FIELD SAMPLING PLAN

Elliott Ditch
Lafayette, Tippecanoe County, Indiana

Prepared for:
Alcoa
3131 Main Street
Lafayette, IN 47905

Prepared by:
Tetra Tech, INC.
630 Riverfront Drive
Sheboygan, WI 53081

February 2, 2016

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LIST OF ABBREVIATIONS AND ACRONYMS

ALO	Alcoa's Lafayette Operations
C	Degrees Celsius
COC	Chain of Custody
FSP	Field Sampling Plan
GPS	Global Positioning System
HASP	Health and Safety Plan
IDEM	Indiana Department of Environmental Management
mg/kg	Milligram per kilogram
MS	Matrix Spike
MSD	Matrix Spike Duplicate
NRCS	Natural Resource Conservation Service
oz	Ounces
PCBs	Polychlorinated Biphenyls
PPE	Personal Protective Equipment
ppm	Parts per Million
PRP	Potentially Responsible Party
QAPP	Quality Assurance Project Plan
QA/QC	Quality Assurance/Quality Control
RPM	Remedial Project Manager
SOP	Standard Operating Procedure
TSCA	Toxic Substances Control Act
Tt	Tetra Tech
USCS	Unified Soil Classification System
USDA	United States Department of Agriculture Soil Classification System
USEPA	United States Environmental Protection Agency

1. INTRODUCTION

Elliott Ditch is a tributary to Wea Creek, which is a tributary to the Wabash River, downstream of Lafayette, Indiana (Figure 1). In addition to its base flow, Elliott Ditch receives wastewater discharges through an outfall (Outfall 001) from Alcoa's Lafayette Operations (ALO). These discharges include treated sanitary and industrial process water, as well as storm water. The distance from the outfall to the Wabash River is 7.5 miles. The distance from the outfall to the Elliott Ditch and Wea Creek confluence is 4.1 miles. This Field Sampling Plan (FSP) is focused on the area from the outfall (Milepost 0.0) to Milepost 1.59, the end of the channelized portion of Elliott Ditch.

Tetra Tech performed a geomorphology and depositional pattern assessment of Elliott Ditch (between Alcoa's Outfall 001 and Wea Creek) and the surrounding floodplain in Lafayette, Indiana in 2013 and 2014. Assessment work proceeded, over this period, on an iterative basis. In 2013, preliminary geomorphic surface mapping (desktop) was conducted to evaluate the depositional/erosional pattern in the channel and surrounding floodplain. Field work included a detailed survey of the upstream 0.5 mile of Elliott Ditch and the 100-year floodplain to complete detailed channel profiles. In 2014, the desktop geomorphic surfaces were field confirmed and edited to reflect the field conditions.

The objective of this FSP is to support a site conceptual model to understand the distribution of potential PCB impacts in Elliott Ditch and the adjacent floodplain caused by historical releases from Alcoa's storm water outfall. This objective will be met by poling and GPS readings to define the horizontal and vertical extent of fine grained deposits in-channel, sediment sampling to characterize the sediment profile, soil sampling to characterize the soil profile and sediment and soil analytical samples to determine the presence/absence and concentration of PCBs.

The purpose of this FSP is to describe site-specific tasks that will be performed in support of the stated objectives. The FSP will reference the Quality Assurance Project Plan (QAPP) for generic tasks common to all data collection activities including routine procedures for sampling and analysis, sample documentation, equipment decontamination, sample handling, data management, assessment, and data review. Any deviations or modifications to the approved FSP will be documented using Table 1: FSP Revision Form.

1.1. Problem Definition

Polychlorinated Biphenyls (PCBs) are present in the Elliott Ditch watershed from the Alcoa Outfall to the County Road 350 South Bridge based on sediment samples collected by Anchor QEA in 2004 and 2010. The PCB concentrations range from <1 ppm to 27 ppm at sample locations. The horizontal and vertical extent of the PCB concentrations are currently not understood within the channel or floodplain.

The natural processes of a flowing stream develop a pool and riffle system which means the channel gradient will alternate from a relatively steeper gradient (riffle) to a relatively shallower gradient (pool). The lengths of a stream’s pool and riffle system are affected by a number of stream characteristics including; channel width, channel bed type, floodplain width, water velocity, sediment load, and sinuosity. The pool and riffle system is unique to each stream and also variable within a single stream. An effective sampling strategy requires an understanding of the pool and riffle system for the given stream.

The fate and transport of PCBs is dictated by their affinity to adsorb to silt and clay size particles in the stream system. The silt and clay size particles stay in suspension in a stream until the velocity drops to near zero for a number of hours. The silt and clay particles can be re-suspended with an increase in water velocity. Since PCBs adsorb to sediment, the PCB deposition pattern corresponds to the deposition of the fine-grained sediments. Within the pool and riffle system, the silts and clays typically deposit in the pools (shallower stream gradient) and not within the riffles.

The stream’s geomorphic and anthropogenic characteristics define the depositional patterns within the channel and on the adjacent floodplain. Streams are linear features that vary longitudinally (pool and riffle system), vertically due to varying water depths, and horizontally within the channel (thalweg vs. point bars) and on the floodplain due to elevation changes and historic stream development (floodplain and terraces). A fluvial environment like Elliott Ditch is not homogeneous, therefore,, a biased sampling approach based on an understanding of the silt and clay (fine-grained) deposition pattern is the most effective approach to define the horizontal and vertical extent of contamination.

1.2 Project Management

The following personnel will be involved in planning and/or technical activities.. Each will receive a copy of the approved FSP. A copy of the FSP will also be retained in the site file.

Personnel	Title	Organization	Phone Number	Email
Robert Prezbindowski	Alcoa Project Manager	Alcoa	(865) 977-3811	Robert.Prezbindowski@alcoa.com
Dave Richardson	Senior Fluvial Geomorphologist	Tetra Tech	(920) 634-5531	Dave.Richardson@tetratech.com
Heather Phelan	Tetra Tech Project Manager	Tetra Tech	(920) 857-8422	Heather.Phelan@tetratech.com
Don Stilz	Senior Environmental Manager	Indiana Dept. of Env. Management	(317) 232-3409	DSTILZ@ idem.IN.gov
Jean Greensley	Geologist	USEPA Region V	(312) 353-1171	Greensley.Jean@epa.gov

2. PROJECT DESCRIPTION

2.1 Site Location and Background

Elliott Ditch is located in the Wabash River Basin in Tippecanoe County, IN, and flows west into Wea Creek, a tributary of the Wabash River. The streams of the Wabash River Basin formed in glacial outwash deposited during the Pleistocene epoch. During the Pleistocene, various glaciations leveled plains and filled in valleys, resulting in a gently undulating plain. As glaciers receded, meltwater streams cut drainage ways and stream valleys that drain toward the Wabash River. The streams draining the Wea Plains (which includes Elliott Ditch), were formed after glaciers receded from the area. Generally, the topography of the area is relatively unchanged by stream development since glaciation, as most streams are typically shallow and have gently sloping gradients. Glacial landforms (e.g. kames, eskers, swales, etc.) are plentiful (USDA, 1958).

Review of the aerial photographs provided by Alcoa reveals that Elliott Ditch formed sometime before 1939 since the Ditch is clearly visible in the 1939 aerial photo. The 1939 aerial suggests that at least part of Elliott Ditch originated as a naturally formed stream that was later modified by human activity. The stream appears to be free flowing and naturally meandering along the western portion of the stream in 1939. Some channelization may have occurred prior to the photo because the stream channel appears abnormally straight where Elliott Ditch crosses the railway.

Elliott Ditch is a tributary to Wea Creek, which is a tributary to the Wabash River, just downstream of Lafayette, Indiana (Figure 1). In addition to its base flow, Elliott Ditch receives wastewater discharges through an outfall (Outfall 001) from Alcoa's Lafayette Operations (ALO). These discharges include treated sanitary and industrial process water, as well as storm water. The distance from the outfall to the Wabash River is 7.5 miles. The distance from the outfall to the Elliott Ditch and Wea Creek confluence is 4.1 miles. This FSP is focused on the area from the outfall (Milepost 0.0) to Milepost 1.59, the end of the channelized portion of Elliott Ditch (Figure 2).

The geomorphic surface mapping completed for Elliott Ditch suggests that Elliott Ditch has eight distinct reaches (erosional/depositional regimes):

- Reach 1: Outfall 001 to downstream of the railroad bridge (Transects 1-14)
- Reach 2: Transect 14 to the South 18th Street Bridge (Transect 19)
- Reach 3: South 18th Street Bridge to upstream of the 9th Street Bridge (Transects 19-30)
- Reach 4: South 9th Street Bridge (Transect 30) to Transect 39, located north of Brookside Drive
- Reach 5: Transect 39 to Transect 50 (located downstream of Poland Hill Road)
- Reach 6: Transect 50 to Transect 60 (located downstream of the Old Romney Road Bridge)
- Reach 7: Transect 60 to Transect 64 (located upstream of US Highway 231 South Bridge)
- Reach 8: Transect 64 to Transect 66 (Elliott Ditch –Wea Creek confluence)

This FSP is focused on Reaches 1 – 3 or the upstream 1.59 miles downstream of Outfall 001 (Figure 3).

2.2 Target Analyte - PCBs

Samples of fish, water, and sediment collected in the 1980s from Elliott Ditch and Wea Creek indicated that PCBs were present in these media. In response to these findings, Alcoa pursued two approaches to reducing PCB levels in fish from Elliott Ditch and Wea Creek: in-stream remediation and source reduction. In 1990, Alcoa remediated sediments in the first mile (to the 18th Street Bridge). Then, in the late 1990s, Alcoa instituted a wastewater management program, which significantly reduced flow to Outfall 001 through removal of non-contact cooling water. To further reduce PCB loadings to Elliott Ditch, Alcoa began to treat its dry weather discharge to Elliott Ditch using canister filter systems in January 2000. In 2007, Alcoa developed and implemented a Natural Media Filtration treatment process. These actions have reduced PCB loadings from Outfall 001 by at least tenfold (Anchor QEA 2009).

PCBs are present in the Elliott Ditch watershed from the Alcoa Outfall to the County Road 350 South Bridge based on sediment samples collected by Anchor QEA in 2004 and 2010. The PCB concentrations range from <1 ppm to 27 ppm at sample locations. The distribution of the PCB concentrations are currently not well understood within the channel or floodplain.

3. INVESTIGATION STRATEGY

The soil and sediment investigation for Elliott Ditch is designed with geomorphic principals which dictate the strategy for sample location and sample intervals. The first step is using fluvial geomorphology to define the erosional and depositional patterns for Elliott Ditch and its floodplain. This process started as a desktop review of aerial photographs and topographic maps to determine preliminary geomorphic surfaces on the Elliott Ditch floodplain. The desktop review was supplemented with a field survey to verify and review the preliminary mapping. The boundaries were documented in the field using a GPS. The results of the geomorphic mapping were used to develop the sample transects and sample locations perpendicular to the stream. The distance between transects varies based on the complexity of the local fluvial geomorphology. The geomorphic surfaces represent areas of similar depositional or erosional characteristics and these surfaces are important in the interpretation of the field sampling results.

A second step of the investigation strategy is the use of geomorphic characteristics of Elliott Ditch to determine the area of investigation. The Elliott Ditch area of investigation includes the channel and the floodplain and terrace surfaces up to the upland boundary. The in-channel area includes the parts of the ditch that have deposits of silt and clay because PCBs absorb to these particle sizes. In the overbank areas, flood deposits on the floodplain and terraces during and after the time of release are subject to PCB deposition.

After the geomorphic surface mapping was field confirmed, a broad review of Elliott Ditch and the geomorphic surfaces allowed reaches to be mapped based on the similarity of geomorphic setting, anthropogenic features, and/or stream/floodplain characteristics. For example, the 2016 FSP area was selected based on the portion of Elliott Ditch that was anthropogenically straightened, Reaches 1 – 3. This part of the ditch is relatively straight, incised, and has limited geomorphic surface development. Although there will be some variability, the deposition pattern for Reaches 1 – 3 will be similar.

A third criteria of the investigation strategy is to determine what portion of the channel and overbank could be remediated in a single field season. Rivers and streams flow continuously so conducting an investigation that will not be remediated within a short period of time may alter the original deposition pattern if a significant flood event impacts the watershed. The objective is to investigate an area and define the depositional pattern during one field season, remediate the investigated area the following field season and investigate the next downstream portion of the stream while the remediation is being conducted on the adjacent upstream segment.

The sample locations are selected in depositional areas to define the concentration and extent of the target analyte. An important part of the sampling strategy is to sample in areas that are not depositional to prove they do not include the target analyte. This approach allows for a confirmation of the erosional surfaces and a confidence that the fluvial geomorphology of the stream is accurate. The sampling strategy is designed to allow for iterative sample locations to be incorporated into the FSP based on data obtained during the field work and from the analytical results. For example, if the lab results from a sample location at the end of the sample transect (away from the channel) contains PCBs above the target cleanup level, an additional sample location(s) may be added to define the horizontal extent.

In order to fully understand the spatial distribution of PCBs within the investigation area we must also define the vertical extent of PCBs. Target sample depths have been defined for each sample location based on the NRCS Soil Survey mapping. The soil survey provides the typical profile thickness to the parent material or C horizon. The target depths are conservative to attempt to obtain a clean horizon with only one sampling mobilization to a location. Although a longer soil profile will be collected and logged, the sample selection and laboratory analysis will be iterative based on the soil profile characteristics. For example, a soil profile may be sampled into the C horizon but during the logging it is decided to only submit the A horizon for lab analysis. If the A horizon contains PCBs above the target cleanup level, the B horizon will be submitted. If the B horizon has a concentration below the target cleanup level, the vertical boundary has been defined and the C horizon will not be submitted for analysis.

Sample intervals will vary based on the thickness of the soil horizon/sediment layer. The focus of this investigation is to understand the deposition pattern and the best way to accomplish this is to sample specific soil horizons or sediment layers regardless of their thickness. Soil horizons/sediment layers form under specific conditions which creates a unique horizon/layer. A change in conditions means a change in the horizon/layer. An exception to this sampling approach will be made if a horizon/layer is greater than 12 inches thick, the horizon/layer will be sampled by its top half and bottom half to gain a detailed understanding of the vertical extent of contamination.

The horizon/layer based sampling provides a context of the geomorphic and pedogenic (soil profile) environment and it is easier to characterize the PCB distribution.

The fluvial geomorphology approach is beneficial to determine where PCBs are located in Elliott Ditch and its floodplain but more importantly, why the deposits are located where they are. In any investigation, a limited number of sample locations are collected to characterize a large area. It is important to have a scientific way to interpolate or extrapolate data from where it was collected to the other areas of the project.

4. PROPOSED SCHEDULE

Upon verbal approval of the FSP, the QAPP and Health and Safety Plans will be prepared. The FSP field work can begin after snow melt and the spring flooding period. The preliminary start date based on flow conditions is mid-May 2016.

The results of the field work and chemical analysis will be prepared in a report and submitted for review by Indiana Department of Environmental Management (IDEM) and United States Environmental Protection Agency (USEPA) Region 5 by October 1, 2016.

5. FIELD PROCEDURES AND SAMPLE COLLECTION

In-channel sediment samples and overbank soil samples will be collected to determine if PCBs are present in the sediment of Elliott Ditch and adjacent overbank soils of various geomorphic surfaces. The proposed sampling locations are depicted on Figure 4**.**

5.1 In-Channel Poling

In-channel poling will be conducted to define the volume and extent of soft sediment within the channel. The term ‘poling’ refers to procedure by which a pole that is marked with unit length graduations is used to measure soft sediment thickness on the bed of a waterbody. A metal pole marked with 0.1-foot graduations is advanced vertically through the river bed sediment to document the material present (i.e., soft, hard, granular, etc.) and to determine the overall soft material thickness (depth to refusal). The pole is extended downward through the soft sediment using manual force only until resistance inhibits additional advancement. Poling data will be obtained by or supervised by personnel with experience in poling methods.

The occurrence of PCBs in sediment is most probable within depositional areas of Elliott Ditch. Poling locations will be selected based on field observations of possible depositional areas. Poling will be conducted throughout the channel length and width to define the horizontal extent of soft sediment. The boundaries of the soft sediment will be defined using the poling and documented with GPS coordinates. The volume of the soft sediment for a given area will be determined by measuring the soft sediment thickness over the extent of the soft sediment area. Soft sediment thickness will be defined as the difference in elevation between the top of sediment and the depth of refusal (bottom of sediment). Poling data will be evaluated prior to sediment sampling to refine in-channel sampling locations, determine the proper length of core to be used at each location, and to assess potential sample recovery.

Global Positioning System (GPS) coordinates, water depth, advancement depth, soft sediment thickness, sediment type, geomorphic setting, and presence/absence of aquatic vegetation will be documented at each location.

5.2 Sample Locations

Sediment and soil cores will be collected at the locations described in Table 3. Cores will be advanced to the target depth unless prevented by refusal. Overbank soil sample locations have been pre-selected based on desktop and field geomorphic surface mapping. Soil sample locations were chosen to be representative of the various geomorphic surfaces encountered. Geomorphic surfaces represent unique fluvial environments and typically represent different relative heights above the stream surface (Figure 5). In-channel sample locations were selected based on channel morphology and geomorphic setting (e.g., meander bend, pool) observed during the 2014 topographic survey of Elliott Ditch. Poling data, described in the previous section, will be used to refine the exact location of in-channel sample locations prior to sediment sampling.

Exact sediment and soil sampling locations will be determined in the field based on accessibility and geomorphic features which may indicate the location of PCB deposition.

5.3 In-Channel Sediment Sampling

Sediment core sampling will be conducted using a piston corer, check valve sampler, or Russian Peat Borer (discrete interval sampler). The location, date-time, sample advancement length from the sediment surface, sediment core recovery length, and percent recovery will be documented.. The target depth for each location will be based on the poling results as described in Section 4.1. The project target for sample recovery is 80 percent. If the initial sampling does not obtain at least 80 percent recovery, additional attempts will be made using the equipment and methods determined most appropriate by the Field Manager or his/her designee in the field.

Sediment sampling and decontamination procedures for each sampling device are described in Tetra Tech SOPs in Attachment A. Specific procedures for sediment sampling are listed below:

- Coordinates of the sampling location will be recorded using a geographic position system (GPS) receiver with sub-meter accuracy.
- A tape measure or pole with minimum graduations of 0.1 foot attached to a 6-inch diameter disc will be used to determine the water depth prior to sampling. In the event of deep/swift water, a lead line will be used to determine the water depth.

- The core sampler will be advanced to the target depth and retracted. The core sample retrieved is capped on the bottom and removed from the core sampler.
- The core sample is then capped on top and labeled with the location, date, time, and sample recovery lengths
- The core sample is stored in an upright position and then transferred to the processing area.
- The cores will be cut open and placed on a designated logging table.
- The cores will then be logged by a field geomorphologist using the methods described in the Sediment Logging SOP found in Attachment A.
- Laboratory-provided glass jars will be filled with sediment for PCB analysis. Sediment samples will be collected based on the sediment layers and may vary in length.
- Sample jars will be labeled using the nomenclature outlined in Section 5.1.

Field team members will wear a new pair of disposable nitrile gloves prior to the collection of each sample. The sediment sampling equipment will be decontaminated after collection of each core interval by washing in an Alconox solution and rinsing with distilled water.

The table below summarizes the container and analytical requirements for sediment sampling.

Sample Collection Equipment

- Laboratory-provided sample containers
- Plastic spoons

Container and Analytical Requirements List

Matrix	Containers (Numbers, Size, and Type)	Analytical Parameter	Analytical Method	Preservation Requirements	Holding Time
Sediment	One 8 oz glass jar	PCBs	SW846-8082	Cool to 4°C	6 Months

5.4 Overbank Soil Sampling

Soil sampling will be conducted at 33 locations in 13 transects using a soil recovery auger or sampling tube. A soil recovery auger or soil sampling tube will be used to collect soil in one-foot cores for soil profile description and laboratory analysis. The location, date, time, advancement depth, and recovered interval are documented.

Soil sampling and decontamination procedures for the soil recovery auger or soil sampling tube are described in Tetra Tech SOPs in Attachment A**.** Specific procedures for soil sampling are summarized below:

- Coordinates of the sampling location will be recorded using a geographic position system (GPS) receiver with sub-meter accuracy.
- A soil recovery auger or soil sampling tube capable of taking a one-foot sample equipped with a liner will be used to collect samples at each location. The first sample will be collected from the surface to a depth of 12 inches. The next sample will be collected by inserting the soil recovery auger into the boring created by the first sample, the sample will be collected at a depth of 12 – 24 inches below the ground surface. The soil recovery auger or soil sampling tube will be decontaminated between each sample or multiple augers/sampling tubes will be used at a location and the equipment decontaminated after sampling at a location is complete.
- The soil core liners will be capped at both ends. The location, date, time, and sample interval will be labeled on the core and the cores will be stored in an upright position and transported to the processing area.
- The cores will be cut open and placed on a designated logging table.
- The lithology for each boring will be classified by a field geomorphologist in accordance with the Unified Soil Classifications System (USCS) and United States Department of Agriculture Soil Classification System (USDA).
- Laboratory-provided glass jars will be filled with soil for PCB analysis. Soil samples will be collected in based on the soil horizons. If the A horizon is 12 inches thick or more, the horizon will be split into a 0 - 6 inch interval and a 6 – 12 inch interval. The overbank

deposition will be from flood deposits so a thick A horizon may require a tighter sampling interval.

