Prepared for

HERCULES

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FOCUSED REMEDIAL INVESTIGATION/FEASIBILITY STUDY REPORT

OPERABLE UNIT 1 (OU1) OUTFALL DITCH

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1. INTRODUCTION AND BACKGROUND

1.1 Terms of Reference

Geosyntec Consultants (Geosyntec) is conducting a Focused Remedial Investigation and Feasibility Study (RI/FS) on behalf of Hercules Incorporated[1] (Hercules) for the Outfall Ditch/Operable Unit 1 (OU1) at the Terry Creek Site (Site) located in Brunswick, Georgia (Figure 1-1). It is noted that the terms "OU1" and "Outfall Ditch" are used interchangeably throughout this document.

The RI/FS is being performed pursuant to the 30 September 1999 Administrative Order on Consent (AOC) between Hercules and the United States Environmental Protection Agency (USEPA). Pursuant to the 1999 AOC, Hercules submitted a revised RI/FS Work Plan to USEPA in 2001. However, due to concerns regarding the analytical method for toxaphene, the project was temporarily suspended by USEPA. In June 2008, USEPA requested a schedule for resuming RI/FS activities at the Site. In July 2009, Hercules submitted a Site Management Plan (SMP) that described a plan and schedule to complete the response actions at the Site pursuant to the 1999 AOC. A component of that plan was to subdivide the Site into three operable units. This Focused RI/FS addresses only the Outfall Ditch; Operable Unit 1 (OU1).

The Focused RI/FS is being conducted in accordance with the *Focused RI/FS Work Plan Operable Unit 1 (OU1) Outfall Ditch* (Work Plan, [Geosyntec, 2012]) and pursuant to the 30 September 1999 AOC. The USEPA approved the Work Plan in a letter dated 5 January 2012. Due to the relatively small size of OU1 (Figure 1-2), the existing toxaphene concentrations present in the OU1 sediments and developing analytical methods and toxicity reference values for weathered toxaphene, the USEPA and Hercules agreed to perform a Focused RI/FS that allows for the selection of a final remedy at OU1 that is not reliant on the toxaphene analytical methodology or toxicity reference value development. As stated in the Work Plan, selected remedial action objectives and cleanup goals defined for OU1 will be a narrative performance-based goal (i.e., protectiveness achieved via pathway elimination) rather than numerical risk-based concentrations. Following the 1999-2000 removal action at the Site, the highest

[1] On November 13, 2008, Hercules Incorporated was acquired by Ashland Inc. However, the responsible party for the Terry Creek Site will continue to be referred to as Hercules. On January 28, 2010 Hercules sold the Brunswick Plant Resins business and a portion of the property to Pinova, Inc.

relative residual concentrations of toxaphene (i.e., post removal action) were found in the Outfall Ditch. Therefore, prioritizing and implementing remedial actions at the Outfall Ditch will address a significant source of toxaphene to the Terry and Dupree Creek system.

1.2 Purpose of Report

The purpose of this report is to establish the nature and extent of contamination in the Outfall Ditch, discuss the contaminant fate and transport, report on the baseline risk assessment, and develop and screen remedial alternatives to address potential excess risk posed by the contamination present in OU1.

1.3 Site Background

1.3.1 Site Operating History

The plant became operational in 1911; it is believed that the Outfall Ditch was constructed at this time. Between 1948 and 1980 Hercules produced toxaphene, a chlorinated pesticide, at its Brunswick Plant. Untreated wastewater from the production of toxaphene was discharged through the Outfall Ditch into Dupree Creek until 1972. A wastewater treatment system was installed in 1972, and the amount of toxaphene in the permitted discharge was significantly reduced after that time until toxaphene production ceased in 1980. Portions of Terry Creek and Dupree Creek have been dredged by USACE beginning with enactment of the Rivers and Harbors Act of 1938 (Terry Creek Project), authorizing dredging of a navigational channel. The Terry Creek project was completed by the Corps in 1939; and subsequently, maintenance dredging occurred in 1940, 1941, 1942, and 1946, prior to production of toxaphene. Some dredge spoils from these dredging activities were disposed in an area located adjacent to the Torras Causeway beside Terry Creek, which is currently known as the Trailer Park Dredge Spoil Area.

Dredging of Terry Creek and Dupree Creek resumed in 1971 with subsequent dredging in 1972, 1983, 1987, and 1988/89. With the approval of USEPA, in 1972 the US Fish and Wildlife Services, the State of Georgia, and the USACE chose an area on the north side of Terry Creek at the confluence of Terry and Dupree Creeks for placement of dredge spoils. This area (Main Dredge Spoil Area) served as the primary disposal area for dredge spoils until dredging was discontinued in 1989. Some dredge spoils were

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also disposed by the USACE at the Riverside Dredge Spoil Area and, prior to 1972, on Carter's Island.

On January 28, 2010 Hercules sold the Brunswick Plant Resins business and a portion of the property to Pinova, Inc. Hercules continues to own the property east of Highway 17 that contains the Outfall Ditch and the Marsh Wood Storage Yard.

1.3.2 Previous Site Characterization Studies

This section summarizes previous studies that have been conducted at the Site, which include: (i) measurement of specific toxicity of sediment samples in 1994 by the U.S. National Oceanographic and Atmospheric Administration (NOAA) [NOAA, 1994]; (ii) an Expanded Site Investigation (ESI) conducted by USEPA Region IV in 1995 (Black and Veatch, 1997); (iii) an Ecological Screening Evaluation (ESE) conducted by USEPA in 1997 (USEPA, 1997a); and (iv) a Site Status Investigation conducted by Geosyntec on behalf of Hercules in 1997 and 1998 (Geosyntec, 1998). Investigations have also been performed in the Marsh Wood Storage Area in conjunction with RCRA Corrective Action activities for the Brunswick Plant.

In 1994, NOAA obtained sediment samples from estuarine settings in the Terry Creek and Back River areas and analyzed these samples for acute toxicity to the marine amphipod *Ampelisca abdita* (NOAA, 1994). Results indicated that sediments from Terry Creek exhibited sediment toxicity to *A. abdita* that was not observed in sediments from other areas of the Brunswick/St. Simon's estuary.

In 1995, USEPA Region IV conducted an ESI at the Site (Black and Veatch, 1997). A total of 45 groundwater, surface water, soil, and sediment samples was collected from Terry Creek, Dupree Creek, the Back River, and dredge spoil areas at the Site, and analyzed for toxaphene during the ESI. Soil and sediment samples collected from the dredge spoil areas, Dupree Creek and Terry Creek contained detectable concentrations of toxaphene at concentrations up to 430 milligrams per kilogram (mg/kg). USEPA (Black and Veatch, 1997) collected samples of killifish from the confluence of Terry and Dupree Creek during the spring and summer of 1996 as part of a Community Based Environmental Project. Results from whole-body fish analyses of these samples indicated that toxaphene concentrations were estimated at 19 parts per million (ppm) and 27 ppm.

USEPA conducted an ESE for the vicinity of Terry and Dupree Creeks in the spring of 1997 (USEPA, 1997a). During the ESE, sediment and surface water samples were collected as well as various species of forage fish, consumer fish, and shellfish. Results from analyses for toxaphene indicated that the presence of toxaphene was not confirmed in any fish or shellfish samples. Toxaphene was detected at concentrations up to 230 mg/kg in sediment samples collected from Terry and Dupree Creeks.

On behalf of Hercules, Geosyntec conducted a Site Status Investigation from November 1997 to July 1998 to fulfill the requirements of an AOC for Removal Action between Hercules and USEPA. A total of 375 soil and sediment and groundwater samples was collected during the SSI and analyzed for toxaphene. Sediments in the Outfall Ditch had toxaphene concentrations generally in excess of 100 mg/kg to a depth of 5-ft. Deeper samples (5-8.5 ft) exhibited similar concentrations in the center, but low and non-detect concentrations along the margins of the ditch. Surficial sediments in Dupree Creek were generally less than 10 mg/kg with some exceptions. In Terry Creek, toxaphene concentrations were in the range of 20-50 mg/kg near the confluence with Dupree Creek, but generally less than 10 mg/kg elsewhere. Toxaphene concentrations in soils in the dredged spoil areas varied considerable depending on location but frequently had concentrations between 10 and 50 mg/kg with a few sample locations greater than 100 mg/kg. Toxaphene was not detected in groundwater samples. Complete results from the SSI were provided in a Site Status Report (Geosyntec, 1998).

1.3.3 Previous Removal Action

Pursuant to the 1999 AOC for Removal Action, a removal action was conducted at the Site from August 1999 to April 2000 to remove sediment containing the highest concentrations of toxaphene, including the pre-weir and post-weir Outfall Ditch, the mouth of the Outfall Ditch, the confluence area of Terry and Dupree Creeks, and north Dupree Creek. These removal areas are shown in Figure 1-3. Post-removal confirmation sampling was conducted in the dredged areas following the removal action. These samples were analyzed for toxaphene to document residual levels of toxaphene in sediment.

A large mass of toxaphene was contained in the Outfall Ditch prior to the removal action, with concentrations as high as 33,000 mg/kg. The objective of the removal action was a ninety-percent mass removal (Geosyntec, 1999). Per the terms of the 1998 AOC Amendment, the removal action was to include minimum excavations in the pre-

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weir area of 1 to 8 feet and 1 to 5 feet in the post-weir area. Although, some difficulties were encountered due to debris in the sediments and sloughing of excavations areas, the removal action was largely successful at meeting the mass removal objectives. However, despite the success of the removal action, elevated concentrations of toxaphene remain in the Outfall Ditch (see Figure 1-4).

A total of approximately 16,800 cubic yards (yd^3) of sediment was dredged/excavated from the Outfall Ditch. Post-removal sediment samples were collected from multiple cores at one-foot depth intervals within the sediment bed down to 12 ft below the sediment/water interface.

Toxaphene concentrations in post-removal samples ranged from not detected to 2,200 mg/kg in the 0-1 ft sediment depth interval. Toxaphene was detected in 33 of 38 samples analyzed in this interval. In the 1-2 ft depth interval, toxaphene was detected in 20 of 21 samples, with the highest concentration of 2,100 mg/kg in the post-weir area. Similarly, a high concentration of 2,100 mg/kg was detected in the 2-3 ft sediment depth interval; toxaphene was detected in 14 of 21 samples analyzed in this depth interval. Concentrations generally decreased with depth, and within the pre-weir section, toxaphene was not detected deeper than 4 ft below the sediment/water interface. Toxaphene was detected to a depth of 12 ft in one post-weir sample. Toxaphene concentrations and distribution by depth in the post-excavation Outfall Ditch samples are provided on Figure 1-4. Post-removal ranges and averages of toxaphene concentrations for the 0-1 ft interval in the Outfall Ditch, and Terry and Dupree Creek sediments are shown on Figure 1-5. As can be observed on Figure 1-5, the average residual toxaphene concentration in the Outfall Ditch, based on the post–removal analytical results, was two orders of magnitude higher than all other downstream segments of the tidal creek system.

1.3.4 Fish Tissue

The release of toxaphene to the surrounding marsh via the Outfall Ditch has resulted in detectable concentrations of toxaphene and chlorinated camphenes (weathered toxaphene) in the tissues of aquatic organisms living in Terry and Dupree Creeks. A study from 1974 indicated that the body burden of fish species were in the part per million range (Reimhold and Durant 1974). Prior to the removal action the Georgia Department of Natural Resources (GDNR) conducted a study in 1997, which, at first, indicated that fish and shellfish did not contain detectable concentrations of technical

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toxaphene. However, re-analysis of these samples using more sophisticated analytical methods (see Section 2.4) indicated that toxaphene residues were present at detectable concentrations in fish (Maruya, 2000). These detected concentrations caused GDNR to place specific fish consumption guidelines that recommended the limited consumption of certain fish species in the area (Maruya et al., 2001).

Subsequent to the removal action in 1999-2000, GDNR conducted another fish tissue evaluation in 2001. Due to changes in the study design and collection areas, a somewhat different group of consumer fish species and areas were evaluated. However, when broadly comparing the 1997 data to the 2001 data, an over four-fold reduction in the concentration of toxaphene residues was reported (Maruya et al., 2005). Both the 1997 and 2001 studies exhibited a statistically significant concentration gradient with fish collected closer to the Outfall Ditch having greater body burdens of toxaphene residues than fish collected at greater distances from the discharge. The results of this study were used to ease the fish consumption guidelines that GDNR had put in place for the area (GDNR, 2003).

Hercules, on behalf of GDNR, repeated the 2001 study in 2005, 2007, 2009, and 2011 using the same geographic boundaries and the same target species. GDNR has relied upon these data to routinely evaluate and update the fish consumption guidelines as necessary for the area; however, no additional substantial reductions in toxaphene body burdens have been documented beyond the initial decline observed between the 1997 study and the 2001 study.

1.4 Focused RI/FS Rationale

Identifying and controlling contaminant sources is critical to a successful remedy (USEPA, 2005). In its Contaminated Sediment Management Strategy (1998), U.S. EPA stated that "before initiating any remediation, active or natural, it is important that point and nonpoint sources of contamination be identified and controlled." Source control generally is defined as those efforts taken to eliminate or reduce, to the extent practicable, the release of contaminants from direct and indirect continuing sources to the water body under investigation (USEPA, 2005). Therefore, remedial action performed in the Outfall Ditch is consistent with the EPA's strategy (2002) of prioritizing sources according to their relative contributions to site risk.

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In accordance with the Site Management Plan (Geosyntec, 2009), it is presumed that the sediment in the Outfall Ditch is a source of contamination to the Terry Creek site as a whole. Addressing sediment contamination with higher concentrations at a specific location has been shown to be an effective risk reduction measure that can be implemented before the remedy approach for the entire site has been evaluated. (USEPA, 2005). Any remedial action in the Outfall Ditch will serve as a remediation of OU1 on its own, as well source control for OU2/OU3. In summary, EPD has issued a fish consumption advisory due to toxaphene and toxaphene residues in fish tissue for Terry and Dupree Creeks. These upper-trophic level receptors (game fish) are potentially exposed to bioaccumulated toxaphene concentrations from lower-trophic level food/prey biota. These lower-trophic level (benthic and aquatic) receptors are exposed to toxaphene-impacted sediments in the Outfall Ditch and Terry and Dupree Creeks. There are four potential sources of toxaphene and toxaphene residues to the Terry and Dupree Creek system. These areas include the Outfall Ditch and the three dredge spoil areas (Main, Riverside, and Carter's Island); the Outfall Ditch exhibited the highest relative concentrations of toxaphene at the Terry Creek Site. Therefore, prioritizing and implementing remedial actions at the Outfall Ditch will address a significant source of toxaphene to the creek system and its ecological receptors. Strategic use of early actions is a key component of a streamlined approach toward risk reduction (Bridges et al, 2012). Furthermore, cleanup activities at the Plant, performed under the EPD RCRA Corrective Action Program, were completed in January 2010. SWMU 5, identified in the Plant's hazardous waste permit, was the former toxaphene plant and SWMU 29 is the N-Street Ditch. Both of these units are located upstream of the Outfall Ditch. Stormwater runoff from the former toxaphene plant flowed into the N-Street Ditch and discharged into the Outfall Ditch. Corrective actions on the former toxaphene plant and the N-Street Ditch were physically completed in January 2010. The completion of corrective actions on the former toxaphene plant and N-Street Ditch at the Plant clears the path for additional Outfall Ditch remedial actions since potential "upstream" sources of toxaphene loading to the Outfall Ditch have been controlled.

Since the science regarding toxaphene and its breakdown products continues to evolve and because of the size and complexities of OU2 and OU3, the implementation of the RI/FS at these operable units is contingent upon gaining consensus on the toxicity of toxaphene breakdown products for both human and ecological receptors. However, due to the relatively small size of OU1 and the existing elevated toxaphene concentrations present in the OU1 sediments following the removal action, USEPA and Hercules have

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agreed to perform a Focused RI/FS that may allow for the selection of a final remedy at OU1 that is not reliant on the new toxaphene analytical methodology (see Section 2.3) or toxicity reference value development. The approach is appropriate for developing remedial action objectives and cleanup goals defined for OU1 as a narrative performance-based goal (i.e., protectiveness achieved via pathway elimination) rather than numerical risk-based concentrations.

This approach is consistent with USEPA guidance documents, particularly with the Contaminated Sediment Remediation Guidance for Hazardous Waste Sites (USEPA, 2005) and the Principles for Managing Contaminated Sediment Risks at Hazardous Waste Sites (USEPA, 2002). Collectively, these guidance documents highlight the consideration of separating the management of source areas with the most elevated concentrations of chemicals of potential concern (COPCs) from other, less concentrated areas. The use of an iterative adaptive management approach provides more certainty for future risk management decisions.

There is no universal remedy applicable to all sediment sites and many risk management decisions for sediment sites include a combination of remedial options. For the Terry Creek Site, one interim management option that has already been implemented was hot-spot dredging in the Outfall Ditch and Terry and Dupree Creeks. A substantial decrease in fish tissue concentrations was observed following these removal actions (Maruya et al, 2005). The selected remedy for the Outfall Ditch should complement the dredging previously performed in Terry and Dupree Creeks, with the overall goal of achieving further reductions in fish tissue concentrations. As noted in the National Research Council report on the management of PCB-contaminated sediments (NRC, 2001), fish tissue concentrations are the most relevant means of measuring exposure of receptors to contaminated sediments.

1.5 Report Organization

The Focused RI/FS Report is organized as follows:

- Site setting information and the OU1 Conceptual Site Model is provided in Section 2;
- the investigative approach for the Focused RI/FS is presented in Section 3;

- the physical characteristics of OU1 are summarized in Section 4;
- Section 5 summarizes the nature and extent of the contamination;
- contaminant fate and transport is presented in Section 6;
- a summary of the risk assessment is provided in Section 7;
- the feasibility study is contained in Section 8; and
- cited references are provided in Section 9.

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2. SITE SETTING

2.1 Site Description

The Terry Creek Site consists of a salt water tidal creek and marsh system located on the Atlantic coast directly east of the City of Brunswick in Glynn County, Georgia (Figure 1-1). The Site is located near the confluence of Terry Creek, Dupree Creek, and the Back River north of the Torras Causeway and east of U.S. Highway 17. The Site is comprised of the Outfall Ditch from the former Hercules Plant (OU1), portions of the former Hercules Plant east of Highway 17 known as the Marsh Wood Storage Yard (Operable Unit 2 – OU2) and three dredge spoil areas (OU2), and creek sediments in Terry and Dupree Creeks (Operable Unit 3 – OU3).

Figure 1-2 shows the location of OU1 relative to the other OUs at the Site. The Outfall Ditch is a Hercules constructed conveyance system that was used until 1972 to discharge untreated wastewater containing toxaphene from the Plant. After 1972, process wastewater was treated prior to discharge and toxaphene concentrations in the discharge significantly decreased. Around 1984, the facility began discharged the pretreated process wastewater to the Academy Creek POTW. Currently, pretreated wastewater from Outfall 002 (consisting of solids removal and pH adjustment of streams from the boiler and mill room area), condensate blow down, cooling tower blowdown, washdown from the vinsol area, non-contact cooling water and stormwater runoff from surrounding neighborhoods are discharged under a National Pollutant Discharge Elimination System (NPDES) permit through the Outfall Ditch. An under/overflow weir, which was built in 1976 to prevent floating discharge, is located at the approximate mid-point of the Outfall Ditch and divides the Outfall Ditch into a "pre-weir" and "post-weir" section. The pre-weir and post-weir sections of the Outfall Ditch are approximately 900 feet (ft) long and range from 40 ft wide at the inlet to 150 ft wide at its confluence with Dupree Creek. The NPDES-permitted discharge is currently monitored for toxaphene, carbon tetrachloride, total organic carbon (TOC), pH, solids, and along with biomonitoring for chronic toxicity. No toxicity has been detected at the outfall since testing began in 1994. The point of compliance is adjacent to and on the western side of Highway 17. In the mid-1990s, the Plant implemented a number of stormwater best management practices (BMPs) to control the erosion and runoff of toxaphene-contaminated soils on the Plant site from discharging into the Outfall Ditch which were maintained until completion of the SWMU 5 project in 2010. In 1999, the plant installed new grinding equipment at the millroom which reduced the

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solids discharge from Outfall 002. A set of corrective actions on the plant and the stormwater conveyance system (i.e., the N-Street Ditch) were physically completed in January 2010 and were documented and submitted to EPD in a Corrective Action Report SWMU 5 Area (CRA, 2010). Pinova has a Stormwater Best Management Practices (BMP) plan which includes numerous measures such as rock dams, silt screen barriers, drain screens, sediment traps, periodic sediment removal upstream of the outfall, and housekeeping measures to reduce solids to the outfall. Pinova also has a soil and demolition debris handling protocol which provides internal requirements for the handling of any excavated soils to ensure that excavated soils are not exposed to stormwater runoff.

The OU2 upland area consists of the Marsh Wood Storage Yard adjacent to the Outfall Ditch and several dredge spoil areas. The dredge spoil areas are: (i) the Main Dredge Spoil Area; (ii) the Riverside Dredge Spoil Area; and (iii) Carter's Island (Figure 1-2).

The Main Dredge Spoil Area comprises approximately 72 acres of land located near the confluence of Terry and Dupree Creeks, directly north of Terry Creek and directly east of Dupree Creek. Dredge spoils were placed by the United States Army Corps of Engineers (USACE) within a constructed berm and allowed to dewater by gravity drainage (to Terry and Dupree Creeks). Currently, storm water runoff drains from the Main Dredge Spoil Area via three weirs. However, one of the weirs, located on the northeastern corner of the Main Dredge Spoil Area, has collapsed and is not functional. The Main Dredge Spoil Area is densely vegetated in most areas; however, some areas of the berms are denuded possibly due to the high clay content of the soils. The Main Dredge Spoil Area is only accessible by boat.

The Riverside Dredge Spoil Area was used as an alternate disposal area for dredge spoils and comprises approximately 48 acres of land and is surrounded by a berm that ranges from 4 ft to 6 ft in height. Approximately 11 of the 48 acres located in the southernmost portion of the area nearest the Terry Creek were used for dredge spoil disposal. Breaches exist at two locations along the berm, permitting tidal inundation of the interior areas. The Riverside Dredge Spoil Area is located adjacent to a low-density residential area.

Carter's Island was also used as an alternate disposal area for dredge spoils. This area comprises approximately 3.5 acres of land located south of Terry Creek and approximately 400 ft north of Torras Causeway. Carter's Island is not accessible by

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boat and is only accessible by foot during low tide. Carter's Island is elevated from the marsh flats in some areas by up to 9 ft. Carter's Island is not surrounded by a constructed berm.

The Trailer Park Dredge Spoil Area is not included as part of OU2. This area comprises approximately 7 acres of land located adjacent to and north of Torras Causeway beside Terry Creek and is currently a low-density residential area. The Trailer Park Area was used for Dredge Spoil disposal prior to toxaphene production at the Plant site in 1948, therefore Trailer Park Area was built before toxaphene-contaminated sediment was dredged from Terry Creek (U.S. Army Corps of Engineers, September 1997). Thus, this area is not considered a source of toxaphene contamination.

OU3 is comprised of sediments in Terry and Dupree Creeks. Dupree Creek is located east of the Hercules Plant and receives discharges from the Hercules Outfall Ditch and the defunct Fuller O'Brien Paint Company Outfall as well as runoff from the Main Dredge Spoil Area, Riverside Dredge Spoil Area, and the Marsh Wood Storage Yard area. Dupree Creek joins Terry Creek to the south, where it flows east to the Back River. Terry Creek receives runoff from each of the dredge spoil areas, as well as tidal inflow from the Back River.

Prior removal actions were conducted in Terry and Dupree Creeks as well as the Outfall Ditch in 1999-2000 to remove toxaphene-impacted sediments. Figure 1-3 identifies the locations of these removal areas, and the removal actions are described in Subsection 2.3.3 below.

2.2 Site Setting

2.2.1 General Setting

Glynn County is located in coastal Georgia in the Sea Island section of the Atlantic Coastal Plain Physiographic Province. Topography in Glynn County consists of relatively flat land, 0 to 15 ft above mean sea level (msl), surrounded by tidal marshes, creeks, and rivers. The Site is located on the eastern side of the Brunswick peninsula. In general terms, the Site area is bounded to the north, south, and east by a tidal marsh which is periodically submerged and on the west by the Hercules Outfall Ditch and the west bank of Dupree Creek. The climate of Glynn County is warm and humid with hot

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summers and cool damp winters. Average precipitation is 52 inches of rainfall per year. The Site is located near residential and commercial areas, and is situated contiguous to the Brunswick peninsula surrounded by coastal wetlands.

2.2.2 Geologic and Hydrogeologic Setting

2.2.2.1 Regional Geologic Setting

Glynn County lies in the Atlantic Coastal Plain Physiographic Province and is underlain by more than 4,000 ft of sedimentary rocks. The upper 2,000 ft have been investigated intensively to define the extent of the groundwater resources of Glynn County and to evaluate salt water intrusion into the Floridan aquifer due to extensive groundwater pumping for industrial, agricultural, and residential uses. These studies have been conducted in cooperation with federal, state, county, and city governments.

The geology discussed in this Focused RI/FS Report ranges in age from Cretaceous to Holocene and consists of a thick sequence of carbonates (i.e., limestone and dolomite) overlain by sands, silts, and clays.

Pleistocene to recent (Holocene) age soils in the area are composed of sandy beach and dune deposits in the upland areas and organic-rich silty clays in the tidal marshes. The soils are referred to in the literature as the Satilla Formations and Cypresshead Formations and range in thickness from about 50 ft to 180 ft. Miocene sediments lie beneath the Satilla and Cypresshead Formations and consist of a thick sequence of silt, clay, phosphatic sand, and limestone of the Hawthorne Group which extends to a depth of approximately 500 ft. The Hawthorne Group in the Brunswick area is comprised of the Ebenezer, Coosawhatchie, Marks Head, Parachucla, and Tigers Leap Formations. The Hawthorne Group is underlain by the Suwanee Limestone and the Ocala Group. The Ocala Group limestone is extremely porous and is from 500 ft to 700 ft thick in the Brunswick area and exists under artesian heads (flowing wells). This unit is underlain by at least another 1,000 ft of carbonates ranging from Middle Eocene to Cretaceous in age (Clark et al., 1990). This basal carbonate sequence is highly cavernous and contains salt water under sufficient artesian head to flow at the land surface.

2.2.2.2 Regional and Site Hydrogeology

Multiple aquifers have been identified in the Brunswick area. In descending order, they are the surficial aquifer, the Brunswick aquifer, and the upper Floridan aquifer. The

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surficial aquifer consists of water-bearing sands under water-table or unconfined conditions in the Satilla and Cypresshead Formations and two confined water bearing zones in the Ebenezer formation. For the water-table zone, reported well yields are ranging from 2 gallons per minute (gpm) to 140 gpm in Glynn and Camden Counties. For the confined water-bearing zones in the surficial aquifer, reported well yields are ranging from 40 gpm to 180 gpm (Clark et al., 1990). The depth of the surficial aquifer varies but can be as deep as 200 ft. The surficial aquifer receives recharge from rainfall which percolates through the shallow soils to the water-table.

The Brunswick Aquifer is comprised of two confined water-bearing zones. The upper zone is comprised of the Coosawhatchie and Marks Head Formations and the lower zone is comprised of the Tigers Leap Formation. The upper Brunswick aquifer is separated from the overlying surficial aquifer system by a confining unit comprised of clay from the Coosawhatchie Formation. The upper and lower Brunswick aquifers are separated from one another by clay of the Parachucla Formation. Well yields in the Brunswick aquifer range from 350 gpm to 750 gpm. These artesian aquifers are used together in the Brunswick area for light industrial use. Pumpage from the underlying Floridan aquifer has a significant impact on water levels in these aquifers indicating a hydraulic interconnection. The upper and lower Brunswick aquifers on Colonels Island in Glynn County are being considered as alternative water supplies to the Floridan aquifer.

The most prolific aquifer in the Brunswick area is the upper Floridan aquifer. The aquifer is found at a depth of approximately 500 ft below land surface and extends to a depth of over 1,500 ft. Groundwater circulation is rapid through vuggy, fossiliferous zones of high primary porosity. The water-bearing zones were enhanced by further dissolution features. The upper Floridan aquifer comprises two fresh water permeable zones in the Brunswick area, the "upper and the lower water-bearing zones" (Wait and Gregg, 1973). The thickness of the upper water-bearing zone ranges from about 85 ft to 180 ft and the thickness of the lower water-bearing zone ranges from about 15 ft to 115 ft. The two zones are separated by a low-permeability, semi-confining unit that ranges in thickness from about 150 ft to 200 ft. This semi-confining unit partially restricts flow between the zones in the Brunswick area. Reported well yields of 5,000 gpm to 10,000 gpm are common in Glynn County (Clark et al., 1990).

Groundwater pumpage in the Brunswick area from the upper Floridan aquifer was about 56 million gallons per day (MGD) in 2005. Groundwater withdrawals in Brunswick

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have resulted in water-level declines since the late 1800s. Prior to development, the head in the upper Floridan aquifer was about 40 ft above sea level. By 1985, the water-level in the center of the cone had declined to more than 10 ft below sea level. Salt-water with chloride concentrations above 1,000 milligrams per liter (mg/L) has been drawn upward into the fresh water zones in the Brunswick area from a deeper salt water source in cavernous zones in the carbonate rocks below depths of 2,000 ft (Gill and Mitchell, 1979).

Locally, extensive subsurface investigations have been performed at the Plant site under the Resource Conservation and Recovery Act (RCRA) Corrective Action Program. Groundwater is encountered approximately 2 ft to 5 ft below ground surface and flows from west to east toward the Outfall Ditch and Dupree Creek. Very shallow groundwater in the vicinity of the ditch likely discharges into the Outfall Ditch and Dupree Creek with hydraulic gradients that are tidally influenced. Groundwater releases from the plant are being addressed under the RCRA corrective action program. Note that, the groundwater plume emanating from the plant site plunges as it migrates and is not believed to discharge into surface water in the Outfall Ditch.

2.2.3 Site Topography and Drainage

Terry and Dupree Creeks experience a tidal stage variation of approximately 7 ft. The surface water velocities in Terry and Dupree Creeks range from approximately 0.2 ft/s to 2.3 ft/s, with the maximum surface water velocity occurring during the mid-flood or mid-ebb portion of the tidal cycle. Measured salinities vary between 19 and 24 parts per thousand. The Outfall Ditch empties into Dupree Creek, which, after flowing about 800 ft, merges with Terry Creek. Terry Creek flows about 6,000 ft and empties into the Back River which, in turn flows just under 2 miles into the St. Simon Sound. At a point approximately 6.5 stream-miles from the Site, St. Simon's Sound empties into the Atlantic Ocean.

The land area immediately adjacent to the Outfall Ditch is an upland area referred to as the Marsh Wood Storage Yard. The Outfall Ditch divides this upland area into a northern and southern section. The Marsh Wood Storage Yard area is a flat open area with an elevation approximately 5 ft to 9 ft above msl. The Outfall Ditch itself has relatively steep banks sloping down to the intertidal zone. At high tide, the banks are full nearly to the upland area. At low tide, the volume of water in the ditch is greatly

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reduced with a narrow thalweg (~20 ft wide) remaining and an expansive mudflat (50-100 ft) exposed on either side.

In addition to the semi-diurnal rise and fall of the tide, the Outfall Ditch receives water input from a conveyance system originating at the Plant known as the N-Street Ditch. Surface drainage at the Plant is directed to this ditch, as well as non-contact cooling water from the Plant and stormwater runoff from residential areas surrounding the Plant. The drainage area for the N-Street Ditch is over 400 acres. The N-Street Ditch discharges approximately 6 MGD to the Outfall Ditch under a NPDES permit. The Outfall Ditch also receives direct overland runoff from the Marsh Wood Storage Yard.

2.3 Background on Toxaphene

Technical toxaphene (TT) is comprised of over 670 congeners (de Geus et al., 1999) and was manufactured by Hercules by means of chlorination of camphene. Toxaphene use was widespread around the United States and the world until 1982 when USEPA banned it because of its potential classification as a human carcinogen. It is an amber-colored, waxy solid made from the alpha-pinene extracted from pine stumps. While readily soluble in organic solvents, it is only slightly soluble in water with reported solubilities ranging from 0.4 mg/L to 3.3 mg/L (de Geus et al., 1999). It is tightly sorbed to organic particles ($K_{oc}=2.1\times10^5$) and has the ability to bioconcentrate (BCF=3,100 to 69,000) (USEPA 2009).

TT is quickly transformed in the environment, such that the mix of congeners and the concentrations of the congeners are not the same as a laboratory standard of technical toxaphene. Therefore, the "weathered" toxaphene (also known as chlorinated camphenes) no longer matches the analytical standard for TT. This transformation process poses significant technical challenges for both laboratory analysis and for understanding the toxicities of TT and chlorinated camphenes in the environment. As discussed in the Site Management Plan (Geosyntec, 2009), it is this analytical difficulty that is the critical item in the path forward at the Terry Creek Site.

Historically, analytical method SW-846 Method 8080, employing gas chromatography (GC) for separation and GC-ECD (electron capture detector) for detection, was used for the analysis of TT. It became evident in the early 1990s that the interpretation of chromatograms was subjective and therefore, guidance for interpreting the toxaphene chromatograms was developed. The Toxaphene Task Force was convened by chemists

from USEPA, Georgia Environmental Protection Division (EPD), and Hercules, and chartered to develop what is now known as the Task Force Method, or Method 1. Another method, Method 2, was intended to quantify all the chlorinated camphenes by using the total area under the curve (TAUC) on the chromatogram. Note that Method 1 and Method 2 rely upon the same sample preparation and analysis; they differ only in reporting the numerical value for toxaphene. Method 1 matches peaks on the chromatogram to the TT standard and Method 2 integrates the area under the curve between two specific peaks. However, neither of these methods measure individual toxaphene breakdown products (i.e., congeners).

A method using gas chromatography/electron capture detector (GC-ECD) and negative-ion mass spectrophotometry (NIMS) was developed to allow for better specificity and sensitivity when quantifying individual congeners in the environment. The USEPA Office of Solid Waste has recently issued this new method (SW 846 Method 8276) using GC-ECD/NIMS to measure/analyze individual toxaphene breakdown products of interest. The analytical method is designed to quantify a number of individual toxaphene congeners including Parlar 26 (p-26), Parlar 50 (p-50), Parlar 62 (p-62), as well as Hx-Sed and Hp-Sed. These individual congeners have been reported to be persistent in fish tissue and other environmental samples (Simon and Manning, 2006). Hercules has been employing the NIMS method, along with Method 1 and Method 2, on fish tissue samples since 2001. The NIMS method was also used to re-analyze the fish tissue samples collected in 1997 (see Section 2.3.4). Unless otherwise noted, references to toxaphene concentrations in this document refer to TT analyzed using Method 1.

During the course of the OU1 Focused RI/FS, all toxaphene samples were analyzed using Method 1 and Method 2. Since Method 1 is the most widely used method and is analogous to the SW 846 Method 8081B, the data from this method are used to inform remedial decisions at the Site. Selection of this method is appropriate for OU1, because it is the only method for which there are screening criteria available for which to compare the results.

Analyses by Method 8276 have been performed in consideration of planning and scoping the RI/FS for OU2 and OU3. However, the results are not relied upon for the evaluation of remedial options for OU1. Results obtained from Method 8276 will be discussed separately under different cover, however, the results are provided in Appendix A.

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2.4 Outfall Ditch Conceptual Site Model

The Brunswick Plant has been in continuous operation from 1911 to the present, producing a variety of rosin-based resins from wood resins. Between 1948 and 1980 Hercules produced toxaphene, a chlorinated pesticide, and the primary contaminant of concern at the Terry Creek Site. During the period of production from 1948 to 1972, untreated wastewater was discharged through the Outfall Ditch, a constructed conveyance system, into Dupree Creek; these discharges are believed to be the primary source of toxaphene at OU1 (i.e., the Outfall Ditch). The Outfall Ditch is currently permitted to discharge storm water runoff and non-contact cooling water from the facility.

In January 2010, the implementation of the RCRA Corrective Action Plan was completed for Solid Waste Management Unit (SWMU) 5 at the Plant (i.e., the former toxaphene plant) as well as for SWMU 29 (i.e., the N-Street Ditch) and three other SWMUs. These corrective actions, and other improvements at the Plant, have addressed upstream sources of contamination to the Outfall Ditch. However, historical operations at the Plant, i.e., incidental releases (e.g., spills, leaks) of chemicals used in and produced during the operations, have potentially impacted soil and subsequently groundwater (via leaching) at the Plant. Thus, soil at the Brunswick Plant may also be a potential source of contaminants in the Outfall Ditch via particulates in stormwater runoff through the N-Street Ditch. As noted earlier, BMPs were implemented in the 1990s to control the erosion and runoff of toxaphene-contaminated soils from discharging into the N-Street Ditch and subsequently, the Outfall Ditch. Releases from neighborhoods and facilities adjacent to the Brunswick Plant or along Terry and Dupree Creeks may also be sources of contaminants or other stressors to the Outfall Ditch. Potential transport mechanisms include particulate-laden stormwater runoff and tidal influx. Discharge of groundwater to surface water may also transport dissolved contaminants to the Outfall Ditch, Dupree and Terry Creeks, and are being addressed as part of the Plant's RCRA Corrective Action.

Contaminants that have reached the Outfall Ditch, the primary exposure point, may have undergone a variety of partitioning and deposition mechanisms between sediment and surface water/pore water. Thus, ecological receptors at OU1 may have direct contact with site-related contaminants in sediment and surface water/pore water.

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Chemicals present in abiotic media (i.e., sediment and surface water/pore water) in the Outfall Ditch may also be transported through the food chain via bioaccumulation/. Thus, ecological receptors at OU1 may also have contact with site-related contaminants through the consumption of food/prey items.

The Outfall Ditch empties into Dupree Creek, which, after running about 800 ft, flows into Terry Creek. Contaminants in the Outfall Ditch may be transported downstream by a variety of transport mechanisms including sediment re-suspension and deposition. Historic dredging operations and wastewater discharges prior to 1972 are believed to be the primary source of contaminants beyond the Outfall Ditch. (Note: media outside of the Outfall Ditch will be evaluated separately as part of the OU2 and OU3 RI/FS.) Contaminants partitioned into surface water in the pre-weir section of the Outfall Ditch (that maintains a pool of water at low tide), may also migrate to groundwater via percolation/infiltration; however, direct exposure to groundwater is considered an incomplete exposure pathway for ecological receptors at OU1.

As described above, ongoing sources of contamination to the Outfall Ditch are well controlled and the contaminated sediment within the ditch is from historical releases. Impacts from any potential ongoing sources are likely to be minimal and are regulated under the NPDES permit.

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3. OU1 INVESTIGATIVE APPROACH

3.1 RI/FS Approach

The RI/FS for OU1 was a "focused" effort with regards to the following issues: (i) the investigations evaluated the nature of contaminants within the OU1 boundaries to support remedy development and evaluation; (ii) the risk assessment was streamlined and focuses on potential ecological receptor risk; and (iii) the remedy evaluations considered a focused group of viable alternatives that will minimize the sediment exposure pathway. The primary function of the remedy will be separation (physical isolation) of the toxaphene-impacted sediments from potential ecological and human receptors. This Focused RI/FS for OU1 will not limit the assessment of remedial alternatives considered for OU2 and OU3. Broadly speaking, the Focused RI/FS for OU1 consisted of the following components:

- **Characterization.** Characterization addressed the collection of data for both risk characterization and remedy evaluation. Characterization included laboratory analysis for toxaphene and its breakdown products as well as analysis for a broader suite of chemicals of concern. (Note that while the laboratory results of the toxaphene breakdown products are being submitted in this Report, evaluation of the data will be performed under separate cover).

- **Risk assessment.** Risk assessment entailed a qualitative and quantitative characterization of the threats posed to potential receptors.

- **Remedy evaluation.** In this final stage of the RI/FS, potential management strategies have been developed and screened for applicability. A selected list of the viable management approaches/remedial alternatives were evaluated in greater detail. These alternatives were presented to USEPA in a Technical Memorandum for review prior to performing the detailed and comparative analysis in this Report.

The overall objective of the RI/FS was to assess the nature of the contaminants in the Outfall Ditch sediments and to collect data to support the development and evaluation of remedial alternatives. The horizontal extent of the ditch is considered to be the OU1 boundary (i.e., sediments in the Outfall Ditch from Highway 17 to its confluence with

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Dupree Creek). Additional characterization was performed to support the development and evaluation of remedial alternatives.

3.2 Field Investigations

Field investigations were implemented in accordance with the EPA-approved RI/FS Work Plan, Field Sampling Plan and Quality Assurance Project Plan. The field investigations were performed between 27 February and 21 August 2012 and are summarized below.

3.2.1 Sediment Sampling

Sediment sampling was conducted 28 February through 1 March 2012 by Athena Technologies, Inc. of McClellanville, South Carolina under subcontract to Geosyntec. Core samples were collected from a modular sampling platform consisting of two Jon Boats joined by an A-frame and utilizing their custom designed vibracore system. The core vibrator was attached directly to a three-inch diameter stainless steel casing with a Lexan liner inserted. The sample barrel was lowered to the sediment surface between the Jon boats. The vibracore machine was then turned on and the sample barrel was allowed to penetrate until it reaches target depth or refusal. The sample barrel was then retrieved using an electric winch. Once the sample is on deck, the liner is removed from the casing, cut, capped and labeled. Completed cores were transferred to a Geosyntec geologist for core logging and sample collection.

Sediment cores were collected from 17 locations along the Outfall Ditch. Three cores were collected along each of five transects; two transects were located in the Pre-Weir section and three transects were located in the Post-Weir section of the Outfall Ditch. Furthermore, two cores were collected from near each outlet of the triple box culvert at Highway 17 (see Figure 3-1). Along each transect, two shallow cores (0 to 2.0-ft) and one deep core (up to 10-ft) were collected; only shallow cores were collected from the culvert. The shallow cores were sub-divided into two intervals: the surface interval (0 to 0.5-ft) and the sub-surface interval (0.5 to 2.0 ft); the deeper cores were subdivided the same, but then at 2-ft intervals from two feet to the bottom of the core. Each interval was analyzed for toxaphene using both Method 1 for “technical toxaphene” and Method 2 for the total area under the curve (TAUC). The same depth intervals (0 to 0.5-ft and 0.5 to 2.0-ft) across each transect were composited together and analyzed for Target Analyte List/Target Compound List (TAL/TCL) constituents (see Table 3-1).

The samples were shipped under chain-of-custody (COC) protocol to TestAmerica in Savannah, Georgia

A limited number of samples (10) were also analyzed for toxaphene congeners using Method 8276. However, the data are intended for informational purposes only (i.e., planning for the OU2 and OU3) and will not be used in the OU1 RI/FS process. The data are included in Appendix A.

3.2.2 Bathymetry Data

A bathymetric map of the Outfall Ditch was generated by ARC Surveying and Mapping (ARC Surveying) of Jacksonville, Florida, using differential GPS for positioning and a Knudsen 320M dual-frequency fathometer operating at 24 KHz and 200KHz. The survey was conducted between 3-5 April 2012.

3.2.3 Surface Water Sampling

Surface water samples were collected from just above the sediment-water interface at two locations: the mouth of the Outfall Ditch with Dupree Creek and east of the Highway 17 culvert. Figure 3-2 shows the locations of the surface water samples. Samples were collected on 4 April and 5 April 2012 during a spring tide near the mid-point of both flood and ebb tides to correspond with times of higher surface water velocities (i.e., higher tidal amplitude, greater surface water velocities). Prior to sampling, the total water depth at the deepest point of the channel was measured and samples were collected at a depth equal to 0.8 times the total water depth. Samples were collected at specified depths using new Teflon tubing and a peristaltic pump. Water was pumped to the surface and transferred to appropriate laboratory containers. Samples were collected and analyzed as a whole water fraction. Additional volumes of water were analyzed for the dissolved fraction by filtering the sample through a 0.45-micrometer (µm) filter. Field parameters including pH, salinity, conductivity, turbidity and dissolved oxygen were recorded and shown in Table 3-2.

Additional samples were collected on 21 August 2012 after a rainfall event. Samples were collected at both the mouth and culvert on the ebb tide. An additional sample was collected at the culvert on the flood tide. The samples were shipped under chain-of-custody (COC) protocol to TestAmerica in Savannah, Georgia and analyzed for the analytes listed in Table 3-1.

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On 4-5 April 2012, surface water velocity measurements were collected across the mouth of the Outfall Ditch and on the east side of the culvert under Highway 17 during incoming and outgoing tides over various stages of the tidal cycle (see Figure 3-3). A hand-held current meter attached to a wading pole was used to measure surface water velocities. Measurements were made at four stages of the tide cycle:

- Mid-tide on the outgoing (i.e., ebb) and incoming tide (flood) approximately mid-way between low tide and high tide.
- Low tide (i.e., low slack) and high tide (high slack) when tidal currents are at their minimum and flow coming out of the Outfall Ditch may be dominated by discharge from the Plant.
- Flow measurements were be collected at multiple depths equal to 0.2, 0.6, and 0.8 times total water depth and at multiple locations along a transect across the mouth of the Outfall Ditch and on the east side of the culvert under Highway 17.

The results of the surface water velocity readings are shown in Table 3-2.

3.2.4 Pore Water Sampling

Pore water samples were collected on 28-29 February 2012 in the Pre-Weir and Post-Weir of the Outfall Ditch (see Figure 3-2). Pore water was collected using the MHE Products PushPoint sampler. An 8-inch diameter stainless steel platform was carefully fitted to the guard rod and secured before insertion into the sediments. The platform ensured proper sampling depth and minimized the potential for draw-down of surface water. The PushPoint was fitted with a nylon screen filter to avoid being clogged by fine particles and then inserted into the sediment to a depth of 12 inches. The guard rod was carefully removed to allow water to flow through the PushPoint and attached to a length of Tygon tubing and a peristaltic pump. The pump was carefully monitored and operated at a very low speed to slowly extract pore water from the surrounding sediments. A photograph of the PushPoint in use at both high tide and low tide is shown on Figure 3-2. Several liters of water were collected over a period of three to six hours. Samples were collected and analyzed as both the total and dissolved fractions (i.e., unfiltered and filtered). Field parameters were used to confirm the collection of pore water. Low ORP values and pH values different from surface water were used to confirm the collection of pore water. Field parameters measured are shown in Table 3-

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3. The samples were shipped under chain-of-custody (COC) protocol to TestAmerica in Savannah, Georgia and analyzed for the analytes listed in Table 3-1.

3.2.5 Surface Water / Groundwater Interactions

The Focused RI included an assessment of the surface water / groundwater interactions in the Outfall Ditch. The seepage of water through the sediment bed is the result of a surface water / groundwater gradient. The gradient results from variations between the groundwater elevation and surface water elevation, which is influenced by storm water runoff, process flows, and tidal conditions.

Twelve piezometers were installed adjacent to the Outfall Ditch to measure groundwater elevations as part of the Groundwater RFI (Antea Group, 2013), as shown in Figure 3-3. The piezometers were installed on 22-23 April 2010 by SAEDACCO, Inc. of Fort Mill, South Carolina under subcontract to Antea. Eight locations had a shallow piezometer installed with the screen interval of 10-15 ft below ground surface (bgs). Two piezometers were installed with the screen interval from 20-25 ft bgs; below the shallow water table. Two additional piezometers have their screen interval from 30-35 ft bgs. Six of these piezometers (four shallow and two deep) closest to the Outfall Ditch had pressure transducers installed to investigate the groundwater/surface water interaction at the ditch. In addition to the piezometers, pressure transducers were also placed at the culvert, inside the weir, and in the post-weir section of the Outfall Ditch, as shown in Figure 3-3. Pressure transducers were used to measure the surface water elevation in the Pre-Weir and Post-Weir area of the Outfall Ditch and groundwater elevations in nested piezometers installed adjacent to the Outfall Ditch. Pressure transducers recorded water levels from 29 February through 5 April 2012.

The piezometers were surveyed for horizontal and vertical control on 3-5 April 2012 by ARC Surveyors of Jacksonville, Florida and correlated to the elevations of the pressure transducers.

3.2.6 Hydrologic and Hydraulic Investigation

The hydrologic and hydraulic investigation was performed to develop a conceptual model of the major features and components of the non-tidal flows to the Outfall Ditch through the Triple Box Culvert, which appears to be the major source of non-tidal flows to the Outfall Ditch. The conceptual model was developed through an investigation,

analysis, and calculation of the hydrodynamic properties of discharges from the Triple Box Culvert for various extreme precipitation events.

3.2.7 Geotechnical Investigation

The geotechnical investigation was conducted to evaluate the existing subsurface conditions at the Site to aid in the development and evaluation of a remedy for OU1.

The scope of work performed consisted of drilling eleven Standard Penetration Test (SPT) borings shown in Figure 3-4. Five borings were located along the potential re-routing alignment of the Outfall Ditch, four borings were located north of the Outfall Ditch, and the remaining borings were located in areas that provide data that are representative of subsurface soil below the Outfall Ditch. Borings B-1 through B-9 were advanced to a total depth of 16 feet below ground surface (bgs). Borings B-10 and B-11 were advanced to a total depth of 36 feet bgs. Table 1 of the Geotechnical Investigation Memorandum (Geotech Memo) in Appendix B presents the coordinates of the borings and the ground surface elevation. The SPT borings were advanced between 27 February and 29 February 2012 using hollow stem auger (HSA) drilling techniques. The geotechnical drilling services were provided by SAEDACCO, Inc. of Fort Mill, South Carolina under subcontract to Geosyntec.

SPTs and soil sampling were performed using continuous split-spoon sampling procedures in accordance with ASTM D1586 "Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils". The subsurface soils encountered were logged in accordance with ASTM D2488 "Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)". Lithologic field logs for each borings are presented in Attachment A of Appendix B (Geotech Memo). The lithologic boring logs include general soil classification and description, recovery percentage, recorded blow counts and the corresponding SPT N value. The approximate depth to groundwater at each boring location, as indicated by the saturated conditions of the soils, was also noted during drilling and included on the respective lithologic boring logs.

A total of three thin-walled Shelby tube samples from predominantly clayey layers were also collected. Upon completion of drilling activities, each borehole was grouted from the bottom up to the ground surface with neat cement.

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Furthermore, two sediment samples were obtained from the Outfall Ditch, one from the pre-weir and one from the post-weir section as shown in Figure 3-4. The samples were collected using a vibracoring device up to a depth of approximately 10 feet below the sediment-water interface.

The soil samples, including the sediment samples, were sent to Excel Geotechnical Testing, Inc. in Roswell, Georgia for laboratory testing, which included (i) index property tests (i.e., moisture content, ASTM D2216; particle size, ASTM D422; and Atterberg limits, ASTM D4318), and (ii) performance tests (i.e., compaction tests, ASTM D698; hydraulic conductivity tests, ASTM D5084; one-dimensional consolidation tests, ASTM D2435; and consolidated undrained (CU) triaxial compression tests with pore water pressure measurements, ASTM D4767).

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4. PHYSICAL CHARACTERISTICS

4.1 Bathymetry

In 1999, Hercules performed a sediment excavation in the Outfall Ditch. The removal action excavated approximately 7,500 cubic yards of sediment in the Pre-Weir area and approximately 9,400 cubic yards in the Post-Weir area. A post-excavation bathymetric survey was performed by ARC Surveying following the removal action. ARC Surveying completed a bathymetric survey in 2012 (Figure 4-1), and the 2012 survey was compared to the 1999 post-excavation survey. The difference in the sediment elevation between the two surveys was used to calculate the thickness of sediment accumulation over the last, approximately, 13 years.

Figure 4-2 shows the amount of sediment deposition that has occurred since the 1999-2000 removal action. Deposition was measured by comparing the difference between the sediment elevation recorded by bathymetric surveys in 1999 and 2012. Up to nine feet of sediment have accumulated over this time period, with deeper accumulations generally found in the Pre-Weir section. The accumulated volume of sediment since the removal action in the Pre-Weir section was calculated to be approximately 7,500 cubic yards and in the Post-Weir section approximately 10,500 cubic yards. This volume is consistent with (and even slightly higher than) the volume of sediment removed during the 1999/2000 removal action, indicating a significant rate of accumulation since the removal action was completed.

Between November 2003 and February 2004, the Georgia DOT replaced the culvert under Highway 17 leading from the N Street Ditch at the Plant to the Outfall Ditch in the Marsh Wood Storage Area. The new culvert, the Triple Box Culvert, was constructed approximately 40-ft to the south and the Outfall Ditch was re-configured to meet the entrance of the culvert (see Figure 4-2 for historical location).

The depth of sediment accumulation (generally between one and nine feet, with an average of 5.2 ft) appears to be consistent with the fact that deeper sediments are more contaminated than shallower, more recent sediments. These deeper sediments represent the previous surface and near-surface sediments following the 1999/2000 removal action. The post-removal action sampling at the time showed elevated residual contamination, which now is mostly buried by less-impacted sediments.

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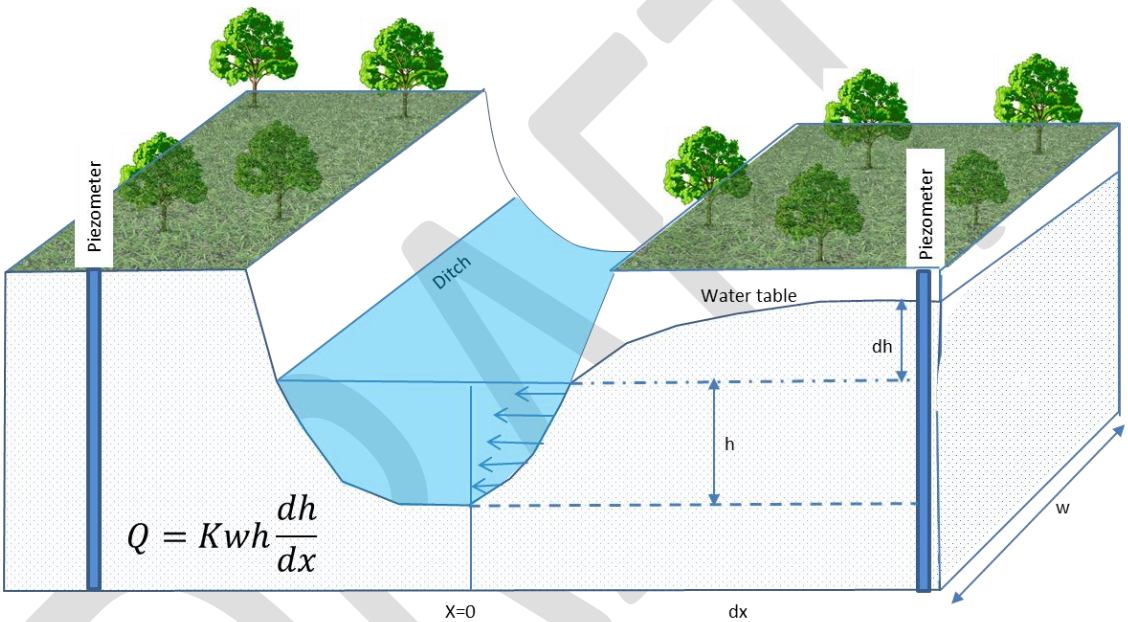
4.2 Surface Water / Groundwater Interactions

Darcy's law for fluid flow though porous media was employed to calculate the seepage rates of groundwater into the Outfall Ditch. Water elevation data were obtained from transducers installed at surface water locations (pre-weir and post-weir) and transducers installed inside piezometers. The location of piezometers is presented in Figure 3-3. A schematic illustration showing piezometers, the Outfall Ditch and Darcy's equation is provided below.



Groundwater discharge was estimated based on Darcy's equation, which is expressed as:

$$Q = KA(\frac{hP - hD}{dx})$$

Where: Q is discharge (ft^3/day);

K is the hydraulic conductivity of the aquifer (ft/day);

A is the cross sectional area where groundwater discharges into the Outfall Ditch or surface water discharges from the Outfall Ditch into the groundwater

(ft^2). The cross sectional area is the product of the height (h) and width of the Outfall Ditch (w) where a hydraulic connection between groundwater and surface water in the Outfall Ditch was present based on the pressure transducer responses;

hP and hD are hydraulic head (groundwater elevation) at piezometers and the surface water elevation in the Outfall Ditch (ft), respectively; and

dx is the distance between a piezometer and the Outfall Ditch.

Assumptions:

- The principal assumption in the application of Darcy's law for this analysis is that the aquifer surrounding the Outfall Ditch area is homogeneous;
- The hydraulic conductivity of the upper unit of the surficial aquifer was estimated to be approximately 6 ft/day (Antea Group, 2013).
- Flow is laterally into the ditch (e.g., vertical components of flow were not accounted for with the data).

This analysis resulted in a calculated time-series of groundwater seepage into the Outfall Ditch and groundwater recharge rates from the Outfall Ditch throughout the five weeks of investigation (surface and groundwater elevation data were collected at five minutes interval). The hydraulic gradient ((hP-hD)/dx) was calculated by subtracting the surface water elevation in the outfall Ditch from the groundwater elevation at a piezometer at each time-step recorded by the pressure transducers. Thus, a positive hydraulic gradient indicates groundwater is flowing to the Outfall Ditch (the Ditch is gaining water) whereas a negative hydraulic gradient indicates the Ditch is losing water at each time-step. The net change (e.g., net gain or net loss) was calculated by calculating the average discharge for all time-steps. The results of the groundwater discharge estimates were evaluated on a weekly basis**.** Positive values of the net gain indicate that gaining conditions prevail through most of the low and high tide cycle and result in a net gain (discharge) of groundwater into the Outfall Ditch.

In general, uniform discharge to the Ditch from groundwater on either side of the Outfall Ditch would be expected. However, variations in discharge to the Outfall Ditch are apparent from the north and south sides. Above the Weir, higher groundwater

discharge was calculated from the north side (213.8 ± 40.5 ft^3/day) than the south side (147.6 ± 34.3 ft^3/day), reflecting the higher groundwater elevation at PZ-OD-01 compared to PZ-OD-03 resulting in a steeper hydraulic gradient toward the Outfall Ditch. Below the Weir, higher groundwater discharge was calculated at the south side (511.6 ± 32.9 ft^3/day) than at the north side (181.8 ± 34.2 ft^3/day) due to the higher groundwater elevation at PZ-OD-09S compared to PZ-OD-10S resulting in a steeper hydraulic gradient toward the Outfall Ditch.

A summary of the seepage rates from the time-series is provided below:

Location	Groundwater Seepage Rate (Average ± SD in ft^3/sec)	Groundwater Seepage Rate (Average ± SD in gallon/day)
Pre-Weir	2.1E-03 ± 5.8E-04	1,352 ± 372
Post-Weir	4.0E-03 ± 2.0E-03	2,593 ± 1,322

The results of the surface water / groundwater interactions indicate that the seepage rate for the Pre-Weir is 1,352 gallons per day (gpd) and the seepage rate for the Post-Weir is 2,593 gpd.

4.3 Hydrologic and Hydraulic Investigation

A desktop review of available documents and field reconnaissance was performed to develop a conceptual understanding of the sources of flows to the Outfall Ditch (GDOT, 2001; Pinova, 2010; Stantec, 2009). This investigation showed that the flows to the Outfall Ditch were mainly from the Triple Box Culvert, which conveys flows from the Pinova Plant drainage system under Highway 17. Additional inflows to the Triple Box Culvert were from drainage pipes that are used to manage storm water runoff for various segments of Highway 17 (GDOT, 2001). The Pinova Plant drainage system was evaluated to characterize the flow contributions from the facility and the surrounding neighborhoods.

Total flow contributions from the facility were estimated using information provided by Pinova to EPA in a recent NPDES Permit Application (Pinova, 2010). The document demonstrates that the Pinova Plant drainage system collects storm water runoff from the facility drainage areas and non-contact process flows from on-going operations. In

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addition, the Pinova Plant drainage system receives storm water runoff from upstream surrounding neighborhoods, which were characterized using the basis of a previous study performed by Stantec for the City of Brunswick (Stantec, 2009) and assumptions of the physical limitations of the conveyance features for these storm water runoff flows.

This investigation produced a basis for a conceptual model for total inflows to the Triple Box Culvert. The development of this conceptual model was back-checked with the design of the Triple Box Culvert to confirm that the potential of total inflows was representative of the Triple Box Culvert discharge capacity; the simulated discharge flows for the 100-year, 24-hour storm event were comparable with the estimated design capacity of the Triple Box Culvert (see Appendix D for details). The simulation results of the conceptual model for various extreme precipitation events are summarized below. These results can be used to evaluate the feasibility for hydraulic technologies (e.g., pipe or channel sizing, energy dissipation features, etc.) that are incorporated in the remedial alternatives.

24-hour Storm Event	Triple Box Culvert Discharge Rate (cfs)	Triple Box Culvert Discharge Velocity (ft/s)	Triple Box Culvert Peak Shear Stress (lb/ft^2)
2-Year	683	13.2	0.62
25-Year	1,011	14.5	0.72
50-Year	1,161	14.9	0.75
100-Year	1,286	15.3	0.78

These simulation results indicate that the discharge velocity of flows from the Triple Box Culvert may approach or exceed 15 feet per second (fps) for extreme precipitation events. This high discharge velocity may result in significant deterioration of downstream conveyance structures that are not constructed erosion resistant materials. As a result, remedial alternatives should include energy dissipation features and materials to mitigate the potential for failure resulting from a high discharge velocity. Furthermore, this high discharge velocity provides significant transport potential for already suspended solids within flows of the Triple Box Culvert. However, the shear stresses calculated within the Triple Box Culvert and, therefore, the area immediately downstream of the outlet, are relatively low. Thus, discharge flows are not expected to

result in significant particle separation in the outlet area. The shear stresses were compared with the allowable shear stress (3 lb/ft^2) for un-vegetated non-degradable reinforced erosion control products (RECPs) [NRCS, 2007]. The calculated shear stresses were found to be lower than the allowable shear stress (3 lb/ft^2) for un-vegetated reinforced erosion control products (RECPs) [NRCS, 2007] as these products may be used as the design progresses (beyond the Focused RI/FS) to reduce particle separation within the Outfall Ditch.

Furthermore, it is important to note that the simulated peak discharge flow rates from the Triple Box Culvert were significant and should be considered in the development of a construction water management plan for the applicable remedial alternatives. These discharge flows may greatly affect construction sequencing and procedures for implementing remedial alternatives.

The measurement and analyses of hydrodynamic properties of tidal flows within the Outfall Ditch were performed through measurements of surface water and groundwater elevations and the calculation of shear stress at the mouth of the discharge into Dupree Creek. The surface water elevations within the Outfall Ditch were calculated to fluctuate between -4 and 6-ft mean sea level (ft-MSL). The groundwater elevations in the surrounding areas were calculated to fluctuate between 1- and 4-ft MSL. Very low tidal flow velocity (<0.5 ft/s) measurements were recorded at the mouth during each tide cycle; therefore, the observed sediment transport capacity was low based on velocity alone. However, the calculated shear stresses (3.4 lb/ft^2) are significant (compared to allowable shear stresses of non-degradable RECPs) and could initiate soil/sediment movement. The higher shear stresses near the mouth versus the Triple Box Culvert were the result of the higher surface water depths near the mouth of the Outfall Ditch which results in greater force on the underlying sediment.

4.4 Geotechnical Investigation

The results of the geotechnical investigation are summarized below. Details of the geotechnical investigation are presented in Appendix B (Geotech Memo).

The purpose of the geotechnical investigation was to provide a baseline understanding from focused sampling and analyses of existing conditions at the Site to assess the feasibility of various remedial alternatives. As described in Subsection 3.3.7, the scope of work consisted of drilling 11 Standard Penetration Test (SPT) borings and associated

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laboratory testing. Nine borings were advanced to a total depth of 16-ft below ground surface (bgs) and two borings (i.e., B-10 and B-11) were advanced to a total depth of 36-ft bgs. Furthermore, two sediment samples were obtained from the Outfall Ditch, one from the pre-weir and one from the post-weir section as shown in as shown in Figure 3-4).

4.4.1 Subsurface Stratigraphy

The subsurface conditions on the southern side of the Outfall Ditch consist of a 4- to 8-ft thick layer of poorly graded sand (SP) underlain by a 4- to 6-ft thick layer of clayey sand (SC). The SC layer is generally underlain by SP to the depths of borings. In locations within 200-ft of Dupree Creek, a high plasticity clay (CH) layer was encountered below the SC layer. This CH layer was about 7-ft thick at the location of borings B-2 and B-1, and extends to a thickness of about 14-ft at B-11, which is located near the intersection of the Outfall Ditch and Dupree Creek. A dense SP layer underlies the CH to the depth of boring at B-11.

The subsurface conditions on the northern side of the Outfall Ditch consist of SP to the depths of borings (i.e., 16-ft) with 1- to 2-ft thick interlayers of SC and CH to a limited extent. In locations within 200-ft of Dupree Creek, a high plasticity clay (CH) layer was encountered within the SP layer. This CH layer was about 7-ft thick at the location of boring B-9, and extends to a thickness of about 14-ft at B-10, which is located near the intersection of the Outfall Ditch and Dupree Creek. Another CH layer with about 4-ft of thickness is located deeper, and is underlain by a dense SP layer to the depth of boring at B-10. Subsurface profiles are shown in Attachment C of Appendix B (Geotech Memo).

The SPT blow counts (N values) of the shallower SP layers ranged from 0 to 16 with an average value of 6. The N values of the deeper SP layer located in the deep borings (B-10 and B-11) ranged from 0 to 50 with an average value of 12. The N values of the SC layer located east of the Outfall Ditch ranged from 0 to 14 with an average value of 5. The N values of the CH located within 200-ft of Dupree Creek ranged 0 to 7 with an average value of 2. These N values indicate that (i) the shallower SP layer is loose; (ii) the deeper SP layer is medium dense; (iii) the SC layer is loose; and (iv) the CH layer is very soft to soft. The groundwater table was observed at approximately 4- to 6-ft bgs.

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4.4.2 Material Properties

Note that material properties of Outfall Ditch sediments are discussed separately under Section 4.4.3 below.

4.4.2.1 Moisture Content

For Sand, the in-situ moisture contents ranged from 14 to 75 percent with an average of 31 percent. For Clayey Sand, the in-situ moisture contents ranged from 24 to 74 percent with an average of 36 percent. For Clay, the in-situ moisture contents ranged from 25 to 134 percent with an average of 62 percent.

4.4.2.2 Particle Size Analyses

The results of the particle-size analyses indicated that the soil samples tested are generally classified as either poorly graded sand or clay. The results also confirmed the visual classification descriptions from the field.

4.4.2.3 Atterberg Limits

Atterberg limit tests were performed on five (5) samples of Clay [i.e., Boreholes B-2 (10-14 feet, bgs), B-7 (2-6 feet, bgs), B-10 (7-16 feet, bgs), B-10 (24-26 feet, bgs), and B-11 (10-18 feet, bgs)]. Based on the standard plasticity chart, samples of Clay have a USCS classification of CH (high plasticity clay).

4.4.2.4 Compaction Characteristics

The optimum moisture content corresponds to the moisture content of the soil at which the maximum dry unit weight can be attained. As the sample becomes coarser the resulting optimum moisture content becomes lower and the maximum dry unit weight becomes higher. For Sand, compaction test results showed that the maximum dry unit weight and optimum moisture content were approximately 105.2 pcf and 14.9%, respectively.

4.4.2.5 Unit Weight, Drained Shear Strength, Undrained Shear Strength, and Consolidation Parameters

Table 5 of the Geotech Memo (Appendix B) summarizes the recommended material properties to be used in developing and evaluating remedial alternatives for OU1.

Details of the methodology and measurements performed to obtain these parameters are found also found in Appendix B.

4.4.3 Outfall Ditch Sediments

Within the Outfall Ditch, the Pre-Weir sediments were characterized as dark gray, non-plastic, clayey silty sand with a Unified Soil Classification System (USCS) classification of SM. The Post-Weir sediments were characterized as dark gray, highly plastic, fat clay with a USCS classification of CH. Coarser particles entering the Outfall Ditch from the culvert will settle out in the Pre-Weir as velocities decrease resulting in coarser particles being deposited in the Pre-Weir and leaving only finer particles that may overflow the weir to be deposited in the Post-Weir.

The total unit weights of Pre-Weir sediments and Post-Weir sediments were estimated to be 100 pcf and 85 pcf, respectively. In general, these sediments are very soft in their in-situ condition. Compaction test results showed that the maximum dry unit weight and optimum moisture content of Pre-Weir sediments under standard Proctor effort were approximately 87.7 pcf and 25.0%, respectively. For Post-Weir sediments, the maximum dry unit weight and optimum moisture content under standard Proctor effort were approximately 67.0 pcf and 47.5%, respectively. The in-situ moisture contents of the Pre-Weir and Post-Weir sediments were 71% and 135%, respectively, while the particle size analyses indicated 75% sand (25% fines) and 10 % sand (90% fines) for the Pre-Weir and Post-Weir sediments, respectively.

Hydraulic conductivity tests were performed on Post-Weir Outfall Ditch sediment samples. The measured saturated hydraulic conductivity of the sediments is 2.8×10^{-5} cm/s under an effective confining pressure of 125 pounds per square foot (psf) and 3.4×10^{-6} cm/s under an effective confining pressure of 500 psf.

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5. NATURE AND EXTENT OF CONTAMINATION

5.1 Sediment

The sediment results are summarized in the following subsections, while the entire Focused RI sediment dataset is included in Appendix C. Furthermore, the bathymetry data are also discussed in a subsection below within the context of sediment contamination and accumulation since the 1999 Removal Action.

The surface sediment concentrations of toxaphene in the Outfall Ditch are shown on Figures 5-1 (0.0 to 0.5 ft) and 5-2 (0.5 to 2 ft). Figure 5-3 shows the toxaphene concentrations in sub-surface sediment. Toxaphene concentrations for the sediment samples are presented in Table 5-1, while Table 5-2 summarizes the detections for the additional compounds analyzed.

5.1.1 Pre-Weir Results

Concentrations of toxaphene in pre-weir sediments ranged from non-detect to 84 milligram per kilogram (mg/kg).[2] The highest detected toxaphene concentration was along the north bank of the Outfall Ditch in Transect 1 from the 2- to 4-ft depth interval (SD-OD1N-03). The deepest sample interval (6- to 8-ft) at this core location (sample SD-OD1N-05) was non-detect for toxaphene (Figure 5-3). The second highest toxaphene concentration of 75 mg/kg was found in the surface sample (0- to 0.5-ft) at the north end of the culvert at Highway 17 (SD-ODCN-01). The remainder of the locations had toxaphene concentrations ranging from 1.0 mg/kg to 22 mg/kg with an average concentration of 10 mg/kg.

5.1.2 Post-Weir Results

Concentrations of toxaphene in Post-Weir sediments ranged from non-detect to 210 mg/kg. The highest concentrations were observed in the deeper sample intervals from the southernmost sample locations (SD-OD5S-04 and SD-OD5S-05) in the wide mud-flat along Transect 5. Toxaphene concentrations at this core location were 29 mg/kg in

[2] All toxaphene concentrations are reported here as Method 2 (TAUC) values. Toxaphene by Method 1, while generally somewhat lower in concentration, correlated very well with Method 2 results (R-squared = 0.87; $p<0.001$). Both Method 1 and Method 2 data are reported in the data tables.

the 2- to 4-ft interval, 210 mg/kg in the 4- to 6-ft interval, and 120 mg/kg in the 6- to 8-ft interval (Figure 5-3). The two surface intervals had significantly lower concentrations at 0.70 mg/kg and 0.55 mg/kg in the 0- to 0.5-ft and the 0.5- to 2.0-ft intervals, respectively. The shallow surface interval (0- to 0.5-ft) along both Transects 4 and 5 had concentrations at or below 1 mg/kg. Surface intervals along Transect 3, closer to the weir, were higher with concentrations ranging from 1.4 mg/kg to 25 mg/kg. The deeper intervals of the center core along Transect 3 were near or below the detection limit for toxaphene.

5.1.3 Summary of Toxaphene Concentrations in Sediment

Figure 5-4 depicts a sketch detail of the Outfall Ditch along with the location and concentration ranges of toxaphene in the sediment cores. Each color band at the location of each core sample represents the concentration ranges at that location and depth. Lowest concentrations (<1 mg/kg) are shown in blue and the highest concentrations are shown in red (>50 mg/kg). The figure indicates that much of the toxaphene contamination is found at depth with the exception of the culvert locations. Further analysis of the toxaphene concentration distributions supports this finding as shown on Figure 5-5. The higher toxaphene concentrations are within the depth intervals between 2- and 8-ft, with the 4 to 6-ft interval exhibiting the highest concentrations. Figure 5-5 also shows the distribution of concentrations from west to east (i.e., from the culvert to Transect 5), depicting higher concentrations at the culvert and at the mouth with Dupree Creek, with generally lower concentrations in the middle.

Surface sediment concentrations of toxaphene measured in 2012 are substantially lower compared to the levels measured during the post-excavation investigation of the 1999-2000 removal action. Figure 5-6 shows the toxaphene concentrations in surface sediments as measured in 2000 along with the data collected during the current investigation. It can be readily observed that nearly all samples in 2000 exceeded 50 mg/kg. During the March 2012 sampling, only a single surficial sample exceeded this concentration. This reduction in exposure potential is likely due to the deposition of recent sediments over previously more impacted surface sediments. Figure 5-7 shows an interpolated three-dimensional image of the volume toxaphene-impacted sediment at various concentrations.

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5.1.4 Summary of Other Compounds in Sediment

Table 5-2 summarizes the detections for the additional compounds analyzed. Most other compounds detected in sediment were detected at estimated concentrations between the respective method detection limits (MDL) and the reporting limits (RL). These concentrations are not quantifiable, but confirm that a given compound is present. These low-level detections included pesticides, polyaromatic hydrocarbons (PAHs), and volatile organic compounds (VOCs). Furthermore, various metals were detected in sediment samples, but the concentrations appear to be consistent with anthropogenic and geogenic background concentrations. Dioxins and furans were also measured and detected in two sediment samples. These compounds are addressed as part of the SLERA presented in Section 7. Dioxins are not known to have been used or produced at the Plant. Since dioxins are ubiquitous in the environment, it is likely that the dioxins are present in the Outfall Ditch sediments due to other anthropogenic sources.

5.2 Surface Water

Table 5-3 summarizes the constituents detected in surface water samples. As can be seen in this table, toxaphene was not detected in any of the surface water samples. Detected compounds included various metals, semi-volatile organic compounds (SVOCs), and VOCs. These compounds were detected at low concentrations, with organic constituents being mainly detected at estimated concentrations between the MDL and the RL, indicating that they were present, but not at quantifiable concentrations. Pinova's NPDES-permitted discharge is currently monitored for toxaphene, carbon tetrachloride, total organic carbon (TOC), pH, solids, and chronic toxicity. Carbon tetrachloride was measured at 9 ug/L in the surface water sample collected on the ebb tide (i.e., discharging), which is attributed to Plant-permitted surface water discharges.

In general, culvert samples exhibited higher concentrations of metallic constituents and lower concentrations of organics during the flood tide as compared to the ebb tide, while samples collected at the mouth of the Outfall Ditch did not exhibit a consistent trend. Furthermore, wet weather samples collected at the culvert location during the ebb tide also indicated higher metals concentrations than samples collected during the ebb tide under dry weather conditions. Again, no consistent trend was observed for the samples collected at the mouth of the Outfall Ditch. In contrast, concentrations of organic constituents (other than toxaphene, which was non-detect in all samples and

under all tested conditions) were generally lower during wet weather conditions in the culvert samples, suggesting dilution during high flows originating from upland areas. Overall, these trends appear to indicate that that flood tide entering the Outfall Ditch has the most noticeable impact on metals concentrations at the culvert location, which are mainly naturally occurring constituents in seawater, while diluting already low concentrations of organics at this location.

The detected constituents are further addressed in the SLERA presented in Section 7 below. The complete dataset is included in Appendix C.

5.3 Pore Water

A summary of the detected concentrations of various compounds analyzed in pore water samples is presented in Table 5-4. Toxaphene was detected in pore water samples collected from the Pre-Weir location at a concentration of 17 µg/L in the unfiltered sample and 8.8 µg/L in the filtered sample. Toxaphene was not detected in the Post-Weir samples.

Metals and a few SVOCs and VOCs were detected at low levels, with organic constituents being detected at estimated concentrations between the MDL and the RL, indicating that these constituents were present but could not be quantified. Most trace metals were also detected at estimated concentrations between the MDL and the RL, with the exception of the major cations calcium, magnesium, sodium, and potassium, which are naturally high in seawater.

The detected compounds are further addressed in the SLERA presented in Section 7 below. The complete dataset is included in Appendix C.

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6. CONTAMINANT FATE AND TRANSPORT

6.1 Contaminants

Toxaphene is the main contaminant of concern at the Site, and the fate and transport section mainly focuses on toxaphene.

Toxaphene is only slightly soluble in water with reported solubility ranging from 0.4 mg/L to 3.3 mg/L (de Geus et al., 1999). Toxaphene is relatively immobile in soils. Long-range atmospheric transport of toxaphene has been attributed as a potential transport mechanism since toxaphene was found in surface waters in the Great Lakes Region, but was mainly only used in the southern United States (ATSDR, 2010). Toxaphene in surface waters is rapidly sorbed to deposited sediments or suspended particulates and can bioconcentrate in the tissues of aquatic organisms. It is tightly sorbed to organic particles ($K_{oc}=2.1\times10^5$), and the low aqueous solubility and high sorptive capacity make sediment transport the main route of migration for toxaphene.

Incidental releases (e.g., spills, leaks) of chemicals used in and produced during Plant Site operations have potentially impacted soil and subsequently groundwater (via leaching) at the facility. These chemicals may include volatile organic compounds (VOCs) such as benzene, chlorobenzene, xylene, chloroform, methylene chloride, ethylbenzene, and toluene (Antea Group, 2013). Thus, soil and groundwater at the Plant Site are also a potential source of dissolved phase and particulate stressors at the Outfall Ditch. Based on previous investigations, other chemical stressors include various inorganics (arsenic, copper, chromium, mercury, thallium, and zinc), polycyclic aromatic hydrocarbons (PAHs), pesticides (e.g., heptachlor) and polychlorinated biphenyls (PCBs).

Point and non-point source urban runoff from adjacent neighborhoods and nearby industries may also be sources of chemical and physical stressors. Stormwater runoff can load both particle-bound and dissolved phase chemicals to the system with little or no attenuation.

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6.2 Sources and Migration

6.2.1 Toxaphene

During the period of toxaphene production between 1948 and 1980, some material was discharged in the wastewater through the Outfall Ditch into Dupree Creek. It has been reported that Hercules discharged in excess of 200 pounds per day of toxaphene in its wastewater discharge from 1966 until about 1972 when a wastewater treatment system was installed and reduced toxaphene discharges to about 1 pound per day. This discharge was the primary source of toxaphene at the Site, and resulted in a removal action in the Outfall Ditch and Terry and Dupree Creeks in 1999/2000.

Furthermore, in addition to direct wastewater discharges, the Plant Site was a potential additional source of toxaphene-impacted particulates/sediments to the Outfall Ditch and other downstream areas via stormwater runoff from former toxapene production facilities. This upstream source was addressed in a RCRA Corrective Action completed in January 2010. Currently, only surface water runoff from the Plant Site (and surrounding neighborhoods) and non-contact cooling water from the Plant Site are discharged through the Outfall Ditch under a National Pollutant Discharge Elimination System (NPDES) permit. The concrete lining of the N-Street Ditch and the substantial toxaphene mass removal from the Plant Site have resulted in a decrease of both sediment volumes and toxaphene concentrations in sediments deposited within OU1 since there have been virtually no detections of toxaphene in the NPDES outfall since remedial construction was completed.

Toxaphene adsorbed on sediment particles can be conveyed from the Outfall Ditch via surface water flow, and can be buried or deposited in the creek bottoms or the marshes. Subsequently, sediments can be re-suspended by natural erosive forces or prop wash from boat traffic. To a certain extent, toxaphene can be used as a tracer for sediment transport; however, dredging operations that were conducted by the USACE in the 1970s and 1980s to maintain navigation would have re-suspended and re-distributed sediment. Likewise, boat traffic occurring in Terry and Dupree Creeks could possibly re-suspend contaminated sediments with propeller wash and bow waves.

Biota living in the marsh and creek complex at the Site can uptake toxaphene through ingestion or adsorption by direct contact. As a result toxaphene can be transferred through the marsh complex food web. The fate of toxaphene in biota is based on exposure routes of ingestion, direct contact, and inhalation of environmental media.

Chemicals are accumulated in various tissues (e.g., muscle, lipid, liver, kidney, or brain, depending upon the chemical/chemical form) and are transferred throughout the food web or released to the environment upon death and decomposition of organisms. The successive accumulation of chemicals to higher concentrations in organisms at higher trophic levels is termed biomagnification.

6.2.2 Other Potential Contaminants of Concern

Chemicals in upland soils are subject to physical, chemical, and biological processes. Physical transport includes runoff/erosion from storm events into OU1 and Terry and Dupree Creeks. The pre-weir portion of the Outfall Ditch will function as a settling basin and minimize downstream transport of particulates and associated contaminants into Dupree and Terry Creeks from the upland storm water runoff. Chemical transport processes include dissolution (i.e., dissolving into solution) and adsorption/desorption (i.e., attachment or detachment of chemicals to soil particles).

Chemicals in surface water can be transported through physical, chemical, or biological mechanisms. Physical transport processes include in-stream flow/advection (i.e., longitudinal, horizontal, and vertical movement), infiltration (i.e., movement of surface water into sediment pore spaces), and diffusion (i.e., movement from high to low chemical concentration). Chemical transport mechanisms include precipitation (i.e., dissolved chemicals forming solids due to chemical and environmental characteristics) and adsorption (i.e., attachment of dissolved chemicals to solid materials). Biological transport can occur when biota bio-concentrate chemicals through ingestion or adsorption and migrate from the Site.

Chemicals in sediment pore water experience the same processes and in addition can be transported across the sediment column as a result of bioturbation by benthic infauna. Chemicals in pore water may be available for biological uptake, leading to bioaccumulation of chemicals in tissues of ecological receptors and transport from the Site.

In general, the VOCs affiliated with former and/or current Plant processes that may be transported into OU1 are subject to volatilization and biodegradation. They have a relatively low tendency to sorb to soils and sediments and would generally be transported as dissolved constituents within groundwater. While groundwater discharge into OU1 is a potential mechanism to contribute VOCs to the OU1 Outfall Ditch, the

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mass loading of these VOCs is believed to be small based on the net groundwater discharged into the Outfall Ditch.

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7. ECOLOGICAL RISK ASSESSMENT

The purpose of an ecological risk assessment (ERA) is to evaluate the likelihood that adverse ecological effects are occurring or may potentially occur as a result of the site-specific constituent concentrations in environmental media. The potential for adverse effects is assessed through a sequential series of activities that increase in complexity and site-specificity depending on the results of previous evaluations. The USEPA (1997) Ecological Risk Assessment Guidance for Superfund describes an eight-step process for conducting ERAs. Components of the ERA process are the following:

Screening Level Ecological Risk Assessment (SLERA)

- Step 1 - Screening Level Problem Formulation;
- Step 2 - Screening Level Exposure Estimate and Risk Calculation;

Baseline Ecological Risk Assessment (BERA)

- Step 3 - Baseline Problem Formulation;
- Step 4 - Study Design and Data Quality Objective Process;
- Step 5 - Verification of Field Sampling Design;
- Step 6 - Site Investigation and Data Analysis;
- Step 7 - Risk Characterization; and
- Step 8 - Risk Management.

This report documents the completion of the SLERA phase of the USEPA eight-step process (Steps 1 and 2). Briefly, objectives of the Focused SLERA are to:

- evaluate whether there is a potential for ecological receptors to be exposed to constituents in OU1 (e.g., identify potentially complete exposure pathways in the Outfall Ditch); and
- evaluate whether site-related constituents are present in OU1 media (sediment, surface water, and pore water) at concentrations that have the potential to result in adverse ecological effects.

Under USEPA guidance, ERAs are conducted using a tiered approach and are punctuated with Scientific Management Decision Points (SMDPs). SMDPs represent

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points in the ERA process where the risk assessor, risk manager, and interested parties reach concurrence on conclusions, actions, or methodologies that are needed such that the ERA process can continue (or terminate) in a technically defensible manner.

This SLERA concludes with a SDMP recommending no further ecological investigation for OU1. Rather, it is recommended that performance-based remedial goals for the Outfall Ditch be developed that focus on eliminating direct exposure to contaminants in the Outfall Ditch and eliminating the potential transport of contaminants to Dupree Creek and other downstream locations.

The full text of the SLERA is presented in Appendix E and a summary is given below.

7.1 Screening Level Problem Formulation (Step 1)

Problem formulation establishes the goals, scope, and focus of the ERA. Its primary objective is to collect sufficient information concerning the Site to develop a preliminary ecological conceptual site model (CSM), which considers the Site setting and environment, nature and extent of contamination, potential fate and transport processes, and ecological characteristics of the Site (see Figure 7-1).

7.1.1 Primary Sources, Transport Mechanisms, Exposure Media

Between 1948 and 1980 Hercules produced toxaphene at its Brunswick Plant. Toxaphene is a chlorinated pesticide, and the primary contaminant of interest at the Site. Incidental releases (e.g., spills, leaks) of chemicals used in and produced during the operations have potentially impacted soil and subsequently groundwater (via leaching) at the Hercules Facility. Thus, soil and groundwater at the Hercules Facility are also a potential source of contaminants in the Outfall Ditch. Soil is potentially transported to the Outfall Ditch as particulates in stormwater runoff. Discharge of groundwater to surface water, if occurring, may transport dissolved contaminants to the Outfall Ditch. Releases from neighborhoods and facilities adjacent to the Hercules plant or overland runoff along Terry and Dupree Creeks may also be sources of contaminants/stressors to the Outfall Ditch. Potential transport mechanisms include stormwater runoff and tidal influx.

Once contaminants reach the Outfall Ditch, the primary exposure point, they may undergo a variety of partitioning and deposition mechanisms between sediment and

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surface water/pore water. Thus, the primary exposure media for ecological receptors at OU1 are sediment and surface water/pore water.

7.1.2 Secondary Transport Mechanisms, Exposure Media

Chemicals present in abiotic media (i.e., sediment and surface water/pore water) in the Outfall Ditch may also be transported through the food chain via bioaccumulation/ bioconcentration. Toxaphene has the ability to bioconcentrate (USEPA, 2009). Thus, ecological receptors at OU1 may also have contact with site-related contaminants through the consumption of food/prey items.

The Outfall Ditch empties into Dupree Creek which, after running about 800 ft, flows into Terry Creek. Contaminants in the Outfall Ditch may migrate offsite by a variety of transport mechanisms including runoff/deposition. (Note: media outside of the Outfall Ditch will be evaluated separately as part of OU3.) Contaminants partitioned to surface water in the Outfall Ditch may also migrate to groundwater via percolation/infiltration; however, direct exposure to groundwater is considered an incomplete exposure pathway for ecological receptors at OU1.

7.1.3 Potential Ecological Receptors and Exposure Routes

Specific species are not evaluated in the SLERA; however, general receptor categories are identified to allow evaluation of potentially complete exposure pathways. Based on previous investigations, benthic, aquatic, and wildlife species are considered appropriate preliminary ecological receptors for the Outfall Ditch. Thus, potentially complete ecological exposure pathways evaluated at OU1 are:

- Exposure of benthic receptors to site-related constituents in sediment and pore water in the Outfall Ditch;
- Exposure of aquatic (fish) receptors to site-related constituents in surface water of the Outfall Ditch; and
- Exposure of wildlife receptors to site-related constituents in sediment, surface water, and food/prey items.

The vast majority of exposure to contaminants in the Outfall Ditch is assumed to be in surficial rather than deeper sediment. For ecological receptors, surficial sediment in the

biologically active zone (0 to 0.5 ft below the sediment/water interface) is considered the point-of-exposure for most sediment-dwelling or sediment-foraging receptors.

Potential direct exposure routes for ecological receptors include dermal contact/absorption, direct ingestion, and inhalation. In addition to these direct uptake mechanisms, ecological receptors may be exposed via consumption of food/prey items that have bioaccumulated/bioconcentrated constituents. Of these exposure routes, benthic macroinvertebrates and aquatic (fish) receptors are primarily expected to be exposed via direct/ingestion contact with substrate whereas wildlife receptors are primarily exposed to be exposed via dietary ingestion and, to a lesser extent, incidental ingestion of sediment.

7.1.4 Preliminary Assessment Endpoints

Assessment endpoints for OU1 were selected based on three principal criteria: (i) ecological relevance, (ii) susceptibility to potential stressors, and (iii) representation of management goals. General ecological assessment endpoints identified for complete exposure pathways at the Outfall Ditch are:

- Protection of benthic receptors from direct exposure/ingestion of contaminated sediment and pore water in the Outfall Ditch;
- Protection of aquatic (fish) receptors from direct exposure to contaminated surface water in the Outfall Ditch; and
- Protection of wildlife receptors to bioaccumulated/bioconcentrated constituents in food/prey items.

7.1.5 Ecological Effects Evaluation

The final component of Step 1 is the screening level ecological effects evaluation, which identifies threshold exposure concentrations for chemicals of interest below which adverse effects in potentially exposed receptors will not occur. These are conservative values that are unlikely to result in ecological effects in even the most sensitive ecological receptors. Priority was given to Region IV values and marine-specific values.

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Sediment ESVs were obtained from the sources listed below, in the order of preference in which they are listed. A comprehensive list of potential sediment ESVs is provided in Table A-1 of Attachment A of the complete SLERA in Appendix E.

1. USEPA (2001) Region IV Ecological Effects Values;
2. USEPA (1996) Office of Solid Waste and Emergency Response (OSWER) EcoTox Thresholds for marine sediment;
3. NOAA marine sediment Screening Quick Reference Tables (SQuiRTs) (Buchman, 2008);
4. USEPA Region III Biological Technical Assistance Group (BTAG) screening benchmarks for marine sediment;
5. USEPA (2005) Region V RCRA Ecological Screening Levels (ESLs); and
6. Other literature-derived or regulatory values (see Attachment A).

Surface water/pore water ESVs were obtained from the sources listed below, in the order of preference in which they are listed. A comprehensive list of potential sediment ESVs is provided in Table A-2 of Attachment A of the complete SLERA in Appendix E.

1. USEPA Region IV (2001) Ecological Effects Values for saltwater;
2. USEPA National Recommended Water Quality Criteria (NRWQC) for saltwater, chronic values;
3. USEPA (1996) OSWER EcoTox Thresholds for marine waters;
4. NOAA chronic marine water SQuiRTs (Buchman, 2008);
5. USEPA Region III BTAG screening benchmarks for marine water; and
6. USEPA (2003) Region V RCRA ESLs.

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ESVs are used in Step 2 as the basis of comparison with Site data to evaluate whether there may be the potential for adverse effects to ecological receptors from exposure to constituent concentrations in OU1 media.

7.2. Exposure Estimate and Risk Calculations (Step 2)

The primary objective of Step 2 is to identify constituents of potential ecological concern (COPECs) and provide a conservative evaluation of the potential for adverse ecological effects related to constituent concentrations in environmental media at the Site. This step combines ecological exposure estimates with effects thresholds described in Step 1 to yield an estimate of potential ecological risks at the Site.

7.2.1 Screening Level Exposure Estimates

Screening level exposure point concentrations (EPCs) are assumed to be maximum concentrations of constituents detected in environmental media. The following conservative assumptions are inherent to the SLERA EPCs:

- ecological receptors spend 100 percent of their time exposed to constituents at the Site;
- ecological receptors are exposed to maximum constituent concentrations 100 percent of the time;
- constituents are 100 percent bioavailable for ecological exposure; and
- there is a potential for adverse effects at constituent concentrations greater than the ESV.

Each of these assumptions is associated with a level of uncertainty, and overestimation of risk is likely under these assumptions. Uncertainty associated with the exposure estimate is discussed in Section 4.4 of the SLERA in Appendix E.

7.2.2 Screening Level Risk Calculations

Screening level ecological risks are evaluated using a hazard quotient (HQ) approach. This approach compares exposure levels (EPCs) to conservative ESVs, which are identified in Step 1, to calculate an HQ as follows:

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$$HQ = \frac{EPC}{ESV}$$

The USEPA HQ threshold value of 1 was used to identify COPECs; an HQ of approximately 1 is generally regarded as indicating a low probability adverse ecological effects. When a constituent has an HQ greater than 1, it is present at levels above its threshold concentration; however, this does not imply that adverse effects will occur, only that the potential for adverse effects exists. Consistent with the Work Plan, bioaccumulative compounds detected in the Outfall Ditch are also identified as COPECs regardless of the calculated HQ. Bioaccumulative compounds were identified using the USEPA (2000) guidance. Detected constituents for which an ESV is not identified are also identified as COPECs. Geochemical parameters and essential nutrients measured in environmental media were excluded from quantitative evaluation in the SLERA; these are: TOC, TSS, calcium, magnesium, potassium, and sodium.

7.2.2.1 Sediment

The results of screening level evaluation are described below by constituent group. Table 7-1 presents summary statistics, ESVs, and calculated HQs for constituents detected in Outfall Ditch surficial sediment.

- ***Toxaphene.*** Toxaphene was detected in each of the 22 surficial sediment samples evaluated in the SLERA. The calculated maximum HQ for toxaphene indicates that toxaphene is likely to be the primary risk driver for sediment.
- ***Metals.*** Sixteen metals were detected in surficial sediment. Maximum HQs exceed 1 for 13 of the 16 detected metals. Maximum HQs are generally low in magnitude (i.e., less than 10), with the exception of mercury. The highest concentrations were reported in the pre-weir section of the Outfall Ditch.
- ***PCBs.*** No PCBs were detected in surficial sediment.
- ***Organochlorine Pesticices (OCPs).*** Maximum detected HQs are greater than 1 for three detected OCPs (DDD, DDE, and gamma-BHC); however, OCPs were detected at a relatively low frequency. The highest concentrations were reported in sediments collected near the Outfall Ditch culvert.
- ***PAHs.*** Five PAHs were detected in surficial sediment: acenaphthylene, fluoranthene, naphthalene, phenanthrene, and pyrene. Concentrations of these

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five PAHs were summed (assuming one-half the detection limit for non-detect results) and evaluated as 'total PAHs' in the SLERA. Maximum detected concentration of total PAHs result in an HQ of 2. The highest concentrations were reported in sediments from the pre-weir section of the Outfall Ditch.

- ***SVOCs.*** Six SVOCs were detected in surficial sediment; maximum HQs for four phenolic compounds exceed 1 (1,1-biphenyl, 2-methyphenol, 3&4-methylphenol, and phenol). Note that ESVs for phenolic compounds are Region V ESLs, which were developed using equilibrium partitioning from freshwater surface water criteria, assuming a TOC of 1 percent; significantly lower TOC concentrations were measured at the site. Two additional SVOCs are identified as COPECs due to a lack of ESVs.
- ***VOCs.*** Four VOCs were detected in surficial sediment; maximum HQs for three detected VOCs exceed 1 (1,1-biphenyl, 2-methyphenol, 3&4-methylphenol, and phenol). HQs for carbon disulfide and 2-butanone are of low magnitude. Note that VOC ESVs are Region V ESLs, which were developed using equilibrium partitioning from freshwater surface water criteria, assuming a TOC of 1 percent. One additional VOC is identified as COPECs due to a lack of ESVs.

Thus, based on ESV comparisons, which is the SLERA metric for predicting potential ecological risk, 24 constituents/constituent groups are identified as sediment COPECs. Four additional constituents are identified as COPECs due to a lack of ESVs.

7.2.2.2 Surface Water

Table 7-2 presents summary statistics, ESVs, and calculated HQs for constituents detected in Outfall Ditch surface water.

- ***Toxaphene.*** Toxaphene was not detected in surface water[3]. One additional metal is identified as COPECs due to a lack of ESV.
- ***Metals.*** Maximum HQs exceed 1 for cobalt, cyanide, iron, and manganese. Per the Work Plan, nine other metals that are identified by USEPA (2000) as

[3] As noted above, the SLERA was based on Method 1 toxaphene data. Some toxaphene parlars were detected in water using the GC-ECD/NIMS method. These results are discussed further in the uncertainty section of the SLERA in Appendix E.

potentially bioaccumulative are also identified as COPECs. One additional metal is identified as COPECs due to a lack of ESV.

- ***PCBs.*** No PCBs were detected in surface water.
- ***OCPs.*** No OCPs were detected in surface water.
- ***PAHs.*** No PAHs are identified as OU1 COPECs in surface water.
- ***SVOCs.*** The maximum HQ for diethyl phthalate is less than 1. Three additional SVOCs are identified as COPECs due to a lack of ESVs.
- ***VOCs.*** Maximum HQs for detected VOCs are less than 1. One additional VOC is identified as COPECs due to a lack of ESV.

Based on ESV comparisons, which is the SLERA metric for predicting potential ecological risk, four metals are identified as surface water COPECs. One metal, three SVOCs, and one VOC are identified as COPECs due to a lack of ESVs. Nine additional metals are identified as COPECs based on their potential to bioaccumulate.

7.2.2.3 Pore Water

Table 7-3 presents summary statistics, ESVs, and calculated HQs for constituents detected in Outfall Ditch pore water.

- ***Toxaphene.*** Toxaphene was detected and HQ exceeds 1 for one filtered pore water sample collected in the post-weir section of the Outfall Ditch.
- ***Metals.*** Maximum HQs exceed 1 for cobalt, copper, iron, and manganese. Per the Work Plan, five other metals that are identified by USEPA (2000) as potentially bioaccumulative are also identified as COPECs. One additional metal is identified as COPECs due to a lack of ESV.
- ***PCBs.*** No PCBs were detected in pore water.
- ***OCPs.*** No OCPs were detected in pore water.
- ***PAHs.*** No PAHs are identified as OU1 COPECs in pore water.
- ***SVOCs.*** Maximum HQs for detected SVOCs are less than 1. One additional SVOC is identified as COPECs due to a lack of ESV.
- ***VOCs.*** No VOCs are identified as OU1 COPECs in pore water.

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Based on ESV comparisons, which is the SLERA metric for predicting potential ecological risk, toxaphene and four metals are identified as pore water COPECs. One additional metal and one SVOC are identified as COPECs due to a lack of ESVs. Five metals are identified as COPECs based on their potential to bioaccumulate.

7.2.3 SLERA Uncertainty Assessment

The final component of Step 2 is to describe potential uncertainties associated with the SLERA. These uncertainties are included in Section 4.4 of the SLERA in Appendix E.

7.3. SLERA SUMMARY AND SMDP

The results of the screening level exposure estimate and risk calculation (Step 2) indicate that concentrations of several constituents exceed ESVs, which is the SLERA metric for predicting potential adverse ecological effects. Maximum HQs for the majority of constituents detected in sediment exceed the USEPA threshold value of 1 and, in the case of toxaphene, the maximum concentration exceeds potential ESVs by several orders of magnitude. Although concentrations of toxaphene vary spatially in the Outfall Ditch, with the highest concentrations occurring near the culvert and outfall, HQs exceed 1 in each of the 22 surficial samples evaluated in the SLERA.

Given the magnitude of HQs for toxaphene, it is unlikely that the potential for ecological risk can be attributed to the conservative assumptions or uncertainties of the SLERA discussed in Section 4.4 of the SLERA in Appendix E. As such, it is unlikely that a BERA will provide significant refinement of potential risks predicted by the SLERA approach or contribute useful information for remedial actions at the Outfall Ditch.

Therefore, a performance-based remedial goal that focuses on eliminating direct exposure to contaminants in the Outfall Ditch and eliminating the transport of contaminants to Dupree Creek and other downstream locations is recommended. This approach is consistent with the USEPA's Contaminated Sediment Remediation Guidance for Hazardous Waste Sites (USEPA, 2005) and the Principles for Managing Contaminated Sediment Risks at Hazardous Waste Sites (USEPA, 2002), which collectively, highlight the consideration of separating the management of source areas with the most elevated concentrations of constituents from other, less concentrated areas.

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8. FEASIBILITY STUDY

8.1 Purpose of the OU1 Feasibility Study

The purpose of a feasibility study is to facilitate USEPA's selection of a Remedial Action Alternative for OU1 at the Site. The National Contingency Plan (NCP) dictates that the selected alternative be protective of human health and the environment while complying with ARARs. The Focused FS for OU1 provides an analysis of alternatives that are assembled based on the results of the Focused RI and the SLERA presented within the previous section of this document.

8.2 Overview of ARARs

Section 121(d)(2) of CERCLA, as amended by the 1986 Superfund Amendments and Reauthorization Act (SARA), requires that site remedial actions comply with state and federal ARARs upon completion of the remedial action. CERCLA §121(b)(1) 42 U.S.C. §9621(b)(1), mandates that remedial actions must be protective of human health and the environment, cost-effective, comply with ARARs, and utilize permanent solutions and alternative treatment technologies and resource recovery alternatives to the maximum extent practicable.

CERCLA §121(d), 42 U.S.C. §9621(d) further specifies that a remedial action must attain a level or standard of control of the hazardous substances, pollutants, and contaminants, which at least attains ARARs under Federal and State laws, unless a waiver is justified pursuant to CERCLA §121(d)(4), 42 U.S.C. §9621(d)(4). However, the requirement that the remedy be protective of human health and the environment cannot be waived.

The revised National Oil and Hazardous Substances Pollution Contingency Plan, otherwise known as the National Contingency Plan (NCP), requires compliance with ARARs during remedial actions as well as at the completion of the remedial actions. ARARs must be attained for hazardous substances remaining on Site at the completion of the remedial action. In addition, USEPA intends that the implementation of remedial actions should also comply with ARARs to protect public health and the environment.

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8.2.1 Definition of ARARs

Applicable requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, and limitations promulgated under Federal or State law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site. Examples of substantive requirements include quantitative health- or risk-based restrictions upon exposure to types of hazardous substances (e.g., maximum contaminant levels (MCLs_ establishing drinking water standards for particular contaminants), technology-based requirements for actions taken upon hazardous substances (e.g., incinerator standards requiring particular destruction and removal efficiency), and restrictions upon activities in certain special locations (e.g., standards prohibiting certain types of facilities in floodplains). Administrative requirements prescribe methods and procedures by which substantive requirements are made effective for purposes of a particular environmental or public health program.

Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under Federal or State law that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site. However, in some circumstances, a requirement may be relevant but not appropriate for the site-specific situation.

The determination that a requirement is relevant and appropriate involves a comparison of a number of site-specific factors, including the characteristics of the remedial action, the hazardous substances present at the site, or the physical circumstances of the site, with those addressed in the statutory or regulatory requirement. In some cases, a requirement may be relevant, but not appropriate given site-specific circumstances; such a requirement would not be an ARAR for the site. In addition, there is more discretion in the determination of relevant and appropriate; it is possible for only part of a requirement to be considered relevant and appropriate in a given case.

ARARs must be identified in connection with the characteristics of the particular site, the substances at the site, and the remedial action alternatives that are suggested by the circumstances of the site. The process of identifying ARARs for remedial actions

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essentially begins during the remedial investigation and may continue through the remedial design phase.

The requirements of CERCLA Section 121 generally apply as a matter of law only to remedial actions. USEPA's policy for removal actions, however, is that ARARs will be identified and attained to the extent practicable. Three factors are typically considered to determine whether the identification and attainment of ARARs is practicable in a particular removal situation: 1) the exigencies of the situation; 2) the scope of the removal action to be taken; and 3) the effect of ARAR attainment on the statutory limits for removal action duration and cost.

Section 121 (d) of CERCLA and 40 Code of Federal Regulations (CFR) Sections 300.430(f)(ii)(IB) and 300.435(b)(2) state that site actions must attain those ARARs identified at the time of the ROD signature or provide grounds for invoking a waiver. The NCP defines ARARs as substantive requirements, criteria, or limitations. In contrast, procedural requirements such as permit applications, reporting, record keeping, and consultation with administrative bodies are not ARARs.

Section 121(e) of CERCLA specifies that no Federal, State, or local permits are required for onsite response actions. Although consultation with the State and Federal offices responsible for issuing the permits is not required, it is recommended for compliance with the substantive requirements. Permits must be obtained for all response activities conducted offsite. OU1 is considered an offsite area. Offsite actions must comply with both the substantive and administrative parts of those requirements.

8.2.2 Definition of TBCs

Other requirements "To Be Considered" (TBC) are Federal and State guidance documents or criteria that are not generally enforceable but are advisory and do not have the status of potential ARARs. Guidance documents or advisories that are TBC in determining the necessary level of cleanup for protection of human health or the environment may be used where no specific ARARs exist for a chemical or situation, or where such ARARs are not sufficient to be protective.

8.2.3 Types of ARARs

There are three broad categories of ARARs, as follows: (i) chemical-specific ARARs, (ii) location-specific ARARs, and (iii) action-specific ARARs. These categories are not always mutually exclusive, and there may be some conceptual overlapping.

8.2.3.1 Chemical-Specific

Chemical-specific ARARs are health- or risk-based concentrations that have been established for specific chemicals (e.g., related to hazardous substances present at the site); if a chemical has more than one such requirement that is an ARAR, the most stringent will generally receive preference.

8.2.3.2 Location-Specific

Location-specific ARARs are restrictions placed on the concentration of hazardous substances or the conduct of activities solely because they are in specific locations. Some examples of special locations include floodplains, wetlands, historic places, and sensitive ecosystems or habitats. An example of a location-specific requirement is the substantive Clean Water Act §404 prohibitions of the unrestricted discharge of dredged or fill material into wetlands.

8.2.3.3 Action-Specific

Action-specific ARARs are usually technology- or activity-based requirements or limitations on actions taken with respect to hazardous wastes. These requirements are triggered by the particular remedial activities that are selected to accomplish a remedy. Since there are usually several alternative actions for any remedial site, very different requirements can come into play. These action-specific requirements do not in themselves determine the remedial alternative; rather, they indicate how a selected alternative must be achieved.

8.2.4 Waiver of ARARs

CERCLA Section 121(d) provides that under certain circumstances an ARAR may be waived. The six statutory waivers are as follows:

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1. **Interim Measure.** Occurs when the selected remedial action is only part of a total remediation action that will attain ARARs when completed.

2. **Greater Risk to Health and the Environment.** Occurs when compliance with such requirements will result in greater risk to human health and the environment than the alternative options.

3. **Technical Impracticability.** Occurs when compliance with such requirements is technically impracticable from an engineering perspective.

4. **Equivalent Standard of Performance.** Occurs when the selected remedial action will provide a standard of performance equivalent to that required under the otherwise applicable standard, requirement, criteria, or limitation through use of another method or approach.

5. **Inconsistent Application of State Requirements.** Occurs when a State requirement has been inconsistently applied in similar circumstances at other remedial actions within the State.

6. **Fund-Balancing.** Occurs when, in the case of an action undertaken using Superfund resources, the attainment of the ARAR would entail extremely high costs relative to the added degree of reduction of risk afforded by the standard such that remedial actions at other sites would be jeopardized.

8.2.5 Development of ARARs

Table 8-1 summarizes a list of potential ARARs. The table includes both Federal and State requirements divided into those that address certain chemicals, actions and locations.

8.3 Identification and Screening of Technologies

8.3.1 Overview

This section provides a description of the remedial action objectives (RAOs) followed by a description of the remedial alternatives, technologies and process options provided

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in the Focused RI/FS Work Plan and the preliminary screening submitted to USEPA in the Remedial Alternative Screening Technical Memorandum (Geosyntec, 2012).

8.3.2 Remedial Action Objectives

Consistent with the Work Plan and the findings of the Remedial Investigation and SLERA, the following RAOs have been developed for OU1:

1. Eliminate or minimize direct exposure pathways to potential receptors to elevated concentrations of toxaphene and other COPECs present in OU1 sediments;

2. Eliminate or minimize transport of sediments contaminated with toxaphene and other COPECs to downstream locations;

3. Eliminate or minimize exposure pathways to potential receptors to elevated concentrations of toxaphene and other COPECs present in OU1 pore water; and

4. Eliminate or minimize exposure pathways to potential receptors to elevated concentrations of COPECs present in OU1 surface water.

8.3.3 General Response Actions

Consistent with USEPA's *Contaminated Sediment Remediation Guidance for Hazardous Waste Sites* (USEPA 2005), sediment remedies fall into three General Response Actions: sediment removal, sediment containment (i.e., capping) and monitored natural recovery (MNR). Furthermore, to be consistent with the requirements of the National Contingency Plan (NCP), a No Further Action (NFA) remedy was also included.

8.3.4 Identification and Screening of Alternatives, Technologies and Process Options

A Technical Memorandum was submitted to USEPA that summarized the screening of select remedial alternatives, technologies and/or process options (Geosyntec, 2012). The alternatives, technologies and/or process options screened included the following:

- No Further Action

- Monitored Natural Recovery (MNR)
- Sediment Removal (as a stand-alone remedy)
- Containment - Sheet Pile Walled Channel within the Existing Channel
- Containment – Discharge Pipe within the Existing Channel
- Containment – Sub-Aqueous Cap utilizing Low Permeability Isolation Cap
- Containment – Sub-Aqueous Cap utilizing Traditional Armoring (sand/rip rap)
- Containment – Sub-Aqueous Cap utilizing Fabriform (concrete)
- Containment – Backfill OU1 and Re-Route Flow into an Open Channel
- Containment – Backfill OU1 and Re-Route Flow through a Pipe

The alternatives, technologies and/or process options were screened against three broad screening criteria: effectiveness, implementability, and relative cost. Screening for effectiveness mainly considered the protectiveness of each remedial alternative, technology and/or process option for receptors and the mitigation of toxaphene-contaminated sediment transport. Implementability considered the technical and administrative feasibility of constructing, operating and maintaining a remedial alternative or technology, while the cost evaluation at the screening level was based on a relative comparison of costs rather than absolute costs.

All of the alternatives, technologies and process options described above were retained for detailed analysis with the exception of MNR and Sediment Removal (as a stand-alone remedy). MNR has essentially been occurring within the Outfall Ditch since the completion of the removal action in 2000, and while it is noted that surficial concentrations of toxaphene have substantially declined over time, the current levels of toxaphene concentrations would indicate that the rate of recovery through MNR alone is not sufficient for this alternative/technology to serve adequately as a stand-alone remedy for source control at OU1. Therefore, MNR was not included for further analysis in the FS.

Likewise, sediment removal as a stand-alone technology was eliminated from further consideration in the detailed FS. The RI data demonstrated that a significant volume of sediment above the OSWER screening level remains in the Outfall Ditch (Figure 5-7). Based on the alternative's (or technology's) probable ineffectiveness of achieving complete removal of all toxaphene-impacted sediment, the challenges associated with water management during construction, as well as the potential for re-contamination of the Outfall Ditch after excavation, the sediment removal technology was eliminated

from further consideration as a stand-alone alternative. However, limited sediment removal has been incorporated as a component of all of the retained alternatives with the exception of No Further Action.

The remedial alternatives described below in Section 8.4 have been developed without including any transitional structure, between the Outfall Ditch and Dupree Creek. Maintaining an unobstructed channel profile between the Highway 17 box culvert and Dupree Creek will allow for improved system performance under design storm events, while reducing the rate of sediment accumulation (and associated maintenance) currently taking place within the existing box culvert and the pre-weir area.

8.4 Development of Remedial Alternatives

Based on the screening of remedial alternatives, technologies and options presented above and in the Technical Memorandum submitted to USEPA, the following remedial alternatives were developed for the detailed analysis presented in Subsection 8.5. The alternatives, technologies and process options presented have been refined based on further review of the site data and considering constructability issues.

With the exception of the No Further Action Alternative, all evaluated remedial alternatives considered the following design parameters:

- Environmental Parameters
  - Effectively cap/contain sediment, minimize pathways for receptors;
  - Avoid creation of aquatic habitat, the Outfall Ditch is a stormwater and industrial discharge conveyance feature;
- Hydraulic Design Parameters
  - Convey surface water discharges in a manner that does not adversely impact Highway 17, or immediate upstream areas;
  - Minimize future operations and maintenance requirements;
  - Simplify design components and features, avoiding reliance upon mechanical, electrical, or motorized equipment;

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- Constructability Parameters
  - Minimize the area to be disturbed, to the extent practicable;
  - Avoid disturbance and/or re-suspension of OU1 sediment during construction;
  - Use readily available construction materials consistent with materials used locally within the project vicinity;
  - Use cost-effective design approach and materials;
  - Provide for effective surface water management and flow bypass during construction.

8.4.1 Alternative 1: No Further Action

No Further Action (NFA) includes site monitoring and general maintenance (i.e., erosion control, maintenance of fencing, etc.), but no further active remediation within OU1 and/or additional "limited" action alternatives such as deed restrictions would be implemented. This alternative is carried through consistent with the requirements of the NCP.

8.4.2 Alternative 2: Sheet Pile Channel Re-Routed With Limited Sediment Removal

Alternative 2 includes re-routing the discharge into a newly constructed conveyance channel along an alignment parallel to the Outfall Ditch, excavation and offsite disposal of sediment within the Highway 17 Triple Box Culvert and the area in the existing Outfall Ditch used as the transition zone between the new conveyance channel and the Triple Box Culvert, removal of the weir, and backfilling the Outfall Ditch with compacted soil and armoring the backfill slope into Dupree Creek with rip rap. The configuration of this alternative, shown on Figure 8-1, is just south of the Outfall Ditch, but an alternative alignment north of the Outfall Ditch is also possible. There are several significant advantages to re-routing the existing Outfall Ditch, including:

- Surface water management during construction;
- Balancing of earthwork (cut and fill quantities);

- Avoiding soft subsurface/subgrade conditions within the Outfall Ditch during construction.

Under this alternative, the re-routed channel would consist of steel sheet pile driven to form the channel sides and excavating the soil in between the sheet pile walls to form the channel. Material excavated during construction of the re-routed channel would be temporarily stockpiled for future use in backfilling the Outfall Ditch. The re-routed channel dimensions are 30 feet wide by approximately 10 feet deep, as necessary, to maintain the required channel profile and convey plant discharges and stormwater flows generated from the drainage basin upstream of the Triple Box Culvert. The re-routed channel bottom would be concrete-lined to facilitate future maintenance and periodic sediment removal. The sheet pile channel profile is provided on Figure 8-2.

During construction of the re-routed channel, surface water flow would be maintained within the existing Outfall Ditch. A temporary coffer dam and by-pass pump would be required for a short duration to convey flow across a segment of the active construction site as the re-routed channel is connected to the downstream side of the existing Highway 17 Triple Box Culvert. A detail of the transition zone where the sheet pile is connected to the Triple Box Culvert is shown on Figure 8-2. This alternative also includes excavation and offsite disposal of approximately 1,200 cubic yards of contaminated sediment within the Highway 17 Triple Box Culvert and in the Outfall Ditch transition zone where the new channel connects to the Triple Box Culvert.

Surface water flows would be directed to the re-routed channel once it is constructed and functional. A riprap coffer dam would be constructed at the discharge end of the existing Outfall Ditch adjacent to Dupree Creek to control surface water flow (tidal flow) into the Outfall Ditch. The existing weir would be mechanically removed, at a minimum, to below the backfill grade elevation. As shown on Figure 8-1, a layer of geotextile fabric would be installed over the existing sediment within the Outfall Ditch, followed by placement and grading of fill over the fabric. Fill material from the re-routed channel excavation would be used to the extent possible with additional material imported from off-site. Placement of fill would continue until the final grade generally matches the grading plan shown on Figure 8-1.

Following placement of fill and grading as described above, the stream bank along Dupree Creek would be further armored to protect the bank from erosion and to contain the newly-placed fill in position (also restricting the potential for migration of the

capped sediment into Dupree Creek). A detail of the riprap armoring is provided on Figure 8-1. The final graded and restored site, including all areas disturbed during construction, would be seeded and stabilized.

Additionally, an Environmental Covenant would be placed on the property in accordance with the Georgia Uniform Environmental Covenants Act, OCGA § 44-16-1, *et seq.* This Environmental Covenant will subject the Property to following activity and/or use limitations:

- The Property shall be used only for non-residential uses, as defined in and allowed under Glynn County's zoning regulations as of the date of the Environmental Covenant. Further, activity on the Property that may result in the release or exposure to the regulated substances that were contained as part of the Remedy (corrective action), or create a new exposure pathway, is prohibited, with the exception of work necessary for the maintenance, repair, or replacement of engineering controls.

- The use or extraction of groundwater beneath the Property for drinking water or for any other non-remedial purposes shall also be prohibited.

8.4.3 Alternative 2A: Sheet Pile Channel Within Existing Channel With Limited Sediment Removal

With Alternative 2A, steel sheet pile would be driven to create a channel similar to the channel presented under Alternative 2, but the channel would be constructed within the existing Outfall Ditch. Alternative 2A also includes excavation and offsite disposal of sediments within the Triple Box Culvert and in the bottom of the Outfall Ditch within the sheet pile walls to obtain the profile needed to convey the discharge water, removal of the weir, and backfilling the portions of the Outfall Ditch outside the sheet pile walls. The configuration of this alternative is shown on Figure 8-3, which shows the channel generally within the middle of the Outfall Ditch.

However, due to the anticipated construction sequencing to manage surface water flows, the new channel would likely be located either on the north or south side of the Outfall Ditch. For discussion purposes, let’s consider that the new channel would be located on the south side (but within) the Outfall Ditch. During construction, a sufficiently wide portion of the south side of the existing Outfall Ditch would be filled

with imported fill to create a stable working platform for construction of the sheet pile channel. Surface water would gravity flow (i.e. no pumping systems) on the north side of the Outfall Ditch. Then, within the backfilled portion (the south side) of the Outfall Ditch, the sheet pile would be driven/installed and the soil/sediment within the sheet pile walls would be excavated to the appropriate depths to create the new channel. Temporary coffer dams and by-pass pumps may be required at times to convey flow across segments of active construction areas and while the new sheet pile channel is connected to the existing Highway 17 Triple Box Culvert. A detail of the transition zone where the sheet pile is connected to the Triple Box Culvert is shown on Figure 8-4.

The soil excavated from within the sheet pile channel would be stockpiled and utilized to backfill the north side of the Outfall Ditch once the new sheet pile channel is functional. The channel dimensions would be 30 feet wide by approximately 10 feet deep, as necessary to maintain the required channel profile and convey plant discharges and stormwater flows generated from the drainage basin upstream of the Highway 17 Triple Box Culvert. Within the sheet pile walls, sufficient soil/sediment would be removed to install appropriate foundation materials to concrete-line the channel, which will facilitate easier inspections, maintenance and periodic sediment removal. The sheet pile channel profile is provided on Figure 8-3. Additionally, the existing weir would be mechanically removed to allow construction of the new channel within the existing Outfall Ditch.

The sediment from the transition zone (connecting the sheet pile channel to the Triple Box Culvert) and the excavated sediment within the new sheet pile channel would be disposed offsite. It is estimated that approximately 7,900 cubic yards of sediment would be solidified and managed as environmentally impacted waste materials.

Once the sheet pile channel is functional, additional imported fill material would be used to bring the north side of the Outfall Ditch to final grade. Following placement of fill, the stream bank along Dupree Creek would be further armored to protect the bank from erosion and to contain the newly-placed fill in position (also restricting the potential for migration of the capped sediment into Dupree Creek). A detail of the riprap armoring is provided on Figure 8-3. The final graded and restored site, including all areas disturbed during construction, would be seeded and stabilized.

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Additionally, an Environmental Covenant would be placed on the property in accordance with the Georgia Uniform Environmental Covenants Act, OCGA § 44-16-1, *et seq.* This Environmental Covenant will subject the Property to following activity and/or use limitations:

- The Property shall be used only for non-residential uses, as defined in and allowed under Glynn County's zoning regulations as of the date of the Environmental Covenant. Further, activity on the Property that may result in the release or exposure to the regulated substances that were contained as part of the Remedy (corrective action), or create a new exposure pathway, is prohibited, with the exception of work necessary for the maintenance, repair, or replacement of engineering controls.

- The use or extraction of groundwater beneath the Property for drinking water or for any other non-remedial purposes shall also be prohibited.

8.4.4 Alternative 3: Concrete-Lined Channel Re-Routed With Limited Sediment Removal

Alternative 3 includes re-routing the discharge into a newly constructed concrete lined conveyance channel along an alignment parallel to the Outfall Ditch, excavation and offsite disposal of sediment within the Highway 17 Triple Box Culvert and the area in the existing Outfall Ditch used as the transition zone between the new conveyance channel and the Triple Box Culvert, removal of the weir, backfilling the Outfall Ditch with compacted soil, and armoring the backfill slope into Dupree Creek with rip rap. The configuration of this alternative, shown on Figure 8-5, is just south of the Outfall Ditch, but an alternative alignment north of the Outfall Ditch is also possible.

The re-routed channel would consist of a trapezoidal cross section, as described in more detail below. The existing Outfall Ditch would be utilized for conveyance of surface water during construction, but then backfilled, graded, and stabilized. The advantages of constructing a re-routed channel to replace the existing Outfall Ditch are similar to those previously described in Alternative 2.

Under this alternative, the re-routed channel would be excavated and a concrete liner (FabriForm or equivalent) would be installed in the trapezoidal channel. Material excavated during construction of the re-routed channel would be temporarily stockpiled

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for later use in backfilling the Outfall Ditch. The re-routed channel dimensions include a 5-foot wide flat bottom and 3:1 (horizontal to vertical) side slopes. The channel profile is indicated on Figure 8-5, along with the transition or tie-in into the existing Highway 17 Triple Box Culvert invert. The Highway 17 Triple Box Culvert would be cleaned of existing sediment during construction. The resulting average channel depth ranges from 8 to 10 feet, as necessary, to maintain the required channel profile and convey plant discharges and stormwater flows generated from the drainage basin upstream of the Triple Box Culvert. The concrete-lined channel bottom would facilitate future inspections, maintenance and periodic sediment removal.

Surface water flow would be maintained within the existing Outfall Ditch during construction of the re-routed channel. A temporary coffer dam and by-pass pump would be required for a short duration to convey flow across a segment of the active construction site as the re-routed channel is connected to the downstream side of the existing Highway 17 Triple Box Culvert. A detail of the transition zone where the concrete-lined channel is connected to the Triple Box Culvert is shown on Figure 8-6. This alternative also includes excavation and offsite disposal of approximately 1,200 cubic yards of contaminated sediment within the Highway 17 Triple Box Culvert and in the Outfall Ditch transition zone where the new channel connects to the Triple Box Culvert.

Surface water flows would be directed to the re-routed channel once it is constructed and functional. A riprap coffer dam would be constructed at the discharge end of the existing Outfall Ditch adjacent to Dupree Creek to control surface water flow into the Outfall Ditch. The existing weir would be mechanically removed, at a minimum, to below the backfill grade elevation. As shown on Figure 8-5, a layer of geotextile fabric would be installed over the existing sediment within the Outfall Ditch, followed by placement and grading of fill over the fabric. Fill material from the re-routed channel excavation would be used to the extent possible to backfill the Outfall Ditch with additional material imported from off-site. Placement of fill would continue until the final grade generally matches the grading plan shown on Figure 8-5.

Following placement of fill and grading as described above, the stream bank along Dupree Creek would be further armored to protect the bank from erosion and to contain the newly-placed fill in position (also restricting the potential for migration of the capped sediment into Dupree Creek). The final graded and restored site, including all areas disturbed during construction, would be seeded and stabilized.

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Additionally, an Environmental Covenant would be placed on the property in accordance with the Georgia Uniform Environmental Covenants Act, OCGA § 44-16-1, *et seq.* This Environmental Covenant will subject the Property to following activity and/or use limitations:

- The Property shall be used only for non-residential uses, as defined in and allowed under Glynn County's zoning regulations as of the date of the Environmental Covenant. Further, activity on the Property that may result in the release or exposure to the regulated substances that were contained as part of the Remedy (corrective action), or create a new exposure pathway, is prohibited, with the exception of work necessary for the maintenance, repair, or replacement of engineering controls.

- The use or extraction of groundwater beneath the Property for drinking water or for any other non-remedial purposes shall also be prohibited.

8.4.5 Alternative 3A: Concrete-Lined Channel Within Existing Channel With Limited Sediment Removal

Alternative 3A includes construction of a concrete-lined channel within the existing Outfall Ditch. The concrete-lined channel would be trapezoidal in shape, matching the cross-sectional dimensions of the re-routed concrete-lined channel described in Alternative 3. This alternative also includes excavation and offsite disposal of sediments within the Triple Box Culvert and in the bottom of the Outfall Ditch to obtain the profile needed to convey the discharge water, and removal of the weir. The configuration of this alternative is shown on Figure 8-7.

This alternative would be constructed similar to the sheet pile channel alternative, except that the new channel would be a concrete lined channel. During construction, surface water discharges would be rerouted to the north side of the Outfall Ditch by excavation of a channel. A portion of the south side of the existing Outfall Ditch would be filled with imported fill to create a stable working platform for construction of the new concrete lined channel. Doing so will mitigate the amount of active dewatering necessary during the construction. The proposed channel would initially be excavated to the cross section shown on Figure 8-7 and FabriForm (or equivalent) concrete liner materials used to reinforce the channel shape.

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During construction, surface water flow would gravity flow along the north side of the Outfall Ditch. Temporary coffer dams and by-pass pumps may be required at times to convey flow across segments of active construction areas, and while the new channel is connected to the downstream side of the existing Highway 17 Triple Box Culvert. A detail of the transition zone where the concrete-lined channel is connected to the Triple Box Culvert is shown on Figure 8-8. Furthermore, the existing weir would be mechanically removed to allow construction of the new channel within the existing Outfall Ditch.

This alternative also includes excavation and offsite disposal of approximately 12,800 cubic yards of contaminated sediments within the Highway 17 Triple Box Culvert, the Outfall Ditch transition zone where the new channel connects to the Triple Box Culvert, as well as sediments from within the existing Outfall Ditch to maintain the required channel profile and convey plant discharges and stormwater flows generated from the drainage basin upstream of the Triple Box Culvert.

Soil excavated from the backfilled platform to construct the new concrete-lined channel would be used as backfill for the north side of existing Outfall Ditch. Existing sediment, encountered in the lower horizons of the new channel construction would be solidified and managed as environmentally impacted waste materials. As shown on Figure 8-7, a layer of geotextile fabric would be installed over the existing sediment within the Outfall Ditch prior to placement of imported fill. Imported fill material would be used to bring the site to final grade.

Following placement of fill and grading described above, the stream bank along Dupree Creek would be further armored to protect the bank from erosion and to contain the newly-placed fill in position (also restricting the potential for migration of the capped sediment into Dupree Creek). The final graded and restored site, including all areas disturbed during construction, would be seeded and stabilized.

Additionally, an Environmental Covenant would be placed on the property in accordance with the Georgia Uniform Environmental Covenants Act, OCGA § 44-16-1, *et seq.* This Environmental Covenant will subject the Property to following activity and/or use limitations:

- The Property shall be used only for non-residential uses, as defined in and allowed under Glynn County's zoning regulations as of the date of the

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Environmental Covenant. Further, activity on the Property that may result in the release or exposure to the regulated substances that were contained as part of the Remedy (corrective action), or create a new exposure pathway, is prohibited, with the exception of work necessary for the maintenance, repair, or replacement of engineering controls.

- The use or extraction of groundwater beneath the Property for drinking water or for any other non-remedial purposes shall also be prohibited.

8.4.6 Alternative 4: Box Culvert Re-Routed With Limited Sediment Removal

Alternative 4 includes re-routing the discharge into a newly constructed culvert conveyance system along an alignment parallel to the Outfall Ditch, excavation and offsite disposal of sediment within the Highway 17 Triple Box Culvert and the area in the existing Outfall Ditch used as the transition zone between the new conveyance structure and the Triple Box Culvert, removal of the weir, and backfilling the existing Outfall Ditch with compacted soil and armoring the backfill slope into Dupree Creek with rip rap. The configuration of this alternative, shown on Figure 8-9, is just south of the Outfall Ditch, but an alternative alignment north of the Outfall Ditch is also possible

This alternative includes the installation of a quadruple (4) 8-foot by 6-foot concrete box culvert. The existing Outfall Ditch would be utilized for conveyance of surface water during construction. Following completion of the re-routed culvert system the existing Outfall Ditch would be backfilled, graded, and stabilized as indicated on the conceptual drawings and described further below. The advantages to constructing a re-routed channel (or box culvert) to replace the existing Outfall Ditch are similar to those previously described in Alternative 2.

Under this alternative, material excavated during construction of the box culvert would be temporarily stockpiled for later use in backfilling the Outfall Ditch. The culvert profile and dimensions are appropriate to maintain the required channel profile (matching the invert of the Highway 17 Triple Box Culvert) and convey plant discharges and stormwater flows generated from the drainage basin upstream of the Triple Box Culvert. With the culvert being a closed conveyance system, maintenance of the box culvert and periodic removal of accumulated sediment would require points of access and specialized equipment to loosen and pump sediment from the culvert system.

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Surface water flow would be maintained within the existing Outfall Ditch during construction of the re-routed channel/box culvert. A temporary coffer dam and by-pass pump may be required for short durations to convey flow across a segment of the active construction site as the new box culvert is connected to the downstream side of the existing Highway 17 Triple Box Culvert. A detail of the transition zone where the box culvert is connected to the Highway 17 Triple Box Culvert is shown on Figure 8-10. This alternative also includes excavation and offsite disposal of approximately 1,200 cubic yards of contaminated sediment within the Highway 17 Triple Box Culvert and in the Outfall Ditch transition zone where the new box culvert connects to the Triple Box Culvert.

Surface water flows would be directed to the re-routed channel once it is constructed and functional. A riprap coffer dam would be constructed at the discharge end of the existing Outfall Ditch adjacent to Dupree Creek to control surface water flow into the Outfall Ditch. The existing weir would be mechanically removed, at a minimum, to below the backfill grade elevation. As shown on Figure 8-9, a layer of geotextile fabric would be installed over the existing sediment within the Outfall Ditch, followed by placement and grading of fill over the fabric. Fill material from the re-routed channel excavation would be used to the extent possible with additional material imported from off-site. Placement of fill would continue until the final grade generally matches the grading plan shown on Figure 8-9.

Following placement of fill and grading as described above, the stream bank along Dupree Creek would be further armored to protect the bank from erosion and to contain the newly-placed fill in position (also restricting the potential for migration of the capped sediment into Dupree Creek). The final graded and restored site, including all areas disturbed during construction, would be seeded and stabilized.

Additionally, an Environmental Covenant would be placed on the property in accordance with the Georgia Uniform Environmental Covenants Act, OCGA § 44-16-1, *et seq.* This Environmental Covenant will subject the Property to following activity and/or use limitations:

- The Property shall be used only for non-residential uses, as defined in and allowed under Glynn County's zoning regulations as of the date of the Environmental Covenant. Further, activity on the Property that may result in the release or exposure to the regulated substances that were contained as part of the

Remedy (corrective action), or create a new exposure pathway, is prohibited, with the exception of work necessary for the maintenance, repair, or replacement of engineering controls.

- The use or extraction of groundwater beneath the Property for drinking water or for any other non-remedial purposes shall also be prohibited.

8.4.7 Alternative 4A: Box Culvert Within Existing Outfall Ditch With Limited Sediment Removal

Alternative 4A includes installation of a quadruple (4) 8-foot by 6-foot concrete box culvert within the existing Outfall Ditch. This alternative also includes excavation and offsite disposal of sediments within the Highway 17 Triple Box Culvert and in the bottom of the Outfall Ditch to obtain the profile needed to convey the discharge water, and removal of the weir. The configuration of this alternative is shown on Figure 8-11.

This alternative would be constructed similar to the previously described "in-channel" alternatives. During construction, surface water discharges would be rerouted to the north side of the Outfall Ditch. A portion of the south side of the existing Outfall Ditch would be filled with imported fill to create a stable working platform for construction of the culvert system. The box culvert profile was designed to maintain the profile matching the invert of the Highway 17 Triple Box Culvert and with dimensions to convey plant discharges and stormwater flows generated from the drainage basin upstream of the Triple Box Culvert.

With the culvert being a closed conveyance system, maintenance of the box culvert and periodic removal of accumulated sediment would require points of access and specialized equipment to loosen and pump sediment from the new culvert.

During construction, surface water flow would be directed to the north side of the existing Outfall Ditch. Temporary coffer dams and by-pass pumps may be required at times to convey flow across segments of active construction areas, and while the new box culvert channel is connected to the downstream side of the existing Highway 17 Triple Box Culvert. A detail of the transition zone where the new box culvert channel is connected to the Triple Box Culvert is shown on Figure 8-12. Furthermore, the existing weir would be mechanically removed to allow construction of the new channel within the existing Outfall Ditch.

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This alternative also includes excavation and offsite disposal of approximately 9,800 cubic yards of contaminated sediments within the Highway 17 Triple Box Culvert, the Outfall Ditch transition zone where the new box culvert channel connects to the Triple Box Culvert, as well as sediments from within the existing Outfall Ditch to maintain the required channel profile and convey plant discharges and stormwater flows generated from the drainage basin upstream of the Triple Box Culvert.

Originally imported and placed material excavated from the upper horizons of the working platform construction would be used as backfill for the north side of the Outfall Ditch. Existing sediment, encountered in the lower horizons of the new channel construction and from the transition zone tie-in of the new box culvert to the existing box culvert would be solidified and managed as environmentally impacted waste materials. As shown on Figure 8-11, a layer of geotextile fabric would be installed over the existing sediment within the Outfall Ditch prior to placement of imported fill. Imported fill material would be used to bring the site to final grade.

Following placement of fill and grading described above, the stream bank along Dupree Creek would be further armored to protect the bank from erosion and to contain the newly-placed fill in position (also restricting the potential for migration of the capped sediment into Dupree Creek). The final graded and restored site, including all areas disturbed during construction, would be seeded and stabilized.

Additionally, an Environmental Covenant would be placed on the property in accordance with the Georgia Uniform Environmental Covenants Act, OCGA § 44-16-1, *et seq*. This Environmental Covenant will subject the Property to following activity and/or use limitations:

- The Property shall be used only for non-residential uses, as defined in and allowed under Glynn County's zoning regulations as of the date of the Environmental Covenant. Further, activity on the Property that may result in the release or exposure to the regulated substances that were contained as part of the Remedy (corrective action), or create a new exposure pathway, is prohibited, with the exception of work necessary for the maintenance, repair, or replacement of engineering controls.

- The use or extraction of groundwater beneath the Property for drinking water or for any other non-remedial purposes shall also be prohibited.

8.4.8 Alternative 5: Low Permeability Isolation Cap With Limited Sediment Removal

Alternative 5 includes construction of a low permeability isolation cap (e.g., AquaBlok™) and rip-rap armored channel within the existing Outfall Ditch. This alternative also includes excavation and offsite disposal of sediments within the Triple Box Culvert and in the bottom of the Outfall Ditch to obtain the profile needed to convey the discharge water, and removal of the weir. The configuration of this alternative is shown on Figure 8-13.

The a low permeability isolation cap will create a bentonite barrier between overlying materials and underlying sediment. The cap would be placed at a thickness of approximately four inches on compacted clean fill and armored with a 24-inch thick layer of GDOT type 1 riprap. The channel would be trapezoidal in shape, similar to the cross sectional dimensions of the concrete-lined channel described in Alternatives 3 and 3A.

This alternative would be constructed similar to the previously described "in-channel" alternatives. During construction, surface water discharges would be routed to the north side of the Outfall Ditch. A portion of the south side of the existing Outfall Ditch would be filled with imported fill to create a stable working platform for construction of the new channel. Doing so will mitigate the amount of active dewatering necessary during the construction. The proposed channel would initially be excavated to the cross section shown on Figure 8-13.

Temporary coffer dams and by-pass pumps may be required at times to convey flow across segments of active construction areas, and while the new channel is connected to the downstream side of the existing Highway 17 Triple Box Culvert. A detail of the transition zone where the isolation cap-lined channel is connected to the Triple Box Culvert is shown on Figure 8-14. Furthermore, the existing weir would be mechanically removed to allow construction of the new channel within the existing Outfall Ditch.

The isolation cap would be installed along the channel side and bottom to an approximate thickness of 4-inches using a "telebelt" handler or similar. Following installation of the isolation cap, GDOT Type 1 riprap will be placed over the cap to form the final channel shape and provide protection from erosion.

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This alternative also includes excavation and offsite disposal of approximately 12,800 cubic yards of impacted sediments. The sediments will be excavated from within the Highway 17 Triple Box Culvert, the Outfall Ditch transition zone where the new capped channel connects to the Triple Box Culvert, as well as sediments from within the existing Outfall Ditch excavated to maintain the required channel profile and convey plant discharges and stormwater flows generated from the drainage basin upstream of the Triple Box Culvert.

Once the new channel is functional, originally imported and placed material excavated from the upper horizons of the working platform construction would be used as backfill the north side of the Outfall Ditch. Existing sediment, encountered in the lower horizons of the new channel construction would be solidified and managed as environmentally impacted waste materials. As shown on Figure 8-13, a layer of geotextile fabric would be installed over the existing sediment within the Outfall Ditch prior to placement of imported fill. Imported fill material would be used to bring the site to final grade.

Following placement of fill and grading described above, the stream bank along Dupree Creek would be further armored to protect the bank from erosion and to contain the newly-placed fill in position (also restricting the potential for migration of the capped sediment into Dupree Creek). The final graded and restored site, including all areas disturbed during construction, would be seeded and stabilized.

Additionally, an Environmental Covenant would be placed on the property in accordance with the Georgia Uniform Environmental Covenants Act, OCGA § 44-16-1, *et seq.* This Environmental Covenant will subject the Property to following activity and/or use limitations:

- The Property shall be used only for non-residential uses, as defined in and allowed under Glynn County's zoning regulations as of the date of the Environmental Covenant. Further, activity on the Property that may result in the release or exposure to the regulated substances that were contained as part of the Remedy (corrective action), or create a new exposure pathway, is prohibited, with the exception of work necessary for the maintenance, repair, or replacement of engineering controls.

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- The use or extraction of groundwater beneath the Property for drinking water or for any other non-remedial purposes shall also be prohibited.

8.4.9 Alternative 5A: Carbon-Amended Sand Cap Channel With Limited Sediment Removal

Alternative 5A includes construction of a sand cap amended with granular activated carbon with rip-rap armoring channel within the existing Outfall Ditch. This alternative also includes excavation and offsite disposal of sediments within the Triple Box Culvert and in the bottom of the Outfall Ditch to obtain the profile needed to convey the discharge water, and removal of the weir. The configuration of this alternative is shown on Figure 8-15.

The sand cap creates a barrier between overlying materials and underlying sediment. The addition of granular activated carbon (GAC) is intended to promote the sorption and permanent in situ sequestration of hydrophobic organic contaminants, such as toxaphene. GAC is derived from carbonaceous materials which are physically "activated" at high temperatures through the creation of porous structures characterized by very high surface areas. The sand cap (composed of a manufactured sand) mixed with 5-10 percent GAC to a depth of approximately 1-foot and armored with a 24-inch thick layer of GDOT type 1 riprap. Treatability studies would be performed to determine the appropriate GAC amendment ratio. The channel would be trapezoidal in shape, similar to the cross sectional dimensions of the concrete-lined channel described in Alternatives 3 and 3A.

This alternative would be constructed similar to the previously described "in-channel" alternatives. During construction, surface water discharges would be routed to the north side of the Outfall Ditch. A portion of the south side of the existing Outfall Ditch would be filled with imported fill to create a stable working platform for construction of the new channel. Doing so will mitigate the amount of active dewatering necessary during the construction. The proposed channel would initially be excavated to the cross section shown on Figure 8-15.

Temporary coffer dams and by-pass pumps may be required at times to convey flow across segments of active construction areas, and while the new channel is connected to the downstream side of the existing Highway 17 Triple Box Culvert. A detail of the transition zone where the sand/GAC-lined channel is connected to the Triple Box

Culvert is shown on Figure 8-16. Furthermore, the existing weir would be mechanically removed to allow construction of the new channel within the existing Outfall Ditch.

Sand and granular activated carbon would be mixed at a ratio of up to 10% GAC and installed along the channel side and bottom to an approximate thickness of 12-inches using a "telebelt" handler or similar. Following installation of the sand/GAC mixture, GDOT Type 1 riprap will be placed over the sand cap to form the final channel shape and provide protection from erosion.

This alternative also includes excavation and offsite disposal of approximately 12,800 cubic yards of impacted sediments. The sediments will be excavated from within the Highway 17 Triple Box Culvert, the Outfall Ditch transition zone where the new sand capped channel connects to the Triple Box Culvert, as well as sediments from within the existing Outfall Ditch excavated to maintain the required channel profile and convey plant discharges and stormwater flows generated from the drainage basin upstream of the Triple Box Culvert.

Once the new channel is functional, originally imported and placed material excavated from the upper horizons of the working platform construction would be used as backfill the north side of the Outfall Ditch. Existing sediment, encountered in the lower horizons of the new channel construction would be solidified and managed as environmentally impacted waste materials. As shown on Figure 8-13, a layer of geotextile fabric would be installed over the existing sediment within the Outfall Ditch prior to placement of imported fill. Imported fill material would be used to bring the site to final grade.

Following placement of fill and grading described above, the stream bank along Dupree Creek would be further armored to protect the bank from erosion and to contain the newly-placed fill in position (also restricting the potential for migration of the capped sediment into Dupree Creek). The final graded and restored site, including all areas disturbed during construction, would be seeded and stabilized.

Additionally, an Environmental Covenant would be placed on the property in accordance with the Georgia Uniform Environmental Covenants Act, OCGA § 44-16-1, *et seq.* This Environmental Covenant will subject the Property to following activity and/or use limitations:

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- The Property shall be used only for non-residential uses, as defined in and allowed under Glynn County's zoning regulations as of the date of the Environmental Covenant. Further, activity on the Property that may result in the release or exposure to the regulated substances that were contained as part of the Remedy (corrective action), or create a new exposure pathway, is prohibited, with the exception of work necessary for the maintenance, repair, or replacement of engineering controls.

- The use or extraction of groundwater beneath the Property for drinking water or for any other non-remedial purposes shall also be prohibited.

8.4.10 Alternative 6: Riprap-Armored Channel With Limited Sediment Removal

Alternative 6 includes construction of a new channel with a traditional sand cap (or compacted clean fill) and rip rap armoring within the existing Outfall Ditch. The channel would be trapezoidal in shape, similar to the cross sectional dimensions of the concrete-lined channel described in Alternatives 3 and 3A. This alternative also includes excavation and offsite disposal of sediments within the Triple Box Culvert and in the bottom of the Outfall Ditch to obtain the profile needed to convey the discharge water, and removal of the weir. The configuration of this alternative is shown on Figure 8-17.

This alternative would be constructed similar to the previously described “in-channel” alternatives. During construction, surface water discharges would be routed to the north side of the Outfall Ditch. A portion of the south side of the existing Outfall Ditch would be filled with imported fill to create a stable working platform for construction of the new channel. Doing so will mitigate the amount of active dewatering necessary during the construction. During construction, surface water flow would be directed around the filled portions of the existing Outfall Ditch. The proposed channel would initially be excavated to the cross section shown on Figure 8-17. Sand (or compacted fill) armored with GDOT Type 1 riprap would be placed over the prepared earthen channel sides and bottom to form the final channel shape and provide protection from erosion.

Temporary coffer dams and by-pass pumps may be required at times to convey flow across segments of active construction areas, and while the new channel is connected to the downstream side of the existing Highway 17 Triple Box Culvert. A detail of the

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transition zone where the riprap-lined channel is connected to the Triple Box Culvert is shown on Figure 8-18. Furthermore, the existing weir would be mechanically removed to allow construction of the new channel within the existing Outfall Ditch.

This alternative also includes excavation and offsite disposal of approximately 12,800 cubic yards of impacted sediments. The sediments will be excavated from within the Highway 17 Triple Box Culvert, the Outfall Ditch transition zone where the new channel connects to the Triple Box Culvert, as well as sediments from within the existing Outfall Ditch to maintain the required channel profile and convey plant discharges and stormwater flows generated from the drainage basin upstream of the Triple Box Culvert.

Originally imported and placed material excavated from the upper horizons of the working platform construction would be used as backfill in the remaining portions of the existing Outfall Ditch. Existing sediment, encountered in the lower horizons of the new channel construction would be solidified and managed as environmentally impacted waste materials. As shown on Figure 8-17, a layer of geotextile fabric would be installed over the existing sediment within the Outfall Ditch prior to placement of imported fill. Imported fill material would be used to bring the site to final grade.

Following placement of fill and grading described above, the stream bank along Dupree Creek would be further armored to protect the bank from erosion and to contain the newly-placed fill in position (also restricting the potential for migration of the capped sediment into Dupree Creek). The final graded and restored site, including all areas disturbed during construction, would be seeded and stabilized.

Additionally, an Environmental Covenant would be placed on the property in accordance with the Georgia Uniform Environmental Covenants Act, OCGA § 44-16-1, *et seq.* This Environmental Covenant will subject the Property to following activity and/or use limitations:

- The Property shall be used only for non-residential uses, as defined in and allowed under Glynn County's zoning regulations as of the date of the Environmental Covenant. Further, activity on the Property that may result in the release or exposure to the regulated substances that were contained as part of the Remedy (corrective action), or create a new exposure pathway, is prohibited,

with the exception of work necessary for the maintenance, repair, or replacement of engineering controls.

- The use or extraction of groundwater beneath the Property for drinking water or for any other non-remedial purposes shall also be prohibited.

8.5 Detailed Analysis of Remedial Alternatives

A detailed analysis was performed for each of the alternatives developed in the previous section, and is presented below. The detailed analysis consists of an assessment of each alternative against the evaluation criteria. These evaluation criteria are as follows:

1. Overall protection of human health and the environment;
    - Describes how the alternative provides for protection of human health and the environment
2. Compliance with ARARs;
    - Chemical-specific, Action-specific, and Location-specific

The first two criteria are the minimum "threshold criteria" and are related to the statutory requirements that must be satisfied.

3. Long-term effectiveness and permanence;
    - Magnitude of residual risk
    - Reliability and adequacy of controls
    - Time until RAOs are achieved
4. Reduction of toxicity, mobility, or volume;
    - Treatment process and materials
5. Short-term effectiveness;
    - Protection of community during remediation

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- Protection of workers during remediation
- Environmental impacts from implementing the remediation

6. Implementability;
   - Ability to construct the remedy
   - Ability to operate the remedy/technology, if applicable
   - Reliability of technology
   - Ease of undertaking additional remedial actions, if necessary
   - Ability to monitor effectiveness
   - Ability to obtain approvals from other agencies, if necessary
   - Availability of services and materials
7. Cost;
   - Capital (+50%/-30%)
   - Cost-effectiveness
   - Operating and maintenance, if any
   - Present net worth

These five criteria are the "primary balancing criteria" which are the technical criteria upon which the detailed analysis is based.

8. State acceptance; and
9. Community acceptance.

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The last two criteria are “modifying criteria” and will be formally assessed after the public comment period, but are considered, to the extent they are known, in the selection of the preferred alternative.

Evaluation of "State Acceptance" and "Community Acceptance" will be provided by USEPA after release of the RI/FS report to the public and are therefore not included in the discussion below.

8.5.1 Alternative 1: No Further Action

Overall Protection of Human Health and the Environment:

This alternative is not protective of human health and the environment due to the presence of contamination in excess of screening-level risk standards that will not be addressed by any remedial action.

Compliance with ARARs:

This alternative does not comply with ARARs due to the presence of contamination in excess of screening-level risk standards that will not be addressed by any remedial action.

Long-Term Effectiveness and Permanence:

This alternative does not provide a remedy that would be effective over the long-term or provide permanent protection from contamination in excess of screening-level risk standards.

Reduction of Toxicity, Mobility, or Volume:

This alternative does not reduce the toxicity, mobility or volume of contaminants due to the lack of implementing any additional remedial actions.

Short-Term Effectiveness:

This alternative does not provide a remedy that would be effective in the short-term.

Implementability:

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This alternative is readily implementable.

Cost:

The costs to implement this alternative are assumed to be "zero."

8.5.2 Alternative 2: Sheet Pile Channel Re-Routed With Limited Sediment Removal

Overall Protection of Human Health and the Environment:

This alternative is protective of human health and the environment because contaminated sediments in the existing Outfall Ditch will be capped, thereby eliminating exposure pathways and eliminating potential transport of contaminated sediments to downstream receptors. The re-routed open channel will be constructed in an area of "clean" soil that reduces remedy failure risk, construction management risks and construction health and safety concerns. The new open channel will be constructed with durable sheet pile and concrete, which will also minimize groundwater/surface interactions and facilitate relatively straightforward future inspections and maintenance.

Compliance with ARARs:

This alternative will comply with chemical-specific, location-specific, and action-specific ARARs listed in Table 8-1. Capping will eliminate a source of impacted sediments in the estuary, potentially reduce fish tissue sample concentrations and lead towards achieving Total Maximum Daily Loads (TMDLs) established for the creek system that is protective of aquatic life. Action- and media-specific ARARs can be met by substantially complying with local, state and Federal permitting requirements (such as disposal of sediment in offsite permitted landfills).

Long-Term Effectiveness and Permanence:

This alternative provides a long-term effective remedy with a high degree of permanence; the Outfall Ditch sediments are permanently capped/contained, which will reduce long-term exposure to potential receptors and loading of toxaphene-impacted sediments to the Terry and Dupree Creek system. The sheet pile system and concrete floor are durable construction materials and can be readily inspected and maintained/repaired via the open channel design. Additionally, construction of a re-

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routed channel in "clean" soil reduces the risks/concerns of remedy failure in the future (i.e. if the floor or sidewalls of the channel fail; only "clean" soil would be eroded into the channel). The permanence of the remedy is enhanced with the implementation of Land Use Controls. Operation and maintenance (O&M) of this alternative is straight-forward and primarily includes only the periodic removal of accumulated sediments from within the new outfall channel and inspection and maintenance of the sheet pile system and concrete floor. Accumulated sediments can be readily removed with a variety of equipment and techniques through the open channel design.

Reduction of Toxicity, Mobility, or Volume:

This alternative reduces or eliminates the mobility of contaminants by capping the impacted sediments within the existing Outfall Ditch. It also provides some reduction in the volume of contaminated sediments through excavation and offsite disposal of approximately 1,200 cubic yards of impacted materials. Furthermore, while not reducing the toxicity of the sediments, it eliminates the exposure pathways, thereby mitigating the potential effects of sediment toxicity to aquatic organisms.

Short-Term Effectiveness:

Sheet pile installation is relatively rapid and can provide for a shorter construction schedule than other evaluated alternatives, thereby reducing short-term construction risks. Additionally, the re-routed channel minimizes the short term risk associated with water management during construction.

Implementability:

This alternative is readily implementable. The technologies and materials necessary for this alternative are readily available and encompass traditional construction techniques. Construction of the alternative in a re-routed alignment allows the existing Outfall Ditch to remain in place and functional until the new, re-routed channel is completed and brought into service.

Sheet pile systems provide for rapid construction with engineered, structurally stable construction materials. The sheet pile can be used to mitigate the impacts of poor soil conditions, erosion caused by precipitation and tidal intrusions, and groundwater intrusion into the channel. Construction of the major components of the alternative outside of the existing Outfall Ditch mitigates several issues associated with worker

health and safety, water management (tidal, storm, and plant discharges), working with environmentally impacted sediments, and construction over known poor foundation materials (sediments).

While some work will be conducted in the existing Outfall Ditch, such as sediment removal from the existing box culverts and construction of the transition structure (similar for all options), the issues associated with constructability, impacted sediment handling, and worker health and safety are substantially less than with "in-channel" alternatives.

Cost:

The capital costs to implement this alternative were estimated at $4.82M (see Table 8-2 and Appendix F). Annual operations and maintenance (O&M) costs for this alternative were estimated at $118,740 with a net present value of $2.397M over a 30-year period at a 3% discount rate.

8.5.3 Alternative 2A: Sheet Pile Channel Within Existing Channel With Limited Sediment Removal

Overall Protection of Human Health and the Environment:

This alternative is protective of human health and the environment since contaminated sediments in the existing Outfall Ditch will be capped, thereby eliminating exposure pathways and eliminating potential transport of contaminated sediments to downstream receptors. The new open channel will be constructed with durable construction materials (concrete), which will also help reduce groundwater/surface interactions, and facilitate relatively straightforward future inspections and maintenance. Since the channel will be constructed within the existing Outfall Ditch, remedy failure could result in release of impacted sediment downstream and there is heightened construction management risks associated with; (i) soft sediments, (ii) water management, (iii) release of sediments during construction, and (iv) health and safety concerns dealing with impacted sediments.

Compliance with ARARs:

This alternative will comply with chemical-specific, location-specific, and action-specific ARARs listed in Table 8-1. Capping will eliminate a source of impacted

sediments in the estuary, potentially reduce fish tissue sample concentrations and lead towards achieving Total Maximum Daily Loads (TMDLs) established for the creek system that is protective of aquatic life. Action- and media-specific ARARs can be met by substantially complying with local, state and Federal permitting requirements (such asdisposal of sediment offsite in permitted landfills).

Long-Term Effectiveness and Permanence:

This alternative provides a long-term effective remedy with a high degree of permanence; the Outfall Ditch sediments are permanently capped/contained, which will reduce long-term exposure to potential receptors and loading of toxaphene-impacted sediments to the Terry and Dupree Creek system. The sheet pile system and concrete floor are durable construction materials and can be readily inspected and maintained/repaired via the open channel design. Construction of the channel in the existing Outfall Ditch increases the risks/concerns of remedy failure in the future (i.e. if the floor or sidewalls of the channel fail; impacted sediment could be eroded into the channel). The permanence of the remedy is enhanced with the implementation of Land Use Controls. Operation and maintenance (O&M) of this alternative is straight-forward and primarily includes only the periodic removal of accumulated sediments from within the new outfall channel and inspection and maintenance of the sheet pile system and concrete floor. Accumulated sediments can be readily removed with a variety of equipment and techniques through the open channel design.

Reduction of Toxicity, Mobility, or Volume:

This alternative reduces or eliminates the mobility of contaminants by isolating the underlying contaminated sediments through a concrete bottom within the sheet pile channel and by capping the impacted sediments outside of the sheet pile channel. It also provides reduction in the volume of contaminated sediments through excavation and offsite disposal of approximately 7,950 cubic yards of impacted sediments. Furthermore, while not reducing the toxicity of the sediments, it eliminates the exposure pathways, thereby mitigating the potential effects of sediment toxicity to aquatic organisms.

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Short-Term Effectiveness:

Sheet pile installation is rapid and can provide for a shorter construction schedule than other evaluated "in-channel" alternatives. Because of the issues associated with working within the existing channel, including additional water management, poor foundation soils, and handling of environmentally impacted soil, this alternative will require a longer construction schedule than the similar "re-routed" alternative (Alternative 2). Excavation and grading work within the existing channel poses a risk for disturbance of and unintended releases of sediments from the area during the work, particularly during storm events or other high water discharge events (flood tides, etc.).

Implementability:

Construction of this alternative within the Outfall Ditch presents some significant challenges; however, the technologies and materials necessary for this alternative are readily available and encompass traditional construction techniques. Construction of the alternative within the existing Outfall Ditch will require the construction of a bypass ditch within the confines of the existing Outfall Ditch in order to re-route water away from the construction area. Additionally, the existing Outfall Ditch will have to be partially backfilled to allow construction of the alternative on a stable working surface. The existing Outfall Ditch will have to remain in service adjacent to the ongoing alternative construction until construction of the alternative is completed and brought into service.

Sheet pile systems provide for rapid construction with engineered, structurally stable and durable construction materials. The sheet pile can be used to mitigate the impacts of poor soil conditions, erosion caused by precipitation and tidal intrusions, and groundwater intrusion into the channel. Buried logs within the sediment will be an impediment for driving sheet pile.

