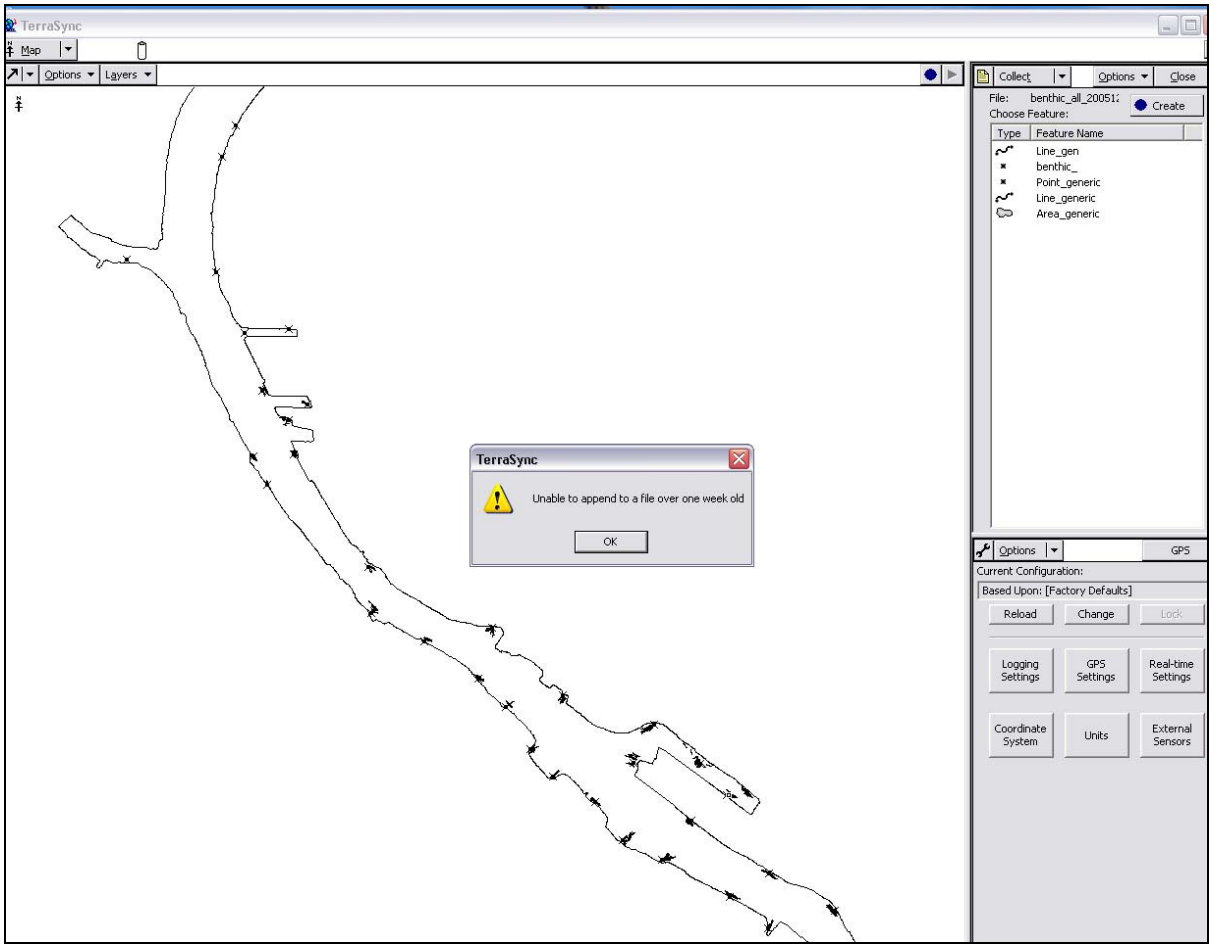


Figure 3. Notice That Terrasync File Older Than 1 Week Will Not Allow User To Collect Features (time begins to elapse when first feature is collected in the field, not when file is created)

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.

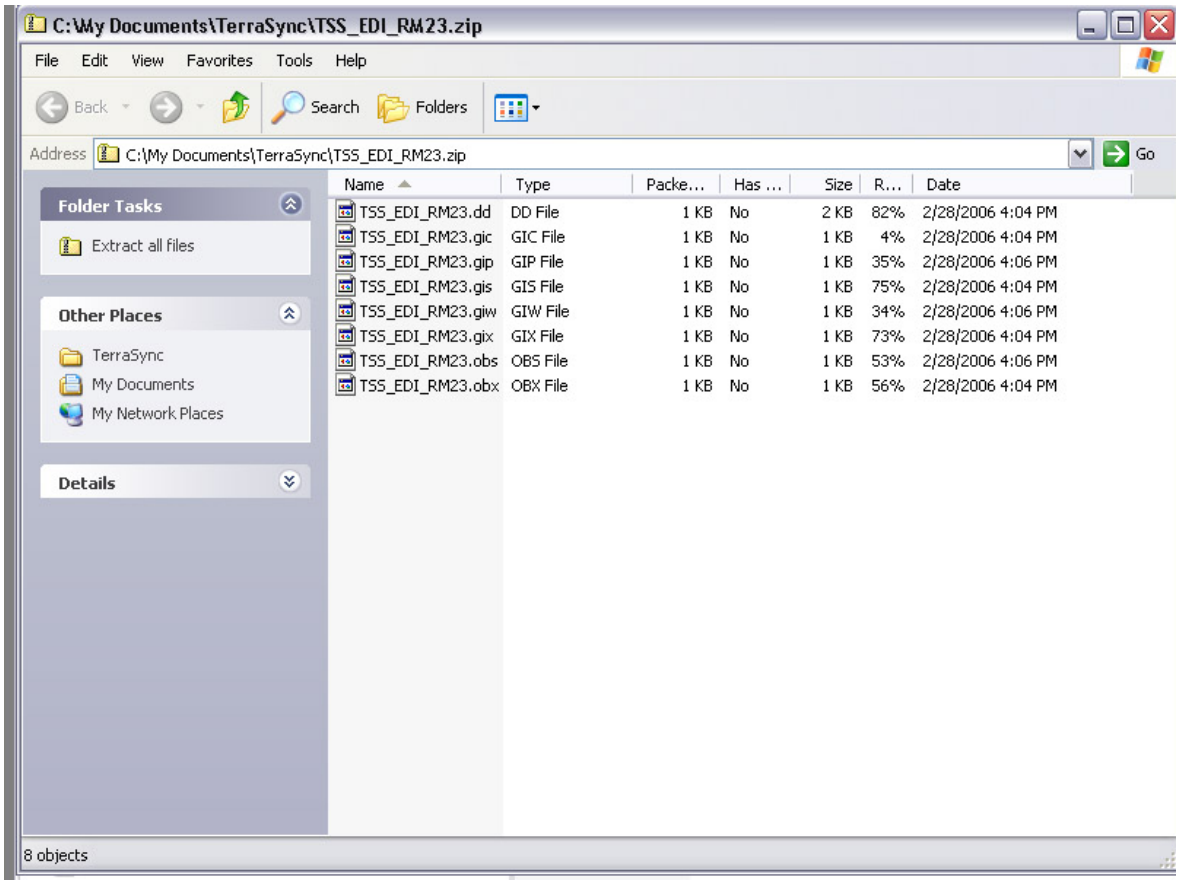


Figure 4. Example of File Set To Be Unzipped into the Terrasync Folder

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.

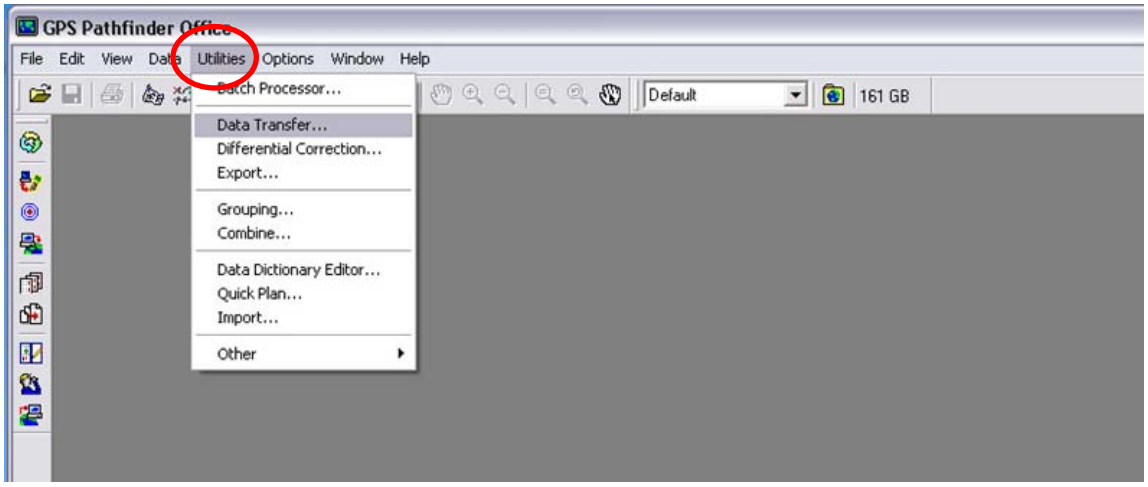


Figure 6. Data Transfer Menu

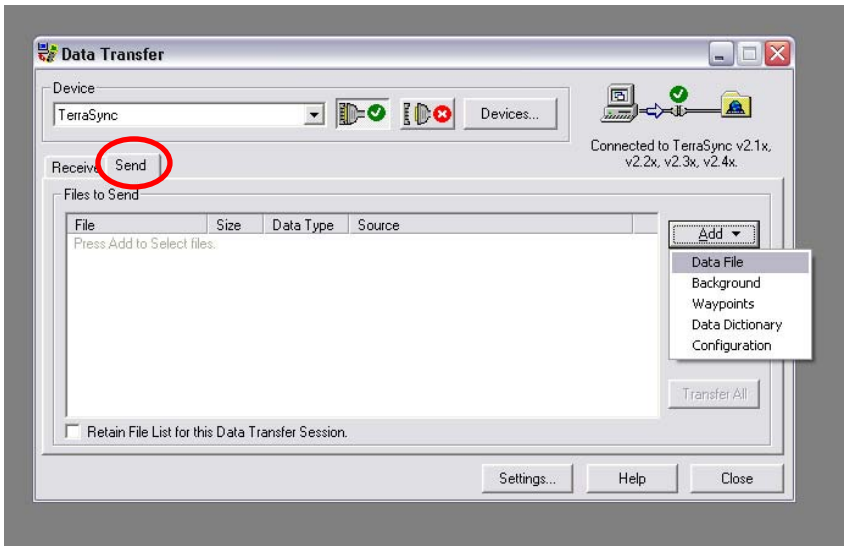


Figure 7. Sending Data File

# 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.

[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-04

# SURFACE SEDIMENT SAMPLING

## SCOPE AND APPLICATION

This SOP defines and standardizes the methods for collecting surface sediment samples from freshwater or marine environments. Surface sediments are defined as those from 0 to at most 10 cm below the sediment-water interface. The actual definition of surface sediments is typically program-specific and depends on the purpose of the study and the regulatory criteria (if any) to which the data will be compared.

This SOP utilizes and augments the procedures outlined in USEPA (1996) and ASTM (2003) guidelines. A goal of this SOP is to ensure that the highest quality, most representative data are collected, and that these data are comparable to data collected by different programs that follow the USEPA (1996) guidelines.

## SUMMARY OF METHOD

Sediment samples for chemical and toxicity analysis are collected using a surface sediment sampling device (e.g., grab sampler). If a sample meets acceptability guidelines, overlying water is carefully siphoned off the surface, and the sediment is described in the field log. Sediment samples for chemical analysis may be collected directly from the sampler (e.g., volatile organic compounds and sulfides), or sediment from the sampler may be homogenized using decontaminated, stainless-steel containers and utensils prior to being placed in sample jars. Sediment from several sampler casts may also be composited and homogenized prior to being placed in sample jars.

## SUPPLIES AND EQUIPMENT

A generalized supply and equipment list appears below. Additional equipment may be required depending on project requirements.

- Grab sampler or box corer (see examples below in procedures for "Sediment Sample Collection")
- Field equipment
  - Siphoning hose

  - Stainless-steel bowls or containers
  - Stainless-steel spoons, spatulas, and/or mixer
  - Project-specific decontamination supplies (e.g., Alconox™ detergent, 0.1 N nitric acid, methanol, hexane, distilled/deionized water)
  - Personal protective equipment for field team (e.g., rain gear, safety goggles, hard hats, nitrile gloves)
  - First aid kit
  - Cell phone
  - Camera
  - Sample containers
  - Bubble wrap
  - Sample jar labels
  - Clear tape
  - Permanent markers
  - Indelible black-ink pens
  - Pencils
  - Coolers
  - Ice
- Documentation
  - Waterproof field logbook
  - Field sampling plan
  - Health and safety plan
  - Correction forms
  - Request for change forms
  - Waterproof sample description forms.

# PROCEDURES

## Sediment Sample Collection

Use a sampler that obtains a quantifiable volume of sediment with minimal disturbance of the surrounding sediments to collect sediment for chemical and biological analyses. The sampler

should be composed of a material such as stainless steel or aluminum, or have a noncontaminating coating such as Teflon™. Samplers capable of providing high-quality sediment samples include grab-type samplers (e.g., van Veen, Ekman, Smith-McIntyre, Young grab, Power Grab and modified-ponar grab) and box cores (Soutar, mini-Soutar, Gray-O'Hara, spade core). Some programs require a sampler that collects from a specific area (e.g., 0.1 $m^2$). Most sampling devices are typically a standard size; however, some non-standard sizes are available to meet the requirements of specific programs. Grab samplers, especially van Veen grab and Ekman grab, are the most commonly used samplers to collect surface sediment. Power Grab samplers are often used for programs requiring collection of sediment deeper than 10 cm (4 in.) or in areas with debris.

Depending on grab weight and water depth, use a hydraulic winch system to deploy the heavier samplers at a rate not exceeding 1 m/second to minimize the bow wake associated with sampler descent. Once the sampler hits the bottom, close the jaws slowly and bring the sampler to the deck of the vessel at a rate not exceeding 1 m/second to minimize any washing and disturbance of the sediment within the sampler. At the moment the sampler hits the bottom, record the time, depth, and location of sample acquisition in the field logbook.

Retrieve and secure the sampler, and carefully siphon off any overlying water. Inspect the sample to determine acceptability using the criteria detailed in PSEP (1996), except when noted in the project-specific field safety plan. These criteria include but are not limited to the following:

- There is minimal or no excessive water leakage from the jaws of the sampler
- There is no excessive turbidity in the water overlying the sample
- The sampler is not over-penetrated
- The sediment surface appears to be intact with minimal disturbance
- The program-specified penetration depths are attained.

If the sample meets acceptability criteria, record the sample and enter observations onto a sample description form or log. Once the sample has been characterized, subsample the sediment for chemical and biological analyses.

## Sample Processing

Using a stainless-steel spoon, remove from the sediment from the sampler for chemical and/or toxicity analyses. Depending on programmatic goals, remove the upper 10 cm (4 in.) of sediment. To prevent possible cross-contamination, do not use sediments touching the margins of the sampler.

Complete all sample logs, labels, custody seals, and chain-of-custody forms, and record sample information in the field notebook.

Collect samples for volatile compounds (either organics or sulfides) using a decontaminated stainless-steel spoon while sediment is still in the sampler. These sediments are not homogenized. Tightly pack the volatile organics sample jar with sediment (to eliminate obvious air pockets) and fill it so that no headspace remains in the jar. Alternatively, if there is adequate water in the sediment, fill the container to overflowing so that a convex meniscus forms at the top, and then carefully place the cap on the jar. Once sealed, the jar should contain no air bubbles.

Place the remaining sediment in a precleaned, stainless-steel bowl. Typically, sediment from a minimum of three separate casts of the sampler is composited at each station. Once you have collected a sufficient amount of sediment, mix the sediment until it is of uniform color and smooth consistency. Dispense the sediment into precleaned sample jars for the various chemical or biological analyses. For toxicity testing, fill sample jars to the top with sediment to minimize available headspace. This procedure will minimize any oxidation reactions within the sediment. For chemical analysis, sample containers may be frozen for storage. Leave enough headspace to allow for sediment expansion.

After dispensing the sediment, place the containers into coolers with ice and either ship them directly to the analytical laboratories or transport them to a storage facility.

## REFERENCES

ASTM. 2003. *Standard Practice for Collecting Benthic Macroinvertebrates with Ekman Grab Sampler*. ASTM Standards on Disc, Volume 11.05.

USEPA. 1996. Puget Sound Estuary Program: Recommended protocols for measuring selected environmental variables in Puget Sound. Prepared for U.S. Environmental Protection Agency, Region 10, and Puget Sound Estuary Program, Seattle, WA. Tetra Tech and HRA, Inc., Bellevue, WA.

# STANDARD OPERATING PROCEDURE (SOP) SD-06

# SEDIMENT CORING PROCEDURES USING HOLLOW-STEM AUGER BORINGS WITH SPLIT SPOON AND SHELBY TUBE SAMPLERS

## SCOPE AND APPLICATION

Sediment cores are collected to evaluate sediment at depths that greatly exceed those achieved by grab or other surface samplers. The purpose of this standard operating procedure (SOP) is to define and standardize procedures for core collection using split-spoon and Shelby tube samplers advanced through hollow-stem auger borings, following American Society for Testing and Materials (ASTM) Method D1586 and Method D1587, respectively (ASTM 1999, 2000a). Shelby tubes are used to recover relatively undisturbed sediment samples suitable for laboratory tests of engineering properties such as strength, compressibility, permeability, and density and are not used to collect samples for chemical analyses.

## REQUIRED EQUIPMENT

- Project-specific field sampling plan (FSP)
- Project-specific health and safety plan (HSP)
- Field logbook and boring log
- Indelible black-ink pens and markers
- Camera
- Hollow-stem auger drill rig
- Split-spoon samplers (typically 2-in. diameter; a larger 3-in. diameter, 2-ft-length split-spoon may be used to obtain more material from each depth interval)
- Shelby tube samplers conforming to thin-walled tube specifications outlined in ASTM D1587 (ASTM 2000a) with a 2- to 5-in. O.D. and 5 to 10 times the diameter in length.
- Wax and end caps for proper field sealing of the tubes
- Photoionization detector (PID) (if required, consult project-specific HSP)
- Plastic sheeting
- 55-gallon drums (if required consult project-specific FSP)
- Insulated cooler(s), chain-of-custody seals, Ziploc® bags

- Sample labels and appropriate documentation
- Assorted geology supplies (i.e., hand lens, grain-size card, scales, etc.)

## PROCEDURES

1. Ensure underground utilities in the vicinity of each boring location have been marked prior to mobilizing drill rig to site
2. Conduct daily site activity/health and safety briefing
3. Calibrate field instrumentation, if applicable
4. Record necessary data in field logbook
5. Obtain photographs of the site prior to coring if site is on land (e.g., marsh, beach)
6. Place plastic sheeting and/or drums at coring location to collect cuttings (if necessary)
7. Move equipment and supplies to coring location
8. Set up decontamination and sampling stations.

## Split-Spoon Sampling

1. Obtain surface sediment sample, if required (consult project-specific FSP)
2. Core to first sampling depth, as described in the project-specific FSP
3. Place decontaminated split-spoon sampler on center rods
4. Drive split-spoon sampler, as described in ASTM Method D1586 (ASTM 1999)
5. Drive sampler to 18 in. or to refusal (no progress for 50 blows)
6. Record blow counts on boring log form
7. Retrieve sampler
8. Screen sampler with PID (if required; consult project-specific HSP)
9. Collect volatile organic compounds (VOCs) as appropriate (see project-specific FSP)
10. Describe sediment sample as detailed in SOP SD-12, *Logging of Sediment Cores,* and SOP SD-13, *Field Classification of Sediment,* and in compliance with ASTM D2488 (ASTM 2000b) on the Field Sediment Core Form
11. Composite sediment sample as necessary (see project-specific FSP)
12. Label and manage sample containers in accordance with the project-specific FSP and SOP AP-02 *Field Documentation* and SOP AP-03, *Sample Custody*

13. Continue coring to next sample interval as specified in the project-specific FSP; collect samples as outlined above
14. Decontaminate sampling equipment in accordance with the project-specific FSP
15. Document activities in the field logbook
16. Backfill or grout hole, as necessary
17. Move to next location.

## Shelby Tube Sampling

1. Obtain surface sediment sample, if required (consult project-specific FSP)
2. Core to first sampling depth, as described in the project-specific FSP
3. Place decontaminated Shelby tube sampler on center rods
4. Drive Shelby tube sampler, as described in ASTM Method D1587 (ASTM 2000a)
5. Retrieve the sampling tube and removed the disturbed material from the top of the tube
6. Remove 1-in. of sediment from the base of the tube
7. Screen sampler with PID (if required; consult project-specific HSP)
8. Place an impervious disk at both ends of the tube and seal with wax prior to shipment to the testing laboratory
9. If Shelby tubes are to be extruded in the field for composite sampling, the driller will use a hydraulic extruder to obtain the sample
10. Describe sediment sample as detailed in SOP SD-12, *Logging of Sediment Cores,* and SOP SD-13, *Field Classification of Sediment,* and in compliance with ASTM D2488 (ASTM 2000b) on the Field Sediment Core Form
11. Composite sediment sample as necessary (see project-specific FSP)
12. Label and manage sample containers in accordance with the project-specific FSP and SOP AP-02, *Field Documentation,* and SOP AP-03, *Sample Custody*
13. Continue coring to next sample interval as specified in the project-specific FSP; collect samples as outlined above
14. Decontaminate sampling equipment in accordance with the project-specific FSP
15. Document activities in the field logbook
16. Backfill or grout hole, as necessary
17. Move to next location.

## REFERENCES

ASTM. 1999. Standard test method for penetration test and split-barrel sampling of soils. ASTM Standard Method No. D 1586-99. In: ASTM Book of Standards, Volume 04.08. American Society for Testing and Materials, West Conshohocken, PA.

ASTM. 2000a. Standard practice for thin-walled tube sampling of soils for geotechnical purposes. ASTM Standard Method No. D 1587-00. In: ASTM Book of Standards, Volume 04.08. American Society for Testing and Materials, West Conshohocken, PA.

ASTM. 2000b. Standard practice for description and identification of soils (visual-manual procedure). ASTM Standard Method No. D 2488-00. In: ASTM Book of Standards, Volume 04.08. American Society for Testing and Materials, West Conshohocken, PA.

# STANDARD OPERATING PROCEDURE (SOP) SD-08

# SUBSURFACE SEDIMENT CORE COLLECTION USING A VIBRACORER

## SCOPE AND APPLICATION

This SOP describes the procedure for collecting and processing sediment core samples using a vibracore system, which collects continuous and relatively undisturbed sediment cores. This method of sediment coring is performed from a boat and uses high-frequency low-amplitude vibration to break down the frictional resistance of the sediment and allow the core tube to penetrate into the sediment with minimal distortion. It is best used for sampling coarse, consolidated sediment and very cohesive sediment, where static weight (e.g., piston-type or conventional gravity corers) will not produce adequate penetration into the sediment. In addition, the vibracorer offers a high rate of production, superior retention of shallow samples, and a greater sample volume compared to conventional drilling equipment.

Vibracorers generally consist of a metal corer barrel (usually a 4-in.-outside-diameter, aluminum core barrel) with a location-dedicated polycarbonate or Lexan®-lined core tube, and a vibrator mechanism attached to the top of the barrel. The vibration is created either by an electric motor, a hydraulic system, or a pneumatic piston attached to the top of the barrel. Therefore, a generator or air compressor is needed on board to power the corer. The pneumatic piston does not have the same function as a piston in a piston corer. Because vibracorers generally do not have a piston in the corer, some compaction and/or bypass will occur, and recovery will be less than 100 percent.

A continuous sediment sample is retained within the tubing with the aid of a stainless-steel core cutter/catcher or nosecone attached to the bottom of each aluminum tube.

It is always best to keep the core in a vertical position to prevent the top layers of sediment (i.e., the top 5 to 15 cm) from slumping. However, in many cases, it is not feasible to process the core in a vertical position because the tripod needs to be at least twice the height of corer, and sectioning and logging the sample would have to be performed from a ladder. For studies that specify sectioning the sample into coarse intervals (>20 cm), processing the core in a horizontal position will generally not significantly disrupt the stratigraphy. For studies that specify shorter intervals (<5–10 cm), processing the core in a horizontal position is likely to disrupt stratigraphy. In this case, the top layers of sediment that have high water content should be sectioned while the core is in a vertical position, and when the sediment becomes thicker, the corer can be laid horizontally.

# PROCEDURES

## Decontamination

To prevent potential cross-contamination of samples, all reusable sediment sampling equipment must be decontaminated prior to use at each station and between field replicates.

Before each station is sampled, decontaminate the inner surfaces of the corer or core tube liner and all stainless-steel sample compositing equipment. Prior to sampling, all core liners will be washed in sequence with a standard detergent (e.g., Alconox®), rinsed with site water, and then air-dried. During storage and transport, decontaminated core liners will be capped at both ends to prevent contamination. Details on correct decontamination procedures can be found in SOP SD-01, *Decontamination of Equipment—Sediment*. The project-specific field sampling plan (FSP) should also be consulted to determine any project-specific decontamination procedures. The personnel performing the decontamination procedures will wear protective clothing as specified in the site-specific health and safety plan.

All solvent rinsates (if used) will be collected into a bucket or tub and allowed to evaporate over the course of the day. Any rinsate that has not evaporated by the end of the sampling event will be containerized and disposed of in accordance with applicable regulations.

## Vibracorer Deployment and Retrieval

The following procedures are based on using the vibracorer aboard a boat equipped with a tripod or A-frame of sufficient height to allow recovery of the core (see project-specific FSP for information on target coring depth), and a power winch. On pontoon boats, the tripod is centered over a hole in the floor, whereas on other boats, the corer may be lowered over the side or stern. To obtain cores of high quality, the boat must be anchored with at least three anchors so the boat will not drift during the coring process.

1. Maneuver the sampling vessel to the targeted sampling location using the positioning procedures and minimum water depth restrictions.
2. Deploy 3- or 4-point anchor system to maintain position; record and monitor position throughout core acquisition.
3. Once on location, measure the water depth (depth to top of sediment) using the onboard depth sounder (fathometer) or lead line and record measured depth in the field logbook. If the water level is affected by tides, obtain tide level measurements and calculate tidal height in feet above mean low water. The date, time, weather, and water conditions (e.g., high wave activity, strong currents, turbidity, tidal flux) should also be recorded in the field logbook.

4. Assemble the decontaminated core tube, liner, core catcher, and cutter heads (or nose cone depending on the model of vibracorer used), using care to not contact decontaminated surfaces. Attach assembled vibracorer to winch cable. Note that several decontaminated catchers and cutterheads will be on hand, in case of loss. Core catchers and cutter heads can be decontaminated and reused for subsequent core collection.
5. Attach a tape measure to the vibracorer or mark the winch cable in 1/2-ft increments to measure penetration depth.
6. Inspect connections of winch cable and electrical or pneumatic lines to confirm they are secure.
7. Signal the winch operator to slowly raise the vibracorer into a vertical position and guide the vibracorer (with core liner, valve, core catcher, and cutterhead in place) overboard until it is clear of the vessel.
8. Using the winch, slowly lower the vibracorer through the water column at a speed of about 1 ft/s to avoid creating a bow wake or overturning of the vibracore. Stop lowering the corer a few feet above the sediment and confirm that the boat has not drifted.
9. Continue lowering the vibracorer until the tip of the core is resting on the sediment or to the depth recorded by the fathometer, depending on the consistency of the sediment. Record the vibracorer depth as derived from the attached tape measure or marked winch cable. Measurements will serve as a basis for determining penetration depth.
10. Resume lowering the corer at about 1 ft/s. When the nosecone or core catcher contacts the sediment, turn on the vibracorer motor. The vibracorer is then allowed to slowly penetrate the sediments. Initially, light tension should be maintained on the cable to keep the corer from tipping over.
11. Lower the vibracorer to the target penetration depth as measured by the attached tape measure or marked winch cable. If the targeted penetration depth is met, proceed to the next step; if refusal is met, retrieve the vibracorer, perform gross decontamination (i.e., rinse with river water and brush off visible sediment from the outside of the core barrel) and re-attempt at new location offset at least 3–5 ft from original location.
12. When the target penetration depth is reached, or refusal occurs, turn off the vibracorer and record the time, penetration depth, angle of the cable relative to the boat, and any other observations.
13. The vibracorer is slowly withdrawn from the sediments at a constant rate, to keep it upright and not dislodge any sediment from within the core barrel, and raised to the surface.