- Sample jars will be labeled using the nomenclature outlined in Section 5.1.

Field team members will wear a new pair of disposable nitrile gloves prior to the collection of each sample. The soil recovery auger or soil sampling tube will be decontaminated after collection of each core interval by washing in an Alconox solution and rinsing with distilled water.

The table below summarizes the container and analytical requirements for soil sampling.

Sample Collection Equipment

- Laboratory-provided sample containers
- Plastic spoons

Container and Analytical Requirements List

Matrix	Containers (Numbers, Size, and Type)	Analytical Parameter	Analytical Method	Preservation Requirements	Holding Time
Soil	One 8 oz glass jar	PCBs	SW846-8082	Cool to 4°C	6 Months

6. SAMPLING PROCEDURES

This section describes the project-specific sample nomenclature, management of investigative-derived waste, decontamination, custody procedures and other standard operating procedures.

6.1 Sample Nomenclature

All samples for analysis, including QC samples, will be given a unique sample identification (ID). The sample numbers will be recorded in the field tablet (or similar), on the sample jars, and on the COC paperwork. The sample ID will be used to track field data and laboratory analytical results, as well as presentation of analytical data in memoranda and reports. Tetra Tech will assign each sample a unique identification based on the nomenclature outlined below.

Project ID Code

ED = Elliott Ditch

Four-Digit Milepost Code

Nearest milepost (XX.XX) of sample location.

Examples:

- 01.22
- 00.15

Sample Location

Sample location will consist of an in-channel sediment (SD) or overbank soil (SL) code followed by a two-digit numerical identifier (XX). Numerical identifiers will be ordered from north to south and west to east when possible.

Examples:

- SD02
- SL05

Two-Digit Sample Start Depth

Indicates the sample start depth to the nearest 10th of a foot (X.X).

Examples:

- 0.5
- 2.3

<u>Sample End Depth</u>

Indicates the sample end depth to the nearest 10th of a foot (X.X).

Examples:

- 1.1
- 2.0

<u>QA/QC Code</u>

If applicable, the following QA/QC codes will be included in the sample ID:

- FD = Field duplicate
- MS = MS/MSD

Sample IDs will be constructed in the following sequence: project identification code, four-digit milepost code, the sample location, sample start depth, sample end depth, and the QA/QC code, if applicable.

Example sample IDs:

- In-channel sediment sample 01 collected at milepost 2.4 from 1.2 to 1.9 feet would be "ED-02.40-SD01-1.2-1.9"
- Overbank field duplicate soil sample 03 collected at milepost 0.11 from 0.0 to 0.7 feet would be "ED-00.11-SL03-0.0-0.7-FD"

6.2 Management of Investigative-Derived Wastes

The field activities described in this FSP will generate investigative-derived wastes (IDW) consisting of water from decontamination of the equipment, used personal protective equipment, and sample core liners. There may also be excess soil and sediment, although it is anticipated that the majority of the soil and sediments collected will be transferred into the sample containers and delivered to the analytical laboratory. The wastes will be placed in appropriate containers and labeled with the waste type, the generation date and the generator information. Waste specific testing will be conducted, if appropriate. The volume of the IDW generated will be minimized to the least extent possible.

6.3 Decontamination Procedures

Effective decontamination procedures are required to prevent potential cross contamination. The decontamination procedures are in accordance with approved procedures. All equipment that comes into contact with potentially contaminated media will be decontaminated. Disposable sampling equipment will be used when applicable. Such equipment will be removed from protective packaging immediately before use and will be discarded after use. Reusable sampling equipment that is in direct contact with the media to be sampled will be decontaminated before each use. Decontamination will be conducted as follows:

1. Remove all visible contaminants (solids) using a non-phosphate laboratory detergent (e.g., Alconox).

2. Rinse with distilled or deionized water.

3. All water will be discarded into appropriate containers and disposed of properly.

6.4 Sample Handling, Tracking, and Custody Procedures

Sample custody must be strictly maintained and carefully documented each time the sample material is collected, transported, received, prepared, and analyzed. Custody procedures are necessary to ensure the integrity of the samples. Samples collected during the field investigation must be traceable from the time the samples are collected until disposal and/or storage, and their derived data are used in the final report. Sample custody is defined as (1) being in the sampler’s possession; (2) being in the sampler’s view, after being in the sampler’s possession; (3) being locked in a secured container, after being in the sampler's possession; and (4) being placed in a designated secure area.

Field custody procedures will be implemented for each sample or sediment core collected. The Tetra Tech Team member performing the sampling, as overseen by the Project Quality Manager or designee, will be responsible for the care and custody of the samples or cores until they are properly transferred or dispatched. To ensure the integrity of the samples, the samples are to be maintained in a designated, secure area and/or be custody sealed in the appropriate containers prior to shipment.

6.5 Sampling SOPs

The following SOPs will be used during the site evaluation, if applicable for the site conditions:

- SOP – Check Valve Sampling
- SOP – Piston Core Sampling
- SOP – Russian Peat Borer Sampling
- SOP – Soil Recovery Auger
- SOP – Poling
- SOP – Sediment Logging
- SOP – Soil Logging

6.6 Soil/Sediment Core Processing

Soil and sediment core analytical sampling will occur in a dedicated on-land sampling area. Cores will be collected in 0 to 4-foot sections for sediment locations and 1 foot sections for soil locations (filled to the desired depth based on the requirements for that location). The cores will be capped and stored upright on the sampling vessel prior to transport to the sampling area. This will maintain the integrity of the core section, ensure minimal disturbance during transport, and allow safe handling.

All cores collected on a given day will be transported to the sampling area during or at the end of the day's activities. The core sections not logged and sampled the day they are collected will be stored upright overnight in a cooler in the building for subsequent processing. At that time, each core section will be split longitudinally and logged by Tetra Tech trained logging personnel. Sediment samples will be collected from the appropriate intervals (as specified in the applicable planning documents), homogenized, and placed in the proper containers for shipment to the laboratory.

7. LABORATORY INFORMATION

Investigative samples will be delivered by a courier or shipped under chain of custody to the laboratories.

7.1 Measurement and Performance Criteria

Generic measurement and performance criteria will be used. These criteria will ensure that data are sufficiently sensitive, precise, accurate, and representative to support site decisions. The criteria are summarized below.

- Sensitivity–Sensitivity is the ability of the method or instrument to detect the contaminant of concern and other target analytes at the level of interest. For this project, the laboratory quantitation limits are below the site action levels for PCBs as required.

- Accuracy–Accuracy is a measure of the agreement between an observed value and an accepted reference value. It is a combination of the random error (precision) and systematic error (bias), which are due to sampling and analytical operations. Accuracy is determined by percent recovery calculations of laboratory QC samples.

- Precision–Precision is a measure of the closeness of agreement among individual measurements. Precision is determined by relative percent difference (RPD) and/or standard deviation calculations for laboratory duplicate samples.

- Completeness–Completeness is a measure of the amount of valid data obtained compared to the amount of data that was planned to be collected. Completeness is project specific but is generally around 90 percent.

- Representativeness–Representativeness is a measure of the degree to which data accurately and precisely represents a characteristic of a population, parameter variations at a sampling point, or an environmental condition. Simply, this is the degree to which samples represent the conditions for which they were taken.

- Comparability–Comparability is a measure of the degree to which one data set can be compared with another. Some conditions of comparability of data sets are as follows: standardized sampling and analysis, consistency of reporting units, and standardized data format.

7.2 Data Quality Objectives

Data quality objectives address requirements that include when, where, and how to collect samples; the number of samples; and the limits on tolerable error rates. These steps should periodically be revisited as new information about a problem is learned.

Analytical sampling results for total PCBs will be compared to the EPA's Removal Management Levels (RMLs) residential and industrial criteria (based on a Hazard Quotient (HQ) of 3 for non-carcinogens chemical contaminants. RMLs are risk-based, although not necessarily protective for long term exposures, concentrations derived from standardized equations combining exposure assumptions with toxicity data from the Superfund program's hierarchy. RMLs are generic. In other words, they are calculated without site-specific information (e.g., the time- frame over which individuals may have been exposed to site contaminants). RMLs help identify areas, contaminants, and conditions where a removal action may be appropriate. Sites where contaminant concentrations fall below RMLs, are not necessarily “clean,” and further action or study may be warranted. In addition, sites with contaminant concentrations above the RMLs may not necessarily warrant a removal action dependent upon such factors as background concentrations, the use of site-specific exposure scenarios or other program considerations. This data will help determine the risk to the immediate community and the environment.

8. QUALITY CONTROL ACTIVITES

The following sections describe the field and laboratory quality control procedures.

8.1 Field Quality Control

QC samples will be collected for sediment and soil samples to evaluate the field sampling and decontamination methods, and the overall reproducibility of the laboratory analytical results. Specifically, QC samples will be collected at the following frequencies:

- Field duplicate samples
  - 1 per 10 investigative samples

- Matrix spike/matrix spike duplicate samples
  - 1 per 20 investigative samples

Field duplicate samples will be collected from the homogenized sample removed from the same disposable polycarbonate core tube as its associated investigative sample. Field duplicate samples will be processed, stored, packaged, and analyzed by the same methods as the investigative samples. Sample nomenclature specific to QC samples is listed in Section 5.1. Corrective actions may include resampling, reassessment of the laboratory's methods, and/or the addition of data qualifiers to laboratory results.

8.2 Analytical Quality Control

QC for analytical procedures will be performed at the frequency described in the laboratory SOPs. In addition, method-specific QC requirements will be used to ensure data quality.

8.3 Performance Evaluation Samples

Performance evaluation samples will not be used in this site assessment.

8.4 Documentation, Records, and Data Management

The laboratories will be expected to provide analytical results in electronic data deliverable (EDD) and report formats, with QA/QC data included for a Level II data report (case narrative, investigated data results summary, and QC sample summary results). Laboratory-generated data will be imported to a project database for mapping, reporting, and archival activities. Laboratory reports and data validation reports will be archived in the project file.

8.5 Data Validation Requirements

Analytical and QA/QC data will be reviewed to determine if the data are usable or require additional qualification. A data validation report will be produced for each discrete report received from each laboratory.

8.6 Data Analysis

The data collected from the field and laboratory analysis will be provided for statistical analysis of the data. The data will be reviewed to determine the likely spatial extent of elevated PCB concentrations.

9.0 REFERENCES

Anchor QEA 2009. *Final Draft Phase IV Report for Elliott Ditch/Wea Creek Investigation*

USDA. 1958. “Soil Survey of Tippecanoe County, Indiana.” Washington, D.C.

TABLES

Table 1
FSP Revision Form

Site: Elliott Ditch

Date	Revision Number	Proposed Change to FSP/QAPP	Reason for Change of Scope/Procedures	FSP Section Superseded	Requested By	Approved By

Table 2
Sampling and Analysis Summary

Site: Elliott Ditch

Matrix	Analytical Parameters	Number of Sampling Locations	Number of Samples[1]	Number of Field Duplicates	Number of MS/MSDs	Number of Blanks (Trip, Field, Equip. Rinsate)[2]	Total Number of Samples to Lab
Soil	Total PCBs	33	99	10	5	0	114
Sediment	Total PCBs	13	39	4	2	1	46

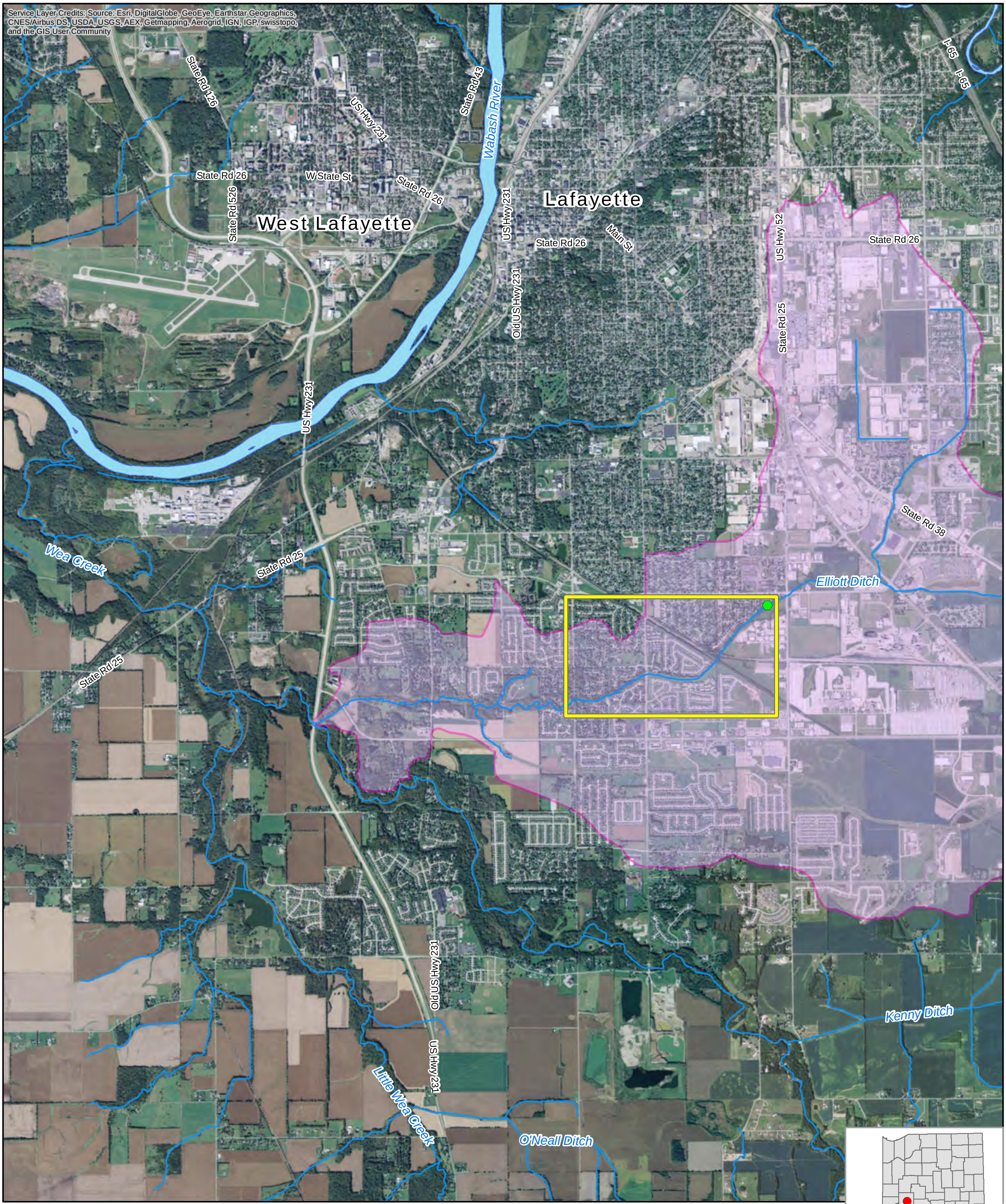
Notes:
[1] Number of samples estimated via the assumption of 3 sediment/soil layers per coring location.
[2] Core tubes are single use disposable. A equipment rinsate sample will be collected if the piston sampler is used to collect sediment cores.

MS/MSD – Matrix Spike/Matrix Spike Duplicate

Table 3. Sample Identification and Justification Summary

Location ID	Reach	Primary Sampler	Latitude	Longitude	Target Core Depth	Geomorphic Position	Justification
ED-00.08-SD02	1	Check Valve/Piston Corer/Russian Peat Borer	40.3799	-86.86106	4 ft	In-channel	Possible area of depostioin due to bank armoring
ED-00.08-SL01	1	Auger/Core Sampler	40.37997	-86.86115	2 ft	Upland	Verify the absence on RDB upland
ED-00.08-SL03	1	Auger/Core Sampler	40.37982	-86.86098	2 ft	Levee	Possible man-made levee on LDB
ED-00.08-SL04	1	Auger/Core Sampler	40.37963	-86.86074	2 ft	Upland swale	Spatial coverage on lower LDB surface
ED-00.25-SD01	1	Check Valve/Piston Corer/Russian Peat Borer	40.37834	-86.86362	4 ft	In-channel	Inside of the meader bend (depostional surface)
ED-00.25-SL02	1	Auger/Core Sampler	40.3783	-86.86355	2 ft	Levee	Inside of the meader bend on levee should be realtively untouched by stream erosion
ED-00.25-SL03	1	Auger/Core Sampler	40.37812	-86.8633	2 ft	Upland swale	Spatial coverage on lower LDB surface
ED-00.39-SD02	1	Check Valve/Piston Corer/Russian Peat Borer	40.37673	-86.86501	4 ft	In-channel	Upstream end of depostional area (implied by a fine-grain bed type)
ED-00.39-SL01	1	Auger/Core Sampler	40.37676	-86.8651	2 ft	Upland	RDB bank is ~ 0.5 ft lower in elevation than LDB which would cause flood waters to naturally flow towards the RDB
ED-00.39-SL03	1	Auger/Core Sampler	40.37669	-86.8649	2 ft	Levee	Possible man-made levee on LDB
ED-00.39-SL04	1	Auger/Core Sampler	40.37657	-86.86459	2 ft	Upland swale	Spatial coverage on lower LDB surface
ED-00.47-SD02	1	Check Valve/Piston Corer/Russian Peat Borer	40.37583	-86.86592	4 ft	In-channel	Downstream of the depostional area (implied by coarse-grain bed type)
ED-00.47-SL01	1	Auger/Core Sampler	40.37586	-86.86606	2 ft	Upland	The channel banks are lower than upstream and RR bridge downstream may cause ponding during flooding
ED-00.47-SL03	1	Auger/Core Sampler	40.37578	-86.86581	2 ft	Levee	The channel banks are lower than upstream and RR bridge downstream may cause ponding during flooding
ED-00.47-SL04	1	Auger/Core Sampler	40.37566	-86.86548	2 ft	Upland swale	Spatial coverage on lower LDB surface
ED-00.51-SD02	1	Check Valve/Piston Corer/Russian Peat Borer	40.37526	-86.86635	4 ft	In-channel	In-channel location near original Anchor location (Possible petroleum sheen observed during topo survey)
ED-00.51-SL01	1	Auger/Core Sampler	40.37531	-86.86651	2 ft	Upland	Characterize upland
ED-00.51-SL03	1	Auger/Core Sampler	40.37523	-86.86624	2 ft	Upland	Characterize upland (possible dredge spoils pile on LDB)
ED-00.60-SD02	2	Check Valve/Piston Corer/Russian Peat Borer	40.37426	-86.86753	4 ft	In-channel	Pool - soft sediment observed during topographic survey
ED-00.60-SL01	2	Auger/Core Sampler	40.37433	-86.86762	2 ft	Upland	Verify the absence on RDB of the upland
ED-00.60-SL03	2	Auger/Core Sampler	40.37421	-86.86746	2 ft	T-4	Furthest upstream T-4 surface within study area. Deposition on the T-4 surface is possible after large flood events.
ED-00.72-SD03	2	Check Valve/Piston Corer/Russian Peat Borer	40.37314	-86.86914	4 ft	In-channel	In-channel location is upstream of knickpoint where soft sediment was noted.
ED-00.72-SL01	2	Auger/Core Sampler	40.37326	-86.86918	2 ft	Upland	Verify the absence on RDB of the upland
ED-00.72-SL02	2	Auger/Core Sampler	40.37317	-86.86915	2 ft	Floodplain	Small floodplain surface on inside meander may have deposited fine grain sediment
ED-00.72-SL04	2	Auger/Core Sampler	40.3731	-86.86912	2 ft	T-4	Deposition on the T-4 surface is possible after large flood events
ED-00.82-SD02	2	Check Valve/Piston Corer/Russian Peat Borer	40.37315	-86.87107	4 ft	In-channel	Pool - soft sediment observed during topographic survey
ED-00.82-SL01	2	Auger/Core Sampler	40.37324	-86.87104	2 ft	Upland	Verify the absence on RDB of the upland
ED-00.82-SL03	2	Auger/Core Sampler	40.3731	-86.87114	2 ft	Depression	Man-made depression due to outfall may collect fine grain sediment during flooding
ED-00.82-SL04	2	Auger/Core Sampler	40.37298	-86.87106	2 ft	T-4	Deposition on the T-4 surface is possible after large flood events
ED-01.03-SD02	2	Check Valve/Piston Corer/Russian Peat Borer	40.37371	-86.87484	4 ft	In-channel	Deposition on inside menader bend possible
ED-01.03-SL01	2	Auger/Core Sampler	40.37379	-86.87479	2 ft	Upland	Verify the absence on RDB of the upland
ED-01.03-SL03	2	Auger/Core Sampler	40.37356	-86.87493	2 ft	T-4	Deposition on the T-4 surface is possible after large flood events
ED-01.14-SD02	3	Check Valve/Piston Corer/Russian Peat Borer	40.37327	-86.87695	4 ft	In-channel	Downstream of concrete channel section, possible deposition area
ED-01.14-SL01	3	Auger/Core Sampler	40.37334	-86.87708	2 ft	T-7	Furthest upstream T-7 surface within study area
ED-01.14-SL03	3	Auger/Core Sampler	40.37323	-86.87686	2 ft	T-6	Furthest upstream T-6 surface within study area
ED-01.24-SD02	3	Check Valve/Piston Corer/Russian Peat Borer	40.37261	-86.87859	4 ft	In-channel	In-channel near the inside of meander bend
ED-01.24-SL01	3	Auger/Core Sampler	40.37272	-86.87857	2 ft	T-6	Characterize T-6 surface on outside meander bend
ED-01.24-SL03	3	Auger/Core Sampler	40.37258	-86.87854	2 ft	T-7	Characterize T-7 surface on inside of slight meander bend
ED-01.39-SD02	3	Check Valve/Piston Corer/Russian Peat Borer	40.37153	-86.88094	4 ft	In-channel	In-channel near sand bar
ED-01.39-SL01	3	Auger/Core Sampler	40.37163	-86.881	2 ft	T-6	Located in shallow depression on T-6 surface
ED-01.39-SL03	3	Auger/Core Sampler	40.37148	-86.88091	2 ft	T-1	Furthest upstream T-1 surface in study area
ED-01.39-SL04	3	Auger/Core Sampler	40.37141	-86.88088	2 ft	Upland	Verify the absence on LDB of the upland
ED-01.49-SD03	3	Check Valve/Piston Corer/Russian Peat Borer	40.37102	-86.88256	4 ft	In-channel	Channel width increases possibly causing depostional area
ED-01.49-SL01	3	Auger/Core Sampler	40.37118	-86.88255	2 ft	T-7	Characterize T-7 surface
ED-01.49-SL02	3	Auger/Core Sampler	40.37111	-86.88255	2 ft	T-6	Characterize T-6 surface
ED-01.49-SL04	3	Auger/Core Sampler	40.37092	-86.88255	2 ft	T-6	Characterize T-6 surface

FIGURES



Tetra Tech, Inc.