Construction of the major components of the alternative within the existing Outfall Ditch is significantly more complex and will require management of multiple issues associated with worker health and safety, water management (tidal, storm, and plant discharges), work with environmentally impacted sediments, and construction over poor foundation materials that would not be encountered in the "re-routed channel" (i.e., Alternative 2) and other re-routed alternatives.

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Cost:

The capital costs to implement this alternative were estimated at $5.38M (see Table 8-2 and Appendix F). Annual operations and maintenance (O&M) costs for this alternative were estimated at $118,740 with a net present value of $2.397M over a 30-year period at a 3% discount rate.

8.5.4 Alternative 3: Concrete-Lined Channel Re-Routed With Limited Sediment Removal

Overall Protection of Human Health and the Environment:

This alternative is protective of human health and the environment since contaminated sediments in the existing Outfall Ditch will be capped, thereby eliminating exposure pathways and eliminating potential transport of contaminated sediments to downstream receptors. The re-routed open channel will be constructed in an area of "clean" soil that reduces remedy failure risk, as well as, reduces construction management risks and construction health and safety concerns. The new open channel will be constructed with concrete, which will minimize groundwater/surface interactions, increase long-term durability and facilitate relatively straightforward future inspections and maintenance.

Compliance with ARARs:

This alternative will comply with chemical-specific, location-specific, and action-specific ARARs listed in Table 8-1. Capping the Outfall Ditch sediments will eliminate a source of impacted sediments in the estuary, potentially reduce fish tissue sample concentrations and lead towards achieving Total Maximum Daily Loads (TMDLs) established for the creek system that is protective of aquatic life. Action- and media-specific ARARs can be met by substantially complying with local, state and Federal permitting requirements (such asdisposal of sediment will be in offsite permitted landfills).

Long-Term Effectiveness and Permanence:

This alternative provides a long-term effective remedy with a high degree of permanence; the Outfall Ditch sediments are permanently capped/contained, which will reduce long-term exposure to potential receptors and loading of toxaphene-impacted

sediments to the Terry and Dupree Creek system. The concrete floor and walls of the channel are durable construction materials and can be readily inspected and maintained/repaired via the open channel design. Additionally, construction of a re-routed channel in "clean" soil reduces the risks/concerns of remedy failure in the future (i.e. if the floor or sidewalls of the channel fail; only "clean" soil could be eroded into the channel). The permanence of the remedy is enhanced with the implementation of Land Use Controls. Operation and maintenance (O&M) of this alternative is straight-forward and primarily includes only the periodic removal of accumulated sediments from within the new outfall channel and inspection and maintenance of the concrete floor and walls. Accumulated sediments can be readily removed with a variety of equipment and techniques through the open channel design; however, access and removal of the sediments will be more challenging than the sheet pile design (Alternatives 2 and 2A) due to the long slopes (wider open channel) and textured surface of the concrete lining.

Reduction of Toxicity, Mobility, or Volume:

This alternative reduces or eliminates the mobility of contaminants by capping the impacted sediments within the existing Outfall Ditch. It also provides some reduction in the volume of contaminated sediments through excavation and offsite disposal of approximately 1,200 cubic yards of impacted materials. Furthermore, while not reducing the toxicity of the sediments, it eliminates the exposure pathways, thereby mitigating the potential effects of sediment toxicity to aquatic organisms.

Short-Term Effectiveness:

The short-term effectiveness of this alternative is similar to the sheet pile channel (Alternative 2). The open concrete channel design in a re-routed configuration is relatively quick to install, but requires more excavation and soil handling than the sheet pile alternative (Alternative 2).

Implementability:

This alternative is readily implementable and more implementable than the remedies constructed within the existing channel. The technologies and materials necessary for this alternative are readily available and encompass traditional construction techniques. Construction of the alternative in a re-routed alignment allows the existing Outfall Ditch

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to remain in place and functional until the new, re-routed channel is completed and brought into service.

Concrete-lined channels provide for rapid construction with engineered, structurally stable and durable construction materials. Because of the trapezoidal channel design, the required depth and sloping of the excavation, the work is subject to delay during construction due to slope failure (or shoring) as well as groundwater intrusion into the work area, which may require dewatering. Construction of the major components of the alternative outside of the existing Outfall Ditch mitigates several issues associated with worker health and safety, water management (tidal, storm, and plant discharges), working with environmentally impacted sediments, and construction over known poor foundation materials (sediments).

While some work will be conducted in the existing Outfall Ditch, such as sediment removal from the existing box culverts and construction of the transition structure (similar for all options), the issues associated with constructability, impacted sediment handling, and worker health and safety are substantially less than with "in-channel" alternatives.

Cost:

The capital costs to implement this alternative were estimated at $3.02M (see Table 8-2 and Appendix F). Annual operations and maintenance (O&M) costs for this alternative were estimated at $118,740 with a net present value of $2.397M over a 30-year period at a 3% discount rate.

8.5.5 Alternative 3A: Concrete-Lined Channel Within Existing Channel With Limited Sediment Removal

Overall Protection of Human Health and the Environment:

This alternative is protective of human health and the environment since contaminated sediments in the existing Outfall Ditch will be capped, thereby eliminating exposure pathways and eliminating potential transport of contaminated sediments to downstream receptors. The new concrete-lined will help reduce groundwater/surface interactions and facilitate relatively straightforward future inspections and maintenance. Since the channel will be constructed within the existing Outfall Ditch, remedy failure could result in release of impacted sediment downstream and there are heightened

construction management risks associated with; (i) soft sediments, (ii) water management, (iii) release of sediments during construction; and (iv) health and safety concerns dealing with impacted sediments.

Compliance with ARARs:

This alternative will comply with chemical-specific, location-specific, and action-specific ARARs listed in Table 8-1. Capping will eliminate a source of impacted sediments in the estuary, potentially reduce fish tissue sample concentrations and lead towards achieving Total Maximum Daily Loads (TMDLs) established for the creek system that is protective of aquatic life. Action- and media-specific ARARs can be met by substantially complying with local, state and Federal permitting requirements (such as disposal of sediment offsite in permitted landfills).

Long-Term Effectiveness and Permanence:

This alternative provides a long-term effective remedy with a high degree of permanence; the Outfall Ditch sediments are permanently capped/contained, which will reduce long-term exposure to potential receptors and loading of toxaphene-impacted sediments to the Terry and Dupree Creek system. The concrete walls and floor of the channel are durable construction materials and can be readily inspected and maintained/repaired via the open channel design. Construction of the channel in the existing Outfall Ditch increases the risks/concerns of remedy failure in the future (i.e. if the floor or sidewalls of the channel fail; impacted sediment could be eroded into the channel). The permanence of the remedy is enhanced with the implementation of Land Use Controls. Operation and maintenance (O&M) of this alternative is straightforward and primarily includes only the periodic removal of accumulated sediments from within the new outfall channel and inspection and maintenance of the concrete floor and walls. Accumulated sediments can be readily removed with a variety of equipment and techniques through the open channel design; however, access and removal of the sediments will be more challenging than the sheet pile design (Alternatives 2 and 2A) due to the long slopes (wider open channel) and textured surface of the concrete lining.

Reduction of Toxicity, Mobility, or Volume:

This alternative reduces or eliminates the mobility of contaminants by capping the impacted sediments within the existing Outfall Ditch. It also provides reduction in the

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volume of contaminated sediments through excavation and offsite disposal of approximately 12,800 cubic yards of impacted materials. Furthermore, while not reducing the toxicity of the sediments, it eliminates the exposure pathways, thereby mitigating the potential effects of sediment toxicity on aquatic organisms.

Short-Term Effectiveness:

The open channel design of the concrete-lined channel installation within the existing Outfall Ditch requires more excavation and soil handling than the sheet pile alternatives (Alternatives 2 or 2A). Because of the issues associated with working within the existing channel, including additional water management, poor foundation soils, and handling of environmentally impacted soil, this alternative will require a longer construction schedule than the similar "re-routed" alternative (Alternative 3). Excavation and grading work within the existing channel poses a risk for disturbance of and unintended releases of sediments from the area during the work, particularly during storm events or other high water discharge events (flood tides, etc.).

Implementability:

Construction of this alternative within the Outfall Ditch presents some significant challenges compared to the other alternatives which rely on creating a new channel location. However, the technologies and materials necessary for this alternative are available and encompass traditional construction techniques. Construction of the alternative within the existing Outfall Ditch will require the construction of a bypass ditch within the limits of the existing Outfall Ditch in order to re-route water away from the construction area. Additionally, the existing Outfall Ditch will have to be partially backfilled to permit construction of the alternative on a stable working surface. Due to the wider open channel design, a larger portion of the existing Outfall Ditch will need to be filled to permit construction of the alternative versus the sheet pile alternative (Alternative 2A). The Outfall Ditch will have to remain in service adjacent to the ongoing construction until construction of the alternative is completed and brought into service.

Construction of the major components of the alternative within the existing Outfall Ditch is significantly more complex will require management of multiple issues associated with worker health and safety, water management (tidal, storm, and plant discharges), work with environmentally impacted sediments, and construction over poor

foundation materials that would not be encountered for the "re-routed channel" (Alternative 3).

Cost:

The capital costs to implement this alternative were estimated at $4.28M (see Table 8-2 and Appendix F). Annual operations and maintenance (O&M) costs for this alternative were estimated at $118,740 with a net present value of $2.397M over a 30-year period at a 3% discount rate.

8.5.6 Alternative 4: Culvert Re-Routed With Limited Sediment Removal

Overall Protection of Human Health and the Environment:

This alternative is protective of human health and the environment since contaminated sediments in the existing Outfall Ditch will be capped, thereby eliminating exposure pathways and eliminating potential transport of contaminated sediments to downstream receptors. The re-routed surface water conveyance will be constructed in an area of "clean" soil that reduces remedy failure risk, as well as, reducing construction management risks and construction health and safety concerns. The new surface water conveyance will be constructed with a concrete quadruple box culvert which will minimize groundwater/surface interactions and increase long-term durability, but will make future inspections and maintenance of the conveyance more difficult.

Compliance with ARARs:

This alternative will comply with chemical-specific, location-specific, and action-specific ARARs listed in Table 8-1. Capping will eliminate a source of impacted sediments in the estuary, potentially reduce fish tissue sample concentrations and lead towards achieving Total Maximum Daily Loads (TMDLs) established for the creek system that is protective of aquatic life. Action- and media-specific ARARs can be met by substantially complying with local, state and Federal permitting requirements (such as disposal of sediment offsite in permitted landfills).

Long-Term Effectiveness and Permanence:

This alternative provides a long-term effective remedy with a high degree of permanence; the Outfall Ditch sediments are permanently capped/contained, which will

reduce long-term exposure to potential receptors and loading of toxaphene-impacted sediments to the Terry and Dupree Creek system. The quadruple box culvert will be constructed with durable construction materials and the permanence of the remedy is enhanced with the implementation of Land Use Controls. Operation and maintenance (O&M) primarily includes only the periodic removal of accumulated sediments from within the culvert and inspection and maintenance of the concrete floor and walls. O&M of this alternative has several challenges related primarily to access to the interior of the box culverts. Due to limited accessibility to the interior of the box culverts (i.e., via manholes) sediment removal (for maintenance purposes) will be more challenging than open channel designs. Accumulated sediments will have to be removed using specialized equipment and specially trained personnel for confined space entry.

Reduction of Toxicity, Mobility, or Volume:

This alternative reduces or eliminates the mobility of contaminants by capping the impacted sediments within the existing Outfall Ditch. It also provides some reduction in the volume of contaminated sediments through excavation and offsite disposal of approximately 1,200 cubic yards of impacted materials. Furthermore, while not reducing the toxicity of the sediments, it eliminates the exposure pathways, thereby mitigating the potential effects of sediment toxicity aquatic organisms.

Short-Term Effectiveness:

The box culvert installation in a re-routed configuration is relatively quick to install, requiring similar excavation efforts as the trapezoidal channel system (Alternative 3), but significantly more time to install the box culverts.

Implementability:

This alternative is implementable. The technologies and materials necessary for this alternative are available and encompass traditional construction techniques. Construction of the alternative in a re-routed alignment will allow the existing Outfall Ditch to remain in place and functional until the new, re-routed channel can be completed and brought into service.

Precast box culverts provide for efficient construction. Because of the depth of the culvert installation, sloping and/or benching will be necessary to safely install the culverts. As such, the construction work is subject to delay and uncertainty due to slope

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failure (or shoring), excavating excess soil, and groundwater intrusion into the work area, which may require dewatering.

While some work will be conducted in the existing Outfall Ditch, such as sediment removal from the existing box culverts and construction of the transition structure (similar for all options), the issues associated with constructability, impacted sediment handling, and worker health and safety are substantially less than with "in-channel" alternatives.

Cost:

The capital costs to implement this alternative were estimated at $5.12M (see Table 8-2 and Appendix F). Annual operations and maintenance (O&M) costs for this alternative were estimated at $118,740 with a net present value of $2.397M over a 30-year period at a 3% discount rate.

8.5.7 Alternative 4A: Culvert Within Existing Channel With Limited Sediment Removal

Overall Protection of Human Health and the Environment:

This alternative is protective of human health and the environment since contaminated sediments in the existing Outfall Ditch will be capped, thereby eliminating exposure pathways and eliminating potential transport of contaminated sediments to downstream receptors. The concrete quadruple box culvert within the existing channel will help reduce groundwater/surface interactions; however, future inspections and maintenance will be significantly more difficult. Since the surface water conveyance will be constructed within the existing Outfall Ditch, construction management risks include dealing with; (i) soft sediments, (ii) water management, (iii) release of sediments during construction; and (iv) health and safety concerns dealing with impacted sediments. While not considered a remedy failure, the differential settlement of the underlying soft sediments would result in significant maintenance and repair issues.

Compliance with ARARs:

This alternative will comply with chemical-specific, location-specific, and action-specific ARARs listed in Table 8-1. Capping will eliminate a source of impacted sediments in the estuary, potentially reduce fish tissue sample concentrations and lead

towards achieving Total Maximum Daily Loads (TMDLs) established for the creek system that is protective of aquatic life. Action- and media-specific ARARS can be met by substantially complying with local, state and Federal permitting requirements (such as disposal of sediment offsite in permitted landfills).

Long-Term Effectiveness and Permanence:

This alternative provides a long-term effective remedy with a moderate degree of permanence; the Outfall Ditch sediments are permanently capped/contained, which will reduce long-term exposure to potential receptors and loading of toxaphene-impacted sediments to the Terry and Dupree Creek system. The quadruple box culvert will be constructed with durable construction materials and the permanence of the remedy is enhanced with the implementation of Land Use Controls. Operation and maintenance (O&M) primarily includes only the periodic removal of accumulated sediments from within the box culvert and inspection and maintenance of the concrete floor and walls. O&M of this alternative has several challenges related primarily to access to the interior of the box culverts. Due to limited accessibility to the interior of the box culverts (i.e., via manholes) sediment removal will be more challenging than open channel designs. Accumulated sediments will have to be removed using specialized equipment and specially trained personnel for confined space entry.

Reduction of Toxicity, Mobility, or Volume:

This alternative reduces or eliminates the mobility of contaminants by installing the box culvert and capping the remaining impacted sediments within the existing Outfall Ditch. It also provides reduction in the volume of contaminated sediments through excavation and offsite disposal of approximately 9,800 cubic yards of impacted materials. Furthermore, while not reducing the toxicity of the sediments, it eliminates the exposure pathways, thereby mitigating the potential effects of sediment toxicity to aquatic organisms.

Short-Term Effectiveness:

The box culvert installation in of itself is relatively quick to construct, requiring similar excavation efforts as the sheet pile system (Alternative 2A), but significantly more time to install the box culverts themselves. Significant effort is anticipated to be necessary to improve the foundation soils, and as such, the schedule to install this alternative will be

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longer than other alternatives. Additionally, the issues associated with working within the existing channel, including additional water management requirement, poor foundation soils, and multiple handling of select parts of the soil management, this alternative will require a longer construction schedule than the "out-of-ditch" alternative (Alternative 4). Excavation and grading work within the existing channel does pose a risk for disturbance of and unintended releases of sediments from the area during the work, particularly during storm events or other high water discharge events (storm, flood tides, etc.).

Implementability:

Although implementable, construction of this alternative presents some significant challenges and is less implementable that some of the other alternatives. However, the technologies and materials necessary for this alternative are available and encompass traditional construction techniques. Using precast box culverts provides for efficient construction. Because of the depth of the culvert installation, sloping and/or benching will be necessary to safely install the culverts. As such, the work is subject to delay and uncertainty due to slope failure (or shoring installation) and groundwater intrusion into the work area, which may require dewatering.

Construction of the alternative within the existing Outfall Ditch will require the construction of a bypass ditch within the confines of the existing Outfall Ditch in order to re-route water away from the construction area. Installation of the box culverts in the existing Outfall Ditch will present special issues due to the known impacted sediments and the poor condition of these sediments from a structural/geotechnical perspective. The existing Outfall Ditch will have to be partially backfilled to permit construction of the alternative on a stable working surface. The Outfall Ditch will have to remain in service adjacent to the ongoing alternative construction until construction of the alternative is completed and can be brought into service.

Construction of the major components of the alternative within the existing Outfall Ditch will require management of several issues associated with worker health and safety, water management (tidal, storm, and plant discharges), work with environmentally impacted sediments, and construction over poor foundation materials that would not be encountered for the "re-routed channel" (Alternative 4).

Cost:

The capital costs to implement this alternative were estimated at $5.80M (see Table 8-2 and Appendix F). Annual operations and maintenance (O&M) costs for this alternative were estimated at $118,740 with a net present value of $2.397M over a 30-year period at a 3% discount rate.

8.5.8 Alternative 5: Low Permeability Isolation Cap With Limited Sediment Removal

Overall Protection of Human Health and the Environment:

This alternative is protective of human health and the environment since contaminated sediments in the existing Outfall Ditch will be capped, thereby eliminating exposure pathways and eliminating potential transport of contaminated sediments to downstream receptors. The low permeability isolation cap will help reduce groundwater/surface interactions. Since the surface water conveyance will be constructed within the existing Outfall Ditch, construction management risks include dealing with; (i) soft sediments, (ii) water management, (iii) release of sediments during construction; and (iv) health and safety concerns dealing with impacted sediments.

Compliance with ARARs:

This alternative will comply with chemical-specific, location-specific, and action-specific ARARs listed in Table 8-1. Capping will eliminate a source of impacted sediments in the estuary, potentially reduce fish tissue sample concentrations and lead towards achieving Total Maximum Dailey Loads (TMDLs) established for the creek system that is protective of aquatic life. Action- and media-specific ARARs can be met by substantially complying with local, state and Federal permitting requirements (such as disposal of sediment offsite in permitted landfills).

Long-Term Effectiveness and Permanence:

This alternative will provide a long-term effective solution with a moderate degree of permanence. Permanence of the remedy is enhanced with the implementation of Land Use Controls. Operation and maintenance (O&M) of this alternative is anticipated to be minimal and would likely be limited to periodic inspection and replacement of riprap armoring. Occasional removal of sediment over the sub-aqueous cap may be necessary to keep the conveyance channel functional. Major storm events could damage the sub-aqueous cap due to excessive scouring and would require repair. Failure of the remedy

could result in the release of impacted sediment to downstream environs. Inspection of the system is difficult as much of the system may be normally under water and the low permeability isolation cap material will be under the riprap armoring system.

Reduction of Toxicity, Mobility, or Volume:

This alternative reduces or eliminates the mobility of contaminants by installing a cap over impacted sediments within the existing Outfall Ditch. It also provides reduction in the volume of contaminated sediments through excavation and offsite disposal of approximately 12,800 cubic yards of impacted materials. Furthermore, while not reducing the toxicity of the sediments, it eliminates the exposure pathways, thereby mitigating the potential effects of sediment toxicity to aquatic organisms.

Short-Term Effectiveness:

The open channel design of the alternative in the existing Outfall Ditch requires comparable excavation and soil handling as the concrete-lined open channel (Alternative 3A). Because of the issues associated with working within the existing channel, including additional water management requirement, poor foundation soils, and multiple handling of select parts of the soil management, this alternative will require a longer construction schedule than a "re-route" alternative. Excavation and grading work within the existing channel poses a risk for disturbance of and unintended releases of sediments from the area during the work, particularly during storm events or other high water discharge events (storm, flood tides, etc.).

Implementability:

Construction of this alternative is less implementable than several of the other alternatives, and it presents some challenging issues; however, the technologies and materials necessary for this alternative are available and encompass traditional construction techniques with some specialty techniques for placement of the cap material.

Construction of the alternative within the existing Outfall Ditch will require the construction of a bypass ditch within the confines of the existing Outfall Ditch in order to re-route water away from the construction area. Additionally, the existing Outfall Ditch will have to be partially backfilled to permit construction of the alternative on a stable working surface. Due to a wider open channel design, a larger portion of the

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existing Outfall Ditch will need to be filled to permit construction of the alternative versus the sheet pile system or the box culvert system (Alternatives 2A and 4A). The Outfall Ditch will have to remain in service adjacent to the ongoing alternative construction until construction of the alternative is completed and can be brought into service.

Construction of the major components of the alternative within the existing Outfall Ditch will require management of several issues associated with worker health and safety, water management (tidal, storm, and plant discharges), work with environmentally impacted sediments, and construction over poor foundation materials that would not be encountered for the "re-routed" channel alternatives.

Cost:

The capital costs to implement this alternative were estimated at $5.84M (see Table 8-2 and Appendix F). Annual operations and maintenance (O&M) costs for this alternative were estimated at $118,740 with a net present value of $2.397M over a 30-year period at a 3% discount rate.

8.5.9 Alternative 5A: Carbon-amended Sand Cap Channel With Limited Sediment Removal

Overall Protection of Human Health and the Environment:

This alternative is protective of human health and the environment since contaminated sediments in the existing Outfall Ditch will be capped, thereby eliminating exposure pathways and eliminating potential transport of contaminated sediments to downstream receptors. Since the surface water conveyance will be constructed within the existing Outfall Ditch, construction management risks include dealing with; (i) soft sediments, (ii) water management, (iii) release of sediments during construction; and (iv) health and safety concerns dealing with impacted sediments.

Compliance with ARARs:

This alternative will comply with chemical-specific, location-specific, and action-specific ARARs listed in Table 8-1. Capping will eliminate a source of impacted sediments in the estuary, potentially reduce fish tissue sample concentrations and lead towards achieving Total Maximum Daily Loads (TMDLs) established for the creek

system that is protective of aquatic life. Action- and media-specific ARARs can be met by substantially complying with local, state and Federal permitting requirements (such as disposal of sediment offsite in permitted landfills).

Long-Term Effectiveness and Permanence:

This alternative will provide a long-term effective solution with a moderate degree of permanence. Permanence of the remedy is enhanced with the implementation of Land Use Controls. Operation and maintenance (O&M) of this alternative is anticipated to be minimal and would likely be limited to periodic inspection and replacement of riprap armoring. Occasional removal of sediment over the sub-aqueous cap may be necessary to keep the conveyance channel functional. Major storm events could damage the sub-aqueous cap due to excessive scouring and would require repair. Failure of the remedy could result in the release of impacted sediment to downstream environs. Inspection of the system is difficult as much of the system may be normally under water.

Reduction of Toxicity, Mobility, or Volume:

This alternative reduces or eliminates the mobility of contaminants by installing a cap over impacted sediments within the existing Outfall Ditch. It also provides reduction in the volume of contaminated sediments through excavation and offsite disposal of approximately 12,800 cubic yards of impacted materials. The ability of the granular activated carbon within the sand cap will bind contaminants and thereby reduce the mobility of the contaminants. Furthermore, the capping eliminates the exposure pathways, thereby mitigating the potential effects of sediment toxicity to aquatic organisms.

Short-Term Effectiveness:

Because of the issues associated with working within the existing channel, including additional water management requirement, poor foundation soils, and multiple handling of select parts of the soil management, this alternative will require a longer construction schedule than the “re-route” alternatives. Excavation and grading work within the existing channel poses a risk for disturbance of and unintended releases of sediments from the area during the work, particularly during storm events or other high water discharge events (storm, flood tides, etc.).

Implementability:

Construction of this alternative presents some challenging issues and is less implementable than the re-routed channel alternatives submitted; however, the technologies and materials necessary for this alternative are available and encompass traditional construction techniques. Construction of the alternative within the existing Outfall Ditch will require the construction of a bypass ditch within the limits of the existing Outfall Ditch in order to re-route water away from the construction area. Additionally, the existing Outfall Ditch will have to be partially backfilled to permit construction of the alternative on a stable working surface. Due to a wider open channel design, a larger portion of the existing Outfall Ditch will need to be filled to permit construction of the alternative versus the sheet pile system or the box culvert system (Alternatives 2A and 4A). The Outfall Ditch will have to remain in service adjacent to the ongoing alternative construction until construction of the alternative is completed and can be brought into service.

Construction of the major components of the alternative within the existing Outfall Ditch will require management of several issues associated with worker health and safety, water management (tidal, storm, and plant discharges), work with environmentally impacted sediments, and construction over poor foundation materials that would not be encountered for the "re-routed" channel alternatives.

Cost:

The capital costs to implement this alternative were estimated at $5.85M (see Table 8-2 and Appendix F). Annual operations and maintenance (O&M) costs for this alternative were estimated at $118,740 with a net present value of $2.397M over a 30-year period at a 3% discount rate.

8.5.10 Alternative 6: Riprap-Armored Channel With Limited Sediment Removal

Overall Protection of Human Health and the Environment:

This alternative is protective of human health and the environment since contaminated sediments in the existing Outfall Ditch will be capped, thereby eliminating exposure pathways and eliminating potential transport of contaminated sediments to downstream receptors. Since the surface water conveyance will be constructed within the existing Outfall Ditch, construction management risks include dealing with; (i) soft sediments,

(ii) water management, (iii) release of sediments during construction; and (iv) health and safety concerns dealing with impacted sediments.

Compliance with ARARs:

This alternative will comply with chemical-specific, location-specific, and action-specific ARARs listed in Table 8-1. Capping will eliminate a source of impacted sediments in the estuary, potentially reduce fish tissue sample concentrations and lead towards achieving Total Maximum Daily Loads (TMDLs) established for the creek system that is protective of aquatic life. Action- and media-specific ARARs can be met by substantially complying with local, state and Federal permitting requirements (such as disposal of sediment offsite in permitted landfills).

Long-Term Effectiveness and Permanence:

This alternative will provide a long-term effective solution with a moderate degree of permanence. Permanence of the remedy is enhanced with the implementation of Land Use Controls. Operation and maintenance (O&M) of this alternative is anticipated to be minimal and would likely be limited to periodic inspection and replacement of riprap armoring. Occasional removal of sediment over the sub-aqueous cap may be necessary to keep the conveyance channel functional. Major storm events could damage the sub-aqueous cap due to excessive scouring and would require repair. Failure of the remedy could result in the release of impacted sediment to downstream environs. Inspection of the system is difficult as much of the system may be normally under water.

Reduction of Toxicity, Mobility, or Volume:

This alternative reduces or eliminates the mobility of contaminants by installing a cap over impacted sediments within the existing Outfall Ditch. It also provides reduction in the volume of contaminated sediments through excavation and offsite disposal of approximately 12,800 cubic yards of impacted materials. Furthermore, while not reducing the toxicity of the sediments, it eliminates the exposure pathways, thereby mitigating the potential effects of sediment toxicity to aquatic organisms.

Short-Term Effectiveness:

Because of the issues associated with working within the existing channel, including additional water management requirement, poor foundation soils, and multiple handling

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of select parts of the soil management, this alternative will require a longer construction schedule than the "re-route" alternatives. Excavation and grading work within the existing channel poses a risk for disturbance of and unintended releases of sediments from the area during the work, particularly during storm events or other high water discharge events (storm, flood tides, etc.).

Implementability:

Construction of this alternative presents some challenging issues and is less implementable than some of the other re-routed channel alternatives under consideration. However, the technologies and materials necessary for this alternative are available and encompass traditional construction techniques. Construction of the alternative within the existing Outfall Ditch will require the construction of a bypass ditch within the limits of the existing Outfall Ditch in order to re-route water away from the construction area. Additionally, the existing Outfall Ditch will have to be partially backfilled to permit construction of the alternative on a stable working surface. Due to a wider open channel design, a larger portion of the existing Outfall Ditch will need to be filled to permit construction of the alternative versus the sheet pile system or the box culvert system (Alternatives 2A and 4A). The Outfall Ditch will have to remain in service adjacent to the ongoing alternative construction until construction of the alternative is completed and can be brought into service.

Construction of the major components of the alternative within the existing Outfall Ditch will require management of several issues associated with worker health and safety, water management (tidal, storm, and plant discharges), work with environmentally impacted sediments, and construction over poor foundation materials that would not be encountered for the "re-routed" channel alternatives.

Cost:

The capital costs to implement this alternative were estimated at $4.70M (see Table 8-2 and Appendix F). Annual operations and maintenance (O&M) costs for this alternative were estimated at $118,740 with a net present value of $2.397M over a 30-year period at a 3% discount rate.

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8.6 Comparative Analysis

Table 8-3 provides a comparative analysis of all the presented alternatives. The criteria were weighted with "Threshold Criteria" (i.e., Protection of the Environment, Compliance with ARARs) receiving the highest weighting factor (i.e., 3), followed by a weighting factor of 2 for the "Balancing Criteria" (i.e. Long-Term Effectiveness, Reduction of Toxicity, Mobility, or Volume, Short-Term Effectiveness, Implementability, and Cost). The "Modifying Criteria" (i.e., State Acceptance, Community Acceptance) received a weighting factor of 1, but these two criteria have not been included in Table 8-3 since they will be determined by USEPA and therefore are not factored into this ranking and scoring.

As can be seen in Table 8-3, Alternative 3 (Concrete-Lined Channel Re-Routed With Limited Sediment Removal) had the highest score (most favorable) and was therefore ranked number 1 (the best) of the alternatives. Alternative 3's ranking was followed by Alternative 2 (Sheet Pile Channel Re-routed with Limited Sediment Removal) and Alternative 4 (Culvert Channel Re-Routed With Limited Sediment Removal). The alternatives constructed within the Outfall Ditch ranked the lowest. The lowest-ranking alternative was the Low Permeability Isolation Cap With Limited Sediment Removal (Alternative 5).

In addition to the factors listed in the remedy evaluation chart (Table 8-3), EPA's Contaminated Sediment Guidance (2005) indicates, "A risk management process should be used to select a remedy designed to reduce the key human health and ecological risks effectively. Another important risk management function generally is to compare and contrast the costs and benefits of various remedies." Applying risk management principles as specified in the Sediment Guidance to the array of alternatives under consideration at this site clearly supports the ranking developed.

It is apparent that the re-routed options are preferable over the in-channel options due to a variety of issues including materials handling, constructability issues associated primarily with water management, worker health and safety, and not insignificantly, costs. CERCLA and the NCP both require that remedies be cost-effective (42 U.S.C. §9621(a); 40 CFR §300.430(f)(1)(ii)(D)): "Each remedial action selected shall be cost-effective" (40 CFR 300.430(f)(1)(ii)(D)). Cost-effectiveness is defined as "costs are proportional to its overall effectiveness." (40 CFR §300.430(f)(1)(ii)(D)). None of the other re-routed options (Alternatives 2 and 4), provide any incremental protectiveness

compared to the Alternative 3. Therefore, the most appropriate alternative for OU1 is Alternative 3.

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40 CFR Part 131-Water Quality Standards

40 CFR Part 141-National Primary Drinking Water Regulations

40 CFR Part 261-Identification and Listing of Hazardous Waste

40 CFR Part 262-Standards Applicable To Generators of Hazardous Waste

40 CFR Part 263-Standards Applicable To Transporters of Hazardous Waste

40 CFR Part 264- Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities

40 CFR Part 268- Land Disposal Restrictions

40 CFR Part 300.430 Remedial Investigation/Feasibility Study And Selection of Remedy

40 CFR Part 300.435-Remedial Design/Remedial Action, Operation and Maintenance

40 CFR Part 300-National Oil and Hazardous Substances Pollution Contingency Plan (NCP)

40 CFR Part 402-Interagency Cooperation-Endangered Species Act Of 1973, As Amended

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40 CFR Part 50- National Primary and Secondary Ambient Air Quality Standards

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40 CFR Part 930-Federal Consistency with Approved Coastal Management Programs

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33 U.S.C. § 1344 – Clean Water Act, Section 404. Permits for dredged or fill material

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TABLES

Table 3-1. Sample Analyte List for Terry Creek OU1 RI/FS

Geosyntec consultants

TAL metals	Volatile Organic Compounds	Semi-Volatile Organic Compounds	Pesticides	Polychlorinated Biphenyls / Dioxins
Aluminum	Acetone	Acenaphthene	Aldrin	Aroclor® 1016
Antimony	Benzene	Acenaphthylene	alpha-BHC	Aroclor® 1221
Arsenic	Bromodichloromethane	Anthracene	beta-BHC	Aroclor® 1232
Barium	Bromoform	Benzo(a)anthracene	delta-BHC	Aroclor® 1242
Beryllium	Bromomethane	Benzo(a)pyrene	gamma-BHC (Lindane)	Aroclor® 1248
Calcium	Carbon Disulfide	Benzo(b)fluoranthene	alpha-Chlordane	Aroclor® 1254
Chromium	Carbon Tetrachloride	Benzo(g,h,i)perylene	gamma-Chlordane	Aroclor® 1260
Cobalt	Chlorobenzene	Benzo(k)fluoranthene	4,4'-DDD	Aroclor® 1268
Copper	Chloroethane	4-Bromophenyl-phenylether	4,4'-DDE	
Lead	Chloromethane	Butylbenzylphthalate	4,4'-DDT	
Magnesium	Dibromochloromethane	Carbazole	Dieldrin	Dioxins
Mercury	1,2-Dichloroethane	4-Chloro-3-methylphenol	Endosulfan I	1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin (HpCDD)
Nickel	1,1-Dichloroethene	4-Chloroaniline	Endosulfan II	1,2,3,4,6,7,8-Heptachlorodibenzofuran (HpCDF)
Potassium	1,2-Dichloroethene (total)	bis(2-Chloroethoxy)methane	Endosulfan sulfate	1,2,3,4,7,8,9-Heptachlorodibenzofuran (HpCDF)
Selenium	1,2-Dichloropropane	bis-(2-Chloroethyl)ether	Endrin	1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin (HxCDD)
Silver	cis-1,3-Dichloropropene	2-Chloronaphthalene	Endrin aldehyde	1,2,3,4,7,8-Hexachlorodibenzofuran (HxCDF)
Sodium	trans-1,3-Dichloropropene	2-Chlorophenol	Endrin ketone	1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin (HxCDD)
Thallium	Ethylbenzene	4-Chlorophenyl-phenylether	Heptachlor	1,2,3,6,7,8-Hexachlorodibenzofuran (HxCDF)
Vanadium	2-Hexanone	2,2'-oxybis(1-Chloropropane)	Heptachlor epoxide	1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin (HxCDD)
Zinc	4-Methyl-2-pentanone	Chrysene	Methoxychlor	1,2,3,7,8,9-Hexachlorodibenzofuran (HxCDF)
	Methylene Chloride	Dibenzo(a,h)anthracene	**Toxaphene**	1,2,3,7,8-Pentachlorodibenzo-p-dioxin (PeCDD)
Cyanide	Styrene	1,2-Dichlorobenzene	(Method 1)	1,2,3,7,8-Pentachlorodibenzofuran (PeCDF)
	1,1,2,2-Tetrachloroethane	1,3-Dichlorobenzene	**Chlorinated camphenes**	2,3,4,6,7,8-Hexachlorodibenzofuran (HxCDF)
	Tetrachloroethene	1,4-Dichlorobenzene	(Method 2)	2,3,4,7,8-Pentachlorodibenzofuran (PeCDF)
	Toluene	3,3'-Dichlorobenzidine		2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)
	1,1,1-Trichloroethane	2,4-Dichlorophenol	Toxaphene Breakdown	2,3,7,8-Tetrachlorodibenzofuran (TCDF)
	1,1,2-Trichloroethane	Diethylphthalate	Products	1,2,3,4,6,7,8,9-Octachlorodibenzo-p-dioxin (OCDD)
	Trichloroethene	2,4-Dimethylphenol	**Hx-Sed**	1,2,3,4,6,7,8,9-Octachlorodibenzofuran (OCDF)
	Vinyl Chloride	2,4-Dinitrophenol	**Hp-Sed**	
	Xylenes (total)	2,4-Dinitrotoluene	**Parlar 26**	
		2,6-Dinitrotoluene	**Parlar 40**	
		Di-n-octylphthalate	**Parlar 41**	
		bis(2-Ethylhexyl)phthalate	**Parlar 44**	
		Fluoranthene	**Parlar 50**	
		Fluorene	**Parlar 62**	
		Hexachlorobenzene		
		Hexachlorobutadiene		
		Hexachlorocyclopentadiene		
		Hexachloroethane		
		Indeno(1,2,3-cd)pyrene		
		Isophorone		
		2-Methylnaphthalene		
		2-Methylphenol		
		4-Methylphenol		
		Naphthalene		
		2-Nitroaniline		
		3-Nitroaniline		
		4-Nitroaniline		
		Nitrobenzene		
		2-Nitrophenol		
		4-Nitrophenol		
		N-Nitroso-di-n-propylamine		
		N-Nitroso-diphenylamine		
		Pentachlorophenol		
		Phenanthrene		
		Phenol		
		Pyrene		
		1,2,4-Trichlorobenzene		
		2,4,5-Trichlorophenol		
		2,4,6-Trichlorophenol		

Table 3-2. Water Quality Parameters and Velocity Readings for Surface Water Sampling

Location	Tide	Date	Time	Transect Location	Depth *m*	pH	Temp *°C*	DO *mg/L*	Salinity *ppt*	Conductivity *ms/cm*	ORP *mV*	Turbidity *NTU*	Flow velocity *ft/sec*	Sample ID
mouth	ebb tide	4/4/2012	10:00	4	0.34	5.7	26.92	4.07	*31.03*	*49.97*	*-168.9*	12.9	0.5	
					0.64	7.63	23.62	4.03	*61.35*	*84.23*	*-218*	10.8	0.25	
					0.86	7.6	23.2	3.64	*63.19*	*85.71*	*-159.8*	12	0.34	SW-DMEB-01 & 02
culvert	ebb tide	4/4/2012	12:04	1	0.08	8.03	32.64	5.57	2.01	4.427	*-288*	3	0.65	
					0.24	8.03	32.6	5.73	2.08	4.407	*-272.8*	3	0.43	
					0.32	8.03	32.72	5.48	2.02	4.448	*-271.1*	2.73	0.32	
			11:48	2	0.07	8.11	32.45	6.33	2.04	4.463	*-366.1*	3	0.78	
					0.21	8.07	32.46	6.04	2.04	4.47	*-371.4*	3	0.54	
					0.28	8.05	32.51	5.75	2.04	4.47	*-659*	3	0.65	SW-DCEB-01 & 02
mouth	flood tide	4/4/2012	17:22	3	0.4	7.53	25.24	4.59	*57.96*	*82.99*	*-327.1*	12.09	0.09	
					1.2	7.5	24.72	4.37	*59.53*	*53.98*	*-296.7*	14.01	0	
					1.6	7.58	24.57	4.55	*60.73*	*85.84*	*-244.3*	19.09	0.04	
			16:45	4	0.2	7.45	25.51	4.34	*54.85*	*79.18*	*-346.2*	13.8	0.045	
					0.6	7.38	25	4.04	*57.63*	*81.74*	*-321.7*	18.2	0.45	
					0.8	7.34	24.46	3.99	*58*	*82.96*	*-319.3*	19.05	0.47	SW-DMFL-01 & 02
			16:03	5	0.12	7.7	27.9	4.24	*39.32*	*62.12*	*-296.7*	13.4	0.17	
					0.36	7.41	25.09	3.98	*56.05*	*80.54*	*-302.5*	16.1	0.15	
					0.48	7.35	24.74	3.71	*58.4*	*82.33*	*-343.2*	16.2	0.2	
culvert	flood tide	4/4/2012	18:12	1	0.32	7.49	24.95	4.08	*59.01*	*83.66*	*18.3*	10.5	0	
					0.96	7.54	24.86	3.84	*59.27*	*83.88*	*18.2*	13.01	0	
					1.28	7.59	24.88	3.95	*59.47*	*84.09*	*23.3*	11.2	0	
			18:23	2	0.38	7.45	24.84	3.86	*59.26*	*83.84*	*57.3*	5.02	0	
					1.02	7.46	24.84	3.8	*59.46*	*84.09*	*44*	9.04	0	
					1.36	7.45	24.86	3.73	*59.39*	*84.03*	*39.5*	14.01	0	SW-DCFL-01 & 02
mouth	slack high	4/4/2012	7:15	1	0.12	7.55	23.19	3.52	*63.08*	*85.58*	*-133*	9.55	0	
					0.36	7.57	23.24	3.57	*63.45*	*86.09*	*-141*	10.3	0	
					0.48	7.61	23.23	3.66	*63.77*	*86.5*	*-153.5*	8.68	0	
			7:40	2	0.12	7.66	23.06	3.64	*63.53*	*85.92*	*-144.2*	9.28	0	
					0.3	7.68	23.22	3.72	*63.3*	*86.51*	*-166.5*	11.9	0	
					0.48	7.71	23.22	3.78	*63.91*	*86.64*	*-185.5*	9.73	0	
			8:10	3	0.57	7.66	23.26	3.62	*63.08*	*86.1*	*-237.2*	14.4	0.28	
					1.71	7.75	23.13	3.81	*64.8*	*87.58*	*-271*	16.4	0	
					2.28	7.81	23.11	4.58	*66.04*	*88.89*	*-171.6*	20.3	0	
			8:41	4	0.15	7.53	23.64	3.38	*61.46*	*84.38*	*-45.8*	11.8	0.27	
					0.9	7.72	23.22	3.89	*65.08*	*87.8*	*-188.4*	19.2	0.28	
					1.2	7.74	23.13	3.9	*65.06*	*87.8*	*-187*	19	0	SW-DMSH-05
			9:15	5	0.23	7.56	24.09	3.35	*56.53*	*79.35*	*-263.1*	9.49	0.11	
					0.69	7.68	23.28	3.99	*64.03*	*86.82*	*-220*	12.4	0.12	
					0.92	7.72	23.19	4.08	*64.59*	*87.36*	*-242.9*	14	0.12	

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Location	Tide	Date	Time	Transect Location	Depth *m*	pH	Temp *°C*	DO *mg/L*	Salinity *ppt*	Conductivity *ms/cm*	ORP *mV*	Turbidity *NTU*	Flow velocity *ft/sec*	Sample ID
mouth	slack low	4/4/2012	13:40	4	0.11	7.84	32.96	4.72	6.03	12.71	262.9	17	0	
					0.33	7.84	32.63	4.7	5.99	12.43	289.1	17	0	
					0.44	7.57	30.41	4.72	15.12	29.4	286.7	17	0	SW-DMSL-06
culvert	slack high	4/5/2012	8:17	1	0.34	7.41	25.19	3.45	20.55	33	*-50.5*	9.09	0	
					1.02	7.38	23.33	3.54	25.33	38.5	*-75.5*	8.4	0	
					1.36	7.39	23.33	3.58	25.39	38.5	*-85.8*	11.1	0	
			8:00	2	0.35	7.4	25.36	3.03	22.45	33.51	*-102*	10.8	0	
					1.05	7.36	23.28	3.7	25.65	38.77	*-111.05*	9.85	0	
					1.4	7.34	23.31	3.37	25.75	38.88	*-108.7*	12.9	0	SW-DCSH-05
culvert	slack low	4/4/2012	14:20	1	0.064	7.97	32.68	6.04	1.88	4.15	212	3	0.57	
					0.192	7.98	32.74	6.02	1.88	4.14	256.7	3	0.62	
					0.256	7.99	32.66	6.05	1.87	4.14	288.3	3	0.51	
			14:10	2	0.076	7.91	32.4	6.21	1.92	4.14	125.6	2.5	0.67	
					0.228	7.94	32	6.06	1.87	4.14	148	2.5	0.67	
					0.304	7.94	32.43	6.1	1.88	4.12	176	2.5	0.72	SW-DCSL-06
Rainfall Event Sampling														
mouth	ebb tide	8/21/2012	13:30	4	1.38	7.52	28.33	3	29.9	49.12	100	15.9	-	SW-DMEB-03 & 04
culvert	ebb tide	8/21/2012	15:30	1	0.69	7.88	29.07	4.21	26.6	44.861	150.01	51	-	SW-DCEB-03 & 04
culvert	flood tide	8/21/2012	10:00	1	1.46	6.83	28.19	1.34	26.7	44.33	154.1	10.6	-	SW-DCFL-03 & 04

Note:

Readings in italics have readings outside expected values. Water quality meter error is likely.

Table 3-3. Pore Water Sampling Water Quality Parameters

Sample Type	Time	Conductivity *mS/cm*	ORP *mV*	pH	Salinity *ppt*
Post-Weir Sample Collection (2/28/12)					
Pore water	13:55	3.778	-193	6.72	0.2824
Surface water	14:16	2.948	0	7.84	0.2165
Pore water	14:48	3.787	-195	6.41	0.2847
Surface water	14:52	2.802	-10	7.78	0.2064
Pore water	15:19	3.602	-185	6.57	0.2704
Pore water	15:48	3.675	-186	6.56	0.2761
Pore water	16:02	3.719	-183	6.58	0.2806
Pre-Weir Sample Collection (2/29/12)					
Surface water	8:30	low tide (no surface water)			
Pore water	8:54	14.58	-229	6.68	12.92
Pore water	9:43	14.43	-221	6.69	12.8
Pore water	10:22	13.78	-216	7.06	12.08
Pore water	10:59	13.61	-228	6.78	11.83
Pore water	12:10	12.77	-230	6.72	10.94
Pore water	12:37	12.97	-229	6.86	11.15
Surface water	12:54	3.2	-11	7.99	0.2369
Pore water	13:24	12.33	-237	6.39	10.53
Surface water	13:27	3.148	22	7.86	0.2335
Pore water	14:31	12.1	-228	6.79	10.27
Surface water	14:52	2.802	--	7.78	0.2064
Pore water	15:06	12.02	-230	6.64	10.21
Pore water	15:36	11.63	-230	6.64	9.893
Pore water	16:06	10.12	-227	6.75	8.501

Table 5-1. Toxaphene Concentrations in Outfall Ditch Sediment Samples

Field ID	Depth (ft)	Toxaphene (µg/kg)		Total Organic Carbon (mg/kg)
		Method 1 (Technical)	Method 2 (TAUC)	
SD-OD1C-01	0 - 0.5	5400 J	10,000	--
SD-OD1C-02	0.5 - 2	8,200	12,000	--
SD-OD1N-01	0 - 0.5	12,000 J	3,400	170,000 J
SD-OD1N-02	0.5 - 2	27,000	10,000	49,000
SD-OD1N-03	2 - 4	62,000	84,000	88,000
SD-OD1N-04	4 - 6	9,400	20,000	30,000
SD-OD1N-05	6 - 8	110 U	37 U	1,500
SD-OD1S-01	0 - 0.5	1,800 J	960	140,000 J
SD-OD1S-02	0.5 - 2	4,500 J	11,000	130,000 J
SD-OD1T-01	0 - 0.5	5,300	5,900	11,000
SD-OD1T-02	0.5 - 2	6,700	7,400	7,300
SD-OD2C-01	0 - 0.5	21,000 J	19,000	510,000 J
SD-OD2C-02	0.5 - 2	14,000 J	12,000	320,000 J
SD-OD2N-01	0 - 0.5	2,000 J	2,600	370,000 J
SD-OD2N-02	0.5 - 2	3,600 J	3,400	190,000 J
SD-OD2S-01	0 - 0.5	14,000 J	9,500	200,000 J
SD-OD2S-02	0.5 - 2	3,000	5,600	88,000
SD-OD2T-01	0 - 0.5	5,100 J	6,300	180,000 J
SD-OD2T-02	0.5 - 2	6,900 J	4,200	180,000 J
SD-OD2T-03	2 - 4	4,900 J	9,600	91,000 J
SD-OD2T-04	4 - 6	7,600	16,000	180,000
SD-OD2T-05	6 - 8	5,000	9,700	270,000
SD-OD3C-01	0 - 0.5	630 J	1,500	53,000 J
SD-OD3C-02	0.5 - 2	7,900	12,000	48,000
SD-OD3N-01	0 - 0.5	550 J	1,400	54,000 J
SD-OD3N-02	0.5 - 2	15,000	18,000	35,000
SD-OD3S-01	0 - 0.5	860 J	2,000	55,000 J
SD-OD3S-02	0.5 - 2	7,100 J	13,000	37,000 J
SD-OD3T-01	0 - 0.5	11,000 J	25,000	53,000 J
SD-OD3T-02	0.5 - 2	440 J	1,500	37,000 J
SD-OD3T-03	2 - 4	78,000	35,000	69,000
SD-OD3T-04	4 - 6	3,500	2,400	46,000
SD-OD3T-05	6 - 8	170 U	77 J	75,000
SD-OD3T-06	8 - 10	46 U	46 U	5,400
SD-OD4C-01	0 - 0.5	190 J	610	--
SD-OD4C-02	0.5 - 2	660 J	1,600	--
SD-OD4N-01	0 - 0.5	210 J	440	49,000 J
SD-OD4N-02	0.5 - 2	280 J	940	45,000 J
SD-OD4N-03	2 - 4	570	990	52,000
SD-OD4N-04	4 - 6	8,500	21,000	65,000
SD-OD4N-05	6 - 8	5,100	13,000	72,000
SD-OD4S-01	0 - 0.5	170 J	630	40,000 J
SD-OD4S-02	0.5 - 2	310 J	1,000	48,000 J
SD-OD4T-01	0 - 0.5	500 J	1,300	48,000 J
SD-OD4T-02	0.5 - 2	530	1,100	36,000
SD-OD5C-01	0 - 0.5	360 J	R	60,000 J
SD-OD5C-02	0.5 - 2	8,500 J	21,000	55,000 J
SD-OD5N-01	0 - 0.5	320 J	1,100	46,000 J
SD-OD5N-02	0.5 - 2	6,100 J	14,000	68,000 J
SD-OD5S-01	0 - 0.5	270 J	700	35,000 J
SD-OD5S-02	0.5 - 2	190 J	550	51,000
SD-OD5S-03	2 - 4	10,000	29,000	170,000
SD-OD5S-04	4 - 6	170,000	210,000	180,000
SD-OD5S-05	6 - 8	87,000	120,000	77,000
SD-OD5T-01	0 - 0.5	1,100 J	240	54,000 J
SD-OD5T-02	0.5 - 2	16,000	31,000	120,000
SD-ODCC-02	0.5 - 2	17,000	22,000	38,000
SD-ODCN-01	0 - 0.5	71,000	75,000	4,000
SD-ODCS-01	0 - 0.5	5,700 J	5,300	110,000 J

NOTES:
U: not detected;
J: estimated concent
--: not analyzed

Table 5-2. Summary of Detected Compounds in Sediment, Terry Creek OU1 RI/FS

Compound Name	SD-OD1C-01	SD-OD1C-02	SD-OD2C-01	SD-OD2C-02	SD-OD3C-01	SD-OD3C-02	SD-OD4C-01	SD-OD4C-02	SD-OD5C-01	SD-OD5C-02
Depth (ft)	0 - 0.5	0.5 - 2	0 - 0.5	0.5 - 2	0 - 0.5	0.5 - 2	0 - 0.5	0.5 - 2	0 - 0.5	0.5 - 2
Toxaphene (µg/kg)										
Method 1 (Technical)	**5,400 J**	**8,200**	**21,000 J**	**14,000 J**	**630 J**	**7,900**	**190 J**	**660 J**	**360 J**	**8,500 J**
Method 2 (TAUC)	**10,000**	**12,000**	**19,000**	**12,000**	**1,500**	**12,000**	**610**	**1,600**	R	**21,000**
Pesticides (µg/kg)										
4,4-DDD	38 UJ	110 U	600 UJ	150 UJ	29 UJ	110 U	2.3 UJ	0.41 UJ	R	43 UJ
4,4-DDE	38 UJ	110 U	600 UJ	150 UJ	29 UJ	110 U	1.8 UJ	**5.8 J**	R	34 UJ
Aldrin	19 UJ	55 U	310 UJ	**44 J**	15 UJ	56 U	4.3 UJ	0.77 UJ	R	**320 J**
gamma-BHC (Lindane)	19 UJ	55 U	310 UJ	77 UJ	15 UJ	56 U	1 UJ	**0.52 J**	R	**40 J**
SVOCs (µg/kg)										
1,1-Biphenyl	1,500 UJ	850 U	3,000 UJ	3,000 UJ	1,400 UJ	1,100 U	280 UJ	250 UJ	370 UJ	**290 J**
2-Methylnaphthalene	310 UJ	170 U	610 UJ	620 UJ	290 UJ	220 U	130 UJ	110 UJ	170 UJ	120 UJ
2-Methylphenol	1,500 UJ	850 U	3,000 UJ	3,000 UJ	1,400 UJ	1,100 U	240 UJ	220 UJ	330 UJ	220 UJ
3 & 4 Methylphenol	1,500 UJ	**190 J**	**2,900 J**	**2,700 J**	1,400 UJ	1,100 U	280 UJ	250 UJ	380 UJ	260 UJ
Acenaphthene	310 UJ	170 U	610 UJ	620 UJ	290 UJ	220 U	130 UJ	110 UJ	170 UJ	120 UJ
Acenaphthylene	310 UJ	170 U	**510 J**	**510 J**	290 UJ	220 U	130 UJ	110 UJ	170 UJ	120 UJ
Acetophenone	1,500 UJ	850 U	3,000 UJ	3,000 UJ	1,400 UJ	1,100 U	260 UJ	230 UJ	350 UJ	240 UJ
Anthracene	310 UJ	170 U	610 UJ	620 UJ	290 UJ	220 U	130 UJ	110 UJ	170 UJ	120 UJ
Benzaldehyde	**490 J**	**290 J**	**2200 J**	**2300 J**	1,400 UJ	1,100 U	380 UJ	340 UJ	510 UJ	**580 J**
Benzo[a]anthracene	310 UJ	170 U	610 UJ	620 UJ	290 UJ	220 U	130 UJ	110 UJ	170 UJ	120 UJ
Benzo[a]pyrene	310 UJ	170 U	610 UJ	620 UJ	290 UJ	220 U	46 UJ	41 UJ	62 UJ	43 UJ
Benzo[b]fluoranthene	310 UJ	170 U	610 UJ	620 UJ	290 UJ	220 U	130 UJ	110 UJ	170 UJ	120 UJ
Benzo[g,h,i]perylene	310 UJ	170 U	610 UJ	620 UJ	290 UJ	220 U	130 UJ	110 UJ	170 UJ	120 UJ
Benzo[k]fluoranthene	310 UJ	170 U	610 UJ	620 UJ	290 UJ	220 U	77 UJ	69 UJ	100 UJ	71 UJ
Chrysene	310 UJ	170 U	610 UJ	620 UJ	290 UJ	220 U	130 UJ	110 UJ	170 UJ	120 UJ
Dibenzofuran	1,500 UJ	850 U	3,000 UJ	3,000 UJ	1,400 UJ	1,100 U	260 UJ	230 UJ	350 UJ	240 UJ
Di-n-butyl phthalate	7,800 UJ	4,400 U	16,000 UJ	16,000 UJ	7,400 UJ	5,600 U	650 UJ	580 UJ	880 UJ	610 UJ
Fluoranthene	**190 J**	**100 J**	**700 J**	**630 J**	290 UJ	**110 J**	130 UJ	110 UJ	170 UJ	120 UJ
Fluorene	310 UJ	170 U	610 UJ	620 UJ	290 UJ	220 U	130 UJ	110 UJ	170 UJ	120 UJ
Indeno[1,2,3-cd]pyrene	310 UJ	170 U	610 UJ	620 UJ	290 UJ	220 U	130 UJ	110 UJ	170 UJ	120 UJ
Naphthalene	**430 J**	**270**	**1400 J**	**1900 J**	**210 J**	**210 J**	130 UJ	**160 J**	**170 J**	240 UJ
Phenanthrene	**190 J**	**150 J**	**650 J**	**820 J**	290 UJ	**120 J**	92 UJ	82 UJ	120 UJ	86 UJ
Phenol	**430 J**	850 U	**1700 J**	**1200 J**	1,400 UJ	1,100 U	250 UJ	220 UJ	340 UJ	230 UJ
Pyrene	**180 J**	**130 J**	**320 J**	**700 J**	290 UJ	220 U	130 UJ	110 UJ	170 UJ	120 UJ
VOCs (µg/kg)										
2-Butanone	**49 J**	**31 J**	**110 J**	**440 J**	**42 J**	**34 J**	**40 J**	**24 J**	**72 J**	8.6 U
4-Methyl-2-pentanone	26 UJ	**16 J**	15 UJ	29 UJ	140 UJ	50 U	20 UJ	17 UJ	19 UJ	15 U
Acetone	**310 J**	170 U	**760 J**	**2100 J**	**150 J**	**160**	**150 J**	**130 J**	**240 J**	**180**
Benzene	4.5 UJ	2.5 U	2.6 UJ	5 UJ	27 UJ	10 U	3.5 UJ	3 UJ	3.3 UJ	2.6 U
Carbon disulfide	**8.5 J**	**5.5 J**	**13 J**	**26 J**	**31 J**	**12**	5.3 UJ	**32 J**	**22 J**	**7.4 J**
Chlorobenzene	5.9 UJ	3.4 U	3.4 UJ	6.6 UJ	27 UJ	10 U	4.6 UJ	3.9 UJ	4.3 UJ	3.5 U
Cyclohexane	8 UJ	**5.4 J**	4.6 UJ	9 UJ	55 UJ	20 U	6.3 UJ	5.3 UJ	5.9 UJ	4.7 U
Isopropylbenzene	12 UJ	6.6 U	**9.5 J**	**31 J**	27 UJ	10 U	9.2 UJ	7.7 UJ	8.6 UJ	**7.9 J**
Methyl acetate	31 UJ	17 U	18 UJ	35 UJ	55 UJ	20 U	24 UJ	20 UJ	23 UJ	18 U
Methylcyclohexane	5.3 UJ	3 U	3 UJ	5.9 UJ	55 UJ	20 U	4.2 UJ	3.5 UJ	3.9 UJ	3.1 U
Toluene	5.2 UJ	2.9 U	3 UJ	**6.1 J**	27 UJ	**1.9 J**	4.1 UJ	3.4 UJ	3.8 UJ	3 U

Table 5-2. continued

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Compound Name	SD-OD1C-01	SD-OD1C-02	SD-OD2C-01	SD-OD2C-02	SD-OD3C-01	SD-OD3C-02	SD-OD4C-01	SD-OD4C-02	SD-OD5C-01	SD-OD5C-02
Depth (ft)	0 - 0.5	0.5 - 2	0 - 0.5	0.5 - 2	0 - 0.5	0.5 - 2	0 - 0.5	0.5 - 2	0 - 0.5	0.5 - 2
Metals (mg/kg)										
Aluminum	**15,000 J**	**8,900**	**34,000 J**	**46,000 J**	**33,000 J**	**26,000**	**22,000 J**	**34,000 J**	**38,000 J**	**26,000 J**
Arsenic	**9.4 J**	**7**	**17 J**	**33 J**	**13 J**	**12**	**15 J**	**14 J**	**17 J**	**14 J**
Barium	**66 J**	**59**	**160 J**	**290 J**	**39 J**	**35**	**25 J**	**36 J**	**43 J**	**31 J**
Beryllium	**0.5 J**	**0.31 J**	**1 J**	**1.5 J**	**1.4 J**	**1**	**1.4 J**	**1.6 J**	**1.8 J**	**1.4 J**
Cadmium	**0.55 J**	**0.41 J**	**1.3 J**	**1.8 J**	**0.49 J**	1.6 U	0.34 UJ	0.33 UJ	0.5 UJ	0.34 UJ
Calcium	**7,600 J**	**8,900**	**25,000 J**	**46,000 J**	**4,000 J**	**4,000**	**4,300 J**	**5,900 J**	**6,600 J**	**5,700 J**
Chromium	**43 J**	**23**	**83 J**	**110 J**	**53 J**	**46**	**43 J**	**52 J**	**64 J**	**48 J**
Cobalt	**3.1 J**	**2 J**	**6.2 J**	**9.1 J**	**6.2 J**	**5**	**5.5 J**	**6.6 J**	**7.4 J**	**5.6 J**
Copper	**86 J**	**71**	**160 J**	**240 J**	**51 J**	**30**	**18 J**	**24 J**	**27 J**	**37 J**
Iron	**13,000 J**	**7,900**	**28,000 J**	**38,000 J**	**27,000 J**	**25,000**	**25,000 J**	**29,000 J**	**34,000 J**	**27,000 J**
Lead	**72 J**	**47**	**93 J**	**160 J**	**32 J**	**30**	**25 J**	**28 J**	**31 J**	**29 J**
Magnesium	**5,200 J**	**2,800**	**14,000 J**	**18,000 J**	**8,800 J**	**7,300**	**8,400 J**	**9,100 J**	**11,000 J**	**7,000 J**
Manganese	**200 J**	**160**	**460 J**	**770 J**	**310 J**	**260**	**280 J**	**330 J**	**440 J**	**320 J**
Mercury	**0.75 J**	**0**	**1.5 J**	**2.3 J**	**0.21 J**	**0**	**0.14 J**	**0.16 J**	**0.15 J**	**0.23 J**
Nickel	**14 J**	**9 J**	**25 J**	**36 J**	**16 J**	**13**	**11 J**	**15 J**	**18 J**	**13 J**
Potassium	**2,600**	**1,400**	**8,000**	**10,000**	**4,900**	**4,000**	**4,400**	**4,800**	**6,000**	**4,200**
Silver	4.2 UJ	2.4 U	8.9 UJ	8.6 UJ	4 UJ	3.2 U	0.33 UJ	0.32 UJ	0.48 UJ	**0.42 J**
Sodium	**18,000 J**	**6,900**	**62,000 J**	**66,000 J**	**33,000 J**	**20,000**	**31,000 J**	**29,000 J**	**43,000 J**	**18,000 J**
Vanadium	**30 J**	**17**	**60 J**	**82 J**	**65 J**	**59**	**59 J**	**70 J**	**79 J**	**65 J**
Zinc	**340 J**	**280**	**580 J**	**860 J**	**140 J**	**120**	**81 J**	**110 J**	**110 J**	**97 J**
Other (mg/kg)										
Cyanide, Total	2.3 UJ	1.2 UJ	4.5 UJ	**3.4 J**	2.1 UJ	1.6 U	0.8 UJ	0.71 UJ	1.1 UJ	**0.96 J**
Total Organic Carbon	NA	NA	**510,000 J**	**320,000 J**	**53,000 J**	**48,000**	NA	NA	**60,000 J**	**55,000 J**

Table 5-2. Summary of Detected

Compound Name	SD-ODCC-02	SD-OD1N-05	SD-OD2T-05	SD-OD3T-06	SD-OD4N-05	SD-OD5S-01	SD-OD5S-05	SD-ODCN-01	SD-ODCS-01
Depth (ft)	0.5 - 2	6 - 8	6 - 8	8 - 10	6 - 8	0 - 0.5	6 - 8	0 - 0.5	0 - 0.5
Toxaphene (µg/kg)									
Method 1 (Technical)	**17,000**	110 U	**5,000**	46 U	**5,100**	**270 J**	**87,000**	**71,000**	**5,700 J**
Method 2 (TAUC)	**22,000**	37 U	**9,700**	46 U	**13,000**	**700**	**120,000**	**75,000**	**5,300**
Pesticides (µg/kg)									
4,4-DDD	470 U	2 U	90 U	0.18 U	7.2 U	**3.3 J**	150 U	120 U	27 UJ
4,4-DDE	470 U	2 U	90 U	0.15 U	5.7 U	0.42 UJ	120 U	**470**	**68 J**
Aldrin	**190 J**	1.1 U	**58**	0.35 U	13 U	0.99 UJ	**780 J**	60 U	14 UJ
gamma-BHC (Lindane)	**19 J**	1.1 U	**22 J**	0.085 U	**33 J**	0.24 UJ	67 U	**7.4 J**	14 UJ
SVOCs (µg/kg)									
1,1-Biphenyl	470 U	41 U	**620 J**	11 U	**320 J**	320 UJ	**460 J**	590 U	1,400 UJ
2-Methylnaphthalene	96 U	8.3 U	180 U	5.1 U	98 U	140 UJ	**85 J**	120 U	280 UJ
2-Methylphenol	470 U	41 U	900 U	9.7 U	190 U	280 UJ	150 U	590 U	**340 J**
3 & 4 Methylphenol	**560**	41 U	**2,200**	11 U	220 U	320 UJ	**330 J**	590 U	**2,200 J**
Acenaphthene	96 U	**5.1 J**	**140 J**	5.1 U	98 U	140 UJ	**240**	120 U	280 UJ
Acenaphthylene	**49 J**	8.3 U	**200**	5.1 U	98 U	140 UJ	81 U	120 U	**430 J**
Acetophenone	470 U	41 U	900 U	11 U	200 U	300 UJ	**450 J**	590 U	1,400 UJ
Anthracene	96 U	**4.8 J**	180 U	5.1 U	98 U	140 UJ	81 U	120 U	280 UJ
Benzaldehyde	**230 J**	41 U	**1,100**	15 U	**630 J**	430 UJ	**1,700**	590 U	**1,200 J**
Benzo[a]anthracene	**99**	**5.4 J**	**130 J**	5.1 U	98 U	140 UJ	81 U	120 U	280 UJ
Benzo[a]pyrene	**130**	8.3 U	180 U	1.9 U	36 U	53 UJ	29 U	120 U	280 UJ
Benzo[b]fluoranthene	**120**	**6.3 J**	180 U	5.1 U	98 U	140 UJ	81 U	120 U	280 UJ
Benzo[g,h,i]perylene	**75 J**	8.3 U	180 U	5.1 U	98 U	140 UJ	81 U	120 U	280 UJ
Benzo[k]fluoranthene	**110**	8.3 U	180 U	3.1 U	60 U	88 UJ	49 U	120 U	280 UJ
Chrysene	**130**	**7.2 J**	180 U	5.1 U	98 U	140 UJ	81 U	120 U	280 UJ
Dibenzofuran	470 U	41 U	900 U	10 U	200 U	290 UJ	**230 J**	590 U	1,400 UJ
Di-n-butyl phthalate	2,400 U	210 U	4,700 U	**96 J**	510 U	750 UJ	420 U	3,000 U	7,100 UJ
Fluoranthene	**250**	**16**	**190**	**9.5 J**	98 U	140 UJ	81 U	120 U	**150 J**
Fluorene	96 U	**4.3 J**	**98 J**	5.1 U	98 U	140 UJ	**280**	120 U	280 UJ
Indeno[1,2,3-cd]pyrene	**57 J**	8.3 U	180 U	5.1 U	98 U	140 UJ	81 U	120 U	280 UJ
Naphthalene	**160**	8.3 U	**400**	5.1 U	**110 J**	140 UJ	**460**	120 U	**1,300 J**
Phenanthrene	**130**	**5.1 J**	**270**	3.7 U	72 U	110 UJ	**260**	120 U	**280 J**
Phenol	**110 J**	41 U	**1,100**	51 U	190 U	290 UJ	**360 J**	590 U	**5,900 J**
Pyrene	**210**	**16**	**160 J**	**7.1 J**	98 U	140 UJ	81 U	**60 J**	280 UJ
VOCs (µg/kg)									
2-Butanone	**3.5 J**	23 U	**15 J**	**3 J**	**23 J**	NA	**460 J**	NA	NA
4-Methyl-2-pentanone	24 U	23 U	78 U	4.6 U	14 U	NA	750 U	NA	NA
Acetone	**35 J**	**18 J**	**230**	**15 J**	**130 J**	NA	**8,700 J**	NA	NA
Benzene	4.8 U	4.6 U	16 U	0.81 U	2.4 U	NA	**1,600**	NA	NA
Carbon disulfide	**5.5**	**2.3 J**	16 U	**2.2 J**	**13 J**	NA	**250 J**	NA	NA
Chlorobenzene	4.8 U	4.6 U	16 U	1.1 U	3.1 U	NA	**300 J**	NA	NA
Cyclohexane	9.6 U	9.2 U	31 U	1.4 U	4.2 U	NA	230 U	NA	NA
Isopropylbenzene	4.8 U	4.6 U	16 U	2.1 U	6.2 U	NA	**8,900**	NA	NA
Methyl acetate	9.6 U	9.2 U	31 U	5.5 U	16 U	NA	**2,200**	NA	NA
Methylcyclohexane	9.6 U	9.2 U	31 U	0.95 U	2.8 U	NA	**300 J**	NA	NA
Toluene	4.8 U	4.6 U	16 U	0.93 U	2.7 U	NA	**600 J**	NA	NA

Table 5-2. continued

Geosyntec consultants

Compound Name	SD-ODCC-02	SD-OD1N-05	SD-OD2T-05	SD-OD3T-06	SD-OD4N-05	SD-OD5S-01	SD-OD5S-05	SD-ODCN-01	SD-ODCS-01
Depth (ft)	0.5 - 2	6 - 8	6 - 8	8 - 10	6 - 8	0 - 0.5	6 - 8	0 - 0.5	0 - 0.5
Metals (mg/kg)									
Aluminum	**3,600**	**1,500**	**18,000**	**11,000**	**47,000**	NA	**32,000**	**1,700**	**12,000 J**
Arsenic	**1.6 J**	**3**	**3.6 J**	**8**	**15**	NA	**14**	**1 J**	**13 J**
Barium	**21**	**4**	**82**	**18**	**56**	NA	**36**	**7**	**84 J**
Beryllium	**0.12 J**	**0.21 J**	**0.43 J**	**1**	**2**	NA	**2**	**0.08 J**	**0.34 J**
Cadmium	**0.15 J**	0.57 U	**0.3 J**	0.15 U	0.29 U	NA	0.24 U	0.87 U	**0.71 J**
Calcium	**4,900**	**6,400**	**7,400**	**2,400**	**3,700**	NA	**6,500**	**23,000**	**12,000 J**
Chromium	**8**	**5**	**32**	**19**	**60**	NA	**47**	**4**	**45 J**
Cobalt	**0.76 J**	**0.49 J**	**2.1 J**	**3**	**9**	NA	**7**	**0.38 J**	**2.4 J**
Copper	**26**	2.8 U	**70**	**2.4 J**	**57**	NA	**70**	**3.8 J**	**68 J**
Iron	**3,600**	**2,400**	**12,000**	**12,000**	**36,000**	NA	**31,000**	**1,500**	**10,000 J**
Lead	**22**	**2**	**51**	**9**	**32**	NA	**31**	**5**	**45 J**
Magnesium	**1,800**	**400**	**3,700**	**1,500**	**6,400**	NA	**5,800**	**1,100**	**4,300 J**
Manganese	**45**	**23**	**120**	**71**	**460**	NA	**350**	**38**	**230 J**
Mercury	**1**	0.021 U	**1**	**0.024 J**	**0**	NA	**0**	**0.016 J**	**6.2 J**
Nickel	**3.9 J**	**0.89 J**	**14**	**4.2 J**	**20**	NA	**21**	**1.6 J**	**14 J**
Potassium	**720**	**160**	**1,400**	**870**	**3,600**	NA	**3,000**	**540**	**3,000**
Silver	1.3 U	1.1 U	2.7 U	0.14 U	0.28 U	NA	**9**	1.7 U	3.9 UJ
Sodium	**6,100**	**220 J**	**5,600**	**690**	**6,900**	NA	**3,100**	**3,000**	**16,000 J**
Vanadium	**9**	**5**	**28**	**28**	**85**	NA	**72**	**6**	**21 J**
Zinc	**140**	**4**	**190**	**15**	**82**	NA	**58**	**25**	**220 J**
Other (mg/kg)									
Cyanide, Total	0.71 U	0.6 U	**0.75 J**	0.31 U	0.6 U	NA	**1 J**	0.87 U	2 UJ
Total Organic Carbon	**38,000**	**1,500**	**270,000**	**5,400**	**72,000**	**35,000 J**	**77,000**	**4,000**	**110,000 J**

Dioxin data
(pg/g)

Compound	SD-OD2T-04	SD-OD5C-02
Depth (ft)	4 - 6	0.5 - 2
1,2,3,4,6,7,8-HpCDD	**140**	**79 J**
1,2,3,4,6,7,8-HpCDF	**32**	**7.2 J**
1,2,3,4,7,8-HxCDF	**5.4 J**	2.8 UJ
1,2,3,6,7,8-HxCDD	**8**	4.2 UJ
1,2,3,7,8,9-HxCDD	ND	**6.1 J**
1,2,3,7,8-PeCDF	**11**	12 UJ
2,3,4,7,8-PeCDF	**11**	13 UJ
OCDD	**1,700**	**980 J**
OCDF	**78**	**12 J**
Dioxin TEQ sum	**7.2**	**1.8**

Notes:
U: not detected; J: estimated concentration; R: rejected; NA: not analyzed
Detected values are indicated in bold type.
Dioxin TEQ sum calculated using dioxin toxcity equivalency factors from WHO, 2005. Not detected compounds not included in the sum.

Table 5-3. Summary of Detected Compounds in Surface Water, Terry Creek OU1 RI/FS

	Culvert Samples								Mouth Samples					
	SW-DCEB-01	SW-DCEB-02	SW-DCEB-03	SW-DCEB-04	SW-DCFL-01	SW-DCFL-02	SW-DCFL-03	SW-DCFL-04	SW-DMEB-01	SW-DMEB-02	SW-DMEB-03	SW-DMEB-04	SW-DMFL-01	SW-DMFL-02
Compound Name	ebb tide, filtered	ebb tide, unfiltered	ebb tide, filtered, wet weather	ebb tide, unfiltered, wet weather	flood tide, filtered	flood tide, unfiltered	flood tide, filtered, wet weather	flood tide, unfiltered, wet weather	ebb tide, filtered	ebb tide, unfiltered	ebb tide, filtered, wet weather	ebb tide, unfiltered, wet weather	flood tide, filtered	flood tide, unfiltered
Toxaphene (µg/L)														
Method 1 (Technical)	0.53 U	0.51 U	0.52 U	0.47 U	0.51 U	0.48 U	0.46 U	0.52 U	0.51 U	0.47 U	0.54 U	0.5 U	0.47 U	0.51 U
Method 2 (TAUC)	0.53 U	0.51 U	0.52 U	0.47 U	0.51 U	0.48 U	0.46 U	0.52 U	0.24 U	0.47 U	0.54 U	0.5 U	0.47 U	0.51 U
SVOCs (µg/L)														
Acetophenone	0.95 U	**0.39 J**	**0.11 J**	**0.11 J**	1.1 U	0.1 U	0.092 U	0.096 U	1 U	1 U	0.1 U	0.11 U	0.093 U	1 U
Benzaldehyde	0.095 U	**0.19 J**	**0.4 J**	**0.43 J**	0.11 U	0.1 U	0.092 U	0.096 U	0.1 U	0.1 U	0.1 U	0.11 U	0.093 U	0.1 U
Caprolactam	0.12 U	0.13 U	**24**	0.13 U	**0.18 J**	0.13 U	**0.21 J**	**0.15 J**	**0.25 J**	0.14 U	**0.2 J**	**0.19 J**	0.12 U	0.14 U
Diethyl phthalate	**0.12 J**	0.11 U	0.11 U	0.11 U	0.12 U	0.11 U	0.1 U	0.11 U	**0.11 J**	0.11 U	0.11 U	0.12 U	0.1 U	0.12 U
Naphthalene	0.095 U	0.1 U	0.1 U	**0.3**	0.11 U	0.1 U	0.092 U	0.096 U	0.1 U	0.1 U	0.1 U	0.11 U	0.093 U	0.1 U
VOCs (µg/L)														
Acetone	NA	**6.1 J**	NA	5 U	NA	5 U	NA	NA	NA	5 U	NA	NA	NA	5 UJ
Benzene	NA	**0.53 J**	NA	0.25 U	NA	0.25 U	NA	NA	NA	0.25 U	NA	NA	NA	0.25 U
Carbon tetrachloride	NA	**9**	NA	**0.66 J**	NA	0.5 UJ	NA	NA	NA	0.5 U	NA	NA	NA	0.5 U
Chlorobenzene	NA	**0.78 J**	NA	0.25 U	NA	0.25 U	NA	NA	NA	0.25 U	NA	NA	NA	0.25 U
Chloroform	NA	**3.3**	NA	**0.39 J**	NA	0.14 U	NA	NA	NA	0.14 U	NA	NA	NA	0.14 U
Ethylbenzene	NA	**2.3**	NA	**0.4 J**	NA	0.11 U	NA	NA	NA	0.11 U	NA	NA	NA	0.11 U
Isopropylbenzene	NA	**0.91 J**	NA	**0.16 J**	NA	0.1 U	NA	NA	NA	0.1 U	NA	NA	NA	0.1 U
Xylenes, Total	NA	**16**	NA	**2.5**	NA	0.2 U	NA	NA	NA	0.2 U	NA	NA	NA	**0.2 J**
Metals (mg/L)														
Aluminum	**0.07 J**	**0.11**	NA	**1.4**	0.05 U	**0.89**	0.05 U	**1.2**	0.05 U	**2**	0.05 U	**1.4**	0.05 U	**0.0029**
Arsenic	**0.0039**	**0.0037**	NA	**0.0057**	**0.0025**	**0.0031 J**	**0.0026**	**0.0034**	**0.0028**	**0.0032**	**0.0027**	**0.0031 J**	**0.0024 J**	**0.0029 J**
Barium	**0.086**	**0.088**	NA	**0.057**	**0.028**	**0.032**	**0.023**	**0.028**	**0.033**	**0.039**	**0.016**	**0.018 J**	**0.029**	**0.03**
Cadmium	0.00013 U	0.00013 U	NA	0.00026 U	0.00026 U	0.00026 U	0.00026 U	0.00052 U	**0.00017 J**	0.00065 U	0.00026 U	0.00052 U	0.00026 U	0.00026 U
Calcium	**84**	**84**	NA	**390**	**310**	**320**	**350**	**340**	**310**	**280**	**390**	**370**	**310**	**310**
Chromium	0.0025 U	0.0025 U	NA	0.0025 U	0.0025 U	0.005 U	0.0025 U	0.0025 U	0.0025 U	**0.0034 J**	0.0025 U	0.005 U	0.0025 U	**0.0026 J**
Cobalt	0.0005 U	0.0005 U	NA	**0.0011**	**0.0014**	**0.0012**	**0.00081**	**0.0011**	**0.00086**	**0.0015**	**0.00075**	**0.00092 J**	**0.0012**	**0.0013**
Copper	0.0011 U	**0.0012 J**	NA	**0.0015 J**	0.0011 U	0.0022 U	0.0011 U	0.0011 U	0.0011 U	**0.0012 J**	0.0011 U	0.0022 U	0.0011 U	0.0011 U
Iron	0.044 U	**0.17**	NA	**0.94**	0.044 U	**0.54**	0.044 U	**0.85**	0.044 U	**1.3**	0.044 U	**0.96**	0.044 U	**1**
Lead	**0.0021**	0.0005 U	NA	**0.001 J**	0.0005 U	0.0005 U	0.0005 U	**0.00078 J**	0.0005 U	0.0015 U	0.0005 U	0.001 U	0.0015 U	0.0015 U
Magnesium	**52**	**54**	NA	**1,100**	**1,100**	**1,100**	**1,200**	**1,000**	**980**	**940**	**1,200**	**1,100**	**1,100**	**1,100**
Manganese	**0.035**	**0.037**	NA	**0.21**	**0.099**	**0.14**	**0.091**	**0.12**	**0.095**	**0.12**	**0.0091**	**0.034**	**0.13**	**0.15**
Mercury	0.000091 U	0.000091 U	NA	0.000091 U	0.000091 U	0.000091 U	0.000091 U	0.000091 U	0.000091 U	0.000091 U	0.000091 U	**0.00012 J**	0.000091 U	0.000091 U
Nickel	0.002 U	0.002 U	NA	0.002 U	0.002 U	0.004 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.004 U	0.002 U	**0.0025 J**
Potassium	**9.6**	**10**	NA	**390**	**340**	**370**	**350**	**340**	**330**	**300**	**390**	**360**	**350**	**340**
Selenium	0.0011 U	0.0011 U	NA	0.0022 U	0.0022 U	0.0022 U	**0.0011 J**	0.0022 U	0.0022 U	0.0011 U	0.0044 U	0.0044 U	0.0022 U	0.0022 U
Sodium	**210**	**230**	NA	**9,300**	**8,200**	**8,300**	**9,700**	**9,000**	**8,000**	**7,800**	**10,000**	**9,300**	**8,800**	**8,700**
Vanadium	**0.0041 J**	**0.0045 J**	NA	**0.0074 J**	**0.0039 J**	0.0064 U	**0.0048 J**	**0.0074 J**	**0.0042 J**	**0.0083 J**	**0.0044 J**	0.013 U	**0.0042 J**	**0.0078 J**
Zinc	0.0084 U	**0.0099 J**	NA	**0.025 J**	**0.014 J**	0.017 U	**0.015 J**	**0.017 J**	**0.013 J**	0.017 U	**0.015 J**	0.034 U	**0.014 J**	**0.019 J**
Other (mg/L)														
Cyanide, Total	0.005 U	0.005 U		0.005 U	**0.006 J**	0.005 U	**0.013**	**0.0065 J**	**0.0062 J**	0.005 U	**0.0094 J**	**0.008 J**	0.005 U	0.005 U
Total Suspended Solids		**5.5**		**43**		**30**		**31**		**29**		**43**		**37**

	SW-DCSH-05	SW-DCSL-06	SW-DMSH-05	SW-DMSL-06
	high slack in culvert	low slack in culvert	high slack in mouth	low slack in mouth
Total Suspended Solids (mg/L)	**24**	5 U	**48**	**44**

NOTES:
U: not detected; J: estimated concentration
NA: not analyzed

Table 5-4. Summary of Detected Compounds in Pore Water, Terry Creek OU1 RI/FS

Compound Name	PW-ODPO-01 filtered	PW-ODPO-02 total	PW-ODPR-01 filtered	PW-ODPR-02 unfiltered
Toxaphene (µg/L)				
Method 1 (Technical)	**2.3 J**	9.5 U	0.49 U	0.49 U
Method 2 (TAUC)	**8.8**	**17**	0.49 U	0.49 U
SVOCs (µg/L)				
Benzaldehyde	**0.52 J**	**0.57 J**	**0.54 J**	**0.46 J**
Diethyl phthalate	0.11 U	0.12 U	**0.21 J**	**0.31 J**
Hexachlorocyclopentadiene	R	R	R	R
Phenol	**0.25 J**	**0.36 J**	0.13 U	**0.15 J**
VOCs (µg/L)				
Acetone	**10 J**	5 U	5 U	5 U
Methyl tert-butyl ether	0.2 U	0.2 U	**1.5 J**	**1.7 J**
Toluene	**0.33 J**	0.33 U	**0.37 J**	**0.63 J**
Metals (mg/L)				
Aluminum	0.05 U	**0.35**	0.05 U	**1.6**
Arsenic	**0.0016 J**	**0.002 J**	**0.0013 J**	**0.0021 J**
Barium	**0.098**	**0.1**	**0.14**	**0.18**
Calcium	**220**	**210**	**220**	**260**
Chromium	**0.0077**	**0.0032 J**	**0.0045 J**	**0.0094**
Cobalt	**0.0022**	**0.00039 J**	**0.00092**	**0.00092**
Copper	**0.0011 J**	**0.0019 J**	0.0011 U	**0.0048 J**
Iron	**0.091 J**	**0.41**	**0.064 J**	**1.3**
Lead	0.0005 U	0.0005 U	0.0005 U	**0.0043**
Magnesium	**580**	**590**	**290**	**330**
Manganese	**0.49**	**0.58**	**0.087**	**0.096**
Nickel	**0.0031 J**	0.002 U	0.002 U	**0.0024 J**
Potassium	**200**	**180**	**86**	**100**
Sodium	**5,300**	**5,000**	**1,900**	**2,200**
Vanadium	**0.0073 J**	**0.0053 J**	**0.0058 J**	**0.01**
Zinc	0.0084 U	0.0084 U	0.0084 U	**0.031**

Notes:
U: not detected; J: estimated concentration, R: rejected after data validation

Table 7-1. Constituent Screening - Outfall Ditch Surficial Sediment
Terry Creek Superfund Site - Brunswick, Georgia

Class	Detected Constituents	CAS	Units	Average [1]	Minimum (Qualifier) [2]	Location of Minimum	Maximum (Qualifier) [2]	Location of Maximum	Detection Frequency	MDL Range [3]	SLERA EPC [4]	SLERA ESV [5] (Source)		Maximum SLERA HQ [6]	Average SLERA HQ [6]	PBC [7]	COPEC [8]	Rationale [8]
METAL	Aluminum	7429-90-5	mg/kg	21,957	1,700	SD-ODCN-01	36,000 J	SD-OD5C-01	7 / 7	n/a	36000	18000	(f)	2	1.2	-	Yes	ASV
METAL	Arsenic	7440-38-2	mg/kg	12.2	1 J	SD-ODCN-01	17 J	SD-OD2C-01	7 / 7	n/a	17	7.24	(a)	2.3	1.7	Yes	Yes	ASV
METAL	Barium	7440-39-3	mg/kg	60.3	6.9	SD-ODCN-01	160 J	SD-OD2C-01	7 / 7	n/a	160	130.1	(c)	1.2	0.46	-	Yes	ASV
METAL	Beryllium	7440-41-7	mg/kg	0.910	0.08 J	SD-ODCN-01	1.65 J	SD-OD5C-01	7 / 7	n/a	1.65	NSV	--	--	--	-	Yes	NSV
METAL	Cadmium	7440-43-9	mg/kg	0.552	0.49 J	SD-OD3C-01	1.3 J	SD-OD2C-01	4 / 7	0.34 - 0.87	1.3	0.676	(a)	1.9	0.82	Yes	Yes	ASV
METAL	Chromium	7440-47-3	mg/kg	47.0	3.9	SD-ODCN-01	83 J	SD-OD2C-01	7 / 7	n/a	83	52.3	(a)	1.6	0.9	Yes	Yes	ASV
METAL	Cobalt	7440-48-4	mg/kg	4.40	0.38 J	SD-ODCN-01	7 J	SD-OD5C-01	7 / 7	n/a	7	50	(e)	0.14	0.088	-	No	BSV
METAL	Copper	7440-50-8	mg/kg	61.4	3.8 J	SD-ODCN-01	160 J	SD-OD2C-01	7 / 7	n/a	160	18.7	(a)	8.6	3.3	Yes	Yes	ASV
METAL	Iron	7439-89-6	mg/kg	19,357	1500	SD-ODCN-01	31000 J	SD-OD5C-01	7 / 7	n/a	31000	220000	(f)	0.14	0.088	-	No	BSV
METAL	Lead	7439-92-1	mg/kg	43.0	5.2	SD-ODCN-01	93 J	SD-OD2C-01	7 / 7	n/a	93	30.2	(a)	3.1	1.4	Yes	Yes	ASV
METAL	Manganese	7439-96-5	mg/kg	274	38	SD-ODCN-01	460 J	SD-OD2C-01	7 / 7	n/a	460	260	(f)	1.8	1.1	-	Yes	ASV
METAL	Mercury	7439-97-6	mg/kg	1.29	0.016 J	SD-ODCN-01	6.2 J	SD-ODCS-01	7 / 7	n/a	6.2	0.13	(a)	48	9.9	Yes	Yes	ASV
METAL	Nickel	7440-02-0	mg/kg	14.0	1.6 J	SD-ODCN-01	25 J	SD-OD2C-01	7 / 7	n/a	25	15.9	(a)	1.6	0.88	Yes	Yes	ASV
METAL	Silver	7440-22-4	mg/kg	1.8	0.9 J	SD-OD5C-01	0.9 J	SD-OD5C-01	1 / 7	0.33 - 8.9	0.9	0.733	(a)	1.2	2.4	Yes	Yes	ASV
METAL	Vanadium	7440-62-2	mg/kg	44.8	6.3	SD-ODCN-01	72.5 J	SD-OD5C-01	7 / 7	n/a	72.5	57	(f)	1.3	0.79	-	Yes	ASV
METAL	Zinc	7440-66-6	mg/kg	213	25	SD-ODCN-01	580 J	SD-OD2C-01	7 / 7	n/a	580	124	(a)	4.7	1.7	Yes	Yes	ASV
PEST	DDD	72-54-8	µg/kg	52.4	3.3 J	SD-OD5S-01	3.3 J	SD-OD5S-01	1 / 8	2.3 - 600	3.3	1.22	(a)	2.7	43	Yes	Yes	ASV
PEST	DDE	72-55-9	µg/kg	110	68 J	SD-ODCS-01	470	SD-ODCN-01	2 / 8	0.42 - 600	470	2.07	(a)	230	53	Yes	Yes	ASV
PEST	gamma-BHC (Lindane)	58-89-9	µg/kg	24	7.4 J	SD-ODCN-01	7.4 J	SD-ODCN-01	1 / 8	0.24 - 310	7.4	0.32	(a)	23	74	Yes	Yes	ASV
PEST	Toxaphene [9]	8001-35-2	µg/kg	8,186.4	170 J	SD-OD4S-01	71000	SD-ODCN-01	22 / 22	n/a	71000	28	(b)	2500	290	Yes	Yes	ASV
HPAH	Pyrene	129-00-0	µg/kg	140	60 J	SD-ODCN-01	320 J	SD-OD2C-01	4 / 8	130 - 290	320							
LPAH	Acenaphthylene	208-96-8	µg/kg	188	430 J	SD-ODCS-01	510 J	SD-OD2C-01	2 / 8	120 - 310	510							
LPAH	Fluoranthene	206-44-0	µg/kg	190	140 J	SD-OD5C-01	700 J	SD-OD2C-01	4 / 8	120 - 290	700							
LPAH	Naphthalene	91-20-3	µg/kg	465	185 J	SD-OD5C-01	1400 J	SD-OD2C-01	5 / 8	120 - 140	1400							
LPAH	Phenanthrene	85-01-8	µg/kg	191	100 J	SD-OD5C-01	650 J	SD-OD2C-01	4 / 8	92 - 290	650							
PAH	Total PAHs [10]	PAH SUM	µg/kg	1,111	300 J	SD-ODCN-01	3580 J	SD-OD2C-01	6 / 8	92 - 310	3580	1684	(a)	2.1	0.66	Yes	Yes	ASV
SVOC	Acetophenone	98-86-2	µg/kg	566	300 J	SD-OD5C-01	300 J	SD-OD5C-01	1 / 8	260 - 3000	300	NSV	--	--	--	-	Yes	NSV
SVOC	Benzaldehyde	100-52-7	µg/kg	811	490 J	SD-OD1C-01	2200 J	SD-OD2C-01	4 / 8	380 - 1400	2200	NSV	--	--	--	-	Yes	NSV
SVOC	1,1-Biphenyl	92-52-4	µg/kg	609	630 J	SD-OD5C-01	630 J	SD-OD5C-01	1 / 8	280 - 3000	630	1100	(b)	0.57	0.55	-	No	BSV
SVOC	2-Methylphenol	95-48-7	µg/kg	497.5	340 J	SD-ODCS-01	340 J	SD-ODCS-01	1 / 8	240 - 3000	340	55.4	(e)	6.1	9.0	-	Yes	ASV
SVOC	3 & 4 Methylphenol [11]	TTNUS042	µg/kg	913	2200 J	SD-ODCS-01	2900 J	SD-OD2C-01	2 / 8	280 - 1500	2900	20.2	(e)	140	45	-	Yes	ASV
SVOC	Phenol	108-95-2	µg/kg	1,211	390 J	SD-OD5C-01	5900 J	SD-ODCS-01	4 / 8	250 - 1400	5900	49.1	(e)	120	25	-	Yes	ASV
VOC	Acetone	67-64-1	µg/kg	322	150 J	SD-OD3C-01	760 J	SD-OD2C-01	5 / 5	n/a	760	9.9	(e)	77	33	-	Yes	ASV
VOC	Carbon disulfide	75-15-0	µg/kg	15.4	8.5 J	SD-OD1C-01	31 J	SD-OD3C-01	4 / 5	5.3 - 5.3	31	23.9	(e)	1.3	0.65	-	Yes	ASV
VOC	Isopropylbenzene	98-82-8	µg/kg	7.58	9.5 J	SD-OD2C-01	9.5 J	SD-OD2C-01	1 / 5	8.6 - 27	9.5	NSV	--	--	--	-	Yes	NSV
VOC	2-Butanone (MEK)	78-93-3	µg/kg	62.6	40 J	SD-OD4C-01	110 J	SD-OD2C-01	5 / 5	n/a	110	42.4	(e)	2.6	1.5	-	Yes	ASV

See notes on following page

Notes:

(1) Arithmetic average calculated using one-half the method detection limit (MDL) for non-detect results.
(2) Minimum/maximum detected concentration. "J" indicates an estimated concentration.
(3) MDL range based on non-detect sample results.
(4) SLERA exposure point concentration (EPC) is the maximum detected concentration.
(5) Ecological screening values (ESVs) were selected using the following hierarchy (see Attachment A in Appendix A, SLERA):
  (a) USEPA Region IV ecological effects values, sediment
  (b) USEPA EcoTox Thresholds (SQC/SQB) for marine sediment
  (c) NOAA SQuiRTs for marine sediment (minimum of T_{20}, TEL, ERL, T_{50}, PEL, and ERM)
  (d) USEPA Region III BTAG ecological screening benchmarks for marine sediment
  (e) USEPA Region V ESLs for freshwater sediment
  (f) Apparent effects threshold (NOAA)
(6) Screening level hazard quotient (HQ) calculated (to two significant figures) as follows: HQ = EPC/ESV.
(7) Bioaccumulation potential based on: USEPA. 2000. Bioaccumulation Testing and Interpretation for the Purpose of Sediment Quality Assessment, Status and Needs. Office of Water. EPA-823-R-00-001. February.
(8) Rationale for COPEC selection/exclusion:

Selection	*Exclusion*
ASV = above ecological screening value	BSV = below ecological screening value
PBC = potentially bioaccumulative constituent	
NSV = no screening value	

(9) Per the Work Plan, the SLERA utilizes Method 1 toxaphene results. The SLERA HQ is based on the EPA EcoTox SQB.
(10) Detected PAHs were evaluated as "Total PAHs." Summed PAHs are acenaphthylene, fluoranthene, naphthalene, phenanthrene, and pyrene. Non-detect PAHs were excluded from the summations; otherwise, non-detect results were include as one-half the MDL. The MDL range presented in the table represents the lowest and highest MDL for these five PAHs (i.e.,
(11) Surrogate ESVs were utilized as follows:
  3&4-Methylphenol uses 4-Methylphenol as a surrogate

Shading = Maximum HQ > 1

Definitions:

OU1 = Operable Unit 1 (Outfall Ditch)
SLERA = Screening Level Ecological Risk Assessment
mg/kg = milligram per kilogram
µg/kg = microgram per kilogram
CAS = chemical abstract number
TXP = toxaphene
PEST = pesticide
SVOC = semivolatile organic compound
PAH = polynuclear aromatic hydrocarbon
VOC = volatile organic compound

Table 7-2. SLERA Constituent Screening - Outfall Ditch Surface Water
Terry Creek Superfund Site - Brunswick, Georgia

Class	Detected Constituents [1]	CAS	Units	Average [2]	Minimum (Qualifier) [3]	Maximum (Qualifier) [3]	Location of Maximum [3]	Detection Frequency	MDL Range [4]	SLERA EPC [5]	SLERA ESV [6] (Source)		Maximum SLERA HQ [7]	PBC? [8]	COPEC [9]	Rationale [9]
METAL	Aluminum	7429-90-5	µg/L	554	2.9	2,000	DMEB-02	8 / 13	50 - 50	2,000	NSV		--	-	Yes	NSV
METAL	Arsenic	7440-38-2	µg/L	3.2	2.4 J	5.7	DCEB-04	13 / 13	n/a	5.7	36	(a)	0.16	Yes	Yes	PBC
METAL	Barium	7440-39-3	µg/L	39	16	88	DCEB-02	13 / 13	n/a	88	200	(d)	0.44	-	No	BSV
METAL	Cadmium	7440-43-9	µg/L	0.16	0.17 J	0.17 J	DMEB-01 F	1 / 13	0.13 - 0.65	0.17	8.8	(a)	0.019	Yes	Yes	PBC
METAL	Chromium [10]	7440-47-3	µg/L	1.7	2.6 J	3.4 J	DMEB-02	2 / 13	2.5 - 5	3.4	50.4	(a)	0.068	Yes	Yes	PBC
METAL	Cobalt	7440-48-4	µg/L	0.97	0.75	1.5	DMEB-02	11 / 13	0.5 - 0.5	1.5	1.0	(d)	1.5	-	Yes	ASV
METAL	Copper	7440-50-8	µg/L	0.81	1.2 J	1.5 J	DCEB-04	3 / 13	1.1 - 2.2	1.5	3.7	(a)	0.4	Yes	Yes	PBC
METAL	Cyanide Total	74-90-8	µg/L	5.1	6 J	13	DCFL-03	6 / 13	5 - 5	13	1	(a)	13	-	Yes	ASV
METAL	Iron	7439-89-6	µg/L	453	170	1,300	DMEB-02	7 / 13	44 - 44	1,300	50	(d)	26	-	Yes	ASV
METAL	Lead	7439-92-1	µg/L	0.63	0.78 J	2.1	DCEB-01 F	3 / 13	0.5 - 1.5	2.1	8.1	(a)	0.26	Yes	Yes	PBC
METAL	Manganese	7439-96-5	µg/L	98	9.1	210	DCEB-04	13 / 13	n/a	210	100	(d)	2.1	-	Yes	ASV
METAL	Mercury	7439-97-6	µg/L	0.051	0.12 J	0.12 J	DMEB-04	1 / 13	0.091 - 0.091	0.12	1.1	(a)	0.11	Yes	Yes	PBC
METAL	Nickel	7440-02-0	µg/L	1.3	2.5 J	2.5 J	DMFL-02	1 / 13	2 - 4	2.5	8.3	(a)	0.3	Yes	Yes	PBC
METAL	Selenium	7782-49-2	µg/L	1.1	1.1 J	1.1 J	DCFL-03	1 / 13	1.1 - 4.4	1.1	71	(a)	0.015	Yes	Yes	PBC
METAL	Vanadium	7440-62-2	µg/L	5.4	3.9 J	8.3 J	DMEB-02	11 / 13	6.4 - 13	8.3	50	(d)	0.17	-	No	BSV
METAL	Zinc	7440-66-6	µg/L	14	9.9 J	25 J	DCEB-04	9 / 13	8.4 - 34	25	86	(a)	0.29	Yes	Yes	PBC
PAH	Naphthalene	91-20-3	µg/L	0.068	0.3	0.3	DCEB-04	1 / 14	0.092 - 0.11	0.3	23.5	(b)	0.013	-	No	BSV
SVOC	Acetophenone	98-86-2	µg/L	0.25	0.11 J	0.39 J	DCEB-02	3 / 14	0.092 - 1.1	0.39	NSV		--	-	Yes	NSV
SVOC	Benzaldehyde	100-52-7	µg/L	0.11	0.19 J	0.43 J	DCEB-04	3 / 14	0.092 - 0.11	0.43	NSV		--	-	Yes	NSV
SVOC	Caprolactam	105-60-2	µg/L	1.8	0.15 J	24	DCEB-03	7 / 14	0.12 - 0.14	24	NSV		--	-	Yes	NSV
SVOC	Diethylphthalate	84-66-2	µg/L	0.064	0.11 J	0.12 J	DCEB-01 F	2 / 14	0.1 - 0.12	0.12	75.9	(b)	0.0016	-	No	BSV
VOC	Acetone	67-64-1	µg/L	3.2	6.1 J	6.1 J	DCEB-02	1 / 5	5 - 5	6.1	564,000	(e)	0.000011	-	No	BSV
VOC	Benzene	71-43-2	µg/L	0.21	0.53 J	0.53 J	DCEB-02	1 / 5	0.25 - 0.25	0.53	109	(b)	0.0049	-	No	BSV
VOC	Carbon tetrachloride	56-23-5	µg/L	2.1	0.66 J	9	DCEB-02	2 / 5	0.5 - 0.5	9	1,500	(b)	0.006	-	No	BSV
VOC	Chlorobenzene	108-90-7	µg/L	0.26	0.78 J	0.78 J	DCEB-02	1 / 5	0.25 - 0.25	0.78	105	(b)	0.0074	-	No	BSV
VOC	Chloroform	67-66-3	µg/L	0.78	0.39 J	3.3	DCEB-02	2 / 5	0.14 - 0.14	3.3	815	(b)	0.004	-	No	BSV
VOC	Ethylbenzene	100-41-4	µg/L	0.57	0.4 J	2.3	DCEB-02	2 / 5	0.11 - 0.11	2.3	4.3	(b)	0.53	-	No	BSV
VOC	Isopropylbenzene	98-82-8	µg/L	0.24	0.16 J	0.91 J	DCEB-02	2 / 5	0.1 - 0.1	0.91	NSV		--	-	Yes	NSV
VOC	Tetrachloroethene	127-18-4	µg/L	0.10	0.2 J	0.2 J	DCEB-04	1 / 5	0.15 - 0.15	0.2	45	(b)	0.0044	-	No	BSV
VOC	Toluene	108-88-3	µg/L	0.20	0.33 J	0.33 J	DCEB-02	1 / 5	0.33 - 0.33	0.33	37	(b)	0.0089	-	No	BSV
VOC	Xylene Total	1330-20-7	µg/L	3.8	0.2 J	16	DCEB-02	3 / 5	0.2 - 0.2	16	19	(e)	0.84	-	No	BSV

Notes:
(1) Both unfiltered (total) and filtered (dissolved) surface water samples were analyzed for chemical constituents. Filtered and unfiltered results were generally comparable and, therefore, combined for screening purposes. An "F" suffix in the location code indicates a filtered result (e.g., cadmium). For certain metals (As, Cd, Cr, Cu, Pb, Hg, Ni, Se, Zn), ESVs are specific to dissolved results; if the maximum detected concentration was from an unfiltered (total) sample, the ESV was divided by the appropriate conversion factor (see Attachment A).
(2) Arithmetic average calculated using one-half the method detection limit (MDL) for non-detect results.
(3) Minimum/maximum detected concentration. "J" indicates an estimated concentration.
(4) MDL range based on non-detect results.
(5) SLERA exposure point concentration (EPC) is the maximum detected concentration.
(6) Ecological screening levels (ESVs) were selected using the following hierarchy (see also Attachment A):
(a) USEPA NRWQC for the protection of aquatic life, saltwater
(b) USEPA Region IV chronic ecological effects values, saltwater

Definitions:
OU1 = Operable Unit 1 (Outfall Ditch)
SLERA = Screening Level Ecological Risk Assessment
CAS = chemical abstract number
µg/L = microgram per liter
PAH = polynuclear aromatic hydrocarbon
SVOC = semivolatile organic compound
VOC = volatile organic compound

Table 7-2. continued

(c) USEPA EcoTox Thresholds (SQC/SQB) for marine water
(d) NOAA SQuiRTs for marine water
(d) USEPA Region III BTAG ecological screening benchmarks for marine surface water
(e) USEPA Region V ESLs for freshwater
(7) Screening level hazard quotient (HQ) calculated (to two significant figures) as follows: HQ = EPC/ESV,
(8) Bioaccumulation potential based on: USEPA. 2000. Bioaccumulation Testing and Interpretation for the Purpose of Sediment Quality Assessment, Status and Needs. Office of Water. EPA-823-R-00-001. February.
(9) Rationale for COPEC selection/exclusion:

Selection	*Exclusion*
ASV = above ecological screening value	BSV = below ecological screening value
PBC = potentially bioaccumulative constituent	
NSV = no screening value	

(10) Surrogate ESVs were utilized as follows:
Chromium (total) uses hexavalent chromium as a surrogate

Shading = Maximum HQ > 1

Table 7-3. SLERA Detected Constituent Screening - Outfall Ditch Pore Water
Terry Creek Superfund Site - Brunswick, Georgia

Class	Detected Constituents [1]	CAS	Units	Average [2]	Minimum (Qualifier) [3]	Location of Minimum	Maximum (Qualifier) [3]	Location of Maximum [3]	Detection Frequency	MDL Range [4]	SLERA EPC [5]	SLERA ESV [6] (Source)				Maximum SLERA HQ [7]	Average SLERA HQ [7]	PBC? [8]	COPEC [9]	Rationale [9]
TXP	Toxaphene [10]	8001-35-2	µg/L	1.9	2.3 J	PW-ODPO-01 F	2.3 J	PW-ODPO-01 F	1 / 4	0.49 - 9.5	2.3	0.0002	--	0.0002	(a)	12000	9400	Yes	Yes	ASV
METAL	Aluminum	7429-90-5	µg/L	500	350	PW-ODPO-02	1600	PW-ODPR-02	2 / 4	50 - 50	1600	NSV	--	NSV		--	--	-	Yes	NSV
METAL	Arsenic	7440-38-2	µg/L	1.8	1.3 J	PW-ODPR-01 F	2.1 J	PW-ODPR-02	4 / 4	n/a	2.1	36	1	36	(a)	0.058	0.049	Yes	Yes	PBC
METAL	Barium	7440-39-3	µg/L	130	98	PW-ODPO-01 F	180	PW-ODPR-02	4 / 4	n/a	180	200	--	200	(d)	0.90	0.65	-	No	BSV
METAL	Chromium [11]	7440-47-3	µg/L	6.2	3.2 J	PW-ODPO-02	9.4	PW-ODPR-02	4 / 4	n/a	9.4	50	0.993	50.4	(a)	0.19	0.12	Yes	Yes	PBC
METAL	Cobalt	7440-48-4	µg/L	1.1	0.39 J	PW-ODPO-02	2.2	PW-ODPO-01 F	4 / 4	n/a	2.2	1	--	1	(d)	2.2	1.1	-	Yes	ASV
METAL	Copper	7440-50-8	µg/L	2.1	1.1 J	PW-ODPO-01 F	4.8 J	PW-ODPR-02	3 / 4	1.1 - 1.1	4.8	3.1	0.83	3.7	(a)	1.3	0.56	Yes	Yes	ASV
METAL	Iron	7439-89-6	µg/L	466	64 J	PW-ODPR-01 F	1300	PW-ODPR-02	4 / 4	n/a	1300	50	--	50	(d)	26	9.3	-	Yes	ASV
METAL	Lead	7439-92-1	µg/L	1.3	4.3	PW-ODPR-02	4.3	PW-ODPR-02	1 / 4	0.5 - 0.5	4.3	8.1	0.951	8.5	(a)	0.5	0.15	Yes	Yes	PBC
METAL	Manganese	7439-96-5	µg/L	313	87	PW-ODPR-01 F	580	PW-ODPO-02	4 / 4	n/a	580	100	--	100	(d)	5.8	3.1	-	Yes	ASV
METAL	Nickel	7440-02-0	µg/L	1.9	2.4 J	PW-ODPR-02	3.1 J	PW-ODPO-01 F	2 / 4	2 - 2	3.1	8.2	0.99	8.2	(a)	0.38	0.23	Yes	Yes	PBC
METAL	Vanadium	7440-62-2	µg/L	7.1	5.3 J	PW-ODPO-02	10	PW-ODPR-02	4 / 4	n/a	10	50	--	50	(d)	0.20	0.14	-	No	BSV
METAL	Zinc	7440-66-6	µg/L	11	31	PW-ODPR-02	31	PW-ODPR-02	1 / 4	8.4 - 8.4	31	81	0.946	86	(a)	0.36	0.13	Yes	Yes	PBC
PAH	Naphthalene	91-20-3	µg/L	0.079	0.16 J	PW-ODPR-02	0.16 J	PW-ODPR-02	1 / 4	0.1 - 0.11	0.16	23.5	--	23.5	(b)	0.0068	0.0034	-	No	BSV
SVOC	Benzaldehyde	100-52-7	µg/L	0.52	0.46 J	PW-ODPR-02	0.57 J	PW-ODPO-02	4 / 4	n/a	0.57	NSV	--	NSV		--	--	-	Yes	NSV
SVOC	Diethylphthalate	84-66-2	µg/L	0.16	0.21 J	PW-ODPR-01 F	0.31 J	PW-ODPR-02	2 / 4	0.11 - 0.12	0.31	75.9	--	75.9	(b)	0.0041	0.0021	-	No	BSV
SVOC	Phenol	108-95-2	µg/L	0.21	0.15 J	PW-ODPR-02	0.36 J	PW-ODPO-02	3 / 4	0.13 - 0.13	0.36	58	--	58	(b)	0.0062	0.0036	-	No	BSV
VOC	Acetone	67-64-1	µg/L	4.4	10 J	PW-ODPO-01 F	10 J	PW-ODPO-01 F	1 / 4	5 - 5	10	564000	--	564000	(e)	0.000018	0.0000078	-	No	BSV
VOC	Methyl tert-Butyl Ethe	1634-04-4	µg/L	0.85	1.5 J	PW-ODPR-01 F	1.7 J	PW-ODPR-02	2 / 4	0.2 - 0.2	1.7	5000	--	5000	(d)	0.00034	0.00017	-	No	BSV
VOC	Toluene	108-88-3	µg/L	0.37	0.33 J	PW-ODPO-01 F	0.63 J	PW-ODPR-02	3 / 4	0.33 - 0.33	0.63	37	--	37	(b)	0.017	0.01	-	No	BSV
TXP	Toxaphene (Unfiltered)	8001-35-2	µg/L	ND	ND		ND		0 / 2	0.49 - 9.5	ND	0.0002	--	0.0002	(a)	--	--	Yes	No	ND
TXP	Toxaphene (Filtered)	8001-35-2	µg/L	1.27	2.3 J	PW-ODPO-01 F	2.3 J	PW-ODPO-01 F	1 / 2	0.49 - 0.49	2.3	0.0002	--	0.0002	(a)	12000	6400	Yes	Yes	ASV
ING	Aluminum (Unfiltered)	7429-90-5	µg/L	975.00	350 0	PW-ODPO-02	1600 0	PW-ODPR-02	2 / 2	n/a	1600	NSV	--	NSV		--	--	-	Yes	NSV
ING	Aluminum (Filtered)	7429-90-5	µg/L	ND	ND		ND		0 / 2	50 - 50	ND	NSV	--	NSV		--	--	-	No	ND
ING	Arsenic (Unfiltered)	7440-38-2	µg/L	2.05	2 J	PW-ODPO-02	2.1 J	PW-ODPR-02	2 / 2	n/a	2.1	36	1	36	(a)	0.058	0.057	Yes	Yes	PBC
ING	Arsenic (Filtered)	7440-38-2	µg/L	1.45	1.3 J	PW-ODPR-01 F	1.6 J	PW-ODPO-01 F	2 / 2	n/a	1.6	36	1	36	(a)	0.044	0.04	Yes	Yes	PBC
ING	Barium (Unfiltered)	7440-39-3	µg/L	140.00	100 0	PW-ODPO-02	180 0	PW-ODPR-02	2 / 2	n/a	180	200	--	200	(d)	0.9	0.7	-	No	BSV
ING	Barium (Filtered)	7440-39-3	µg/L	119.00	98 0	PW-ODPO-01 F	140 0	PW-ODPR-01 F	2 / 2	n/a	140	200	--	200	(d)	0.7	0.6	-	No	BSV
ING	Chromium (Unfiltered)	7440-47-3	µg/L	6.30	3.2 J	PW-ODPO-02	9.4 0	PW-ODPR-02	2 / 2	n/a	9.4	50	0.993	50.35246727	(a)	0.19	0.13	Yes	Yes	PBC
ING	Chromium (Filtered)	7440-47-3	µg/L	6.10	4.5 J	PW-ODPR-01 F	7.7 0	PW-ODPO-01 F	2 / 2	n/a	7.7	50	0.993	50	(a)	0.15	0.12	Yes	Yes	PBC
ING	Cobalt (Unfiltered)	7440-48-4	µg/L	0.66	0.39 J	PW-ODPO-02	0.92 0	PW-ODPR-02	2 / 2	n/a	0.92	1	--	1.0	(d)	0.92	0.66	-	No	BSV
ING	Cobalt (Filtered)	7440-48-4	µg/L	1.56	0.92 0	PW-ODPR-01 F	2.2 0	PW-ODPO-01 F	2 / 2	n/a	2.2	1	--	1	(d)	2.2	1.6	-	Yes	ASV
ING	Copper (Unfiltered)	7440-50-8	µg/L	3.35	1.9 J	PW-ODPO-02	4.8 J	PW-ODPR-02	2 / 2	n/a	4.8	3.1	0.83	3.7	(a)	1.3	0.9	Yes	Yes	ASV
ING	Copper (Filtered)	7440-50-8	µg/L	0.83	1.1 J	PW-ODPO-01 F	1.1 J	PW-ODPO-01 F	1 / 2	1.1 - 1.1	1.1	3.1	0.83	3.1	(a)	0.35	0.27	Yes	Yes	PBC
ING	Iron (Unfiltered)	7439-89-6	µg/L	855.00	410 0	PW-ODPO-02	1300 0	PW-ODPR-02	2 / 2	n/a	1300	50	--	50	(d)	26	17	-	Yes	ASV
ING	Iron (Filtered)	7439-89-6	µg/L	77.50	64 J	PW-ODPR-01 F	91 J	PW-ODPO-01 F	2 / 2	n/a	91	50	--	50	(d)	1.8	1.6	-	Yes	ASV
ING	Lead (Unfiltered)	7439-92-1	µg/L	2.28	4.3 0	PW-ODPR-02	4.3 0	PW-ODPR-02	1 / 2	0.5 - 0.5	4.3	8.1	0.951	8.5	(a)	0.5	0.27	Yes	Yes	PBC
ING	Lead (Filtered)	7439-92-1	µg/L	ND	ND		ND		0 / 2	0.5 - 0.5	ND	8.1	0.951	8.5	(a)	--	--	Yes	No	ND
ING	Manganese (Unfiltered)	7439-96-5	µg/L	338.00	96 0	PW-ODPR-02	580 0	PW-ODPO-02	2 / 2	n/a	580	100	--	100	(d)	5.8	3.4	-	Yes	ASV
ING	Manganese (Filtered)	7439-96-5	µg/L	288.50	87 0	PW-ODPR-01 F	490 0	PW-ODPO-01 F	2 / 2	n/a	490	100	--	100	(d)	4.9	2.9	-	Yes	ASV
ING	Nickel (Unfiltered)	7440-02-0	µg/L	1.70	2.4 J	PW-ODPR-02	2.4 J	PW-ODPR-02	1 / 2	2 - 2	2.4	8.2	0.99	8.3	(a)	0.29	0.21	Yes	Yes	PBC
ING	Nickel (Filtered)	7440-02-0	µg/L	2.05	3.1 J	PW-ODPO-01 F	3.1 J	PW-ODPO-01 F	1 / 2	2 - 2	3.1	8.2	0.99	8.2	(a)	0.38	0.25	Yes	Yes	PBC
ING	Vanadium (Unfiltered)	7440-62-2	µg/L	7.65	5.3 J	PW-ODPO-02	10 0	PW-ODPR-02	2 / 2	n/a	10	50	--	50	(d)	0.2	0.15	-	No	BSV
ING	Vanadium (Filtered)	7440-62-2	µg/L	6.55	5.8 J	PW-ODPR-01 F	7.3 J	PW-ODPO-01 F	2 / 2	n/a	7.3	50	--	50	(d)	0.15	0.13	-	No	BSV
ING	Zinc (Unfiltered)	7440-66-6	µg/L	17.60	31 0	PW-ODPR-02	31 0	PW-ODPR-02	1 / 2	8.4 - 8.4	31	81	0.946	86	(a)	0.36	0.21	Yes	Yes	PBC
ING	Zinc (Filtered)	7440-66-6	µg/L	ND	ND		ND		0 / 2	8.4 - 8.4	ND	81	0.946	86	(a)	--	--	Yes	No	ND
SVOC	Benzaldehyde (Unfiltered)	100-52-7	µg/L	0.52	0.46 J	PW-ODPR-02	0.57 J	PW-ODPO-02	2 / 2	n/a	0.57	NSV	--	NSV		--	--	-	Yes	NSV
SVOC	Benzaldehyde (Filtered)	100-52-7	µg/L	0.53	0.52 J	PW-ODPO-01 F	0.54 J	PW-ODPR-01 F	2 / 2	n/a	0.54	NSV	--	NSV		--	--	-	Yes	NSV

SVOC	Diethylphthalate (Unfiltered)	84-66-2	µg/L	0.19	0.31	J	PW-ODPR-02	0.31	J	PW-ODPR-02	1 / 2	0.12 - 0.12	0.31	75.9	--	75.9	(b)	0.0041	0.0024	-	No	BSV
SVOC	Diethylphthalate (Filtered)	84-66-2	µg/L	0.13	0.21	J	PW-ODPR-01 F	0.21	J	PW-ODPR-01 F	1 / 2	0.11 - 0.11	0.21	75.9	--	75.9	(b)	0.0028	0.0017	-	No	BSV
SVOC	Naphthalene (Unfiltered)	91-20-3	µg/L	0.11	0.16	J	PW-ODPR-02	0.16	J	PW-ODPR-02	1 / 2	0.11 - 0.11	0.16	23.5	--	23.5	(b)	0.0068	0.0046	-	No	BSV
SVOC	Naphthalene (Filtered)	91-20-3	µg/L	ND	ND			ND			0 / 2	0.1 - 0.1	ND	23.5	--	23.5	(b)	--	--	-	No	ND
SVOC	Phenol (Unfiltered)	108-95-2	µg/L	0.26	0.15	J	PW-ODPR-02	0.36	J	PW-ODPO-02	2 / 2	n/a	0.36	58	--	58	(b)	0.0062	0.0044	-	No	BSV
SVOC	Phenol (Filtered)	108-95-2	µg/L	0.16	0.25	J	PW-ODPO-01 F	0.25	J	PW-ODPO-01 F	1 / 2	0.13 - 0.13	0.25	58	--	58	(b)	0.0043	0.0027	-	No	BSV
VOC	Acetone (Unfiltered)	67-64-1	µg/L	ND	ND			ND			0 / 2	5 - 5	ND	564000	--	564000	(e)	--	--	-	No	ND
VOC	Acetone (Filtered)	67-64-1	µg/L	6.25	10	J	PW-ODPO-01 F	10	J	PW-ODPO-01 F	1 / 2	5 - 5	10	564000	--	564000	(e)	0.000018	0.000011	-	No	BSV
VOC	MTBE (Unfiltered)	1634-04-4	µg/L	0.90	1.7	J	PW-ODPR-02	1.7	J	PW-ODPR-02	1 / 2	0.2 - 0.2	1.7	5000	--	5000	(d)	0.00034	0.00018	-	No	BSV
VOC	MTBE (Filtered)	1634-04-4	µg/L	0.80	1.5	J	PW-ODPR-01 F	1.5	J	PW-ODPR-01 F	1 / 2	0.2 - 0.2	1.5	5000	--	5000	(d)	0.0003	0.00016	-	No	BSV
VOC	Toluene (Unfiltered)	108-88-3	µg/L	0.40	0.63	J	PW-ODPR-02	0.63	J	PW-ODPR-02	1 / 2	0.33 - 0.33	0.63	37	--	37	(b)	0.017	0.011	-	No	BSV
VOC	Toluene (Filtered)	108-88-3	µg/L	0.35	0.33	J	PW-ODPO-01 F	0.37	J	PW-ODPR-01 F	2 / 2	n/a	0.37	37	--	37	(b)	0.01	0.0095	-	No	BSV

Notes:

(1) Both unfiltered (total) and filtered (dissolved) surface water samples were analyzed for chemical constituents (with the exception of VOCs which were only analyzed for in unfiltered samples). Filtered and unfiltered results were generally comparable and, therefore, combined for screening purposes. An "F" suffix in the location code indicates a filtered sampled (e.g., cadmium). For certain metals (As, Cd, Cr, Cu, Pb, Hg, Ni, Se, Zn), ESVs are specific to dissolved results; if the

(2) Arithmetic average calculated using one-half the method detection limit (MDL) for non-detect results.

(3) Minimum/maximum detected concentration. "J" indicates an estimated concentration.

(4) MDL range based on non-detect sample results.

(5) SLERA exposure point concentration (EPC) is the maximum detected concentration.

(6) Ecological screening values (ESVs) were selected using the following hierarchy (see also Appendix A, Attachment A):

- (a) USEPA NRWQC for the protection of aquatic life, saltwater
- (b) USEPA Region IV chronic ecological effects values, saltwater
- (c) USEPA EcoTox Thresholds (SQC/SQB) for marine water
- (d) NOAA SQuiRTs for marine water
- (d) USEPA Region III BTAG ecological screening benchmarks for marine surface water
- (e) USEPA Region V ESLs for freshwater

(7) Screening level hazard quotient (HQ) calculated (to two significant figures) as follows: HQ = EPC/ESV.

(8) Bioaccumulation potential based on: USEPA. 2000. Bioaccumulation Testing and Interpretation for the Purpose of Sediment Quality Assessment, Status and Needs. Office of Water. EPA-823-R-00-001. February.

(9) Rationale for COPEC selection/exclusion:

Selection	*Exclusion*
ASV = above ecological screening value	BSV = below ecological screening value
PBC = potentially bioaccumulative constituent	
NSV = no screening value	

(10) Per the Work Plan, the SLERA utilizes only toxaphene samples analyzed using Method 1. Uncertainty associated with the results is discussed in the SLERA uncertainty section.

(11) Surrogate ESVs were utilized as follows:

total chromium uses hexavalent chromium as a surrogate

Shading = Maximum HQ > 1

Definitions:

OU1 = Operable Unit 1 (Outfall Ditch)
SLERA = Screening Level Ecological Risk Assessment
CAS = chemical abstract number
µg/L = microgram per liter
TXP = toxaphene
PAH = polynuclear aromatic hydrocarbon
SVOC = semivolatile organic compound
VOC = volatile organic compound

Table 8-1. Federal and State ARARs
Terry Creek Site; Brunswick, Georgia

Geosyntec consultants

POTENTIAL ARAR	CITATION	BRIEF DESCRIPTION
CHEMICAL-SPECIFIC		
SURFACE WATER		
Clean Water Act-Water Quality Standards	40 CFR Part 131	Sets criteria for surface water quality for 95 carcinogenic and non-carcinogenic compounds based on toxicity to aquatic organisms and human health. Involves river listing and Total Maximum Daily Loads (TMDLs).
USEPA National Recommended Water Quality Criteria	Clean Water Act Part 304(a)	National recommended water quality criteria for protection of aquatic life and human health in surface water for approximately 150 pollutants.
SEDIMENT		
Identification and Listing of Hazardous Waste	40 CFR Part 261	Defines those solid wastes that are subject to regulation as hazardous wastes under 40 CFR Parts 263-265 and Parts 124, 270, and 271
Toxic Substances Control Act	40 CFR Parts 700-766	TSCA addresses the disposal of specific chemicals including polychlorinated biphenyls (PCBs).

Table 8-1. Federal and State ARARs
Terry Creek Site; Brunswick, Georgia

Geosyntec consultants

POTENTIAL ARAR	CITATION	BRIEF DESCRIPTION
LOCATION-SPECIFIC		
FEDERAL COASTAL/FLOODPLAIN WETLANDS		
Endangered Species Act of 1973	50 CFR Part 200 and Part 402	Critical Habitat upon which endangered or threatened species depends.
Fish and Wildlife Coordination Act	33 CFR Parts 320-330	Critical Habitat upon which endangered or threatened species depends.
Policy on Floodplain and Wetlands Assessments for CERCLA Actions	OSWER Directives 9280.0	Provides policy on considering wetlands and floodplains at CERCLA Sites.
Wild and Scenic Rivers Act	16 USC 1271-1287	Rivers shall be preserved in free-flowing condition, and their immediate environments shall be protected for the benefit and enjoyment of present and future generations.
STATE COASTAL/FLOODPLAIN WETLANDS		
Georgia Coastal Marshlands Protection Act	O.C.G.A. 12-5-280	Excavated or dredged material must not be placed in marsh areas to the extent to which it can reasonably be avoided.
Water Quality Control Act	O.C.G.A. 12-5-20	This Act states that the water resources of the state shall be utilized prudently for the maximum benefit of the people. The Act directs that the government of the state shall assume responsibility for the quality and quantity of such water resources and the establishment and maintenance of a water quality and water quantity control program.
Endangered Wildlife and Wildflower Preservation Acts	O.C.G.A. 12-6-170 and O.C.G.A. §§ 27-3-130	The wildflower Act provides for the designation of officially protected plants and authorizes rules for the collection, transport, sale and listing of these plants. The wildlife Act prohibits the capture, killing, or selling of protected species and protects the habitat of these species on public lands.

Table 8-1. Federal and State ARARs
Terry Creek Site; Brunswick, Georgia

Geosyntec consultants

POTENTIAL ARAR	CITATION	BRIEF DESCRIPTION
ACTION- SPECIFIC		
Section 404 of the Clean Water Act	Clean Water Act Part 404(a)	Regulates the discharge of dredged or fill material to waters of the United States.
Occupational Safety and Health Act (OSHA) 29 CFR Part 1910-Occupational Safety And Health Standards	29 CFR Part 1910	Requirements for worker safety.
Occupational Safety and Health Act (OSHA) 29 CFR Part 1926-OSHA Safety and Health Standards for Construction	29 CFR Part 1926	Requirements for worker safety during construction.
Georgia Erosion and Sedimentation Act	O.C.G.A 12-7-1	A sedimentation and erosion control plan must be developed that outlines the procedures that will be followed to prevent erosion and sedimentation.
National Pollutant Discharge Elimination System	40 CFR Part 122, 125	Requires permits for discharge of pollutants for any point source into waters of the U.S.
Guidelines for the Land Disposal of Solid Wastes	40 CFR Part 241	Establishes minimum levels of performance required of any solid waste land disposal site operation and includes operation and maintenance.
Rivers and Harbors Act of 1899	Section 10, U.S.C. § 403	Governs construction in navigable waters of the U.S.
USACE-NED Regulatory Programs	33 CFR Parts 320-330	Governs access to and use of Federal Channels.
Standards Applicable to Transportation of Hazardous Waste	40 CFR Part 263	Establishes standards that apply to transporters of hazardous waste within the U.S. if the transportation requires a manifest under 40 CFR Part 262.
Hazardous Materials Transportation Regulations	40 CRF Parts 107, 171-177	Regulates transportation of hazardous materials.
Hazardous Site Response Act	O.C.G.A. 12-8-90	Governs clean up of releases of hazardous substances.
Hazardous Waste Management Act	O.C.G.A. 12-8-60	Governs the management of hazardous wastes through the regulation of the generation, transportation, storage, treatment, and disposal of hazardous wastes.

Table 8-2. OU1 Rough Order of Magnitude Cost Estimates for Remedial Options for OU1

Name	Description	ROM COST
2	**Sheetpile Re-Routed**	
	Oversight & Other Third Party Services	*$223,790*
	Pre-Mobilization	*$51,249*
	Contractor's Project Management, Site Set-up, Admin.	*$293,214*
	Initial Site Preparation and Controls	*$204,466*
	Dewatering / By-Pass Pumping / Water Management	*$183,964*
	Earthwork - Excavation & Removal, Excluding S,T&D	*$255,761*
	Solidification, Transportation & Disposal (S,T&D)	*$60,252*
	Earthwork - Backfill & Compaction	*$280,321*
	Earthwork - Sub-Aqueous Cap Installation	*$0*
	Earthwork - Aggregates and Armoring	*$355,212*
	Systems Construction / De-Construction	*$2,154,634*
	Final Restoration, Stabilization, Protection	*$125,095*
	SUBTOTAL	$4,187,958
	Contingency, 15%	$628,194
	TOTAL	**$4,816,152**
2A	**Sheetpile Within Existing Channel**	
	Oversight & Other Third Party Services	*$291,900*
	Pre-Mobilization	*$51,741*
	Contractor's Project Management, Site Set-up, Admin.	*$329,389*
	Initial Site Preparation and Controls	*$204,466*
	Dewatering / By-Pass Pumping / Water Management	*$249,514*
	Earthwork - Excavation & Removal, Excluding S,T&D	*$320,862*
	Solidification, Transportation & Disposal (S,T&D)	*$420,262*
	Earthwork - Backfill & Compaction	*$359,640*
	Earthwork - Sub-Aqueous Cap Installation	*$0*
	Earthwork - Aggregates and Armoring	*$253,723*
	Systems Construction / De-Construction	*$1,721,111*
	Final Restoration, Stabilization, Protection	*$103,143*
	SUBTOTAL	$4,305,751
	Contingency, 25%	$1,076,438
	TOTAL	**$5,382,189**
3	**Concrete-Lined Channel Re-Routed**	
	Oversight & Other Third Party Services	*$243,250*
	Pre-Mobilization	*$35,553*
	Contractor's Project Management, Site Set-up, Admin.	*$238,130*
	Initial Site Preparation and Controls	*$152,596*
	Dewatering / By-Pass Pumping / Water Management	*$251,464*
	Earthwork - Excavation & Removal, Excluding S,T&D	*$245,921*
	Solidification, Transportation & Disposal (S,T&D)	*$60,252*
	Earthwork - Backfill & Compaction	*$279,316*
	Earthwork - Sub-Aqueous Cap Installation	*$0*
	Earthwork - Aggregates and Armoring	*$954,030*
	Systems Construction / De-Construction	*$28,407*
	Final Restoration, Stabilization, Protection	*$133,145*
	SUBTOTAL	$2,622,063
	Contingency, 15%	$393,309
	TOTAL	**$3,015,373**
3A	**Concrete-Lined Channel Within Existing Channel**	
	Oversight & Other Third Party Services	*$311,360*
	Pre-Mobilization	*$42,791*
	Contractor's Project Management, Site Set-up, Admin.	*$302,360*
	Initial Site Preparation and Controls	*$152,596*
	Dewatering / By-Pass Pumping / Water Management	*$294,739*
	Earthwork - Excavation & Removal, Excluding S,T&D	*$441,652*
	Solidification, Transportation & Disposal (S,T&D)	*$480,142*
	Earthwork - Backfill & Compaction	*$407,027*
	Earthwork - Sub-Aqueous Cap Installation	*$0*
	Earthwork - Aggregates and Armoring	*$852,541*
	Systems Construction / De-Construction	*$32,871*
	Final Restoration, Stabilization, Protection	*$103,143*
	SUBTOTAL	$3,421,221
	Contingency, 25%	$855,305
	TOTAL	**$4,276,526**
4	**Culvert Re-Routed**	
	Oversight & Other Third Party Services	*$272,440*
	Pre-Mobilization	*$52,779*
	Contractor's Project Management, Site Set-up, Admin.	*$323,631*
	Initial Site Preparation and Controls	*$144,466*
	Dewatering / By-Pass Pumping / Water Management	*$261,214*
	Earthwork - Excavation & Removal, Excluding S,T&D	*$400,639*
	Solidification, Transportation & Disposal (S,T&D)	*$60,252*
	Earthwork - Backfill & Compaction	*$450,377*
	Earthwork - Sub-Aqueous Cap Installation	*$0*
	Earthwork - Aggregates and Armoring	*$355,212*
	Systems Construction / De-Construction	*$2,070,900*
	Final Restoration, Stabilization, Protection	*$59,430*
	SUBTOTAL	$4,451,340
	Contingency, 15%	$667,701
	TOTAL	**$5,119,040**

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Table 8-2. OU1 Rough Order of Magnitude Cost Estimates for Remedial Options for OU1

Name	Description	ROM COST
4A	**Culvert Within Existing Channel**	
	Oversight & Other Third Party Services	*$340,550*
	Pre-Mobilization	*$54,590*
	Contractor's Project Management, Site Set-up, Admin.	*$365,542*
	Initial Site Preparation and Controls	*$213,428*
	Dewatering / By-Pass Pumping / Water Management	*$282,109*
	Earthwork - Excavation & Removal, Excluding S,T&D	*$309,767*
	Solidification, Transportation & Disposal (S,T&D)	*$486,094*
	Earthwork - Backfill & Compaction	*$424,944*
	Earthwork - Sub-Aqueous Cap Installation	*$0*
	Earthwork - Aggregates and Armoring	*$253,723*
	Systems Construction / De-Construction	*$1,859,458*
	Final Restoration, Stabilization, Protection	*$51,968*
	SUBTOTAL	$4,642,173
	Contingency, 25%	$1,160,543
	TOTAL	**$5,802,717**
5	**Sub-Aqueous Low Permeability Isolation Cap**	
	Oversight & Other Third Party Services	*$330,820*
	Pre-Mobilization	*$48,577*
	Contractor's Project Management, Site Set-up, Admin.	*$336,511*
	Initial Site Preparation and Controls	*$161,178*
	Dewatering / By-Pass Pumping / Water Management	*$298,114*
	Earthwork - Excavation & Removal, Excluding S,T&D	*$1,201,465*
	Solidification, Transportation & Disposal (S,T&D)	*$649,615*
	Earthwork - Backfill & Compaction	*$537,431*
	Earthwork - Sub-Aqueous Cap Installation	*$247,643*
	Earthwork - Aggregates and Armoring	*$727,339*
	Systems Construction / De-Construction	*$32,871*
	Final Restoration, Stabilization, Protection	*$103,143*
	SUBTOTAL	$4,674,705
	Contingency, 25%	$1,168,676
	TOTAL	**$5,843,381**
5A	**Sub-Aqueous Carbon-Amended Cap (Sand/GAC & Rip Rap)**	
	Oversight & Other Third Party Services	*$330,820*
	Pre-Mobilization	*$48,662*
	Contractor's Project Management, Site Set-up, Admin.	*$336,879*
	Initial Site Preparation and Controls	*$161,178*
	Dewatering / By-Pass Pumping / Water Management	*$298,114*
	Earthwork - Excavation & Removal, Excluding S,T&D	*$1,201,465*
	Solidification, Transportation & Disposal (S,T&D)	*$649,615*
	Earthwork - Backfill & Compaction	*$537,431*
	Earthwork - Sub-Aqueous Cap Installation	*$255,750*
	Earthwork - Aggregates and Armoring	*$727,339*
	Systems Construction / De-Construction	*$32,871*
	Final Restoration, Stabilization, Protection	*$103,143*
	SUBTOTAL	$4,683,266
	Contingency, 25%	$1,170,816
	TOTAL	**$5,854,082**
6	**Sub-Aqueous Armoured Cap (Soil & Rip Rap)**	
	Oversight & Other Third Party Services	*$330,820*
	Pre-Mobilization	*$45,988*
	Contractor's Project Management, Site Set-up, Admin.	*$325,257*
	Initial Site Preparation and Controls	*$161,178*
	Dewatering / By-Pass Pumping / Water Management	*$298,114*
	Earthwork - Excavation & Removal, Excluding S,T&D	*$548,239*
	Solidification, Transportation & Disposal (S,T&D)	*$653,226*
	Earthwork - Backfill & Compaction	*$537,431*
	Earthwork - Sub-Aqueous Cap Installation	*$0*
	Earthwork - Aggregates and Armoring	*$727,339*
	Systems Construction / De-Construction	*$32,871*
	Final Restoration, Stabilization, Protection	*$103,143*
	SUBTOTAL	$3,763,606
	Contingency, 25%	$940,901
	TOTAL	**$4,704,507**

Notes
ROM: Rough Order of Magnitude estimates are provided for comparison of remedial options
Detailed estimates for each alternative are presented in Appendix F.
Costs based on 2013 published industry standards and preliminary engineering estimates.
Costs do not include design, contractor oversight or quality assurance.
Estimates assume all soils excavated can be used for fill.
Transportation and disposal of excavated sediments is assumed to be non-hazardous.

Table 8-3. Summary and Ranking of Remedial Alternatives

	Alternative #	*1*	*2*	*2A*	*3*	*3A*	*4*	*4A*	*5*	*5A*	*6*
	Weighting Factor	**No Further Action**	**Sheet Pile Channel Re-Routed**	**Sheet Pile Channel within Existing Channel**	**Concrete-Lined Channel Re-Routed**	**Concrete-Lined Channel within Existing Channel**	**Culvert Re-Routed**	**Culvert within Existing Channel**	**Isolation Cap**	**Sand/GAC Channel**	**Riprap Armored Channel**
Threshold Criteria											
Protection of Environment	*3*	1	10	7	10	7	10	7	4	4	4
Compliance with ARARs	*3*	1	10	10	10	10	10	10	10	10	10
Balancing Criteria											
Long-term effectiveness	*2*	1	10	7	10	7	10	7	7	7	7
Reduction of toxicity, mobility, or volume	*2*	1	10	7	10	7	10	7	7	7	7
Short-term effectiveness	*2*	1	10	10	10	10	10	10	10	10	10
Implementability	*2*	10	9	6	8	5	7	4	1	2	3
Cost	*2*	10	6	4	9	8	5	3	2	1	7
Summed Weighted Score		**52**	**150**	**119**	**154**	**125**	**144**	**113**	**96**	**96**	**110**
Ranking Summary		**10**	**2**	**5**	**1**	**4**	**3**	**6**	**8**	**8**	**7**
Capital and O&M Cost (in millions $)		$0.00	$4.82	$5.38	$3.02	$4.28	$5.12	$5.80	$5.84	$5.85	$4.70

Notes

The 10 OPTIONS are scored with 1 being the "worst" score and 10 being the "best" score relative to each other. Scores were then multiplied by a weighting factor and summed for a summed weighted score. The highest total score is the most favorable option.

Ranking summary: the highest total score option was assigned a rank of 1 (most favorable); the lowest scoring option a 10 (least favorable).

Threshold criteria were assigned the highest weight due to the need to be met. All options meet these criteria, but differ slightly according to rank assigned. Balancing criteria were assigned a lower weight.

Protection of Environment

Options 2,3,4 rank highest since the discharge will flow through a new, uncontaminated conveyance structure. Options 5,5A,6 are considered least protective because capping materials used are potentially more permeable to contaminants, there is a greater potential for release of downstream during construction, and longer term structural failure could result in future receptor exposure to OU1 sediments.

Long-term effectiveness

Options 2,3,4 are expected to have more permanence since any potential structural failure will not result in the release of contamination to the environment

Reduction of toxicity, mobility or volume

Options 2,3,4 rank highest since the mobility of contaminated sediments will be reduced via a new conveyance structure.

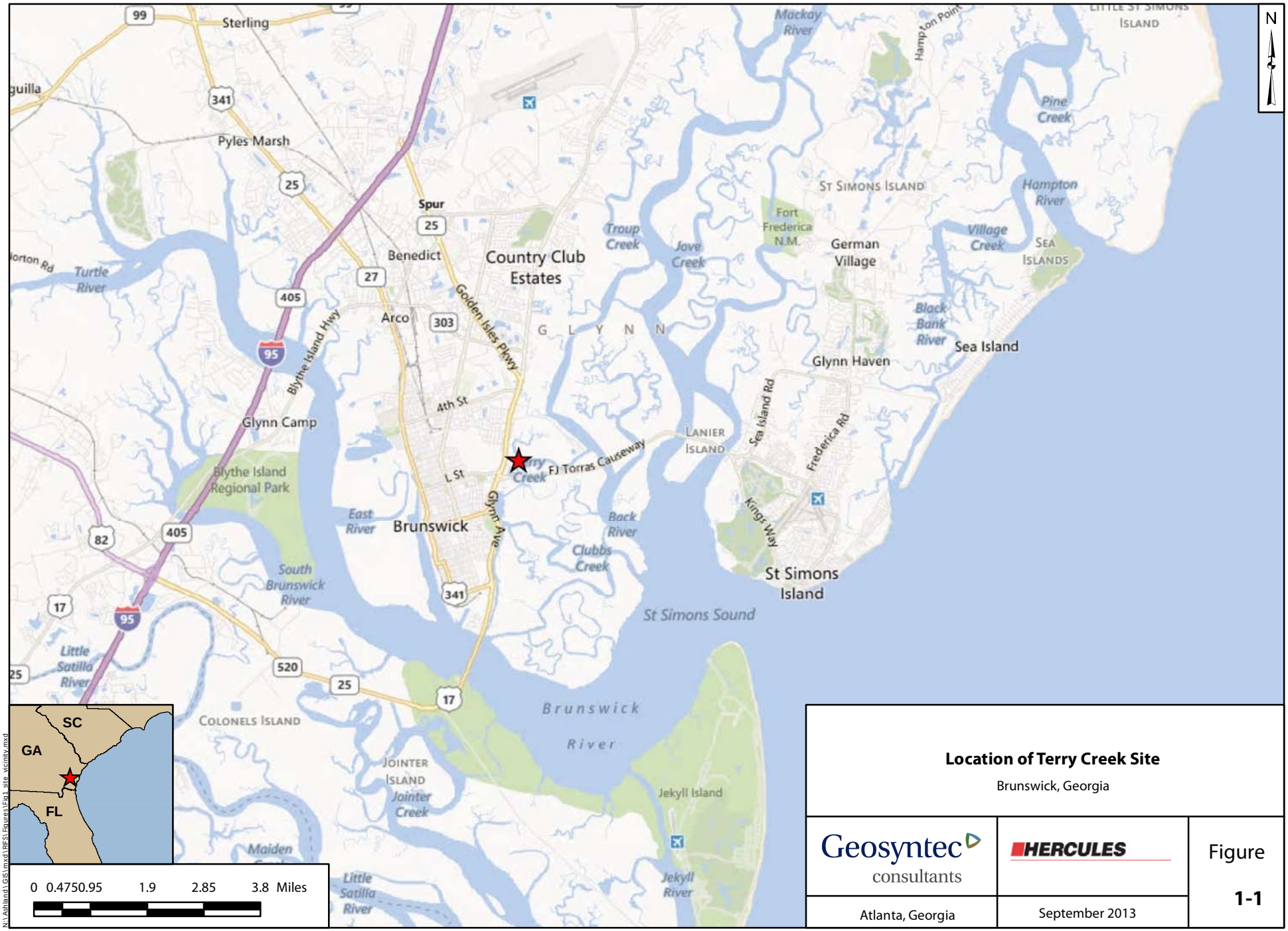
Implementability

Each option has a unique rank based on constructability items such as importing backfill and water management during construction, etc.

Cost

Detailed cost estimates were prepared for each estimate (provided in Appendix F) and ranked according to total capital and operational and maintenance costs.

FIGURES



Location of Terry Creek Site

Brunswick, Georgia

Geosyntec consultants

HERCULES

Figure 1-1

Atlanta, Georgia

September 2013

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Terry Creek Site Operable Units

Brunswick, Georgia

Geosyntec consultants

HERCULES

Figure 1-2

Atlanta, Georgia

Qcnrc k ber 2011

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1999-2000 Sediment Removal Areas in Outfall Ditch and Terry and Dupree Creeks

Brunswick, Georgia

Geosyntec consultants

HERCULES

Figure 1-3

Atlanta, Georgia

January 2014

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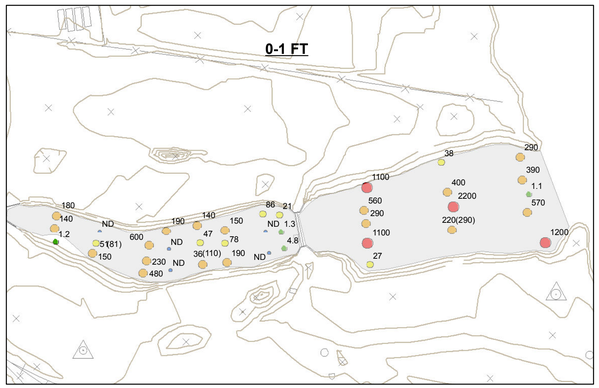
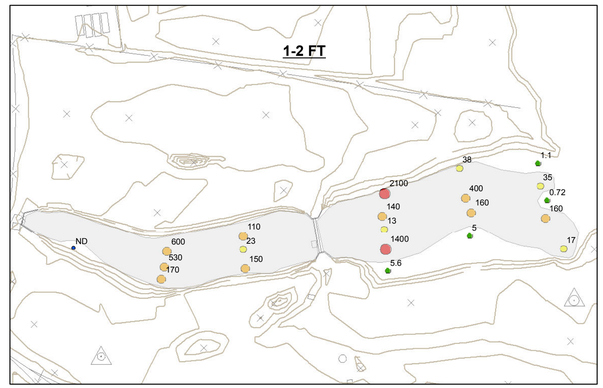
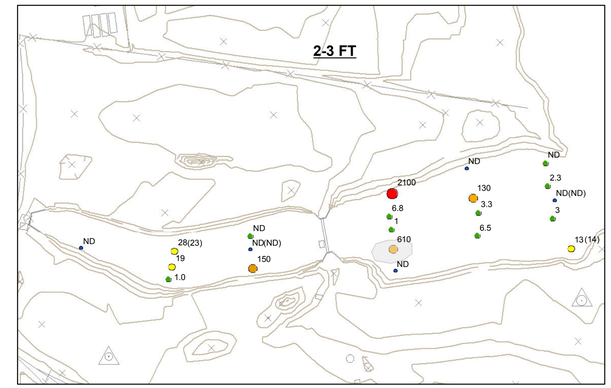
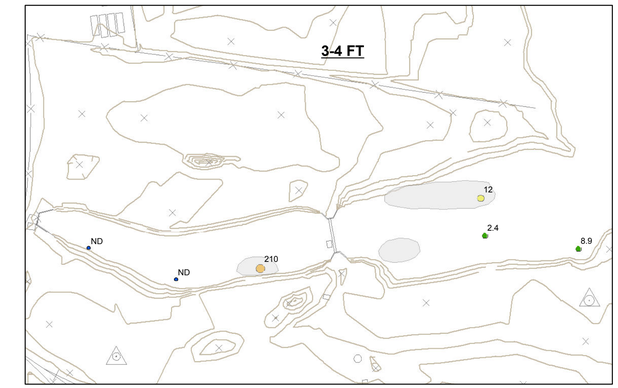
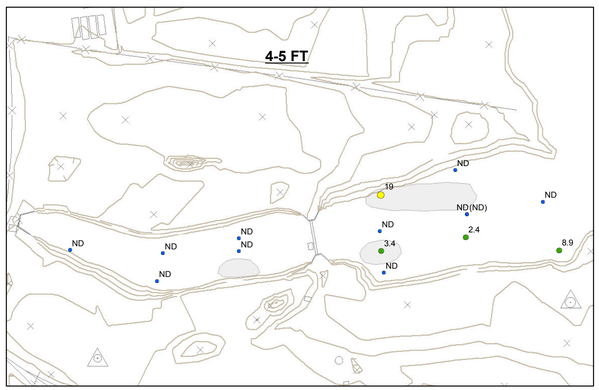
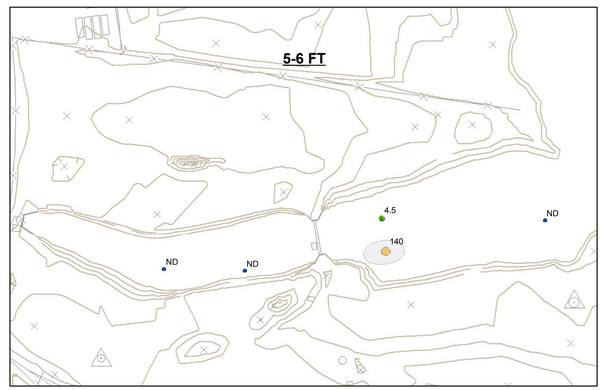


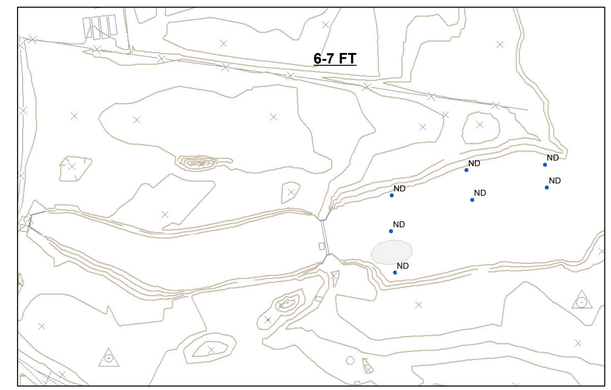


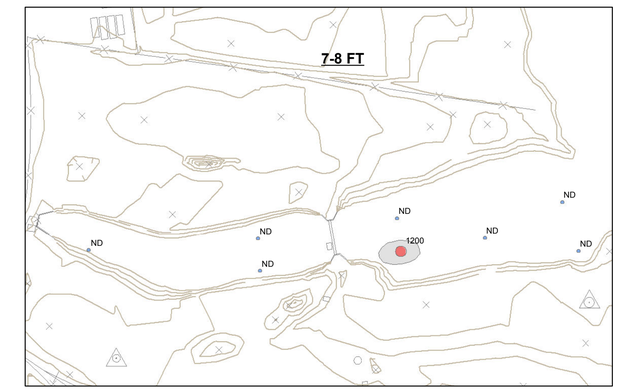


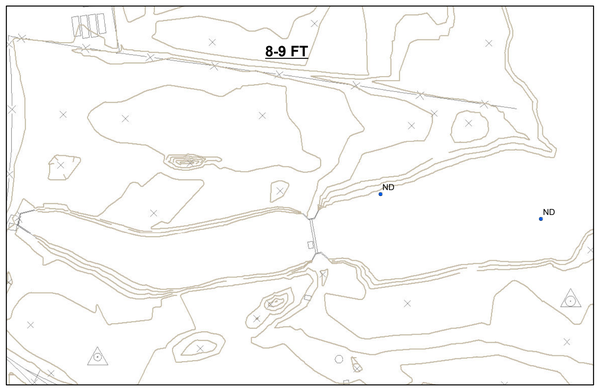


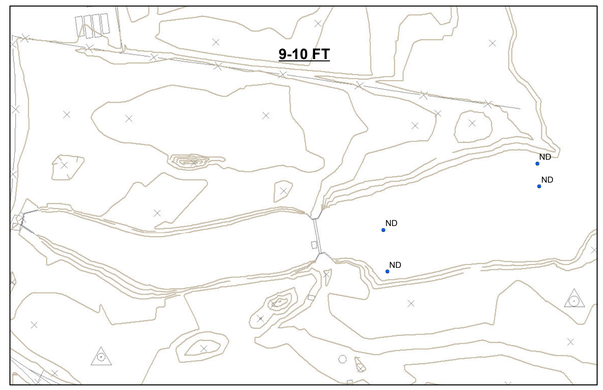


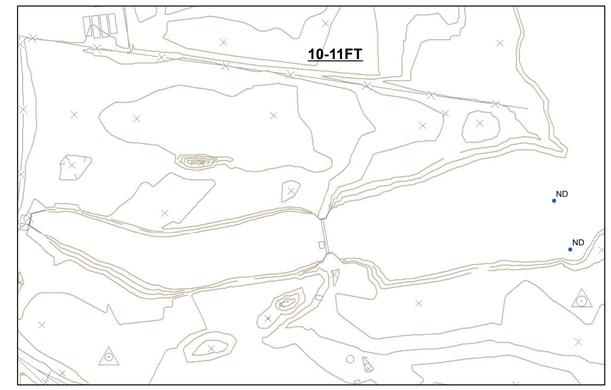


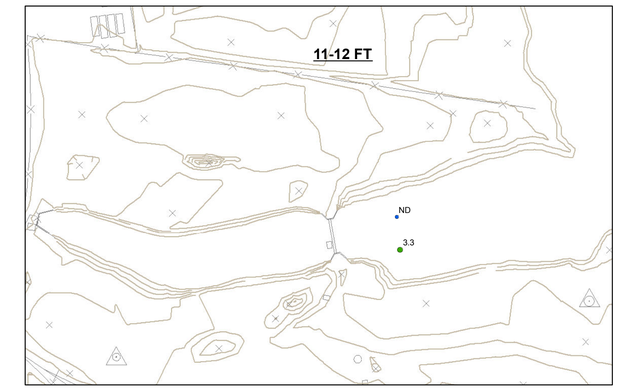


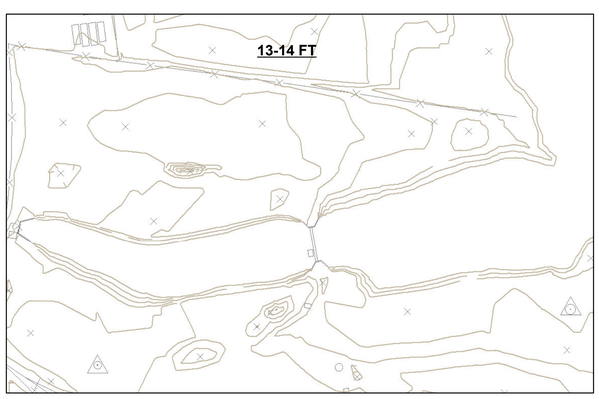












Legend

Toxaphene Concentrations (ppm)
Samples collected in 1999-2000

- ND
- 1 - 10
- 10 - 100
- 100 - 1000
- 1000 - 2200
- Contours
- Site Features
- Removal Area Estimate

Values in parenthesis indicate duplicate results.