14. With the corer hanging in a vertical position, clean the vibracorer assembly by hosing down the equipment with site water prior to being brought on board. If the corer is not plugged, care should be taken not to direct water into the open end of the core barrel.
15. After collection of the core sample, the vibracorer is slowly guided onboard the vessel; use care to avoid jostling that might disturb the integrity of the core. Care must be taken to keep the top end of core elevated to prevent sediment from "pouring" out. Use a sawhorse or equivalent to elevate the top of the core. If necessary, as soon as the nosecone clears the water surface, the bottom of the corer may be plugged with a rubber stopper to prevent loss of sediment.
16. Before the polycarbonate or Lexan®-lined core tube is removed from the vibracorer, the nosecone or core cutter/catcher is visually inspected to ensure that proper penetration has been attained and that there is no obvious loss of sediment from the tube. Any presence of noticeable odors, the core penetration depth, and physical characteristics (e.g., color, texture, odor) of the sediment sample as observed at the ends of the tube will be recorded in the field logbook or on the Field Sediment Core form by an experienced geologist. In addition, any sheen in the water will also be noted in the field logbook.
17. If the core will be processed horizontally, slowly lay the corer down. Unscrew the cutter head (or nosecone) and carefully remove the core catcher, while retaining as much sediment as possible.
18. While removing the core catcher (or nosecone), be ready to immediately seal the end of the core liner by placing a plastic cap over the open end.
19. Carefully remove the core liner that contains the sample by lifting the lower end from the deck as needed to provide clearance. Affix core cap, wrap with tape, label core liner and end of core, remove valve from top of core liner, stand core upright, and place in a processing rack or tray to allow the sediment at the top of the core to settle. Avoid sudden movements to the core that would disrupt the sediment interface.
20. While waiting for sediment to settle, prepare the Field Sediment Core form. Identify any debris and note its depth in the core and what the debris is, if possible.
21. Once resuspended sediment has settled, measure the length of the recovered core, calculate percent recovery (100 x recovered length/penetration depth), and record in the logbook or on the Field Sediment Core form.
22. Check the core for acceptability. The following acceptability criteria should be satisfied:
    - The core tube is not overfilled with sample so that the sediment surface presses against the bottom of the vibracorer head.
    - Overlying water is present (indicates minimal leakage).

- The overlying water is not excessively turbid (indicates minimal disturbance).
- The desired penetration depth (see project-specific FSP for required penetration depth) or refusal has been reached.

Depending on requirements of the project-specific FSP, a core may be rejected based on percent recovery. Commonly, a core is deemed unacceptable if recovery is less than 80 percent. If recovery is less than 80 percent, the core sample will be retained for possible processing, while additional sampling attempts are made to collect a core with greater than 80 percent recovery. If subsequent attempts result in recoveries of less than 80 percent, then the sample with the highest percent recovery may be used for analysis. The number of attempts to collect an acceptable sample will be specified in the project-specific FSP. If recovery is less than 80 percent, the core may be acceptable if the penetration depth is deeper than the target core length. In this case, the recovered length should be equal to the target length.

23. Once sufficient time has been allowed for the sediment to settle (i.e., no sediment is suspended in the overlying water), use a decontaminated saw to cut a drain-slit or a decontaminated drill bit to drill in the side of the core liner approximately 1 to 2 in. above the sediment–water interface; allow excess water to drain. Cut excess polycarbonate liner with decontaminated blade and use a siphon to decant off the overlying water. Ensure that the saw blade, drill bit, or siphon does not contact the sediments and that fine-grained suspended sediment is not removed.
24. Cut cores into manageable sections (3–4 ft) aboard the vessel immediately after their retrieval. Cap each section with aluminum foil and plastic caps, and seal with duct tape. Mark the core with permanent marker using a unique number or alphanumeric code identifying sampling location, core number, core section, and segment orientation (i.e., which end is up). Following sectioning, store the cores in an upright position onboard the vessel in a core box and have them transported periodically throughout each field day by small boat to a field processing area where they are to be stored upright under custody on ice or refrigerated at 4°C to await processing.
25. In preparation for next core, thoroughly rinse the interior of the core barrel until all loose sediment has been washed off. Repeat process at next sampling location. Continue coring until requirements are met.

In situations where there is significant surface water depth and/or water current that could cause the vibracorer setup to lean at an unacceptable angle, a buoyant frame or rigid frame configuration should be used.

With the buoyant frame, the vibracorer is maintained in proper vertical position by two guidelines held taut between a float package and a weight stand. The larger weight stand is provided with ballast boxes so that easy-to-find ballasting material such as lead bags or scrap

metal can be used in the field. For deployment, the vibracorer is lowered with the weight stand hanging on its guidelines from the vibrahead. The float package is hooked up to the guidelines when the vibrahead reaches the deck level.

After coring and pull-up, the system is retrieved in the reverse manner. In case of limited deck space or overhead clearance, or to further accelerate the procedure on the water, the weight stand can be left in as overboard cradle.

## Sample Handling, Storage, and Processing

Cores should be processed concurrently with core collection, and every effort should be made to ensure cores are processed within 24 hours of collection. Cores awaiting processing will be sealed tightly at both ends and stored upright in ice or in a refrigerator. If core collection outpaces processing such that significant delays in core processing appear likely, core collection will be suspended to allow the core processing to catch up.

As mentioned above, once coring has been completed at a given location, the cores will be transported in an upright position on ice to a designated field processing area, where they will be logged and processed. The field processing area will be equipped with a core-cutting table, core-processing tables, a decontamination area, and a storage area with appropriate refrigeration. Appropriate lighting will be installed in the field processing area so that consistent, high quality photographs can be taken of the opened cores. Care should be taken to create a field processing area that minimizes the potential for outside contamination.

Sample processing includes removing the sample from the liner, recording observations of sample characteristics, mixing subsamples, and distributing the sample to containers for shipping to the testing laboratory. Vibracore processing most often consists of the following steps:

1. Cut each core tube along the long axis using decontaminated hook blade. Rotate the tube 180$^{o}$ and cut again.
2. After each core is cut, move the entire core tube to an aluminum foil-covered table and open it so that it can be systematically logged, described, and photographed.

However, depending on the project-specific FSP, the core may be extruded from the liner and cut into the specified intervals as it emerges or the core liner may be cut into sections, sealed, and shipped intact to the testing laboratory.

### Core Observations

1. Verify that the length of the core, water depth, and all required position data have been recorded in the field logbook together with all pertinent observations and communications with the field team leader.

2. After each core is cut open, describe the sediment on a Field Sediment Core form in the field processing area notebook. When recording the information for each core, follow the guidelines below:
   - Physical sediment description (i.e., sediment type [e.g., silt, sand], density/consistency, color)
   - Odor (e.g., hydrogen sulfide, petroleum, creosote)
   - Visual stratification, laminations, and lenses
   - Presence/location/thickness of the redox potential discontinuity layer (a visual indication of black is often adequate for documenting anoxia)
   - Approximate percentage of moisture
   - Vegetation
   - Approximate percentage of vegetation
   - Debris
   - Approximate percentage of debris
   - Presence of biological structures (e.g., detritus, shells, tubes, bioturbation, live or dead organisms, chironomids)
   - Approximate percentage of biological structures
   - Presence of a sheen
   - Other distinguishing characteristics or features.

   The visual observations of sediment lithology (dominant grain sizes) will be the primary criteria for determining sample intervals (i.e., lithologic units) in the cores. For consistency, core descriptions and terms used will follow the criteria below, which are modified from methods presented in ASTM D 2488-00 (ASTM 2000):

3. Record visual estimates of the grain-size percentages of sediment units within each core on the Field Sediment Core form so that the total sum will add up to 100 percent. Make estimates of gravel, sand, and fines (silt and clay) content generally to the nearest quartiles:
   - 0 to 25 percent
   - >25 to 50 percent
   - >50 to 75 percent
   - >75 to 100 percent.

   If appropriate, describe the sediment narratively on the log based on the estimated grain-size percentages. Use the dominant constituent grain size as the primary unit

descriptor, and describe the abundance of other grain sizes present using the following terms:

- The grain-size adjective (e.g., gravelly, sandy, silty, or clayey), if estimated to constitute more than 25 percent of the sediment
- *With*, for example, sand with silt, silt with sand, etc., if estimated to constitute less than 25 percent of the sediment
- *Trace*, if estimated at less than 5 percent of the sediment (and not included in the total 100 percent).

For other features observed, such as organic matter or debris, use the following additional descriptive terms as appropriate:

- *Mostly*, if estimated to constitute 50 percent or more of the unit
- *Some*, if estimated to constitute more than 25 to 50 percent of the unit
- *Little*, if estimated to be 25 percent of the unit or less
- *Trace*, if estimated at less than 5 percent (and not included in the total 100 percent).

4. Describe density using the following terms:
   - *Loose*, if easily penetrated with a sampling spoon
   - *Dense*, if penetration is more difficult.
5. Describe consistency using the following terms:
   - *Very soft*, if present as an ooze that holds no shape
   - *Soft*, if saggy
   - *Stiff*, if it holds a shape
   - *Very stiff*, if penetration with a spoon is low
   - *Hard*, if no penetration with a spoon is possible.
6. Use other observations (e.g., obvious anthropogenic material, dramatic color changes) to define or help define sample intervals (check project-specific FSP for sample interval definition; depending upon the project-specific requirements the sample interval could be based on lithology or it could be set to a specific interval [e.g., 1 ft]).
7. Determine the boundaries of lithologic units primarily by changes in the top two dominant grain sizes estimated visually (e.g., a change from a silty sand to a gravelly sand or to a sandy silt).

8. Photograph the cores after they have been described and before any sediment is removed for processing. It is important for each core section to be photographed with adequate lighting from a standard measured distance from the core. Digital photographs will be used later in the production of digital core logs.

### Mixing and Sample Preparation

1. After the sample is characterized and the core observation logged on the Field Sediment Core form, remove the specified sample interval using a stainless-steel spatula or spoon (see project-specific FSP for correct sampling interval). Exercise care to not include sediment that is in direct contact with the core tube. With the approval of the field team leader, and using a decontaminated stainless-steel instrument, carefully remove unrepresentative material (e.g., large shells, stones). Exercise care not to touch the sediment during this process. Note any unrepresentative material removed from the sample in the field processing area notebook.
2. Remove subsamples for analysis of unstable constituents (e.g., volatile organic compounds, acid- volatile sulfides), and place them directly into sample containers without homogenization. Completely fill the sample container so that there is no headspace or entrapped bubbles.
3. Transfer the remainder of the sample interval to a decontaminated stainless-steel bowl for homogenization. If additional sediment volume is required to fill all sample bottles (see project-specific FSP) and multiple cores need to be collected at a given station, cover the compositing bowl covered with aluminum foil (dull side down) to prevent sample contamination (e.g., from precipitation, engine exhaust, splashing water) and place in a cool dark place until the next core from that location is processed.
4. After all the sediment is transferred to the compositing bowl, homogenize the contents of the bowl using stainless-steel spoons until the texture and color of the sediment appears to be uniform.
5. Distribute subsamples to the various containers specified in the project-specific FSP and preserve the samples as specified in the project-specific FSP. Briefly stir the sediment in the compositing bowl between each spoon transfer to the sample containers.
6. After all subsamples have been placed in the sample containers, if it is suspected that there is clay in a sample, perform a "ribbon test." Perform a separate ribbon test for each interval within the core where clay is suspected to be present. To perform this test, remove a small piece of sediment from the sampled interval using a decontaminated stainless-steel spoon and roll it between the fingers while wearing protective gloves. If the piece easily rolls into a ribbon it is clay; if it breaks apart, it is silt. Note this information in the field processing area notebook.
7. Subsequent intervals should be processed in the same way.

## Field Quality Control Samples

If additional volumes of sediment are required to perform all analyses including quality control analyses, an additional core may need to be collected from the same location and subsampled and homogenized accordingly. Details on collection of field quality control samples (e.g., field duplicates) will be specified in the project-specific FSP. Details on collection of field quality control samples and preparation of the certified reference materials can be found in SOP SD-02, *Preparation of Field Quality Control Samples—Sediment,* and SOP SD-03, *Preparation of Reference Materials—Sediment*. 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 described in the project-specific FSP and quality assurance project plan.

## Field Measurements

A water depth measurement must be collected at every sampling location. Depending on the specific project objectives, it may be necessary to perform field measurements of the *in situ* environment. Possible field measurements include temperature and pH of the sediment at the sediment-water interface and concentration of dissolved oxygen, salinity, or conductivity in the overlying water. Details on collection of field measurements can be found in SOP SD-11, *Field Analyses for Sediment.* The specific field measurements, if any, will be specified in the project-specific FSP.

## Station Location Coordinates

Station locations for all field sampling will be determined using a differential global positioning system (DGPS) or by surveying. The accuracy to which the latitude and longitude of a station location is determined will be specified in the FSP. At a minimum, a DGPS capable of providing latitude and longitude coordinates with an accuracy of approximately 3 m is recommended. The DGPS consists of two satellite receivers linked to each other by a VHF telemetry radio system. The receiver will be on the sampling vessel. Details on collection of very accurate station coordinates can be found in SOP AP-06, *Navigation.*

## Sample Custody and Shipping

Sample custody will be maintained in accordance with procedures outlined in SOP AP-03, *Sample Custody*. All samples will be packaged and shipped with other samples in accordance with procedures outlined in SOP AP-01, *Sample Packaging and Shipping*.

## Troubleshooting

### Insufficient Sample

The corer may not collect enough sediment because of 1) inadequate penetration, 2) adequate penetration but poor recovery due to compaction, 3) adequate penetration but poor recovery as a result of bypass, or 4) adequate penetration but loss of sample during retrieval. Compaction and bypass are two different artifacts that are difficult to distinguish and quantify. Following is an approach to identifying the causes and remedies of insufficient sample length. Keep in mind that a combination of these causes may occur:

- **Inadequate Penetration**—Allow more vibration time at the refusal depth, or increase the vibrator frequency.
- **Poor Recovery Due to Compaction**—Compaction is the process of rearranging the sediment particles, so that less volume is occupied by pore water, which results in a shorter column of sediment in the corer than *in situ*. Compaction occurs only in clean coarse silt, sand, and gravel sediments that have a high hydraulic conductivity and are not terminally compacted *in situ*. Fine-grained cohesive sediment (i.e., low hydraulic conductivity) does not compact. The key feature of compaction is that all of the solids ahead of the nosecone are collected as the corer penetrates. So, although the calculated recovery is less than 10 percent, 100 percent of the sediment solids were recovered. Therefore, if the sample has poor recovery, is composed of clean coarse-grained materials, and there is no evidence of sediment falling out the bottom, then the sample is likely to have been compacted. Depending on the project-specific FSP, the specified sample intervals may be shortened proportional to recovery. Because compaction of the solids displaces pore water, minimal compaction is needed for cores that are intended for porewater studies, or cores that will be analyzed for substances that have low $K_d$ values. Vibration in vibracorers is known to rearrange particles, which leads to compaction, so another type of corer may be appropriate if compaction is a problem.
- **Poor Recovery as a Result of Bypass**—Bypass is the process of pushing sediment out of the path of the nosecone/corer as it penetrates the sediment. This is caused by the friction of sediment inside the core liner making it difficult for more sediment to enter the tube. This is most pronounced in fine-grained sediments that have low hydraulic conductivity, or layers of hard and soft sediment, or long cores. The low hydraulic conductivity prevents porewater from being displaced, so compaction cannot occur. Fine-grained sediments in this context are those in which particles cannot be felt between the thumb and forefinger of an ungloved hand. These are generally "sticky" or cohesive sediments. Therefore, if a sample has poor recovery, is fine grained and cohesive, and there is no evidence of sediment falling out the bottom, then some of the sediment column has likely been bypassed.
- **Poor Recovery Because of Loss of Sample during Retrieval**—This is often diagnosed by observing some of the core falling out the bottom as the corer approaches the water surface during retrieval, or a core liner that is empty near the bottom. Sample slipping

out the bottom of the corer can be caused by a loss of suction or noncohesive sediment that does not stick to the liner wall. Depending on the specific design of the vibracorer, there are several places at which suction can be lost. These may include the valve seat, the valve assembly, the nose piece, and couplings between the barrel and extensions. To prevent loss of suction, Teflon® plumber's tape should be used on all the threaded connections, and the valve assembly should be clean. For coarse-grained sediment (e.g., clean coarse sand and gravel, and shells) that is non-cohesive and falls out the bottom of the corer, it is sometimes possible to penetrate to a lower layer that is finer grained and will effectively plug the bottom of the core. As mentioned above, core catchers may are used to retain sediment in a vibracorer, although they should not be used if the surface sediments have high water contents and are to be sectioned at less than about 2 inch intervals.

Because recovery can be an important indicator of corer performance, sediment characteristics, and sample quality, some simple tests can be performed as a diagnostic tool. Penetration of the corer can be measured by putting Velcro® tape on the outside of the corer. Velcro® tape can also be used on the inside of the liner during testing to see how far up inside the liner the sediment interface moves, how much sample slips out the bottom, and how much compaction or bypass occurs.

### Notes

1. For long cores that require more than one piece of liner, squarely cut the ends of both pieces with a plastic pipe cutter, butt the ends of the two pieces of liner squarely together and tape them securely so no leaks occur. Do not use too many layers of tape or the liner will not fit into the barrel. Do not use duct tape for this process. Use a high quality tape (i.e., 3M 3750) and dry the tubes before applying.
2. Sometimes tripods are not tall enough to lift the corer so that the barrel will clear the top edge of the liner when removing the liner. To remove the liner in this case, upon unscrewing the cutter head (or nose piece), lower the cutter head (or nose piece) and liner into a pail that has a rope securely tied to the handle. While the corer is raised by the winch, lower the pail through the hole in the deck and into the water (if necessary) until the top edge of the liner clears the bottom edge of the barrel. Then lift it back onto the deck.
3. If the vibracorer does not penetrate significantly or if the cable is let out too quickly, the vibracorer will contact the bottom, tip over, and fall sideways. When this happens, the line will initially go slack, then quickly snap to the side and take up the slack. In this case, reject the core and begin again.

4. A good measure of whether the vibracorer collected the sediment-water interface is to inspect the interface for a thin layer (about 1 mm) of olive green benthic or detrital algae. Also, if the core liner is rotated back and forth gently, the top centimeter will appear to have a gelatinous response.
5. It is sometimes impossible to collect an intact interface because gas bubbles are commonly released from sediment when the corer contacts the sediment. The released gas bubbles entrain surface sediment and cause the overlying water to become turbid. If this is the case, gas bubbles in the sediment can likely be observed through the liner wall.

## REFERENCES

ASTM. 2000. Standard practice for description and identification of soils (visual-manual procedure). ASTM Standard Method No. D 2488-00. In: ASTM Book of Standards, Volume 04.08. American Society for Testing and Materials, West Conshohocken, PA.

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

# STANDARD OPERATING PROCEDURE (SOP) SD-13

# FIELD CLASSIFICATION OF SEDIMENT

## SCOPE AND APPLICATION

This SOP presents the field classification of sediments to be used by Integral field staff. Sediment descriptions should be precise and comprehensive without being verbose. Assumptions and personal comments should not be included in the sediment descriptions. These descriptions will be used to interpret environmental conditions and other potential properties, rather than the exact mineralogy or tectonic environment.

Sediment descriptions should be recorded in either the observing scientist's field logbook, or if subsurface sediment is collected, then the sediment description column of the Field Sediment Core Form should be completed for each core collected. If no difference between consecutive sediment samples exists, subsequent descriptions can be noted as "same as above," or minor changes such as "increasing sand" or "becomes dark brown" can be added.

After the overlying water is removed, characterize the sediment. Sediment characteristics that are often recorded in the field logbook or the Field Sediment Core Form if subsurface sediment is collected, include:

- Sediment type (e.g., silt, sand)
- Texture (e.g., fine grain, coarse, poorly sorted sand)
- Color
- Presence/location/thickness of the redox potential discontinuity layer (a visual
- indication of black is often adequate for documenting anoxia)
- Approximate percentage of moisture
- Presence of biological structures (e.g., chironomids, tubes, macrophytes) and the
- approximate percentage of these structures
- Presence of organic debris (e.g., twigs, leaves) and the approximate percentage of
- debris
- Presence of shells and the approximate percentage of shells
- Stratification, if any
- Presence of a sheen
- Odor (e.g., hydrogen sulfide, oil, creosote).

In addition, the project-specific field sampling plan should be reviewed to determine if there are any project-specific reporting requirements.

In general, the similarities of consecutive sediment samples should be noted. Examples of surface sediment descriptions are provided in Table SD-13(1). The minimum elements of the sediment descriptions are discussed below. The format of sediment descriptions for each sample should be consistent throughout the logbook.

**Table SD-13(1). Example of Surface Sediment Desctiptions**

| Station No. | Grab No. | Example Descriptions |
|---|---|---|
| TC01 | 1 | SILT, mottled dark gray (10YR 4/1) with thin layer < 1 cm of very pale brown (10YR 7/4) on surface. Occasional roots, some twigs, and leaves on surface. Slight reducing odor. Sheen on overlying water in grab. |
| TC02 | 1 | Sandy SILT, fine sand, dark gray (10YR 4/1) throughout grab, with 10 percent medium to coarse sand, trace woody debris. Chironomid on surface. |
| TC02 | 2 | Same description as first grab at Station TC02. |
| TC02 | 3 | Same description as first grab at Station TC02, but no sand (SILT only) and color is very dark gray (10YR 3/1) with no chironomid present. |

## Definition of Sediment Types

Fine- grained sediments are classified as either silts or clays. Field determinations of silts and clays are based on observations of dry strength, dilatancy, toughness, and plasticity. Field procedures for these tests are included in ASTM D-2488-84. If these tests are used, the results should be included in the sediment description. Sediments with high plasticity can be emphasized by describing them as “silty CLAY with high plasticity.” Plasticity is an important descriptor because a sediment can be dilatant/nonplastic and serve as a transport pathway, or it can be highly plastic and very impervious.

Coarse-grained sediments are classified as predominantly sand. The gradation of a coarse grained sediment is included in the specific sediment name (i.e., fine to medium SAND with silt). Estimating the percentage of size ranges following the group name is encouraged for mixtures of silty sand and sand. If applicable, use the modifiers “poorly graded” or “well graded” when describing the sand component of the sediment.

## Color

The basic color of a sediment, such as brown or gray, must be provided in the description. The color term can be modified by adjectives such as light, dark, or very dark. Especially

note streaking or mottling. The color chart designations provided in either the *Globe Soil Color Book* or the Munsell color guide can be used.

## Moisture Content

The degree of moisture present in the sediment should be defined as moist, wet, or very wet. The percent moisture content should be estimated.

## Other Components

Other components, such as organic debris and shell fragments, should be preceded by the appropriate adjective reflecting relative percentages: trace (0–5 percent), few (5–10 percent), little (15–25 percent), and some (30–45 percent). The word "occasional" can be applied to random particles of a larger size than the general sediment matrix (i.e., occasional stone, large piece of wood).

## Additional Descriptions

Features such as sloped surface in the grab, root holes, odor, and sheen should be noted if they are observed. Anything unusual should be noted. Additional sediment descriptions may be made at the discretion of the project manager or as the field conditions warrant.

# STANDARD OPERATING PROCEDURE (SOP) SL-05

# SURFACE SOIL SAMPLING

## SCOPE AND APPLICATION

This SOP defines and standardizes the collection of surface soil samples (e.g., 0 to 12 in. below ground surface). Soil samples should be collected from areas having lower levels of constituents of interest first, followed by stations with higher expected levels of constituents of interest.

The procedures listed below may be modified in the field upon the agreement of the lead site sampler and field personnel, based on field and site conditions, after appropriate annotations have been made in the field logbook. If specialized sampling methods (e.g., ENCORE®) are to be used, refer to the manufacturer's recommended procedures. If methanol preservation is required, refer to Integral's SOP on methanol preservation of soil samples. Record all pertinent information on Integral's surface soil sampling field data form or field logbook.

## EQUIPMENT AND SUPPLIES REQUIRED

- Decontaminated sampling tool (stainless-steel shovel, scoop, trowel, or spoon)
- Large stainless steel mixing bowl and spoon
- Laboratory-supplied sample containers, insulated coolers, and ice
- Chain-of-custody forms, custody seals, sample labels
- Ziploc® bags
- Camera
- Tape measure
- Field logbook, surface soil field collection form, and pens
- Project-specific field sampling plan (FSP) and health and safety plan (HSP)
- Personal protective equipment (safety glasses, steel-toed boots, nitrile gloves, and any other items required by the project-specific HSP)
- Decontamination equipment.

## PROCEDURES

1. Locate the sample station as directed in the project-specific FSP. Label containers with sample tags prior to filling in accordance with Integral's SOP on sample labeling (SOP-AP04). If analytical testing will be performed for volatile organic compounds (VOCs), collect the VOC sample first (with a minimum of disturbance) by placing the sample into the container with a minimum amount of headspace and sealed tightly.
2. Don a new pair of nitrile gloves and expose the soil surface by clearing an approximately 1 $ft^2$ area at the sampling site of any rocks or organic material greater than approximately 3 in. in size. Note any material removed from the sampling site in the field logbook.
3. Using a decontaminated stainless-steel sampling tool, excavate soil to the depth specified in the work plan.
4. If required for analysis, first collect VOC samples (prior to any homogenization) from a discrete location, placing the samples in the appropriate containers. Label sample containers before filling in accordance with Integral's SOP on sample labeling (SOP AP-04).
5. Place additional sample material in a decontaminated plastic or stainless-steel mixing bowl.
6. Describe the soil in accordance with ASTM D2488-00 (see Integral's SOP on field classification of soils, SOP SL-04).
7. Thoroughly mix and homogenize the sample using disposable equipment or a decontaminated stainless-steel spoon until the color and texture are consistent throughout.
8. If required for analysis, first collect samples for grain-size tests before any large rocks are removed from the homogenized soil.
9. Identify any rocks that are greater than 0.5 in. in diameter. Determine their percentage contribution to the homogenized soil volume, note it on the surface soil field collection form or in the field logbook, and then discard the rocks.
10. Remove samples of the homogenized soil from the mixing bowl with the decontaminated stainless steel spoon and place in the appropriate size sample container. Do not touch the sample with your gloves. Fill the sample container with soil to just below the container lip, and seal the container tightly. Label sample containers before filling in accordance with Integral's SOP on sample labeling.
11. Mark the sampling site with a wire flag, wooden stake, metal rebar, or flagging, as appropriate.

12. Complete all pertinent field QA/QC documentation, logbooks, sample labels, and field data sheets. Record any deviations from the specified sampling procedures or any obstacles encountered.
13. Photograph sample location and document it in the logbook.
14. Decontaminate all sampling equipment according to Integral's SOP on decontaminating equipment for soil sampling (SOP SL-01) and in accordance with the project-specific FSP.

# STANDARD OPERATING PROCEDURE (SOP) SL-06

# LOGGING OF SOIL BOREHOLES

## SCOPE AND APPLICATION

This SOP describes how to complete a Soil Boring Log form, which must be completed for Integral projects where soil boring techniques are performed during field exploration. A correctly completed form contains all of the information that must be recorded in the field to adequately characterize soil boreholes.

These procedures are adapted from ASTM D-2488-00. Field staff are encouraged to examine ASTM D-2488-00 in its entirety. This SOP represents minor modifications to emphasize environmental investigations rather than geotechnical investigations, for which the standards were written. Because each environmental project is unique and because job requirements can vary widely, the minimum standards presented may need to be supplemented with additional technical descriptions or field test results. However, all soil boring field logs, regardless of special project circumstances, must include information addressed in this SOP to achieve the minimum acceptable standards required by Integral.

## LOG FORM INFORMATION

**Project Number**—Use the standard contract number.

**Client**—Identify the name of the client and the project site location.

**Location**—If stations, coordinates, mileposts, or similar markers are applicable, use them to identify the location of the project. If this information is not available, identify the facility (e.g., 20 ft NE of Retort #1).