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Sheboygan, WI 53081
Tel: (920) 452-7962
Fax: (920) 457-2357

N

0 0.5 1 Miles

1:50,000

Figure 1 - Site Location Map

Elliott Ditch - Lafayette, Tippecanoe County, Indiana

Alcoa Outfall 001
River or Stream
Site Boundary
Elliott Ditch Watershed

Drawn By: MEB Date Created: 1/12/2016 Last Revised: 1/20/2016 Approved By: DBR Document Name: AlcoaElliottDitchSiteLocation.mxd File Path: F:\Alcoa Elliott Ditch\GIS\AlcoaElliottDitchSiteLocation.mxd

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N

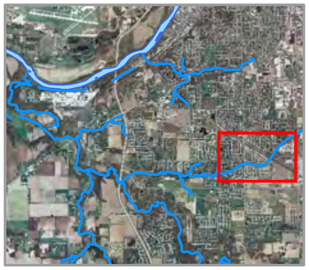
0 625 1,250 Feet

1:8,500

Figure 2 - Site Overview Map

Elliott Ditch - Lafayette, Tippecanoe County, Indiana

- Proposed Sample Location
- Milepost
- Alcoa Outfall 001



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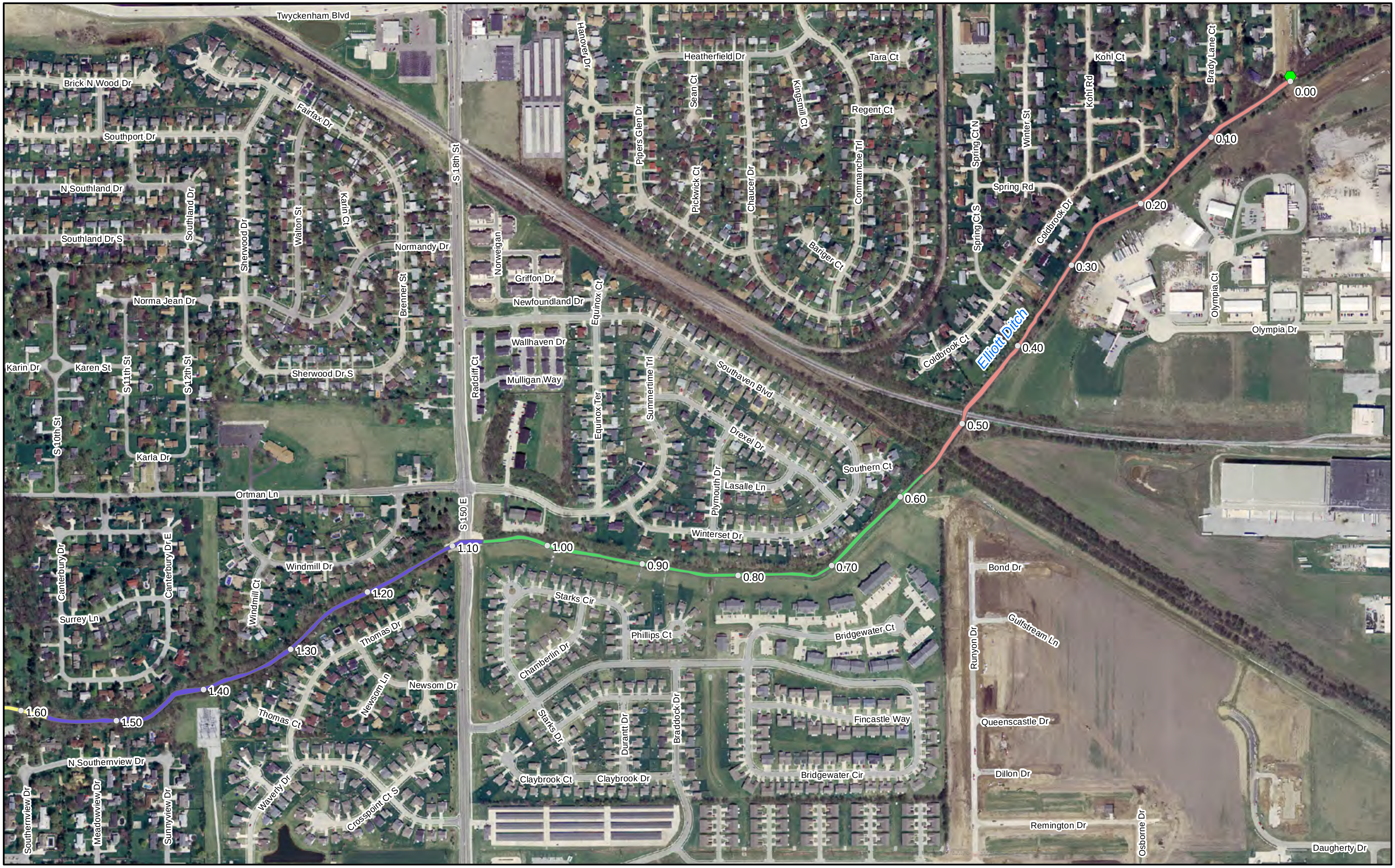

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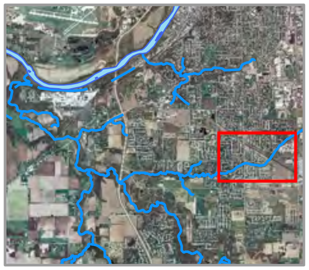
N
0 625 1,250 Feet
1:8,500

Figure 3 - Stream Reaches

Elliott Ditch - Lafayette, Tippecanoe County, Indiana

Milepost
Alcoa Outfall 001

Stream Reach
Reach 1
Reach 2
Reach 3
Reach 4



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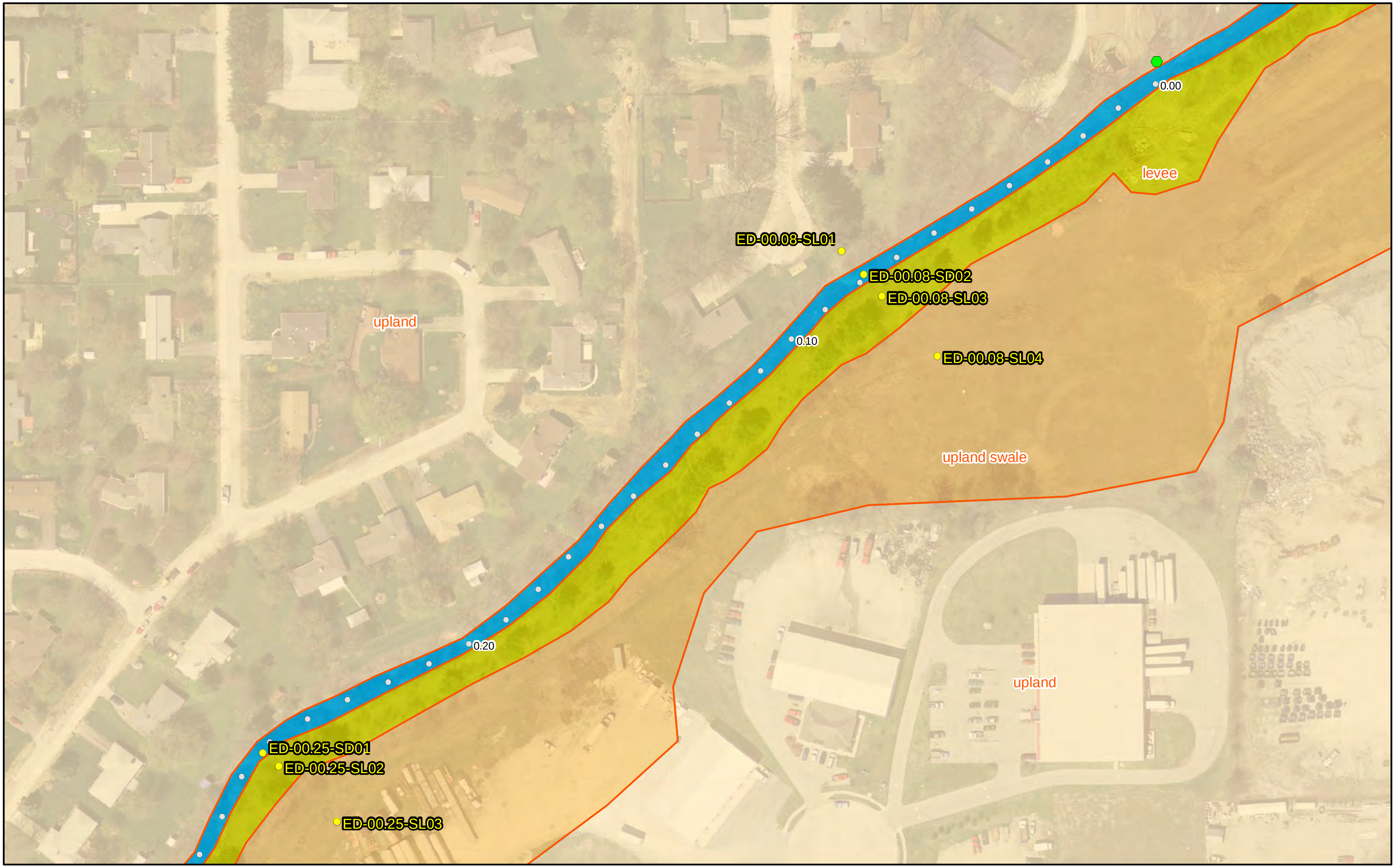

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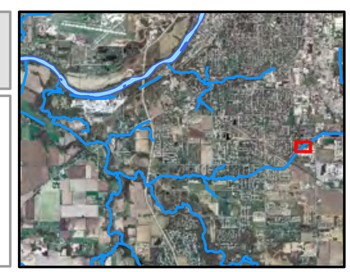
Figure 4 - Proposed Sample Locations & Geomorphic Surfaces

Elliott Ditch - Lafayette, Tippecanoe County, Indiana



Milepost
Proposed Sample Location
Alcoa Outfall 001
Geomorphic Surface Boundary

Geomorphic Surface
stream
levee
upland swale
upland

Drawn By: MEB Date Created: 6/17/2013 Last Revised: 1/20/2016 Approved By: DBR Document Name: AlcoaElliottDitchGeoSurfaces.mxd File Path: F:\Alcoa Elliott Ditch\GIS\AlcoaElliottDitchGeoSurfaces.mxd

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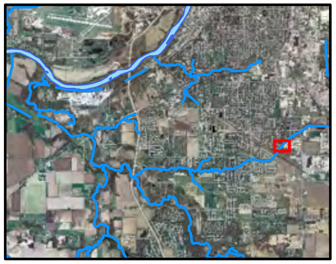
Figure 4 - Proposed Sample Locations & Geomorphic Surfaces

Elliott Ditch - Lafayette, Tippecanoe County, Indiana

- Milepost
- Proposed Sample Location
- Geomorphic Surface Boundary

Geomorphic Surface
- stream
- levee
- upland swale
- upland



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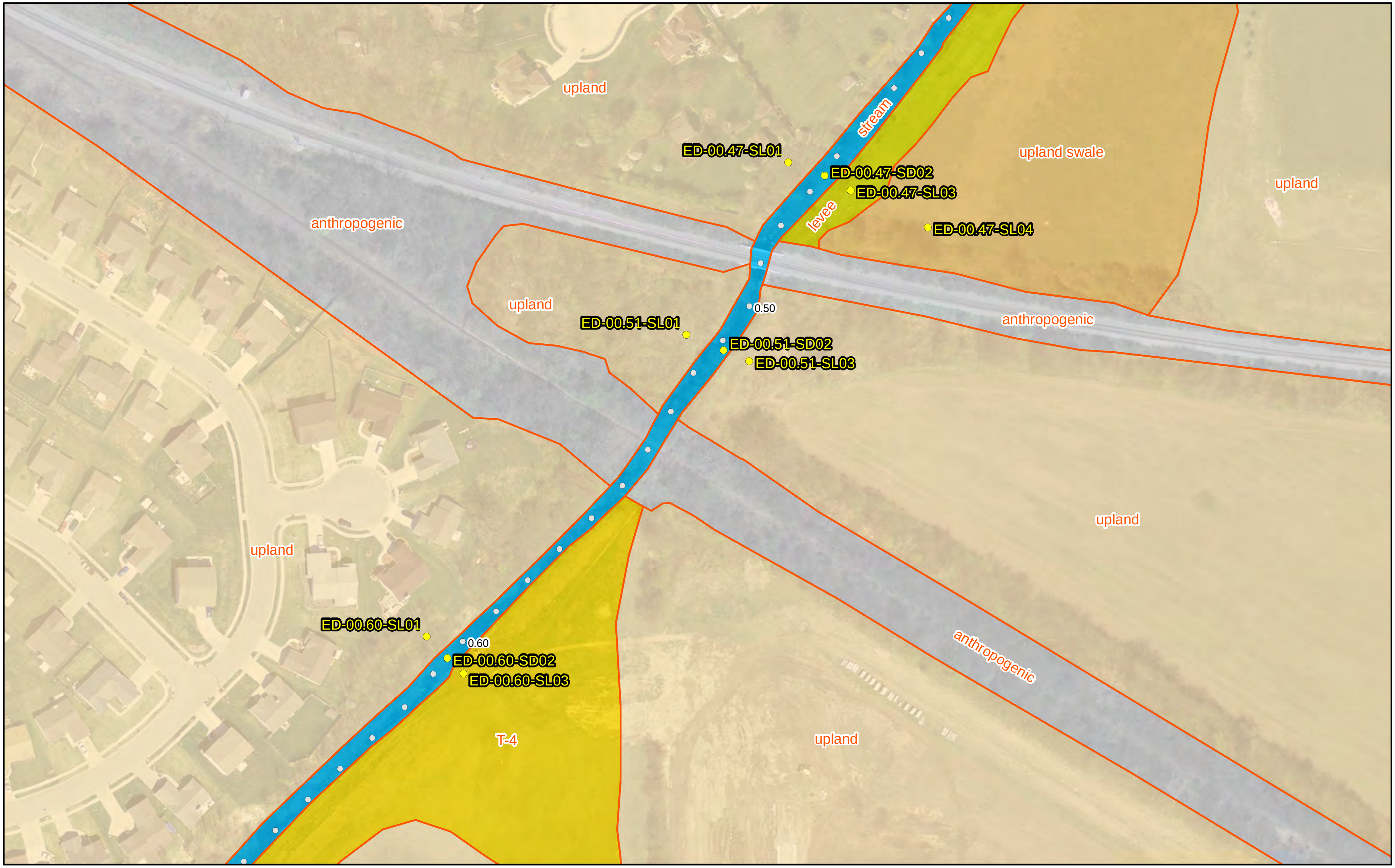

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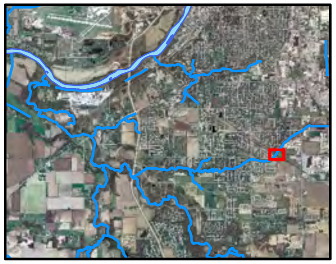
N
0 120 240 Feet
1:1,850

Figure 4 - Proposed Sample Locations & Geomorphic Surfaces

Elliott Ditch - Lafayette, Tippecanoe County, Indiana

Milepost
Proposed Sample Location
Geomorphic Surface Boundary

Geomorphic Surface
stream
T-4
anthropogenic
levee
upland swale
upland



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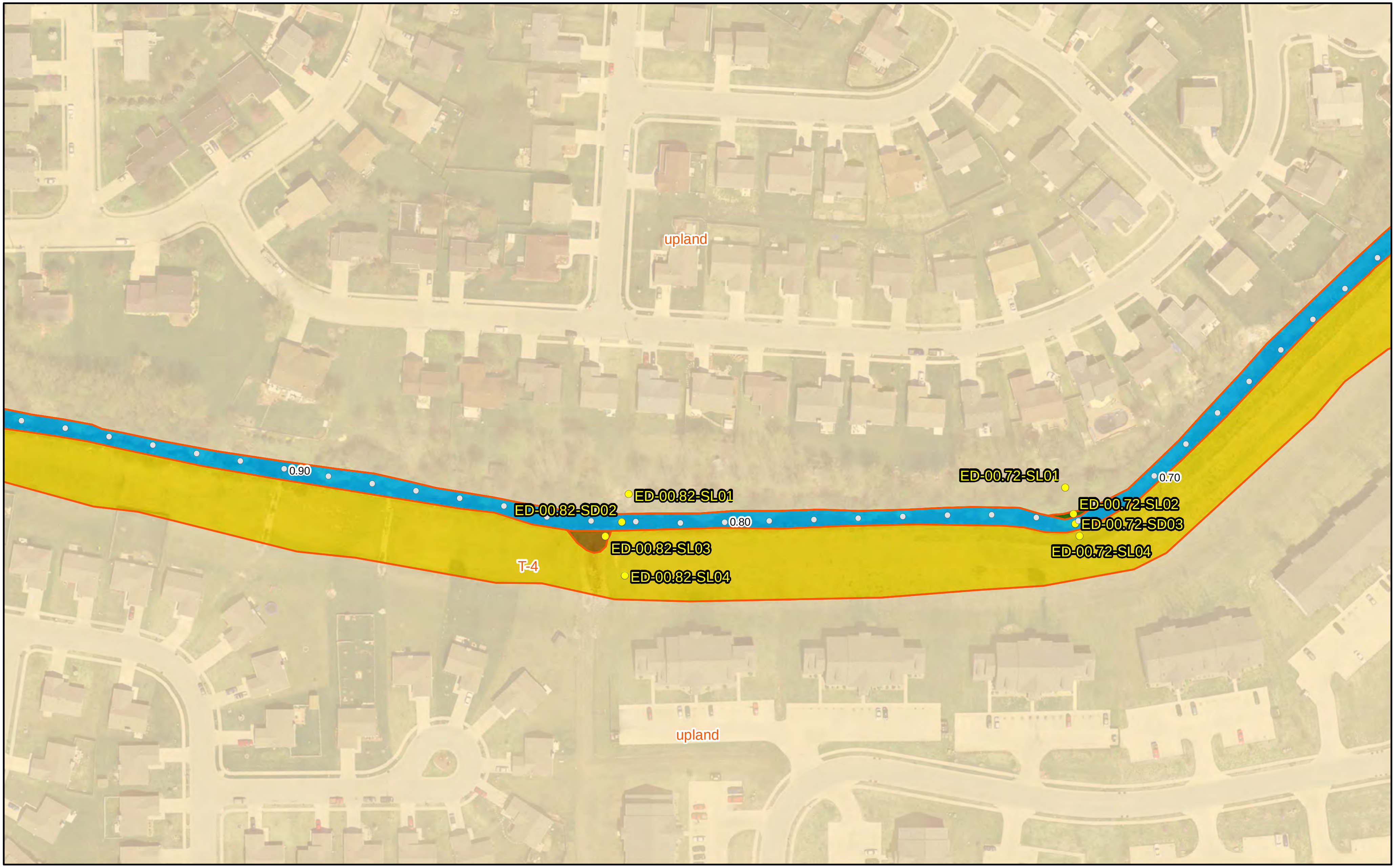