N

0 60 120 240 Feet

Post-Excavation Sediment Sample Results in the Terry Creek Outfall Ditch

Brunswick, Georgia

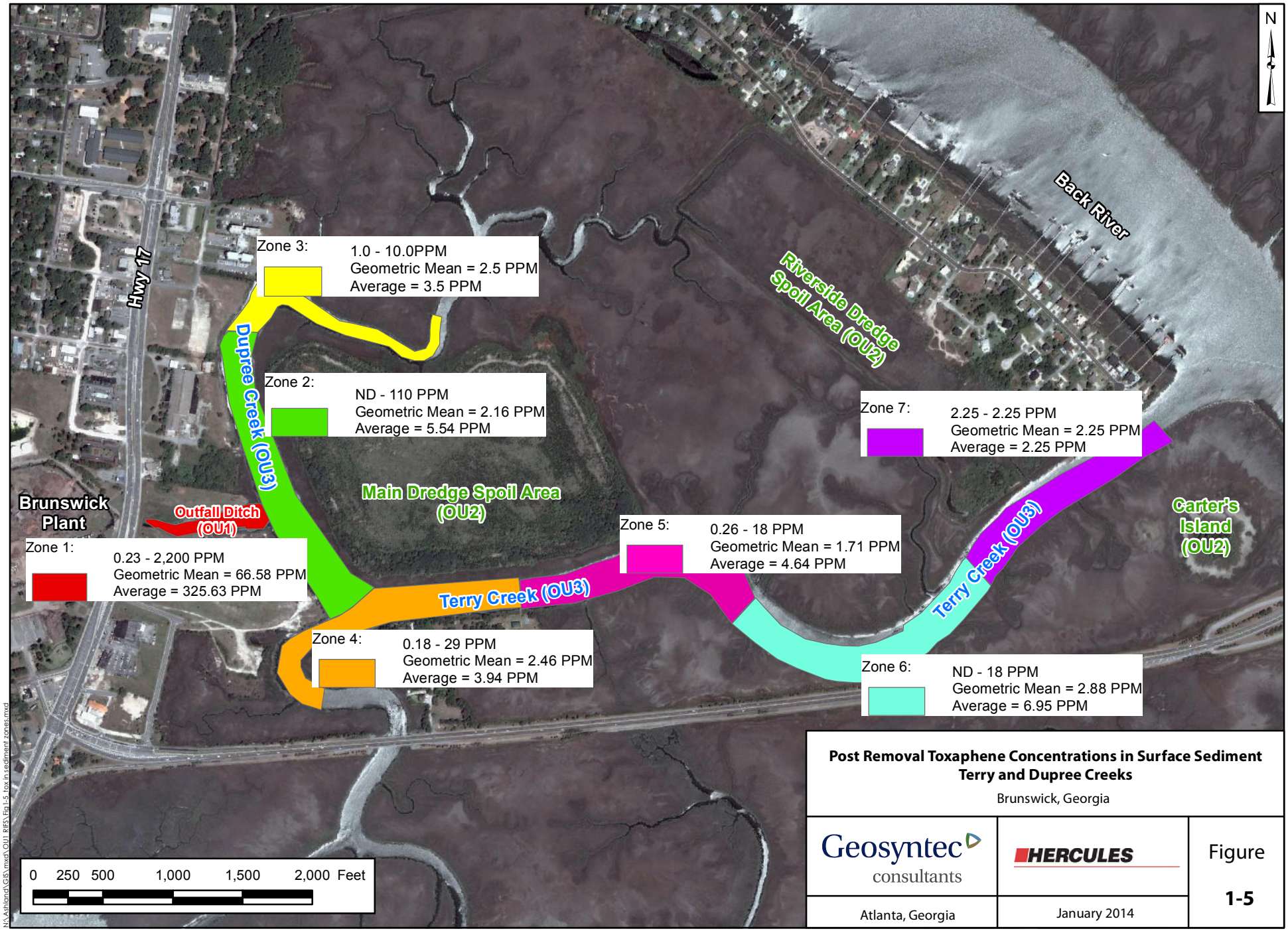
Geosyntec consultants

HERCULES

Figure 1-4

Atlanta, Georgia

September 2013



Post Removal Toxaphene Concentrations in Surface Sediment
Terry and Dupree Creeks

Brunswick, Georgia

Geosyntec consultants	HERCULES	Figure
Atlanta, Georgia	January 2014	1-5

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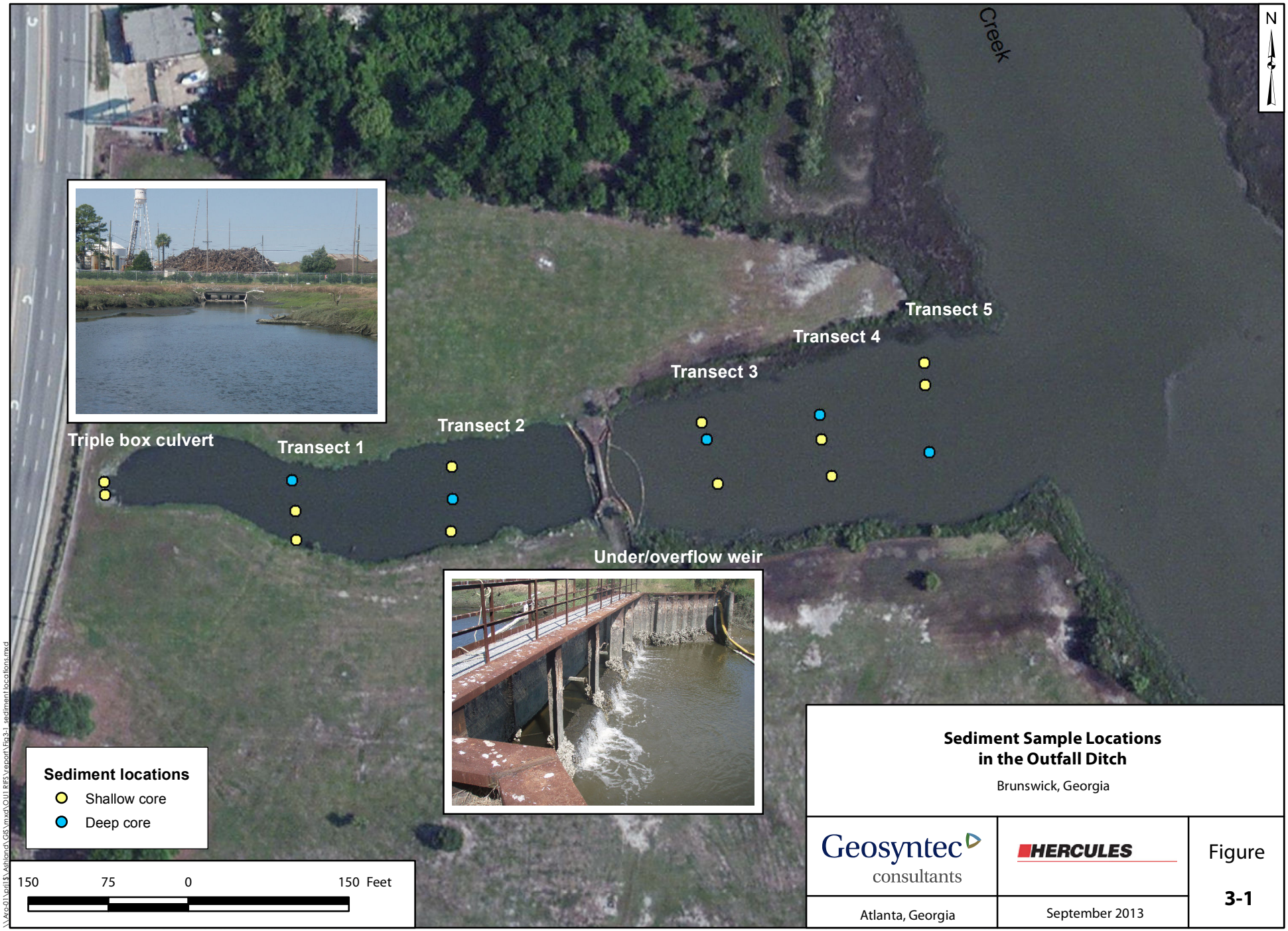


Sediment Sample Locations in the Outfall Ditch

Brunswick, Georgia

Geosyntec consultants

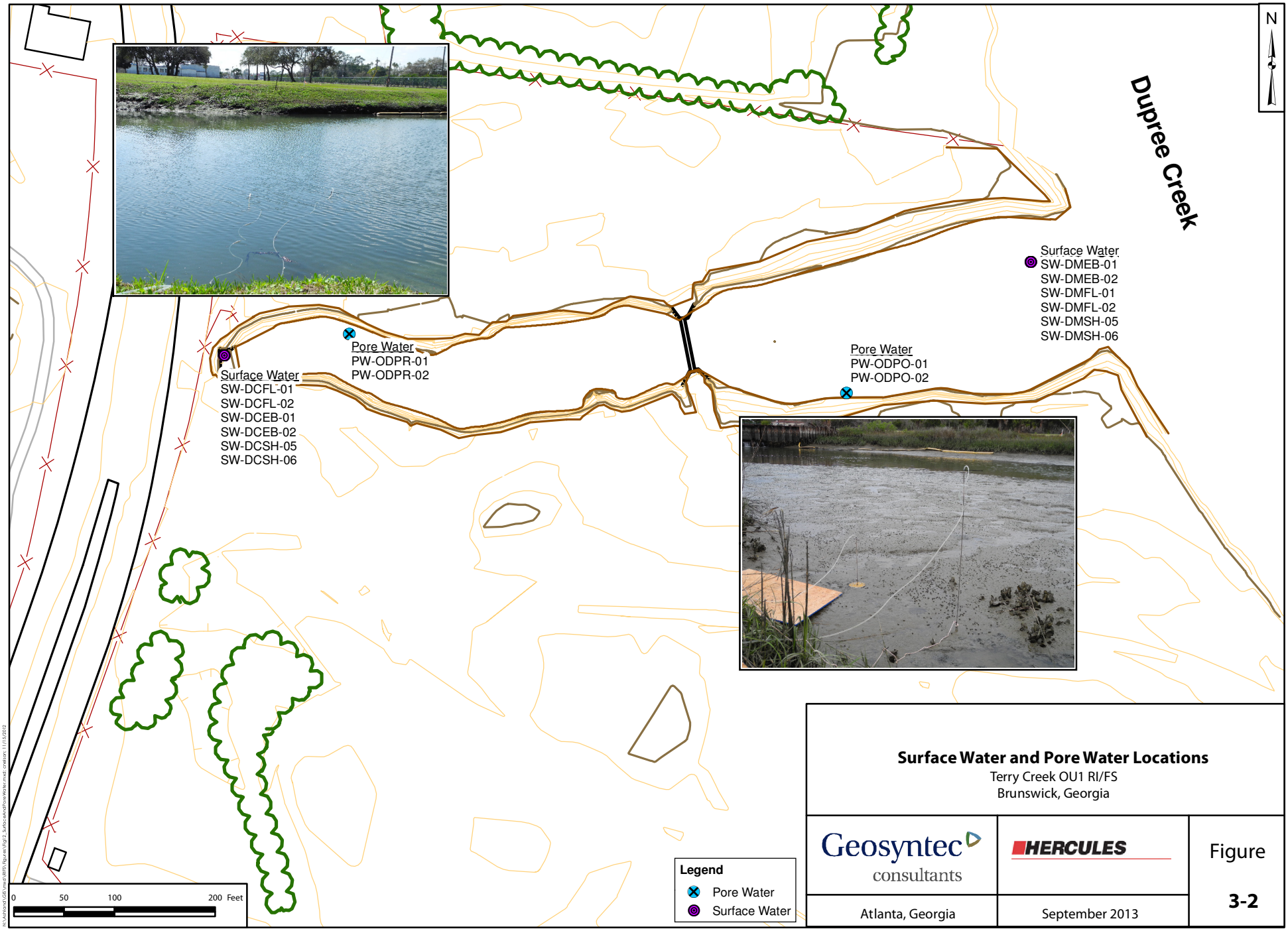
HERCULES

Figure 3-1

Atlanta, Georgia

September 2013

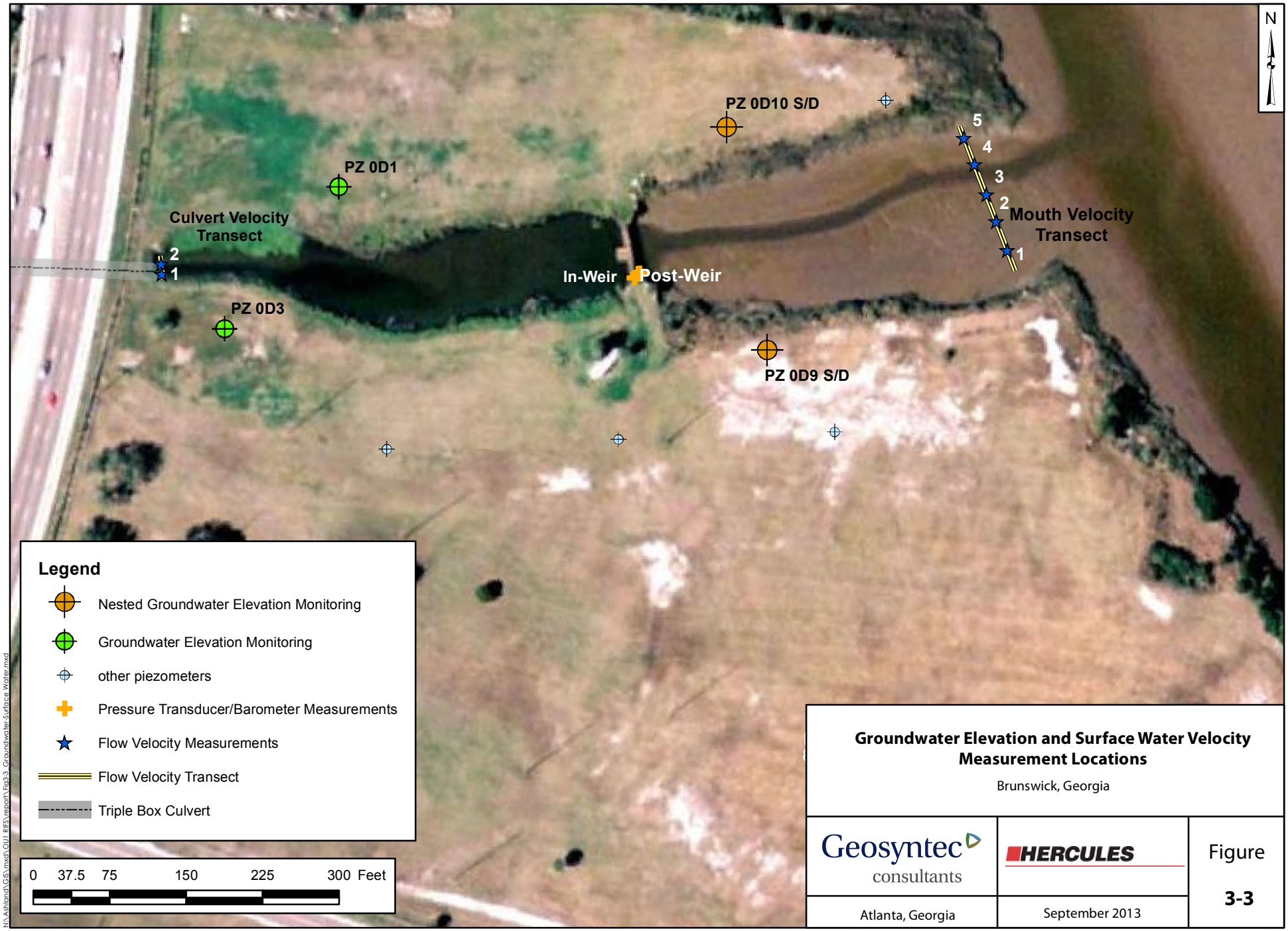
\\Ara-01\prj1$\Ashland\GIS\mxd\OU1 RIFS\report\Fig3-1_sediment locations.mxd



Surface Water and Pore Water Locations
Terry Creek OU1 RI/FS
Brunswick, Georgia

Geosyntec consultants | HERCULES | Figure 3-2

Atlanta, Georgia | September 2013



Groundwater Elevation and Surface Water Velocity Measurement Locations

Brunswick, Georgia

Geosyntec consultants

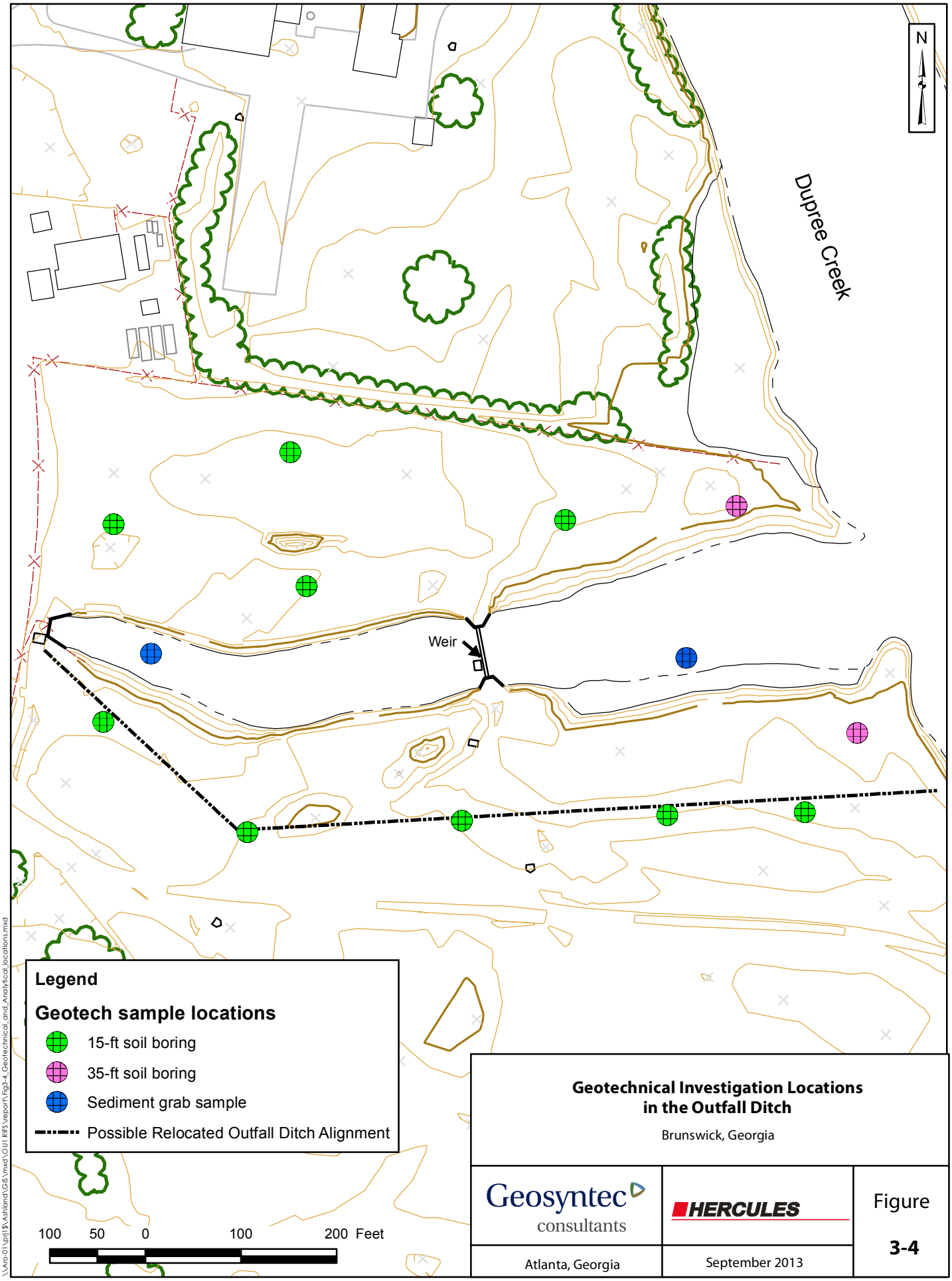
HERCULES

Figure 3-3

Atlanta, Georgia

September 2013

N:\Ashland\GIS\mxd\OU1 RIFS\report\Fig3-3_Groundwater-Surface Water.mxd



Geotechnical Investigation Locations in the Outfall Ditch

Brunswick, Georgia

Geosyntec consultants

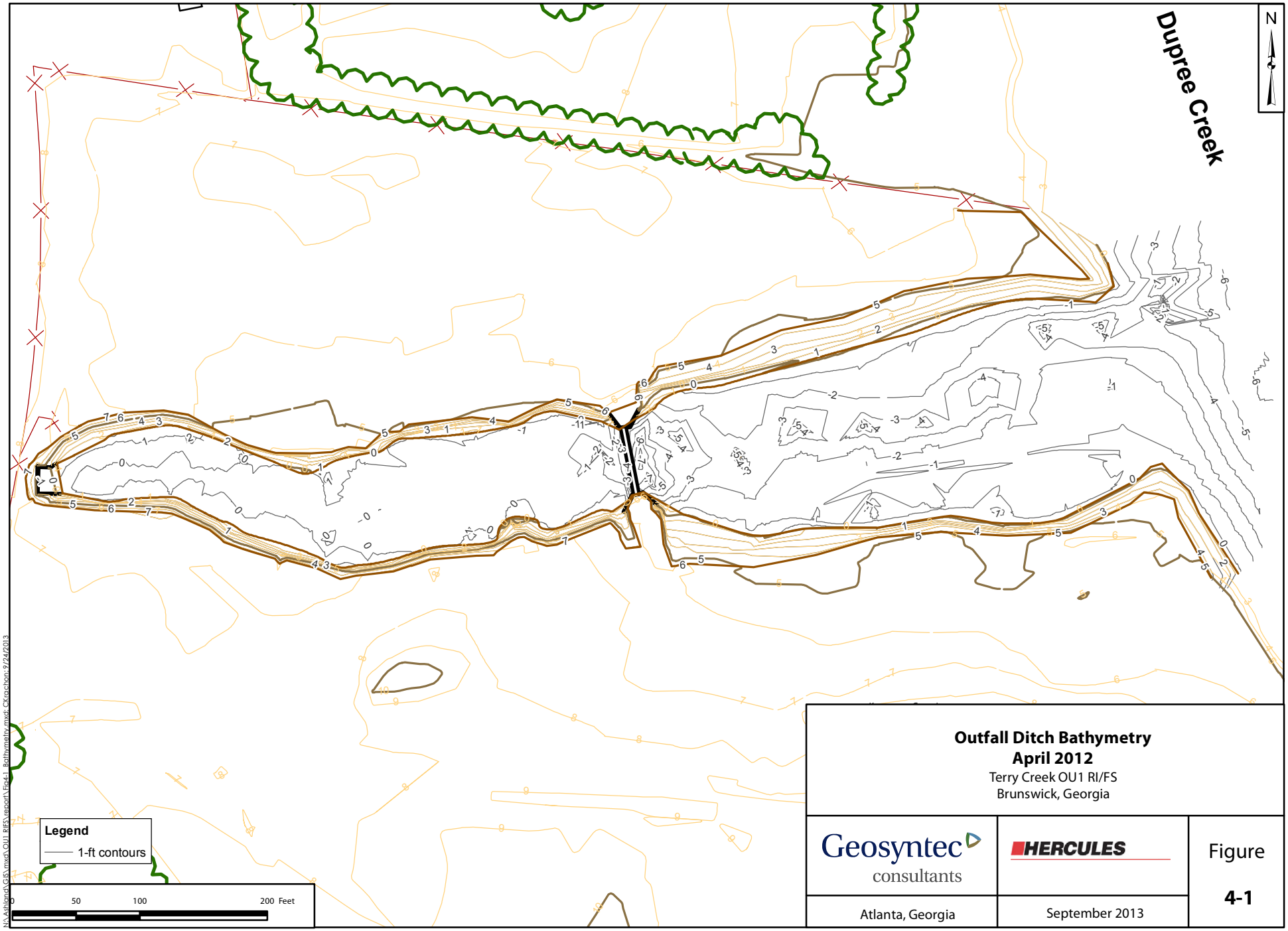
HERCULES

Atlanta, Georgia

September 2013

Figure 3-4

\\Aro-01\proj$\Ashland\GIS\mxd\OU1 RIFS\report\Fig3-4_Geotechnical_and_Analytical_locations.mxd



Outfall Ditch Bathymetry
April 2012
Terry Creek OU1 RI/FS
Brunswick, Georgia

Geosyntec consultants

HERCULES

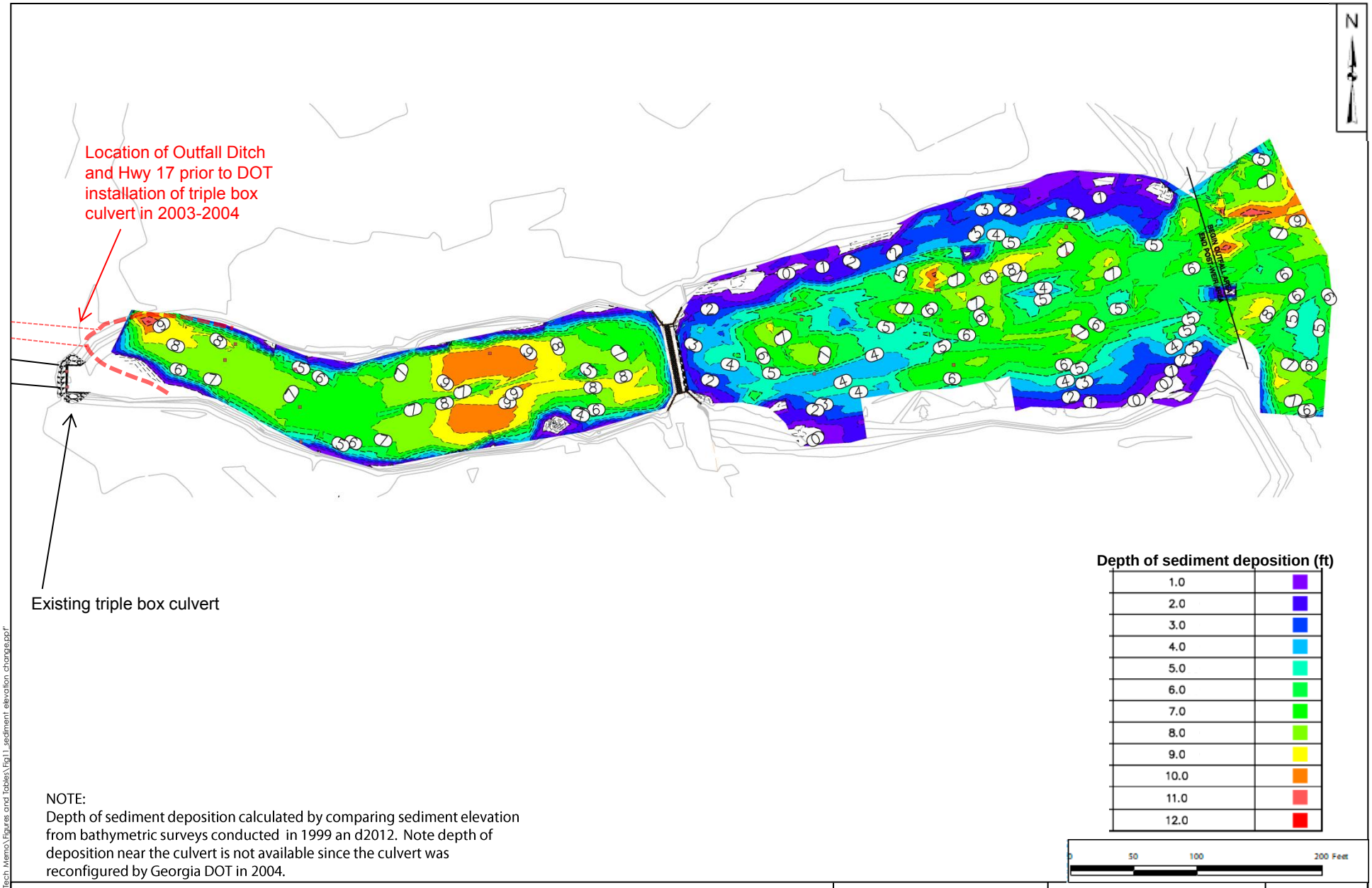
Atlanta, Georgia

September 2013

Figure

4-1

N:\Ashland\GIS\mxd\OU1 RIFS\report\Fig4-1_Bathymetry.mxd; CKrgochon; 9/24/2013



NOTE:
Depth of sediment deposition calculated by comparing sediment elevation from bathymetric surveys conducted in 1999 an d2012. Note depth of deposition near the culvert is not available since the culvert was reconfigured by Georgia DOT in 2004.

Sediment deposition in Outfall Ditch between 1999 and 2012

Terry Creek OU1 RI/FS
Brunswick, Georgia

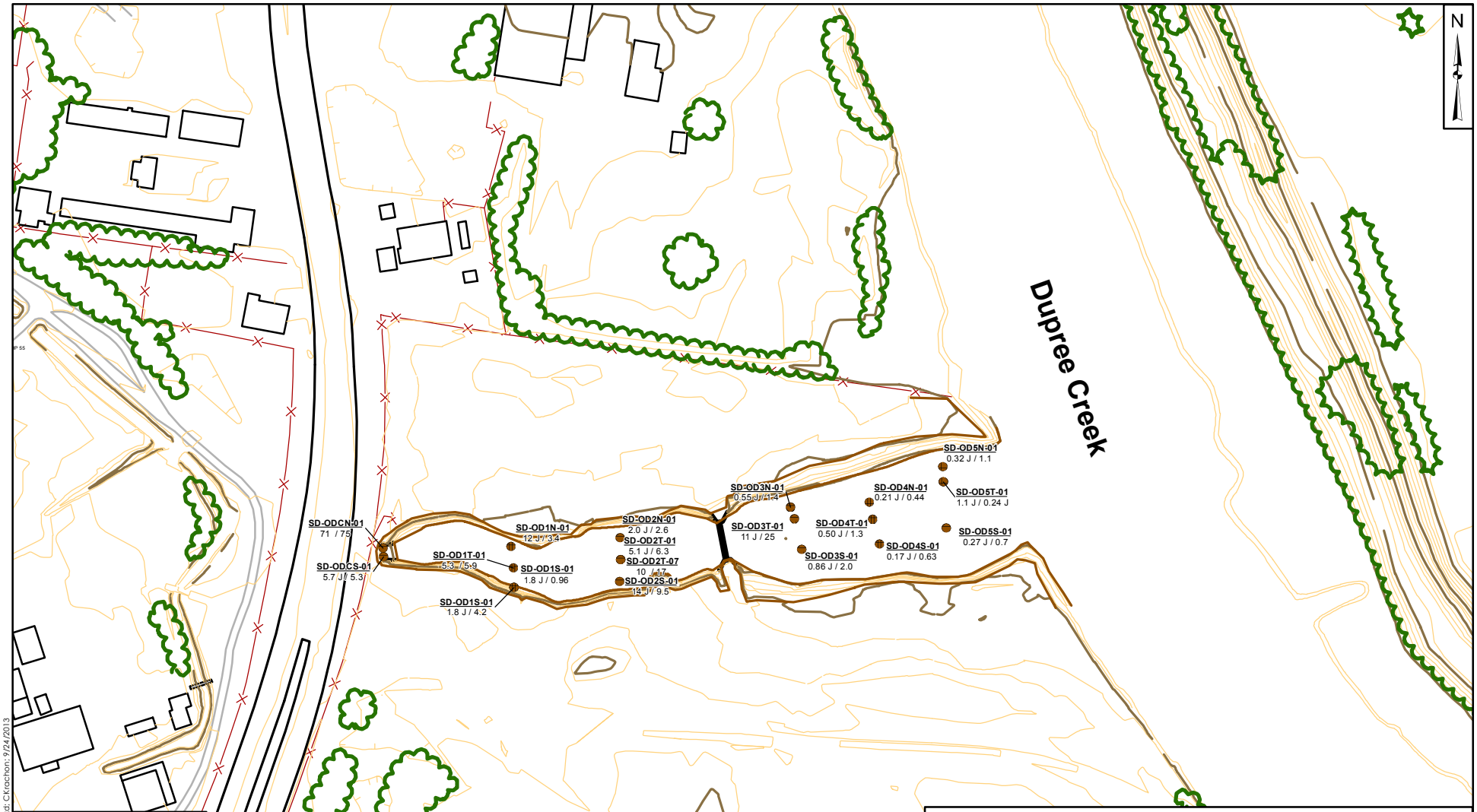
Geosyntec consultants
Atlanta, Georgia

HERCULES

September 2013

Figure 4-2

N:\Ashland\OU1 RIFS Report\Tech Memo\Figures and Tables\Fig11_sediment elevation change.ppt



Legend

- Sediment Sample Location

Notes:
1. All toxaphene results are report in mg/kg.
2. J - Estimated value
3. Sediment samples collected between 0 - 0.5 ft bgs.

Location
Method 1 / Method 2

Toxaphene in Shallow Sediment Samples
0 - 0.5 ft bgs
Terry Creek OU1 RI/FS
Brunswick, Georgia

Geosyntec consultants

HERCULES

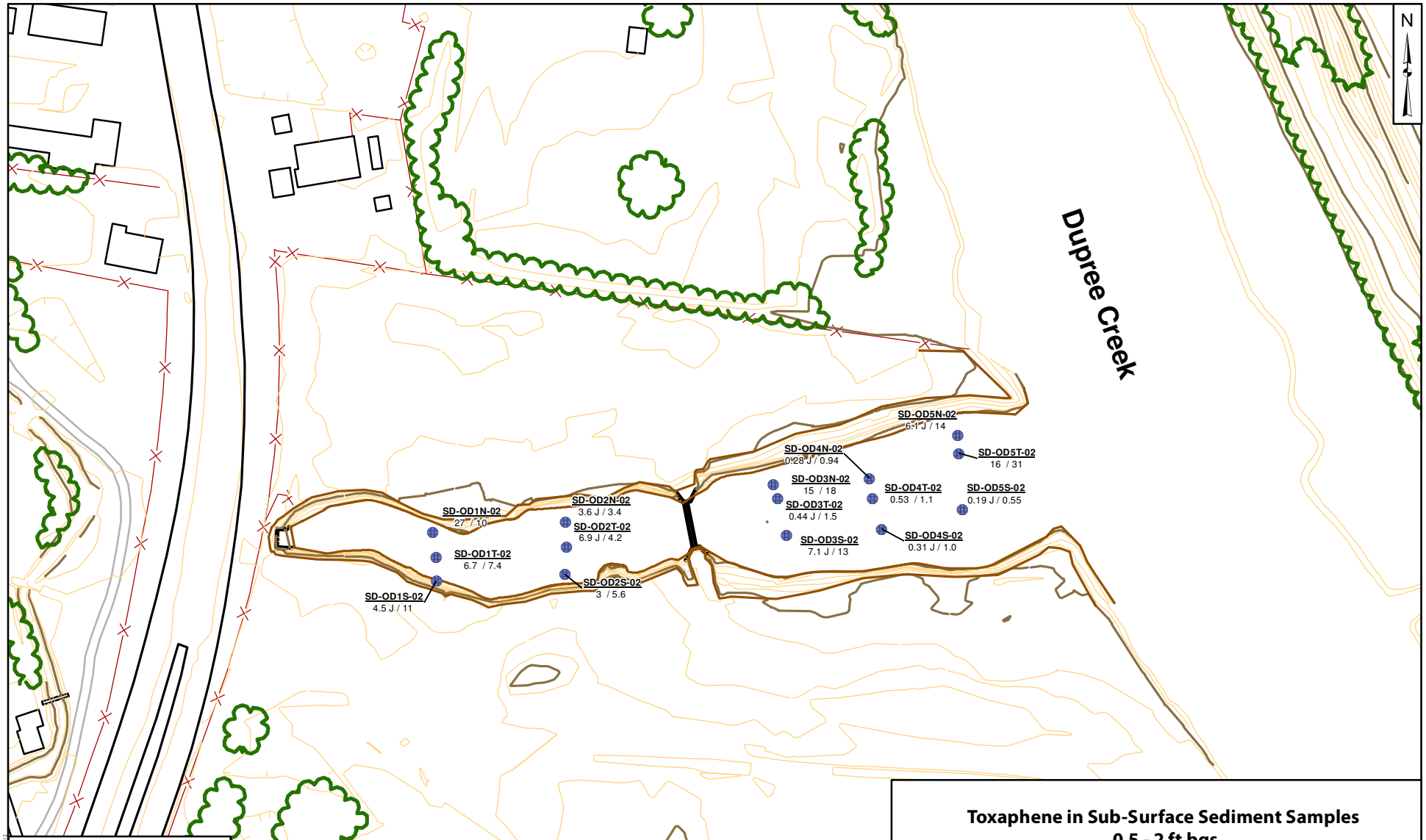
Atlanta, Georgia

September 2013

Figure

5-1

N:\Ashland\GIS\mxd\OU1 RIFS\report\Fig5-1_Sediment0_05.mxd; CKrachon; 9/24/2013



Notes:
1. All toxaphene results are report in mg/kg.
2. J - Estimated value
3. Sediment samples collected between 0.5 - 2 ft bgs.

Location
Method 1 / Method 2

Legend
Sediment Sample Location

Toxaphene in Sub-Surface Sediment Samples
0.5 - 2 ft bgs
Terry Creek OU1 RI/FS
Brunswick, Georgia

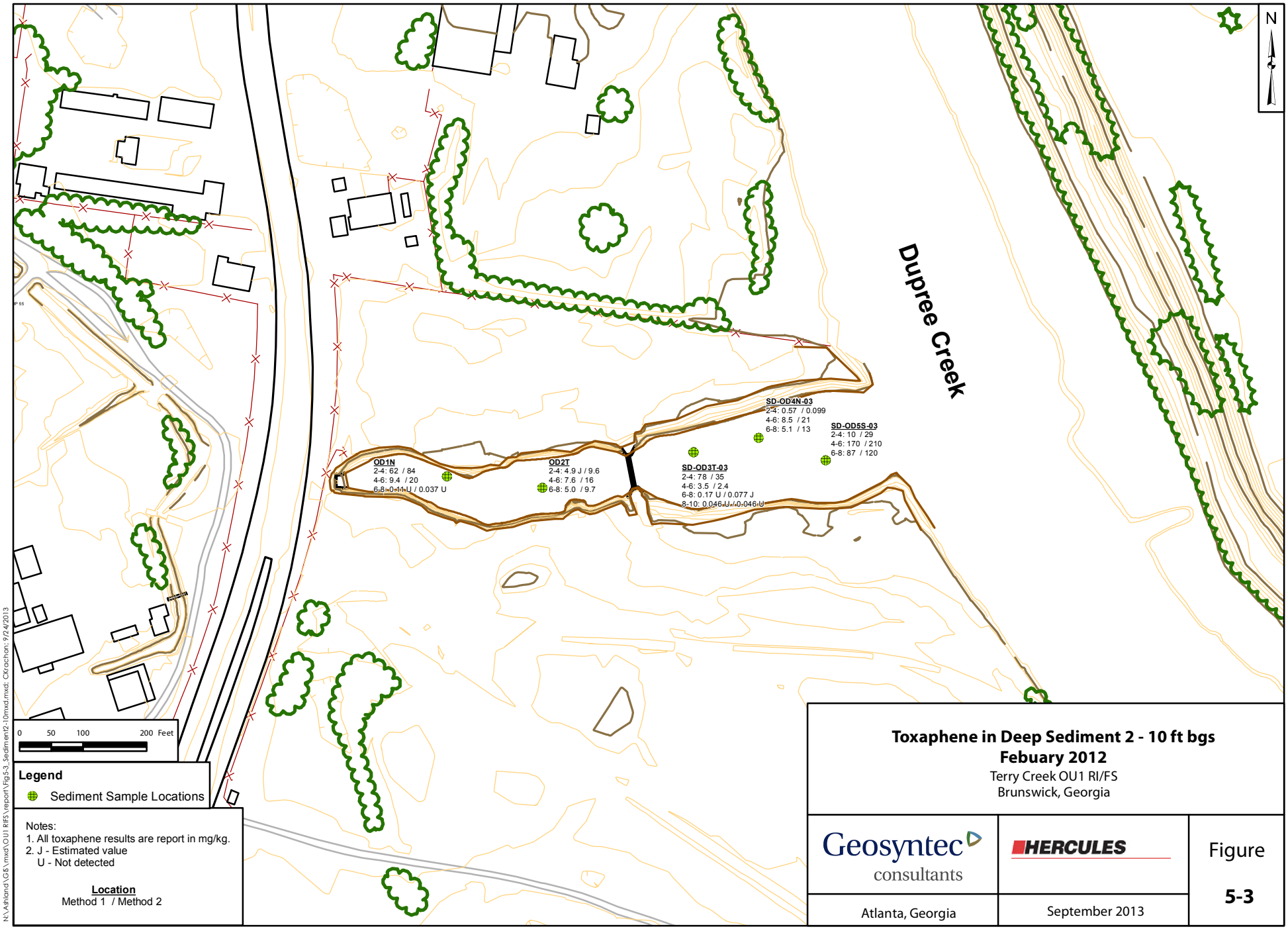
Geosyntec consultants

HERCULES

Figure **5-2**

Atlanta, Georgia

September 2013


N
Duprée Creek
OD1N
2-4: 62 / 84
4-6: 9.4 / 20
6-8: 0.11 U / 0.037 U
OD2T
2-4: 4.9 J / 9.6
4-6: 7.6 / 16
6-8: 5.0 / 9.7
SD-OD3T-03
2-4: 78 / 35
4-6: 3.5 / 2.4
6-8: 0.17 U / 0.077 J
8-10: 0.046 U / 0.046 U
SD-OD4N-03
2-4: 0.57 / 0.099
4-6: 8.5 / 21
6-8: 5.1 / 13
SD-OD5S-03
2-4: 10 / 29
4-6: 170 / 210
6-8: 87 / 120
0 50 100 200 Feet
Legend
Sediment Sample Locations
Notes:
1. All toxaphene results are report in mg/kg.
2. J - Estimated value
U - Not detected
Location
Method 1 / Method 2
Toxaphene in Deep Sediment 2 - 10 ft bgs
Febuary 2012
Terry Creek OU1 RI/FS
Brunswick, Georgia
Geosyntec consultants
HERCULES
Figure
5-3
Atlanta, Georgia
September 2013
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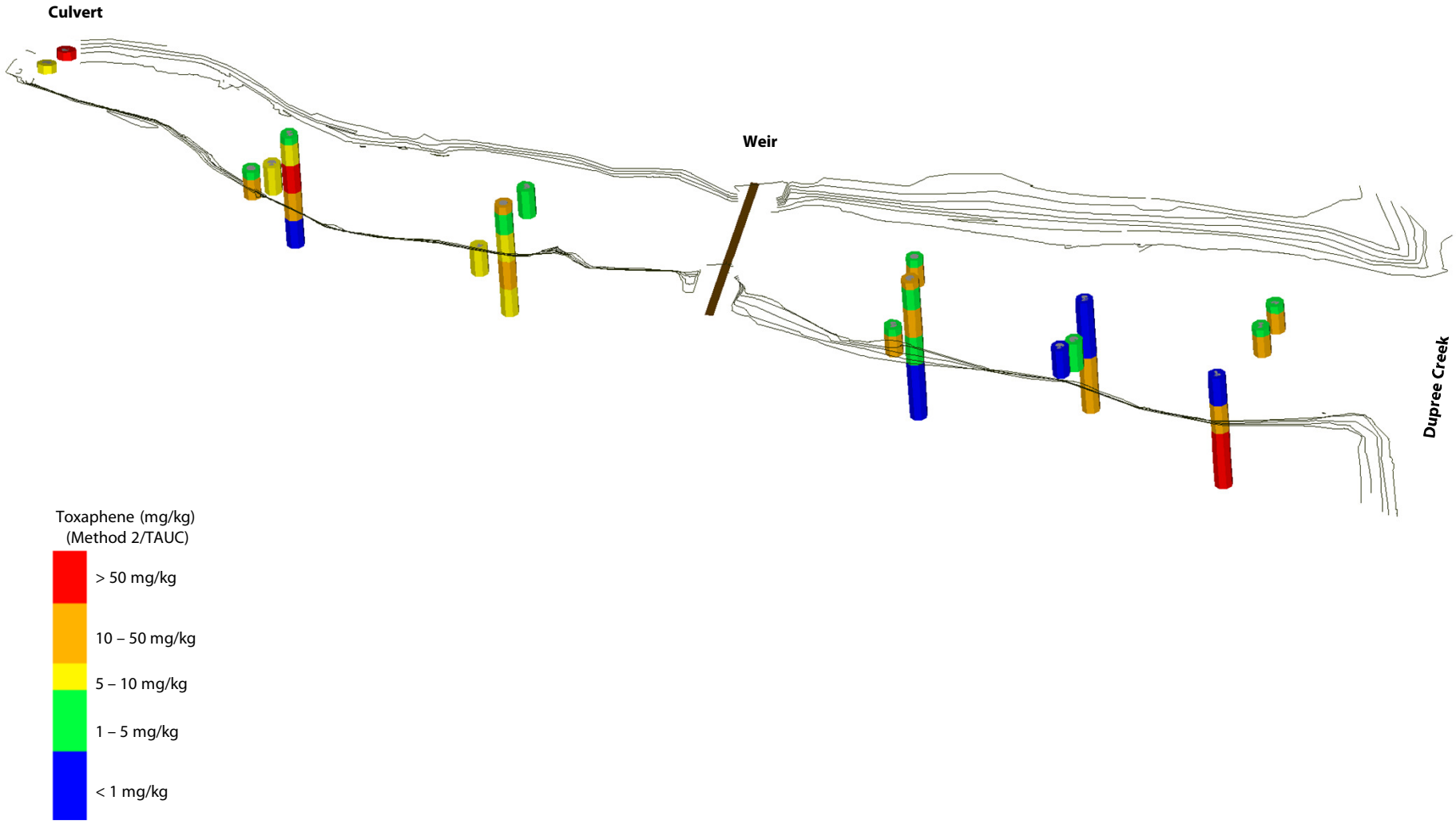

Toxaphene Concentrations in Core Samples

Terry Creek OU1 RI/FS
Brunswick, Georgia

Geosyntec consultants
Atlanta, Georgia

HERCULES

September 2013

Figure 5-4

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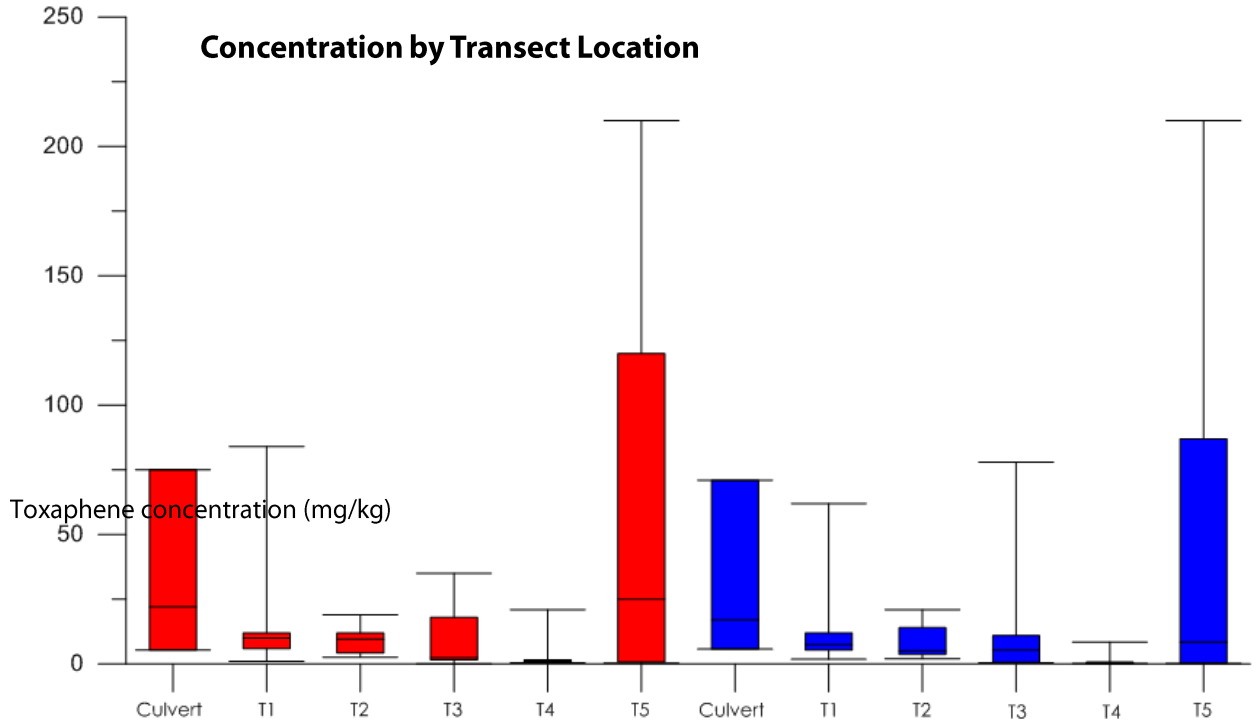
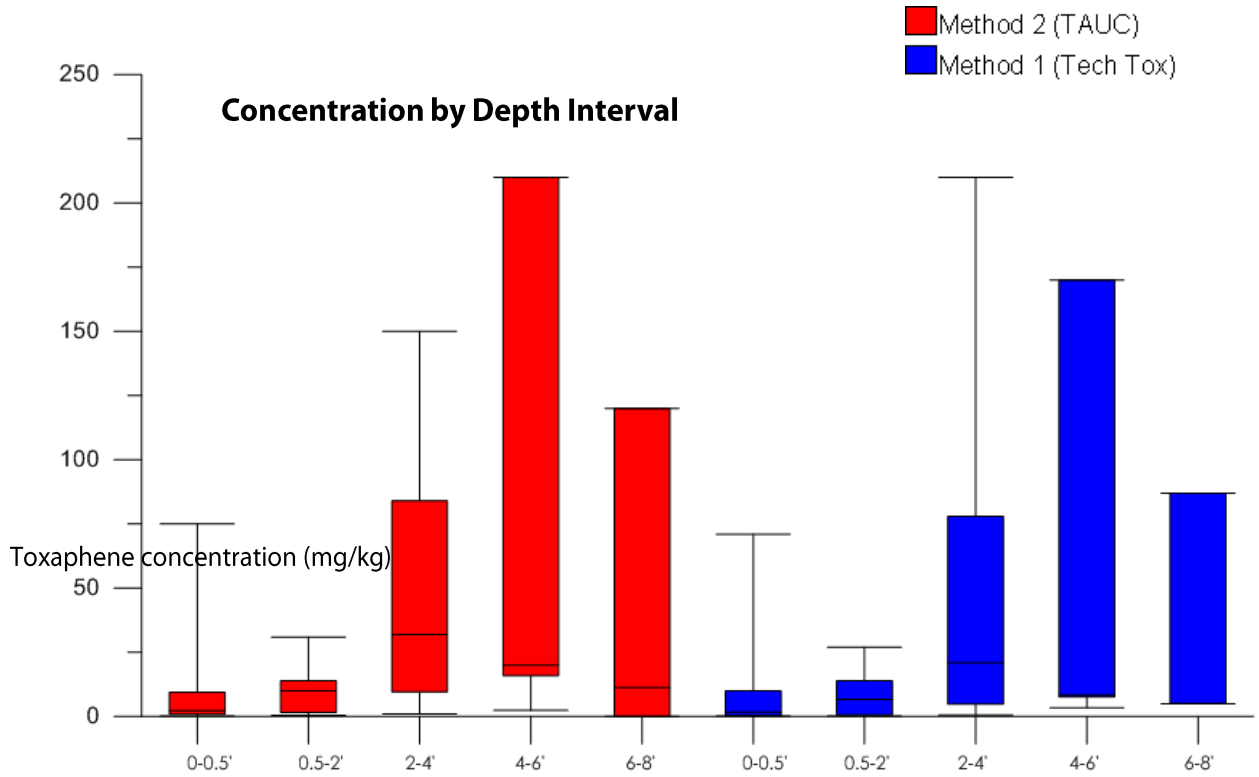
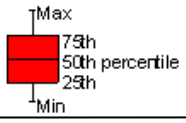


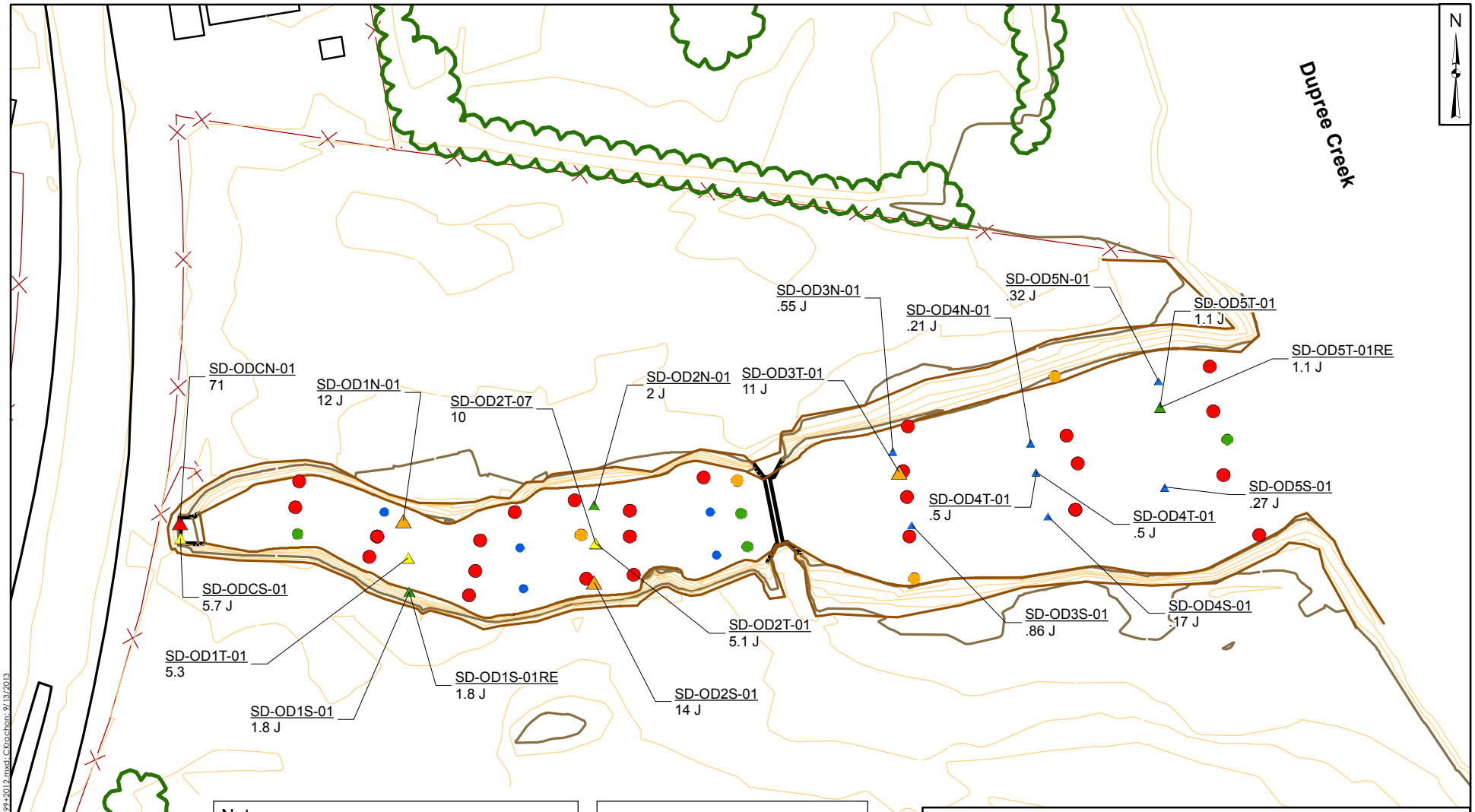


NOTE:
Data distributions presented as box-whisker plots, as defined here:



Distribution of Toxaphene Concentrations	Geosyntec consultants	HERCULES	Figure
Terry Creek OU1 RI/FS Brunswick, Georgia	Atlanta, Georgia	September 2013	5-5

N:\Ashland\OU1 RIFS Report\Figures and Tables\Fig5-5_toxaphene box-whisker.ppt"



Notes:
1. All toxaphene results are report in mg/kg.
2. Technical toxaphene refers to Method 1 or the Task Force Method
3. Sediment samples collected between 0 - 0.5 ft bgs.

Technical Toxaphene (mg/kg)

2012	1999-2000
< 1	< 1
1 - 5	1 - 5
5 - 10	5 - 10
10 - 50	10 - 50
> 50	> 50

0 50 100 200 Feet

Toxaphene in Surface Sediment 1999-2000 and 2012

Terry Creek OU1 RI/FS
Brunswick, Georgia

Geosyntec consultants

HERCULES

Figure 5-6

Kennesaw, Georgia

October 2012

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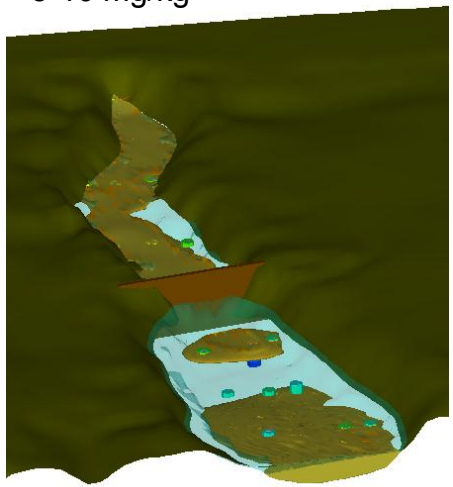
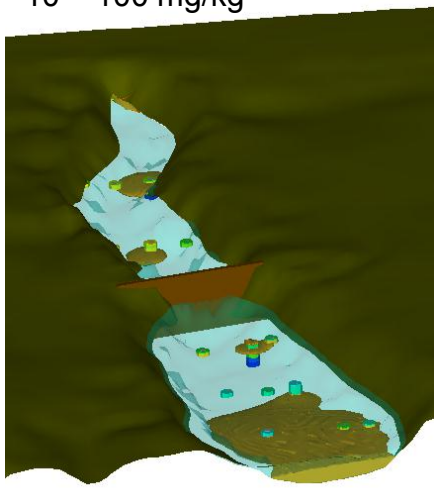
> ND – < 1 mg/kg

1 – 5 mg/kg

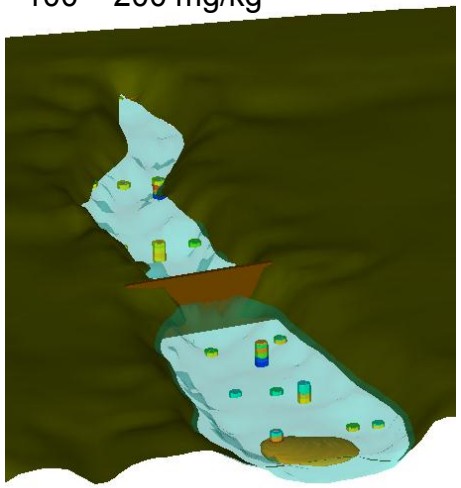
5-10 mg/kg



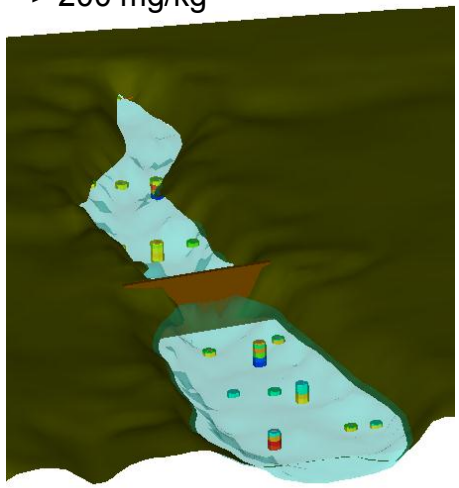
10 – 100 mg/kg



100 – 200 mg/kg



> 200 mg/kg



Volume of toxaphene-impacted sediment at specified concentration

Concentration mg/kg	Volume yd^3
ND - 1	17,121
1 - 5	15,742
5 - 10	8,150
10 - 100	3,891
100 - 200	389
> 200	<1

Volume of toxaphene contaminated sediment

Terry Creek OU1 RI/FS
Brunswick, Georgia

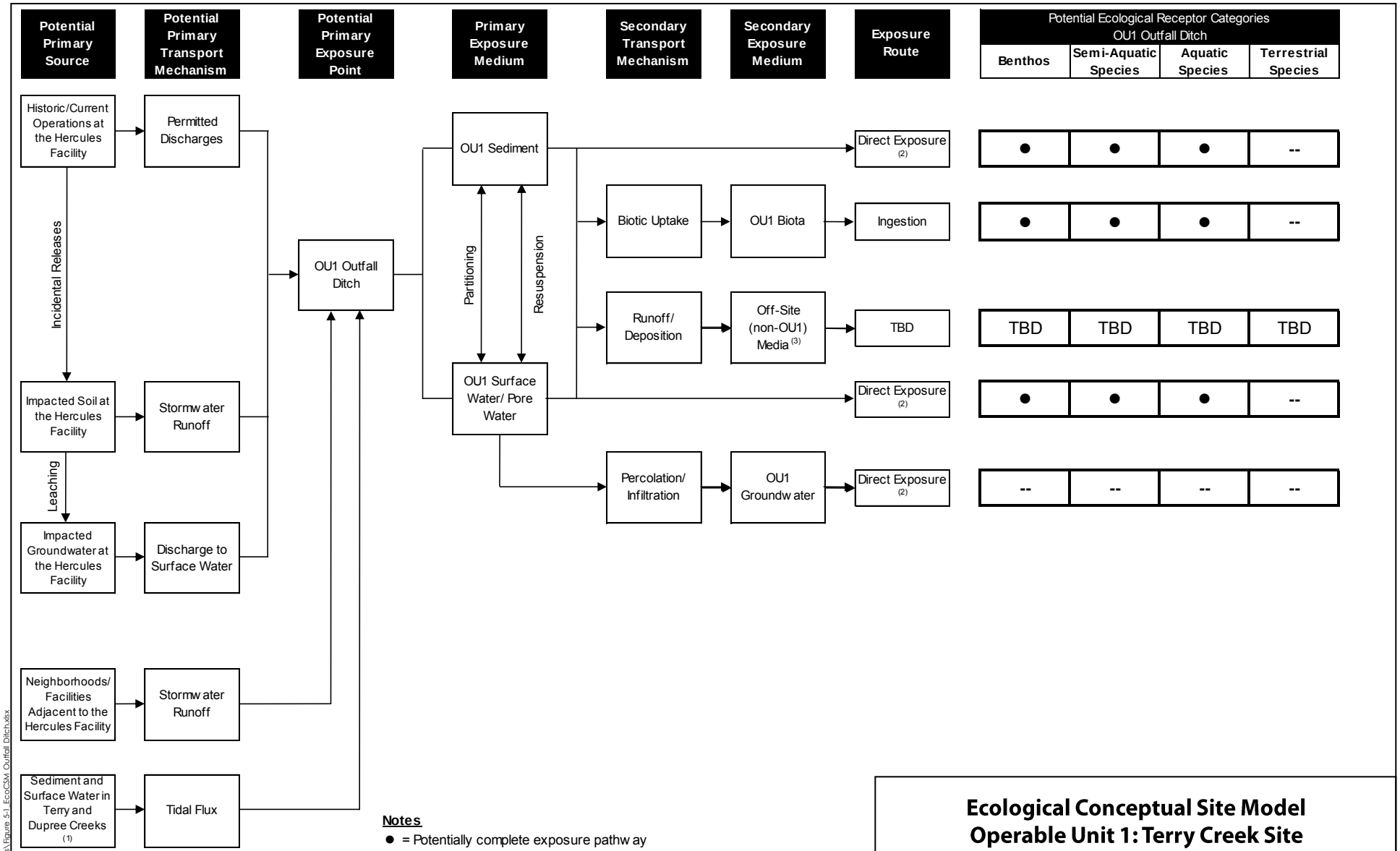
Geosyntec consultants
Atlanta, Georgia

HERCULES

September 2013

Figure 5-7

N:\Ashland\OU1 RI\FS Report\Tech Memo\Figures and Tables\Fig14_toxaphene volumes.ppt



Notes

● = Potentially complete exposure pathway

-- = Incomplete or insignificant exposure pathway

TBD = To be determined

(1) Several industrial facilities are present along Terry and Dupree Creeks which may potentially release contaminants.

(2) Direct exposure pathways include ingestion of, dermal contact with, and respiration of COPCs in affected media; however, it should be noted that not all direct exposure pathways will be quantitatively evaluated in the ecological risk

(3) Off-site (i.e., non-OU1) media will be evaluated separately (e.g., sediment and surface water of Terry and Dupree Creeks as part of OU2 and OU3 RI/FS).

Ecological Conceptual Site Model
Operable Unit 1: Terry Creek Site

Brunswick, Georgia

Geosyntec consultants

Atlanta, Georgia

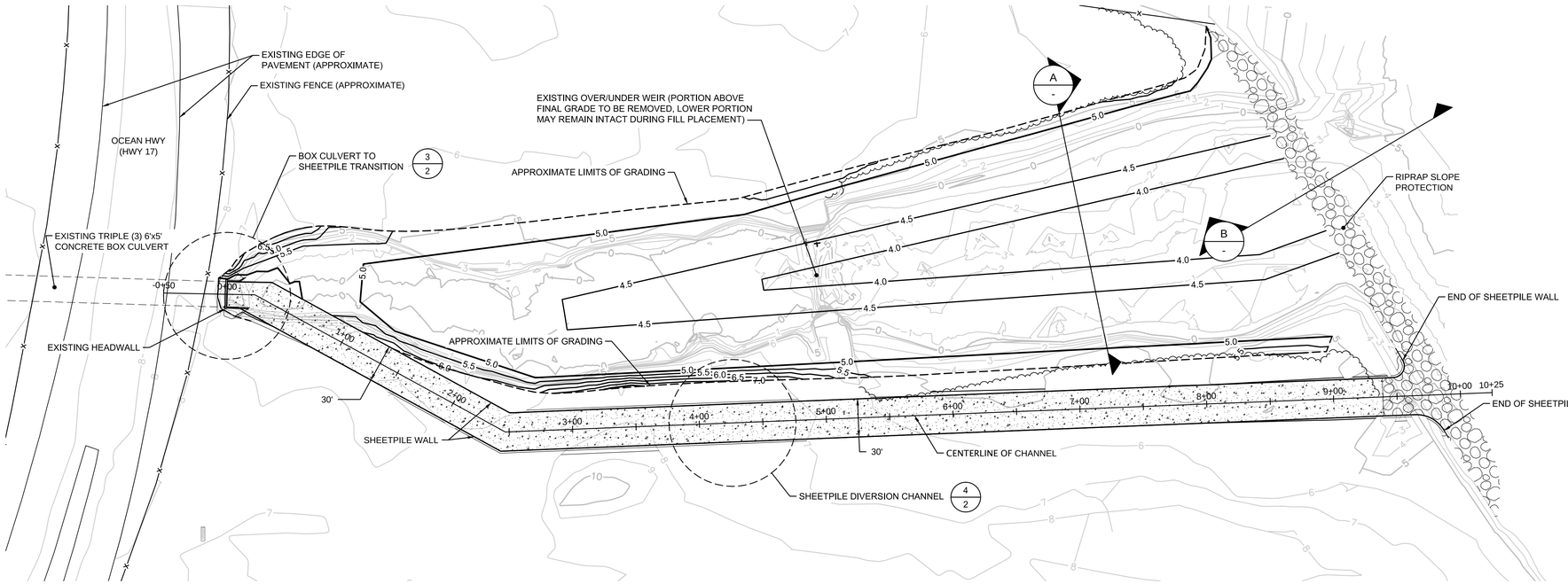
HERCULES

September 2013

Figure

7-1

Path: N:\Ashland\OU1 RIFS Work Plan\Figures\Figure 5-1 EcoCSM Outfall Ditch.xlsx



1 - PLAN VIEW
SHEETPILE DIVERSION CHANNEL
SCALE: 1" = 50'

LEGEND

- EXISTING GRADES
- PROPOSED GRADES
- FENCE
- LINE OF VEGETATION
- CONCRETE CHANNEL LINING
- RIPRAP

DETAIL NUMBER (4/2): DRAWING ON WHICH ABOVE DETAIL IS PRESENTED

DETAIL NUMBER (4/1): DETAIL — TITLE OF DETAIL — SCALE: 1"=2'
DRAWING ON WHICH ABOVE DETAIL WAS FIRST REFERENCED

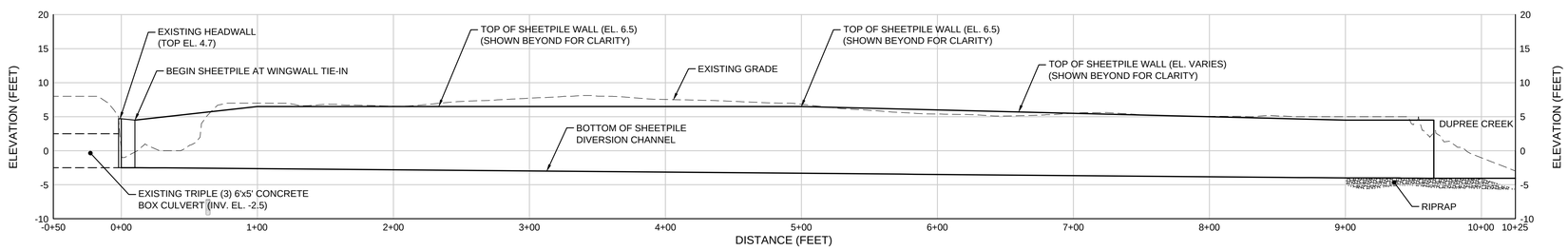
EXAMPLE: DETAIL NUMBER 4 PRESENTED ON DRAWING NO. 2 WAS REFERENCED FOR THE FIRST TIME ON DRAWING NO. 1.

ABOVE SYSTEM ALSO APPLIES TO SECTION IDENTIFICATIONS.

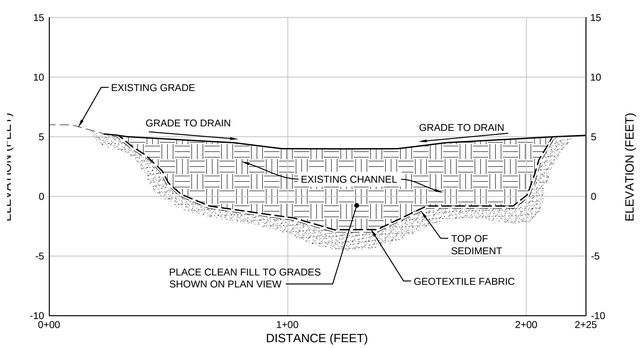
DETAIL IDENTIFICATION LEGEND

NOTES:

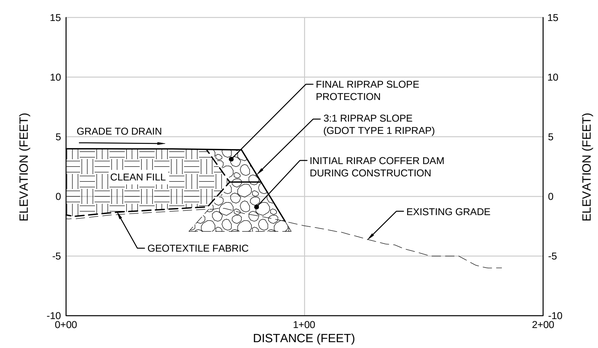
1. THE BASE MAPPING USED FOR THIS DRAWING WAS PREPARED USING AVAILABLE AERIAL PHOTOGRAPHS, MAPPING PROVIDED BY HERCULES, RECENT SURVEYS, AND GIS DATABASE INFORMATION. NOT ALL STRUCTURES OR OTHER SITE FEATURES THAT MAY BE PRESENT ON THE SITE ARE SHOWN.
2. TOPOGRAPHIC INFORMATION PROVIDED IS BASED ON A FIELD SURVEY COMPLETED BY ARC SURVEYING AND MAPPING, INC, ON 5 APRIL 2012.
3. THE PROPOSED CHANNEL, ALIGNMENT, AND DETAILS SHOWN HEREIN ARE CONCEPTUAL. ACTUAL ALIGNMENT, ELEVATIONS AND OTHER FEATURES ARE SUBJECT TO CHANGE DURING DESIGN.



2 - PROFILE VIEW
SHEETPILE DIVERSION CHANNEL
SCALE: 1"=50' (HORIZONTAL); 1"=10' (VERTICAL)



A - 1 SECTION
EXISTING CHANNEL
SCALE: 1"=30' (HORIZONTAL); 1"=6' (VERTICAL)
XREF: 4443A-X001-A



B - 1 SECTION
EXISTING CHANNEL OUTLET
SCALE: 1"=30' (HORIZONTAL); 1"=6' (VERTICAL)
XREF: 4443A-A001-A

PRELIMINARY
CONCEPTUAL DRAWING ONLY
NOT FOR CONSTRUCTION

Figure 8-1.
ALTERNATIVE 2
SHEETPILE CHANNEL RE-ROUTED

REV	DATE	DESCRIPTION	DRN	APP

Geosyntec consultants
1255 ROBERTS BOULEVARD, N.W., SUITE 200
KENNESAW, GEORGIA 30144 USA
PHONE: 678.202.9500

HERCULES

TITLE: SHEETPILE CHANNEL RE-ROUTED

PROJECT: REMEDIAL ALTERNATIVE CONCEPTUAL DESIGN

SITE: TERRY CREEK OU1 RI/FS, BRUNSWICK, GA

THIS DRAWING MAY NOT BE ISSUED FOR PROJECT TENDER OR CONSTRUCTION, UNLESS SEALED.

SIGNATURE

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DESIGN BY:	TLF	DATE:	AUG 2013
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CHECKED BY:	TLF	FILE:	4443A-F001-NG-1
REVIEWED BY:	JAS	DRAWING NO.:	1 OF 2
APPROVED BY:	GR		

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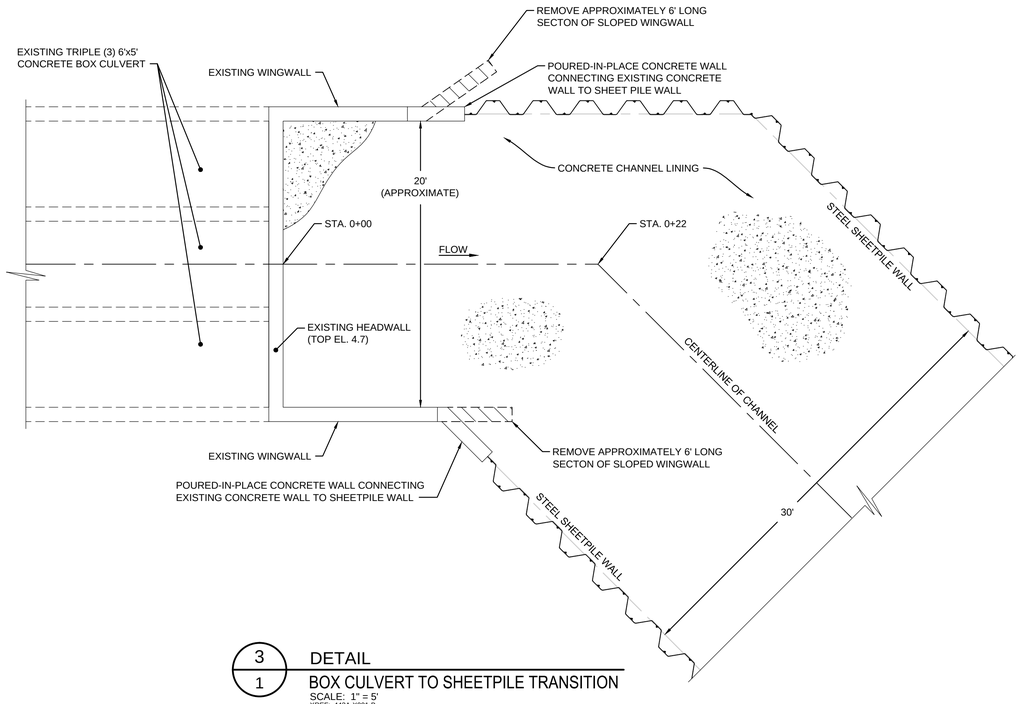
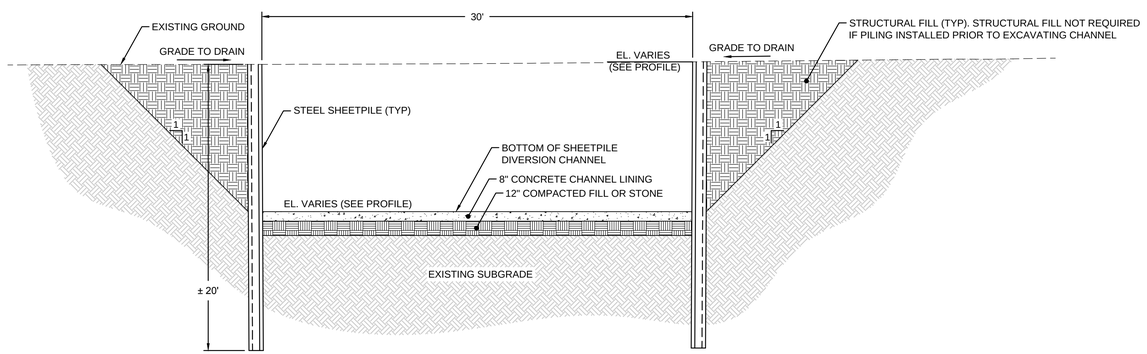


3/1 DETAIL
BOX CULVERT TO SHEETPILE TRANSITION
SCALE: 1" = 5'
XREF: 443A-X001-B



4/1 DETAIL
SHEETPILE DIVERSION CHANNEL
SCALE: 1" = 5'
XREF: 443A-X001-B

Figure 8-2
ALTERNATIVE 2
SHEETPILE CHANNEL RE-ROUTED

REV	DATE	DESCRIPTION	DRN	APP

Geosyntec consultants
1255 ROBERTS BOULEVARD, N.W., SUITE 200
KENNESAW, GEORGIA 30144 USA
PHONE: 678.202.9500

HERCULES

TITLE: SHEETPILE CHANNEL RE-ROUTED

PROJECT: REMEDIAL ALTERNATIVE CONCEPTUAL DESIGN

SITE: TERRY CREEK OU1 RI/FS, BRUNSWICK, GA

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CHECKED BY:	TLF	FILE:	4443A-F001-NG-2
REVIEWED BY:	JAS	DRAWING NO.:	
APPROVED BY:	GR		2 OF 2

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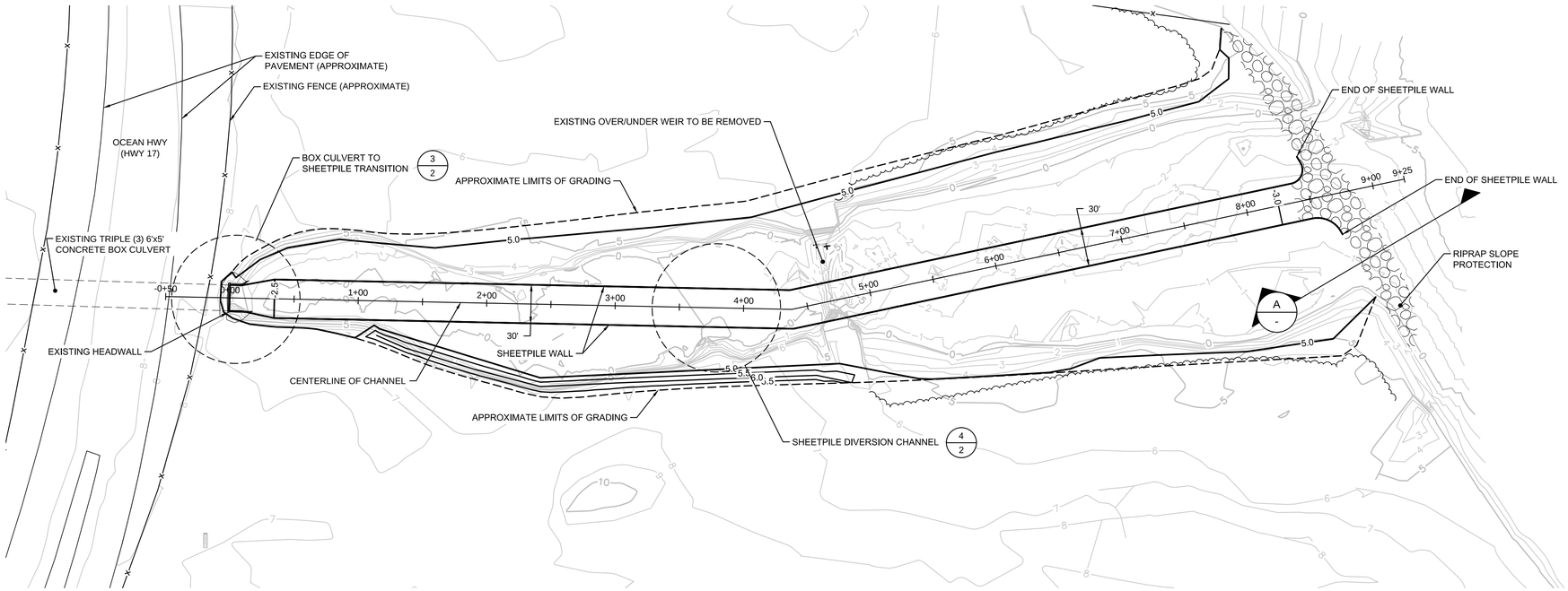
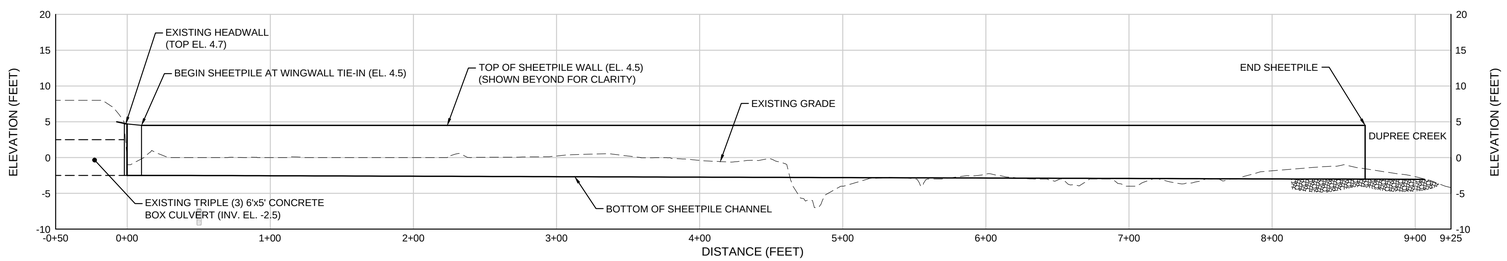
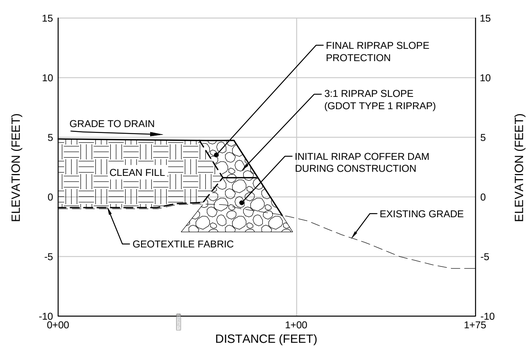


1 / - PLAN VIEW
SHEETPILE CHANNEL
SCALE: 1" = 50'



2 / - PROFILE VIEW
SHEETPILE CHANNEL
SCALE: 1"=50' (HORIZONTAL); 1"=10' (VERTICAL)



A / 1 SECTION
EXISTING CHANNEL BACKFILL
SCALE: 1"=30' (HORIZONTAL); 1"=6' (VERTICAL)
XREF: 4443A-X001-A

LEGEND

- EXISTING GRADES
- PROPOSED GRADES
- FENCE
- LINE OF VEGETATION
- CONCRETE CHANNEL LINING
- RIPRAP

N

DETAIL NUMBER (4) / DRAWING ON WHICH ABOVE DETAIL IS PRESENTED (2)

DETAIL NUMBER (4) / DRAWING ON WHICH ABOVE DETAIL WAS FIRST REFERENCED (1)

DETAIL
TITLE OF DETAIL
SCALE: 1"=2'

EXAMPLE: DETAIL NUMBER 4 PRESENTED ON DRAWING NO. 2 WAS REFERENCED FOR THE FIRST TIME ON DRAWING NO. 1.

ABOVE SYSTEM ALSO APPLIES TO SECTION IDENTIFICATIONS.

DETAIL IDENTIFICATION LEGEND

NOTES:

1. THE BASE MAPPING USED FOR THIS DRAWING WAS PREPARED USING AVAILABLE AERIAL PHOTOGRAPHS, MAPPING PROVIDED BY HERCULES, RECENT SURVEYS, AND GIS DATABASE INFORMATION. NOT ALL STRUCTURES OR OTHER SITE FEATURES THAT MAY BE PRESENT ON THE SITE ARE SHOWN.
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3. THE PROPOSED CHANNEL, ALIGNMENT, AND DETAILS SHOWN HEREIN ARE CONCEPTUAL. ACTUAL ALIGNMENT, ELEVATIONS AND OTHER FEATURES ARE SUBJECT TO CHANGE DURING DESIGN.

Figure 8-3.
ALTERNATIVE 2A
SHEETPILE CHANNEL WITHIN EXISTING OUTFALL DITCH

REV	DATE	DESCRIPTION	DRN	APP

Geosyntec consultants
1255 ROBERTS BOULEVARD, N.W., SUITE 200
KENNESAW, GEORGIA 30144 USA
PHONE: 678.202.9500

HERCULES

TITLE: SHEETPILE CHANNEL WITHIN EXISTING OUTFALL DITCH

PROJECT: REMEDIAL ALTERNATIVE CONCEPTUAL DESIGN

SITE: TERRY CREEK OU1 RI/FS, BRUNSWICK, GA

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REVIEWED BY:	JAS	DRAWING NO.:	1 OF 2
APPROVED BY:	GR		

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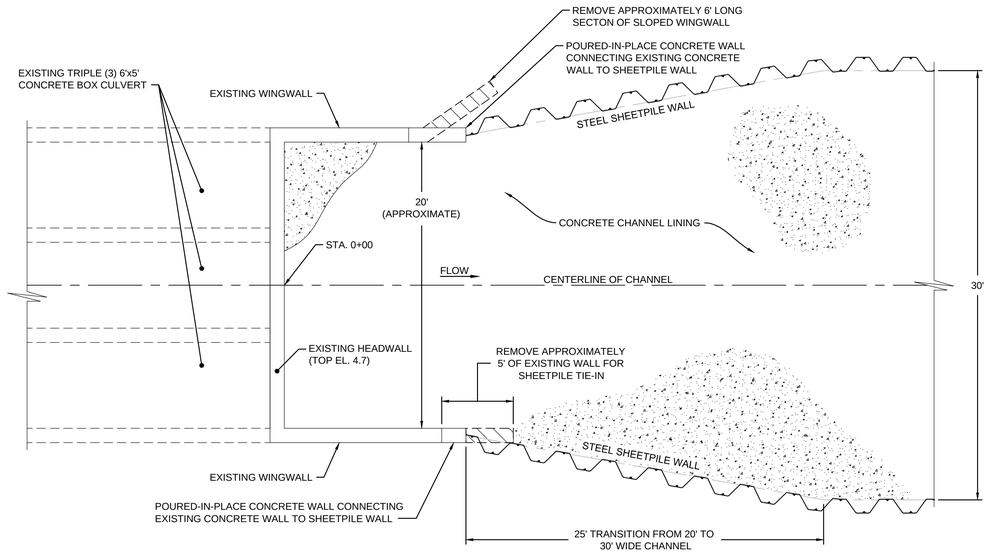
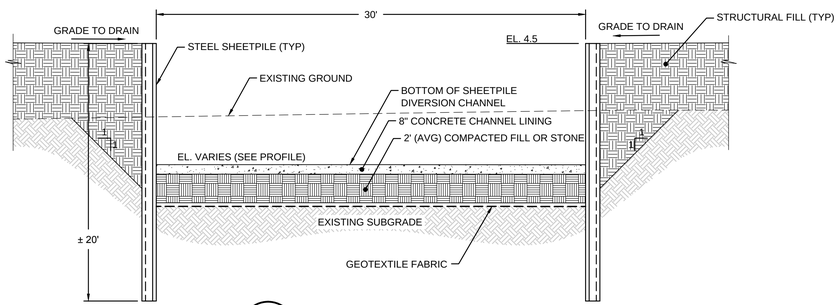


3/1 DETAIL
BOX CULVERT TO SHEETPILE TRANSITION
SCALE: 1" = 5'
XREF: 443A-X001-B



4/1 DETAIL
SHEETPILE CHANNEL
SCALE: 1" = 5'
XREF: 443A-X001-B

Figure 8-4.

ALTERNATIVE 2A
SHEETPILE CHANNEL WITHIN
EXISTING OUTFALL DITCH

REV	DATE	DESCRIPTION	DRN	APP

Geosyntec consultants
1255 ROBERTS BOULEVARD, N.W., SUITE 200
KENNESAW, GEORGIA 30144 USA
PHONE: 678.202.9500

HERCULES

TITLE: SHEETPILE CHANNEL WITHIN EXISTING OUTFALL DITCH

PROJECT: REMEDIAL ALTERNATIVE CONCEPTUAL DESIGN

SITE: TERRY CREEK OU1 RI/FS, BRUNSWICK, GA

THIS DRAWING MAY NOT BE ISSUED FOR PROJECT TENDER OR CONSTRUCTION, UNLESS SEALED.

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CHECKED BY:	TLF	FILE:	4443A-F002-NG-2
REVIEWED BY:	JAS	DRAWING NO.:	
APPROVED BY:	GR	2 OF 2	

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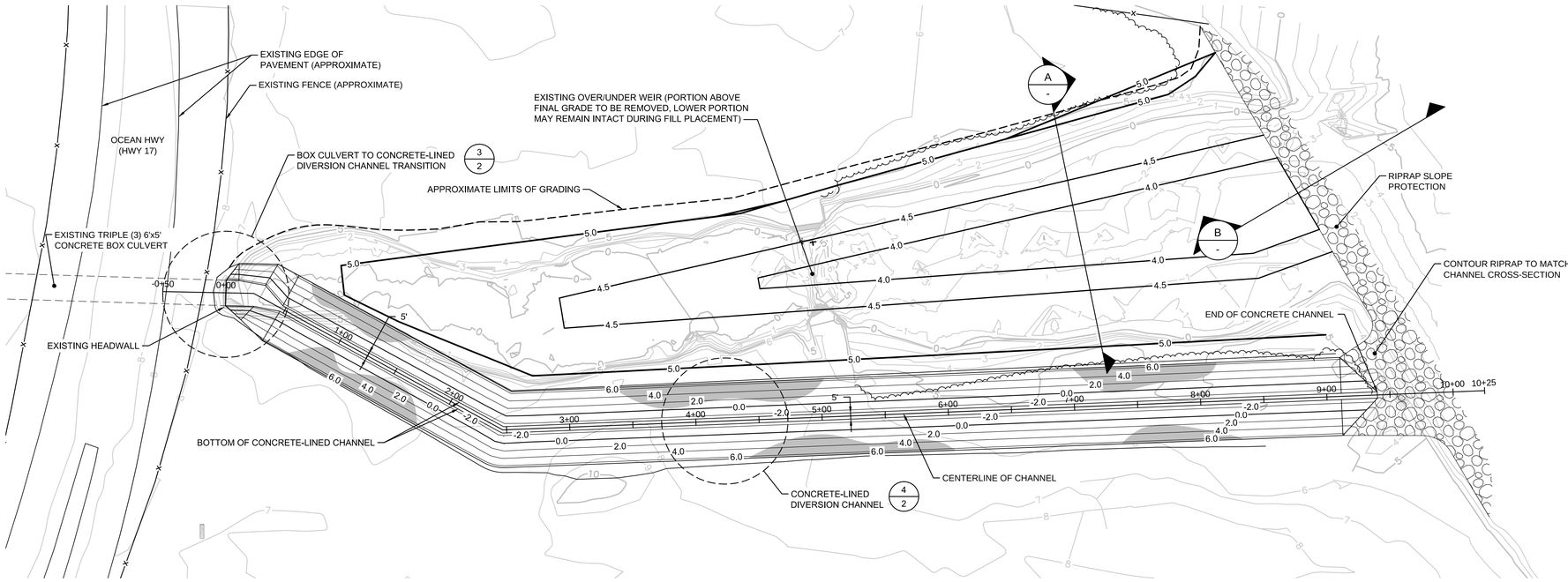
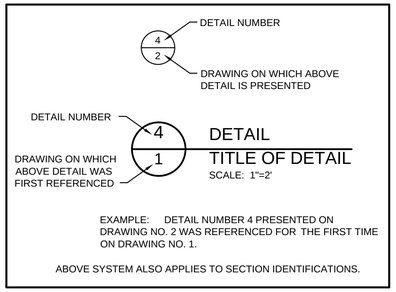


1 - PLAN VIEW
CONCRETE-LINED DIVERSION CHANNEL
SCALE: 1" = 50'

LEGEND

- EXISTING GRADES
- PROPOSED GRADES
- FENCE
- LINE OF VEGETATION
- CONCRETE CHANNEL LINING
- RIPRAP



DETAIL IDENTIFICATION LEGEND

NOTES:

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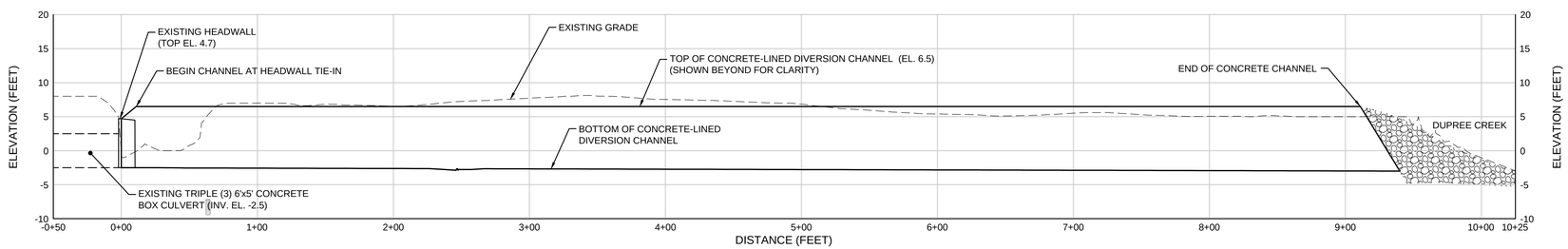
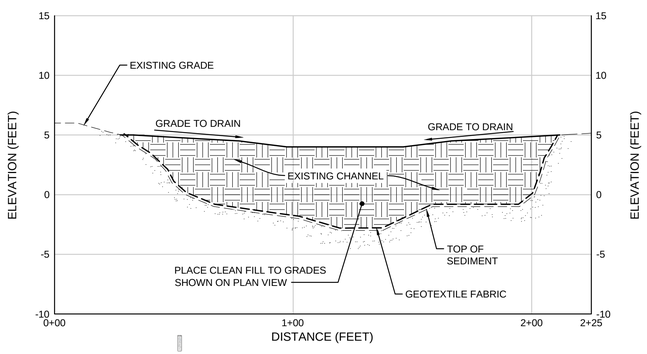
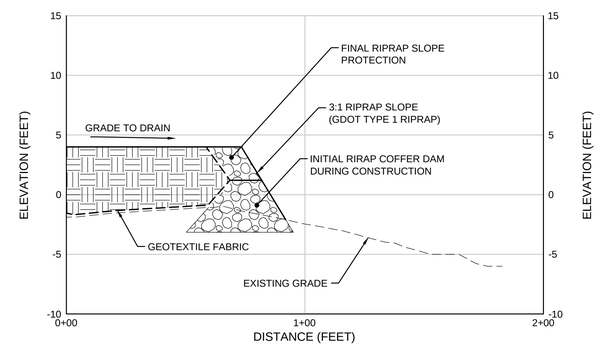
2. TOPOGRAPHIC INFORMATION PROVIDED IS BASED ON A FIELD SURVEY COMPLETED BY ARC SURVEYING AND MAPPING, INC, ON 5 APRIL 2012.
3. THE PROPOSED CHANNEL, ALIGNMENTS, AND DETAILS SHOWN HEREIN ARE CONCEPTUAL. ACTUAL ALIGNMENT, ELEVATIONS AND OTHER FEATURES ARE SUBJECT TO CHANGE DURING DESIGN.



2 - PROFILE VIEW
CONCRETE-LINED DIVERSION CHANNEL
SCALE: 1"=50' (HORIZONTAL); 1"=10' (VERTICAL)



A 1 - SECTION
EXISTING CHANNEL
SCALE: 1"=30' (HORIZONTAL); 1"=6' (VERTICAL)
XREF: 4443A-X001-A



B 1 - SECTION
EXISTING CHANNEL OUTLET
SCALE: 1"=30' (HORIZONTAL); 1"=6' (VERTICAL)
XREF: 4443A-A001-A

PRELIMINARY
CONCEPTUAL DRAWING ONLY
NOT FOR CONSTRUCTION

Figure 8-5.
ALTERNATIVE 3
CONCRETE-LINED CHANNEL
RE-ROUTED

REV	DATE	DESCRIPTION	DRN	APP

Geosyntec consultants
1255 ROBERTS BOULEVARD, N.W., SUITE 200
KENNESAW, GEORGIA 30144 USA
PHONE: 678.202.9500

HERCULES

TITLE: CONCRETE-LINED CHANNEL RE-ROUTED

PROJECT: REMEDIAL ALTERNATIVE CONCEPTUAL DESIGN

SITE: TERRY CREEK OU1 RI/FS, BRUNSWICK, GA

THIS DRAWING MAY NOT BE ISSUED FOR PROJECT TENDER OR CONSTRUCTION, UNLESS SEALED.

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CHECKED BY:	TLF	FILE:	4443A-F003-NG-1
REVIEWED BY:	JAS	DRAWING NO.:	1 OF 2
APPROVED BY:	GR		

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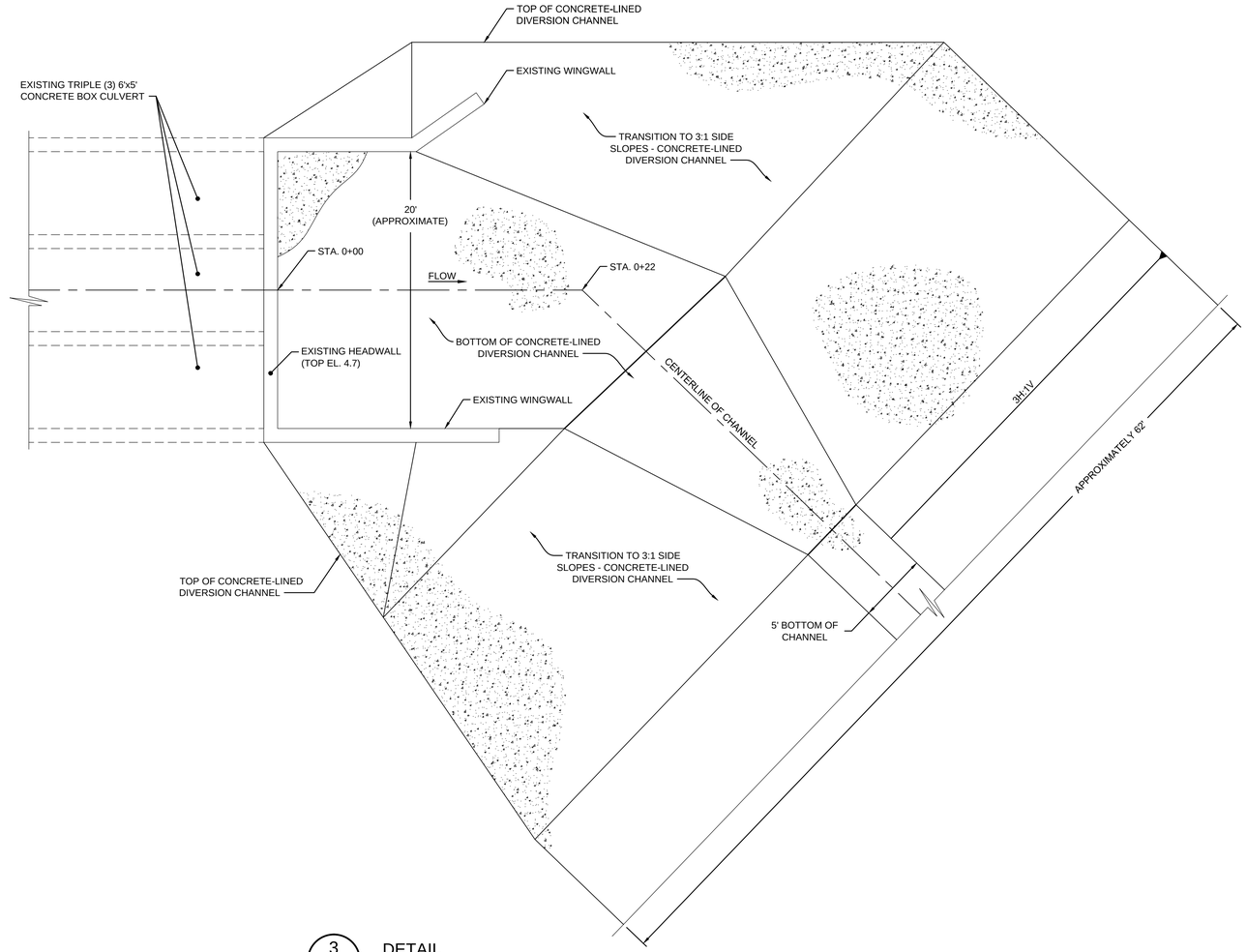
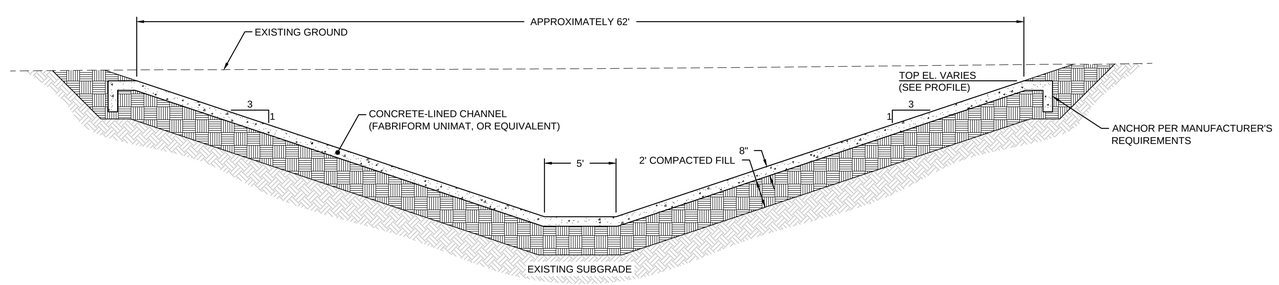


3/1 DETAIL
BOX CULVERT TO CONCRETE-LINED CHANNEL TRANSITION
SCALE: 1" = 5'
XREF: 443A-X001-B



4/1 DETAIL
CONCRETE-LINED DIVERSION CHANNEL
SCALE: 1" = 5'
XREF: 443A-X001-C

Figure 8-6.

ALTERNATIVE 3
CONCRETE-LINED CHANNEL
RE-ROUTED

REV	DATE	DESCRIPTION	DRN	APP

Geosyntec consultants
1255 ROBERTS BOULEVARD, N.W., SUITE 200
KENNESAW, GEORGIA 30144 USA
PHONE: 678.202.9500

HERCULES

TITLE: CONCRETE-LINED CHANNEL RE-ROUTED

PROJECT: REMEDIAL ALTERNATIVE CONCEPTUAL DESIGN

SITE: TERRY CREEK OU1 RI/FS, BRUNSWICK, GA

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SIGNATURE

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CHECKED BY:	TLF	FILE:	4443A-F003-NG-2
REVIEWED BY:	JAS	DRAWING NO.:	2 OF 2
APPROVED BY:	GR		

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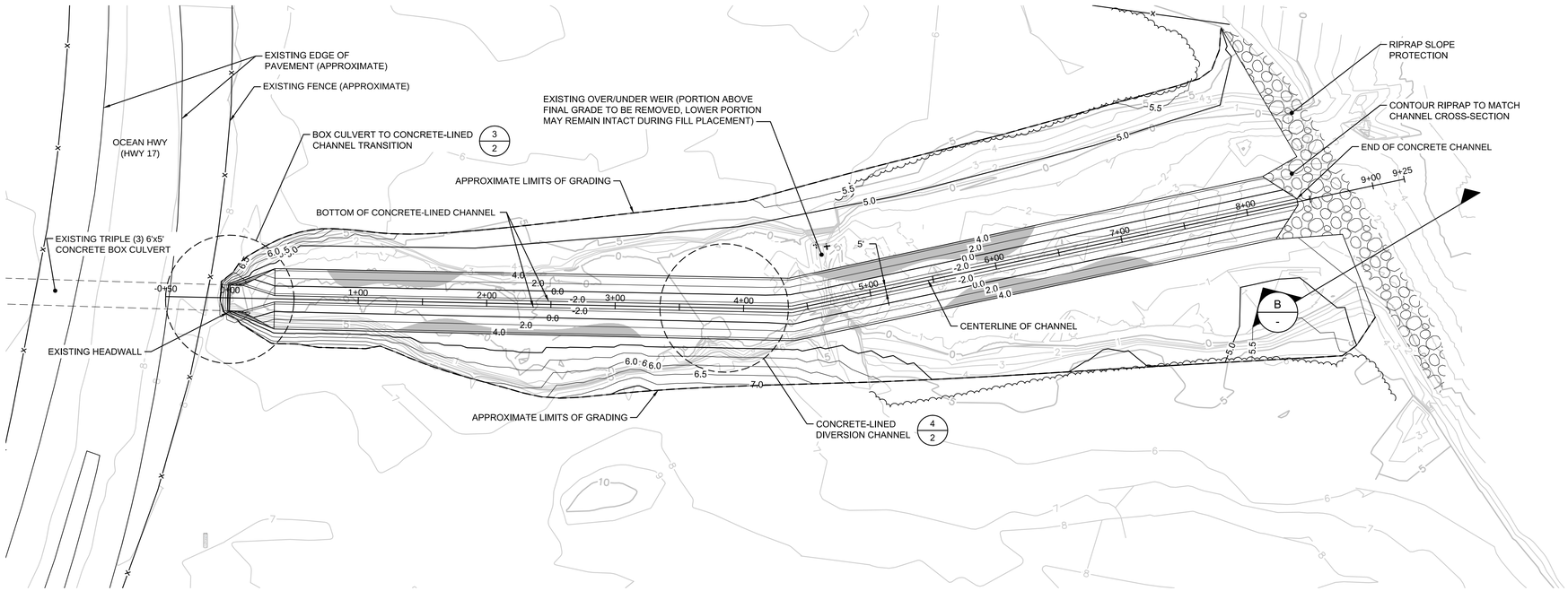
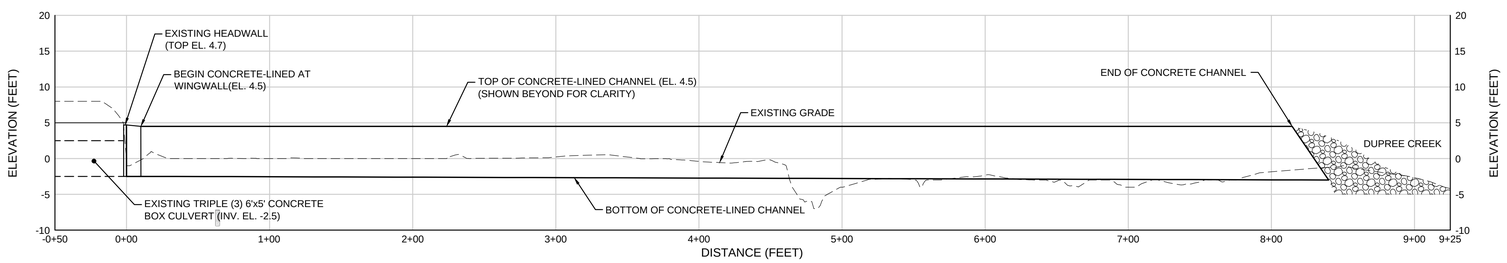
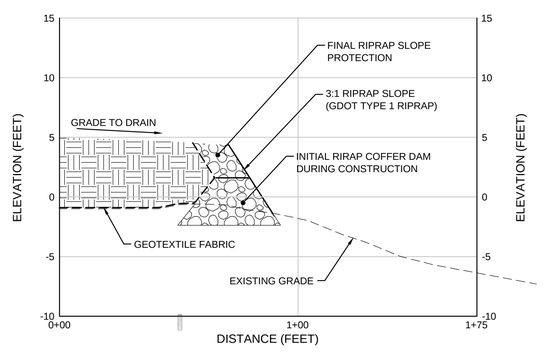


1 / - PLAN VIEW
CONCRETE-LINED CHANNEL
SCALE: 1" = 50'



2 / - PROFILE VIEW
CONCRETE-LINED DIVERSION CHANNEL
SCALE: 1"=50' (HORIZONTAL); 1"=10' (VERTICAL)



A / 1 SECTION
EXISTING CHANNEL BACKFILL
SCALE: 1"=30' (HORIZONTAL); 1"=6' (VERTICAL)
XREF: 4443A-X004-A

LEGEND

- EXISTING GRADES
- PROPOSED GRADES
- FENCE
- LINE OF VEGETATION
- CONCRETE CHANNEL LINING
- RIPRAP

N

DETAIL NUMBER
DRAWING ON WHICH ABOVE DETAIL IS PRESENTED

DETAIL NUMBER — 4/1 — DETAIL TITLE OF DETAIL
DRAWING ON WHICH ABOVE DETAIL WAS FIRST REFERENCED
SCALE: 1"=2'

EXAMPLE: DETAIL NUMBER 4 PRESENTED ON DRAWING NO. 2 WAS REFERENCED FOR THE FIRST TIME ON DRAWING NO. 1.

ABOVE SYSTEM ALSO APPLIES TO SECTION IDENTIFICATIONS.

DETAIL IDENTIFICATION LEGEND

NOTES:

1. THE BASE MAPPING USED FOR THIS DRAWING WAS PREPARED USING AVAILABLE AERIAL PHOTOGRAPHS, MAPPING PROVIDED BY HERCULES, RECENT SURVEYS, AND GIS DATABASE INFORMATION. NOT ALL STRUCTURES OR OTHER SITE FEATURES THAT MAY BE PRESENT ON THE SITE ARE SHOWN.
2. TOPOGRAPHIC INFORMATION PROVIDED IS BASED ON A FIELD SURVEY COMPLETED BY ARC SURVEYING AND MAPPING, INC, ON 5 APRIL 2012.
3. THE PROPOSED DIVERSION CHANNEL, TIDAL GATE STRUCTURES, AND DETAILS SHOWN HEREIN ARE CONCEPTUAL. ACTUAL ALIGNMENT, ELEVATIONS AND OTHER FEATURES ARE SUBJECT TO CHANGE DURING DESIGN.

Figure 8-7.

ALTERNATIVE 3A CONCRETE-LINED CHANNEL WITHIN EXISTING OUTFALL DITCH

REV	DATE	DESCRIPTION	DRN	APP

Geosyntec consultants
1255 ROBERTS BOULEVARD, N.W., SUITE 200
KENNESAW, GEORGIA 30144 USA
PHONE: 678.202.9500

HERCULES

TITLE: CONCRETE-LINED CHANNEL WITHIN EXISTING OUTFALL DITCH

PROJECT: REMEDIAL ALTERNATIVE CONCEPTUAL DESIGN

SITE: TERRY CREEK OU1 RI/FS, BRUNSWICK, GA

THIS DRAWING MAY NOT BE ISSUED FOR PROJECT TENDER OR CONSTRUCTION, UNLESS SEALED.

SIGNATURE

DATE

DESIGN BY:	TLF	DATE:	AUG 2013
DRAWN BY:	WWS	PROJECT NO.:	GR4443A
CHECKED BY:	TLF	FILE:	4443A-F004-NG-1
REVIEWED BY:	JAS	DRAWING NO.:	1 OF 2
APPROVED BY:	GR		

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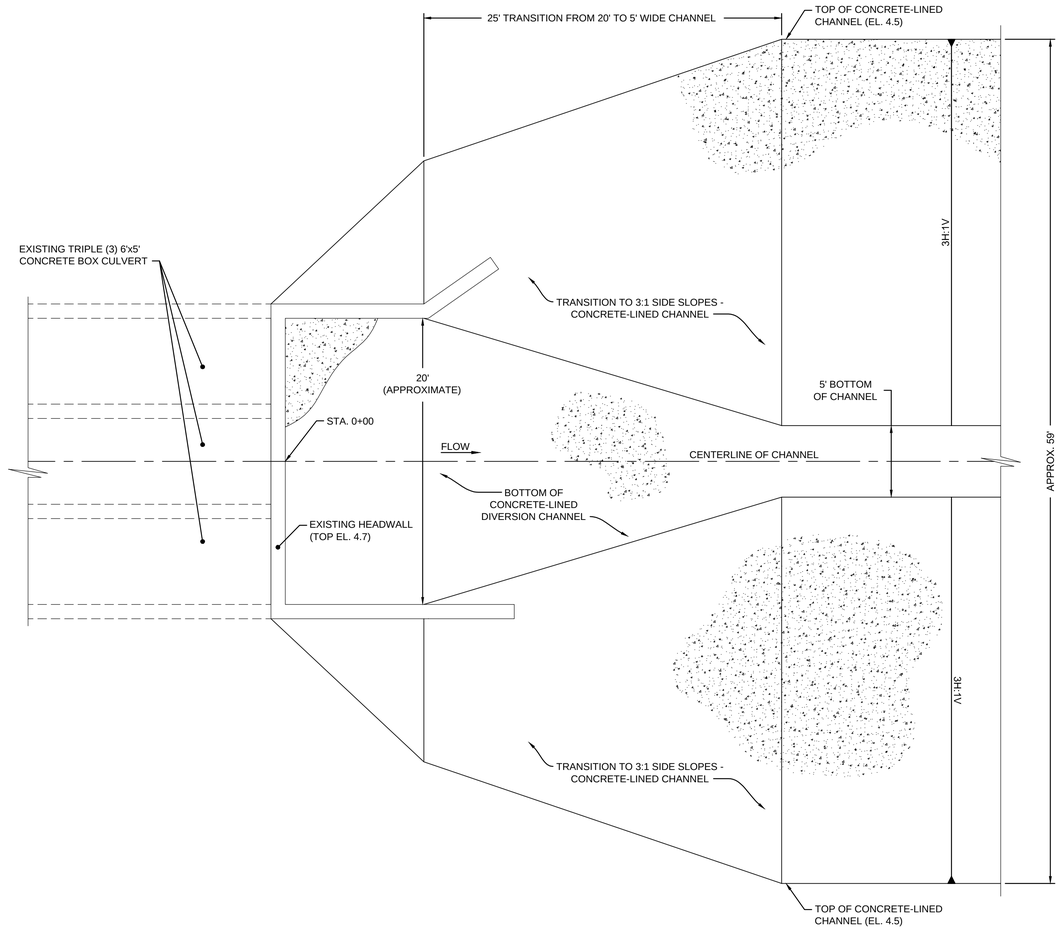
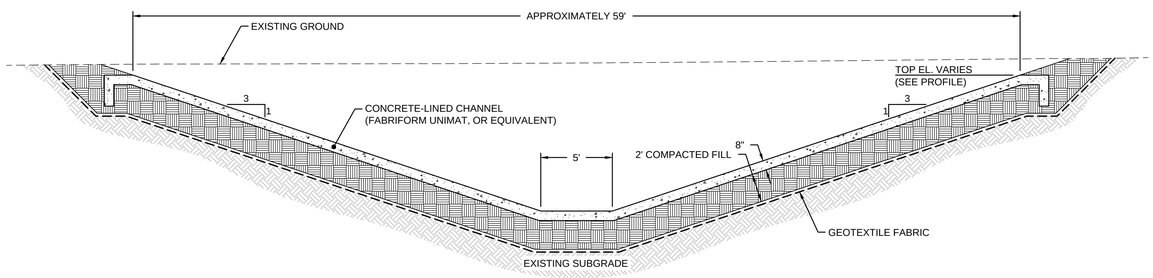
L:\CADDA\4443A-NAD\TERRY CREEK\CONCEPTUAL FIGURES\ALTERNATIVE 3A - CONCRETE-LINED CHANNEL WITHIN EXISTING OUTFALL DITCH\ALTERNATIVE 3A - WITH NO FLAP GATES\4443A-F004-NG-1



3/1 DETAIL
BOX CULVERT TO CONCRETE-LINED CHANNEL TRANSITION
SCALE: 1" = 5'
XREF: 443A-X004-B



4/1 DETAIL
CONCRETE-LINED DIVERSION CHANNEL
SCALE: 1" = 5'
XREF: 443A-X004-C

Figure 8-8.
ALTERNATIVE 3A
CONCRETE-LINED CHANNEL
WITHIN EXISTING OUTFALL DITCH

REV	DATE	DESCRIPTION	DRN	APP

Geosyntec consultants
1255 ROBERTS BOULEVARD, N.W., SUITE 200
KENNESAW, GEORGIA 30144 USA
PHONE: 678.202.9500

HERCULES

TITLE: CONCRETE-LINED CHANNEL WITHIN EXISTING OUTFALL DITCH

PROJECT: REMEDIAL ALTERNATIVE CONCEPTUAL DESIGN

SITE: TERRY CREEK OU1 RI/FS, BRUNSWICK, GA

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DRAWN BY:	WWS	PROJECT NO.:	GR4443A
CHECKED BY:	TLF	FILE:	4443A-F004-NG-2
REVIEWED BY:	JAS	DRAWING NO.:	2 OF 2
APPROVED BY:	GR		

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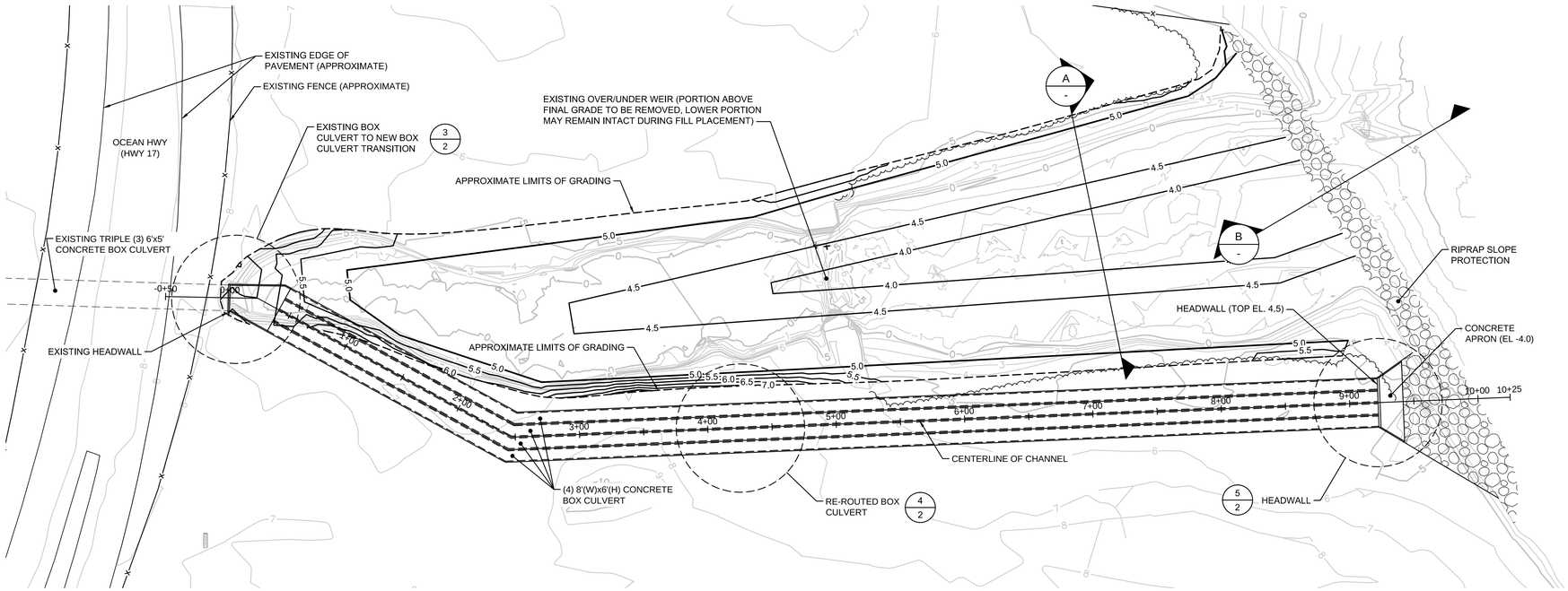
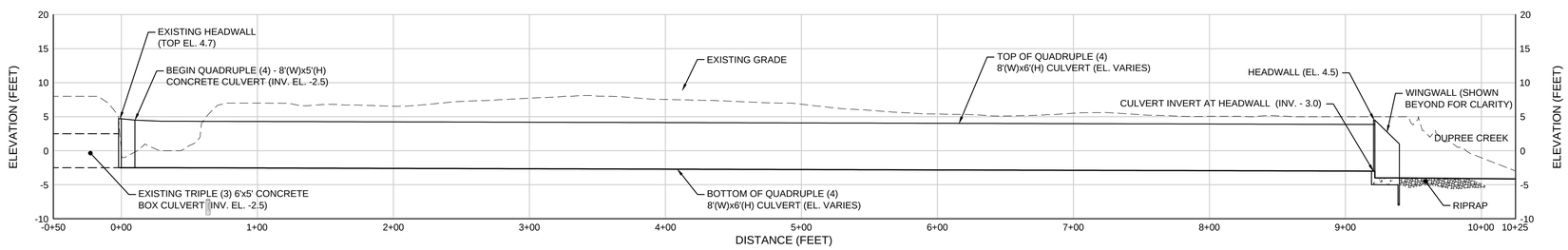
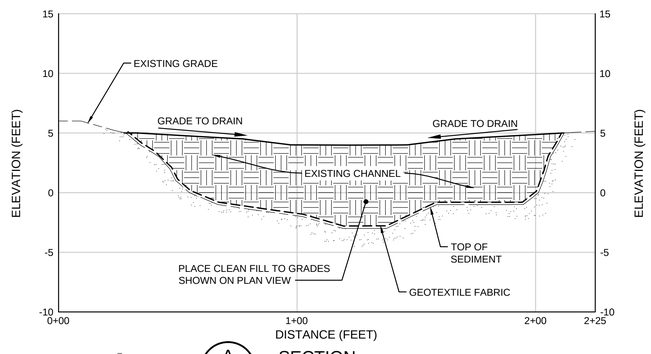
L:\CADD\443A-RI\OU1\TERRY CREEK\CONCEPTUAL FIGURES\ALTERNATIVE 3A - CONCRETE-LINED CHANNEL WITHIN EXISTING OUTFALL DITCH\ALTERNATIVE 3A - WITH NO FLAP GATES\443A-F004-NG-2



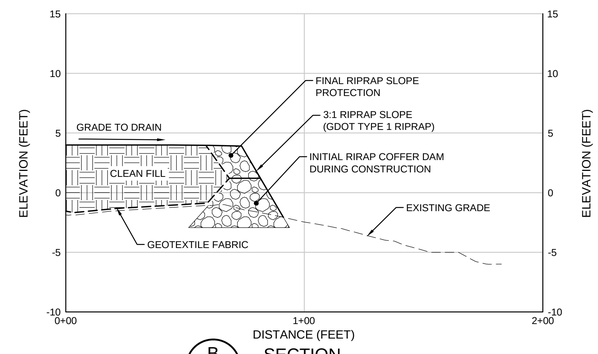
1 / - PLAN VIEW
BOX CULVERT RE-ROUTED
SCALE: 1" = 50'



2 / - PROFILE VIEW
BOX CULVERT RE-ROUTED
SCALE: 1"=50' (HORIZONTAL); 1"=10' (VERTICAL)



A / 1 SECTION
EXISTING CHANNEL
SCALE: 1"=30' (HORIZONTAL); 1"=6' (VERTICAL)
XREF: 4443A-X001-A



B / 1 SECTION
EXISTING CHANNEL OUTLET
SCALE: 1"=30' (HORIZONTAL); 1"=6' (VERTICAL)
XREF: 4443A-A001-A

LEGEND

- EXISTING GRADES
- PROPOSED GRADES
- FENCE
- LINE OF VEGETATION
- BOX CULVERT
- RIPRAP

N

DETAIL NUMBER (4/2): DRAWING ON WHICH ABOVE DETAIL IS PRESENTED

DETAIL NUMBER (4/1): DRAWING ON WHICH ABOVE DETAIL WAS FIRST REFERENCED

DETAIL
TITLE OF DETAIL
SCALE: 1"=2'

EXAMPLE: DETAIL NUMBER 4 PRESENTED ON DRAWING NO. 2 WAS REFERENCED FOR THE FIRST TIME ON DRAWING NO. 1.

ABOVE SYSTEM ALSO APPLIES TO SECTION IDENTIFICATIONS.

DETAIL IDENTIFICATION LEGEND

NOTES:

1. THE BASE MAPPING USED FOR THIS DRAWING WAS PREPARED USING AVAILABLE AERIAL PHOTOGRAPHS, MAPPING PROVIDED BY HERCULES, RECENT SURVEYS, AND GIS DATABASE INFORMATION. NOT ALL STRUCTURES OR OTHER SITE FEATURES THAT MAY BE PRESENT ON THE SITE ARE SHOWN.
2. TOPOGRAPHIC INFORMATION PROVIDED IS BASED ON A FIELD SURVEY COMPLETED BY ARC SURVEYING AND MAPPING, INC, ON 5 APRIL 2012.
3. THE PROPOSED CULVERT, ALIGNMENT, AND DETAILS SHOWN HEREIN ARE CONCEPTUAL. ACTUAL ALIGNMENT, ELEVATIONS AND OTHER FEATURES ARE SUBJECT TO CHANGE DURING DESIGN.

Figure 8-9.
ALTERNATIVE 4
CULVERT RE-ROUTED

REV	DATE	DESCRIPTION	DRN	APP

Geosyntec consultants
1255 ROBERTS BOULEVARD, N.W., SUITE 200
KENNESAW, GEORGIA 30144 USA
PHONE: 678.202.9500

HERCULES

TITLE: CULVERT RE-ROUTED

PROJECT: REMEDIAL ALTERNATIVE CONCEPTUAL DESIGN

SITE: TERRY CREEK OU1 RI/FS, BRUNSWICK, GA

THIS DRAWING MAY NOT BE ISSUED FOR PROJECT TENDER OR CONSTRUCTION, UNLESS SEALED.

SIGNATURE

DATE

DESIGN BY:	TLF	DATE:	AUG 2013
DRAWN BY:	WWS	PROJECT NO.:	GR4443A
CHECKED BY:	TLF	FILE:	4443A-F005-NG-1
REVIEWED BY:	JAS	DRAWING NO.:	1 OF 2
APPROVED BY:	GR		

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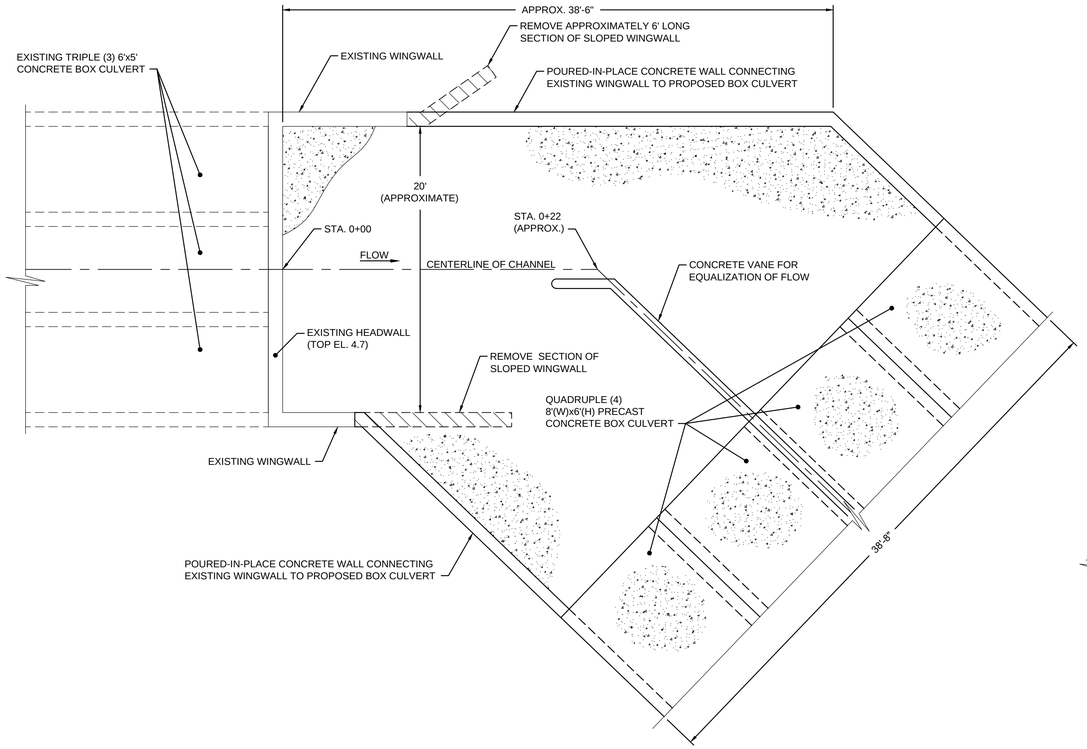
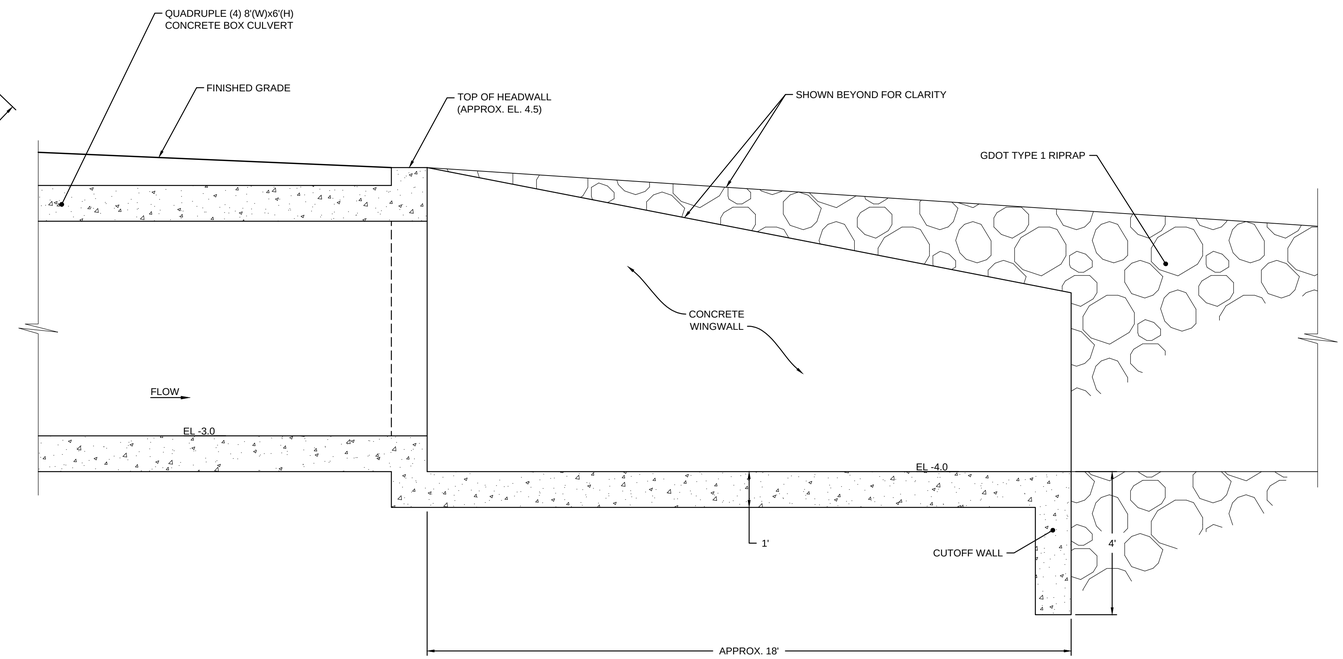
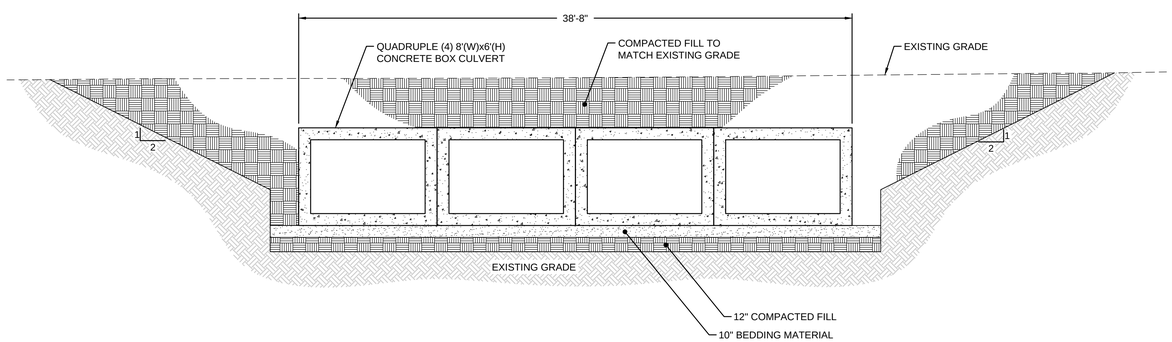
L:\CADD\HASH\ARD\TERRY CREEK\CONCEPTUAL FIGURES\ALT\ERNATIVE 4 - CULVERT RE-REROUTED\ALTERNATIVE 4 - WITH NO FLAP GATES\4443A-F005-NG-1



3 / 1 DETAIL
EXISTING BOX CULVERT TO NEW BOX CULVERT TRANSITION
SCALE: 1" = 5'
XREF: 443A-X005-B



5 / 1 DETAIL
HEADWALL AND TIDE/FLAP GATES
SCALE: 1" = 2'
XREF: 443A-X005-C



4 / 1 DETAIL
RE-ROUTED BOX CULVERT
SCALE: 1" = 5'
XREF: 443A-X005-D

Figure 8-10.
ALTERNATIVE 4
CULVERT RE-ROUTED

REV	DATE	DESCRIPTION	DRN	APP

Geosyntec consultants
1255 ROBERTS BOULEVARD, N.W., SUITE 200
KENNESAW, GEORGIA 30144 USA
PHONE: 678.202.9500

HERCULES

TITLE: CULVERT RE-ROUTED

PROJECT: REMEDIAL ALTERNATIVE CONCEPTUAL DESIGN

SITE: TERRY CREEK OU1 RI/FS, BRUNSWICK, GA

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CHECKED BY:	TLF	FILE:	4443A-F005-NG-2
REVIEWED BY:	JAS	DRAWING NO.:	
APPROVED BY:	GR		2 OF 2

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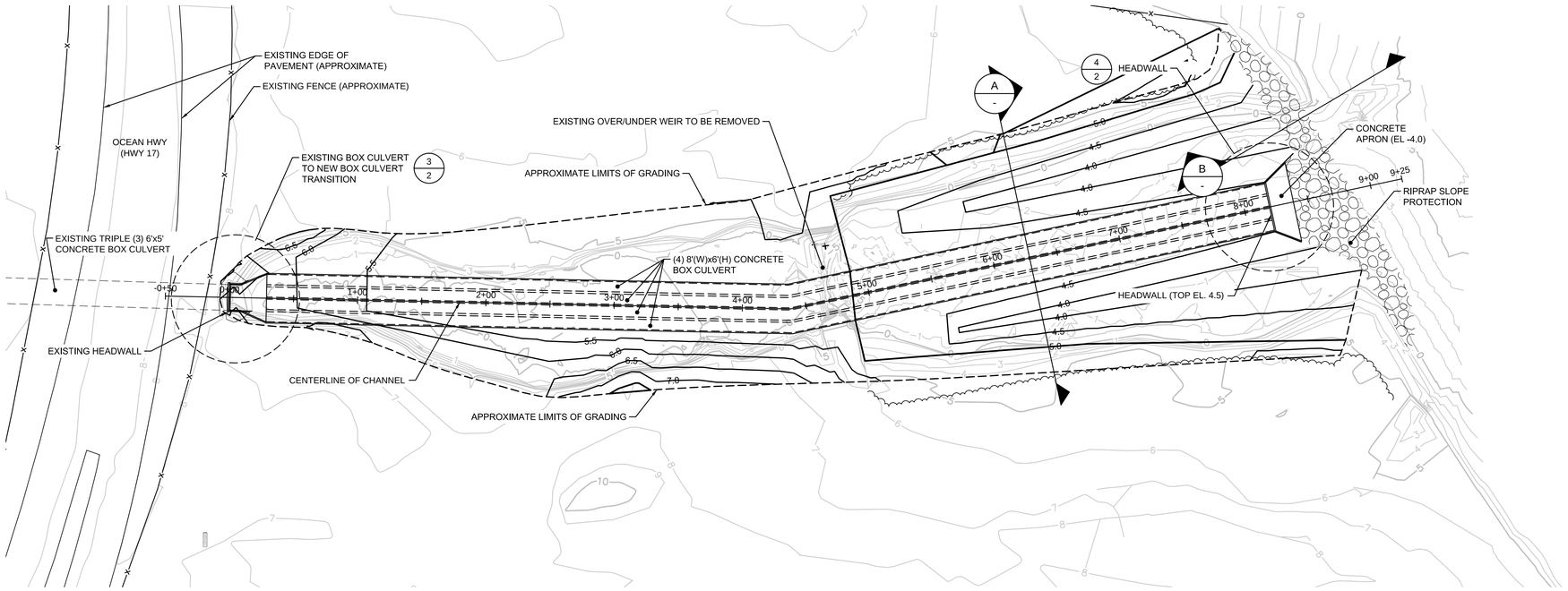
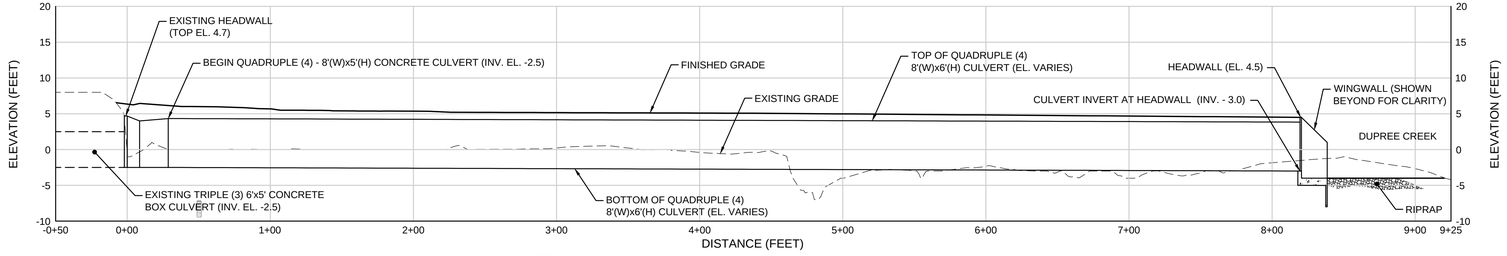


1 - PLAN VIEW

BOX CULVERT WITHIN EXISTING OUTFALL DITCH

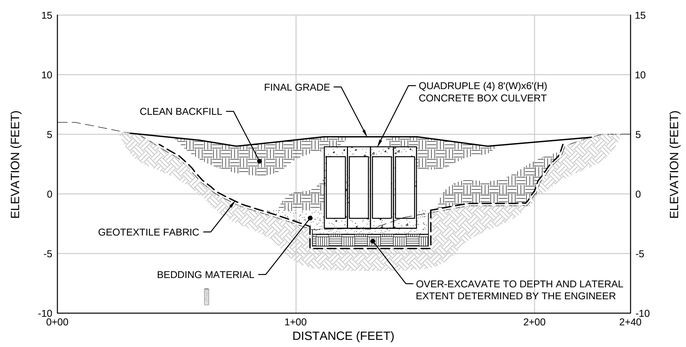
SCALE: 1" = 50'



2 - PROFILE VIEW

BOX CULVERT WITHIN EXISTING OUTFALL DITCH

SCALE: 1"=50' (HORIZONTAL); 1"=10' (VERTICAL)

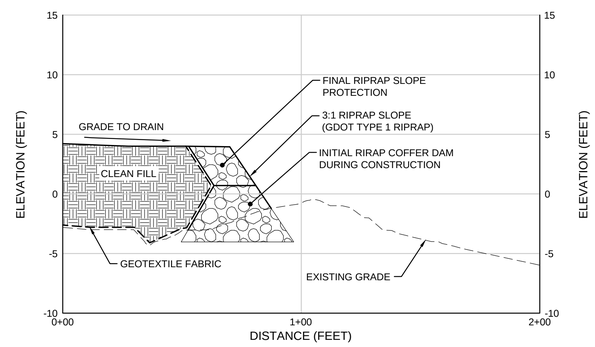


A 1 - SECTION

CULVERT WITHIN EXISTING OUTFALL DITCH

SCALE: 1"=30' (HORIZONTAL); 1"=6' (VERTICAL)

XREF: 4443A-X006-A



B 1 - SECTION

EXISTING CHANNEL BACKFILL

SCALE: 1"=30' (HORIZONTAL); 1"=6' (VERTICAL)

XREF: 4443A-X006-A

LEGEND

- EXISTING GRADES
- PROPOSED GRADES
- FENCE
- LINE OF VEGETATION
- BOX CULVERT
- RIPRAP

N

DETAIL NUMBER (4) / DRAWING ON WHICH ABOVE DETAIL IS PRESENTED (2)

DETAIL NUMBER 4 / DRAWING ON WHICH ABOVE DETAIL WAS FIRST REFERENCED 1 — DETAIL: TITLE OF DETAIL — SCALE: 1"=2'

EXAMPLE: DETAIL NUMBER 4 PRESENTED ON DRAWING NO. 2 WAS REFERENCED FOR THE FIRST TIME ON DRAWING NO. 1.

ABOVE SYSTEM ALSO APPLIES TO SECTION IDENTIFICATIONS.

DETAIL IDENTIFICATION LEGEND

NOTES:

1. THE BASE MAPPING USED FOR THIS DRAWING WAS PREPARED USING AVAILABLE AERIAL PHOTOGRAPHS, MAPPING PROVIDED BY HERCULES, RECENT SURVEYS, AND GIS DATABASE INFORMATION. NOT ALL STRUCTURES OR OTHER SITE FEATURES THAT MAY BE PRESENT ON THE SITE ARE SHOWN.
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3. THE PROPOSED CULVERT, ALIGNMENT, AND DETAILS SHOWN HEREIN ARE CONCEPTUAL. ACTUAL ALIGNMENT, ELEVATIONS AND OTHER FEATURES ARE SUBJECT TO CHANGE DURING DESIGN.

Figure 8-11.

ALTERNATIVE 4A CULVERT WITHIN EXISTING OUTFALL DITCH

REV	DATE	DESCRIPTION	DRN	APP

Geosyntec consultants
1255 ROBERTS BOULEVARD, N.W., SUITE 200
KENNESAW, GEORGIA 30144 USA
PHONE: 678.202.9500

HERCULES

TITLE: CULVERT WITHIN EXISTING OUTFALL DITCH

PROJECT: REMEDIAL ALTERNATIVE CONCEPTUAL DESIGN

SITE: TERRY CREEK OU1 RI/FS, BRUNSWICK, GA

THIS DRAWING MAY NOT BE ISSUED FOR PROJECT TENDER OR CONSTRUCTION, UNLESS SEALED.

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CHECKED BY:	TLF	FILE:	4443A-F006-NG-1
REVIEWED BY:	JAS	DRAWING NO.:	1 OF 2
APPROVED BY:	GR		

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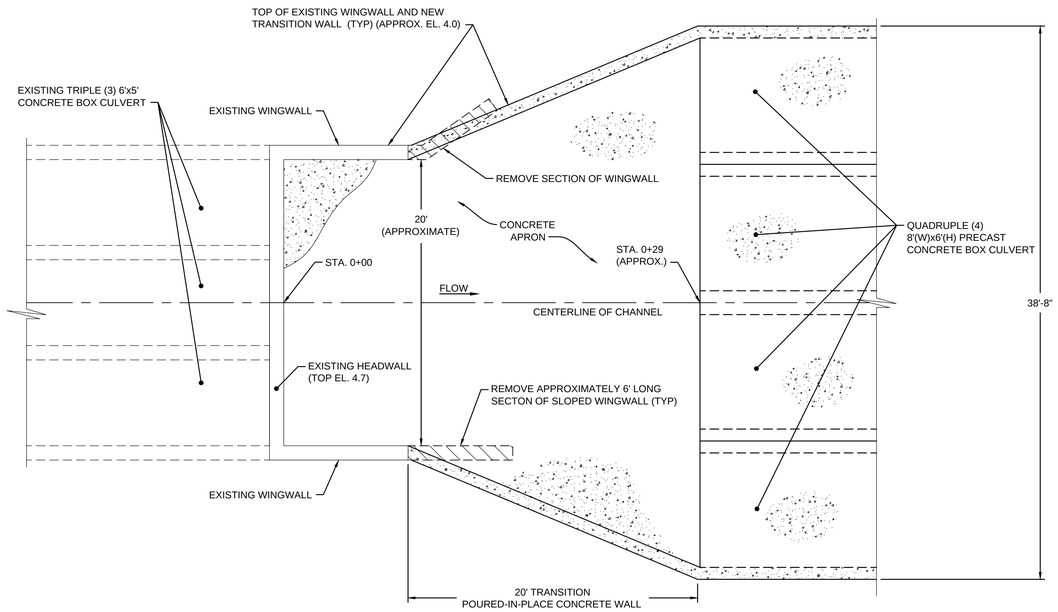
L:\CADDA\4443A-NN\TERRY CREEK\CONCEPTUAL FIGURES\ALTERNATIVE 4A - CULVERT WITHIN EXISTING OUTFALL DITCH\ALTERNATIVE 4A - WITH NO FLAP GATES\4443A-F006-NG-1

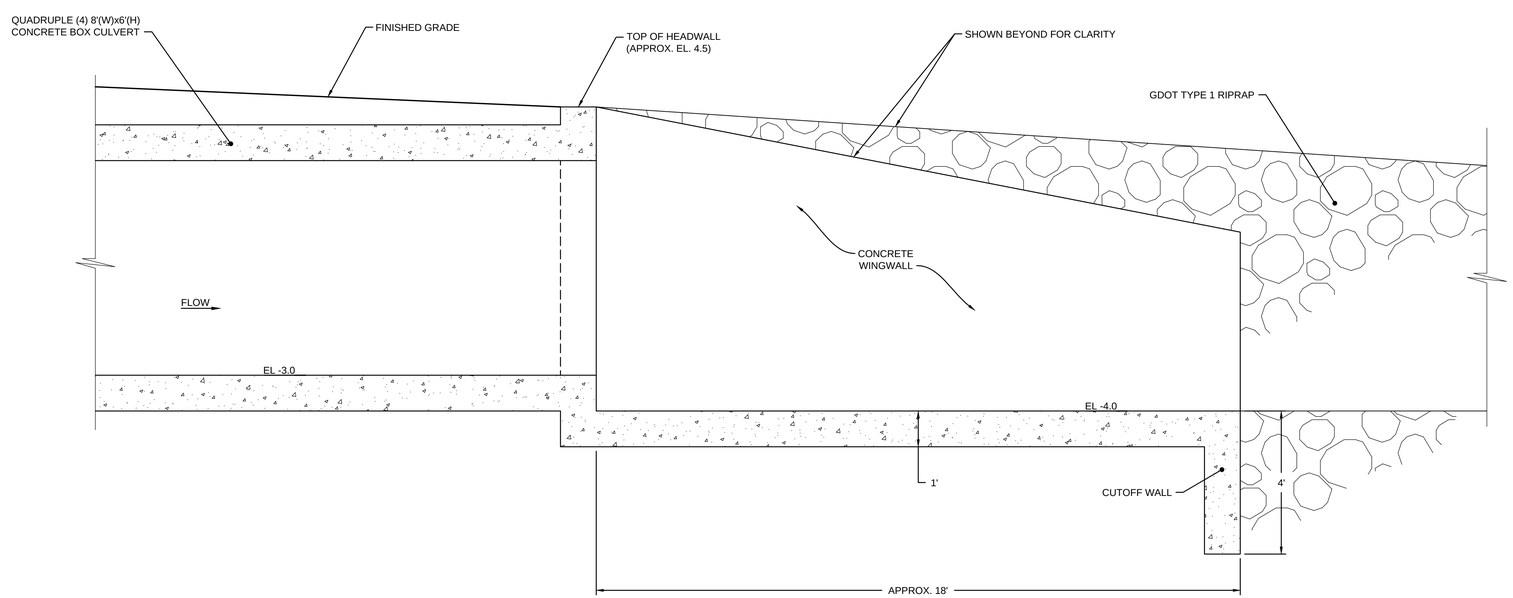


3/1 DETAIL

EXISTING BOX CULVERT TO NEW BOX CULVERT TRANSITION

SCALE: 1" = 5'

XREF: 443A-X006-B



4/1 DETAIL

HEADWALL AND TIDE/FLAP GATES

SCALE: 1" = 2'

XREF: 443A-X006-C

Figure 8-12.

ALTERNATIVE 4A
CULVERT WITHIN
EXISTING OUTFALL DITCH

REV	DATE	DESCRIPTION	DRN	APP

Geosyntec consultants
1255 ROBERTS BOULEVARD, N.W., SUITE 200
KENNESAW, GEORGIA 30144 USA
PHONE: 678.202.9500

HERCULES

TITLE: CULVERT WITHIN EXISTING OUTFALL DITCH

PROJECT: REMEDIAL ALTERNATIVE CONCEPTUAL DESIGN

SITE: TERRY CREEK OU1 RI/FS, BRUNSWICK, GA

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CHECKED BY:	TLF	FILE:	4443A-F006-NG-2
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APPROVED BY:	GR		

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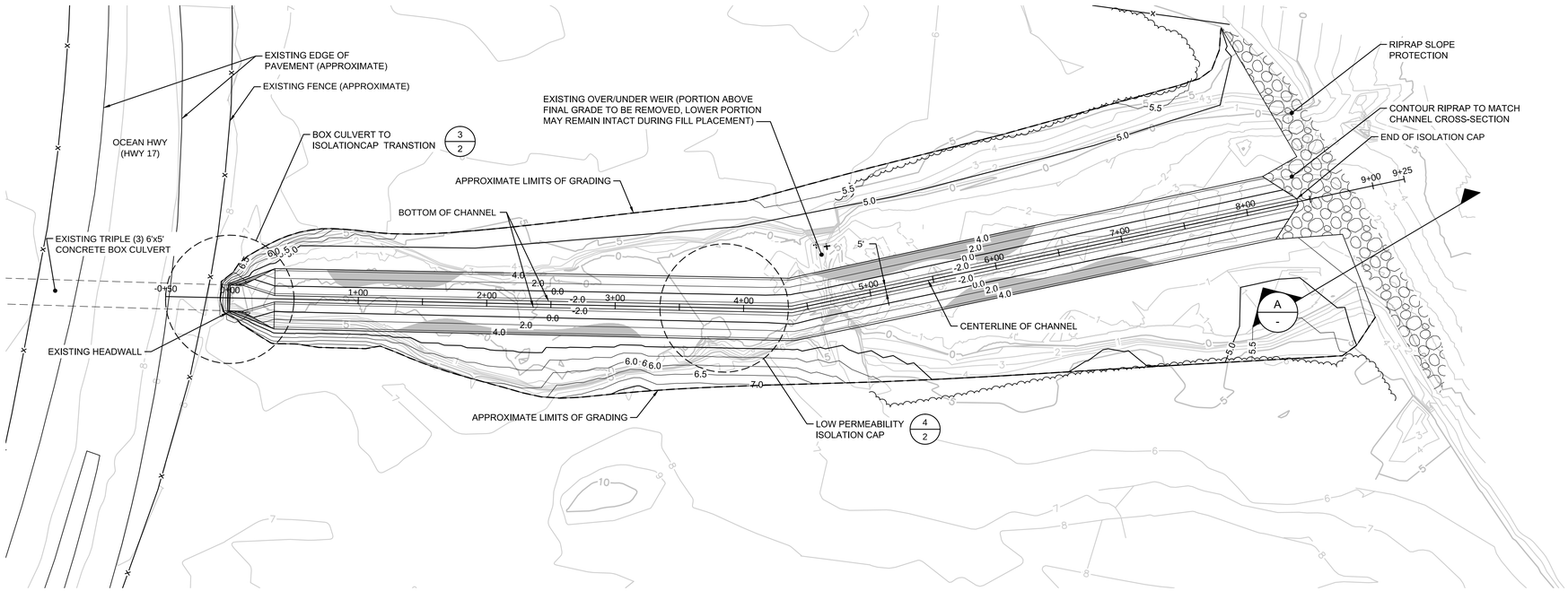
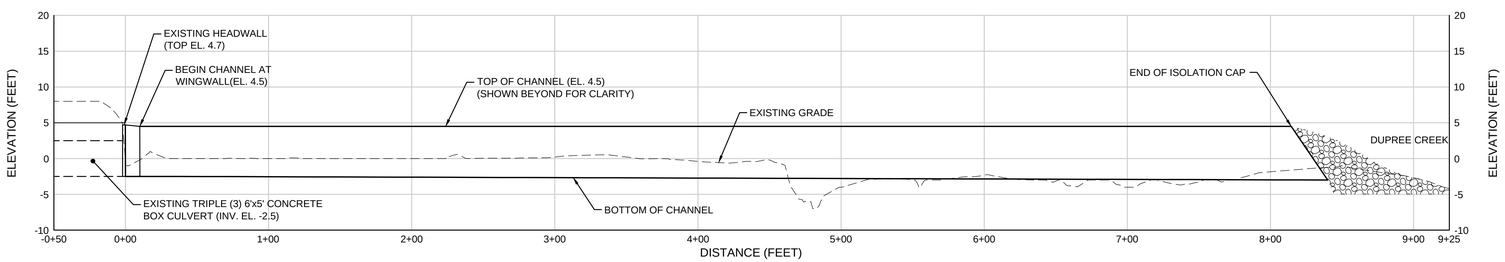
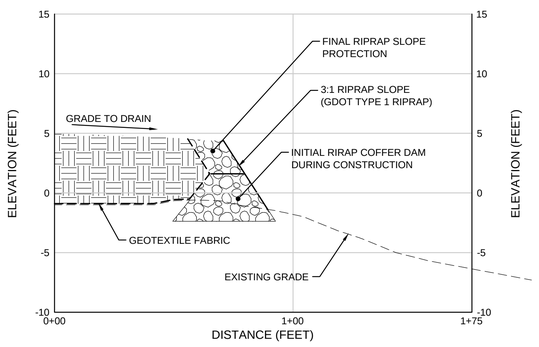


1 / - PLAN VIEW
LOW PERMEABILITY ISOLATION CAP
SCALE: 1" = 50'



2 / - PROFILE VIEW
LOW PERMEABILITY ISOLATION CAP
SCALE: 1"=50' (HORIZONTAL); 1"=10' (VERTICAL)



A / 1 SECTION
EXISTING CHANNEL BACKFILL
SCALE: 1"=30' (HORIZONTAL); 1"=6' (VERTICAL)
XREF: 4443A-X007-A

LEGEND

- EXISTING GRADES
- PROPOSED GRADES
- FENCE
- LINE OF VEGETATION
- ISOLATION CAP
- RIPRAP

N

DETAIL NUMBER (4/2): DRAWING ON WHICH ABOVE DETAIL IS PRESENTED

DETAIL NUMBER (4/1): DETAIL — TITLE OF DETAIL — SCALE: 1"=2'
DRAWING ON WHICH ABOVE DETAIL WAS FIRST REFERENCED

EXAMPLE: DETAIL NUMBER 4 PRESENTED ON DRAWING NO. 2 WAS REFERENCED FOR THE FIRST TIME ON DRAWING NO. 1.

ABOVE SYSTEM ALSO APPLIES TO SECTION IDENTIFICATIONS.

DETAIL IDENTIFICATION LEGEND

NOTES:

1. THE BASE MAPPING USED FOR THIS DRAWING WAS PREPARED USING AVAILABLE AERIAL PHOTOGRAPHS, MAPPING PROVIDED BY HERCULES, RECENT SURVEYS, AND GIS DATABASE INFORMATION. NOT ALL STRUCTURES OR OTHER SITE FEATURES THAT MAY BE PRESENT ON THE SITE ARE SHOWN.
2. TOPOGRAPHIC INFORMATION PROVIDED IS BASED ON A FIELD SURVEY COMPLETED BY ARC SURVEYING AND MAPPING, INC, ON 5 APRIL 2012.
3. THE PROPOSED CHANNEL, ALIGNMENT, AND DETAILS SHOWN HEREIN ARE CONCEPTUAL. ACTUAL ALIGNMENT, ELEVATIONS AND OTHER FEATURES ARE SUBJECT TO CHANGE DURING DESIGN.