**Drilling Method**—Identify the bit size and type, drilling fluid (if used), and method of drilling (e.g., rotary, hollow-stem auger, cable tool) and the name of the drill rig (e.g., Mobil B 61, CME 55).

**Diameter**—Provide the diameter of the borehole. If the borehole has variable diameters, provide the depth interval for each diameter.

**Sampling Method**—Identify the type of sampler(s) used (e.g., standard split spoon, Dames & Moore sampler, grab).

**Drilling Contractor**—Provide the name of the drilling contractor.

**Integral Staff**—Enter the name(s) of Integral staff members performing logging and sampling activities.

**Water Level Information**—Provide the date, time, depth to static water, and casing depth. Generally, water levels should be taken each day before resuming drilling and at the completion of drilling. If water is not encountered in the boring, this information should be recorded.

**Boring Number**—Provide the boring number. A numbering system should be developed prior to drilling that does not conflict with other site information, such as previous drilling or other sampling activities.

**Sheet**—Number the sheets consecutively for each boring and continue the consecutive depth numbering.

**Drilling Start and Finish**—Provide the drilling start and finish dates and times.

For consecutive sheets, provide (at a minimum) the job number, boring number, and sheet number.

## TECHNICAL DATA

**Sampler Type**—Provide the sampler type (e.g., SS = split spoon, G = grab).

**Depth of Casing**—Enter the depth of the casing below ground surface immediately prior to sampling.

**Driven/Recovery**—Provide the length that the sampler was driven and the length of sample recovered in the sampler. This column would not apply to grab samples.

**Sample Number/Sample Depth**—Provide the sample number. The sample numbering scheme should be established prior to drilling. One method is to use the boring number and consecutive alphabetical letters. For instance, the first sample obtained from boring MW-4 would be identified as 4A, the second would be identified as 4B, and so on. Another method for sample identification is naming the boring number with the depth. For example, the sample from Boring 1 at 10 ft would be labeled B1-10'. The depth of the sample is the depth of the casing plus the length to the middle of the recovered sample to the nearest 0.1 ft. Typically, split spoon samplers are 18 in. long. Samples should be obtained from the middle of the recovered sample. The depth of the sample with the casing at 10 ft would then be 10.7 ft.

**Number of Blows**—For standard split-spoon samplers, record the number of blows for each 6 in. of sampler penetration. A typical blow count of 6, 12, and 14 is recorded as 6/12/14. Refusal is a penetration of less than 6 in. with a blow count of 50. A partial penetration of 50 blows for 4 in. is recorded as 50/4". Total blows will be recorded for nonstandard split spoons (e.g., 5-ft tube used for continuous sampling).

**Blank Columns**—Two blank columns are provided. Use these columns for site-specific information, usually related to the chemicals of concern. Examples for a hydrocarbon site would be sheen and photoionization detector readings of the samples.

**Depth**—Use a depth scale that is appropriate for the complexity of the subsurface conditions. The boxes located to the right of the scale should be used to graphically indicate sample locations as shown in the example.

**Surface Conditions**—Describe the surface conditions (e.g., paved, 4-in. concrete slab, grass, natural vegetation and surface soil, oil-stained gravel).

**Soil Description**—Enter the soil classification and definition of soil contacts using the format described in SOP SL-04, *Field Classification of Soil*.

**Comments**—Include all pertinent observations. Drilling observations might include drilling chatter, rod-bounce (boulder), sudden differences in drilling speed, damaged samplers, and malfunctioning equipment. Information provided by the driller should be attributed to the driller. Information on possible contaminants might include odor, staining, color, and presence or absence of some indicator of contamination. Describe what it is that indicates contamination (e.g., fuel-like odor, oily sheen in drill cuttings, yellow water in drill cuttings).

# ATTACHMENT 1. SOIL BORING LOG FORM

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319 SW Washington St., Suite 1150
Portland, OR 97204
(503) 284-5545

STATION NUMBER
PROJECT
LOCATION
PROJECT NUMBER
LOGGED BY



| SAMPLE INFORMATION | | | | | | STRATA | DESCRIPTION |
|---|---|---|---|---|---|---|---|
| Sample ID | Depth | Time | Tag No. | % Recov. | Depth (Feet) | | USCS group name, color, grain size range, minor constituents, plasticity, odor, sheen, moisture content, texture, weathering, cementation, geologic interpretation, etc. |
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DRILLING CONTRACTOR
DRILLING METHOD
SAMPLING EQUIPMENT
DRILLING STARTED
COORDINATES
SURFACE ELEVATION
DATUM

Location Sketch

# ATTACHMENT 2. ASTM D 2488 – 00, STANDARD PRACTICE FOR DESCRIPTION AND IDENTIFICATION OF SOILS (VISUAL-MANUAL PROCEDURE)

Designation: D 2488 – 00

# Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)[1]

This standard is issued under the fixed designation D 2488; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

*This standard has been approved for use by agencies of the Department of Defense.*

## 1. Scope *

1.1 This practice covers procedures for the description of soils for engineering purposes.

1.2 This practice also describes a procedure for identifying soils, at the option of the user, based on the classification system described in Test Method D 2487. The identification is based on visual examination and manual tests. It must be clearly stated in reporting an identification that it is based on visual-manual procedures.

1.2.1 When precise classification of soils for engineering purposes is required, the procedures prescribed in Test Method D 2487 shall be used.

1.2.2 In this practice, the identification portion assigning a group symbol and name is limited to soil particles smaller than 3 in. (75 mm).

1.2.3 The identification portion of this practice is limited to naturally occurring soils (disturbed and undisturbed).

NOTE 1—This practice may be used as a descriptive system applied to such materials as shale, claystone, shells, crushed rock, etc. (see Appendix X2).

1.3 The descriptive information in this practice may be used with other soil classification systems or for materials other than naturally occurring soils.

1.4 The values stated in inch-pound units are to be regarded as the standard.

1.5 *This standard does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.* For specific precautionary statements see Section 8.

1.6 *This practice offers a set of instructions for performing one or more specific operations. This document cannot replace education or experience and should be used in conjunction with professional judgment. Not all aspects of this practice may be applicable in all circumstances. This ASTM standard is not intended to represent or replace the standard of care by which the adequacy of a given professional service must be judged, nor should this document be applied without consideration of a project's many unique aspects. The word "Standard" in the title of this document means only that the document has been approved through the ASTM consensus process.*

## 2. Referenced Documents

2.1 *ASTM Standards:*

D 653 Terminology Relating to Soil, Rock, and Contained Fluids[2]

D 1452 Practice for Soil Investigation and Sampling by Auger Borings[2]

D 1586 Test Method for Penetration Test and Split-Barrel Sampling of Soils[2]

D 1587 Practice for Thin-Walled Tube Sampling of Soils[2]

D 2113 Practice for Diamond Core Drilling for Site Investigation[2]

D 2487 Classification of Soils for Engineering Purposes (Unified Soil Classification System)[2]

D 3740 Practice for Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and rock as Used in Engineering Design and Construction[3]

D 4083 Practice for Description of Frozen Soils (Visual-Manual Procedure)[2]

## 3. Terminology

3.1 *Definitions*—Except as listed below, all definitions are in accordance with Terminology D 653.

NOTE 2—For particles retained on a 3-in. (75-mm) US standard sieve, the following definitions are suggested:
*Cobbles*—particles of rock that will pass a 12-in. (300-mm) square opening and be retained on a 3-in. (75-mm) sieve, and
*Boulders*—particles of rock that will not pass a 12-in. (300-mm) square opening.

3.1.1 *clay*—soil passing a No. 200 (75-µm) sieve that can be made to exhibit plasticity (putty-like properties) within a range of water contents, and that exhibits considerable strength when air-dry. For classification, a clay is a fine-grained soil, or the

[1] This practice is under the jurisdiction of ASTM Committee D-18 on Soil and Rock and is the direct responsibility of Subcommittee D18.07 on Identification and Classification of Soils.

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[2] *Annual Book of ASTM Standards*, Vol 04.08.

[3] *Annual Book of ASTM Standards*, Vol 04.09.

***A Summary of Changes section appears at the end of this standard.**

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fine-grained portion of a soil, with a plasticity index equal to or greater than 4, and the plot of plasticity index versus liquid limit falls on or above the "A" line (see Fig. 3 of Test Method D 2487).

3.1.2 *gravel*—particles of rock that will pass a 3-in. (75-mm) sieve and be retained on a No. 4 (4.75-mm) sieve with the following subdivisions:

*coarse*—passes a 3-in. (75-mm) sieve and is retained on a ¾-in. (19-mm) sieve.

*fine*—passes a ¾-in. (19-mm) sieve and is retained on a No. 4 (4.75-mm) sieve.

3.1.3 *organic clay*—a clay with sufficient organic content to influence the soil properties. For classification, an organic clay is a soil that would be classified as a clay, except that its liquid limit value after oven drying is less than 75 % of its liquid limit value before oven drying.

3.1.4 *organic silt*—a silt with sufficient organic content to influence the soil properties. For classification, an organic silt is a soil that would be classified as a silt except that its liquid limit value after oven drying is less than 75 % of its liquid limit value before oven drying.

3.1.5 *peat*—a soil composed primarily of vegetable tissue in various stages of decomposition usually with an organic odor, a dark brown to black color, a spongy consistency, and a texture ranging from fibrous to amorphous.

3.1.6 *sand*—particles of rock that will pass a No. 4 (4.75-mm) sieve and be retained on a No. 200 (75-µm) sieve with the following subdivisions:

*coarse*—passes a No. 4 (4.75-mm) sieve and is retained on a No. 10 (2.00-mm) sieve.

*medium*—passes a No. 10 (2.00-mm) sieve and is retained on a No. 40 (425-µm) sieve.

*fine*—passes a No. 40 (425-µm) sieve and is retained on a No. 200 (75-µm) sieve.

3.1.7 *silt*—soil passing a No. 200 (75-µm) sieve that is nonplastic or very slightly plastic and that exhibits little or no strength when air dry. For classification, a silt is a fine-grained soil, or the fine-grained portion of a soil, with a plasticity index less than 4, or the plot of plasticity index versus liquid limit falls below the "A" line (see Fig. 3 of Test Method D 2487).

## 4. Summary of Practice

4.1 Using visual examination and simple manual tests, this practice gives standardized criteria and procedures for describing and identifying soils.

4.2 The soil can be given an identification by assigning a group symbol(s) and name. The flow charts, Fig. 1a and Fig. 1b for fine-grained soils, and Fig. 2, for coarse-grained soils, can be used to assign the appropriate group symbol(s) and name. If the soil has properties which do not distinctly place it into a specific group, borderline symbols may be used, see Appendix X3.

NOTE 3—It is suggested that a distinction be made between *dual symbols* and *borderline symbols.*

*Dual Symbol*—A dual symbol is two symbols separated by a hyphen, for example, GP-GM, SW-SC, CL-ML used to indicate that the soil has been identified as having the properties of a classification in accordance with Test Method D 2487 where two symbols are required. Two symbols are required when the soil has between 5 and 12 % fines or when the liquid limit and plasticity index values plot in the CL-ML area of the plasticity chart.

*Borderline Symbol*—A borderline symbol is two symbols separated by a slash, for example, CL/CH, GM/SM, CL/ML. A borderline symbol should be used to indicate that the soil has been identified as having properties that do not distinctly place the soil into a specific group (see Appendix X3).

## 5. Significance and Use

5.1 The descriptive information required in this practice can be used to describe a soil to aid in the evaluation of its significant properties for engineering use.

5.2 The descriptive information required in this practice should be used to supplement the classification of a soil as determined by Test Method D 2487.

5.3 This practice may be used in identifying soils using the classification group symbols and names as prescribed in Test Method D 2487. Since the names and symbols used in this practice to identify the soils are the same as those used in Test Method D 2487, it shall be clearly stated in reports and all other appropriate documents, that the classification symbol and name are based on visual-manual procedures.

5.4 This practice is to be used not only for identification of soils in the field, but also in the office, laboratory, or wherever soil samples are inspected and described.

5.5 This practice has particular value in grouping similar soil samples so that only a minimum number of laboratory tests need be run for positive soil classification.

NOTE 4—The ability to describe and identify soils correctly is learned more readily under the guidance of experienced personnel, but it may also be acquired systematically by comparing numerical laboratory test results for typical soils of each type with their visual and manual characteristics.

5.6 When describing and identifying soil samples from a given boring, test pit, or group of borings or pits, it is not necessary to follow all of the procedures in this practice for every sample. Soils which appear to be similar can be grouped together; one sample completely described and identified with the others referred to as similar based on performing only a few of the descriptive and identification procedures described in this practice.

5.7 This practice may be used in combination with Practice D 4083 when working with frozen soils.

NOTE 5—Notwithstanding the statements on precision and bias contained in this standard: The precision of this test method is dependent on the competence of the personnel performing it and the suitability of the equipment and facilities used. Agencies that meet the criteria of Practice D 3740 are generally considered capable of competent and objective testing. Users of this test method are cautioned that compliance with Practice D 3740 does not in itself assure reliable testing. Reliable testing depends on several factors; Practice D 3740 provides a means for evaluating some of those factors.

## 6. Apparatus

6.1 *Required Apparatus*:

6.1.1 *Pocket Knife or Small Spatula*.

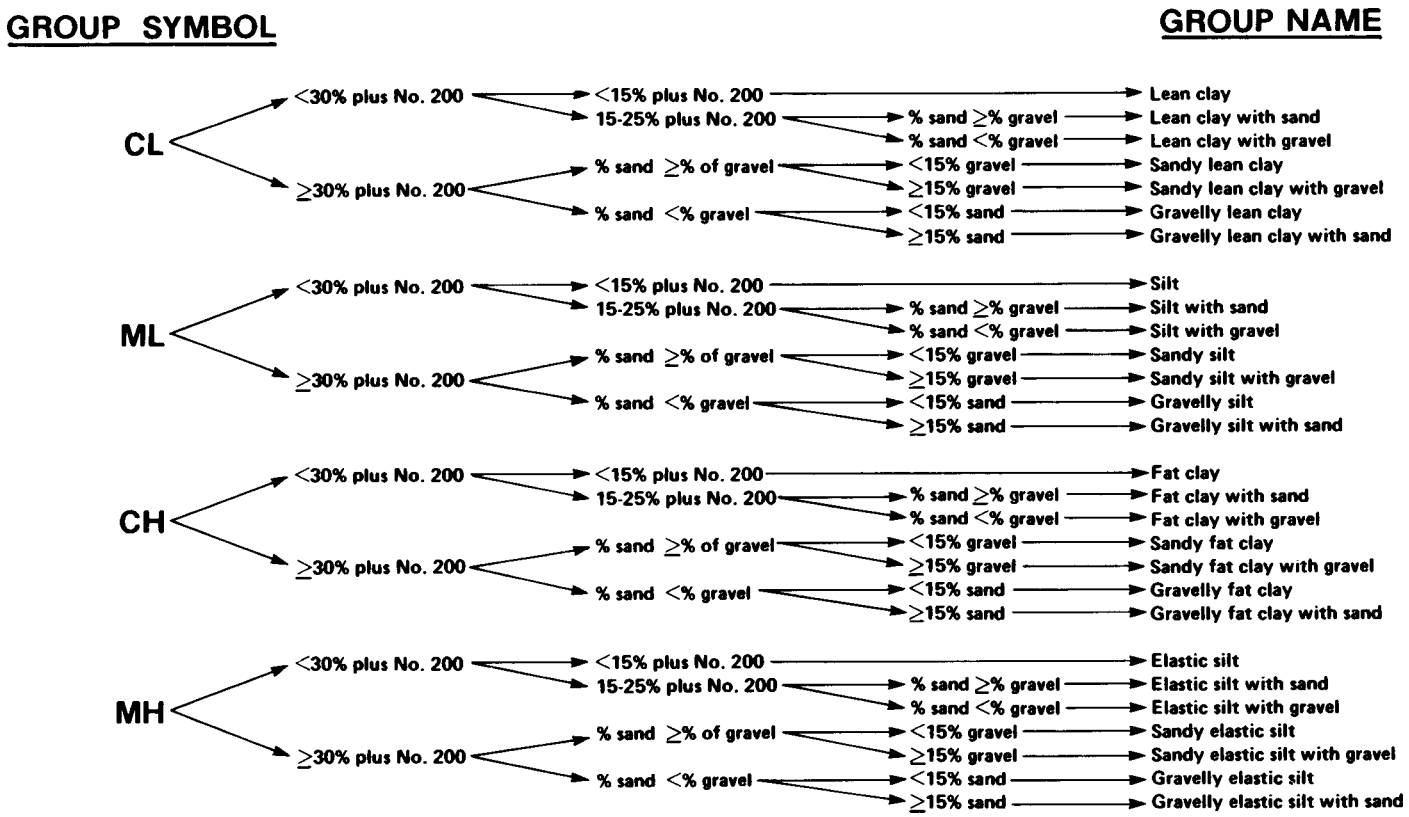
6.2 *Useful Auxiliary Apparatus*:

6.2.1 *Small Test Tube and Stopper* (or jar with a lid).

6.2.2 *Small Hand Lens*.

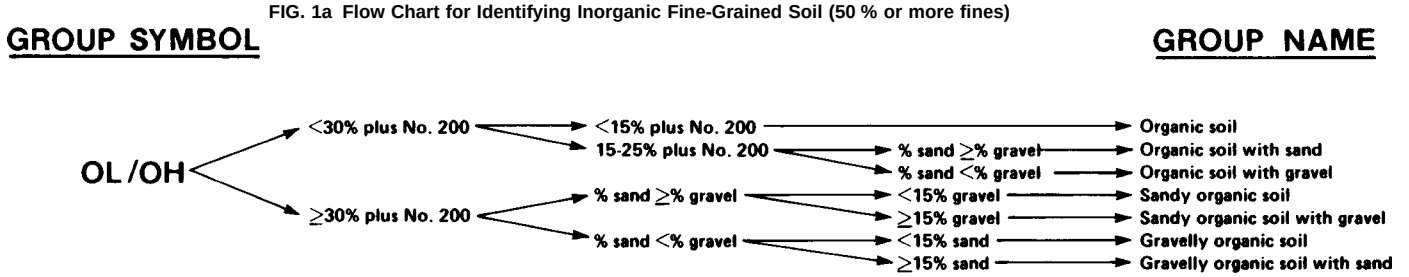
## 7. Reagents

7.1 *Purity of Water*—Unless otherwise indicated, references




NOTE 1—Percentages are based on estimating amounts of fines, sand, and gravel to the nearest 5 %.

**FIG. 1a Flow Chart for Identifying Inorganic Fine-Grained Soil (50 % or more fines)**




NOTE 1—Percentages are based on estimating amounts of fines, sand, and gravel to the nearest 5 %.

**FIG. 1 b Flow Chart for Identifying Organic Fine-Grained Soil (50 % or more fines)**

to water shall be understood to mean water from a city water supply or natural source, including non-potable water.

7.2 *Hydrochloric Acid*—A small bottle of dilute hydrochloric acid, HCl, one part HCl (10 *N*) to three parts water (This reagent is optional for use with this practice). See Section 8.

## 8. Safety Precautions

8.1 When preparing the dilute HCl solution of one part concentrated hydrochloric acid (10 *N*) to three parts of distilled water, slowly add acid into water following necessary safety precautions. Handle with caution and store safely. If solution comes into contact with the skin, rinse thoroughly with water.

8.2 **Caution**—Do not add water to acid.

## 9. Sampling

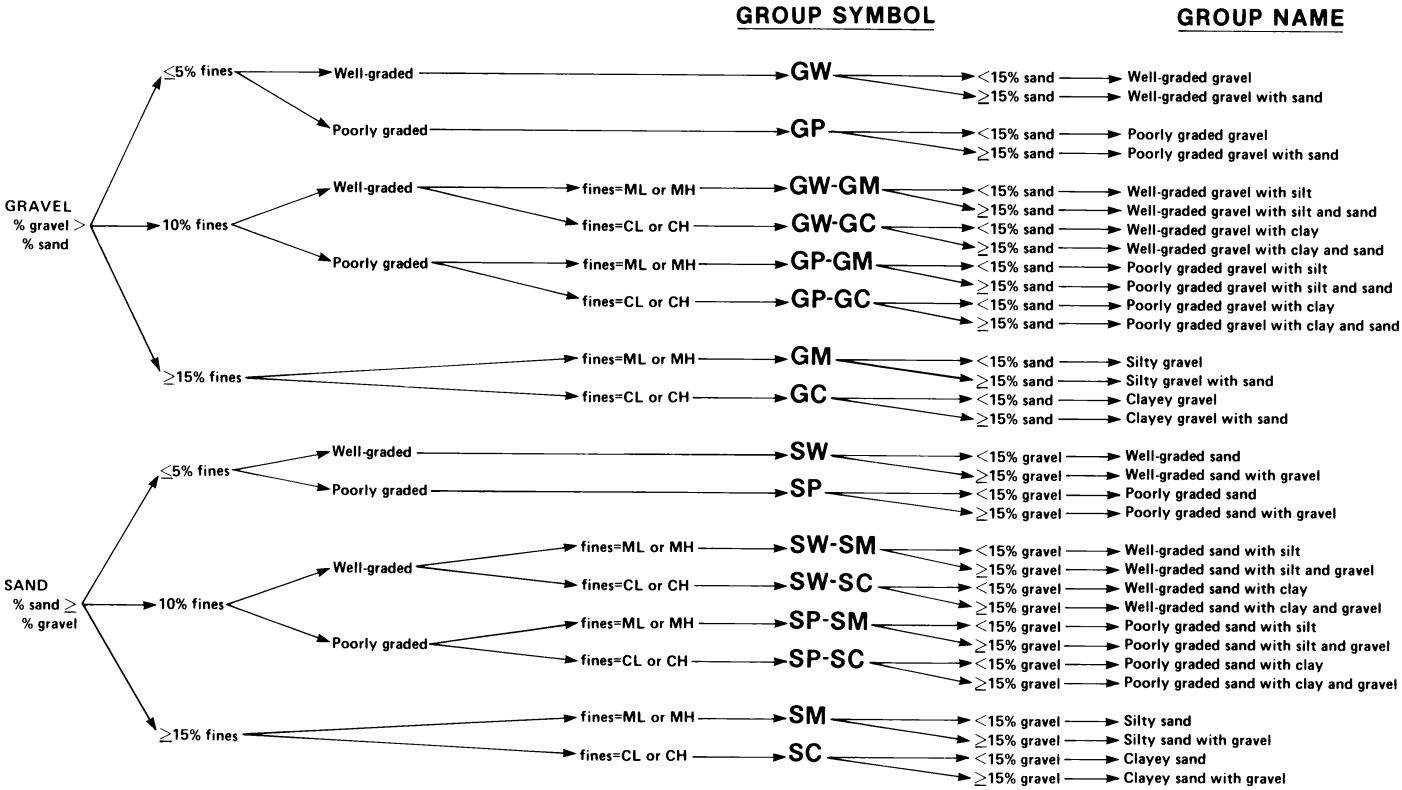
9.1 The sample shall be considered to be representative of the stratum from which it was obtained by an appropriate, accepted, or standard procedure.

NOTE 6—Preferably, the sampling procedure should be identified as having been conducted in accordance with Practices D 1452, D 1587, or D 2113, or Test Method D 1586.

9.2 The sample shall be carefully identified as to origin.

NOTE 7—Remarks as to the origin may take the form of a boring number and sample number in conjunction with a job number, a geologic stratum, a pedologic horizon or a location description with respect to a permanent monument, a grid system or a station number and offset with respect to a stated centerline and a depth or elevation.

9.3 For accurate description and identification, the minimum amount of the specimen to be examined shall be in accordance with the following schedule:




NOTE 1—Percentages are based on estimating amounts of fines, sand, and gravel to the nearest 5 %.

**FIG. 2 Flow Chart for Identifying Coarse-Grained Soils (less than 50 % fines)**

| Maximum Particle Size, Sieve Opening | Minimum Specimen Size, Dry Weight |
|---|---|
| 4.75 mm (No. 4) | 100 g (0.25 lb) |
| 9.5 mm (⅜ in.) | 200 g (0.5 lb) |
| 19.0 mm (¾ in.) | 1.0 kg (2.2 lb) |
| 38.1 mm (1½ in.) | 8.0 kg (18 lb) |
| 75.0 mm (3 in.) | 60.0 kg (132 lb) |

NOTE 8—If random isolated particles are encountered that are significantly larger than the particles in the soil matrix, the soil matrix can be accurately described and identified in accordance with the preceeding schedule.

9.4 If the field sample or specimen being examined is smaller than the minimum recommended amount, the report shall include an appropriate remark.

## 10. Descriptive Information for Soils

10.1 *Angularity*—Describe the angularity of the sand (coarse sizes only), gravel, cobbles, and boulders, as angular, subangular, subrounded, or rounded in accordance with the criteria in Table 1 and Fig. 3. A range of angularity may be stated, such as: subrounded to rounded.

10.2 *Shape*—Describe the shape of the gravel, cobbles, and boulders as flat, elongated, or flat and elongated if they meet the criteria in Table 2 and Fig. 4. Otherwise, do not mention the shape. Indicate the fraction of the particles that have the shape, such as: one-third of the gravel particles are flat.

10.3 *Color*—Describe the color. Color is an important property in identifying organic soils, and within a given locality it may also be useful in identifying materials of similar geologic origin. If the sample contains layers or patches of varying colors, this shall be noted and all representative colors shall be described. The color shall be described for moist samples. If the color represents a dry condition, this shall be stated in the report.

**TABLE 1 Criteria for Describing Angularity of Coarse-Grained Particles (see Fig. 3)**

| Description | Criteria |
|---|---|
| Angular | Particles have sharp edges and relatively plane sides with unpolished surfaces |
| Subangular | Particles are similar to angular description but have rounded edges |
| Subrounded | Particles have nearly plane sides but have well-rounded corners and edges |
| Rounded | Particles have smoothly curved sides and no edges |

10.4 *Odor*—Describe the odor if organic or unusual. Soils containing a significant amount of organic material usually have a distinctive odor of decaying vegetation. This is especially apparent in fresh samples, but if the samples are dried, the odor may often be revived by heating a moistened sample. If the odor is unusual (petroleum product, chemical, and the like), it shall be described.

10.5 *Moisture Condition*—Describe the moisture condition as dry, moist, or wet, in accordance with the criteria in Table 3.

10.6 *HCl Reaction*—Describe the reaction with HCl as none, weak, or strong, in accordance with the critera in Table 4. Since calcium carbonate is a common cementing agent, a report of its presence on the basis of the reaction with dilute hydrochloric acid is important.

10.7 *Consistency*—For intact fine-grained soil, describe the

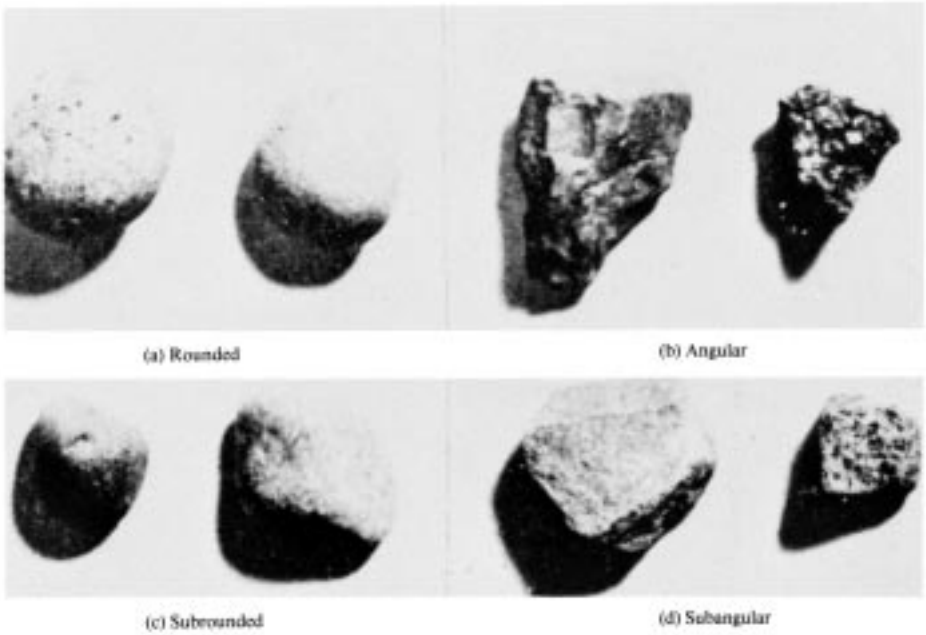



**FIG. 3 Typical Angularity of Bulky Grains**

**TABLE 2 Criteria for Describing Particle Shape (see Fig. 4)**

| | |
|---|---|
| The particle shape shall be described as follows where length, width, and thickness refer to the greatest, intermediate, and least dimensions of a particle, respectively. | |
| Flat | Particles with width/thickness > 3 |
| Elongated | Particles with length/width > 3 |
| Flat and elongated | Particles meet criteria for both flat and elongated |

consistency as very soft, soft, firm, hard, or very hard, in accordance with the criteria in Table 5. This observation is inappropriate for soils with significant amounts of gravel.