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Figure 4 - Proposed Sample Locations & Geomorphic Surfaces

Elliott Ditch - Lafayette, Tippecanoe County, Indiana

Milepost
Proposed Sample Location
Geomorphic Surface Boundary

Geomorphic Surface
stream
floodplain
T-4
depression
upland

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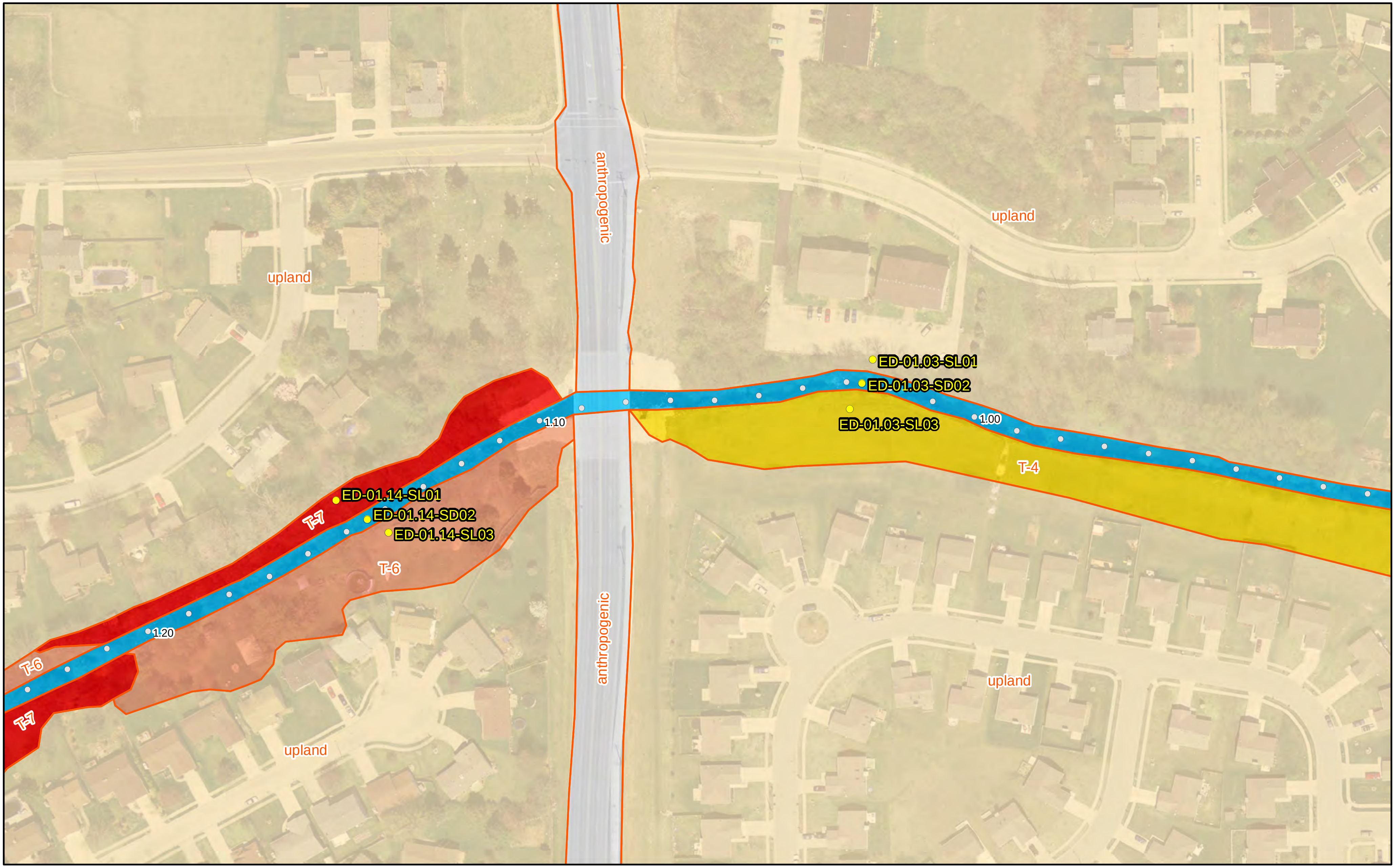

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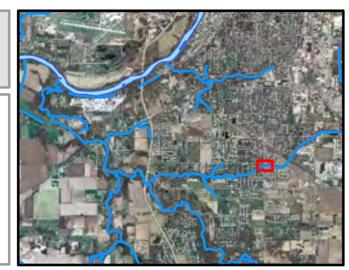
1:1,850

Figure 4 - Proposed Sample Locations & Geomorphic Surfaces

Elliott Ditch - Lafayette, Tippecanoe County, Indiana

Milepost
Proposed Sample Location
Geomorphic Surface Boundary

Geomorphic Surface
stream
T-4
T-6
T-7
anthropogenic
upland



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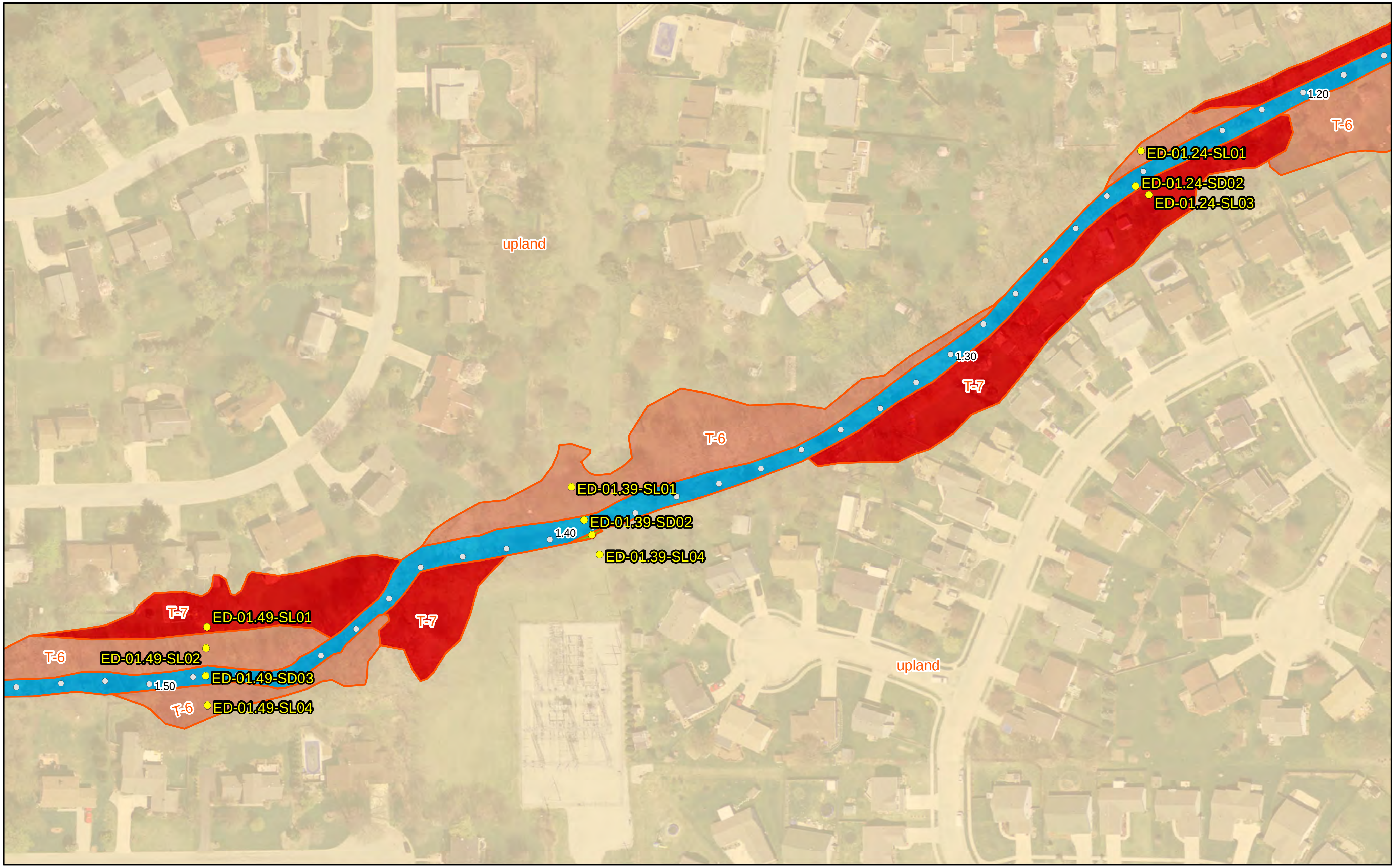

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0 120 240 Feet
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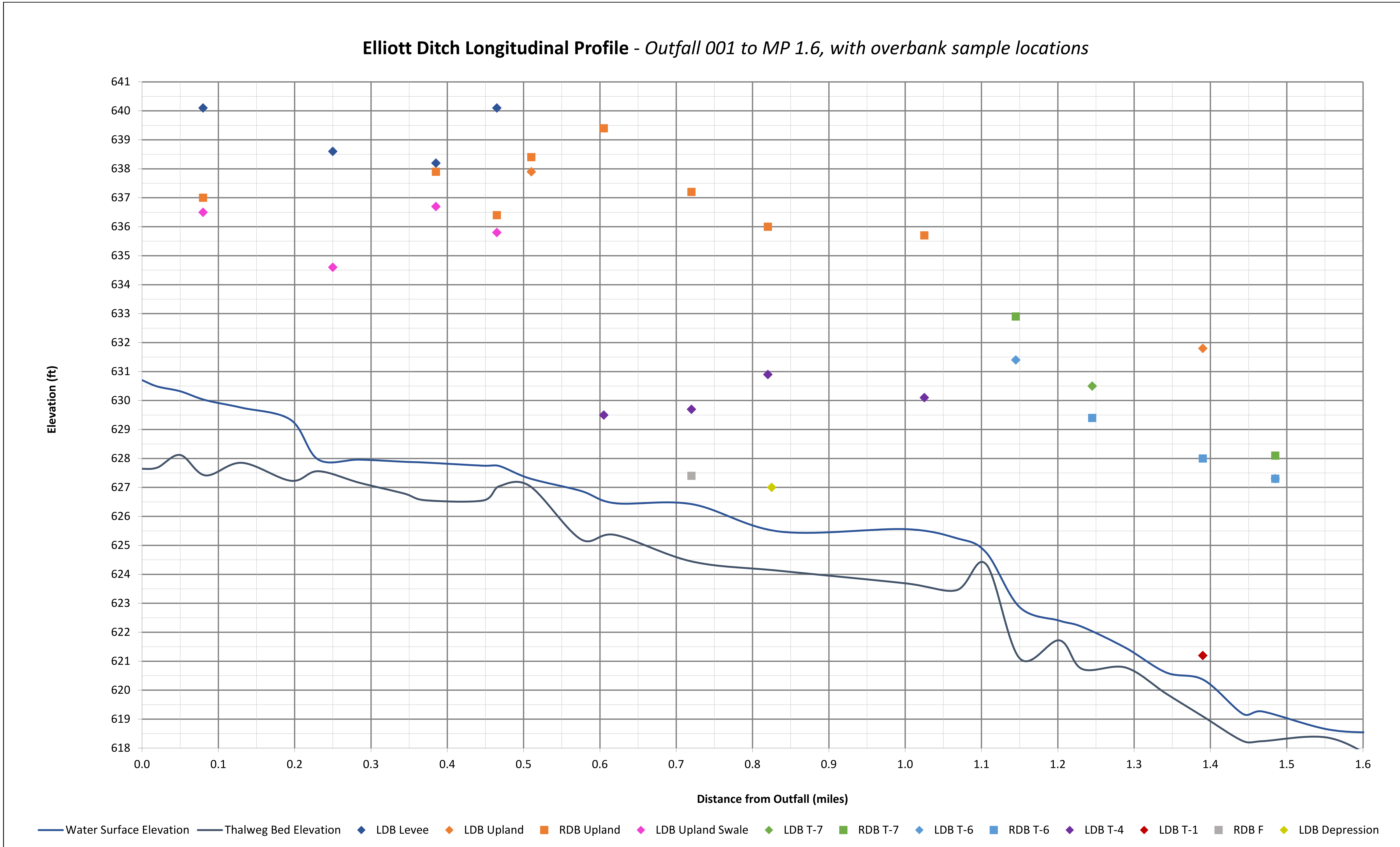
Figure 4 - Proposed Sample Locations & Geomorphic Surfaces

Elliott Ditch - Lafayette, Tippecanoe County, Indiana

- Milepost
- Proposed Sample Location
- Geomorphic Surface Boundary

Geomorphic Surface
- stream
- T-1
- T-6
- T-7
- upland

Drawn By: MEB Date Created: 6/17/2013 Last Revised: 1/20/2016 Approved By: DBR Document Name: AlcoaElliottDitchGeoSurfaces.mxd File Path: F:\Alcoa Elliott Ditch\GIS\AlcoaElliottDitchGeoSurfaces.mxd



Elliott Ditch Longitudinal Profile - Outfall 001 to MP 1.6, with overbank sample locations
Elevation (ft)
641
640
639
638
637
636
635
634
633
632
631
630
629
628
627
626
625
624
623
622
621
620
619
618
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
1.3
1.4
1.5
1.6
Distance from Outfall (miles)
Water Surface Elevation
Thalweg Bed Elevation
LDB Levee
LDB Upland
RDB Upland
LDB Upland Swale
LDB T-7
RDB T-7
LDB T-6
RDB T-6
LDB T-4
LDB T-1
RDB F
LDB Depression

ATTACHMENT A

STANDARD OPERATING PROCEDURE
CHECK VALVE SAMPLING

Elliott Ditch

Lafayette, IN

Prepared by:
Tetra Tech CES, Inc.

Prepared for:
Tetra Tech CES, Inc.
Elliott Ditch Sampling Plan

January 2016

ACRONYM LIST

GPS	Global Positioning System
NAD	North American Datum
PPE	Personal Protective Equipment
QAPP	Quality Assurance Project Plan
RTK	Real Time Kinematic
SHSP	Site Health and Safety Plan
SOP	Standard Operating Procedure

1.0 SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure (SOP) is to establish a standard procedure for the collection of sediment core samples using a check valve core sampler. Procedures are described for the collection of soft sediments and fine-grained sands. This SOP should be consulted during the preparation of any plan requiring procedures for sediment sample collection using a check valve core sampler.

2.0 SUMMARY OF METHOD

A tape measure or pole with minimum graduations of 0.1 feet attached to a 6-inch diameter disc is used to determine the depth from the water surface to sediment surface prior to sampling. In the event of deep/swift water, a lead line will be permissible to determine the depth from the water surface to sediment surface. The check valve sampler is advanced to the specified depth and retracted. The core sample retrieved is capped on the bottom and removed from the check valve sampler. The core sample is then capped on top, labeled and stored upright in a rack. The location, date-time, sample advancement length from the sediment surface, sediment core recovery length, and percent recovery are documented using the data collector (e.g., Leica Viva) or alternative documentation method. The project target for sample recovery is 80 percent. If the initial sampling does not obtain at least 80 percent recovery, additional attempts will be made using the equipment and methods determined most appropriate by the Field Manager or his/her designee in the field.

3.0 SAFETY

All work must be performed under the approved Site Health and Safety Plan (SHSP) for the project. The SHSP identifies proper personal protective equipment (PPE) and potential site/work hazards. Daily safety meetings will be conducted before work begins.

4.0 APPARATUS AND EQUIPMENT

- Vessel (sampling platform) that complies with U.S. Coast Guard regulations with a minimum of 3 anchors or two anchoring spuds
- PPE specified in the SHSP
- Tape measure, lead line, and/or pole with minimum graduations of 0.1 feet attached to disc to determine depth from water surface to sediment surface
- Check valve sampler
- Core tubes (typically about 3-inch diameter) with end caps
- Core rack used to store sediment cores vertically
- Electronic data storage unit for core collection documentation
- Nut driver and/or Phillips screwdriver
- Duct and/or electrical tape
- Permanent marker/paint pen to label core liners
- Real Time Kinematic (RTK) Global Positioning System (GPS) or equivalent, with horizontal accuracy of ± 1 meter

5.0 PROCEDURES

5.1 Sample Location Positioning

Positioning for sampling will be achieved using an RTK GPS, or equivalent, that is capable of locating stations with an accuracy and repeatability of ±1 meter.

5.2 Depth from Water Surface to Sediment Surface

A tape measure, pole with minimum graduations of 0.1 feet attached to a disc, or lead line will be used to determine the depth from the water surface to sediment surface prior to sampling. The depth to sediment from the water surface is used to establish a reference for sample advancement.

5.3 Core Sample Collection

1. Add the depth that the sample core will be advanced into the sediment to the measured depth to sediment from the water surface. Mark the total depth with tape on the sample rod or tube after the sample tube is connected to the check valve. Use this mark as a reference for depth of advancement from the water surface.

2. Advance the sampler into the sediment surface slowly to the specified depth. Rotate sampler to shear core sample from sediment column. Retract the sampler.

3. Cap the bottom of the core. Remove the core from the sampler. Cap the top of core. Place duct tape over the core caps. Use permanent marker to denote the top of the core with the location identification (ID), date, time, and sample recovery length/sample advancement length and store it in an upright position.

4. Record location, date, time, core sample advancement length, sample recovery length, and percent recovery ([sample recovery length /sample advancement length] x 100) in electronic data collection device or using alternative documentation method.

Note: The project target for sample recovery is 80 percent. Excess sediment that is not used in the processed sample will be discarded into the appropriate waste container. A core barrel will be reused at the same sample location but will not be reused at another sample location unless it is decontaminated.

STANDARD OPERATING PROCEDURE
PISTON CORE SAMPLING

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Elliott Ditch Sampling Plan

January 2016

ACRONYM LIST

GPS	Global Positioning System
NAD	North American Datum
PPE	Personal Protective Equipment
QAPP	Quality Assurance Project Plan
RTK	Real Time Kinematic
SHSP	Site Health and Safety Plan
SOP	Standard Operating Procedure

1.0 SCOPE AND APPLICATION

This Standard Operating Procedure (SOP) establishes standards for collecting sediment samples using a piston core sampling device. Procedures are described for the collection of soft sediments and fine-grained sands. This SOP should be consulted during the preparation of any plan requiring procedures for sediment sample collection using a piston core sampler.

A piston core device can be used to collect sediment samples for polychlorinated biphenyl (PCB) analysis. This device can be used to collect continuous, undisturbed, surface sediment samples up to 7 feet long (depending on the type of underlying deposit), in water depths up to approximately 32 feet.

2.0 SUMMARY OF METHOD

The techniques and tools for sampling soft sediment with a core tube depend on river current, depth of water, substrate characteristics, and the objective of the sampling program. Once a sampling location is determined, the sampling vessel is anchored or spudded in place using at least three anchors or two spuds. Typically, the boat is anchored with the front or back facing directly into the wind or current, whichever exerts a stronger force on the sampling vessel.

A sub-meter accuracy reference surface location will be obtained at each sample location using Real Time Kinematic Global Positioning System (RTK GPS) equipment and recorded.

The reference surface elevation will be used to establish the depth-to-sediment surface at each sample location. Sampling and depth–to-sediment surface measurements will be conducted by experienced personnel who can differentiate the water/sediment surface interface using methods described in this SOP. Prior to sampling, a surveyor's rod, graduated pole (marked with minimum 0.1 foot graduations and attached to a 6-inch diameter disc), or lead line will be used to determine the vertical distance from the reference surface to the sediment surface. This distance, plus the target sample depth, will be marked on the sampler core tube or on the aluminum rod attached to the piston sampler head.

The sampling device will be slowly lowered into the water just below the surface. This slow motion will allow the tube to be completely filled with water, eliminating any vacuum effect that can occur. After the core tube has filled with water, it will be lowered completely to the marked depth. The pull rope or cable that is attached to the piston core will be pulled gently up towards the surface of the water/sampling platform until it is taut and then it will be attached to an anchor point such as a sampling vessel or sampling platform with the use of a t-bar. Once the pull rope or cable has been attached, the sampler rod will be first advanced/pushed and if required driven with a 10 pound drive hammer into the substrate until refusal or until the target depth has been reached. When performed, the distance the core tube is driven/hammered will be noted in the daily field log sheet. Once the piston core is pushed to refusal or desired depth, the depth of core advancement will be measured and recorded.

Upon retrieval of the core tube, the bottom of the core sample will be capped underwater. Two holes will be drilled in the core tube between the top of the sediment and the bottom of the piston, with the bottom hole no closer than 0.5 inch from the top of the captured sediment. Water will be allowed to drain. The thickness of the sediment recovered in the core tube will be measured and recorded, and the contents of the core tube will be described and documented in the daily field logs. The sampling head and piston will then be removed from the core tube. After the water has drained from the core, an end cap will be placed on top of the core tube with the sample location, date, time, total advancement, and recovery noted. Both the top and bottom end caps should be taped at this time using either duct or electrical tape. The sample core tube will then be placed upright in a storage rack and all data will be recorded in the daily field logs and also in the Leica Viva or equivalent system.