Figure 8-13.
ALTERNATIVE 5
LOW PERMEABILITY ISOLATION CAP

REV	DATE	DESCRIPTION	DRN	APP

Geosyntec consultants
1255 ROBERTS BOULEVARD, N.W., SUITE 200
KENNESAW, GEORGIA 30144 USA
PHONE: 678.202.9500

HERCULES

TITLE: LOW PERMEABILITY ISOLATION CAP

PROJECT: REMEDIAL ALTERNATIVE CONCEPTUAL DESIGN

SITE: TERRY CREEK OU1 RI/FS, BRUNSWICK, GA

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DESIGN BY:	TLF	DATE:	AUG 2013
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CHECKED BY:	TLF	FILE:	4443A-F007-NG-1
REVIEWED BY:	JAS	DRAWING NO.:	1 OF 2
APPROVED BY:	GR		

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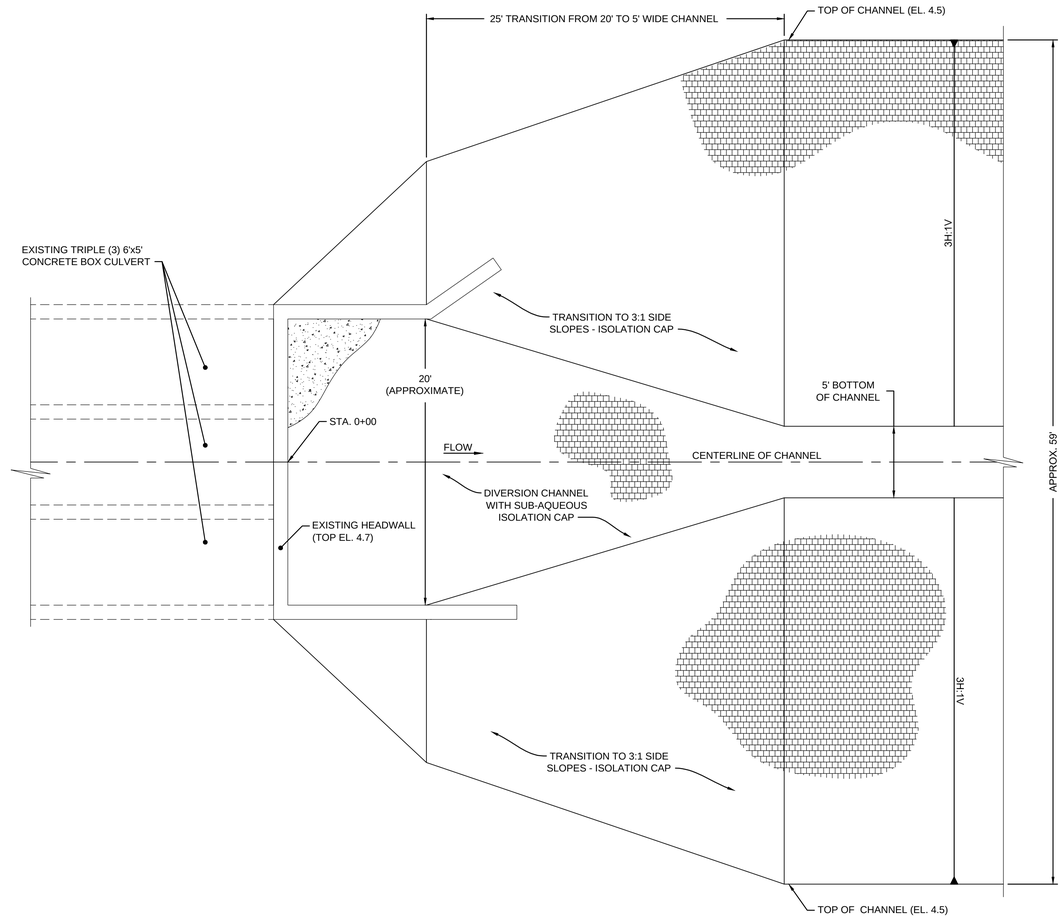
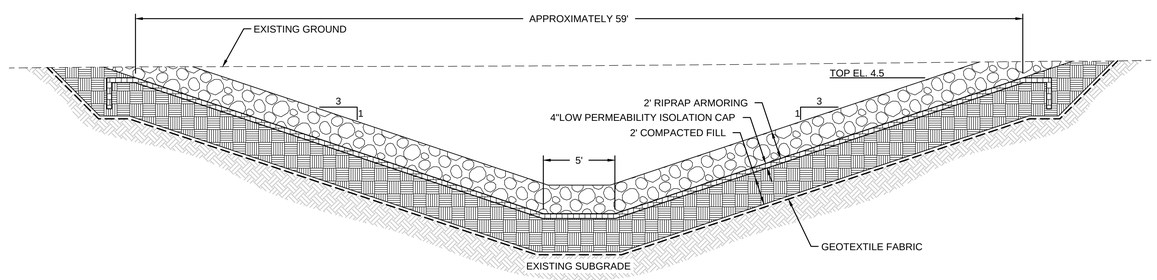
L:\CADD\ASHLAND\TERRY CREEK\CONCEPTUAL FIGURES\ALTERNATIVE 5 - SUB-AQUEOUS ISOLATION CAP\ALTERNATIVE 5 - WITH NO FLAP GATES\4443A-F007-NG-1



3/1 DETAIL
BOX CULVERT TO ISOLATION CAP TRANSITION
SCALE: 1" = 5'
XREF: 443A-X007-B



4/1 DETAIL
LOW PERMEABILITY ISOLATION CAP
SCALE: 1" = 5'
XREF: 443A-X007-C

Figure 8-14.

ALTERNATIVE 5
LOW PERMEABILITY ISOLATION CAP

REV	DATE	DESCRIPTION	DRN	APP

Geosyntec consultants
1255 ROBERTS BOULEVARD, N.W., SUITE 200
KENNESAW, GEORGIA 30144 USA
PHONE: 678.202.9500

HERCULES

TITLE: LOW PERMEABILITY ISOLATION CAP

PROJECT: REMEDIAL ALTERNATIVE CONCEPTUAL DESIGN

SITE: TERRY CREEK OU1 RI/FS, BRUNSWICK, GA

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DATE

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DRAWN BY:	WWS	PROJECT NO.:	GR4443A
CHECKED BY:	TLF	FILE:	4443A-F007-NG-2
REVIEWED BY:	JAS	DRAWING NO.:	
APPROVED BY:	GR		2 OF 2

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NOT FOR CONSTRUCTION

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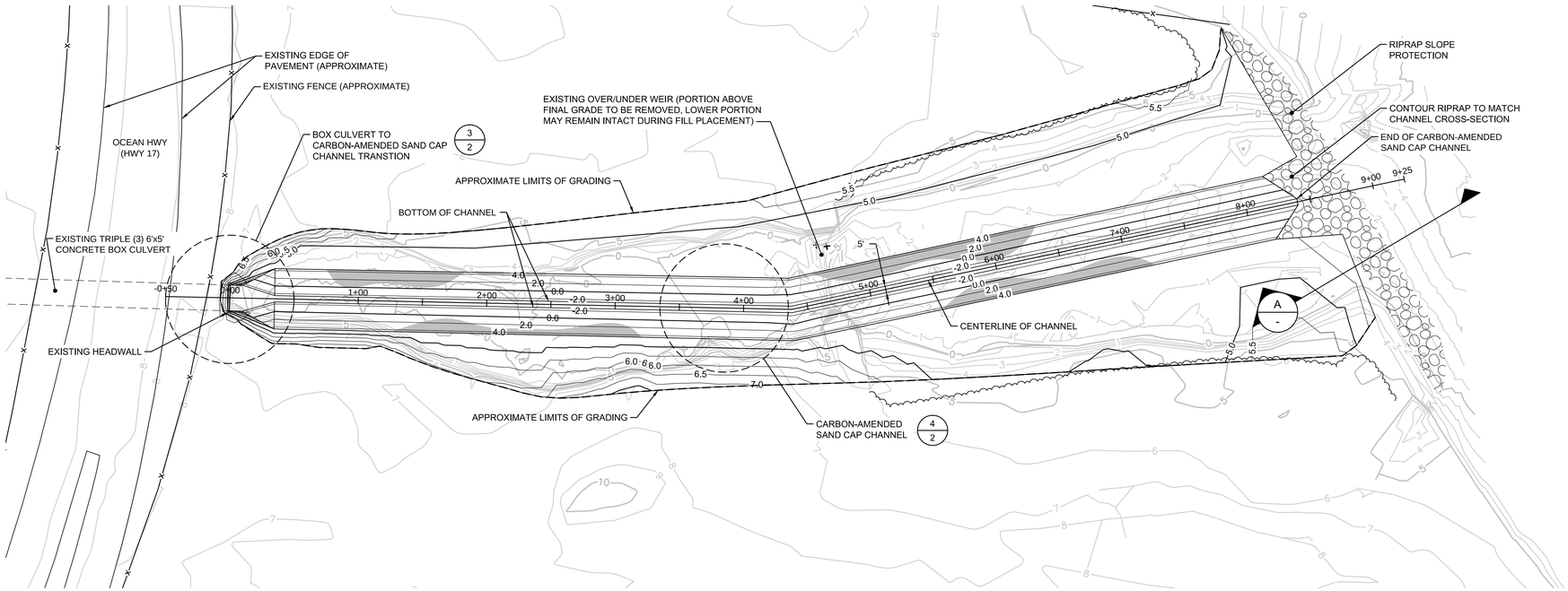
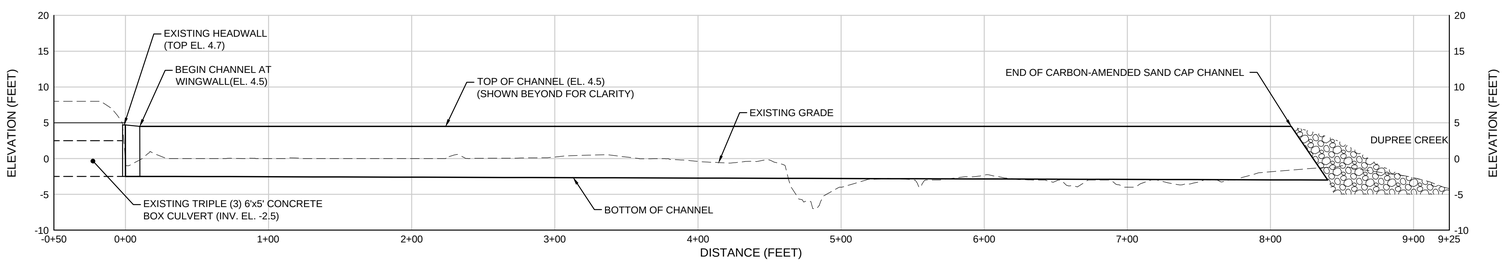
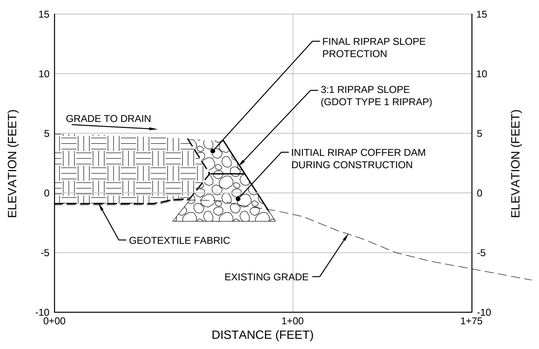


1 / - PLAN VIEW
CARBON-AMENDED SAND CAP CHANNEL
SCALE: 1" = 50'



2 / - PROFILE VIEW
CARBON-AMENDED SAND CAP CHANNEL
SCALE: 1"=50' (HORIZONTAL); 1"=10' (VERTICAL)



A / 1 SECTION
EXISTING CHANNEL BACKFILL
SCALE: 1"=30' (HORIZONTAL); 1"=6' (VERTICAL)
XREF: 4443A-X007-A

LEGEND

- EXISTING GRADES
- PROPOSED GRADES
- FENCE
- LINE OF VEGETATION
- CARBON-AMENDED SAND CAP LINING
- RIPRAP

N

DETAIL NUMBER (4/2): DRAWING ON WHICH ABOVE DETAIL IS PRESENTED

DETAIL NUMBER (4/1): DRAWING ON WHICH ABOVE DETAIL WAS FIRST REFERENCED

DETAIL
TITLE OF DETAIL
SCALE: 1"=2'

EXAMPLE: DETAIL NUMBER 4 PRESENTED ON DRAWING NO. 2 WAS REFERENCED FOR THE FIRST TIME ON DRAWING NO. 1.

ABOVE SYSTEM ALSO APPLIES TO SECTION IDENTIFICATIONS.

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Figure 8-15.

ALTERNATIVE 5A CARBON-AMENDED SAND CAP CHANNEL

REV	DATE	DESCRIPTION	DRN	APP

Geosyntec consultants
1255 ROBERTS BOULEVARD, N.W., SUITE 200
KENNESAW, GEORGIA 30144 USA
PHONE: 678.202.9500

HERCULES

TITLE: CARBON-AMENDED SAND CAP CHANNEL

PROJECT: REMEDIAL ALTERNATIVE CONCEPTUAL DESIGN

SITE: TERRY CREEK OU1 RI/FS, BRUNSWICK, GA

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SIGNATURE

DATE

DESIGN BY:	TLF	DATE:	AUG 2013
DRAWN BY:	WWS	PROJECT NO.:	GR4443A
CHECKED BY:	TLF	FILE:	4443A-F009-NG-1
REVIEWED BY:	JAS	DRAWING NO.:	1 OF 2
APPROVED BY:	GR		

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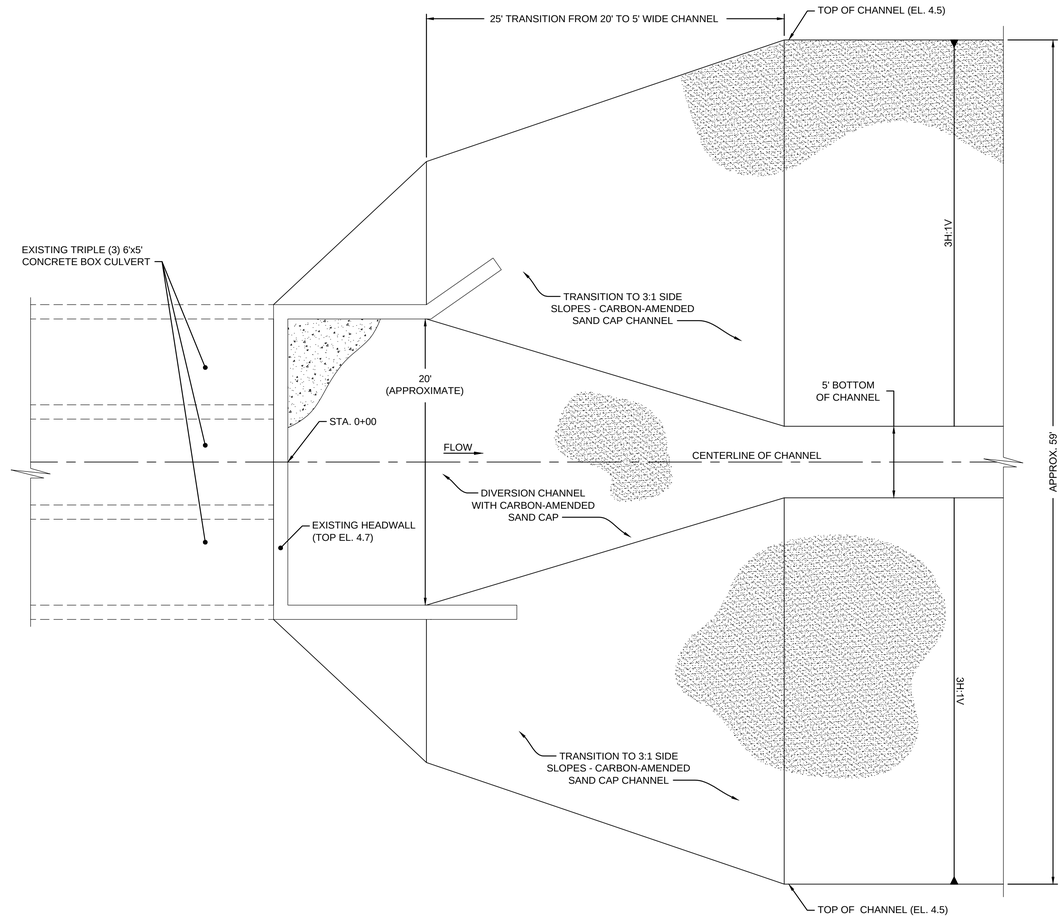
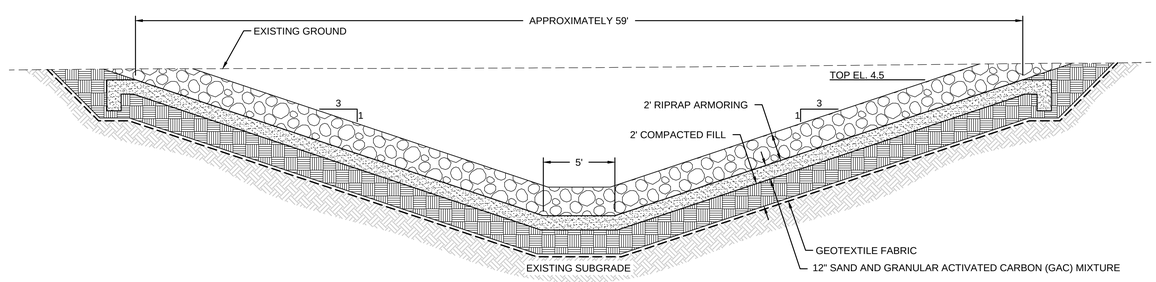
L:\CADD\4443A-AROTERRY CREEK\CONCEPTUAL FIGURES\ALTERNATIVE 5A - CARBON AMENDED SAND CAP\ALTERNATIVE 5 - WITH NO FLAP GATES\4443A-F009-NG-1



3/1 DETAIL
BOX CULVERT TO CARBON-AMENDED SAND CAP CHANNEL TRANSITION
SCALE: 1" = 5'
XREF: 443A-X007-B



4/1 DETAIL
CARBON-AMENDED SAND CAP CHANNEL
SCALE: 1" = 5'
XREF: 443A-X007-C

Figure 8-16.

ALTERNATIVE 5A
CARBON-AMENDED
SAND CAP CHANNEL

REV	DATE	DESCRIPTION	DRN	APP

Geosyntec consultants
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KENNESAW, GEORGIA 30144 USA
PHONE: 678.202.9500

HERCULES

TITLE: CARBON-AMENDED SAND CAP CHANNEL

PROJECT: REMEDIAL ALTERNATIVE CONCEPTUAL DESIGN

SITE: TERRY CREEK OU1 RI/FS, BRUNSWICK, GA

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DATE

DESIGN BY:	TLF	DATE:	AUG 2013
DRAWN BY:	WWS	PROJECT NO.:	GR4443A
CHECKED BY:	TLF	FILE:	4443A-F009-NG-2
REVIEWED BY:	JAS	DRAWING NO.:	
APPROVED BY:	GR		2 OF 2

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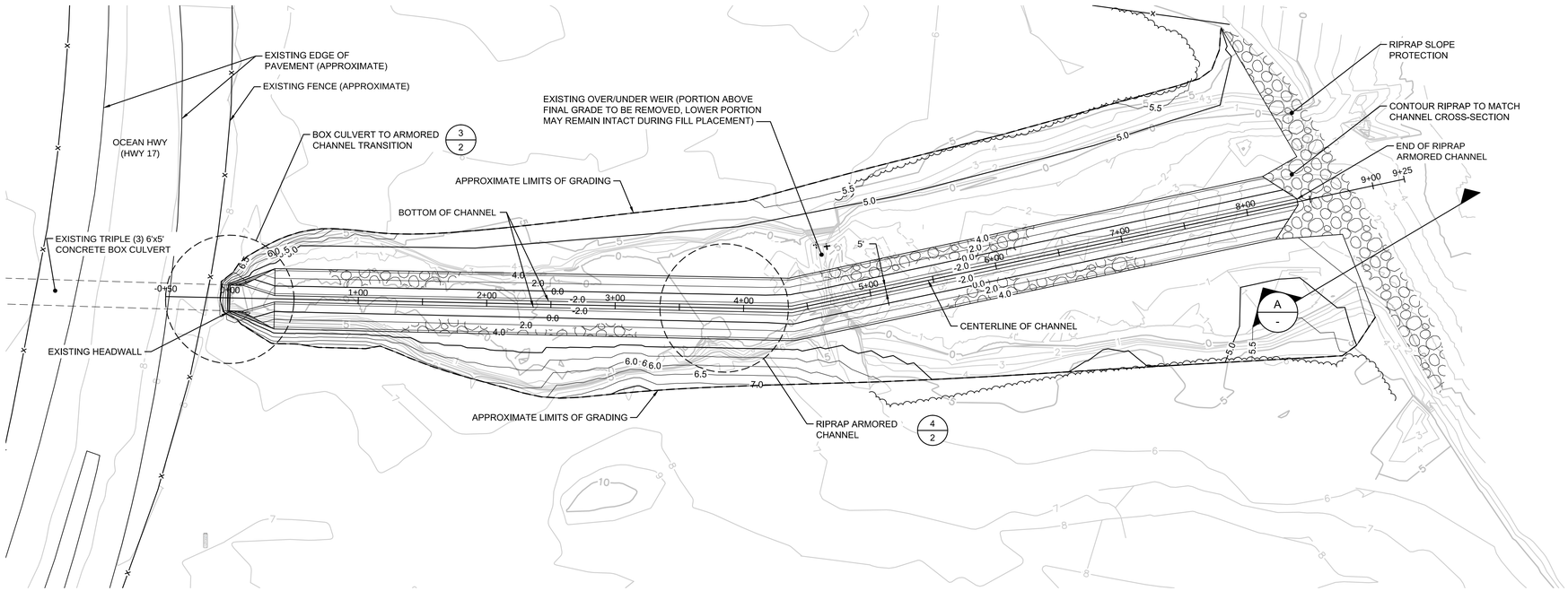
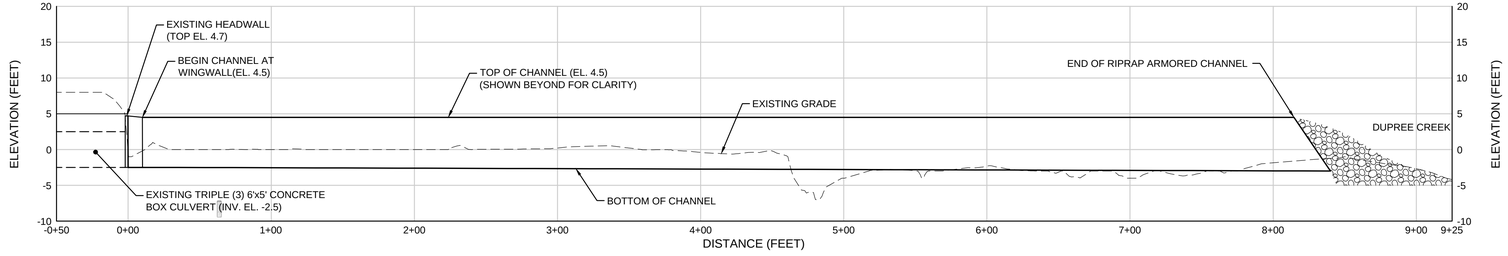
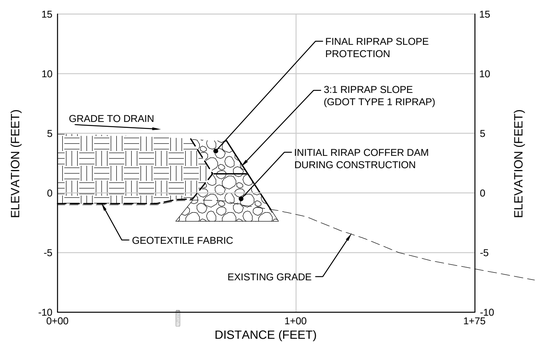
L:\CADD\4A5RLA\ROT\TERRY CREEK\CONCEPTUAL FIGURES\ALTERNATIVE 5A - CARBON AMENDED SAND CAP\ALTERNATIVE 5 - WITH NO FLAP GATES\4443A-F009-NG-2



1 / - PLAN VIEW
RIPRAP ARMORED CHANNEL
SCALE: 1" = 50'



2 / - PROFILE VIEW
RIPRAP ARMORED CHANNEL
SCALE: 1"=50' (HORIZONTAL); 1"=10' (VERTICAL)



A / 1 SECTION
EXISTING CHANNEL BACKFILL
SCALE: 1"=30' (HORIZONTAL); 1"=6' (VERTICAL)
XREF: 4443A-X008-A

LEGEND

- EXISTING GRADES
- PROPOSED GRADES
- FENCE
- LINE OF VEGETATION
- RIPRAP

N

DETAIL NUMBER (4/2)
DRAWING ON WHICH ABOVE DETAIL IS PRESENTED

DETAIL NUMBER (4/1) — DETAIL
DRAWING ON WHICH ABOVE DETAIL WAS FIRST REFERENCED — TITLE OF DETAIL
SCALE: 1"=2'

EXAMPLE: DETAIL NUMBER 4 PRESENTED ON DRAWING NO. 2 WAS REFERENCED FOR THE FIRST TIME ON DRAWING NO. 1.

ABOVE SYSTEM ALSO APPLIES TO SECTION IDENTIFICATIONS.

DETAIL IDENTIFICATION LEGEND

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Figure 8-17.
ALTERNATIVE 6
RIPRAP ARMORED CHANNEL

REV	DATE	DESCRIPTION	DRN	APP

Geosyntec consultants
1255 ROBERTS BOULEVARD, N.W., SUITE 200
KENNESAW, GEORGIA 30144 USA
PHONE: 678.202.9500

HERCULES

TITLE: RIPRAP ARMORED CHANNEL

PROJECT: REMEDIAL ALTERNATIVE CONCEPTUAL DESIGN

SITE: TERRY CREEK OU1 RI/FS, BRUNSWICK, GA

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DESIGN BY:	TLF	DATE:	AUG 2013
DRAWN BY:	WWS	PROJECT NO.:	GR4443A
CHECKED BY:	TLF	FILE:	4443A-F008-NG-1
REVIEWED BY:	JAS	DRAWING NO.:	1 OF 2
APPROVED BY:	GR		

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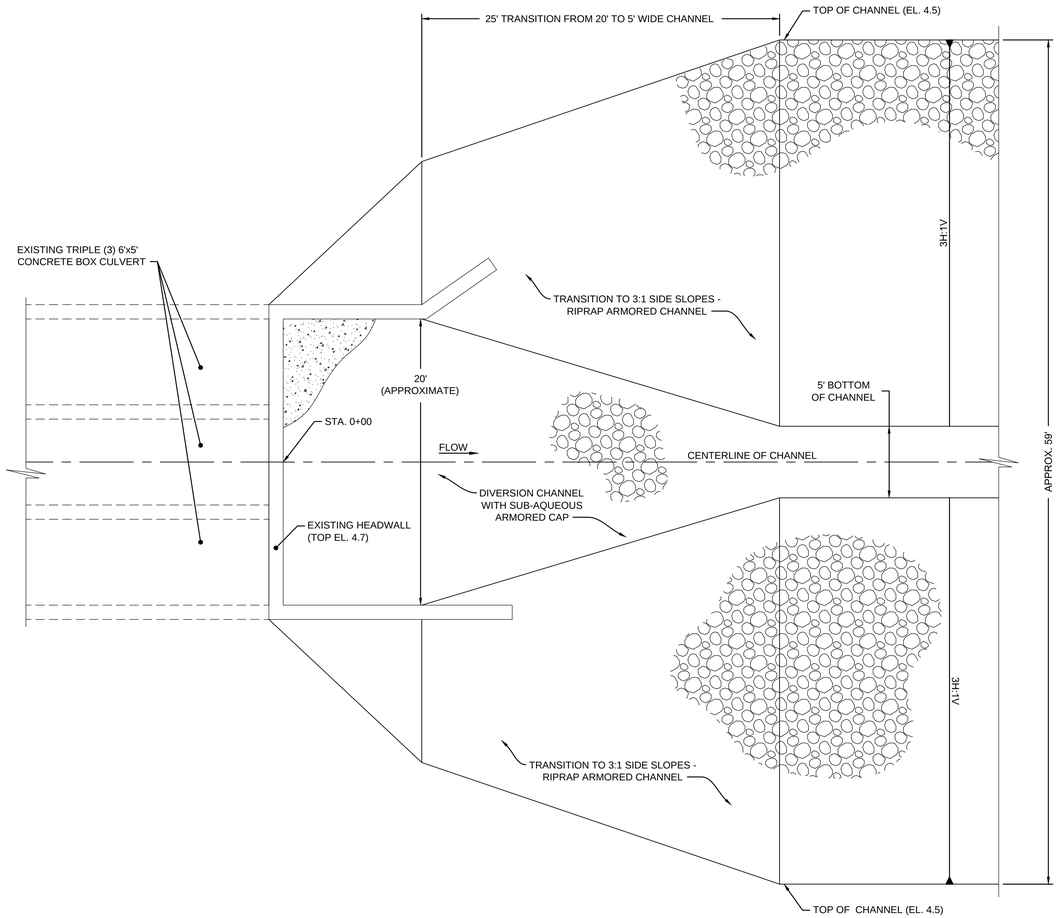
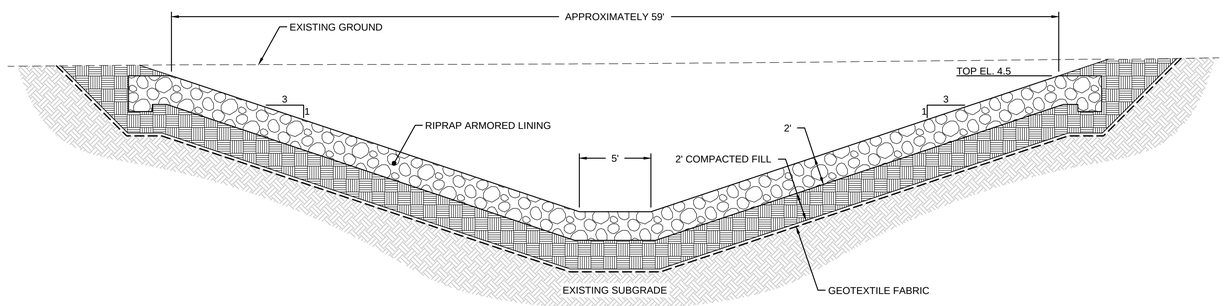
L:\CADD\HASPA\BRUNTERRY CREEK\CONCEPTUAL FIGURES\ALTERNATIVE 6 - SUB-AQUEOUS ARMORED CAP\ALTERNATIVE 6 - WITH NO FLAP GATE\4443A-F008-NG-1



3/1 DETAIL
BOX CULVERT TO ARMORED CHANNEL TRANSITION
SCALE: 1" = 5'
XREF: 443A-X008-B



4/1 DETAIL
RIPRAP ARMORED CHANNEL
SCALE: 1" = 5'
XREF: 443A-X008-C

Figure 8-18.
ALTERNATIVE 6
RIPRAP ARMORED CHANNEL

REV	DATE	DESCRIPTION	DRN	APP

Geosyntec consultants
1255 ROBERTS BOULEVARD, N.W., SUITE 200
KENNESAW, GEORGIA 30144 USA
PHONE: 678.202.9500

HERCULES

TITLE: RIPRAP ARMORED CHANNEL

PROJECT: REMEDIAL ALTERNATIVE CONCEPTUAL DESIGN

SITE: TERRY CREEK OU1 RI/FS, BRUNSWICK, GA

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DATE

DESIGN BY:	TLF	DATE:	AUG 2013
DRAWN BY:	WWS	PROJECT NO.:	GR4443A
CHECKED BY:	TLF	FILE:	4443A-F008-NG-2
REVIEWED BY:	JAS	DRAWING NO.:	
APPROVED BY:	GR		2 OF 2

PRELIMINARY
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APPENDIX A

Appendix A
Comparison of Toxaphene and Weathered Toxaphene Concentrations by Different EPA Analytical Methods

Outfall Ditch Sediment, February 2012

Sample ID	Depth	Total Organic Carbon	Method 1 (Technical)	Method 2 (TAUC)	Hp-Sed	Hx-Sed	Parlar 26	Parlar 40	Parlar 41	Parlar 44	Parlar 50	Parlar 62	Toxaphene, 8276
	ft	*mg/kg*	*µg/kg*	*µg/kg*	*µg/kg*	*µg/kg*	*µg/kg*	*µg/kg*	*µg/kg*	*µg/kg*	*µg/kg*	*µg/kg*	*µg/kg*
SD-OD1N-01	0 - 0.5	170,000 J	12,000 J	3,400	400 J	410 J	26 J	29 J	6.9 J	4.1 UJ	19 J	55 J	12,000 J
SD-OD1N-02	0.5 - 2	49,000	27,000	10,000	870	840	87	87	24	22	75	160	27,000
SD-OD1N-05	6 - 8	1,500	110 U	37 U	0	0	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	1 U	110 U
SD-OD2T-01	0 - 0.5	180,000 J	5,100 J	6,300	230 J	170 J	62 J	62 J	25 J	14 J	44 J	30 UJ	5,100 J
SD-OD3T-03	2 - 4	69,000	78,000	35,000	2,100	2,700	110	160	44 U	44 U	44 U	440 U	78,000
SD-OD3T-05	6 - 8	75,000	170 U	77 J	3	4	0	1	0.17 U	0.17 U	0	1.7 U	170
SD-OD5S-02	0.5 - 2	51,000	190 J	550	55	64	2	2	1	1	2	4	190 J
SD-OD5S-05	6 - 8	77,000	87,000	120,000	3,800	4,500	870	950	370	300	750	2,000 U	87,000
SD-OD5T-02	0.5 - 2	120,000	16,000	31,000	1,100	1,300	90	130	56 U	56 U	56 U	560 U	44,000

Outfall Ditch Surface Water, February 2012

Sample ID	Sample Type	Total Suspended Solids	Method 1 (Technical)	Method 2 (TAUC)	Hp-Sed	Hx-Sed	Parlar 26	Parlar 40	Parlar 41	Parlar 44	Parlar 50	Parlar 62	Toxaphene, 8276
		mg/L	*µg/L*	*µg/L*	*µg/L*	*µg/L*	*µg/L*	*µg/L*	*µg/L*	*µg/L*	*µg/L*	*µg/L*	*µg/L*
SW-DCEB-01	ebb tide, dissolved	NA	0.53 U	0.53 U	NA	NA	NA	NA	NA	NA	NA	NA	NA
SW-DCEB-02	ebb tide, total	5.5	0.51 U	0.51 U	NA	NA	NA	NA	NA	NA	NA	NA	NA
SW-DCFL-01	flood tide, dissolved	NA	0.51 U	0.51 U	0.0028	0.006	0.0025 U	0.0025 U	0.0025 U	0.0025 U	0.0025 U	0.025 U	0.51 U
SW-DCFL-02	flood tide, total	30	0.48 U	0.48 U	0.0066	0.0096	0.0026 U	0.0026 U	0.0026 U	0.0026 U	0.0026 U	0.026 U	0.48 U
SW-DMEB-01	ebb tide, dissolved	NA	0.24 U	0.51 U	0.004	0.0083	0.0024 U	0.0024 U	0.0024 U	0.0024 U	0.0024 U	0.024 U	0.24 U
SW-DMEB-02	ebb tide, total	29	0.47 U	0.47 U	0.0051	0.0064	0.0026 U	0.0026 U	0.0026 U	0.0026 U	0.0026 U	0.026 U	0.47 U
SW-DMFL-01	flood tide, dissolved	NA	0.47 U	0.47 U	NA	NA	NA	NA	NA	NA	NA	NA	NA
SW-DMFL-02	flood tide, total	37	0.51 U	0.51 U	NA	NA	NA	NA	NA	NA	NA	NA	NA

Weathered Toxaphene in Outfall Ditch Surface Water, February 2012

Sample ID	Sample Type	Total Suspended Solids	Method 1 (Technical)	Method 2 (TAUC)	Hp-Sed	Hx-Sed	Parlar 26	Parlar 40	Parlar 41	Parlar 44	Parlar 50	Parlar 62	Toxaphene, 8276
		mg/L	*µg/L*	*µg/L*	*µg/L*	*µg/L*	*µg/L*	*µg/L*	*µg/L*	*µg/L*	*µg/L*	*µg/L*	*µg/L*
SW-DCEB-01	ebb tide, dissolved	NA	0.53 U	0.53 U	NA	NA	NA	NA	NA	NA	NA	NA	NA
SW-DCEB-02	ebb tide, total	5.5	0.51 U	0.51 U	NA	NA	NA	NA	NA	NA	NA	NA	NA
SW-DCFL-01	flood tide, dissolved	NA	0.51 U	0.51 U	0.0028	0.006	0.0025 U	0.0025 U	0.0025 U	0.0025 U	0.0025 U	0.025 U	0.51 U
SW-DCFL-02	flood tide, total	30	0.48 U	0.48 U	0.0066	0.0096	0.0026 U	0.0026 U	0.0026 U	0.0026 U	0.0026 U	0.026 U	0.48 U
SW-DMEB-01	ebb tide, dissolved	NA	0.24 U	0.51 U	0.004	0.0083	0.0024 U	0.0024 U	0.0024 U	0.0024 U	0.0024 U	0.024 U	0.24 U
SW-DMEB-02	ebb tide, total	29	0.47 U	0.47 U	0.0051	0.0064	0.0026 U	0.0026 U	0.0026 U	0.0026 U	0.0026 U	0.026 U	0.47 U
SW-DMFL-01	flood tide, dissolved	NA	0.47 U	0.47 U	NA	NA	NA	NA	NA	NA	NA	NA	NA
SW-DMFL-02	flood tide, total	37	0.51 U	0.51 U	NA	NA	NA	NA	NA	NA	NA	NA	NA

NA: Not analyzed

APPENDIX B

Geosyntec consultants

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Jacksonville, Florida 32207
PH 904.858-1818
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Memorandum

Date: 18 June 2012

To: Cristin Corless Krachon, Project Scientist

From: Ramil Mijares, Ph.D., Senior Staff Engineer
Ramachandran Kulasingam, Ph.D., P.E., Senior Engineer

Subject: Geotechnical Investigation: Subsurface Stratigraphy and Material Properties
Terry Creek Site, Brunswick, Georgia

The purpose of this memorandum is to present the results of the limited geotechnical subsurface investigation activities performed in accordance with the focused Remedial Investigation and Feasibility Study (RI/FS) Work Plan prepared by Geosyntec Consultants (Geosyntec) for Operable Unit 1 (OU1) at the Terry Creek Site (Site) located in Brunswick, Georgia. The intent of the geotechnical investigation was to evaluate the existing subsurface conditions at the Site to aid in the development and evaluation of a remedy for OU1.

The remainder of this memorandum is organized to present: (i) a summary of the geotechnical investigation activities; (ii) interpretation of subsurface stratigraphy; (iii) a summary of geotechnical laboratory analyses and interpretation of material properties (i.e., index properties, compressibility, and shear strength); and (iv) recommendation on material properties to be used in developing and evaluating remedial alternatives.

GEOTECHNICAL INVESTIGATION

The scope of work performed by Geosyntec consisted of drilling 11 Standard Penetration Test (SPT) borings shown in Figure 1. Five (5) borings were located along the potential re-routing alignment of the Outfall Ditch, four (4) borings were located north of the Outfall Ditch, and the remaining borings were located in areas that will provide data that are representative of subsurface soil below the Outfall Ditch. Borings B-1 through B-9 were advanced to a total depth of 16 feet, below ground surface (bgs). Borings B-10 and B-11 were advanced to a total depth of 36 feet, bgs. Table 1 presents the coordinates of the borings and the ground surface elevation. The SPT borings were advanced using hollow stem auger (HSA) drilling techniques on February 27 to 29, 2012. The geotechnical drilling services were provided by SAEDACCO, Inc. of Fort Mill, South Carolina under subcontract to Geosyntec.

SPTs and soil sampling were performed using continuous split-spoon sampling procedures in accordance with ASTM D1586 “Standard Test Method for Standard Penetration Test (SPT) and

Split-Barrel Sampling of Soils". The subsurface soils encountered were logged in accordance with ASTM D2488 "Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)". Lithologic field logs for each borings are presented in Attachment A. The lithologic boring logs include general soil classification and description, recovery percentage, recorded blow counts and the corresponding SPT N value. The approximate depth to groundwater at each boring location, as indicated by the saturated conditions of the soils, was also noted during drilling and included on the respective lithologic boring logs.

A total of three (3) thin-walled Shelby tube samples from predominantly clayey layers were also collected. Upon completion of drilling activities, each borehole was grouted from the bottom up to the ground surface with neat cement.

Furthermore, two sediment samples were obtained from the Outfall Ditch, one from the pre-weir and one from the post-weir section as shown in Figure 1. The samples were collected using a vibracoring device up to a depth of approximately 10 feet below the sediment-water interface.

A photography log with select photographs during the geotechnical site investigation is presented in Attachment B.

SUBSURFACE STRATIGRAPHY

The subsurface stratigraphy in the OU1 Site was developed based on the geotechnical information interpreted from the lithologic boring logs presented in Attachment A. Subsurface profiles developed for the northern (i.e., north of the Outfall Ditch) and southern (i.e., south of the Outfall Ditch) sides of the OU1 site are presented in Attachment C. The subsurface conditions encountered during the geotechnical investigation are summarized as follows:

- Sand (shallow): Sand was encountered on the upper portions of the OU1 Site and was found to extend approximately up to 4 to 8 feet, bgs on the southern side of the OU1 Site, as illustrated in Subsurface Profile 1 on Attachment C. It was found to extend throughout the depth of Boreholes B-6 through B-8 on the northern side of the OU1 Site, as illustrated in Subsurface Profile 2 on Attachment C, with pockets of Clayey Sand and Clay at varying intervals. The Sand consisted primarily of poorly graded, fine to medium sand. The SPT N value ranged from 0 to 16 with an average value of 6 as shown in Figure 2.

- Clayey Sand: Clayey Sand was encountered on the southern side of the OU1 Site on the borings located along the potential re-routing alignment of the Outfall Ditch (i.e., Boreholes B-1 through B-5 and B-11), as illustrated in Subsurface Profile 1 on Attachment C, and was found to extend approximately from 4 to 8 feet, bgs up to 8 to 14 feet, bgs. The Clayey Sand consisted primarily of fine to medium sand with some

clay. Presence of crushed shells was found in some areas. The SPT N value ranged from 0 to 14 with an average value of 5 as shown in Figure 2.

- Sand (deep): Sand was encountered on the lower portions of the OU1 Site on the bottom of the boreholes extending approximately from 10 to 14 feet, bgs on shallow borings and approximately from 24 to 28 feet, bgs on deep borings. The Sand consisted primarily of poorly graded, fine to medium sand. The SPT N value ranged from 0 to 50 with an average value of 12 as shown in Figure 2.

- Clay: Clay was encountered in the eastern side of the OU1 Site (i.e., Boreholes B-1, B-2, B-9, B-10 and B-11) and was found to extend approximately from 4 to 10 feet, bgs up to 14 to 18 feet, bgs. It was also found to extend up to approximately 24 to 28 feet, bgs on Boreholes B-10 and B-11. The Clay consisted of highly plastic, sandy fat clay to fat clay. The SPT N value ranged from 0 to 7 with an average value of 2 as shown in Figure 2.

Groundwater table was observed approximately 4 to 6 feet, bgs. Trace organic material (i.e., mostly small roots) was identified in the upper portions (i.e., approximately 0 to 4 feet, bgs) of the OU1 Site.

The descriptions of Outfall Ditch sediments are as follows:

- Pre-Weir Sediments: The Pre-Weir Sediments consist of sediments located within the Outfall Ditch on the west side of the weir. The Pre-Weir Sediments were characterized as dark gray, non-plastic, clayey silty sand with a USCS classification of SM.

- Post-Weir Sediments: The Post-Weir Sediments consist of sediments located within the Outfall Ditch on the east side of the weir. The Post-Weir Sediments were characterized as dark gray, highly plastic, fat clay with a USCS classification of CH.

MATERIAL PROPERTIES

Properties of the subsurface soils and sediments from the Outfall Ditch were selected based on laboratory data, empirical correlations using in-situ test data when laboratory data were not available, or prior experience with similar materials. Representative and undisturbed soil samples from selected depth intervals were collected in the field from the soil borings. The soil samples, including the sediment samples, were sent to Excel Geotechnical Testing, Inc. in Roswell, Georgia for laboratory testing, which included:

- Index property tests (i.e., moisture content, particle size, and Atterberg limits); and

- Performance tests (i.e., compaction tests, hydraulic conductivity tests, one-dimensional consolidation tests, and consolidated undrained (CU) triaxial compression tests with pore water pressure measurements).

The results of all geotechnical laboratory testing are presented in Attachment D.

Moisture Content

Moisture content tests were performed in accordance with ASTM D2216 "Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass". The results of the moisture content tests are presented in Attachment D. The measured natural moisture contents were also plotted with respect to depth as shown in Figure 3.

For Sand, the in-situ moisture contents range from 14 to 75 percent with an average of 31 percent. For Clayey Sand, the in-situ moisture contents range from 24 to 74 percent with an average of 36 percent. For Clay, the in-situ moisture contents range from 25 to 134 percent with an average of 62 percent. A sample of Pre-Weir Sediments has a moisture content of 71 percent and a sample of Post-Weir Sediments has a moisture content of 135 percent.

Particle-Size Analysis

Particle size analyses were performed for materials in the OU1 Site. The particle size distribution was measured using mechanical sieves and hydrometer methods in accordance with ASTM D422 "Standard Test Method for Particle-Size Analysis of Soils". A total of nine (9) particle-size analyses were performed using the samples obtained from the soil borings, one (1) particle-size analysis was performed using a sample of Pre-Weir Sediments, and one (1) particle-size analysis was performed using a sample of Post-Weir Sediments. The particle-size distribution curves are presented in Attachment D.

The results of the particle-size analyses indicated that the soil samples tested are generally classified as either poorly graded sand or clay. The results also confirmed the visual classification descriptions from the field. The results of the particle-size analyses for the sediment samples indicated that Pre-Weir Sediments primarily consist of sand (73 percent) with fines content of 25 percent while the Post-Weir Sediments have fines content of 90 percent with only 10 percent sand.

Atterberg Limits

Atterberg limits were measured for Clay and Sediments (Pre-Weir and Post-Weir) in accordance with ASTM D4318 "Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils". Atterberg limit tests were performed on five (5) samples of Clay [i.e., Boreholes B-2

(10-14 feet, bgs), B-7 (2-6 feet, bgs), B-10 (7-16 feet, bgs), B-10 (24-26 feet, bgs), and B-11 (10-18 feet, bgs)], a sample of Pre-Weir Sediments, and a sample of Post-Weir Sediments. The results of the Atterberg limit tests are presented in Attachment D.

The resulting liquid limit (LL), plastic limit (PL), and plasticity index (PI) were plotted with respect to depth as shown in Figure 4. The Atterberg limits were also plotted on Casagrande's plasticity chart shown in Figure 5. Based on the standard plasticity chart, samples of Clay have a USCS classification of CH (high plasticity clay). The sample of Pre-Weir Sediments was found to be non-plastic with a USCS classification of SM (silty sand). The sample of Post-Weir Sediments was found to be CH.

Unit Weight

The unit weights of samples of Clay were measured during consolidated undrained (CU) triaxial tests. The results are plotted in Figure 6 as a function of depth. The unit weights of samples of Sand, Clayey Sand, Pre-Weir Sediments, and Post-Weir Sediments were estimated from the measured moisture content of samples taken below the groundwater table (i.e., under saturated condition) and assuming a specific gravity of soil solids of 2.65. The total unit weight recommended for Clay is 110 pcf. The recommended total unit weight of Sand and Clayey Sand is 120 pcf. The recommended total unit weights of Pre-Weir Sediments and Post-Weir Sediments are 100 pcf and 85 pcf, respectively.

Compaction Characteristics

Standard Proctor compaction tests were performed on samples of Sand, Pre-Weir Sediments, and Post-Weir Sediments in accordance with ASTM D698 "Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3)". The results of the standard Proctor compaction tests are presented in Attachment D.

Figure 7 shows the compiled Proctor compaction curves. Also shown for comparison in Figure 7 are the zero air void curves based on specific gravity of soil solids ranging from 2.60 to 2.75. The optimum moisture content corresponds to the moisture content of the soil at which the maximum dry unit weight can be attained. As shown in Figure 7, as the sample becomes coarser the resulting optimum moisture content becomes lower and the maximum dry unit weight becomes higher. Table 2 presents the calculated optimum moisture contents and maximum dry densities.

Hydraulic Conductivity

Hydraulic conductivity tests were performed on Outfall Ditch sediment samples obtained from the east side of the weir (Location S-1 in Figure 1), i.e., Post-Weir Sediments, in accordance with

ASTM D5084 "Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter". The samples were remolded in the laboratory at optimum moisture content and dry unit weight corresponding to 95% of the standard Proctor maximum dry unit weight. The results of the hydraulic conductivity tests are presented in Attachment D. The measured saturated hydraulic conductivity of the sediments is 2.8×10^{-5} cm/s under an effective confining pressure of 125 psf and 3.4×10^{-6} cm/s under an effective confining pressure of 500 psf.

Consolidation Parameters

To evaluate the consolidation characteristics of fine-grained soils and sediments, one-dimensional (1-D) consolidation tests were performed in accordance with ASTM D2435 "Standard Test Methods for One-Dimensional Consolidation Properties of Soils Using Incremental Loading". One 1-D consolidation test was performed on undisturbed sample of Clay [i.e., Shelby tube sample from Borehole B-11, ST-GTB11 (22-24 feet, bgs)]. Due to the loose nature of the sediments, undisturbed samples of sediments could not be collected for consolidation testing. The Outfall Ditch sediment samples obtained from the east side of the weir (Location S-1 in Figure 1), i.e., Post-Weir Sediments, were remolded in the laboratory at optimum moisture content and dry unit weight corresponding to 95% of the standard Proctor maximum dry unit weight. One 1-D consolidation test was performed on the remolded Post-Weir Sediments.

The undisturbed sample of Clay was consolidated incrementally at consolidation pressures of 100 psf, 250 psf, 500 psf, 1000 psf, 2000 psf, 4000 psf and then unloaded to consolidation pressure of 1000 psf, and then incrementally reloaded at consolidation pressures of 4000 psf, 8000 psf, and 16000 psf. The remolded sample of Post-Weir Sediments was consolidated under similar loading-unloading-reloading sequence except that the 250 psf and 500 psf consolidation pressures were eliminated. The results of the consolidation tests are presented in Attachment D.

The preconsolidation pressures (P_c') calculated from the consolidation test results, using Casagrande method, were plotted with respect to depth in Figure 8. The profile of the in-situ effective vertical stress was calculated for the sample of Clay and plotted as well in Figure 8. The overconsolidation ratio, which is the ratio of P_c' to the in-situ effective vertical stress, was also calculated and plotted in Figure 9 as a function of depth. Based on this figure, the Clay was assumed to be normally consolidated (OCR = 1.0).

The modified compression index ($C_{c\varepsilon}$) was calculated by taking the slope of the fitted straight line through the linear portion of the strain versus log of consolidation pressure curve. The modified recompression index ($C_{r\varepsilon}$) was calculated by taking the slope of the fitted straight line through the unloading and reloading portions of the strain versus log of consolidation pressure

curve. The calculated $C_{c\varepsilon}$ and $C_{r\varepsilon}$ values were plotted with depth as shown in Figures 10 and 11, respectively.

The coefficient of consolidation (C_v) was calculated using the Taylor method (i.e., the square root of time method) for all loading increments. The calculated C_v values were plotted as a function of stress ratio (σ_v'/σ_p') as shown in Figure 12 for Clay and in Figure 13 for reconstituted Post-Weir Sediments. Furthermore, the C_v values were calculated for stress ratios less than 1.0 and greater than 1.0. The C_v value for Clay for a stress ratio below 1.0 was selected to be 0.035 cm^2/min (0.054 ft^2/day); while for a stress ratio above 1.0, the C_v value for Clay was selected to be 0.019 cm^2/min (0.029 ft^2/day). The C_v value for reconstituted Post-Weir Sediments for a stress ratio below 1.0 and above 1.0 were selected to be 0.466 cm^2/min (0.722 ft^2/day) and 0.226 cm^2/min (0.350 ft^2/day), respectively.

The modified coefficient of secondary compression index ($C_{\alpha\varepsilon}$) was calculated by taking the slope of the long-term portion of the strain versus log of time curve for all loading increments. The calculated $C_{\alpha\varepsilon}$ values were plotted as a function of stress ratio (σ_v'/σ_p') as shown in Figure 14 for Clay. For reconstituted Post-Weir Sediments, the sample generally did not exhibit secondary compression during consolidation testing. The $C_{\alpha\varepsilon}$ values for Clay were also calculated for stress ratios less than 1.0 and greater than 1.0. The $C_{\alpha\varepsilon}$ value for a stress ratio below 1.0 was selected to be 0.0027; while for a stress ratio above 1.0, the $C_{\alpha\varepsilon}$ value was selected to be 0.0052.

Undrained Shear Strength

Consolidated undrained (CU) triaxial tests were performed on samples of Clay, Pre-Weir Sediments, and Post-Weir Sediments in accordance with ASTM D4767 "Standard Test Method for Consolidated Undrained Triaxial Compression Test for Cohesive Soils". For Clay, CU triaxial tests were performed on Shelby tube samples obtained from boreholes B-1, B-10, and B-11 [i.e., ST-GTB1 (10-12 feet, bgs), ST-GTB10 (26-28 feet, bgs), and ST-GTB11 (22-24 feet, bgs), respectively]. Three-point CU triaxial test was conducted for ST-GTB1 under effective consolidation pressures of 850 psf, 1700 psf, and 3400 psf. One-point CU triaxial test was conducted for ST-GTB10 and ST-GTB11 under effective consolidation pressures of 6600 psf and 5600 psf, respectively.

Samples of Pre-Weir Sediments and Post-Weir Sediments were remolded in the laboratory at optimum moisture content and dry unit weight corresponding to 95% of the standard Proctor maximum dry unit weight. For Pre-Weir Sediments, one-point CU triaxial test was conducted under an effective consolidation pressure of 375 psf. For Post-Weir Sediments, three-point CU triaxial test was conducted under an effective consolidation pressure of 100 psf, 250 psf, and 500 psf. The results of the CU triaxial tests are presented in Attachment D.

Undrained shear strength properties were interpreted from the CU triaxial tests. The undrained shear strength (S_u) is equal to half of the deviator stress at failure for each soil specimen. The failure criterion corresponds to the maximum deviator stress attained or the deviator stress at 15 percent axial strain, whichever occurred first during testing. The S_u measured in each CU triaxial test corresponds to the effective consolidation pressure applied in the laboratory. Hence, the interpretation of shear strengths will not be too affected by the sample disturbance. An increase in effective consolidation pressure causes a decrease in void ratio and an increase in undrained shear strength.

The undrained shear strength ratios were calculated by dividing the measured S_u by the applied effective consolidation pressure (σ_c') in the laboratory. Figure 15 shows the plot of the undrained shear strength ratios versus the applied σ_c'. The shear strength ratios generally decrease with higher consolidation pressures and reach a lower bound ratio as shown in Figure 15. The recommended undrained shear strength ratio for Clay is also presented in Figure 15. With a minimum undrained shear strength ratio of 0.32 (for a Clay with plasticity index of approximately 31 percent) under a CU triaxial compression test, the corresponding undrained shear strength ratio under direct simple shear is 0.24 as illustrated in Figure 16. Hence, an undrained shear strength ratio of 0.24 is recommended for Clay. As presented in Table 3, using an estimated average SPT N value of 2 for Clay, the recommended minimum S_u is conservatively chosen as 200 psf.

Drained Shear Strength

The drained shear strength parameters, i.e., effective stress friction angles (ϕ') and effective stress cohesion (c'), for Clay, Pre-Weir Sediments, and Post-Weir Sediments were estimated using the data from the CU test results. Using the effective stresses at failure for each CU test, Mohr-Coulomb failure envelopes were plotted in Figure 17 for Clay. Similarly, Figure 18 shows the effective stress Mohr-Coulomb failure envelopes for Pre-Weir Sediments and Post-Weir Sediments.

Based on the failure envelope plots, the following are the recommended drained shear strength parameters:

- For Clay, the ϕ' is recommended to be 28 degrees and the c' is recommended to be 133 psf;
- For reconstituted Pre-Weir Sediments, the ϕ' is recommended to be 25 degrees and c' is recommended to be 0 psf; and

- For reconstituted Post-Weir Sediments, the ϕ' is recommended to be 41 degrees and c' is recommended to be 18 psf.

The drained shear strength parameters for other materials (i.e., Sand and Clayey Sand) were estimated using the empirical relationship between the SPT N value and ϕ' shown in Table 4 [Kulhawy and Mayne, 1990]. Using an estimated average SPT N value of 6 for Sand (shallow) and 12 for Sand (deep), the recommended ϕ' are 29 and 31 degrees, respectively. With an estimated average SPT N value of 5 for Clayey Sand, the recommended ϕ' is 28 degrees.

SUMMARY OF RECOMMENDED MATERIAL PROPERTIES

Table 5 summarizes the recommended material properties to be used in developing and evaluating remedial alternatives for OU1.

REFERENCES

Kulhawy, F. H. and Mayne, P. W. (1990). "Manual on Estimating Soil Properties for Foundation Design", EPRI EL-6800, Research Project 1493-6.

Ladd, C. C. (1991). "Stability Evaluation During Staged Construction", ASCE Journal of Geotechnical Engineering, Vol. 117, No. 4, pp. 540-615.

* * * * *

TABLES

Table 1. Borehole coordinates and ground surface elevation

Borehole	Easting (ft)	Northing (ft)	Ground Elevation (ft)
B1	873441.84	424577.29	5.63
B2	873297.88	424574.12	6.89
B3	873083.00	424568.45	7.50
B4	872858.90	424556.17	7.68
B5	872708.48	424671.36	6.76
B6	872719.05	424878.34	6.67
B7	872903.56	424953.52	6.89
B8	872920.67	424813.55	5.84
B9	873190.91	424882.57	6.33
B10	873369.92	424897.58	6.35
B11	873496.33	424659.61	5.10

Table 2. Optimum moisture content and maximum dry density

Soil	**Optimum Moisture Content (%)**	**Maximum Dry Density (pcf)**
Sand	14.9	105.2
Sediments (Pre-Weir)	25.0	87.7
Sediments (Post-Weir)	47.5	67.0

Table 3. Empirical relation between undrained shear strength and SPT N value [Kulhawy and Mayne, 1990]

N Value (blows/ft or 305 mm)	Consistency	Approximate s_u/p_a
0 to 2	very soft	< 1/8
2 to 4	soft	1/8 to 1/4
4 to 8	medium	1/4 to 1/2
8 to 15	stiff	1/2 to 1
15 to 30	very stiff	1 to 2
> 30	hard	> 2

Source: Terzaghi and Peck (4), p. 347.

where P_a is the atmospheric pressure which is approximately 2,000 psf.

Table 4. Empirical relation between friction angle and SPT N value

[Kulhawy and Mayne, 1990]

N Value (blows/ft or 305 mm)	Relative Density	Approximate $\bar{\phi}_{tc}$ (degrees)	
		(a)	(b)
0 to 4	very loose	< 28	< 30
4 to 10	loose	28 to 30	30 to 35
10 to 30	medium	30 to 36	35 to 40
30 to 50	dense	36 to 41	40 to 45
> 50	very dense	> 41	> 45

a - Source: Peck, Hanson, and Thornburn (12), p. 310.
b - Source: Meyerhof (13), p. 17.

Table 5. Summary of recommended material properties

Soil	Total Unit Weight (pcf)	Drained Shear Strength		Undrained Shear Strength		Consolidation Parameters				
		ϕ' (degrees)	c' (psf)	Min. S_u (psf)	S_u / σ_v'	$C_{c\varepsilon}$	$C_{r\varepsilon}$	σ_v' / σ_p'	C_v (ft^2/day)	$C_{\alpha\varepsilon}$
Sand (Shallow)	120	29	0	N/A	N/A	N/A	N/A	< 1.0	N/A	N/A
								> 1.0	N/A	N/A
Clayey Sand	120	28	0	N/A	N/A	N/A	N/A	< 1.0	N/A	N/A
								> 1.0	N/A	N/A
Sand (Deep)	120	31	0	N/A	N/A	N/A	N/A	< 1.0	N/A	N/A
								> 1.0	N/A	N/A
Clay	110	28	133	200	0.24	0.212	0.030	< 1.0	0.054	0.0027
								> 1.0	0.029	0.0052
Pre-Weir Sediments	100	25(1)	0(1)	N/A	N/A	N/A	N/A	< 1.0	N/A	N/A
								> 1.0	N/A	N/A
Post-Weir Sediments	85	41(1)	18(1)	-	-	0.217(1)	0.028(1)	< 1.0	0.722 (1)	-
								> 1.0	0.350 (1)	-

Notes:

N/A = Not Applicable

(1) This is valid for reconstituted sediments (i.e., the sediments are removed and re-compacted).

FIGURES

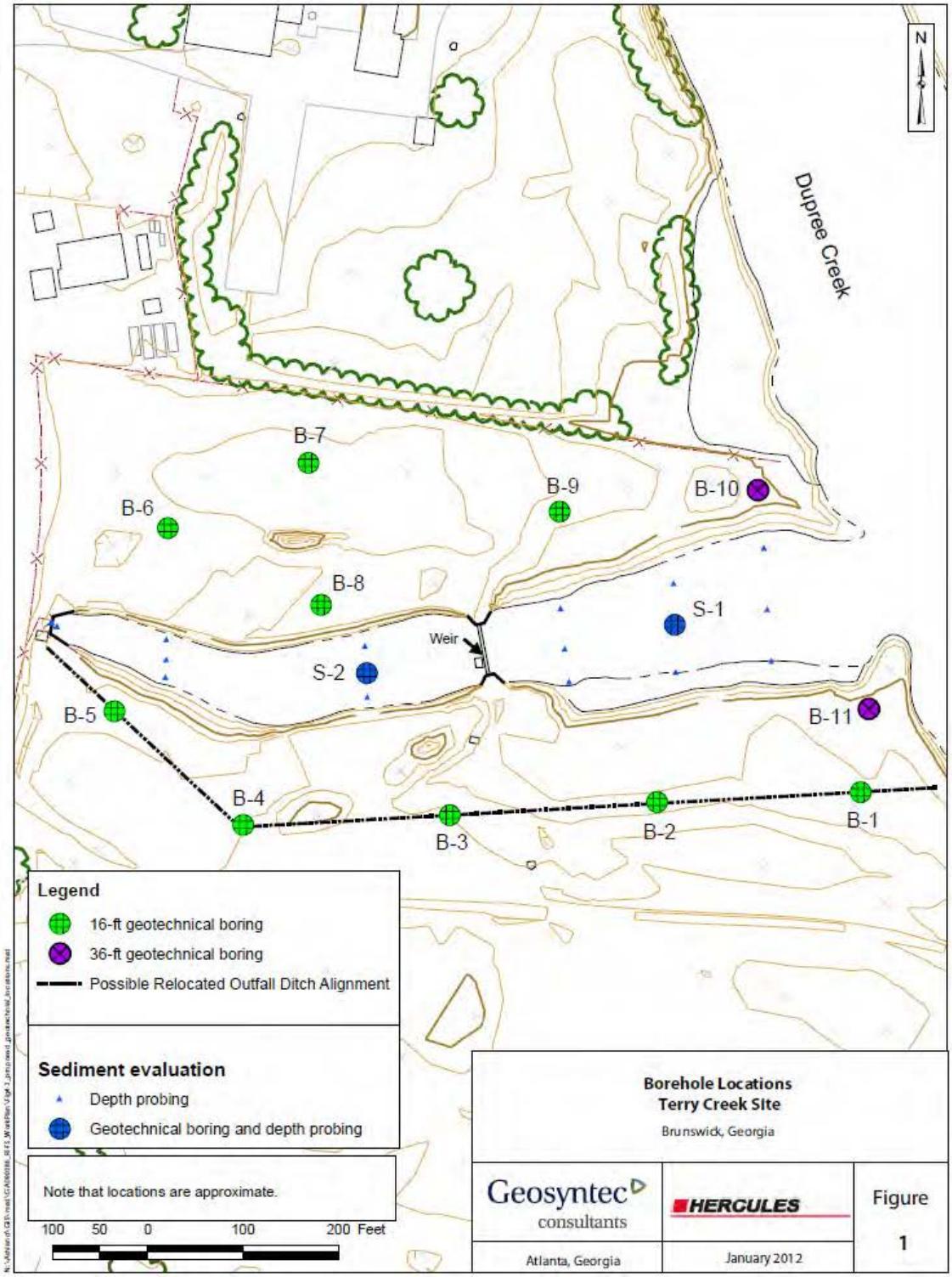

Figure 1. Borehole Locations (Note: Borehole coordinates are provided in Table 1)

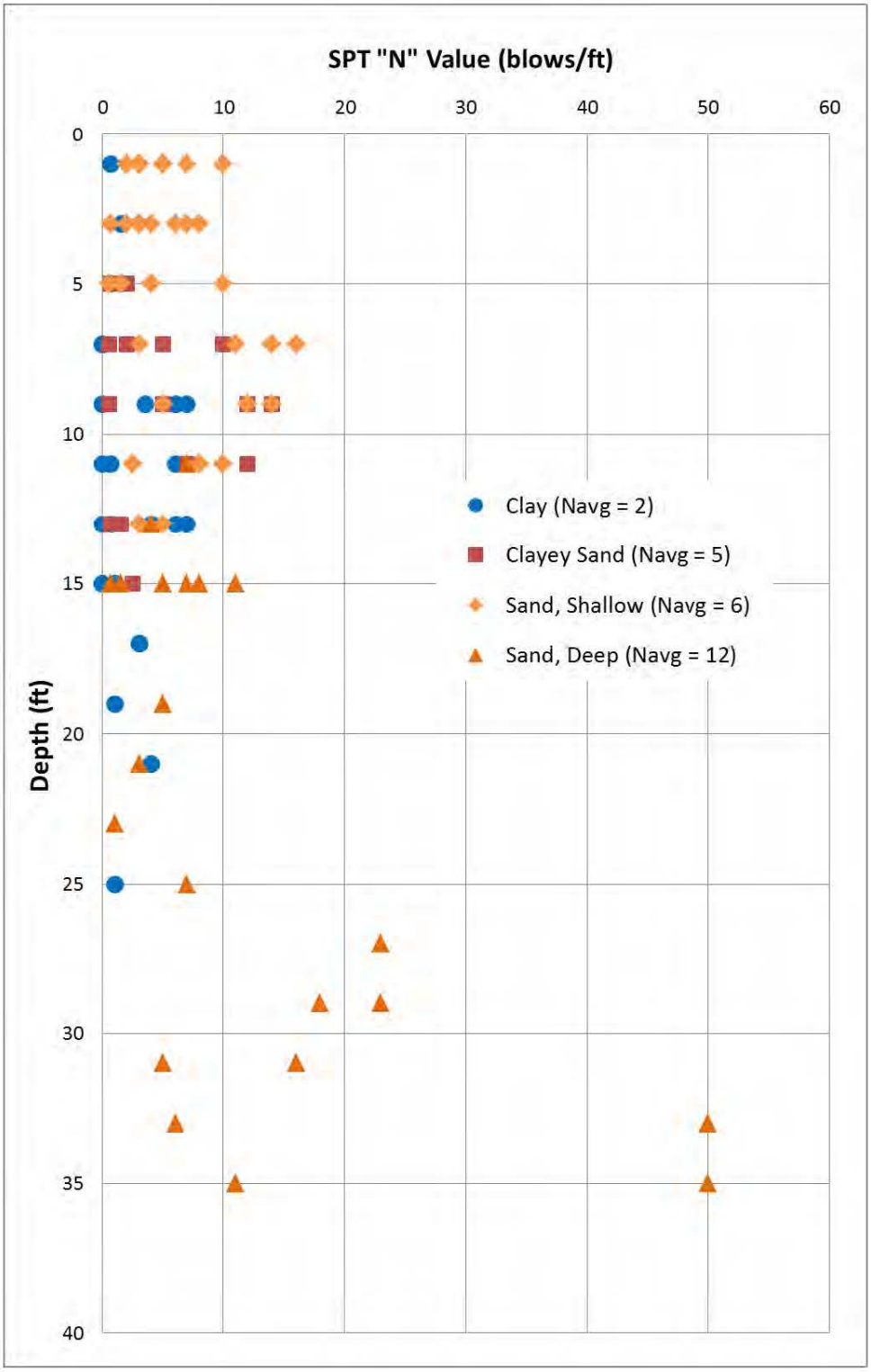

Figure 2. Plot of SPT N Values versus Depth

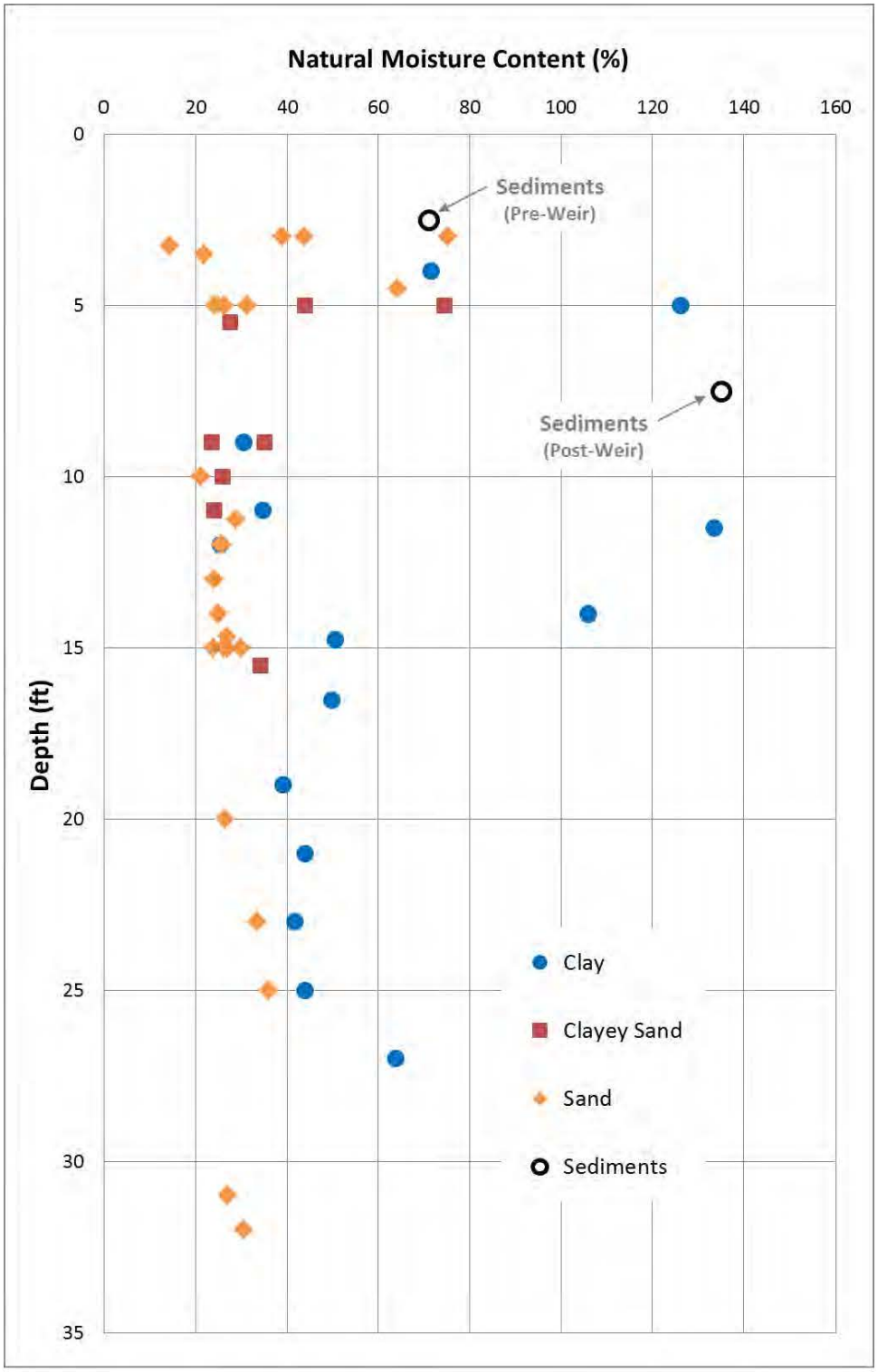

Figure 3. Plot of Natural Moisture Content versus Depth

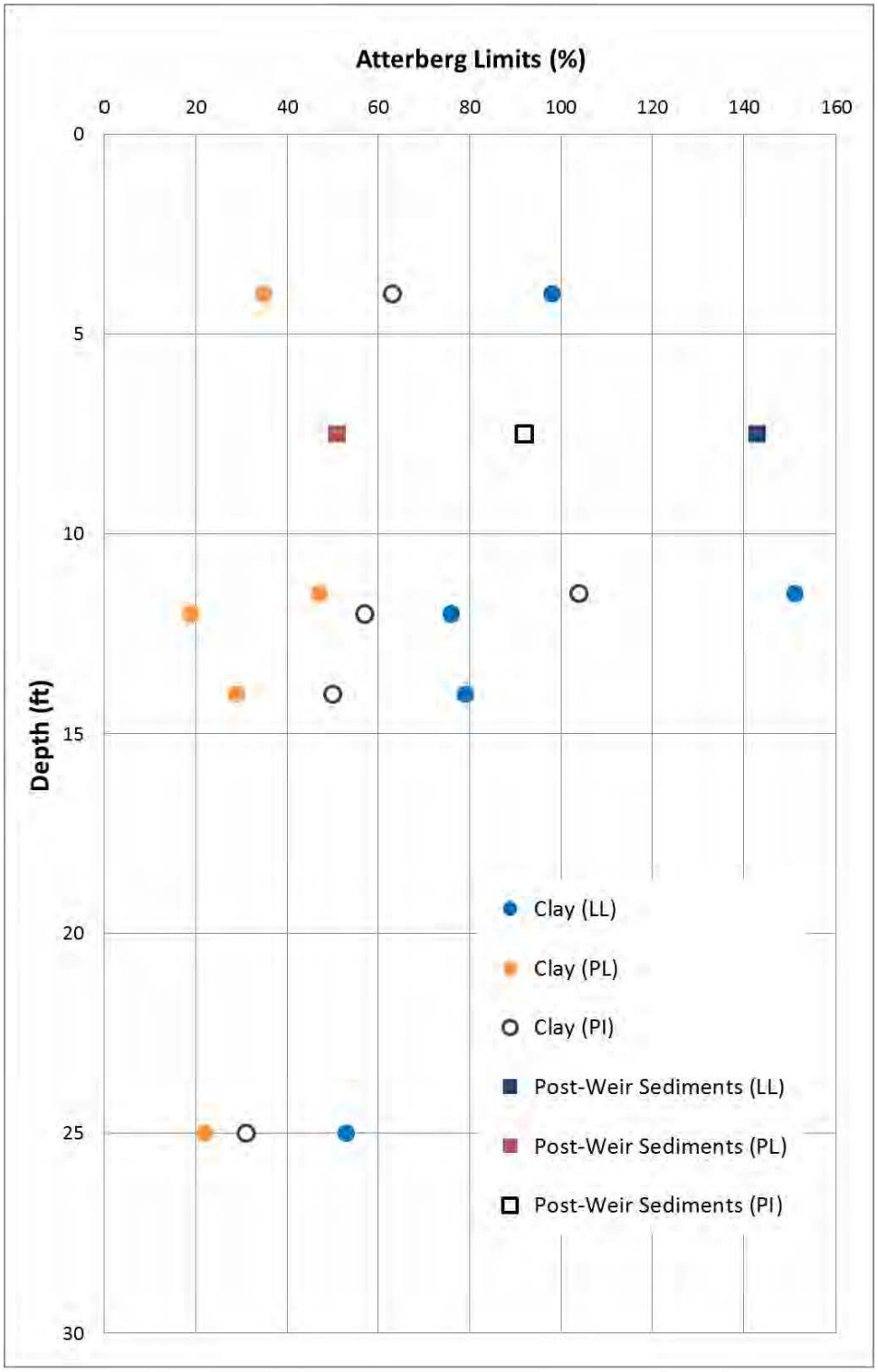

Figure 4. Plot of Atterberg Limits versus Depth

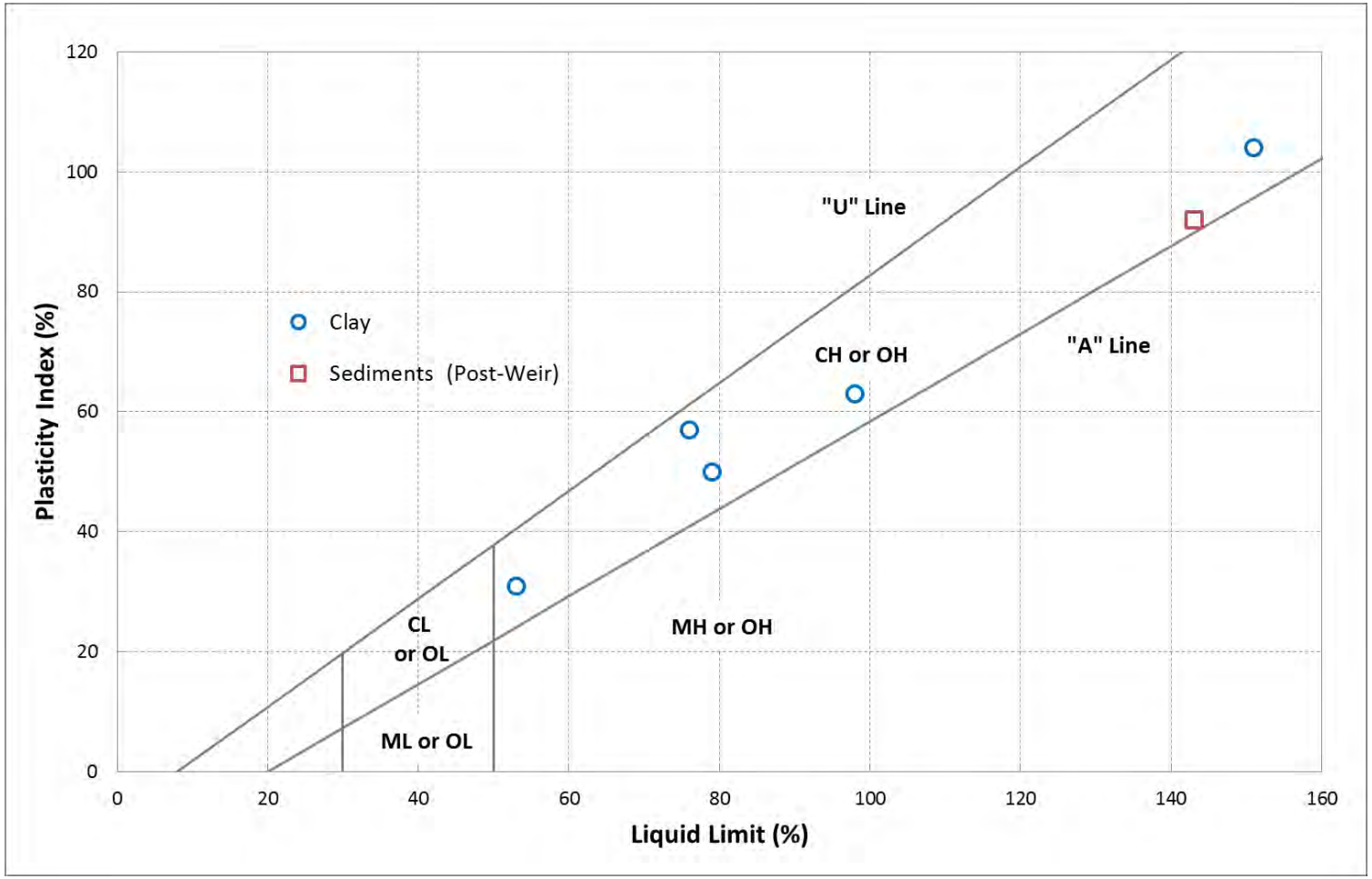

Figure 5. Casagrande's Plasticity Chart

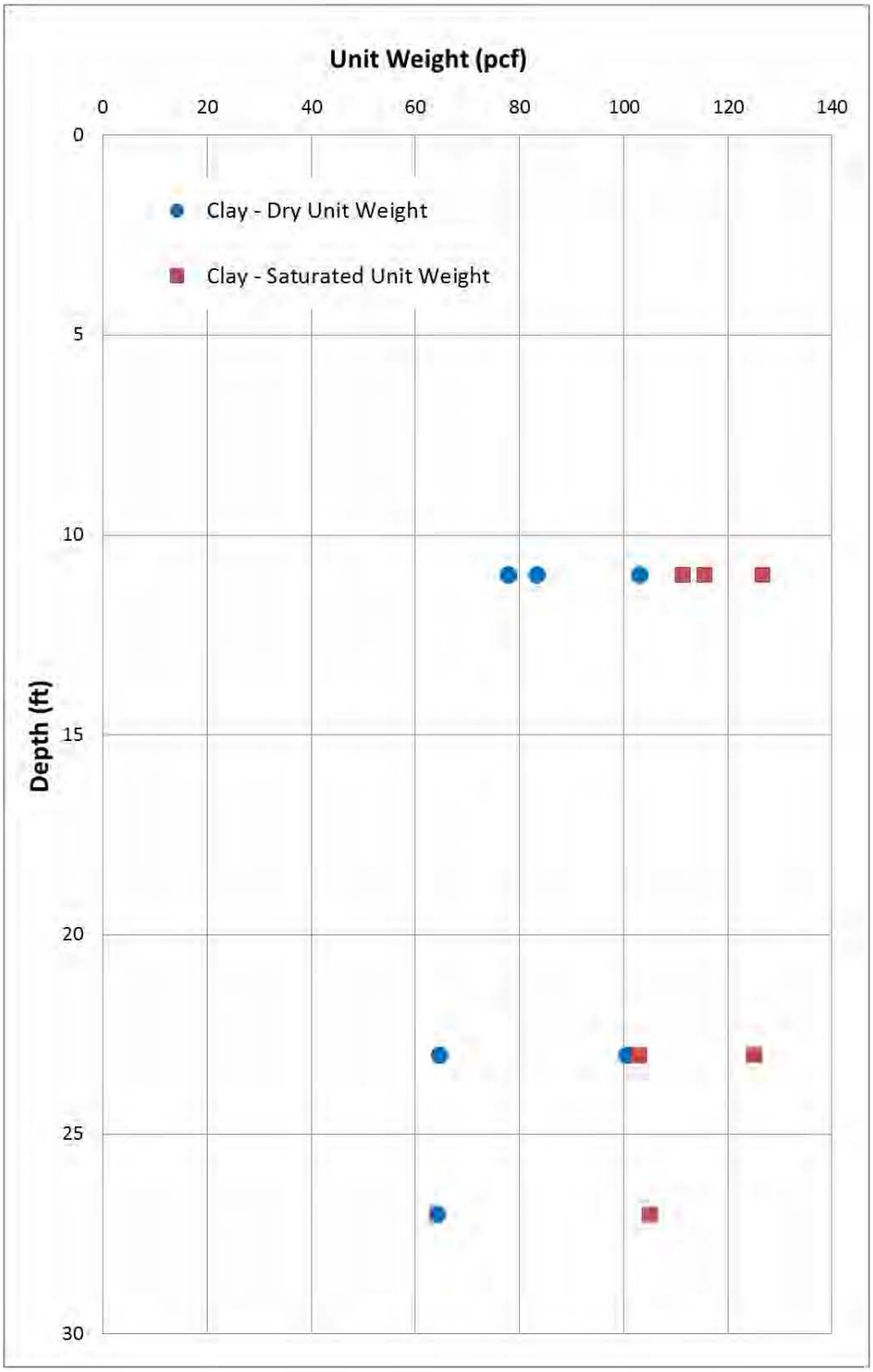

Figure 6. Plot of Total Unit Weight versus Depth (from CU Triaxial Test Samples)

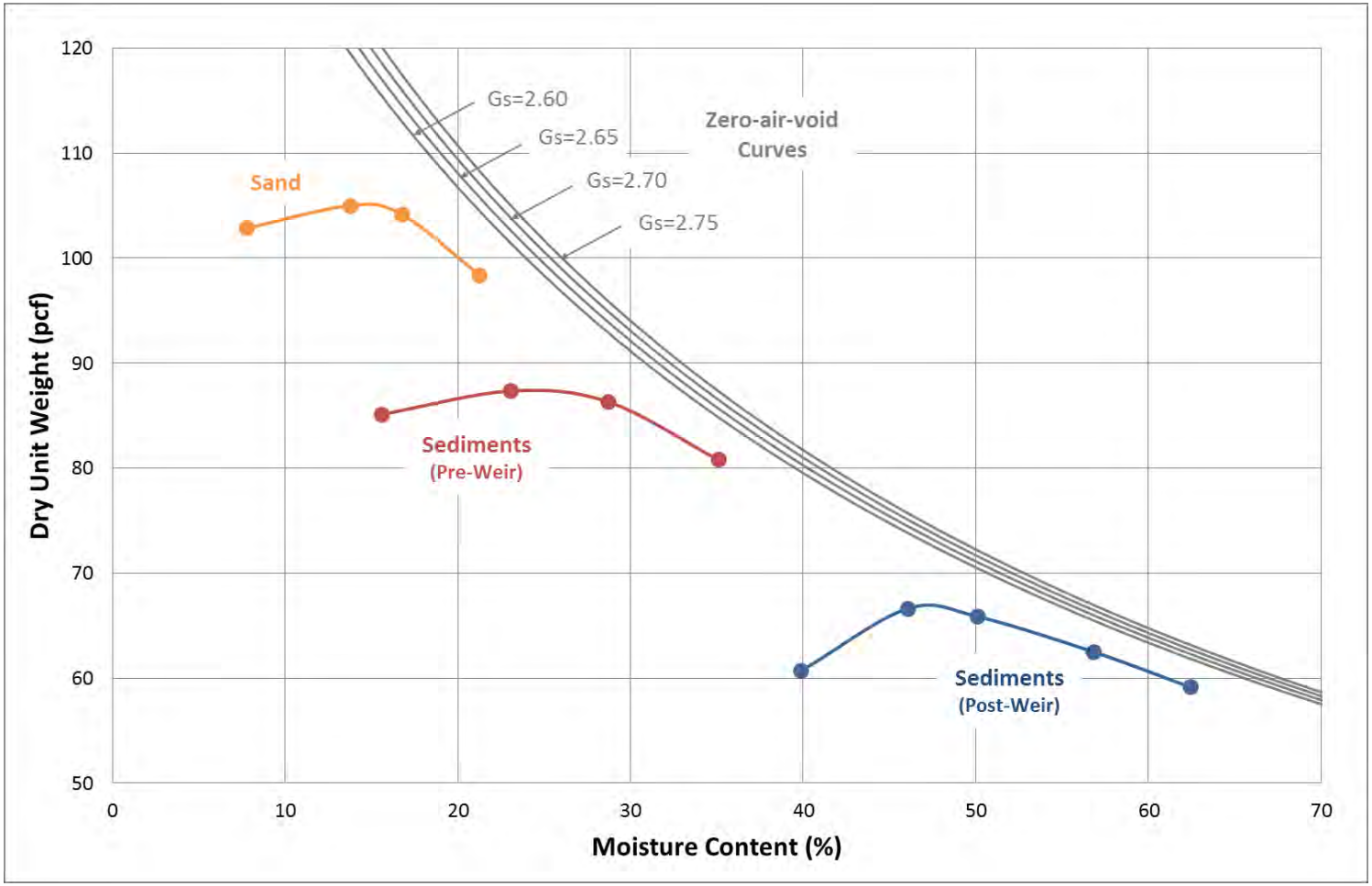

Figure 7. Compiled Proctor Compaction Curves

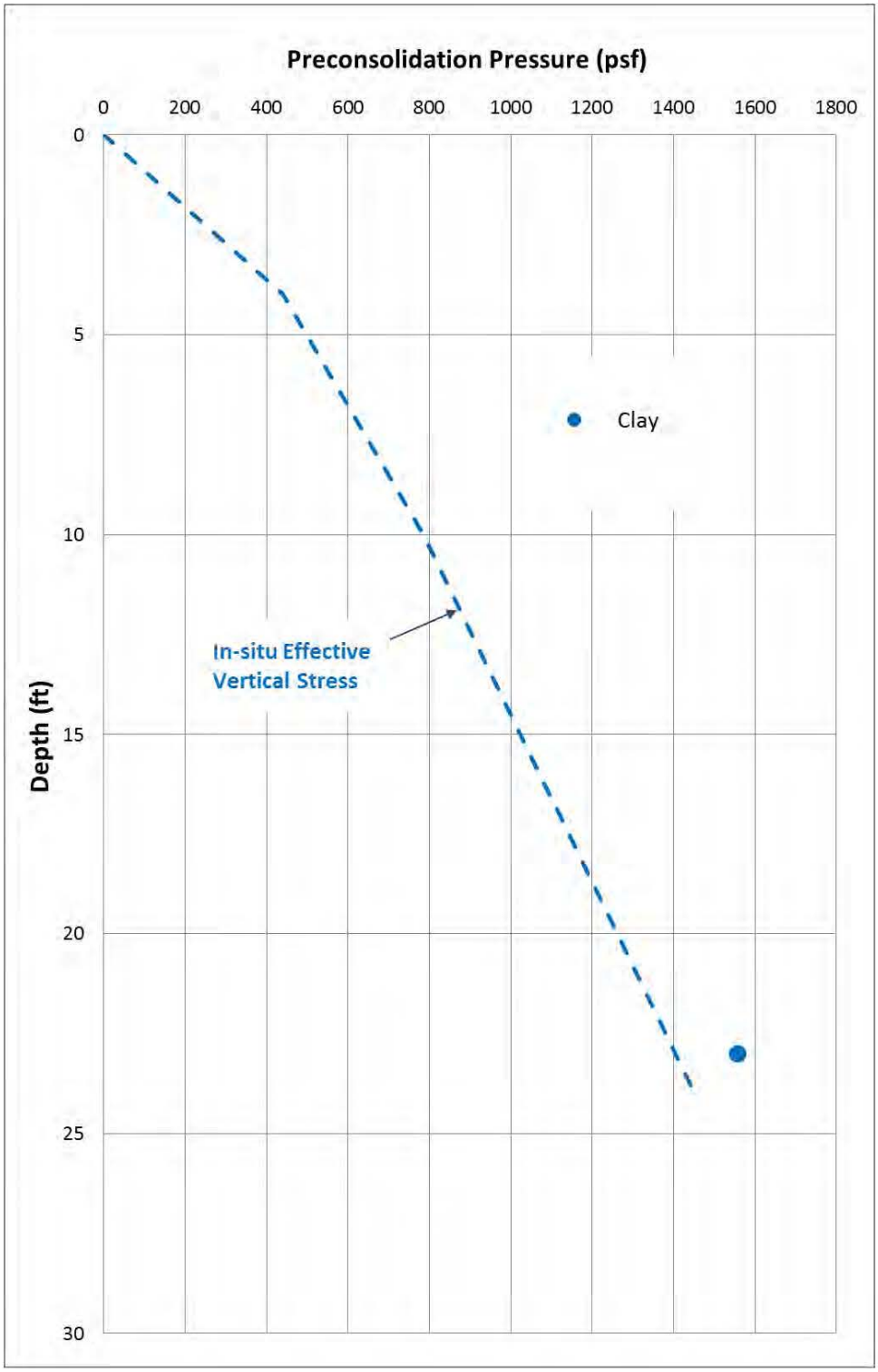

Figure 8. Profile of Preconsolidation Pressure (P_c')

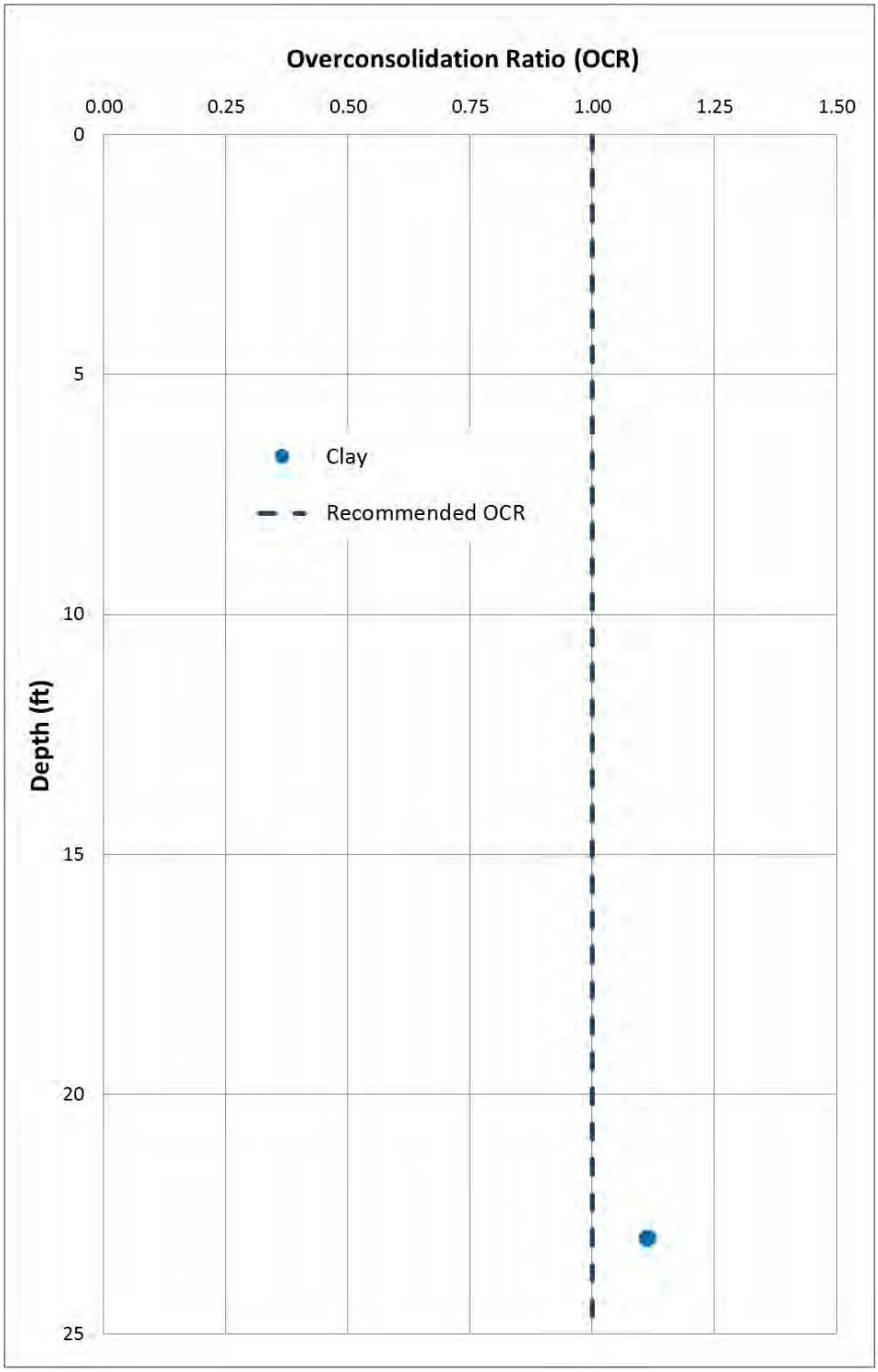

Figure 9. Profile of Overconsolidation Ratio (OCR)

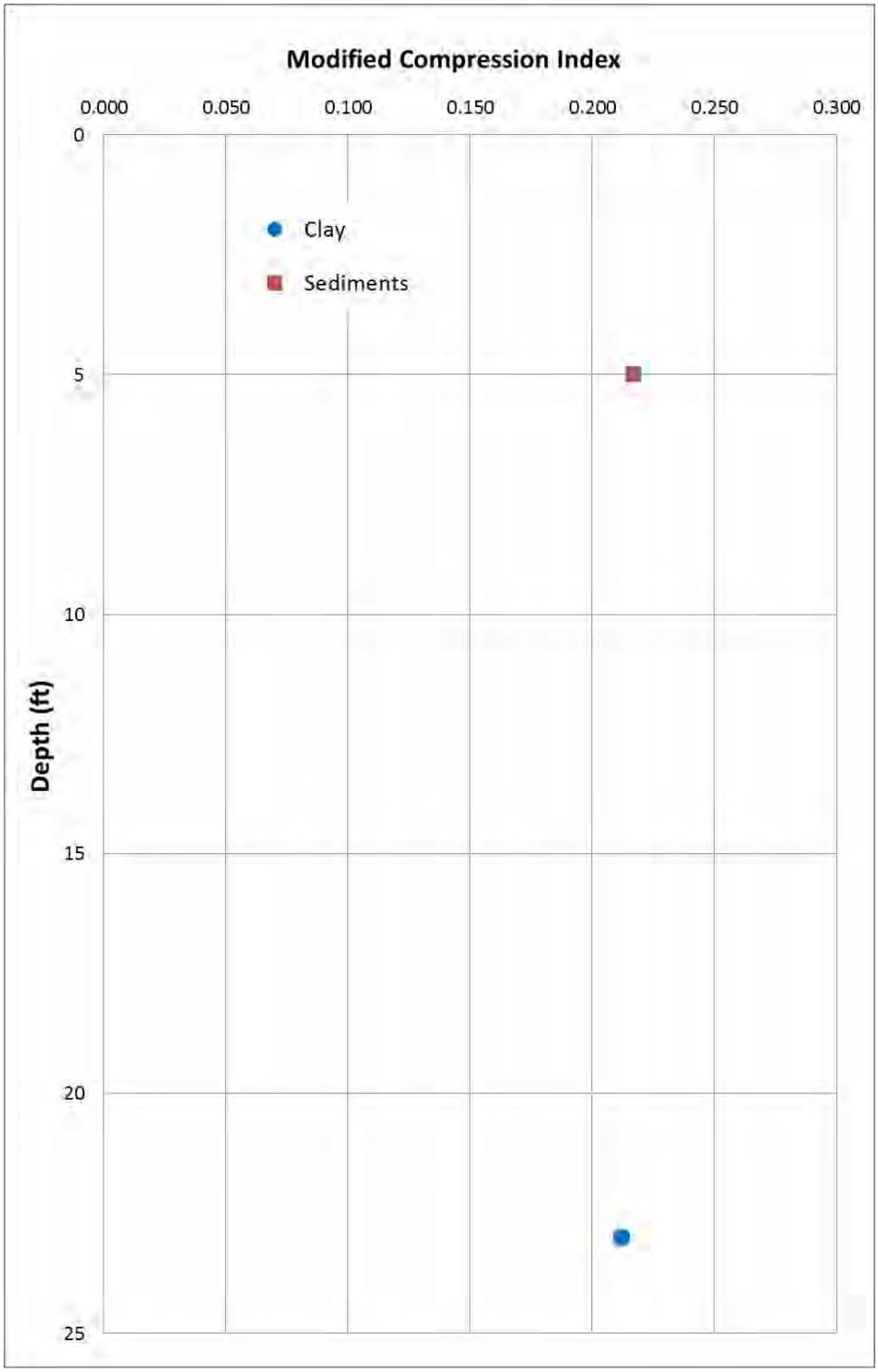

Figure 10. Modified Compression Index vs. Depth

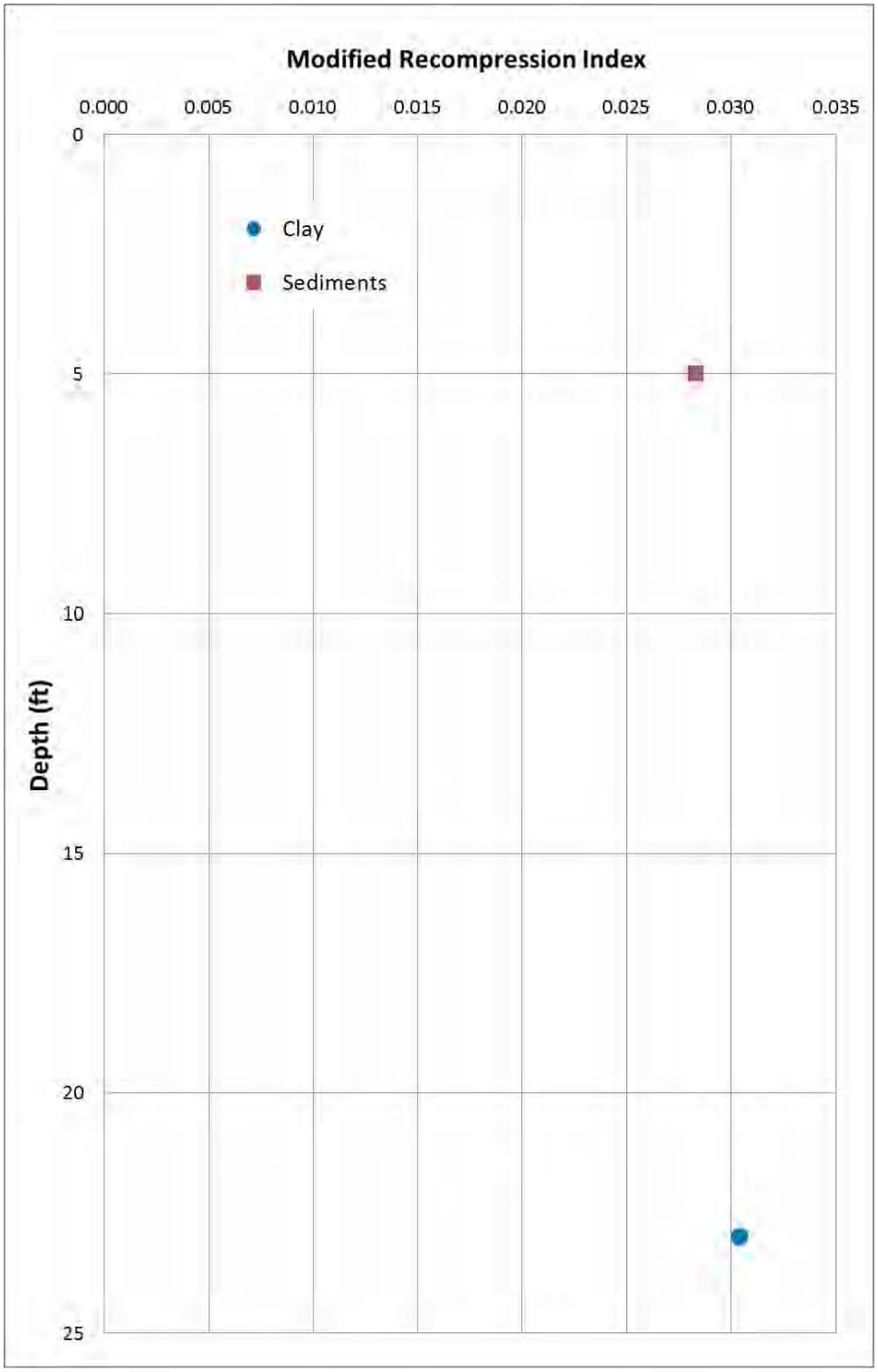

Figure 11. Modified Recompression Index vs. Depth

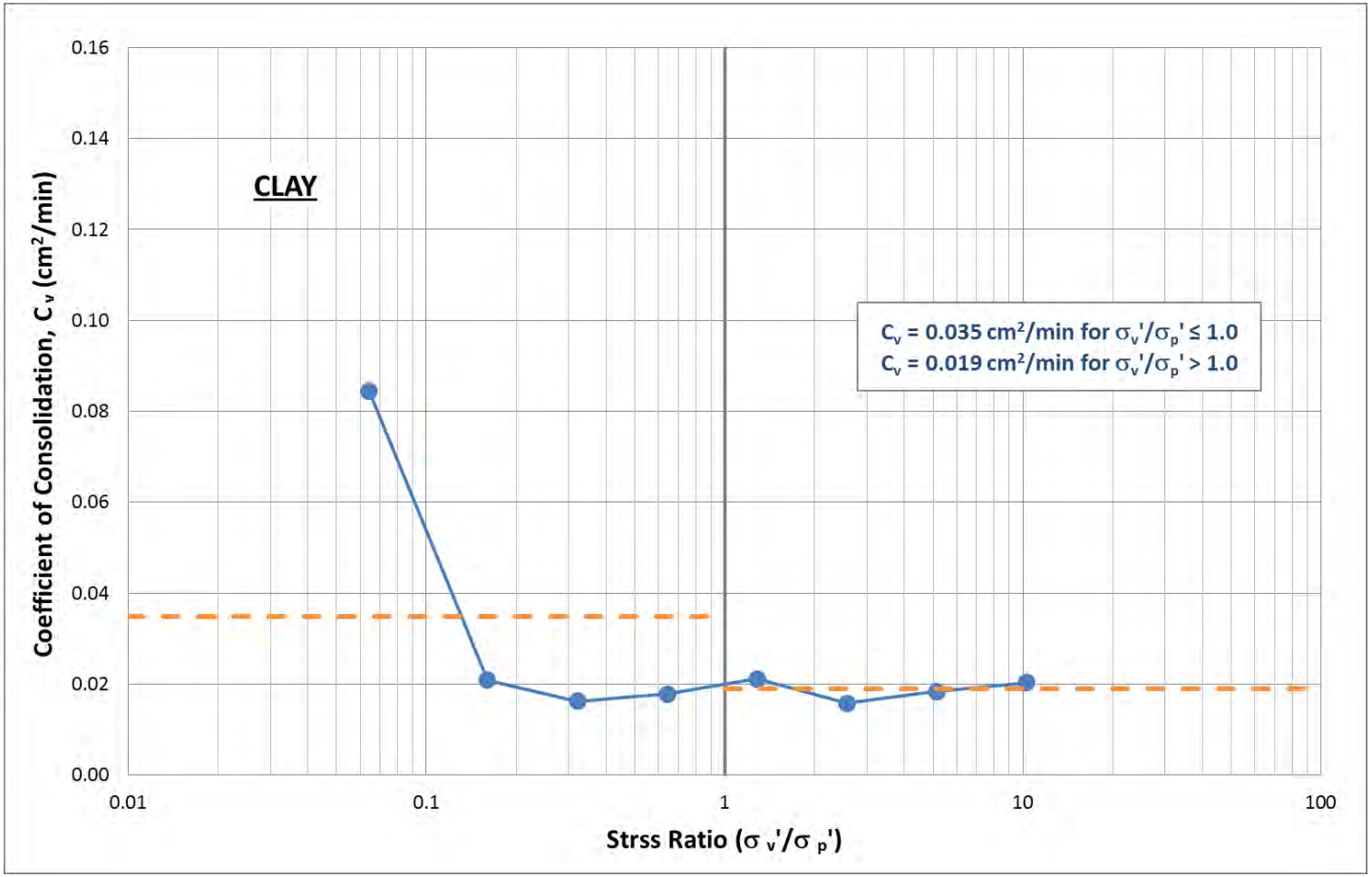

Figure 12. Coefficient of Consolidation (C_v) with Stress Ratio (σ_v'/σ_p') for Clay

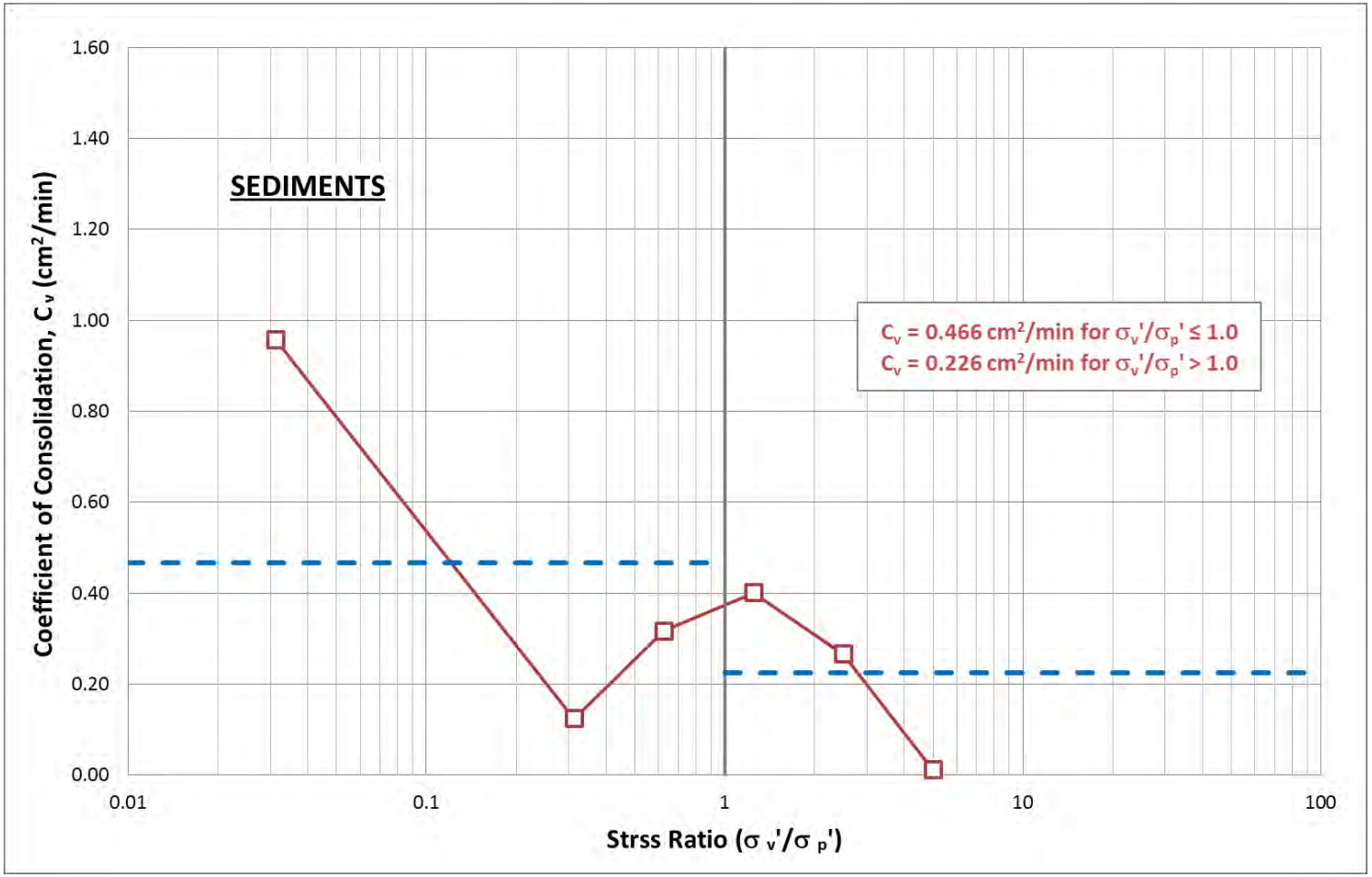

Figure 13. Coefficient of Consolidation (C_v) with Stress Ratio (σ_v'/σ_p') for Post-Weir Sediments

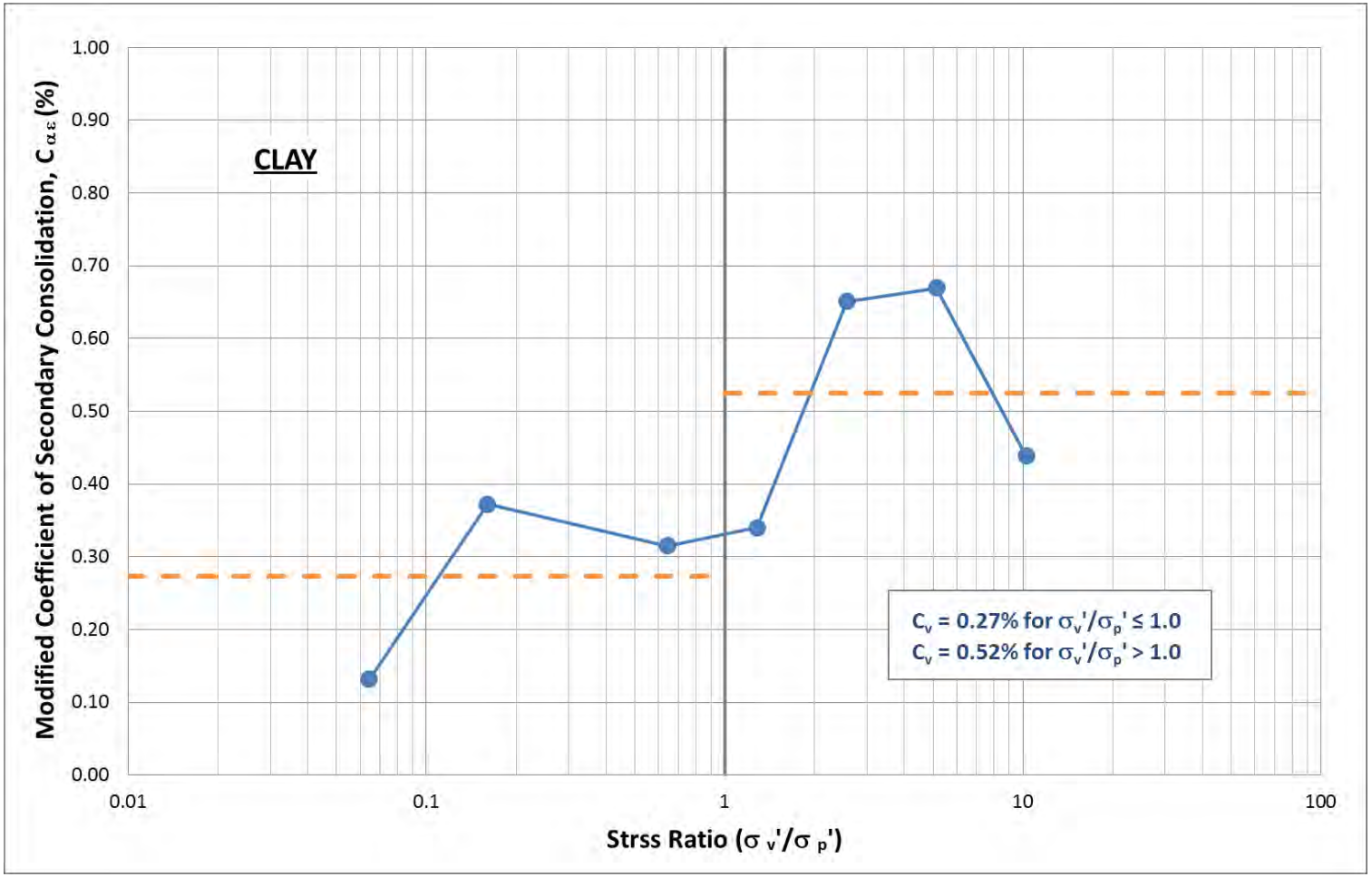

Figure 14. Modified Coefficient Secondary Compression ($C_{\alpha\varepsilon}$) with Stress Ratio (σ_v'/σ_p')

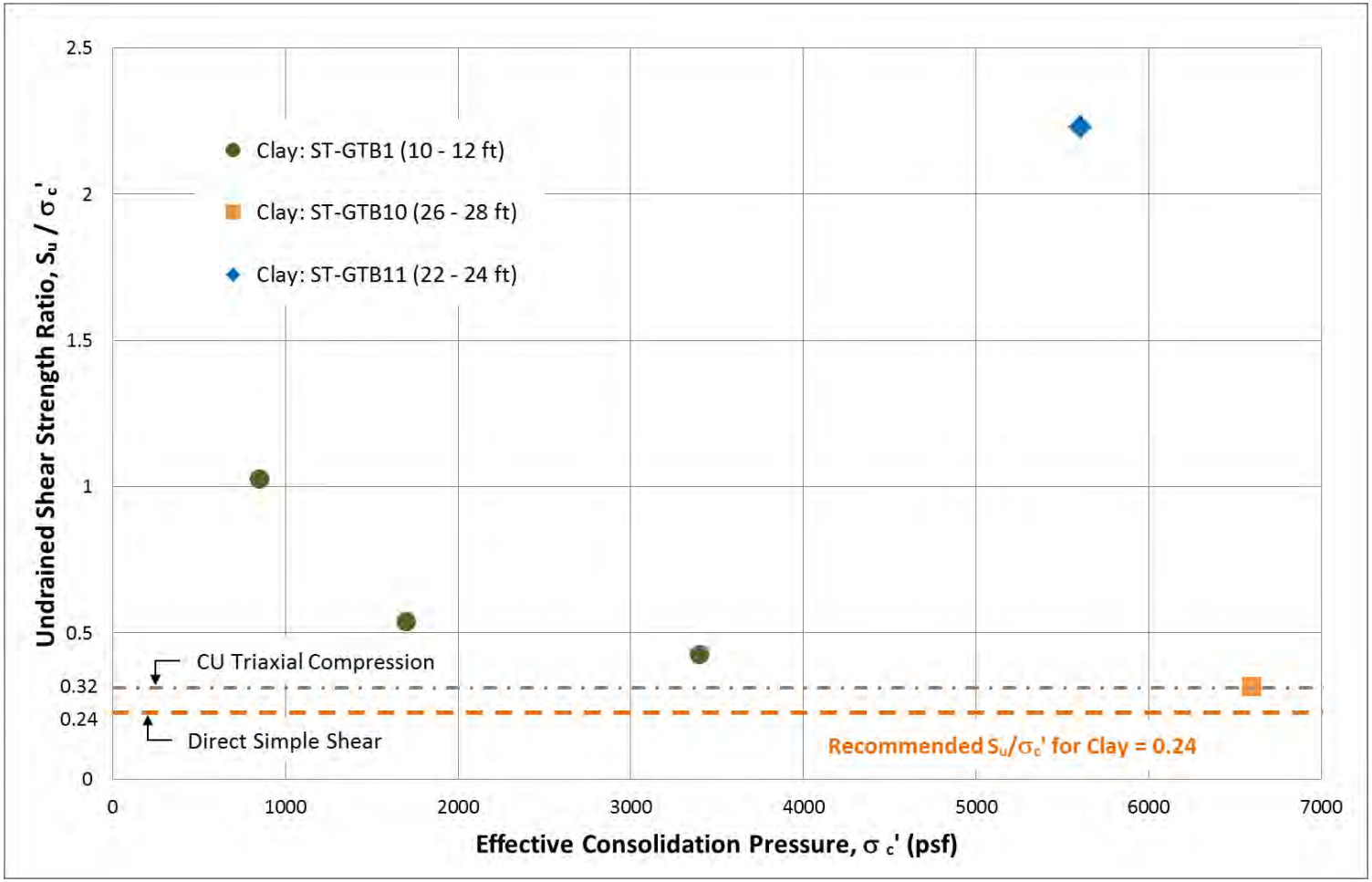

Figure 15. Undrained Shear Strength Ratio from CU Tests

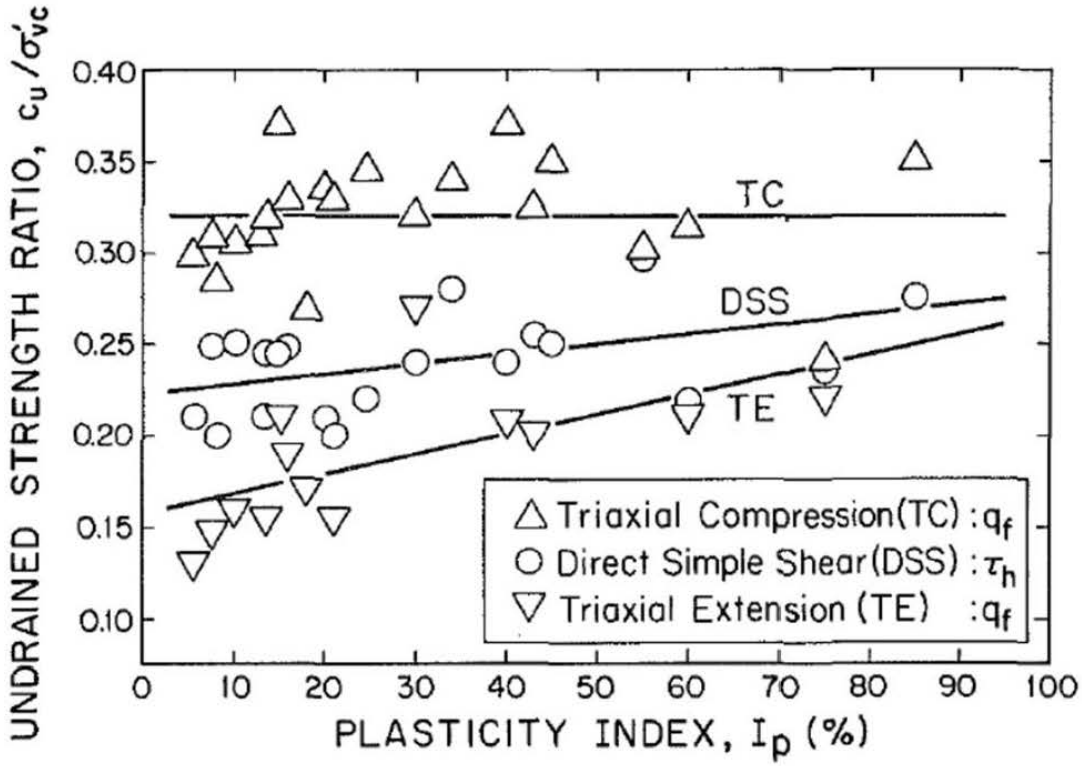

FIG. 15. Undrained Strength Anisotropy from CK_0U Tests on Normally Consolidated Clays and Silts [Data from Lefebvre et al. (1983); Vaid and Campanella (1974); and Various MIT and NGI Reports]

Figure 16. Undrained Strength Anisotropy [Ladd, 1991]

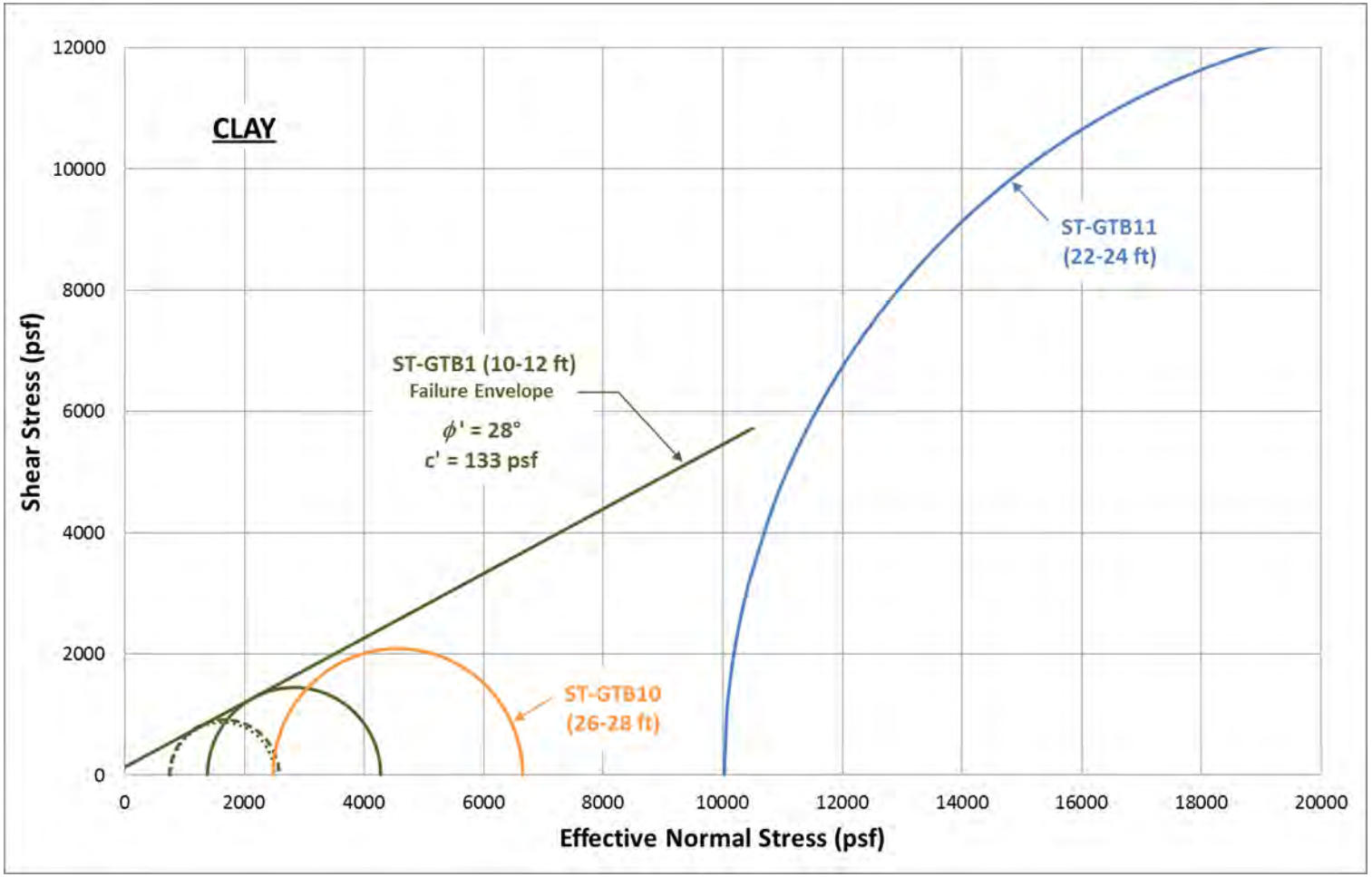

Figure 17. Mohr-Coulomb Failure Envelopes from CU Triaxial Tests for Clay

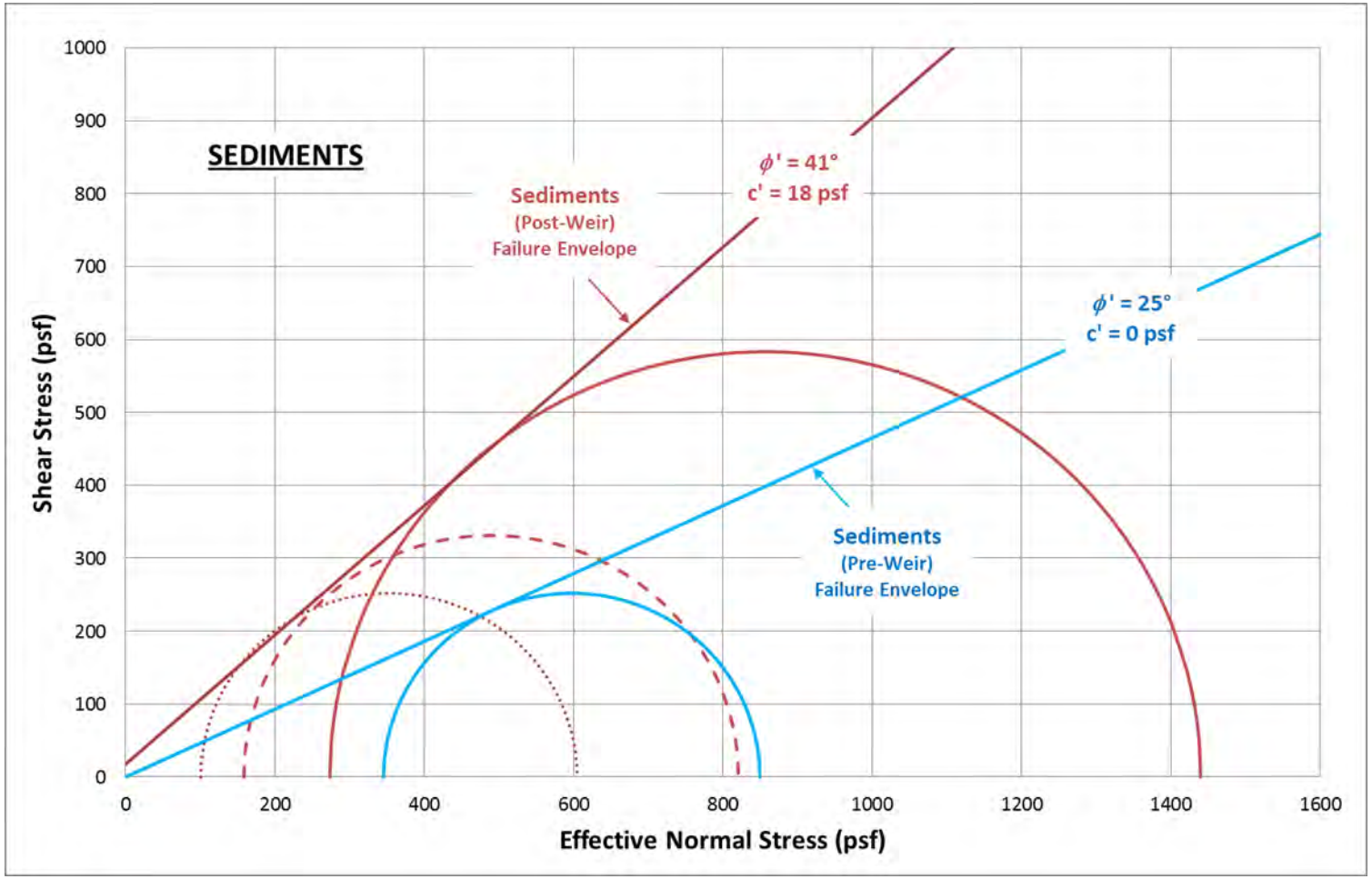

Figure 18. Mohr-Coulomb Failure Envelopes from CU Triaxial Tests for Pre-Weir Sediment and Post-Weir Sediments

ATTACHMENT A

LITHOLOGIC BORING LOGS

Geosyntec consultants

1200 Riverplace Boulevard,
Suite 710,
Jacksonville, Florida 32207

BORING LOG

BOREHOLE ID: *B-1*

GENERAL INFORMATION

PROJECT NO: *GK4443*
CLIENT: *Hercules Incorporated*
SITE LOCATION: *Brunswick, Georgia*
BORING DATE: *2/28/2012*
GEOSYNTEC SUPERVISOR: *Ramil Mijares*
DRILLING CONTRACTOR: *SAEDACCO*
DRILLER NAME: *Stefan Smith*

TECHNICAL INFORMATION

DRILLING METHOD: *Hollow Stem Auger*
RIG TYPE: *D-50*
BOREHOLE DIA: *4.25 in.*
NORTHING: *424577.29*
EASTING: *873441.84*
GROUND ELEVATION: *5.63'*

Depth (ft)	Water Level	Lithologic Description	Pattern	Unified Soil Classification	SPT Blowcount	SPT-Curve (0 5 10 15 20 25 30 35 40 45 50)	Recovery	Comments
0		Fine to medium sand with roots; Very dark gray (Munsell Gley 1 3/N); Moist; Poorly graded; Loose		SP	1-2-1-2			
		Same as 0'-2'			1-1-2-2			Lower 1 ft (3-4): Clayey sand with crushed shells; Dark gray (Munsell 5Y 4/1); Moist; Poorly graded;Loose
5	▽	Clayey sand with crushed shells; Dark gray (Munsell 5Y 4/1); Saturated; Poorly graded; Loose		SC	1/12"-1/12"			
		Clayey sand; Very dark gray (Munsell Gley 1 3/N); Saturated; Poorly graded; Loose			1-2-3-5			Lower 1 ft (7-8): Sandy fat clay; Dark gray (Munsell Gley 1 4/N); Saturated; Firm; Analytical sample SO-MSB1-01 2/28/12 9:45 for COPC analysis
		Sandy fat clay; Dark gray (Munsell Gley 1 4/N); Saturated; Firm		CH	3-3-4-1			
10		N/A			N/A			Shelby tube sample collected
		Sandy fat clay; Dark gray (Munsell Gley 1 4/N); Saturated; Firm			3-5-2-2			
15		Fine to medium sand with crushed shells; Gray (Munsell 5Y 5/1); Saturated; Poorly graded; Loose		SP	3-5-6-4			

All depths referenced to ground surface.

Total Depth: 16'

engineers | scientists | innovators

Geosyntec consultants

1200 Riverplace Boulevard,
Suite 710,
Jacksonville, Florida 32207

BORING LOG

BOREHOLE ID: *B-2*

GENERAL INFORMATION

PROJECT NO: *GK4443*
CLIENT: *Hercules Incorporated*
SITE LOCATION: *Brunswick, Georgia*
BORING DATE: *2/28/2012*
GEOSYNTEC SUPERVISOR: *Ramil Mijares*
DRILLING CONTRACTOR: *SAEDACCO*
DRILLER NAME: *Stefan Smith*

TECHNICAL INFORMATION

DRILLING METHOD: *Hollow Stem Auger*
RIG TYPE: *D-50*
BOREHOLE DIA: *2.25 in.*
NORTHING: *424574.12*
EASTING: *873297.88*
GROUND ELEVATION: *6.89'*

Depth (ft)	Water Level	Lithologic Description	Pattern	Unified Soil Classification	SPT Blowcount	SPT-Curve (0 5 10 15 20 25 30 35 40 45 50)	Recovery	Comments
0		Fine to medium sand with roots; Very dark gray (Munsell Gley 1 3/N); Moist; Poorly graded; Loose		SP	3-2-3-2			
		Medium sand with roots and mulch; Very dark gray (Munsell Gley 1 3/N); Moist; Poorly graded; Loose			2-1-1-2			
5		Clayey sand with roots; Very dark gray to black (Munsell Gley 1 3/N to 2.5/N); Moist; Poorly graded; Loose		SC	1-1/18"			
		Clayey sand; Very dark gray to black (Munsell Gley 1 3/N to 2.5/N); Moist; Poorly graded; Loose			1-2-3-4			No analytical sample obtained due to small recovery
	▽	Sandy fat clay; Dark gray (Munsell Gley 1 4/N); Saturated; Firm		CH	2-2-4-4			Analytical sample SO-MSB2-01 2/28/12 9:05 for COPC analysis
10					2-2-4-4			
					2-3-3-6			
15		Fine to medium sand with crushed shells; Gray (Munsell 5Y 5/1); Saturated; Poorly graded; Loose		SP	3-4-4-3			

All depths referenced to ground surface.

Total Depth: 16'

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1200 Riverplace Boulevard,
Suite 710,
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BORING LOG

BOREHOLE ID: *B-3*

GENERAL INFORMATION

PROJECT NO: *GK4443*
CLIENT: *Hercules Incorporated*
SITE LOCATION: *Brunswick, Georgia*
BORING DATE: *2/27/2012*
GEOSYNTEC SUPERVISOR: *Ramil Mijares*
DRILLING CONTRACTOR: *SAEDACCO*
DRILLER NAME: *Stefan Smith*

TECHNICAL INFORMATION

DRILLING METHOD: *Hollow Stem Auger*
RIG TYPE: *D-50*
BOREHOLE DIA: *4.25 in.*
NORTHING: *424568.45*
EASTING: *873083.00*
GROUND ELEVATION: *7.50'*

Depth (ft)	Water Level	Lithologic Description	Pattern	Unified Soil Classification	SPT Blowcount	SPT-Curve (0 5 10 15 20 25 30 35 40 45 50)	Recovery	Comments
0		Medium sand with roots; Very dark gray (Munsell Gley 1 3/N); Moist; Poorly graded; Loose		SP	2-1-2-3			
		Fine to medium sand; Light gray (Munsell 5Y 7/1); Moist; Poorly graded; Loose			2-4-2-2			Upper 1 ft (2-3) = Very dark gray sand with roots (Munsell Gley 1 3/N); Moist; Loose
	▽	Fine to medium sand; Gray (Munsell 5Y 5/1); Saturated; Poorly graded; Loose			1/24"			
5		Clayey sand; Gray (Munsell 5Y 5/1); Saturated; Poorly graded; Loose		SC	1-1-1-3			Analytical sample SO-MSB3-01 2/27/12 16:35 for COPC analysis
		Clayey sand; Dark gray (Munsell 5Y 4/1); Saturated; Poorly graded; Medium dense			1-2-3-7			
10					3-6-6-5			
		Fine to medium sand; Gray (Munsell 5Y 5/1); Saturated; Poorly graded; Loose		SP	2-2-2-2			
15					2-1/18"			

All depths referenced to ground surface.

Total Depth: 16'

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BORING LOG

BOREHOLE ID: *B-4*

GENERAL INFORMATION

PROJECT NO: *GK4443*
CLIENT: *Hercules Incorporated*
SITE LOCATION: *Brunswick, Georgia*
BORING DATE: *2/27/2012*
GEOSYNTEC SUPERVISOR: *Ramil Mijares*
DRILLING CONTRACTOR: *SAEDACCO*
DRILLER NAME: *Stefan Smith*

TECHNICAL INFORMATION

DRILLING METHOD: *Hollow Stem Auger*
RIG TYPE: *D-50*
BOREHOLE DIA: *2.25 in.*
NORTHING: *424556.17*
EASTING: *872858.90*
GROUND ELEVATION: *7.68'*

Depth (ft)	Water Level	Lithologic Description	Pattern	Unified Soil Classification	SPT Blowcount	SPT-Curve (0 5 10 15 20 25 30 35 40 45 50)	Recovery	Comments
0		Fine to medium sand with isolated shell fragments; Light gray (Munsell 5Y 7/1); Moist; Poorly graded; Loose		SP	2-3-4-5			Upper 1 ft (0-1) = Very dark gray sand with roots (Munsell Gley 1 3/N); Moist; Loose
		Fine to medium sand; Light gray (Munsell 5Y 7/1); Moist; Poorly graded; Loose			5-5-3-2			Upper 6 in (2-2.5) = Brown sand (Munsell 10YR 4/3); Moist; Loose
5	▽	Medium sand; Dark gray (Munsell 5Y 4/1); Saturated; Poorly graded; Loose			2-3-1-3			
		Clayey sand; Gray (Munsell 5Y 5/1); Saturated; Poorly graded; Medium dense		SC	3-5-5-6			Analytical sample SO-MSB4-01 2/27/12 17:05 for COPC analysis
					5-6-6-6			
10		Fine to medium sand; Gray (Munsell 5Y 5/1); Saturated; Poorly graded; Loose		SP	3-3-4-3			
					1-1-3-1			
15					1-1/18"			

All depths referenced to ground surface.

Total Depth: 16'

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BORING LOG

BOREHOLE ID: *B-5*

GENERAL INFORMATION

PROJECT NO: *GK4443*
CLIENT: *Hercules Incorporated*
SITE LOCATION: *Brunswick, Georgia*
BORING DATE: *2/28/2012*
GEOSYNTEC SUPERVISOR: *Ramil Mijares*
DRILLING CONTRACTOR: *SAEDACCO*
DRILLER NAME: *Stefan Smith*

TECHNICAL INFORMATION

DRILLING METHOD: *Hollow Stem Auger*
RIG TYPE: *D-50*
BOREHOLE DIA: *2.25 in.*
NORTHING: *424671.36*
EASTING: *872708.48*
GROUND ELEVATION: *6.76'*

Depth (ft)	Water Level	Lithologic Description	Pattern	Unified Soil Classification	SPT Blowcount	SPT-Curve (0 5 10 15 20 25 30 35 40 45 50)	Recovery	Comments
0		Fine to medium sand with roots; Very dark gray (Munsell Gley 1 3/N); Moist; Poorly graded; Loose		SP	2-5-5-5			
		Fine to medium sand; Very dark gray (Munsell Gley 1 3/N); Moist; Poorly graded; Loose			2-2-1-2			
5		Medium sand; Very dark gray (Munsell 5Y 3/1); Moist; Poorly graded; Loose			1/12"-1-4			
	▽	Medium sand; Very dark to light gray (Munsell 5Y 3/1 to 5Y 7/1); Saturated; Poorly graded; Loose			2-7-7-11			Analytical sample SO-MSB5-01 2/28/12 7:50 for COPC analysis
		Clayey sand; Dark gray (Munsell 5Y 4/1); Saturated; Poorly graded; Medium dense		SC	5-7-7-8			
10		Clayey sand; Dark gray (Munsell 5Y 4/1); Saturated; Poorly graded; Loose			4-3-4-4			
					1/18"-2			Lower 1 ft (13-14) = Fat clay with sand; Dark gray (Munsell Gley 1 4/N); Saturated; Very soft
15		Fine to medium sand; Gray (Munsell 5Y 5/1); Saturated; Poorly graded; Loose		SP	WH-3-4-4			

All depths referenced to ground surface.

Total Depth: 16'

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BORING LOG

BOREHOLE ID: *B-6*

GENERAL INFORMATION

PROJECT NO: *GK4443*
CLIENT: *Hercules Incorporated*
SITE LOCATION: *Brunswick, Georgia*
BORING DATE: *2/29/2012*
GEOSYNTEC SUPERVISOR: *Ramil Mijares*
DRILLING CONTRACTOR: *SAEDACCO*
DRILLER NAME: *Stefan Smith*

TECHNICAL INFORMATION

DRILLING METHOD: *Hollow Stem Auger*
RIG TYPE: *D-50*
BOREHOLE DIA: *4.25 in.*
NORTHING: *424878.34*
EASTING: *872719.05*
GROUND ELEVATION: *6.67'*

Depth (ft)	Water Level	Lithologic Description	Pattern	Unified Soil Classification	SPT Blowcount	SPT-Curve (0 5 10 15 20 25 30 35 40 45 50)	Recovery	Comments
0		Fine to medium sand with roots; Very dark gray (Munsell Gley 1 3/N); Moist; Poorly graded; Loose		SP	2-2-3-3			
		Fine to medium sand; Dark gray (Munsell 5Y 4/1); Moist; Poorly graded; Loose			4-3-4-3			Upper 6 in (2-2.5) = Fine to medium sand with roots; Very dark gray (Munsell Gley 1 3/N); Moist; Poorly graded; Loose
5					3-5-5-5			
	▽	Fine to medium sand; Light gray (Munsell 5Y 7/1); Saturated; Poorly graded; Medium dense			8-7-9-11			Analytical sample SO-MNB6-01 2/29/12 12:00 for COPC analysis
					3-8-6-6			
10					1-5-5-6			
		Clayey sand; Dark gray (Munsell Gley 1 4/N); Saturated; Poorly graded; Loose		SC	1-1-1/12"			Upper 1 ft (12-13) = Fine to medium sand; Light gray (Munsell 5Y 7/1); Saturated; Poorly graded; Loose
15		Fine to medium sand; Gray (Munsell 5Y 5/1); Saturated; Poorly graded; Loose		SP	1/12"-1-4			Lower 8 in (15 1/3-16) = Clayey sand; Very dark gray (Munsell Gley 1 3/N); Saturated; Poorly graded; Loose

All depths referenced to ground surface.

Total Depth: 16'

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BORING LOG

BOREHOLE ID: *B-7*

GENERAL INFORMATION

PROJECT NO: *GK4443*
CLIENT: *Hercules Incorporated*
SITE LOCATION: *Brunswick, Georgia*
BORING DATE: *2/29/2012*
GEOSYNTEC SUPERVISOR: *Ramil Mijares*
DRILLING CONTRACTOR: *SAEDACCO*
DRILLER NAME: *Stefan Smith*

TECHNICAL INFORMATION

DRILLING METHOD: *Hollow Stem Auger*
RIG TYPE: *D-50*
BOREHOLE DIA: *4.25 in.*
NORTHING: *424953.52*
EASTING: *872903.56*
GROUND ELEVATION: *6.89'*

Depth (ft)	Water Level	Lithologic Description	Pattern	Unified Soil Classification	SPT Blowcount	SPT-Curve (0 5 10 15 20 25 30 35 40 45 50)	Recovery	Comments
0		Fine to medium sand with roots; Very dark gray (Munsell Gley 1 3/N); Moist; Poorly graded; Loose		SP	2-2-1-1			
		Clay with sand and roots; Very dark gray (Munsell Gley 1 3/N); Moist; Soft		CH	1/12"-1-2			
5		Clay with sand; Very dark gray (Munsell Gley 1 3/N); Moist; Soft			1/12"-1-1			
	▽	Fine to medium sand; Gray (Munsell 5Y 5/1); Saturated; Poorly graded; Loose		SP	1-1-2-5			Analytical sample SO-MNB7-01 2/29/12 11:05 for COPC analysis
		Fine to medium sand; Gray (Munsell 5Y 5/1); Saturated; Poorly graded; Medium dense			3-5-7-7			
10		Fine to medium sand; Light gray (Munsell 5Y 7/1); Saturated; Poorly graded; Loose			2-4-4-2			
					1-2-3-1			
15		Clayey sand; Very dark gray (Munsell Gley 1 3/N); Saturated; Poorly graded; Loose		SC	1/12"-2-3			Upper 1 ft (14-15) = Fine to medium sand; Light gray (Munsell 5Y 7/1); Saturated; Poorly graded; Loose

All depths referenced to ground surface.

Total Depth: 16'

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BORING LOG

BOREHOLE ID: *B-8*

GENERAL INFORMATION

PROJECT NO: *GK4443*
CLIENT: *Hercules Incorporated*
SITE LOCATION: *Brunswick, Georgia*
BORING DATE: *2/29/2012*
GEOSYNTEC SUPERVISOR: *Ramil Mijares*
DRILLING CONTRACTOR: *SAEDACCO*
DRILLER NAME: *Stefan Smith*

TECHNICAL INFORMATION

DRILLING METHOD: *Hollow Stem Auger*
RIG TYPE: *D-50*
BOREHOLE DIA: *2.25 in.*
NORTHING: *424813.55*
EASTING: *872920.67*
GROUND ELEVATION: *5.84'*

Depth (ft)	Water Level	Lithologic Description	Pattern	Unified Soil Classification	SPT Blowcount	SPT-Curve (0 5 10 15 20 25 30 35 40 45 50)	Recovery	Comments
0		Fine to medium sand with roots; Very dark gray (Munsell Gley 1 3/N); Moist; Poorly graded; Loose		SP	1-1-1-1			Upper 1ft (2-3) = Fine to medium sand with roots; Very dark gray (Munsell Gley 1 3/N); Moist; Poorly graded; Loose
		Fine to medium sand; Dark gray (Munsell 5Y 4/1); Moist; Poorly graded; Loose			2-3-4-3			Upper 1ft (4-5) = Fine to medium sand; Dark gray (Munsell 5Y 4/1); Saturated; Poorly graded; Loose
	▽	Clayey sand; Olive gray (Munsell 5Y 4/2); Saturated; Poorly graded; Loose		SC	1/12"-1-1			Analytical sample SO-MNB8-01 2/29/12 10:10 for COPC analysis; Analytical sample SO-MNB8-01 (MS/MSD) 2/29/12 10:10 for COPC analysis
5		Fine to medium sand; Light gray (Munsell 5Y 7/1); Saturated; Poorly graded; Loose		SP	4-5-6-4			
					3-3-2-3			
10					1/12"-2-3			
					1-2-1-4			
15		Fine to medium sand; Gray (Munsell 5Y 5/1); Saturated; Poorly graded; Loose			1-3-2-2			

All depths referenced to ground surface.

Total Depth: 16'

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BORING LOG

BOREHOLE ID: *B-9*

GENERAL INFORMATION

PROJECT NO: *GK4443*
CLIENT: *Hercules Incorporated*
SITE LOCATION: *Brunswick, Georgia*
BORING DATE: *2/29/2012*
GEOSYNTEC SUPERVISOR: *Ramil Mijares*
DRILLING CONTRACTOR: *SAEDACCO*
DRILLER NAME: *Stefan Smith*

TECHNICAL INFORMATION

DRILLING METHOD: *Hollow Stem Auger*
RIG TYPE: *D-50*
BOREHOLE DIA: *4.25 in.*
NORTHING: *424882.57*
EASTING: *873190.91*
GROUND ELEVATION: *6.33'*

Depth (ft)	Water Level	Lithologic Description	Pattern	Unified Soil Classification	SPT Blowcount	SPT-Curve (0 5 10 15 20 25 30 35 40 45 50)	Recovery	Comments
0		Fine to medium sand with roots; Very dark gray (Munsell Gley 1 3/N); Moist; Poorly graded; Loose		SP	2-1-2-2 WH-1/18"			
5	▽	Sandy fat clay with mulch; Dark gray (Munsell Gley 1 4/N); Moist; Soft		CH	WH-1/18"			
		Sandy fat clay; Dark gray (Munsell Gley 1 4/N); Saturated; Soft			WH 1/12"-3-3			Analytical sample SO-MNB9-01 2/29/12 9:00 for COPC analysis; Analytical sample SO-MNB9-02 2/29/12 9:30 for COPC analysis for duplicate
10		Fine to medium sand; Gray (Munsell 5Y 6/1); Saturated; Poorly graded; Loose		SP	2-3-5-5			Upper 6 in (10-10.5) = Sandy fat clay with some sand and mulch; Dark gray (Munsell Gley 1 4/N); Saturated; Soft
		Sandy fat clay; Dark gray (Munsell Gley 1 4/N); Saturated; Soft		CH	2-3-1-1 WH/12"-1-3			Lower 1 ft (13-14) = Fine to medium sand; Gray (Munsell 5Y 6/1); Saturated; Poorly graded; Loose Lower 6 in (15.5-16) = Clayey sand; Dark gray (Munsell 5Y 4/1); Saturated; Poorly graded; Loose
15								

All depths referenced to ground surface.

Total Depth: 16'

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BORING LOG

BOREHOLE ID: *B-10*

GENERAL INFORMATION

PROJECT NO: *GK4443*
CLIENT: *Hercules Incorporated*
SITE LOCATION: *Brunswick, Georgia*
BORING DATE: *2/28/2012*
GEOSYNTEC SUPERVISOR: *Ramil Mijares*
DRILLING CONTRACTOR: *SAEDACCO*
DRILLER NAME: *Stefan Smith*

TECHNICAL INFORMATION

DRILLING METHOD: *Hollow Stem Auger*
RIG TYPE: *D-50*
BOREHOLE DIA: *4.25 in.*
NORTHING: *424897.58*
EASTING: *873369.92*
GROUND ELEVATION: *6.35'*

Depth (ft)	Water Level	Lithologic Description	Pattern	Unified Soil Classification	SPT Blowcount	SPT-Curve (0 5 10 15 20 25 30 35 40 45 50)	Recovery	Comments
0		Fine to medium sand with roots; Very dark gray (Munsell Gley 1 3/N); Moist; Poorly graded; Loose		SP	1-1-1-1			
					1-2-2-3			
					1/24"			Lower 1 ft (5-6): Fat clay; Very dark gray (Munsell Gley 1 3/N); Saturated; Very soft
5		Fat clay; Very dark gray (Munsell Gley 1 3/N); Saturated; Very soft		CH	WH			Upper 1 ft (6-7): Fat clay with sand; Very dark gray (Munsell Gley 1 3/N); Saturated; Very soft
					WH			
10					WH			
					WH			
					WH/18"-1			
15		Fat clay with sand with some crushed shells; Dark gray (Munsell 5Y 4/1); Saturated; Soft			1-1-2-2			Lower 1 ft (17-18): Fine to medium sand with crushed shells; Gray (Munsell 5Y 5/1); Saturated; Poorly graded; Loose
		Fine to medium sand with crushed shells; Gray (Munsell 5Y 5/1); Saturated; Poorly graded; Loose		SP	1-2-3-3			
20								

20			1-2-1-4		
			1/12"-1/12"		
25	Fat clay with sand; Dark gray (Munsell 5Y 4/1); Saturated; Soft	CH	1/12"-1/12"		
	N/A		N/A		Shelby Tube Sample Collected
30	Medium to coarse sand; Gray (Munsell 10YR 5/1); Saturated; Poorly graded; Medium dense	SP	10-10-8-12		
			WR-2-3-2		
			3-3-3-3		
35			1-50/5"		

All depths referenced to ground surface.

Total Depth: 36'

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BORING LOG

BOREHOLE ID: *B-11*

GENERAL INFORMATION

PROJECT NO: *GK4443*
CLIENT: *Hercules Incorporated*
SITE LOCATION: *Brunswick, Georgia*
BORING DATE: *2/28/2012*
GEOSYNTEC SUPERVISOR: *Ramil Mijares*
DRILLING CONTRACTOR: *SAEDACCO*
DRILLER NAME: *Stefan Smith*

TECHNICAL INFORMATION

DRILLING METHOD: *Hollow Stem Auger*
RIG TYPE: *D-50*
BOREHOLE DIA: *4.25 in.*
NORTHING: *424659.61*
EASTING: *873496.33*
GROUND ELEVATION: *5.10'*

Depth (ft)	Water Level	Lithologic Description	Pattern	Unified Soil Classification	SPT Blowcount	SPT-Curve (0 5 10 15 20 25 30 35 40 45 50)	Recovery	Comments
0		Fat clay with sand; Dark gray (Munsell 5Y 4/1); Moist; Soft		CH	1-1/18"			
		Fine to medium sand; Very dark gray (Munsell Gley 1 3/N); Moist; Poorly graded; Loose		SP	1-1-2-1			
	▽	Clayey sand; Very dark gray (Munsell Gley 1 3/N); Saturated; Poorly graded; Very loose		SC	2-1-1-1			
5		No recovery			1/24"			
		Clayey sand; Very dark gray to black (Munsell Gley 1 3/N to 2.5/N); Saturated; Poorly graded; Very loose			1/24"			
10		Fat clay with sand; Very dark gray (Munsell 5Y 3/1); Saturated; Soft		CH	1/18"-1			
					1/18"-1			
		Fat clay with sand; Dark gray (Munsell 5Y 4/1); Saturated; Soft			WH			
15					WH/12"-3-4			
		Fat clay with sand with some crushed shells; Dark gray (Munsell 5Y 4/1); Saturated; Soft			2-1/12"-2			
20					1-2-2-5			

	N/A		N/A		Shelby Tube Sample Collected
25	Medium sand; Gray (Munsell 10YR 5/1); Saturated; Poorly graded; Loose	SP	1-4-3-6		
	Medium to coarse sand; Gray (Munsell 10YR 5/1); Saturated; Poorly graded; Medium dense		10-13-10-6		
			2-9-14-17		
30			3-10-6-4		
			14-16-50/5"		
35			15-6-5-5		

All depths referenced to ground surface.

Total Depth: 16'

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ATTACHMENT B

PHOTO LOGS

GEOSYNTEC CONSULTANTS Photographic Documentation	
Client: Hercules Incorporated	Project Number: GK4443
Project Name: Terry Creek OU1 RI/FS	Project Location: Brunswick, Georgia

Photograph 1	
Date: 27 February 2012	
Direction: N/A	
Comments: Drilling SPT boring using hollow stem auger technique.	
Photograph 2	
Date: 28 February 2012	
Direction: N/A	
Comments: Split-spoon sample from Borehole B-2 (12 to 14 feet below ground surface) where sandy fat clay is observed.	

Photograph 3

Date:

29 February 2012

Direction:

N/A

Comments:

Split-spoon sample from Borehole B-8 (14 to 16 feet below ground surface) where poorly graded sand is observed.

Photograph 4

Date:

28 February 2012

Direction:

N/A

Comments:

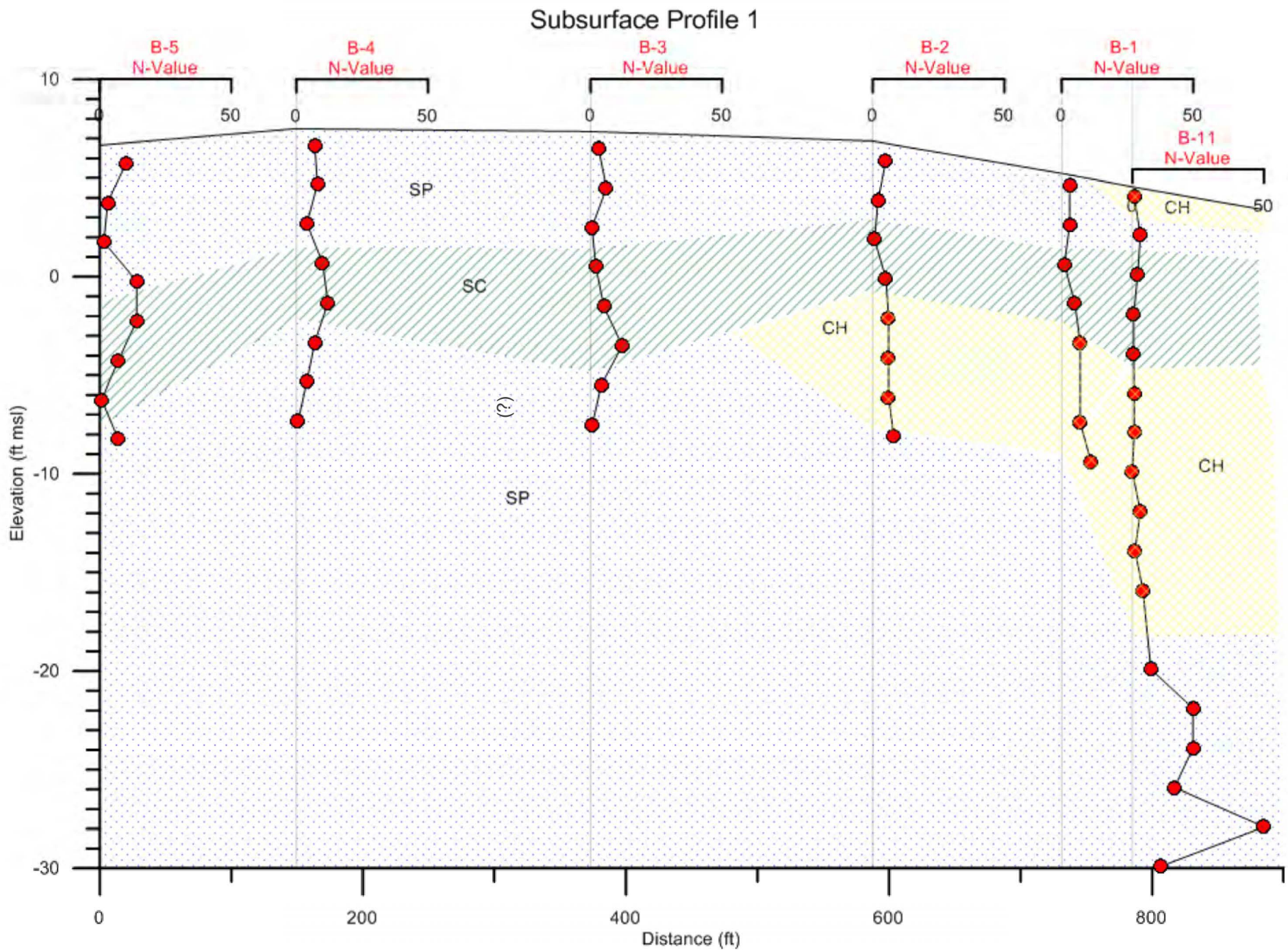
Shelby tube sample from Borehole B-10 (26 to 28 feet below ground surface).