10.8 *Cementation*—Describe the cementation of intact coarse-grained soils as weak, moderate, or strong, in accordance with the criteria in Table 6.

10.9 *Structure*—Describe the structure of intact soils in accordance with the criteria in Table 7.

10.10 *Range of Particle Sizes*—For gravel and sand components, describe the range of particle sizes within each component as defined in 3.1.2 and 3.1.6. For example, about 20 % fine to coarse gravel, about 40 % fine to coarse sand.

10.11 *Maximum Particle Size*—Describe the maximum particle size found in the sample in accordance with the following information:

10.11.1 *Sand Size*—If the maximum particle size is a sand size, describe as fine, medium, or coarse as defined in 3.1.6. For example: maximum particle size, medium sand.

10.11.2 *Gravel Size*—If the maximum particle size is a gravel size, describe the maximum particle size as the smallest sieve opening that the particle will pass. For example, maximum particle size, 1½ in. (will pass a 1½-in. square opening but not a ¾-in. square opening).

10.11.3 *Cobble or Boulder Size*—If the maximum particle size is a cobble or boulder size, describe the maximum dimension of the largest particle. For example: maximum dimension, 18 in. (450 mm).

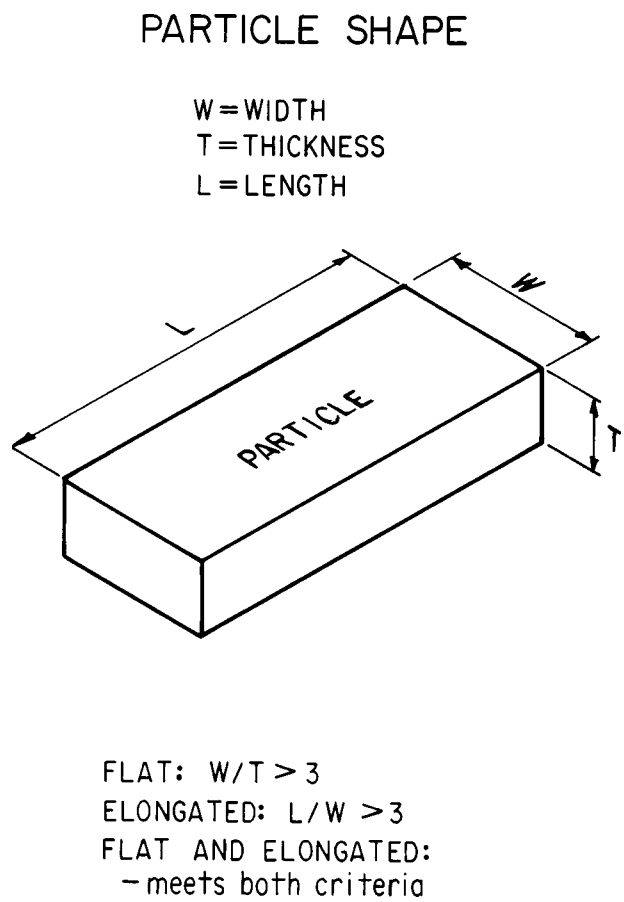



**FIG. 4 Criteria for Particle Shape**

10.12 *Hardness*—Describe the hardness of coarse sand and larger particles as hard, or state what happens when the

**TABLE 3 Criteria for Describing Moisture Condition**

| Description | Criteria |
|---|---|
| Dry | Absence of moisture, dusty, dry to the touch |
| Moist | Damp but no visible water |
| Wet | Visible free water, usually soil is below water table |

**TABLE 4 Criteria for Describing the Reaction With HCl**

| Description | Criteria |
|---|---|
| None | No visible reaction |
| Weak | Some reaction, with bubbles forming slowly |
| Strong | Violent reaction, with bubbles forming immediately |

**TABLE 5 Criteria for Describing Consistency**

| Description | Criteria |
|---|---|
| Very soft | Thumb will penetrate soil more than 1 in. (25 mm) |
| Soft | Thumb will penetrate soil about 1 in. (25 mm) |
| Firm | Thumb will indent soil about ¼in. (6 mm) |
| Hard | Thumb will not indent soil but readily indented with thumbnail |
| Very hard | Thumbnail will not indent soil |

**TABLE 6 Criteria for Describing Cementation**

| Description | Criteria |
|---|---|
| Weak | Crumbles or breaks with handling or little finger pressure |
| Moderate | Crumbles or breaks with considerable finger pressure |
| Strong | Will not crumble or break with finger pressure |

**TABLE 7 Criteria for Describing Structure**

| Description | Criteria |
|---|---|
| Stratified | Alternating layers of varying material or color with layers at least 6 mm thick; note thickness |
| Laminated | Alternating layers of varying material or color with the layers less than 6 mm thick; note thickness |
| Fissured | Breaks along definite planes of fracture with little resistance to fracturing |
| Slickensided | Fracture planes appear polished or glossy, sometimes striated |
| Blocky | Cohesive soil that can be broken down into small angular lumps which resist further breakdown |
| Lensed | Inclusion of small pockets of different soils, such as small lenses of sand scattered through a mass of clay; note thickness |
| Homogeneous | Same color and appearance throughout |

particles are hit by a hammer, for example, gravel-size particles fracture with considerable hammer blow, some gravel-size particles crumble with hammer blow. "Hard" means particles do not crack, fracture, or crumble under a hammer blow.

10.13 Additional comments shall be noted, such as the presence of roots or root holes, difficulty in drilling or augering hole, caving of trench or hole, or the presence of mica.

10.14 A local or commercial name or a geologic interpretation of the soil, or both, may be added if identified as such.

10.15 A classification or identification of the soil in accordance with other classification systems may be added if identified as such.

## 11. Identification of Peat

11.1 A sample composed primarily of vegetable tissue in various stages of decomposition that has a fibrous to amorphous texture, usually a dark brown to black color, and an organic odor, shall be designated as a highly organic soil and shall be identified as peat, PT, and not subjected to the identification procedures described hereafter.

## 12. Preparation for Identification

12.1 The soil identification portion of this practice is based on the portion of the soil sample that will pass a 3-in. (75-mm) sieve. The larger than 3-in. (75-mm) particles must be removed, manually, for a loose sample, or mentally, for an intact sample before classifying the soil.

12.2 Estimate and note the percentage of cobbles and the percentage of boulders. Performed visually, these estimates will be on the basis of volume percentage.

NOTE 9—Since the percentages of the particle-size distribution in Test Method D 2487 are by dry weight, and the estimates of percentages for gravel, sand, and fines in this practice are by dry weight, it is recommended that the report state that the percentages of cobbles and boulders are by volume.

12.3 Of the fraction of the soil smaller than 3 in. (75 mm), estimate and note the percentage, by dry weight, of the gravel, sand, and fines (see Appendix X4 for suggested procedures).

NOTE 10—Since the particle-size components appear visually on the basis of volume, considerable experience is required to estimate the percentages on the basis of dry weight. Frequent comparisons with laboratory particle-size analyses should be made.

12.3.1 The percentages shall be estimated to the closest 5 %. The percentages of gravel, sand, and fines must add up to 100 %.

12.3.2 If one of the components is present but not in sufficient quantity to be considered 5 % of the smaller than 3-in. (75-mm) portion, indicate its presence by the term *trace*, for example, trace of fines. A trace is not to be considered in the total of 100 % for the components.

## 13. Preliminary Identification

13.1 The soil is *fine grained* if it contains 50 % or more fines. Follow the procedures for identifying fine-grained soils of Section 14.

13.2 The soil is *coarse grained* if it contains less than 50 % fines. Follow the procedures for identifying coarse-grained soils of Section 15.

## 14. Procedure for Identifying Fine-Grained Soils

14.1 Select a representative sample of the material for examination. Remove particles larger than the No. 40 sieve (medium sand and larger) until a specimen equivalent to about a handful of material is available. Use this specimen for performing the dry strength, dilatancy, and toughness tests.

14.2 *Dry Strength*:

14.2.1 From the specimen, select enough material to mold into a ball about 1 in. (25 mm) in diameter. Mold the material until it has the consistency of putty, adding water if necessary.

14.2.2 From the molded material, make at least three test specimens. A test specimen shall be a ball of material about ½ in. (12 mm) in diameter. Allow the test specimens to dry in air, or sun, or by artificial means, as long as the temperature does not exceed 60°C.

14.2.3 If the test specimen contains natural dry lumps, those that are about ½ in. (12 mm) in diameter may be used in place of the molded balls.

NOTE 11—The process of molding and drying usually produces higher strengths than are found in natural dry lumps of soil.

14.2.4 Test the strength of the dry balls or lumps by crushing between the fingers. Note the strength as none, low, medium, high, or very high in accorance with the criteria in Table 8. If natural dry lumps are used, do not use the results of any of the lumps that are found to contain particles of coarse sand.

14.2.5 The presence of high-strength water-soluble cementing materials, such as calcium carbonate, may cause exceptionally high dry strengths. The presence of calcium carbonate can usually be detected from the intensity of the reaction with dilute hydrochloric acid (see 10.6).

14.3 *Dilatancy*:

14.3.1 From the specimen, select enough material to mold into a ball about ½ in. (12 mm) in diameter. Mold the material, adding water if necessary, until it has a soft, but not sticky, consistency.

14.3.2 Smooth the soil ball in the palm of one hand with the blade of a knife or small spatula. Shake horizontally, striking the side of the hand vigorously against the other hand several times. Note the reaction of water appearing on the surface of the soil. Squeeze the sample by closing the hand or pinching the soil between the fingers, and note the reaction as none, slow, or rapid in accordance with the criteria in Table 9. The reaction is the speed with which water appears while shaking, and disappears while squeezing.

14.4 *Toughness*:

14.4.1 Following the completion of the dilatancy test, the test specimen is shaped into an elongated pat and rolled by hand on a smooth surface or between the palms into a thread about ⅛ in. (3 mm) in diameter. (If the sample is too wet to roll easily, it should be spread into a thin layer and allowed to lose some water by evaporation.) Fold the sample threads and reroll repeatedly until the thread crumbles at a diameter of about ⅛ in. The thread will crumble at a diameter of ⅛ in. when the soil is near the plastic limit. Note the pressure required to roll the thread near the plastic limit. Also, note the strength of the thread. After the thread crumbles, the pieces should be lumped together and kneaded until the lump crumbles. Note the toughness of the material during kneading.

14.4.2 Describe the toughness of the thread and lump as low, medium, or high in accordance with the criteria in Table 10.

**TABLE 8 Criteria for Describing Dry Strength**

| Description | Criteria |
|---|---|
| None | The dry specimen crumbles into powder with mere pressure of handling |
| Low | The dry specimen crumbles into powder with some finger pressure |
| Medium | The dry specimen breaks into pieces or crumbles with considerable finger pressure |
| High | The dry specimen cannot be broken with finger pressure. Specimen will break into pieces between thumb and a hard surface |
| Very high | The dry specimen cannot be broken between the thumb and a hard surface |

**TABLE 9 Criteria for Describing Dilatancy**

| Description | Criteria |
|---|---|
| None | No visible change in the specimen |
| Slow | Water appears slowly on the surface of the specimen during shaking and does not disappear or disappears slowly upon squeezing |
| Rapid | Water appears quickly on the surface of the specimen during shaking and disappears quickly upon squeezing |

14.5 *Plasticity*—On the basis of observations made during the toughness test, describe the plasticity of the material in accordance with the criteria given in Table 11.

14.6 Decide whether the soil is an *inorganic* or an *organic* fine-grained soil (see 14.8). If inorganic, follow the steps given in 14.7.

14.7 *Identification of Inorganic Fine-Grained Soils*:

14.7.1 Identify the soil as a *lean clay*, CL, if the soil has medium to high dry strength, no or slow dilatancy, and medium toughness and plasticity (see Table 12).

14.7.2 Identify the soil as a *fat clay*, CH, if the soil has high to very high dry strength, no dilatancy, and high toughness and plasticity (see Table 12).

14.7.3 Identify the soil as a *silt*, ML, if the soil has no to low dry strength, slow to rapid dilatancy, and low toughness and plasticity, or is nonplastic (see Table 12).

14.7.4 Identify the soil as an *elastic silt*, MH, if the soil has low to medium dry strength, no to slow dilatancy, and low to medium toughness and plasticity (see Table 12).

NOTE 12—These properties are similar to those for a lean clay. However, the silt will dry quickly on the hand and have a smooth, silky feel when dry. Some soils that would classify as MH in accordance with the criteria in Test Method D 2487 are visually difficult to distinguish from lean clays, CL. It may be necessary to perform laboratory testing for proper identification.

14.8 *Identification of Organic Fine-Grained Soils*:

14.8.1 Identify the soil as an *organic soil*, OL/OH, if the soil contains enough organic particles to influence the soil properties. Organic soils usually have a dark brown to black color and may have an organic odor. Often, organic soils will change color, for example, black to brown, when exposed to the air. Some organic soils will lighten in color significantly when air dried. Organic soils normally will not have a high toughness or plasticity. The thread for the toughness test will be spongy.

NOTE 13—In some cases, through practice and experience, it may be possible to further identify the organic soils as organic silts or organic clays, OL or OH. Correlations between the dilatancy, dry strength, toughness tests, and laboratory tests can be made to identify organic soils in certain deposits of similar materials of known geologic origin.

**TABLE 10 Criteria for Describing Toughness**

| Description | Criteria |
|---|---|
| Low | Only slight pressure is required to roll the thread near the plastic limit. The thread and the lump are weak and soft |
| Medium | Medium pressure is required to roll the thread to near the plastic limit. The thread and the lump have medium stiffness |
| High | Considerable pressure is required to roll the thread to near the plastic limit. The thread and the lump have very high stiffness |

**TABLE 11 Criteria for Describing Plasticity**

| Description | Criteria |
|---|---|
| Nonplastic | A ⅛-in. (3-mm) thread cannot be rolled at any water content |
| Low | The thread can barely be rolled and the lump cannot be formed when drier than the plastic limit |
| Medium | The thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be rerolled after reaching the plastic limit. The lump crumbles when drier than the plastic limit |
| High | It takes considerable time rolling and kneading to reach the plastic limit. The thread can be rerolled several times after reaching the plastic limit. The lump can be formed without crumbling when drier than the plastic limit |

**TABLE 12 Identification of Inorganic Fine-Grained Soils from Manual Tests**

| Soil Symbol | Dry Strength | Dilatancy | Toughness |
|---|---|---|---|
| ML | None to low | Slow to rapid | Low or thread cannot be formed |
| CL | Medium to high | None to slow | Medium |
| MH | Low to medium | None to slow | Low to medium |
| CH | High to very high | None | High |

14.9 If the soil is estimated to have 15 to 25 % sand or gravel, or both, the words “with sand” or “with gravel” (whichever is more predominant) shall be added to the group name. For example: “lean clay with sand, CL” or “silt with gravel, ML” (see Fig. 1a and Fig. 1b). If the percentage of sand is equal to the percentage of gravel, use “with sand.”

14.10 If the soil is estimated to have 30 % or more sand or gravel, or both, the words “sandy” or “gravelly” shall be added to the group name. Add the word “sandy” if there appears to be more sand than gravel. Add the word “gravelly” if there appears to be more gravel than sand. For example: “sandy lean clay, CL”, “gravelly fat clay, CH”, or “sandy silt, ML” (see Fig. 1a and Fig. 1b). If the percentage of sand is equal to the percent of gravel, use “sandy.”

## 15. Procedure for Identifying Coarse-Grained Soils

(Contains less than 50 % fines)

15.1 The soil is a *gravel* if the percentage of gravel is estimated to be more than the percentage of sand.

15.2 The soil is a *sand* if the percentage of gravel is estimated to be equal to or less than the percentage of sand.

15.3 The soil is a *clean gravel* or *clean sand* if the percentage of fines is estimated to be 5 % or less.

15.3.1 Identify the soil as a *well-graded gravel*, GW, or as a *well-graded sand*, SW, if it has a wide range of particle sizes and substantial amounts of the intermediate particle sizes.

15.3.2 Identify the soil as a *poorly graded gravel*, GP, or as a *poorly graded sand*, SP, if it consists predominantly of one size (uniformly graded), or it has a wide range of sizes with some intermediate sizes obviously missing (gap or skip graded).

15.4 The soil is either a *gravel with fines* or a *sand with fines* if the percentage of fines is estimated to be 15 % or more.

15.4.1 Identify the soil as a *clayey gravel*, GC, or a *clayey sand*, SC, if the fines are clayey as determined by the procedures in Section 14.

15.4.2 Identify the soil as a *silty gravel*, GM, or a *silty sand*, SM, if the fines are silty as determined by the procedures in Section 14.

15.5 If the soil is estimated to contain 10 % fines, give the soil a dual identification using two group symbols.

15.5.1 The first group symbol shall correspond to a clean gravel or sand (GW, GP, SW, SP) and the second symbol shall correspond to a gravel or sand with fines (GC, GM, SC, SM).

15.5.2 The group name shall correspond to the first group symbol plus the words “with clay” or “with silt” to indicate the plasticity characteristics of the fines. For example: “well-graded gravel with clay, GW-GC” or “poorly graded sand with silt, SP-SM” (see Fig. 2).

15.6 If the specimen is predominantly sand or gravel but contains an estimated 15 % or more of the other coarse-grained constituent, the words “with gravel” or “with sand” shall be added to the group name. For example: “poorly graded gravel with sand, GP” or “clayey sand with gravel, SC” (see Fig. 2).

15.7 If the field sample contains any cobbles or boulders, or both, the words “with cobbles” or “with cobbles and boulders” shall be added to the group name. For example: “silty gravel with cobbles, GM.”

## 16. Report

16.1 The report shall include the information as to origin, and the items indicated in Table 13.

NOTE 14—*Example: Clayey Gravel with Sand and Cobbles, GC*—About 50 % fine to coarse, subrounded to subangular gravel; about 30 % fine to coarse, subrounded sand; about 20 % fines with medium plasticity, high dry strength, no dilatancy, medium toughness; weak reaction with HCl; original field sample had about 5 % (by volume) subrounded cobbles, maximum dimension, 150 mm.

In-Place Conditions—Firm, homogeneous, dry, brown

Geologic Interpretation—Alluvial fan

**TABLE 13 Checklist for Description of Soils**

1. Group name
2. Group symbol
3. Percent of cobbles or boulders, or both (by volume)
4. Percent of gravel, sand, or fines, or all three (by dry weight)
5. Particle-size range:
   Gravel—fine, coarse
   Sand—fine, medium, coarse
6. Particle angularity: angular, subangular, subrounded, rounded
7. Particle shape: (if appropriate) flat, elongated, flat and elongated
8. Maximum particle size or dimension
9. Hardness of coarse sand and larger particles
10. Plasticity of fines: nonplastic, low, medium, high
11. Dry strength: none, low, medium, high, very high
12. Dilatancy: none, slow, rapid
13. Toughness: low, medium, high
14. Color (in moist condition)
15. Odor (mention only if organic or unusual)
16. Moisture: dry, moist, wet
17. Reaction with HCl: none, weak, strong

*For intact samples:*

18. Consistency (fine-grained soils only): very soft, soft, firm, hard, very hard
19. Structure: stratified, laminated, fissured, slickensided, lensed, homogeneous
20. Cementation: weak, moderate, strong
21. Local name
22. Geologic interpretation
23. Additional comments: presence of roots or root holes, presence of mica, gypsum, etc., surface coatings on coarse-grained particles, caving or sloughing of auger hole or trench sides, difficulty in augering or excavating, etc.

NOTE 15—Other examples of soil descriptions and identification are given in Appendix X1 and Appendix X2.

NOTE 16—If desired, the percentages of gravel, sand, and fines may be stated in terms indicating a range of percentages, as follows:

*Trace*—Particles are present but estimated to be less than 5 %
*Few*—5 to 10 %
*Little*—15 to 25 %
*Some*—30 to 45 %
*Mostly*—50 to 100 %

16.2 If, in the soil description, the soil is identified using a classification group symbol and name as described in Test Method D 2487, it must be distinctly and clearly stated in log forms, summary tables, reports, and the like, that the symbol and name are based on visual-manual procedures.

## 17. Precision and Bias

17.1 This practice provides qualitative information only, therefore, a precision and bias statement is not applicable.

## 18. Keywords

18.1 classification; clay; gravel; organic soils; sand; silt; soil classification; soil description; visual classification

# APPENDIXES

**(Nonmandatory Information)**

## X1. EXAMPLES OF VISUAL SOIL DESCRIPTIONS

X1.1 The following examples show how the information required in 16.1 can be reported. The information that is included in descriptions should be based on individual circumstances and need.

X1.1.1 *Well-Graded Gravel with Sand (GW)*—About 75 % fine to coarse, hard, subangular gravel; about 25 % fine to coarse, hard, subangular sand; trace of fines; maximum size, 75 mm, brown, dry; no reaction with HCl.

X1.1.2 *Silty Sand with Gravel (SM)*—About 60 % predominantly fine sand; about 25 % silty fines with low plasticity, low dry strength, rapid dilatancy, and low toughness; about 15 % fine, hard, subrounded gravel, a few gravel-size particles fractured with hammer blow; maximum size, 25 mm; no reaction with HCl (Note—Field sample size smaller than recommended).

*In-Place Conditions*—Firm, stratified and contains lenses of silt 1 to 2 in. (25 to 50 mm) thick, moist, brown to gray; in-place density 106 lb/ft$^3$; in-place moisture 9 %.

X1.1.3 *Organic Soil (OL/OH)*—About 100 % fines with low plasticity, slow dilatancy, low dry strength, and low toughness; wet, dark brown, organic odor; weak reaction with HCl.

X1.1.4 *Silty Sand with Organic Fines (SM)*—About 75 % fine to coarse, hard, subangular reddish sand; about 25 % organic and silty dark brown nonplastic fines with no dry strength and slow dilatancy; wet; maximum size, coarse sand; weak reaction with HCl.

X1.1.5 *Poorly Graded Gravel with Silt, Sand, Cobbles and Boulders (GP-GM)*—About 75 % fine to coarse, hard, subrounded to subangular gravel; about 15 % fine, hard, subrounded to subangular sand; about 10 % silty nonplastic fines; moist, brown; no reaction with HCl; original field sample had about 5 % (by volume) hard, subrounded cobbles and a trace of hard, subrounded boulders, with a maximum dimension of 18 in. (450 mm).

## X2. USING THE IDENTIFICATION PROCEDURE AS A DESCRIPTIVE SYSTEM FOR SHALE, CLAYSTONE, SHELLS, SLAG, CRUSHED ROCK, AND THE LIKE

X2.1 The identification procedure may be used as a descriptive system applied to materials that exist in-situ as shale, claystone, sandstone, siltstone, mudstone, etc., but convert to soils after field or laboratory processing (crushing, slaking, and the like).

X2.2 Materials such as shells, crushed rock, slag, and the like, should be identified as such. However, the procedures used in this practice for describing the particle size and plasticity characteristics may be used in the description of the material. If desired, an identification using a group name and symbol according to this practice may be assigned to aid in describing the material.

X2.3 The group symbol(s) and group names should be placed in quotation marks or noted with some type of distinguishing symbol. See examples.

X2.4 Examples of how group names and symbols can be incororated into a descriptive system for materials that are not naturally occurring soils are as follows:

X2.4.1 *Shale Chunks*—Retrieved as 2 to 4-in. (50 to 100-mm) pieces of shale from power auger hole, dry, brown, no reaction with HCl. After slaking in water for 24 h, material identified as "Sandy Lean Clay (CL)"; about 60 % fines with medium plasticity, high dry strength, no dilatancy, and medium toughness; about 35 % fine to medium, hard sand; about 5 % gravel-size pieces of shale.

X2.4.2 *Crushed Sandstone*—Product of commercial crushing operation; "Poorly Graded Sand with Silt (SP-SM)"; about 90 % fine to medium sand; about 10 % nonplastic fines; dry, reddish-brown, strong reaction with HCl.

X2.4.3 *Broken Shells*—About 60 % gravel-size broken

shells; about 30 % sand and sand-size shell pieces; about 10 % fines; "Poorly Graded Gravel with Sand (GP)."

X2.4.4 *Crushed Rock*—Processed from gravel and cobbles in Pit No. 7; "Poorly Graded Gravel (GP)"; about 90 % fine, hard, angular gravel-size particles; about 10 % coarse, hard, angular sand-size particles; dry, tan; no reaction with HCl.

## X3. SUGGESTED PROCEDURE FOR USING A BORDERLINE SYMBOL FOR SOILS WITH TWO POSSIBLE IDENTIFICATIONS.

X3.1 Since this practice is based on estimates of particle size distribution and plasticity characteristics, it may be difficult to clearly identify the soil as belonging to one category. To indicate that the soil may fall into one of two possible basic groups, a borderline symbol may be used with the two symbols separated by a slash. For example: SC/CL or CL/CH.

X3.1.1 A borderline symbol may be used when the percentage of fines is estimated to be between 45 and 55 %. One symbol should be for a coarse-grained soil with fines and the other for a fine-grained soil. For example: GM/ML or CL/SC.

X3.1.2 A borderline symbol may be used when the percentage of sand and the percentage of gravel are estimated to be about the same. For example: GP/SP, SC/GC, GM/SM. It is practically impossible to have a soil that would have a borderline symbol of GW/SW.

X3.1.3 A borderline symbol may be used when the soil could be either well graded or poorly graded. For example: GW/GP, SW/SP.

X3.1.4 A borderline symbol may be used when the soil could either be a silt or a clay. For example: CL/ML, CH/MH, SC/SM.

X3.1.5 A borderline symbol may be used when a fine-grained soil has properties that indicate that it is at the boundary between a soil of low compressibility and a soil of high compressibility. For example: CL/CH, MH/ML.

X3.2 The order of the borderline symbols should reflect similarity to surrounding or adjacent soils. For example: soils in a borrow area have been identified as CH. One sample is considered to have a borderline symbol of CL and CH. To show similarity, the borderline symbol should be CH/CL.

X3.3 The group name for a soil with a borderline symbol should be the group name for the first symbol, except for:

CL/CH lean to fat clay
ML/CL clayey silt
CL/ML silty clay

X3.4 The use of a borderline symbol should not be used indiscriminately. Every effort shall be made to first place the soil into a single group.

## X4. SUGGESTED PROCEDURES FOR ESTIMATING THE PERCENTAGES OF GRAVEL, SAND, AND FINES IN A SOIL SAMPLE

X4.1 *Jar Method*—The relative percentage of coarse- and fine-grained material may be estimated by thoroughly shaking a mixture of soil and water in a test tube or jar, and then allowing the mixture to settle. The coarse particles will fall to the bottom and successively finer particles will be deposited with increasing time; the sand sizes will fall out of suspension in 20 to 30 s. The relative proportions can be estimated from the relative volume of each size separate. This method should be correlated to particle-size laboratory determinations.

X4.2 *Visual Method*—Mentally visualize the gravel size particles placed in a sack (or other container) or sacks. Then, do the same with the sand size particles and the fines. Then, mentally compare the number of sacks to estimate the percentage of plus No. 4 sieve size and minus No. 4 sieve size present. The percentages of sand and fines in the minus sieve size No. 4 material can then be estimated from the wash test (X4.3).