The percent recovery (recovered sediment length/tube advancement length x 100) will be determined by measuring the sediment length in the recovered core and comparing that value to the distance the core was advanced. The recovery must be equal to or greater than 80 percent. If the required recovery is not reached on the first attempt, the first core should be saved and the location should be resampled (following the listed procedures). If the second attempt results in a greater recovery than the first attempt, and there is a recovery of 80 percent or greater, the first core will be brought back to the processing area and properly disposed of.

After each attempt, the sampler will be decontaminated following the procedures outlined below:

- Remove all visible contaminants (solids) using a brush and a non-phosphate laboratory detergent (e.g., Alconox).
- Rinse with distilled or deionized water.

3.0 SAFETY

All work must be performed under the approved Site Health and Safety Plan (SHSP) for the project. The SHSP identifies proper personal protective equipment (PPE) and potential site/work hazards. Daily safety meetings will be conducted before work begins.

4.0 APPARATUS AND EQUIPMENT

- Vessel (sampling platform) that complies with U.S. Coast Guard regulations with a minimum of three anchors or two anchoring spuds.
- PPE specified in the SHSP
- Tape measure, lead line, or graduated pole with minimum graduations of 0.1 foot and 6-inch diameter disc to determine water depth
- Pole to measure soft sediment thickness with minimum graduations of 0.1foot
- Piston core sampler
- Plastic core tubes (3-inch outside diameter) with end caps
- Core rack to store sediment cores vertically
- Duct tape
- Electrical tape
- Permanent marker/paint pen to label core tubes
- Measuring tape to measure sample recovered

- Real Time Kinematic (RTK) Global Positioning System (GPS) or equivalent, with horizontal accuracy of ± 1 meter
- Truck with core rack to transport sediment cores vertically
- T-bar
- Nut driver and/or Phillips screwdriver
- Alconox
- Deionized water
- Aluminum sampling rod, length as needed per field conditions
- Scrub brushes
- Garden sprayer

5.0 PROCEDURES

5.1 Sample Location Positioning

Positioning for sample collection will be achieved using an RTK GPS, or equivalent, that is capable of locating stations with an accuracy and repeatability of ±1 meter.

5.2 Water and Sediment Surface Elevations

A reference surface elevation will be established for all vertical measurements using the boat deck or water surface. The elevation for the reference elevation will be obtained with RTK GPS. If the boat deck is the reference surface elevation, the water surface elevation will be documented once before daily sampling is initiated and once after completion of sampling. The water surface elevation will be obtained by measuring (tape or equivalent) the vertical distance from the boat deck to the water surface. The sediment surface elevation will be determined using the reference surface elevation prior to collection of each sample. A surveyor's rod, graduated pole, lead line, or tape measure (secondary) will be used to measure vertical distance from the reference surface to the sediment surface. The measuring device will have minimum graduations of 0.1 foot and will be attached to a 6-inch diameter disc. The measurement of the depth from the reference elevation (water surface or boat deck) to sediment surface will be conducted by experienced personnel that are capable of establishing the interface between the water and sediment surface. Sample advancement will be done by taping the piston core sampler rod to indicate the advancement depth from the established reference. The significant figures used to record measurements will be dependent on conditions. Data should be reported within the precision of measurement that is possible at the time of measurement considering wave action, boat stability, or other factors. Work should be conducted when the precision of measurement is at least 0.1 foot so all measurements can be documented accordingly. All data will be documented in an electronic database and/or field forms.

5.3 Sample Collection

The sample collection method is as follows:

1. If the boat deck is the reference surface elevation, measure (tape or equivalent) the vertical distance from the boat deck to the water surface before and after daily sampling to obtain the water surface elevation.

2. Mark the sum of the measured distance (result of step 1) and the target sample depth (below the sediment bed) on the sampler core tube or on the aluminum rod attached to the piston sampler head using colored electrical tape.

3. Slowly lower the sampling device to just below the surface of the water (leaving the pull rope or cable attached to the piston core on the deck of the boat) to allow the tube to be completely filled with water, eliminating any vacuum effect that can occur.

4. Lower sampler to the marked depth.

5. Gently pull the pull rope or cable that is attached to the piston core up towards the surface of the boat until it is taut. Attach the rope or cable to the T-bar that is stabilized on the boat or sampling platform.

6. The sampler rod will be first advanced/pushed by hand, and if required, driven with a 10 pound drive hammer into the substrate until refusal or until the target depth has been reached. When performed, note the distance the core tube is advanced/driven on the daily field log sheet.

7. Measure and record the depth of core advancement once the piston core is pushed to refusal or desired depth. Retrieve the sample, place the bottom cap, and wipe free any sediment that remains on the core tube exterior and bring sampler/core tube to the deck of the sampling boat.

8. Drill two holes in the core tube between the top of the sediment and the bottom of the piston, with the bottom hole no closer than 0.5 inches from the top of the captured sediment.

9. Drain water from the core tube.

10. Remove the sampling head and piston from the core tube.

11. Place an end cap on top of the core tube and note the sample ID, date, time, total advancement, and recovery.

12. Record in the daily field log: 1) the measurement of the thickness of the sediment recovered in the core tube, 2) a description of the sediment composition, and 3) the percent recovery (recovered sediment length/tube advancement length x 100) for each core while on the sampling vessel by measuring the sediment length in the recovered core and comparing that value to the distance the core was advanced. Note: The project target for sample recovery is 80 percent.

    - If the required recovery is not reached on the first attempt, save the first core, off-set from the original sample position, and resample the location following the listed procedures.

    - If the second attempt results in a greater recovery than the first attempt, and the recovery is 80 percent or greater, the first core will be brought back to the processing facility and properly disposed of.

    - If the required recovery is not reached on the second attempt, off-set again and resample the location using a different sampling device.

13. Place upright in a storage rack and record all data in the daily field logs and also in the Leica Viva or equivalent system.

14. Decontaminate the piston with Alconox solution and rinse with deionized water.

15. Collect rinsate sample as required (see project QAPP) by pouring deionized water over and into the top of the decontaminated sampler and collecting the rinsate with a glass jar.

5.4 Sampler Decontamination and Field Quality Control Sampling

The sampler decontamination process for non-disposable sampling equipment is described below:

1. Remove all visible contaminants (solids) using a non-phosphate laboratory detergent (e.g., Alconox).

2. Rinse with distilled or deionized water.

6.0 REFERENCES

Tetra Tech EC, Inc. (Tetra Tech), Anchor QEA, L.L.C., J.F. Brennan, and Stuyvesant Projects Realization, Inc. 2013a. Quality Assurance Project Plan for Remedial Action of Operable Units 2, 3, 4, and 5 Lower Fox River and Green Bay Site Brown, Outagamie, and Winnebago Counties, Wisconsin. Prepared for Lower Fox River Remediation LLC. May 2013.

Tetra Tech EC, Inc. (Tetra Tech), Anchor QEA, L.L.C., J.F. Brennan, and Stuyvesant Projects Realization, Inc. 2013b. Final Site Specific Health and Safety Plan. Phase 2B for the Implementation of the Remedial Action at the Lower Fox River Operable Units 2 through 5. February 2013.

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STANDARD OPERATING PROCEDURE
POLING MEASUREMENTS TO ESTIMATE SOFT SEDIMENT THICKNESS

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ACRONYM LIST

GPS	global positioning system
NAD	North American Datum
PPE	personal protective equipment
QAPP	Quality Assurance Project Plan
RTK	Real Time Kinematic
SHSP	Site Health and Safety Plan
SOP	Standard Operating Procedure

1.0 SCOPE AND APPLICATION

Poling is conducted to define soft sediment thickness in areas where soft sediment is present. The soft sediment thickness is based on the difference in elevation from the top of sediment to the depth of refusal. Poling data will be evaluated prior to sediment sampling to refine in-channel sampling locations, determine the proper length of core to be used at each location, and to assess potential sample recovery. Poling data will also be used to support design delineation. This standard operating procedure (SOP) describes the procedures and methods that will be used to estimate soft sediment thickness using poling measurements.

2.0 SUMMARY OF METHOD

The term ‘poling’ refers to the procedure by which a pole that is marked with unit length graduations is used to measure soft sediment thickness on the bed of a waterbody. A metal pole marked with 0.1-foot graduations and with a base probe (minimum 1-foot length by 1-inch diameter) is advanced vertically through the river bed sediment to document the material present (i.e., soft, hard, granular, etc.) and to determine the overall soft material thickness (depth to refusal). The pole is extended downward through the soft sediment using manual force only until resistance inhibits additional advancement. Poling data will be obtained by or supervised by personnel with experience in poling methods.

3.0 SAFETY

All work must be performed under the approved Site Health and Safety Plan (SHSP) for the project. The SHSP identifies proper personal protective equipment (PPE) and potential site/work hazards. Daily safety meetings will be conducted before work begins.

4.0 APPARATUS AND EQUIPMENT

- Vessel (sampling platform) that complies with U.S. Coast Guard regulations with a minimum of three anchors or two anchoring spuds. (Note: If conditions warrant, hovering using engine power against current or wind forces may be substituted for an anchoring system).
- Personal protective equipment specified in the SHSP
- Tape measure and/or rod with maximum graduations of tenths of feet attached to a 6-inch diameter disc, to determine the distance from either the water surface or the sampling platform to the sediment surface
- Metal pole with maximum graduations of tenths of feet with a base probe of minimum 1-foot length by 1-inch diameter
- Maps and field forms
- Real Time Kinematic (RTK) GPS, or equivalent, with +/- 1 meter horizontal accuracy
- Database available on portable computer (or optional field log book)

5.0 PROCEDURES

5.1 Sample Location Positioning

Positioning for sampling will be achieved using an RTK GPS, or equivalent, that is capable of locating stations with an accuracy and repeatability of ±1 meter.

5.2 Poling Data Collection

Poling data should be obtained or supervised by personnel with experience in poling methods. A 6-inch diameter disc attached to a tape measure or rod with maximum 0.1 foot graduations will be used by experienced/qualified personnel capable of detecting the sediment surface (mudline). The measurement will be from the water surface or boat deck reference elevation to the top of sediment to determine the vertical distance to the sediment surface. A pole with maximum 0.1-foot graduations and a base probe (minimum 1-foot length by 1-inch diameter) will be used to advance vertically through the river bed sediment to document the material present with a soft push, using arm strength only, and a hard push using arm strength and body weight. A soft [S] push is defined as the depth of penetration to refusal achieved using one hand (arm strength only). A hard [H] push is defined as the additional depth of penetration to refusal achieved by the same sampler using two hands (arm strength plus body weight). The overall [O] push is the combined total of the soft and hard push [S+H=O]. A qualified individual will conduct the poling and estimate the type of material (e.g., soft sediment, sand, gravel, rocks, rip rap, till, etc.) probed with the pole during advancement and observation of material present on the pole upon retrieval. The following data will be recorded in an electronic data collection device and/or on a field form for each poling location:

- Surface water elevation (reference method dependent);
- Vertical distance from the water surface to the sediment surface;
- Probing depth measurements or vertical distance from the water surface to refusal (S, H, and O); and estimated type of material present.

STANDARD OPERATING PROCEDURE
RUSSIAN PEAT BORER

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January 2016

ACRONYM LIST

GPS	Global Positioning System
NAD	North American Datum
PPE	Personal Protective Equipment
QAPP	Quality Assurance Project Plan
RTK	Real Time Kinematic
SHSP	Site Health and Safety Plan
SOP	Standard Operating Procedure

1.0 SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure (SOP) is to establish a standard procedure for the collection of sediment samples using a Russian Peat Borer Sampler. The Russian Peat Borer Sampler is a discrete interval sampler that collects sediment using a lateral in-place collection technique, as opposed to traditional core sample collection through the face of the advancing core (EPA 1999). The sampler is used to obtain samples for specified intervals and/or to support traditional core sampling methods when sample recovery or disturbance may influence sample integrity.

2.0 SUMMARY OF METHOD

The Russian Peat Borer (RPB) Sampler collects sediment/peat by rotating the core barrel around the sampler core axis to obtain a discrete interval sample. Sampling and measuring the depth to the sediment surface should be conducted by qualified and experienced personnel who can differentiate the water/sediment surface interface using the methods described in this SOP.

A reference surface elevation (boat deck or water surface) will be obtained at each sample location using Real Time Kinematic Global Positioning System (RTK GPS) equipment, or equivalent, and recorded. If the boat deck is the reference surface elevation, the water surface elevation will be obtained by measuring (tape or equivalent) the vertical distance from the boat deck to the water surface before and after daily sampling.

The reference surface elevation will be used to establish the depth to the sediment surface at each sample location. Prior to sampling, a surveyor's rod, pole, or tape measure (marked, at a minimum, in tenths of feet graduations and attached to a 6-inch diameter disc) will be used to determine the distance from the reference elevation to the sediment surface. Because the water provides almost no resistance to the dropping of the rod (due to the rod's weight), the rate of advancement must be controlled so that detection of the minimal resistance provided by the sediment surface is possible. This distance (e.g., depth), plus the target sample depth, will then be marked on the RPB Sampler, which will be lowered through the water column slowly to the marked depth.

Once at the required sediment depth, the sampler rod will be rotated to initiate the sampling while the pivotal cover plate supports the cutting action of the bore. As the sampler is turned, the edge of the bore will longitudinally cut a semi-cylindrical shaped sample until the cover plate encloses an interval of relatively undisturbed sediment.

After the sampler is retrieved and placed on the deck of the boat/sampling platform, the sediment will be removed from the sampler by rotating the cover plate to displace captured sediment. The sample will be photographed and sampled in 0.5-foot intervals (three sample intervals with 1.65-feet length collection chamber). The 0.5-foot sample intervals of all targeted intervals sampled with the RPB will be placed in labeled quart-size plastic bags. All samples from a given location will be stored in a labeled gallon-size plastic bag. For each sample location, the date-time, location coordinates, reference surface elevation (boat deck or water surface), vertical distance from reference elevation to sediment surface, sample advancement length from the sediment surface, target interval, and sediment sample length (intervals) will be documented on an electronic data collection device (e.g. tablet computer) and/or on field forms.

3.0 SAFETY

All work must be performed under the approved Site Health and Safety Plan (SHSP) for the project. The SHSP identifies proper personal protective equipment (PPE) and potential site/work hazards. Daily safety meetings will be conducted before work begins.

4.0 APPARATUS AND EQUIPMENT

The following equipment is recommended to perform discrete sampling with the RPB Sampler:

- Boat (sampling platform) that complies with U.S. Coast Guard regulations with a minimum of three anchors or two anchoring spuds
- PPE specified in the SHSP
- Pole, surveyor's rod, or tape measure (secondary) with maximum 0.1-foot graduations attached to a disc (6-inch diameter) to determine depth from boat deck or water surface to sediment surface
- Tape measure with maximum 0.1-foot graduations
- RPB Sampler
- Quart- and gallon-size plastic bags
- Permanent marker to label sample bags
- Electronic data storage unit for core collection documentation
- Electrical tape
- White board and dry erase markers
- Digital camera
- RTK GPS equipment with horizontal accuracy of ± 1 meter

5.0 PROCEDURES

5.1 Sample Location Positioning

Positioning for sampling will be achieved using an RTK GPS, or equivalent, that is capable of locating stations with an accuracy and repeatability of ±1 meter.

5.2 Water and Sediment Surface Elevations

A reference surface elevation will be established for all vertical measurements using the boat deck or water surface. The elevation for the reference elevation will be obtained with RTK GPS, or equivalent. If the boat deck is the reference surface elevation, the water surface elevation will be documented once before daily sampling is initiated and once after completion of sampling. The water surface elevation will be obtained by measuring (tape or equivalent) the vertical distance from the boat deck to the water surface. The sediment surface elevation will be determined using the reference surface elevation prior to collection of each sample. Vertical distance measurement from the reference to the sediment surface will be done with a surveyor's rod, pole, or tape measure (secondary), all with maximum graduations of 0.1 foot and attached to a 6-inch diameter disc. The measurement of the depth from the reference elevation (water surface or boat deck) to sediment surface will be conducted by qualified and experienced personnel who are capable of establishing the interface between the water and sediment surface. The RPB rod will be taped to indicate the advancement depth from the established reference. The significant figures used to record measurements will be dependent on conditions. Data should be reported within the precision of measurement that is possible at the time of measurement considering wave action, boat stability, or other factors. Work should be conducted when the precision of measurement is at least 0.1 foot so all measurements can be documented accordingly. All data will be documented on an electronic data collection device (e.g. tablet computer) and/or on field forms.

5.3 Sample Collection

The sample collection method is as follows:

1. Add the planned core length to the measured water depth (reference point [water surface or boat deck] to top of sediment). Mark this length with tape on the sample rod from the bottom of the sample core chamber and use this measurement for depth of advancement from the reference.

2. Advance the sampler into the sediment surface slowly to the specified depth. Rotate the sampler to capture the sample. Retract the sampler.

3. Place a clean barrier on the deck, then keeping the sampler horizontal at the boat's deck, rotate the cover plate to open the sampler and extrude the sample. Evaluate sample profile and/or characteristics to verify sampler performance and identify intervals that may not represent in-situ sediment (e.g., slough). Replace any samplers that do not function properly. Resample any sample intervals that do not represent the in-situ sediment. Do not retain the misrepresentative samples.

4. Label white board with date, core sample location identification (ID), and depth interval. Place white board next to the sample and photograph. The photo will be used to assist in sample characterization.

5. Sample in 0.5-foot intervals (site sampler includes 1.65-foot length collection chamber that accommodates three sample intervals) and place all samples from the target interval sampled into labeled (sample ID, depth interval, date) quart-size plastic bags. Transfer the sample from the sampler to the container bag using clean spoons (cohesive sediment) or clean nitrile gloves (non-cohesive sediment) for each sample interval. Place all samples in a 5-gallon bucket for storage on the sampling vessel and transportation to the processing facility.

6. For each sample location, record the following in electronic data collection unit and/or field forms:

   - Date and time

   - Core sample ID and coordinates (note distance [feet] sample was offset from location if additional sampling is required)

   - Depth from reference surface elevation (boat deck or surface water) to the top of the sediment

   - Sample advancement depth from reference surface

   - Target depth interval and collected sample length associated with target depth interval

   - Deliver samples to processing facility for characterization, if required, and processing/packaging for shipment to laboratory.

5.4 Sampler Decontamination and Field Quality Control Sampling

The sampler decontamination process for non-disposal sampling equipment is described below:

1. Remove all visible contaminants (solids) using a non-phosphate laboratory detergent (e.g., Alconox).

2. Rinse with distilled or deionized water.

REFERENCES

U.S. Environmental Protection Agency (EPA). 1999. Innovative Technology Verification Report, Sediment Sampling Technology, Aquatic Research Instruments, Russian Peat Borer. EPA/600/R-01/010.

STANDARD OPERATING PROCEDURE
SEDIMENT LOGGING

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January 2016

1 SCOPE AND APPLICATION

This Standard Operating Procedure for Sediment Logging is intended for use specifically during field activities.

2 SUMMARY OF METHOD

The purpose of the Standard Operating Procedure (SOP) is to provide a step-by step process for describing in-channel sediments using United States Department of Agriculture (USDA) and Unified Soil Classification System (USCS) official descriptors. Boring logs are to be completed using either hard copy hand written or an electronic data logging form (Figure 1). Hard-copy print-outs (Figure 2) from the electronic data logging system will be archived as a backup to the electronic data. A project-specific paper data form (Figure 3) will be used only in the event that electronic data collection is unavailable. At a minimum, sediment will be described using the steps outlined below. For each step, approved descriptors (USDA and/or USCS) have been listed in bold type, followed by official descriptions. Logging of sediments will be done prior to sampling unless otherwise specified in the approved Work Plan, Sampling and Analysis Plan, and/or Quality Assurance Project Plan. Additional sediment characteristics may be included at the direction and approval of the Field Manager.

Following this Standard Operating Procedure ensures that sediment logging procedures are scientifically defensible and meet the task-specific data quality objectives identified in the specific Work Plan. It provides specific quality assurance and quality control mechanisms that validate the information that is collected, and ensure it is useable to all study participants.

3 COMMENTS

Reusable sampling and processing equipment that comes into contact with sediments must be decontaminated prior to reuse in accordance with section 5.3 Decontamination Procedures, of the Field Sampling Plan.

4 SAFETY

All work must be performed under an approved health and safety plan (HASP). The HASP identifies proper personnel protective equipment (PPE) and identifies potential site hazards. Daily safety tailgate meetings must take place before fieldwork begins.

5 APPARATUS AND EQUIPMENT

5.1 Personal protective equipment specified in the Health and Safety Plan

5.2 Core liner cutter.

5.3 Full-spectrum fluorescent lighting, if access to natural sunlight is not available.

5.4 Stainless steel utensils or appropriate disposable utensils.

5.5 Electronic data logging computer or tablet (e.g. iPad).

5.6 For back up in the event the appropriate software and/or computer are not available, use the paper Sediment Logging Form (Figure 3) and waterproof ink pens.