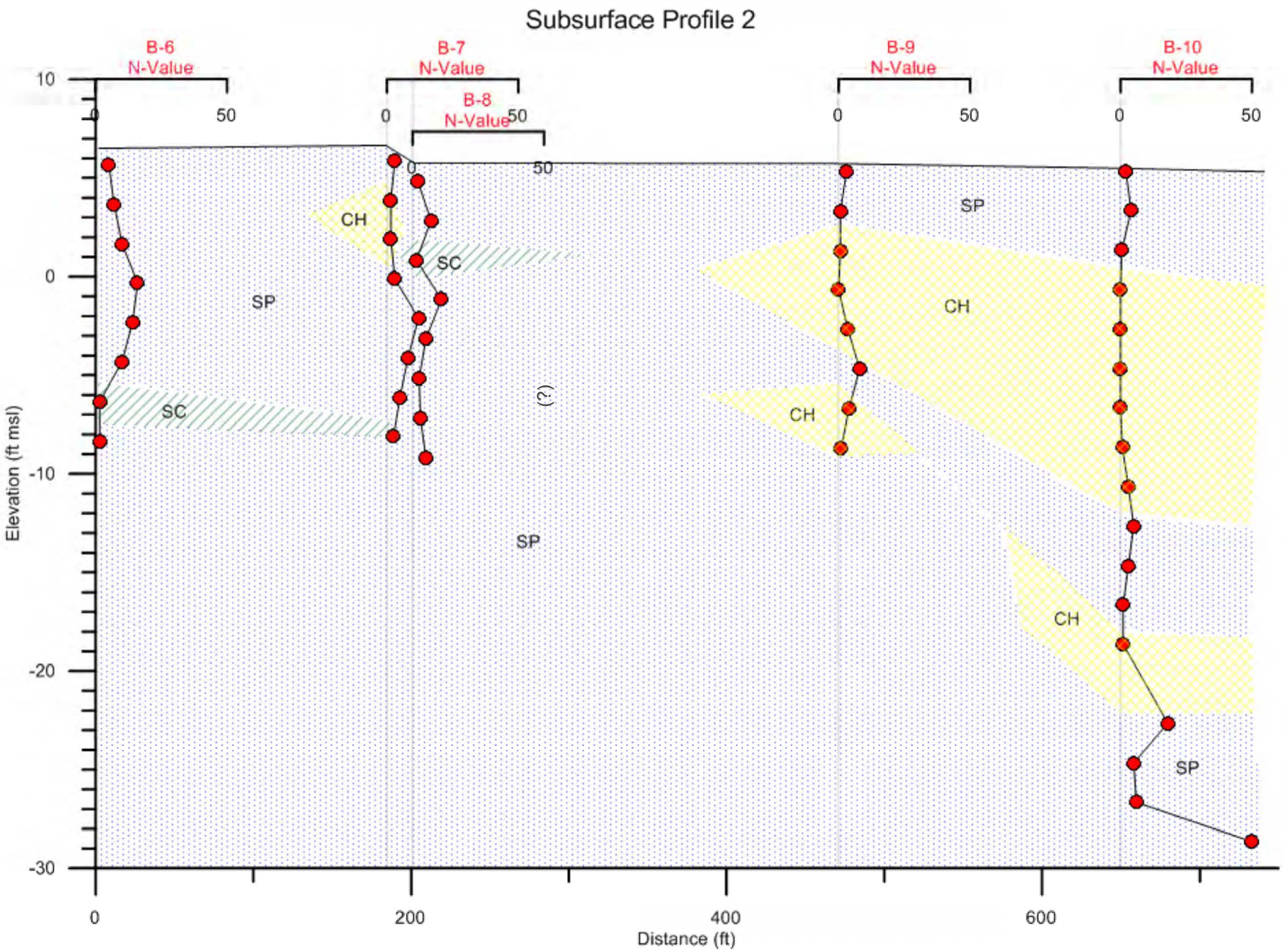
GEOSYNTEC CONSULTANTS Photographic Documentation	
Client: Hercules Incorporated	Project Number: GK4443
Project Name: Terry Creek OU1 RI/FS	Project Location: Brunswick, Georgia

Photograph 5	
Date: 29 February 2012	
Direction: N/A	
Comments: Disturbed and undisturbed Shelby tube samples collected for laboratory testing.	
Photograph 6	
Date: 29 February 2012	
Direction: N/A	
Comments: View of a completed (i.e., grouted) borehole location.	

ATTACHMENT C

SUBSURFACE PROFILES


Subsurface Profile 1
B-5
N-Value
B-4
N-Value
B-3
N-Value
B-2
N-Value
B-1
N-Value
B-11
N-Value
0
50
SP
SC
CH
(?)
SP
CH
CH
Elevation (ft msl)
10
0
-10
-20
-30
0
200
400
600
800
Distance (ft)


Subsurface Profile 2
B-6
N-Value
B-7
N-Value
B-8
N-Value
B-9
N-Value
B-10
N-Value
0
50
10
0
-10
-20
-30
Elevation (ft msl)
SP
SC
CH
(?)
0
200
400
600
Distance (ft)

ATTACHMENT D

GEOTECHNICAL LABORATORY TEST RESULTS

Excel Geotechnical Testing, Inc.
"Excellence in Testing"
953 Forrest Street, Roswell, Georgia 30075
Tel: (770) 910 7537 Fax: (770) 910 7538

Test Results Summary

Project Name: Terry Creek OU1 RI/FS
Project No.: 534

Sample Information			Test Information								
Boring No.	Depth	Lab. No.	Moisture Content	Sieve Analysis ASTM D 422			Atterberg Limits ASTM D 4318			Engineering Classific.	Notes
			ASTM D 2216	Gravel Content	Sand Content	Fines Content	LL	PL	PI	ASTM D 2487	
(-)	(ft)	(-)	(%)	(%)	(%)	(%)	(-)	(-)	(-)	(-)	
GT-MSB1-01	0-2	12C003									
GT-MSB1-02	4-6	12C004	44.0								
GT-MSB1-03	8-10	12C005	30.5								
GT-MSB1-04	14-16	12C006	30.0								
GT-MSB2-01	0-2	12C007									
GT-MSB2-02	2-4	12C008	75.3								
GT-MSB2-03	10-14	12C009	25.3	0	39.8	60.2	76	19	57	CH	1 & 2
GT-MSB2-04	14-16	12C010	23.8								
GT-MSB3-01	0-2	12C011									
GT-MSB3-02	3-4	12C012	21.9								
GT-MSB3-03	8-12	12C013	25.9								
GT-MSB3-04	12-16	12C014	25.0								
GT-MSB4-01	2.5-4	12C015	14.3								
GT-MSB4-02	4-6	12C016	24.3								
GT-MSB4-03	8-10	12C017	23.5								
GT-MSB4-04	10-16	12C018	24.0	0	83.4	16.6					
GT-MSB5-01	0-2	12C019									
GT-MSB5-02	4-6	12C020	31.3								
GT-MSB5-03	10-12	12C021	24.1								
GT-MSB5-04	14-16	12C022	26.2								
GT-MNB6-01	0-2	12C023									
GT-MNB6-02	4-6	12C024	26.2								
GT-MNB6-03	8-12	12C025	21.1								
GT-MNB6-04	14-15 1/3	12C026	26.9								
GT-MNB7-01	0-2	12C027									
GT-MNB7-02	2-6	12C028	71.5	0.2	33.6	66.2	98	35	63	CH	1 & 2
GT-MNB7-03	10-14	12C029	25.5								
GT-MNB7-04	15-16	12C030	34.1								

Notes:
1 - See Soil Index Properties page for hydrometer test results.
2 - See Soil Index Properties page for specific gravity test results.
3 - Bucket Sample.

3-19-12 NSK

Excel Geotechnical Testing, Inc.
"Excellence in Testing"
953 Forrest Street, Roswell, Georgia 30075
Tel: (770) 910 7537 Fax: (770) 910 7538

Test Results Summary

Project Name: Terry Creek OU1 RI/FS
Project No.: 534

Sample Information			Test Information								
Boring No.	Depth	Lab. No.	Moisture Content	Sieve Analysis ASTM D 422			Atterberg Limits ASTM D 4318			Engineering Classific.	Notes
			ASTM D 2216	Gravel Content	Sand Content	Fines Content	LL	PL	PI	ASTM D 2487	
(-)	(ft)	(-)	(%)	(%)	(%)	(%)	(-)	(-)	(-)	(-)	
GT-MNB8-01	0-2	12C031									
GT-MNB8-02	5-6	12C032	27.6								
GT-MNB8-03	10-14	12C033	25.8	0	86.7	13.3					
GT-MNB8-04	14-16	12C034	27.1								
GT-MNB9-01	0-2	12C035									
GT-MNB9-02	4-6	12C036	126.1								
GT-MNB9-03	10.5-12	12C037	28.8								
GT-MNB9-04	14-15.5	12C038	50.6								
GT-MNB10-01	0-2	12C039									
GT-MNB10-02	2-4	12C040	38.9								
GT-MNB10-03	4-5	12C041	64.2								
GT-MNB10-04	7-16	12C042	133.6	0	7.6	92.7	151	47	104	CH	1
GT-MNB10-05	16-17	12C043	49.9								
GT-MNB10-06	18-22	12C044	26.5								
GT-MNB10-07	22-24	12C045	33.4								
GT-MNB10-08	24-26	12C046	43.9	0	45.2	54.8	53	22	31	CH	1
GT-MNB10-09	28-30	12C047	30.6	1.2	67.6	31.2					
GT-MSB11-01	0-2	12C048									
GT-MSB11-02	2-4	12C049	43.8								
GT-MSB11-03	4-6	12C050	74.4								
GT-MSB11-04	8-10	12C051	35.1								
GT-MSB11-05	10-18	12C052	106.0	2.2	25.2	72.6	79	29	50	CH	1
GT-MSB11-06	18-20	12C053	39.2								
GT-MSB11-07	20-22	12C054	43.9								
GT-MSB11-08	24-26	12C055	36.1								
GT-MSB11-09	26-36	12C056	27.0	0.7	62.1	37.2					
SD-S101-Post Weir	0-5	12C057									3
SD-S102-POST Weir	5-10	12C058	135.1	0.2	9.7	90.1	143	51	92	CH	1 & 3
SD-S201-Pre Weir	0-5	12C059	71.0	1.9	72.7	25.4	NP	NP	NP	SM	1 & 3

Notes:
1 - See Soil Index Properties page for hydrometer test results.
2 - See Soil Index Properties page for specific gravity test results.
3 - Bucket Sample.

3-19-12 NSK

Excel Geotechnical Testing, Inc.
"Excellence in Testing"
953 Forrest Street, Roswell, Georgia 30075
Tel: (770) 910 7537 Fax: (770) 910 7538

Test Results Summary

Project Name: Terry Creek OU1 RI/FS
Project No.: 534

Sample Information			Test Information								
Boring No.	Depth	Lab. No.	Moisture Content	Sieve Analysis ASTM D 422			Atterberg Limits ASTM D 4318			Engineering Classific.	Notes
			ASTM D 2216	Gravel Content	Sand Content	Fines Content	LL	PL	PI	ASTM D 2487	
(-)	(ft)	(-)	(%)	(%)	(%)	(%)	(-)	(-)	(-)	(-)	
ST-SD-Post T4-5	0-3.75	12C060									
ST-GTB1	10-12	12C061									
ST-GTB10	26-28	12C062									
ST-GTB11	22-24	12C063									
ST-SD-Pre Weir	0-2.5	12C064									

Notes:
1 - See Soil Index Properties page for hydromete test results.
2 - See Soil Index Properties page for specific gravity test results.
3 - Bucket Sample.

3-19-12 NK

Excel Geotechnical Testing, Inc.
"Excellence in Testing"
953 Forrest Street, Roswell, Georgia 30075
Tel: (770) 910 7537 Fax: (770) 910 7538

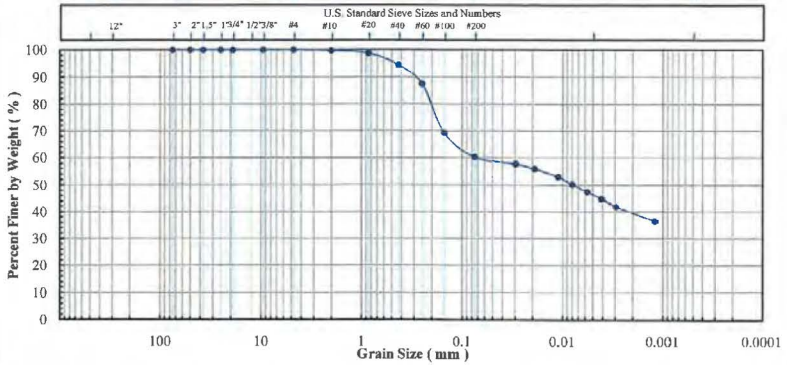
Project Name:	Terry Creek OU1 RI/FS
Project No:	534
Client Sample ID:	GT-MSB2-03 (10-14')
Lab Sample No:	12C009

ASTM C 136, D 422, D 854, D 1140, D 2216, D 2487, D 4318

SOIL INDEX PROPERTIES

Grain Size, Spec. Gravity, Moist. Cont., Eng. Classification, Atterberg Limits

Boulder	Cobbles	Gravel: Coarse	Gravel: Fine	Sand: Coarse	Sand: Medium	Sand: Fine	Fines: Silt	Fines: Clay



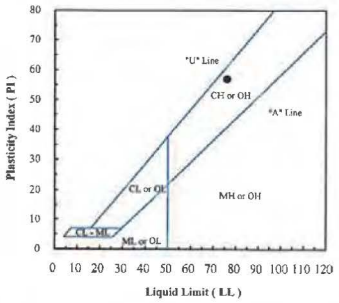
Sieve No.	Size (mm)	% Finer
3"	75	100.0
2"	50	100.0
1.5"	37.5	100.0
1"	25	100.0
3/4"	19	100.0
3/8"	9.5	100.0
#4	4.75	100.0
#10	2.00	99.8
#20	0.850	98.7
#40	0.425	94.3
#60	0.250	87.4
#100	0.150	69.1
#200	0.075	60.2

Specific Gravity (-):	2.71

Hydrometer Particle Diameter (mm)	% Finer
0.0297	57.7
0.0111	53.0
0.0057	47.5
0.0029	41.9
0.0012	36.4

Gravel (%):	
Sand (%):	39.8
Fines (%):	60.2
Silt (%):	13.9
Clay (%):	46.3

Coeff. Unif. (Cu):	
Coeff. Curv. (Cc):	



Client Sample ID.	Lab Sample No:	Moisture Content (%)	Fines Content < No. 200 (%)	Atterberg Limits LL (-)	PL (-)	PI (-)	Engineering Classification
GT-MSB2-03 (10-14')	12C009	25.3	60.2	76	19	57	CH - Sandy fat clay

Note(s):

3-19-12 NK

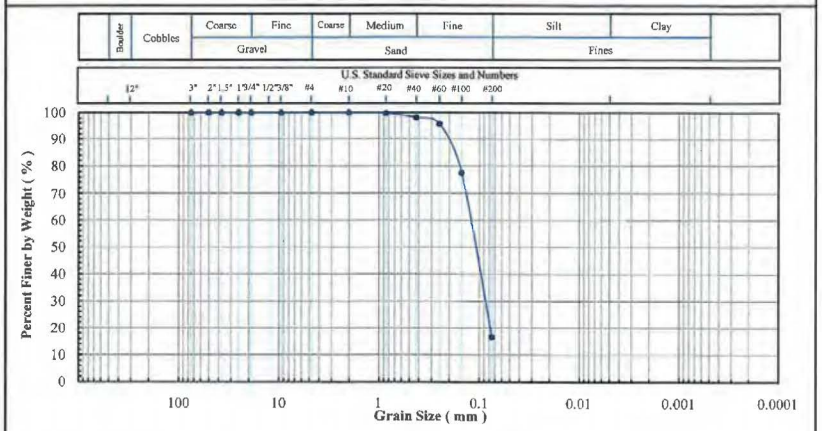
Excel Geotechnical Testing, Inc.
"Excellence in Testing"
953 Forrest Street, Roswell, Georgia 30075
Tel: (770) 910 7537 Fax: (770) 910 7538

Project Name: Terry Creek OU1 RI/FS
Project No: 534
Client Sample ID: GT-MSB4-04 (10-16')
Lab Sample No: 12C018

ASTM C 136, D 422, D 854, D 1140, D2216, D 2487, D4318

SOIL INDEX PROPERTIES

Grain Size, Spec. Gravity, Moist. Content, Eng. Classification, Atterberg Limits



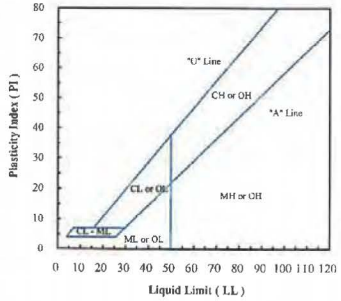
Sieve No.	Size (mm)	% Finer
3"	75	100.0
2"	50	100.0
1.5"	37.5	100.0
1"	25	100.0
3/4"	19	100.0
3/8"	9.5	100.0
#4	4.75	100.0
#10	2.00	100.0
#20	0.850	99.8
#40	0.425	98.2
#60	0.250	95.7
#100	0.150	77.5
#200	0.075	16.6

Specific Gravity (-):	

Hydrometer Particle Diameter (mm)	% Finer

Gravel (%):	
Sand (%):	83.4
Fines (%):	16.6
Silt (%):	
Clay (%):	

Coeff. Unif. (Cu):	
Coeff. Curv. (Cc):	



Client Sample ID.	Lab Sample No:	Moisture Content (%)	Fines Content < No. 200 (%)	Atterberg Limits LL (-)	PL (-)	PI (-)	Engineering Classification
GT-MSB4-04 (10-16')	12C018	24.0	16.6				

Note(s):

3-19-12 MK

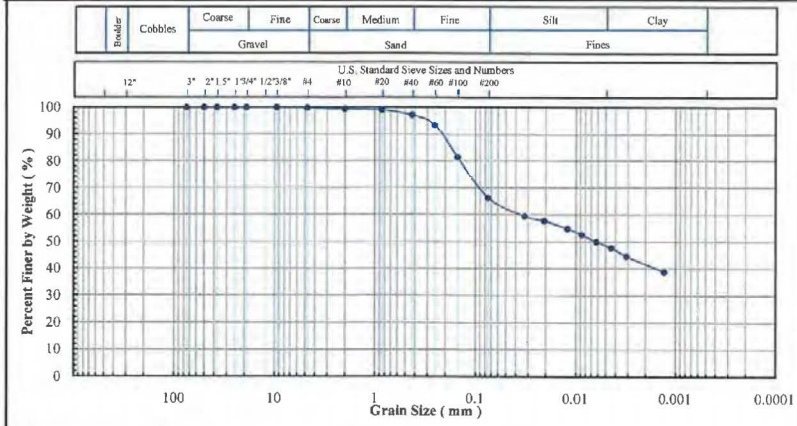
Excel Geotechnical Testing, Inc.
"Excellence in Testing"
953 Forrest Street, Roswell, Georgia 30075
Tel: (770) 910 7537 Fax: (770) 910 7538

Project Name: Terry Creek OU1 RI/FS
Project No: 534
Client Sample ID: GT-MNB7-02 (2-6')
Lab Sample No: 12C028

ASTM C 136, D 422, D 854, D 1140, D 2216, D 2487, D 4318

SOIL INDEX PROPERTIES

Grain Size, Spec. Gravity, Moist. Cont., Eng. Classification, Atterberg Limits



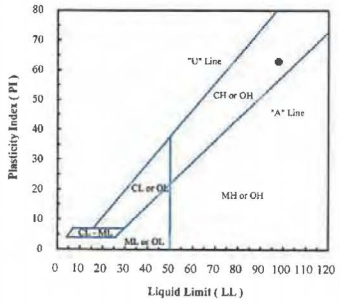
Sieve No.	Size (mm)	% Finer
3"	75	100.0
2"	50	100.0
1.5"	37.5	100.0
1"	25	100.0
3/4"	19	100.0
3/8"	9.5	100.0
#4	4.75	99.8
#10	2.00	99.4
#20	0.850	99.0
#40	0.425	97.1
#60	0.250	93.3
#100	0.150	81.4
#200	0.075	66.2

Specific Gravity (-):	2.49

Hydrometer Particle Diameter (mm)	% Finer
0.0326	59.4
0.0121	54.8
0.0062	50.0
0.0031	44.5
0.0013	38.7

Gravel (%):	0.2
Sand (%):	33.6
Fines (%):	66.2
Silt (%):	17.7
Clay (%):	48.5

Coeff. Unif. (Cu):	
Coeff. Curv. (Cc):	



Client Sample ID.	Lab Sample No:	Moisture Content (%)	Fines Content < No. 200 (%)	Atterberg Limits LL (-)	PL (-)	PI (-)	Engineering Classification
GT-MNB7-02 (2-6')	12C028	71.5	66.2	98	35	63	CH - Sandy fat clay

Note(s): Organic matters in soil may affect the hydrometer test results.
Atterberg results and the engineering classification may be affected by the organic matters in the test material.

3-19-12 MK

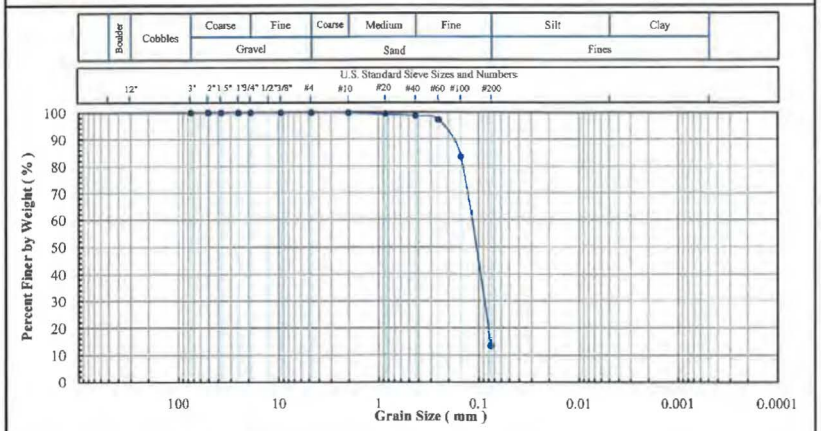
Excel Geotechnical Testing, Inc.
"Excellence in Testing"
953 Forrest Street, Roswell, Georgia 30075
Tel: (770) 910 7537 Fax: (770) 910 7538

Project Name:	Terry Creek OU1 RI/FS
Project No:	534
Client Sample ID:	GT-MNB8-03 (10-14')
Lab Sample No:	12C033

ASTM C 136, D 422, D 854, D 1140, D2216, D 2487, D4318

SOIL INDEX PROPERTIES

Grain Size, Spec. Gravity, Moist. Content, Eng. Classification, Atterberg Limits



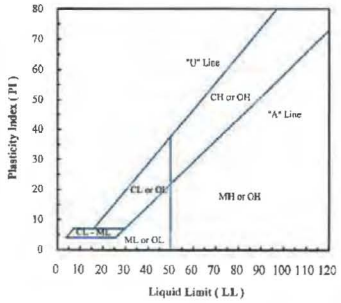
Sieve No.	Size (mm)	% Finer
3"	75	100.0
2"	50	100.0
1.5"	37.5	100.0
1"	25	100.0
3/4"	19	100.0
3/8"	9.5	100.0
#4	4.75	100.0
#10	2.00	99.9
#20	0.850	99.4
#40	0.425	98.8
#60	0.250	97.2
#100	0.150	83.5
#200	0.075	13.3

Specific Gravity (-):	

Hydrometer Particle Diameter (mm)	% Finer

Gravel (%):	
Sand (%):	86.7
Fines (%):	13.3
Silt (%):	
Clay (%):	

Coeff. Unif. (Cu):	
Coeff. Curv. (Cc):	



Client Sample ID.	Lab Sample No:	Moisture Content (%)	Fines Content < No. 200 (%)	Atterberg Limits LL (-)	PL (-)	PI (-)	Engineering Classification
GT-MNB8-03 (10-14')	12C033	25.8	13.3				

Note(s):

3-14-12 NJK

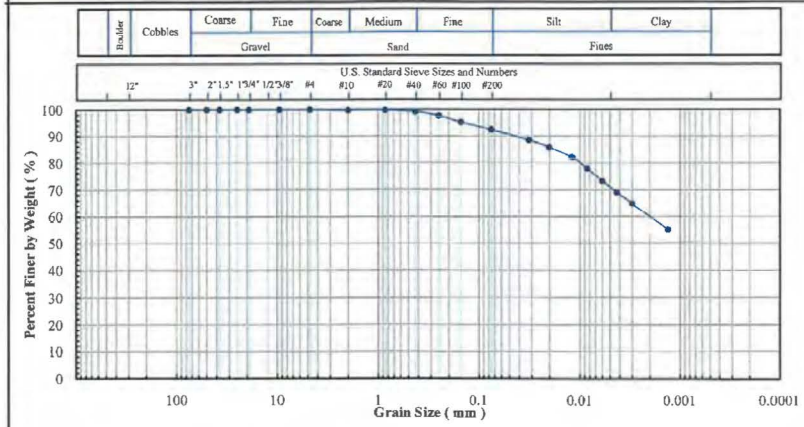
Excel Geotechnical Testing, Inc.
"Excellence in Testing"
953 Forrest Street, Roswell, Georgia 30075
Tel: (770) 910 7537 Fax: (770) 910 7538

Project Name:	Terry Creek OU1 RI/FS
Project No:	534
Client Sample ID:	GT-MNB10-04 (7-16')
Lab Sample No:	12C042

ASTM C 136, D 422, D 854, D 1140, D 2216, D 2487, D 4318

SOIL INDEX PROPERTIES

Grain Size, Spec. Gravity, Moist. Cont., Eng. Classification, Atterberg Limits



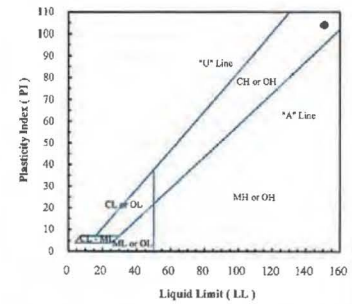
Sieve No.	Size (mm)	% Finer
3"	75	100.0
2"	50	100.0
1.5"	37.5	100.0
1"	25	100.0
3/4"	19	100.0
3/8"	9.5	100.0
#4	4.75	100.0
#10	2.00	99.8
#20	0.850	99.8
#40	0.425	99.2
#60	0.250	97.7
#100	0.150	95.2
#200	0.075	92.4

Specific Gravity (-):	2.55

Hydrometer Particle Diameter (mm)	% Finer
0.0318	88.5
0.0118	82.0
0.0060	73.2
0.0030	64.8
0.0013	55.0

Gravel (%):	
Sand (%):	7.6
Fines (%):	92.4
Silt (%):	21.7
Clay (%):	70.7

Coeff. Unif. (Cu):	
Coeff. Curv. (Cc):	



Client Sample ID.	Lab Sample No:	Moisture Content (%)	Fines Content < No. 200 (%)	Atterberg Limits LL (-)	PL (-)	PI (-)	Engineering Classification
GT-MNB10-04 (7-16	12C042	133.6	92.4	151	47	104	CH - Fat clay

Note(s): Organic matters in soil may affect the hydrometer test results.
Atterberg results and the engineering classification may be affected by the organic matters in the test material.
An assumed specific gravity of 2.55 was used when analyzing the hydrometer test results.

3-19-12 NJK

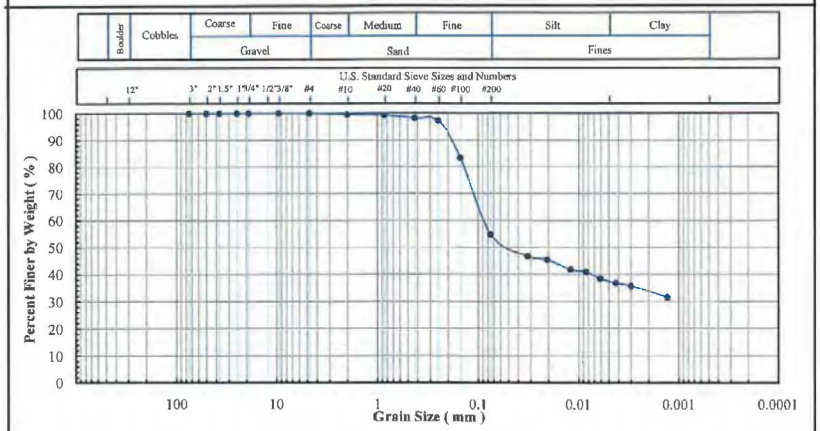
Excel Geotechnical Testing, Inc.
"Excellence in Testing"
953 Forrest Street, Roswell, Georgia 30075
Tel: (770) 910 7537 Fax: (770) 910 7538

Project Name:	Terry Creek OU1 RI/FS
Project No:	534
Client Sample ID:	GT-MNB10-08 (24-26')
Lab Sample No:	12C046

ASTM C 136, D 422, D 854, D 1140, D 2216, D 2487, D 4318

SOIL INDEX PROPERTIES

Grain Size, Spec. Gravity, Moist. Cont, Eng. Classification, Atterberg Limits



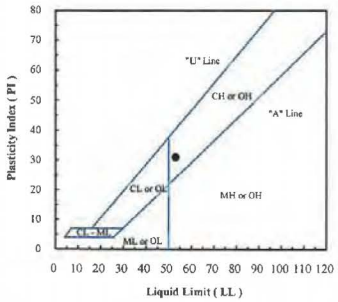
Sieve No.	Size (mm)	% Finer
3"	75	100.0
2"	50	100.0
1.5"	37.5	100.0
1"	25	100.0
3/4"	19	100.0
3/8"	9.5	100.0
#4	4.75	100.0
#10	2.00	99.6
#20	0.850	99.2
#40	0.425	98.2
#60	0.250	97.2
#100	0.150	83.5
#200	0.075	54.8

Specific Gravity (-):	2.60

Hydrometer Particle Diameter (mm)	% Finer
0.0322	46.8
0.0120	41.7
0.0061	38.4
0.0030	35.6
0.0013	31.4

Gravel (%):	
Sand (%):	45.2
Fines (%):	54.8
Silt (%):	17.4
Clay (%):	37.4

Coeff. Unif. (Cu):	
Coeff. Curv. (Cc):	



Client Sample ID.	Lab Sample No:	Moisture Content (%)	Fines Content < No. 200 (%)	Atterberg Limits LL (-)	PL (-)	PI (-)	Engineering Classification
GT-MNB10-08 (24-26')	12C046	43.9	54.8	53	22	31	CH - Sandy fat clay

Note(s): Organic matters in soil may affect the hydrometer test results.
Atterberg results and the engineering classification may be affected by the organic matters in the test material.
An assumed specific gravity of 2.60 was used when analyzing the hydrometer test results.

3-19-12 MJK

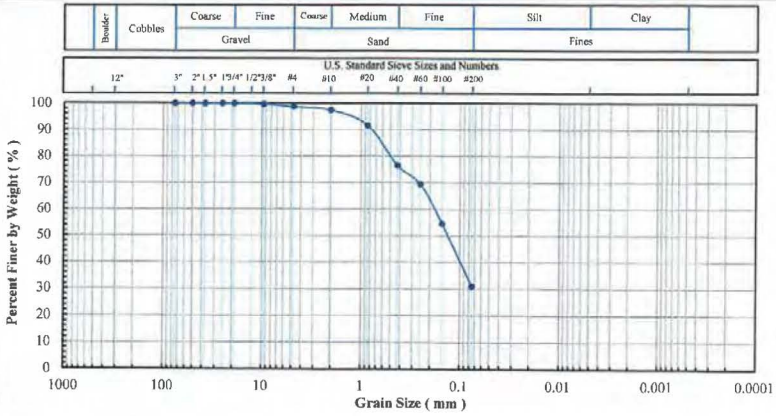
Excel Geotechnical Testing, Inc.
"Excellence in Testing"
953 Forrest Street, Roswell, Georgia 30075
Tel: (770) 910 7537 Fax: (770) 910 7538

Project Name:	Terry Creek OU1 RI/FS
Project No:	534
Client Sample ID:	GT-MNB10-09 (28-30')
Lab Sample No:	12C047

ASTM C 136, D 422, D 854, D 1140, D2216, D 2487, D4318

SOIL INDEX PROPERTIES

Grain Size, Spec. Gravity, Moist. Content, Eng. Classification, Atterberg Limits



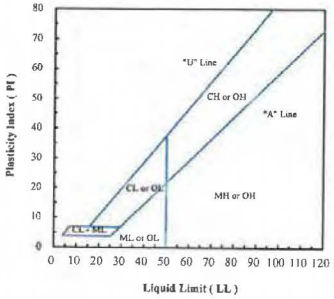
Sieve No.	Size (mm)	% Finer
3"	75	100.0
2"	50	100.0
1.5"	37.5	100.0
1"	25	100.0
3/4"	19	100.0
3/8"	9.5	99.7
#4	4.75	98.8
#10	2.00	97.6
#20	0.850	91.8
#40	0.425	76.5
#60	0.250	69.6
#100	0.150	54.7
#200	0.075	31.2

Specific Gravity (-):	

Hydrometer Particle Diameter (mm)	% Finer

Gravel (%):	1.2
Sand (%):	67.6
Fines (%):	31.2
Silt (%):	
Clay (%):	

Coeff. Unif. (Cu):	
Coeff. Curv. (Cc):	



Client Sample ID.	Lab Sample No:	Moisture Content (%)	Fines Content < No. 200 (%)	Atterberg Limits LL (-)	PL (-)	PI (-)	Engineering Classification
GT-MNB10-09 (28-30')	12C047	30.6	31.2				

Note(s):

3-19-12 MJK

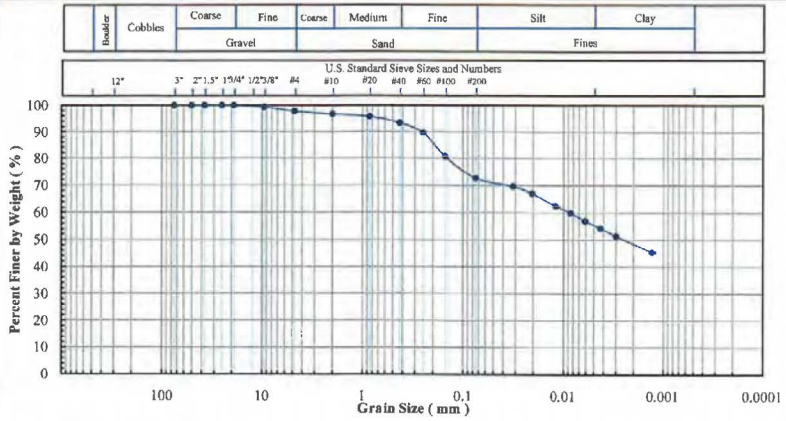
Excel Geotechnical Testing, Inc.
"Excellence in Testing"
953 Forrest Street, Roswell, Georgia 30075
Tel: (770) 910 7537 Fax: (770) 910 7538

Project Name:	Terry Creek OU1 RI/FS
Project No:	534
Client Sample ID:	GT-MSB11-05 (10-18')
Lab Sample No:	12C052

ASTM C 136, D 422, D 854, D 1140, D 2216, D 2487, D 4318

SOIL INDEX PROPERTIES

Grain Size, Spec. Gravity, Moist. Cont, Eng. Classification, Atterberg Limits



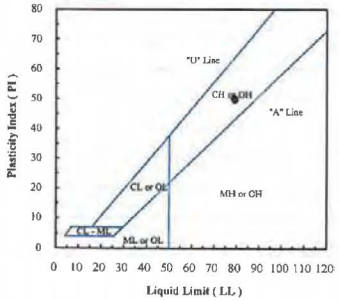
Sieve No.	Size (mm)	% Finer
3"	75	100.0
2"	50	100.0
1.5"	37.5	100.0
1"	25	100.0
3/4"	19	100.0
3/8"	9.5	99.4
#4	4.75	97.8
#10	2.00	96.8
#20	0.850	95.8
#40	0.425	93.4
#60	0.250	89.6
#100	0.150	80.6
#200	0.075	72.6

Specific Gravity (-):	2.55

Hydrometer Particle Diameter (mm)	% Finer
0.0319	69.6
0.0119	62.5
0.0061	56.9
0.0030	51.4
0.0013	45.4

Gravel (%):	2.2
Sand (%):	25.2
Fines (%):	72.6
Silt (%):	17.3
Clay (%):	55.3

Coeff. Unif. (Cu):	
Coeff. Curv. (Cc):	



Client Sample ID.	Lab Sample No:	Moisture Content (%)	Fines Content < No. 200 (%)	Atterberg Limits LL (-)	PL (-)	PI (-)	Engineering Classification
GT-MSB11-05 (10-18')	12C052	106.0	72.6	79	29	50	CH - Sandy fat clay

Note(s): Organic matters in soil may affect the hydrometer test results.
Atterberg results and the engineering classification may be affected by the organic matters in the test material.
An assumed specific gravity of 2.55 was used when analyzing the hydrometer test results.

3-19-12 MSK

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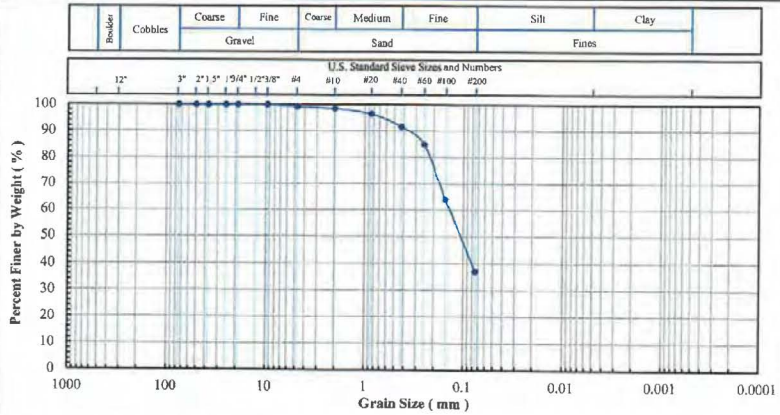
Project Name:	Terry Creek OU1 RI/FS
Project No:	534
Client Sample ID:	GT-MSB11-09 (26-36')
Lab Sample No:	12C056

ASTM C 136, D 422, D 854, D 1140, D2216, D 2487, D4318

SOIL INDEX PROPERTIES

Grain Size, Spec. Gravity, Moist. Content, Eng. Classification, Atterberg Limits



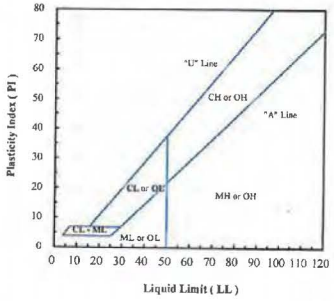
Sieve No.	Size (mm)	% Finer
3"	75	100.0
2"	50	100.0
1.5"	37.5	100.0
1"	25	100.0
3/4"	19	100.0
3/8"	9.5	100.0
#4	4.75	99.3
#10	2.00	98.6
#20	0.850	96.5
#40	0.425	91.7
#60	0.250	85.0
#100	0.150	64.1
#200	0.075	37.2

Specific Gravity (-):	

Hydrometer Particle Diameter (mm)	% Finer

Gravel (%):	0.7
Sand (%):	62.1
Fines (%):	37.2
Silt (%):	
Clay (%):	

Coeff. Unif. (Cu):	
Coeff. Curv. (Cc):	



Client Sample ID.	Lab Sample No:	Moisture Content (%)	Fines Content < No. 200 (%)	Atterberg Limits LL (-)	PL (-)	PI (-)	Engineering Classification
GT-MSB11-09 (26-36')	12C056	27.0	37.2				

Note(s):

3-19-12 MSK

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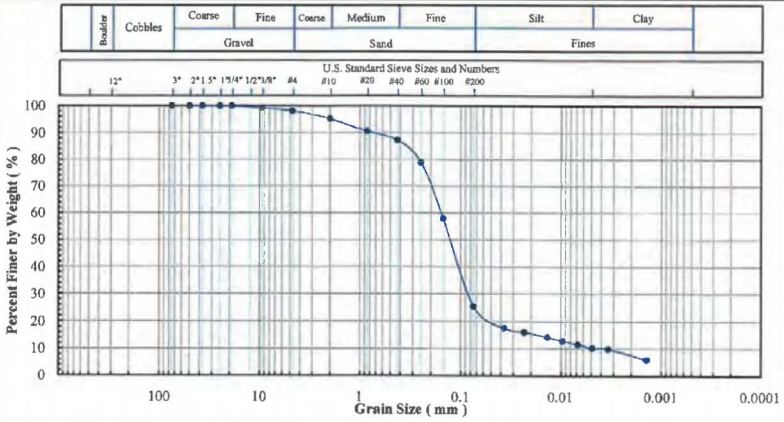
Tel: (770) 910 7537 Fax: (770) 910 7538

Project Name: Terry Creek OU1 RI/FS
Project No: 534
Client Sample ID: SD-S201-Pre Weir (0-5')
Lab Sample No: 12C059

ASTM C 136, D 422, D 854, D 1140, D 2216, D 2487, D 4318

SOIL INDEX PROPERTIES

Grain Size, Spec. Gravity, Moist. Cont., Eng. Classification, Atterberg Limits



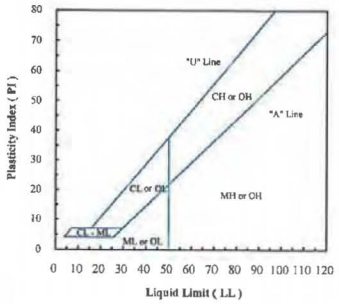
Sieve No.	Size (mm)	% Finer
3"	75	100.0
2"	50	100.0
1.5"	37.5	100.0
1"	25	100.0
3/4"	19	100.0
3/8"	9.5	99.2
#4	4.75	98.1
#10	2.00	95.2
#20	0.850	90.7
#40	0.425	87.3
#60	0.250	78.9
#100	0.150	58.0
#200	0.075	25.4

Specific Gravity (-):	2.55

Hydrometer Particle Diameter (mm)	% Finer
0.0368	17.4
0.0136	14.2
0.0068	11.6
0.0034	9.9
0.0014	6.1

Gravel (%):	1.9
Sand (%):	72.7
Fines (%):	25.4
Silt (%):	15.1
Clay (%):	10.3

Coeff. Unif. (Cu):	
Coeff. Curv. (Cc):	



Client Sample ID.	Lab Sample No:	Moisture Content (%)	Fines Content < No. 200 (%)	Atterberg Limits LL (-)	PL (-)	PI (-)	Engineering Classification
D-S201-Pre Weir (0-	12C059	71.0	25.4	NP	NP	NP	SM - Silty sand

Note(s): Organic matters in soil may affect the hydrometer test results.
Atterberg results and the engineering classification may be affected by the organic matters in the test material.
An assumed specific gravity of 2.55 was used when analyzing the hydrometer test results.

3-19-12 NJK

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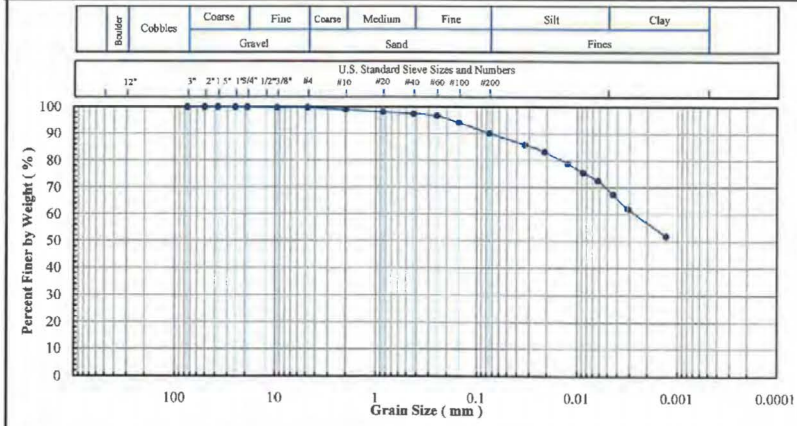
Project Name: Terry Creek OU1 RI/FS
Project No: 534
Client Sample ID: SD-S102- Post Weir (5-10')
Lab Sample No: 12C058

ASTM C 136, D 422, D 854, D 1140, D 2216, D 2487, D 4318

SOIL INDEX PROPERTIES

Grain Size, Spec. Gravity, Moist. Cont., Eng. Classification, Atterberg Limits



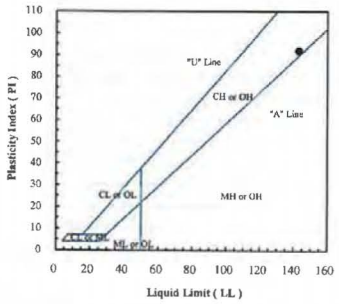
Sieve No.	Size (mm)	% Finer
3"	75	100.0
2"	50	100.0
1.5"	37.5	100.0
1"	25	100.0
3/4"	19	100.0
3/8"	9.5	99.8
#4	4.75	99.8
#10	2.00	99.0
#20	0.850	98.2
#40	0.425	97.5
#60	0.250	96.6
#100	0.150	94.1
#200	0.075	90.1

Specific Gravity (-):	2.55

Hydrometer Particle Diameter (mm)	% Finer
0.0330	85.8
0.0123	78.8
0.0062	72.3
0.0031	62.0
0.0013	51.8

Gravel (%):	0.2
Sand (%):	9.7
Fines (%):	90.1
Silt (%):	21.1
Clay (%):	69.0

Coeff. Unif. (Cu):	
Coeff. Curv. (Cc):	



Client Sample ID.	Lab Sample No:	Moisture Content (%)	Fines Content < No. 200 (%)	Atterberg Limits LL (-)	PL (-)	PI (-)	Engineering Classification
SD-S102- Post Weir (5-10')	12C058	135.1	90.1	143	51	92	CH - Fat clay

Note(s): Organic matters in soil may affect the hydrometer test results.
Atterberg results and the engineering classification may be affected by the organic matters in the test material.
An assumed specific gravity of 2.55 was used when analyzing the hydrometer test results.

3-19-12 NJK

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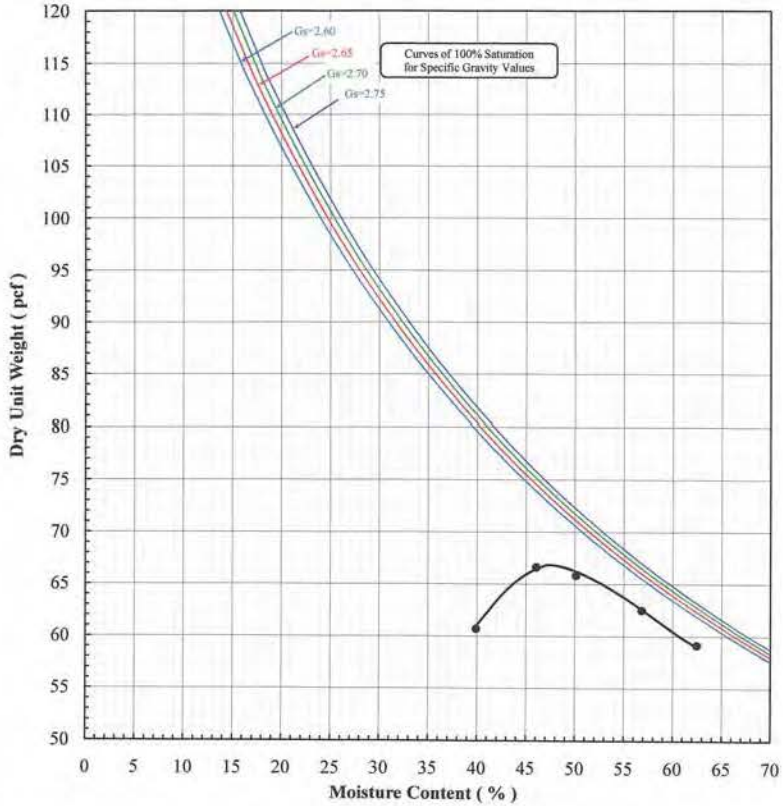
Tel: (770) 910 7537 Fax: (770) 910 7538

Project Name:	Terry Creek OUI RI/FS
Project No:	534
Client Sample ID:	Mix-01*
Lab Sample No:	12D043

ASTM D 698 - Method B

COMPACTION MOISTURE-DENSITY RELATIONSHIP

Moist Preparation



Client/Site Sample ID.	Lab Sample No:	Maximum Dry Unit Weight (pcf)	Optimum Moisture Content (%)	Visual Soil Description
Mix-01*	12D043	67.0	47.5	Dark gray silty clay

Note(s): * Amixture of Bucket-SD-S101 (0-5') Post Weir, Bucket-SD-S102 (5-10') Post Weir and Shelby-SDPostT4-5 (0-3.75').

5-4-12 NJR

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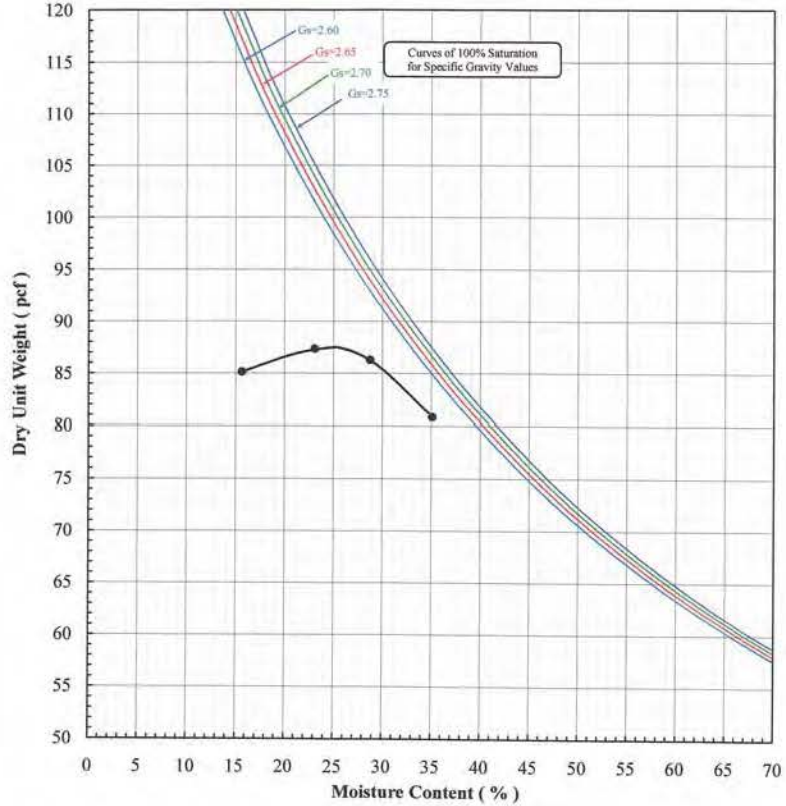
Project Name:	Terry Creek OUI RI/FS
Project No:	534
Client Sample ID:	Mix-02*
Lab Sample No:	12D044

ASTM D 698 - Method B

COMPACTION MOISTURE-DENSITY RELATIONSHIP

Moist Preparation



Client/Site Sample ID.	Lab Sample No:	Maximum Dry Unit Weight (pcf)	Optimum Moisture Content (%)	Visual Soil Description
Mix-02*	12D044	87.7	25.0	Dark gray clayey silty sand

Note(s): * A mixture of Bucket-SD-S201 (0-5') Pre Weir and Shelby-SD Pre Wier (0-2.5').

5-4-12 NJR

Excel Geotechnical Testing, Inc.
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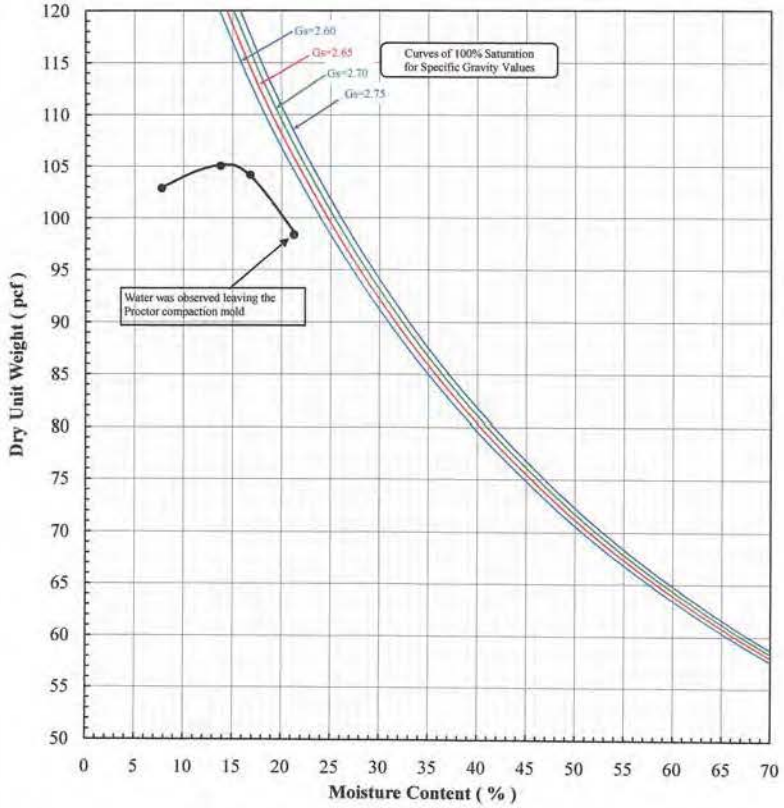
Project Name:	Terry Creek OUI RI/FS
Project No:	534
Client Sample ID:	Mix-03*
Lab Sample No:	12D045

ASTM D 698 - Method B **COMPACTION MOISTURE-DENSITY RELATIONSHIP** **Moist Preparation**



Client/Site Sample ID.	Lab Sample No:	Maximum Dry Unit Weight (pcf)	Optimum Moisture Content (%)	Visiual Soil Description
Mix-03*	12D045	105.2	14.9	Gray-tan slightly clayey silty sand

Note(s): * A mixture of GT-MSB1-04 (14-16'), GT-MSB2-04 (14-16'), GT-MSB3-04 (12-16'), GT-MSB4-04 (10-16'), GT-MSB5-04 (14-16'), GT-MNB7-03 (10-14') and GT-MNB8-03 (10-14')

5/14/12 NSR

Excel Geotechnical Testing, Inc.
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FLEXIBLE WALL PERMEABILITY TEST [1]

ASTM D5084 #

Project Name:	Terry Creek OU1 RI/FS
Project Number:	534
Client Name:	Geosyntec Consultants
Site Sample ID:	Mix-01*
Lab Sample Number:	12D043
Material Type:	Soil
Specified Value (cm/sec):	NA
Date Test Started:	5/8/2012

Remolded Specimen	Proctor [5] Compaction		Specimen Initial Conditions [6]		Test Conditions					Hydraulic Conductivity [8]
	Max. DUW	Opt. MC	Dry Unit Weight	Moisture Content	Cell Press.	Back Press.	Consolid. Press.	Permeant Liquid [7]	Average Gradient	
(-)	(pcf)	(%)	(pcf)	(%)	(psi)	(psi)	(psi)	(-)	(-)	(cm/s)
Notes 2 , 3 & 4	67.0	47.5	63.8	47.3	75.9	75.0	0.9	DTW	7	2.8E-5
					78.5	75.0	3.5		8	3.4E-6

Notes:

1. Method C, "Falling-Head, Increasing-Tailwater" test procedures were followed during the testing.
2. All particles larger than 3/8 inch, if any, were discarded when forming the remolded specimen.
3. Remolded specimen was formed by tamping the soil in 0.5 inch thick layers.
4. Remolded specimen approximately 2.8 inches in diameter and 2.5 inches in height.
5. Maximum Dry Unit Weight (DUW) and Optimum Moisture Content (MC) based on the Standard Proctor Compaction Test (ASTM D 698).
6. Based on the target values of 95% of the maximum dry unit weight and at the optimum moisture.
7. Type of permeant liquid: DTW = Deaired Tap Water, DDI = Deaired Deionized Water
8. **Specimen had a honeycomb structure which could strongly affect the permeability value (i.e., higher values are measured than should be expected).**

* A mixture of Bucket-SD-S101 (0-5') Post Weir, Bucket-SD-S102 (5-10') Post Weir and Shelby-SDPostT4-5 (0-3.75').

Deviations:

Laboratory temperature at 22±3 °C.
Test specimen final conditions are not presented.

5-17-12 NSR

Excel Geotechnical Testing, Inc
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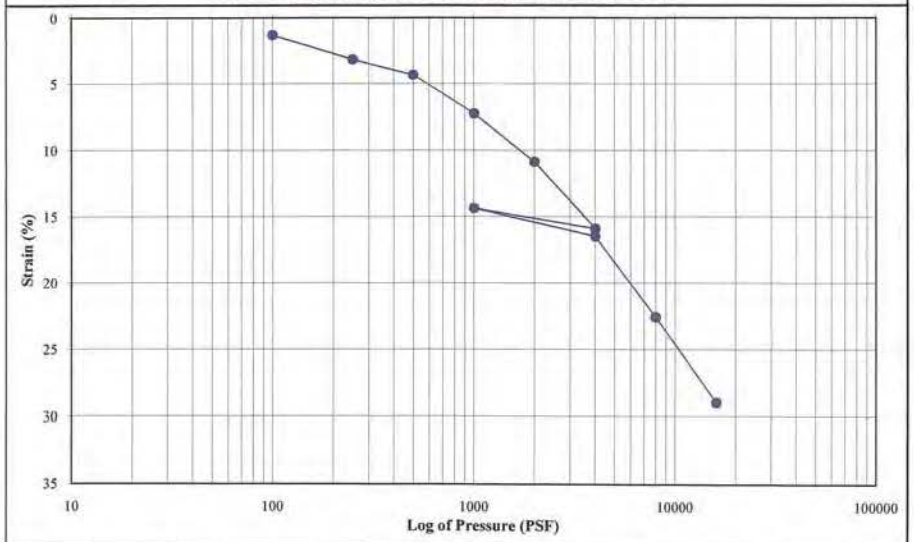
Project Name: Terry Creek OU1 RI/FS
Project No: 534
Client Sample ID: ST-GTB11
Lab Sample No: 12C063

ASTM D 2435

ONE-DIMENSIONAL CONSOLIDATION TEST



Client Sample ID	Lab Sample No.	Specimen Quality 1-10 (Bad to Good)	Test Specimen Initial Conditions				Consolidation Pressure (psf)	Pressure Increment Duration (min)	Accumu.[1] Vertical Strain (%)	Figure No.	Remarks
			Height (cm)	Diameter (cm)	Dry Unit Weight (pcf)	Moisture Content (%)					
ST-GTB11	12C063	8	2.54	6.35	64.6	59.2	100	316	1.28	1	
							250	1034	3.14	2	
							500	260	4.33	3	
							1000	1152	7.27	4	
							2000	1448	10.88	5	
							4000	1417	15.92	6	
							1000	1403	14.37	7	
							4000	1542	16.48	8	
							8000	1505	22.59	9	
							16000	1321	28.97	10	

Note(s):
1. For each pressure increment, the vertical strain values were calculated based on the final deformation measurements.

5-2-12
SRS

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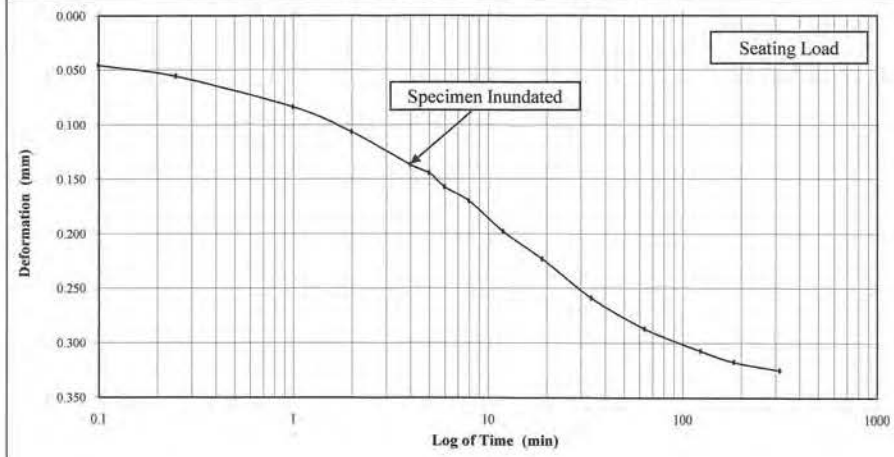
953 Forrest Street, Roswell, Georgia 30075
Tel: (770) 910 7537 Fax: (770) 910 7538

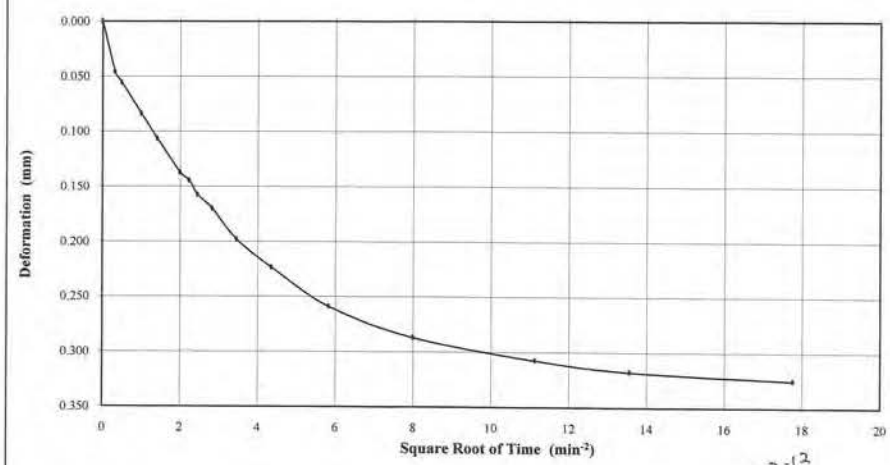
Project Name: Terry Creek OU1 RI/FS
Project No: 534
Client Sample ID: ST-GTB11
Lab Sample No: 12C063

ASTM D 2435

ONE-DIMENSIONAL CONSOLIDATION TEST

Figure 1 - 100 psf





5-2-12
SRS

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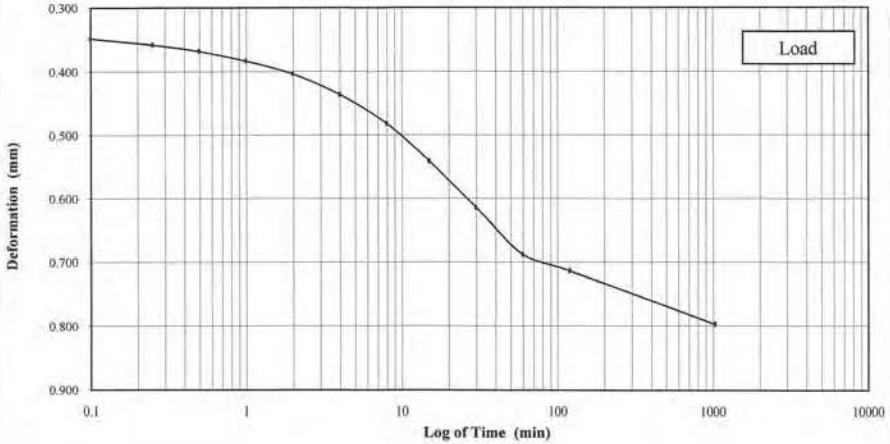
"Excellence in Testing"
953 Forrest Street, Roswell, Georgia 30075
Tel: (770) 910 7537 Fax: (770) 910 7538

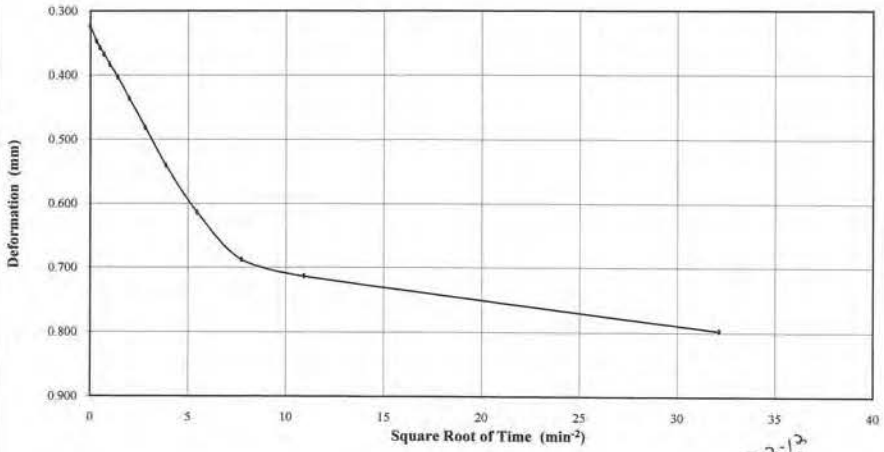
Project Name: Terry Creek OU1 RI/FS
Project No: 534
Client Sample ID: ST-GTB11
Lab Sample No: 12C063

ASTM D 2435

ONE-DIMENSIONAL CONSOLIDATION TEST

Figure 2 - 250 psf





5-2-12
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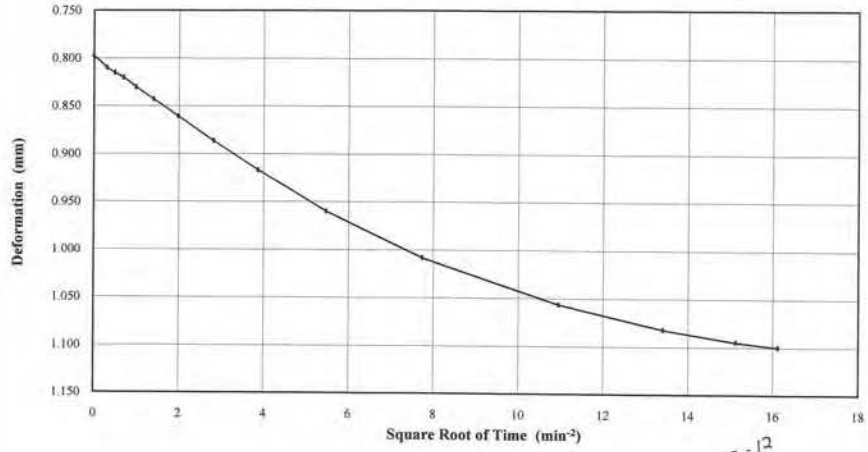
Project Name: Terry Creek OU1 RI/FS
Project No: 534
Client Sample ID: ST-GTB11
Lab Sample No: 12C063

ASTM D 2435

ONE-DIMENSIONAL CONSOLIDATION TEST

Figure 3 - 500 psf



5-2-12
SRS

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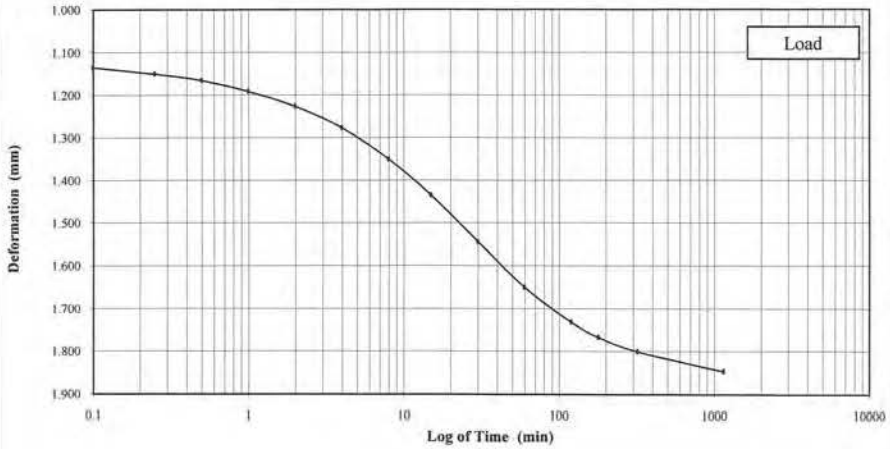
Tel: (770) 910 7537 Fax: (770) 910 7538

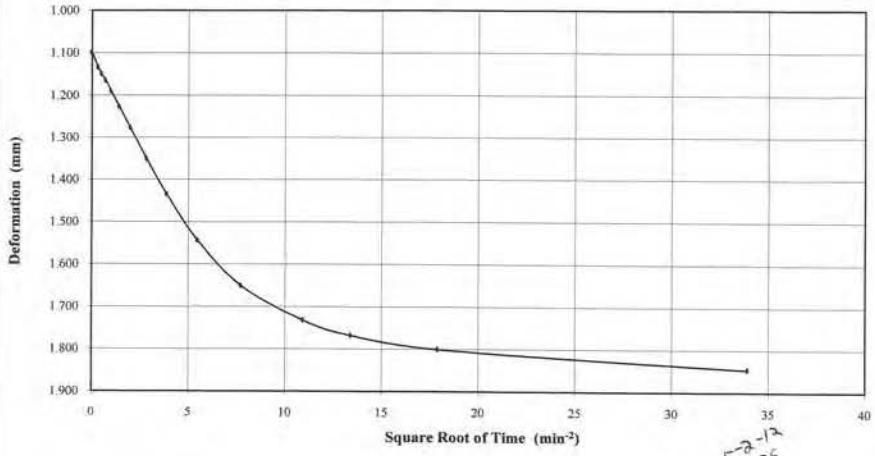
Project Name: Terry Creek OU1 RI/FS
Project No: 534
Client Sample ID: ST-GTB11
Lab Sample No: 12C063

ASTM D 2435

ONE-DIMENSIONAL CONSOLIDATION TEST

Figure 4 - 1000 psf





5-2-12
SAS

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953 Forrest Street, Roswell, Georgia 30075
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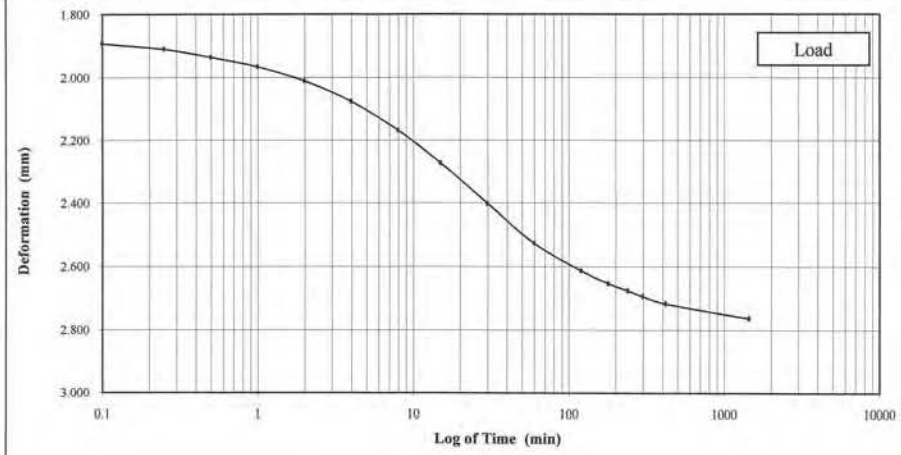
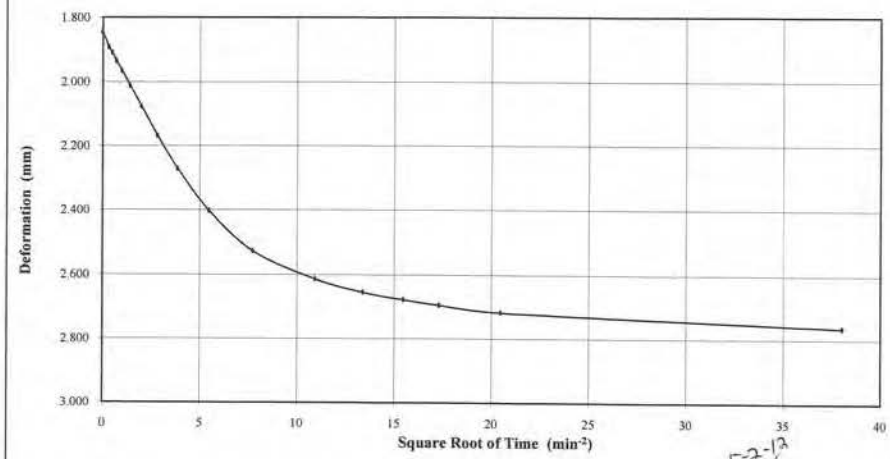
Project Name: Terry Creek OU1 RI/FS
Project No: 534
Client Sample ID: ST-GTB11
Lab Sample No: 12C063

ASTM D 2435

ONE-DIMENSIONAL CONSOLIDATION TEST

Figure 5 - 2000 psf





5-2-12
SAS

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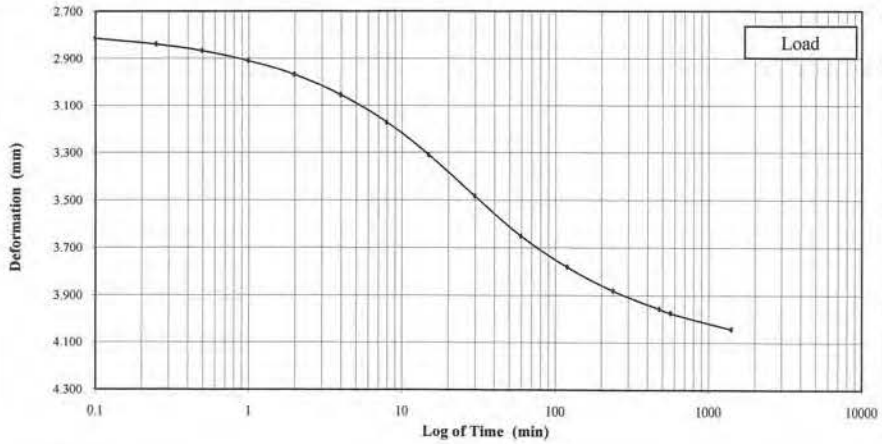
"Excellence in Testing"
953 Forrest Street, Roswell, Georgia 30075
Tel: (770) 910 7537 Fax: (770) 910 7538

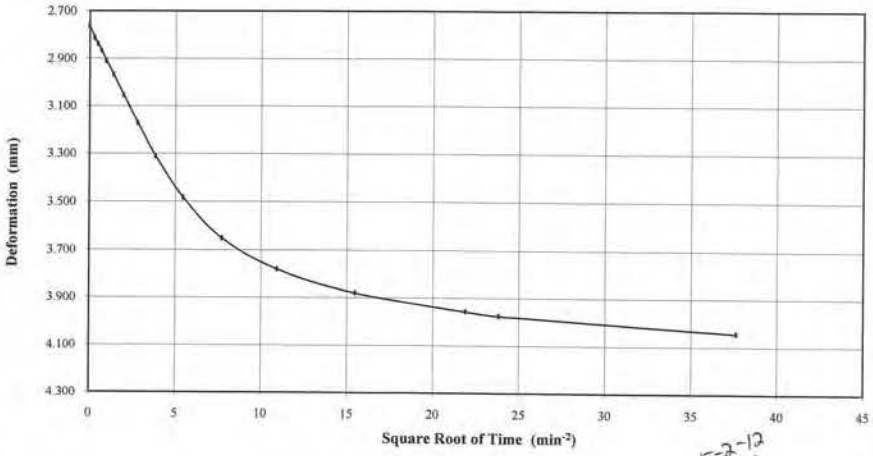
Project Name: Terry Creek OU1 RI/FS
Project No: 534
Client Sample ID: ST-GTB11
Lab Sample No: 12C063

ASTM D 2435

ONE-DIMENSIONAL CONSOLIDATION TEST

Figure 6 - 4000 psf





5-2-12
SRS

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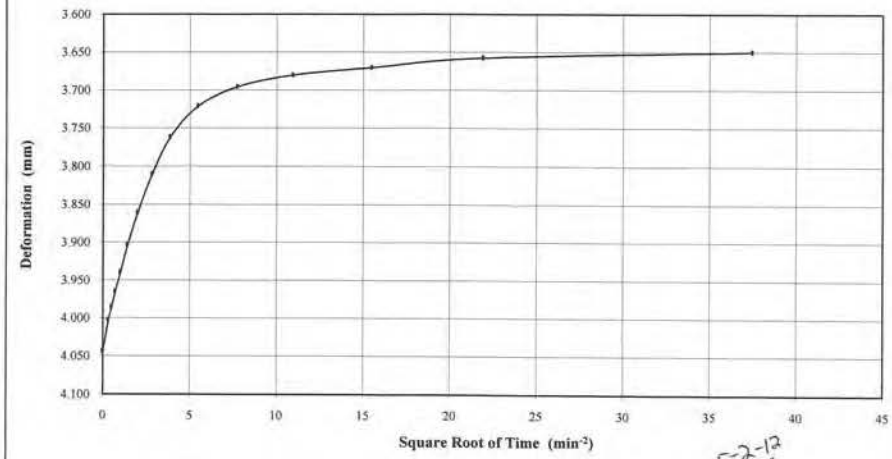
953 Forrest Street, Roswell, Georgia 30075
Tel: (770) 910 7537 Fax: (770) 910 7538

Project Name: Terry Creek OU1 RI/FS
Project No: 534
Client Sample ID: ST-GTB11
Lab Sample No: 12C063

ASTM D 2435

ONE-DIMENSIONAL CONSOLIDATION TEST

Figure 7 - 1000 psf



5-2-12
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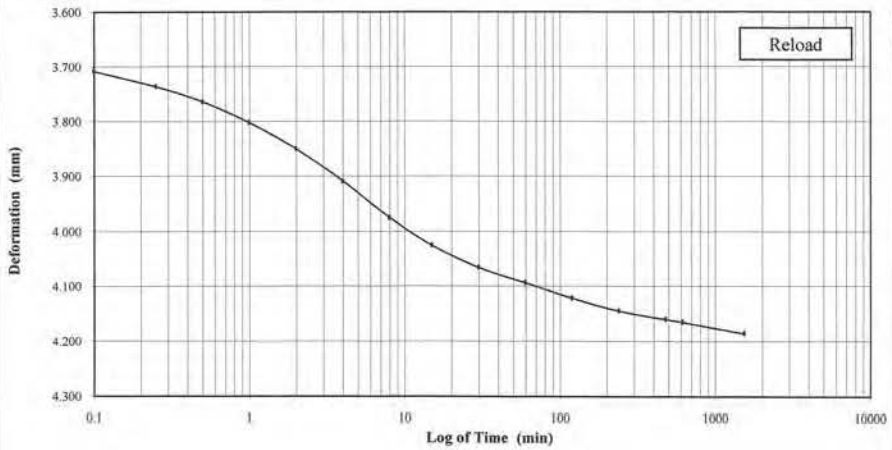
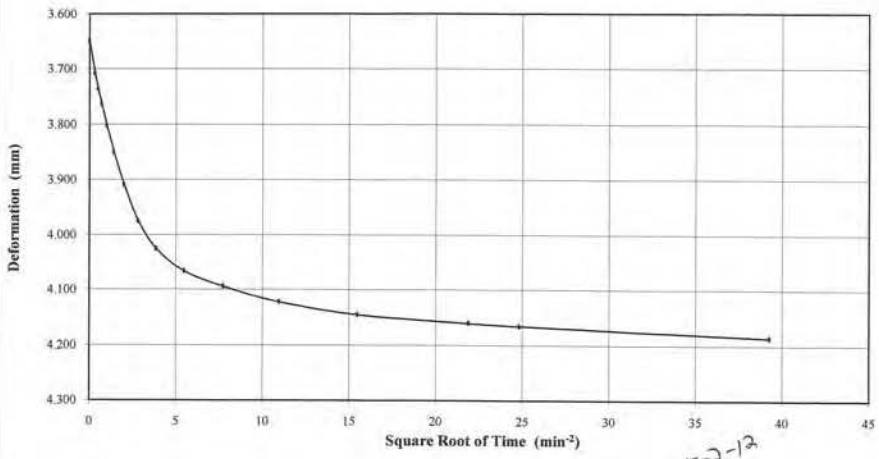
Project Name: Terry Creek OU1 RI/FS
Project No: 534
Client Sample ID: ST-GTB11
Lab Sample No: 12C063

ASTM D 2435

ONE-DIMENSIONAL CONSOLIDATION TEST

Figure 8 - 4000 psf





5-2-12
SRS

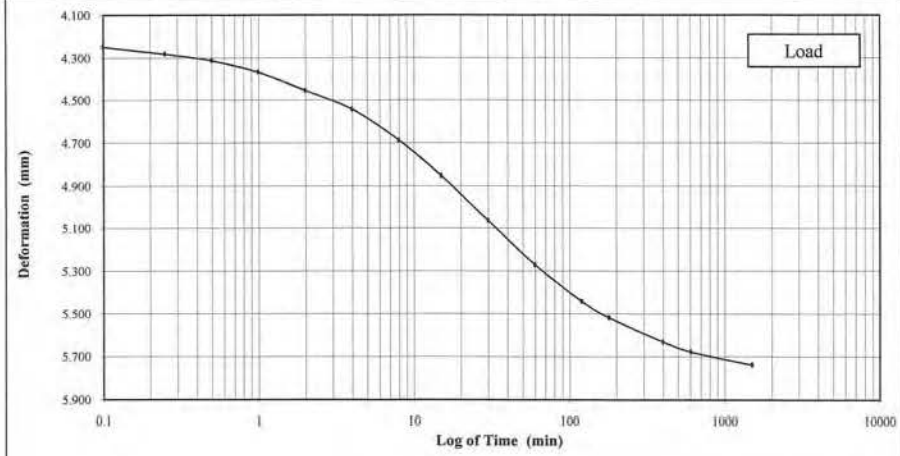
Excel Geotechnical Testing, Inc
"Excellence in Testing"
953 Forrest Street, Roswell, Georgia 30075
Tel: (770) 910 7537 Fax: (770) 910 7538

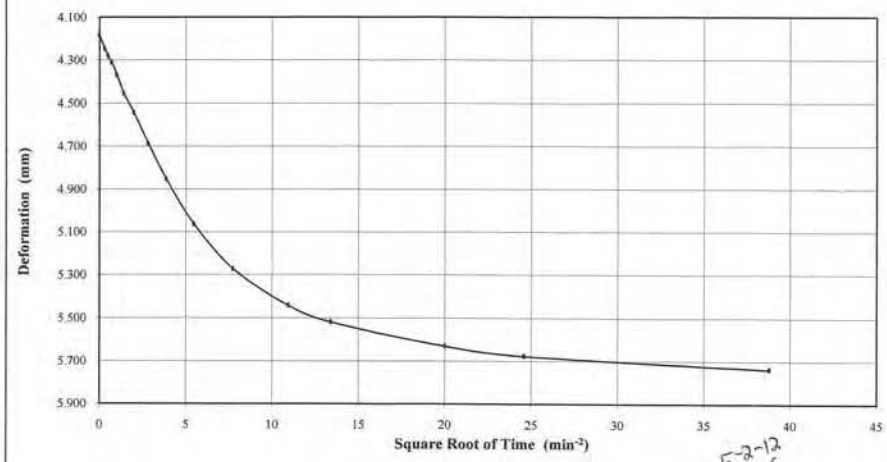
Project Name: Terry Creek OU1 RI/FS
Project No: 534
Client Sample ID: ST-GTB11
Lab Sample No: 12C063

ASTM D 2435

ONE-DIMENSIONAL CONSOLIDATION TEST

Figure 9 - 8000 psf





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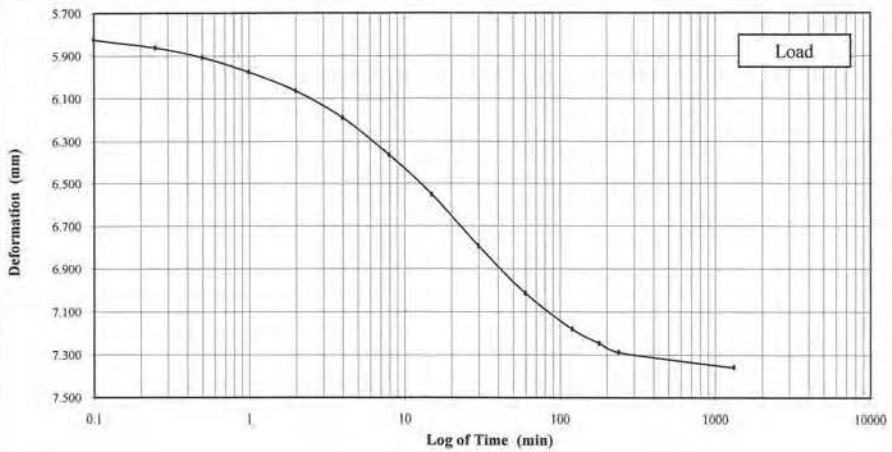
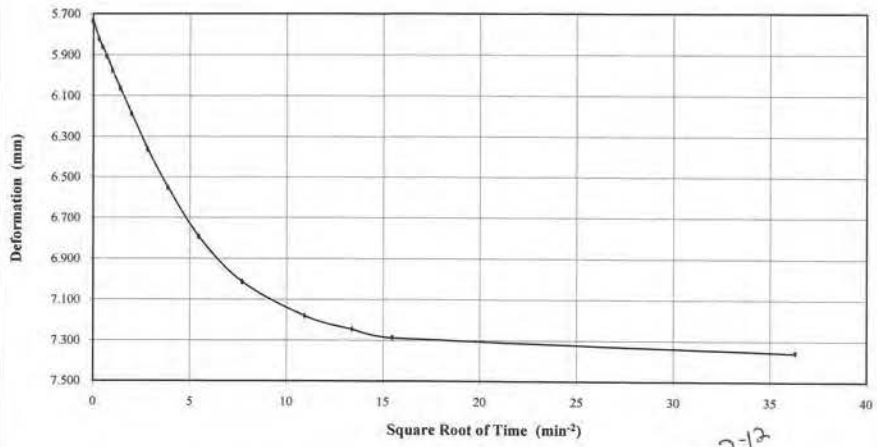
Project Name: Terry Creek OU1 RI/FS
Project No: 534
Client Sample ID: ST-GTB11
Lab Sample No: 12C063

ASTM D 2435

ONE-DIMENSIONAL CONSOLIDATION TEST

Figure 10 - 16000 psf





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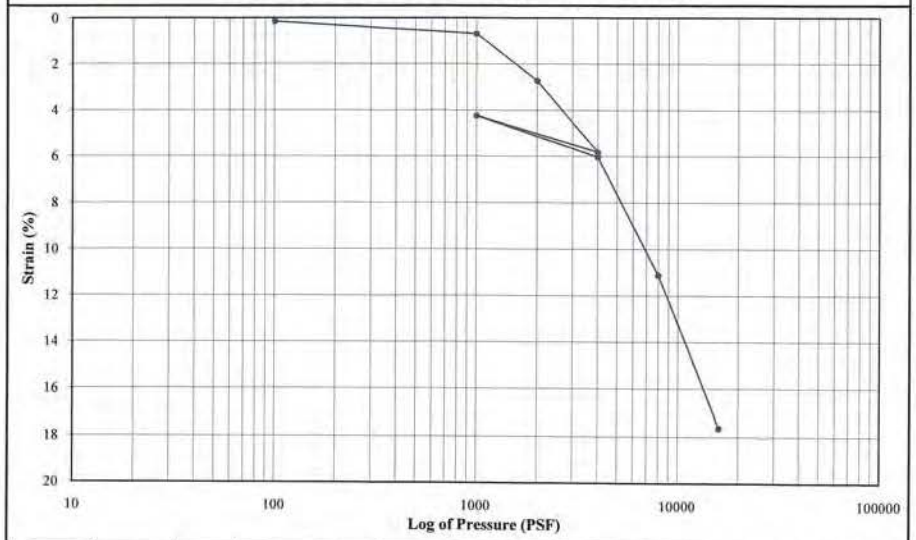
953 Forrest Street, Roswell, Georgia 30075
Tel: (770) 910 7537 Fax: (770) 910 7538

Project Name: Terry Creek OU1 RI/FS
Project No: 534
Client Sample ID: Mix-01*
Lab Sample No: 12D043

ASTM D 2435

ONE-DIMENSIONAL CONSOLIDATION TEST



Client Sample ID	Lab Sample No.	Specimen Quality 1-10 (Bad to Good)	Test Specimen Initial Conditions				Consolidation Pressure (psf)	Pressure Increment Duration (min)	Accumu.[1] Vertical Strain (%)	Figure No.	Remarks
			Height (cm)	Diameter (cm)	Dry Unit Weight (pcf)	Moisture Content (%)					
Mix-01*	12D043	7	2.54	6.35	62.7	47.2	100	64	0.15	1	
							1000	320	0.68	2	
							2000	1133	2.73	3	
							4000	360	5.83	4	
							1000	1045	4.23	5	
							4000	300	6.04	6	
							8000	1095	11.12	7	
							16000	5781	17.64	8	

Note(s):
1. For each pressure increment, the vertical strain values were calculated based on the final deformation measurements.
* A mixture of Bucket-SD-S101 (0-5') Post Weir, Bucket-SD-S102 (5-10') Post Weir and Shelby-SDPostT4-5 (0-3.75').

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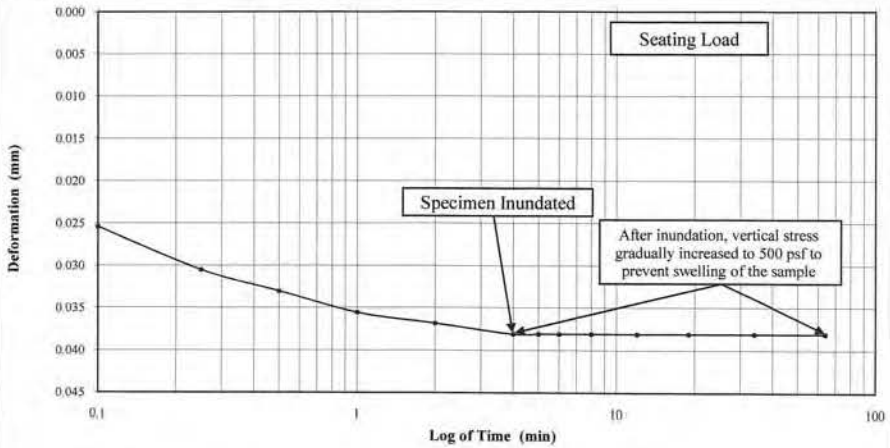
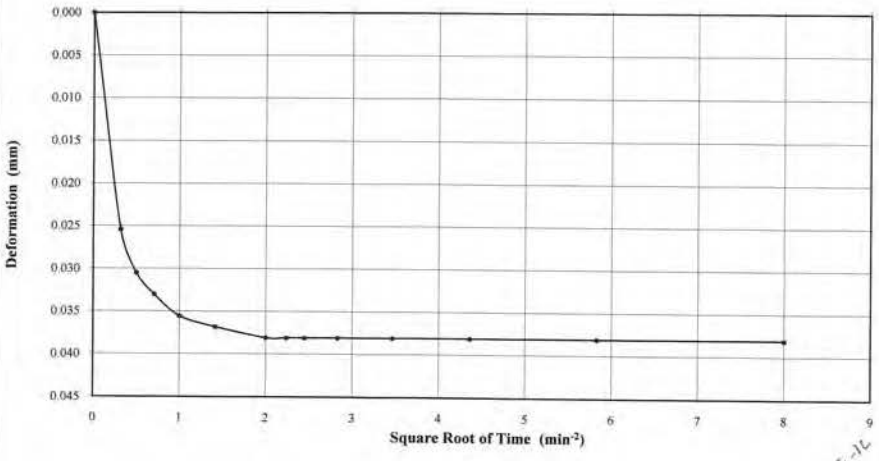
Project Name: Terry Creek OU1 RI/FS
Project No: 534
Client Sample ID: Mix-01*
Lab Sample No: 12D043

ASTM D 2435

ONE-DIMENSIONAL CONSOLIDATION TEST

Figure 1 - 100 psf





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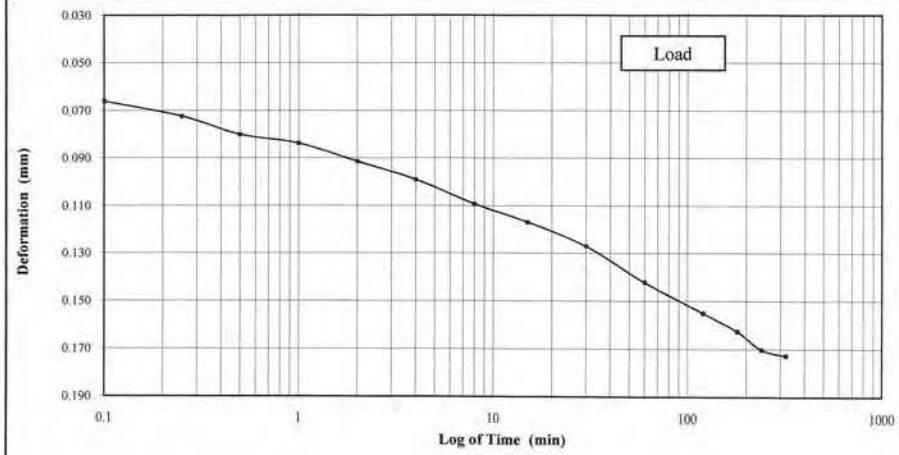
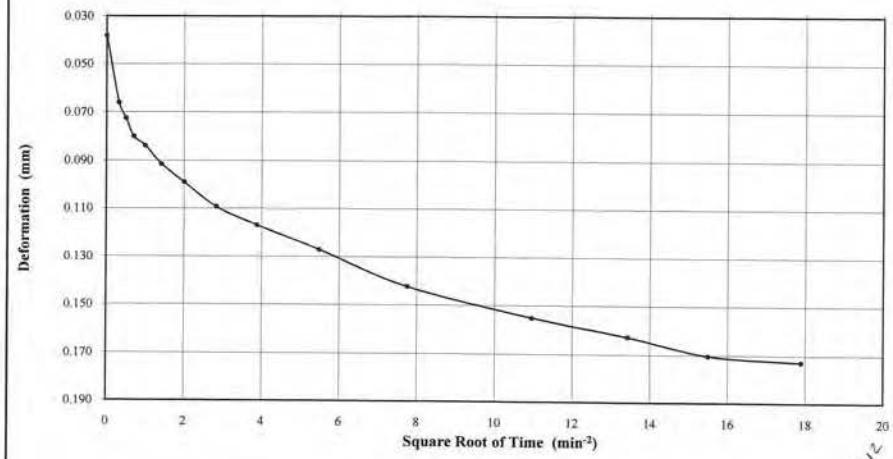
Project Name: Terry Creek OU1 RI/FS
Project No: 534
Client Sample ID: Mix-01*
Lab Sample No: 12D043

ASTM D 2435

ONE-DIMENSIONAL CONSOLIDATION TEST

Figure 2 - 1000 psf





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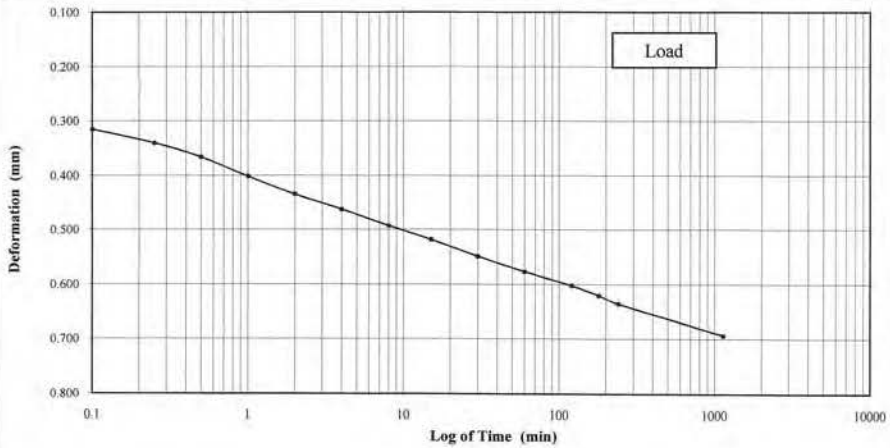
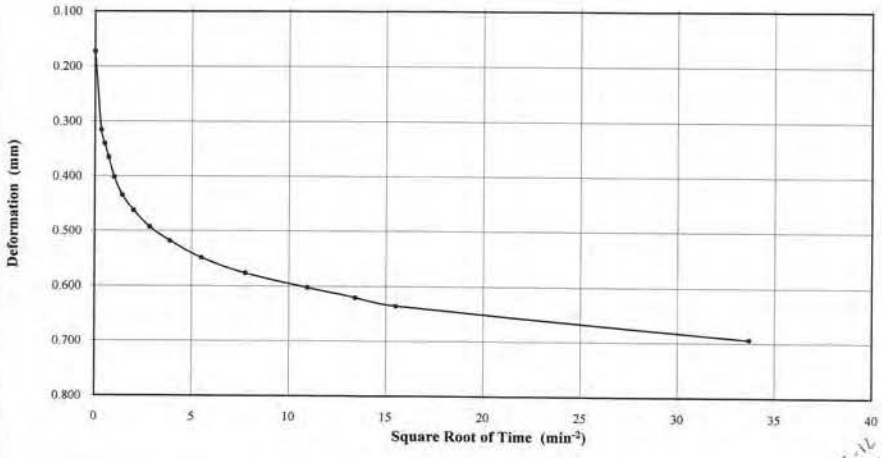
Project Name: Terry Creek OU1 RI/FS
Project No: 534
Client Sample ID: Mix-01*
Lab Sample No: 12D043

ASTM D 2435

ONE-DIMENSIONAL CONSOLIDATION TEST

Figure 3 - 2000 psf





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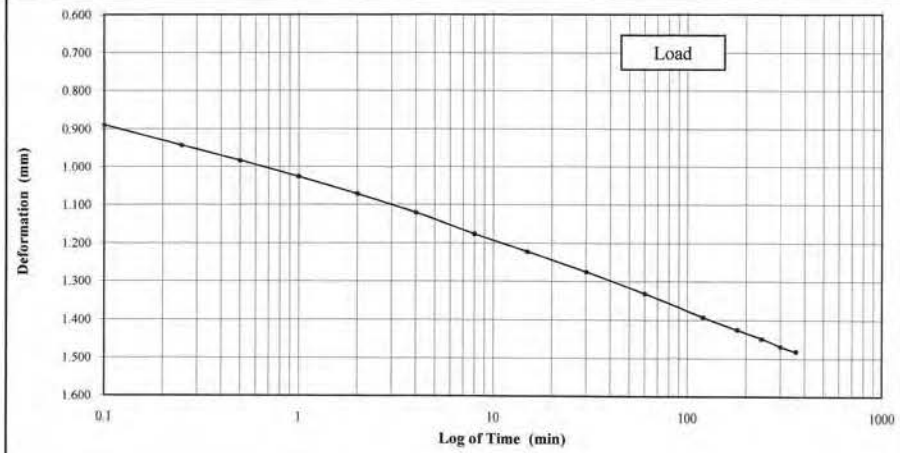
Project Name: Terry Creek OU1 RI/FS
Project No: 534
Client Sample ID: Mix-01*
Lab Sample No: 12D043

ASTM D 2435

ONE-DIMENSIONAL CONSOLIDATION TEST

Figure 4 - 4000 psf



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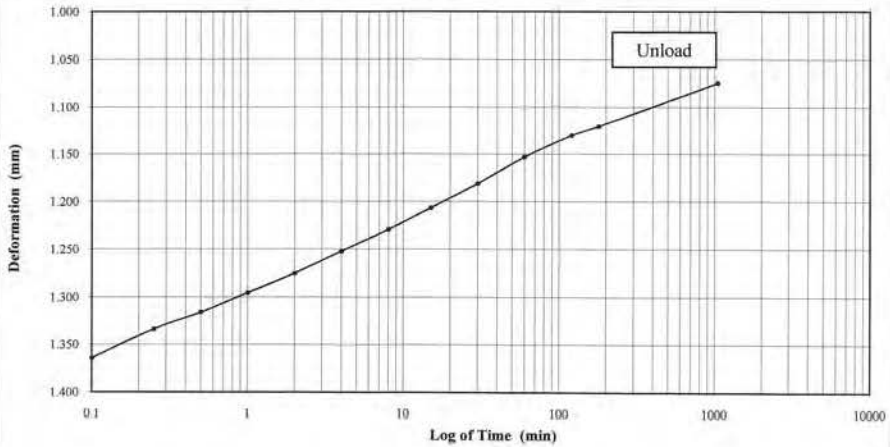
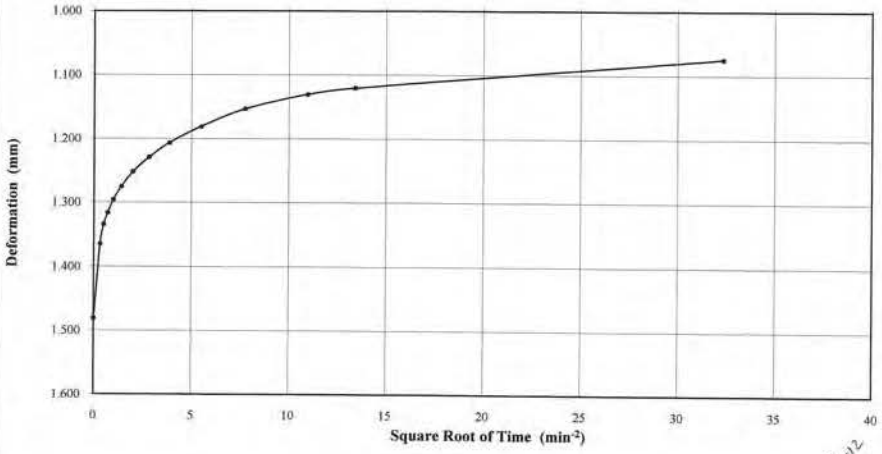
Project Name: Terry Creek OU1 RI/FS
Project No: 534
Client Sample ID: Mix-01*
Lab Sample No: 12D043

ASTM D 2435

ONE-DIMENSIONAL CONSOLIDATION TEST

Figure 5 - 1000 psf





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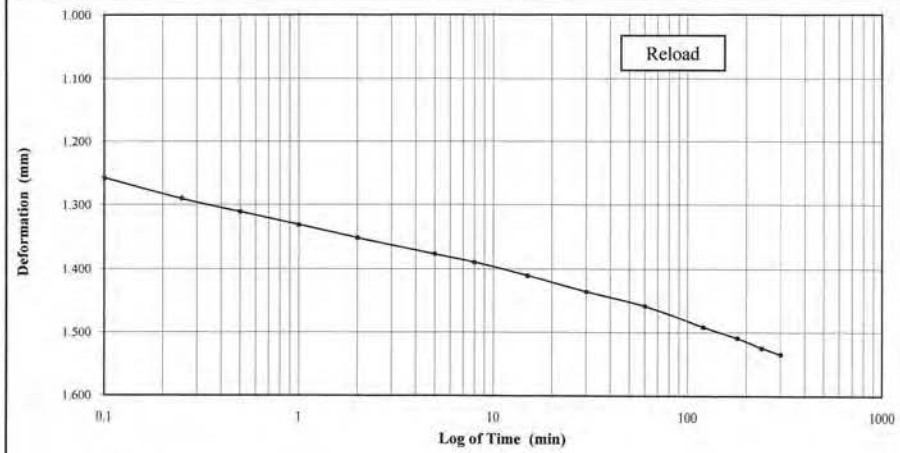
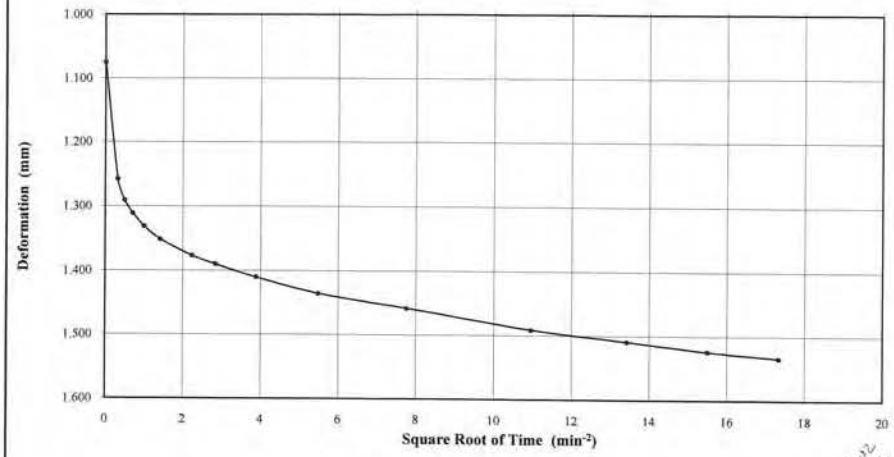
Project Name: Terry Creek OU1 RI/FS
Project No: 534
Client Sample ID: Mix-01*
Lab Sample No: 12D043

ASTM D 2435

ONE-DIMENSIONAL CONSOLIDATION TEST

Figure 6 - 4000 psf





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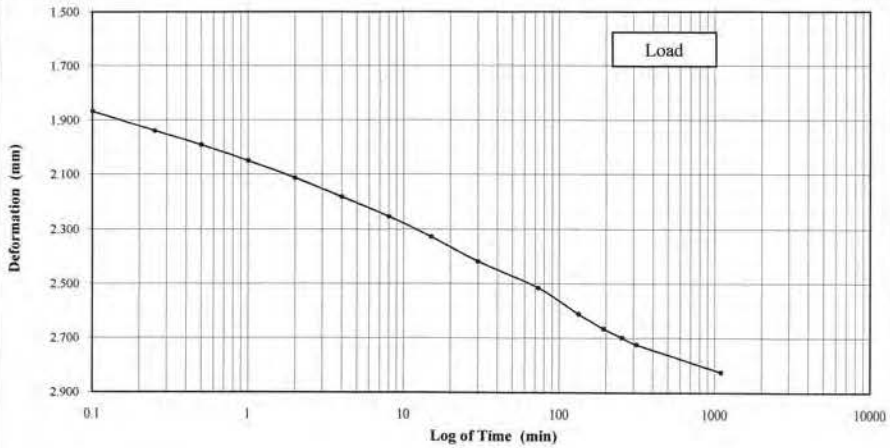
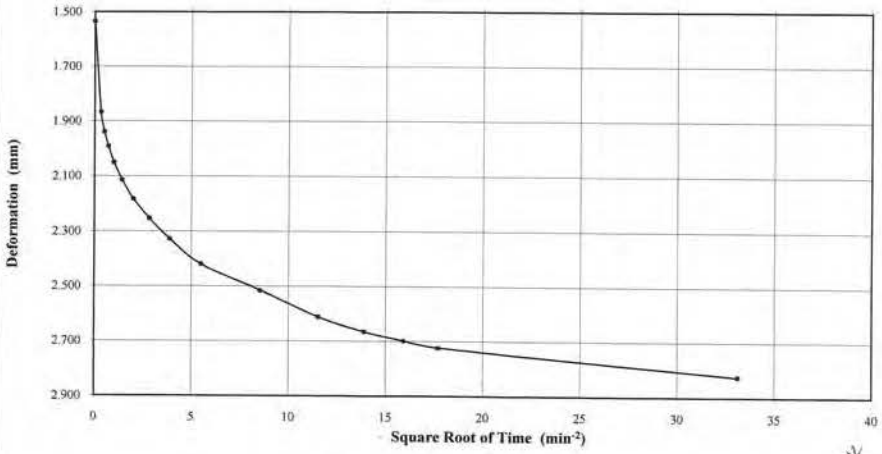
Project Name: Terry Creek OU1 RI/FS
Project No: 534
Client Sample ID: Mix-01*
Lab Sample No: 12D043

ASTM D 2435

ONE-DIMENSIONAL CONSOLIDATION TEST

Figure 7 - 8000 psf





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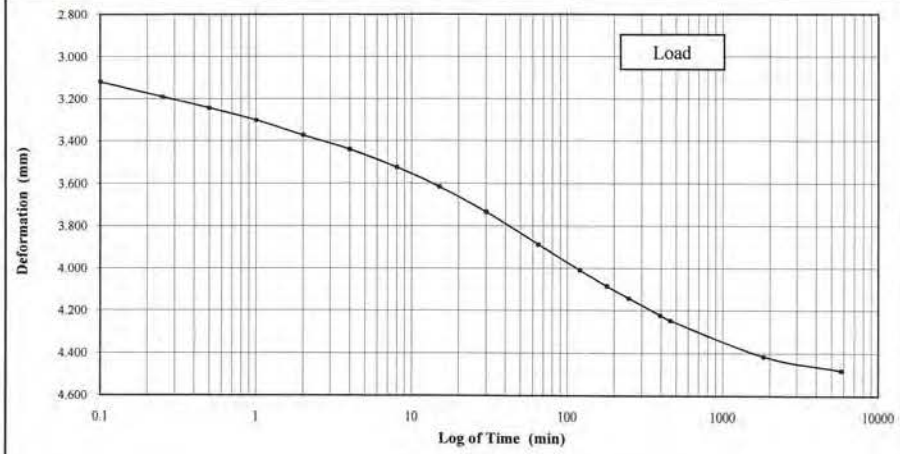
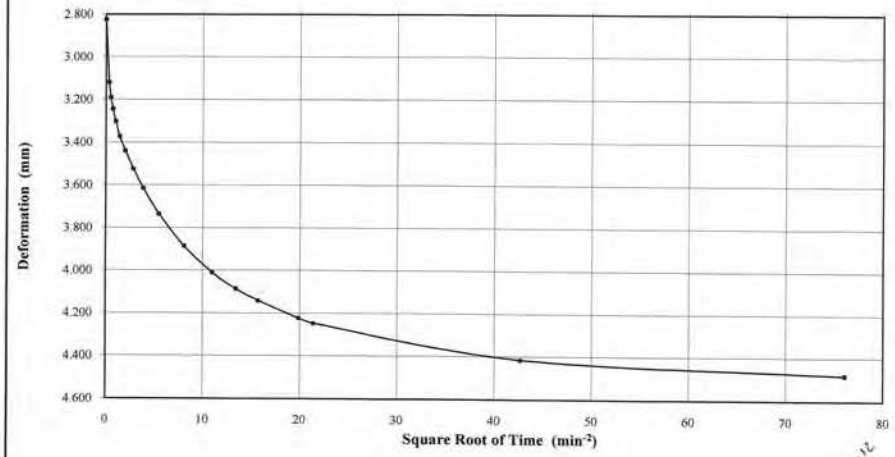
Project Name: Terry Creek OU1 RI/FS
Project No: 534
Client Sample ID: Mix-01*
Lab Sample No: 12D043

ASTM D 2435

ONE-DIMENSIONAL CONSOLIDATION TEST

Figure 8 - 16000 psf





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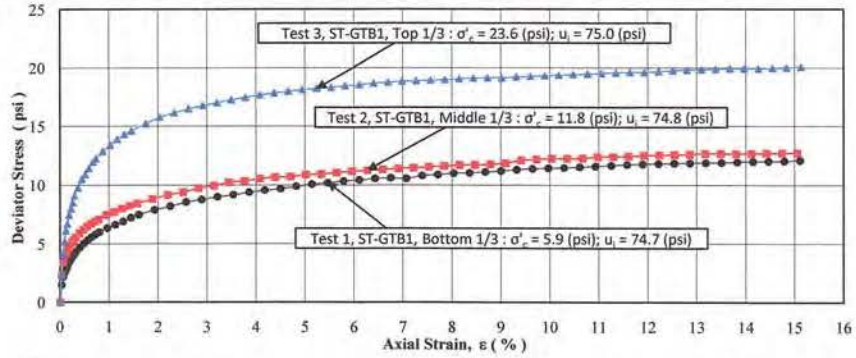
953 Forrest Street, Roswell, Georgia 30075
Tel: (770) 910 7537 Fax: (770) 910 7538

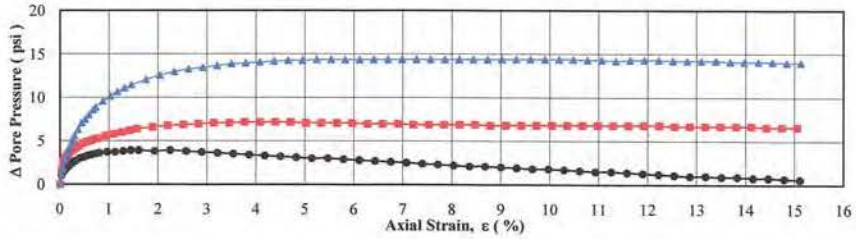
Project Name:	Terry Creek OU1 RI/FS
Project No:	534
Site Sample ID:	ST-GTB1
Lab Sample No:	12C061

ASTM D 4767

CONSOLIDATED-UNDRAINED (CU) TRIAXIAL TEST WITH PORE PRESSURE MEASUREMENTS

Figure 1





Test Specimen No.	Maximum Strength				
	$\sigma'_1 - \sigma'_3$ (psi)	σ'_1 (psi)	σ'_3 (psi)	u (psi)	ε_a (%)
1	12.1	17.4	5.3	75.3	15.1
2	12.7	17.9	5.2	81.4	15.1
3	20.1	29.7	9.6	89.0	15.1

Test Specimen No.	Strength at App. 15% Axial Strain				
	$\sigma'_1 - \sigma'_3$ (psi)	σ'_1 (psi)	σ'_3 (psi)	u (psi)	ε_a (%)
1	12.1	17.4	5.3	75.3	15.1
2	12.7	17.9	5.2	81.4	15.1
3	20.1	29.7	9.6	89.0	15.1

Notes:

σ'_c = Consolidation pressure, (psi)
σ'_1 = Effective axial stress, (psi)
u = Pore pressure,(psi)
u_i = Initial pore pressure,(psi)
σ'_3 = Effective radial stress (confining pressure), (psi)
ε_a = Axial strain, (%)
$\sigma'_1 - \sigma'_3$ = Deviator stress, (psi)

5-2-12
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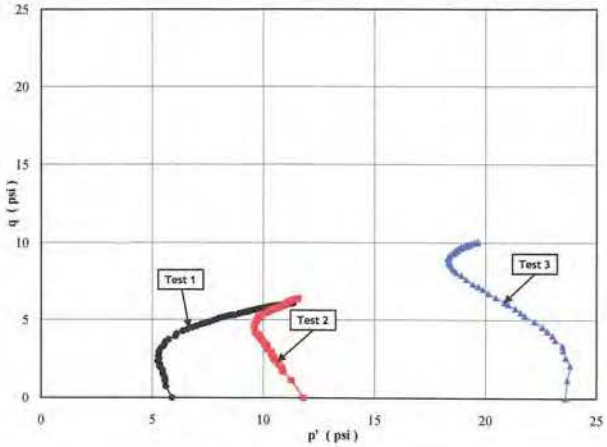
Tel: (770) 910 7537 1666 Fax: (770) 910 7538

Project Name:	Terry Creek OU1 RI/FS
Project No:	534
Site Sample ID:	ST-GTB1
Lab Sample No:	12C061

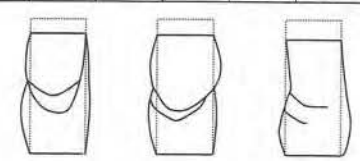
ASTM D 4767

CONSOLIDATED-UNDRAINED (CU) TRIAXIAL TEST WITH PORE PRESSURE MEASUREMENTS

Figure 2



Test Specimen No.	Initial Conditions							Strain Rate	Specimen Quality Bad to Good
	Height (in.)	Diameter (in.)	Moisture Content (%)	Dry Unit Weight (pcf)	B Parameter (-)	u_i (psi)	σ'_c (psi)	(% / min)	(1 to 10)
1	6.22	2.84	38.5	83.4	0.99	74.7	5.9	0.032	8
2	6.38	2.82	23.0	103.0	0.96	74.8	11.8	0.031	8
3	6.88	2.81	42.9	77.9	0.98	75.0	23.6	0.029	5



Specimen No.1 Specimen No. 2 Specimen No. 3

Notes:

u_i = Initial pore pressure,(psi)
σ'_c = Consolidation pressure, (psi)

5-2-12
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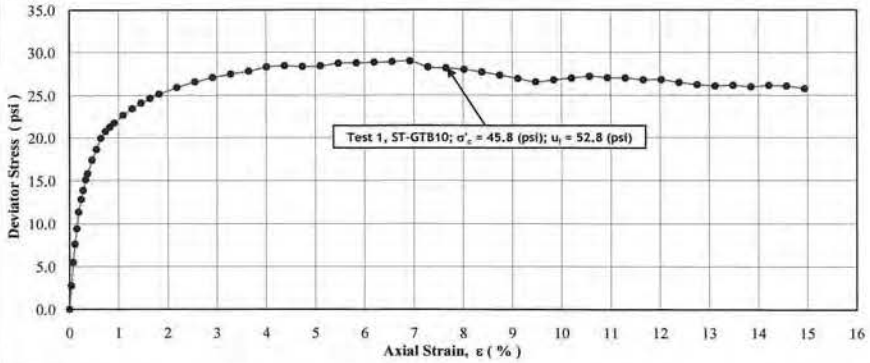
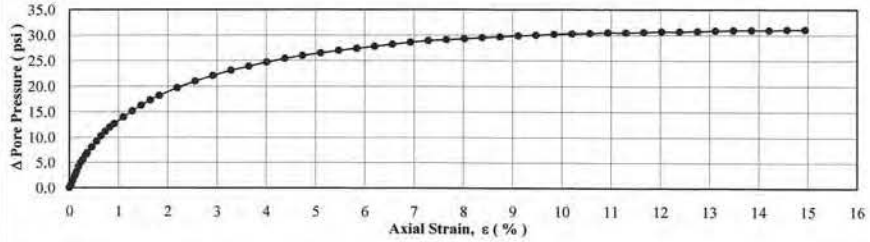
Project Name:	Terry Creek OU1 RI/FS
Project No:	534
Site Sample ID:	ST-GTB10
Lab Sample No:	12C062

ASTM D 4767

CONSOLIDATED-UNDRAINED (CU) TRIAXIAL TEST WITH PORE PRESSURE MEASUREMENTS

Figure 1





Test Specimen No.	Maximum Strength				
	$\sigma'_1 - \sigma'_3$ (psi)	σ'_1 (psi)	σ'_3 (psi)	u (psi)	ε_a (%)
1	29.0	46.2	17.2	81.4	6.9
2					
3					

Test Specimen No.	Strength at App. 15% Axial Strain				
	$\sigma'_1 - \sigma'_3$ (psi)	σ'_1 (psi)	σ'_3 (psi)	u (psi)	ε_a (%)
1	25.8	40.5	14.7	83.9	14.9
2					
3					

Notes:

σ'_c = Consolidation pressure, (psi)
σ'_3 = Effective axial stress, (psi)
u = Pore pressure,(psi)
u_i = Initial pore pressure,(psi)
σ'_3 = Effective radial stress (confining pressure), (psi)
ε_a = Axial strain, (%)
$\sigma'_1 - \sigma'_3$ = Deviator stress, (psi)

Sample consisted of hard and soft layers with moisture contents ranging from low 40's to high 80's (%).
Sample experienced an axial strain of 12.5% during the consolidation stage of the test.

3-17-12 NSK

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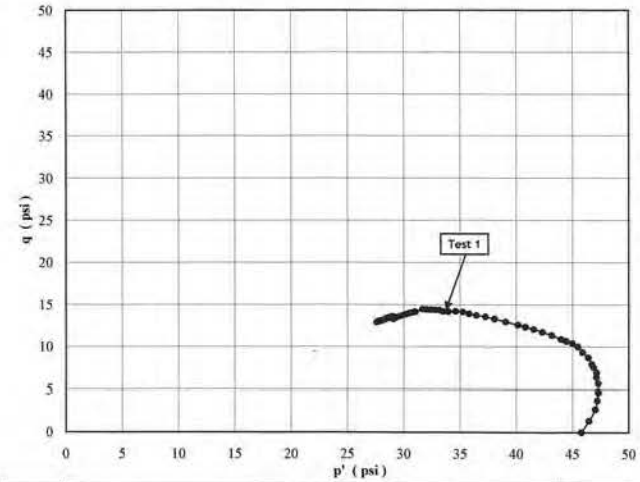
Project Name:	Terry Creek OU1 RI/FS
Project No:	534
Site Sample ID:	ST-GTB10
Lab Sample No:	12C062

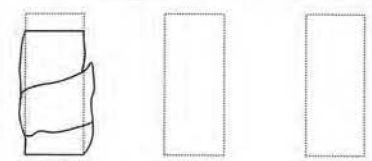
ASTM D 4767

CONSOLIDATED-UNDRAINED (CU) TRIAXIAL TEST WITH PORE PRESSURE MEASUREMENTS

Figure 2



Test Specimen No.	Initial Conditions							Strain Rate	Specimen Quality
	Height (in.)	Diameter (in.)	Moisture Content (%)	Dry Unit Weight (pcf)	B Parameter (-)	u_i (psi)	σ'_c (psi)	(% / min)	Bad to Good (1 to 10)
1	6.24	2.83	63.9	64.1	0.98	52.8	45.8	0.032	7
2									
3									



Notes:

u_i = Initial pore pressure,(psi)
σ'_c = Consolidation pressure, (psi)

Sample consisted of hard and soft layers with moisture contents ranging from low 40's to high 80's (%).
Sample experienced an axial strain of 12.5% during the consolidation stage of the test.

3-17-12 NSK

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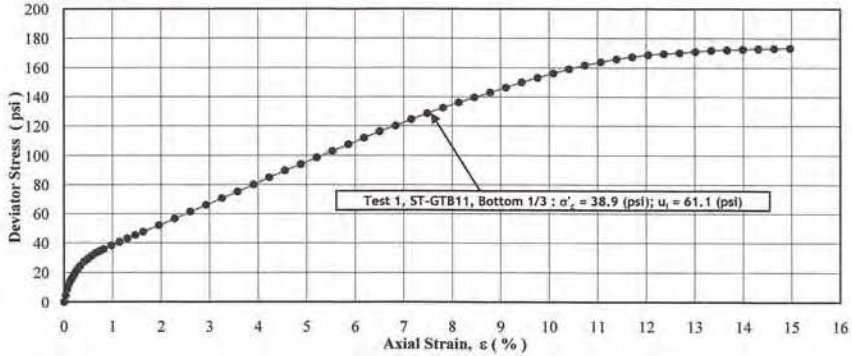
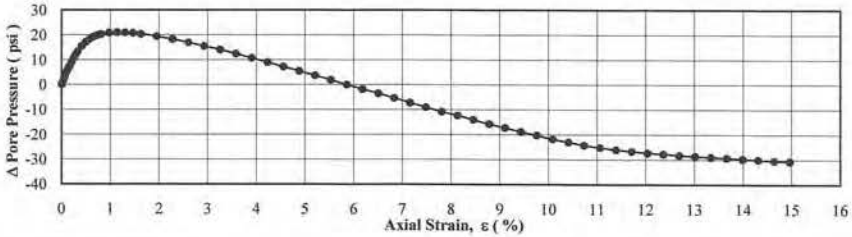
Project Name:	Terry Creek OU1 RI/FS
Project No:	534
Site Sample ID:	ST-GTB11
Lab Sample No:	12C063

ASTM D 4767

CONSOLIDATED-UNDRAINED (CU) TRIAXIAL TEST WITH PORE PRESSURE MEASUREMENTS

Figure 1





Test Specimen No.	Maximum Strength				
	$\sigma'_1 - \sigma'_3$ (psi)	σ'_1 (psi)	σ'_3 (psi)	u (psi)	ε_a (%)
1	173.3	242.9	69.6	30.4	15.0
2					
3					

Test Specimen No.	Strength at App. 15% Axial Strain				
	$\sigma'_1 - \sigma'_3$ (psi)	σ'_1 (psi)	σ'_3 (psi)	u (psi)	ε_a (%)
1	173.3	242.9	69.6	30.4	15.0
2					
3					

Notes:

σ'_c = Consolidation pressure, (psi)
σ'_1 = Effective axial stress, (psi)
u = Pore pressure,(psi)
u_i = Initial pore pressure,(psi)
σ'_3 = Effective radial stress (confining pressure), (psi)
ε_a = Axial strain, (%)
$\sigma'_1 - \sigma'_3$ = Deviator stress, (psi)

5-2-12
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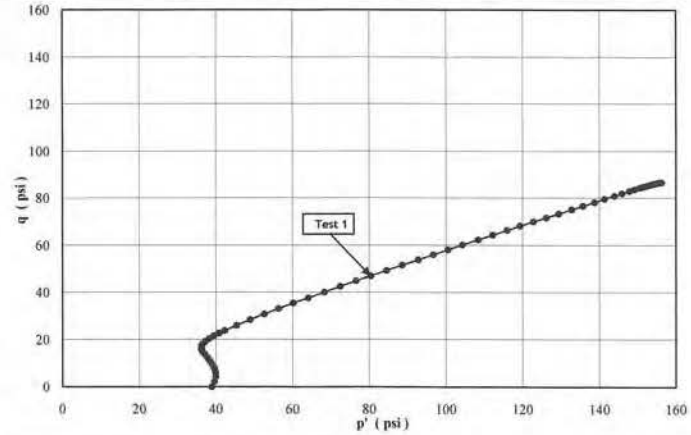
Project Name:	Terry Creek OU1 RI/FS
Project No:	534
Site Sample ID:	ST-GTB11
Lab Sample No:	12C063

ASTM D 4767

CONSOLIDATED-UNDRAINED (CU) TRIAXIAL TEST WITH PORE PRESSURE MEASUREMENTS

Figure 2



Test Specimen No.	Initial Conditions							Strain Rate	Specimen Quality Bad to Good
	Height (in.)	Diameter (in.)	Moisture Content (%)	Dry Unit Weight (pcf)	B Parameter (-)	u_i (psi)	σ'_c (psi)	(% / min)	(1 to 10)
1	6.15	2.90	24.2	100.6	0.98	61.1	38.9	0.065	5
2									
3									

Specimen No. 1 Specimen No. 2 Specimen No. 3

Notes:

u_i = Initial pore pressure,(psi)
σ'_c = Consolidation pressure, (psi)

5-2-12
SRS

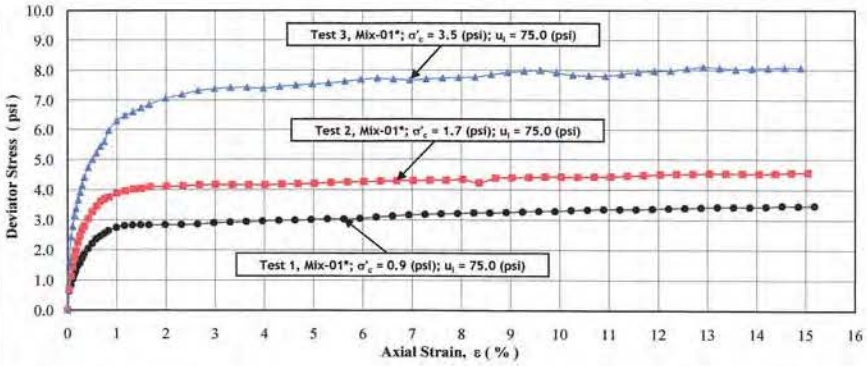
Excel Geotechnical Testing, Inc.
"Excellence in Testing"
953 Forrest Street, Roswell, Georgia 30075
Tel: (770) 910 7537 Fax: (770) 910 7538

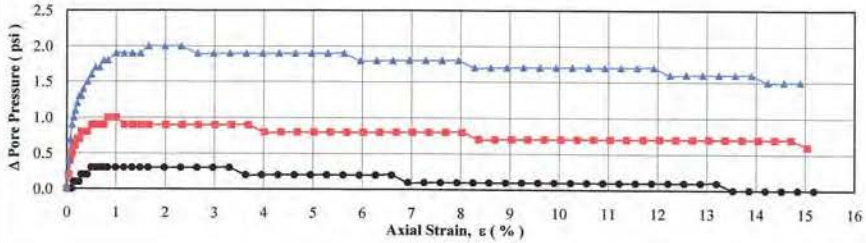
Project Name:	Terry Creek OU1 RI/FS
Project No:	534
Site Sample ID:	Mix-01*
Lab Sample No:	12D043

ASTM D 4767

CONSOLIDATED-UNDRAINED (CU) TRIAXIAL TEST WITH PORE PRESSURE MEASUREMENTS

Figure 1





Test Specimen No.	Maximum Strength				
	$\sigma'_1 - \sigma'_3$ (psi)	σ'_1 (psi)	σ'_3 (psi)	u (psi)	ε_a (%)
1	3.5	4.2	0.7	75.2	15.2
2	4.6	5.7	1.1	75.6	15.0
3	8.1	10.0	1.9	76.6	12.9

Test Specimen No.	Strength at App. 15% Axial Strain				
	$\sigma'_1 - \sigma'_3$ (psi)	σ'_1 (psi)	σ'_3 (psi)	u (psi)	ε_a (%)
1	3.5	4.2	0.7	75.2	15.2
2	4.6	5.7	1.1	75.6	15.0
3	8.1	10.1	2.0	76.5	14.9

Notes:

σ'_c = Consolidation pressure, (psi)
σ'_1 = Effective axial stress, (psi)
u = Pore pressure,(psi)
u_i = Initial pore pressure,(psi)
σ'_3 = Effective radial stress (confining pressure), (psi)
ε_a = Axial strain, (%)
$\sigma'_1 - \sigma'_3$ = Deviator stress, (psi)

* A mixture of Bucket-SD-S101 (0-5') Post Weir, Bucket-SD-S102 (5-10') Post Weir and Shelby-SDPostT4-5 (0-3.75').

5-17-12
JSK

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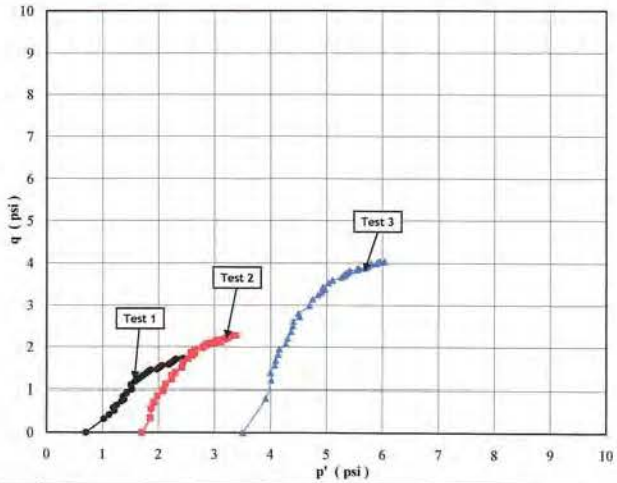
Project Name:	Terry Creek OU1 RI/FS
Project No:	534
Site Sample ID:	Mix-01*
Lab Sample No:	12D043

ASTM D 4767

CONSOLIDATED-UNDRAINED (CU) TRIAXIAL TEST WITH PORE PRESSURE MEASUREMENTS

Figure 2



Test Specimen No.	Initial Conditions							Strain Rate	Specimen Quality
	Height (in.)	Diameter (in.)	Moisture Content (%)	Dry Unit Weight (pcf)	B Parameter (-)	u_i (psi)	σ'_c (psi)	(% / min)	Bad to Good (1 to 10)
1	6.06	2.84	47.2	62.7	0.98	75.2	0.7	0.066	8
2	5.98	2.84	47.4	63.7	0.96	75.0	1.7	0.067	8
3	6.04	2.84	47.4	64.2	1.00	75.0	3.5	0.066	8

Notes:

u_i = Initial pore pressure,(psi)
σ'_c = Consolidation pressure, (psi)

* A mixture of Bucket-SD-S101 (0-5') Post Weir, Bucket-SD-S102 (5-10') Post Weir and Shelby-SDPostT4-5 (0-3.75').

5-17-12
JSK

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953 Forrest Street, Roswell, Georgia 30075
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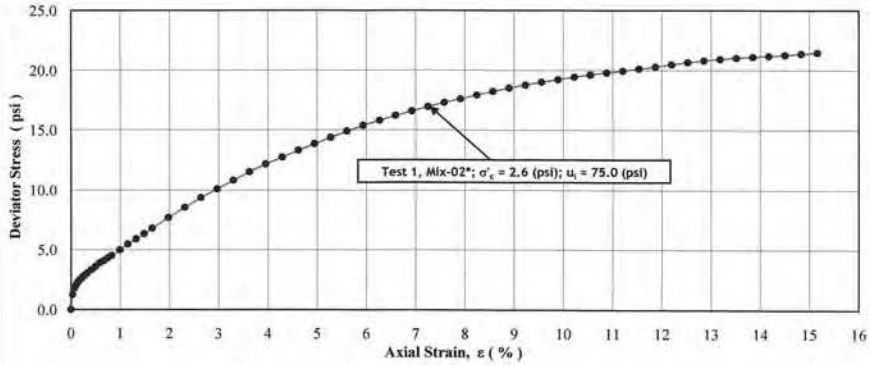
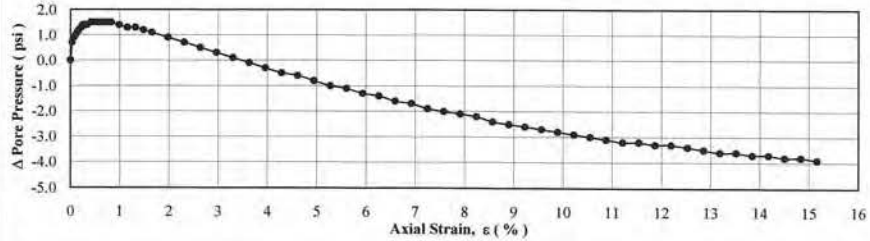
Project Name:	Terry Creek OU1 RI/FS
Project No:	534
Site Sample ID:	Mix-02*
Lab Sample No:	12D044

ASTM D 4767

CONSOLIDATED-UNDRAINED (CU) TRIAXIAL TEST WITH PORE PRESSURE MEASUREMENTS

Figure 1





Test Specimen No.	Maximum Strength				
	$\sigma'_1 - \sigma'_3$ (psi)	σ'_1 (psi)	σ'_3 (psi)	u (psi)	ε_a (%)
1	3.5	5.9	2.4	75.2	15.2
2					
3					

Test Specimen No.	Strength at App. 15% Axial Strain				
	$\sigma'_1 - \sigma'_3$ (psi)	σ'_1 (psi)	σ'_3 (psi)	u (psi)	ε_a (%)
1	3.5	5.9	2.4	75.2	15.2
2					
3					

Notes:

σ'_c = Consolidation pressure, (psi)
σ'_1 = Effective axial stress, (psi)
u = Pore pressure,(psi)
u_i = Initial pore pressure,(psi)
σ'_3 = Effective radial stress (confining pressure), (psi)
ε_a = Axial strain, (%)
$\sigma'_1 - \sigma'_3$ = Deviator stress, (psi)

* A mixture of Bucket-SD-S201 (0-5') Pre Weir and Shelby-SD Pre Wier (0-2.5').

5-17-12 MJR

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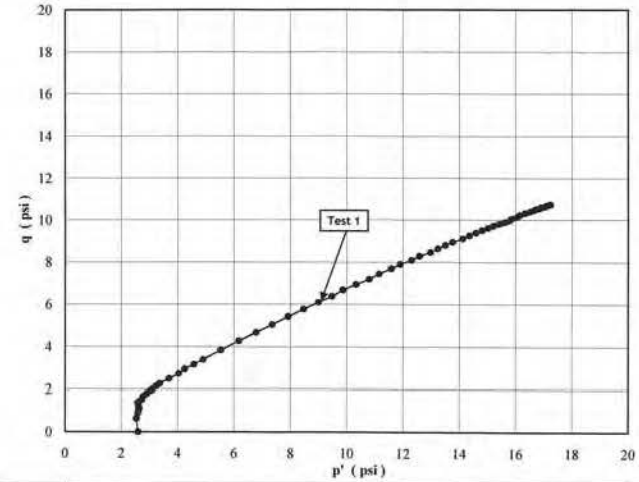
Project Name:	Terry Creek OU1 RI/FS
Project No:	534
Site Sample ID:	Mix-02*
Lab Sample No:	12D044

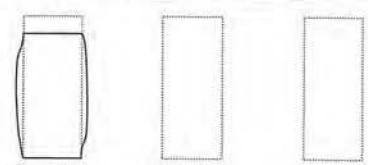
ASTM D 4767

CONSOLIDATED-UNDRAINED (CU) TRIAXIAL TEST WITH PORE PRESSURE MEASUREMENTS

Figure 2



Test Specimen No.	Initial Conditions							Strain Rate	Specimen Quality Bad to Good
	Height (in.)	Diameter (in.)	Moisture Content (%)	Dry Unit Weight (pcf)	B Parameter (-)	u_i (psi)	σ'_c (psi)	(% / min)	(1 to 10)
1	6.07	2.83	25.4	82.2	0.98	75.0	2.6	0.066	7
2									
3									



Notes:

u_i = Initial pore pressure,(psi)
σ'_c = Consolidation pressure, (psi)

* A mixture of Bucket-SD-S201 (0-5') Pre Weir and Shelby-SD Pre Wier (0-2.5').