X4.3 *Wash Test (for relative percentages of sand and fines)*—Select and moisten enough minus No. 4 sieve size material to form a 1-in (25-mm) cube of soil. Cut the cube in half, set one-half to the side, and place the other half in a small dish. Wash and decant the fines out of the material in the dish until the wash water is clear and then compare the two samples and estimate the percentage of sand and fines. Remember that the percentage is based on weight, not volume. However, the volume comparison will provide a reasonable indication of grain size percentages.

X4.3.1 While washing, it may be necessary to break down lumps of fines with the finger to get the correct percentages.

## X5. ABBREVIATED SOIL CLASSIFICATION SYMBOLS

X5.1 In some cases, because of lack of space, an abbreviated system may be useful to indicate the soil classification symbol and name. Examples of such cases would be graphical logs, databases, tables, etc.

X5.2 This abbreviated system is not a substitute for the full name and descriptive information but can be used in supplementary presentations when the complete description is referenced.

X5.3 The abbreviated system should consist of the soil classification symbol based on this standard with appropriate lower case letter prefixes and suffixes as:

| *Prefix:* | Suffix: |
|---|---|
| s = sandy | s = with sand |
| g = gravelly | g = with gravel |
| | c = with cobbles |
| | b = with boulders |

X5.4 The soil classification symbol is to be enclosed in parenthesis. Some examples would be:

| *Group Symbol and Full Name* | Abbreviated |
|---|---|
| CL, Sandy lean clay | s(CL) |
| SP-SM, Poorly graded sand with silt and gravel | (SP-SM)g |
| GP, poorly graded gravel with sand, cobbles, and boulders | (GP)scb |
| ML, gravelly silt with sand and cobbles | g(ML)sc |

## SUMMARY OF CHANGES

In accordance with Committee D18 policy, this section identifies the location of changes to this standard since the last edition (1993$^{\epsilon 1}$) that may impact the use of this standard.

(1) Added Practice D 3740 to Section 2.

(2) Added Note 5 under 5.7 and renumbered subsequent notes.

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# ANCHOR QEA

# STANDARD OPERATING PROCEDURE
# SEDIMENT GRAB SAMPLING

## Introduction

Sediment grab samples are collected for the analysis of surficial sediment quality analyses (typically the 0-10 cm biologically active zone) for a variety of sediment investigations including sediment quality standard (SQS) chemical testing, NPDES mixing zone verification, and bioassay or benthic infauna investigations. Sediment grabs are collected using a variety of sampling equipment including a van Veen grab, Ekman grab, or petite Ponar sediment grab. Sediment grabs are collected by lowering the grab devise through the water column, either by hand or under winch control, and the grab penetrates the sediment by means of its weight. The operation of individual grab samplers is not described in this SOP as individual grab types require different tripping mechanisms in the collection of sediments. The following steps outline the general procedure for the collection of sediment samples regardless of the specific grab sampler used.

## Grab Sample Collection Procedures

1. Determine the appropriate equipment to be used for sediment collection requirements prior to field mobilization
2. Maneuver the sampling vessel to the proposed sampling location (within 3 meters) using the navigation system. The vessel operator should hold the vessel on location if possible to allow for the sediment collection by "live boating." Alternatively, the vessel can be anchored using a 3 point anchoring array to hold position over the sample location.
3. Prior to sampler deployment, discuss safety issues involved in sample usage. Operators of grab equipment must be adequately familiar with grab and retrieval equipment usage prior to use. Practice grabs may be necessary for procedure familiarity.
4. Follow decontamination procedures of the grab sampler as outlined in the Sampling and Analysis Plan.

5. Ensure that deployment lines are free and clear and retrieval equipment is operational. Check that appropriate knots are prepared and that any mechanical retrieval equipment (davit and winch) are functioning properly.
6. Slowly lower the grab to the sediment surface. Too rapid deployment can cause the grab to sail off station or flip over. Deployment speeds can be adjusted according to various sediment types (i.e., soft sediments require a slower deployment to avoid over filling the grab devise).
7. Once on the bottom, give the grab sufficient slack to allow the tripping mechanism to release. In the case of the Ekman grab, maintain sufficient tension for the tripping messenger to glide smoothly along the line to trip the sampler.
8. When "live boating" maintain vertical control over the sampling position prior to lifting the grab so that the grab can be lifted vertically off the bottom. Begin to lift the sampler, either by hand (Ekman) or using the davit and winch on the vessel. Lifting the grab off the bottom will allow the jaws to close.
9. Upon retrieval of the grab to the water surface maintain ergonomic control, when hand lifting, to lift into the vessel or lift the grab high enough to place on a stable surface on the sampling vessel. When lifting onto the vessel, use care not to disturb the sample by banging against the side of the vessel.
10. After the grab sampler is retrieved aboard and placed in a stable position the sediment sample will be evaluated against Puget Sound Estuary Program (PSEP) sample acceptance protocols (PSEP 1997). PSEP acceptability criteria generally are listed in the SAP and include:
    - Sampler is not overfilled (i.e., there is no sediment surface against top doors of sampler
    - Sediment surface is relatively flat, indicating minimal disturbance or winnowing
    - Overlying water is present, indicating minimal leakage
    - Overlying water has low turbidity, indicating minimal sample disturbance
    - Desired penetration depth is achieved
11. When sample criteria are deemed sufficient, use a siphon hose, or turkey baster, to remove overlying water in the sampler to expose the sediment surface.
12. Follow Grab Sample Possessing procedures outline in SOP 2.2 and sample handling procedures outlined in SOP 4.1.

13. Photograph the sediment surface in the grab, note the GPS position, and follow the Sample Logging Procedures outlined in SOP Number 2.3.

## Minimum Equipment Checklist

- Grab sampler with doors and weights
- Lines and pulleys
- Marker buoy with weight and line
- Siphon hose and/or turkey baster
- Decontamination equipment
- Stainless bowls and spoons for processing
- GPS and coordinates
- SAP and HSP
- Camera
- White board and marker
- Data logs
- Sample jars
- Sample labels
- Coolers and ice

## References

PSEP. 1997. Puget Sound Estuary Program (PSEP) 1997 manual: Recommended Guidelines for Sampling Marine Sediment, Water Column, and Tissue in Puget Sound

# STANDARD OPERATING PROCEDURE
# SPT AND SPLIT SPOON SAMPLING

## Introduction

Soils can be sampled in a variety of ways. One way is with the use of a split spoon sampler advanced from a land- or water-based drill rig, and driven using the Standard Penetration Test (SPT). Split spoon sampling is generally used to collect disturbed soil cores of 18 or 24 inches in length. A series of consecutive cores may be extracted with a split spoon sampler to give a complete soil column profile, or an auger may be used to drill down to the desired depth for sampling. The split spoon is then driven to its sampling depth through the bottom of the augured hole and the core extracted. A split-spoon sample is ideal for collecting subsurface geotechnical data, including relative soil strength information through the SPT. When split spoon sampling is performed to gain geologic information, all work should be performed in accordance with ASTM D1586, "Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils". This SOP describes the SPT and collection of soil samples using the split spoon.

## Standard Penetration Test

The SPT is an approximate measure of soil density and consistency. To be useful, the results must be used with engineering judgment in conjunction with other tests. The SPT (as described in ASTM D 1586) is used to obtain disturbed soil samples. This test employs a standard 2-inch outside diameter split-spoon sampler. Using a 300-pound hammer, free-falling 30 inches, the sampler is driven into the soil for 18 inches. The number of blows required to drive the sampler <u>the last 12 inches only</u> is the Standard Penetration Resistance. This resistance, or blow count, measures the relative density of granular soils and the consistency of cohesive soils. The blow counts are plotted on the boring logs at their respective sample depths.

Soil samples are recovered from the split-barrel sampler, field classified, and placed into watertight jars or double bagged in ziplock bags. They are then shipped to the geotechnical laboratory for further testing.

### *In the Event of Hard Driving*

Occasionally very dense materials preclude driving the total 18-inch sample. When this happens, the penetration resistance is entered on logs as follows:

**Penetration less than six inches.** The log indicates the total number of blows over the number of inches of penetration.

**Penetration greater than six inches.** The blow count noted on the log is the sum of the total number of blows completed after the first 6 inches of penetration. This sum is expressed over the number of inches driven that exceed the first 6 inches. The number of blows needed to drive the first 6 inches are not reported. For example, a blow count series of 12 blows for 6 inches, 30 blows for 6 inches, and 50 (the maximum number of blows counted within a 6-inch increment for SPT) for 3 inches would be recorded as 80/9.

## Required Information on Boring Logs

Logs shall include the following information, at a minimum, to describe the drilling work:

1. Date and time of collection of each sample
2. Names of field personnel collecting and handling the samples
3. Type of sampling equipment used (i.e. split spoon diameter; hammer weight; free fall height; hammer deployment method)
4. Observations made during sample collection, including weather conditions, complications, and other details associated with the sampling effort
5. The sample station identification
6. Length and depth intervals of each sample and measured recovery
7. Qualitative notation of apparent resistance during driving
8. Any deviation from the approved SAP

## Split Spoon Sample Collection and Processing

The following procedures are used for collecting soil samples with a split spoon:

1. Assemble the sampler by aligning both sides of barrel and then screwing the drive shoe on the bottom and the head piece on top.

2. Place the sampler in a perpendicular position on the sample material. Where a drill rig is used, this step is performed by the drilling contractor.
3. Use the SPT hammer to drive the tube. Do not drive past the bottom of the sample length. Where a drill rig is used, this step is performed by the drilling contractor.
4. Record in the site logbook or on field data sheets the length of the tube used to penetrate the material being sampled, and the number of blows required to obtain this depth.
5. Withdraw the sampler, and open by unscrewing the bit and head and splitting the barrel. The amount of recovery and soil type should be recorded on the boring log. If a split sample is desired, a cleaned, stainless steel knife should be used to divide the tube contents in half, longitudinally. This sampler is typically available in 2 and 3 1/2 inch diameters. A larger barrel may be necessary to obtain the required sample volume.
6. Record soil description on the field log, and place samples in labeled, watertight containers.
7. Store sample in a dry location outside of direct sunlight.

## Split Spoon Sample Logging

Split spoon samples will be logged on-site by an experienced field geologist or geotechnical engineer. Prior to sub-sampling, a description of each sample will be recorded on a standard boring log. The following parameters will be noted:

1. Sample recovery
2. Physical soil description in accordance with the Unified Soil Classification System (includes soil type, moisture, density/consistency of soil, color)
3. Odor (e.g., hydrogen sulfide, petroleum)
4. Visual stratification, structure, and texture
5. Vegetation and debris (e.g. woodchips or fibers, concrete , metal debris)
6. Biological activity (e.g., detritus, shells, tubes, bioturbation, live or dead organisms)
7. Presence of oil sheen

Standard terminology for field logs is attached to this SOP.

## Sample Description

Classification of soils in this report is based on visual field and laboratory observations which include density/consistency, moisture condition, grain size, and plasticity estimates and should not be construed to imply field nor laboratory testing unless presented herein. Visual-manual classification methods of ASTM D 2488 were used as an identification guide.

Soil descriptions consist of the following:
Density/consistency, moisture, color, minor constituents, MAJOR CONSTITUENT, additional remarks.

### Density/Consistency

Soil density/consistency in borings is related primarily to the Standard Penetration Resistance. Soil density/consistency in test pits is estimated based on visual observation and is presented parenthetically on the test pit logs.

| Density SAND or GRAVEL | Standard Penetration Resistance (N) in Blows/Foot | SILT or CLAY Consistency | Standard Penetration Resistance (N) in Blows/Foot | Approximate Shear Strength in TSF |
|---|---|---|---|---|
| Very loose | 0 - 4 | Very soft | 0 - 2 | <0.125 |
| Loose | 4 - 10 | Soft | 2 - 4 | 0.125 - 0.25 |
| Medium dense | 10 - 30 | Medium stiff | 4 - 8 | 0.25 - 0.5 |
| Dense | 30 - 50 | Stiff | 8 - 15 | 0.5 - 1.0 |
| Very dense | >50 | Very stiff | 15 - 30 | 1.0 - 2.0 |
| | | Hard | >30 | >2.0 |

### Moisture

| | |
|---|---|
| Dry | Little perceptible moisture |
| Damp | Some perceptible moisture, probably below optimum |
| Moist | Probably near optimum moisture content |
| Wet | Much perceptible moisture, probably above optimum |

### Minor Constituents

| | Estimated Percentage |
|---|---|
| Not identified in description | 0 - 5 |
| Slightly (clayey, silty, etc.) | 5 - 12 |
| Clayey, silty, sandy, gravelly | 12 - 30 |
| Very (clayey, silty, etc.) | 30 - 50 |

## Legends

### Sampling Test Symbols

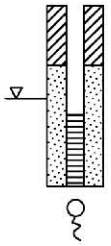
BORING SAMPLES

- ☒ Split Spoon
- ⧅ Shelby Tube
- ▥ Cuttings
- ◫ Core Run
- ✳ No Sample Recovery
- P Tube Pushed, Not Driven

TEST PIT SAMPLES

- ☒ Grab (Jar)
- ⧄ Bag
- ⧅ Shelby Tube

### Groundwater Observations



Surface Seal

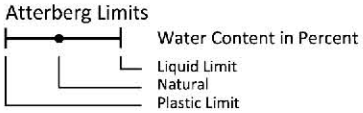
Groundwater Level on Date (ATD) At Time of Drilling

Observation Well Tip or Slotted Section

Groundwater Seepage (Test Pits)

### Test Symbols

| | |
|---|---|
| GS | Grain Size |
| Comp | Composite |
| Chem | Chemistry |
| NS | No Sheen |
| SS | Slight Sheen |
| MS | Moderate Sheen |
| HS | Heavy Sheen |
| TCD | Triaxial Consolidated Drained |
| QU | Unconfined Compression |
| DS | Direct Shear |
| K | Permeability |
| PP | Pocket Penetrometer<br>Approximate Compressive Strength in TSF |
| TV | Torvane<br>Approximate Shear Strength in TSF |
| CBR | California Bearing Ratio |
| MD | Moisture Density Relationship |
| AL | Atterberg Limits |
| PID | Photoionization Detector Reading |
| CA | Chemical Analysis |
| DT | In Situ Density Test |



# STANDARD OPERATING PROCEDURE
# THIN WALL SAMPLING

## Introduction

Soils can be sampled in a variety of ways. One way is with the use of a thin wall (a.k.a. Shelby tube) sampler advanced by hand, or hydraulically pushed from a land- or water-based drill rig. Thin wall sampling is generally used to collect undisturbed soil cores of 24 to 36 inches in length. A series of consecutive cores may be extracted with a thin wall sampler to give a complete soil column profile, or an auger may be used to drill down to the desired depth for sampling. The thin wall sampler is then pushed to its sampling depth through the bottom of the augured hole and the core extracted. A thin wall sampler is ideal for collecting relatively undisturbed subsurface geotechnical samples for advanced geotechnical laboratory testing. When thin wall sampling is performed to gain geologic information, all work should be performed in accordance with ASTM D1587, "Thin-Walled Tube Sampling of Soils for Geotechnical Purposes". This SOP describes the collection of soil samples using the thin walled sampler.

## Thin Wall Sample Collection and Processing

The following procedures are used for collecting soil samples with a thin-walled sampler:

1. Assemble the sampler by attaching the driving head to the sampling tube.
2. Place the sampler in a perpendicular position on the sample material. Where a drill rig is used, this step is performed by the drilling contractor.
3. Use a smooth continuous push to advance the tube. Do not drive past the bottom of the sample length. Where a drill rig is used, this step is performed by the drilling contractor.
4. Record in the site logbook or on field data sheets the length of the tube used to penetrate the material being sampled, as well as the detailed information described in this SOP.
5. Withdraw the sampler, and remove the drive head. The amount of recovery and soil type should be measured recording the depth to soil from both the top and bottom of the sample tube. Note any aberrations such as rocks or other objects visible in the drive end of the sampler.

6. Store sample upright in a protected and dry location outside of direct sunlight.

## Required Information on Boring Logs

Logs shall include the following information, at a minimum, to describe the drilling work:

1. Date and time of collection of each sample
2. Names of field personnel collecting and handling the samples
3. Type of sampling equipment used (i.e. split spoon diameter; hammer weight; free fall height; hammer deployment method)
4. Observations made during sample collection, including weather conditions, complications, and other details associated with the sampling effort
5. The sample station identification
6. Length and depth intervals of each sample and measured recovery
7. Qualitative notation of apparent resistance during driving
8. Any deviation from the approved SAP

## Thin Wall Sample Handling

Thin walled tube samples do not allow for direct observation or logging in the field. When recovered from the boring, the tubes will be measured for amount of recovery and checked to ensure the tube was not dented or damaged while driving or removing. The tubes will then be quickly cleaned, sealed with a plastic cap and duct tape on both ends, and labeled with boring name, sample name, date, approximate depth, and the location of the top of the sample with respect to the orientation it was removed from the subsurface. Every effort will be made to store and transport the Shelby tubes with minimal disturbance in the upright, vertical position. Split spoon samples will be logged on-site by an experienced field geologist or geotechnical engineer.

Standard terminology for field logs is attached to this SOP.

## Sample Description

Classification of soils in this report is based on visual field and laboratory observations which include density/consistency, moisture condition, grain size, and plasticity estimates and should not be construed to imply field nor laboratory testing unless presented herein. Visual-manual classification methods of ASTM D 2488 were used as an identification guide.

Soil descriptions consist of the following:
Density/consistency, moisture, color, minor constituents, MAJOR CONSTITUENT, additional remarks.

### Density/Consistency

Soil density/consistency in borings is related primarily to the Standard Penetration Resistance. Soil density/consistency in test pits is estimated based on visual observation and is presented parenthetically on the test pit logs.

| Density SAND or GRAVEL | Standard Penetration Resistance (N) in Blows/Foot | SILT or CLAY Consistency | Standard Penetration Resistance (N) in Blows/Foot | Approximate Shear Strength in TSF |
|---|---|---|---|---|
| Very loose | 0 - 4 | Very soft | 0 - 2 | <0.125 |
| Loose | 4 - 10 | Soft | 2 - 4 | 0.125 - 0.25 |
| Medium dense | 10 - 30 | Medium stiff | 4 - 8 | 0.25 - 0.5 |
| Dense | 30 - 50 | Stiff | 8 - 15 | 0.5 - 1.0 |
| Very dense | >50 | Very stiff | 15 - 30 | 1.0 - 2.0 |
| | | Hard | >30 | >2.0 |

### Moisture

| | |
|---|---|
| Dry | Little perceptible moisture |
| Damp | Some perceptible moisture, probably below optimum |
| Moist | Probably near optimum moisture content |
| Wet | Much perceptible moisture, probably above optimum |

### Minor Constituents

| | Estimated Percentage |
|---|---|
| Not identified in description | 0 - 5 |
| Slightly (clayey, silty, etc.) | 5 - 12 |
| Clayey, silty, sandy, gravelly | 12 - 30 |
| Very (clayey, silty, etc.) | 30 - 50 |

## Legends

### Sampling Test Symbols

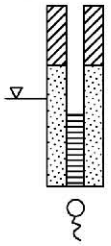
BORING SAMPLES

- ☒ Split Spoon
- ⧅ Shelby Tube
- ▥ Cuttings
- ◫ Core Run
- ✳ No Sample Recovery
- P Tube Pushed, Not Driven

TEST PIT SAMPLES

- ☒ Grab (Jar)
- ⧄ Bag
- ⧅ Shelby Tube

### Groundwater Observations



Surface Seal

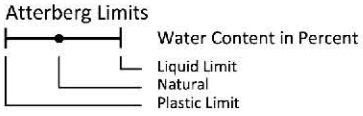
Groundwater Level on Date (ATD) At Time of Drilling

Observation Well Tip or Slotted Section

Groundwater Seepage (Test Pits)

### Test Symbols

| | |
|---|---|
| GS | Grain Size |
| Comp | Composite |
| Chem | Chemistry |
| NS | No Sheen |
| SS | Slight Sheen |
| MS | Moderate Sheen |
| HS | Heavy Sheen |
| TCD | Triaxial Consolidated Drained |
| QU | Unconfined Compression |
| DS | Direct Shear |
| K | Permeability |
| PP | Pocket Penetrometer<br>Approximate Compressive Strength in TSF |
| TV | Torvane<br>Approximate Shear Strength in TSF |
| CBR | California Bearing Ratio |
| MD | Moisture Density Relationship |
| AL | Atterberg Limits |
| PID | Photoionization Detector Reading |
| CA | Chemical Analysis |
| DT | In Situ Density Test |



ROCTEST TELEMAC

# INSTRUCTION MANUAL

## FIELD INSPECTION VANE TESTER

## Model H-60

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This product should be installed and operated only by qualified personnel. Its misuse is potentially dangerous. The Company makes no warranty as to the information furnished in this manual and assumes no liability for damages resulting from the installation or use of this product. The information herein is subject to change without notification.

Tel.: 1.450.465.1113 • 1.877.ROCTEST (Canada, USA) • 33 (1) 64.06.40.80 (Europe) • www.roctest.com • www.telemac.fr

E10136-050209

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# 1 INTRODUCTION

The inspection vane borer is used to measure in situ undrained shear strength in clays. It is primarily intended for use in trenches and excavations at a depth not influenced by drying and excavation procedure.

When different sizes of vanes are used, the instrument range is from 0 to 260 kPa (0 to 26 t/m²). The accuracy of the instrument should be within 10% of the reading.

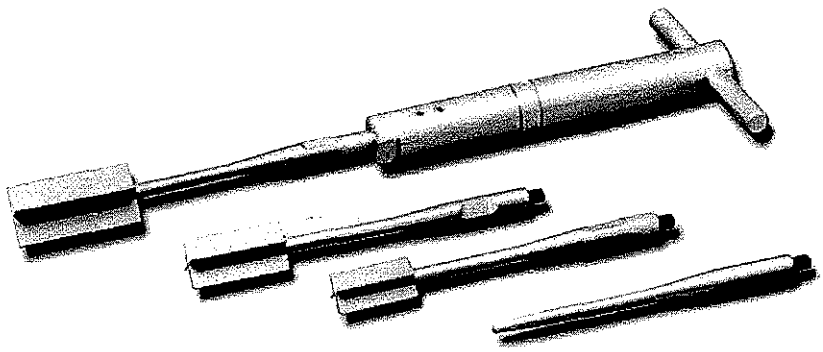

**Figure 1: H-60 vanes in three different sizes**

# 2 DESCRIPTION

The measurement part of the instrument is a spiral-spring (3). When the handle (1) is turned, the spring deforms and the upper part (4) and the lower part (8) of the instrument get a mutual angular displacement. The size of this displacement depends on the torque which is necessary to turn the vane (11). By means of a graduated scale (5) the shear strength of the clay is obtained (see Figure 2).

The lower and upper halves of the instrument are connected by means of threads. The scale (5) is also supplied with threads, and follows the upper part of the instrument by means of two lugs. The zero-point is indicated by a line on the upper part (4). When torque is applied, the scale-ring follows the upper part of the instrument, and when failure in the clay is obtained, the scale-ring (5) will remain in its position due to the friction in the threads.

| Vane Diameter (mm) | Length | Area (horizontal) | Volume | Factor | Vane constants (Vc) | Capacity (T/m²) | Capacity (kPa) |
|---|---|---|---|---|---|---|---|
| **16** | 32 | 201.0624 | 6433.9968 | 1.95313 | **1.953** | **26** | **260** |
| **20** | 40 | 314.16 | 12566.4 | 1.00000 | **1.000** | **13** | **130** |
| **25.4** | 50.8 | 506.708664 | 25740.8001 | 0.48819 | **0.488** | **6.5** | **65** |
| **32** | 64 | 804.2496 | 51471.9744 | 0.24414 | **0.244** | **3.2** | **32.5** |
| **65** | 130 | 3318.315 | 431380.95 | 0.02913 | **0.029** | **0.4** | **3.9** |

The scale-ring is graduated either from 1 to 13 corresponding to T/m² or from 10 to 130 relating to kPa.

$$Sr = Vc \times \text{Scale Reading} \times (C.F. / 3.00 kgf\ cm)$$

where:

| | | |
|---|---|---|
| Sr | = | Undrain Shear Strength (in T/m² or kPa) |
| Vc | = | Vane Constant |
| Scale Reading | = | Units on the vane. (T/m² (*) or kPa) |
| C.F. | = | Calibration factor shown on the Calibration Data Sheet in kgf cm |

(*) One unit theoretically corresponds to 1 T/m²

The vane blades are soldered to a vane-shaft (9) which again is extended by one or more 0.5 m (0.49 m) long rods. The connection between the shaft-rods and the instrument is made by threads. To make the connections as straight as possible, the rods have to be screwed tight together and threads cleaned for dirt.

The maximum shear strength that can be measured with the inspection vane is 260 kPa (26 t/m²). In clays with this shear strength a force of about 40 to 50 kilos is required to press the vane down into the clay. The vane-shaft is designed to take this force, but if extension rods are used, precautions against buckling are required.

# 3 INSTALLATION PROCEDURES

## 3.1 GENERAL PROCEDURES

1. Connect required vane (11) and extension rods to the inspection vane instrument.

   *N.B.: While screwing vane or rods to instrument, hold onto lower part.*

2. Push vane into the ground to the required position.

   *N.B.: Do not twist inspection vane during penetration.*

3. Make sure that the graduated scale (5) is set to zero-position.

4. Turn handle (1) clockwise.

   *N.B.: Be careful not to overturn.*

5. When the lower part (8) follows the upper part (4) around or even falls back, failure and maximum shear strength is obtained in the clay at the vane.

6. Holding handle firmly, allow it to return to zero-position.

   *N.B.: Do not allow the handle to spring back uncontrolled.*

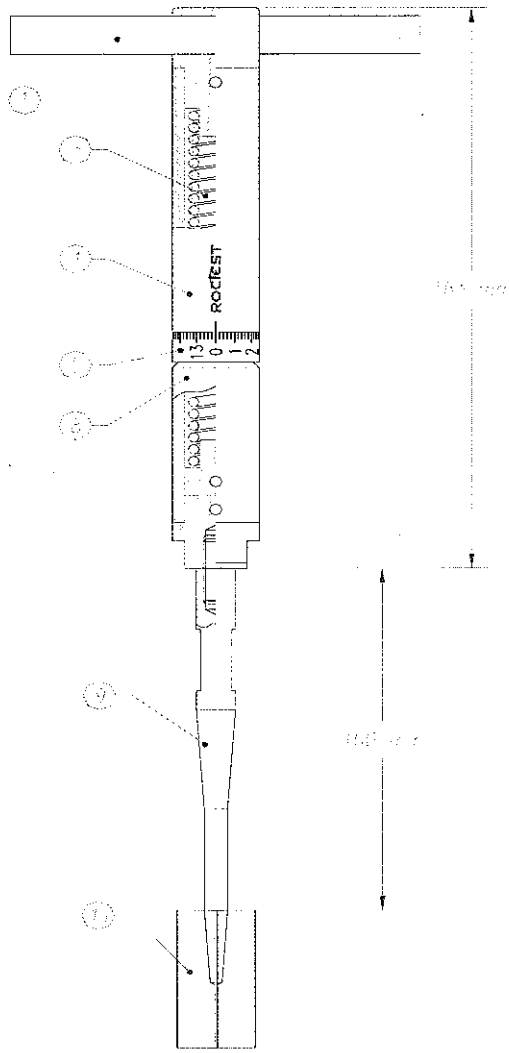


**Figure 2: H-60 vane borer**

7. Note the reading on the graduated scale.

   *N.B.: Do not touch or in any way disturb the position of the graduated ring until the reading is taken.*

8. Write down the reading together with position of hole and depth.

9. Turn the graduated scale anti-clockwise back to zero-position.

10. To determine the remoulded shear strength, the following procedure is used:

    - Turn the vane quickly at least 25 revolutions. Do not turn using handle. Turn using wrenches provided.

    - Zero the scale and take at least two measurements by turning the instrument as slowly as possible.

- The minimum value is considered the correct one.

11. Push the vane down to next position. If necessary, screw on another extension rod.

12. Repeat the above measurement procedure (3-10).

13. When the last reading is taken, pull the vane up. If the clay is comparatively soft, this can be done by hand, gripping the handle. In harder clays, some mechanical device might be necessary. It is then advisable to connect this device directly to the connection rods (not to the instrument).