5.7 Disposable non-powdered nitrile gloves.

5.8 Calibrated measuring stick.

5.9 Decontamination equipment (see section 5.3 of the Field Sampling Plan)

6 REAGENTS

6.1 Distilled water.

6.2 Tap water

6.3 Non-phosphate cleaner (e.g., Alconox, or equivalent)

7 SEDIMENT LOGGING PROCEDURE

7.1 Prepare the sediment core for description by cutting the plastic liner lengthwise. Use only an approved cutting device with Kevlar or heavy leather gloves.

7.2 Remove the upper half of the cut plastic liner, leaving the sediment exposed and resting in the bottom half of the liner.

7.3 Using approved nitrile gloves and stainless steel utensils, inspect the sediment under natural sunlight or full-spectrum light to determine the natural layers that are present across the core. Do not include thin laminations, bedding planes, varves, or other thin sedimentary structures as individual layers. Group these features into layers according to overall pattern.

7.4 For each layer, list the sediment logger (person describing the sediment), data entry technician (even if the same as the sediment logger), the layer number (number layers sequentially starting with 1 at the surface), the interval (range of depth below the surface for that layer), and any gap in the sample (difference between the distance the core was pushed and the amount of sediment recovered).

7.5 For each layer, describe the characteristics listed below.

a. *Sediment Color*

Sediment color should be described using an approved Munsell Soil Color Chart. Whenever possible, describe color under natural sunlight. If this is not feasible, use only strong, full-spectrum light at close range. While wearing nitrile gloves, place a small amount of sediment behind the chart apertures until the closest match is found to a chart color chip. Record the hue, value, and chroma of the closest match.

i. Hue (Munsell Color, 2000)

1. **10YR**
2. **7.5YR**
3. **2.5Y**
4. **5Y**
5. **5YR**
6. **2.5YR**
7. **10R**
8. **5PB**
9. **10B**
10. **10BG**
11. **5BG**
12. **10G**
13. **5G**
14. **10GY**
15. **10Y**
16. **N**

ii. Value (Munsell Color, 2000)

1. **8**
2. **7**
3. **6**
4. **5**
5. **4**

6. **3**
7. **2.5**
8. **2**

iii. Chroma (Munsell Color, 2000)
1. **0**
2. **1**
3. **2**
4. **3**
5. **4**
6. **6**
7. **8**

b. *Second sediment color* (if applicable; same hue, value, and chroma categories as above)

c. *Texture*

i. USDA Texture (Schoeneberger et al., 2002)

USDA texture should be estimated by hand texturing. Fine earth texture classes from the textural triangle (Figure 4) should be used. Sand, loamy sand, and sandy loam categories can be further subdivided based on the dominant size of the sand fraction. Absence of a modifier implies a "medium" size.

1. **Gravel –** only used if sample is 90+ % gravel
2. **Coarse sand**
3. **Sand**
4. **Fine sand**
5. **Very fine sand**
6. **Loamy coarse sand**
7. **Loamy sand**
8. **Loamy fine sand**
9. **Loamy very fine sand**
10. **Coarse sandy loam**
11. **Sandy loam**
12. **Fine sandy loam**
13. **Very fine sandy loam**
14. **Loam**
15. **Silt loam**
16. **Silt**
17. **Sandy clay loam**
18. **Clay loam**
19. **Silty clay loam**
20. **Sandy clay**
21. **Silty clay**

22. **Clay**

ii. USCS Texture (ASTM, 1985)

USCS texture should be estimated by hand texturing and a 2-letter code should be chosen to describe the texture. The first letter refers to the size fraction of the dominant particle: G = gravel, S = sand, M = silt, C = clay, O = organic. The second letter is a modifier of the dominant particle size: P = poorly graded (well sorted/uniform particle size), W = well graded (poorly sorted/diversified particle size), H = high plasticity, L = low plasticity. Pt is used for sediment that is almost entirely organic.

1. **GP**
2. **GW**
3. **GM**
4. **GC**
5. **SP**
6. **SW**
7. **SM**
8. **SC**
9. **ML**
10. **MH**
11. **CL**
12. **CH**
13. **OL**
14. **OH**
15. **Pt**

d. Structure

Structure denotes the tendency for a soil or sediment to break, upon pressure being applied, into aggregates resulting from pedogenic processes (Figure 5). To determine structure, apply pressure to an appropriately sized block of sediment placed between the thumb and forefinger. After the block ruptures or deforms, determine which of the 9 structure types the resulting peds most resemble. Determine the appropriate grade by observing in situ peds in the liner. Single grain and massive types always have a grade of structureless.

i. Type (Schoeneberger et al., 2002)

1. **Granular –** small polyhedrals, with curved or very irregular faces
2. **Angular blocky –** polyhedrals with faces that intersect at sharp angles (planes)
3. **Subangular blocky –** polyhedrals with sub-rounded and planar faces, lack sharp angles

4. **Platy –** flat and tabular-like units (not common; must be due to pedogenesis; do not confuse with sedimentary structure)
5. **Wedge –** elliptical, interlocking lenses that terminate in acute angles, bounded by slickensides; not limited to vertic materials (not common)
6. **Prismatic –** vertically elongated units with flat tops (not common)
7. **Columnar –** vertically elongated units with rounded tops which are commonly "bleached" (not common)
8. **Single grain –** no structural units; entirely noncoherent (e.g. loose sand)
9. **Massive –** no structural units; material is a coherent mass (not necessarily cemented)

ii. Grade (Schoeneberger et al., 2002)

1. **Structureless –** no discrete units observable in place or in hand sample
2. **Weak –** units are barely observable in place or in a hand sample
3. **Moderate –** units well-formed and evident in place or in a hand sample
4. **Strong –** units are distinct in place (undisturbed soil), and separate cleanly when disturbed

e. *Plasticity*

Plasticity is the degree to which reworked sediment can be permanently deformed without rupturing. To determine plasticity mix a small amount of sediment with an amount of water sufficient to give the sediment its maximum plasticity. If too much water is added, more sediment can be added. Make a roll of sediment 4cm long and evaluate it using the criteria below.

i. Class (Schoeneberger et al., 2002)

1. **Non-plastic –** will not form a 6mm diameter roll, or if formed, can't support itself if held on end
2. **Slightly plastic –** 6mm diameter roll supports itself; 4mm diameter roll does not
3. **Moderately plastic –** 4mm diameter roll supports itself, 2mm diameter roll does not
4. **Very plastic –** 2mm diameter roll supports its weight

f. *Density (Optional)*

Density describes the degree of firmness for coarse-grained sediments. Official density determination uses the Standard Penetration Test, in a field setting. When describing sediment in a lab setting, an estimate of the density should be made using undisturbed sediment in the plastic liner. Density should only be described for sediments in which the USCS texture is GW, GP, GM, GC, SW, SP, SM, or SC. For other textures, consistency should be used.

i. Class
    1. **Very Loose** (0-4 SPT)
    2. **Loose** (5-10 SPT)
    3. **Medium Dense** (11-30 SPT)
    4. **Dense** (31-50 SPT)
    5. **Very Dense** (>50 SPT)

g. *Consistency (Optional)*

Consistency describes the degree of firmness for intact fine-grained sediments. Official consistency determination uses the Standard Penetration Test, in a field setting. When describing sediment in a lab setting, an estimate of the consistency should be made using undisturbed sediment in the plastic liner. Consistency should only be described for fine-grained sediments.

i. Class
    1. **Very Soft** (<2 SPT)
    2. **Soft** (2-4 SPT)
    3. **Firm** (5-15 SPT)
    4. **Hard** (16-30 SPT)
    5. **Very Hard** (>30 SPT)

h. *Roots*

Describe the quantity and size class of roots per unit area. The area in which to assess root quantity is based on the size of the roots being assessed. For very fine and fine roots, record the average quantity from 3 to 5 units of 1cm by 1cm. For medium and coarse roots, record the average quantity from 3 to 5 units of 10cm by 10cm. For very coarse roots, the appropriate unit area is 1m by 1m. Because of limited sample size when describing sediment from a core sample, very coarse root quantity should be estimated.

i. Quantity (Schoeneberger et al., 2002)
    1. **Few** - <1 per area
    2. **Common** – 1 to <5 per area
    3. **Many** - ≥5 per area

ii. Size (Schoeneberger et al., 2002)
    1. **Very fine** - <1mm
    2. **Fine** – 1 to <2mm

3. **Medium –** 2 to <5mm
4. **Coarse –** 5 to <10mm
5. **Very Coarse** - ≥10mm

i. Rock fragments

Estimate rock fragment percentage by volume. Use a ruler to estimate the average rock fragment size for the entire layer. If multiple size classes are present, use the largest size class, unless the smaller size class has more than twice the percentage by volume of the larger (e.g. 30% fine gravel and 20% coarse gravel, choose "35-60% coarse gravel"; 40% fine gravel and 10% coarse gravel, choose "35-60% fine gravel"). Use comparison samples if available.

i. Quantity (Schoeneberger et al., 2002)
1. **<15%** - no texture adjective added to USDA texture
2. **15 to <35%** - use adjective for appropriate size (e.g. gravelly)
3. **35 to <60%** - use "very" with the appropriate size adjective (e.g. very gravelly)
4. **60 to <90%** - use "extremely" with the appropriate size adjective (e.g. extremely gravelly)
5. **≥90%** - no modifier; use the appropriate noun for the dominant size class (e.g. gravel)

ii. Size (Schoeneberger et al., 2002)
1. **fine gravel –** >2 to 5mm diameter
2. **medium gravel –** >5 to 20mm diameter
3. **coarse gravel –** >20 to 75mm diameter
4. **cobbles –** >75 to 250mm diameter

iii. Angularity
1. **angular** (fragments have sharp edges and relatively planar sides with unpolished surfaces)
2. **subangular** (fragments are similar to angular description but with rounded edges)
3. **subrounded** (fragments have nearly planar sides but well-rounded corners and edges)
4. **rounded** (fragments have smoothly curved sides and no edges)

j. Shells

Note the presence of shells or shell fragments in the layer.

k. Plant fragments

Note the presence of plant fragments in the layer.

l. Wood

Note the dominant wood type if wood is found in the layer. Do not include roots here. Secondary wood types that are deemed important should be listed in the comments section. Estimate the percentage of the layer that is composed of the dominant wood type using the increments listed below.

i. Type

1. **wood –** wood in a generally natural state, any color but black
2. **black wood –** wood that is black, but unburned, inside and out
3. **burned wood –** visibly burned wood
4. **sawdust –** fine wood shavings, either dispersed or clumped together
5. **wood chips –** non-naturally cut small wood pieces
6. **wood pulp –** fibrous, ground wood used in making paper
7. **charcoal –** compressed carbon residue of burned wood

ii. Quantity

1. **<5%**
2. **10%**
3. **20%**
4. **30%**
5. **40%**
6. **50%**
7. **60%**
8. **70%**
9. **80%**
10. **90%**
11. **95%**
12. **100%**

m. Odor

Note any odor detected from the layer after the core has been cut open. Use the wafting method to avoid overexposure to strong chemicals. If the odor is strong and is easily detected without wafting, it may indicate a hazard. Leave the logging area immediately until proper equipment (PID, etc.) can be utilized to verify, monitor, and/or mitigate the risk. Because certain volatile compounds are only released during mixing, an odor may not be detectable until a layer is being composited during sampling. Pay specific attention during this step of the sampling process and adjust the sediment description accordingly.

.

i. Type

1. **Petrochemical**
2. **Sulfur**
3. **Other**

ii. Amount

1. **Slight –** odor is barely detectable, even at close range
2. **Moderate –** odor is detectable when wafting from the proper distance
3. **Strong –** odor permeates after the core liner is cut open and/or during mixing of the sediment; no wafting is needed to detect the odor.

n. Sublayers

Sublayers are thin but distinct bands of sediment within the larger layer. A layer may be composed of many sublayers, in a repeating pattern, or it may be generally uniform but with a few thin bands that differ from the rest of the layer in regards to certain major characteristics, like texture or color. These thin bands should not be separated as individual layers but should be noted and described here. Sublayers include characteristics such as varves, sedimentary structures, thin bedding planes, or stratification.

i. Thickness

1. **<0.05 ft**
2. **0.05 – 0.1 ft**
3. **0.1 – 0.2 ft**
4. **0.2 – 0.5 ft**
5. **>0.5 ft**

ii. Texture

1. Same options as section c. i. (USDA texture)

iii. Color

1. Same options as section a. i, ii, and iii. (Munsell color)

o. Geomorphic Setting

If possible, note the geomorphic setting of the layer in its natural state, based on the characteristics already described. Choose one of the three options below. If none apply, leave this section blank.

i. **Till**

ii. **Lacustrine**

iii. **Sand/gravel bed**

7.6 For each layer, after describing the characteristics above, note any additional remarks. These can be elaborations on characteristics already mentioned or notable layer characteristics that do not fit in any of the categories above. Any speculative comments should be noted as internal sample remarks.

7.7 For each sample interval, fill out the appropriate lab information as listed below.

a. Duplicate

List whether a field duplicate sample will be collected for this interval.

b. Grab/Composite

Identify whether the sample for this interval is a grab sample or composite sample (intervals with field duplicates will always be composite).

c. Matrix

Identify the sample matrix for each sample interval. Default is 'sediment'. Other values are not common.

i. **Sediment**
ii. **Soil**
iii. **Air**
iv. **Water**

d. # of Containers

Identify the number of sample containers used when sampling the interval. Default is 1.

i. **1**
ii. **2**
iii. **3**
iv. **4**
v. **5**
vi. **6**
vii. **7**
viii. **8**
ix. **9**
x. **10**

e. Priority

Identify the lab priority for the sample interval. Methods for prioritizing of samples will be decided by the Field Manager in consultation with the lab.

i. **Urgent (1) –** Samples from this interval will receive expedited lab analysis
ii. **Standard (2) –** Samples from this interval will be analyzed according to the standard lab schedule

iii. **As able (3) –** Samples from this interval will be analyzed after all outstanding ‘urgent’ and ‘standard’ samples

iv. **As needed (4) –** Samples from this interval will not be analyzed unless determined necessary at a later date

v. **Archive (5) –** Samples from this interval will not be analyzed unless determined necessary at a later date and will be archived to allow for future chemistry analysis

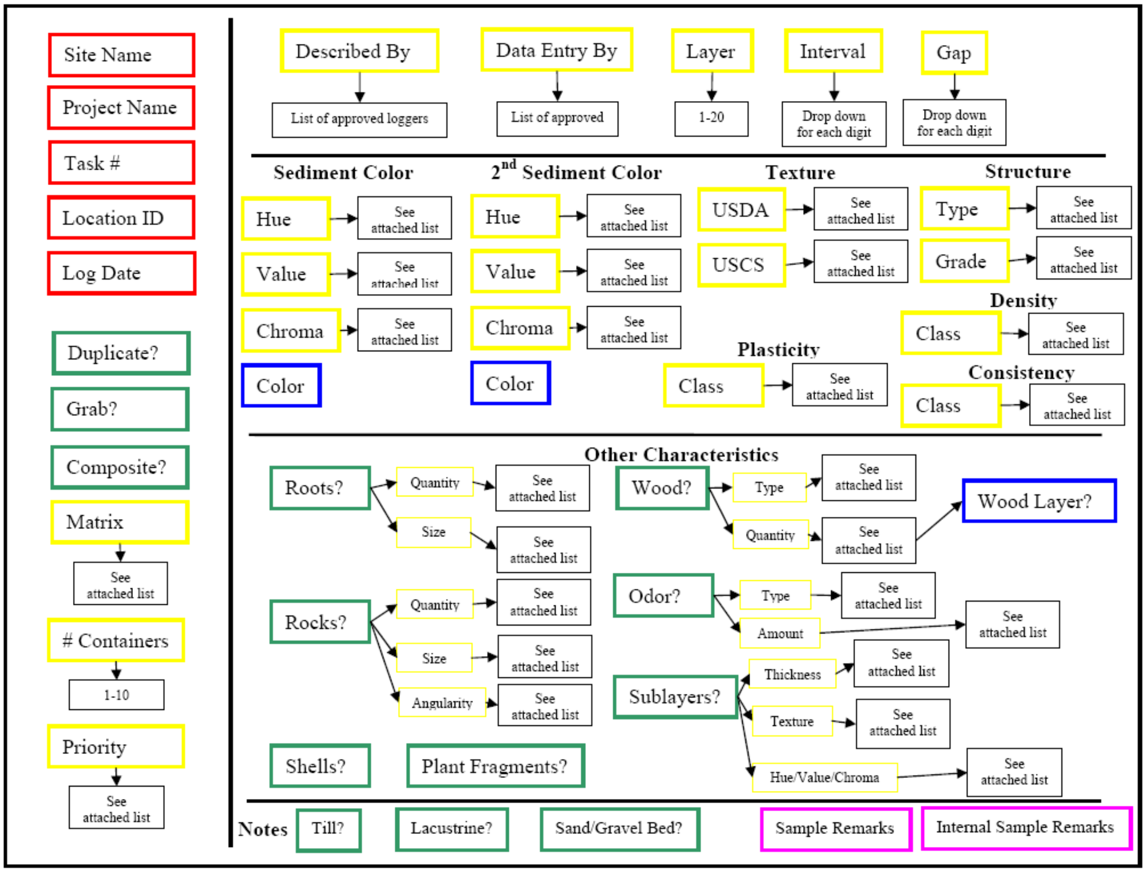
7.8 Repeat steps 7.4, 7.5, 7.6, and 7.7 for each layer until all layers have been described. If multiple samples will be collected from a single layer, or if sample intervals will not align with sediment layers, repeat step 7.7 for each sample interval, making sure to indicate prominently the sampled interval.

8 QUALITY CONTROL

8.1 Initial review of sediment logs will occur immediately after logging of a core. This review will be completed by a qualified soil scientist, geomorphologist, or geologist, with experience in the USDA and USCS systems. Changes will be noted on a paper print-out from the electronic data form. Any changes necessary will be promptly made in the electronic data form. After the changes are made, the reviewer will sign and date the paper print-out, which will be archived.

8.2 A second review of sediment logs will occur by the Field Manager, or their designee, who is independent and separate of the scientist who initially described the sediment. Once the second review is complete, sediment log data will be transferred to the project database.

9 FIGURES



Box Color	Field Type
Red	auto-populate when data form is opened
Yellow	drop-down list
Green	check box
Blue	auto-populate based on form inputs
Pink	manual entry
Black	drop-down menu contents

Yellow boxes sub to green boxes are only be available if the green box is checked (e.g. no rock fragments (unchecked) means form will not let you select drop-down quantity or size).

Figure 1. Diagram of typical electronic data collection form. “Attached list” refers to values described in this SOP.

Sediment Data Sheet

Project Name:
Project Number:
Field Location ID:
Core Type:
Field Remarks:
Northing: (ft)
Easting (ft):

Cored By:
Cored Date:
Described By:
Described Date:

Sample Depth	Layer	Priority	Physical Description	Sample Remarks	Internal Sample Remarks

Core Interval (ft)	Measured Sediment in Core (ft)	% Recovery

Reviewed By ______________________ Date ________

Page 1 of 1

Figure 2. Sample hard-copy print-out from electronic data logging system. Hard copies will be archived as a backup to the electronic system

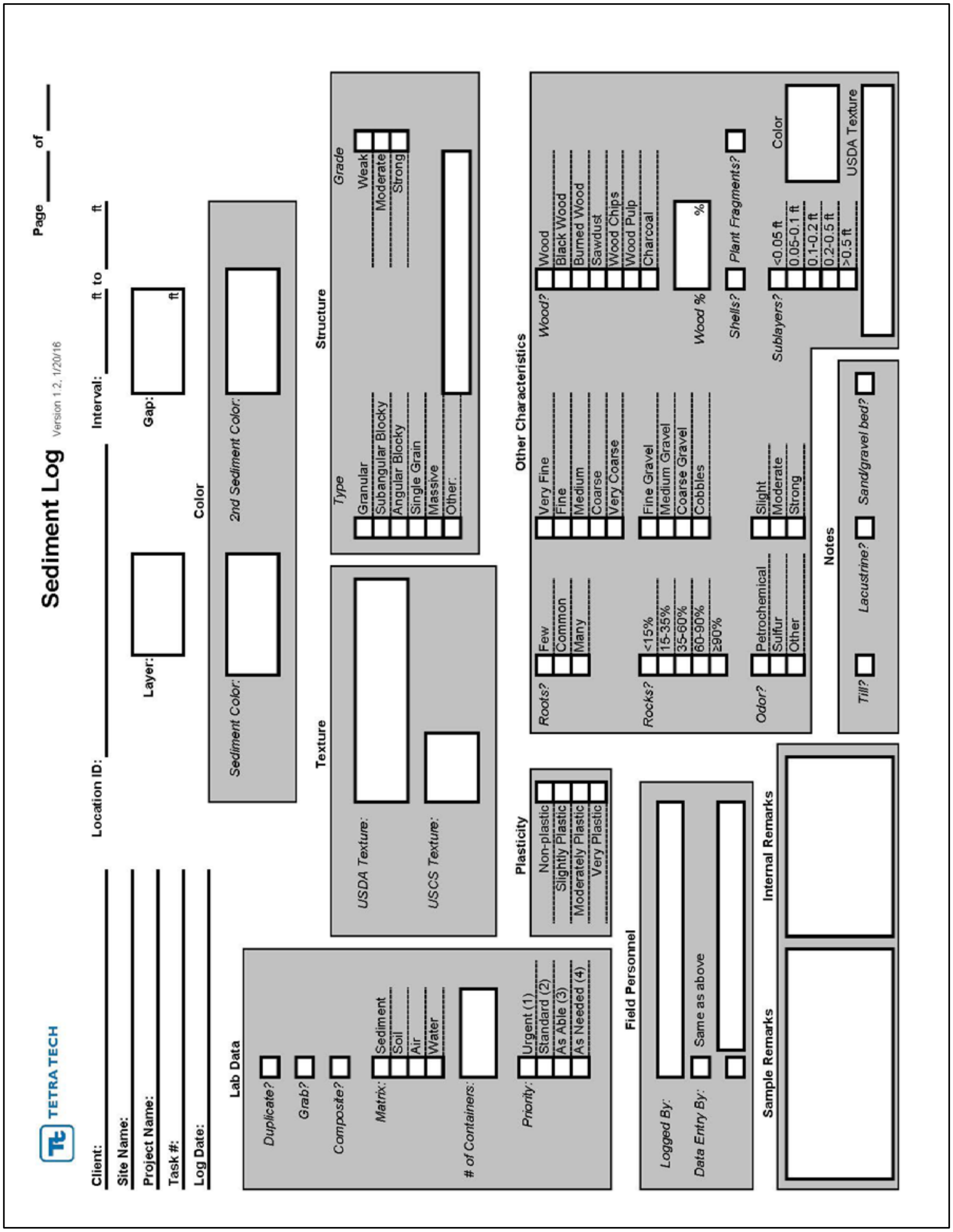


Figure 3. Sample paper sediment logging form. Paper forms will be used only if the electronic data logging system is not available.