5-17-12 MJR

APPENDIX C

Geosyntec consultants

Table C-1. Analytical Results for Sediment Samples, Terry Creek OU1 RI/FS

Compound Name	SD-OD1C-01	SD-OD1C-02	SD-OD1N-05	SD-OD2C-01	SD-OD2C-02	SD-OD2T-05	SD-OD3C-01	SD-OD3C-02	SD-OD3T-06	SD-OD4C-01
Depth (ft)	0 - 0.5	0.5 - 2	6 - 8	0 - 0.5	0.5 - 2	6 - 8	0 - 0.5	0.5 - 2	8 - 10	0 - 0.5
Toxaphene (µg/kg)										
Method 1 (Technical)	5400 J	8,200	110 U	21,000 J	14,000 J	5,000	630 J	7,900	46 U	190 J
Method 2 (TAUC)	10,000	12,000	37 U	19,000	12,000	9,700	1,500	12,000	46 U	610
Pesticides (µg/kg)										
4,4-DDD	38 UJ	110 U	2 U	600 UJ	150 UJ	90 U	29 UJ	110 U	0.18 U	2.3 UJ
4,4-DDE	38 UJ	110 U	2 U	600 UJ	150 UJ	90 U	29 UJ	110 U	0.15 U	1.8 UJ
4,4-DDT	38 UJ	110 U	2 U	600 UJ	150 UJ	90 U	29 UJ	110 U	0.18 U	2.2 UJ
Aldrin	19 UJ	55 U	1.1 U	310 UJ	44 J	58	15 UJ	56 U	0.35 U	4.3 UJ
alpha-BHC	19 UJ	55 U	1.1 U	310 UJ	77 UJ	47 U	15 UJ	56 U	0.085 U	1 UJ
alpha-Chlordane	19 UJ	55 U	1.1 U	310 UJ	77 UJ	47 U	15 UJ	56 U	0.11 U	1.3 UJ
beta-BHC	19 UJ	55 U	1.1 U	310 UJ	77 UJ	47 U	15 UJ	56 U	0.085 U	1 UJ
delta-BHC	19 UJ	55 U	1.1 U	310 UJ	77 UJ	47 U	15 UJ	56 U	0.1 U	1.2 UJ
Dieldrin	38 UJ	110 U	2 U	600 UJ	150 UJ	90 U	29 UJ	110 U	0.22 U	2.7 UJ
Endosulfan I	19 UJ	55 U	1.1 U	310 UJ	77 UJ	47 U	15 UJ	56 U	0.12 U	1.4 UJ
Endosulfan II	38 UJ	110 U	2 U	600 UJ	150 UJ	90 U	29 UJ	110 U	0.18 U	2.2 UJ
Endosulfan sulfate	38 UJ	110 U	2 U	600 UJ	150 UJ	90 U	29 UJ	110 U	0.18 U	2.3 UJ
Endrin	38 UJ	110 U	2 U	600 UJ	150 UJ	90 U	29 UJ	110 U	0.56 U	6.9 UJ
Endrin aldehyde	38 UJ	110 U	2 U	600 UJ	150 UJ	90 U	29 UJ	110 U	0.23 U	2.8 UJ
Endrin ketone	38 UJ	110 U	2 U	600 UJ	150 UJ	90 U	29 UJ	110 U	0.21 U	2.6 UJ
gamma-BHC (Lindane)	19 UJ	55 U	1.1 U	310 UJ	77 UJ	22 J	15 UJ	56 U	0.085 U	1 UJ
gamma-Chlordane	19 UJ	55 U	1.1 U	310 UJ	77 UJ	47 U	15 UJ	56 U	0.12 U	1.5 UJ
Heptachlor	19 UJ	55 U	1.1 U	310 UJ	77 UJ	47 U	15 UJ	56 U	0.064 U	0.79 UJ
Heptachlor epoxide	19 UJ	55 U	1.1 U	310 UJ	77 UJ	47 U	15 UJ	56 U	0.11 U	1.3 UJ
Methoxychlor	38 UJ	110 U	2 U	600 UJ	150 UJ	90 U	29 UJ	110 U	0.27 U	3.3 UJ
PCB-1016	380 UJ	430 U	20 U	750 UJ	150 UJ	230 U	71 UJ	270 U	2.2 U	5.5 UJ
PCB-1221	770 UJ	860 U	41 U	1,500 UJ	300 UJ	460 U	140 UJ	550 U	3.7 U	9.1 UJ
PCB-1232	380 UJ	430 U	20 U	750 UJ	150 UJ	230 U	71 UJ	270 U	2.5 U	6.3 UJ
PCB-1242	380 UJ	430 U	20 U	750 UJ	150 UJ	230 U	71 UJ	270 U	2.2 U	5.3 UJ
PCB-1248	380 UJ	430 U	20 U	750 UJ	150 UJ	230 U	71 UJ	270 U	5.5 U	14 UJ
PCB-1254	380 UJ	430 U	20 U	750 UJ	150 UJ	230 U	71 UJ	270 U	1.8 U	4.4 UJ
PCB-1260	380 UJ	430 U	20 U	750 UJ	150 UJ	230 U	71 UJ	270 U	5.2 U	13 UJ
PCB-1268	380 UJ	430 U	20 U	750 UJ	150 UJ	230 U	71 UJ	270 U	1.3 U	3.2 UJ
SVOCs (µg/kg)										
1,1-Biphenyl	1,500 UJ	850 U	41 U	3,000 UJ	3,000 UJ	620 J	1,400 UJ	1,100 U	11 U	280 UJ
2,2-oxybis[1-chloropropane]	1,500 UJ	850 U	41 U	3,000 UJ	3,000 UJ	900 U	1,400 UJ	1,100 U	11 U	280 UJ
2,4,5-Trichlorophenol	1,500 UJ	850 U	41 U	3,000 UJ	3,000 UJ	900 U	1,400 UJ	1,100 U	12 U	290 UJ
2,4,6-Trichlorophenol	1,500 UJ	850 U	41 U	3,000 UJ	3,000 UJ	900 U	1,400 UJ	1,100 U	12 U	300 UJ
2,4-Dichlorophenol	1,500 UJ	850 U	41 U	3,000 UJ	3,000 UJ	900 U	1,400 UJ	1,100 U	11 U	280 UJ
2,4-Dimethylphenol	3,000 UJ	1700 U	82 U	6,000 UJ	6,100 UJ	1,800 U	2,900 UJ	2,200 U	12 U	290 UJ
2,4-Dinitrophenol	15000 UJ	R	410 UJ	30,000 UJ	30,000 UJ	9,000 U	14000 UJ	11000 U	26 U	650 UJ

Table C-1. continued

Compound Name	SD-OD1C-01	SD-OD1C-02	SD-OD1N-05	SD-OD2C-01	SD-OD2C-02	SD-OD2T-05	SD-OD3C-01	SD-OD3C-02	SD-OD3T-06	SD-OD4C-01
Depth (ft)	0 - 0.5	0.5 - 2	6 - 8	0 - 0.5	0.5 - 2	6 - 8	0 - 0.5	0.5 - 2	8 - 10	0 - 0.5
2,4-Dinitrotoluene	1,500 UJ	850 U	41 U	3,000 UJ	3,000 UJ	900 U	1,400 UJ	1,100 U	12 U	290 UJ
2,6-Dinitrotoluene	1,500 UJ	850 U	41 U	3,000 UJ	3,000 UJ	900 U	1,400 UJ	1,100 U	12 U	300 UJ
2-Chloronaphthalene	1,500 UJ	850 U	41 U	3,000 UJ	3,000 UJ	900 U	1,400 UJ	1,100 U	9.3 U	230 UJ
2-Chlorophenol	1,500 UJ	850 U	41 U	3,000 UJ	3,000 UJ	900 U	1,400 UJ	1,100 U	8.2 U	200 UJ
2-Methylnaphthalene	310 UJ	170 U	8.3 U	610 UJ	620 UJ	180 U	290 UJ	220 U	5.1 U	130 UJ
2-Methylphenol	1,500 UJ	850 U	41 U	3,000 UJ	3,000 UJ	900 U	1,400 UJ	1,100 U	9.7 U	240 UJ
2-Nitroaniline	7,800 UJ	4,400 U	210 U	16,000 UJ	16,000 UJ	4,700 U	7,400 UJ	5,600 U	11 U	270 UJ
2-Nitrophenol	1,500 UJ	850 U	41 U	3,000 UJ	3,000 UJ	900 U	1,400 UJ	1,100 U	9 U	220 UJ
3 & 4 Methylphenol	1,500 UJ	190 J	41 U	2900 J	2700 J	2,200	1,400 UJ	1,100 U	11 U	280 UJ
3,3-Dichlorobenzidine	R	R	R	R	R	R	R	R	R	650 UJ
3-Nitroaniline	7,800 UJ	4,400 U	210 U	16,000 UJ	16,000 UJ	4,700 U	7,400 UJ	5,600 U	10 U	260 UJ
4,6-Dinitro-2-methylphenol	7,800 UJ	R	210 UJ	16,000 UJ	16,000 UJ	4,700 U	7,400 UJ	5,600 U	26 U	650 UJ
4-Bromophenyl phenyl ether	1,500 UJ	850 U	41 U	3,000 UJ	3,000 UJ	900 U	1,400 UJ	1,100 U	11 U	270 UJ
4-Chloro-3-methylphenol	1,500 UJ	850 U	41 U	3,000 UJ	3,000 UJ	900 U	1,400 UJ	1,100 U	11 U	270 UJ
4-Chloroaniline	3,000 UJ	1700 U	82 U	6,000 UJ	6,100 UJ	1,800 U	2,900 UJ	2,200 U	8 U	200 UJ
4-Chlorophenyl phenyl ether	1,500 UJ	850 U	41 U	3,000 UJ	3,000 UJ	900 U	1,400 UJ	1,100 U	9.9 U	250 UJ
4-Nitroaniline	7,800 UJ	4,400 U	210 U	16,000 UJ	16,000 UJ	4,700 U	7,400 UJ	5,600 U	13 U	320 UJ
4-Nitrophenol	7,800 UJ	4,400 U	210 U	16,000 UJ	16,000 UJ	4,700 U	7,400 UJ	5,600 U	110 U	2,800 UJ
Acenaphthene	310 UJ	170 U	5.1 J	610 UJ	620 UJ	140 J	290 UJ	220 U	5.1 U	130 UJ
Acenaphthylene	310 UJ	170 U	8.3 U	510 J	510 J	200	290 UJ	220 U	5.1 U	130 UJ
Acetophenone	1,500 UJ	850 U	41 U	3,000 UJ	3,000 UJ	900 U	1,400 UJ	1,100 U	11 U	260 UJ
Anthracene	310 UJ	170 U	4.8 J	610 UJ	620 UJ	180 U	290 UJ	220 U	5.1 U	130 UJ
Atrazine	1,500 UJ	850 U	41 U	3,000 UJ	3,000 UJ	900 U	1,400 UJ	1,100 U	12 U	290 UJ
Benzaldehyde	490 J	290 J	41 U	2,200 J	2,300 J	1,100	1,400 UJ	1,100 U	15 U	380 UJ
Benzo[a]anthracene	310 UJ	170 U	5.4 J	610 UJ	620 UJ	130 J	290 UJ	220 U	5.1 U	130 UJ
Benzo[a]pyrene	310 UJ	170 U	8.3 U	610 UJ	620 UJ	180 U	290 UJ	220 U	1.9 U	46 UJ
Benzo[b]fluoranthene	310 UJ	170 U	6.3 J	610 UJ	620 UJ	180 U	290 UJ	220 U	5.1 U	130 UJ
Benzo[g,h,i]perylene	310 UJ	170 U	8.3 U	610 UJ	620 UJ	180 U	290 UJ	220 U	5.1 U	130 UJ
Benzo[k]fluoranthene	310 UJ	170 U	8.3 U	610 UJ	620 UJ	180 U	290 UJ	220 U	3.1 U	77 UJ
Bis(2-chloroethoxy)methane	1,500 UJ	850 U	41 U	3,000 UJ	3,000 UJ	900 U	1,400 UJ	1,100 U	10 U	250 UJ
Bis(2-chloroethyl)ether	1,500 UJ	850 U	41 U	3,000 UJ	3,000 UJ	900 U	1,400 UJ	1,100 U	10 U	250 UJ
Bis(2-ethylhexyl) phthalate	3,000 UJ	1700 UJ	82 UJ	6,000 UJ	6100 UJ	1,800 U	2,900 UJ	2,200 U	100 U	230 UJ
Butyl benzyl phthalate	1,500 UJ	850 U	41 U	3,000 UJ	3,000 UJ	900 U	1,400 UJ	1,100 U	8.5 U	210 UJ
Caprolactam	1,500 UJ	850 U	41 U	3,000 UJ	3,000 UJ	900 U	1,400 UJ	1,100 U	11 U	270 UJ
Carbazole	1,500 UJ	850 U	41 U	3,000 UJ	3,000 UJ	900 U	1,400 UJ	1,100 U	10 U	260 UJ
Chrysene	310 UJ	170 U	7.2 J	610 UJ	620 UJ	180 U	290 UJ	220 U	5.1 U	130 UJ
Dibenz(a,h)anthracene	310 UJ	170 U	8.3 U	610 UJ	620 UJ	180 U	290 UJ	220 U	5.1 U	130 UJ
Dibenzofuran	1,500 UJ	850 U	41 U	3,000 UJ	3,000 UJ	900 U	1,400 UJ	1,100 U	10 U	260 UJ
Diethyl phthalate	1,500 UJ	850 U	41 U	3,000 UJ	3,000 UJ	900 U	1,400 UJ	1,100 U	51 U	280 UJ
Dimethyl phthalate	1,500 UJ	850 U	41 U	3,000 UJ	3,000 UJ	900 U	1,400 UJ	1,100 U	12 U	290 UJ
Di-n-butyl phthalate	7,800 UJ	4,400 U	210 U	16,000 UJ	16,000 UJ	4,700 U	7,400 UJ	5,600 U	96 J	650 UJ

Table C-1. continued

Compound Name	SD-OD1C-01	SD-OD1C-02	SD-OD1N-05	SD-OD2C-01	SD-OD2C-02	SD-OD2T-05	SD-OD3C-01	SD-OD3C-02	SD-OD3T-06	SD-OD4C-01
Depth (ft)	0 - 0.5	0.5 - 2	6 - 8	0 - 0.5	0.5 - 2	6 - 8	0 - 0.5	0.5 - 2	8 - 10	0 - 0.5
Di-n-octyl phthalate	1,500 UJ	850 U	41 U	3,000 UJ	3,000 UJ	900 U	1,400 UJ	1,100 U	5.6 U	140 UJ
Fluoranthene	190 J	100 J	16	700 J	630 J	190	290 UJ	110 J	9.5 J	130 UJ
Fluorene	310 UJ	170 U	4.3 J	610 UJ	620 UJ	98 J	290 UJ	220 U	5.1 U	130 UJ
Hexachlorobenzene	1,500 UJ	850 U	41 U	3,000 UJ	3,000 UJ	900 U	1,400 UJ	1,100 U	12 U	290 UJ
Hexachlorobutadiene	1,500 UJ	850 U	41 U	3,000 UJ	3,000 UJ	900 U	1,400 UJ	1,100 U	11 U	260 UJ
Hexachlorocyclopentadiene	3,000 UJ	R	82 U	6,000 UJ	6,100 UJ	1,800 U	2,900 UJ	2,200 U	5.7 U	140 UJ
Hexachloroethane	1,500 UJ	850 U	41 U	3,000 UJ	3,000 UJ	900 U	1,400 UJ	1,100 U	9 U	220 UJ
Indeno[1,2,3-cd]pyrene	310 UJ	170 U	8.3 U	610 UJ	620 UJ	180 U	290 UJ	220 U	5.1 U	130 UJ
Isophorone	1,500 UJ	850 U	41 U	3,000 UJ	3,000 UJ	900 U	1,400 UJ	1,100 U	11 U	270 UJ
Naphthalene	430 J	270	8.3 U	1400 J	1,900 J	400	210 J	210 J	5.1 U	130 UJ
Nitrobenzene	1,500 UJ	850 U	41 U	3,000 UJ	3,000 UJ	900 U	1,400 UJ	1,100 U	10 U	250 UJ
N-Nitrosodi-n-propylamine	1,500 UJ	850 U	41 U	3,000 UJ	3,000 UJ	900 U	1,400 UJ	1,100 U	12 U	290 UJ
N-Nitrosodiphenylamine	1,500 UJ	850 U	41 U	3,000 UJ	3,000 UJ	900 U	1,400 UJ	1,100 U	9.4 U	230 UJ
Pentachlorophenol	7,800 UJ	4400 U	210 U	16,000 UJ	16,000 UJ	4,700 U	7,400 UJ	5,600 U	26 U	650 UJ
Phenanthrene	190 J	150 J	5.1 J	650 J	820 J	270	290 UJ	120 J	3.7 U	92 UJ
Phenol	430 J	850 U	41 U	1700 J	1200 J	1,100	1,400 UJ	1,100 U	51 U	250 UJ
Pyrene	180 J	130 J	16	320 J	700 J	160 J	290 UJ	220 U	7.1 J	130 UJ
VOCs (µg/kg)										
1,1,1-Trichloroethane	3.6 UJ	2.1 U	4.6 U	2.1 UJ	4.1 UJ	16 U	27 UJ	10 U	0.65 U	2.9 UJ
1,1,2,2-Tetrachloroethane	9.8 UJ	5.6 U	4.6 U	5.6 UJ	11 UJ	16 U	27 UJ	10 U	1.8 U	7.7 UJ
1,1,2-Trichloro-1,2,2-	8 UJ	4.5 U	4.6 U	4.6 UJ	9 UJ	16 U	27 UJ	10 U	1.4 U	6.3 UJ
1,1,2-Trichloroethane	8 UJ	4.5 U	4.6 U	4.6 UJ	9 UJ	16 U	27 UJ	10 U	1.4 U	6.3 UJ
1,1-Dichloroethane	6.7 UJ	3.8 U	4.6 U	3.9 UJ	7.6 UJ	16 U	27 UJ	10 U	1.2 U	5.3 UJ
1,1-Dichloroethene	9.2 UJ	5.2 U	4.6 U	5.3 UJ	10 UJ	16 U	27 UJ	10 U	1.7 U	7.2 UJ
1,2,4-Trichlorobenzene	5.5 UJ	3.1 U	4.6 U	3.1 UJ	6.1 UJ	16 U	27 UJ	10 U	0.98 U	4.3 UJ
1,2-Dibromo-3-Chloropropane	27 UJ	15 U	9.2 U	16 UJ	30 UJ	31 U	55 UJ	20 U	4.9 U	21 UJ
1,2-Dibromoethane	9.2 UJ	5.2 U	4.6 U	5.3 UJ	10 UJ	16 U	27 UJ	10 U	1.7 U	7.2 UJ
1,2-Dichlorobenzene	8 UJ	4.5 U	4.6 U	4.6 UJ	9 UJ	16 U	27 UJ	10 U	1.4 U	6.3 UJ
1,2-Dichloroethane	6.7 UJ	3.8 U	4.6 U	3.9 UJ	7.6 UJ	16 U	27 UJ	10 U	1.2 U	5.3 UJ
1,2-Dichloropropane	5.3 UJ	3 U	4.6 U	3 UJ	5.9 UJ	16 U	27 UJ	10 U	0.95 U	4.2 UJ
1,3-Dichlorobenzene	9.8 UJ	5.6 U	4.6 U	5.6 UJ	11 UJ	16 U	27 UJ	10 U	1.8 U	7.7 UJ
1,4-Dichlorobenzene	4.5 UJ	2.6 U	4.6 U	2.6 UJ	5.1 UJ	16 U	27 UJ	10 U	0.82 U	3.6 UJ
2-Butanone	49 J	31 J	23 U	110 J	440 J	15 J	42 J	34 J	3 J	40 J
2-Hexanone	20 UJ	12 U	23 U	12 UJ	23 UJ	78 U	140 UJ	50 U	3.6 U	16 UJ
4-Methyl-2-pentanone	26 UJ	16 J	23 U	15 UJ	29 UJ	78 U	140 UJ	50 U	4.6 U	20 UJ
Acetone	310 J	170 U	18 J	760 J	2100 J	230	150 J	160	15 J	150 J
Benzene	4.5 UJ	2.5 U	4.6 U	2.6 UJ	5 UJ	16 U	27 UJ	10 U	0.81 U	3.5 UJ
Bromodichloromethane	5.9 UJ	3.4 U	4.6 U	3.4 UJ	6.7 UJ	16 U	27 UJ	10 U	1.1 U	4.7 UJ
Bromoform	9.2 UJ	5.2 U	4.6 U	5.3 UJ	10 UJ	16 U	27 UJ	10 U	1.7 U	7.2 UJ
Bromomethane	9.2 UJ	5.2 U	4.6 U	5.3 UJ	10 UJ	16 U	27 UJ	10 U	1.7 U	7.2 UJ
Carbon disulfide	8.5 J	5.5 J	2.3 J	13 J	26 J	16 U	31 J	12	2.2 J	5.3 UJ

Table C-1. continued

Compound Name	SD-OD1C-01	SD-OD1C-02	SD-OD1N-05	SD-OD2C-01	SD-OD2C-02	SD-OD2T-05	SD-OD3C-01	SD-OD3C-02	SD-OD3T-06	SD-OD4C-01
Depth (ft)	0 - 0.5	0.5 - 2	6 - 8	0 - 0.5	0.5 - 2	6 - 8	0 - 0.5	0.5 - 2	8 - 10	0 - 0.5
Carbon tetrachloride	5.1 UJ	2.9 U	4.6 U	2.9 UJ	5.7 UJ	16 U	27 UJ	10 U	0.92 U	4 UJ
Chlorobenzene	5.9 UJ	3.4 U	4.6 U	3.4 UJ	6.6 UJ	16 U	27 UJ	10 U	1.1 U	4.6 UJ
Chloroethane	17 UJ	9.4 U	4.6 U	9.5 UJ	19 UJ	16 U	27 UJ	10 U	3 U	13 UJ
Chloroform	6.7 UJ	3.8 U	4.6 U	3.9 UJ	7.6 UJ	16 U	27 UJ	10 U	1.2 U	5.3 UJ
Chloromethane	6.1 UJ	3.5 U	4.6 U	3.5 UJ	6.9 UJ	16 U	27 UJ	10 U	1.1 U	4.8 UJ
cis-1,2-Dichloroethene	8.6 UJ	4.9 U	4.6 U	4.9 UJ	9.7 UJ	16 U	27 UJ	10 U	1.5 U	6.8 UJ
cis-1,3-Dichloropropene	5.1 UJ	2.9 U	4.6 U	2.9 UJ	5.7 UJ	16 U	27 UJ	10 U	0.92 U	4 UJ
Cyclohexane	8 UJ	5.4 J	9.2 U	4.6 UJ	9 UJ	31 U	55 UJ	20 U	1.4 U	6.3 UJ
Dibromochloromethane	10 UJ	5.9 U	4.6 U	6 UJ	12 UJ	16 U	27 UJ	10 U	1.9 U	8.2 UJ
Dichlorodifluoromethane	5.8 UJ	3.3 U	4.6 U	3.3 UJ	6.5 UJ	16 U	27 UJ	10 U	1 U	4.5 UJ
Ethylbenzene	8 UJ	4.5 U	4.6 U	4.6 UJ	9 UJ	16 U	27 UJ	10 U	1.4 U	6.3 UJ
Isopropylbenzene	12 UJ	6.6 U	4.6 U	9.5 J	31 J	16 U	27 UJ	10 U	2.1 U	9.2 UJ
Methyl acetate	31 UJ	17 U	9.2 U	18 UJ	35 UJ	31 U	55 UJ	20 U	5.5 U	24 UJ
Methyl tert-butyl ether	6.1 UJ	3.5 U	9.2 U	3.5 UJ	6.9 UJ	31 U	55 UJ	20 U	1.1 U	4.8 UJ
Methylcyclohexane	5.3 UJ	3 U	9.2 U	3 UJ	5.9 UJ	31 U	55 UJ	20 U	0.95 U	4.2 UJ
Methylene Chloride	6 UJ	3.4 U	4.6 U	3.5 UJ	6.8 UJ	16 U	27 UJ	10 U	1.1 U	4.7 UJ
Styrene	5.7 UJ	3.2 U	4.6 U	3.3 UJ	6.4 UJ	16 U	27 UJ	10 U	1 U	4.5 UJ
Tetrachloroethene	12 UJ	6.6 U	4.6 U	6.7 UJ	13 UJ	16 U	27 UJ	10 U	2.1 U	9.2 UJ
Toluene	5.2 UJ	2.9 U	4.6 U	3 UJ	6.1 J	16 U	27 UJ	1.9 J	0.93 U	4.1 UJ
trans-1,2-Dichloroethene	3.9 UJ	2.2 U	4.6 U	2.2 UJ	4.4 UJ	16 U	27 UJ	10 U	0.7 U	3 UJ
trans-1,3-Dichloropropene	5.3 UJ	3 U	4.6 U	3.1 UJ	6 UJ	16 U	27 UJ	10 U	0.96 U	4.2 UJ
Trichloroethene	8 UJ	4.5 U	4.6 U	4.6 UJ	9 UJ	16 U	27 UJ	10 U	1.4 U	6.3 UJ
Trichlorofluoromethane	7.4 UJ	4.2 U	4.6 U	4.2 UJ	8.3 UJ	16 U	27 UJ	10 U	1.3 U	5.8 UJ
Vinyl chloride	9.2 UJ	5.2 U	4.6 U	5.3 UJ	10 UJ	16 U	27 UJ	10 U	1.7 U	7.2 UJ
Xylenes, Total	6.7 UJ	3.8 U	9.2 U	3.9 UJ	8.4 J	31 U	55 UJ	20 U	1.2 U	5.3 UJ
Metals (mg/kg)										
Aluminum	15,000 J	8,900	1,500	34,000 J	46,000 J	18,000	33,000 J	26,000	11,000	22,000 J
Antimony	8.3 UJ	4.9 U	2.3 U	18 UJ	17 UJ	5.4 U	8.1 UJ	6.4 U	0.77 U	1.8 UJ
Arsenic	9.4 J	6.6	3.2	17 J	33 J	3.6 J	13 J	12	7.5	15 J
Barium	66 J	59	4.2	160 J	290 J	82	39 J	35	18	25 J
Beryllium	0.5 J	0.31 J	0.21 J	1 J	1.5 J	0.43 J	1.4 J	1.3	0.62	1.4 J
Cadmium	0.55 J	0.41 J	0.57 U	1.3 J	1.8 J	0.3 J	0.49 J	1.6 U	0.15 U	0.34 UJ
Calcium	7,600 J	8,900	6,400	25,000 J	46,000 J	7,400	4,000 J	4,000	2,400	4,300 J
Chromium	43 J	23	4.6	83 J	110 J	32	53 J	46	19	43 J
Cobalt	3.1 J	2 J	0.49 J	6.2 J	9.1 J	2.1 J	6.2 J	5.4	2.6	5.5 J
Copper	86 J	71	2.8 U	160 J	240 J	70	51 J	30	2.4 J	18 J
Iron	13,000 J	7,900	2,400	28,000 J	38,000 J	12,000	27,000 J	25,000	12,000	25,000 J
Lead	72 J	47	1.6	93 J	160 J	51	32 J	30	8.9	25 J
Magnesium	5,200 J	2,800	400	14,000 J	18000 J	3,700	8,800 J	7,300	1,500	8,400 J
Manganese	200 J	160	23	460 J	770 J	120	310 J	260	71	280 J
Mercury	0.75 J	0.22	0.021 U	1.5 J	2.3 J	0.82	0.21 J	0.16	0.024 J	0.14 J

Table C-1. continued

Compound Name	SD-OD1C-01	SD-OD1C-02	SD-OD1N-05	SD-OD2C-01	SD-OD2C-02	SD-OD2T-05	SD-OD3C-01	SD-OD3C-02	SD-OD3T-06	SD-OD4C-01
Depth (ft)	0 - 0.5	0.5 - 2	6 - 8	0 - 0.5	0.5 - 2	6 - 8	0 - 0.5	0.5 - 2	8 - 10	0 - 0.5
Nickel	14 J	9 J	0.89 J	25 J	36 J	14	16 J	13	4.2 J	11 J
Potassium	2,600	1,400	160	8,000	10,000	1,400	4,900	4,000	870	4,400
Selenium	10 UJ	6.1 U	2.8 U	22 UJ	22 UJ	6.7 U	10 UJ	8 U	1.5 U	3.4 UJ
Silver	4.2 UJ	2.4 U	1.1 U	8.9 UJ	8.6 UJ	2.7 U	4 UJ	3.2 U	0.14 U	0.33 UJ
Sodium	18,000 J	6,900	220 J	62,000 J	66,000 J	5,600	33,000 J	20,000	690	31,000 J
Thallium	10 UJ	6.1 U	2.8 U	22 UJ	22 UJ	6.7 U	10 UJ	8 U	1.4 U	3.4 UJ
Vanadium	30 J	17	4.9	60 J	82 J	28	65 J	59	28	59 J
Zinc	340 J	280	3.8	580 J	860 J	190	140 J	120	15	81 J
Other (mg/kg)										
Cyanide, Total	2.3 UJ	1.2 UJ	0.6 U	4.5 UJ	3.4 J	0.75 J	2.1 UJ	1.6 U	0.31 U	0.8 UJ
Total Organic Carbon	NA	NA	1,500	510,000 J	320000 J	270,000	53,000 J	48,000	5,400	NA

Table C-1. continued

Compound Name	SD-OD4C-02	SD-OD4N-05	SD-OD5C-01	SD-OD5C-02	SD-OD5S-01	SD-OD5S-05	SD-ODCC-02	SD-ODCN-01	SD-ODCS-01
Depth (ft)	0.5 - 2	6 - 8	0 - 0.5	0.5 - 2	0 - 0.5	6 - 8	0.5 - 2	0 - 0.5	0 - 0.5
Toxaphene (µg/kg)									
Method 1 (Technical)	660 J	5,100	360 J	8,500 J	270 J	87,000	17,000	71,000	5,700 J
Method 2 (TAUC)	1,600	13,000	940	21,000	700	120,000	22,000	75,000	5,300
Pesticides (µg/kg)									
4,4-DDD	0.41 UJ	7.2 U	5 J	43 UJ	3.3 J	150 U	470 U	120 U	27 UJ
4,4-DDE	5.8 J	5.7 U	9.3 J	34 UJ	0.42 UJ	120 U	470 U	470	68 J
4,4-DDT	0.39 UJ	6.9 U	0.59 UJ	41 UJ	0.51 UJ	140 U	470 U	120 U	27 UJ
Aldrin	0.77 UJ	13 U	1.2 UJ	320 J	0.99 UJ	780 J	190 J	60 U	14 UJ
alpha-BHC	0.19 UJ	3.3 U	0.28 UJ	20 UJ	0.24 UJ	67 U	240 U	60 U	14 UJ
alpha-Chlordane	0.24 UJ	4.2 U	0.36 UJ	25 UJ	0.31 UJ	86 U	240 U	60 U	14 UJ
beta-BHC	0.19 UJ	3.3 U	0.28 UJ	20 UJ	0.24 UJ	67 U	240 U	60 U	14 UJ
delta-BHC	0.22 UJ	3.9 U	0.34 UJ	23 UJ	0.29 UJ	80 U	240 U	60 U	14 UJ
Dieldrin	0.48 UJ	8.4 U	0.72 UJ	50 UJ	0.62 UJ	170 U	470 U	120 U	27 UJ
Endosulfan I	0.26 UJ	4.5 U	0.39 UJ	27 UJ	0.33 UJ	92 U	240 U	60 U	14 UJ
Endosulfan II	0.39 UJ	6.9 U	0.59 UJ	41 UJ	0.51 UJ	140 U	470 U	120 U	27 UJ
Endosulfan sulfate	0.41 UJ	7.2 U	0.62 UJ	43 UJ	0.53 UJ	150 U	470 U	120 U	27 UJ
Endrin	1.2 UJ	22 U	1.9 UJ	130 UJ	1.6 UJ	450 U	470 U	120 U	27 UJ
Endrin aldehyde	0.51 UJ	8.9 U	0.77 UJ	54 UJ	0.66 UJ	180 U	470 U	120 U	27 UJ
Endrin ketone	0.46 UJ	8.1 U	0.7 UJ	48 UJ	0.59 UJ	170 U	470 U	120 U	27 UJ
gamma-BHC (Lindane)	0.52 J	33 J	1.1 J	40 J	0.24 UJ	67 U	19 J	7.4 J	14 UJ
gamma-Chlordane	0.27 UJ	4.8 U	0.41 UJ	29 UJ	0.35 UJ	98 U	240 U	60 U	14 UJ
Heptachlor	0.14 UJ	2.5 U	0.21 UJ	15 UJ	0.18 UJ	51 U	240 U	60 U	14 UJ
Heptachlor epoxide	0.24 UJ	4.2 U	0.36 UJ	25 UJ	0.31 UJ	86 U	240 U	60 U	14 UJ
Methoxychlor	0.6 UJ	10 U	0.9 UJ	63 UJ	0.77 UJ	210 U	470 U	120 U	27 UJ
PCB-1016	5 UJ	22 U	7.5 UJ	26 UJ	6.4 UJ	360 U	470 U	1200 U	69 UJ
PCB-1221	8.2 UJ	36 U	12 UJ	43 UJ	11 UJ	590 U	960 U	2,400 U	140 UJ
PCB-1232	5.6 UJ	25 U	8.5 UJ	29 UJ	7.3 UJ	400 U	470 U	1200 U	69 UJ
PCB-1242	4.8 UJ	21 U	7.2 UJ	25 UJ	6.2 UJ	340 U	470 U	1200 U	69 UJ
PCB-1248	12 UJ	54 U	19 UJ	64 UJ	16 UJ	880 U	470 U	1200 U	69 UJ
PCB-1254	3.9 UJ	17 U	5.9 UJ	21 UJ	5.1 UJ	280 U	470 U	1200 U	69 UJ
PCB-1260	11 UJ	50 U	17 UJ	60 UJ	15 UJ	820 U	470 U	1200 U	69 UJ
PCB-1268	2.9 UJ	13 U	4.4 UJ	15 UJ	3.7 UJ	210 U	470 U	1200 U	69 UJ
SVOCs (µg/kg)									
1,1-Biphenyl	250 UJ	320 J	370 UJ	290 J	320 UJ	460 J	470 U	590 U	1,400 UJ
2,2-oxybis[1-chloropropane]	250 UJ	210 U	370 UJ	260 UJ	320 UJ	180 U	470 U	590 U	1,400 UJ
2,4,5-Trichlorophenol	260 UJ	230 U	390 UJ	270 UJ	330 UJ	190 U	470 U	590 U	1,400 UJ
2,4,6-Trichlorophenol	270 UJ	240 U	410 UJ	280 UJ	350 UJ	190 U	470 U	590 U	1,400 UJ
2,4-Dichlorophenol	250 UJ	210 U	370 UJ	260 UJ	320 UJ	180 UJ	470 U	590 U	1,400 UJ
2,4-Dimethylphenol	260 UJ	230 U	390 UJ	270 UJ	330 UJ	190 U	940 U	1,200 U	2,700 UJ
2,4-Dinitrophenol	580 UJ	510 U	880 UJ	R	750 UJ	420 U	4,700 U	5,900 UJ	14,000 UJ

Table C-1. continued

Compound Name	SD-OD4C-02	SD-OD4N-05	SD-OD5C-01	SD-OD5C-02	SD-OD5S-01	SD-OD5S-05	SD-ODCC-02	SD-ODCN-01	SD-ODCS-01
Depth (ft)	0.5 - 2	6 - 8	0 - 0.5	0.5 - 2	0 - 0.5	6 - 8	0.5 - 2	0 - 0.5	0 - 0.5
2,4-Dinitrotoluene	260 UJ	220 U	390 UJ	270 UJ	330 UJ	180 U	470 U	590 U	1,400 UJ
2,6-Dinitrotoluene	270 UJ	240 U	410 UJ	280 UJ	350 UJ	190 U	470 U	590 U	1,400 UJ
2-Chloronaphthalene	210 UJ	180 U	310 UJ	210 UJ	260 UJ	150 U	470 U	590 U	1,400 UJ
2-Chlorophenol	180 UJ	160 U	270 UJ	190 UJ	230 UJ	130 U	470 U	590 U	1,400 UJ
2-Methylnaphthalene	110 UJ	98 U	170 UJ	120 UJ	140 UJ	85 J	96 U	120 U	280 UJ
2-Methylphenol	220 UJ	190 U	330 UJ	220 UJ	280 UJ	150 U	470 U	590 U	340 J
2-Nitroaniline	240 UJ	210 U	360 UJ	250 UJ	310 UJ	170 U	2,400 U	3,000 U	7,100 UJ
2-Nitrophenol	200 UJ	170 U	300 UJ	210 UJ	250 UJ	140 U	470 U	590 U	1,400 UJ
3 & 4 Methylphenol	250 UJ	220 U	380 UJ	260 UJ	320 UJ	330 J	560	590 U	2200 J
3,3-Dichlorobenzidine	580 UJ	510 U	880 UJ	R	R	R	R	1200 U	2700 UJ
3-Nitroaniline	230 UJ	200 U	350 UJ	R	290 UJ	160 U	2,400 U	3,000 U	7,100 UJ
4,6-Dinitro-2-methylphenol	580 UJ	510 U	880 UJ	R	750 UJ	420 UJ	2,400 U	3,000 UJ	7,100 UJ
4-Bromophenyl phenyl ether	240 UJ	210 U	360 UJ	250 UJ	300 UJ	170 U	470 U	590 U	1,400 UJ
4-Chloro-3-methylphenol	240 UJ	210 U	360 UJ	250 UJ	310 UJ	170 U	470 U	590 U	1,400 UJ
4-Chloroaniline	180 UJ	160 U	270 UJ	R	230 UJ	130 U	940 U	1,200 U	2,700 UJ
4-Chlorophenyl phenyl ether	220 UJ	190 U	330 UJ	230 UJ	280 UJ	160 U	470 U	590 U	1,400 UJ
4-Nitroaniline	280 UJ	250 U	430 UJ	R	360 UJ	200 U	2,400 U	3,000 U	7,100 UJ
4-Nitrophenol	2,500 UJ	2,200 U	3,800 UJ	R	3,200 UJ	1,800 U	2,400 U	3,000 U	7,100 UJ
Acenaphthene	110 UJ	98 U	170 UJ	120 UJ	140 UJ	240	96 U	120 U	280 UJ
Acenaphthylene	110 UJ	98 U	170 UJ	120 UJ	140 UJ	81 U	49 J	120 U	430 J
Acetophenone	230 UJ	200 U	350 UJ	240 UJ	300 UJ	450 J	470 U	590 U	1,400 UJ
Anthracene	110 UJ	98 U	170 UJ	120 UJ	140 UJ	81 U	96 U	120 U	280 UJ
Atrazine	260 UJ	230 U	390 UJ	270 UJ	330 UJ	190 U	470 U	590 U	1,400 UJ
Benzaldehyde	340 UJ	630 J	510 UJ	580 J	430 UJ	1,700	230 J	590 U	1,200 J
Benzo[a]anthracene	110 UJ	98 U	170 UJ	120 UJ	140 UJ	81 U	99	120 U	280 UJ
Benzo[a]pyrene	41 UJ	36 U	62 UJ	43 UJ	53 UJ	29 U	130	120 U	280 UJ
Benzo[b]fluoranthene	110 UJ	98 U	170 UJ	120 UJ	140 UJ	81 U	120	120 U	280 UJ
Benzo[g,h,i]perylene	110 UJ	98 U	170 UJ	120 UJ	140 UJ	81 U	75 J	120 U	280 UJ
Benzo[k]fluoranthene	69 UJ	60 U	100 UJ	71 UJ	88 UJ	49 U	110	120 U	280 UJ
Bis(2-chloroethoxy)methane	220 UJ	190 U	340 UJ	230 UJ	290 UJ	160 U	470 U	590 U	1,400 UJ
Bis(2-chloroethyl)ether	220 UJ	190 U	340 UJ	230 UJ	290 UJ	160 U	470 U	590 U	1,400 UJ
Bis(2-ethylhexyl) phthalate	210 UJ	180 U	3400 UJ	210 UJ	260 UJ	150 U	940 U	1,200 U	2,700 UJ
Butyl benzyl phthalate	190 UJ	160 U	280 UJ	200 UJ	240 UJ	130 U	470 U	590 U	1,400 UJ
Caprolactam	240 UJ	210 U	360 UJ	250 UJ	310 UJ	170 U	470 U	590 U	1,400 UJ
Carbazole	230 UJ	200 U	350 UJ	240 UJ	290 UJ	160 U	470 U	590 U	1,400 UJ
Chrysene	110 UJ	98 U	170 UJ	120 UJ	140 UJ	81 U	130	120 U	280 UJ
Dibenz(a,h)anthracene	110 UJ	98 U	170 UJ	120 UJ	140 UJ	81 U	96 U	120 U	280 UJ
Dibenzofuran	230 UJ	200 U	350 UJ	240 UJ	290 UJ	230 J	470 U	590 U	1,400 UJ
Diethyl phthalate	250 UJ	220 U	380 UJ	260 UJ	320 UJ	180 U	470 U	590 U	1,400 UJ
Dimethyl phthalate	260 UJ	220 U	390 UJ	270 UJ	330 UJ	180 U	470 U	590 U	1,400 UJ
Di-n-butyl phthalate	580 UJ	510 U	880 UJ	610 UJ	750 UJ	420 U	2,400 U	3,000 U	7,100 UJ

Table C-1. continued

Compound Name	SD-OD4C-02	SD-OD4N-05	SD-OD5C-01	SD-OD5C-02	SD-OD5S-01	SD-OD5S-05	SD-ODCC-02	SD-ODCN-01	SD-ODCS-01
Depth (ft)	0.5 - 2	6 - 8	0 - 0.5	0.5 - 2	0 - 0.5	6 - 8	0.5 - 2	0 - 0.5	0 - 0.5
Di-n-octyl phthalate	120 UJ	110 U	190 UJ	130 UJ	160 UJ	88 U	470 U	590 U	1,400 UJ
Fluoranthene	110 UJ	98 U	170 UJ	120 UJ	140 UJ	81 U	250	120 U	150 J
Fluorene	110 UJ	98 U	170 UJ	120 UJ	140 UJ	280	96 U	120 U	280 UJ
Hexachlorobenzene	260 UJ	230 U	390 UJ	270 UJ	330 UJ	190 U	470 U	590 U	1,400 UJ
Hexachlorobutadiene	230 UJ	200 U	350 UJ	240 UJ	300 UJ	170 U	470 U	590 U	1,400 UJ
Hexachlorocyclopentadiene	130 UJ	110 U	190 UJ	R	160 UJ	91 U	940 U	1,200 U	2,700 UJ
Hexachloroethane	200 UJ	170 U	300 UJ	210 UJ	250 UJ	140 U	470 U	590 U	1,400 UJ
Indeno[1,2,3-cd]pyrene	110 UJ	98 U	170 UJ	120 UJ	140 UJ	81 U	57 J	120 U	280 UJ
Isophorone	240 UJ	210 U	360 UJ	250 UJ	310 UJ	170 U	470 U	590 U	1,400 UJ
Naphthalene	160 J	110 J	170 J	240 UJ	140 UJ	460	160	120 U	1,300 J
Nitrobenzene	230 UJ	200 U	340 UJ	240 UJ	290 UJ	160 U	470 U	590 U	1,400 UJ
N-Nitrosodi-n-propylamine	260 UJ	220 U	390 UJ	270 UJ	330 UJ	180 U	470 U	590 U	1,400 UJ
N-Nitrosodiphenylamine	210 UJ	180 U	310 UJ	220 UJ	270 UJ	150 U	470 U	590 U	1,400 UJ
Pentachlorophenol	580 UJ	510 U	880 UJ	610 UJ	750 UJ	420 UJ	2,400 U	3,000 U	7,100 UJ
Phenanthrene	82 UJ	72 U	120 UJ	86 UJ	110 UJ	260	130	120 U	280 J
Phenol	220 UJ	190 U	340 UJ	230 UJ	290 UJ	360 J	110 J	590 U	5,900 J
Pyrene	110 UJ	98 U	170 UJ	120 UJ	140 UJ	81 U	210	60 J	280 UJ
VOCs (µg/kg)									
1,1,1-Trichloroethane	2.4 UJ	1.9 U	2.7 UJ	2.1 U	NA	110 U	4.8 U	NA	NA
1,1,2,2-Tetrachloroethane	6.5 UJ	5.2 U	7.2 UJ	5.8 U	NA	290 U	4.8 U	NA	NA
1,1,2-Trichloro-1,2,2-	5.3 UJ	4.2 U	5.9 UJ	4.7 U	NA	230 U	4.8 U	NA	NA
1,1,2-Trichloroethane	5.3 UJ	4.2 U	5.9 UJ	4.7 U	NA	230 U	4.8 U	NA	NA
1,1-Dichloroethane	4.4 UJ	3.6 U	5 UJ	4 U	NA	200 U	4.8 U	NA	NA
1,1-Dichloroethene	6.1 UJ	4.9 U	6.8 UJ	5.4 U	NA	270 U	4.8 U	NA	NA
1,2,4-Trichlorobenzene	3.6 UJ	2.9 U	4 UJ	3.2 U	NA	160 U	4.8 U	NA	NA
1,2-Dibromo-3-Chloropropane	18 UJ	14 U	20 UJ	16 U	NA	790 U	9.6 U	NA	NA
1,2-Dibromoethane	6.1 UJ	4.9 U	6.8 UJ	5.4 U	NA	270 U	4.8 U	NA	NA
1,2-Dichlorobenzene	5.3 UJ	4.2 U	5.9 UJ	4.7 U	NA	230 U	4.8 U	NA	NA
1,2-Dichloroethane	4.4 UJ	3.6 U	5 UJ	4 U	NA	200 U	4.8 U	NA	NA
1,2-Dichloropropane	3.5 UJ	2.8 U	3.9 UJ	3.1 U	NA	150 U	4.8 U	NA	NA
1,3-Dichlorobenzene	6.5 UJ	5.2 U	7.2 UJ	5.8 U	NA	290 U	4.8 U	NA	NA
1,4-Dichlorobenzene	3 UJ	2.4 U	3.3 UJ	2.7 U	NA	130 U	4.8 U	NA	NA
2-Butanone	24 J	23 J	72 J	8.6 U	NA	460 J	3.5 J	NA	NA
2-Hexanone	13 UJ	11 U	15 UJ	12 U	NA	590 U	24 U	NA	NA
4-Methyl-2-pentanone	17 UJ	14 U	19 UJ	15 U	NA	750 U	24 U	NA	NA
Acetone	130 J	130 J	240 J	180	NA	8700 J	35 J	NA	NA
Benzene	3 UJ	2.4 U	3.3 UJ	2.6 U	NA	1600	4.8 U	NA	NA
Bromodichloromethane	3.9 UJ	3.1 U	4.4 UJ	3.5 U	NA	170 U	4.8 U	NA	NA
Bromoform	6.1 UJ	4.9 U	6.8 UJ	5.4 U	NA	270 U	4.8 U	NA	NA
Bromomethane	6.1 UJ	4.9 U	6.8 UJ	5.4 U	NA	270 U	4.8 U	NA	NA
Carbon disulfide	32 J	13 J	22 J	7.4 J	NA	250 J	5.5	NA	NA

Table C-1. continued

Compound Name	SD-OD4C-02	SD-OD4N-05	SD-OD5C-01	SD-OD5C-02	SD-OD5S-01	SD-OD5S-05	SD-ODCC-02	SD-ODCN-01	SD-ODCS-01
Depth (ft)	0.5 - 2	6 - 8	0 - 0.5	0.5 - 2	0 - 0.5	6 - 8	0.5 - 2	0 - 0.5	0 - 0.5
Carbon tetrachloride	3.4 UJ	2.7 U	3.7 UJ	3 U	NA	150 U	4.8 U	NA	NA
Chlorobenzene	3.9 UJ	3.1 U	4.3 UJ	3.5 U	NA	300 J	4.8 U	NA	NA
Chloroethane	11 UJ	8.7 U	12 UJ	9.7 U	NA	480 U	4.8 U	NA	NA
Chloroform	4.4 UJ	3.6 U	5 UJ	4 U	NA	200 U	4.8 U	NA	NA
Chloromethane	4 UJ	3.2 U	4.5 UJ	3.6 U	NA	180 U	4.8 U	NA	NA
cis-1,2-Dichloroethene	5.7 UJ	4.5 U	6.3 UJ	5 U	NA	250 U	4.8 U	NA	NA
cis-1,3-Dichloropropene	3.4 UJ	2.7 U	3.7 UJ	3 U	NA	150 U	4.8 U	NA	NA
Cyclohexane	5.3 UJ	4.2 U	5.9 UJ	4.7 U	NA	230 U	9.6 U	NA	NA
Dibromochloromethane	6.9 UJ	5.5 U	7.7 UJ	6.1 U	NA	300 U	4.8 U	NA	NA
Dichlorodifluoromethane	3.8 UJ	3 U	4.2 UJ	3.4 U	NA	170 U	4.8 U	NA	NA
Ethylbenzene	5.3 UJ	4.2 U	5.9 UJ	4.7 U	NA	230 U	4.8 U	NA	NA
Isopropylbenzene	7.7 UJ	6.2 U	8.6 UJ	7.9 J	NA	8900	4.8 U	NA	NA
Methyl acetate	20 UJ	16 U	23 UJ	18 U	NA	2200	9.6 U	NA	NA
Methyl tert-butyl ether	4 UJ	3.2 U	4.5 UJ	3.6 U	NA	180 U	9.6 U	NA	NA
Methylcyclohexane	3.5 UJ	2.8 U	3.9 UJ	3.1 U	NA	300 J	9.6 U	NA	NA
Methylene Chloride	4 UJ	3.2 U	4.4 UJ	3.5 U	NA	180 U	4.8 U	NA	NA
Styrene	3.8 UJ	3 U	4.2 UJ	3.3 U	NA	170 U	4.8 U	NA	NA
Tetrachloroethene	7.7 UJ	6.2 U	8.6 UJ	6.8 U	NA	340 U	4.8 U	NA	NA
Toluene	3.4 UJ	2.7 U	3.8 UJ	3 U	NA	600 J	4.8 U	NA	NA
trans-1,2-Dichloroethene	2.5 UJ	2 U	2.8 UJ	2.3 U	NA	110 U	4.8 U	NA	NA
trans-1,3-Dichloropropene	3.5 UJ	2.8 U	3.9 UJ	3.1 U	NA	160 U	4.8 U	NA	NA
Trichloroethene	5.3 UJ	4.2 U	5.9 UJ	4.7 U	NA	230 U	4.8 U	NA	NA
Trichlorofluoromethane	4.8 UJ	3.9 U	5.4 UJ	4.3 U	NA	210 U	4.8 U	NA	NA
Vinyl chloride	6.1 UJ	4.9 U	6.8 UJ	5.4 U	NA	270 U	4.8 U	NA	NA
Xylenes, Total	4.4 UJ	3.6 U	5 UJ	4 U	NA	200 U	9.6 U	NA	NA
Metals (mg/kg)									
Aluminum	34,000 J	47,000	38,000 J	26,000 J	NA	32,000	3,600	1,700	12,000 J
Antimony	1.8 UJ	1.6 U	2.6 UJ	1.8 UJ	NA	1.3 U	2.6 U	3.5 U	7.8 UJ
Arsenic	14 J	15	17 J	14 J	NA	14	1.6 J	1 J	13 J
Barium	36 J	56	43 J	31 J	NA	36	21	6.9	84 J
Beryllium	1.6 J	1.8	1.8 J	1.4 J	NA	1.5	0.12 J	0.08 J	0.34 J
Cadmium	0.33 UJ	0.29 U	0.5 UJ	0.34 UJ	NA	0.24 U	0.15 J	0.87 U	0.71 J
Calcium	5,900 J	3,700	6,600 J	5,700 J	NA	6,500	4,900	23,000	12,000 J
Chromium	52 J	60	64 J	48 J	NA	47	8	3.9	45 J
Cobalt	6.6 J	8.7	7.4 J	5.6 J	NA	6.7	0.76 J	0.38 J	2.4 J
Copper	24 J	57	27 J	37 J	NA	70	26	3.8 J	68 J
Iron	29,000 J	36,000	34,000 J	27,000 J	NA	31,000	3,600	1,500	10,000 J
Lead	28 J	32	31 J	29 J	NA	31	22	5.2	45 J
Magnesium	9,100 J	6,400	11,000 J	7,000 J	NA	5,800	1,800	1,100	4,300 J
Manganese	330 J	460	440 J	320 J	NA	350	45	38	230 J
Mercury	0.16 J	0.18	0.15 J	0.23 J	NA	0.07	1.4	0.016 J	6.2 J

Table C-1. continued

Compound Name	SD-OD4C-02	SD-OD4N-05	SD-OD5C-01	SD-OD5C-02	SD-OD5S-01	SD-OD5S-05	SD-ODCC-02	SD-ODCN-01	SD-ODCS-01
Depth (ft)	0.5 - 2	6 - 8	0 - 0.5	0.5 - 2	0 - 0.5	6 - 8	0.5 - 2	0 - 0.5	0 - 0.5
Nickel	15 J	20	18 J	13 J	NA	21	3.9 J	1.6 J	14 J
Potassium	4,800	3,600	6,000	4,200	NA	3,000	720	540	3,000
Selenium	3.3 UJ	2.9 U	5 UJ	3.4 UJ	NA	2.4 U	3.3 U	4.4 U	9.8 UJ
Silver	0.32 UJ	0.28 U	0.48 UJ	0.42 J	NA	9.1	1.3 U	1.7 U	3.9 UJ
Sodium	29,000 J	6,900	43,000 J	18000 J	NA	3,100	6,100	3,000	16,000 J
Thallium	3.3 UJ	2.9 U	4.9 UJ	3.3 UJ	NA	2.4 U	3.3 U	4.4 U	9.8 UJ
Vanadium	70 J	85	79 J	65 J	NA	72	9.2	6.3	21 J
Zinc	110 J	82	110 J	97 J	NA	58	140	25	220 J
Other (mg/kg)									
Cyanide, Total	0.71 UJ	0.6 U	1.1 UJ	0.96 J	NA	1 J	0.71 U	0.87 U	2 UJ
Total Organic Carbon	NA	72,000	60,000 J	55,000 J	35000 J	77,000	38,000	4,000	110,000 J

Notes:
U: not detected; J: estimated concentration; R: rejected after data validation; NA: not analyzed

Table C-2. Analytical Results for Surface Water, Terry Creek OU1 RI/FS

	Culvert Samples							
	SW-DCEB-01	SW-DCEB-02	SW-DCEB-03	SW-DCEB-04	SW-DCFL-01	SW-DCFL-02	SW-DCFL-03	SW-DCFL-04
Compound Name	ebb tide, filtered	ebb tide, unfiltered	ebb tide, filtered, wet weather	ebb tide, unfiltered, wet weather	flood tide, filtered	flood tide, unfiltered	flood tide, filtered, wet weather	flood tide, unfiltered, wet weather
Toxaphene (µg/L)								
Method 1 (Technical)	0.53 U	0.51 U	0.52 U	0.47 U	0.51 U	0.48 U	0.46 U	0.52 U
Method 2 (TAUC)	0.53 U	0.51 U	0.52 U	0.47 U	0.51 U	0.48 U	0.46 U	0.52 U
Pesticides (µg/L)								
4,4-DDD	0.0068 U	0.0067 U	0.0068 U	0.0061 U	0.0066 U	0.0062 U	0.006 U	0.0068 U
4,4-DDE	0.0081 U	0.0079 U	0.008 U	0.0072 U	0.0079 U	0.0073 UJ	0.0071 U	0.008 U
4,4-DDT	0.01 U	0.0099 U	0.01 U	0.0091 U	0.0099 U	0.0092 U	0.009 U	0.01 U
Aldrin	0.0074 U	0.0072 U	0.0073 U	0.0066 U	0.0071 U	0.0067 U	0.0065 U	0.0073 U
alpha-BHC	0.006 U	0.0058 U	0.0059 U	0.0053 U	0.0058 U	0.0054 U	0.0053 U	0.0059 U
alpha-Chlordane	0.0063 U	0.0061 U	0.0062 U	0.0056 U	0.0061 U	0.0057 UJ	0.0055 U	0.0063 U
beta-BHC	0.007 U	0.0069 U	0.007 U	0.0063 U	0.0068 U	0.0064 U	0.0062 U	0.007 U
delta-BHC	0.005 U	0.0049 U	0.005 U	0.0045 U	0.0049 U	0.0046 U	0.0044 U	0.005 U
Dieldrin	0.0096 U	0.0093 U	0.0095 U	0.0085 U	0.0093 U	0.0087 UJ	0.0084 U	0.0095 U
Endosulfan I	0.0044 U	0.0043 U	0.0044 U	0.0039 U	0.0043 U	0.004 U	0.0039 U	0.0044 U
Endosulfan II	0.01 UJ	0.01 UJ	0.01 U	0.0092 U	0.01 UJ	0.0093 UJ	0.0091 U	0.01 U
Endosulfan sulfate	0.0071 UJ	0.007 UJ	0.0071 U	0.0064 U	0.0069 UJ	0.0065 UJ	0.0063 U	0.0071 U
Endrin	0.01 UJ	0.0099 UJ	0.01 U	0.0091 U	0.0099 UJ	0.0092 UJ	0.009 U	0.01 U
Endrin aldehyde	0.017 U	0.016 U	0.017 U	0.015 U	0.016 U	0.015 U	0.015 U	0.017 U
Endrin ketone	0.0088 U	0.0086 U	0.0087 U	0.0079 U	0.0086 U	0.008 U	0.0078 U	0.0088 U
gamma-BHC (Lindane)	0.0062 U	0.006 U	0.0061 U	0.0055 U	0.006 U	0.0056 U	0.0055 U	0.0062 U
gamma-Chlordane	0.0054 U	0.0052 U	0.0053 U	0.0048 U	0.0052 U	0.0049 U	0.0047 U	0.0053 U
Heptachlor	0.0074 U	0.0072 U	0.0073 U	0.0066 U	0.0071 U	0.0067 U	0.0065 U	0.0073 U
Heptachlor epoxide	0.0063 U	0.0061 U	0.0062 U	0.0056 U	0.0061 U	0.0057 U	0.0055 U	0.0063 U
Methoxychlor	0.014 U	0.013 U	0.014 U	0.012 U	0.013 U	0.012 U	0.012 U	0.014 U
PCB-1016	0.075 U	0.073 U	0.074 U	0.067 U	0.072 U	0.068 U	0.066 U	0.074 U
PCB-1221	0.29 U	0.29 U	0.29 U	0.26 U	0.29 U	0.27 U	0.26 U	0.29 U
PCB-1232	0.12 U	0.11 U	0.11 U	0.1 U	0.11 U	0.1 U	0.1 U	0.11 U
PCB-1242	0.19 U	0.18 U	0.19 U	0.17 U	0.18 U	0.17 U	0.17 U	0.19 U
PCB-1248	0.38 U	0.37 U	0.37 U	0.34 U	0.37 U	0.34 U	0.33 U	0.38 U
PCB-1254	0.27 U	0.27 U	0.27 U	0.24 U	0.27 U	0.25 U	0.24 U	0.27 U
PCB-1260	0.21 U	0.2 U	0.21 U	0.19 U	0.2 U	0.19 U	0.18 U	0.21 U
PCB-1268	0.27 U	0.27 U	0.27 U	0.24 U	0.27 U	0.25 U	0.24 U	0.27 U
SVOCs (µg/L)								
1,1-Biphenyl	0.095 U	0.1 U	0.1 U	0.096 U	0.11 U	0.1 U	0.092 U	0.096 U
2,2-oxybis[1-chloropropane]	0.095 U	0.1 U	0.1 U	0.096 U	0.11 U	0.1 U	0.092 U	0.096 U
2,4,5-Trichlorophenol	0.11 U	0.12 U	0.12 U	0.12 U	0.13 U	0.12 U	0.11 U	0.12 U
2,4,6-Trichlorophenol	0.16 U	0.18 U	0.17 U	0.16 U	0.18 U	0.17 U	0.16 U	0.16 U
2,4-Dichlorophenol	0.095 U	0.1 U	0.1 U	0.096 U	0.11 U	0.1 U	0.092 U	0.096 U
2,4-Dimethylphenol	0.65 U	0.71 U	0.7 U	0.66 U	0.75 U	0.71 U	0.64 U	0.67 U

	Culvert Samples							
	SW-DCEB-01	SW-DCEB-02	SW-DCEB-03	SW-DCEB-04	SW-DCFL-01	SW-DCFL-02	SW-DCFL-03	SW-DCFL-04
Compound Name	ebb tide, filtered	ebb tide, unfiltered	ebb tide, filtered, wet weather	ebb tide, unfiltered, wet weather	flood tide, filtered	flood tide, unfiltered	flood tide, filtered, wet weather	flood tide, unfiltered, wet weather
2,4-Dinitrophenol	1 U	1.1 U	1.1 U	1.1 U	1.2 U	1.1 U	1 U	1.1 U
2,4-Dinitrotoluene	0.11 U	0.12 U	0.12 U	0.12 U	0.13 U	0.12 U	0.11 U	0.12 U
2,6-Dinitrotoluene	0.12 U	0.13 U	0.13 U	0.13 U	0.14 U	0.13 U	0.12 U	0.13 U
2-Chloronaphthalene	0.095 U	0.1 U	0.1 U	0.096 U	0.11 U	0.1 U	0.092 U	0.096 U
2-Chlorophenol	0.11 U	0.12 U	0.12 U	0.12 U	0.13 U	0.12 U	0.11 U	0.12 U
2-Methylnaphthalene	0.095 U	0.1 U	0.1 U	0.096 U	0.11 U	0.1 U	0.092 U	0.096 U
2-Methylphenol	0.7 U	0.76 U	0.75 U	0.71 U	0.8 U	0.76 U	0.68 U	0.71 U
2-Nitroaniline	0.15 U	0.17 U	0.16 U	0.15 U	0.17 U	0.16 U	0.15 U	0.15 U
2-Nitrophenol	0.095 U	0.1 U	0.1 U	0.096 U	0.11 U	0.1 U	0.092 U	0.096 U
3 & 4 Methylphenol	0.62 U	0.68 U	0.67 U	0.64 U	0.72 U	0.68 U	0.61 U	0.64 U
3,3'-Dichlorobenzidine			2 U	1.9 U			1.8 U	1.9 U
3,3-Dichlorobenzidine	1.9 U	2.1 U			2.2 U	R		
3-Nitroaniline	0.15 U	0.17 U	0.16 U	0.15 U	0.17 U	R	0.15 U	0.15 U
4,6-Dinitro-2-methylphenol	0.12 U	0.13 U	0.13 U	0.13 U	0.14 U	0.13 U	0.12 U	0.13 U
4-Bromophenyl phenyl ether	0.11 U	0.12 U	0.12 U	0.12 U	0.13 U	0.12 U	0.11 U	0.12 U
4-Chloro-3-methylphenol	0.11 U	0.12 U	0.12 U	0.12 U	0.13 U	0.12 U	0.11 U	0.12 U
4-Chloroaniline	0.34 U	0.37 U	0.36 U	0.35 U	0.39 U	R	0.33 U	0.35 U
4-Chlorophenyl phenyl ether	0.095 U	0.1 U	0.1 U	0.096 U	0.11 U	0.1 U	0.092 U	0.096 U
4-Nitroaniline	0.47 U	0.52 U	0.51 U	0.48 U	0.54 U	R	0.46 U	0.48 U
4-Nitrophenol	0.47 U	0.52 U	0.51 U	0.48 U	0.54 U	0.51 U	0.46 U	0.48 U
Acenaphthene	0.095 U	0.1 U	0.1 U	0.096 U	0.11 U	0.1 U	0.092 U	0.096 U
Acenaphthylene	0.095 U	0.1 U	0.1 U	0.096 U	0.11 U	0.1 U	0.092 U	0.096 U
Acetophenone	0.95 U	0.39 J	0.11 J	0.11 J	1.1 U	0.1 U	0.092 U	0.096 U
Anthracene	0.095 U	0.1 U	0.1 U	0.096 U	0.11 U	0.1 U	0.092 U	0.096 U
Atrazine	0.33 U	0.36 U	0.35 U	0.34 U	0.38 U	0.36 U	0.32 U	0.34 U
Benzaldehyde	0.095 U	0.19 J	0.4 J	0.43 J	0.11 U	0.1 U	0.092 U	0.096 U
Benzo[a]anthracene	0.095 U	0.1 U	0.1 U	0.096 U	0.11 U	0.1 U	0.092 U	0.096 U
Benzo[a]pyrene	0.095 U	0.1 U	0.1 U	0.096 U	0.11 U	0.1 U	0.092 U	0.096 U
Benzo[b]fluoranthene	0.095 U	0.1 U	0.1 U	0.096 U	0.11 U	0.1 U	0.092 U	0.096 U
Benzo[g,h,i]perylene	0.095 U	0.1 U	0.1 U	0.096 U	0.11 U	0.1 U	0.092 U	0.096 U
Benzo[k]fluoranthene	0.095 U	0.1 U	0.1 U	0.096 U	0.11 U	0.1 U	0.092 U	0.096 U
Bis(2-chloroethoxy)methane	0.095 U	0.1 U	0.1 U	0.096 U	0.11 U	0.1 U	0.092 U	0.096 U
Bis(2-chloroethyl)ether	0.095 U	0.1 U	0.1 U	0.096 U	0.11 U	0.1 U	0.092 U	0.096 U
Bis(2-ethylhexyl) phthalate	0.61 U	0.66 U	0.65 U	0.62 U	0.7 U	0.66 U	0.59 U	0.62 U
Butyl benzyl phthalate	0.11 U	0.12 U	0.12 U	0.12 U	0.13 U	0.12 U	0.11 U	0.12 U
Caprolactam	0.12 U	0.13 U	24	0.13 U	0.18 J	0.13 U	0.21 J	0.15 J
Carbazole	0.095 U	0.1 U	0.1 U	0.096 U	0.11 U	0.1 U	0.092 U	0.096 U
Chrysene	0.043 U	0.046 U	0.046 U	0.043 U	0.049 U	0.046 U	0.042 U	0.043 U
Dibenz(a,h)anthracene	0.095 U	0.1 U	0.1 U	0.096 U	0.11 U	0.1 U	0.092 U	0.096 U
Dibenzofuran	0.095 U	0.1 U	0.1 U	0.096 U	0.11 U	0.1 U	0.092 U	0.096 U

	Culvert Samples							
	SW-DCEB-01	SW-DCEB-02	SW-DCEB-03	SW-DCEB-04	SW-DCFL-01	SW-DCFL-02	SW-DCFL-03	SW-DCFL-04
Compound Name	ebb tide, filtered	ebb tide, unfiltered	ebb tide, filtered, wet weather	ebb tide, unfiltered, wet weather	flood tide, filtered	flood tide, unfiltered	flood tide, filtered, wet weather	flood tide, unfiltered, wet weather
Diethyl phthalate	0.12 J	0.11 U	0.11 U	0.11 U	0.12 U	0.11 U	0.1 U	0.11 U
Dimethyl phthalate	0.095 U	0.1 U	0.1 U	0.096 U	0.11 U	0.1 U	0.092 U	0.096 U
Di-n-butyl phthalate	0.37 U	0.4 U	0.39 U	0.38 U	0.42 U	0.4 U	0.36 U	0.38 U
Di-n-octyl phthalate	0.16 U	0.18 U	0.17 U	0.16 U	0.18 U	0.17 U	0.16 U	0.16 U
Fluoranthene	0.095 U	0.1 U	0.1 U	0.096 U	0.11 U	0.1 U	0.092 U	0.096 U
Fluorene	0.095 U	0.1 U	0.1 U	0.096 U	0.11 U	0.1 U	0.092 U	0.096 U
Hexachlorobenzene	0.095 U	0.1 U	0.1 U	0.096 U	0.11 U	0.1 U	0.092 U	0.096 U
Hexachlorobutadiene	0.095 U	0.1 U	0.1 U	0.096 U	0.11 U	0.1 U	0.092 U	0.096 U
Hexachlorocyclopentadiene	0.47 U	0.52 U	0.51 U	0.48 U	0.54 U	0.51 U	0.46 U	0.48 U
Hexachloroethane	0.47 U	0.52 U	0.51 U	0.48 U	0.54 U	0.51 U	0.46 U	0.48 U
Indeno[1,2,3-cd]pyrene	0.095 U	0.1 U	0.1 U	0.096 U	0.11 U	0.1 U	0.092 U	0.096 U
Isophorone	0.095 U	0.1 U	0.1 U	0.096 U	0.11 U	0.1 U	0.092 U	0.096 U
Naphthalene	0.095 U	0.1 U	0.1 U	0.3	0.11 U	0.1 U	0.092 U	0.096 U
Nitrobenzene	0.095 U	0.1 U	0.1 U	0.096 U	0.11 U	0.1 U	0.092 U	0.096 U
N-Nitrosodi-n-propylamine	0.12 U	0.13 U	0.13 U	0.13 U	0.14 U	0.13 U	0.12 U	0.13 U
N-Nitrosodiphenylamine	0.35 U	0.38 U	0.37 U	0.36 U	0.4 U	0.38 U	0.34 U	0.36 U
Pentachlorophenol	0.38 U	0.41 U	0.4 U	0.38 U	0.44 U	0.41 U	0.37 U	0.39 U
Phenanthrene	0.095 U	0.1 U	0.1 U	0.096 U	0.11 U	0.1 U	0.092 U	0.096 U
Phenol	0.12 U	0.13 U	0.13 U	0.13 U	0.14 U	0.13 U	0.12 U	0.13 U
Pyrene	0.095 U	0.1 U	0.1 U	0.096 U	0.11 U	0.1 U	0.092 U	0.096 U
VOCs (µg/L)								
1,1,1-Trichloroethane	NA	0.5 U	NA	0.5 U	NA	0.5 U	NA	NA
1,1,2,2-Tetrachloroethane	NA	0.18 U	NA	0.18 U	NA	0.18 U	NA	NA
1,1,2-Trichloro-1,2,2-	NA	0.5 U	NA	0.5 U	NA	0.5 U	NA	NA
1,1,2-Trichloroethane	NA	0.13 U	NA	0.13 U	NA	0.13 U	NA	NA
1,1-Dichloroethane	NA	0.25 U	NA	0.25 U	NA	0.25 U	NA	NA
1,1-Dichloroethene	NA	0.11 U	NA	0.11 U	NA	0.11 U	NA	NA
1,2,4-Trichlorobenzene	NA	0.25 U	NA	0.25 U	NA	0.25 U	NA	NA
1,2-Dibromo-3-	NA	0.44 U	NA	0.44 U	NA	0.44 UJ	NA	NA
1,2-Dibromoethane	NA	0.25 U	NA	0.25 U	NA	0.25 U	NA	NA
1,2-Dichlorobenzene	NA	0.21 U	NA	0.21 U	NA	0.21 U	NA	NA
1,2-Dichloroethane	NA	0.1 U	NA	0.1 U	NA	0.1 U	NA	NA
1,2-Dichloropropane	NA	0.13 U	NA	0.13 U	NA	0.13 U	NA	NA
1,3-Dichlorobenzene	NA	0.25 U	NA	0.25 U	NA	0.25 U	NA	NA
1,4-Dichlorobenzene	NA	0.28 U	NA	0.28 U	NA	0.28 U	NA	NA
2-Butanone	NA	1 U	NA	1 U	NA	1 U	NA	NA
2-Hexanone	NA	1 U	NA	1 U	NA	1 U	NA	NA
4-Methyl-2-pentanone	NA	1 U	NA	1 U	NA	1 U	NA	NA
Acetone	NA	6.1 J	NA	5 U	NA	5 U	NA	NA
Benzene	NA	0.53 J	NA	0.25 U	NA	0.25 U	NA	NA

	Culvert Samples							
	SW-DCEB-01	SW-DCEB-02	SW-DCEB-03	SW-DCEB-04	SW-DCFL-01	SW-DCFL-02	SW-DCFL-03	SW-DCFL-04
Compound Name	ebb tide, filtered	ebb tide, unfiltered	ebb tide, filtered, wet weather	ebb tide, unfiltered, wet weather	flood tide, filtered	flood tide, unfiltered	flood tide, filtered, wet weather	flood tide, unfiltered, wet weather
Bromodichloromethane	NA	0.25 U	NA	0.25 U	NA	0.25 U	NA	NA
Bromoform	NA	0.5 U	NA	0.5 U	NA	0.5 UJ	NA	NA
Bromomethane	NA	0.8 U	NA	0.8 U	NA	0.8 U	NA	NA
Carbon disulfide	NA	0.6 U	NA	0.6 U	NA	0.6 U	NA	NA
Carbon tetrachloride	NA	9	NA	0.66 J	NA	0.5 UJ	NA	NA
Chlorobenzene	NA	0.78 J	NA	0.25 U	NA	0.25 U	NA	NA
Chloroethane	NA	1 U	NA	1 U	NA	1 U	NA	NA
Chloroform	NA	3.3	NA	0.39 J	NA	0.14 U	NA	NA
Chloromethane	NA	0.33 U	NA	0.33 U	NA	0.33 U	NA	NA
cis-1,2-Dichloroethene	NA	0.15 U	NA	0.15 U	NA	0.15 U	NA	NA
cis-1,3-Dichloropropene	NA	0.11 U	NA	0.11 U	NA	0.11 U	NA	NA
Cyclohexane	NA	0.25 U	NA	0.25 U	NA	0.25 U	NA	NA
Dibromochloromethane	NA	0.1 U	NA	0.1 U	NA	0.1 UJ	NA	NA
Dichlorodifluoromethane	NA	0.25 U	NA	0.25 U	NA	0.25 U	NA	NA
Ethylbenzene	NA	2.3	NA	0.4 J	NA	0.11 U	NA	NA
Isopropylbenzene	NA	0.91 J	NA	0.16 J	NA	0.1 U	NA	NA
Methyl acetate	NA	0.19 U	NA	0.19 U	NA	0.19 U	NA	NA
Methyl tert-butyl ether	NA	0.2 U	NA	0.2 U	NA	0.2 U	NA	NA
Methylcyclohexane	NA	0.1 U	NA	0.1 U	NA	0.1 U	NA	NA
Methylene Chloride	NA	1 U	NA	1 U	NA	1 U	NA	NA
Styrene	NA	0.11 U	NA	0.11 U	NA	0.11 U	NA	NA
Tetrachloroethene	NA	0.15 U	NA	0.2 J	NA	0.15 U	NA	NA
Toluene	NA	0.33 J	NA	0.33 U	NA	0.33 U	NA	NA
trans-1,2-Dichloroethene	NA	0.2 U	NA	0.2 U	NA	0.2 U	NA	NA
trans-1,3-Dichloropropene	NA	0.21 U	NA	0.21 U	NA	0.21 U	NA	NA
Trichloroethene	NA	0.13 U	NA	0.13 U	NA	0.13 U	NA	NA
Trichlorofluoromethane	NA	0.25 U	NA	0.25 U	NA	0.25 U	NA	NA
Vinyl chloride	NA	0.18 U	NA	0.18 U	NA	0.18 U	NA	NA
Xylenes, Total	NA	16	NA	2.5	NA	0.2 U	NA	NA
Metals (mg/L)								
Aluminum	0.07 J	0.11	NA	1.4	0.05 U	0.89	0.05 U	1.2
Antimony	0.002 U	0.002 U	NA	0.004 U	0.004 U	0.004 U	0.004 U	0.008 U
Arsenic	0.0039	0.0037	NA	0.0057	0.0025	0.0031 J	0.0026	0.0034
Barium	0.086	0.088	NA	0.057	0.028	0.032	0.023	0.028
Beryllium	0.00015 U	0.00015 U	NA	0.0006 U	0.0003 U	0.00015 U	0.00015 U	0.0006 U
Cadmium	0.00013 U	0.00013 U	NA	0.00026 U	0.00026 U	0.00026 U	0.00026 U	0.00052 U
Calcium	84	84	NA	390	310	320	350	340
Chromium	0.0025 U	0.0025 U	NA	0.0025 U	0.0025 U	0.005 U	0.0025 U	0.0025 U
Cobalt	0.0005 U	0.0005 U	NA	0.0011	0.0014	0.0012	0.00081	0.0011
Copper	0.0011 U	0.0012 J	NA	0.0015 J	0.0011 U	0.0022 U	0.0011 U	0.0011 U

	Culvert Samples							
	SW-DCEB-01	SW-DCEB-02	SW-DCEB-03	SW-DCEB-04	SW-DCFL-01	SW-DCFL-02	SW-DCFL-03	SW-DCFL-04
Compound Name	ebb tide, filtered	ebb tide, unfiltered	ebb tide, filtered, wet weather	ebb tide, unfiltered, wet weather	flood tide, filtered	flood tide, unfiltered	flood tide, filtered, wet weather	flood tide, unfiltered, wet weather
Iron	0.044 U	0.17	NA	0.94	0.044 U	0.54	0.044 U	0.85
Lead	0.0021	0.0005 U	NA	0.001 J	0.0005 U	0.0005 U	0.0005 U	0.00078 J
Magnesium	52	54	NA	1,100	1,100	1,100	1,200	1,000
Manganese	0.035	0.037	NA	0.21	0.099	0.14	0.091	0.12
Mercury	0.000091 U	0.000091 U	NA	0.000091 U	0.000091 U	0.000091 U	0.000091 U	0.000091 U
Nickel	0.002 U	0.002 U	NA	0.002 U	0.002 U	0.004 U	0.002 U	0.002 U
Potassium	9.6	10	NA	390	340	370	350	340
Selenium	0.0011 U	0.0011 U	NA	0.0022 U	0.0022 U	0.0022 U	0.0011 J	0.0022 U
Silver	0.00018 U	0.00018 U	NA	0.00036 U	0.00036 U	0.00036 U	0.00036 U	0.00072 U
Sodium	210	230	NA	9,300	8,200	8,300	9,700	9,000
Thallium	0.00025 U	0.00025 U	NA	0.0005 U	0.00025 U	0.00025 U	0.00025 U	0.00025 U
Vanadium	0.0041 J	0.0045 J	NA	0.0074 J	0.0039 J	0.0064 U	0.0048 J	0.0074 J
Zinc	0.0084 U	0.0099 J	NA	0.025 J	0.014 J	0.017 U	0.015 J	0.017 J
Cyanide, Total	0.005 U	0.005 U	NA	0.005 U	0.006 J	0.005 U	0.013	0.0065 J
Total Suspended Solids	NA	5.5	NA	43	NA	30	NA	31

NOTES:
U: not detected; J: estimated concentration; R: rejected after data analysis
NA: not analyzed

	Mouth Samples					
	SW-DMEB-01	SW-DMEB-02	SW-DMEB-03	SW-DMEB-04	SW-DMFL-01	SW-DMFL-02
Compound Name	ebb tide, filtered	ebb tide, unfiltered	ebb tide, filtered, wet weather	ebb tide, unfiltered, wet weather	flood tide, filtered	flood tide, unfiltered
Toxaphene (µg/L)						
Method 1 (Technical)	0.24 U	0.47 U	0.54 U	0.5 U	0.47 U	0.51 U
Method 2 (TAUC)	0.51 U	0.47 U	0.54 U	0.5 U	0.47 U	0.51 U
Pesticides (µg/L)						
4,4-DDD	0.0066 U	0.0061 U	0.0071 U	0.0065 U	0.0061 U	0.0066 U
4,4-DDE	0.0078 U	0.0072 U	0.0084 U	0.0077 U	0.0072 U	0.0078 U
4,4-DDT	0.0098 U	0.009 U	0.011 U	0.0097 U	0.0091 U	0.0098 U
Aldrin	0.0071 U	0.0065 U	0.0076 U	0.007 U	0.0065 U	0.0071 U
alpha-BHC	0.0058 U	0.0053 U	0.0062 U	0.0057 U	0.0053 U	0.0058 U
alpha-Chlordane	0.0061 U	0.0056 U	0.0065 U	0.006 U	0.0056 U	0.0061 U
beta-BHC	0.0068 U	0.0062 U	0.0073 U	0.0067 U	0.0063 U	0.0068 U
delta-BHC	0.0049 U	0.0045 U	0.0052 U	0.0048 U	0.0045 U	0.0049 U
Dieldrin	0.0092 U	0.0085 U	0.0099 U	0.0091 U	0.0085 U	0.0092 U
Endosulfan I	0.0043 U	0.0039 U	0.0046 U	0.0042 U	0.0039 U	0.0043 U
Endosulfan II	0.0099 UJ	0.0091 UJ	0.011 U	0.0098 U	0.0092 UJ	0.0099 UJ
Endosulfan sulfate	0.0069 UJ	0.0063 UJ	0.0074 U	0.0068 U	0.0064 UJ	0.0069 UJ
Endrin	0.0098 UJ	0.009 UJ	0.011 U	0.0097 U	0.0091 UJ	0.0098 UJ
Endrin aldehyde	0.016 U	0.015 U	0.017 U	0.016 U	0.015 U	0.016 U
Endrin ketone	0.0085 U	0.0078 U	0.0091 U	0.0084 U	0.0079 U	0.0085 U
gamma-BHC (Lindane)	0.006 U	0.0055 U	0.0064 U	0.0059 U	0.0055 U	0.006 U
gamma-Chlordane	0.0052 U	0.0048 U	0.0056 U	0.0051 U	0.0048 U	0.0052 U
Heptachlor	0.0071 U	0.0065 U	0.0076 U	0.007 U	0.0065 U	0.0071 U
Heptachlor epoxide	0.0061 U	0.0056 U	0.0065 U	0.006 U	0.0056 U	0.0061 U
Methoxychlor	0.013 U	0.012 U	0.014 U	0.013 U	0.012 U	0.013 U
PCB-1016	0.072 U	0.066 U	0.077 U	0.071 U	0.066 U	0.072 U
PCB-1221	0.28 U	0.26 U	0.3 U	0.28 U	0.26 U	0.28 U
PCB-1232	0.11 U	0.1 U	0.12 U	0.11 U	0.1 U	0.11 U
PCB-1242	0.18 U	0.17 U	0.2 U	0.18 U	0.17 U	0.18 U
PCB-1248	0.36 U	0.34 U	0.39 U	0.36 U	0.34 U	0.37 U
PCB-1254	0.26 U	0.24 U	0.28 U	0.26 U	0.24 U	0.26 U
PCB-1260	0.2 U	0.19 U	0.22 U	0.2 U	0.19 U	0.2 U
PCB-1268	0.26 U	0.24 U	0.28 U	0.26 U	0.24 U	0.26 U
SVOCs (µg/L)						
1,1-Biphenyl	0.1 U	0.1 U	0.1 U	0.11 U	0.093 U	0.1 U
2,2-oxybis[1-chloropropane]	0.1 U	0.1 U	0.1 U	0.11 U	0.093 U	0.1 U
2,4,5-Trichlorophenol	0.12 U	0.12 U	0.12 U	0.13 U	0.11 U	0.13 U
2,4,6-Trichlorophenol	0.17 U	0.18 U	0.17 U	0.19 U	0.16 U	0.18 U
2,4-Dichlorophenol	0.1 U	0.1 U	0.1 U	0.11 U	0.093 U	0.1 U
2,4-Dimethylphenol	0.71 U	0.72 U	0.71 U	0.77 U	0.64 U	0.72 U

	Mouth Samples					
	SW-DMEB-01	SW-DMEB-02	SW-DMEB-03	SW-DMEB-04	SW-DMFL-01	SW-DMFL-02
Compound Name	ebb tide, filtered	ebb tide, unfiltered	ebb tide, filtered, wet weather	ebb tide, unfiltered, wet weather	flood tide, filtered	flood tide, unfiltered
2,4-Dinitrophenol	1.1 U	1.1 U	1.1 U	1.2 U	1 U	1.2 U
2,4-Dinitrotoluene	0.12 U	0.12 U	0.12 U	0.13 U	0.11 U	0.13 U
2,6-Dinitrotoluene	0.13 U	0.14 U	0.13 U	0.14 U	0.12 U	0.14 U
2-Chloronaphthalene	0.1 U	0.1 U	0.1 U	0.11 U	0.093 U	0.1 U
2-Chlorophenol	0.12 U	0.12 U	0.12 U	0.13 U	0.11 U	0.13 U
2-Methylnaphthalene	0.1 U	0.1 U	0.1 U	0.11 U	0.093 U	0.1 U
2-Methylphenol	0.76 U	0.77 U	0.76 U	0.82 U	0.69 U	0.78 U
2-Nitroaniline	0.16 U	0.17 U	0.16 U	0.18 U	0.15 U	0.17 U
2-Nitrophenol	0.1 U	0.1 U	0.1 U	0.11 U	0.093 U	0.1 U
3 & 4 Methylphenol	0.68 U	0.69 U	0.67 U	0.73 U	0.62 U	0.69 U
3,3'-Dichlorobenzidine			2 U	2.2 U		
3,3-Dichlorobenzidine	2 U	2.1 U			1.9 U	2.1 U
3-Nitroaniline	0.16 U	0.17 U	0.16 U	0.18 U	0.15 U	0.17 U
4,6-Dinitro-2-methylphenol	0.13 U	0.14 U	0.13 U	0.14 U	0.12 U	0.14 U
4-Bromophenyl phenyl ether	0.12 U	0.12 U	0.12 U	0.13 U	0.11 U	0.13 U
4-Chloro-3-methylphenol	0.12 U	0.12 U	0.12 U	0.13 U	0.11 U	0.13 U
4-Chloroaniline	0.37 U	0.37 U	0.37 U	0.4 U	0.34 U	0.38 U
4-Chlorophenyl phenyl ether	0.1 U	0.1 U	0.1 U	0.11 U	0.093 U	0.1 U
4-Nitroaniline	0.51 U	0.52 U	0.51 U	0.56 U	0.47 U	0.52 U
4-Nitrophenol	0.51 U	0.52 U	0.51 U	0.56 U	0.47 U	0.52 U
Acenaphthene	0.1 U	0.1 U	0.1 U	0.11 U	0.093 U	0.1 U
Acenaphthylene	0.1 U	0.1 U	0.1 U	0.11 U	0.093 U	0.1 U
Acetophenone	1 U	1 U	0.1 U	0.11 U	0.093 U	1 U
Anthracene	0.1 U	0.1 U	0.1 U	0.11 U	0.093 U	0.1 U
Atrazine	0.36 U	0.36 U	0.36 U	0.39 U	0.33 U	0.37 U
Benzaldehyde	0.1 U	0.1 U	0.1 U	0.11 U	0.093 U	0.1 U
Benzo[a]anthracene	0.1 U	0.1 U	0.1 U	0.11 U	0.093 U	0.1 U
Benzo[a]pyrene	0.1 U	0.1 U	0.1 U	0.11 U	0.093 U	0.1 U
Benzo[b]fluoranthene	0.1 U	0.1 U	0.1 U	0.11 U	0.093 U	0.1 U
Benzo[g,h,i]perylene	0.1 U	0.1 U	0.1 U	0.11 U	0.093 U	0.1 U
Benzo[k]fluoranthene	0.1 U	0.1 U	0.1 U	0.11 U	0.093 U	0.1 U
Bis(2-chloroethoxy)methane	0.1 U	0.1 U	0.1 U	0.11 U	0.093 U	0.1 U
Bis(2-chloroethyl)ether	0.1 U	0.1 U	0.1 U	0.11 U	0.093 U	0.1 U
Bis(2-ethylhexyl) phthalate	0.66 U	0.67 U	0.65 U	0.71 U	0.6 U	0.67 U
Butyl benzyl phthalate	0.12 U	0.12 U	0.12 U	0.13 U	0.11 U	0.13 U
Caprolactam	0.25 J	0.14 U	0.2 J	0.19 J	0.12 U	0.14 U
Carbazole	0.1 U	0.1 U	0.1 U	0.11 U	0.093 U	0.1 U
Chrysene	0.046 U	0.047 U	0.046 U	0.05 U	0.042 U	0.047 U
Dibenz(a,h)anthracene	0.1 U	0.1 U	0.1 U	0.11 U	0.093 U	0.1 U
Dibenzofuran	0.1 U	0.1 U	0.1 U	0.11 U	0.093 U	0.1 U

	Mouth Samples					
	SW-DMEB-01	SW-DMEB-02	SW-DMEB-03	SW-DMEB-04	SW-DMFL-01	SW-DMFL-02
Compound Name	ebb tide, filtered	ebb tide, unfiltered	ebb tide, filtered, wet weather	ebb tide, unfiltered, wet weather	flood tide, filtered	flood tide, unfiltered
Diethyl phthalate	0.11 J	0.11 U	0.11 U	0.12 U	0.1 U	0.12 U
Dimethyl phthalate	0.1 U	0.1 U	0.1 U	0.11 U	0.093 U	0.1 U
Di-n-butyl phthalate	0.4 U	0.41 U	0.4 U	0.43 U	0.36 U	0.41 U
Di-n-octyl phthalate	0.17 U	0.18 U	0.17 U	0.19 U	0.16 U	0.18 U
Fluoranthene	0.1 U	0.1 U	0.1 U	0.11 U	0.093 U	0.1 U
Fluorene	0.1 U	0.1 U	0.1 U	0.11 U	0.093 U	0.1 U
Hexachlorobenzene	0.1 U	0.1 U	0.1 U	0.11 U	0.093 U	0.1 U
Hexachlorobutadiene	0.1 U	0.1 U	0.1 U	0.11 U	0.093 U	0.1 U
Hexachlorocyclopentadiene	0.51 U	0.52 U	0.51 U	0.56 U	0.47 U	0.52 U
Hexachloroethane	0.51 U	0.52 U	0.51 U	0.56 U	0.47 U	0.52 U
Indeno[1,2,3-cd]pyrene	0.1 U	0.1 U	0.1 U	0.11 U	0.093 U	0.1 U
Isophorone	0.1 U	0.1 U	0.1 U	0.11 U	0.093 U	0.1 U
Naphthalene	0.1 U	0.1 U	0.1 U	0.11 U	0.093 U	0.1 U
Nitrobenzene	0.1 U	0.1 U	0.1 U	0.11 U	0.093 U	0.1 U
N-Nitrosodi-n-propylamine	0.13 U	0.14 U	0.13 U	0.14 U	0.12 U	0.14 U
N-Nitrosodiphenylamine	0.38 U	0.38 U	0.38 U	0.41 U	0.35 U	0.39 U
Pentachlorophenol	0.41 U	0.42 U	0.41 U	0.44 U	0.37 U	0.42 U
Phenanthrene	0.1 U	0.1 U	0.1 U	0.11 U	0.093 U	0.1 U
Phenol	0.13 U	0.14 U	0.13 U	0.14 U	0.12 U	0.14 U
Pyrene	0.1 U	0.1 U	0.1 U	0.11 U	0.093 U	0.1 U
VOCs (µg/L)						
1,1,1-Trichloroethane	NA	0.5 U	NA	NA	NA	0.5 U
1,1,2,2-Tetrachloroethane	NA	0.18 U	NA	NA	NA	0.18 U
1,1,2-Trichloro-1,2,2-	NA	0.5 U	NA	NA	NA	0.5 U
1,1,2-Trichloroethane	NA	0.13 U	NA	NA	NA	0.13 U
1,1-Dichloroethane	NA	0.25 U	NA	NA	NA	0.25 U
1,1-Dichloroethene	NA	0.11 U	NA	NA	NA	0.11 U
1,2,4-Trichlorobenzene	NA	0.25 U	NA	NA	NA	0.25 U
1,2-Dibromo-3-	NA	0.44 U	NA	NA	NA	0.44 U
1,2-Dibromoethane	NA	0.25 U	NA	NA	NA	0.25 U
1,2-Dichlorobenzene	NA	0.21 U	NA	NA	NA	0.21 U
1,2-Dichloroethane	NA	0.1 U	NA	NA	NA	0.1 U
1,2-Dichloropropane	NA	0.13 U	NA	NA	NA	0.13 U
1,3-Dichlorobenzene	NA	0.25 U	NA	NA	NA	0.25 U
1,4-Dichlorobenzene	NA	0.28 U	NA	NA	NA	0.28 U
2-Butanone	NA	1 U	NA	NA	NA	1 U
2-Hexanone	NA	1 U	NA	NA	NA	1 U
4-Methyl-2-pentanone	NA	1 U	NA	NA	NA	1 U
Acetone	NA	5 U	NA	NA	NA	5 UJ
Benzene	NA	0.25 U	NA	NA	NA	0.25 U

	Mouth Samples					
	SW-DMEB-01	SW-DMEB-02	SW-DMEB-03	SW-DMEB-04	SW-DMFL-01	SW-DMFL-02
Compound Name	ebb tide, filtered	ebb tide, unfiltered	ebb tide, filtered, wet weather	ebb tide, unfiltered, wet weather	flood tide, filtered	flood tide, unfiltered
Bromodichloromethane	NA	0.25 U	NA	NA	NA	0.25 U
Bromoform	NA	0.5 U	NA	NA	NA	0.5 U
Bromomethane	NA	0.8 U	NA	NA	NA	0.8 U
Carbon disulfide	NA	0.6 U	NA	NA	NA	0.6 U
Carbon tetrachloride	NA	0.5 U	NA	NA	NA	0.5 U
Chlorobenzene	NA	0.25 U	NA	NA	NA	0.25 U
Chloroethane	NA	1 U	NA	NA	NA	1 U
Chloroform	NA	0.14 U	NA	NA	NA	0.14 U
Chloromethane	NA	0.33 U	NA	NA	NA	0.33 U
cis-1,2-Dichloroethene	NA	0.15 U	NA	NA	NA	0.15 U
cis-1,3-Dichloropropene	NA	0.11 U	NA	NA	NA	0.11 U
Cyclohexane	NA	0.25 U	NA	NA	NA	0.25 U
Dibromochloromethane	NA	0.1 U	NA	NA	NA	0.1 U
Dichlorodifluoromethane	NA	0.25 U	NA	NA	NA	0.25 U
Ethylbenzene	NA	0.11 U	NA	NA	NA	0.11 U
Isopropylbenzene	NA	0.1 U	NA	NA	NA	0.1 U
Methyl acetate	NA	0.19 U	NA	NA	NA	0.19 U
Methyl tert-butyl ether	NA	0.2 U	NA	NA	NA	0.2 U
Methylcyclohexane	NA	0.1 U	NA	NA	NA	0.1 U
Methylene Chloride	NA	1 U	NA	NA	NA	1 U
Styrene	NA	0.11 U	NA	NA	NA	0.11 U
Tetrachloroethene	NA	0.15 U	NA	NA	NA	0.15 U
Toluene	NA	0.33 U	NA	NA	NA	0.33 U
trans-1,2-Dichloroethene	NA	0.2 U	NA	NA	NA	0.2 U
trans-1,3-Dichloropropene	NA	0.21 U	NA	NA	NA	0.21 U
Trichloroethene	NA	0.13 U	NA	NA	NA	0.13 U
Trichlorofluoromethane	NA	0.25 U	NA	NA	NA	0.25 U
Vinyl chloride	NA	0.18 U	NA	NA	NA	0.18 U
Xylenes, Total	NA	0.2 U	NA	NA	NA	0.2 J
Metals (mg/L)						
Aluminum	0.05 U	2	0.05 U	1.4	0.05 U	0.0029
Antimony	0.002 U	0.01 U	0.004 U	0.008 U	0.004 U	0.004 U
Arsenic	0.0028	0.0032	0.0027	0.0031 J	0.0024 J	0.0029 J
Barium	0.033	0.039	0.016	0.018 J	0.029	0.03
Beryllium	0.0003 U	0.0003 U	0.0006 U	0.0006 U	0.0003 U	0.00015 U
Cadmium	0.00017 J	0.00065 U	0.00026 U	0.00052 U	0.00026 U	0.00026 U
Calcium	310	280	390	370	310	310
Chromium	0.0025 U	0.0034 J	0.0025 U	0.005 U	0.0025 U	0.0026 J
Cobalt	0.00086	0.0015	0.00075	0.00092 J	0.0012	0.0013
Copper	0.0011 U	0.0012 J	0.0011 U	0.0022 U	0.0011 U	0.0011 U

	Mouth Samples									
	SW-DMEB-01	SW-DMEB-02	SW-DMEB-03	SW-DMEB-04	SW-DMFL-01	SW-DMFL-02				
Compound Name	ebb tide, filtered	ebb tide, unfiltered	ebb tide, filtered, wet weather	ebb tide, unfiltered, wet weather	flood tide, filtered	flood tide, unfiltered				
Iron	0.044 U	1.3	0.044 U	0.96	0.044 U	1				
Lead	0.0005 U	0.0015 U	0.0005 U	0.001 U	0.0015 U	0.0015 U				
Magnesium	980	940	1,200	1,100	1,100	1,100				
Manganese	0.095	0.12	0.0091	0.034	0.13	0.15				
Mercury	0.000091 U	0.000091 U	0.000091 U	0.00012 J	0.000091 U	0.000091 U				
Nickel	0.002 U	0.002 U	0.002 U	0.004 U	0.002 U	0.0025 J				
Potassium	330	300	390	360	350	340				
Selenium	0.0022 U	0.0011 U	0.0044 U	0.0044 U	0.0022 U	0.0022 U				
Silver	0.00018 U	0.0009 U	0.00036 U	0.00072 U	0.00036 U	0.00036 U				
Sodium	8,000	7,800	10,000	9,300	8,800	8,700				
Thallium	0.00025 U	0.00025 U	0.00025 U	0.0005 U	0.00025 U	0.00025 U				
Vanadium	0.0042 J	0.0083 J	0.0044 J	0.013 U	0.0042 J	0.0078 J				
Zinc	0.013 J	0.017 U	0.015 J	0.034 U	0.014 J	0.019 J	SW-DCSH-05	SW-DCSL-06	SW-DMSH-05	SW-DMSL-06
Cyanide, Total	0.0062 J	0.005 U	0.0094 J	0.008 J	0.005 U	0.005 U	high slack in culvert	low slack in culvert	high slack in mouth	low slack in mouth
Total Suspended Solids	NA	29	NA	43	NA	37	**24**	5 U	**48**	**44**

Table C-3. Analytical Results for Pore Water Samples, Terry Creek OU1 RI/FS

Compound Name	PW-ODPO-01 dissolved	PW-ODPO-02 total	PW-ODPR-01 dissolved	PW-ODPR-02 total
Toxaphene (µg/L)				
Method 1 (Technical)	2.3 J	9.5 U	0.49 U	0.49 U
Method 2 (TAUC)	**8.8**	**17**	0.49 U	0.49 U
Pesticides/PCBs (µg/L)				
4,4-DDD	0.13 U	0.12 U	0.0063 U	0.0064 U
4,4-DDE	0.15 U	0.15 U	0.0075 U	0.0076 U
4,4-DDT	0.19 U	0.18 U	0.0094 U	0.0095 U
Aldrin	0.14 U	0.13 U	0.0068 U	0.0069 U
alpha-BHC	0.11 U	0.11 U	0.0056 U	0.0056 U
alpha-Chlordane	0.12 U	0.11 U	0.0058 U	0.0059 U
beta-BHC	0.13 U	0.13 U	0.0065 U	0.0066 U
delta-BHC	0.093 U	0.091 U	0.0047 U	0.0047 U
Dieldrin	0.18 U	0.17 U	0.0089 U	0.0089 U
Endosulfan I	0.082 U	0.08 U	0.0041 U	0.0041 U
Endosulfan II	0.19 U	0.19 U	0.0095 U	0.0096 U
Endosulfan sulfate	0.13 U	0.13 U	0.0066 U	0.0067 U
Endrin	0.19 U	0.18 U	0.0094 U	0.0095 U
Endrin aldehyde	0.31 U	0.3 U	0.016 U	0.016 U
Endrin ketone	0.16 U	0.16 U	0.0082 U	0.0083 U
gamma-BHC (Lindane)	0.11 U	0.11 U	0.0057 U	0.0058 U
gamma-Chlordane	0.099 U	0.097 U	0.005 U	0.005 U
Heptachlor	0.14 U	0.13 U	0.0068 U	0.0069 U
Heptachlor epoxide	0.12 U	0.11 U	0.0058 U	0.0059 U
Methoxychlor	0.25 U	0.25 U	0.013 U	0.013 U
PCB-1016	0.069 U	1.3 U	0.069 U	0.07 U
PCB-1221	0.27 U	5.3 U	0.27 U	0.28 U
PCB-1232	0.11 U	2.1 U	0.11 U	0.11 U
PCB-1242	0.18 U	3.4 U	0.18 U	0.18 U
PCB-1248	0.35 U	6.8 U	0.35 U	0.35 U
PCB-1254	0.25 U	4.9 U	0.25 U	0.26 U
PCB-1260	0.19 U	3.8 U	0.19 U	0.2 U
PCB-1268	0.25 U	4.9 U	0.25 U	0.26 U
SVOCs (µg/L)				
1,1-Biphenyl	0.1 U	0.11 U	0.1 U	0.12 U
2,2-oxybis[1-chloropropane]	0.1 U	0.11 U	0.1 U	0.12 U
2,4,5-Trichlorophenol	0.12 U	0.13 U	0.12 U	0.14 U
2,4,6-Trichlorophenol	0.18 U	0.18 U	0.17 U	0.2 U
2,4-Dichlorophenol	0.1 U	0.11 U	0.1 U	0.12 U
2,4-Dimethylphenol	0.71 U	0.74 U	0.7 U	0.81 U
2,4-Dinitrophenol	1.1 U	1.2 U	1.1 U	1.3 U
2,4-Dinitrotoluene	0.12 U	0.13 U	0.12 U	0.14 U
2,6-Dinitrotoluene	0.13 U	0.14 U	0.13 U	0.15 U
2-Chloronaphthalene	0.1 U	0.11 U	0.1 U	0.12 U
2-Chlorophenol	0.12 U	0.13 U	0.12 U	0.14 U
2-Methylnaphthalene	0.1 U	0.11 U	0.1 U	0.12 U
2-Methylphenol	0.76 U	0.79 U	0.76 U	0.86 U
2-Nitroaniline	0.16 U	0.17 U	0.16 U	0.19 U
2-Nitrophenol	0.1 U	0.11 U	0.1 U	0.12 U
3 & 4 Methylphenol	0.68 U	0.7 U	0.67 U	0.77 U
3,3-Dichlorobenzidine	2.1 U	2.1 U	2 U	2.3 U
3-Nitroaniline	0.16 U	0.17 U	0.16 U	0.19 U
4,6-Dinitro-2-methylphenol	0.13 U	0.14 U	0.13 U	0.15 U
4-Bromophenyl phenyl ether	0.12 U	0.13 U	0.12 U	0.14 U
4-Chloro-3-methylphenol	0.12 U	0.13 U	0.12 U	0.14 U
4-Chloroaniline	0.37 U	0.38 U	0.37 U	0.42 U

Compound Name	PW-ODPO-01 dissolved	PW-ODPO-02 total	PW-ODPR-01 dissolved	PW-ODPR-02 total
4-Chlorophenyl phenyl ether	0.1 U	0.11 U	0.1 U	0.12 U
4-Nitroaniline	0.52 U	0.53 U	0.51 U	0.58 U
4-Nitrophenol	0.52 U	0.53 U	0.51 U	0.58 U
Acenaphthene	0.1 U	0.11 U	0.1 U	0.12 U
Acenaphthylene	0.1 U	0.11 U	0.1 U	0.12 U
Acetophenone	1 U	1.1 U	1 U	1.2 U
Anthracene	0.1 U	0.11 U	0.1 U	0.12 U
Atrazine	0.36 U	0.37 U	0.36 U	0.41 U
Benzaldehyde	0.52 J	0.57 J	0.54 J	0.46 J
Benzo[a]anthracene	0.1 U	0.11 U	0.1 U	0.12 U
Benzo[a]pyrene	0.1 U	0.11 U	0.1 U	0.12 U
Benzo[b]fluoranthene	0.1 U	0.11 U	0.1 U	0.12 U
Benzo[g,h,i]perylene	0.1 U	0.11 U	0.1 U	0.12 U
Benzo[k]fluoranthene	0.1 U	0.11 U	0.1 U	0.12 U
Bis(2-chloroethoxy)methane	0.1 U	0.11 U	0.1 U	0.12 U
Bis(2-chloroethyl)ether	0.1 U	0.11 U	0.1 U	0.12 U
Bis(2-ethylhexyl) phthalate	0.66 U	0.68 U	0.65 U	0.75 U
Butyl benzyl phthalate	0.12 U	0.13 U	0.12 U	0.14 U
Caprolactam	0.13 U	0.14 U	0.13 U	0.15 U
Carbazole	0.1 U	0.11 U	0.1 U	0.12 U
Chrysene	0.046 U	0.048 U	0.046 U	0.053 U
Dibenz(a,h)anthracene	0.1 U	0.11 U	0.1 U	0.12 U
Dibenzofuran	0.1 U	0.11 U	0.1 U	0.12 U
Diethyl phthalate	0.11 U	0.12 U	0.21 J	0.31 J
Dimethyl phthalate	0.1 U	0.11 U	0.1 U	0.12 U
Di-n-butyl phthalate	0.4 U	0.42 U	0.4 U	0.46 U
Di-n-octyl phthalate	0.18 U	0.18 U	0.17 U	0.2 U
Fluoranthene	0.1 U	0.11 U	0.1 U	0.12 U
Fluorene	0.1 U	0.11 U	0.1 U	0.12 U
Hexachlorobenzene	0.1 U	0.11 U	0.1 U	0.12 U
Hexachlorobutadiene	0.1 U	0.11 U	0.1 U	0.12 U
Hexachlorocyclopentadiene	R	R	R	R
Hexachloroethane	0.52 U	0.53 U	0.51 U	0.58 U
Indeno[1,2,3-cd]pyrene	0.1 U	0.11 U	0.1 U	0.12 U
Isophorone	0.1 U	0.11 U	0.1 U	0.12 U
Naphthalene	0.1 U	0.11 U	0.1 U	0.16 J
Nitrobenzene	0.1 U	0.11 U	0.1 U	0.12 U
N-Nitrosodi-n-propylamine	0.13 U	0.14 U	0.13 U	0.15 U
N-Nitrosodiphenylamine	0.38 U	0.39 U	0.38 U	0.43 U
Pentachlorophenol	0.41 U	0.43 U	0.41 U	0.47 U
Phenanthrene	0.1 U	0.11 U	0.1 U	0.12 U
Phenol	0.25 J	0.36 J	0.13 U	0.15 J
Pyrene	0.1 U	0.11 U	0.1 U	0.12 U
VOCs (µg/L)				
1,1,1-Trichloroethane	0.5 U	0.5 U	0.5 U	0.5 U
1,1,2,2-Tetrachloroethane	0.18 U	0.18 U	0.18 U	0.18 U
1,1,2-Trichloro-1,2,2-trifluoroethane	0.5 U	0.5 U	0.5 U	0.5 U
1,1,2-Trichloroethane	0.13 U	0.13 U	0.13 U	0.13 U
1,1-Dichloroethane	0.25 U	0.25 U	0.25 U	0.25 U
1,1-Dichloroethene	0.11 U	0.11 U	0.11 U	0.11 U
1,2,4-Trichlorobenzene	0.25 U	0.25 U	0.25 U	0.25 U
1,2-Dibromo-3-Chloropropane	0.44 U	0.44 U	0.44 U	0.44 U
1,2-Dibromoethane	0.25 U	0.25 U	0.25 U	0.25 U
1,2-Dichlorobenzene	0.21 U	0.21 U	0.21 U	0.21 U
1,2-Dichloroethane	0.1 U	0.1 U	0.1 U	0.1 U
1,2-Dichloropropane	0.13 U	0.13 U	0.13 U	0.13 U
1,3-Dichlorobenzene	0.25 U	0.25 U	0.25 U	0.25 U

Compound Name	PW-ODPO-01 dissolved	PW-ODPO-02 total	PW-ODPR-01 dissolved	PW-ODPR-02 total
1,4-Dichlorobenzene	0.28 U	0.28 U	0.28 U	0.28 U
2-Butanone	1 U	1 U	1 U	1 U
2-Hexanone	1 U	1 U	1 U	1 U
4-Methyl-2-pentanone	1 U	1 U	1 U	1 U
Acetone	10 J	5 U	5 U	5 U
Benzene	0.25 U	0.25 U	0.25 U	0.25 U
Bromodichloromethane	0.25 U	0.25 U	0.25 U	0.25 U
Bromoform	0.5 U	0.5 U	0.5 U	0.5 U
Bromomethane	0.8 U	0.8 U	0.8 U	0.8 U
Carbon disulfide	0.6 U	0.6 U	0.6 U	0.6 U
Carbon tetrachloride	0.5 U	0.5 U	0.5 U	0.5 U
Chlorobenzene	0.25 U	0.25 U	0.25 U	0.25 U
Chloroethane	1 U	1 U	1 U	1 U
Chloroform	0.14 U	0.14 U	0.14 U	0.14 U
Chloromethane	0.33 U	0.33 U	0.33 U	0.33 U
cis-1,2-Dichloroethene	0.15 U	0.15 U	0.15 U	0.15 U
cis-1,3-Dichloropropene	0.11 U	0.11 U	0.11 U	0.11 U
Cyclohexane	0.25 U	0.25 U	0.25 U	0.25 U
Dibromochloromethane	0.1 U	0.1 U	0.1 U	0.1 U
Dichlorodifluoromethane	0.25 U	0.25 U	0.25 U	0.25 U
Ethylbenzene	0.11 U	0.11 U	0.11 U	0.11 U
Isopropylbenzene	0.1 U	0.1 U	0.1 U	0.1 U
Methyl acetate	0.19 U	0.19 U	0.19 U	0.19 U
Methyl tert-butyl ether	0.2 U	0.2 U	1.5 J	1.7 J
Methylcyclohexane	0.1 U	0.1 U	0.1 U	0.1 U
Methylene Chloride	1 U	1 U	1 U	1 U
Styrene	0.11 U	0.11 U	0.11 U	0.11 U
Tetrachloroethene	0.15 U	0.15 U	0.15 U	0.15 U
Toluene	0.33 J	0.33 U	0.37 J	0.63 J
trans-1,2-Dichloroethene	0.2 U	0.2 U	0.2 U	0.2 U
trans-1,3-Dichloropropene	0.21 U	0.21 U	0.21 U	0.21 U
Trichloroethene	0.13 U	0.13 U	0.13 U	0.13 U
Trichlorofluoromethane	0.25 U	0.25 U	0.25 U	0.25 U
Vinyl chloride	0.18 U	0.18 U	0.18 U	0.18 U
Xylenes, Total	0.2 U	0.2 U	0.2 U	0.2 U
Metals (mg/L)				
Aluminum	0.05 U	0.35	0.05 U	1.6
Antimony	0.004 U	0.004 U	0.004 U	0.004 U
Arsenic	0.0016 J	0.002 J	0.0013 J	0.0021 J
Barium	0.098	0.1	0.14	0.18
Beryllium	0.00015 U	0.00015 U	0.00015 U	0.00015 U
Cadmium	0.00013 U	0.00013 UJ	0.00013 U	0.00013 U
Calcium	220	210	220	260
Chromium	0.0077	0.0032 J	0.0045 J	0.0094
Cobalt	0.0022	0.00039 J	0.00092	0.00092
Copper	0.0011 J	0.0019 J	0.0011 U	0.0048 J
Iron	0.091 J	0.41	0.064 J	1.3
Lead	0.0005 U	0.0005 U	0.0005 U	0.0043
Magnesium	580	590	290	330
Manganese	0.49	0.58	0.087	0.096
Mercury	0.000091 U	0.000091 U	0.000091 U	0.000091 U
Nickel	0.0031 J	0.002 U	0.002 U	0.0024 J
Potassium	200	180	86	100
Selenium	0.0022 U	0.0022 U	0.0022 U	0.0022 U
Silver	0.00018 U	0.00018 U	0.00018 U	0.00018 U
Sodium	5,300	5,000	1,900	2,200
Thallium	0.00025 U	0.00025 U	0.00025 U	0.00025 U

Compound Name	PW-ODPO-01	PW-ODPO-02	PW-ODPR-01	PW-ODPR-02
	dissolved	total	dissolved	total
Vanadium	0.0073 J	0.0053 J	0.0058 J	0.01
Zinc	0.0084 U	0.0084 U	0.0084 U	0.031
Cyanide, Total	0.005 U	0.005 U	0.005 U	0.005 U

Notes:
U: not detected; J: estimated concentration, R: rejected after data validation

APPENDIX D

Geosyntec consultants

CALCULATION PACKAGE COVER SHEET

Client: Hercules **Project:** Terry Creek OU1 RI/FS **Project #:** GR4443B

TITLE OF PACKAGE: **HYDRAULIC ANALYSIS OF TERRY CREEK REMEDIAL ALTERNATIVES**

CALCULATION PREPARED BY:
(Calculation Preparer, CP)

Signature: Mark Schillinger — Date: 12 Dec. 2013
Name: Mark W. Schillinger

ASSUMPTIONS & PROCEDURES CHECKED BY:
(Assumptions & Procedures Checker, APC)

Signature: G. Venkat — Date: 12 Dec. 2013
Name: Venkat Gummadi

COMPUTATIONS CHECKED BY:
(Computation Checker, CC)

Signature: G. Venkat — Date: 12 Dec. 2013
Name: Venkat Gummadi

BACK-CHECKED BY:
(Calculation Preparer, CP)

Signature: Mark Schillinger — Date: 12 Dec. 2013
Name: Mark W. Schillinger

APPROVED BY:
(Calculation Approver, CA)

Signature: Thomas L. Fendley — Date: 12 Dec. 2013
Name: Tom Fendley, P.E.

REVISION HISTORY:

NO.	DESCRIPTION	DATE	CP	APC	CC	CA

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ACRONYMS & ABBREVIATIONS

APC	Assumptions & Procedures Checker
CA	Calculation Approver
CC	Computation Checker
cfs	Cubic Feet per Second
CP	Calculation Preparer
El.	Elevation
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
ft	Feet
GDOT	Georgia Department of Transportation
Geosyntec	Geosyntec Consultants
HEC-RAS	Hydraulic Engineering Center's River Analysis System
Hercules	Hercules Incorporated
in	Inch
Inc.	Incorporated
OU1	Operable Unit 1
Outfall Ditch	Operable Unit 1
RI/FS	Remedial Investigation and Feasibility Study
Site	Terry Creek Site
TBC	Triple 6' by 5' Concrete Box Culvert
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
WSEL	Water Surface Elevation

HYDRAULIC ANALYSIS OF TERRY CREEK REMEDIAL ALTERNATIVES

1. PURPOSE AND BACKGROUND

1.1 Purpose

The purpose of this calculation package is to present the methods, assumptions, and analysis for the hydraulic design for containment responses as part of the Focused Remedial Investigation and Feasibility Study (RI/FS) of the Operable Unit 1 (OU1) (Outfall Ditch) at the Terry Creek Site (Site) located in Brunswick, Georgia (Figures 1 and 2). The containment responses generally consist of (i) re-routing the conveyance system and backfilling the Outfall Ditch, (ii) retrofitting the Outfall Ditch with a culvert and backfilling the Outfall Ditch, and (iii) using a variety of subaqueous engineered caps within the Outfall Ditch. The containment responses are developed to meet or exceed the capacity of the existing Outfall Ditch; with the capacity of the system defined as the maximum capacity before Highway 17 (located upstream of OU1) would be overtopped. These containment responses or conceptual alternatives (which are referred to interchangeably throughout this document) are discussed in greater detail within the *Methodology* section.

1.2 Site Background

The plant became operational in 1911; it is believed that the Outfall Ditch was constructed at this time. Between 1948 and 1980 Hercules produced toxaphene, a chlorinated pesticide, at its Brunswick Plant. Untreated wastewater from the production of toxaphene was discharged through the Outfall Ditch into Dupree Creek until 1972. A wastewater treatment plant was installed in 1972, and the amount of toxaphene in the permitted discharge was significantly reduced after that time until toxaphene production ceased in 1980. Portions of Terry Creek and Dupree Creek have been dredged by USACE beginning with enactment of the Rivers and Harbors Act of 1938 (Terry Creek Project), authorizing dredging of a navigational channel. The Terry Creek project was completed by the Corps in 1939; and subsequently, maintenance dredging occurred in 1940, 1941, 1942, and 1946, prior to production of toxaphene. Some dredge spoils from these dredging activities were disposed in an area located adjacent to the Torras Causeway beside Terry Creek, which is currently known as the Trailer Park Dredge Spoil Area.

Dredging of Terry Creek and Dupree Creek resumed in 1971 with subsequent dredging in 1972, 1983, 1987, and 1988/89. With the approval of USEPA, in 1972 the US Fish

and Wildlife Services, the State of Georgia, and the USACE chose an area on the north side of Terry Creek at the confluence of Terry and Dupree Creeks for placement of dredge spoils. This area (Main Dredge Spoil Area) served as the primary disposal area for dredge spoils until dredging was discontinued in 1989. Some dredge spoils were also disposed by the USACE at the Riverside Dredge Spoil Area and, prior to 1972, on Carter's Island.

On January 28, 2010 Hercules sold the Brunswick Plant Resins business and a portion of the property to Pinova, Inc. Hercules continues to own the property east of Highway 17 that contains the Outfall Ditch and the Marsh Wood Storage Yard. Geosyntec Consultants (Geosyntec) is conducting a Focused Remedial Investigation and Feasibility Study (RI/FS) on behalf of Hercules Incorporated (Hercules) for the Outfall Ditch/Operable Unit 1 (OU1) at the Site located in Brunswick, Georgia (Figure 1).

1.3 Outfall Ditch (OU1) Background and Characterization

The Outfall Ditch is located at the confluence of stormwater and industrial process inflows from a triple 6' by 5' concrete box culvert (TBC) and downstream tidally-influenced flows from Dupree Creek and Terry Creek. Furthermore, the Outfall Ditch is partitioned approximately 450 ft downstream of the TBC by a under/overflow weir, which was built to minimize floating debris discharging into Dupree Creek.

The TBC located west of the Outfall Ditch is designed to convey flows from portions of U.S. Highway 17 and the Pinova Plant drainage system; which includes industrial process flow and stormwater runoff from the plant as well as stormwater runoff from the City of Brunswick. The location of these features is presented in Figure 2.

Hydraulic capacity of the Outfall Ditch is dependent on downstream tidally-influenced flows from Dupree Creek and Terry Creek, which vary throughout the day. Based on water surface measurements measured at a location immediately downstream of the under/overflow weir from March 2nd to April 4th, 2012 (Geosyntec, 2012b), the average daily low and high tide are -3.4 ft and 4.2 ft respectively. The minimum and maximum tidal elevations recorded over the 34 days were -4.1-ft and 6.1-ft, respectively. A summary table of the tidal statistics downstream of the under/overflow weir is provided as Table 1.

2. DESIGN CRITERIA

Multiple alternatives are proposed to replace OU1. These conceptual alternatives were designed to convey stormwater and industrial process flows in a manner that does not adversely impact Highway 17 or upstream areas by designing the system to meet or exceed the capacity of the existing system (i.e., OU1, TBC, and the under/overflow weir). Additional design criteria included simplifying design components and features, avoiding reliance upon electrical, mechanical, or motorized equipment.

It should be noted that Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps (FIRM) show that the Site would still be inundated during 100-year flood events (WSEL = 13 ft), as provided in Attachment 1 (FEMA, 2006). For comparison, the floodplain in the vicinity of OU1 is generally at an elevation of 6-ft; thus the area would be inundated by approximately 7 ft of water during a 100-year flood event.

3. METHODOLOGY

3.1 Analysis Scenarios:

The design and analysis described herein consists of modeling the existing conditions and conceptual alternatives under two different scenarios. The first scenario assumes that the TBC (or existing box culvert) and conceptual alternatives are clear of sediment. A second scenario also was analyzed due to the expectation that sediment will accumulate within the TBC and proposed channels or culverts. For the second scenario (interchangeably referred to as the accumulated sediment scenario), the culverts and/or channels were assumed to have accumulated one foot of sediment that was uniformly spread throughout the hydraulic system.

Existing condition models were then completed for both scenarios where the TBC was modeled with and without 1-ft of sediment (clean and accumulated sediment scenarios, respectively). Based on these models, the maximum capacity of the system (i.e., design discharge) was obtained for both scenarios. The maximum capacity of the system was defined as the discharge capacity of the system before flooding of Highway 17 (approximate El. = 8-ft) would occur. These design discharges were then used to check that the alternatives (discussed below) would meet or exceed the maximum capacity of the existing system under both scenarios.

The first conceptual alternatives, Alternatives 2 and 2A, were selected to consist of 10-ft deep (approximate) by 30-ft wide concrete lined channels with vertical sheet pile

walls located downstream of the TBC. Alternatives 2 and 2A differ primarily in their alignment and total length. Alternative 2A follows the general alignment of the Outfall Ditch and is shorter in length than Alternative 2 which consists of an excavated channel located south of the Outfall Ditch. Due to the similarity of Alternatives 2 and 2A, only Alternative 2 was modeled. Alternative 2 was considered to be the more conservative option due to the additional bends within the channel and increased channel length; thus this alternative would have a lower capacity under both scenarios (clean and accumulated sediment) compared to Alternative 2A. Preliminary drawings for Alternatives 2 and 2A are provided as Attachments 2 and 3, respectively.

The second alternatives, Alternatives 3 and 3A, were selected to consist of 5-ft wide concrete lined channels with 3H:1V (3 Horizontal to 1 Vertical) side slopes located downstream of the TBC. Alternatives 3 and 3A differ primarily in their alignment and total length. Alternative 3A follows the general alignment of the Outfall Ditch and is shorter in length than Alternative 3 which consists of an excavated channel located south of the Outfall Ditch. Due to the similarity of Alternatives 3 and 3A, only Alternative 3 was modeled. Alternative 3 was considered to be the more conservative option due to the additional bends within the channel and increased channel length; thus this alternative would have a lower capacity under both scenarios (clean and accumulated sediment) compared to Alternative 3A. Preliminary drawings for Alternatives 3 and 3A are provided as Attachments 4 and 5, respectively.

Alternatives 4 and 4A were selected to consist of a quadruple (4), 8’ by 6’ concrete box culvert downstream of the TBC. Alternatives 4 and 4A differ primarily in their alignment and total length. Alternative 4A follows the general alignment of the Outfall Ditch and is shorter in length than Alternative 4 which consists of an excavated channel located south of the Outfall Ditch. Due to the similarity of Alternatives 4 and 4A, only Alternative 4 was modeled. Alternative 4 was considered to be the more conservative option due to the increased culvert length; thus this alternative would have a lower capacity under both scenarios (clean and accumulated sediment) compared to Alternative 4A. Preliminary drawings for Alternatives 4 and 4A are provided as Attachments 6 and 7, respectively.

Alternatives 5, 5A, and 6, were selected to consist of a sub-aqueous isolation cap channel lined with a low permeability and Georgia Department of Transportation (GDOT) Type I riprap surfacing, a carbon-amended sand cap channel lined with GDOT Type I riprap, and a sub-aqueous armored cap channel lined with GDOT Type I riprap (also referred to as a riprap armored channel), respectively. Alternatives 5, 5A, and 6 follow the general alignment of the Outfall Ditch and have the same lengths, depths, and surface lining as each other. Due to the hydraulic similarity between the three

alternatives, only Alternative 6 was modeled. Since Alternatives 5 and 5A were considered to be hydraulically equivalent to Alternative 6; the results from Alternative 6 modeling are applicable to Alternatives 5 and 5A. Preliminary drawings for Alternatives 5, 5A, and 6 are provided as Attachments 8, 9, and 10, respectively.

3.2 Calculation Methodology

Hydraulics: The Hydrologic Engineering Center's River Analysis System (HEC-RAS) program from the United States Army Corps of Engineers (USACE) (2010) was used for computing the hydraulics of the existing conditions and remedial alternatives including the computation for channels, culverts, and weir structures.

The basic computational procedure of the program is based on solution of the one-dimensional energy equation. Energy losses are evaluated by friction (Manning's equation) and contraction/expansion (coefficient multiplied by the change in velocity head). The momentum equation is used where the water surface profile is rapidly varied. These situations include mixed flow regime (i.e., subcritical and supercritical flow), hydraulics of bridges, and evaluating profiles at river confluences.

The required elevation data for the HEC-RAS program were primarily extracted using AutoCAD Civil 3D based on (a) A topographic and bathymetric survey conducted by Arc Surveying and Mapping, Inc. and provided to Geosyntec on 13 April 2012 (Arc Surveying and Mapping,, Inc. 2012) and (b) conceptual drawings as submitted on 27 September 2013. Additional channel sections were also periodically inserted using interpolated sections generated within HEC-RAS in regions with abrupt transitions to produce more stable and realistic models results. The peak discharge used in the evaluation of the remedial alternatives was considered to be the peak capacity of the existing hydraulic system (TBC, weir structure, and Outfall Ditch) during daily high tide under two assumptions (i) the TBC is free of sediment (clean) and (ii) the TBC had a 1-ft layer of uniform sediment within the culvert. The peak capacity was considered to be the elevation at which Highway 17 would overtop which was assumed to occur at approximately El. 8-ft; although this may be refined in the future.

3.3 Modeling Limitations

It was assumed the sediment depth was 1-ft deep for modeling of the accumulated sediment scenario for the alternatives. In the future, the assumed sediment depth will be refined based on maintenance schedules and/or sediment load computations, however, this value was considered appropriate for the preliminary analysis described herein.

The overtopping elevation of Highway 17 was assumed to occur at approximately El. 8-ft, however, more detailed surveying in this vicinity should be completed in the future.

4. DESIGN PARAMETERS

Input parameters for the hydraulic models and calculations are described below.

- Boundary Conditions: Only a downstream boundary condition was needed for the analysis of the nine (9) conceptual alternatives and analysis of the existing conditions, as the flow was downstream controlled (i.e., subcritical flow). The average daily high tide WSEL of 4.2-ft was used as the downstream boundary condition for the ten models (Geosyntec, 2012b). This value was selected since lower tidal conditions [such as the average daily low tide (WSEL = -3.4 ft)] result in less conservative scenarios based on preliminary analyses. The average daily high tide elevation was considered to be a conservatively selected boundary condition, as the capacity of the alternatives were considerably higher during low tide compared to high tide; while in existing conditions the design discharge were fairly similar regardless of the tidal condition (e.g., daily high vs. daily low) due to the influence of the under/overflow weir. The under/overflow weir has a strong influence on the capacity of the existing system since the weir invert elevation of approximately 0.23-ft (based on field measurements from Geosyntec conducted in March 2012) is higher than some tidal conditions. Thus for tidal elevations lower than 0.23-ft, the discharge capacity is independent of tidal conditions and water below 0.23-ft upstream of the under/overflow weir within OU1 can only drain through groundwater seepage.

- Manning's Roughness Coefficients: Roughness coefficients were selected based on literature from Chow (1959) and the Georgia Stormwater Management Manual (Atlanta Regional Commission, 2001). A summary table of the selected Manning's roughness coefficients is provided as Table 2. Excerpts from Chow (1959) and the Georgia Stormwater Management Manual (Atlanta Regional Commission, 2001) are provided as Attachments 11 and 12, respectively.

  The Outfall Ditch was modeled with a Manning's roughness coefficient of 0.030 for main channels that are clean, straight, at full stage, without rifts or deep pools. The floodplain was assumed to have a Manning's roughness coefficient of 0.030 corresponding to floodplains with pasture, short grass

(Chow, 1959). Photography of the TBC, Outfall Ditch, and floodplain are provided below as Photos 1 to 4 (Geosyntec, 2012a).

Photo 1. Floodplain and Outfall Ditch at TBC (Looking Downstream)

Photo 2. Outfall Ditch near Weir Structure (Looking Upstream)

Photo 3. Outfall Ditch Downstream of Weir Structure (Looking Downstream)

Photo 4. Outlet of TBC (Looking Upstream)

Concrete box culverts [including the TBC and the quadruple (4), 8' by 6' box culverts for Alternatives 4 and 4A] were modeled with different Manning's roughness coefficients for the two modeled scenarios (i) clean and (ii) after sediment accumulation. For the clean scenario, a Manning's roughness coefficient of 0.013 was selected for culverts with bends, connections, and some debris (Chow, 1959). Under the second scenario (accumulated sediment), the bottom of the culverts were modeled with a coefficient of 0.022 corresponding to straight, clean excavated or dredged channels after weathering (Chow, 1959). During this scenario, the sides and top of the culvert were still assumed to be clean and were modeled with a Manning's roughness coefficient of 0.013.

The TBC has headwalls at both the upstream and downstream ends which convey flow as an open channel and are approximately 10 ft long (Photo 4). In the first scenario (clean), the bottom of the headwalls was modeled with a Manning's roughness coefficient of 0.015 corresponding to float finished concrete channels (Chow, 1959). During the second scenario (accumulated sediment), the bottom of the headwalls were modeled with a coefficient of 0.022 corresponding to straight, clean excavated or dredged channels after

weathering (Chow, 1959). During this scenario, the sides and top of the culvert were still assumed to be clean and were modeled with a Manning's roughness coefficient of 0.015.

Alternatives 2 and 2A were modeled as a channel with vertical sheet pile walls and the bottom lined with concrete. In both the first scenario (clean) and second scenario (accumulated sediment), the sides of the channel were assumed to be hydraulically similar to corrugated metal lined channels due to the lack of available literature on sheet pile channels. Thus a Manning's roughness coefficient of 0.030 was selected corresponding to the maximum recommended value for corrugated metal lined channels (Chow, 1959). In the first and second scenario, the bottom of the concrete lined channel was modeled with Manning's roughness coefficients of 0.015 and 0.022, respectively. These values correspond to the recommended values for float finished concrete channels and straight, clean excavated or dredged channels after weathering, respectively (Chow, 1959).

Alternatives 3 and 3A were simulated to be a concrete channel with trapezoidal side slopes. In both the first scenario (clean) and second scenario (accumulated sediment), the sides of the channel were modeled with a Manning's roughness coefficient of 0.015 corresponding to float finished concrete channels (Chow, 1959). The bottom of the concrete lined channel was modeled using Manning's roughness coefficients of 0.015 and 0.022, respectively. These values correspond to the recommended values for float finished concrete channels and straight, clean excavated or dredged channels after weathering, respectively (Chow, 1959).

The sub-aqueous isolation cap with riprap armoring (Alternative 5) would have the same approximate alignment as the existing Outfall Ditch. The riprap consists of GDOT Type I riprap (12-in) which has Manning's roughness coefficient of 0.04 for depths greater than 2 feet (Atlanta Regional Commission, 2001); which is applicable for these alternatives as the depths are typically about 7 ft. Thus Alternative 5 was modeled with a Manning's roughness coefficient of 0.04 during the clean scenario. During the second scenario, the riprap was assumed to be clogged with sediment and would have a Manning's roughness coefficient of 0.022 corresponding to straight, clean excavated or dredged channels after weathering (Chow, 1959). The carbon-amended sand cap lined with GDOT Type I riprap (Alternative 5A) and the riprap armored channel (Alternative 6) have the same surfacing as Alternative 5 and thus were

modeled with Manning's roughness coefficients of 0.04 and 0.022 for the clean and accumulated scenarios, respectively.

Riprap armored areas downstream of alternatives were modeled with the same Manning's roughness coefficients used for modeling of Alternatives 5, 5A, and 6 (i.e., 0.04 for the clean scenario and 0.022 for the accumulated scenario).

Under/Overflow Weir: The under/overflow weir located in the Outfall Ditch was modeled as a sluice gate located upstream of a broad-crested weir. Since the invert of the overflow weir (El. = 0.23-ft) is higher than the top invert of the gate (El. = -0.77-ft), the gate (underflow weir) is always submerged; thus the gate was modeled as a submerged orifice using a coefficient of 0.8 as recommended in HEC-RAS (USACE, 2010). The overflow weir which is an approximately 1-ft wide concrete structure was modeled as a broad crested weir within HEC-RAS using a weir coefficient of 3.0; which is a typical value used within the program. It is probable that there would be bending losses within the under/overflow weir, however, these were not accounted for resulting in more conservative existing design discharges (i.e., greater maximum capacity during existing conditions). The total length of the under/overflow weir (perpendicular to flow) is 52 feet with approximately six (6), 1-ft wide supports and thus was modeled as a 46-ft long weir. Measurements for the under/overflow weir were typically from field measurements by Geosyntec staff conducted in March 2012.

Culvert Entrance and Exit Coefficients: The entrance coefficient to the TBC was assumed to be 0.4 for the models. This value was selected as it corresponds to the recommended value for concrete box culverts with flared wing walls that are 30 to 75 degrees relative to the culvert barrel (USACE, 2010). The wingwalls at the upstream end of the TBC are approximately 37 degrees relative to the culvert barrels. The entrance coefficient for the box culvert proposed in Alternatives 4 and 4A was selected to have a coefficient of 0.7; corresponding to concrete culverts with wingwalls parallel to the culvert (i.e., 0 degree angle relative to the culvert barrel) (USACE, 2010).

For sudden expansion of flow, which is typical for culverts, the Federal Highway Administration (1985) recommends selecting an exit coefficient of 1.0. This exit coefficient was applied to the downstream end of the TBC for each analysis and to the proposed box culvert in Alternatives 4 and 4A.

Losses at the transition between the culverts due to transitions and bends were assumed to be accounted for in the selection of a higher Manning's roughness coefficient of 0.013. This Manning's roughness coefficient corresponds to concrete culverts with bends, connections, and some debris; which is higher than the Manning's roughness coefficient of 0.011 used for clean, straight concrete culverts (Chow, 1959).

5. CALCULATIONS AND RESULTS

The maximum capacity of the existing system was estimated to be 645 cfs with an assumed 1-ft of sediment within the TBC. If the TBC was clean (i.e., without accumulated sediment), the capacity was estimated to increase by 185 cfs to 830 cfs. These two discharges were then used to estimate the maximum water surface elevation upstream of the TBC for the alternatives under both scenarios (i.e., clean and accumulated sediment).

As discussed previously, only the most hydraulically conservative conceptual alternatives were modeled (Alternatives 2, 3, 4, and 6); thus conceptual alternatives that were hydraulically equivalent or similar but more hydraulically efficient than previously modeled scenarios were not further evaluated (i.e., Alternatives 2A, 3A, 4A, 5, and 5A). For example, Alternatives 2 and 2A both consist of a 30-ft wide sheet pile channel, however, their alignment differs. Since Alternative 2A is shorter and has fewer bends, it was considered more hydraulically efficient then Alternative 2 and was not modeled.

The alternatives were found to generally meet or exceed the hydraulic capacity of the existing system under both scenarios. The capacity of Alternatives 4 and 6 with accumulated sediment were found to be approximately 5% and 3% less than the capacity of the existing system, respectively. The capacity of Alternatives 6 was also found to be approximately 2% less than the capacity of the existing system during the clean scenario as well. These reduced capacities were considered reasonable for the purposes of the conceptual alternatives analysis. If either Alternative 4 or 6 are selected as the preferred alternative, the design would be slightly modified to increase the discharge capacity. For the scenario without accumulated sediment (clean), the capacity of Alternatives 4 had a greater discharge capacity than the existing system. The results for each alternative under both the accumulated sediment and clean scenarios are summarized as part of Table 3. Flow profiles and output tables from HEC-RAS for the existing system and conceptual alternatives are provided in Attachments 13 to 22.

6. SUMMARY AND CONCLUSION

The Terry Creek containment responses generally consist of (i) re-routing the conveyance system and backfilling the Outfall Ditch, (ii) retrofitting the Outfall Ditch with hard pipe and backfilling the Outfall Ditch, and (iii) a variety of subaqueous engineered caps. The remedial alternatives were typically evaluated in HEC-RAS and were found to convey stormwater in a manner that does not adversely impact Highway 17 or upstream areas by designing the system to meet or exceed the capacity of the existing system; as summarized in Table 3.

Alternative 2, a 10-ft deep (approximate) by 30-ft wide concrete lined channel, was found to be sufficiently sized and would have greater capacities than the existing system in both scenarios (clean and accumulated scenarios); based on HEC-RAS modeling. Alternative 3, a 5-ft wide concrete channel with 3H:1V side slopes, was also found to be adequately sized and would have a greater capacity than the existing system under both scenarios. Alternative 4 was modeled within HEC-RAS and was found to have a greater capacity than the existing system in the first (clean) scenario and a capacity 5% less than the existing system in the second (accumulated sediment) scenario. Alternative 6 was computed to have a capacity 2 to 3% less than the existing system under both scenarios. For the purposes of the analysis of the conceptual alternatives; the culvert and channel size for Alternatives 4 and 6, respectively were both considered reasonable. Alternatives 2A, 3A, and 4A were qualitatively evaluated instead of being modeled in HEC-RAS due to their similarity to Alternatives 2, 3, and 4, respectively. Since Alternatives 2A, 3A, and 4A were considered to be more hydraulically efficient (due to shorter lengths or lower Manning's roughness coefficients) than similar alternatives modeled in HEC-RAS, it was assumed these alternatives would have a greater capacity than the existing system. Alternatives 5 and 5A were considered to be hydraulically equivalent to Alternative 6 (i.e., same alignment, shape, and surface lining) thus the HEC-RAS results for Alternative 6 are applicable to Alternatives 5 and 5A as well.

The nine alternatives (2, 2A, 3, 3A, 4, 4A, 5, 5A, and 6) met the other design criteria as well by simplifying components and features, avoiding reliance upon electrical, mechanical, or motorized equipment. Based on the analysis presented herein, the nine alternatives provide a similar or greater hydraulic capacity than the existing system under both clean and accumulated sediment scenario and comply with the design criteria.

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Table 1. Summary of Tidal Elevations (adapted from Geosyntec, 2012b)

Water Surface Elevation Statistics	Daily High Water Elevation (ft)	Daily Low Water Elevation (ft)
Average	4.2	-3.4
Median	4.1	-3.5
Minimum	2.5	-4.1
Maximum	6.1	-2.4

Note:
1. Water surface elevation measurements were taken from March 2nd to April 4th, 2012 by Geosyntec immediately downstream of the weir. Elevations are referenced to the North American Vertical Datum of 1988 (i.e., NAVD88).

Table 2. Selected Manning's Coefficients

Alternative		Selected Manning's Roughness Coefficient				References			
		Bottom of Pipe or Channel				Bottom of Pipe or Channel			
#	Description	Without Accumulated Sediment (Clean)	With Accumulated Sediment	Sides/Top of Pipe or Channel	Floodplain	Without Accumulated Sediment (Clean)	With Accumulated Sediment	Sides/Top of Pipe or Channel	Floodplain
Existing Features	Triple, 6' by 5' Concrete Box Culvert (TBC)	0.013	0.022	0.013	-	#2	#1	#2	-
	Downstream Headwall of TBC	0.015/0.022	0.022	0.015	-	#3/#1 (See Note 1)	#1 (See Note 1)	#3	-
	Outfall Ditch/OU1	0.030	0.030	0.030	0.030	#4 (See Note 1)	#4 (See Note 1)	#4	#5
2(2)	Sheet Pile Channel Re-routed	0.015	0.022	0.030	0.030	#3	#1	#6	#5
2A(2)	Sheet Pile Channel within Existing Outfall Ditch	0.015	0.022	0.030	0.030	#3	#1	#6	#5
3(3)	Concrete-Lined Channel Re-routed	0.015	0.022	0.015	0.030	#3	#1	#3	#5
3A(3)	Concrete-Lined Channel within Existing Outfall Ditch	0.015	0.022	0.015	0.030	#3	#1	#3	#5
4(4)	Culvert Re-routed	0.013	0.022	0.013	-	#2	#1	#2	-
4A(4)	Culvert within Existing Outfall Ditch	0.013	0.022	0.013	-	#2	#1	#2	-
5(5)	Aquablok-Lined Channel	0.040	0.022	0.040	0.030	#7	#1	#7	#5
5A(5)	Carbon-Amended Sand Cap Channel	0.040	0.022	0.040	0.030	#7	#1	#7	#5
6(5)	Riprap Armored Channel	0.040	0.022	0.040	0.030	#7	#1	#7	#5

Notes:
1. The downstream headwall currently has sediment deposition and thus the bottom of the headwall was modeled with an assumed Manning's roughness coefficient of 0.022 (Reference #1) in both existing condition scenarios (clean and accumulated sediment scenarios). For the conceptual alternatives, it is assumed this accumulated sediment will be removed and thus was modeled with a Manning's roughness coefficient of 0.015 (Reference #3) in the clean scenarios.
2. Due to the similarity of Alternatives 2 and 2A, only Alternative 2 was modeled. Alternative 2 was considered to be the more conservative option for the purposes of this analysis due to additional bends within the channel and longer length.
3. Due to the similarity of Alternatives 3 and 3A, only Alternative 3 was modeled. Alternative 3 was considered to be the more conservative option for the purposes of this analysis due to additional bends within the channel and longer length.
4. Due to the similarity of Alternatives 4 and 4A, only Alternative 4 was modeled. Alternative 4 was considered to be the more conservative option for the purposes of this analysis due to additional bends within the culvert and longer length.
5. Due to the similarity of Alternatives 5, 5A, and 6, only Alternative 6 was modeled. Alternative 5 and 5A are considered hydraulically equivalent to Alternative 6; thus the results from Alternative 6 modeling are applicable for Alternative 5 and 5A.

References:
1. Excavated or dredged channels - straight, clean channel after weathering (Chow, 1959)
2. Culverts with bends, connections, and some debris (Chow, 1959)
3. Float finished concrete channel (Chow, 1959)
4. Main channel - clean, straight, full stage, no rifts or deep pools (Chow, 1959)
5. Floodplain with pasture, short grass (Chow, 1959)
6. Maximum value for corrugated metal lined channels (Chow, 1959)
7. Georgia Department of Transportation Type I Riprap for flow depths greater than 2.0 ft (Atlanta Regional Commission, 2001)

Table 3. Model Summary Table

Alternative		Water Surface Elevation Upstream of TBC (ft)	
#	Description	Clean (Without Accumulated Sediment)	With Accumulated Sediment
		Q = 830 cfs	Q = 645 cfs
-	Existing System/Conditions	7.95	7.94
2	Sheet Pile Channel Re-routed	6.87	7.57
2A	Sheet Pile Channel within Existing Outfall Ditch	See Note 1	
3	Concrete-Lined Channel Re-routed	6.94	7.39
3A	Concrete-Lined Channel within Existing Outfall Ditch	See Note 2	
4	Culvert Re-routed	7.51	See Note 3
4A	Culvert within Existing Outfall Ditch	See Note 4	
5	Aquablok-Lined Channel	See Note 5	
5A	Carbon-Amended Sand Cap Channel	See Note 5	
6	Riprap Armored Channel	See Note 3	See Note 3

Notes:

1. Due to the similarity of Alternatives 2 and 2A, only Alternative 2 was modeled. Alternative 2 was considered to be the more conservative option for the purposes of this analysis due to additional bends within the channel and longer length.

2. Due to the similarity of Alternatives 3 and 3A, only Alternative 3 was modeled. Alternative 3 was considered to be the more conservative option for the purposes of this analysis due to additional bends within the channel and longer length.

3. Alternatives 4 and 6 were calculated to have capacities of 610 cfs and 625 cfs under the accumulated sediment scenario before overtopping Highway 17, respectively and Alternative 6 was calculated to have a capacity of 810 cfs before overtopping Highway 17. Thus the capacity of Alternative 6 is approximately 2 to 3% less than the capacity of the existing system under both scenarios and Alternative 4 was calculated to have a capacity 5% less than the existing system during the accumulated sediment scenario. These values were considered reasonable for the conceptual design presented herein.

4. Due to the similarity of Alternatives 4 and 4A, only Alternative 4 was modeled. Alternative 4 was considered to be the more conservative option for the purposes of this analysis due to additional bends within the culvert and longer length.

5. Due to the similarity of Alternatives 5, 5A, and 6, only Alternative 6 was modeled. Alternative 5 and 5A are considered hydraulically equivalent to Alternative 6; thus the results from Alternative 6 modeling are applicable for Alternative 5 and 5A.

FIGURES

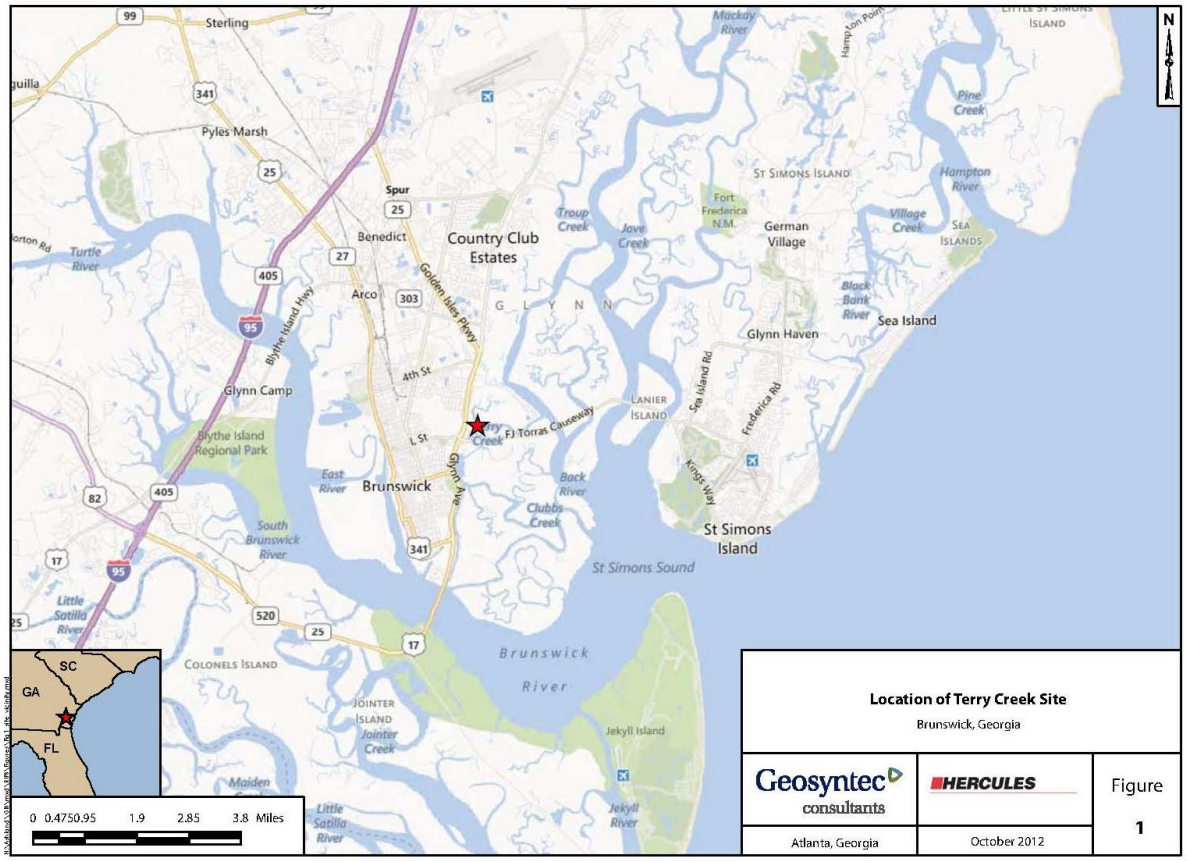


Figure 1 – Location of Terry Creek Site (Geosyntec, 2012b)

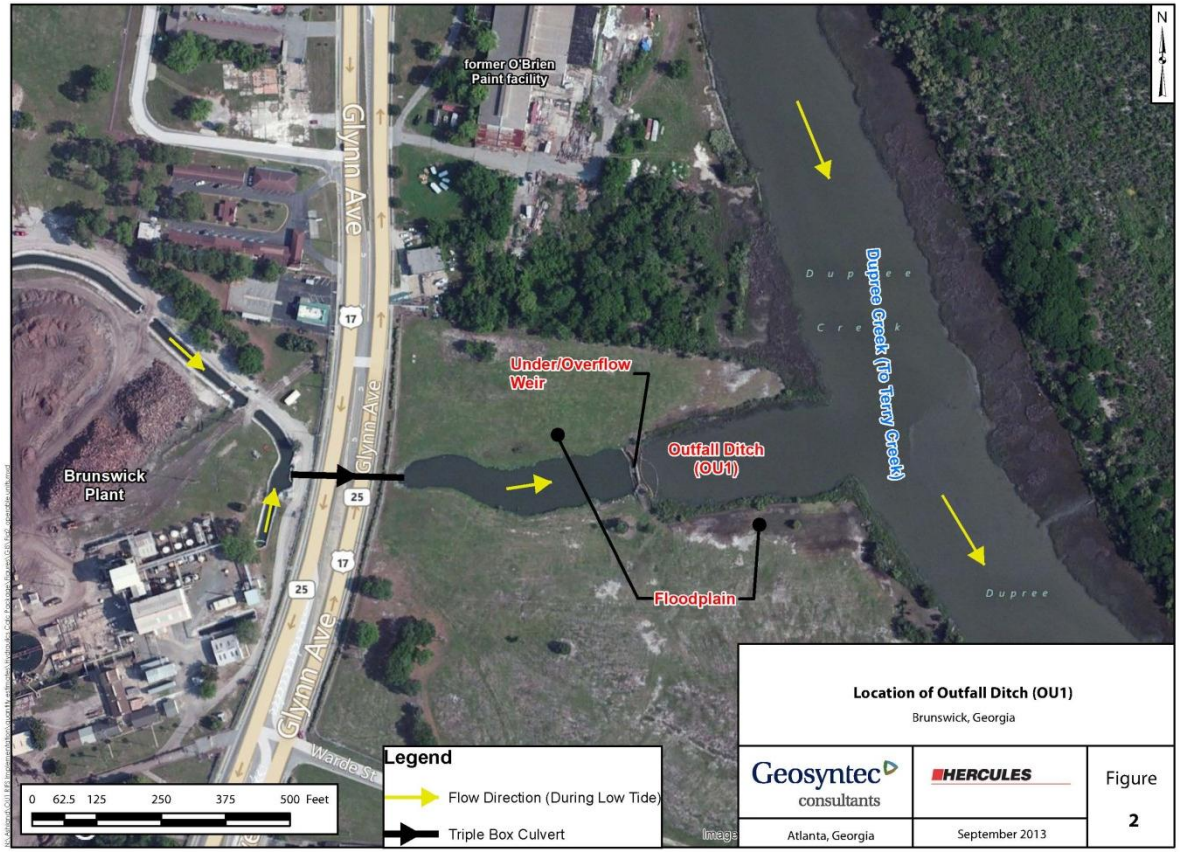


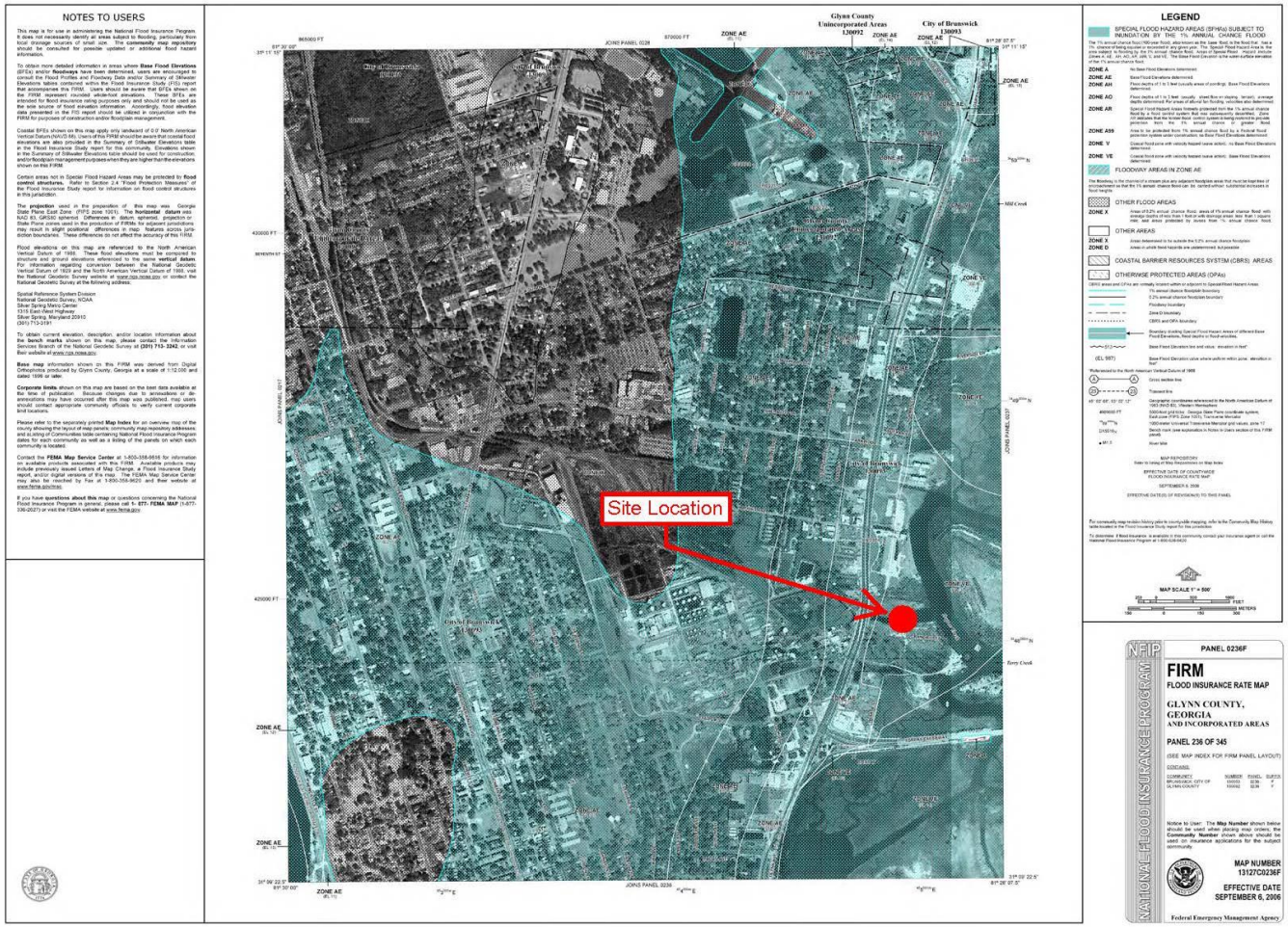
Figure 2 – Location of Outfall Ditch (OU1)

ATTACHMENT 1

FLOOD INSURANCE RATE MAP (FEMA, 2006)

CP: **MWS** Date: **12/12/13** APC: **VG** Date: **12/12/13** CC: **VG** Date: **12/12/13**

Client: **Hercules** Project: **Terry Creek OU1 RI/FS** Project No: **GR4443B**

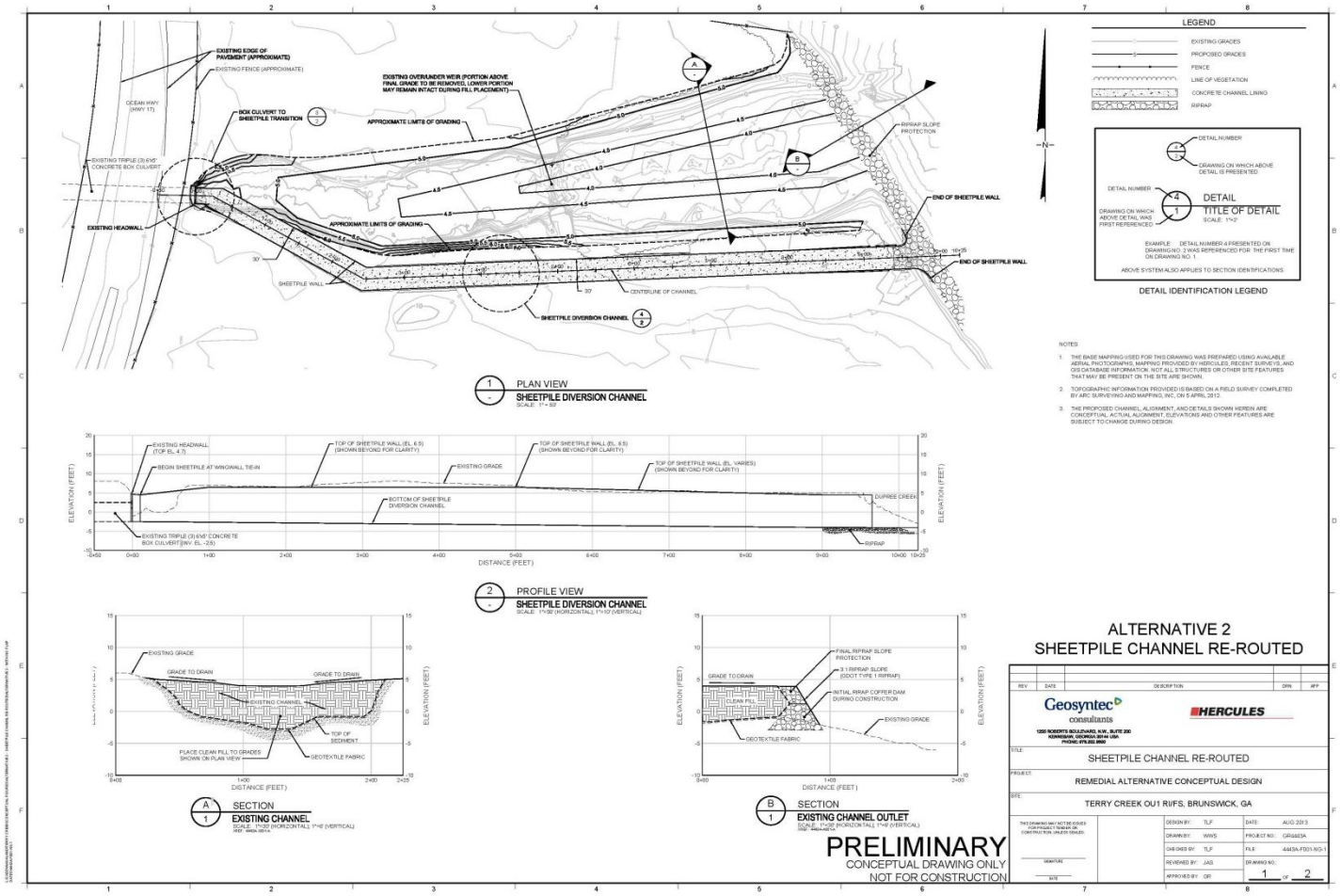


ATTACHMENT 2

ALTERNATIVE 2 DRAWINGS

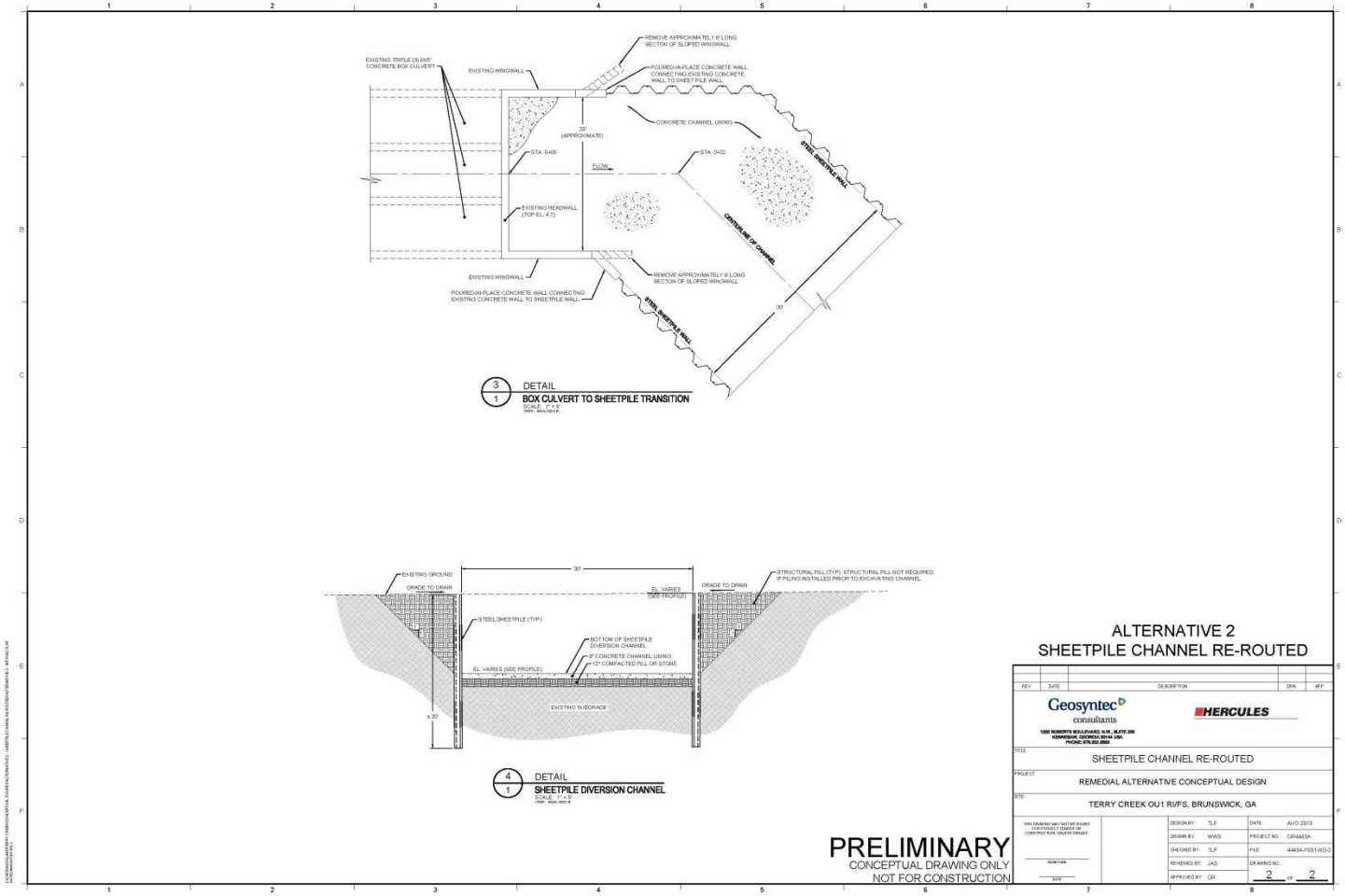
CP: **MWS** Date: **12/12/13** APC: **VG** Date: **12/12/13** CC: **VG** Date: **12/12/13**

Client: **Hercules** Project: **Terry Creek OU1 RI/FS** Project No: **GR4443B**



CP: **MWS** Date: **12/12/13** APC: **VG** Date: **12/12/13** CC: **VG** Date: **12/12/13**

Client: **Hercules** Project: **Terry Creek OU1 RI/FS** Project No: **GR4443B**

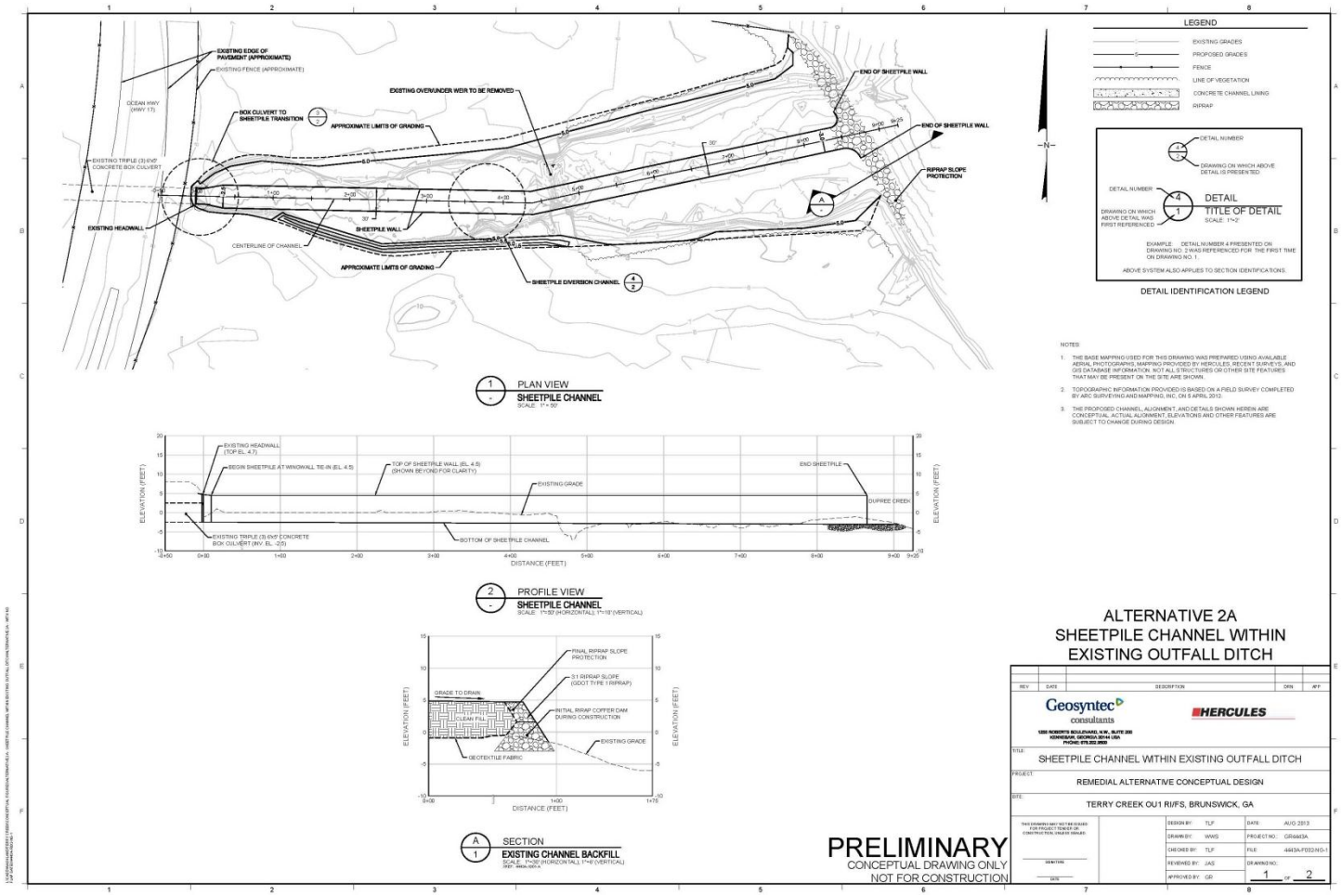


ATTACHMENT 3

ALTERNATIVE 2A DRAWINGS

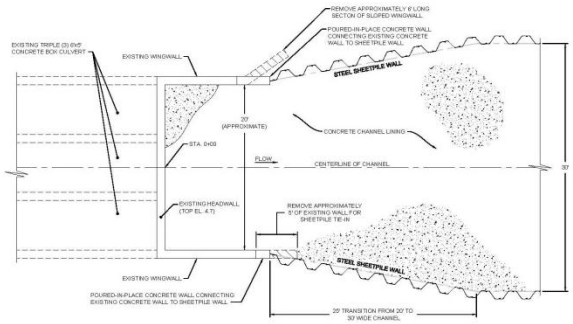
CP: **MWS** Date: **12/12/13** APC: **VG** Date: **12/12/13** CC: **VG** Date: **12/12/13**

Client: **Hercules** Project: **Terry Creek OU1 RI/FS** Project No: **GR4443B**

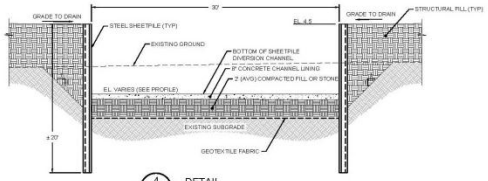


CP: **MWS** Date: **12/12/13** APC: **VG** Date: **12/12/13** CC: **VG** Date: **12/12/13**

Client: **Hercules** Project: **Terry Creek OU1 RI/FS** Project No: **GR4443B**



3/1 DETAIL
BOX CULVERT TO SHEETPILE TRANSITION
SCALE: 1" = 5'
REF: 4GA-101-B



4/1 DETAIL
SHEETPILE CHANNEL
SCALE: 1" = 5'
REF: 4GA-101-B

ALTERNATIVE 2A
SHEETPILE CHANNEL WITHIN
EXISTING OUTFALL DITCH

REV	DATE	DESCRIPTION	DRN	APP

Geosyntec consultants
1255 ROBERTS BOULEVARD, N.W., SUITE 200
KENNESAW, GEORGIA 30144 USA
PHONE: 678.202.2600

HERCULES

TITLE: SHEETPILE CHANNEL WITHIN EXISTING OUTFALL DITCH
PROJECT: REMEDIAL ALTERNATIVE CONCEPTUAL DESIGN
SITE: TERRY CREEK OU1 RI/FS, BRUNSWICK, GA

THIS DRAWING MAY NOT BE ISSUED FOR PROJECT TENDER OR CONSTRUCTION UNLESS SIGNED:
SIGNATURE
DATE

DESIGN BY:	TLF	DATE:	AUG 2013
DRAWN BY:	WWG	PROJECT NO.:	GR4443A
CHECKED BY:	TLF	FILE:	4443A-F032-NG-2
REVIEWED BY:	JAS	DRAWING NO.:	
APPROVED BY:	GD	2 OF 2	