### 3.2 SPECIAL PROCEDURES

When measuring the shear strength at greater depths, the friction between the clay and the extension rods can be appreciable, and must be taken into consideration.

To measure this friction, extension rods and a vane-shaft without vane (dummy) are pushed into the ground to the depths required for shear force measurements. The friction is then measured in the same way as when using vanes (above 3-9). The friction-value thus obtained is used to evaluate the actual shear strength from the measured shear strength.

To penetrate through firm layers a pre-boring using a rod with the same diameter as the vane may be helpful.

## 4 MAINTENANCE

The H-60 vane borer is simply designed, and does not require much attention. But it is most important to keep it as clean as possible. Periodically, the instrument should be sent back to factory for recalibration.

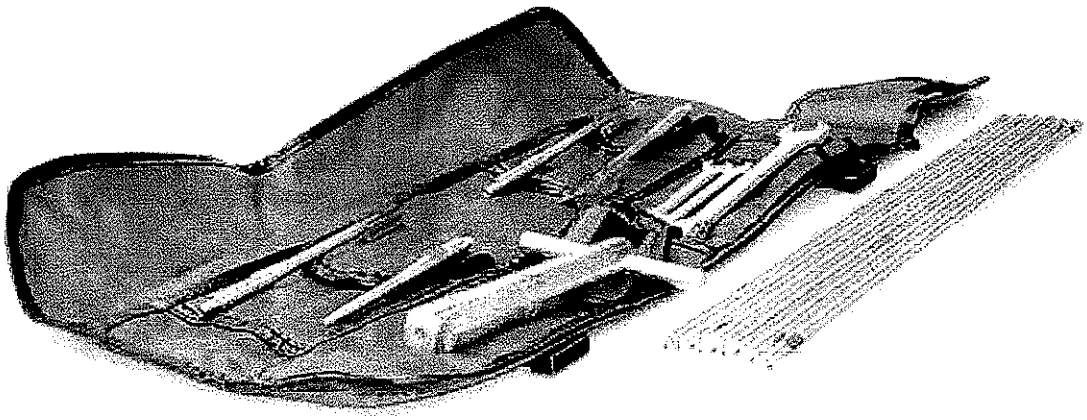

**Figure 3: H-60 vane borer simple design**

# 5 CONVERSION FACTORS

| | To Convert From | To | Multiply By |
|---|---|---|---|
| LENGTH | Microns | Inches | 3.94E-05 |
| | Millimetres | Inches | 0.0394 |
| | Meters | Feet | 3.2808 |
| AREA | Square millimetres | Square inches | 0.0016 |
| | Square meters | Square feet | 10.7643 |
| VOLUME | Cubic centimetres | Cubic inches | 0.06101 |
| | Cubic meters | Cubic feet | 35.3357 |
| | Litres | U.S. gallon | 0.26420 |
| | Litres | Can–Br gallon | 0.21997 |
| MASS | Kilograms | Pounds | 2.20459 |
| | Kilograms | Short tons | 0.00110 |
| | Kilograms | Long tons | 0.00098 |
| FORCE | Newtons | Pounds-force | 0.22482 |
| | Newtons | Kilograms-force | 0.10197 |
| | Newtons | Kips | 0.00023 |
| PRESSURE AND STRESS | Kilopascals | Psi | 0.14503 |
| | Bars | Psi | 14.4928 |
| | Inches head of water* | Psi | 0.03606 |
| | Inches head of Hg | Psi | 0.49116 |
| | Pascal | Newton / square meter | 1 |
| | Kilopascals | Atmospheres | 0.00987 |
| | Kilopascals | Bars | 0.01 |
| | Kilopascals | Meters head of water* | 0.10199 |
| TEMPERATURE | Temp. in °F = (1.8 x Temp. in °C) + 32<br>Temp. in °C = (Temp. in °F – 32) / 1.8 | | |

* at 4 °C

E6TabConv-990505

**Table 1: Conversion factors**

# ATTACHMENT A3

## FIELD FORMS

# LIST OF FIELD FORMS

Surface Sediment/Soil Collection Form

Sediment Core Log

Chain of Custody/Laboratory Analysis Request Form

Field Change Request and Corrective Action Record

Soil Boring Processing Log

Vane Shear Log

integral consulting inc.

# SURFACE SEDIMENT/SOIL COLLECTION FORM

**Project Name:**_____ **Project No.** _____ **Page:**_____

**Date:**_____ **Crew:**_____

**Weather:**_____

**Sampling Method:**_____

**Time:**_____ **Station:** _____ **Replicate:**_____ **Acceptable grab:** ☐ Yes ☐ No

**Bottom Depth:**_____ **Penetration Depth:**_____ **RPD Depth:**_____

**Analyses before homogenization:** ☐ **VOC** ☐ **Sulfides** ☐ **Other**

**Sample ID:**_____

**Type:** ☐ cobble ☐ gravel ☐ sand C M F ☐ silt clay ☐ organic matter ☐ wood/shell fragments

**Color:** ☐ drab olive ☐ gray ☐ black ☐ brown ☐ brown surface

**Odor:** ☐ none ☐ slight ☐ moderate ☐ strong ☐ sulfidic ☐ petroleum ☐ other

**Comments:**

**Time:**_____ **Station:** _____ **Replicate:**_____ **Acceptable grab:** ☐ Yes ☐ No

**Bottom Depth:**_____ **Penetration Depth:**_____ **RPD Depth:**_____

**Analyses before homogenization:** ☐ **VOC** ☐ **Sulfides** ☐ **Other**

**Sample ID:**_____

**Type:** ☐ cobble ☐ gravel ☐ sand C M F ☐ silt clay ☐ organic matter ☐ wood/shell fragments

**Color:** ☐ drab olive ☐ gray ☐ black ☐ brown ☐ brown surface

**Odor:** ☐ none ☐ slight ☐ moderate ☐ strong ☐ sulfidic ☐ petroleum ☐ other

**Comments:**

**Time:**_____ **Station:** _____ **Replicate:**_____ **Acceptable grab:** ☐ Yes ☐ No

**Bottom Depth:**_____ **Penetration Depth:**_____ **RPD Depth:**_____

**Analyses before homogenization:** ☐ **VOC** ☐ **Sulfides** ☐ **Other**

**Sample ID:**_____

**Type:** ☐ cobble ☐ gravel ☐ sand C M F ☐ silt clay ☐ organic matter ☐ wood/shell fragments

**Color:** ☐ drab olive ☐ gray ☐ black ☐ brown ☐ brown surface

**Odor:** ☐ none ☐ slight ☐ moderate ☐ strong ☐ sulfidic ☐ petroleum ☐ other

**Comments:**

**Time:**_____ **Station:** _____ **Replicate:**_____ **Acceptable grab:** ☐ Yes ☐ No

**Bottom Depth:**_____ **Penetration Depth:**_____ **RPD Depth:**_____

**Analyses before homogenization:** ☐ **VOC** ☐ **Sulfides** ☐ **Other**

**Sample ID:**_____

**Type:** ☐ cobble ☐ gravel ☐ sand C M F ☐ silt clay ☐ organic matter ☐ wood/shell fragments

**Color:** ☐ drab olive ☐ gray ☐ black ☐ brown ☐ brown surface

**Odor:** ☐ none ☐ slight ☐ moderate ☐ strong ☐ sulfidic ☐ petroleum ☐ other

**Comments:**

# SEDIMENT CORE LOG

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

| **Collected:** | | **Processed:** | |
|---|---|---|---|
| Date: __/__/2010 | Drive Length: _____ | Date: __/__/2010 | |
| 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):

# CHAIN OF CUSTODY/LABORATORY ANALYSIS REQUEST FORM

Page _____ of _____ Turn Around Requested: _____

| Report to: | Phone: | | | | Analyses Requested | | | | | | | | | | Notes/Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Company: | Fax: | | | | | | | | | | | | | | |
| Address: | Proj Name: | | | | | | | | | | | | | | |
| City: | Proj Number: | | | | | | | | | | | | | | |
| State: | Sampler: | | | | | | | | | | | | | | |
| Zipcode: | | | | | | | | | | | | | | | |
| Sample ID | Sample Date | Sample Time | Sample Matrix | No. Con-tainers | | | | | | | | | | | |
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| Relinquished: (Signature) | Received by: (Signature) | Special Instructions/Notes | |
|---|---|---|---|
| Printed name: | Printed name: | | |
| Company: | Company: | | Number of Coolers: |
| | | | Cooler Temp(s): |
| Date: Time: | Date: Time: | | COC Seals Intact? |
| | | | Bottles Intact? |

| | **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:

# *Soil Boring Processing Log*

ANCHOR QEA

| | |
|---|---|
| Boring Location: | Boring _____ Date ____ Sheet ____ of ____ |
| | Job San Jacinto Waste Pits Job No. 090557-01 |
| | Logged By _____ Weather _____ |
| | Drilled By _____ |
| | Drill Type/ Method _____ |
| | Sampling Method |
| Elevation: Datum: | Bottom of Boring _____ ATD Water Level Depth |
| Obs. Well Install. Yes No | |

| SIZE (%) G Max. | SIZE (%) S Range | SIZE (%) F Att. Limits | Time / PID | DEPTH From | DEPTH To | SAMPLE Type | SAMPLE Number | DEPTH/ SAMPLE RECOVERY | Penetration Resistance | DESCRIPTION: Den., moist., color, minor, MAJOR CONSTITUENT, NON-SOIL SUBSTANCES: Odor, staining, sheen, scrag, slag, etc. | REMARKS: Drill action, drill and sample procedures, water conditions, heave, etc. | SUMMARY LOG (Water & Date) |
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# Vane Shear Log

Project: San Jacinto Waste Pits 090557-01

Location: _____

Technician: _____

Date: _____

| ROCTEST M-3 Vane Tester | |
|---|---|
| Vane Diameter | Vane constant |
| 25.4mm (1") | 0.488 |
| 32mm (1.25") | 0.244 |
| 65mm (2.56") | 0.029 |

ANCHOR QEA

| Test Location ID | Coordinates | | Test Time | Water Depth in feet | Test Depth below Mudline in feet | Vane Diameter in mm | Vane Scale Reading in kPa | Undrained Shear Strength | | Sample Description |
|---|---|---|---|---|---|---|---|---|---|---|
| | Easting | Northing | | | | | | in kPa | in lbs/ft$^2$ | |
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Note - 1 kPa = 20.89 psf

# ATTACHMENT A4

USEPA RISK ASSESSMENT GUIDANCE FORMS (PER THE UNILATERAL ADMINISTRATIVE ORDER STATEMENT OF WORK)

# EXHIBIT 5

## USEPA SAMPLING DESIGN SELECTION WORKSHEETS

# Exhibit 5. Part I: Medium Sampling Summary
## Sampling Design Selection Worksheet

**A. Site Name** San Jacinto River Waste Pits **B. Base Map Code** _____

**C. Medium: Groundwater, Soil, Sediment, Surface Water, Air or Other (specify)** Sediment

**D. Comments**
1. The number of subsurface sediment samples that will be collected during this study is not included in this form. The number of sediment samples that will be collected from each core will vary and will be unknown until the time of sample collection. Sediment samples will be collected from 11 locations from each 1-foott interval to a maximum depth of 10 feet (exact depth will vary at each station).
2. Samples that will be collected for geotechnical and engineering analyses will not be used in the risk assessment and are therefore not included on these worksheets.

| E. Medium/ Pathway Code | Exposure Pathway/ Exposure Area Name | F. Number of Samples from Part II | | | | | |
|---|---|---|---|---|---|---|---|
| | | Judgmental/ Purposive | Background | Statistical Design | Geometrical or Geostatistical Design | QC | Row Total |
| Sediment | Nature and extent | 59 | 11 | NA | NA | 32 | 102 |
| Sediment | Human health risk assessment | 30 | 10 | NA | NA | 16 | 56 |
| Sediment | Ecological risk assessment | 9 | 3 | NA | NA | 6 | 18 |
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| | **Column Totals:** | 98 | 24 | NA | NA | 54 | 176 |
| | | | | | **G. Grand Total:** | | 176 |

## Exhibit 5. Part II: Exposure Pathway Summary

### Sampling Design Selection Worksheet (cont'd.)

| H. Radionuclide of Potential Concern and CAS Number | I. Frequency of Occurrence | J. Estimation | | K. CV | L. Background |
|---|---|---|---|---|---|
| | | Arithmetic Mean | Maximum | | |
| NA | NA | NA | NA | NA | NA |
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**M. Code (CAS Number) of Radionuclide of Potential Concern Selected as Proxy** **NA**

**N. Reason for Defining New Stratum or Domain (check one)**

- ☐ Heterogeneous Radionuclide Distribution
- ☐ Geological Stratum Controls
- ☐ Historical Information Indicates Difference
- ☐ Field Screening Indicates Difference
- ☐ Exposure Variations
- ☒ Other (specify) NA

| Q. Stratum or Exposure Area | P. Reason | Q. Number of Samples from Part III | | | | | |
|---|---|---|---|---|---|---|---|
| Name and Code | | Judgmental/ Purposive | Background | Statistical Design | Geometrical or Geostatistical Design | QC | Row Total |
| Sediment | Nature and extent | 59 | 11 | NA | NA | 32 | 102 |
| Sediment | Human health risk assessment | 30 | 10 | NA | NA | 16 | 56 |
| Sediment | Ecological risk assessment | 9 | 3 | NA | NA | 6 | 18 |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | **R. Total (Part I, Step F):** | | 24 | NA | NA | 54 | 176 |

## Exhibit 5. Part III: Exposure Area Summary
### Sampling Design Selection Worksheet (cont'd.)

**O. Stratum or Exposure Area** San Jacinto River Waste Pits **Domain Code** _____

**E. Medium/Pathway Code** Sediment **Pathway Code** _____

**S. Judgmental or Purposive Sampling**

**Comments** _____

Use prior site information to place samples, or determine location and extent of contamination. Judgmental or purposive samples generally cannot be used to replace statistically located samples. An exposure area and stratum MUST be sampled by at leaste TWO samples.

**Number of Samples** 176

**T. Background Samples**

Background samples must be taken for each medium relevant to each stratum/area. Zero background samples are not acceptable. See the discussion on pp. 74-75 of Guidance for Data Useability in Risk Assessment Part A.

**Number of Background Samples** 24

**U. Statistical Samples**

CV of proxy or radionuclide of potential concern NA

Minimum Detectable Relative Difference (MDRD) NA (<40% if no other information exists)

Confidence Level NA (>80%) Power of Test NA (>90%)

**Number of Samples** (See formula in Appendix IV) NA

**V. Geometrical Samples**

Hot spot radius NA Enter distance units) NA

Probability of hot spot prior to investigation NA (0 to 100%)

Probability that NO hot spot exists after investigation (See formula in Appendix IV) NA (enter only if >75%)

**W. Geostatistical Samples**

Required number of samples to complete grid + number of short range samples NA

**X. Quality Control samples**

Number of Duplicates (Minimum 1:20 environmental samples) 27

Number of Blanks (Minimum 1 per medium per day or 1 per sampling process, whichever is greater) 26

**Y. Sample Total for Stratum** (Part II, Step U)

| Judgmental/ Purposive | Background | Statistical Design | Geometrical or Geostatistical Design | QC | Row Total |
|---|---|---|---|---|---|
| 98 | 24 | NA | NA | 54 | 172 |

# EXHIBIT 52

## METHOD SELECTION WORKSHEET

## Exhibit 52. Method Selection Worksheet

| I. Analytes | | II. Medium | III. Critical parameters | | | | IV. Routine Available Methods[4] |
|---|---|---|---|---|---|---|---|
| A. Chemical or Class of Chemicals of Potential Concern | B. Reporting Requirement[1] (Y/N) | | A. Turnaround Time (enter hours or days) | B. ID Only or ID Plus Quant (ID or ID+Q) | C. Concentration of Concern (or PRG)[2] | D. Required Method Detection Limit[3] | |
| Dioxins/furans | N | Sediment | 21 days | ID+Q | 2,3,7,8-TCDD TEQ of 4.5 ng/kg | Not applicable | 1613B / 8290A |
| Aluminum | N | Sediment | 21 days | ID+Q | 77,000 mg/kg | 15,400 mg/kg | 6010B / 6020 |
| Arsenic | N | Sediment | 21 days | ID+Q | 0.39 mg/kg | 0.08 mg/kg | 6010B / 6020 |
| Barium | N | Sediment | 21 days | ID+Q | 15,000 mg/kg | 3,000 mg/kg | 6010B / 6020 |
| Cadmium | N | Sediment | 21 days | ID+Q | 1.2 mg/kg | 0.24 mg/kg | 6010B / 6020 |
| Chromium | N | Sediment | 21 days | ID+Q | 0.29 mg/kg | 0.06 mg/kg | 6010B / 6020 |
| Cobalt | N | Sediment | 21 days | ID+Q | 23 mg/kg | 4.6 mg/kg | 6010B / 6020 |
| Copper | N | Sediment | 21 days | ID+Q | 34 mg/kg | 6.8 mg/kg | 6010B / 6020 |
| Lead | N | Sediment | 21 days | ID+Q | 46.7 mg/kg | 9.3 mg/kg | 6010B / 6020 |
| Magnesium | N | Sediment | 21 days | ID+Q | 50 mg/kg | 10 mg/kg | 6010B / 6020 |
| Manganese | N | Sediment | 21 days | ID+Q | 1,800 mg/kg | 360 mg/kg | 6010B / 6020 |
| Nickel | N | Sediment | 21 days | ID+Q | 20.9 mg/kg | 4.18 mg/kg | 6010B / 6020 |
| Thallium | N | Sediment | 21 days | ID+Q | 43 mg/kg | 8.6 mg/kg | 6010B / 6020 |
| Vanadium | N | Sediment | 21 days | ID+Q | 330 mg/kg | 66 mg/kg | 6010B / 6020 |
| Zinc | N | Sediment | 21 days | ID+Q | 150 mg/kg | 30 mg/kg | 6010B / 6020 |
| Mercury | N | Sediment | 21 days | ID+Q | 0.15 mg/kg | 0.03 mg/kg | 7471A |
| Total PCBs | N | Sediment | 21 days | ID+Q | 220 µg/kg | 44 µg/kg | 8081A |
| Acenaphthene | N | Sediment | 21 days | ID+Q | 16 µg/kg | 3.2 µg/kg | 8270C |
| Fluorene | N | Sediment | 21 days | ID+Q | 19 µg/kg | 3.8 µg/kg | 8270C |

| I. Analytes | | II. Medium | III. Critical parameters | | | | IV. Routine Available Methods[4] |
|---|---|---|---|---|---|---|---|
| A. Chemical or Class of Chemicals of Potential Concern | B. Reporting Requirement[1] (Y/N) | | A. Turnaround Time (enter hours or days) | B. ID Only or ID Plus Quant (ID or ID+Q) | C. Concentration of Concern (or PRG)[2] | D. Required Method Detection Limit[3] | |
| Naphthalene | N | Sediment | 21 days | ID+Q | 160 µg/kg | 32 µg/kg | 8270C |
| Phenanthrene | N | Sediment | 21 days | ID+Q | 240 µg/kg | 48 µg/kg | 8270C |
| 2,4,6-Trichlorophenol | N | Sediment | 21 days | ID+Q | 44,000 µg/kg | 8,800 µg/kg | 8270C |
| 2,4-Dichlorophenol | N | Sediment | 21 days | ID+Q | 180,000 µg/kg | 36,000 µg/kg | 8270C |
| Pentachlorophenol | N | Sediment | 21 days | ID+Q | 3,000 µg/kg | 600 µg/kg | 8270C |
| Phenol | N | Sediment | 21 days | ID+Q | 18,000,000 µg/kg | 3,600,00 µg/kg | 8270C |
| Hexachlorobenzene | N | Sediment | 21 days | ID+Q | 300 µg/kg | 60 µg/kg | 8270C |
| 2,3,4,6-Tetrachlorophenol | N | Sediment | 21 days | ID+Q | 1,800,000 µg/kg | 360,000 µg/kg | 8270C |
| Carbazole | N | Sediment | 21 days | ID+Q | 710,000 µg/kg | 142,000 µg/kg | 8270C |
| 2,4,5-Trichlorophenol | N | Sediment | 21 days | ID+Q | 6,100,000 µg/kg | 1,220,000 µg/kg | 8270C |
| Bis(2-ethylhexyl) phthalate | N | Sediment | 21 days | ID+Q | 182 µg/kg | 36.4 µg/kg | 8270C |
| 1,2,4-Trichlorobenzene | N | Sediment | 21 days | ID+Q | 390 µg/kg | 78 µg/kg | 8260B |
| 1,2,3-Trichlorobenzene | N | Sediment | 21 days | ID+Q | 49,000 µg/kg | 9,800 µg/kg | 8260B |
| 1,2-Dichlorobenzene | N | Sediment | 21 days | ID+Q | 740 µg/kg | 148 µg/kg | 8260B |
| 1,3-Dichlorobenzene | N | Sediment | 21 days | ID+Q | 320 µg/kg | 64 µg/kg | 8260B |
| 1,4-Dichlorobenzene | N | Sediment | 21 days | ID+Q | 700 µg/kg | 140 µg/kg | 8260B |
| Chloroform | N | Sediment | 21 days | ID+Q | 290 µg/kg | 58 µg/kg | 8260B |

[1]Y = total reported for compound class
N = each analyte reported separately
[2]Preliminary remediation goal
[3]Method detection limit should b no greater than 20% of concentration of concern
[4]Refer to Appendix III for specific methods. Recommend consultation with chemist and/or automated methods search to determine all methods available. (Exhibit 53 lists computer systems that support method selection.

# APPENDIX B
# RESPONSE TO AGENCY COMMENTS ON THE DRAFT SEDIMENT SAMPLING AND ANALYSIS PLAN

## SAN JACINTO RIVER WASTE PITS SUPERFUND SITE

Appendix B. EPA Comments on SJRWP Sediment Sampling and Analysis Plan, and Responses

| Comment No. | Section | Page | Line | Requested Change | Comment | Response to Comment - Proposed Revision |
|---|---|---|---|---|---|---|
| EPA1 | General Comment | Whole Document | | Mentions of the "CDF" should be preceded by "potential." | Everywhere in the body of the sediment sampling & analysis plan that "CDF" is mentioned; add the word "potential" beforehand (with grammatical adjustments, as necessary). This is necessary because a CDF remedial alternative has not been selected at this stage and the geotechnical sampling data is for an evaluation of CDF feasibility, along with other containment systems. | The word "potential" will be used to modify mentions of the confined disposal facility (CDF) and other potential remedies. |
| EPA2 | General Comment | Whole Document | | Replace "Big Star Property" with "property west of the impoundments." | Everywhere that "Big Star" or "Big Star property" is mentioned, replace with: "property west of the impoundments" (with grammatical adjustments, as necessary). This is necessary due to ongoing enforcement and privacy considerations. | The text will be edited as requested. |
| EPA3 | General Comment | Other | | None | Required dioxin consultation with the EPA Office of Superfund Remediation and Technology Innovation (OSRTI) indicated that the sample grid (500 ft) is too large for soil sampling. An alternate grid size should be discussed for soils when planning for soil sampling. | Comment noted. Sampling design for soils will be addressed in a Soil Sampling and Analysis Plan (SAP). |
| EPA4 | Figure 5 | Study Area Overview | | Change the extent of the "Study Area." | Figure 5 and text in Section 1.4.1.2 are inconsistent (i.e., Figure 5 should include southern boundary of Study Area as stated, which is Upper Galveston Bay). | The ultimate extent of the study area will be defined by the results of the RI/FS. According to agreement at the March 16, 2010, meeting between EPA, TCEQ, and Respondents to discuss these comments, the concept of the "Study Area" will be removed from the Sediment SAP. |
| EPA5 | Figure 14 | | | Add 8 geotechnical borings to the area within the historic perimeter of the impoundments, with 4 on the western side and 4 on the eastern side of the impoundments. | Proposed Geotechnical Borings and Vane Shear Test Locations: Additional borings are needed to fully delineate the surface area and depth of the waste pits, including risk characterization and engineering construction evaluation. EPA recommends the addition of at least eight geotechnical borings within the source impoundments (not on the perimeter berm, separator berm, or scour channels) with chemistry profiles for Primary and Secondary COPCs. A minimum of four additional borings shall be in the western impoundment and four in the eastern impoundment. | Eight additional borings will be added as requested. The borings will terminate 5 to 10 feet into native sediments. The response to this comment addresses Comment TCEQ 17. |
| EPA6 | Figure 14 | | | Add 4 geotechnical borings to the northern edges of Highway 10. | Proposed Geotechnical Borings and Vane Shear Test Locations: Additional borings are needed to verify that the I-10 Highway (when expanded from Highway 73) was not built in the waste pits. EPA recommends the addition of at least four geotechnical borings underneath the northern edges of the I-10 Highway that is parallel to the current southern perimeter berm of the impoundments, with chemistry profiles for Primary and Secondary COPCs. | Additional information will be gathered from Texas Department of Transportation, such as existing data from geotechnical borings, and analyzed. If additional borings are needed the borings will be recommended in the Soil SAP. |
| EPA7 | Figure 15 | | | Add cores to stations SJNE026 and SJNE032. | Nature and Extent Sediment Sampling: SJNE026 and SJNE032 should be core samples as well. Possible contamination may have been moved to depth by dredging activities. | Core samples will be added to the samples to be collected at stations SJNE026 and SJNE032. |
| EPA8 | Figure 16 | | | Move stations for assessment of ecological exposures | Upstream Sediment Sampling Locations: The ecological samples SJRH050, SJRH051, and SJRH052 should not be located so near a railroad bridge. These samples should be taken at the same location as those proposed for the human health risk assessment (i.e., SJSH031 to | According to agreement at the March 16, 2010, meeting between EPA, TCEQ, and Respondents to discuss these comments, the three stations (SJSJ050, SJSH051, SJSH052) will be moved to the eastern and northern shore of the island across the |

| Comment No. | Section | Page | Line | Requested Change | Comment | Response to Comment - Proposed Revision |
|---|---|---|---|---|---|---|
| | | | | in upstream areas (SJSJ050, SJSH051, SJSH052) away from the railroad bridge, and to the location of stations upstream of the Site for assessment of human exposures. | SJSH040). This request assumes that area also represents suitable ecological habitat. If that area is not representative, then the team will need to determine an alternate reference area for ecological sampling and perhaps human health as well. | channel and to the west of the location shown in Figure 16. Samples collected for evaluation of human exposures at the northern extent of the upstream reference area shown in Figure 16 will also be used to evaluate ecological exposures. Text will be added to Section 1.9 and Section 1.10.2.2 of the SAP to clarify this use of the data. |
| EPA9 | Figure 17 | | | Add 10 stations for evaluation of human exposures to the shoreline between the impoundments and the upland area to the west of the impoundments. | Human Health and Ecological Exposure Sediment: Add at least ten HH surface and subsurface sediment samples to the shoreline area immediately west, southwest, south, southeast, and east of SJSH044 to SJSH046 to address potential recreational and trespasser/transient exposure. | Ten stations will be added at this location. Samples will be analyzed in an iterative fashion: surface sediments from five stations from this location and five from the shoreline of the upland area to the west of the impoundments will be analyzed immediately after collection. Statistical tests will be performed to determine if these 10 stations reflect a unique population. If not, the remainder of each set of samples will be analyzed for COPCs.<br><br>Figure 17 will be modified to show 10 additional stations at the location requested. Statistical methods for the analysis will be described in Section 1.10.2.2 of the Sediment SAP. |
| EPA10 | Figure 17 | | | Add 15 stations for evaluation of human exposures to the eastern shoreline of the San Jacinto River, north of the I-10 bridge. | Human Health and Ecological Exposure Sediment: Add at least fifteen HH surface and subsurface sediment samples to the shoreline area (across water) northwest, north, northeast, east, southeast, and south of SJSH047 to SJSH049 to address potential recreational and trespasser/transient exposure. | According to agreement at the March 16, 2010, meeting between EPA, TCEQ, and Respondents to discuss these comments, additional stations at this location are not necessary and will not be added. |
| EPA11 | Figure 17 | | | Add 5 stations for evaluation of human exposures on the shoreline area to the south of the 5 stations that are shown in Figure 17 to be on the eastern bank of the San Jacinto River. | Human Health and Ecological Exposure Sediment: Add at least five HH surface and subsurface sediment samples between SJSH006 and the shoreline area (across water) north, northeast, east, southeast of SJSH041 to SHSH043 to address potential recreational and trespasser/transient exposure. | Five stations will be added to this area, with specific distribution of samples determined in consultation with EPA. Figure 17 will be revised accordingly. |