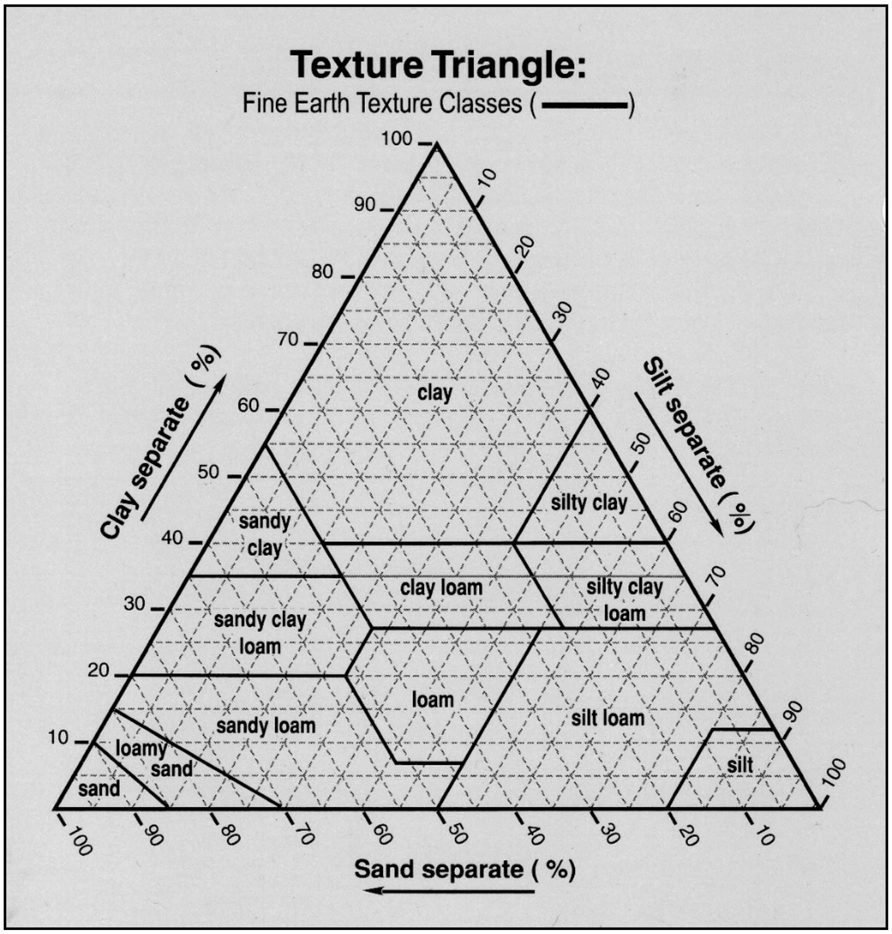


Figure 4. USDA Textural Triangle (from Schoeneberger et al., 2002).

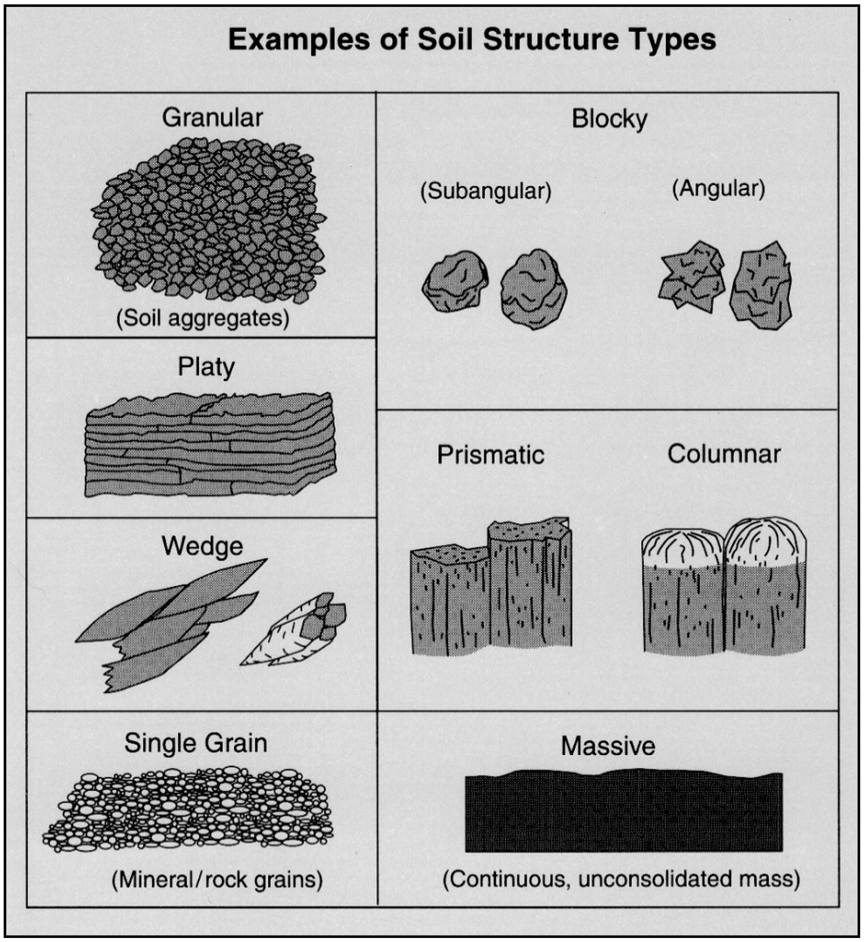


Figure 5. Examples of soil structure types (from Schoeneberger et al., 2002).

10 REFERENCES

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Schoeneberger, P.J., Wysocki, D.A., Benham, E.C., and Broderson, W.D. (editors), 2002. Field book for describing and sampling soils, Version 2.0. Natural Resources Conservation Service, National Soil Survey Center, Lincoln, NE.

STANDARD OPERATING PROCEDURE
SOIL LOGGING

Elliott Ditch
Lafayette, IN

Prepared by:
Tetra Tech CES, Inc.

Prepared for:
Tetra Tech CES, Inc.
Elliott Ditch Sampling Plan

January 2016

1 SCOPE AND APPLICATION

This Standard Operating Procedure for Soil Logging is intended for use specifically during field activities.

2 SUMMARY OF METHOD

The purpose of the Standard Operating Procedure (SOP) is to provide a step-by step process for describing overbank soils using United States Department of Agriculture (USDA) and Unified Soil Classification System (USCS) official descriptors. Boring logs are to be completed using either hard copy hand written or an electronic data logging form (Figure 1). Hard-copy print-outs (Figure 2) from the electronic data logging system will be archived as a backup to the electronic data. A project-specific paper data form (Figure 3) will be used only in the event that electronic data collection is unavailable. At a minimum, soil will be described using the steps outlined below. For each step, approved descriptors (USDA and/or USCS) have been listed in bold type, followed by official descriptions. Logging of soils will be done prior to sampling unless otherwise specified in the approved Work Plan, Sampling and Analysis Plan, and/or Quality Assurance Project Plan. Additional soil characteristics may be included at the direction and approval of the Field Manager.

Following this Standard Operating Procedure ensures that soil logging procedures are scientifically defensible and meet the task-specific data quality objectives identified in the specific Work Plan. It provides specific quality assurance and quality control mechanisms that validate the information that is collected, and ensure it is useable to all study participants.

3 COMMENTS

Reusable sampling and processing equipment that comes into contact with soil must be decontaminated prior to reuse in accordance with section 5.3 Decontamination Procedures, of the Field Sampling Plan.

4 SAFETY

All work must be performed under an approved health and safety plan (HASP). The HASP identifies proper personnel protective equipment (PPE) and identifies potential site hazards. Daily safety tailgate meetings must take place before fieldwork begins.

5 APPARATUS AND EQUIPMENT

5.1 Personal protective equipment specified in the Health and Safety Plan

5.2 Core liner cutter.

5.3 Full-spectrum fluorescent lighting, if access to natural sunlight is not available.

5.4 Stainless steel utensils or appropriate disposable utensils.

5.5 Electronic data logging computer or tablet (e.g. iPad).

5.6 For back up in the event the appropriate software and/or computer are not available, use the paper Soil Logging Form (Figure 3) and waterproof ink pens.

5.7 Disposable non-powdered nitrile gloves.

5.8 Calibrated measuring stick.

5.9 Decontamination equipment (see section 5.3 of the Field Sampling Plan)

6 REAGENTS

6.1 Distilled water.

6.2 Tap water

6.3 Non-phosphate cleaner (e.g., Alconox, or equivalent)

7 SOIL LOGGING PROCEDURE

7.1 Prepare the soil core for description by cutting the plastic liner lengthwise. Use only an approved cutting device with Kevlar or heavy leather gloves.

7.2 Remove the upper half of the cut plastic liner, leaving the soil exposed and resting in the bottom half of the liner.

7.3 Using approved nitrile gloves and stainless steel utensils, inspect the soil under natural sunlight or full-spectrum light to determine the natural layers that are present across the core. Do not include thin laminations, bedding planes, varves, or other thin sedimentary structures as individual layers. Group these features into layers according to overall pattern.

7.4 For each layer, list the sediment logger (person describing the sediment), data entry technician (even if the same as the sediment logger), the horizon (use only official taxonomic designations from Soil Survey Staff, 1999), the interval (range of depth below the surface for that layer), and any gap in the sample (difference between the distance the core was pushed and the amount of soil recovered).

7.5 For each layer, describe the characteristics listed below.

a. *Soil Color*

Soil color should be described using an approved Munsell Soil Color Chart. Whenever possible, describe color under natural sunlight. If this is not feasible, use only strong, full-spectrum light at close range. While wearing nitrile gloves, place a small amount of sediment behind the chart apertures until the closest match is found to a chart color chip. Record the hue, value, and chroma of the closest match.

i. Hue (Munsell Color, 2000)

1. **10YR**
2. **7.5YR**
3. **2.5Y**
4. **5Y**
5. **5YR**
6. **2.5YR**
7. **10R**
8. **5PB**
9. **10B**
10. **10BG**
11. **5BG**
12. **10G**
13. **5G**
14. **10GY**
15. **10Y**
16. **N**

ii. Value (Munsell Color, 2000)

1. **8**
2. **7**
3. **6**
4. **5**
5. **4**
6. **3**
7. **2.5**
8. **2**

iii. Chroma (Munsell Color, 2000)

1. **0**
2. **1**
3. **2**
4. **3**
5. **4**
6. **6**
7. **8**

b. *Second soil color* (if applicable; same hue, value, and chroma categories as above)

c. *Texture*

i. USDA Texture (Schoeneberger et al., 2002)

USDA texture should be estimated by hand texturing. Fine earth texture classes from the textural triangle (Figure 4) should be used. Sand, loamy sand, and sandy loam categories can be further subdivided based on the dominant size of the sand fraction. Absence of a modifier implies a "medium" size.

1. **Gravel –** only used if sample is 90+ % gravel
2. **Coarse sand**
3. **Sand**
4. **Fine sand**
5. **Very fine sand**
6. **Loamy coarse sand**
7. **Loamy sand**
8. **Loamy fine sand**
9. **Loamy very fine sand**
10. **Coarse sandy loam**
11. **Sandy loam**
12. **Fine sandy loam**
13. **Very fine sandy loam**
14. **Loam**
15. **Silt loam**
16. **Silt**
17. **Sandy clay loam**
18. **Clay loam**
19. **Silty clay loam**
20. **Sandy clay**
21. **Silty clay**
22. **Clay**

ii. USCS Texture (ASTM, 1985)

USCS texture should be estimated by hand texturing and a 2-letter code should be chosen to describe the texture. The first letter refers to the size fraction of the dominant particle: G = gravel, S = sand, M = silt, C = clay, O = organic. The second letter is a modifier of the dominant particle size: P = poorly graded (well sorted/uniform particle size), W = well graded (poorly sorted/diversified particle size), H = high plasticity, L = low plasticity. Pt is used for sediment that is almost entirely organic.

1. **GP**
2. **GW**
3. **GM**
4. **GC**
5. **SP**
6. **SW**
7. **SM**
8. **SC**
9. **ML**
10. **MH**
11. **CL**
12. **CH**
13. **OL**
14. **OH**
15. **Pt**

d. *Structure*

Structure denotes the tendency for a soil to break, upon pressure being applied, into aggregates resulting from pedogenic processes (Figure 5). To determine structure, apply pressure to an appropriately sized block of sediment placed between the thumb and forefinger. After the block ruptures or deforms, determine which of the 9 structure types the resulting peds most resemble. Determine the appropriate grade by observing in situ peds in the liner. Single grain and massive types always have a grade of structureless.

i. Type (Schoeneberger et al., 2002)

1. **Granular –** small polyhedrals, with curved or very irregular faces
2. **Angular blocky –** polyhedrals with faces that intersect at sharp angles (planes)
3. **Subangular blocky –** polyhedrals with sub-rounded and planar faces, lack sharp angles
4. **Platy –** flat and tabular-like units (not common; must be due to pedogenesis; do not confuse with sedimentary structure)

5. **Wedge –** elliptical, interlocking lenses that terminate in acute angles, bounded by slickensides; not limited to vertic materials (not common)
6. **Prismatic –** vertically elongated units with flat tops (not common)
7. **Columnar –** vertically elongated units with rounded tops which are commonly "bleached" (not common)
8. **Single grain –** no structural units; entirely noncoherent (e.g. loose sand)
9. **Massive –** no structural units; material is a coherent mass (not necessarily cemented)

ii. Grade (Schoeneberger et al., 2002)

1. **Structureless –** no discrete units observable in place or in hand sample
2. **Weak –** units are barely observable in place or in a hand sample
3. **Moderate –** units well-formed and evident in place or in a hand sample
4. **Strong –** units are distinct in place (undisturbed soil), and separate cleanly when disturbed

e. *Plasticity*

Plasticity is the degree to which reworked soil can be permanently deformed without rupturing. To determine plasticity mix a small amount of soil with an amount of water sufficient to give the soil its maximum plasticity. If too much water is added, more soil can be added. Make a roll of soil 4cm long and evaluate it using the criteria below.

i. Class (Schoeneberger et al., 2002)

1. **Non-plastic –** will not form a 6mm diameter roll, or if formed, can't support itself if held on end
2. **Slightly plastic –** 6mm diameter roll supports itself; 4mm diameter roll does not
3. **Moderately plastic –** 4mm diameter roll supports itself, 2mm diameter roll does not
4. **Very plastic –** 2mm diameter roll supports its weight

f. *Density (Optional)*

Density describes the degree of firmness for coarse-grained soils. Official density determination uses the Standard Penetration Test, in a field setting. When describing soil in a lab setting, an estimate of the density should be made using undisturbed soil in the plastic liner. Density should only be described for soils in which the USCS texture is GW, GP, GM, GC, SW, SP, SM, or SC. For other textures, consistency should be used.

i. Class
1. **Very Loose** (0-4 SPT)
2. **Loose** (5-10 SPT)
3. **Medium Dense** (11-30 SPT)
4. **Dense** (31-50 SPT)
5. **Very Dense** (>50 SPT)

g. *Consistency (Optional)*

Consistency describes the degree of firmness for intact fine-grained soils. Official consistency determination uses the Standard Penetration Test, in a field setting. When describing soil in a lab setting, an estimate of the consistency should be made using undisturbed soil in the plastic liner. Consistency should only be described for fine-grained soil.

i. Class
1. **Very Soft** (<2 SPT)
2. **Soft** (2-4 SPT)
3. **Firm** (5-15 SPT)
4. **Hard** (16-30 SPT)
5. **Very Hard** (>30 SPT)

h. *Roots*

Describe the quantity and size class of roots per unit area. The area in which to assess root quantity is based on the size of the roots being assessed. For very fine and fine roots, record the average quantity from 3 to 5 units of 1cm by 1cm. For medium and coarse roots, record the average quantity from 3 to 5 units of 10cm by 10cm. For very coarse roots, the appropriate unit area is 1m by 1m. Because of limited sample size when describing soil from a core sample, very coarse root quantity should be estimated.

i. Quantity (Schoeneberger et al., 2002)
1. **Few** - <1 per area
2. **Common** – 1 to <5 per area
3. **Many** - ≥5 per area

ii. Size (Schoeneberger et al., 2002)
1. **Very fine** - <1mm
2. **Fine** – 1 to <2mm
3. **Medium** – 2 to <5mm
4. **Coarse** – 5 to <10mm
5. **Very Coarse** - ≥10mm

i. Rock fragments

Estimate rock fragment percentage by volume. Use a ruler to estimate the average rock fragment size for the entire layer. If multiple size classes are present, use the largest size class, unless the smaller size class has more than twice the percentage by volume of the larger (e.g. 30% fine gravel and 20% coarse gravel, choose "35-60% coarse gravel"; 40% fine gravel and 10% coarse gravel, choose "35-60% fine gravel"). Use comparison samples if available.

i. Quantity (Schoeneberger et al., 2002)
1. **<15%** - no texture adjective added to USDA texture
2. **15 to <35%** - use adjective for appropriate size (e.g. gravelly)
3. **35 to <60%** - use "very" with the appropriate size adjective (e.g. very gravelly)
4. **60 to <90%** - use "extremely" with the appropriate size adjective (e.g. extremely gravelly)
5. **≥90%** - no modifier; use the appropriate noun for the dominant size class (e.g. gravel)

ii. Size (Schoeneberger et al., 2002)
1. **fine gravel –** >2 to 5mm diameter
2. **medium gravel –** >5 to 20mm diameter
3. **coarse gravel –** >20 to 75mm diameter
4. **cobbles –** >75 to 250mm diameter

iii. Angularity
1. **angular** (fragments have sharp edges and relatively planar sides with unpolished surfaces)
2. **subangular** (fragments are similar to angular description but with rounded edges)
3. **subrounded** (fragments have nearly planar sides but well-rounded corners and edges)
4. **rounded** (fragments have smoothly curved sides and no edges)

j. Shells

Note the presence of shells or shell fragments in the horizon.

k. Plant fragments

Note the presence of plant fragments in the horizon.

l. Wood

Note the dominant wood type if wood is found in the horizon. Do not include roots here. Secondary wood types that are deemed important should be listed in the comments section. Estimate the percentage of the layer that is composed of the dominant wood type using the increments listed below.

i. Type
   1. **wood –** wood in a generally natural state, any color but black
   2. **black wood –** wood that is black, but unburned, inside and out
   3. **burned wood –** visibly burned wood
   4. **sawdust –** fine wood shavings, either dispersed or clumped together
   5. **wood chips –** non-naturally cut small wood pieces
   6. **wood pulp –** fibrous, ground wood used in making paper
   7. **charcoal –** compressed carbon residue of burned wood

ii. Quantity
   1. **<5%**
   2. **10%**
   3. **20%**
   4. **30%**
   5. **40%**
   6. **50%**
   7. **60%**
   8. **70%**
   9. **80%**
   10. **90%**
   11. **95%**
   12. **100%**

m. Odor

Note any odor detected from the horizon after the core has been cut open. Use the wafting method to avoid overexposure to strong chemicals. If the odor is strong and is easily detected without wafting, it may indicate a hazard. Leave the logging area immediately until proper equipment (PID, etc.) can be utilized to verify, monitor, and/or mitigate the risk. Because certain volatile compounds are only released during mixing, an odor may not be detectable until a layer is being composited during sampling. Pay specific attention during this step of the sampling process and adjust the soil description accordingly.