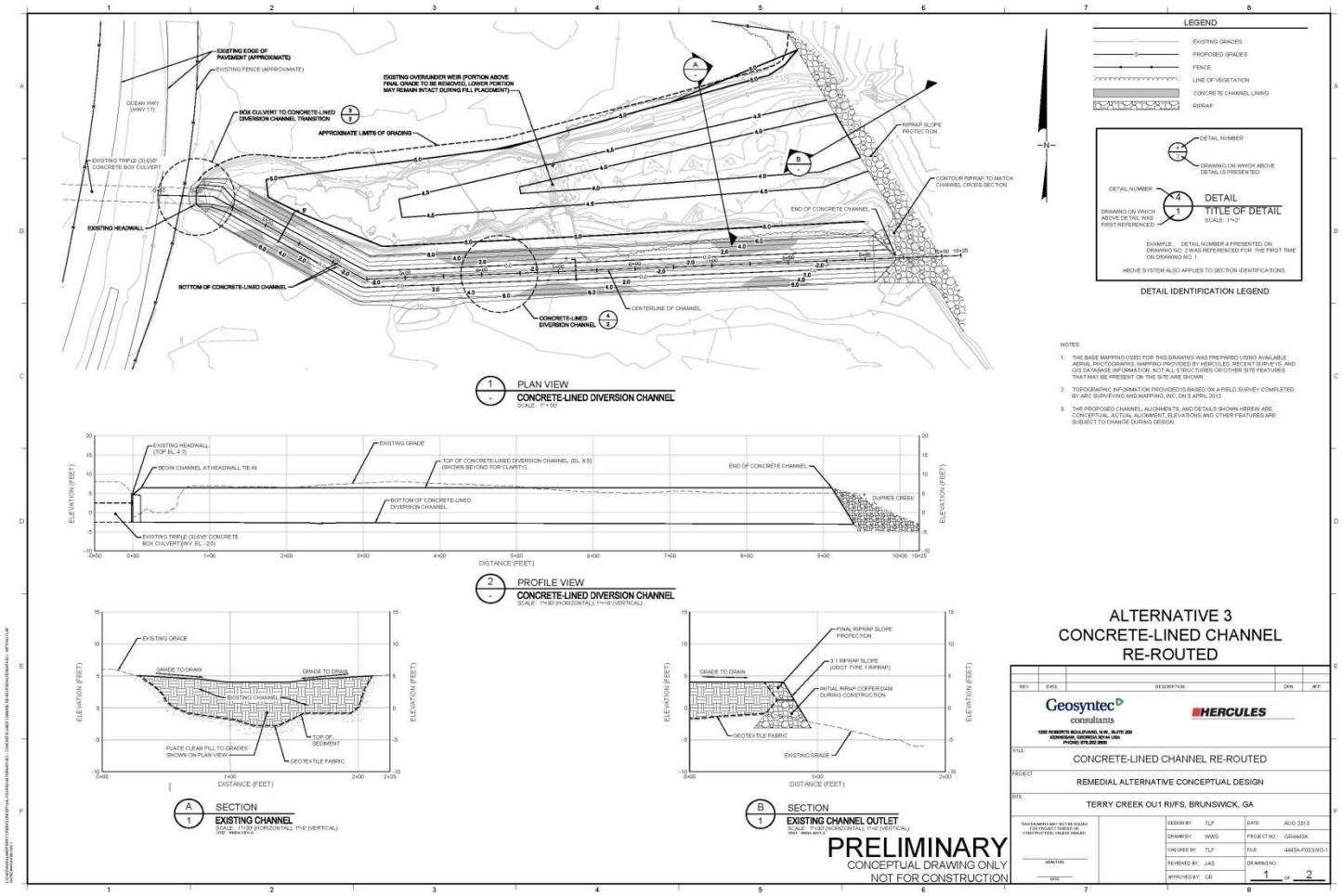
PRELIMINARY
CONCEPTUAL DRAWING ONLY
NOT FOR CONSTRUCTION

ATTACHMENT 4

ALTERNATIVE 3 DRAWINGS

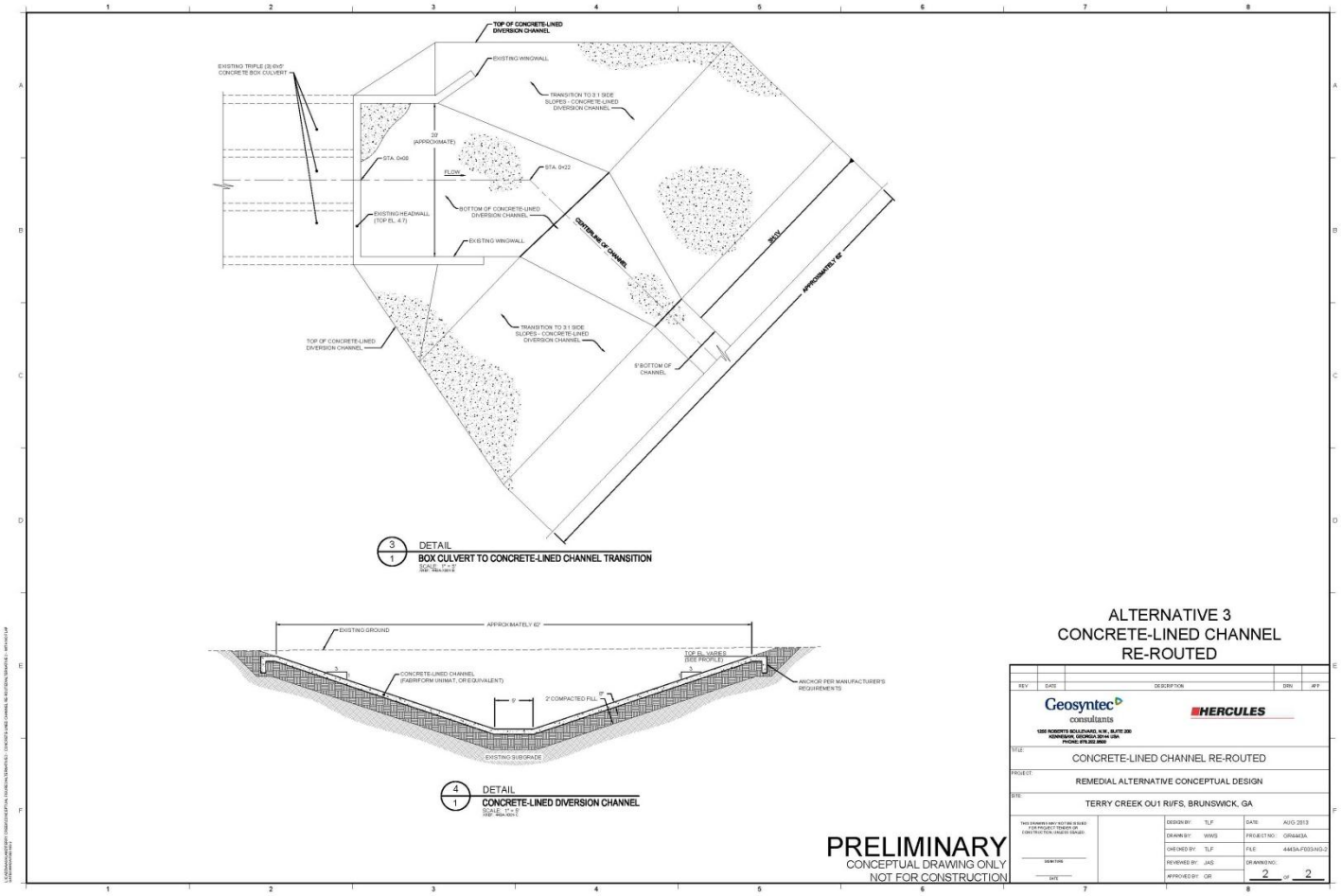
CP: **MWS** Date: **12/12/13** APC: **VG** Date: **12/12/13** CC: **VG** Date: **12/12/13**

Client: **Hercules** Project: **Terry Creek OU1 RI/FS** Project No: **GR4443B**



CP: **MWS** Date: **12/12/13** APC: **VG** Date: **12/12/13** CC: **VG** Date: **12/12/13**

Client: **Hercules** Project: **Terry Creek OU1 RI/FS** Project No: **GR4443B**

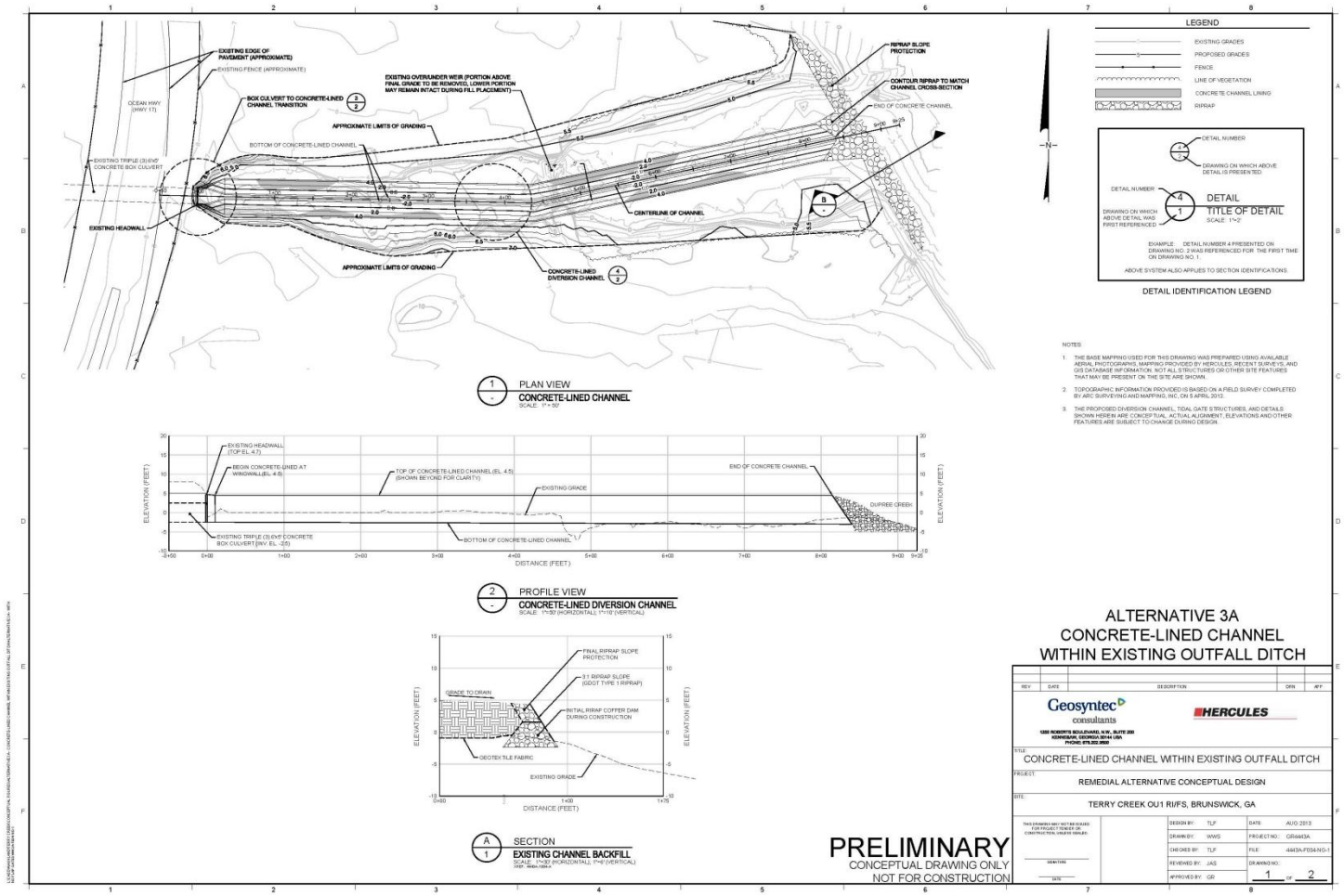


ATTACHMENT 5

ALTERNATIVE 3A DRAWINGS

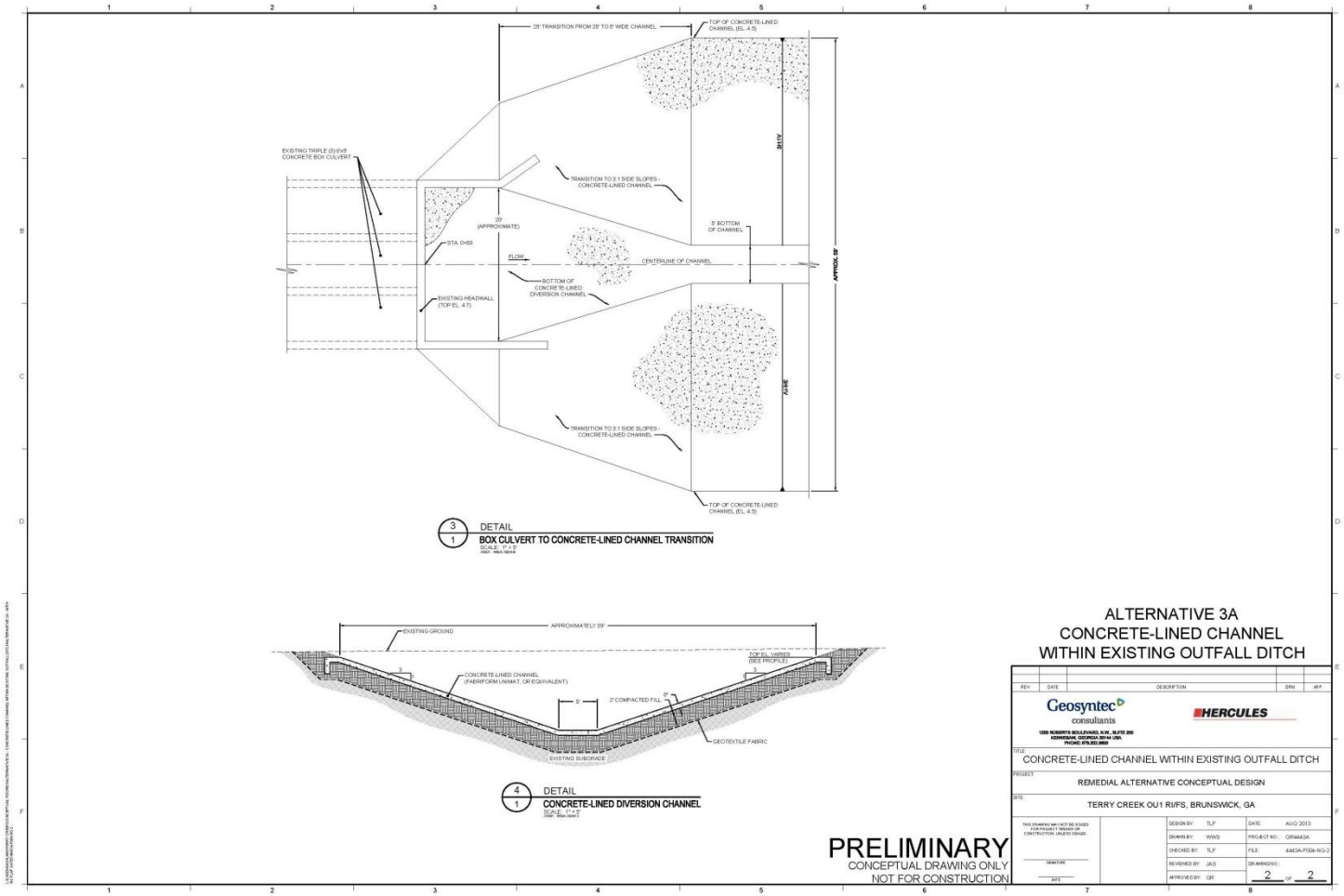
CP: **MWS** Date: **12/12/13** APC: **VG** Date: **12/12/13** CC: **VG** Date: **12/12/13**

Client: **Hercules** Project: **Terry Creek OU1 RI/FS** Project No: **GR4443B**



CP: **MWS** Date: **12/12/13** APC: **VG** Date: **12/12/13** CC: **VG** Date: **12/12/13**

Client: **Hercules** Project: **Terry Creek OU1 RI/FS** Project No: **GR4443B**

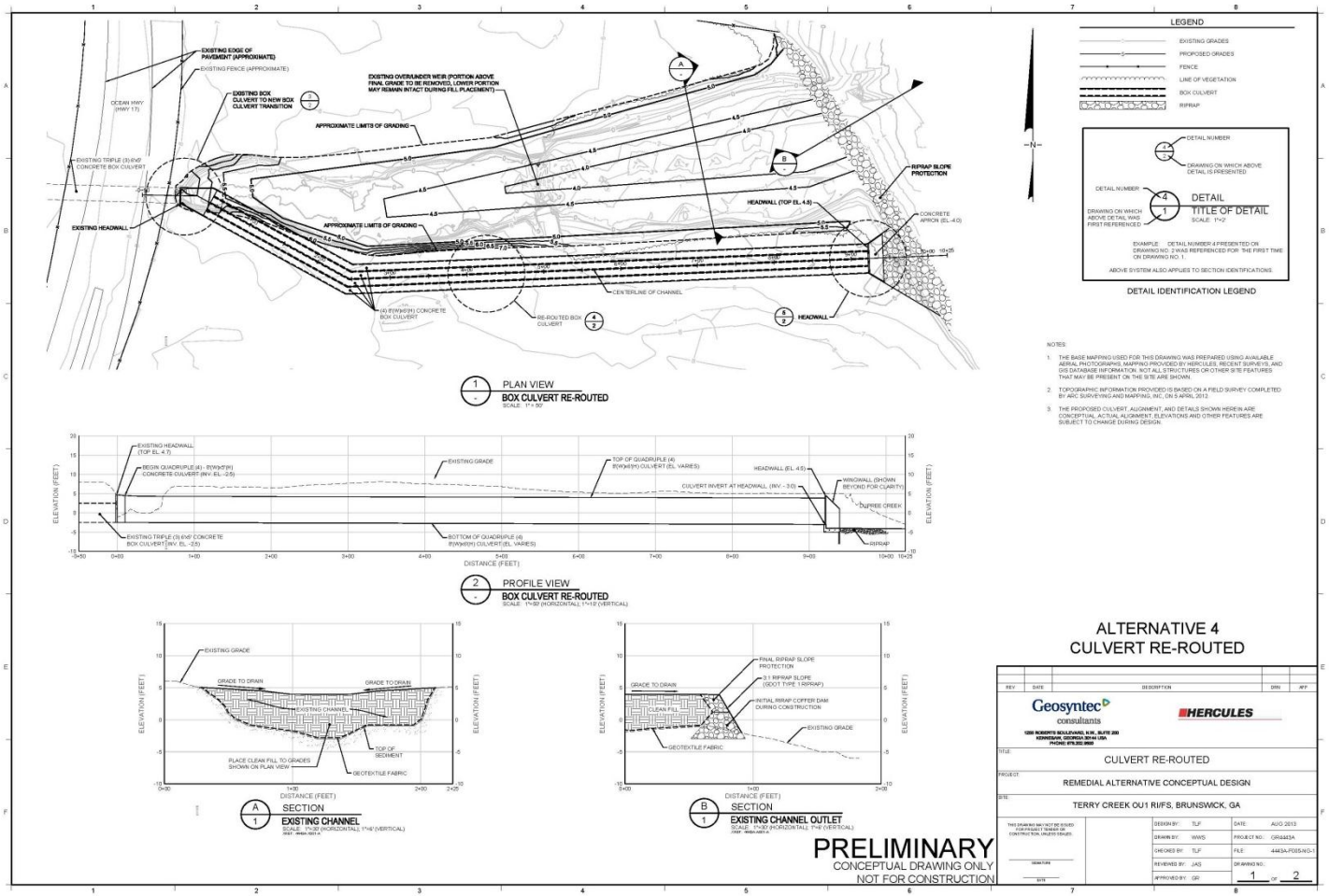


ATTACHMENT 6

ALTERNATIVE 4 DRAWINGS

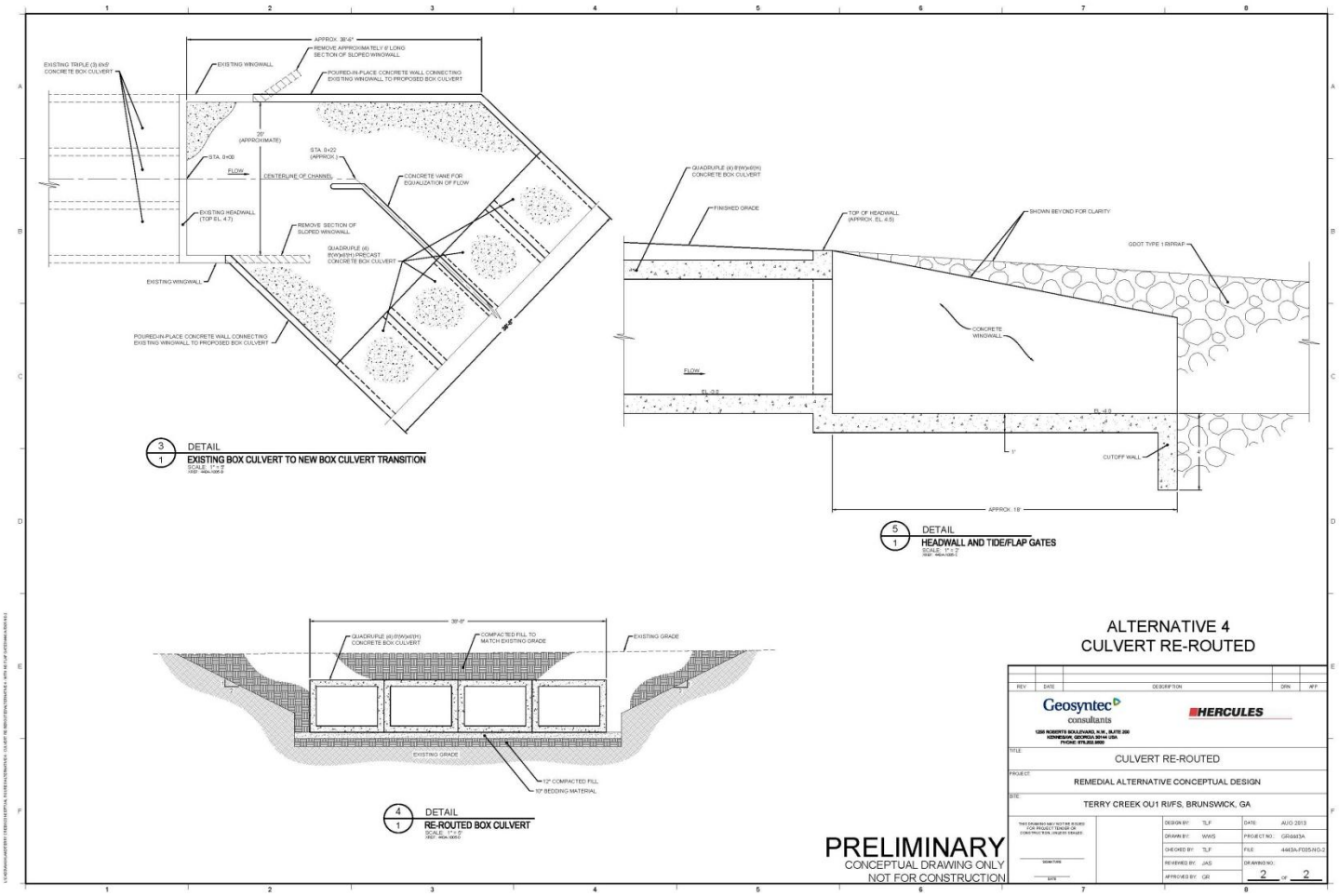
CP: **MWS** Date: **12/12/13** APC: **VG** Date: **12/12/13** CC: **VG** Date: **12/12/13**

Client: **Hercules** Project: **Terry Creek OU1 RI/FS** Project No: **GR4443B**



CP: **MWS** Date: **12/12/13** APC: **VG** Date: **12/12/13** CC: **VG** Date: **12/12/13**

Client: **Hercules** Project: **Terry Creek OU1 RI/FS** Project No: **GR4443B**

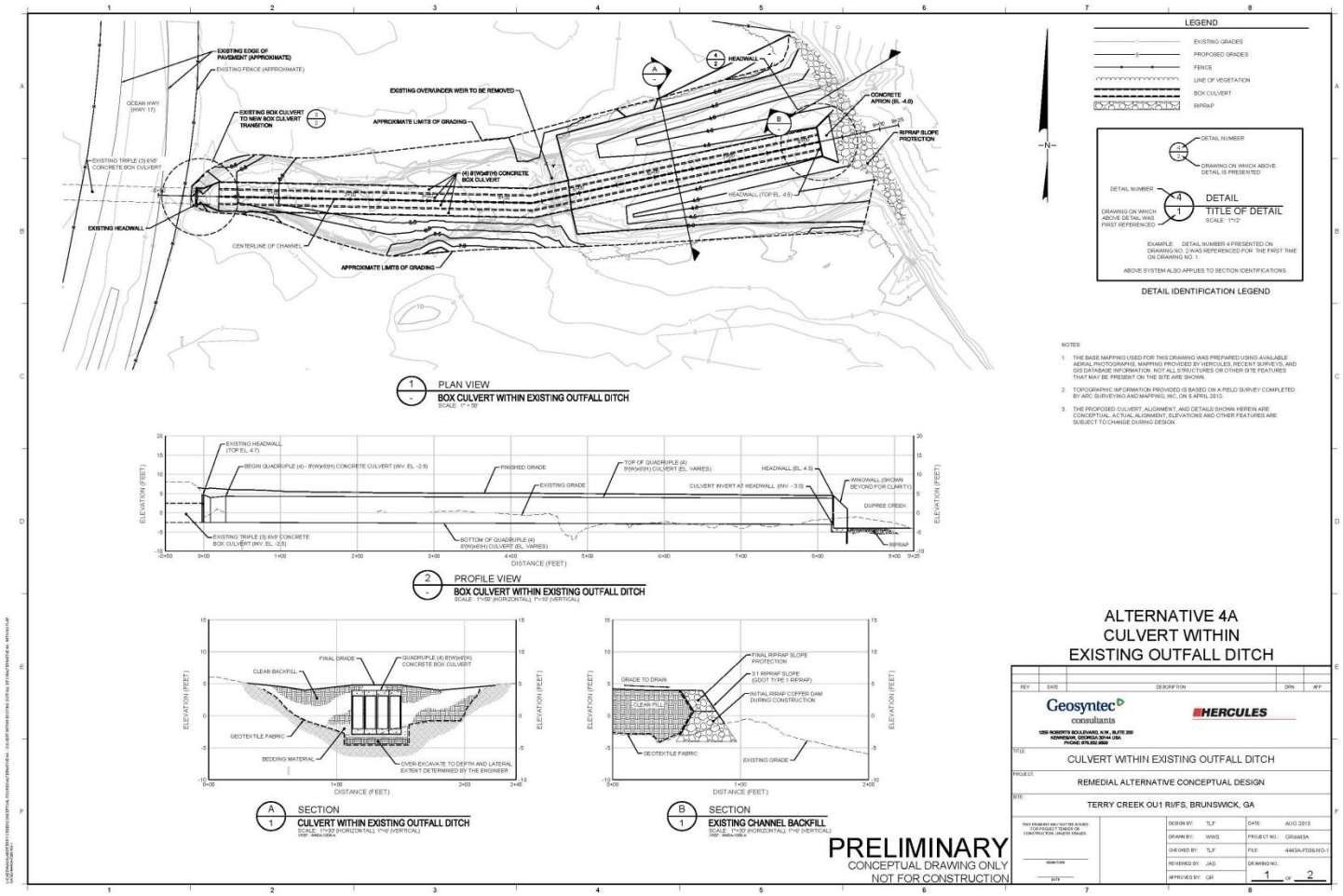


ATTACHMENT 7

ALTERNATIVE 4A DRAWINGS

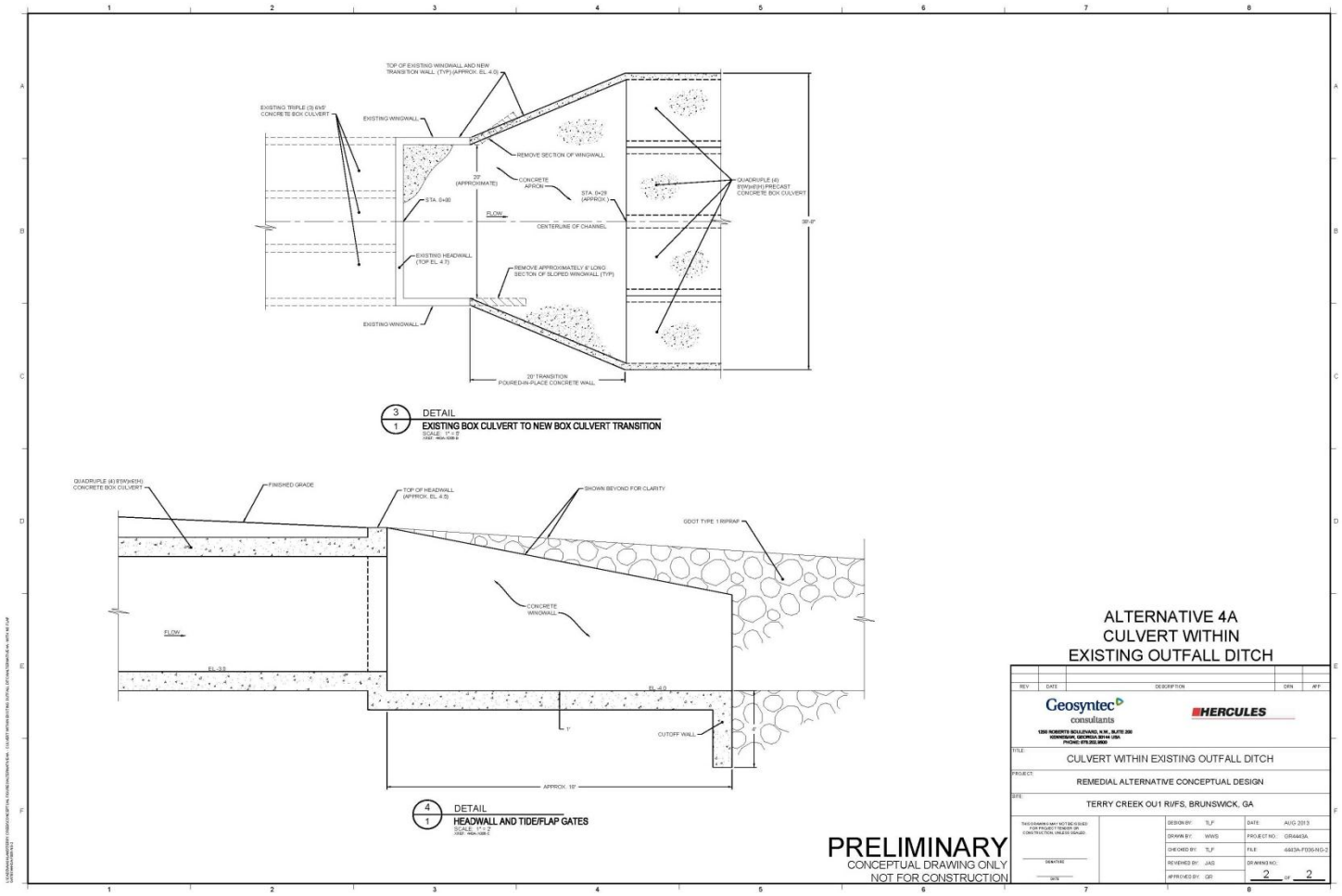
CP: **MWS** Date: **12/12/13** APC: **VG** Date: **12/12/13** CC: **VG** Date: **12/12/13**

Client: **Hercules** Project: **Terry Creek OU1 RI/FS** Project No: **GR4443B**



CP: **MWS** Date: **12/12/13** APC: **VG** Date: **12/12/13** CC: **VG** Date: **12/12/13**

Client: **Hercules** Project: **Terry Creek OU1 RI/FS** Project No: **GR4443B**

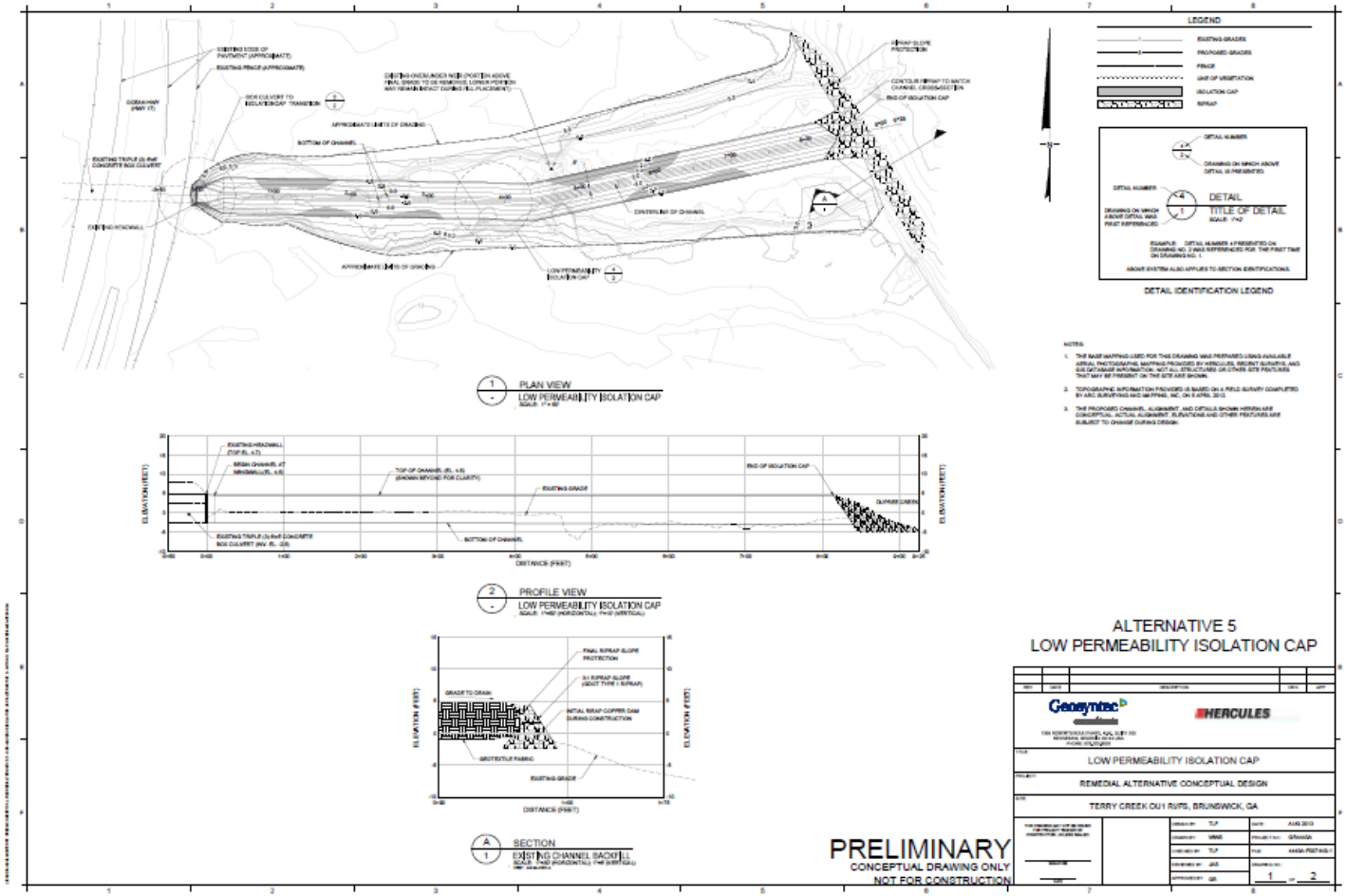


ATTACHMENT 8

ALTERNATIVE 5 DRAWINGS

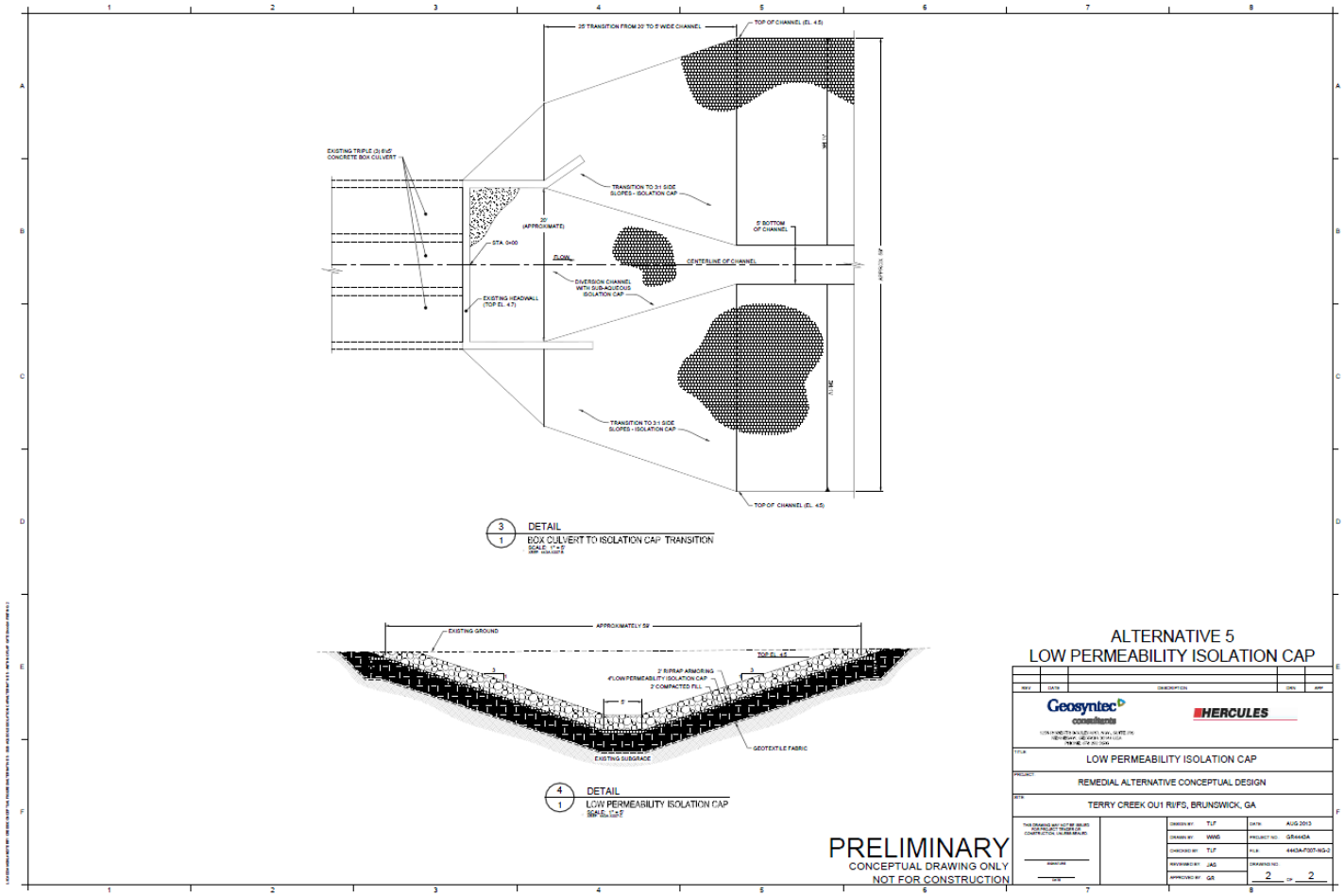
CP: MWS Date: 12/12/13 APC: VG Date: 12/12/13 CC: VG Date: 12/12/13

Client: Hercules Project: Terry Creek OU1 RI/FS Project No: GR4443B



CP: **MWS** Date: **12/12/13** APC: **VG** Date: **12/12/13** CC: **VG** Date: **12/12/13**

Client: **Hercules** Project: **Terry Creek OU1 RI/FS** Project No: **GR4443B**

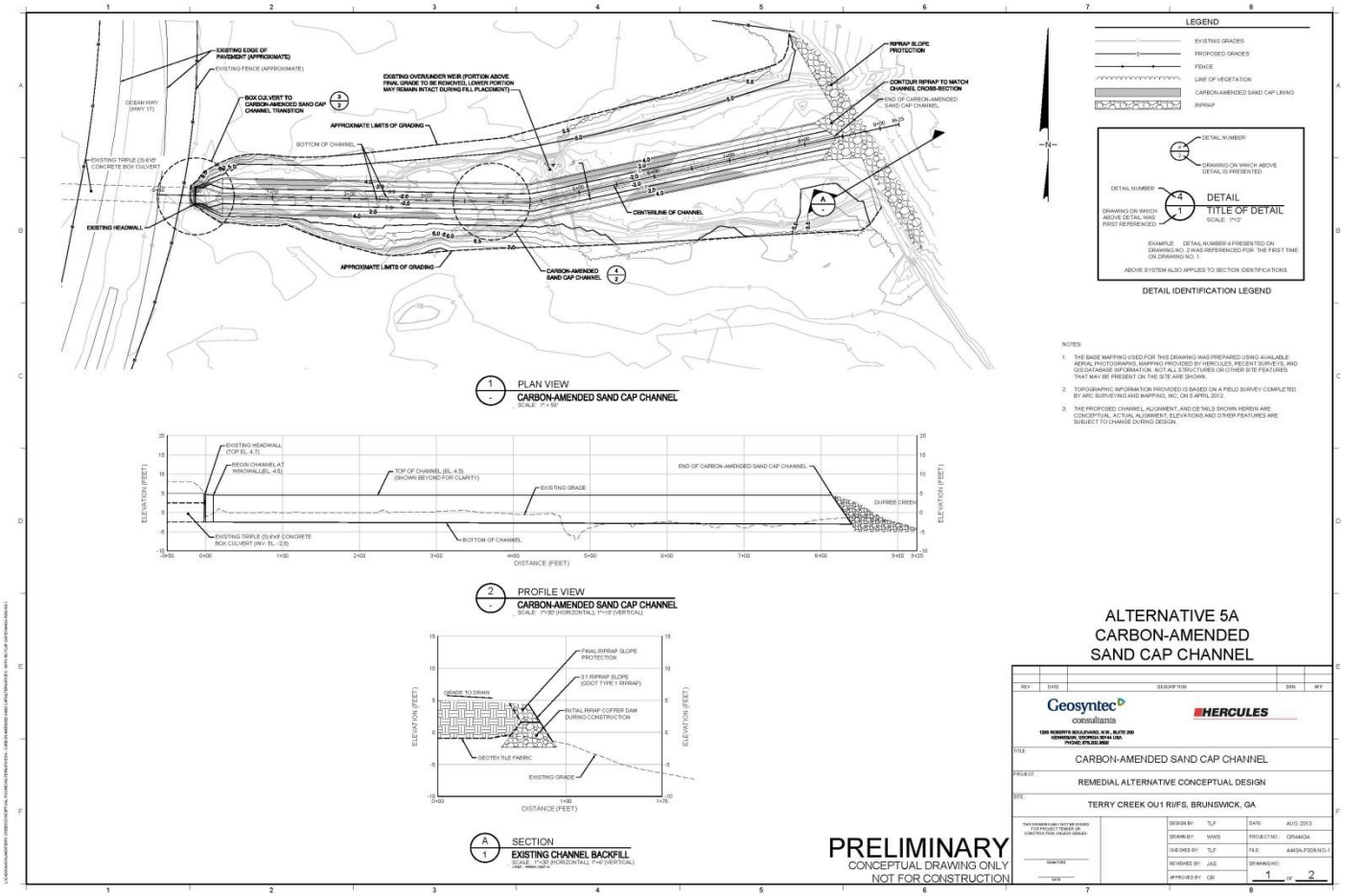


ATTACHMENT 9

ALTERNATIVE 5A DRAWINGS

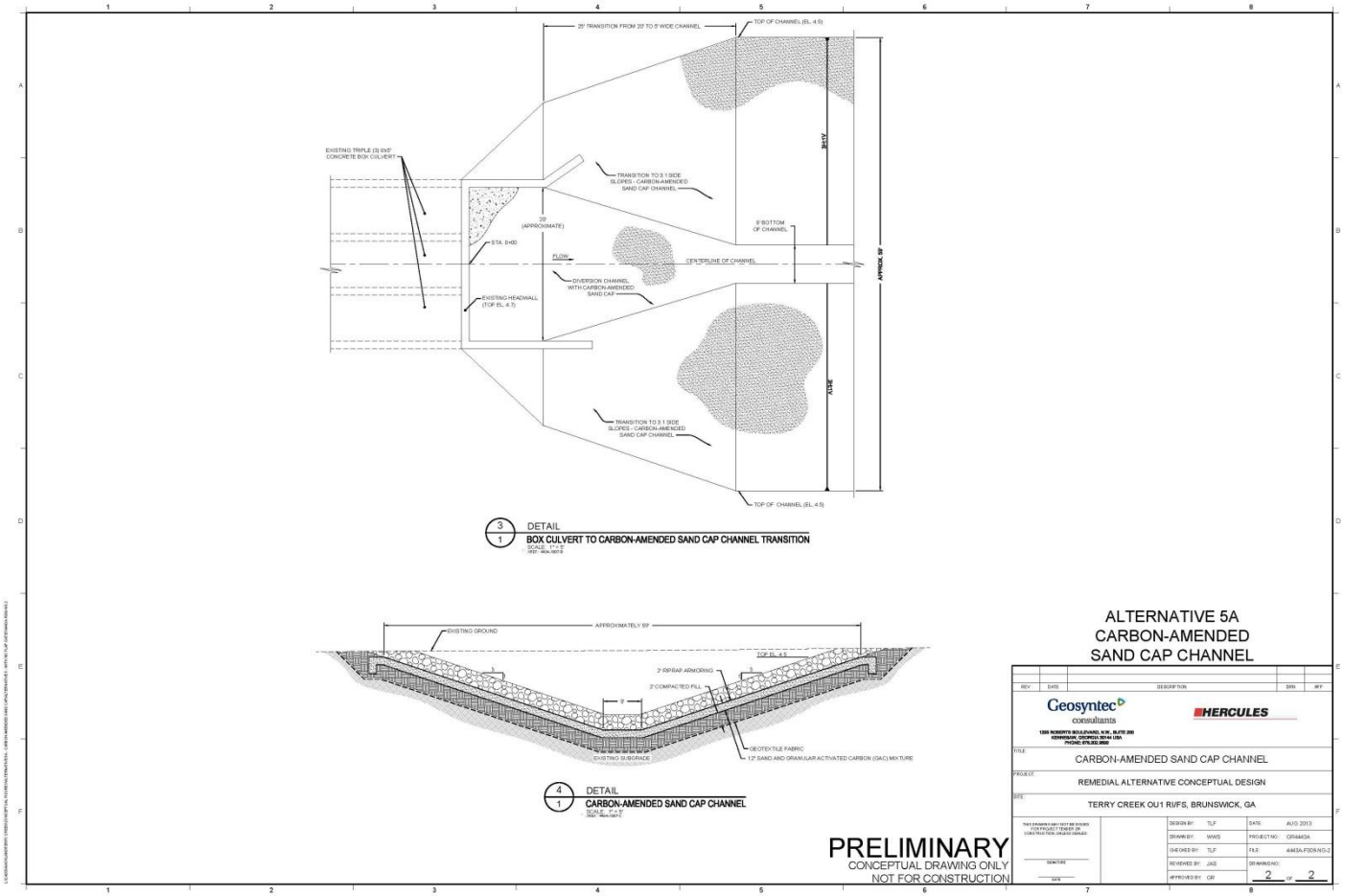
CP: **MWS** Date: **12/12/13** APC: **VG** Date: **12/12/13** CC: **VG** Date: **12/12/13**

Client: **Hercules** Project: **Terry Creek OU1 RI/FS** Project No: **GR4443B**



CP: **MWS** Date: **12/12/13** APC: **VG** Date: **12/12/13** CC: **VG** Date: **12/12/13**

Client: **Hercules** Project: **Terry Creek OU1 RI/FS** Project No: **GR4443B**

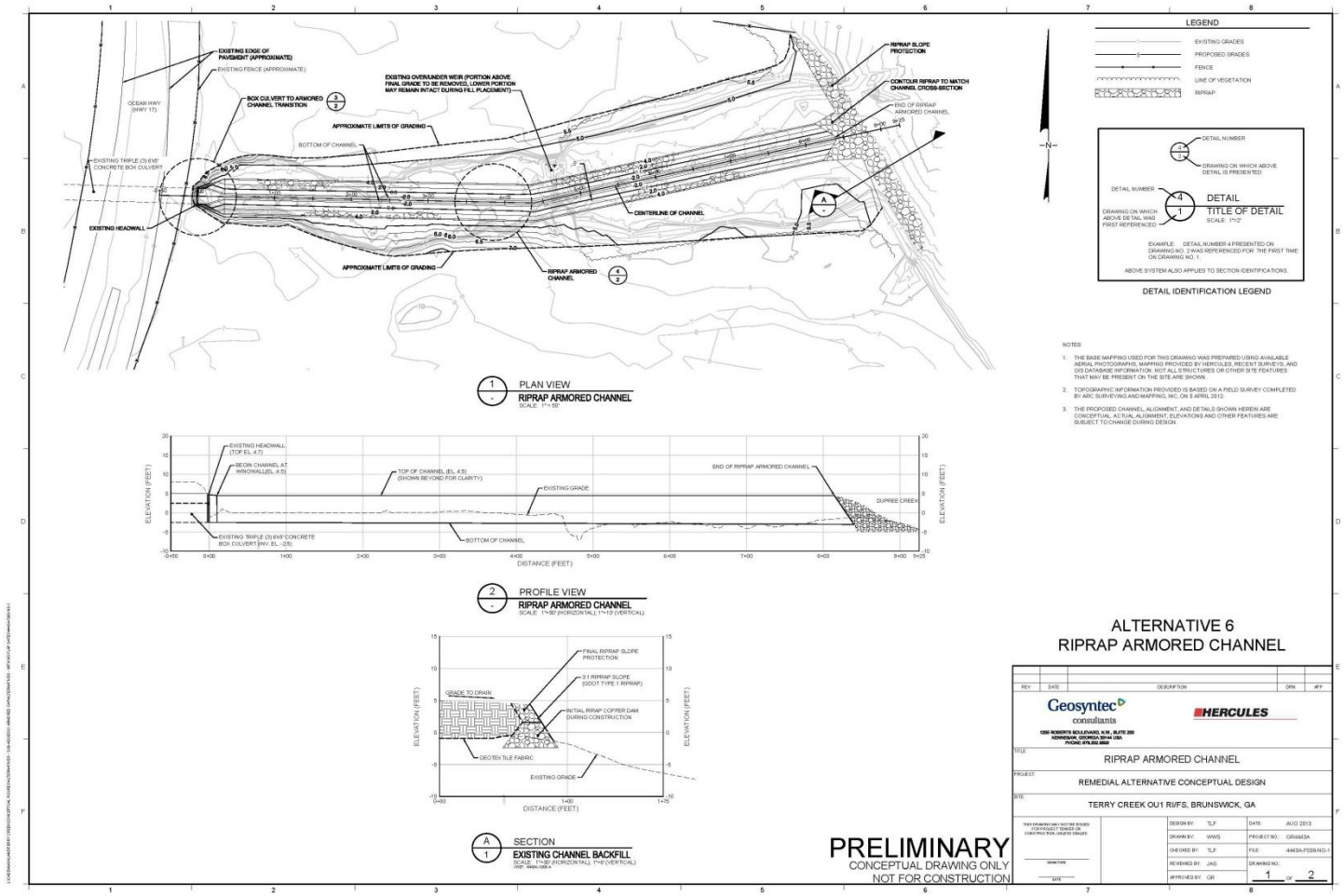


ATTACHMENT 10

ALTERNATIVE 6 DRAWINGS

CP: **MWS** Date: **12/12/13** APC: **VG** Date: **12/12/13** CC: **VG** Date: **12/12/13**

Client: **Hercules** Project: **Terry Creek OU1 RI/FS** Project No: **GR4443B**



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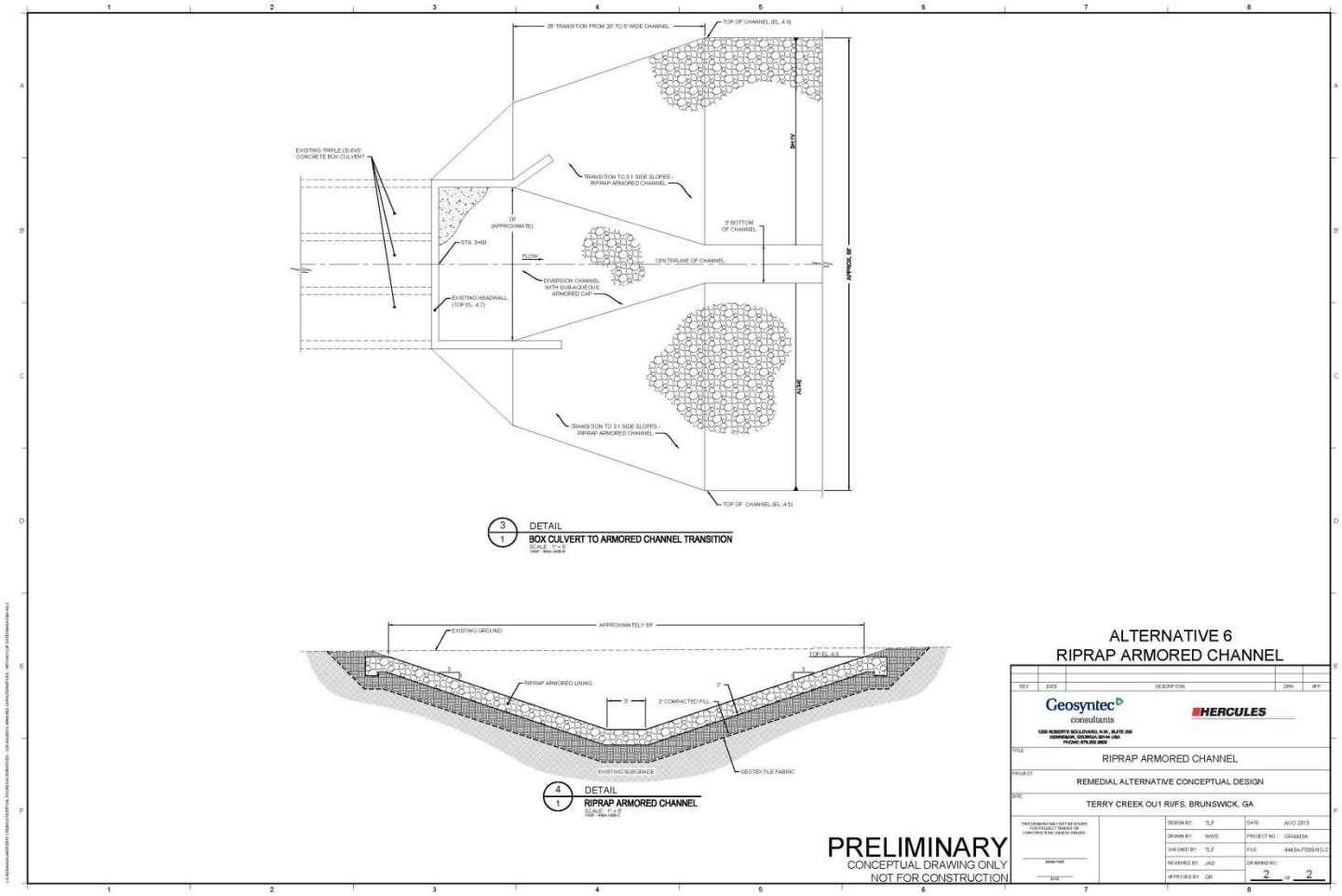
Client: **Hercules** Project: **Terry Creek OU1 RI/FS** Project No: **GR4443B**



ATTACHMENT 11

MANNING'S ROUGHNESS COEFFICIENTS (CHOW, 1959)

CP: **MWS** Date: **12/12/13** APC: **VG** Date: **12/12/13** CC: **VG** Date: **12/12/13**

Client: **Hercules** Project: **Terry Creek OU1 RI/FS** Project No: **GR4443B**

VALUES OF THE ROUGHNESS COEFFICIENT *n*
(Boldface figures are values generally recommended in design)

Type of channel and description	Minimum	Normal	Maximum
A. CLOSED CONDUITS FLOWING PARTLY FULL			
A-1. Metal			
a. Brass, smooth	0.009	**0.010**	0.013
b. Steel			
1. Lockbar and welded	0.010	0.012	0.014
2. Riveted and spiral	0.013	0.016	0.017
c. Cast iron			
1. Coated	0.010	0.013	0.014
2. Uncoated	0.011	0.014	0.016
d. Wrought iron			
1. Black	0.012	0.014	0.015
2. Galvanized	0.013	0.016	0.017
e. Corrugated metal			
1. Subdrain	0.017	0.019	0.021
2. Storm drain	0.021	**0.024**	0.030
A-2. Nonmetal			
a. Lucite	0.008	0.009	0.010
b. Glass	0.009	**0.010**	0.013
c. Cement			
1. Neat, surface	0.010	0.011	0.013
2. Mortar	0.011	0.013	0.015
d. Concrete			
1. Culvert, straight and free of debris	0.010	0.011	0.013
2. Culvert with bends, connections, and some debris	0.011	**0.013**	0.014
3. Finished	0.011	0.012	0.014
4. Sewer with manholes, inlet, etc., straight	0.013	0.015	0.017
5. Unfinished, steel form	0.012	0.013	0.014
6. Unfinished, smooth wood form	0.012	**0.014**	0.016
7. Unfinished, rough wood form	0.015	0.017	0.020
e. Wood			
1. Stave	0.010	0.012	0.014
2. Laminated, treated	0.015	0.017	0.020
f. Clay			
1. Common drainage tile	0.011	**0.013**	0.017
2. Vitrified sewer	0.011	0.014	0.017
3. Vitrified sewer with manholes, inlet, etc.	0.013	0.015	0.017
4. Vitrified subdrain with open joint	0.014	0.016	0.018
g. Brickwork			
1. Glazed	0.011	0.013	0.015
2. Lined with cement mortar	0.012	0.015	0.017
h. Sanitary sewers coated with sewage slimes, with bends and connections	0.012	0.013	0.016
i. Paved invert, sewer, smooth bottom	0.016	0.019	0.020
j. Rubble masonry, cemented	0.018	0.025	0.030

VALUES OF THE ROUGHNESS COEFFICIENT *n* (*continued*)

Type of channel and description	Minimum	Normal	Maximum
B. LINED OR BUILT-UP CHANNELS			
B-1. Metal			
a. Smooth steel surface			
1. Unpainted	0.011	**0.012**	0.014
2. Painted	0.012	0.013	0.017
b. Corrugated	0.021	0.025	0.030
B-2. Nonmetal			
a. Cement			
1. Neat, surface	0.010	0.011	0.013
2. Mortar	0.011	0.013	0.015
b. Wood			
1. Planed, untreated	0.010	0.012	0.014
2. Planed, creosoted	0.011	0.012	0.015
3. Unplaned	0.011	0.013	0.015
4. Plank with battens	0.012	0.015	0.018
5. Lined with roofing paper	0.010	0.014	0.017
c. Concrete			
1. Trowel finish	0.011	**0.013**	0.015
2. Float finish	0.013	0.015	0.016
3. Finished, with gravel on bottom	0.015	0.017	0.020
4. Unfinished	0.014	0.017	0.020
5. Gunite, good section	0.016	0.019	0.023
6. Gunite, wavy section	0.018	0.022	0.025
7. On good excavated rock	0.017	0.020	
8. On irregular excavated rock	0.022	0.027	
d. Concrete bottom float finished with sides of			
1. Dressed stone in mortar	0.015	0.017	0.020
2. Random stone in mortar	0.017	0.020	0.024
3. Cement rubble masonry, plastered	0.016	0.020	0.024
4. Cement rubble masonry	0.020	0.025	0.030
5. Dry rubble or riprap	0.020	0.030	0.035
e. Gravel bottom with sides of			
1. Formed concrete	0.017	0.020	0.025
2. Random stone in mortar	0.020	0.023	0.026
3. Dry rubble or riprap	0.023	0.033	0.036
f. Brick			
1. Glazed	0.011	**0.013**	0.015
2. In cement mortar	0.012	**0.015**	0.018
g. Masonry			
1. Cemented rubble	0.017	0.025	0.030
2. Dry rubble	0.023	0.032	0.035
h. Dressed ashlar	0.013	0.015	0.017
i. Asphalt			
1. Smooth	0.013	0.013	
2. Rough	0.016	0.016	
j. Vegetal lining	0.030	.....	0.500

CP: MWS Date: 12/12/13 APC: VG Date: 12/12/13 CC: VG Date: 12/12/13

Client: Hercules Project: Terry Creek OU1 RI/FS Project No: GR4443B

VALUES OF THE ROUGHNESS COEFFICIENT *n* (*continued*)

Type of channel and description	Minimum	Normal	Maximum
C. EXCAVATED OR DREDGED			
a. Earth, straight and uniform			
1. Clean, recently completed	0.016	0.018	0.020
2. Clean, after weathering	0.018	0.022	0.025
3. Gravel, uniform section, clean	0.022	0.025	0.030
4. With short grass, few weeds	0.022	0.027	0.033
b. Earth, winding and sluggish			
1. No vegetation	0.023	0.025	0.030
2. Grass, some weeds	0.025	0.030	0.033
3. Dense weeds or aquatic plants in deep channels	0.030	0.035	0.040
4. Earth bottom and rubble sides	0.028	0.030	0.035
5. Stony bottom and weedy banks	0.025	0.035	0.040
6. Cobble bottom and clean sides	0.030	0.040	0.050
c. Dragline-excavated or dredged			
1. No vegetation	0.025	0.028	0.033
2. Light brush on banks	0.035	0.050	0.060
d. Rock cuts			
1. Smooth and uniform	0.025	0.035	0.040
2. Jagged and irregular	0.035	0.040	0.050
e. Channels not maintained, weeds and brush uncut			
1. Dense weeds, high as flow depth	0.050	0.080	0.120
2. Clean bottom, brush on sides	0.040	0.050	0.080
3. Same, highest stage of flow	0.045	0.070	0.110
4. Dense brush, high stage	0.080	0.100	0.140
D. NATURAL STREAMS			
D-1. Minor streams (top width at flood stage <100 ft)			
a. Streams on plain			
1. Clean, straight, full stage, no rifts or deep pools	0.025	0.030	0.033
2. Same as above, but more stones and weeds	0.030	0.035	0.040
3. Clean, winding, some pools and shoals	0.033	0.040	0.045
4. Same as above, but some weeds and stones	0.035	0.045	0.050
5. Same as above, lower stages, more ineffective slopes and sections	0.040	0.048	0.055
6. Same as 4, but more stones	0.045	0.050	0.060
7. Sluggish reaches, weedy, deep pools	0.050	0.070	0.080
8. Very weedy reaches, deep pools, or floodways with heavy stand of timber and underbrush	0.075	0.100	0.150

VALUES OF THE ROUGHNESS COEFFICIENT *n* (*continued*)

Type of channel and description	Minimum	Normal	Maximum
b. Mountain streams, no vegetation in channel, banks usually steep, trees and brush along banks submerged at high stages			
1. Bottom: gravels, cobbles, and few boulders	0.030	0.040	0.050
2. Bottom: cobbles with large boulders	0.040	0.050	0.070
D-2. Flood plains			
a. Pasture, no brush			
1. Short grass	0.025	0.030	0.035
2. High grass	0.030	0.035	0.050
b. Cultivated areas			
1. No crop	0.020	0.030	0.040
2. Mature row crops	0.025	0.035	0.045
3. Mature field crops	0.030	0.040	0.050
c. Brush			
1. Scattered brush, heavy weeds	0.035	0.050	0.070
2. Light brush and trees, in winter	0.035	0.050	0.060
3. Light brush and trees, in summer	0.040	0.060	0.080
4. Medium to dense brush, in winter	0.045	0.070	0.110
5. Medium to dense brush, in summer	0.070	0.100	0.160
d. Trees			
1. Dense willows, summer, straight	0.110	0.150	0.200
2. Cleared land with tree stumps, no sprouts	0.030	0.040	0.050
3. Same as above, but with heavy growth of sprouts	0.050	0.060	0.080
4. Heavy stand of timber, a few down trees, little undergrowth, flood stage below branches	0.080	0.100	0.120
5. Same as above, but with flood stage reaching branches	0.100	0.120	0.160
D-3. Major streams (top width at flood stage >100 ft). The *n* value is less than that for minor streams of similar description, because banks offer less effective resistance.			
a. Regular section with no boulders or brush	0.025	.....	0.060
b. Irregular and rough section	0.035	.....	0.100

ATTACHMENT 12
MANNING'S ROUGHNESS COEFFICIENTS
(ATLANTA REGIONAL COMISSION, 2001)

Table 4.4-4 Manning's Roughness Coefficients (n) for Artificial Channels

		Depth Ranges		
Category	**Lining Type**	**0-0.5 ft**	**0.5-2.0 ft**	**>2.0 ft**
Rigid	Concrete	0.015	0.013	0.013
	Grouted Riprap	0.040	0.030	0.028
	Stone Masonry	0.042	0.032	0.030
	Soil Cement	0.025	0.022	0.020
	Asphalt	0.018	0.016	0.016
Unlined	Bare Soil	0.023	0.020	0.020
	Rock Cut	0.045	0.035	0.025
Temporary*	Woven Paper Net	0.016	0.015	0.015
	Jute Net	0.028	0.022	0.019
	Fiberglass Roving	0.028	0.022	0.019
	Straw with Net	0.065	0.033	0.025
	Curled Wood Mat	0.066	0.035	0.028
	Synthetic Mat	0.036	0.025	0.021
Gravel Riprap	1-inch D_{50}	0.044	0.033	0.030
	2-inch D_{50}	0.066	0.041	0.034
Rock Riprap	6-inch D_{50}	0.104	0.069	0.035
	12-inch D_{50}	----	0.078	0.040

Note: Values listed are representative values for the respective depth ranges. Manning's roughness coefficients, n, vary with the flow depth.

*Some "temporary" linings become permanent when buried.

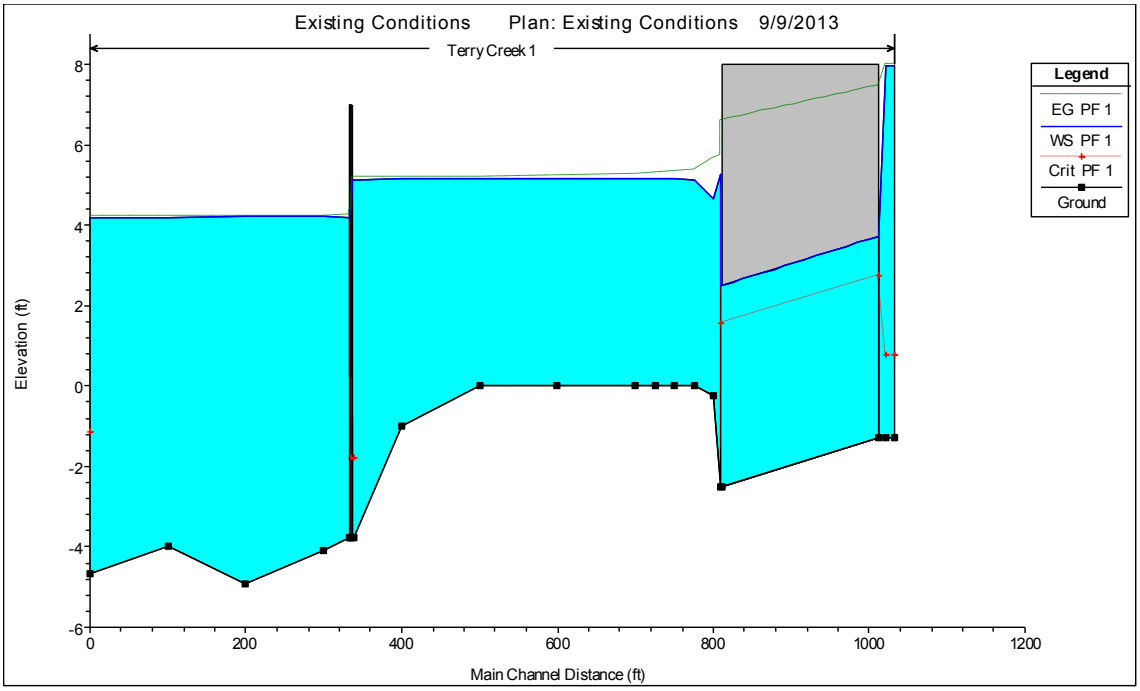
Source: HEC-15, 1988.

ATTACHMENT 13

HEC-RAS OUTPUTS FOR EXISTING CONDITIONS, CLEAN

CP: **MWS** Date: **12/12/13** APC: **VG** Date: **12/12/13** CC: **VG** Date: **12/12/13**

Client: **Hercules** Project: **Terry Creek OU1 RI/FS** Project No: **GR4443B**



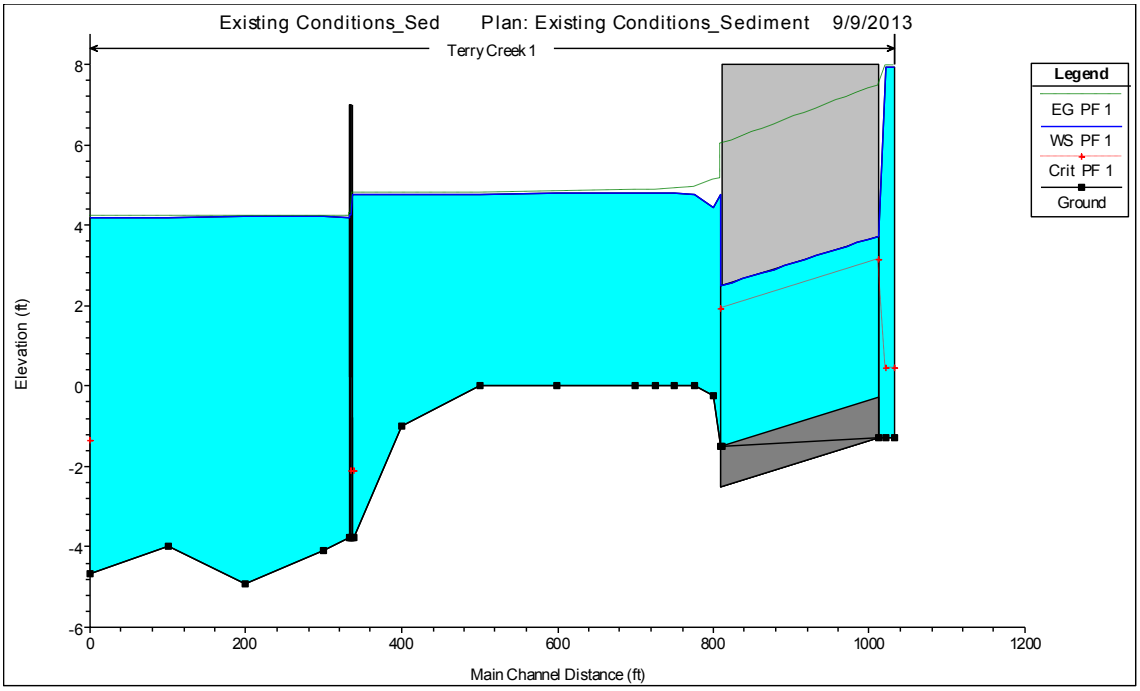
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude #
-	-	-	(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	-
1	20	PF 1	830	-1.28	7.95	0.76	8	0.000026	1.8	461	50	0.10
1	10	PF 1	830	-1.28	7.95	0.76	8	0.000026	1.8	461	50	0.10
1	0		Culvert									
1	-202	PF 1	830	-2.5	5.28		5.72	0.000405	5.34	156	20	0.34
1	-212	PF 1	830	-0.23	4.64		5.65	0.005816	8.07	103	29	0.75
1	-237	PF 1	830	0	5.13		5.36	0.001128	3.9	213	57	0.36
1	-262	PF 1	830	0	5.17		5.32	0.000659	3.14	265	66	0.28
1	-287	PF 1	830	0.01	5.16		5.3	0.000598	2.97	280	71	0.26
1	-312	PF 1	830	0.01	5.17		5.28	0.000432	2.59	320	79	0.23
1	-412	PF 1	830	0	5.16		5.23	0.00025	2.1	419	138	0.17
1	-512	PF 1	830	0	5.16		5.21	0.000153	1.69	492	112	0.14
1	-612	PF 1	830	-0.98	5.15		5.19	0.000111	1.54	545	125	0.12
1	-673	PF 1	830	-3.77	5.13	-1.79	5.18	0.000104	1.78	465	52	0.11
1	-675		Inl Struct									
1	-676	PF 1	830	-3.77	4.3	-1.79	4.36	0.000139	1.97	422	52	0.12
1	-677		Inl Struct									
1	-678	PF 1	830	-3.77	4.18		4.24	0.000146	2	415	52	0.12
1	-712	PF 1	830	-4.11	4.21		4.22	0.000055	1.1	757	145	0.08
1	-812	PF 1	830	-4.9	4.21		4.22	0.000038	0.91	917	188	0.07
1	-912	PF 1	830	-4	4.2		4.21	0.000049	0.98	851	179	0.08
1	-1012	PF 1	830	-4.68	4.2	-1.13	4.21	0.000024	0.75	1105	204	0.06

ATTACHMENT 14

HEC-RAS OUTPUTS FOR EXISTING CONDITIONS, ACCUMULATED SEDIMENT

CP: **MWS** Date: **12/12/13** APC: **VG** Date: **12/12/13** CC: **VG** Date: **12/12/13**

Client: **Hercules** Project: **Terry Creek OU1 RI/FS** Project No: **GR4443B**



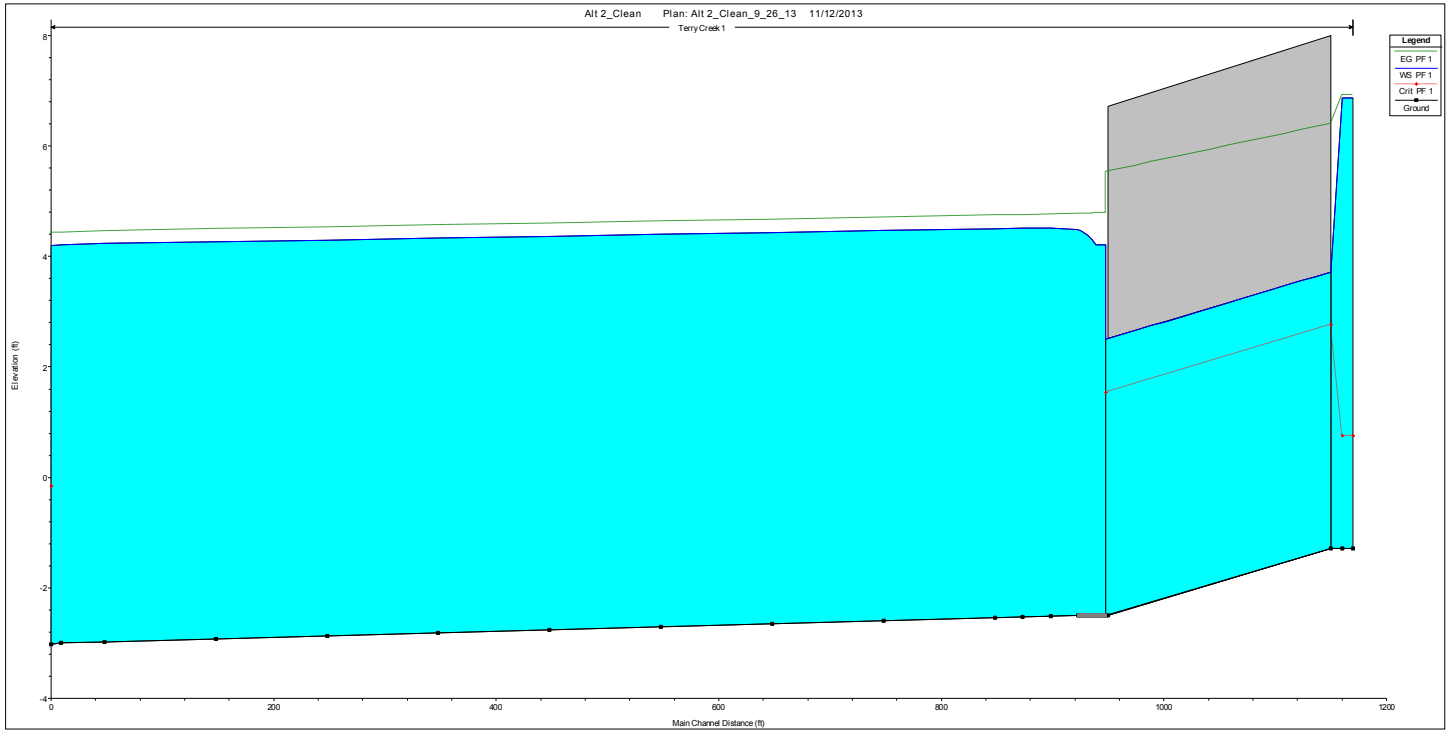
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude #
-	-	-	(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	-
1	20	PF 1	645	-1.28	7.94	0.44	7.97	0.000016	1.4	461	50	0.08
1	10	PF 1	645	-1.28	7.94	0.44	7.97	0.000016	1.4	461	50	0.08
1	0		Culvert									
1	-202	PF 1	645	-1.5	4.76		5.17	0.000964	5.15	125	20	0.36
1	-212	PF 1	645	-0.23	4.45		5.13	0.00395	6.62	97	27	0.62
1	-237	PF 1	645	0	4.76		4.93	0.000919	3.36	192	55	0.32
1	-262	PF 1	645	0	4.79		4.9	0.000532	2.69	240	64	0.24
1	-287	PF 1	645	0.01	4.78		4.88	0.000487	2.55	253	69	0.24
1	-312	PF 1	645	0.01	4.79		4.86	0.00035	2.22	291	77	0.20
1	-412	PF 1	645	0	4.78		4.83	0.000206	1.8	369	119	0.16
1	-512	PF 1	645	0	4.78		4.81	0.000118	1.43	452	101	0.12
1	-612	PF 1	645	-0.98	4.77		4.8	0.000086	1.29	501	106	0.10
1	-673	PF 1	645	-3.77	4.76	-2.1	4.79	0.000071	1.45	446	52	0.09
1	-675		Inl Struct									
1	-676	PF 1	645	-3.77	4.26	-2.1	4.3	0.000086	1.54	420	52	0.10
1	-677		Inl Struct									
1	-678	PF 1	645	-3.77	4.19		4.22	0.000088	1.55	416	52	0.10
1	-712	PF 1	645	-4.11	4.2		4.21	0.000033	0.85	757	145	0.07
1	-812	PF 1	645	-4.9	4.2		4.21	0.000023	0.7	917	188	0.05
1	-912	PF 1	645	-4	4.2		4.21	0.000029	0.76	851	179	0.06
1	-1012	PF 1	645	-4.68	4.2	-1.34	4.21	0.000014	0.58	1105	204	0.04

ATTACHMENT 15

HEC-RAS OUTPUTS FOR ALTERNATIVE 2, CLEAN

CP: **MWS** Date: **12/12/13** APC: **VG** Date: **12/12/13** CC: **VG** Date: **12/12/13**

Client: **Hercules** Project: **Terry Creek OU1 RI/FS** Project No: **GR4443B**



CP: **MWS** Date: **12/12/13** APC: **VG** Date: **12/12/13** CC: **VG** Date: **12/12/13**

Client: **Hercules** Project: **Terry Creek OU1 RI/FS** Project No: **GR4443B**

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude #
-	-	-	(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	-
1	20	PF 1	830	-1.28	6.87	0.76	6.93	0.000038	2.04	407	50	0.13
1	10	PF 1	830	-1.28	6.87	0.76	6.93	0.000038	2.04	407	50	0.13
1	0		Culvert									
1	-202	PF 1	830	-2.5	4.21		4.79	0.000592	6.11	136	20	0.42
1	-203.*	PF 1	830	-2.5	4.21		4.79	0.000596	6.12	136	20	0.42
1	-204.*	PF 1	830	-2.5	4.21		4.79	0.000596	6.12	136	20	0.42
1	-205.*	PF 1	830	-2.5	4.21		4.79	0.000596	6.12	136	20	0.42
1	-206.*	PF 1	830	-2.5	4.21		4.79	0.000596	6.13	136	20	0.42
1	-207.*	PF 1	830	-2.5	4.21		4.79	0.000596	6.13	135	20	0.42
1	-208.*	PF 1	830	-2.5	4.21		4.79	0.000596	6.13	135	20	0.42
1	-209.*	PF 1	830	-2.5	4.21		4.79	0.000597	6.13	135	20	0.42
1	-210.*	PF 1	830	-2.5	4.21		4.79	0.000597	6.13	135	20	0.42
1	-211	PF 1	830	-2.5	4.21		4.79	0.001234	6.12	136	20	0.42
1	-212.*	PF 1	830	-2.5	4.24		4.79	0.000554	5.95	139	21	0.40
1	-213.*	PF 1	830	-2.5	4.26		4.78	0.000515	5.79	143	21	0.39
1	-214.*	PF 1	830	-2.5	4.29		4.78	0.000723	5.65	147	22	0.38
1	-215.*	PF 1	830	-2.5	4.31		4.78	0.000673	5.5	151	22	0.37
1	-216.*	PF 1	830	-2.5	4.33		4.78	0.000427	5.38	154	23	0.36
1	-217.*	PF 1	830	-2.5	4.35		4.78	0.000401	5.24	158	23	0.35
1	-218.*	PF 1	830	-2.5	4.37		4.78	0.000377	5.12	162	24	0.34
1	-219.*	PF 1	830	-2.5	4.39		4.78	0.000523	5.01	166	24	0.34
1	-220.*	PF 1	830	-2.5	4.4		4.78	0.000492	4.9	169.47	24.6	0.33
1	-221.*	PF 1	830	-2.5	4.42		4.77	0.00032	4.8	172.93	25	0.32
1	-222.*	PF 1	830	-2.5	4.43		4.77	0.000303	4.7	176.76	25.5	0.31
1	-223.*	PF 1	830	-2.5	4.45		4.77	0.000288	4.6	180.58	26	0.31
1	-224.*	PF 1	830	-2.5	4.46		4.77	0.000395	4.51	184	26.5	0.3
1	-225.*	PF 1	830	-2.5	4.47		4.77	0.000374	4.42	187.8	27	0.3
1	-226.*	PF 1	830	-2.5	4.48		4.77	0.000249	4.34	191.21	27.4	0.29
1	-227	PF 1	830	-2.5	4.49		4.77	0.000446	4.25	195.22	27.98	0.28
1	-252	PF 1	830	-2.51	4.52		4.76	0.000359	3.93	211.21	30.09	0.26
1	-277	PF 1	830	-2.53	4.51		4.75	0.000272	3.92	211.77	30.09	0.26
1	-302	PF 1	830	-2.54	4.5		4.74	0.000358	3.92	211.6	30.08	0.26
1	-402	PF 1	830	-2.6	4.47		4.71	0.000355	3.91	212.19	30.08	0.26
1	-502	PF 1	830	-2.65	4.43		4.67	0.000353	3.9	212.8	30.08	0.26
1	-602	PF 1	830	-2.71	4.4		4.63	0.000349	3.89	213.58	30.08	0.26
1	-702	PF 1	830	-2.76	4.37		4.6	0.000347	3.88	214.05	30.08	0.26
1	-802	PF 1	830	-2.82	4.33		4.56	0.000344	3.86	214.85	30.08	0.25
1	-902	PF 1	830	-2.87	4.3		4.53	0.000342	3.85	215.36	30.09	0.25
1	-1002	PF 1	830	-2.92	4.26		4.49	0.00034	3.84	215.87	30.09	0.25
1	-1102	PF 1	830	-2.98	4.23		4.46	0.000336	3.83	216.71	30.1	0.25
1	-1141	PF 1	830	-3	4.21		4.44	0.001095	3.83	216.64	30.1	0.25
1	-1150	PF 1	830	-3.02	4.2	-0.15	4.43	0.001091	3.83	216.87	30.08	0.25

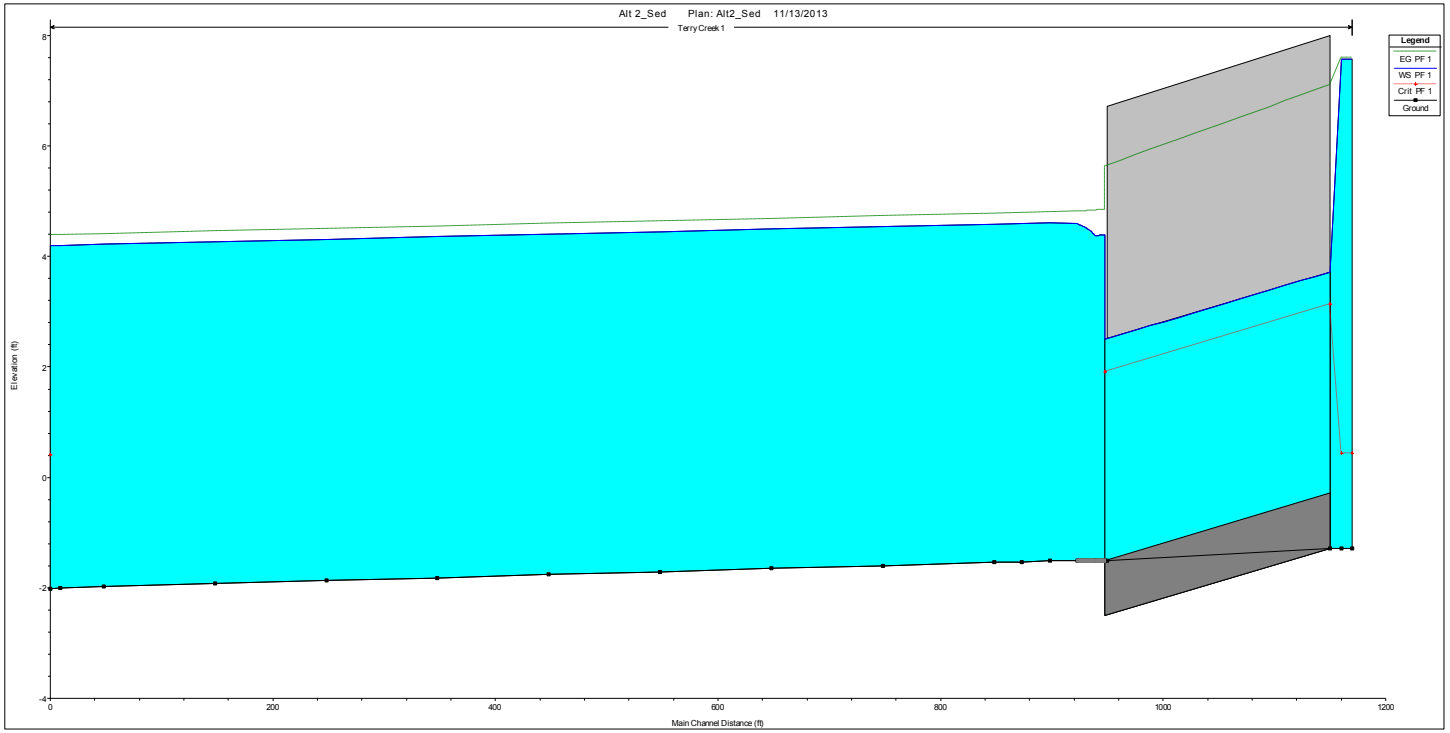
* indicates interpolated cross sections

ATTACHMENT 16

HEC-RAS OUTPUTS FOR ALTERNATIVE 2, ACCUMULATED SEDIMENT

CP: **MWS** Date: **12/12/13** APC: **VG** Date: **12/12/13** CC: **VG** Date: **12/12/13**

Client: **Hercules** Project: **Terry Creek OU1 RI/FS** Project No: **GR4443B**



CP: **MWS** Date: **12/12/13** APC: **VG** Date: **12/12/13** CC: **VG** Date: **12/12/13**

Client: **Hercules** Project: **Terry Creek OU1 RI/FS** Project No: **GR4443B**

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude #
-	-	-	(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	-
1	20	PF 1	645	-1.28	7.57	0.44	7.6	0.000018	1.46	442.41	50	0.09
1	10	PF 1	645	-1.28	7.57	0.44	7.6	0.000018	1.46	442.4	50	0.09
1	0		Culvert									
1	-202	PF 1	645	-1.5	4.39		4.84	0.00088	5.41	119.15	20.26	0.39
1	-203.*	PF 1	645	-1.5	4.39		4.84	0.000881	5.41	119.12	20.26	0.39
1	-204.*	PF 1	645	-1.5	4.39		4.84	0.000882	5.42	119.07	20.26	0.39
1	-205.*	PF 1	645	-1.5	4.39		4.84	0.001079	5.42	119.08	20.27	0.39
1	-206.*	PF 1	645	-1.5	4.39		4.84	0.000882	5.42	119.02	20.27	0.39
1	-207.*	PF 1	645	-1.5	4.38		4.84	0.000883	5.42	119	20.27	0.39
1	-208.*	PF 1	645	-1.5	4.38		4.84	0.000883	5.42	118.95	20.27	0.39
1	-209.*	PF 1	645	-1.5	4.38		4.84	0.000883	5.42	118.96	20.28	0.39
1	-210.*	PF 1	645	-1.5	4.38		4.84	0.000884	5.42	118.9	20.28	0.39
1	-211	PF 1	645	-1.5	4.38		4.84	0.001033	5.43	118.88	20.28	0.39
1	-212.*	PF 1	645	-1.5	4.4		4.83	0.001328	5.28	122.17	20.76	0.38
1	-213.*	PF 1	645	-1.5	4.42		4.83	0.001239	5.14	125.43	21.24	0.37
1	-214.*	PF 1	645	-1.5	4.44		4.83	0.001159	5.01	128.71	21.72	0.36
1	-215.*	PF 1	645	-1.5	4.46		4.83	0.001086	4.89	131.94	22.2	0.35
1	-216.*	PF 1	645	-1.5	4.47		4.83	0.00102	4.77	135.16	22.68	0.34
1	-217.*	PF 1	645	-1.5	4.49		4.83	0.000957	4.66	138.37	23.16	0.34
1	-218.*	PF 1	645	-1.5	4.5		4.82	0.000901	4.56	141.56	23.68	0.33
1	-219.*	PF 1	645	-1.5	4.52		4.82	0.000851	4.45	144.85	24.39	0.32
1	-220.*	PF 1	645	-1.5	4.53		4.82	0.000815	4.36	148.07	25.09	0.31
1	-221.*	PF 1	645	-1.5	4.54		4.82	0.000771	4.26	151.24	25.79	0.31
1	-222.*	PF 1	645	-1.5	4.55		4.82	0.00073	4.18	154.42	26.5	0.3
1	-223.*	PF 1	645	-1.5	4.56		4.82	0.000692	4.09	157.58	27.23	0.29
1	-224.*	PF 1	645	-1.5	4.57		4.82	0.000658	4.01	160.75	27.99	0.29
1	-225.*	PF 1	645	-1.5	4.58		4.82	0.000625	3.94	163.94	28.81	0.28
1	-226.*	PF 1	645	-1.5	4.58		4.82	0.000595	3.86	167.1	29.67	0.28
1	-227	PF 1	645	-1.5	4.59		4.81	0.000567	3.79	170.27	30.62	0.27
1	-252	PF 1	645	-1.51	4.61		4.8	0.000469	3.51	183.87	30.09	0.25
1	-277	PF 1	645	-1.53	4.6		4.79	0.000421	3.5	184.29	30.09	0.25
1	-302	PF 1	645	-1.54	4.59		4.78	0.000468	3.5	184.05	30.08	0.25
1	-402	PF 1	645	-1.6	4.54		4.73	0.000466	3.5	184.29	30.08	0.25
1	-502	PF 1	645	-1.65	4.49		4.68	0.000464	3.49	184.55	30.08	0.25
1	-602	PF 1	645	-1.71	4.45		4.64	0.000461	3.49	184.98	30.08	0.25
1	-702	PF 1	645	-1.76	4.4		4.59	0.00046	3.48	185.1	30.07	0.25
1	-802	PF 1	645	-1.82	4.36		4.54	0.000457	3.48	185.55	30.08	0.25
1	-902	PF 1	645	-1.87	4.31		4.5	0.000456	3.47	185.7	30.08	0.25
1	-1002	PF 1	645	-1.92	4.27		4.45	0.000455	3.47	185.85	30.09	0.25
1	-1102	PF 1	645	-1.98	4.22		4.41	0.000452	3.46	186.33	30.1	0.25
1	-1141	PF 1	645	-2	4.2		4.39	0.000452	3.46	186.32	30.07	0.25
1	-1150	PF 1	645	-2.02	4.2	0.4	4.38	0.000448	3.45	186.9	30.1	0.24

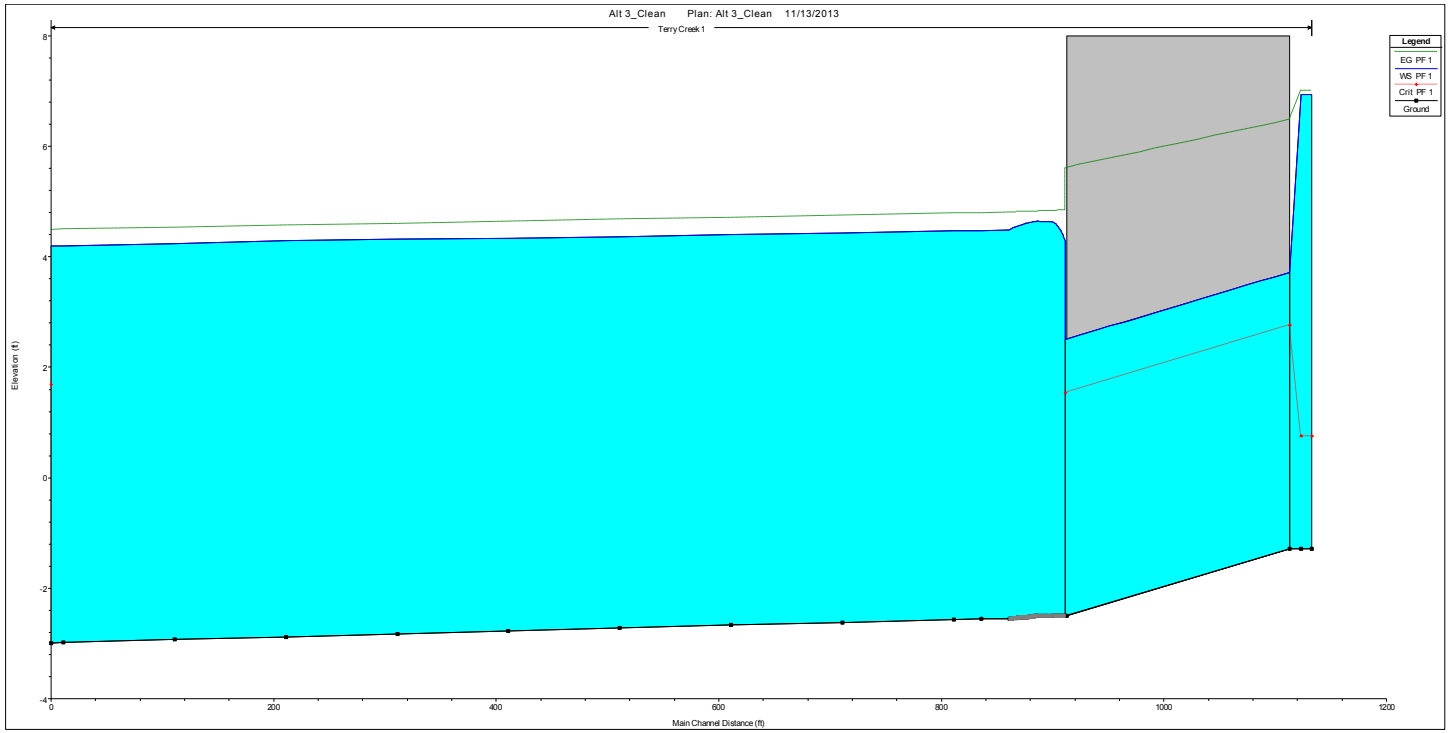
* indicates interpolated cross sections

ATTACHMENT 17

HEC-RAS OUTPUTS FOR ALTERNATIVE 3, CLEAN

CP: **MWS** Date: **12/12/13** APC: **VG** Date: **12/12/13** CC: **VG** Date: **12/12/13**

Client: **Hercules** Project: **Terry Creek OU1 RI/FS** Project No: **GR4443B**



CP: **MWS** Date: **12/12/13** APC: **VG** Date: **12/12/13** CC: **VG** Date: **12/12/13**

Client: **Hercules** Project: **Terry Creek OU1 RI/FS** Project No: **GR4443B**

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude #
-	-	-	(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	-
1	20	PF 1	830	-1.28	6.94	0.76	7.01	0.000037	2.02	411.19	50	0.12
1	10	PF 1	830	-1.28	6.94	0.76	7.01	0.000037	2.02	411.17	50	0.12
1	0		Culvert									
1	-202	PF 1	830	-2.5	4.29		4.85	0.000563	6.01	138.21	20.45	0.41
1	-203.*	PF 1	830	-2.5	4.35		4.85	0.000468	5.66	146.61	22.57	0.39
1	-204.*	PF 1	830	-2.5	4.4		4.84	0.000397	5.35	155.22	24.74	0.38
1	-205.*	PF 1	830	-2.5	4.44		4.84	0.000343	5.06	163.92	26.97	0.36
1	-206.*	PF 1	830	-2.5	4.48		4.84	0.0003	4.81	172.73	29.2	0.35
1	-207.*	PF 1	830	-2.5	4.52		4.84	0.000267	4.57	181.65	31.44	0.34
1	-208.*	PF 1	830	-2.5	4.54		4.84	0.000239	4.35	190.75	33.7	0.32
1	-209.*	PF 1	830	-2.5	4.57		4.84	0.000217	4.15	199.86	35.98	0.31
1	-210.*	PF 1	830	-2.5	4.59		4.84	0.000197	3.97	209.04	38.32	0.3
1	-211.*	PF 1	830	-2.5	4.61		4.84	0.00018	3.8	218.34	40.65	0.29
1	-212	PF 1	830	-2.5	4.63		4.83	0.000165	3.64	227.74	42.96	0.28
1	-215.*	PF 1	830	-2.5	4.63		4.83	0.000161	3.57	232.39	45	0.28
1	-218.*	PF 1	830	-2.5	4.64		4.83	0.000158	3.51	236.66	47.09	0.27
1	-221.*	PF 1	830	-2.5	4.64		4.83	0.000154	3.45	240.57	48.91	0.27
1	-224.*	PF 1	830	-2.5	4.64		4.82	0.000151	3.4	244.23	50.52	0.27
1	-227	PF 1	830	-2.5	4.65		4.82	0.000148	3.35	247.72	52.1	0.27
1	-228.*	PF 1	830	-2.5	4.64		4.82	0.000153	3.38	245.37	51.23	0.27
1	-229.*	PF 1	830	-2.5	4.64		4.82	0.000159	3.41	243.06	50.54	0.27
1	-230.*	PF 1	830	-2.51	4.64		4.82	0.000163	3.44	241.05	50.49	0.28
1	-231.*	PF 1	830	-2.51	4.63		4.82	0.000167	3.48	238.72	50.43	0.28
1	-232.*	PF 1	830	-2.51	4.63		4.82	0.000173	3.51	236.35	50.36	0.29
1	-233.*	PF 1	830	-2.51	4.62		4.82	0.000178	3.55	233.98	50.28	0.29
1	-234.*	PF 1	830	-2.51	4.62		4.82	0.000183	3.58	231.61	50.21	0.29
1	-235.*	PF 1	830	-2.52	4.62		4.82	0.000188	3.62	229.52	50.12	0.3
1	-236.*	PF 1	830	-2.52	4.61		4.82	0.000195	3.66	226.99	50.02	0.3
1	-237.*	PF 1	830	-2.52	4.6		4.82	0.000201	3.7	224.47	49.91	0.31
1	-238.*	PF 1	830	-2.52	4.6		4.82	0.000208	3.74	222.02	49.81	0.31
1	-239.*	PF 1	830	-2.52	4.59		4.82	0.000215	3.78	219.53	49.7	0.32
1	-240.*	PF 1	830	-2.53	4.59		4.82	0.000222	3.82	217.32	49.6	0.32
1	-241.*	PF 1	830	-2.53	4.58		4.81	0.00023	3.87	214.66	49.46	0.33
1	-242.*	PF 1	830	-2.53	4.58		4.81	0.000239	3.91	212.13	49.34	0.33
1	-243.*	PF 1	830	-2.53	4.57		4.81	0.000248	3.96	209.51	49.19	0.34
1	-244.*	PF 1	830	-2.53	4.56		4.81	0.000257	4.01	206.89	49.05	0.34
1	-245.*	PF 1	830	-2.54	4.56		4.81	0.000266	4.06	204.55	48.9	0.35
1	-246.*	PF 1	830	-2.54	4.55		4.81	0.000277	4.11	201.77	48.74	0.36
1	-247.*	PF 1	830	-2.54	4.54		4.81	0.000288	4.17	199.08	48.57	0.36
1	-248.*	PF 1	830	-2.54	4.53		4.81	0.0003	4.23	196.33	48.4	0.37
1	-249.*	PF 1	830	-2.54	4.52		4.81	0.000313	4.29	193.59	48.22	0.38
1	-250.*	PF 1	830	-2.55	4.51		4.81	0.000325	4.34	191.13	48.05	0.38
1	-251.*	PF 1	830	-2.55	4.5		4.81	0.000339	4.41	188.3	47.85	0.39
1	-252	PF 1	830	-2.55	4.49		4.8	0.000355	4.48	185.36	47.64	0.4
1	-277	PF 1	830	-2.56	4.48		4.8	0.000362	4.52	183.72	47.21	0.4
1	-302	PF 1	830	-2.57	4.47		4.79	0.000361	4.52	183.83	47.23	0.4
1	-402	PF 1	830	-2.62	4.43		4.75	0.000357	4.5	184.64	47.34	0.4
1	-502	PF 1	830	-2.67	4.4		4.71	0.000353	4.48	185.38	47.44	0.4
1	-602	PF 1	830	-2.72	4.37		4.68	0.000349	4.46	186.17	47.54	0.4
1	-702	PF 1	830	-2.77	4.33		4.64	0.000346	4.44	186.9	47.63	0.4
1	-802	PF 1	830	-2.83	4.32		4.6	0.000316	4.26	194.67	49.48	0.38
1	-902	PF 1	830	-2.88	4.29		4.57	0.000309	4.22	196.61	49.85	0.37
1	-1002	PF 1	830	-2.93	4.23		4.53	0.000332	4.37	189.8	47.98	0.39
1	-1102	PF 1	830	-2.98	4.2		4.5	0.000328	4.35	190.72	48.1	0.39
1	-1113	PF 1	830	-2.99	4.2	1.69	4.49	0.000326	4.35	190.96	48.12	0.38

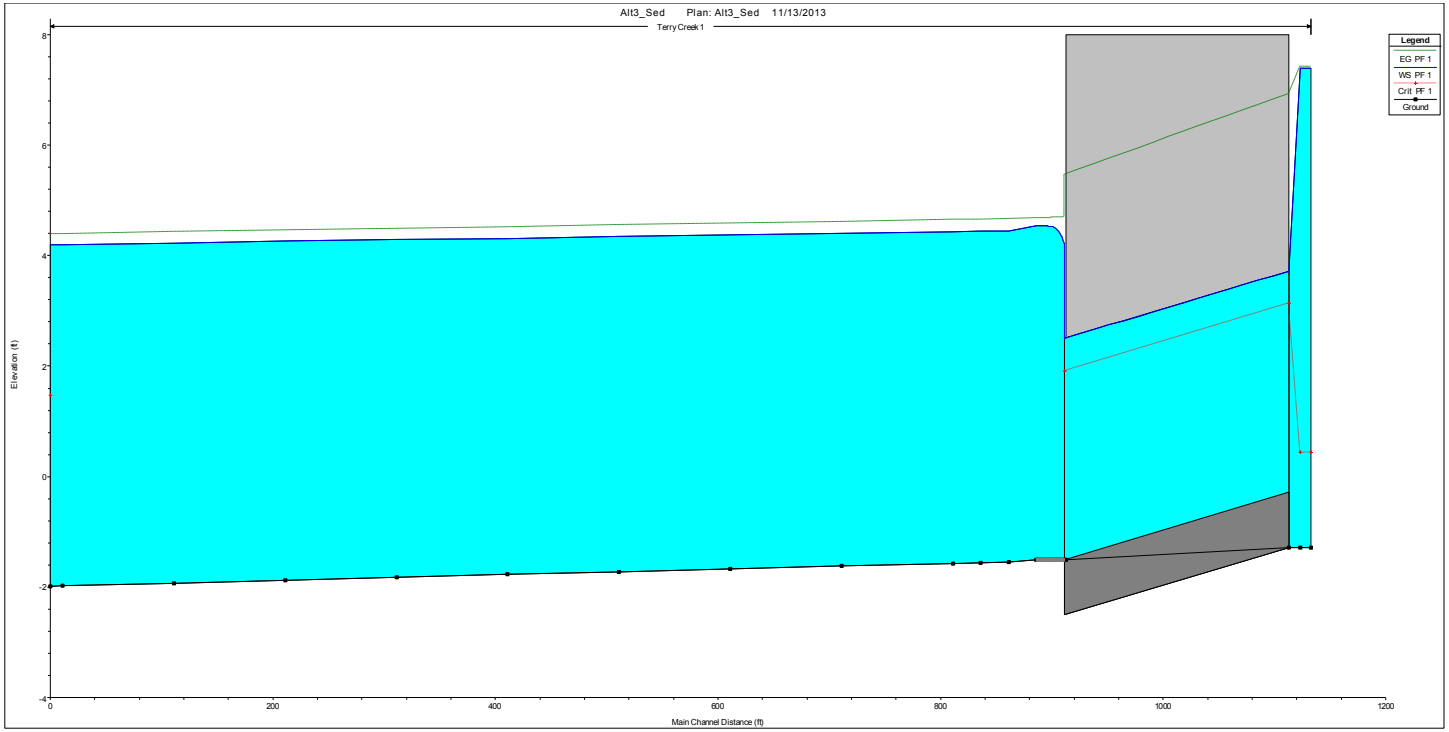
* indicates interpolated cross sections

ATTACHMENT 18

HEC-RAS OUTPUTS FOR ALTERNATIVE 3, ACCUMULATED SEDIMENT

CP: **MWS** Date: **12/12/13** APC: **VG** Date: **12/12/13** CC: **VG** Date: **12/12/13**

Client: **Hercules** Project: **Terry Creek OU1 RI/FS** Project No: **GR4443B**



CP: **MWS** Date: **12/12/13** APC: **VG** Date: **12/12/13** CC: **VG** Date: **12/12/13**

Client: **Hercules** Project: **Terry Creek OU1 RI/FS** Project No: **GR4443B**

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude #
-	-	-	(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	-
1	20	PF 1	645	-1.28	7.39	0.44	7.43	0.000019	1.49	433.69	50	0.09
1	10	PF 1	645	-1.28	7.39	0.44	7.43	0.000019	1.49	433.68	50	0.09
1	0		Culvert									
1	-202	PF 1	645	-1.5	4.22		4.7	0.000816	5.59	115.5	20.23	0.41
1	-203.*	PF 1	645	-1.5	4.28		4.7	0.000671	5.18	124.59	22.04	0.38
1	-204.*	PF 1	645	-1.5	4.33		4.7	0.000569	4.83	133.5	24.37	0.36
1	-205.*	PF 1	645	-1.5	4.38		4.69	0.00049	4.53	142.34	26.69	0.35
1	-206.*	PF 1	645	-1.5	4.41		4.69	0.000427	4.27	151.11	28.99	0.33
1	-207.*	PF 1	645	-1.5	4.44		4.69	0.000377	4.04	159.74	31.28	0.31
1	-208.*	PF 1	645	-1.5	4.46		4.69	0.000337	3.83	168.35	33.58	0.3
1	-209.*	PF 1	645	-1.5	4.48		4.69	0.000303	3.65	176.83	35.85	0.29
1	-210.*	PF 1	645	-1.5	4.5		4.69	0.000275	3.48	185.28	38.13	0.28
1	-211.*	PF 1	645	-1.5	4.52		4.69	0.000252	3.33	193.59	40.4	0.27
1	-212	PF 1	645	-1.5	4.53		4.69	0.000228	3.2	201.88	42.67	0.26
1	-213.*	PF 1	645	-1.5	4.53		4.69	0.000225	3.17	203.36	43.29	0.26
1	-214.*	PF 1	645	-1.5	4.53		4.69	0.000222	3.15	204.87	43.93	0.26
1	-215.*	PF 1	645	-1.5	4.53		4.68	0.000219	3.13	206.31	44.55	0.26
1	-216.*	PF 1	645	-1.5	4.53		4.68	0.000216	3.1	207.75	45.19	0.25
1	-217.*	PF 1	645	-1.5	4.54		4.68	0.000213	3.09	209.01	45.81	0.25
1	-218.*	PF 1	645	-1.5	4.54		4.68	0.000211	3.07	210.38	46.46	0.25
1	-219.*	PF 1	645	-1.5	4.54		4.68	0.000208	3.05	211.68	46.97	0.25
1	-220.*	PF 1	645	-1.5	4.54		4.68	0.000206	3.03	212.95	47.44	0.25
1	-221.*	PF 1	645	-1.5	4.54		4.68	0.000203	3.01	214.15	47.9	0.25
1	-222.*	PF 1	645	-1.5	4.54		4.68	0.000201	2.99	215.41	48.36	0.25
1	-223.*	PF 1	645	-1.5	4.54		4.68	0.000199	2.98	216.58	48.81	0.25
1	-224.*	PF 1	645	-1.5	4.54		4.68	0.000196	2.96	217.84	49.28	0.25
1	-225.*	PF 1	645	-1.5	4.54		4.68	0.000195	2.95	218.92	49.71	0.25
1	-226.*	PF 1	645	-1.5	4.54		4.68	0.000193	2.93	220.1	50.16	0.25
1	-227	PF 1	645	-1.5	4.54		4.68	0.00019	2.92	221.25	50.59	0.24
1	-252	PF 1	645	-1.55	4.45		4.66	0.000317	3.69	174.73	47.35	0.34
1	-277	PF 1	645	-1.56	4.44		4.65	0.00032	3.71	173.96	46.98	0.34
1	-302	PF 1	645	-1.57	4.43		4.65	0.000319	3.7	174.11	47.01	0.34
1	-402	PF 1	645	-1.62	4.4		4.61	0.000314	3.68	175.09	47.15	0.34
1	-502	PF 1	645	-1.67	4.37		4.58	0.00031	3.66	176.03	47.27	0.33
1	-602	PF 1	645	-1.72	4.34		4.55	0.000305	3.64	177.02	47.4	0.33
1	-702	PF 1	645	-1.77	4.31		4.52	0.0003	3.62	177.97	47.51	0.33
1	-802	PF 1	645	-1.83	4.29		4.48	0.000276	3.49	184.63	49.29	0.32
1	-902	PF 1	645	-1.88	4.27		4.46	0.000269	3.46	186.58	49.68	0.31
1	-1002	PF 1	645	-1.93	4.23		4.43	0.000284	3.55	181.56	47.95	0.32
1	-1102	PF 1	645	-1.98	4.2		4.4	0.000279	3.53	182.69	48.1	0.32
1	-1113	PF 1	645	-1.99	4.2	1.47	4.39	0.000278	3.53	182.97	48.12	0.32

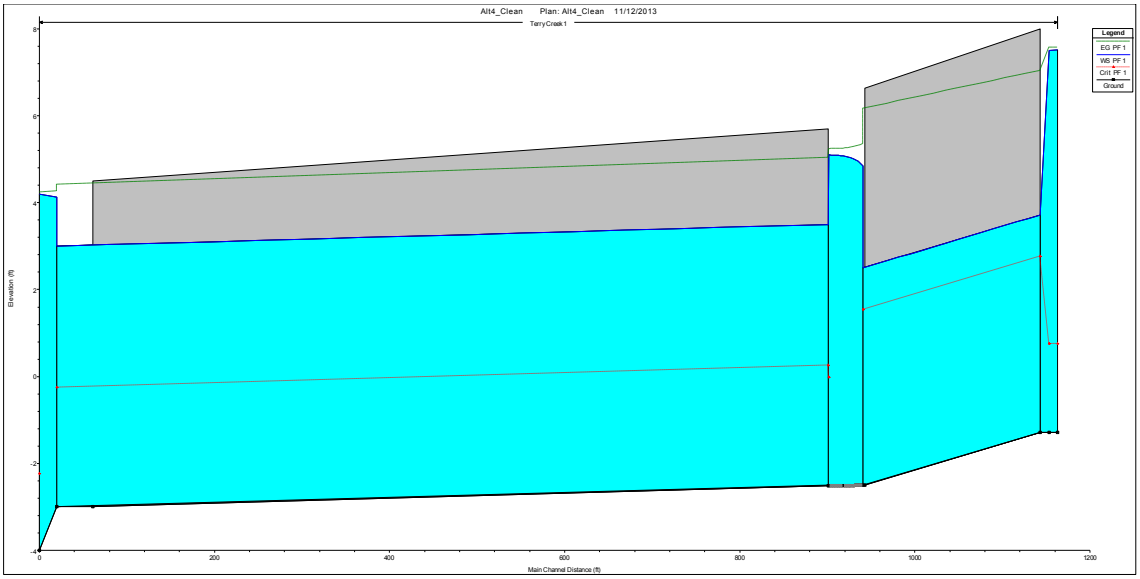
* indicates interpolated cross sections

ATTACHMENT 19

HEC-RAS OUTPUTS FOR ALTERNATIVE 4, CLEAN

CP: **MWS** Date: **12/12/13** APC: **VG** Date: **12/12/13** CC: **VG** Date: **12/12/13**

Client: **Hercules** Project: **Terry Creek OU1 RI/FS** Project No: **GR4443B**



Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude #
-	-	-	(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	-
1	20	PF 1	830	-1.28	7.51	0.76	7.57	0.00003	1.89	440	50	0.11
1	10	PF 1	830	-1.28	7.51	0.76	7.57	0.00003	1.89	440	50	0.11
1	0		Culvert									
1	-202	PF 1	830	-2.5	4.85		5.36	0.000487	5.73	145	24	0.37
1	-205.12*	PF 1	830	-2.5	4.9		5.33	0.000386	5.24	159	25	0.34
1	-208.25*	PF 1	830	-2.5	4.95		5.31	0.000313	4.84	172	26	0.31
1	-211.37*	PF 1	830	-2.5	4.98		5.3	0.000258	4.49	185	27	0.29
1	-214.5*	PF 1	830	-2.51	5.01		5.28	0.000217	4.18	199	28	0.27
1	-217.62*	PF 1	830	-2.51	5.03		5.27	0.000185	3.93	211.71	29.92	0.25
1	-220.75*	PF 1	830	-2.51	5.05		5.26	0.000159	3.7	224.9	31.48	0.24
1	-223.87*	PF 1	830	-2.51	5.07		5.26	0.000138	3.49	237.99	33.07	0.22
1	-227	PF 1	830	-2.51	5.08		5.25	0.000121	3.31	251.04	34.67	0.21
1	-229.66*	PF 1	830	-2.51	5.08		5.25	0.000115	3.24	256.21	35.48	0.21
1	-232.33*	PF 1	830	-2.51	5.09		5.24	0.00011	3.18	261.47	36.32	0.2
1	-235.*	PF 1	830	-2.51	5.09		5.24	0.000104	3.12	266.81	37.14	0.2
1	-237.66*	PF 1	830	-2.51	5.1		5.24	0.000099	3.06	272.05	38.28	0.2
1	-240.33*	PF 1	830	-2.51	5.1		5.24	0.000095	3	277.38	40.01	0.19
1	-243	PF 1	830	-2.51	5.1	-0.01	5.24	0.000091	2.95	282.66	40.36	0.19
1	-244		Culvert									
1	-1124	PF 1	830	-3	4.13		4.27	0.000102	3.01	275.73	38.67	0.2
1	-1144	PF 1	830	-4	4.2	-2.23	4.24	0.000132	1.58	539.75	76.04	0.1

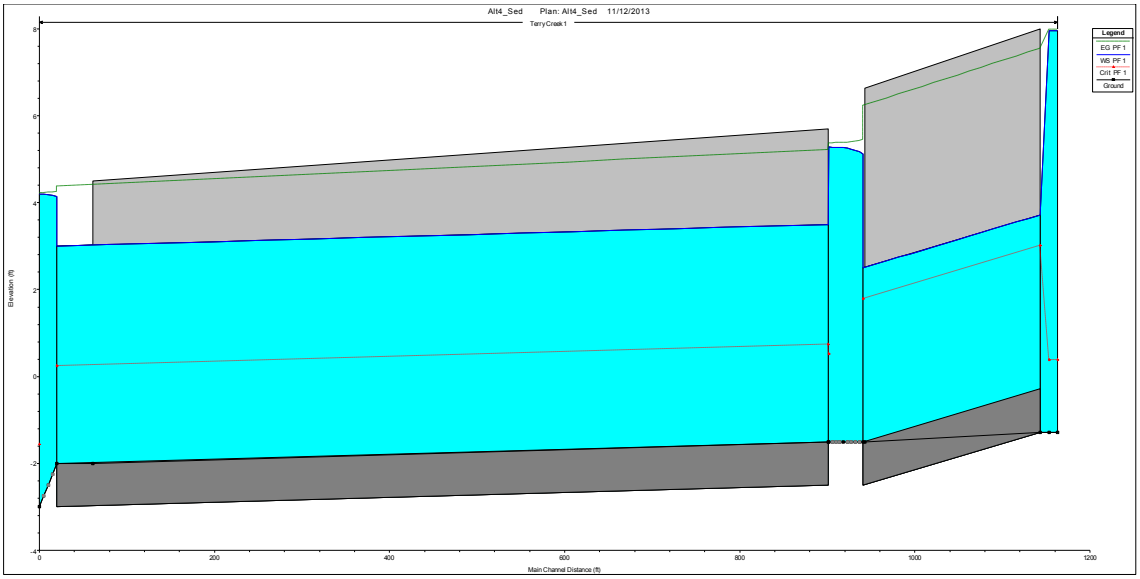
* indicates interpolated cross sections

ATTACHMENT 20

HEC-RAS OUTPUTS FOR ALTERNATIVE 4, ACCUMULATED SEDIMENT

CP: **MWS** Date: **12/12/13** APC: **VG** Date: **12/12/13** CC: **VG** Date: **12/12/13**

Client: **Hercules** Project: **Terry Creek OU1 RI/FS** Project No: **GR4443B**



Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude #
-	-	-	(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	-
1	20	PF 1	610	-1.28	7.96	0.38	7.99	0.000018	1.32	462	50	0.08
1	10	PF 1	610	-1.28	7.96	0.38	7.99	0.000018	1.32	462	50	0.08
1	0		Culvert									
1	-202	PF 1	610	-1.5	5.12		5.46	0.000385	4.67	132	25	0.32
1	-207.*	PF 1	610	-1.5	5.17		5.43	0.000523	4.08	151	28	0.28
1	-212.*	PF 1	610	-1.5	5.21		5.41	0.00039	3.63	169	29	0.25
1	-217.*	PF 1	610	-1.51	5.23		5.4	0.0003	3.26	188	31	0.22
1	-222.*	PF 1	610	-1.51	5.25		5.39	0.000223	2.97	206	33	0.20
1	-227	PF 1	610	-1.51	5.27		5.38	0.000127	2.72	224.55	35.47	0.18
1	-231.*	PF 1	610	-1.51	5.27		5.38	0.000174	2.64	231.51	36.69	0.18
1	-235.*	PF 1	610	-1.51	5.27		5.38	0.000139	2.57	238.57	37.92	0.17
1	-239.*	PF 1	610	-1.51	5.28		5.37	0.000156	2.49	246	41.25	0.17
1	-243	PF 1	610	-1.51	5.28	0.52	5.37	0.0001	2.43	252.96	41.36	0.16
1	-244		Culvert									
1	-1124	PF 1	610	-2	4.15		4.25	0.000185	2.57	237.79	38.67	0.18
1	-1129.*	PF 1	610	-2.25	4.17		4.24	0.000114	2.13	286.85	47.96	0.15
1	-1134.*	PF 1	610	-2.5	4.18		4.23	0.000073	1.81	343.44	58.61	0.12
1	-1139.*	PF 1	610	-2.75	4.19		4.23	0.000048	1.55	407.17	67.4	0.1
1	-1144	PF 1	610	-3	4.2	-1.56	4.23	0.000033	1.34	477.75	76.04	0.09

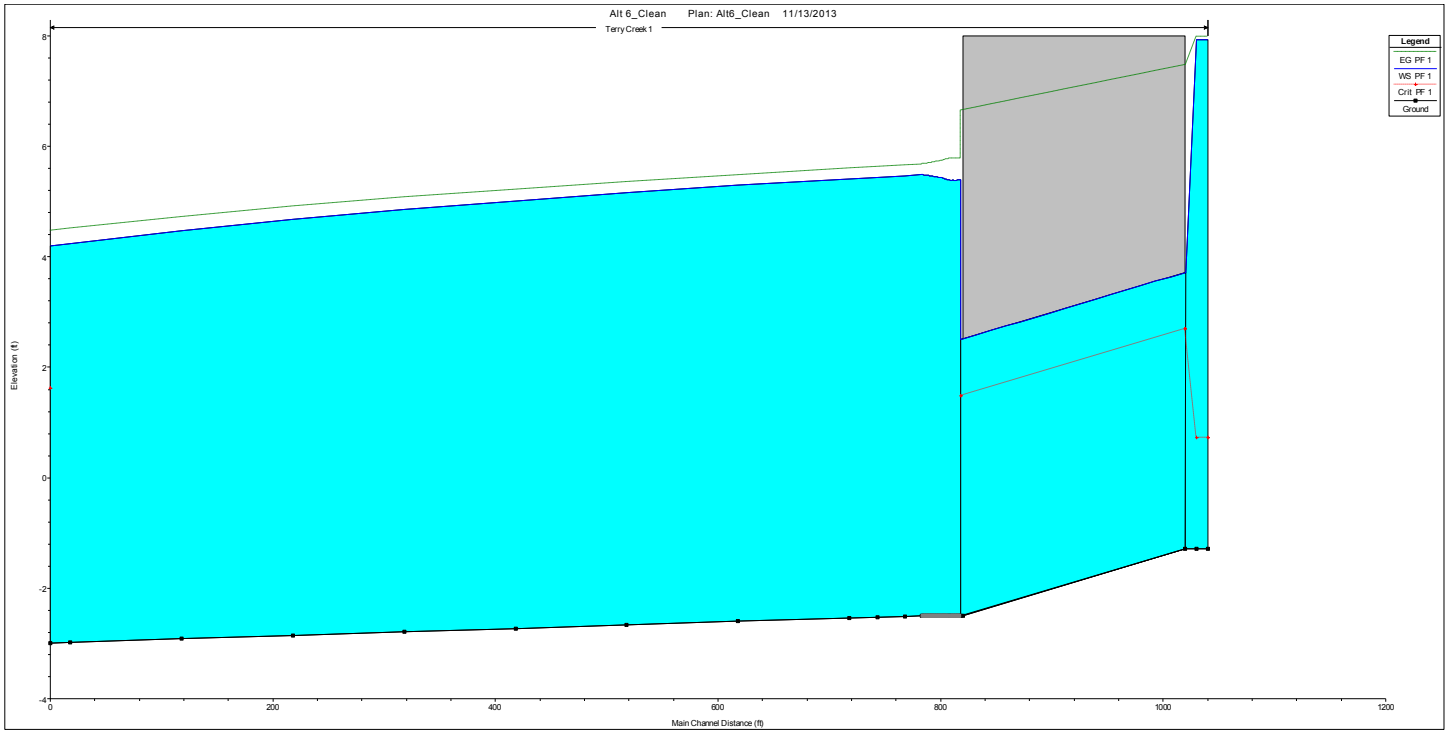
* indicates interpolated cross sections

ATTACHMENT 21

HEC-RAS OUTPUTS FOR ALTERNATIVE 6, CLEAN

CP: **MWS** Date: **12/12/13** APC: **VG** Date: **12/12/13** CC: **VG** Date: **12/12/13**

Client: **Hercules** Project: **Terry Creek OU1 RI/FS** Project No: **GR4443B**



CP: **MWS** Date: **12/12/13** APC: **VG** Date: **12/12/13** CC: **VG** Date: **12/12/13**

Client: **Hercules** Project: **Terry Creek OU1 RI/FS** Project No: **GR4443B**

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude #
-	-	-	(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	-
1	20	PF 1	810	-1.28	7.94	0.72	7.98	0.000025	1.76	461	50	0.10
1	10	PF 1	810	-1.28	7.94	0.73	7.98	0.000025	1.76	461	50	0.10
1	0		Culvert									
1	-202	PF 1	810	-2.5	5.39		5.79	0.000334	5.03	162	25	0.32
1	-203.*	PF 1	810	-2.5	5.39		5.79	0.000333	5.03	163	27	0.32
1	-204.*	PF 1	810	-2.5	5.39		5.79	0.000333	5.03	164	29	0.32
1	-205.*	PF 1	810	-2.5	5.39		5.79	0.000333	5.03	164	30	0.32
1	-206.*	PF 1	810	-2.5	5.39		5.79	0.000339	5.06	164	32	0.32
1	-207.*	PF 1	810	-2.5	5.39		5.78	0.000339	5.06	164	34	0.32
1	-208.*	PF 1	810	-2.5	5.39		5.78	0.000339	5.06	165	35	0.32
1	-209.*	PF 1	810	-2.5	5.39		5.78	0.000337	5.04	166	36	0.32
1	-210.*	PF 1	810	-2.5	5.39		5.78	0.000338	5.05	166	38	0.32
1	-211.*	PF 1	810	-2.5	5.39		5.78	0.000338	5.05	166	39	0.32
1	-212	PF 1	810	-2.5	5.39		5.78	0.002376	5.02	167	40	0.32
1	-212.6*	PF 1	810	-2.5	5.4		5.77	0.002231	4.96	168	41	0.32
1	-213.2*	PF 1	810	-2.5	5.4		5.77	0.002071	4.87	172	42	0.32
1	-213.8*	PF 1	810	-2.5	5.41		5.76	0.001969	4.8	174	43	0.32
1	-214.4*	PF 1	810	-2.5	5.41		5.76	0.001885	4.74	176	44	0.32
1	-215.*	PF 1	810	-2.5	5.42		5.75	0.001802	4.67	179	45	0.32
1	-215.6*	PF 1	810	-2.5	5.42		5.75	0.001733	4.59	182	45	0.32
1	-216.2*	PF 1	810	-2.5	5.43		5.74	0.001633	4.49	187	48	0.31
1	-216.8*	PF 1	810	-2.5	5.43		5.74	0.001591	4.43	189	49	0.31
1	-217.4*	PF 1	810	-2.5	5.44		5.73	0.001547	4.37	191.73	49.71	0.31
1	-218.*	PF 1	810	-2.5	5.44		5.73	0.001499	4.29	194.83	50.43	0.31
1	-218.6*	PF 1	810	-2.5	5.45		5.72	0.001482	4.25	196.53	50.7	0.31
1	-219.2*	PF 1	810	-2.5	5.45		5.72	0.00145	4.19	199.22	51.38	0.31
1	-219.8*	PF 1	810	-2.5	5.45		5.72	0.00142	4.13	202.16	52.61	0.31
1	-220.4*	PF 1	810	-2.5	5.46		5.71	0.001401	4.08	204.37	53.17	0.3
1	-221.*	PF 1	810	-2.5	5.46		5.71	0.001376	4.02	207.04	53.81	0.3
1	-221.6*	PF 1	810	-2.5	5.46		5.71	0.001352	3.97	209.69	54.39	0.3
1	-222.2*	PF 1	810	-2.5	5.47		5.7	0.00133	3.91	212.35	55.01	0.3
1	-222.8*	PF 1	810	-2.5	5.47		5.7	0.001315	3.87	214.76	56.05	0.3
1	-223.4*	PF 1	810	-2.5	5.48		5.69	0.00125	3.78	220.48	57.68	0.29
1	-224.*	PF 1	810	-2.5	5.48		5.69	0.001231	3.73	223.16	58.21	0.29
1	-224.6*	PF 1	810	-2.5	5.48		5.69	0.001224	3.69	224.99	58.66	0.29
1	-225.2*	PF 1	810	-2.5	5.48		5.69	0.001205	3.64	227.67	59.19	0.29
1	-225.8*	PF 1	810	-2.5	5.48		5.68	0.001193	3.6	229.9	59.7	0.28
1	-226.4*	PF 1	810	-2.5	5.49		5.68	0.00117	3.55	233	60.24	0.28
1	-227	PF 1	810	-2.5	5.49		5.68	0.001158	3.51	235.2	60.69	0.28
1	-252	PF 1	810	-2.51	5.47		5.66	0.001159	3.51	236.68	64.59	0.28
1	-277	PF 1	810	-2.52	5.44		5.63	0.001165	3.51	239.38	72.43	0.28
1	-302	PF 1	810	-2.54	5.41		5.6	0.001169	3.51	240.96	77.66	0.28
1	-402	PF 1	810	-2.6	5.3		5.48	0.001182	3.48	252.06	118.56	0.28
1	-502	PF 1	810	-2.66	5.16		5.36	0.001294	3.59	237.55	94.84	0.29
1	-602	PF 1	810	-2.73	5.02		5.22	0.0014	3.67	229.61	91.11	0.3
1	-702	PF 1	810	-2.79	4.86		5.07	0.001535	3.77	222.24	96.45	0.32
1	-802	PF 1	810	-2.85	4.67		4.91	0.001719	3.9	210.67	86.7	0.33
1	-902	PF 1	810	-2.91	4.47		4.73	0.001942	4.04	200.48	49.31	0.35
1	-1002	PF 1	810	-2.98	4.25		4.52	0.002159	4.2	192.67	48.33	0.37
1	-1020	PF 1	810	-2.99	4.2	1.62	4.48	0.002215	4.24	190.83	48.12	0.38

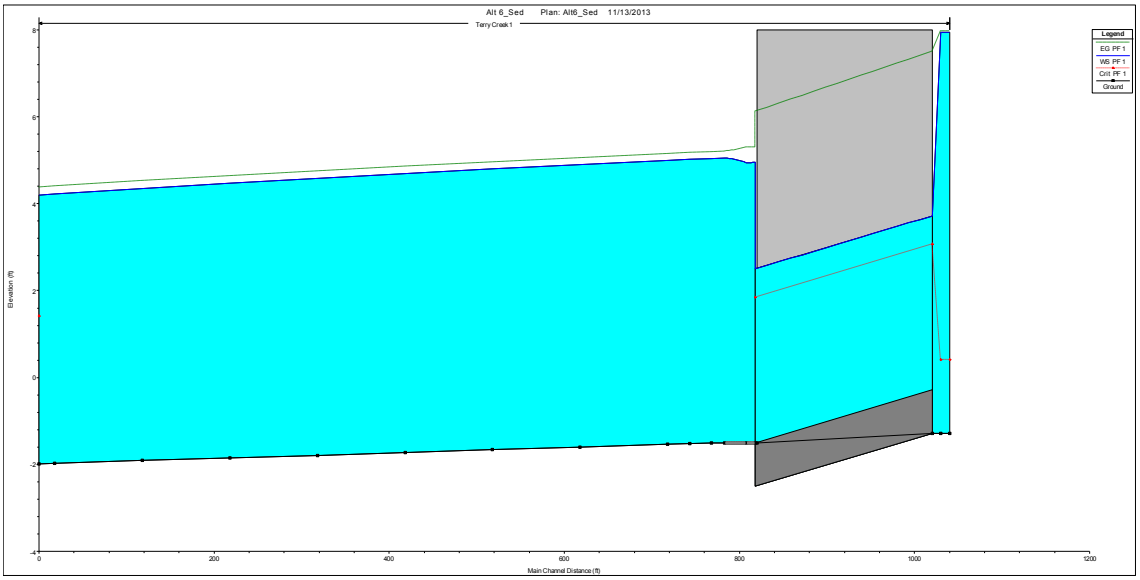
* indicates interpolated cross sections

ATTACHMENT 22

HEC-RAS OUTPUTS FOR ALTERNATIVE 6, ACCUMULATED SEDIMENT

CP: **MWS** Date: **12/12/13** APC: **VG** Date: **12/12/13** CC: **VG** Date: **12/12/13**

Client: **Hercules** Project: **Terry Creek OU1 RI/FS** Project No: **GR4443B**



Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude #
-	-	-	(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	-
1	20	PF 1	625	-1.28	7.94	0.41	7.97	0.000015	1.36	461	50	0.08
1	10	PF 1	625	-1.28	7.94	0.41	7.97	0.000015	1.36	461	50	0.08
1	0		Culvert									
1	-202	PF 1	625	-1.5	4.95		5.3	0.000608	4.75	132	22	0.33
1	-204.5*	PF 1	625	-1.5	4.95		5.3	0.000612	4.76	132	24	0.33
1	-207.*	PF 1	625	-1.5	4.95		5.3	0.000615	4.77	131	25	0.33
1	-209.5*	PF 1	625	-1.5	4.95		5.3	0.000618	4.78	131	26	0.33
1	-212	PF 1	625	-1.5	4.94		5.3	0.001426	4.79	131	27	0.33
1	-213.66*	PF 1	625	-1.5	4.96		5.28	0.001204	4.54	139	31	0.33
1	-215.33*	PF 1	625	-1.5	4.98		5.27	0.001094	4.3	146	34	0.32
1	-217.*	PF 1	625	-1.5	5		5.26	0.001038	4.09	154	38	0.31
1	-218.66*	PF 1	625	-1.5	5.01		5.25	0.001008	3.89	162	41	0.31
1	-220.33*	PF 1	625	-1.5	5.02		5.24	0.000985	3.71	170	44	0.3
1	-222.*	PF 1	625	-1.5	5.03		5.23	0.000965	3.55	178	47	0.29
1	-223.66*	PF 1	625	-1.5	5.04		5.22	0.000939	3.39	186	50	0.28
1	-225.33*	PF 1	625	-1.5	5.05		5.21	0.000915	3.25	194	52	0.27
1	-227	PF 1	625	-1.5	5.06		5.21	0.000889	3.12	202	55	0.27
1	-252	PF 1	625	-1.51	5.04		5.19	0.000892	3.12	203	57	0.27
1	-277	PF 1	625	-1.52	5.02		5.17	0.0009	3.12	203	61	0.27
1	-302	PF 1	625	-1.54	5		5.15	0.000905	3.12	204	64	0.27
1	-402	PF 1	625	-1.6	4.9		5.06	0.000935	3.14	204	79	0.27
1	-502	PF 1	625	-1.66	4.8		4.96	0.000981	3.18	199	68	0.28
1	-602	PF 1	625	-1.73	4.7		4.86	0.001025	3.21	195.86	61.45	0.28
1	-702	PF 1	625	-1.79	4.59		4.75	0.00108	3.25	192.68	58.24	0.29
1	-802	PF 1	625	-1.85	4.47		4.64	0.001141	3.3	189.51	48.94	0.3
1	-902	PF 1	625	-1.91	4.35		4.53	0.001189	3.35	186.53	48.59	0.3
1	-1002	PF 1	625	-1.98	4.22		4.4	0.001238	3.4	183.64	48.2	0.31
1	-1020	PF 1	625	-1.99	4.2	1.42	4.38	0.001253	3.42	182.83	48.12	0.31

* indicates interpolated cross sections

APPENDIX E

Prepared for

HERCULES

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Wilmington, DE 19808

APPENDIX E
FOCUSED SCREENING LEVEL ECOLOGICAL RISK ASSESSMENT
TERRY CREEK OU1 RI/FS

Prepared by

Geosyntec consultants

engineers | scientists | innovators

1255 Roberts Boulevard, Suite 200
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Project Number GK4443C

February 2014

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LIST OF ACRONYMS AND ABBREVIATIONS

AOC	Administrative Order on Consent
BERA	Baseline Ecological Risk Assessment
BTAG	Biological Technical Assistance Group
COPEC	Constituent of Potential Ecological Concern
CSM	Conceptual Site Model
ECD	Electron Capture Detector
EPC	Exposure Point Concentration
EPD	Georgia Environmental Protection Division
ERA	Ecological Risk Assessment
ESE	Ecological Screening Evaluation
ESI	Expanded Site Investigation
ESL	Ecological Screening Level (USEPA Region V)
ESV	Ecological Screening Value
FS	Feasibility Study
ft	foot/feet
GC	Gas Chromatography
GDNR	Georgia Department of Natural Resources
Geosyntec	Geosyntec Consultants, Inc.
Hercules	Hercules Incorporated
HQ	Hazard Quotient
Koc	Octanol-water Partition Coefficient
mg/kg	milligram per kilogram
NIMS	Negative-ion Mass Spectrophotometry
NOAA	National Oceanographic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NRWQC	National Recommended Water Quality Criteria
OCP	Organochlorine Pesticide
OSWER	Office of Solid Waste and Emergency Response
OU	Operable Unit
PAH	Polynuclear Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyl
PCDD	Polychlorinated Dibenzodioxin
PCDF	Polychlorinated Dibenzofuran

TABLE OF CONTENTS (Continued)

LIST OF ACRONYMS AND ABBREVIATIONS (Continued)

PEL	Probable Effects Level
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
Site	Terry Creek Site
SLERA	Screening Level Ecological Risk Assessment
SMP	Site Management Plan
SMDP	Scientific Management Decision Point
SQC	Sediment Quality Criterion
SSI	Site Status Investigation
SVOC	Semivolatile Organic Compound
TAL	Target Analyte List
TAUC	Total Area Under the Curve
TCL	Target Compound List
TEL	Threshold Effects Level
TOC	Total Organic Carbon
TSS	Total Suspended Solids
TT	Technical Toxaphene
µg/kg	microgram per kilogram
µg/L	microgram per liter
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
VOC	Volatile Organic Compound
Work Plan	Focused RI/FS Work Plan Operable Unit 1 (OU1) Outfall Ditch

1. INTRODUCTION

1.1 Overview

Geosyntec Consultants, Inc. (Geosyntec) is conducting a Focused Remedial Investigation (RI) and Feasibility Study (FS) on behalf of Hercules Incorporated (Hercules) for the Outfall Ditch/Operable Unit (OU) 1 at the Terry Creek Site (Site) located in Brunswick, Georgia (Figure 1). This document presents the screening level ecological risk assessment (SLERA) for OU1 and is submitted as a companion document to the Focused OU1 RI/FS. It is noted that the terms "OU1" and "Outfall Ditch" are used interchangeably throughout this document.

The Outfall Ditch is a Hercules-constructed conveyance system that was used until 1972 to discharge untreated wastewater from the Plant. The wastewater contained toxaphene, which has been identified as the primary constituent of interest at the Site. After 1972, wastewater was treated prior to discharge and toxaphene concentrations in the discharge decreased significantly. Currently, non-contact cooling water, cooling water blowdown/condensate, and storm water runoff from the former Hercules Plant (now Pinova Plant) and surrounding neighborhoods are discharged under a National Pollutant Discharge Elimination System (NPDES) permit through the Outfall Ditch via the "N" Street ditch (Figure 2).

The Focused RI/FS is being conducted in accordance with the *Focused RI/FS Work Plan Operable Unit 1 (OU1) Outfall Ditch* (Work Plan) and pursuant to the 30 September 1999 Administrative Order on Consent (AOC) between Hercules and the United States Environmental Protection Agency (USEPA). The USEPA approved the Work Plan in a letter dated 5 January 2012. The rationale for prioritizing remedial actions at OU1 was presented in the Site Management Plan (SMP; Geosyntec, 2009) and reiterated in the Work Plan. In summary, following the 1999-2000 removal action at the Site, the highest relative residual concentrations of toxaphene were found in the Outfall Ditch. Therefore, prioritizing and implementing remedial actions at the Outfall Ditch will address a significant source of toxaphene to the Terry and Dupree Creek system. Due to the relatively small size of OU1 (Figure 2) and its continued use as a conveyance structure for the foreseeable future, USEPA and Hercules agreed that a Focused RI/FS could proceed, with the understanding that the results may allow for the selection of a final remedy at OU1 that is not reliant on the refined toxaphene analytical methodology (i.e., Method 8276) or toxicity reference value development.

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1.2 SLERA Purpose and Objectives

The purpose of an ecological risk assessment (ERA) is to evaluate the likelihood that adverse ecological effects are occurring or may potentially occur as a result of the site-specific constituent concentrations in environmental media. The potential for adverse effects is assessed through a sequential series of activities that increase in complexity and site-specificity depending on the results of previous evaluations. The USEPA (1997) Ecological Risk Assessment Guidance for Superfund describes an eight-step process for conducting ERAs. Components of the ERA process are the following:

Screening Level Ecological Risk Assessment (SLERA)

- Step 1 - Screening Level Problem Formulation;
- Step 2 - Screening Level Exposure Estimate and Risk Calculation;

Baseline Ecological Risk Assessment (BERA)

- Step 3 - Baseline Problem Formulation;
- Step 4 - Study Design and Data Quality Objective Process;
- Step 5 - Verification of Field Sampling Design;
- Step 6 - Site Investigation and Data Analysis;
- Step 7 - Risk Characterization; and
- Step 8 - Risk Management.

This report documents the completion of the SLERA phase of the USEPA eight-step process (Steps 1 and 2). Briefly, objectives of the Focused SLERA are to:

- evaluate whether there is a potential for ecological receptors to be exposed to constituents in OU1 (e.g., identify potentially complete exposure pathways in the Outfall Ditch); and
- evaluate whether site-related constituents are present in OU1 media (sediment, surface water, and pore water) at concentrations that have the potential to result in adverse ecological effects.

Under USEPA guidance, ERAs are conducted using a tiered approach and are punctuated with Scientific Management Decision Points (SMDPs). SMDPs represent

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points in the ERA process where the risk assessor, risk manager, and interested parties reach concurrence on conclusions, actions, or methodologies that are needed such that the ERA process can continue (or terminate) in a technically defensible manner.

This SLERA concludes with a SDMP recommending no further ecological investigation for OU1. Rather, it is recommended that performance-based remedial goals for the Outfall Ditch be developed that focus on eliminating direct exposure to contaminants in the Outfall Ditch and eliminating the potential transport of contaminants to Dupree Creek and other downstream locations.

1.3 Document Organization

The content and organization of the remainder of this SLERA document are as follows:

- Section 2.0: Site Description and Background;
- Section 3.0: Step 1: Problem Formulation and Ecological Effects Evaluation;
- Section 4.0: Step 2: Exposure Estimate and Risk Calculation;
- Section 5.0: SLERA Summary and SMDP; and
- Section 6.0: References.

Tables, figures, and attachments referenced herein follow Section 6.0. Portions of the Focused OU1 RI Report relevant to the evaluation of ecological risks are summarized herein; however, potential risks should be viewed in the full context of the RI Report. Therefore, the reader should refer to the RI Report for a more comprehensive presentation and analysis of the site-specific information and data.

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2. SITE DESCRITPION AND BACKGROUND

2.1 Site Location and Setting

The Terry Creek Site consists of a salt water tidal creek and marsh system located on the Atlantic coast directly east of the City of Brunswick in Glynn County, Georgia (Figure 1). The Site is located near the confluence of Terry Creek, Dupree Creek, and the Back River north of the Torras Causeway and east of U.S. Highway 17. In general terms, the Site area is bounded to the north, south, and east by a tidal marsh and on the west by Highway 17. The Site is located near residential and commercial areas, and is situated contiguous to the Brunswick peninsula surrounded by coastal wetlands.

The SMP subdivided the Site into three operable units (OUs):

- OU1: the Outfall Ditch from the former Hercules Plant;
- OU2: portions of the former Hercules Plant east of U.S. Highway 17 known as the Marsh Wood Storage Yard and three dredge spoil areas; and
- OU3: Terry and Dupree Creeks.

This SLERA addresses the Outfall Ditch, OU1. Figure 2 shows the location of OU1 relative to the other OUs at the Site.

2.2 Site Background

2.2.1 Site Operating History

The Brunswick Plant became operational in 1911; it is believed that the Outfall Ditch was constructed at this time. Between 1948 and 1980 Hercules produced toxaphene, a chlorinated pesticide, at the Plant. Untreated wastewater from the production of toxaphene was discharged through the Outfall Ditch into Dupree Creek until 1972. A wastewater treatment plant was installed in 1972, and the amount of toxaphene in the permitted discharge was significantly reduced after that time until toxaphene production ceased in 1980. Portions of Terry Creek and Dupree Creek have been dredged by the United States Army Corps of Engineers (USACE) beginning with enactment of the Rivers and Harbors Act of 1938 (Terry Creek Project), authorizing dredging of a navigational channel. The Terry Creek project was completed by the USACE in 1939; and subsequently, maintenance dredging occurred in 1940, 1941, 1942, and 1946, prior

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to production of toxaphene. Some dredge spoils from these dredging activities were disposed in an area located adjacent to the Torras Causeway beside Terry Creek, which is currently known as the Trailer Park Dredge Spoil Area.

Dredging of Terry Creek and Dupree Creek resumed in 1971 with subsequent dredging in 1972, 1983, 1987, and 1988/89. With the approval of USEPA, in 1972 the U.S. Fish and Wildlife Services, the State of Georgia, and the USACE chose an area on the north side of Terry Creek at the confluence of Terry and Dupree Creeks for placement of dredge spoils. This area (Main Dredge Spoil Area) served as the primary placement area for dredge spoils until dredging was discontinued in 1989. Some dredge spoils were also placed by the USACE at the Riverside Dredge Spoil Area and, prior to 1972, on Carter's Island.

On January 28, 2010 Hercules sold the Brunswick Plant Resins business and a portion of the property to Pinova, Inc. Hercules continues to own the property east of U.S. Highway 17 that contains the Outfall Ditch and the Marsh Wood Storage Yard.

2.2.2 Previous Site Characterization Studies

Previous studies that have been conducted at the Site include: (i) measurement of specific toxicity of sediment samples in 1994 by the U.S. National Oceanographic and Atmospheric Administration (NOAA) [NOAA, 1994]; (ii) an Expanded Site Investigation (ESI) conducted by USEPA Region IV in 1995 (Black and Veatch, 1997); (iii) an Ecological Screening Evaluation (ESE) conducted by USEPA in 1997 (USEPA, 1997a); and (iv) a Site Status Investigation (SSI) conducted by Geosyntec on behalf of Hercules in 1997 and 1998 (Geosyntec, 1998). Investigations have also been performed in the Marsh Wood Storage Area in conjunction with Resource Conservation and Recovery Act (RCRA) Corrective Action activities for the Brunswick Plant. These studies are summarized below.

In 1994, NOAA obtained sediment samples from Terry Creek and Back River areas and analyzed these samples for acute toxicity to the marine amphipod *Ampelisca abdita* (NOAA, 1994). Results indicated that sediments from Terry Creek exhibited sediment toxicity that was not observed in sediments from other areas of the Brunswick/St. Simon's estuary.

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In 1995, USEPA Region IV conducted an ESI at the Site (Black and Veatch, 1997). A total of 45 groundwater, surface water, soil, and sediment samples were collected from Terry Creek, Dupree Creek, the Back River, and dredge spoil areas at the Site, and analyzed for toxaphene during the ESI. Soil and sediment samples collected from the dredge spoil areas, Dupree Creek and Terry Creek contained detectable concentrations of toxaphene at concentrations up to 430 milligrams per kilogram (mg/kg). USEPA (Black and Veatch, 1997) collected samples of killifish from the confluence of Terry and Dupree Creek during the spring and summer of 1996 as part of a Community Based Environmental Project. Analysis of whole fish samples indicated toxaphene estimated concentrations of 19 and 27 mg/kg.

USEPA conducted an ESE for the vicinity of Terry and Dupree Creeks in the spring of 1997 (USEPA, 1997a). During the ESE, sediment and surface water samples were collected as well as various species of forage fish, consumer fish, and shellfish. Toxaphene was not detected in any fish or shellfish samples. However, toxaphene was detected at concentrations up to estimated 230 mg/kg in sediment samples collected from Terry and Dupree Creeks.

On behalf of Hercules, Geosyntec conducted a SSI from November 1997 to July 1998 to fulfill the requirements of an AOC for Removal Action between Hercules and USEPA. A total of 375 soil and sediment and groundwater samples was collected during the SSI and analyzed for toxaphene. Complete results from the SSI were provided in a Site Status Report (Geosyntec, 1998). Shallow soil samples were collected from the Marsh Wood Storage Yard during the RCRA Facility Investigation in October 2006 (Newfields, 2006).

2.2.3 Previous Removal Actions

Pursuant to the 1999 AOC for Removal Action, work was conducted at the Site from August 1999 to April 2000 to remove sediment containing the highest concentrations of toxaphene, including the pre-weir and post-weir Outfall Ditch, the mouth of the Outfall Ditch, the confluence area of Terry and Dupree Creeks, and north Dupree Creek. Post-removal confirmation sampling was conducted in the dredged areas following the removal action. These samples were analyzed for toxaphene to document residual levels of toxaphene in sediment.

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A large mass of toxaphene was contained in the Outfall Ditch prior to the removal action, with concentrations as high as 33,000 mg/kg. The objective of the removal action was a ninety-percent mass removal (Geosyntec, 1999). Per the terms of the 1998 AOC Amendment, the removal action was to include minimum excavations of 1 to 8 ft in the pre-weir area and 1 to 5 ft in the post-weir area. Although, some difficulties were encountered due to debris in the sediments and sloughing of excavations areas, the removal action was largely successful at meeting these objectives. Despite the success of the removal action, residual concentrations of toxaphene remain in the Outfall Ditch.

The target depth of sediment removal excavation varied within the Outfall Ditch from 1 ft to 8 ft based upon the results of the characterization sampling. A total of approximately 16,800 cubic yards of sediment was excavated from the Outfall Ditch. Post-removal sediment samples were collected from a series of 1-foot intervals within the sediment bed down to 12 ft below the sediment/water interface.

Toxaphene concentrations in post-removal samples ranged from not detected to 2,200 mg/kg in the 0-1 ft sediment depth interval. Toxaphene was detected in 33 of 38 samples analyzed in this interval. In the 1-2 ft depth interval, toxaphene was detected in 20 of 21 samples, with the highest concentration of 2,100 mg/kg in the post-weir area. Similarly, a high concentration of 2,100 mg/kg was detected in the 2-3 ft sediment depth interval; toxaphene was detected in 14 of 21 samples analyzed in this depth interval. Concentrations generally decreased with depth, and within the pre-weir section, toxaphene was not detected deeper than 4 ft below the sediment/water interface. The average residual toxaphene concentration in the Outfall Ditch is two orders of magnitude higher than all other downstream segments of the tidal creek system.

2.2.4 Fish Tissue Analysis

The release of toxaphene via the Outfall Ditch has resulted in detectable concentrations of toxaphene and chlorinated camphenes (weathered toxaphene) in the tissues of aquatic organisms living in Terry and Dupree Creeks. A study from 1974 indicated that the body burden of fish species were in the part per million range (Reimhold and Durant, 1974). Prior to the removal action the Georgia Department of Natural Resources (GDNR) conducted a study in 1997, which, at first, indicated that fish and shellfish did not contain detectable concentrations of technical toxaphene as quantified by the Task Force Method. However, re-analysis of these samples using more sophisticated analytical methods (see Section 2.3) indicated that toxaphene residues were present at

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detectable concentrations in fish (Maruya, 2000).. These detected concentrations caused GDNR to put specific fish consumption guidelines in place that recommended the limited consumption of certain fish species in the area (Maruya et al., 2001).

Subsequent to the removal action in 1999-2000, GDNR conducted another fish tissue evaluation in 2001. Due to changes in the study design and collection areas, a somewhat different group of consumer fish species and areas were evaluated. However, when broadly comparing the 1997 data to the 2001 data, an over four-fold reduction in the concentration of toxaphene residues was reported (Maruya et al., 2005). Both the 1997 and 2001 studies exhibited a statistically significant concentration gradient with fish collected closer to the Outfall Ditch having greater body burdens of toxaphene residues than fish collected at greater distances from the discharge. The results of this study were used to ease the fish consumption guidelines that GDNR had put in place for the area (GDNR, 2003).

Hercules, on behalf of GDNR, repeated the 2001 study using the same geographic boundaries and target species in 2005, 2007, 2009, and 2011. GDNR has relied upon these data to routinely evaluate and update the fish consumption guidelines as necessary for the area; however, no additional substantial reductions in toxaphene body burdens have been documented beyond the initial decline observed between the 1997 study and the 2001 study.

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2.3 Background on Toxaphene

Technical toxaphene (TT) is comprised of over 670 congeners (de Geus et al., 1999) and was manufactured by Hercules by means of chlorination of camphene. It is an amber-colored, waxy solid made from the alpha-pinene extracted from pine stumps. While readily soluble in organic solvents, it is only slightly soluble in water. It is tightly sorbed to organic particles and has the ability to bioconcentrate (USEPA, 2009). Toxaphene use was widespread in the United States and the world until 1982 when USEPA banned it because of its potential classification as a human carcinogen.

TT is quickly transformed in the environment, such that the mix of congeners and the concentrations of the congeners are not the same as a laboratory standard of TT. Therefore, the “weathered” toxaphene (also known as chlorinated camphenes) no longer matches the analytical standard for TT. This transformation process poses significant technical challenges for both laboratory analysis and for understanding the toxicities of

TT and chlorinated camphenes in the environment. As discussed in the SMP (Geosyntec, 2009), this analytical difficulty is the critical item in the path forward at the Terry Creek Site.

Historically, analytical method SW-846 Method 8080, employing gas chromatography (GC) for separation and ECD (electron capture detector) for detection, was used for the analysis of TT. It became evident in the early 1990s that the interpretation of chromatograms was subjective and therefore, guidance for interpreting the toxaphene chromatograms was developed. The Toxaphene Task Force was convened by chemists from USEPA, Georgia Environmental Protection Division (EPD), and Hercules, and chartered to develop what is now known as the Task Force Method, or Method 1. Another method, Method 2, was intended to quantify all the chlorinated camphenes by using the total area under the curve (TAUC) on the chromatogram. Note that Method 1 and Method 2 rely upon the same sample preparation and analysis; they differ only in reporting the numerical value for toxaphene. Method 1 matches peaks on the chromatogram to the TT standard and Method 2 integrates the area under the curve between two specific peaks. However, neither of these methods measure individual toxaphene breakdown products (i.e., congeners).

A method using GC-ECD and negative-ion mass spectrophotometry (NIMS) was developed to allow for better specificity and sensitivity when quantifying individual congeners in the environment. The USEPA Office of Solid Waste has recently issued this new method (SW 846 Method 8276) using GC-ECD/NIMS to measure/analyze individual toxaphene breakdown products of interest. The analytical method is designed to quantify a number of individual toxaphene congeners including Parlar 26, Parlar 50, Parlar 62, as well as Hx-Sed and Hp-Sed. These individual congeners have been reported to be persistent in fish tissue and other environmental samples (Simon and Manning, 2006). Hercules has been employing the NIMS method, along with Method 1 and Method 2, on fish tissue samples since 2001. The NIMS method was also used to re-analyze the fish tissue samples collected in 1997 (see Section 2.2.4).

For the OU1 Focused RI/FS, toxaphene samples were analyzed using Method 1 and Method 2. Since Method 1 is the most widely used method and is analogous to the SW 846 Method 8081B, the data from this method are evaluated in the SLERA and will be used to inform remedial decisions OU1. Selection of this method is appropriate for OU1, because it is the only method for which there are screening criteria available for which to compare the results.

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The additional toxaphene analyses (Method 2 and Method 8276) were performed at OU1 in consideration of planning and scoping the RI/FS for OU2 and OU3. However, the results will not be relied upon for the evaluation of remedial options for OU1. Using more than one toxaphene analytical method for the Focused RI/FS at OU1 will also confirm the presence or absence of toxaphene/weathered toxaphene in the OU1 samples and provide a dataset that can be used in an attempt to evaluate potential correlation of data between various analytical methods and potentially with historical data. Samples with a range of concentrations (e.g., high, low, non-detect) as measured using Methods 1 and 2 will be selected for analysis by Method 8276. This approach combines the reliability of a standard, widely used method (Method 8081) with a method (TAUC) that will conservatively estimate/quantify total camphenes and the newly developed method (8276) that provides greater specificity but is an emerging capability in the commercial laboratory.

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3. STEP 1 PROBLEM FORMULATION AND ECOLOGICAL EFFECTS EVALUATION

3.1 Screening Level Problem Formulation

Problem formulation establishes the goals, scope, and focus of the ERA. Its primary objective is to collect sufficient information concerning the Site to develop a preliminary ecological conceptual site model (CSM), which considers the Site setting and environment, nature and extent of contamination, potential fate and transport processes, and ecological characteristics of the Site. The CSM will identify likely categories of ecological receptors with anticipated complete exposure pathways. Information presented in this section was obtained from Site visits, historical documents, and information gathered during the RI. The habitat characterization (Section 3.1.1) is used in combination with the information from Section 2 to develop a preliminary ecological CSM (Section 3.1.2) for OU1, and identify assessment endpoints (Section 3.1.3).

3.1.1 Habitat Characterization

Exponent conducted an ecological habitat characterization survey of the Terry and Dupree Creek system in November 1997 (Exponent, 1998). Aquatic habitat surveys were conducted during low and high tides in Terry and Dupree Creeks (OU3) and terrestrial habitat surveys were conducted along the perimeter of the Main Dredge Spoil Area (OU2). Surveys included habitat/flora characterization, pre-dawn and diurnal bird surveys, and mammal surveys. Habitat descriptions that follow are paraphrased from Exponent's Report; OU1-specific descriptions are based on observations during Focused RI field investigations.

Generally, the Site consists of a salt water tidal creek and estuarine marsh system with a semidiurnal tidal cycle (i.e., two high and two low tides per day). Terry and Dupree Creeks provide habitat for numerous species of benthic (bottom-dwelling) worms, fish, blue crab, oysters, and turtles. The creek banks provide feeding areas and cover for fish and wildlife, including fiddler crabs (*Uca spp.*), ribbed mussels (*Geukensia demissa*), common egrets (*Ardea alba*), snowy egrets (*Egretta thula*), great blue herons (*Ardea herodias*), willet (*Tringa semipalmata*), and various species of gulls. Estuarine marsh, which is flooded by tidal surface water, is present beyond the creek borders. The low marsh areas, closest to the creek banks, provide numerous species of invertebrates and

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birds with foraging areas (Schoettle, 1993), particularly during high tide when banks and mudflats along the creek are not as accessible. Species found in the low marsh generally include fiddler crabs, green heron (*Butorides virescens*) and numerous other species of marsh birds. Higher elevation marshes typically have salt concentrations due to increased evaporation of tidal surface waters. As a result, salt-tolerant plants are more common in this section of the marsh and, generally, fewer species are present compared to the low marsh areas. Moving farther from the creeks, where tidal cycles are less likely to reach, freshwater and wetland-associated plants are more common as a result of rains and freshwater runoff from the more upland areas (Schoettle, 1993) and, similar to that of the higher elevation marshes, fewer species are likely to be present in this habitat than in the lower marsh. Finally, wetlands transition into drier upland soil, where vegetation consists of woody shrub/scrub plants that serve as habitat for a mix of predominately terrestrial birds and mammals.