| Comment No. | Section | Page | Line | Requested Change | Comment | Response to Comment - Proposed Revision |
|---|---|---|---|---|---|---|
| EPA12 | Figure 17 | | | Add five stations for evaluation of human exposures on the shoreline area to the north of the 5 stations that are shown in Figure 17 to be on the western bank of the San Jacinto River, and along the shoreline of the impoundment area. | Human Health and Ecological Exposure Sediment: Add five HH surface and subsurface sediment samples along the shoreline area immediately north, then west of SJSH005 to address potential recreational and trespasser/transient exposure. | According to agreement at the March 16, 2010, meeting between EPA, TCEQ and Respondents to discuss these comments, additional stations at this location are not necessary and will not be added. Existing data from within the impoundments, and data generated by sampling collected for the time critical removal action, and data generated by the new sampling resulting from comment EPA5 will be used in evaluation of human exposures occurring during activities within the impounded area. Two surface samples will be added and collected from within the impoundments and analyzed for primary and secondary COPCs; these will also be used to evaluate potential human exposures and questions related to nature and extent of contamination. Text will be added to Section 1.10.2.2 to clarify this approach, and the related figure will show these locations. |
| EPA13 | Section 1.2 | | | | Replace second paragraph, "As agreed by USEPA…" with: "As agreed by USEPA on January 20, 2010, the RI/FS Work Plan and SLERA will be submitted on March 31, 2010. This SAP is being submitted prior to the RI/FS Work Plan so that information relevant to the RI can be collected as early as practical. This SAP addresses only the sampling and analysis of sediments required for the RI/FS. This document is the SAP, and consists of this Quality Assurance Project Plan (QAPP) and the Field Sampling Plan (FSP), which is included as Appendix A. The QAPP was prepared consistent with USEPA guidance and requirements for QAPPs (USEPA 1998, 2001), as required by the 2009 UAO. Additional SAPs setting forth the QAPPs and FSPs for sampling of other media (e.g., biological tissue, soils) will be submitted according to the schedule provided in the RI/FS Work Plan." | The text will be edited as requested. |
| EPA14 | Section 1.4.1 | | | | Replace second paragraph, "In 1965, the impoundments…" with: "In 1965, the impoundments were constructed by forming berms within the estuarine marsh, just north of what was then Texas State Highway 73, and is now I-10, to the west of the main river channel. The two primary impoundments at the Site were divided by a central berm running lengthwise (north to south) through the middle, and were connected with a drain line to allow flow of excess water (including rain water) from the impoundment located to the west of the central berm, into the impoundment located to the east of the central berm (Figure 2). The excess water collected in the impoundment located to the east of the central berm was pumped back into barges and returned to the Champion paper plant. | The text will be edited as requested, except that the Respondents propose that the last sentence will be changed as shown:<br><br>"The excess water collected in the impoundment located to the east of the central berm was pumped back into barges and taken off-Site." |
| EPA15 | Section 1.4.1 | | | | Site History: Replace third paragraph, "In 1965 and 1966…" with: "In 1965 and 1966, pulp and paper mill wastes (both solid and liquid) were reportedly transported by barge from the Champion Paper Inc. paper mill in Pasadena, Texas, and unloaded at the Site into the impoundments where the waste was stabilized and stored. The excess water from the impoundments was pumped back into barges and returned to the Champion Paper Inc. paper mill, where it passed through the last settling ponds and discharged into the Channel with the rest of the paper mill effluent. The Champion Paper mill used chlorine as a bleaching agent, and the wastes that were deposited in the impoundments have recently been found to be contaminated with polychlorinated dibenzo-pdioxins, polychlorinated furans (dioxins and furans), | The text will be edited as requested, except that the Respondents propose the following revisions:<br><br>- The last part of the first sentence should state "where the waste was stabilized and disposed."<br>- The sentence that reads "The excess water from the impoundments was pumped back into barges and returned to the Champion Paper Inc. paper mill, where it passed through the last settling ponds and discharged into the Channel with the rest of the paper mill effluent." Will be changed to the following: |

| Comment No. | Section | Page | Line | Requested Change | Comment | Response to Comment - Proposed Revision |
|---|---|---|---|---|---|---|
| | | | | | and some metals (TCEQ and USEPA 2006); additional discussion of the chemical constituents typical of materials like those deposited in the impoundments is provided in Section 1.5. The impoundments were used for waste disposal from September 1965 through May 1966 until both impoundments were filled to capacity. In a letter dated July 1966, the Texas Water Pollution Control Board stated that it was their understanding that no additional waste material would be placed in the impoundments." | The excess water from the impoundments was pumped back into the barges and taken off-Site. |
| EPA16 | Section 1.4.1 | | | | Site History: Replace third paragraph, "Physical changes at the…" with: "Physical changes at the Site in the 1970s and 1980s, including regional subsidence of land in the area due to large scale groundwater extraction and sand mining within the river and marsh to the west of the impoundments, have resulted in partial submergence of the impoundments and exposure of the contents of the impoundments to surface waters. Based upon review of U.S. Corps of Engineers approved dredging permits, dredging by third parties have occurred in the vicinity of the impoundments. Recent samples of sediment in nearby waters north and west of the impoundments (University of Houston and Parsons 2006) indicate that dioxins and furans are present in nearby sediments at levels higher than levels in background areas nationally (USEPA 2000)." | The text will be edited as requested. |
| EPA17 | Section 1.4.1 | | | | Comment #17: Section 1.4.1, Site History: Replace fourth paragraph, "Current land use and…" with: "Current land use and planned zoning and parcel boundaries are shown in Figure 3. Residential, commercial, industrial, and other land use activities occur within the Preliminary Site Perimeter and the Study Area. Residential development on the eastern bank of the river is present within 0.5 mile of the Site. The impoundments are currently occupied by late successional stage estuarine riparian vegetation to the west of the central berm, and are consistently submerged even at low tide to the east of the central berm. Estuarine riparian vegetation lines the upland area that runs parallel to I-10 and west of the impoundments. A sandy intertidal zone is present along the shoreline throughout much of the Site (Figure 2)." | The text will be edited as requested. |
| EPA18 | Section 1.4.2.2 | | | | Existing Physical Data: Replace first paragraph, "Existing physical data include…" with: "Existing physical data include Site bathymetry and geotechnical studies that were performed for the Texas Department of Transportation (TXDOT), which were associated with the I-10 Bridge crossing at the San Jacinto River (Weston 2006). In addition, a 2009 bathymetric survey was conducted west and north of the impoundments (Hydrographic Consultants 2009). Also, there is limited TXDOT bathymetric survey data (date unknown) associated with the dolphin project in the vicinity of the I-10 Bridge." | The text will be edited as requested. |
| EPA19 | Section 1.4.3 | | | | Problem Definition and Overall CSM: Replace first paragraph, "Two major physical changes…" with: "Major physical changes resulted in the exposure of the wastes deposited within the impoundments to surface waters and the distribution of contaminated materials into nearby surface sediments. Land subsidence resulting from groundwater withdrawal in the 1970s contributed to the sinking of the impoundments. As a result of this event, contaminated material was distributed and became potentially accessible to ecological receptors and to people at the | The text will be edited as requested, with the word potentially added in two locations as shown in the following text – the word "potentially" is shown as bold text were it was added.:<br>"Major physical changes resulted in the exposure of the wastes deposited within the impoundments to surface waters and the distribution of contaminated materials into nearby surface sediments. Land subsidence resulting from groundwater withdrawal in |

| Comment No. | Section | Page | Line | Requested Change | Comment | Response to Comment - Proposed Revision |
|---|---|---|---|---|---|---|
| | | | | | Site. Material from the berm and from within the impoundment was subject to mobilization and redistribution by erosion resulting from tidal and river currents. Dredging activities in the area may have affected the Site. Mobilization of materials by dredging may have released sediment-associated contaminants to the water column that would have settled to the bottom. Determining the spatial extent of sediment contaminants from the impoundments is one issue that will be addressed in the RI/FS." | the 1970s contributed to the sinking of the impoundments. As a result of this event, contaminated material was **potentially** distributed and became potentially accessible to ecological receptors and to people at the Site. Material from the berm and from within the impoundment was subject to mobilization and redistribution by erosion resulting from tidal and river currents. Dredging activities in the area may have affected the Site. Mobilization of materials by dredging may have released sediment-associated contaminants to the water column that would have settled to the bottom. Determining the spatial extent of sediment contaminants from the impoundments is one issue that will be addressed in the RI/FS." |
| EPA20 | Section 1.4.3 | | | | Problem Definition and Overall CSM: Replace last sentence of the fourth paragraph, "Finally, characterization of the…" with: "Finally, characterization of the physical properties of the sediment surrounding the impoundments is needed to evaluate remedial alternatives at the location of the impoundments." | The text will be edited as requested. |
| EPA21 | Section 1.6.1 | | | Do not use a comparison to background in the risk-based screens to select chemicals of potential concern (COPCs). | Background Concentrations Used in the Risk-Based Screens: Generally background is not used during the initial screen of chemicals of potential concern (COPC). Background conditions should be noted in the screens but background COPCs should be taken though the risk assessment process and should be differentiated in the Risk Characterization. Note that EPA does not set cleanup levels below the background concentration. | Comparisons to background will not be used in risk based screens, and will not be considered in selection of COPCs. Related text in Section 1.6.1 and Figures 9, 10, and 11 will be modified to reflect this change.<br><br>According to agreement at the March 16, 2010, meeting between EPA, TCEQ, and Respondents to discuss these comments changes will be made to the process of analysis of chemistry results so that chemicals that are never detected or rarely detected will not require inclusion in the baseline risk assessments. Text will be added to Section 1.7.2 to indicate that a chemical that is detected in 5 percent or less of samples collected for this sediment study will not be considered COPCs. |
| EPA22 | Section 1.6.3 | | | Include TCEQ benthic invertebrate screening values in the Sediment SAP. | Benthic Macroinvertebrate Risk-Based Screen: The Texas Commission of Environmental Quality (TCEQ) benchmarks were used as a secondary source of screening level values (SLVs). The TCEQ screening levels should be presented for all chemicals whether or not an Effective Range Low (ERL) is available. EPA and TCEQ will appreciate the transparency of having State values being presented as well as ERLs. | The requested SLVs will be included in Table 10. |
| EPA23 | Section 1.8 | | | State that data developed by the Sediment Study will be used to confirm the existing data. | Comment #23: Section 1.8, Uncertainties and Data Gaps: Replace first paragraph, "Uncertainties and data gaps…" with: "Uncertainties and data gaps currently present in the dataset related to the Site are discussed below. The sediment study proposed in this document addresses the collection and analysis of new information to confirm existing data and to address and reduce the uncertainties in the existing data." | According to agreement at the March 16, 2010, meeting between EPA, TCEQ, and Respondents to discuss these comments, the word "confirm" in this comment will be replaced by the word "supplement."<br><br>The response to this comment addresses comments EPA 25 and EPA 31.<br><br>To address concerns voiced by agencies that Hurricane Ike could have altered sediment quality within the preliminary Site perimeter since August 2005 (when the majority of existing data were developed), Respondents agreed to compare the data generated by the Sediment Study with the 2005 data to determine if sediments are significantly different now than in 2005. The analyses to do this will be described in |

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| | | | | | | Section 1.9 and 1.10.1.2. The determination of the specific data that represents the baseline condition in sediment for the purposes of the Remedial Investigation will be determined on the basis of this comparison. |
| EPA24 | Section 1.8.1 | | | | Nature and Extent: Replace first paragraph, "Surface sediment concentrations of…" with: "Surface sediment concentrations of COPCs have been measured throughout the defined Study Area (Figures 4 and 6). The spatial resolution of these samples is fairly low; the average spacing between the samples collected in 2005 in a grid surrounding the impoundments for the TMDL program (University of Houston and Parsons 2006) is approximately 1,000 feet (305 m), and these data are only for dioxins and furans. The steepest spatial gradients of dioxin/furan concentrations are between samples collected from within the impoundment or on the shoreline of property west of the impoundments and samples that are approximately 1,000 feet (305 m) away (Figure 4). At distances greater than approximately 1,000 feet (305 m) from these two locations, the spatial gradient of concentrations appears to be much lower on the basis of the available data (Figure 13). Sediment conditions within 1,000 feet (305 m) of the impoundments and of the shoreline of property west of the impoundments are not well characterized." | The text will be edited as requested. |
| EPA25 | Section 1.8.1 | | | | Nature and Extent: Replace the first sentence of the second paragraph, "In addition, concentrations of…" with: "In addition, concentrations of dioxins and furans in sediment along the eastern and northeastern perimeter of the original impoundments are not well described by the existing dataset and need to be confirmed (Figure 4)." | The text will be edited as requested. Also see response to comment EPA 23. |
| EPA26 | Section 1.8.5 | | | | Engineering-Related Information: Replace first paragraph, "Additional information is required…" with: "Additional information is required to address the physical properties of sediments surrounding the impoundments to support a full evaluation of remedial alternatives, including the potential construction of a CDF within the Site or complete removal of the contents of the impoundments to be deposed offsite." | The text will be edited as requested. |
| EPA27 | Section 1.8.5.1 | | | | Geotechnical Data: Replace first paragraph, "A key component of…" with: "A component of the FS is developing an understanding if reestablishment of waste pit containment is feasible, either through reconstruction of the berms or by other appropriate measures or if removal of the waste contained in the impoundments is a more appropriate remedial alternative. Additionally, dredging of sediments in the river may be a potential remedial action; and therefore, the dredgability and materials-handling characteristics of the river sediments should be understood. The information used to evaluate these issues is geotechnical engineering data." | The text will be edited as requested. |
| EPA28 | Section 1.8.5.1 | | | | Geotechnical Data: Replace the second sentence of the second paragraph, "As described below, supplemental…" with: "As described below, supplemental geotechnical data are required in order to support assessment of the dredgability of river sediments, and to evaluate berm design and potential construction techniques." | The text will be edited as requested. |

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| EPA29 | Section 1.8.5.3 | | | | Waste Impoundment Containment: Replace first paragraph, "Geotechnical information is required…" with: "Geotechnical information is required to evaluate engineering considerations for the potential re-establishment of a containment system around the Site and to provide design information. Broadly, four categories of subsurface information are required for geotechnical engineering design: conventional geotechnical parameters, soil permeability, soil strength, and soil compressibility. Proposed containment berm side-slopes will need to be designed for static stability under various conditions (e.g., during construction and in the long term). In addition, potential settlement of the subgrade under the berm footprint and within the containment system itself will need to be considered during the FS." | The text will be edited as requested. |
| EPA30 | Section 1.9 | | | | Task Descriptions: Replace fourth bullet, "Study Element 4: Engineering…" with: "Study Element 4: Engineering Construction Evaluation. Data will be used to support design of remedial actions, including removal of contaminated sediments and the potential construction of an on-site CDF or removal of contaminated sediments for offsite disposal." | The text will be edited as requested. |
| EPA31 | Section 1.9.1 | | | | Study Element 1: Nature and Extent Evaluation: Replace first sentence of first paragraph, "Additional data on the horizontal…" with: "Additional data on the horizontal and vertical distribution of COPCs needs to be collected to confirm existing Site data and to address the data gaps associated with evaluation of the nature and extent of contamination (Section 1.8)." | See response to comment EPA 23. |
| EPA32 | Section 1.9.4 | | | A specific text insertion is requested. | Study Element 4: Engineering Construction Evaluation: Replace first paragraph, "This study element requires…" with: "This study element requires geotechnical information, characterization of dredgability of sediments, and information on the physical properties of sediments adjacent to the impoundments to support design of a potential containment system, such as a CDF, within the area of the impoundments as a potential long term remedial action." | The text will be edited as requested. This response also relates to comment EPA5. |
| EPA33 | Section 1.10.2.2 | | | Address the role of the limits of holding times in the discussion of the analytical approach.<br><br>State that ProUCL may be used in the analysis of data. | Analytical Approach: The analytical approach proposes to archive certain samples for later analysis. Please note that the decision to analyze the archived samples needs to be done quickly or the holding times for the analysis may be exceeded. In addition, the analytical approach states that the 95 percent upper confidence limit (UCL) will be used to calculate the exposure point concentration. EPA strongly recommends that ProUCL 4.0 be used to calculate the reasonable maximum exposure (RME) concentration for use in the risk assessments. ProUCL can be found here: http://www.epa.gov/esd/tsc/software.htm | The requested clarifications will be provided in Section 1.10.2.2. |
| EPA34 | Section 1.10.4 | | | A specific text insertion is requested. | DQOs for Study Element 4: Engineering Construction Evaluation: Replace first paragraph, "The RI/FS will address…" with: "The RI/FS will address the nature and extent of contamination and associated risks in the vicinity of the Site (Figure 5), and will result in plans for remedial actions. Additional information is needed to evaluate the feasibility of construction of a containment system, such as a CDF, within the area of the impoundments as a potential long term remedial action." | The text will be edited as requested. |

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| EPA35 | Section 1.10.4.1 | | | A specific text insertion is requested. | Statement of the Problem: Replace first paragraph, "The former impoundment containment…" with: "The former impoundment containment berms have been degraded through regional subsidence and erosional energy from the San Jacinto River. The impoundment containment needs to be re-established. By rebuilding the containment berms, there is a potential to create a replacement of sediments within the impoundment footprint that may have been resuspended and redistributed outside of the impoundment footprint and within the river channel. Geotechnical data are required to evaluate the feasibility of a CDF and containment design and construction elements as a potential remedial design. Evaluations include dredgability of the river sediments, berm design, and CDF design. Geotechnical information required includes conventional parameters, sediment permeability, sediment strength, and sediment compressibility. | The text will be edited as requested. |
| EPA36 | Section 1.10.4.1 | | | A specific text insertion is requested. | Statement of the Problem: Replace last sentence of second paragraph, "The data collection and…" with: "The data collection and evaluation will support feasibility, conceptual, and design studies for the impoundment area." | The text will be edited as requested. |
| EPA37 | Section 1.10.5 | | | A specific text deletion is requested. | Integration of Study Element Designs: Delete section. | The text will be deleted.<br><br>According to agreement at the March 16, 2010, meeting between EPA, TCEQ, and Respondents to discuss these comments, text will be added within discussion of data collection for each study element (Sections 1.10.1 through 1.10.4) to clarify where data collected for one study element will be used for addressing objectives of other study elements. |
| EPA38 | Section 2.2.1 | | | Change the design so that all sediment samples collected for evaluation of ecological exposure will be to a depth of 6 inches. | Surface Sediment Samples for Chemical Analyses: The surface sediment samples are proposed to be collected at two different depths (i.e., 4 inches for the nature and extent and ecological receptors exposure; 6 inches for human health exposure). However, one sediment depth of 6 inches should be collected for the nature and extent, ecological receptors exposure, and human health exposure. This is because the collection devices (e.g., petite-Ponar) are not precise enough to differentiate between 4 and 6 inch depths. Also, if only one sample depth is collected, the sample size potentially could be increased. | The requested change will be made to the study design, and reflected throughout the final Sediment SAP. |
| EPA39 | Appendix A | | | | Draft Sediment Field Sampling Plan, Section 1, Introduction: Replace the third paragraph "The primary objectives of…" with: "The primary objectives of the 2010 sediment study are to collect information on chemical concentrations and geotechnical properties of the sediment at the Site and to collect information for the nature and extent, exposure, and fate and transport analyses of the sediment from the impoundments. Chemicals of potential concern (COPCs) data will also be collected from upstream background areas near the Site. As discussed in the QAPP, sediment data will be used to support Site characterization, and risk assessments (i.e., human health and ecological) that will be conducted as part of the RI/FS." | The text will be edited as requested. |

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| EPA40 | | | | Add stations for performance of vane shear tests.<br><br>Subject deeper sediments to vane shear tests. | Supplemental engineering design considerations for Study Element 4: The anticipated number of samples to be taken is not explicitly justified per pertinent ASTM standards, and may be judged to be too few, given the dimensions and importance of the project. Specifically, only six locations and three depths are currently anticipated for VST (per Section 2.2.4, Vane Shear Testing). This seems inconsistent with the other planned tests (e.g., triaxial testing, per Table 12). Given that a major cost of Study Element 4's activity is mobilization of the equipment, a large enough statistical database must be generated from the less expensive VST tests, so that any data gaps in the more expensive testing (e.g., triaxial testing) may be reliably filled in. Also, additional depths from the current 3 ft maximum depth (per Table 15) to at least 20 ft maximum depth should be subjected to VST, so as to establish connections with other field testing, including the Standard Penetration Test (per Table 12). | As discussed during a March 23, 2010 conference call with EPA, the purpose of the VST data collection is to collect data for near surface sediments (specifically sediment shear strength) that cannot be addressed by the geotechnical boring explorations. When geotechnical borings are performed in soft marine sediments, the initial sample interval is typically a few feet below the mudline (or deeper) because the driller needs to set augers to a stable depth, and/or the sampler advances under its own weight. The VST is not intended to be correlated to deeper SPT blowcount or laboratory CU Triaxial strength test results. The hand-deployed VST that will be used is limited to shallower water depths (approximately 10 to 12 feet deep) and cannot be reliably advanced more than a few feet below mudline before the VST rods begin to bend.<br><br>In consideration of the comment about the amount of VST data that can be generated relatively cost effectively, additional VST sample stations have been added to gather a larger data set on near-surface sediment shear strength. The geotechnical exploration map (Figure 13) has been updated in the QAPP to reflect these additional stations, and clarifying text about the intended use of VST data has been added to the QAPP. |
| EPA41 | | | | Describe the potential containment system model, and describe how related fate and transport issues will be addressed. | Supplemental engineering design considerations for Study Element 4: A potential containment system model and corresponding input parameters should be described, such as a model like Long Term Fate of Dredged Material (a.k.a. LTFATE). Also, as an example of a missing parameter, no mention of measuring current groundwater discharge/recharge and seasonal fluctuations are provided. | Detailed evaluation of any specific remedy, such as a containment system, is appropriate only if a containment system is the selected remedy. The analyses and evaluations suggested in this comment will be considered during detailed design.<br><br>No specific changes will be made to the Sediment SAP in response to this comment.<br><br>This response also applies to comments EPA 43 and EPA 45. |
| EPA42 | | | | None | Supplemental engineering design considerations for Study Element 4: Are future erosion evaluation techniques, such as Sediment Erosion at Depth Flume (a.k.a. SEDFLUME) planned for any potential containment system? | The potential for use of Sedflume tests, and their application, if appropriate, will be discussed in a Technical Memorandum on Fate and Transport, to be submitted according to the schedule described in the RI/FS Work Plan.<br><br>No specific changes will be made to the Sediment SAP in response to this comment. |
| EPA43 | | | | Data suitable for evaluation of the use of geotubes are required. | Supplemental engineering design considerations for Study Element 4: Geotubes are planned to be part of a potential remedy evaluation and Geotube operations include pumping, polymer addition, and allowance of time to dewater. However, no polymer screening methodology is mentioned and no "hanging bag" tests were proposed for the Geotube evaluation. | See response to comment EPA 41. |

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| EPA44 | | | | Data suitable for evaluation of the use of ACBM are required. | Supplemental engineering design considerations for Study Element 4: Are there any geotechnical test specifically designed to evaluate the stability of potential barrier materials (e.g., ACBM) placed on the shoreline? This material can subside in fine grained material. | Barrier materials proposed as part of the Time Critical Removal Action (TCRA) include ACBM to stabilize sediments. The sediment's ability to support the ACBM will be evaluated using a bearing capacity analysis consistent with the ARCS methodologies developed for contaminated sediment capping design. Inputs for this analysis include the load of the ACBM, and the sediment shear strength, which will be measured at multiple locations using the Vane Shear Test (see response to comment EPA 40).<br><br>The ACBM system will likely include a geotextile underlayment that further helps to spread the load of the ACBM and reduces the potential for subsidence. |
| EPA45 | | | | Address the requirements for us of an onsite containment facility. | Supplemental engineering design considerations for Study Element 4: A containment system might be enhanced in performance if geotextiles and/or organophilic clays are incorporated as part of the potential containment system design. If organoclays are considered, both sorption isotherms and compression tests under load should be evaluated. | See response to comment EPA 41. |
| TCEQ 1 | | | | None | This is a multi-faceted work plan containing a diversity of elements expected to be addressed in greater detail in subsequent submittals; however, the document seems to propose significant decisions with minimal discussion or justification. These review comments begin to address these issues when they first arise in order to avoid future miscommunications or delays. | Comment noted. |
| TCEQ 2 | | | | None | It is important for the Remedial Investigation (RI) process to fully consider existing information generated about the Study Area and surrounding areas regarding dioxin contamination, including that data generated as part of the TCEQ Total Maximum Daily Load (TMDL) (e.g., project documents - http://www.tceq.state.tx.us/implementation/water/tmdl). These studies indicate widespread exceedances of Texas water quality standards for the water column and select tissue, sediment levels protective of fish ingestion and that sediment is the primary source of dioxin to the water column and tissue. Furthermore, initial source characterization data of atmospheric deposition, stormwater discharges and point source discharges indicate these sources provide minor explanations of the current dioxin concentrations in multiple media. | Comment noted. |

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| TCEQ 3 | | | | None | The dissolved water column concentrations of dioxin indicate partitioning to sediment may not be as dominant as expected, potentially indicating a dynamic exchange between pulp mill waste, affected sediment, sediment pore water and the water column – particularly in areas of high dioxin concentrations and low total organic carbon levels. This is supported by preliminary findings of fugacity ratio analyses indicating that the normal sorption gradient is reversed for some of the most toxic congeners, such that they can desorb from sediment to the dissolved phase (University of Houston et al., 2005). It is important for the RI/FS process (including Study Element 3: Physical Conceptual Site Model (CSM) and Fate and Transport Evaluation) to consider existing information when determining the media and processes that warrant further examination so that the CSM appropriately identifies and integrates the issues and processes at play within the Study Area. | Comment noted. |
| TCEQ 4 | Section 1.4.2.1 Existing Sediment Data | Page 9 | | Provide more discussion on the basis for determination of the preliminary Site perimeter, and the mechanism to be used to change it. | Text indicates that the preliminary site perimeter was identified in the 2009 Unilateral Agreed Order. TCEQ suggests that the text provide more discussion regarding the basis for this decision and any defined decision mechanism to change this as it is noted as "preliminary." | According to the discussion at the March 16, 2010, meeting among EPA, TCEQ, and Respondents to discuss these comments, the basis for the preliminary Site perimeter was a professional judgment by EPA, and any changes will be addressed in a like manner.<br><br>No specific changes will be made to the Sediment SAP in response to this comment. |
| TCEQ 5 | Section 1.4.2.1 Existing Sediment Data | Page 9 | | Clarify or change the definition of Study Area | To define the downstream limit of the Study Area (i.e., at the confluence with Houston Ship Channel at the San Jacinto Monument) based on the current limited understanding of processes at play within the Preliminary Site Boundary is premature. It is understood that additional evaluation will be performed as part of the RI/FS process, so it seems appropriate to reserve such a determination, except as preliminary, until adequate information is generated and/or justification is provided. | This comment is addressed by the response to comment EPA 4. |
| TCEQ 6 | Section 1.4.2.1 Existing Sediment Data | Page 10 | | Clarify or change the definition of Study Area | The second paragraph: "The confluence of the Houston Ship Channel with upper Galveston Bay at the San Jacinto Monument, approximately five miles downstream of the impoundments, is therefore considered to be the downstream limit of the local sediment data relevant to interpretation of data from the Site (Figure 5)" is not correct.<br><br>The channel joins Galveston Bay at Morgans Point, which is at least another eight miles from the San Jacinto Monument and Lynchburg Ferry, and at least 10 miles from the SJWP site. The Area of Concern (AOC) boundary indicated in Figure 5 is at the confluence of Buffalo Bayou with the San Jacinto River, which (from scale on map) is a little over 2 miles from the SJWP. The ship channel itself is in the San Jacinto River from Morgans Point up to Lynchburg, then follows Buffalo Bayou towards the west.<br><br>There are data from 2008 and 2009 that indicate polychlorinated biphenyls (PCBs) in sediment analyses from at least four sites within the AOC now available from a TMDL project. There | The first two parts of this comment are addressed by the response to comment EPA 4.<br><br>Data on PCBs in sediments at stations within the preliminary Site perimeter, available from the TCEQ's TMDL program, will be incorporated into the discussion describing the available data (Section 1.4.2.1). |