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i. Type
   1. **Petrochemical**
   2. **Sulfur**
   3. **Other**

ii. Amount
   1. **Slight –** odor is barely detectable, even at close range
   2. **Moderate –** odor is detectable when wafting from the proper distance
   3. **Strong –** odor permeates after the core liner is cut open and/or during mixing of the soil; no wafting is needed to detect the odor.

n. *Sublayers*

Sublayers are thin but distinct bands of soil within the larger horizon. A horizon may be composed of many sublayers, in a repeating pattern, or it may be generally uniform but with a few thin bands that differ from the rest of the horizon in regards to certain major characteristics, like texture or color. These thin bands should not be separated as individual horizons but should be noted and described here. Sublayers include characteristics such as varves, sedimentary structures, thin bedding planes, or stratification. They are often found in the soil parent material (C horizon) and are uncommon in the solum.

i. Thickness
   1. **<0.05 ft**
   2. **0.05 – 0.1 ft**
   3. **0.1 – 0.2 ft**
   4. **0.2 – 0.5 ft**
   5. **>0.5 ft**

ii. Texture
   1. Same options as section c. i. (USDA texture)

iii. Color
   1. Same options as section a. i, ii, and iii. (Munsell color)

o. Geomorphic Setting

If possible, note the geomorphic setting of the horizon in its natural state, based on the characteristics already described. Choose one of the three options below. If none apply, leave this section blank. Only complete this section for the soil parent material (C horizon).

i. **Till**
ii. **Lacustrine**
iii. **Sand/gravel bed**

7.6 For each horizon, after describing the characteristics above, note any additional remarks. These can be elaborations on characteristics already mentioned or notable horizon characteristics that do not fit in any of the categories above. Any speculative comments should be noted as internal sample remarks.

7.7 For each sample interval, fill out the appropriate lab information as listed below.

a. Duplicate

List whether a field duplicate sample will be collected for this sample interval.

b. Grab/Composite

Identify whether the sample interval is a grab sample or composite sample (intervals with field duplicates will always be composite).

c. Matrix

Identify the sample matrix for each sample interval. Default is 'soil'. Other values are not common.

i. **Soil**
ii. **Sediment**
iii. **Air**
iv. **Water**

d. # of Containers

Identify the number of sample containers used when sampling the sample interval. Default is 1.

i. **1**
ii. **2**
iii. **3**
iv. **4**
v. **5**
vi. **6**
vii. **7**
viii. **8**
ix. **9**
x. **10**

e. Priority

Identify the lab priority for the sample interval. Methods for prioritizing of samples will be decided by the Field Manager in consultation with the lab.

i. **Urgent (1) –** Samples from this interval will receive expedited lab analysis
ii. **Standard (2) –** Samples from this interval will be analyzed according to the standard lab schedule

iii. **As able (3) –** Samples from this interval will be analyzed after all outstanding 'urgent' and 'standard' samples

iv. **As needed (4) –** Samples from this interval will not be analyzed unless determined necessary at a later date

v. **Archive (5) –** Samples from this interval will not be analyzed unless determined necessary at a later date and will be archived to allow for future chemistry analysis

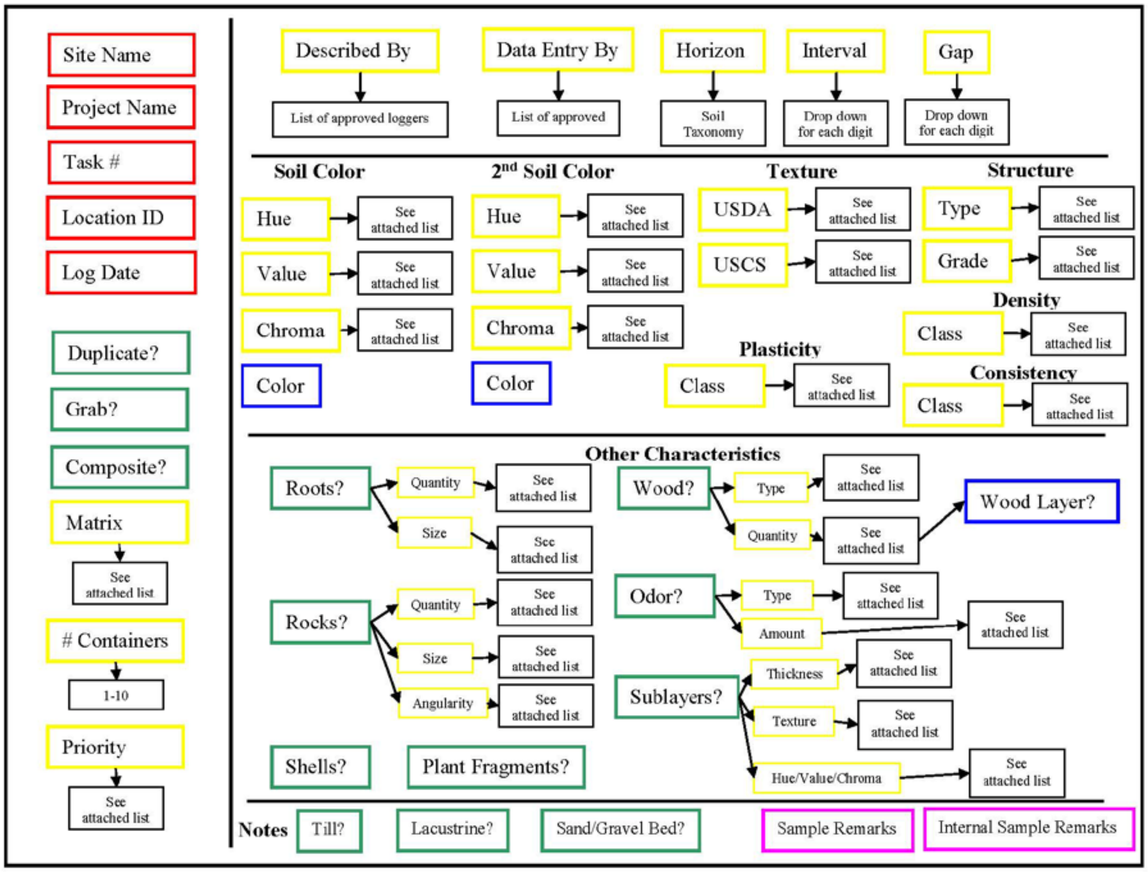
7.8 Repeat steps 7.4, 7.5, 7.6, and 7.7 for each horizon until all horizon have been described. If multiple samples will be collected from a single horizon, repeat step 7.7 for each sample interval, making sure to indicate prominently the sampled interval, since it will be different from the horizon interval.

8 QUALITY CONTROL

8.1 Initial review of soil logs will occur immediately after logging of a core. This review will be completed by a qualified soil scientist, geomorphologist, or geologist, with experience in the USDA and USCS systems. Changes will be noted on a paper print-out from the electronic data form. Any changes necessary will be promptly made in the electronic data form. After the changes are made, the reviewer will sign and date the paper print-out, which will be archived.

8.2 A second review of soil logs will occur by the Field Manager, or their designee, who is independent and separate of the scientist who initially described the sediment. Once the second review is complete, soil log data will be transferred to the project database.

9 FIGURES



Box Color	Field Type
Red	auto-populate when data form is opened
Yellow	drop-down list
Green	check box
Blue	auto-populate based on form inputs
Pink	manual entry
Black	drop-down menu contents

Yellow boxes sub to green boxes are only be available if the green box is checked (e.g. no rock fragments (unchecked) means form will not let you select drop-down quantity or size).

Figure 1. Diagram of typical electronic data collection form. “Attached list” refers to values described in this SOP.

Sediment Data Sheet

Project Name:
Project Number:
Field Location ID:
Core Type:
Field Remarks:
Northing: (ft)
Easting (ft):

Cored By:
Cored Date:
Described By:
Described Date:

Sample Depth	Layer	Priority	Physical Description	Sample Remarks	Internal Sample Remarks

Core Interval (ft)	Measured Sediment in Core (ft)	% Recovery

Reviewed By ____________________________ Date ________

Page 1 of 1

Figure 2. Sample hard-copy print-out from electronic data logging system. Hard copies will be archived as a backup to the electronic system

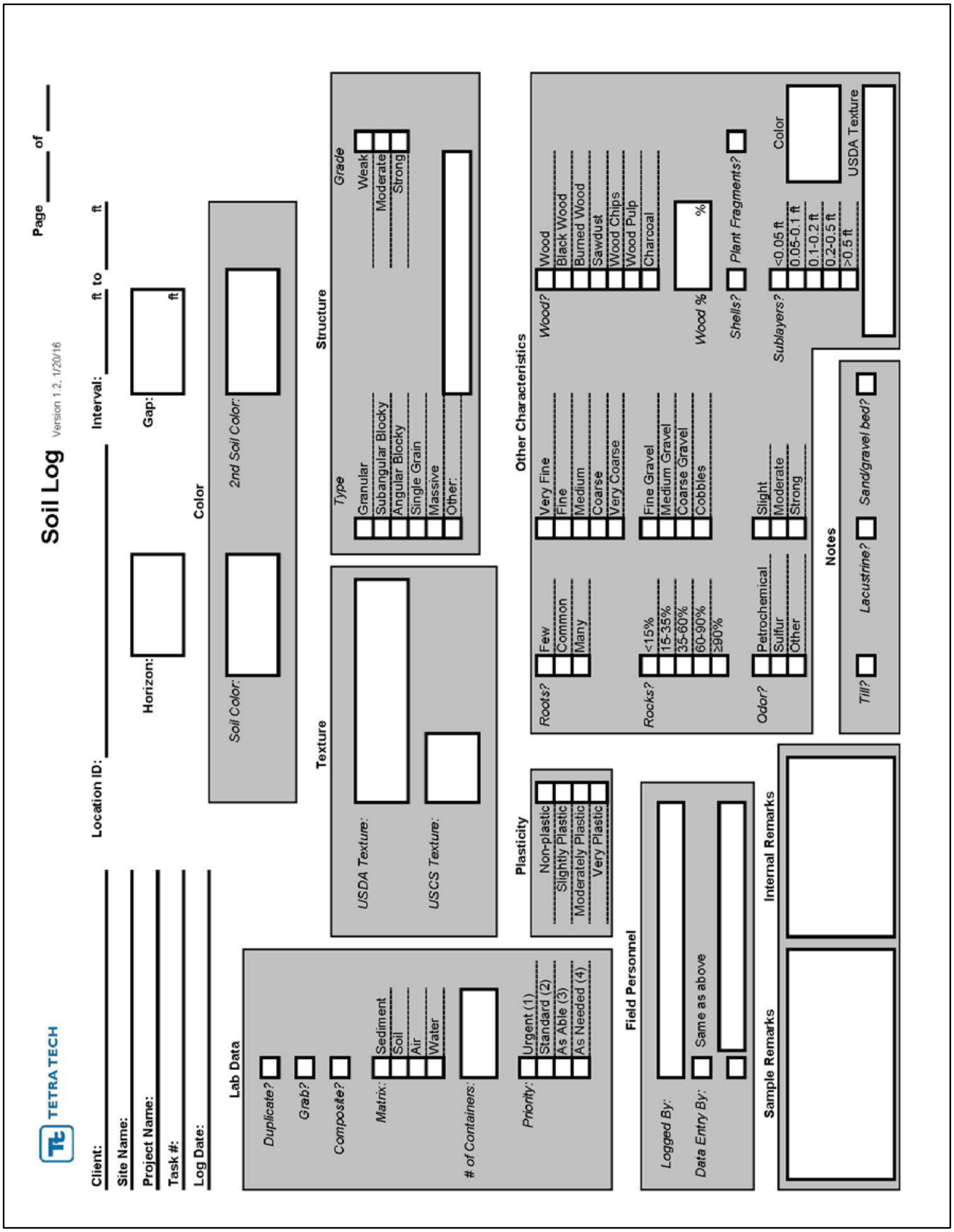


Figure 3. Sample paper soil logging form. Paper forms will be used only if the electronic data logging system is not available.

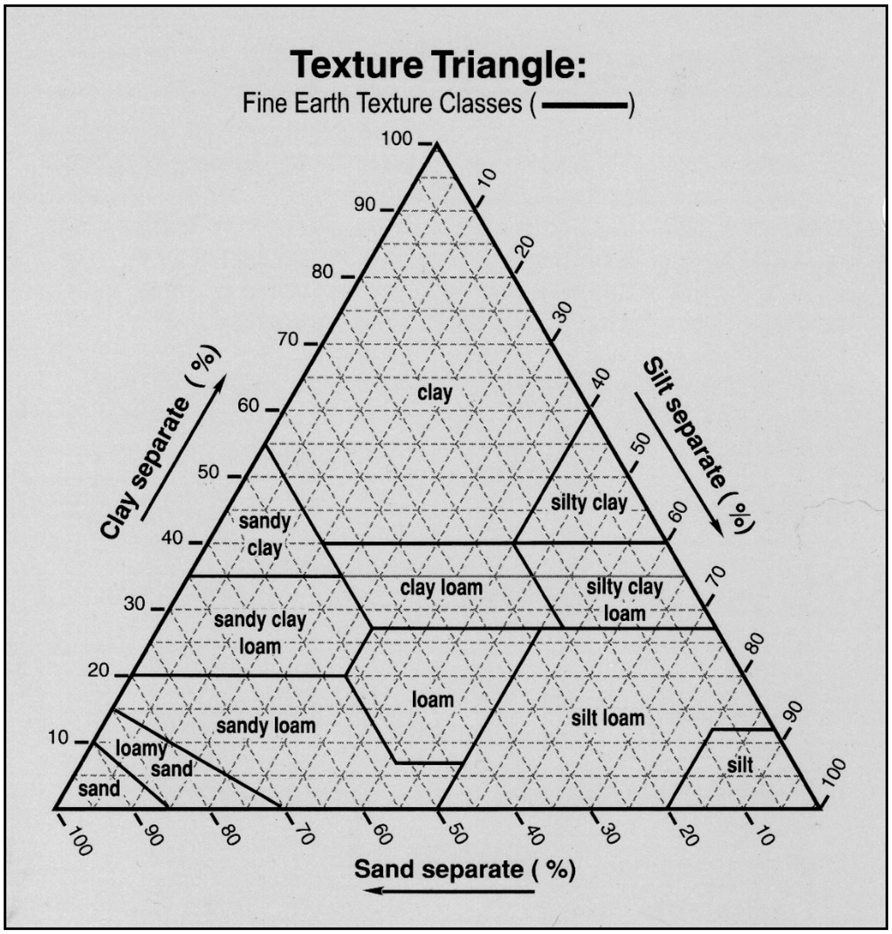


Figure 4. USDA Textural Triangle (from Schoeneberger et al., 2002).

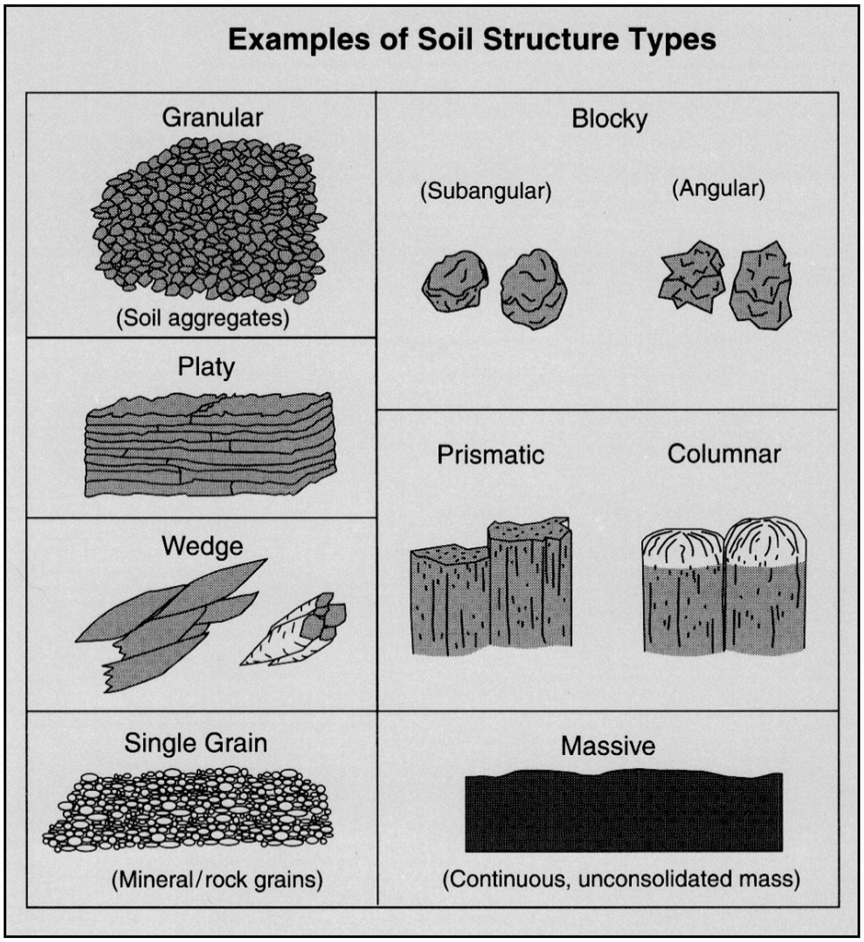


Figure 5. Examples of soil structure types (from Schoeneberger et al., 2002).

10 REFERENCES

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STANDARD OPERATING PROCEDURE
SOIL RECOVERY AUGER

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Prepared for:
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Elliott Ditch Sampling Plan

January 2016

ACRONYM LIST

GPS	Global Positioning System
NAD	North American Datum
PPE	Personal Protective Equipment
QAPP	Quality Assurance Project Plan
RTK	Real Time Kinematic
SHSP	Site Health and Safety Plan
SOP	Standard Operating Procedure

1.0 SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure (SOP) is to establish a standard procedure for the collection of soil core samples using a soil recovery auger with a plastic liner. Procedures are described for the collection of soil, soft sediments, and fine-grained sands. This SOP should be consulted during the preparation of any plan requiring procedures for soil sample collection using a soil recovery auger.

2.0 SUMMARY OF METHOD

The soil recovery auger will be marked to the advancement depth and then placed on the spot to be sampled. The soil recovery auger is then spun clockwise until the advancement depth mark is level with the soil surface. To take a subsurface sample, mark the advancement depth on the soil recovery auger and then place it in the bore hole that was created by the previous sample/s. This step may be repeated to recover multiple intervals from one location. The location, date-time, and the sample advancement length from the soil surface or soil interval collected (e.g. 0.0' – 1.0') are documented using the data collector (e.g., Leica Viva) or alternative documentation method.

3.0 SAFETY

All work must be performed under the approved Site Health and Safety Plan (SHSP) for the project. The SHSP identifies proper personal protective equipment (PPE) and potential site/work hazards. Daily safety meetings will be conducted before work begins.

4.0 APPARATUS AND EQUIPMENT

- PPE specified in the SHSP
- Tape measure, lead line, and/or pole with minimum graduations of 0.1 foot attached to disc to measure the advancement depth on the soil recovery auger
- Electrical tape to mark the advancement depth on the soil recovery auger
- Soil recovery auger
- One foot plastic core liners
- Alconox
- Distilled or deionized water
- Scrub brushes
- Garden Sprayer
- Electronic data storage unit for core collection documentation
- Real Time Kinematic (RTK) Global Positioning System (GPS) or equivalent, with horizontal accuracy of ± 1 meter

5.0 PROCEDURES

5.1 Sample Location Positioning

Positioning for sampling will be achieved using an RTK GPS, or equivalent, that is capable of locating stations with an accuracy and repeatability of ±1 meter.

5.2 Soil recovery auger Sample Collection

1. Insert a plastic core liner.

2. Mark the soil recovery auger to set the advancement depth.

3. While holding the t-handle and using a clockwise motion advance the sampler into the soil surface slowly to the specified depth.

4. Without spinning, carefully remove the soil recovery auger from the soil.

5. Wearing nitrile gloves, carefully remove the plastic core liner with soil/sediment from the auger. If necessary, use a clean needle nose pliers to assist in pulling out the plastic liner.

6. Cap the core at both ends.

7. Label the core sample with sample location identification (ID), date, time, and depth interval (e.g. 0.0’ – 1.0’).

8. Place all samples upright in a 5-gallon bucket for storage while in the field and transportation to the processing area.

9. Record location, date, time, and depth interval into the Leica Viva or using alternative documentation method.

5.3 Decontamination

The soil recovery auger should be decontaminated after every core interval collection attempt by following the procedures outlined below:

- Remove all visible contaminants (solids) using a brush and a non-phosphate laboratory detergent (e.g., Alconox).

- Rinse with distilled or deionized water.