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| | | | | | were also 2002 PCB data from several sites in the San Jacinto River. All those data quantify all PCB congeners, not just Arochlors. The 2008 and 2009 data sets have been FTP'd to Anchor QEA. This document does not seem to recognize the existence of the TMDL PCB data.<br>The 2009 sediment grab sample at station 11193 (near the I-10 bridge) showed a very high PCB concentration. | |
| TCEQ 7 | 1.4.3 Problem Definition and Overall CSM | Page 12 | | The CSM should recognize the sediment – porewater-surface water interactions. | Text indicates that the overall issue to be addressed by the RI/FS, and by sediment sampling in particular, is to determine the horizontal and vertical distribution of pulp mill compounds associated with sediment originating in the impoundments. The CSM provided in Figure 7 does consider sediment releases to surface water and vice versa, but text does not acknowledge the need for the RI to evaluate the potential releases from sediment as pore water mixing into the water column and subsequent partitioning to upstream or downstream sediments or biological uptake from the water column. | Text describing the CSM (Section 1.4.3), and the associated figure will be modified to better address sediment – porewater- surface water interactions. |
| TCEQ 8 | Section 1.5.2 Characteristics of Sediments in the Impound-ments | Page 17 | | Recognize the potential for different rates of sediment-water partitioning by different chemicals and that these differences can affect congener patterns in sediments. | Text indicates the potential for use of patterns of dioxins and furans typical of the impoundments to provide a tracer or signal for impacts of pit material on area sediments. This approach is expected, but should also consider the potential for differential desorption of congeners to water and/or tissue potentially resulting in altered congener patterns, upon subsequent partitioning to sediment. | The fate of chemicals in the environment will be addressed by the Technical Memorandum on Fate and Transport, which will be developed as described in the RI/FS Work Plan.<br><br>No specific changes will be made to the Sediment SAP in response to this comment. |
| TCEQ 9 | Section 1.6.1 Background Concentra-tions Used in the Risk-Based Screens | Page 20 | | Do not use a comparison to background in the risk-based screens to select chemicals of potential concern (COPCs). | Numerous COPCs were screened out based on comparison to background concentrations, when present at concentrations greater than risk-based benchmarks. While this is not atypical, the background data sets used are not appropriate. As discussed in our meeting of January 20, 2010, the SSI data were not intended to support an RI as they were collected prior to our current understanding of the pits, and the TCEQ 85th percentile values are biased high because they are based on routine monitoring events conducted by TCEQ and its contractors, which typically target impacted water bodies. The TCEQ 85th percentile values in particular should not be used as background. Time constraints have not allowed evaluation of the USGS data. It may be prudent to remove the screen based on background, pending collection of appropriate data. Furthermore, our understanding is that EPA guidance does not allow COPC screening based on comparison to background except later in the risk assessment process. While we support a focus on potential risk drivers, the approach taken is questionable. | This comment is addressed by the response to comment EPA 21. |

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| TCEQ 10 | Section 1.6.2-Human Health Risk-Based Screen | Page 21 | | Clarify the role of TCEQ's TotSedComb values; and the screening process for PCBs.<br><br>Use the TEFs as updated by the World Health Organization in 2005. | COPC screening procedures appeared to be inconsistent with TCEQ Texas TRRP Rule, 30 TAC §350. TRRP has applicable TotSedComb PCLs available. When compared to the USEPA Region 3 Soil PRGs used for Human Health COPC screening, there were some COPCs which had a more conservative TotSedComb PCL available. However, when looking at the screening criteria, it appears the COPCs with the lower TotSedComb PCLs would still screen out.<br><br>It is unclear if total PCBs were screened out using congener specific data or arochlor data. Due to the potential for weathering to cause arochlors not to be detected when PCBs may in fact be present, the congener specific analysis should be considered prior to being screened out on arochlor analysis.<br><br>It is unclear if dioxin-like PCBs were considered in the dioxin TEQ, or which TEFs were used. The EPA September 2009 draft Recommended Toxicity Equivalency Factors (TEFs) for Human Health Risk Assessments of Dioxin and Dioxin-Like Compounds recommends the use of the consensus TEF values for 2,3,7,8-tetrachlorodibenzo-p-dioxin and dioxin-like compounds, including polychlorinated dibenzo-p-dioxins (PCDDs), polychlorinated dibenzofurans (PCDFs), and PCBs, published in 2005 by the World Health Organization (WHO). TRRP Figure: 30 TAC §350.76(d)(2)(B) indicates the TEFs to be used for dioxin-like compounds, which also includes dioxin-like PCBs. Although TRRP has not yet been revised to include the 2005 WHO TEFs, it is recommended that those TEFs be considered when calculating a TEQ, especially if they result in a higher TEQ.<br>Sediment concentrations to be protective of consumption of edible fish and shellfish do not appear to be included in this document. However, this pathway is an important one that the TCEQ would like evaluated. Evaluation with temporal and spatially related tissue and sediment data for this site should be considered. | TotSedComb values will be included in the table summarizing the human health risk based screen for selection of COPCs (Table 9).<br><br>Text describing the screening process will be clarified as to how the PCB screening was conducted (Section 1.6).<br><br>WHO 05 TEFs for mammals will be used to calculated TEQs in the RI. A list of TEFs to be used is presented in the RI/FS Work Plan. Dioxin-like PCBs will be included in the calculation of TEQs in the baseline risk assessments, as appropriate to the question being addressed (i.e., PCBs may not always be the subject of evaluation).<br><br>The risk based screens take a conservative approach to address exposure of human and wildlife receptors to chemicals of interest (COIs) via ingestion of foods by including a screening step that addresses the potential bioaccumulation of each chemical. This step is conservative because it does not require knowing or estimating the actual tissue concentration, just whether there's potential for bioaccumulation; if so, the COI is considered a COPC. Text will be edited to clarify this. |
| TCEQ 11 | Section 1.6.3 Benthic Macroinvertebrate Risk-Based Screen | Page 21 | | Include details of the toxicity of dioxins and furans to benthic invertebrates in the SLERA. | Since dioxin will be a part of the SAP analytical program regardless of the benthic screen and a detailed discussion of their toxicity to these organisms has not been provided, this issue and decision should be explored in detail within the SLERA. Be aware of interest in a range of invertebrate species within the Study Area, to include crab, shrimp and bivalves, as well as more traditional members (e.g., oligochaetes and amphipods) of the community. We note that the Barber et al. 1988 results are based on an acute toxicity test to a single species. A detailed literature review that supports a conservative screening value should be provided.<br><br>Additional comment, April 26, 2010:<br>Text indicates the SLERA provided as an Appendix to the RI/FS Workplan provides additional information on the proposed dioxin screening level. Review of the proposed screening of dioxin as a benthic chemical of concern is deferred until review of the SLERA is complete. This deferral in no way impedes implementation of the SAP. This information should be conveyed to respondents. | The requested evaluation is provided in the SLERA, in attachment 2 to that document, which appears as an Appendix to the RI/FS Work Plan.<br><br>The text of Section 1.6.3 will be modified to provide a cross-reference to the SLERA for that information.<br><br>Comment noted. |

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| TCEQ 12 | Section 1.6.4 Fish and Wildlife Risk-Based Screen | Page 23 | | Do not use a comparison to background in the risk-based screens to select chemicals of potential concern (COPCs). | The proposed screening process excludes PCBs as COPC for fish/wildlife based on site data being less than TCEQ tidal stream 85th percentile data. We note that EPA, 2008, which appears to be the most recent and relevant guidance on the TEF approach in ecological risk assessment, recommends that PCB congeners with dioxin-like toxicity mechanisms be included in determining total dose to fish and wildlife. Again, TCEQ 85th percentiles should not be considered background concentrations. | This comment is addressed by the response to comment EPA 21. |
| TCEQ 13 | Section 1.7.2 How the Sediment Study Addresses COPCs and Section 1.8.2.1 Human Exposure | Page 25 and Page 28 | | A receptor reflecting exposures of the "Trespasser" should be included. | It is stated that "If the secondary COPC does correlate with dioxins and furans, it will not be evaluated in the [BLRAs]." Whether or not a secondary COPC will not be evaluated in the BLRAs will depend on the relative concentrations between the secondary COPC and dioxins and furans for each sample. TCEQ will need to see the data to be sure the screening is appropriate.<br><br>Fishers, recreational visitors, and transient people are listed as the three human receptor groups. Although the trespasser will probably be similar, to be consistent with other pathway evaluations, the trespasser receptor should be included.<br><br>Additional Comment, April 26, 2010<br>Text indicates that dioxins and furans provide an appropriate indicator chemical group for the RI/FS. The section should be revised to state the primary COPCs will be evaluated in every sample. If in any sample the data user concludes no further action is warranted for the primary COPCs, the data user will then evaluate the secondary COPCs against the screening criteria to determine if the conclusion of no further action is confirmed for the sample location. | Comment noted; no change will be made to the Sediment SAP in response to the first part of the comment.<br><br>Exposure parameters suitable to represent the more highly exposed of a trespasser or transient will be used to address this receptor. The term "Trespasser" will be used to describe that receptor, in this document and in the RI/FS Work Plan.<br><br>Text in several locations of the SAP text and tables currently indicates that primary COPCs will be evaluated in every sample. Current text also indicates that data for secondary COPCs in newly collected sediment will be subjected to the screening evaluation, independent of any results for primary COPCs.<br><br>To better address the first part of the original comment, text has been added to the end of the second full sentence on page 26 :"…unless additional information indicates that risks should be evaluated for the chemical." |
| TCEQ 14 | Section 1.8.4 Fate and Transport-Related Information | Page 30 | | The CSM should recognize the sediment – porewater-surface water interactions. | The interactions between pulp mill wastes, affected sediment, sediment pore water and the water column in regards to transport and exposure to ecological receptors should be a component of the RI. | Text describing the CSM (Section 1.4.3) and the related figure will be modified to better address sediment – porewater- surface water interactions.<br><br>In the RI/FS work plan, more detailed CSMs are provided which clearly acknowledge the importance of porewater; and methods to address the assessment of sediment-porewater-surface water interactions are described |
| TCEQ 15 | Section 1.9.1 Study Element 1 – Nature and Extent Evaluation | Page 33 | | The text should indicate that subsurface chemistry will be considered in determination of any remedial action boundary. | Text states that the definition of a remedial action boundary is expected to be made primarily on the basis of PRG exceedances in surface sediment as it is the primary exposure source. This does not adequately consider the dynamic nature of area sediments due to storm events, the shallow nature of the water column and shipping disturbances. | The text of this section will be clarified to indicate that subsurface conditions will be considered in defining the boundary of any remedial action area(s). |
| TCEQ 16 | Section 1.10.1.2 DQOs for Study Element 1 – Analytical | Page 38 | | Acknowledge and implement TCEQ guidance on the use of the 95 % upper prediction limit to characterize chemical | Regarding characterization of background concentrations, current TCEQ policy on prediction limits is use of the 95% Upper Prediction Limit. | Text of this section will be modified to reflect TCEQ policy on the appropriate statistic to use to represent background. |

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| | Approach | | | concentrations in background areas. | | |
| TCEQ 17 | Section 1.10.1.3 Sample Collection Design | Page 39 | | Collect core samples within the impoundments. | Text indicates coring will not be conducted within the impoundment because the area is expected to be reconstructed as a Confined Disposal Facility for dredged material and the impoundment itself will not be dredged. Given that an adequate alternatives analysis is expected for the disposition of the pits, it is unclear how the proposed sampling scheme within the pits is capable of determining current waste volume in order to evaluate potential off-site treatment and/or disposal options. Core samples should be collected from the impoundment areas. | This comment is addressed by the response to comment EPA 5. |
| TCEQ 18 | Section 1.10.1.3.1 On-site Chemical Distribution Samples | Page 39 | | Collect additional cores in areas where mechanisms that can expose deeper sediments might occur. | The discussion indicates that cores for nature and extent characterization will be collected at a subset of 10 of the high intensity sampling locations, focusing on locations closest to the impoundment (Figure 15). TCEQ suggests that the potential for prop scouring and navigational dredging, as mechanisms that can expose deeper sediments, should be factored into the location and number of sample locations designated for core sample collections, since preliminary results indicate high concentrations occur at depth. | Areas where navigation dredging and propeller scour could expose deeper sediments occur at stationsSJNE007 (as revised) and SJNE008. Additional cores at these locations will be planned in consultation with TCEQ and EPA, and the figure and text describing sampling for characterization of the nature and extent of contamination will be modified accordingly. |
| TCEQ 19 | Section 1.10.1.3.2 Background Samples | Page 40 | | None.<br><br>Provide more descriptive detail on the conditions upstream that could affect environmental quality in the proposed upstream sampling area, and better justification for the placement and number of background stations. Do not place background stations near known sources.<br><br>Be cautious in planning sampling of fish or other mobile | Regarding the general locations of proposed background samples, text states that locations are below the channelized portion because conditions are more similar to those at the pits. Location of background samples is an important design element as background risk will be developed to gauge what risk would be present in the absence of the pits.<br><br>Detailed justification is needed that considers existing analytical data for the proposed area, congener proportions, the presence of historical spills; as well as analysis of transport issues, including tidal movement and transport as suspended solids, water column and biological movement. Discussion should include the rationale for the location and number of background sample locations considering the nature of the activities surrounding the sample location(s) and any nearby potential sources of contamination (e.g., railroad right-of-way). Background sample locations should not be established at locations directly influenced by or in close proximity to obvious sources.<br><br>Furthermore, should the proposed area be determined appropriate for bulk sediment background determinations, the potential for future collection of mobile tissue from this area is likely to have considerable technical issues. | Comment noted.<br><br>Data for sediment chemistry, water chemistry and sources upstream of the Site will be summarized and discussed in the text addressing existing data for background conditions (1.4.2.1). Text in Section 1.10.1.3.2 will address the need to evaluate the possibility that the Site has influenced sediment quality in the upstream background area as part of the process for evaluating the suitability of that area as representing background.<br><br>Collection of tissue will be addressed in the Tissue SAP, to be prepared as described in the RI/FS work plan. No specific changes will be made to the Sediment SAP in response to this part of the comment. |

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| | | | | species. | | |
| TCEQ 20 | Section 1.10.2 DQOs for Study Element 2: Exposure Evaluation | Page 41 | | Water should be considered. | Text states "the RI/FS will address risks to human and ecological receptors associated with contamination of San Jacinto River sediments at the Site." Granted, this is a bulk sediment sampling plan, but it is laying the foundation for several future submittals. Note that water is a significant media of concern within the Study Area, as it is a bioavailable media previously shown to be affected per TCEQ TMDL project documents. | This comment is addressed by the response to comment TCEQ 7. |
| TCEQ 21 | Section 1.10.2.2 Analytical Approach (Characterization of exposures to ecological receptors on the Site) | Page 42 | | Use the 95%UCL as the EPC for wildlife. | The discussion indicates that the exposure profile will consist of a measure of the central tendency concentration, and the statistics to be used for these (e.g., the mean vs. the median for the central tendency) will be determined after the chemistry data have been evaluated to identify the most appropriate representation for these areas. TCEQ guidance suggests that the 95% Upper Confidence Limit be used as the exposure point concentration for most wildlife receptors. | Methods for exposure assessment and risk assessment are provided in the RI/FS Work Plan.<br><br>No specific changes will be made to the Sediment SAP in response to this comment. |
| TCEQ 22 | Section 1.10.2.2 Analytical Approach (Characterization of exposures to ecological receptors on the Site) | Page 42 | | Ingestion of tissue should be considered. | Text indicates that concentrations of COPCs in intertidal sediments from the shoreline areas listed will be used to characterize the exposure profiles in each area for each bird and mammal receptor, and for near shore-dwelling fishes. This may be appropriate for incidental ingestion of sediment but does not address the prey to wildlife and fish only pathways. | Collection of tissue will be addressed in the Tissue SAP, to be prepared as described in the RI/FS Work Plan.<br><br>No specific changes will be made to the Sediment SAP in response to this comment. |

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| TCEQ 23 | Section 1.10.2.2 Analytical Approach (Characterization of exposures to ecological receptors on the Site) | Page 43 | | Clarify calculation of EPCs from proposed samples. | It is unclear why only nine intertidal sediment samples designated for ecological exposure characterization are proposed, particularly in relation to the number of locations proposed for human health exposure characterization. It is also unclear that the proposed sample locations are adequate to allow interpolation of data (i.e., kriging) throughout the Site. Also, please clarify the intent on development of an exposure point concentration for these data. | Because of changes to the depth of exposure-related sediment samples (see response to comment EPA38), surface samples collected for evaluation of human exposures can be used for evaluation of exposures to ecological receptors.<br><br>Methods for evaluating exposures are addressed in the RI/FS Work Plan.<br><br>No specific changes will be made to the Sediment SAP in response to this comment. |
| TCEQ 24 | Section 1.10.2.2 Analytical Approach | Page 42 | | Add stations for evaluation of human exposures to the shoreline between the impoundments and the upland area to the west of the impoundments. | The "mitigation area" associated with the dredging permit and the northwestern property also looks like a place where people may access the shoreline by foot. It is TCEQ's understanding that the mitigation area was built up using sediment produced by the sand dredging operation, so it may be contaminated, but the mitigation area is closer to I-10. Historic aerial photos show the mitigation area to have been built up during 1998-2005, in the same period when the sand dredging work was active. Figure 17 indicate the mitigation area would be sampled for "ERA Surface Sediment (Primary COPCs)", but much less intensively than the three human use sites listed above. Perhaps the mitigation area needs more sampling or consideration for human use and exposure. | This comment is addressed by the response to comment EPA 9. |
| TCEQ 25 | Section 1.10.2.3 Sample Collection Design | Page 45 | | | The focus on surface sediment sampling (i.e., 0-4 inches) may not be appropriate for this particular site if it is too shallow to represent the biologically active zone. We note the relatively sandy substrate and that invertebrate burrows, potentially deeper than four inches have been observed at the pits. The biologically active zone can probably be represented by the upper six inches, which will allow select intertidal locations to be used to characterize exposure to both human and ecological receptors. | This comment is addressed by the response to comment EPA 38. |
| TCEQ 26 | | | | Characterize subsurface sediment for evaluation of exposures to ecological receptors. | Furthermore, the basis for proposing a single depth for each intertidal sample for ecological characterization is unclear. The potential for disturbances to surface sediment (i.e., storm events, shipping, biological) and potential risk management indicate a similar need for samples at depth as those proposed for the human health exposure characterization. | The baseline risk assessments are conducted to provide a realistic, Site-specific evaluation of risk under current conditions. Exposure scenarios and the risk evaluation should be reasonably realistic. Ecological receptors are not expected to be routinely exposed to sediments below 6 inches deep.<br><br>No specific changes will be made to the Sediment SAP in response to this comment. |

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| TCEQ 27 | Section 2.4.1, Physical Properties and Geotechnical Analyses and Section 4.1, Criteria for Data Review, Verification and validation | Page 61 and Page 75 | Third paragraph | Use the specifications of the method cited in characterizing TOC in sediment samples. | Statements are made that total organic carbon (TOC) in sediment will be analyzed using a modified version of EPA Method 9060A but quadruplicate TOC analyses (as specified in the method) will not be required for this project.<br><br>However, since there is a high degree of variability associated with the determinative technique utilized in EPA Method 9060A (i.e. the instrument is simply counting carbons via either an infrared or flame ionization detector following catalytic combustion in an induction furnace) and the method is being modified for sediment matrices which will likely be somewhat heterogeneous in composition, quadruplicate TOC analyses are warranted as specified in Section 7.6 of the method. Additionally, Section 8.4 of the method requires one spiked duplicate sample be analyzed for every ten project samples, not simply the analysis of one laboratory duplicate per 20 samples as stated in the SAP. Lastly, if the dioxins/furans results are to be normalized based on TOC as a measure of bioavailability, the end data use of the TOC data is critical and justification is warranted for the above significant deviations from the analytical method. | Method specifications will be followed. Text will be clarified in this section. |
| | | | | | TCEQ recommends that if the project QC acceptance criterion has been established for the evaluation of field split sample results and the RPD results will be tabulated, then at a minimum, detected results associated with the field split sample pairs should be qualified as estimated in instances where the project QC acceptance criterion is exceeded. | USEPA National Functional Guidelines (NFG) do not specify the use of field splits in defining acceptance criteria, and project QC acceptance criteria have not been established. Field split RPDs greater than 50 percent will be summarized, but data will not be qualified based on field splits. |
| TCEQ 28 | Exhibit 52 Method Selection Worksheet | | | Provide citation. | Please provide the source and endpoint for the “concentration of concern or PRG” provided for 2,3,7,8-TCDD ng/kg TEQ 3.11 ng/kg. | A citation for the source of this value will be provided. |
| TCEQ ADDITIONAL COMMENTS 1 | Figure 3 | | | Address the locations of wetlands and other habitats nearby. | Land Use Map is hard to interpret, but it seems to place coastal wetlands into a category called “Farm Ranch Lands” or another category. The existence and location of wetlands and other ecological habitats in the vicinity of the site should be acknowledged. | The figure showing land uses will be replaced with a figure showing habitats, and will be cited in Section 1.4.1. |
| TCEQ ADDITIONAL COMMENTS 2 | Figure 14 | | | Correct the figure. | The figure incorrectly labels wetlands within the impoundment as “uplands”. | The figure will be corrected. |

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| TCEQ ADDITIONAL COMMENTS 3 | Figure 15 | | | Better characterize materials in the impoundments<br><br>Take cores within the impoundments<br><br>Take a core at station SJNE032<br><br>Samples that are on the grid, but which appear to be placed on land, should be moved to be in the water. | Several suggestions to improve the quality and usability of the data generated:<br><br>Need surface COPC samples in both pits to characterize the source materials. Although a few samples have been collected in the impoundments, they have been sporadic in location and did not adequately characterize secondary COPCs. Should also ensure that the samples from within the impoundments are not located on old levees.<br><br>Need core samples from both impoundment areas to determine the nature and extent of the materials in the pits. These core samples should also characterize the levels of contamination in native sediment layers under the waste material. This information is needed to evaluate other alternatives to the construction of a CDF and to evaluate the likelihood of contaminant migration into groundwater or sediment layers below the pits.<br><br>The sample at SJNE032 should be a core sample. The depth of contamination in this delta feature will likely differ from that in the other "ambient" cores.<br><br>The grid pattern places the samples SJNE018, SJNE013, SJNE002, and SJNE007 near or on land in the area of the barge activities downstream of the I-10 bridge. These samples should be moved into deeper water where appropriate in order to better characterize distribution of site contaminants. | This comment is addressed by the response to comment EPA 5.<br>This comment is addressed by the response to comment EPA 5.<br>This comment is addressed by the response to comment EPA 7.<br>The following changes to the locations of samples will be made, and will be reflected in revisions to Figure 15:<br><br>SJNE013, will be moved 500 feet south along the grid line<br>SJNE018 will move in the channel, and come off the grid (it will be a focused sample)<br>SJNE007 will move 500 feet to the west along the grid line<br>SJNE002 will move 500 feet to the east along the grid line |
| TCEQ ADDITIONAL COMMENTS 4 | Figure 16 | | | Move stations for assessment of ecological exposures in upstream areas (SJSJ050, SJSH051, SJSH052) away from the railroad bridge. | The ecological samples SJRH050, SJRH051, and SJRH052 are too close to the railroad bridge. (See TCEQ comment 19.) These samples should be further upstream near the SJSH031 sample area. | This comment is addressed by the response to comment EPA 8. |
| TCEQ ADDITIONAL COMMENTS 4 | Figure 17 | | | Extend the line of stations for evaluation of human exposures on the shoreline area to the south of the I-10 bridge to the shoreline area further south on the eastern bank of the San Jacinto River. | Human health samples on the east side of the river should extend further south onto more natural shoreline and not be located just in the armored shoreline near the bridge. On the west side of the bridge, the more natural shoreline is north of the bridge and the samples should reflect this. | This comment is addressed by the response to comment EPA 11. |

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| TCEQ New Comment April 26, 2010 | | Figure 6 | | Show distinctions in recreational and subsistence fishers<br><br>Show surface water as a complete exposure pathway for recreational visitors. | In this diagram, a distinction needs to be made between the recreational and subsistence fisher pathways, and both pathways need to be evaluated. Under the recreational visitor surface water is considered an incomplete exposure pathway. Surface water needs to be considered as a complete exposure pathway for recreational visitor. Additionally, the complete exposure pathway is indicated as being either significant or minor. Despite this distinction, all complete pathways, whether or not they were identified as significant or minor, will need to be fully evaluated. | The different types of human and ecological receptors are not specified in the SAP. The first detailed information on this is provided in the draft RI/FS Work Plan, and will be elaborated further in related risk assessment documents, as described in Section 8 of eth RI/S Work Plan. For this document, a distinction among different types of fishers is not relevant and will not be added.<br><br>The figure will be edited to show that surface water is a complete and minor pathway for the recreational visitor, |
| T 1 | | Page 16 | Last paragraph, 2nd Sentence | Consider the role of liquid effluents in defining COIs. | This sentence indicates that data on liquid effluents from pulp mills derived from Suntio et al (1988) was not used in the COI screening process because liquid effluents and liquid wastes were removed from impoundments at the site. Previous presentations by Anchor QEA indicated that solid and liquid pulp mill wastes were likely to have been placed in the western impoundment and decanted into the eastern impoundment. The discussion on Page 7, second paragraph describes a drain line which allowed flow of excess water from the west impoundment to the east impoundment. These descriptions suggest that:<br><br>a. Liquid effluent may have been retained in the west impoundment if liquid levels were below the drain line. Depending on the characteristics of the COI, retained liquid may have led to sedimentation or similar processes which caused the COI to be permanently retained in the west impoundment,<br><br>b. Liquid effluent may have also been retained in the east impoundment, and<br><br>c. Liquid effluent may have entered the river when liquid levels exceeded impoundment levees due to precipitation, subsidence, or erosion.<br><br>Recommend that the chemicals in Suntio et al (1988) be added to the COI screening process. | Data from Suntio et al (1988) will be included in the evaluation of COIs. The text in Section 1.5, and results of related analyses including tables, will be modified accordingly. |
| T 2 | Section 1.61 | Page 20 | | Do not use a comparison to background in the risk-based screens to select chemicals of potential concern (COPCs). | Neither the NURE or the Texas Water Quality databases are likely to contain any significant sediment data on pulp and paper mill wastes that will be useful as background (See Table 10). It is not clear that the procedure described in the SAP will be appropriate given the lack of a robust data set.<br><br>Some consideration needs to be given to collecting background sediment samples in nearby streams that are not potentially impacted by the site. | Background samples should be collected in an area that represents the physical environment of the Site as much as possible and small streams do not represent a physical environment comparable to that of the Site. TCEQ has an adequate database of sediment conditions within smaller streams.<br><br>According to the discussion at the March 16, 2010, meeting among EPA, TCEQ, and Respondents to discuss these comments, no specific changes will be made to the Sediment SAP in response to this comment. |

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| T 3 | Section 1.10.2 | Page 42 | | Cores at stations for evaluation of human health should be taken to the depth of the original soil profile. | The proposed maximum depth of 6 – 12" for the samples labeled SJSH 11-20 may be insufficient for characterizing either human or ecological risk. This property has been constantly reworked – receiving sand from dredging and removing sand by barge and truck - for delivery to other areas. As such the depth of contaminated sediments may be greater than 12".<br><br>Coring should be performed to identify the original soil profile and samples should be taken to that depth. | The baseline risk assessments are conducted to provide a realistic, Site-specific evaluation of risk under current conditions. Exposure scenarios and the risk evaluation should be reasonably realistic. Human receptors are not expected to be routinely exposed to sediments below 12 inches deep.<br><br>Cores for nature and extent will be taken to the depth of the original soil profile.<br><br>According to the discussion at the March 16, 2010, meeting among EPA, TCEQ, and Respondents to discuss these comments, no specific changes will be made to the Sediment SAP in response to this comment. |