Habitat structure at the Site is a function of tidal cycle and bordering vegetation. During high tide in the creeks, fish may use the incoming surface waters to feed on macroinvertebrates associated with previously submerged sediments and plant roots. In contrast, the receding tide exposes sediments (e.g., mudflats), thereby providing a foraging area for shorebirds. Spartina and other marsh vegetation that borders the creeks offers cover, perching, and nesting sites for numerous species of marsh birds and mammals.

The Outfall Ditch itself has relatively steep banks sloping down to the intertidal zone. At high tide, the banks are full nearly to the upland area. At low tide, the volume of water in the ditch is greatly reduced with a narrow thalweg (20-30 ft wide) remaining and an expansive mudflat (approximately 60 ft) exposed on either side.

3.1.2 Preliminary Ecological Conceptual Site Model

The CSM is used throughout the ERA process to: (i) evaluate the need for additional data collection activities; (ii) evaluate the need for corrective measures; and (iii) provide the framework for the ERA. Previous Work Plan submittals have detailed the comprehensive CSM applicable to the Terry Creek Site (Geosyntec, 2001; 2012). This CSM described below is specific to the Outfall Ditch.

According to USEPA (1997b), the following elements are necessary to form a complete ecological exposure pathway:

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- source of stressors;
- transport mechanism;
- point of potential exposure;
- exposure route; and
- receptor biota.

Using this information, a preliminary ecological CSM is prepared which identifies likely categories of receptors with anticipated complete exposure pathways, and identifies assessment endpoints for the ecological evaluation. These elements, as they relate to the Outfall Ditch, are briefly described in the following subsections. The preliminary ecological CSM is diagrammatically presented in Figure 3.

Primary Sources, Transport Mechanisms, Exposure Media

The Hercules Facility has been in continuous operation from 1911 to the present, producing a variety of rosin-based products from wood. The Outfall Ditch is a Hercules-constructed conveyance system to discharge surface water runoff and non-contact cooling water from the Hercules Facility. Between 1948 and 1980 Hercules produced toxaphene at its Brunswick Plant. Toxaphene is a chlorinated pesticide, and the primary contaminant of interest at the Site. During the period of production, some material was legally discharged in the wastewater through the Outfall Ditch into Dupree Creek; these discharges are believed to be the primary source of toxaphene at OU1. Currently NPDES-permitted discharges through the Outfall Ditch may also be contributing constituents to OU1.

Incidental releases (e.g., spills, leaks) of chemicals used in and produced during the operations have potentially impacted soil and subsequently groundwater (via leaching) at the Hercules Facility. Thus, soil and groundwater at the Hercules Facility are also a potential source of contaminants in the Outfall Ditch. Soil is potentially transported to the Outfall Ditch as particulates in stormwater runoff. Discharge of groundwater to surface water, if occurring, may transport dissolved contaminants to the Outfall Ditch.

Releases from neighborhoods and facilities adjacent to the Hercules plant or overland runoff along Terry and Dupree Creeks may also be sources of contaminants/stressors to the Outfall Ditch. Potential transport mechanisms include stormwater runoff and tidal influx.

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Once contaminants reach the Outfall Ditch, the primary exposure point, they may undergo a variety of partitioning and deposition mechanisms between sediment and surface water/pore water. Thus, the primary exposure media for ecological receptors at OU1 are sediment and surface water/pore water.

Secondary Transport Mechanisms, Exposure Media

Chemicals present in abiotic media (i.e., sediment and surface water/pore water) in the Outfall Ditch may also be transported through the food chain via bioaccumulation/ bioconcentration. Toxaphene has the ability to bioconcentrate (USEPA, 2009). Thus, ecological receptors at OU1 may also have contact with site-related contaminants through the consumption of food/prey items.

The Outfall Ditch empties into Dupree Creek which, after running about 800 ft, flows into Terry Creek. Contaminants in the Outfall Ditch may migrate offsite by a variety of transport mechanisms including runoff/deposition. (Note: media outside of the Outfall Ditch will be evaluated separately as part of OU3.) Contaminants partitioned to surface water in the Outfall Ditch may also migrate to groundwater via percolation/infiltration; however, direct exposure to groundwater is considered an incomplete exposure pathway for ecological receptors at OU1.

Potential Ecological Receptors and Exposure Routes

Specific species are not evaluated in the SLERA; however, general receptor categories are identified to allow evaluation of potentially complete exposure pathways. Based on previous investigations, benthic, aquatic, and wildlife species are considered appropriate preliminary ecological receptors for the Outfall Ditch. OU1 is defined as the sediment and surface water within the Outfall Ditch. As such, terrestrial species will be evaluated as a component of the upland SLERA for OU2.

Thus, potentially complete ecological exposure pathways evaluated at OU1 are:

- Exposure of benthic receptors to site-related constituents in sediment and pore water in the Outfall Ditch;
- Exposure of aquatic (fish) receptors to site-related constituents in surface water of the Outfall Ditch; and

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- Exposure of wildlife receptors to site-related constituents in sediment, surface water, and food/prey items.

The vast majority of exposure to contaminants in the Outfall Ditch is assumed to be in surficial rather than deeper sediment. For ecological receptors, surficial sediment in the biologically active zone (0 to 0.5 ft below the sediment/water interface) is considered the point-of-exposure for most sediment-dwelling or sediment-foraging receptors.

Potential direct exposure routes for ecological receptors include dermal contact/absorption, direct ingestion, and inhalation. In addition to these direct uptake mechanisms, ecological receptors may be exposed via consumption of food/prey items that have bioaccumulated/bioconcentrated constituents. Of these exposure routes, benthic macroinvertebrates and aquatic (fish) receptors are primarily expected to be exposed via direct/ingestion contact with substrate whereas wildlife receptors are primarily exposed to be exposed via dietary ingestion and, to a lesser extent, incidental ingestion of sediment.

3.1.2 Preliminary Assessment Endpoints

An assessment endpoint is an explicit expression of an environmental resource that is to be protected (USEPA, 1997b). Valuable ecological resources include those that are important socially, such as song birds, and/or functionally, such as those that provide food or habitat for other organisms. Appropriate selection and definition of assessment endpoints for a site helps identify ecological resources that will be evaluated and helps to focus the risk assessment. It is not possible to evaluate all of the individual components of an ecosystem. Therefore, assessment endpoints focus the risk assessment on particular ecosystem components that could be adversely affected by the site-related constituents. Assessment endpoints for OU1 were selected based on three principal criteria: (i) ecological relevance, (ii) susceptibility to potential stressors, and (iii) representation of management goals. General ecological assessment endpoints identified for complete exposure pathways at the Outfall Ditch are:

- Protection of benthic receptors from direct exposure/ingestion of contaminated sediment and pore water in the Outfall Ditch;

- Protection of aquatic (fish) receptors from direct exposure to contaminated surface water in the Outfall Ditch; and

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- Protection of wildlife receptors to bioaccumulated/bioconcentrated constituents in food/prey items.

3.2 Ecological Effects Evaluation

The final component of Step 1 is the screening level ecological effects evaluation, which identifies threshold exposure concentrations for chemicals of interest below which adverse effects in potentially exposed receptors will not occur. Effects thresholds for constituents detected at the Site are media-specific ecological screening values (ESVs) selected from the primary literature. These are conservative values that are unlikely to result in ecological effects in even the most sensitive ecological receptors. Sediment and water ESV sources are described below. Priority was given to Region IV values and marine-specific values. Note: geochemical parameters and essential nutrients measured in environmental media were excluded from quantitative evaluation in the SLERA; these are: total organic carbon (TOC), total suspended solids (TSS), calcium, magnesium, potassium, and sodium.

Sediment ESVs were obtained from the sources listed below, in the order of preference in which they are listed. A comprehensive list of potential sediment ESVs is provided in Table A-1 of Attachment A.

1. USEPA (2001) Region IV Ecological Effects Values;
2. USEPA (1996) Office of Solid Waste and Emergency Response (OSWER) EcoTox Thresholds for marine sediment;
3. NOAA marine sediment Screening Quick Reference Tables (SQuiRTs) (Buchman, 2008);
4. USEPA Region III Biological Technical Assistance Group (BTAG) screening benchmarks for marine sediment;
5. USEPA (2005) Region V RCRA Ecological Screening Levels (ESLs); and
6. Other literature-derived or regulatory values (see Attachment A).

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Surface water/pore water ESVs were obtained from the sources listed below, in the order of preference in which they are listed. A comprehensive list of potential sediment ESVs is provided in Table A-2 of Attachment A.

1. USEPA Region IV (2001) Ecological Effects Values for saltwater;
2. USEPA National Recommended Water Quality Criteria (NRWQC) for saltwater, chronic values;
3. USEPA (1996) OSWER EcoTox Thresholds for marine waters;
4. NOAA chronic marine water SQuiRTs (Buchman, 2008);
5. USEPA Region III BTAG screening benchmarks for marine water; and
6. USEPA (2003) Region V RCRA ESLs.

ESVs are used in Step 2 as the basis of comparison with Site data to evaluate whether there may be the potential for adverse effects to ecological receptors from exposure to constituent concentrations in OU1 media.

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4. STEP 2 EXPOSURE ESTIMATE AND RISK CALCULATIONS

The primary objective of Step 2 is to identify constituents of potential ecological concern (COPECs) and provide a conservative evaluation of the potential for adverse ecological effects related to constituent concentrations in environmental media at the Site. This step combines ecological exposure estimates with effects thresholds described in Step 1 to yield an estimate of potential ecological risks at the Site.

The sections that follow present the SLERA dataset (Section 4.1), exposure estimates (Section 4.2), and resultant risk estimates (Section 4.3). Section 4.4 provides a discussion of uncertainties associated with the analysis.

4.1 SLERA Dataset

This Focused SLERA evaluates sediment, surface water, and pore water collected from within the Outfall Ditch. The SLERA dataset for these media are summarized in the following subsections and in Table 1.

4.1.1 Sediment Dataset

RI/FS sediment sampling locations are shown in Figure 4. In accordance with the Focused RI/FS Work Plan, sediment cores were collected from 17 locations along the Outfall Ditch. Three discrete cores (a north, south, and thalweg core) were collected along each of five transects; two transects were located in the pre-weir section and three transects were located in the post-weir section of the Outfall Ditch. In addition, two cores (a north and south core) were collected from near the outlet of the triple box culvert at U.S. Highway 17. Samples were collected from 28 February through 1 March 2012. Note that depth descriptions in this section, expressed as ft, indicate the depth below the sediment/water interface.

Along each transect, two shallow cores (0 to 2.0 ft) and one deep core (up to 10 ft) were collected; only shallow cores were collected from the culvert. Shallow cores were sub-divided into two intervals: the surface interval (0 to 0.5 ft) and the sub-surface interval (0.5 to 2.0 ft); deeper cores were also subdivided, but at 2-ft intervals from 2 ft to the bottom of the core. Finally, the same depth intervals (0 to 0.5 ft and 0.5 to 2.0 ft) across each transect were composited together resulting in five composite samples.

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Each sample was analyzed for toxaphene using both Method 1 for "technical toxaphene" and Method 2 for the TAUC[1]; however, only Method 1 toxaphene data are evaluated in the SLERA. Culvert and composite samples were also analyzed for Target Analyte List/Target Compound List (TAL/TCL) constituents (see Table 1).

As noted above, only surficial sediment samples (0 to 0.5 ft) are evaluated in the SLERA, as this represent the point-of-exposure for most ecological receptors.

4.1.2 Surface Water Dataset

RI/FS surface water sampling locations are shown in Figure 5. Surface water samples were collected from just above the sediment/water interface at two locations: east of U.S. Highway 17 culvert and at the mouth of the Outfall Ditch (i.e., at the confluence with Dupree Creek). Samples were collected on 4 April 2012 during a spring tide near the mid-point of both flood and ebb tides to correspond with times of higher surface water velocities (i.e., higher tidal amplitude, greater surface water velocities). Samples were collected and analyzed as both the total and dissolved fractions (i.e., unfiltered and filtered). Additional samples were collected on 21 August 2012 after a rainfall event at both the culvert and mouth on the ebb tide and at the culvert on the flood tide.

4.1.3 Pore Water Dataset

RI/FS pore water sampling locations are shown in Figure 5. Pore water samples were collected in the pre-weir and post-weir of the Outfall Ditch. Pore water was collected using the MHE Products PushPoint sampler, as described in Section 3.2.4 of the RI/FS Report. Samples were collected and analyzed as both the total and dissolved fractions (i.e., unfiltered and filtered).

4.2 Screening Level Exposure Estimates

Screening level exposure point concentrations (EPCs) are assumed to be maximum concentrations of constituents detected in environmental media. The following conservative assumptions are inherent to the SLERA EPCs:

[1] A limited number of samples (10) were also analyzed for toxaphene congeners using Method 8276. However, the data are intended for informational purposes for OU2/OU3 and will not be used in the RI/FS process for OU1. These data are provided in Appendix A of the OU1 RI/FS Report.

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- ecological receptors spend 100 percent of their time exposed to constituents at the Site;
- ecological receptors are exposed to maximum constituent concentrations 100 percent of the time;
- constituents are 100 percent bioavailable for ecological exposure; and
- there is a potential for adverse effects at constituent concentrations greater than the ESV.

Each of these assumptions is associated with a level of uncertainty, and overestimation of risk is likely under these assumptions. Uncertainty associated with the exposure estimate is discussed in Section 4.4.

4.3 Screening Level Risk Calculations

Screening level ecological risks are evaluated using a hazard quotient (HQ) approach. This approach compares exposure levels (EPCs) to conservative ESVs, which identified in Step 1, to calculate an HQ as follows:

$$HQ = \frac{EPC}{ESV}$$

The USEPA HQ threshold value of 1 was used to identify COPECs. Generally, the greater the HQ, the greater the likelihood a negative effect will occur. Although probabilities cannot be specified based on a point-estimate approach, an HQ of approximately 1 is generally regarded as indicating a low probability adverse ecological effects. When a constituent has an HQ greater than 1, it is present at levels above its threshold concentration; however, this does not imply that adverse effects will occur, only that the potential for adverse effects exists.

Persistent and bioaccumulative compounds (e.g., toxaphene) may pose ecological risk to upper trophic level (wildlife) receptors that are not specifically assessed with a screening level approach. Because these compounds tend to accumulate as they are passed up the food chain, the risks to upper trophic level receptors may be higher than those at lower levels in the food web. Consistent with the Work Plan, bioaccumulative

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compounds detected in the Outfall Ditch are also identified as COPECs regardless of the calculated HQ. Bioaccumulative compounds were identified using the USEPA (2000) guidance.

If an ESV is not identified for a given constituent, then a preliminary assessment of the potential for environmental concentrations to result in adverse ecological effects cannot be made. Therefore, detected constituents for which an ESV is not identified are also identified as COPECs.

Geochemical parameters and essential nutrients measured in environmental media were excluded from quantitative evaluation in the SLERA; these are: TOC, TSS, calcium, magnesium, potassium, and sodium.

Potential ecological risks based on the SLERA methodology are presented in the following subsections by exposure media (i.e., sediment, surface water, and pore water). Uncertainty associated with risk estimates is discussed in Section 4.4.

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4.3.1 Sediment

Maximum detected constituent concentrations in surficial sediment (0 to 0.5 ft below the sediment/water interface) were compared to media-specific ESVs to evaluate the potential for adverse effects to ecological receptors exposed to sediment in the Outfall Ditch. Surficial sediment samples were analyzed for toxaphene, metals, polychlorinated biphenyls (PCBs), organochlorine pesticides (OCPs), polynuclear aromatic hydrocarbons (PAHs), semivolatile organic compounds (SVOCs), and volatile organic compounds (VOCs). Table 2-1 presents summary statistics, ESVs, and calculated HQs for constituents detected in Outfall Ditch surficial sediment. The results of screening level evaluation are described below by constituent group.

- ***Toxaphene.*** Toxaphene was detected in each of the 22 surficial sediment samples evaluated in the SLERA. The calculated maximum HQ for toxaphene indicates that toxaphene is likely to be the primary risk driver for sediment; the maximum detected concentration exceeds the ESV by several orders of magnitude.
- ***Metals.*** Sixteen metals were detected in surficial sediment. Maximum HQs exceed 1 for 13 of the 16 detected metals. Maximum HQs are generally low in magnitude (i.e., less than 10), with the exception of mercury. An ESV was

not identified for beryllium; therefore, a preliminary evaluation of potential risks could not be made. The highest concentrations were reported in the pre-weir section of the Outfall Ditch.

- ***PCBs.*** No PCBs were detected in surficial sediment.
- ***OCPs.*** Three OCPs were detected in surficial sediment: DDD, DDE, and gamma-BHC. Maximum detected HQs are greater than 1 for each detected OCP; however, OCPs were detected at a relatively low frequency. The highest concentrations were reported in sediments collected near the Outfall Ditch culvert.
- ***PAHs.*** Five PAHs were detected in surficial sediment: acenaphthylene, fluoranthene, naphthalene, phenanthrene, and pyrene. Concentrations of these five PAHs were summed (assuming one-half the detection limit for non-detect results) and evaluated as 'total PAHs' in the SLERA. Maximum detected concentration of total PAHs result in an HQ of 2. The highest concentrations were reported in sediments from the pre-weir section of the Outfall Ditch.
- ***SVOCs.*** Six SVOCs were detected in surficial sediment; acetophenone, benzaldehyde, 1,1-biphenyl, 2-methyphenol, 3&4-methylphenol, and phenol. ESVs were not identified for acetophenone or benzaldehyde; therefore, a preliminary evaluation of potential risks could not be made. The maximum HQ for 1,1-biphenyl is less than 1; however, maximum HQs for phenolic compounds exceed 1. Note that ESVs for phenolic compounds are Region V ESLs, which were developed using equilibrium partitioning from freshwater surface water criteria, assuming a TOC of 1 percent.
- ***VOCs.*** Four VOCs were detected in surficial sediment: acetone, 2-butanone, carbon disulfide, and isopropylbenzene. An ESV was not identified for isopropylbenzene; therefore, a preliminary evaluation of potential risks could not be made. Maximum HQs for other detected VOCs exceed 1; however, HQs for carbon disulfide and 2-butanone are of low magnitude. Note that VOC ESVs are Region V ESLs, which were developed using equilibrium partitioning from freshwater surface water criteria, assuming a TOC of 1 percent.

Thus, based on ESV comparisons, which is the SLERA metric for predicting potential ecological risk, 24 constituents/constituent groups are identified as sediment COPECs.

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Four additional constituents are identified as COPECs due to a lack of ESVs. Analytical results for sediment COPECs are presented in Table 2-2 (toxaphene only) and Table 2-3.

4.3.2 Surface Water

Maximum detected constituent concentrations in surface water were compared to media-specific ESVs to evaluate the potential for adverse effects to ecological receptors potentially exposed to surface water in the Outfall Ditch. Surface water samples were analyzed for total and dissolved toxaphene, metals, PCBs, OCPs, PAHs, SVOCs, and VOCs (unfiltered analysis only). Table 3-1 presents summary statistics, ESVs, and calculated HQs for constituents detected in Outfall Ditch surface water. Prior to SLERA evaluation, filtered and unfiltered results were compared. Results were generally similar with no apparent pattern between total and dissolved results; therefore, results were combined for screening purposes.

- ***Toxaphene.*** Toxaphene was not detected in surface water[2].
- ***Metals.*** Sixteen metals were detected in surface water. Maximum HQs exceed 1 for cobalt, cyanide, iron, and manganese. An ESV was not identified for aluminum; therefore, a preliminary evaluation of potential risks could not be made. Per the Work Plan, nine other metals that are identified by USEPA (2000) as potentially bioaccumulative are also identified as COPECs.
- ***PCBs.*** No PCBs were detected in surface water.
- ***OCPs.*** No OCPs were detected in surface water.
- ***PAHs.*** Naphthalene was detected in one surface water sample; however, the concentration is below the ESV. Therefore, no PAHs are identified as OU1 COPECs in surface water.
- ***SVOCs.*** Four SVOCs were detected in surface water: acetophenone, benzaldehyde, caprolactam, and diethyl phthalate. ESVs were not identified acetophenone, benzaldehyde, or caprolactam; therefore, a preliminary

[2] As noted above, the SLERA was based on Method 1 toxaphene data. Some toxaphene Parlars were detected in water using the GC-ECD/NIMS method. These results are discussed further in the uncertainty section.

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evaluation of potential risks could not be made. The maximum HQ for diethyl phthalate is less than 1.

- ***VOCs.*** Ten VOCs were detected in surface water: acetone, benzene, carbon tetrachloride, chlorobenzene, chloroform, ethyl benzene, isopropyl benzene, tetrachloroethylene, toluene, and xylenes. An ESV was not identified for isopropyl benzene; therefore, a preliminary evaluation of risk could not be made. Maximum HQs for other detected VOCs are less than 1.

Based on ESV comparisons, which is the SLERA metric for predicting potential ecological risk, four metals are identified as surface water COPECs. One metal, three SVOCs, and one VOC are identified as COPECs due to a lack of ESVs. Nine additional metals are identified as COPECs based on their potential to bioaccumulate. Analytical results for surface water COPECs are presented in Table 3-2.

4.3.3 Pore Water

Maximum detected constituent concentrations in pore water were compared to media-specific ESVs to evaluate the potential for adverse effects to ecological receptors potentially exposed to pore water in the Outfall Ditch. Pore water samples were analyzed for total and dissolved toxaphene, metals, PCBs, OCPs, PAHs, SVOCs, and VOCs (unfiltered analysis only). Table 4-1 presents summary statistics, ESVs, and calculated HQs for constituents detected in Outfall Ditch pore water. Prior to SLERA evaluation, filtered and unfiltered results were compared. Results were generally similar with no apparent pattern between total and dissolved results; therefore, results were combined for screening purposes.

- ***Toxaphene.*** Toxaphene was detected in one filtered pore water sample collected in the post-weir section of the Outfall Ditch. The maximum detected concentration exceeds the ESV by several orders of magnitude.
- ***Metals.*** Twelve metals were detected in pore water. Maximum HQs exceed 1 for cobalt, copper, iron, and manganese. An ESV was not identified for aluminum; therefore, a preliminary evaluation of potential risks could not be made. Per the Work Plan, five other metals that are identified by USEPA (2000) as potentially bioaccumulative are also identified as COPECs.
- ***PCBs.*** No PCBs were detected in pore water.
- ***OCPs.*** No OCPs were detected in pore water.

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- ***PAHs.*** Naphthalene was detected in one pore water sample; however, the concentration is below the ESV. Therefore, no PAHs are identified as OU1 COPECs in pore water.
- ***SVOCs.*** Three SVOCs were detected in pore water: benzaldehyde, diethyl phthalate, and phenol. An ESV was not identified for benzaldehyde; therefore, a preliminary evaluation of potential risks could not be made. Maximum HQs for diethyl phthalate and phenol are less than 1.
- ***VOCs.*** Three VOCs were detected in pore water: acetone, methyl tert-butyl ether, and toluene. Maximum HQs are less than 1. Therefore, no VOCs are identified as OU1 COPECs in pore water.

Based on ESV comparisons, which is the SLERA metric for predicting potential ecological risk, toxaphene and four metals are identified as pore water COPECs. One additional metal and one SVOC are identified as COPECs due to a lack of ESVs. Five metals are identified as COPECs based on their potential to bioaccumulate. Analytical results for pore water COPECs are presented in Table 4-2.

4.3.3 COPEC Summary

Sediment, surface water, and pore water COPEC HQs are summarized in Table 5. Based on the calculated HQs, there is a potential for adverse effects for ecological receptors directly exposed to constituents in OU1, particularly from exposure to toxaphene. Uncertainties associated with ecological risk estimates are discussed in Section 4.4.

4.4 SLERA Uncertainty Assessment

The final component of Step 2 is to describe potential uncertainties associated with the SLERA. The following subsections discuss uncertainty associated with major SLERA components.

4.4.1 Conceptual Site Model Development

The primary objective of Step 1 of the SLERA is to gather sufficient information concerning the study area to evaluate whether potential complete exposure pathways exist (i.e., develop a CSM). Based on ecological surveys conducted for the larger Terry and Dupree Creek systems (Exponent, 1998), benthic invertebrates, fish, reptiles, birds,

and mammals were identified as potential receptors for the Site. Ecological surveys of the Outfall Ditch itself have not been conducted; however, species representative of each of these receptors classes have been observed in or in the vicinity of OU1. Given that the SLERA does not evaluate specific species, further ecological characterization is unlikely to affect the results of the SLERA. Notably, however, observations during the Focused RI/FS support the assumption that the Outfall Ditch does not offer substantial ecological habitat due to its small size, the lack of water during low tide, physical barriers created by the weir, and limited submerged, emergent, and/or overhanging vegetation. Further, as a permitted discharge point, the Outfall Ditch will continue to have minimal value as an ecological habitat in the foreseeable future. The presence of contamination notwithstanding, further evaluation would not be warranted given these conditions.

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4.4.2 SLERA Dataset

The OU1 SLERA datasets consisted of samples collected between February and August 2012, which represent the most recent analytical data available for OU1. Although older data was available, it was collected immediately after the 1999-2000 removal action and, therefore, not representative of current and future ecological risks. Although the age of the data is unlikely to affect the results of the SLERA, it is noted that, to some extent, the datasets represent only a “snap shot” of chemical concentrations. Due to due to daily, seasonal, and annual fluxes in flow, partitioning, and resuspension of constituents between sediment and surface water, biological transformation, and other naturally occurring fate and transport processes, constituent concentration in the tidal Outfall Ditch are likely to be vary. Thus, the dataset may under- or over-estimate “typical” Outfall Ditch concentrations. However, surface water samples collected at ebb and flood tides, and after a rainfall event showed little variation, indicating that these fluctuations are unlikely to have affected the surface water risk estimates. Sediment movement in and out of the canal, particularly in the pre-weir section of the canal, where concentrations tended to be highest, is likely limited. Overall, the data is expected to provide a reasonable estimate of potential ecological risks.

As indicated in Table 1, sediment samples evaluated in the SLERA (i.e., samples collected in the top 0.5 ft of sediment) were analyzed for toxaphene, other OCPs, inorganics, PCBs, SVOCs (including PAHs), and VOCs. Deeper sediments were analyzed for the same constituents, as well as polychlorinated dibenzofurans (PCDDs)

and polychlorinated dibenzofurans (PCDFs). Thus, it is uncertain whether PCDDs/PCDFs are present in surficial sediment at concentrations with the potential to result in adverse ecological effects. However, toxic equivalency concentrations for detected PCDDs/PCDFs in sediment collected from the 0.5-2 ft interval are below the Region IV criterion of 2.5 parts per trillion, indicating a limited potential for adverse ecological effects; the fish, mammal, and avian PCDD/PCDF toxic equivalency concentrations are 0.13, 1.8, and 0.86, respectively.

4.4.3 SLERA Exposure Estimates

Ecological receptors were assumed to be exposed to sediment in the 0 to 0.5 ft interval. For most constituents, this is likely to provide a conservative estimate of potential risks since concentrations tend to attenuate with depth. However, as described in the OU1 Focused RI Report, the highest levels of toxaphene were found at depth, generally deeper than 2 ft below the sediment/water interface, with the exception of the culvert locations. Should contact occur with deeper sediments, risk may be underestimated. Surface water samples were collected near the sediment/water interface, where concentrations were expected to be highest. This point in the water column may not represent the point of exposure for many aquatic species and, thus, may overestimate risk for some receptors.

The use of maximum concentrations assumes that receptors are exposed to maximum concentrations 100 percent of the time. Within OU1 several locations have COPEC concentrations that exceed ESVs, indicating that for most constituents, EPC selection would not have substantially affected the results of the SLERA. However, given the limited habitat of the Outfall Ditch, this is unlikely for most ecological receptors. Thus, potential risks identified for the relatively small OU1 are unlikely to be indicative of the potential for impacts to the larger population and/or larger ecological community of the Site.

4.4.4 SLERA Effects Estimates

SLERA ESVs were selected using a hierarchical approach, and as a result, may not represent the lowest available criteria. However, in general, ESVs are highly conservative to ensure that the potential for adverse ecological effects is not overlooked. There are large differences in the sensitivity of different organisms to different constituents, and some species and/or life stages are more sensitive than others.

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Frequently, the most sensitive species and life stages are used to evaluate responses to constituents in the published studies (usually laboratory studies) that are revised to establish ESVs. Furthermore, laboratory exposures are usually performed with soluble forms of constituents to elicit a response, and these dose-response concentrations under laboratory conditions are then compared with total concentrations of less soluble or less bioavailable forms in site-specific environmental media. Overall, the ESVs utilized herein are likely to be conservative and not expected to overlook the potential for adverse ecological effects. Chemical-specific effects estimates are discussed in additional detail in the following subsections.

Toxaphene

There are a variety of available screening criteria for toxaphene. Criteria for sediment include 0.077, 0.1, 28 and 536 µg/kg which are available from USEPA Region V, NOAA, USEPA (OSWER), and Region III, respectively. Thus, the toxaphene HQ could be under or overestimated by orders of magnitude. However, as shown in Table 2-2, the majority of surficial sediment concentrations exceed even the highest ESV (536 µg/kg). For surface water and pore water, the selected toxaphene ESV of 0.0002 micrograms per liter (µg/L) represents the lowest criterion from the reviewed sources. An alternative ESV of 0.21 µg/L was also identified. As with sediment, detected pore water concentrations also exceed the higher ESV (toxaphene was not detected in surface water). The selection of the criteria will have a direct effect on the results (i.e., HQ) of the SLERA, however, it does not affect the conclusion that there is a potential for adverse ecological effects from exposure to toxaphene in sediment.

It should also be noted that one of the sediment criteria for toxaphene is a USEPA (1996) OSWER sediment quality criterion (SQC), which was derived as a function of TOC (1 percent), chemical-specific octanol-water partition coefficient (Koc), and a chronic water quality criterion for the protection of aquatic organisms. Each of these variables contributes uncertainty to the SQC. The measured TOC of Outfall Ditch sediment is generally higher than 1 percent; a higher SQC would be derived using this site-specific TOC. Koc is highly variable depending upon experimental methodologies used for its determination. Furthermore, the sediment organic carbon dependency of partitioning to the water phase suggests that a variety of site-specific variables, not least of which is site TOC, as well as potentially carbon type and distribution at the site will determine an appropriate screening level criterion. The selected water quality criterion is based on aquatic species; thus, the derivation of a sediment criterion from this value

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assumes that benthic, epibenthic, or infaunal species are equally as sensitive as aquatic species. Finally, the development of the water quality criterion uses toxicity test data based upon organism exposure to technical toxaphene and not toxaphene which has been significantly weathered. Together, these uncertainties indicate that for more complex sites, the development of a site-specific toxaphene criterion is warranted. The use of site-specific sediment ESV for toxaphene may provide a more refined estimate of OU1-specific risks and, based on a preliminary review of SQC variables, likely reduced risk estimates. Nonetheless, the Outfall Ditch represents a source for the larger Terry and Dupree Creek system.

Other Constituents

Several USEPA (2001) Region IV sediment ESVs correspond to threshold effects levels (TELs). TELs are values below which adverse effects are not expected to occur. Probably effects levels (PELs) are also available for several sediment COPECs. PELs represent a concentration above which, adverse effects are likely to occur more often than not. Together, TELs and PELs provide a bounded estimate of risk, and can be used to focus additional ERA steps (if necessary) on those COPECs with the greatest potential for resulting in adverse ecological effects. Surficial sediment concentrations of arsenic, cadmium, chromium, lead, nickel, DDD, and total PAHs are below PELs; however, barium, copper, mercury, zinc, DDE, and Lindane exceed their respective PELs in one or more samples.

In the absence of marine-specific sediment criteria, Region V ESLs were utilized for screening purposes. This was the case for detected SVOCs, VOCs, and cobalt. The use of Region V ESLs introduces uncertainty into the SLERA for several reasons: 1) ESLs are protective of freshwater organisms, which may be more or less sensitive to COPECs than marine species and 2) ESLs are derived from surface water criteria assuming a TOC of 1 percent; which is lower than TOC measured in the Outfall Ditch and, consequently, results in a lower ESV.

The primary uncertainty in the evaluation is in the analytical measurement of weathered toxaphene residues in sediment and comparison to ESVs that were derived for technical grade toxaphene. To expedite remedial decisions at OU1, and because toxaphene residues consistently exceed ESVs, a screening level approach was agreed to for use with the Focused SLERA. Refinements to analytical methodology and toxicity will be evaluated in greater depth in OU2/OU3 assessments.

4.4.5 SLERA COPEC Selection

Detected constituents were identified as COPECs if: 1) the maximum concentration that exceeded the applicable ESV (HQ greater than 1); 2) an ESV was not available; or 3) the constituent is considered potentially bioaccumulative (USEPA, 2000). This approach is appropriate as an initial step for identifying preliminary COPECs and ecologically significant exposure areas that warrant further evaluation in the ERA process. However, the risk estimates are likely to be conservative as ESVs are developed such that the potential for adverse ecological effects is not overlooked.

Identifying constituents as COPECs based on a comparison to an ESV inherently assumes that there is a potential for adverse ecological effects to occur at constituent concentrations greater than the ESV. However, as described in the previous section, there are several uncertainties associated with this assumption.

If an ESV was not available, a preliminary assessment of concentrations in environmental media could not be made. Thus, the potential for adverse ecological effects is uncertain. For the purposes of the SLERA, detected constituents that lacked screening criteria or for which an appropriate surrogate could not be identified, were conservatively identified as COPECs. However, it is uncertain whether COPECs identified on this basis are risk drivers.

Non-detect constituents were not evaluated in Step 2. If a constituent is present, but at levels which cannot be achieved through standard analytical methods, its exclusion from the quantitative risk characterization may underestimate risks. Conversely, inclusion of non-Site-related constituents due to elevated detection limits relative to conservative ecological screening criteria would have likely overestimated risks. Attachment B presents summary statistics for non-detect constituents and compares detection limits to ESVs. For sediment (Table B-1), detection limits for several non-detect constituents exceeded ESVs whereas detection limits for the majority of constituents analyzed in surface water (Table B-2) and pore water (Table B-3) were below ESVs. The uncertainties associated with non-detect constituents are not likely to affect the OU1 conclusions; however, these MDLs should be considered prior to conducting the OU2 and OU3 SLERAs.

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5. SLERA SUMMARY AND SMDP

Geosyntec, on behalf of Hercules, conducted a Focused SLERA for OU1 of the Terry Creek Site in Brunswick, Georgia. The SLERA, a companion document to the Focused OU1 RI/FS, evaluated the likelihood that adverse ecological effects are occurring or may potentially occur as a result of the site-specific constituent concentrations in environmental media in OU1, the Outfall Ditch. RI/FS activities were prioritized at OU1 as it represents a significant source of toxaphene to the Terry and Dupree Creek system. Further, due to the relatively small size of OU1 (Figure 2) and its expected use as a conveyance structure for the foreseeable future, USEPA and Hercules agreed that a Focused RI/FS could proceed and that the results may allow for the selection of a final remedy at OU1 that is not reliant on the toxaphene analytical methodology or toxicity reference value development.

Potential ecological risks developed under this SLERA are applicable to surficial sediment, surface water, and pore water as represented by the samples described in Section 4.1. The results of the screening level exposure estimate and risk calculation (Step 2) indicate that concentrations of several constituents exceed ESVs, which is the SLERA metric for predicting potential adverse ecological effects. Maximum HQs for the majority of constituents detected in sediment exceed the USEPA threshold value of 1 and, in the case of toxaphene, the maximum concentration exceeds potential ESVs by several orders of magnitude. Although concentrations of toxaphene vary spatially in the Outfall Ditch, with the highest concentrations occurring near the culvert and outfall, HQs exceed 1 in each of the 22 surficial samples evaluated in the SLERA.

Given the magnitude of HQs for toxaphene, it is unlikely that the potential for ecological risk can be attributed to the conservative assumptions or uncertainties of the SLERA discussed in Section 4.4. As such, it is unlikely that a BERA will provide significant refinement of potential risks predicted by the SLERA approach or contribute useful information for remedial actions at the Outfall Ditch.

Therefore, a performance-based remedial goal that focuses on eliminating direct exposure to contaminants in the Outfall Ditch and eliminating the transport of contaminants to Dupree Creek and other downstream locations is recommended. This approach is consistent with the USEPA's Contaminated Sediment Remediation Guidance for Hazardous Waste Sites (USEPA, 2005) and the Principles for Managing Contaminated Sediment Risks at Hazardous Waste Sites (USEPA, 2002), which

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collectively, highlight the consideration of separating the management of source areas with the most elevated concentrations of constituents from other, less concentrated areas.

The Focused FS for OU1 will provide an analysis of alternatives that are assembled based on the results of the Focused RI and the SLERA.

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Table 1
OU1 Focused SLERA
Summary of Analytical Data Evaluated in the SLERA
Terry Creek Site - Brunswick, Georgia

Exposure Media	Sample ID	Pre/Post-Weir	Sampling Location Description		Sampling Date	Constituent Analyses					
						Toxaphene [1]	Inorganics	OCPs	PCBs (Aroclors)	SVOCs/PAHs	VOCs
Surficial Sediment (0-0.5 ft) [2]	SD-OD1N-01	Pre-Weir	Transect 1	North	2/28/12	X					
	SD-OD1T-01			Thalweg	2/28/12	X					
	SD-OD1S-01			South	2/28/12	X					
	SD-OD1C-01			Composite	3/1/12	X	X	X	X	X	X
	SD-OD2N-01		Transect 2	North	2/28/12	X					
	SD-OD2T-01			Thalweg	2/29/12	X					
	SD-OD2S-01			South	2/28/12	X					
	SD-OD2C-01			Composite	3/1/12	X	X	X	X	X	X
	SD-ODCN-01		Box Culvert	North	3/1/12	X	X	X	X	X	
	SD-ODCS-01			South	3/1/12	X	X	X	X	X	
	SD-OD3N-01	Post-Weir	Transect 3	North	2/28/12	X					
	SD-OD3T-01			Thalweg	3/1/12	X					
	SD-OD3S-01			South	2/28/12	X					
	SD-OD3C-01			Composite	3/1/12	X	X	X	X	X	X
	SD-OD4N-01		Transect 4	North	2/29/12	X					
	SD-OD4T-01			Thalweg	2/29/12	X					
	SD-OD4S-01			South	2/29/12	X					
	SD-OD4C-01			Composite	3/1/12	X	X	X	X	X	X
	SD-OD5N-01		Transect 5	North	2/29/12	X					
	SD-OD5T-01			Thalweg	2/29/12	X					
	SD-OD5S-01			South	2/29/12	X		X	X	X	
	SD-OD5C-01 [3]			Composite	2/29/12	X	X	X	X	X	X
Surface Water	SW-DCEB-01	Pre-Weir	Culvert (East of U.S. Highway 17)	Ebb Tide, Filtered	4/4/12	X	X	X	X	X	
	SW-DCEB-02			Ebb Tide	4/4/12	X	X	X	X	X	X
	SW-DCEB-03			Ebb Tide	8/21/12	X		X	X	X	
	SW-DCEB-04			Ebb Tide	8/21/12	X	X	X	X	X	X
	SW-DCFL-01			Flood Tide, Filtered	4/4/12	X	X	X	X	X	
	SW-DCFL-02			Flood Tide	4/4/12	X	X	X	X	X	X
	SW-DCFL-03			Flood Tide	8/21/12	X	X	X	X	X	
	SW-DCFL-04			Flood Tide	8/21/12	X	X	X	X	X	
	SW-DMEB-01	Post-Weir	Mouth (OU1/Dupree Creek confluence)	Ebb Tide, Filtered	4/4/12	X	X	X	X	X	
	SW-DMEB-02			Ebb Tide	4/4/12	X	X	X	X	X	X
	SW-DMEB-03			Ebb Tide	8/21/12	X	X	X	X	X	
	SW-DMEB-04			Ebb Tide	8/21/12	X	X	X	X	X	
	SW-DMFL-01			Flood Tide, Filtered	4/4/12	X	X	X	X	X	
	SW-DMFL-02			Flood Tide	4/4/12	X	X	X	X	X	X
Pore Water	PW-ODPR-01	Pre-Weir	--	Filtered	2/28/12	X	X	X	X	X	X
	PW-ODPR-02		--	Unfiltered (Total)	2/28/12	X	X	X	X	X	X
	PW-ODPO-01	Post-Weir	--	Filtered	2/29/12	X	X	X	X	X	X
	PW-ODPO-02		--	Unfiltered (Total)	2/29/12	X	X	X	X	X	X

Notes:
(1) Sediment and surface water analysis for toxaphene was conducted using Method 1 for "technical toxaphene" and Method 2 for the total area under the curve (TAUC). However, as described in the Work Plan (Geosyntec, 2009), only Method 1 data are evaluated in the SLERA. Method 1 data will be used at OU1 to inform remedial decisions.
(2) Deeper sediment samples were also analyzed for dioxins/furans. The results of this analysis are discussed in the SLERA uncertainty section.
(3) Duplicate sample collected. Prior to evaluation in the SLERA, duplicate results were processed as follows: 1) two detected results with a relative percent difference (RPD) ≥ 25%, the maximum result was used; 2) two detected results with an RPD < 25%, the mean of the results was used; 3) two non-detect results, the average detection limit was used; 4) one detected results and one non-detect result, the detected result was used.

Definitions:
OU1 = Operable Unit 1 (Outfall Ditch)
SLERA = Screening Level Ecological Risk Assessment
OCP = organochlorine pesticide
PCB = polychlorinated biphenyl
SVOC = semivolatile organic compound
PAH = polynuclear aromatic hydrocarbon
VOC = volatile organic compound
"X" = Analysis conducted
ft = feet below the sediment/water interface

Table 2-1
OU1 Focused SLERA
Constituent Screening - Outfall Ditch Surficial Sediment
Terry Creek Superfund Site - Brunswick, Georgia

Class	Detected Constituents	CAS	Units	Average [1]	Minimum (Qualifier) [2]	Maximum (Qualifier) [2]	Location of Maximum	Detection Frequency	MDL Range [3]	SLERA EPC [4]	SLERA ESV [5] (Source)	Maximum SLERA HQ [6]	PBC [7]	COPEC [8]	Rationale [8]
METAL	Aluminum	7429-90-5	mg/kg	21,957	1,700	36,000 J	SD-OD5C-01	7 / 7	n/a	36,000	18,000 (f)	2	-	Yes	ASV
METAL	Arsenic	7440-38-2	mg/kg	12.2	1 J	17 J	SD-OD2C-01	7 / 7	n/a	17	7.24 (a)	2.3	Yes	Yes	ASV
METAL	Barium	7440-39-3	mg/kg	60.3	6.9	160 J	SD-OD2C-01	7 / 7	n/a	160	130 (c)	1.2	-	Yes	ASV
METAL	Beryllium	7440-41-7	mg/kg	0.910	0.08 J	1.65 J	SD-OD5C-01	7 / 7	n/a	1.65	NSV --	--	-	Yes	NSV
METAL	Cadmium	7440-43-9	mg/kg	0.552	0.49 J	1.3 J	SD-OD2C-01	4 / 7	0.34 - 0.87	1.3	0.676 (a)	1.9	Yes	Yes	ASV
METAL	Chromium	7440-47-3	mg/kg	47.0	3.9	83 J	SD-OD2C-01	7 / 7	n/a	83	52.3 (a)	1.6	Yes	Yes	ASV
METAL	Cobalt	7440-48-4	mg/kg	4.40	0.38 J	7 J	SD-OD5C-01	7 / 7	n/a	7	50 (e)	0.14	-	No	BSV
METAL	Copper	7440-50-8	mg/kg	61.4	3.8 J	160 J	SD-OD2C-01	7 / 7	n/a	160	18.7 (a)	8.6	Yes	Yes	ASV
METAL	Iron	7439-89-6	mg/kg	19,357	1,500	31,000 J	SD-OD5C-01	7 / 7	n/a	31,000	220,000 (f)	0.14	-	No	BSV
METAL	Lead	7439-92-1	mg/kg	43.0	5.2	93 J	SD-OD2C-01	7 / 7	n/a	93	30.2 (a)	3.1	Yes	Yes	ASV
METAL	Manganese	7439-96-5	mg/kg	274	38	460 J	SD-OD2C-01	7 / 7	n/a	460	260 (f)	1.8	-	Yes	ASV
METAL	Mercury	7439-97-6	mg/kg	1.29	0.016 J	6.2 J	SD-ODCS-01	7 / 7	n/a	6.2	0.13 (a)	48	Yes	Yes	ASV
METAL	Nickel	7440-02-0	mg/kg	14.0	1.6 J	25 J	SD-OD2C-01	7 / 7	n/a	25	15.9 (a)	1.6	Yes	Yes	ASV
METAL	Silver	7440-22-4	mg/kg	1.8	0.9 J	0.9 J	SD-OD5C-01	1 / 7	0.33 - 8.9	0.9	0.733 (a)	1.2	Yes	Yes	ASV
METAL	Vanadium	7440-62-2	mg/kg	44.8	6.3	72.5 J	SD-OD5C-01	7 / 7	n/a	72.5	57 (f)	1.3	-	Yes	ASV
METAL	Zinc	7440-66-6	mg/kg	213	25	580 J	SD-OD2C-01	7 / 7	n/a	580	124 (a)	4.7	Yes	Yes	ASV
PEST	DDD	72-54-8	µg/kg	52.4	3.3 J	3.3 J	SD-OD5S-01	1 / 8	2.3 - 600	3.3	1.22 (a)	2.7	Yes	Yes	ASV
PEST	DDE	72-55-9	µg/kg	110	68 J	470	SD-ODCN-01	2 / 8	0.42 - 600	470	2.07 (a)	230	Yes	Yes	ASV
PEST	gamma-BHC (Lindane)	58-89-9	µg/kg	23.8	7.4 J	7.4 J	SD-ODCN-01	1 / 8	0.24 - 310	7.4	0.32 (a)	23	Yes	Yes	ASV
PEST	Toxaphene [9]	8001-35-2	µg/kg	8,186	170 J	71,000	SD-ODCN-01	22 / 22	n/a	71,000	28 (b)	2,500	Yes	Yes	ASV
PAH	Total PAHs [10]	PAH SUM	µg/kg	1,111	300 J	3,580 J	SD-OD2C-01	6 / 8	92 - 310	3,580	1,684 (a)	2.1	Yes	Yes	ASV
SVOC	Acetophenone	98-86-2	µg/kg	566	300 J	300 J	SD-OD5C-01	1 / 8	260 - 3000	300	NSV --	--	-	Yes	NSV
SVOC	Benzaldehyde	100-52-7	µg/kg	811	490 J	2,200 J	SD-OD2C-01	4 / 8	380 - 1400	2,200	NSV --	--	-	Yes	NSV
SVOC	1,1-Biphenyl	92-52-4	µg/kg	609	630 J	630 J	SD-OD5C-01	1 / 8	280 - 3000	630	1,100 (b)	0.57	-	No	BSV
SVOC	2-Methylphenol	95-48-7	µg/kg	498	340 J	340 J	SD-ODCS-01	1 / 8	240 - 3000	340	55.4 (e)	6.1	-	Yes	ASV
SVOC	3 & 4 Methylphenol [11]	TTNUS042	µg/kg	913	2,200 J	2,900 J	SD-OD2C-01	2 / 8	280 - 1500	2,900	20.2 (e)	140	-	Yes	ASV
SVOC	Phenol	108-95-2	µg/kg	1,211	390 J	5,900 J	SD-ODCS-01	4 / 8	250 - 1400	5,900	49.1 (e)	120	-	Yes	ASV
VOC	Acetone	67-64-1	µg/kg	322	150 J	760 J	SD-OD2C-01	5 / 5	n/a	760	9.9 (e)	77	-	Yes	ASV
VOC	Carbon disulfide	75-15-0	µg/kg	15.4	8.5 J	31 J	SD-OD3C-01	4 / 5	5.3 - 5.3	31	23.9 (e)	1.3	-	Yes	ASV
VOC	Isopropylbenzene	98-82-8	µg/kg	7.58	9.5 J	9.5 J	SD-OD2C-01	1 / 5	8.6 - 27	9.5	NSV --	--	-	Yes	NSV
VOC	2-Butanone (MEK)	78-93-3	µg/kg	62.6	40 J	110 J	SD-OD2C-01	5 / 5	n/a	110	42.4 (e)	2.6	-	Yes	ASV

Notes:
(1) Arithmetic average calculated using one-half the method detection limit (MDL) for non-detect results.
(2) Minimum/maximum detected concentration. "J" indicates an estimated concentration.
(3) MDL range based on non-detect sample results.
(4) SLERA exposure point concentration (EPC) is the maximum detected concentration.
(5) Ecological screening values (ESVs) were selected using the following hierarchy (see Attachment A):
(a) USEPA Region IV ecological effects values, sediment
(b) USEPA EcoTox Thresholds (SQC/SQB) for marine sediment
(c) NOAA SQuiRTs for marine sediment (minimum of T_{20}, TEL, ERL, T_{50}, PEL, and ERM)
(d) USEPA Region III BTAG ecological screening benchmarks for marine sediment
(e) USEPA Region V ESLs for freshwater sediment
(f) Apparent effects threshold (NOAA)
(6) Screening level hazard quotient (HQ) calculated (to two significant figures) as follows: HQ = EPC/ESV.
(7) Bioaccumulation potential based on: USEPA. 2000. Bioaccumulation Testing and Interpretation for the Purpose of Sediment Quality Assessment, Status and Needs. Office of Water. EPA-823-R-00-001. February.
(8) Rationale for COPEC selection/exclusion:
Selection
ASV = above ecological screening value
PBC = potentially bioaccumulative constituent
NSV = no screening value
Exclusion
BSV = below ecological screening value
(9) Per the Work Plan, the SLERA utilizes Method 1 toxaphene results. The SLERA HQ is based on the EPA EcoTox SQB.
(10) Detected PAHs were evaluated as "Total PAHs." Summed PAHs are acenaphthylene, fluoranthene, naphthalene, phenanthrene, and pyrene. Non-detect PAHs were excluded from the summations; otherwise, non-detect results were include as one-half the MDL. The MDL range presented in the table represents the lowest and highest MDL for these five PAHs (i.e., MDLs were not summed).
(11) Surrogate ESVs were utilized as follows:
3&4-Methylphenol uses 4-Methylphenol as a surrogate

Shading = Maximum HQ > 1

Definitions:
OU1 = Operable Unit 1 (Outfall Ditch)
SLERA = Screening Level Ecological Risk Assessment
mg/kg = milligram per kilogram
µg/kg = microgram per kilogram
CAS = chemical abstract number
PEST = pesticide
SVOC = semivolatile organic compound
PAH = polynuclear aromatic hydrocarbon
VOC = volatile organic compound

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Table 2-2
OU1 Focused SLERA
Analytical Data for Toxaphene - Outfall Ditch Surficial Sediment
Terry Creek Superfund Site - Brunswick, Georgia

Field ID	Depth (ft)	Units	Toxaphene	
SD-ODCN-01	0 - 0.5	µg/kg	**71,000**	
SD-ODCS-01	0 - 0.5	µg/kg	**5,700**	**J**
SD-OD1C-01	0 - 0.5	µg/kg	**5400**	**J**
SD-OD1N-01	0 - 0.5	µg/kg	**12,000**	**J**
SD-OD1S-01	0 - 0.5	µg/kg	**1,800**	**J**
SD-OD1T-01	0 - 0.5	µg/kg	**5,300**	
SD-OD2C-01	0 - 0.5	µg/kg	**21,000**	**J**
SD-OD2N-01	0 - 0.5	µg/kg	**2,000**	**J**
SD-OD2S-01	0 - 0.5	µg/kg	**14,000**	**J**
SD-OD2T-01	0 - 0.5	µg/kg	**5,100**	**J**
SD-OD3C-01	0 - 0.5	µg/kg	**630**	**J**
SD-OD3N-01	0 - 0.5	µg/kg	**550**	**J**
SD-OD3S-01	0 - 0.5	µg/kg	**860**	**J**
SD-OD3T-01	0 - 0.5	µg/kg	**11,000**	**J**
SD-OD4C-01	0 - 0.5	µg/kg	**190**	**J**
SD-OD4N-01	0 - 0.5	µg/kg	**210**	**J**
SD-OD4S-01	0 - 0.5	µg/kg	**170**	**J**
SD-OD4T-01	0 - 0.5	µg/kg	**500**	**J**
SD-OD5C-01	0 - 0.5	µg/kg	**360**	**J**
SD-OD5C-01 DUP	0 - 0.5	µg/kg	**21,000**	
SD-OD5N-01	0 - 0.5	µg/kg	**320**	**J**
SD-OD5S-01	0 - 0.5	µg/kg	**270**	**J**
SD-OD5T-01	0 - 0.5	µg/kg	**1,100**	**J**

Definitions:
OU1 = Operable Unit 1 (Outfall Ditch)
SLERA = Screening Level Ecological Risk Assessment
µg/kg = microgram per kilogram
"J" = estimated concentration
Bold Text = Detected result
Shading indicates the following:

Potential ESV	ESV Source
> 0.077	Region V
> 0.1	NOAA TEL
> 28	OSWER SQB
> 536	Region III BTAG

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Table 2-3
OU1 Focused SLERA
Analytical Data for COPECs - Outfall Ditch Surficial Sediment
Terry Creek Superfund Site - Brunswick, Georgia

Class	CAS	COPECs [2]	SLERA ESV [3]	Units	Analytical Results [1]																	
					SD-ODCN-01		SD-ODCS-01		SD-OD1C-01		SD-OD2C-01		SD-OD3C-01		SD-OD4C-01		SD-OD5C-01 (AVG)		SD-OD5S-01	
METAL	7429-90-5	Aluminum	18,000	mg/kg	**1,700**		**12,000**	J	**15,000**	J	**34,000**	J	**33,000**	J	**22,000**	J	**36,000**	J	--	
METAL	7440-38-2	Arsenic	7.24	mg/kg	**1**	J	**13**	J	**9.4**	J	**17**	J	**13**	J	**15**	J	**17**	J	--	
METAL	7440-39-3	Barium	130	mg/kg	**6.9**		**84**	J	**66**	J	**160**	J	**39**	J	**25**	J	**41.5**	J	--	
METAL	7440-41-7	Beryllium	NSV	mg/kg	**0.08**	J	**0.34**	J	**0.5**	J	**1**	J	**1.4**	J	**1.4**	J	**1.65**	J	--	
METAL	7440-43-9	Cadmium	0.676	mg/kg	0.87	U	**0.71**	J	**0.55**	J	**1.3**	J	**0.49**	J	0.34	UJ	0.415	U	--	
METAL	7440-47-3	Chromium	52.3	mg/kg	**3.9**		**45**	J	**43**	J	**83**	J	**53**	J	**43**	J	**58**	J	--	
METAL	7440-50-8	Copper	18.7	mg/kg	**3.8**	J	**68**	J	**86**	J	**160**	J	**51**	J	**18**	J	**43**		--	
METAL	7439-92-1	Lead	30.2	mg/kg	**5.2**		**45**	J	**72**	J	**93**	J	**32**	J	**25**	J	**29**	J	--	
METAL	7439-96-5	Manganese	260	mg/kg	**38**		**230**	J	**200**	J	**460**	J	**310**	J	**280**	J	**400**	J	--	
METAL	7439-97-6	Mercury	0.13	mg/kg	**0.016**	J	**6.2**	J	**0.75**	J	**1.5**	J	**0.21**	J	**0.14**	J	**0.23**		--	
METAL	7440-02-0	Nickel	15.9	mg/kg	**1.6**	J	**14**	J	**14**	J	**25**	J	**16**	J	**11**	J	**16.5**	J	--	
METAL	7440-22-4	Silver	0.733	mg/kg	1.7	U	3.9	UJ	4.2	UJ	8.9	UJ	4	UJ	0.33	UJ	**0.9**	J	--	
METAL	7440-62-2	Vanadium	57	mg/kg	**6.3**		**21**	J	**30**	J	**60**	J	**65**	J	**59**	J	**72.5**	J	--	
METAL	7440-66-6	Zinc	124	mg/kg	**25**		**220**	J	**340**	J	**580**	J	**140**	J	**81**	J	**103**	J	--	
PEST	72-54-8	DDD	1.22	µg/kg	120	U	27	UJ	38	UJ	600	UJ	29	UJ	2.3	UJ	16	U	**3.3**	J
PEST	72-55-9	DDE	2.07	µg/kg	**470**		**68**	J	38	UJ	600	UJ	29	UJ	1.8	UJ	12	U	0.42	UJ
PEST	58-89-9	gamma-BHC (Lindane)	0.32	µg/kg	**7.4**	J	14	UJ	19	UJ	310	UJ	15	UJ	1	UJ	7.2	U	0.24	UJ
PAH	PAH SUM	Total PAHs	1,684	µg/kg	**300**	J	**2,300**	J	**1,145**	J	**3,580**	J	**790**	J	130	UJ	**635**	J	140	UJ
SVOC	98-86-2	Acetophenone	NSV	µg/kg	590	U	1,400	UJ	1,500	UJ	3,000	UJ	1,400	UJ	260	UJ	**300**	J	300	UJ
SVOC	100-52-7	Benzaldehyde	NSV	µg/kg	590	U	**1,200**	J	**490**	J	**2,200**	J	1,400	UJ	380	UJ	**1,200**		430	UJ
SVOC	95-48-7	2-Methylphenol	55.4	µg/kg	590	U	**340**	J	1,500	UJ	3,000	UJ	1,400	UJ	240	UJ	270	U	280	UJ
SVOC	TTNUS042	3 & 4 Methylphenol	20.2	µg/kg	590	U	**2,200**	J	1,500	UJ	**2,900**	J	1,400	UJ	280	UJ	310	U	320	UJ
SVOC	108-95-2	Phenol	49.1	µg/kg	590	U	**5,900**	J	**430**	J	**1,700**	J	1,400	UJ	250	UJ	**390**	J	290	UJ
VOC	67-64-1	Acetone	9.9	µg/kg	--		--		**310**	J	**760**	J	**150**	J	**150**	J	**240**	J	--	
VOC	78-93-3	2-Butanone (MEK)	42.4	µg/kg	--		--		**49**	J	**110**	J	**42**	J	**40**	J	**72**	J	--	
VOC	75-15-0	Carbon disulfide	23.9	µg/kg	--		--		**8.5**	J	**13**	J	**31**	J	5.3	UJ	**22**	J	--	
VOC	98-82-8	Isopropylbenzene	NSV	µg/kg	--		--		12	UJ	**9.5**	J	27	UJ	9.2	UJ	8.6	UJ	--	

Notes:
(1) Analytical results for detected OU1 sediment COPECs; toxaphene results are presented separately in Table 2-2.
Bold Text = Detected result
"J" indicates an estimated result
"U" - indicates a non-detect results; method detection limit is presented
Shading = Detected concentration exceeds ESV
Underline = One-half the MDL exceeds ESV
(2) Detected constituents are identified as COPECs if: 1) the maximum detected concentration exceeds the ESV; 2) an appropriate ESV was not identified; or 3) the constituent has the potential to bioaccumulate. Note that toxaphene results are presented separately in Table 2-2.
(3) ESVs were selected using the hierarchy described in Attachment A, Table A-1.

Definitions:
OU1 = Operable Unit 1 (Outfall Ditch)
SLERA = Screening Level Ecological Risk Assessment
COPEC = constituent of potential ecological concern
ESV = ecological screening value
mg/kg = milligram per kilogram
µg/kg = microgram per kilogram
CAS = chemical abstract number
PEST = pesticide
PAH = polynuclear aromatic hydrocarbon
SVOC = semivolatile organic compound
VOC = volatile organic compound

Table 3-1
OU1 Focused SLERA
Constituent Screening - Outfall Ditch Surface Water
Terry Creek Superfund Site - Brunswick, Georgia

Class	Detected Constituents [1]	CAS	Units	Average [2]	Minimum (Qualifier) [3]	Maximum (Qualifier) [3]	Location of Maximum [3]	Detection Frequency	MDL Range [4]	SLERA EPC [5]	SLERA ESV [6] (Source)		Maximum SLERA HQ [7]	PBC? [8]	COPEC [9]	Rationale [9]
METAL	Aluminum	7429-90-5	µg/L	554	2.9	2,000	DMEB-02	8 / 13	50 - 50	2,000	NSV		--	-	Yes	NSV
METAL	Arsenic	7440-38-2	µg/L	3.2	2.4 J	5.7	DCEB-04	13 / 13	n/a	5.7	36	(a)	0.16	Yes	Yes	PBC
METAL	Barium	7440-39-3	µg/L	39	16	88	DCEB-02	13 / 13	n/a	88	200	(d)	0.44	-	No	BSV
METAL	Cadmium	7440-43-9	µg/L	0.16	0.17 J	0.17 J	DMEB-01 F	1 / 13	0.13 - 0.65	0.17	8.8	(a)	0.019	Yes	Yes	PBC
METAL	Chromium [10]	7440-47-3	µg/L	1.7	2.6 J	3.4 J	DMEB-02	2 / 13	2.5 - 5	3.4	50.4	(a)	0.068	Yes	Yes	PBC
METAL	Cobalt	7440-48-4	µg/L	0.97	0.75	1.5	DMEB-02	11 / 13	0.5 - 0.5	1.5	1.0	(d)	1.5	-	Yes	ASV
METAL	Copper	7440-50-8	µg/L	0.81	1.2 J	1.5 J	DCEB-04	3 / 13	1.1 - 2.2	1.5	3.7	(a)	0.4	Yes	Yes	PBC
METAL	Cyanide Total	74-90-8	µg/L	5.1	6 J	13	DCFL-03	6 / 13	5 - 5	13	1	(a)	13	-	Yes	ASV
METAL	Iron	7439-89-6	µg/L	453	170	1,300	DMEB-02	7 / 13	44 - 44	1,300	50	(d)	26	-	Yes	ASV
METAL	Lead	7439-92-1	µg/L	0.63	0.78 J	2.1	DCEB-01 F	3 / 13	0.5 - 1.5	2.1	8.1	(a)	0.26	Yes	Yes	PBC
METAL	Manganese	7439-96-5	µg/L	98	9.1	210	DCEB-04	13 / 13	n/a	210	100	(d)	2.1	-	Yes	ASV
METAL	Mercury	7439-97-6	µg/L	0.051	0.12 J	0.12 J	DMEB-04	1 / 13	0.091 - 0.091	0.12	1.1	(a)	0.11	Yes	Yes	PBC
METAL	Nickel	7440-02-0	µg/L	1.3	2.5 J	2.5 J	DMFL-02	1 / 13	2 - 4	2.5	8.3	(a)	0.3	Yes	Yes	PBC
METAL	Selenium	7782-49-2	µg/L	1.1	1.1 J	1.1 J	DCFL-03	1 / 13	1.1 - 4.4	1.1	71	(a)	0.015	Yes	Yes	PBC
METAL	Vanadium	7440-62-2	µg/L	5.4	3.9 J	8.3 J	DMEB-02	11 / 13	6.4 - 13	8.3	50	(d)	0.17	-	No	BSV
METAL	Zinc	7440-66-6	µg/L	14	9.9 J	25 J	DCEB-04	9 / 13	8.4 - 34	25	86	(a)	0.29	Yes	Yes	PBC
PAH	Naphthalene	91-20-3	µg/L	0.068	0.3	0.3	DCEB-04	1 / 14	0.092 - 0.11	0.3	23.5	(b)	0.013	-	No	BSV
SVOC	Acetophenone	98-86-2	µg/L	0.25	0.11 J	0.39 J	DCEB-02	3 / 14	0.092 - 1.1	0.39	NSV		--	-	Yes	NSV
SVOC	Benzaldehyde	100-52-7	µg/L	0.11	0.19 J	0.43 J	DCEB-04	3 / 14	0.092 - 0.11	0.43	NSV		--	-	Yes	NSV
SVOC	Caprolactam	105-60-2	µg/L	1.8	0.15 J	24	DCEB-03	7 / 14	0.12 - 0.14	24	NSV		--	-	Yes	NSV
SVOC	Diethylphthalate	84-66-2	µg/L	0.064	0.11 J	0.12 J	DCEB-01 F	2 / 14	0.1 - 0.12	0.12	75.9	(b)	0.0016	-	No	BSV
VOC	Acetone	67-64-1	µg/L	3.2	6.1 J	6.1 J	DCEB-02	1 / 5	5 - 5	6.1	564,000	(e)	0.000011	-	No	BSV
VOC	Benzene	71-43-2	µg/L	0.21	0.53 J	0.53 J	DCEB-02	1 / 5	0.25 - 0.25	0.53	109	(b)	0.0049	-	No	BSV
VOC	Carbon tetrachloride	56-23-5	µg/L	2.1	0.66 J	9	DCEB-02	2 / 5	0.5 - 0.5	9	1,500	(b)	0.006	-	No	BSV
VOC	Chlorobenzene	108-90-7	µg/L	0.26	0.78 J	0.78 J	DCEB-02	1 / 5	0.25 - 0.25	0.78	105	(b)	0.0074	-	No	BSV
VOC	Chloroform	67-66-3	µg/L	0.78	0.39 J	3.3	DCEB-02	2 / 5	0.14 - 0.14	3.3	815	(b)	0.004	-	No	BSV
VOC	Ethylbenzene	100-41-4	µg/L	0.57	0.4 J	2.3	DCEB-02	2 / 5	0.11 - 0.11	2.3	4.3	(b)	0.53	-	No	BSV
VOC	Isopropylbenzene	98-82-8	µg/L	0.24	0.16 J	0.91 J	DCEB-02	2 / 5	0.1 - 0.1	0.91	NSV		--	-	Yes	NSV
VOC	Tetrachloroethene	127-18-4	µg/L	0.10	0.2 J	0.2 J	DCEB-04	1 / 5	0.15 - 0.15	0.2	45	(b)	0.0044	-	No	BSV
VOC	Toluene	108-88-3	µg/L	0.20	0.33 J	0.33 J	DCEB-02	1 / 5	0.33 - 0.33	0.33	37	(b)	0.0089	-	No	BSV
VOC	Xylene Total	1330-20-7	µg/L	3.8	0.2 J	16	DCEB-02	3 / 5	0.2 - 0.2	16	19	(e)	0.84	-	No	BSV

Notes:
(1) Both unfiltered (total) and filtered (dissolved) surface water samples were analyzed for chemical constituents. Filtered and unfiltered results were generally comparable and, therefore, combined for screening purposes. An "F" suffix in the location code indicates a filtered result (e.g., cadmium). For certain metals (As, Cd, Cr, Cu, Pb, Hg, Ni, Se, Zn), ESVs are specific to dissolved results; if the maximum detected concentration was from an unfiltered (total) sample, the ESV was divided by the appropriate conversion factor (see Attachment A).
(2) Arithmetic average calculated using one-half the method detection limit (MDL) for non-detect results.
(3) Minimum/maximum detected concentration. "J" indicates an estimated concentration.
(4) MDL range based on non-detect results.
(5) SLERA exposure point concentration (EPC) is the maximum detected concentration.
(6) Ecological screening levels (ESVs) were selected using the following hierarchy (see also Attachment A):
(a) USEPA NRWQC for the protection of aquatic life, saltwater
(b) USEPA Region IV chronic ecological effects values, saltwater
(c) USEPA EcoTox Thresholds (SQC/SQB) for marine water
(d) NOAA SQuiRTs for marine water
(d) USEPA Region III BTAG ecological screening benchmarks for marine surface water
(e) USEPA Region V ESLs for freshwater
(7) Screening level hazard quotient (HQ) calculated (to two significant figures) as follows: HQ = EPC/ESV,
(8) Bioaccumulation potential based on: USEPA. 2000. Bioaccumulation Testing and Interpretation for the Purpose of Sediment Quality Assessment, Status and Needs. Office of Water. EPA-823-R-00-001. February.
(9) Rationale for COPEC selection/exclusion:

Selection	*Exclusion*
ASV = above ecological screening value	BSV = below ecological screening value
PBC = potentially bioaccumulative constituent	
NSV = no screening value	

(10) Surrogate ESVs were utilized as follows:
Chromium (total) uses hexavalent chromium as a surrogate

Shading = Maximum HQ > 1

Definitions:
OU1 = Operable Unit 1 (Outfall Ditch)
SLERA = Screening Level Ecological Risk Assessment
CAS = chemical abstract number
µg/L = microgram per liter
PAH = polynuclear aromatic hydrocarbon
SVOC = semivolatile organic compound
VOC = volatile organic compound

Table 3-2
OU1 Focused SLERA
Analytical Data for Detected COPECs - Outfall Ditch Surface Water
Terry Creek Superfund Site - Brunswick, Georgia

Class	COPECs (2)	CAS	SLERA ESV (3)	Units	Analytical Results (1)													
					DCEB-01 F	DCEB-02	DCFL-01 F	DCFL-03	DCFL-04	DCFL-02	DCEB-03	DCEB-04	DMFL-01 F	DMFL-02	DMEB-01 F	DMEB-02	DMEB-03	DMEB-04
					4/4/2012	4/4/2012	4/4/2012	8/21/2012	8/21/2012	4/4/2012	8/21/2012	8/21/2012	4/4/2012	4/4/2012	4/4/2012	4/4/2012	8/21/2012	8/21/2012
METAL	Aluminum	7429-90-5	NSV	µg/L	**70 J**	**110**	50 U	50 U	**1,200**	**890**	-	**1,400**	50 U	**2.9**	50 U	**2,000**	50 U	**1,400**
METAL	Arsenic	7440-38-2	36	µg/L	**3.9**	**3.7**	**2.5**	**2.6**	**3.4**	**3.1 J**	-	**5.7**	**2.4 J**	**2.9 J**	**2.8**	**3.2**	**2.7**	**3.1 J**
METAL	Cadmium	7440-43-9	8.8	µg/L	0.13 U	0.13 U	0.26 U	0.26 U	0.52 U	0.26 U	-	0.26 U	0.26 U	0.26 U	**0.17 J**	0.65 U	0.26 U	0.52 U
METAL	Chromium	7440-47-3	50	µg/L	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	5 U	-	2.5 U	2.5 U	**2.6 J**	2.5 U	**3.4 J**	2.5 U	5 U
METAL	Cobalt	7440-48-4	1	µg/L	0.5 U	0.5 U	**1.4**	**0.81**	**1.1**	**1.2**	-	**1.1**	**1.2**	**1.3**	**0.86**	**1.5**	**0.75**	**0.92 J**
METAL	Copper	7440-50-8	3.1	µg/L	1.1 U	**1.2 J**	1.1 U	1.1 U	1.1 U	2.2 U	-	**1.5 J**	1.1 U	1.1 U	1.1 U	**1.2 J**	1.1 U	2.2 U
METAL	Cyanide Total	74-90-8	1	µg/L	*5 U*	*5 U*	**6 J**	**13**	**6.5 J**	*5 U*	-	*5 U*	*5 U*	*5 U*	**6.2 J**	*5 U*	**9.4 J**	**8 J**
METAL	Iron	7439-89-6	50	µg/L	44 U	**170**	44 U	44 U	**850**	**540**	-	**940**	44 U	**1,000**	44 U	**1,300**	44 U	**960**
METAL	Lead	7439-92-1	8.1	µg/L	**2.1**	**0.5 U**	0.5 U	0.5 U	**0.78 J**	0.5 U	-	**1 J**	1.5 U	1.5 U	0.5 U	1.5 U	0.5 U	1 U
METAL	Manganese	7439-96-5	100	µg/L	**35**	**37**	**99**	**91**	**120**	**140**	-	**210**	**130**	**150**	**95**	**120**	**9.1**	**34**
METAL	Mercury	7439-97-6	0.94	µg/L	0.091 U	0.091 U	0.091 U	0.091 U	0.091 U	0.091 U	-	0.091 U	0.091 U	0.091 U	0.091 U	0.091 U	0.091 U	**0.12 J**
METAL	Nickel	7440-02-0	8.2	µg/L	2 U	2 U	2 U	2 U	2 U	4 U	-	2 U	2 U	**2.5 J**	2 U	2 U	2 U	4 U
METAL	Selenium	7782-49-2	71	µg/L	1.1 U	1.1 U	2.2 U	**1.1 J**	2.2 U	2.2 U	-	2.2 U	2.2 U	2.2 U	2.2 U	1.1 U	4.4 U	4.4 U
METAL	Zinc	7440-66-6	81	µg/L	8.4 U	**9.9 J**	**14 J**	**15 J**	**17 J**	17 U	-	**25 J**	**14 J**	**19 J**	**13 J**	17 U	**15 J**	34 U
SVOC	Acetophenone	98-86-2	NSV	µg/L	0.95 U	**0.39 J**	1.1 U	0.092 U	0.096 U	0.1 U	**0.11 J**	**0.11 J**	0.093 U	1 U	1 U	1 U	0.1 U	0.11 U
SVOC	Benzaldehyde	100-52-7	NSV	µg/L	0.095 U	**0.19 J**	0.11 U	0.092 U	0.096 U	0.1 U	**0.4 J**	**0.43 J**	0.093 U	0.1 U	0.1 U	0.1 U	0.1 U	0.11 U
SVOC	Caprolactam	105-60-2	NSV	µg/L	0.12 U	0.13 U	**0.18 J**	**0.21 J**	**0.15 J**	0.13 U	**24**	0.13 U	0.12 U	0.14 U	**0.25 J**	0.14 U	**0.2 J**	**0.19 J**
VOC	Isopropylbenzene	98-82-8	NSV	µg/L	-	**0.91 J**	-	-	-	0.1 U	-	**0.16 J**	-	0.1 U	-	0.1 U	-	-

Notes:
(1) Analytical results for detected OU1 surface water COPECs.
Bold Text = Detected result
"J" indicates an estimated result
"U" - indicates a non-detect results; method detection limitis presented
Shading = Detected concentration exceeds ESV
(2) Detected constituents were identified as COPECs if: 1) the maximum detected concentration exceeds the ESV; 2) an appropriate ESV was not identified; or 3) the constituent has the potential to bioaccumulate.
(3) ESVs were selected using the hierarchy described in Attachment A, Table A-2.

Definitions:
OU1 = Operable Unit 1 (Outfall Ditch)
SLERA = Screening Level Ecological Risk Assessment
COPEC = constituent of potential ecological concern
CAS = chemical abstract number
ESV = ecological screening value
µg/L = microgram per liter
SVOC = semivolatile organic compound
VOC = volatile organic compound

Table 4-1
OU1 Focused SLERA
Detected Constituent Screening - Outfall Ditch Pore Water
Terry Creek Superfund Site - Brunswick, Georgia

Class	Detected Constituents (1)	CAS	Units	Average (2)	Minimum (Qualifier) (3)	Location of Minimum	Maximum (Qualifier) (3)	Location of Maximum (3)	Detection Frequency	MDL Range (4)	SLERA EPC (5)	SLERA ESV (6) (Source)		Maximum SLERA HQ (7)	PBC? (8)	COPEC (9)	Rationale (9)
METAL	Aluminum	7429-90-5	µg/L	500	350	PW-ODPO-02	1,600	PW-ODPR-02	2 / 4	50 - 50	1,600	NSV		--	-	Yes	NSV
METAL	Arsenic	7440-38-2	µg/L	1.8	1.3 J	PW-ODPR-01 F	2.1 J	PW-ODPR-02	4 / 4	n/a	2.1	36	(a)	0.058	Yes	Yes	PBC
METAL	Barium	7440-39-3	µg/L	130	98	PW-ODPO-01 F	180	PW-ODPR-02	4 / 4	n/a	180	200	(d)	0.90	-	No	BSV
METAL	Chromium (11)	7440-47-3	µg/L	6.2	3.2 J	PW-ODPO-02	9.4	PW-ODPR-02	4 / 4	n/a	9.4	50.4	(a)	0.19	Yes	Yes	PBC
METAL	Cobalt	7440-48-4	µg/L	1.1	0.39 J	PW-ODPO-02	2.2	PW-ODPO-01 F	4 / 4	n/a	2.2	1	(d)	2.2	-	Yes	ASV
METAL	Copper	7440-50-8	µg/L	2.1	1.1 J	PW-ODPO-01 F	4.8 J	PW-ODPR-02	3 / 4	1.1 - 1.1	4.8	3.7	(a)	1.3	Yes	Yes	ASV
METAL	Iron	7439-89-6	µg/L	466	64 J	PW-ODPR-01 F	1,300	PW-ODPR-02	4 / 4	n/a	1,300	50	(d)	26	-	Yes	ASV
METAL	Lead	7439-92-1	µg/L	1.3	4.3	PW-ODPR-02	4.3	PW-ODPR-02	1 / 4	0.5 - 0.5	4.3	8.5	(a)	0.5	Yes	Yes	PBC
METAL	Manganese	7439-96-5	µg/L	313	87	PW-ODPR-01 F	580	PW-ODPO-02	4 / 4	n/a	580	100	(d)	5.8	-	Yes	ASV
METAL	Nickel	7440-02-0	µg/L	1.9	2.4 J	PW-ODPR-02	3.1 J	PW-ODPO-01 F	2 / 4	2 - 2	3.1	8.2	(a)	0.38	Yes	Yes	PBC
METAL	Vanadium	7440-62-2	µg/L	7.1	5.3 J	PW-ODPO-02	10	PW-ODPR-02	4 / 4	n/a	10	50	(d)	0.20	-	No	BSV
METAL	Zinc	7440-66-6	µg/L	11	31	PW-ODPR-02	31	PW-ODPR-02	1 / 4	8.4 - 8.4	31	86	(a)	0.36	Yes	Yes	PBC
PEST	Toxaphene (10)	8001-35-2	µg/L	1.9	2.3 J	PW-ODPO-01 F	2.3 J	PW-ODPO-01 F	1 / 4	0.49 - 9.5	2.3	0.0002	(a)	12,000	Yes	Yes	ASV
PAH	Naphthalene	91-20-3	µg/L	0.079	0.16 J	PW-ODPR-02	0.16 J	PW-ODPR-02	1 / 4	0.1 - 0.11	0.16	23.5	(b)	0.0068	-	No	BSV
SVOC	Benzaldehyde	100-52-7	µg/L	0.52	0.46 J	PW-ODPR-02	0.57 J	PW-ODPO-02	4 / 4	n/a	0.57	NSV		--	-	Yes	NSV
SVOC	Diethylphthalate	84-66-2	µg/L	0.16	0.21 J	PW-ODPR-01 F	0.31 J	PW-ODPR-02	2 / 4	0.11 - 0.12	0.31	75.9	(b)	0.0041	-	No	BSV
SVOC	Phenol	108-95-2	µg/L	0.21	0.15 J	PW-ODPR-02	0.36 J	PW-ODPO-02	3 / 4	0.13 - 0.13	0.36	58	(b)	0.0062	-	No	BSV
VOC	Acetone	67-64-1	µg/L	4.4	10 J	PW-ODPO-01 F	10 J	PW-ODPO-01 F	1 / 4	5 - 5	10	564,000	(e)	0.000018	-	No	BSV
VOC	Methyl tert-Butyl Ether	1634-04-4	µg/L	0.85	1.5 J	PW-ODPR-01 F	1.7 J	PW-ODPR-02	2 / 4	0.2 - 0.2	1.7	5,000	(d)	0.00034	-	No	BSV
VOC	Toluene	108-88-3	µg/L	0.37	0.33 J	PW-ODPO-01 F	0.63 J	PW-ODPR-02	3 / 4	0.33 - 0.33	0.63	37	(b)	0.017	-	No	BSV

Notes:
(1) Both unfiltered (total) and filtered (dissolved) surface water samples were analyzedfor chemical constituents (with the exception of VOCs which were only analyzed for in unfiltered samples). Filtered and unfiltered results were generally comparable and, therefore, combined for screening purposes. An "F" suffix in the location code indicates a filtered sampled (e.g., cadmium). For certain metals (As, Cd, Cr, Cu, Pb, Hg, Ni, Se, Zn), ESVs are specific to dissolved results; if the maximum detected concentration was from an unfiltered (total) sample, the ESV was divided by the appropriate conversion factor (see Attachment A).
(2) Arithmetic average calculated using one-half the method detection limit (MDL) for non-detect results.
(3) Minimum/maximum detected concentration. "J" indicates an estimated concentration.
(4) MDL range based on non-detect sample results.
(5) SLERA exposure point concentration (EPC) is the maximum detected concentration.
(6) Ecological screening values (ESVs) were selected using the following hierarchy (see also Attachment A):
(a) USEPA NRWQC for the protection of aquatic life, saltwater
(b) USEPA Region IV chronic ecological effects values, saltwater
(c) USEPA EcoTox Thresholds (SQC/SQB) for marine water
(d) NOAA SQuiRTs for marine water
(d) USEPA Region III BTAG ecological screening benchmarks for marine surface water
(e) USEPA Region V ESLs for freshwater
(7) Screening level hazard quotient (HQ) calculated (to two significant figures) as follows: HQ = EPC/ESV.
(8) Bioaccumulation potential based on: USEPA. 2000. Bioaccumulation Testing and Interpretation for the Purpose of Sediment Quality Assessment, Status and Needs. Office of Water. EPA-823-R-00-001. February.
(9) Rationale for COPEC selection/exclusion:

Selection	*Exclusion*
ASV = above ecological screening value	BSV = below ecological screening value
PBC = potentially bioaccumulative constituent	
NSV = no screening value	

(10) Per the Work Plan, the SLERA utilizes only toxaphene samples analyzed using Method 1. Uncertainty associated with the results is discussed in the SLERA uncertainty section.
(11) Surrogate ESVs were utilized as follows:
total chromium uses hexavalent chromium as a surrogate

Shading = Maximum HQ > 1

Definitions:
OU1 = Operable Unit 1 (Outfall Ditch)
SLERA = Screening Level Ecological Risk Assessment
CAS = chemical abstract number
µg/L = microgram per liter
PAH = polynuclear aromatic hydrocarbon
PEST = pesticide
SVOC = semivolatile organic compound
VOC = volatile organic compound

Table 4-2
OU1 Focused SLERA
Analytical Data for Detected COPECs - Outfall Ditch Pore Water
Terry Creek Superfund Site - Brunswick, Georgia

Class	COPECs (1)	CAS	SLERA ESV (2)	Units	PW-ODPR-01 (Filtered) 2/29/2012	PW-ODPR-02 (Total) 2/29/2012	PW-ODPO-01 (Filtered) 2/28/2012	PW-ODPO-02 (Total) 2/28/2012
METAL	Aluminum	7429-90-5	NSV	µg/L	50 U	**1,600**	50 U	**350**
METAL	Arsenic	7440-38-2	36	µg/L	**1.3 J**	**2.1 J**	**1.6 J**	**2 J**
METAL	Chromium	7440-47-3	50	µg/L	**4.5 J**	**9.4**	**7.7**	**3.2 J**
METAL	Cobalt	7440-48-4	1	µg/L	**0.92**	**0.92**	**2.2**	**0.39 J**
METAL	Copper	7440-50-8	3.1	µg/L	1.1 U	**4.8 J**	**1.1 J**	**1.9 J**
METAL	Iron	7439-89-6	50	µg/L	**64 J**	**1,300**	**91 J**	**410**
METAL	Lead	7439-92-1	8.1	µg/L	0.5 U	**4.3**	0.5 U	0.5 U
METAL	Manganese	7439-96-5	100	µg/L	**87**	**96**	**490**	**580**
METAL	Nickel	7440-02-0	8.2	µg/L	2 U	**2.4 J**	**3.1 J**	2 U
METAL	Zinc	7440-66-6	81	µg/L	8.4 U	**31**	8.4 U	8.4 U
PEST	Toxaphene	8001-35-2	0.0002	µg/L	0.49 U	0.49 U	**2.3 J**	9.5 U
SVOC	Benzaldehyde	100-52-7	NSV	µg/L	**0.54 J**	**0.46 J**	**0.52 J**	**0.57 J**

Notes:
(1) Analytical results for detected OU1 pore water COPECs.
Bold Text = Detected result
"J" indicates an estimated result
"U" - indicates a non-detect results; method detection limitis presented
Shading = Detected concentration exceeds ESV
(2) Detected constituents were identified as COPECs if: 1) the maximum detected concentration exceeds the ESV; 2) an appropriate ESV was not identified; or 3) the constituent has the potential to bioaccumulate.
(3) ESVs were selected using the hierarchy described in Attachment A, Table A-2.

Definitions:
OU1 = Operable Unit 1 (Outfall Ditch)
SLERA = Screening Level Ecological Risk Assessment
COPEC = constituent of potential ecological concern
CAS = chemical abstract number
ESV = ecological screening value
µg/L = microgram per liter
SVOC = semivolatile organic compound
PEST = pesticide

Table 5
OU1 Focused SLERA
Summary of Outfall Ditch Screening Level Hazard Quotients
Terry Creek Superfund Site - Brunswick, Georgia

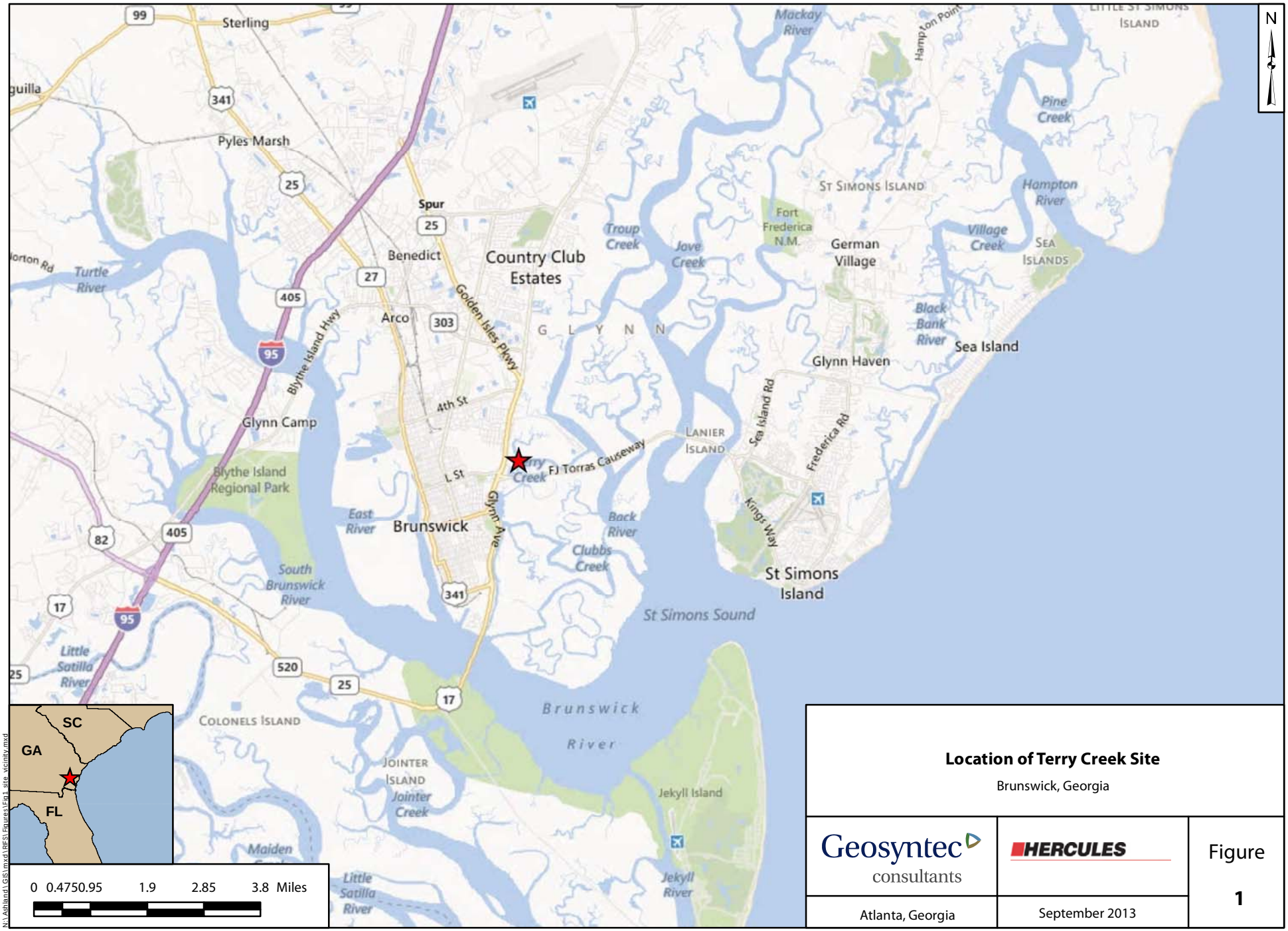
Class	Detected Constituents	CAS	Sediment HQ	Surface Water HQ	Pore Water HQ	Potentially Bioaccumulative
METAL	Aluminum	7429-90-5	2.0	--	--	-
METAL	Arsenic	7440-38-2	2.3	0.16	0.058	Yes
METAL	Barium	7440-39-3	1.2	0.44	0.9	-
METAL	Beryllium	7440-41-7	--	n/a	n/a	-
METAL	Cadmium	7440-43-9	1.9	0.019	n/a	Yes
METAL	Chromium	7440-47-3	1.6	0.068	0.19	Yes
METAL	Cobalt	7440-48-4	0.14	1.5	2.2	-
METAL	Copper	7440-50-8	8.6	0.4	1.3	Yes
METAL	Cyanide Total	74-90-8	ND	13	n/a	-
METAL	Iron	7439-89-6	0.14	26	26	-
METAL	Lead	7439-92-1	3.1	0.26	0.5	Yes
METAL	Manganese	7439-96-5	1.8	2.1	5.8	-
METAL	Mercury	7439-97-6	48	0.11	n/a	Yes
METAL	Nickel	7440-02-0	1.6	0.3	0.38	Yes
METAL	Selenium	7782-49-2	ND	0.015	n/a	Yes
METAL	Vanadium	7440-62-2	1.3	0.17	0.2	-
METAL	Zinc	7440-66-6	4.7	0.29	0.36	Yes
PEST	DDD	72-54-8	2.7	n/a	n/a	Yes
PEST	DDE	72-55-9	230	n/a	n/a	Yes
PEST	gamma-BHC (Lindane)	58-89-9	23	n/a	n/a	Yes
PEST	Toxaphene	8001-35-2	2,500	n/a	12,000	Yes
PAH	Naphthalene	91-20-3	n/a	0.013	0.0068	-
PAH	Total PAHs	PAH SUM	2.1	n/a	n/a	Yes
SVOC	Acetophenone	98-86-2	--	--	n/a	-
SVOC	Benzaldehyde	100-52-7	--	--	--	-
SVOC	Caprolactam	105-60-2	ND	--	n/a	-
SVOC	Diethylphthalate	84-66-2	ND	0.0016	0.0041	-
SVOC	2-Methylphenol	95-48-7	6.1	n/a	n/a	-
SVOC	3 & 4 Methylphenol	TTNUS042	140	n/a	n/a	-
SVOC	Phenol	108-95-2	120	n/a	0.0062	-
VOC	Acetone	67-64-1	77	0.000011	0.000018	-
VOC	Benzene	71-43-2	ND	0.0049	n/a	-
VOC	Carbon disulfide	75-15-0	1.3	n/a	n/a	-
VOC	Carbon tetrachloride	56-23-5	ND	0.006	n/a	-
VOC	Chlorobenzene	108-90-7	ND	0.0074	n/a	-
VOC	Chloroform	67-66-3	ND	0.004	n/a	-
VOC	Ethylbenzene	100-41-4	ND	0.53	n/a	-
VOC	Isopropylbenzene	98-82-8	--	--	n/a	-
VOC	Methyl Ethyl Ketone	78-93-3	2.6	n/a	n/a	-
VOC	Methyl tert-Butyl Ether	1634-04-4	ND	n/a	0.00034	-
VOC	Tetrachloroethene	127-18-4	ND	0.0044	n/a	-
VOC	Toluene	108-88-3	ND	0.0089	0.017	-
VOC	Xylene Total	1330-20-7	ND	0.84	n/a	-

Definitions:
OU1 - Operable Unit 1 (Outfall Ditch)
SLERA - Screening Level Ecological Risk Assessment
HQ - Hazard Quotient (unitless)
ND - constituent was not detected in a given media
"--" - ecological screening value not available
n/a - constituent not a COPEC

PEST - pesticide
PAH - polycyclic aromatic hydrocarbon
SVOC - semivolatile organic compound
VOC - volatile organic compound

Yellow: 1<HQ≤10
Orange: HQ>10

FIGURES



Location of Terry Creek Site

Brunswick, Georgia

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Figure 1

Atlanta, Georgia

September 2013

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Terry Creek Site Operable Units

Brunswick, Georgia

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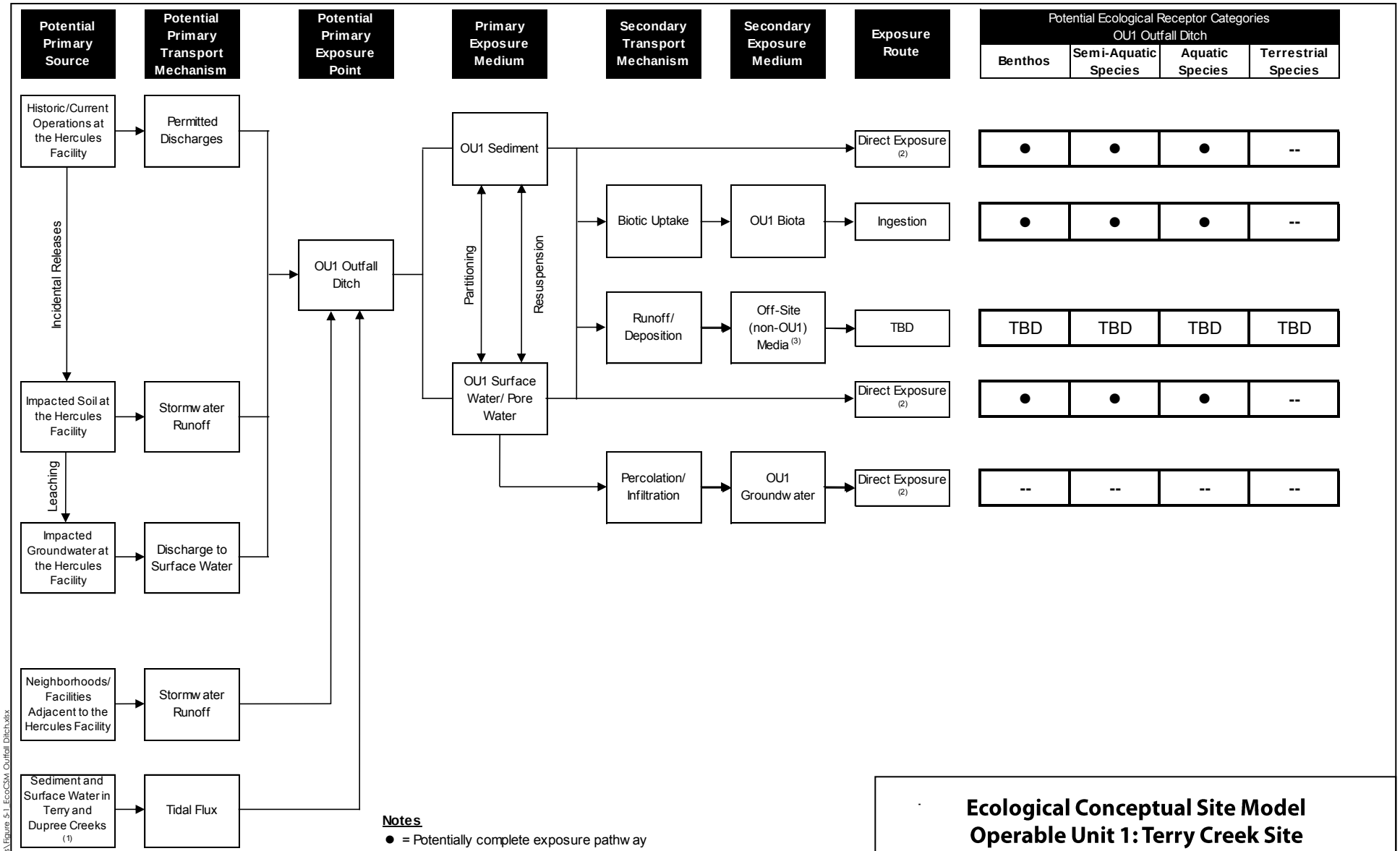

Notes

● = Potentially complete exposure pathway

-- = Incomplete or insignificant exposure pathway

TBD = To be determined

(1) Several industrial facilities are present along Terry and Dupree Creeks which may potentially release contaminants.

(2) Direct exposure pathways include ingestion of, dermal contact with, and respiration of COPCs in affected media; however, it should be noted that not all direct exposure pathways will be quantitatively evaluated in the ecological risk

(3) Off-site (i.e., non-OU1) media will be evaluated separately (e.g., sediment and surface water of Terry and Dupree Creeks as part of OU2 and OU3 RI/FS).

Ecological Conceptual Site Model
Operable Unit 1: Terry Creek Site

Brunswick, Georgia

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Figure 3

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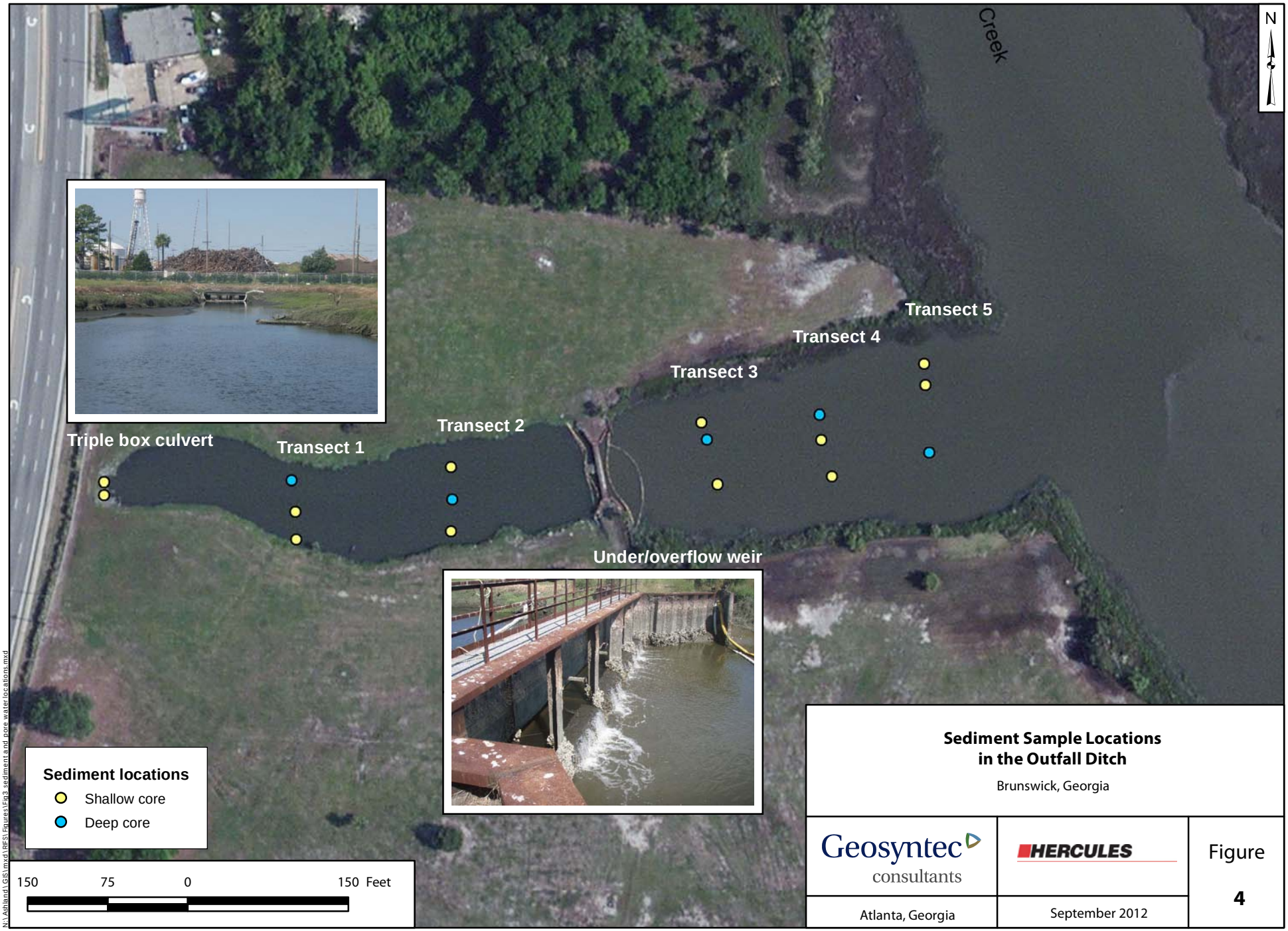

Sediment Sample Locations in the Outfall Ditch

Brunswick, Georgia

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Figure 4

Atlanta, Georgia

September 2012

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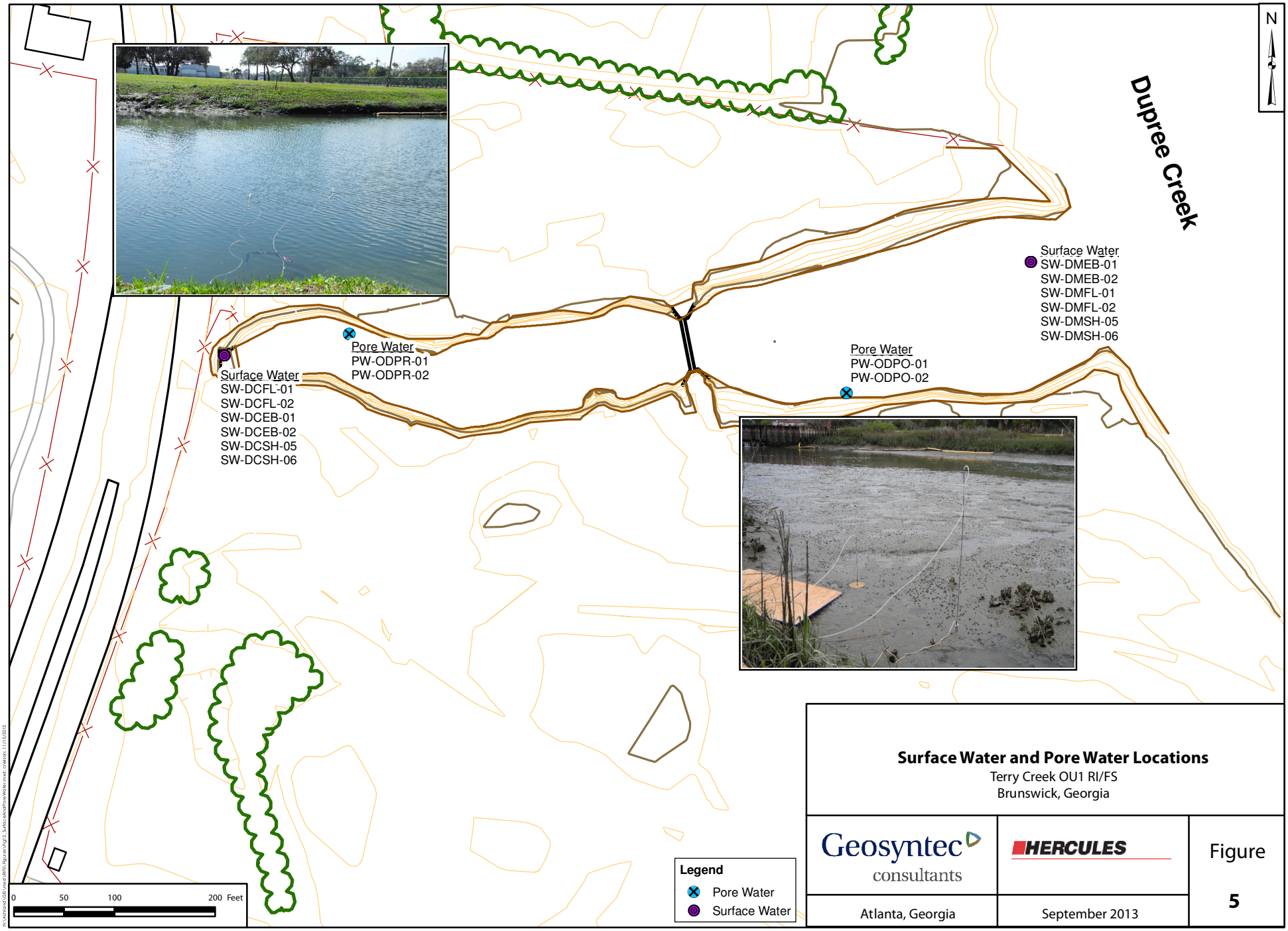

Surface Water and Pore Water Locations
Terry Creek OU1 RI/FS
Brunswick, Georgia

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Atlanta, Georgia | September 2013

ATTACHMENT A

ATTACHMENT A
Table A-1
Focused OU1 SLERA
Selection of Ecological Screening Values - Sediment
Terry Creek Site - Brunswick, Georgia

CLASS	CAS	CONSTITUENT	UNITS	Selected Sediment ESV (Source) [1]	Region IV [a]	OSWER EcoTox SQC/SQB [b]	NOAA T_{20} [c]	NOAA TEL [c]	NOAA ERL [c]	NOAA T_{50} [c]	NOAA PEL [c]	NOAA ERM [c]	Region III [d]	Region V [e]	Other [f]	Potentially Bioaccumulates [2]
METAL	7429-90-5	ALUMINUM	mg/kg	18000 (f)	--	--	--	--	--	--	--	--	--	--	18,000 AET	-
METAL	7440-36-0	ANTIMONY	mg/kg	2 (a)	2	--	0.63	--	--	2.4	--	--	--	--	--	-
METAL	7440-38-2	ARSENIC	mg/kg	7.24 (a)	7.24	--	7.4	7.24	8.2	20	41.6	70	7.24	9.79	--	Yes
METAL	7440-39-3	BARIUM	mg/kg	130.1 (c)	--	--	--	130.1	--	--	--	--	--	--	--	-
METAL	7440-41-7	BERYLLIUM	mg/kg	NSV --	--	--	--	--	--	--	--	--	--	--	--	-
METAL	7440-43-9	CADMIUM	mg/kg	0.676 (a)	0.676	--	0.38	0.68	1.2	1.4	4.21	9.6	0.68	0.99	--	Yes
METAL	7440-47-3	CHROMIUM	mg/kg	52.3 (a)	52.3	--	49	52.3	81	141	160	370	52.3	43.4	--	Yes
METAL	7440-48-4	COBALT	mg/kg	50 (e)	--	--	--	--	--	--	--	--	--	50	--	-
METAL	7440-50-8	COPPER	mg/kg	18.7 (a)	19	--	32	18.7	34	94	108	270	18.7	31.6	--	Yes
METAL	74-90-8	CYANIDE, TOTAL	mg/kg	0.1 (e)	--	--	--	--	--	--	--	--	--	0.1	--	-
METAL	7439-89-6	IRON	mg/kg	220000 (f)	--	--	--	--	--	--	--	--	--	--	220,000 AET	-
METAL	7439-92-1	LEAD	mg/kg	30.2 (a)	30.2	--	30.0	30.2	46.7	94	112	218	30.2	35.8	--	Yes
METAL	7439-96-5	MANGANESE	mg/kg	260 (f)	--	--	--	--	--	--	--	--	--	--	260 AET	-
METAL	7439-97-6	MERCURY	mg/kg	0.13 (a)	0.13	--	0.14	0.13	0.15	0.48	0.7	0.71	--	0.174	--	Yes
METAL	7440-02-0	NICKEL	mg/kg	15.9 (a)	15.9	--	15	15.9	20.9	47	42.8	51.6	15.9	22.7	--	Yes
METAL	7782-49-2	SELENIUM	mg/kg	1 (f)	--	--	--	--	--	--	--	--	--	--	1 AET	Yes
METAL	7440-22-4	SILVER	mg/kg	0.733 (a)	0.733	--	0.23	0.73	1	1.1	1.77	3.7	0.73	0.5	--	Yes
METAL	7440-28-0	THALLIUM	mg/kg	NSV --	--	--	--	--	--	--	--	--	--	--	--	-
METAL	7440-62-2	VANADIUM	mg/kg	57 (f)	--	--	--	--	--	--	--	--	--	--	57 AET	-
METAL	7440-66-6	ZINC	mg/kg	124 (a)	124	--	94	124	150	245	271	410	124	121	--	Yes
PEST	72-54-8	4,4'-DDD	µg/kg	1.22 (a)	1.22	--	--	1.22	2	--	7.81	20	1.22	4.88	--	Yes
PEST	72-55-9	4,4'-DDE	µg/kg	2.07 (a)	2.07	--	--	2.07	2.2	--	374	27	2.07	3.16	--	Yes
PEST	50-29-3	4,4'-DDT	µg/kg	1.19 (a)	1.19	--	--	1.19	1	--	4.77	7	1.19	4.16	--	Yes
PEST	309-00-2	ALDRIN	µg/kg	2 (e)	--	--	--	--	--	--	--	--	--	2	--	Yes
PEST	319-84-6	ALPHA-BHC	µg/kg	1360 (d)	--	--	--	--	--	--	--	--	1360	6	--	Yes
PEST	319-85-7	BETA-BHC	µg/kg	5 (e)	--	--	--	--	--	--	--	--	--	5	--	Yes
PEST	319-86-8	DELTA-BHC	µg/kg	71500 (e)	--	--	--	--	--	--	--	--	--	71500	--	Yes
PEST	58-89-9	GAMMA-BHC (LINDANE)	µg/kg	0.32 (a)	0.32	3.7 EqP	--	0.32	--	--	0.99	--	0.32	2.37	--	Yes
PEST	5103-71-9	ALPHA-CHLORDANE [3]	µg/kg	0.5 (a)	0.5 (s)	--	--	2.26 (s)	0.5 (s)	--	4.79 (s)	6 (s)	2.26 (s)	3.24 (s)	--	Yes
PEST	5103-74-2	GAMMA-CHLORDANE [3]	µg/kg	0.5 (a)	0.5 (s)	--	--	2.26 (s)	0.5 (s)	--	4.79 (s)	6 (s)	2.26 (s)	3.24 (s)	--	Yes
PEST	60-57-1	DIELDRIN	µg/kg	0.02 (a)	0.02	95	0.83	0.72	0.02	2.9	4.3	8	0.72	1.9	--	Yes
PEST	959-98-8	ENDOSULFAN I	µg/kg	2.9 (b)	--	2.9 EqP	--	--	--	--	--	--	0.107	3.26	--	Yes
PEST	33213-65-9	ENDOSULFAN II	µg/kg	14 (b)	--	14 EqP	--	--	--	--	--	--	0.107	1.94	--	Yes
PEST	1031-07-8	ENDOSULFAN SULFATE [3]	µg/kg	2.9 (b)	--	2.9 (s)	--	--	--	--	--	--	0.357	34.6	--	Yes
PEST	72-20-8	ENDRIN	µg/kg	0.02 (a)	0.02	3.5	--	--	--	--	--	--	2.67	2.22	--	Yes
PEST	7421-93-4	ENDRIN ALDEHYDE [3]	µg/kg	0.02 (a)	0.02 (s)	3.5 (s)	--	--	--	--	--	--	2.67 (s)	480	--	Yes
PEST	53494-70-5	ENDRIN KETONE [3]	µg/kg	0.02 (a)	0.02 (s)	3.5 (s)	--	--	--	--	--	--	2.67 (s)	2.22 (s)	--	Yes
PEST	76-44-8	HEPTACHLOR [3]	µg/kg	0.6 (c)	--	--	0.6 (s)	--	--	--	2.74 (s)	--	--	0.6	--	Yes
PEST	1024-57-3	HEPTACHLOR EPOXIDE	µg/kg	0.6 (c)	--	--	0.6	--	--	--	2.74	--	0.6	2.47	--	Yes
PEST	72-43-5	METHOXYCHLOR	µg/kg	19 (b)	--	19 EqP	--	--	--	--	--	--	29.6	13.6	--	Yes
PEST	8001-35-2	TOXAPHENE	µg/kg	28 (b)	--	28 EqP	--	0.1	--	--	--	--	536	0.077	--	Yes
PAH	83-32-9	ACENAPHTHENE	µg/kg	6.71 (a)	6.71	1100	19	6.71	16	116	88.9	500	6.71	6.71	--	Yes
PAH	208-96-8	ACENAPHTHYLENE	µg/kg	5.87 (a)	5.87	--	14	5.87	44	140	128	640	5.87	5.87	--	Yes
PAH	120-12-7	ANTHRACENE	µg/kg	46.9 (a)	46.9	--	34	46.9	85.3	290	245	1100	46.9	57.2	--	Yes
PAH	56-55-3	BENZO(A)ANTHRACENE	µg/kg	74.8 (a)	74.8	--	61	74.8	261	466	693	1600	74.8	108	--	Yes
PAH	50-32-8	BENZO(A)PYRENE	µg/kg	88.8 (a)	88.8	--	69	88.8	430	520	763	1600	88.8	150	--	Yes
PAH	205-99-2	BENZO(B)FLUORANTHENE	µg/kg	130 (c)	--	--	130	--	--	1107	--	--	--	10400	--	Yes
PAH	191-24-2	BENZO(G,H,I)PERYLENE	µg/kg	67 (c)	--	--	67	--	--	497	--	--	--	170	--	Yes
PAH	207-08-9	BENZO(K)FLUORANTHENE	µg/kg	70 (c)	--	--	70	--	--	537	--	--	--	240	--	Yes

ATTACHMENT A
Table A-1
Focused OU1 SLERA
Selection of Ecological Screening Values - Sediment
Terry Creek Site - Brunswick, Georgia

CLASS	CAS	CONSTITUENT	UNITS	Selected Sediment ESV (Source) [1]	Region IV [a]	OSWER EcoTox SQC/SQB [b]	NOAA T_{20} [c]	NOAA TEL [c]	NOAA ERL [c]	NOAA T_{50} [c]	NOAA PEL [c]	NOAA ERM [c]	Region III [d]	Region V [e]	Other [f]	Potentially Bioaccumulates [2]
PAH	218-01-9	CHRYSENE	µg/kg	108 (a)	108	--	82	108	384	650	846	2800	108	166	--	Yes
PAH	53-70-3	DIBENZO(A,H)ANTHRACENE	µg/kg	6.22 (a)	6.22	--	19	6.22	63.4	113	135	260	6.22	33	--	Yes
PAH	206-44-0	FLUORANTHENE	µg/kg	113 (a)	113	1400	119	113	600	1034	1494	5100	113	423	--	Yes
PAH	86-73-7	FLUORENE	µg/kg	21.2 (a)	21.2	540 EqP	19	21.2	19	114	144	540	21.2	77.4	--	Yes
PAH	193-39-5	INDENO(1,2,3-CD)PYRENE	µg/kg	68 (c)	--	--	68	--	--	488	--	--	--	200	--	Yes
PAH	91-57-6	2-METHYLNAPHTHALENE	µg/kg	20.2 (a)	20.2	--	21	20.2	70	128	201	670	20.2	20.2	--	-
PAH	91-20-3	NAPHTHALENE	µg/kg	34.6 (a)	34.6	480 EqP	30	34.6	160	217	391	2100	34.6	176	--	-
PAH	85-01-8	PHENANTHRENE	µg/kg	86.7 (a)	86.7	1100	68	86.7	240	455	544	1500	86.7	204	--	Yes
PAH	129-00-0	PYRENE	µg/kg	153 (a)	153	--	125	153	665	932	1398	2600	153	195	--	Yes
PAH	HPAH SUM	TOTAL HMW PAHS	µg/kg	655 (a)	655	--	--	655	1700	--	6676	9600	655	--	--	Yes
PAH	LPAH SUM	TOTAL LMW PAHS	µg/kg	312 (a)	312	--	--	312	552	--	1442	3160	312	--	--	Yes
PAH	PAH SUM	TOTAL PAHS	µg/kg	1684 (a)	1684	--	--	1684	4022	--	16770	44792	2900	--	--	Yes
PCB	12674-11-2	AROCLOR-1016 [3]	µg/kg	21.6 (a)	21.6 (s)	--	35 (s)	21.6 (s)	22.7 (s)	368 (s)	189 (s)	180 (s)	40 (s)	59.8 (s)	--	Yes
PCB	11104-28-2	AROCLOR-1221 [3]	µg/kg	21.6 (a)	21.6 (s)	--	35 (s)	21.6 (s)	22.7 (s)	368 (s)	189 (s)	180 (s)	40 (s)	59.8 (s)	--	Yes
PCB	11141-16-5	AROCLOR-1232 [3]	µg/kg	21.6 (a)	21.6 (s)	--	35 (s)	21.6 (s)	22.7 (s)	368 (s)	189 (s)	180 (s)	40 (s)	59.8 (s)	--	Yes
PCB	53469-21-9	AROCLOR-1242 [3]	µg/kg	21.6 (a)	21.6 (s)	--	35 (s)	21.6 (s)	22.7 (s)	368 (s)	189 (s)	180 (s)	40 (s)	59.8 (s)	--	Yes
PCB	12672-29-6	AROCLOR-1248 [3]	µg/kg	21.6 (a)	21.6 (s)	--	35 (s)	21.6 (s)	22.7 (s)	368 (s)	189 (s)	180 (s)	40 (s)	59.8 (s)	--	Yes
PCB	11097-69-1	AROCLOR-1254 [3]	µg/kg	21.6 (a)	21.6 (s)	--	--	63.3	--	--	709	--	63.3	59.8 (s)	--	Yes
PCB	11096-82-5	AROCLOR-1260 [3]	µg/kg	21.6 (a)	21.6 (s)	--	35 (s)	21.6 (s)	22.7 (s)	368 (s)	189 (s)	180 (s)	40 (s)	59.8 (s)	--	Yes
PCB	11100-14-4	AROCLOR-1268 [3]	µg/kg	21.6 (a)	21.6 (s)	--	35 (s)	21.6 (s)	22.7 (s)	368 (s)	189 (s)	180 (s)	-- (s)	59.8 (s)	--	Yes
PCB	1336-36-3	TOTAL PCBS	µg/kg	21.6 (a)	21.6	--	35	21.6	22.7	368	189	180	40	59.8 (s)	--	Yes
SVOC	98-86-2	ACETOPHENONE	µg/kg	NSV --	--	--	--	--	--	--	--	--	--	--	--	-
SVOC	1912-24-9	ATRAZINE	µg/kg	NSV --	--	--	--	--	--	--	--	--	--	--	--	-
SVOC	100-52-7	BENZALDEHYDE	µg/kg	NSV --	--	--	--	--	--	--	--	--	--	--	--	-
SVOC	92-52-4	1,1-BIPHENYL	µg/kg	1100 (b)	--	1100 EqP	17	--	--	73	--	--	--	--	--	-
SVOC	111-91-1	BIS(2-CHLOROETHOXY)METHANE	µg/kg	NSV --	--	--	--	--	--	--	--	--	--	--	--	-
SVOC	111-44-4	BIS(2-CHLOROETHYL)ETHER	µg/kg	3520 (e)	--	--	--	--	--	--	--	--	--	3520	--	-
SVOC	39638-32-9	BIS(2-CHLOROISOPROPYL)ETHER	µg/kg	NSV --	--	--	--	--	--	--	--	--	--	--	--	-
SVOC	117-81-7	BIS(2-ETHYLHEXYL)PHTHALATE	µg/kg	182 (a)	182	--	--	182	--	--	2647	--	182	182	--	-
SVOC	101-55-3	4-BROMOPHENYL PHENYL ETHER	µg/kg	1300 (b)	--	1300 EqP	--	--	--	--	--	--	--	1550	--	Yes
SVOC	85-68-7	BUTYL BENZYL PHTHALATE	µg/kg	11000 (b)	--	11000 EqP	--	--	--	--	--	--	16800	1970	--	-
SVOC	105-60-2	CAPROLACTAM	µg/kg	NSV --	--	--	--	--	--	--	--	--	--	--	--	-
SVOC	86-74-8	CARBAZOLE	µg/kg	NSV --	--	--	--	--	--	--	--	--	--	--	--	-
SVOC	106-47-8	4-CHLOROANILINE	µg/kg	146.08 (e)	--	--	--	--	--	--	--	--	--	146.08	--	-
SVOC	91-58-7	2-CHLORONAPHTHALENE	µg/kg	417.23 (e)	--	--	--	--	--	--	--	--	--	417.23	--	-
SVOC	59-50-7	4-CHLORO-3-METHYLPHENOL	µg/kg	388.18 (e)	--	--	--	--	--	--	--	--	--	388.18	--	-
SVOC	95-57-8	2-CHLOROPHENOL	µg/kg	344 (d)	--	--	--	--	--	--	--	--	344	31.9	--	-
SVOC	7005-72-3	4-CHLOROPHENYL PHENYL ETHER [3]	µg/kg	1300 (b)	--	1300 (s)	--	--	--	--	--	--	--	--	--	Yes
SVOC	132-64-9	DIBENZOFURAN	µg/kg	2000 (b)	--	2000 EqP	--	--	--	--	--	--	7300	449	--	-
SVOC	95-50-1	1,2-DICHLOROBENZENE	µg/kg	340 (b)	--	340 EqP	--	--	--	--	--	--	989	294	--	Yes
SVOC	541-73-1	1,3-DICHLOROBENZENE	µg/kg	1700 (b)	--	1700 EqP	--	--	--	--	--	--	842	1315	--	Yes
SVOC	106-46-7	1,4-DICHLOROBENZENE	µg/kg	350 (b)	--	350 EqP	--	--	--	--	--	--	460	318	--	Yes
SVOC	91-94-1	3,3'-DICHLOROBENZIDINE	µg/kg	2060 (d)	--	--	--	--	--	--	--	--	2060	127	--	-
SVOC	120-83-2	2,4-DICHLOROPHENOL	µg/kg	81.7 (e)	--	--	--	--	--	--	--	--	--	81.7	--	-
SVOC	84-66-2	DIETHYL PHTHALATE	µg/kg	630 (b)	--	630 EqP	--	--	--	--	--	--	218	295	--	-
SVOC	131-11-3	DIMETHYL PHTHALATE [3]	µg/kg	630 (b)	--	630 (s)	--	--	--	--	--	--	--	--		-
SVOC	105-67-9	2,4-DIMETHYLPHENOL	µg/kg	304 (e)	--	--	--	--	--	--	--	--	--	304	--	-
SVOC	84-74-2	DI-N-BUTYL PHTHALATE	µg/kg	11000 (b)	--	11000 EqP	--	--	--	--	--	--	1160	1114	--	-
SVOC	117-84-0	DI-N-OCTYL PHTHALATE	µg/kg	40600 (e)	--	--	--	--	--	--	--	--	--	40600	--	-

ATTACHMENT A
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Focused OU1 SLERA
Selection of Ecological Screening Values - Sediment
Terry Creek Site - Brunswick, Georgia

CLASS	CAS	CONSTITUENT	UNITS	Selected Sediment ESV (Source) [1]	Region IV [a]	OSWER EcoTox SQC/SQB [b]	NOAA T_{20} [c]	NOAA TEL [c]	NOAA ERL [c]	NOAA T_{50} [c]	NOAA PEL [c]	NOAA ERM [c]	Region III [d]	Region V [e]	Other [f]	Potentially Bioaccumulates [2]
SVOC	534-52-1	4,6-DINITRO-2-METHYLPHENOL	µg/kg	104 (e)	--	--	--	--	--	--	--	--	--	104	--	-
SVOC	51-28-5	2,4-DINITROPHENOL	µg/kg	6.21 (e)	--	--	--	--	--	--	--	--	--	6.21	--	-
SVOC	121-14-2	2,4-DINITROTOLUENE	µg/kg	14.4 (e)	--	--	--	--	--	--	--	--	--	14.4	--	-
SVOC	606-20-2	2,6-DINITROTOLUENE	µg/kg	39.8 (e)	--	--	--	--	--	--	--	--	--	39.8	--	-
SVOC	118-74-1	HEXACHLOROBENZENE	µg/kg	20 (e)	--	--	--	--	--	--	--	--	--	20	--	Yes
SVOC	87-68-3	HEXACHLOROBUTADIENE	µg/kg	26.5 (e)	--	--	--	--	--	--	--	--	--	26.5	--	Yes
SVOC	77-47-4	HEXACHLOROCYCLOPENTADIENE	µg/kg	139 (d)	--	--	--	--	--	--	--	--	139	901	--	Yes
SVOC	67-72-1	HEXACHLOROETHANE	µg/kg	1000 (b)	--	1000 EqP	--	--	--	--	--	--	804	584	--	Yes
SVOC	78-59-1	ISOPHORONE	µg/kg	432 (e)	--	--	--	--	--	--	--	--	--	432	--	-
SVOC	95-48-7	2-METHYLPHENOL	µg/kg	55.4 (e)	--	--	--	--	--	--	--	--	--	55.4	--	-
SVOC	TTNUS042	3 & 4 METHYLPHENOL [3]	µg/kg	20.2 (e)	--	--	--	--	--	--	--	--	--	20.2 (s)	--	-
SVOC	88-74-4	2-NITROANILINE	µg/kg	NSV --	--	--	--	--	--	--	--	--	--	--	--	-
SVOC	99-09-2	3-NITROANILINE	µg/kg	NSV --	--	--	--	--	--	--	--	--	--	--	--	-
SVOC	100-01-6	4-NITROANILINE	µg/kg	NSV --	--	--	--	--	--	--	--	--	--	--	--	-
SVOC	98-95-3	NITROBENZENE	µg/kg	145 (e)	--	--	--	--	--	--	--	--	--	145	--	-
SVOC	88-75-5	2-NITROPHENOL [3]	µg/kg	13.3 (e)	--	--	--	--	--	--	--	--	--	13.3 (s)	--	-
SVOC	100-02-7	4-NITROPHENOL	µg/kg	13.3 (e)	--	--	--	--	--	--	--	--	--	13.3	--	-
SVOC	621-64-7	N-NITROSO-DI-N-PROPYLAMINE	µg/kg	NSV --	--	--	--	--	--	--	--	--	--	--	--	-
SVOC	86-30-6	N-NITROSODIPHENYLAMINE	µg/kg	422000 (d)	--	--	--	--	--	--	--	--	422000	--	--	-
SVOC	87-86-5	PENTACHLOROPHENOL	µg/kg	7970 (d)	--	--	--	--	--	--	--	--	7970	23000	--	Yes
SVOC	108-95-2	PHENOL	µg/kg	49.1 (e)	--	--	--	--	--	--	--	--	--	49.1	--	-
SVOC	120-82-1	1,2,4-TRICHLOROBENZENE	µg/kg	9200 (b)	--	9200 EqP	--	--	--	--	--	--	473	5062	--	Yes
SVOC	95-95-4	2,4,5-TRICHLOROPHENOL	µg/kg	819 (d)	--	--	--	--	--	--	--	--	819	--	--	-
SVOC	88-06-2	2,4,6-TRICHLOROPHENOL	µg/kg	2650 (d)	--	--	--	--	--	--	--	--	2650	208	--	-
VOC	67-64-1	ACETONE	µg/kg	9.9 (e)	--	--	--	--	--	--	--	--	--	9.9	--	-
VOC	71-43-2	BENZENE	µg/kg	57 (b)	--	57 EqP	--	--	--	--	--	--	137	142	--	-
VOC	75-27-4	BROMODICHLOROMETHANE	µg/kg	NSV --	--	--	--	--	--	--	--	--	--	--	--	-
VOC	75-25-2	BROMOFORM	µg/kg	650 (b)	--	650 EqP	--	--	--	--	--	--	1310	492	--	-
VOC	74-83-9	BROMOMETHANE	µg/kg	1.37 (e)	--	--	--	--	--	--	--	--	--	1.37	--	-
VOC	75-15-0	CARBON DISULFIDE	µg/kg	23.9 (e)	--	--	--	--	--	--	--	--	--	23.9	--	-
VOC	56-23-5	CARBON TETRACHLORIDE	µg/kg	1200 (b)	--	1200 EqP	--	--	--	--	--	--	7240	1450	--	-
VOC	108-90-7	CHLOROBENZENE	µg/kg	820 (b)	--	820 EqP	--	--	--	--	--	--	162	291	--	-
VOC	124-48-1	CHLORODIBROMOMETHANE	µg/kg	1.114 (e)	--	--	--	--	--	--	--	--	--	1.114	--	-
VOC	75-00-3	CHLOROETHANE	µg/kg	NSV --	--	--	--	--	--	--	--	--	--	--	--	-
VOC	67-66-3	CHLOROFORM	µg/kg	121 (e)	--	--	--	--	--	--	--	--	--	121	--	-
VOC	74-87-3	CHLOROMETHANE	µg/kg	NSV --	--	--	--	--	--	--	--	--	--	--	--	-
VOC	156-59-2	CIS-1,2-DICHLOROETHENE [3]	µg/kg	654 (e)	--	--	--	--	--	--	--	--	--	654 (s)	--	-
VOC	10061-01-5	CIS-1,3-DICHLOROPROPENE [3]	µg/kg	7.31 (d)	--	--	--	--	--	--	--	--	7.31 (s)	--	--	-
VOC	110-82-7	CYCLOHEXANE	µg/kg	NSV --	--	--	--	--	--	--	--	--	--	--	--	-
VOC	96-12-8	1,2-DIBROMO-3-CHLOROPROPANE	µg/kg	NSV --	--	--	--	--	--	--	--	--	--	--	--	-
VOC	106-93-4	1,2-DIBROMOETHANE	µg/kg	NSV --	--	--	--	--	--	--	--	--	--	--	--	-
VOC	75-71-8	DICHLORODIFLUOROMETHANE	µg/kg	NSV --	--	--	--	--	--	--	--	--	--	--	--	-
VOC	75-34-3	1,1-DICHLOROETHANE	µg/kg	0.575 (e)	--	--	--	--	--	--	--	--	--	0.575	--	-
VOC	107-06-2	1,2-DICHLOROETHANE	µg/kg	260 (e)	--	--	--	--	--	--	--	--	--	260	--	-
VOC	75-35-4	1,1-DICHLOROETHENE	µg/kg	2780 (d)	--	--	--	--	--	--	--	--	2780	19.4	--	-
VOC	75-09-2	DICHLOROMETHANE	µg/kg	159 (e)	--	--	--	--	--	--	--	--	--	159	--	-
VOC	78-87-5	1,2-DICHLOROPROPANE	µg/kg	333 (e)	--	--	--	--	--	--	--	--	--	333	--	-
VOC	100-41-4	ETHYLBENZENE	µg/kg	3600 (b)	--	3600 EqP	--	--	--	--	--	--	305	175	--	-
VOC	76-13-1	FREON 113	µg/kg	NSV --	--	--	--	--	--	--	--	--	--	--	--	-

ATTACHMENT A
Table A-1
Focused OU1 SLERA
Selection of Ecological Screening Values - Sediment
Terry Creek Site - Brunswick, Georgia

CLASS	CAS	CONSTITUENT	UNITS	Selected Sediment ESV (Source) (1)	Region IV (a)	OSWER EcoTox SQC/SQB (b)	NOAA T_{20} (c)	NOAA TEL (c)	NOAA ERL (c)	NOAA T_{50} (c)	NOAA PEL (c)	NOAA ERM (c)	Region III (d)	Region V (e)	Other (f)	Potentially Bioaccumulates (2)
VOC	591-78-6	2-HEXANONE	µg/kg	58.2 (e)	--	--	--	--	--	--	--	--	--	58.2	--	-
VOC	98-82-8	ISOPROPYLBENZENE	µg/kg	NSV --	--	--	--	--	--	--	--	--	--	--	--	-
VOC	79-20-9	METHYL ACETATE	µg/kg	NSV --	--	--	--	--	--	--	--	--	--	--	--	-
VOC	78-93-3	METHYL ETHYL KETONE	µg/kg	42.4 (e)	--	--	--	--	--	--	--	--	--	42.4	--	-
VOC	108-87-2	METHYLCYCLOHEXANE	µg/kg	NSV --	--	--	--	--	--	--	--	--	--	--	--	-
VOC	108-10-1	4-METHYL-2-PENTANONE	µg/kg	25.1 (e)	--	--	--	--	--	--	--	--	--	25.1	--	-
VOC	1634-04-4	METHYL TERT-BUTYL ETHER	µg/kg	NSV --	--	--	--	--	--	--	--	--	--	--	--	-
VOC	100-42-5	STYRENE	µg/kg	7070 (d)	--	--	--	--	--	--	--	--	7070	254	--	-
VOC	79-34-5	1,1,2,2-TETRACHLOROETHANE	µg/kg	940 (b)	--	940 EqP	--	--	--	--	--	--	202	850	--	-
VOC	127-18-4	TETRACHLOROETHYLENE	µg/kg	530 (b)	--	530 EqP	--	--	--	--	--	--	190	990	--	-
VOC	108-88-3	TOLUENE	µg/kg	670 (b)	--	670 EqP	--	--	--	--	--	--	1090	1220	--	-
VOC	156-60-5	TRANS-1,2-DICHLOROETHENE	µg/kg	654 (e)	--	--	--	--	--	--	--	--	--	654	--	-
VOC	10061-02-6	TRANS-1,3-DICHLOROPROPENE (3)	µg/kg	7.31 (d)	--	--	--	--	--	--	--	--	7.31 (s)	--	--	-
VOC	71-55-6	1,1,1-TRICHLOROETHANE	µg/kg	170 (b)	--	170 EqP	--	--	--	--	--	--	856	213	--	-
VOC	79-00-5	1,1,2-TRICHLOROETHANE	µg/kg	570 (d)	--	--	--	--	--	--	--	--	570	518	--	-
VOC	79-01-6	TRICHLOROETHYLENE	µg/kg	1600 (b)	--	1600 EqP	--	--	--	--	--	--	8950	112	--	-
VOC	75-69-4	TRICHLOROFLUOROMETHANE	µg/kg	NSV --	--	--	--	--	--	--	--	--	--	--	--	-
VOC	75-01-4	VINYL CHLORIDE	µg/kg	202 (e)	--	--	--	--	--	--	--	--	--	202	--	-
VOC	1330-20-7	XYLENES (3)	µg/kg	25 (b)	--	25 EqP(s)	--	--	--	--	--	--	--	433	--	-

Notes:

(1) Ecological Screening Values (ESVs) were selected in the following order of priority:

(a) USEPA 2001. Supplemental Guidance to RAGS: Region 4 Bulletins, Ecological Risk Assessment. Effects Values. Originally published November 1995. Available on-line: http://www.epa.gov/region4/superfund/programs/riskassess/ecolbul.html.

Surrogates:
- individual Aroclors use total PCBs as a surrogate
- alpha- and gamma-chlordane uses chlordane as a surrogate
- endrin aldehyde and endrin ketone use endrin as a surrogate

(b) EPA. 1996. ECO Update: EcoTox Thresholds. Sediment Quality Criteria (SQC) - Marine Water or Sediment Quality Benchmarks based on equilibrium partitioning (EqP) and assuming 1% organic carbon content in sediment. Office of Solid Waste and Emergency Response (OSWER). Intermittent Bulletin (3): 2. January. Available on-line: http://www.epa.gov/oswer/riskassessment/ecoup/pdf/v3no2.pdf

Surrogates:
- endrin aldehyde and endrin ketone use endrin as a surrogate
- endosulfan sulfate uses endosulfan I as a surrogate
- dimethyl phthalate uses diethylphthalate as a surrogate
- 4-chlorophenyl phenyl ether uses 4-bromophenyl phenyl ether as a surrogate
- xylenes use m-xylene as a surrogate

(c) NOAA (National Oceanic and Atmostpheric Administration) 2002. Screening Quick Reference Tables (SQuiRTs). Available on-line: http://archive.orr.noaa.gov/book_shelf/122_NEW-SQuiRTs.pdf.

Minimum of:
- T_{20} - concentration corresponding to 20% probability of observing toxicity in 10pday survival tests for marine amphipods
- TEL - toxic effect level
- ERL - effects range, low
- T_{50} - concentration corresponding to 50% probability of observing toxicity in 10pday survival tests for marine amphipods
- PEL - probable effect level
- ERM - effects range, medium

Surrogates:
- individual Aroclors use total PCBs as a surrogate
- alpha- and gamma-chlordane uses chlordane as a surrogate
- heptachlor uses heptachlor epoxide as a surrogate
- 3&4-methylphenol uses 4-methylphenol as a surrogate

(d) EPA Region 3. Biological Technical Assistance Group Screening Benchmarks for Marine Sediment. Available on-line: http://www.epa.gov/reg3hwmd/risk/eco/index.htm

Surrogates:
- individual Aroclors (except Aroclor 1254) use total PCBs as a surrogate
- alpha- and gamma-chlordane uses chlordane as a surrogate
- endrin aldehyde and endrin ketone use endrin as a surrogate
- cis- and trans-1,3-dichloropropene uses 1,3-dichloropropene as a surrogate

(e) EPA Region V. 2003. Ecological Screening Levels (ESLs) for RCRA Appendix IX Hazardous Constituents. August. Available on-line: http://epa.gov/region05/waste/cars/pdfs/ecological-screening-levels-200308.pdf

Surrogates:
- individual Aroclors use total PCBs as a surrogate
- endrin ketone uses endrin as a surrogate
- alpha- and gamma-chlordane uses chlordane as a surrogate
- 3&4-methylphenol uses 4-methylphenol as a surrogate
- 2-nitrophenol uses 4-nitrophenol as a surrogate
- cis-1,2-dichloroethene uses trans-1,2-dichloroethene as a surrogate

(f) Additional sources were reviewed to identify ESVs for detected constituents. The "AET" - Apparent Effects Threshold value from NOAA (2002) was identified as an appropriate ESV for aluminum, iron, manganese, selenium, and vanadium.

(2) Potentially bioaccumulative compounds are those identified in Table 4-2 of Bioaccumulation Testing and Interpretation for the Purpose of Sediment Quality Assessment - Status and Needs (USEPA, 2000). http://water.epa.gov/polwaste/sediments/cs/upload/bioaccum.pdf

(3) Selected ESV is based on a surrogate compound.

Definitions

OU1 = Operable Unit 1 (Outfall Ditch)
SLERA = Screening Level Ecological Risk Assessment
CAS - chemical abstract number
ESV - ecological screening value
mg/kg - milligram per kilogram
µg/kg - microgram per kilogram
NSV - no screening value
"--" - value not available
(s) - surrogate ESV (see footnotes)
PAH - polycyclic aromatic hydrocarbon
PEST - pesticide
PCB - polychlorinated biphenyl
SVOC - semivolatile organic compound
VOC - volatile organic compound

ATTACHMENT A
Table A-2
Focused OU1 SLERA
Selection of Ecological Screening Values - Surface Water/Pore Water
Terry Creek Site - Brunswick, Georgia

CLASS	CAS	CONSTITUENT	UNITS	Selected Surface Water/Pore Water ESV (Source) [1]	NRWQC [a]	USEPA MW Region IV [b]	OSWER EcoTox Thresholds MW [c]	NOAA MW Chronic [d]	USEPA, MW Region III [e]	USEPA Region V [f]	Conversion Factor for Diss. Metals [2]
M	7429-90-5	ALUMINUM	µg/L	NSV	--	--	--	--	--	--	--
M	7440-36-0	ANTIMONY	µg/L	500 (d)	--	--	--	500	500	80	--
M	7440-38-2	ARSENIC	µg/L	36 (a)	36	36	36	36	12.5	148	1
M	7440-39-3	BARIUM	µg/L	200 (d)	--	--	--	200	--	220	--
M	7440-41-7	BERYLLIUM	µg/L	100 (d)	--	--	--	100	--	3.6	--
M	7440-43-9	CADMIUM	µg/L	8.8 (a)	8.8	9.3	9.3	8.8	0.12	0.15	0.994
M	7440-47-3	CHROMIUM [3]	µg/L	50 (a)	50 (s)	50 (s)	50 (s)	27.4 (s)	1.5 (s)	42	0.993
M	7440-48-4	COBALT	µg/L	1 (d)	--	--	--	1	--	24	--
M	7440-50-8	COPPER	µg/L	3.1 (a)	3.1	2.9	2.4	3.1	3.1	1.58	0.83
M	74-90-8	CYANIDE	µg/L	1 (a)	1	1	1	1	1	5.2	--
M	7439-89-6	IRON	µg/L	50 (d)	--	--	--	50	--	--	--
M	7439-92-1	LEAD	µg/L	8.1 (a)	8.1	8.5	8.1	8.1	8.1	1.17	0.951
M	7439-96-5	MANGANESE	µg/L	100 (d)	--	--	--	100	--	--	--
M	7439-97-6	MERCURY	µg/L	0.94 (a)	0.94	0.025 (F)	1.1	0.94	0.016	0.0013	0.85
M	7440-02-0	NICKEL	µg/L	8.2 (a)	8.2	8.3	8.2	8.2	8.2	28.9	0.99
M	7782-49-2	SELENIUM	µg/L	71 (a)	71	71	71	71	71	5	0.998
M	7440-22-4	SILVER	µg/L	0.23 (b)	--	0.23	--	--	0.23	0.12	--
M	7440-28-0	THALLIUM	µg/L	21.3 (b)	--	21.3	--	17	21.3	10	--
M	7440-62-2	VANADIUM	µg/L	50 (d)	--	--	--	50	--	12	--
M	7440-66-6	ZINC	µg/L	81 (a)	81	86	81	81	81	65.7	0.946
PAH	83-32-9	ACENAPHTHENE	µg/L	9.7 (b)	--	9.7	40	40	6.6	38	--
PAH	208-96-8	ACENAPHTHYLENE [3]	µg/L	9.7 (b)	--	9.7 (s)	--	--	--	4840	--
PAH	120-12-7	ANTHRACENE	µg/L	0.18 (e)	--	--	--	--	0.18	0.035	--
PAH	56-55-3	BENZO(A)ANTHRACENE	µg/L	0.025 (f)	--	--	--	--	--	0.025	--
PAH	50-32-8	BENZO(A)PYRENE	µg/L	0.014 (f)	--	--	--	--	--	0.014	--
PAH	205-99-2	BENZO(B)FLUORANTHENE	µg/L	9.07 (f)	--	--	--	--	--	9.07	--
PAH	191-24-2	BENZO(G,H,I)PERYLENE	µg/L	7.64 (f)	--	--	--	--	--	7.64	--
PAH	207-08-9	BENZO(K)FLUORANTHENE	µg/L	NSV	--	--	--	--	--	--	--
PAH	218-01-9	CHRYSENE	µg/L	NSV	--	--	--	--	--	--	--
PAH	53-70-3	DIBENZO(A,H)ANTHRACENE	µg/L	NSV	--	--	--	--	--	--	--
PAH	206-44-0	FLUORANTHENE	µg/L	1.6 (b)	--	1.6	11	11	1.6	1.9	--
PAH	86-73-7	FLUORENE	µg/L	2.5 (e)	--	--	--	--	2.5	19	--
PAH	193-39-5	INDENO(1,2,3-CD)PYRENE	µg/L	4.31 (f)	--	--	--	--	--	4.31	--
PAH	91-57-6	2-METHYLNAPHTHALENE	µg/L	4.2 (e)	--	--	--	--	4.2	330	--
PAH	91-20-3	NAPHTHALENE	µg/L	23.5 (b)	--	23.5	--	--	1.4	13	--
PAH	85-01-8	PHENANTHRENE	µg/L	8.3 (c)	--	--	8.3	4.6	1.5	3.6	--
PAH	129-00-0	PYRENE	µg/L	0.24 (e)	--	--	--	--	0.24	0.3	--
PCB	12674-11-2	AROCLOR-1016 [3]	µg/L	0.03 (a)	0.03 (s)	0.03 (F,s)	--	0.03 (s)	--	0.00012 (s)	--
PCB	11104-28-2	AROCLOR-1221 [3]	µg/L	0.03 (a)	0.03 (s)	0.03 (F,s)	--	0.03 (s)	--	0.00012 (s)	--
PCB	11141-16-5	AROCLOR-1232 [3]	µg/L	0.03 (a)	0.03 (s)	0.03 (F,s)	--	0.03 (s)	--	0.00012 (s)	--
PCB	53469-21-9	AROCLOR-1242 [3]	µg/L	0.03 (a)	0.03 (s)	0.03 (F,s)	--	0.03 (s)	--	0.00012 (s)	--
PCB	12672-29-6	AROCLOR-1248 [3]	µg/L	0.03 (a)	0.03 (s)	0.03 (F,s)	--	0.03 (s)	--	0.00012 (s)	--
PCB	11097-69-1	AROCLOR-1254 [3]	µg/L	0.03 (a)	0.03 (s)	0.03 (F,s)	--	0.03 (s)	--	0.00012 (s)	--
PCB	11096-82-5	AROCLOR-1260 [3]	µg/L	0.03 (a)	0.03 (s)	0.03 (F,s)	--	0.03 (s)	--	0.00012 (s)	--
PCB	11100-14-4	AROCLOR-1268 [3]	µg/L	0.03 (a)	0.03 (s)	0.03 (F,s)	--	0.03 (s)	--	0.00012 (s)	--
PEST	72-54-8	4,4'-DDD	µg/L	0.025 (b)	--	0.025	--	0.36	0.025	--	--
PEST	72-55-9	4,4'-DDE	µg/L	0.14 (b)	--	0.14	--	1.4	0.14	4.51E-09	--
PEST	50-29-3	4,4'-DDT	µg/L	0.001 (a)	0.001	0.001	--	0.0005	0.0065	0.000011	--
PEST	309-00-2	ALDRIN	µg/L	0.13 (b)	--	0.13	--	--	0.13	0.017	--
PEST	319-84-6	ALPHA-BHC	µg/L	1400 (b)	--	1400	--	--	25	12.4	--
PEST	319-85-7	BETA-BHC [3]	µg/L	0.034 (d)	--	--	--	0.034 (s)	--	0.495	--

ATTACHMENT A
Table A-2
Focused OU1 SLERA
Selection of Ecological Screening Values - Surface Water/Pore Water
Terry Creek Site - Brunswick, Georgia

CLASS	CAS	CONSTITUENT	UNITS	Selected Surface Water/Pore Water ESV (Source) [1]	NRWQC [a]	USEPA MW Region IV [b]	OSWER EcoTox Thresholds MW [c]	NOAA MW Chronic [d]	USEPA, MW Region III [e]	USEPA Region V [f]	Conversion Factor for Diss. Metals [2]
PEST	319-86-8	DELTA-BHC [3]	µg/L	0.034 (d)	--	--	--	0.034 [s]	--	667	--
PEST	58-89-9	GAMMA-BHC (LINDANE)	µg/L	0.016 (b)	--	0.016	--	--	0.016	0.026	--
PEST	5103-71-9	ALPHA-CHLORDANE [3]	µg/L	0.004 (a)	0.004 [s]	0.004 [F,s]	--	0.002 [s]	--	0.0043 [s]	--
PEST	5103-74-2	GAMMA-CHLORDANE [3]	µg/L	0.004 (a)	0.004 [s]	0.004 [F,s]	--	0.002 [s]	--	0.0043 [s]	--
PEST	60-57-1	DIELDRIN	µg/L	0.0019 (a)	0.0019	0.0019 [F]	0.11	0.00095	0.11	0.000071	--
PEST	959-98-8	ENDOSULFAN I	µg/L	0.0087 (a)	0.0087	0.0087 [F,s]	--	0.00435	0.001 [s]	0.056	--
PEST	33213-65-9	ENDOSULFAN II	µg/L	0.0087 (a)	0.0087	0.0087 [F,s]	--	0.00435	0.001 [s]	0.056 [s]	--
PEST	1031-07-8	ENDOSULFAN SULFATE [3]	µg/L	0.0087 (b)	--	0.0087 [F,s]	--	0.00435 [s]	0.009	2.22	--
PEST	72-20-8	ENDRIN	µg/L	0.0023 (a)	0.0023	0.0023 [F]	0.01	0.00115	0.01	0.036	--
PEST	7421-93-4	ENDRIN ALDEHYDE [3]	µg/L	0.0023 (a)	0.0023 [s]	0.0023 [F,s]	0.01 [s]	0.00115 [s]	0.01 [s]	0.15	--
PEST	53494-70-5	ENDRIN KETONE [3]	µg/L	0.0023 (a)	0.0023 [s]	0.0023 [F,s]	0.01 [s]	0.00115 [s]	0.01 [s]	0.036 [s]	--
PEST	76-44-8	HEPTACHLOR	µg/L	0.0036 (a)	0.0036	0.0036 [F]	--	0.0018	--	0.0038	--
PEST	1024-57-3	HEPTACHLOR EPOXIDE	µg/L	0.0036 (a)	0.0036	0.0036 [F]	--	0.0018	--	0.0038	--
PEST	72-43-5	METHOXYCHLOR	µg/L	0.03 (a)	0.03	0.03	--	0.03	0.03	0.019	--
PEST	8001-35-2	TOXAPHENE	µg/L	0.0002 (a)	0.0002	0.0002 [F]	0.21	0.0002	0.21	0.00014	--
SVOC	98-86-2	ACETOPHENONE	µg/L	NSV	--	--	--	--	--	--	--
SVOC	1912-24-9	ATRAZINE	µg/L	10 (d)	--	--	--	10	--	--	--
SVOC	100-52-7	BENZALDEHYDE	µg/L	NSV	--	--	--	--	--	--	--
SVOC	111-91-1	BIS(2-CHLOROETHOXY)METHANE	µg/L	6400 (d)	--	--	--	6400	--	--	--
SVOC	111-44-4	BIS(2-CHLOROETHYL)ETHER	µg/L	1900 (f)	--	--	--	--	--	1900	--
SVOC	39638-32-9	BIS(2-CHLOROISOPROPYL)ETHER	µg/L	NSV	--	--	--	--	--	--	--
SVOC	117-81-7	BIS(2-ETHYLHEXYL)PHTHALATE	µg/L	360 (d)	--	--	--	360	--	0.3	--
SVOC	1667-11-4	1,1-BIPHENYL	µg/L	NSV	--	--	--	--	--	--	--
SVOC	101-55-3	4-BROMOPHENYL PHENYL ETHER	µg/L	1.5 (f)	--	--	--	--	--	1.5	--
SVOC	85-68-7	BUTYL BENZYL PHTHALATE	µg/L	29.4 (b)	--	29.4	--	3.4	29.4	23	--
SVOC	105-60-2	CAPROLACTAM	µg/L	NSV	--	--	--	--	--	--	--
SVOC	86-74-8	CARBAZOLE	µg/L	NSV	--	--	--	--	--	--	--
SVOC	59-50-7	4-CHLORO-3-METHYLPHENOL	µg/L	34.8 (f)	--	--	--	--	--	34.8	--
SVOC	106-47-8	4-CHLOROANILINE	µg/L	129 (d)	--	--	--	129	--	232	--
SVOC	91-58-7	2-CHLORONAPHTHALENE	µg/L	0.396 (f)	--	--	--	--	--	0.396	--
SVOC	95-57-8	2-CHLOROPHENOL	µg/L	265 (e)	--	--	--	--	265	24	--
SVOC	7005-72-3	4-CHLOROPHENYL PHENYL ETHER [3]	µg/L	1.5 (f)	--	--	--	--	--	1.5 [s]	--
SVOC	132-64-9	DIBENZOFURAN	µg/L	65 (e)	--	--	--	--	65	4	--
SVOC	95-50-1	1,2-DICHLOROBENZENE	µg/L	19.7 (b)	--	19.7	--	--	42	14	--
SVOC	541-73-1	1,3-DICHLOROBENZENE	µg/L	28.5 (b)	--	28.5	--	--	28.5	38	--
SVOC	106-46-7	1,4-DICHLOROBENZENE	µg/L	19.9 (b)	--	19.9	--	129	19.9	9.4	--
SVOC	91-94-1	3,3'-DICHLOROBENZIDINE	µg/L	73 (e)	--	--	--	--	73	4.5	--
SVOC	120-83-2	2,4-DICHLOROPHENOL	µg/L	11 (f)	--	--	--	--	--	11	--
SVOC	84-66-2	DIETHYL PHTHALATE	µg/L	75.9 (b)	--	75.9	--	3.4	75.9	110	--
SVOC	131-11-3	DIMETHYL PHTHALATE	µg/L	580 (b)	--	580	--	3.4	580	--	--
SVOC	105-67-9	2,4-DIMETHYLPHENOL	µg/L	100 (f)	--	--	--	--	--	100	--
SVOC	84-74-2	DI-N-BUTYL PHTHALATE	µg/L	3.4 (b)	--	3.4	--	3.4	3.4	9.7	--
SVOC	534-52-1	4,6-DINITRO-2-METHYLPHENOL	µg/L	23 (f)	--	--	--	--	--	23	--
SVOC	51-28-5	2,4-DINITROPHENOL	µg/L	48.5 (b)	--	48.5	--	--	48.5	19	--
SVOC	121-14-2	2,4-DINITROTOLUENE	µg/L	370 (d)	--	--	--	370	--	44	--
SVOC	606-20-2	2,6-DINITROTOLUENE [3]	µg/L	370 (d)	--	--	--	370 [s]	--	81	--
SVOC	117-84-0	DI-N-OCTYL PHTHALATE	µg/L	3.4 (d)	--	--	--	3.4	--	30	--
SVOC	118-74-1	HEXACHLOROBENZENE	µg/L	129 (d)	--	--	--	129	--	0.0003	--
SVOC	87-68-3	HEXACHLOROBUTADIENE	µg/L	0.32 (b)	--	0.32	--	3.2	0.3	0.053	--
SVOC	77-47-4	HEXACHLOROCYCLOPENTADIENE	µg/L	0.07 (b)	--	0.07	--	0.7	0.07	77	--
SVOC	67-72-1	HEXACHLOROETHANE	µg/L	9.4 (b)	--	9.4	--	94	9.4	8	--

ATTACHMENT A
Table A-2
Focused OU1 SLERA
Selection of Ecological Screening Values - Surface Water/Pore Water
Terry Creek Site - Brunswick, Georgia

CLASS	CAS	CONSTITUENT	UNITS	Selected Surface Water/Pore Water ESV (Source) [1]	NRWQC [a]	USEPA MW Region IV [b]	OSWER EcoTox Thresholds MW [c]	NOAA MW Chronic [d]	USEPA, MW Region III [e]	USEPA Region V [f]	Conversion Factor for Diss. Metals [2]
SVOC	78-59-1	ISOPHORONE	µg/L	129 (b)	--	129	--	1290	129	920	--
SVOC	95-48-7	2-METHYLPHENOL	µg/L	1020 (e)	--	--	--	--	1020	67	--
SVOC	TTNUS042	3&4-METHYLPHENOL [3]	µg/L	25 (f)	--	--	--	--	--	25 [s]	--
SVOC	88-74-4	2-NITROANILINE	µg/L	NSV	--	--	--	--	--	--	--
SVOC	99-09-2	3-NITROANILINE	µg/L	NSV	--	--	--	--	--	--	--
SVOC	100-01-6	4-NITROANILINE	µg/L	NSV	--	--	--	--	--	--	--
SVOC	98-95-3	NITROBENZENE	µg/L	66.8 (b)	--	66.8	--	668	66.8	220	--
SVOC	88-75-5	2-NITROPHENOL	µg/L	2940 (e)	--	--	--	--	2940	--	--
SVOC	100-02-7	4-NITROPHENOL	µg/L	71.7 (b)	--	71.7	--	--	71.7	60	--
SVOC	621-64-7	N-NITROSO-DI-N-PROPYLAMINE	µg/L	120 (e)	--	--	--	--	120	--	--
SVOC	86-30-6	N-NITROSODIPHENYLAMINE	µg/L	33000 (b)	--	33000	--	--	33000	--	--
SVOC	87-86-5	PENTACHLOROPHENOL	µg/L	7.9 (a)	7.9	7.9	7.9	7.9	7.9	4	--
SVOC	108-95-2	PHENOL	µg/L	58 (b)	--	58	--	400	58	180	--
SVOC	120-82-1	1,2,4-TRICHLOROBENZENE	µg/L	4.5 (b)	--	4.5	--	--	5.4	30	--
SVOC	95-95-4	2,4,5-TRICHLOROPHENOL	µg/L	12 (e)	--	--	--	--	12	--	--
SVOC	88-06-2	2,4,6-TRICHLOROPHENOL	µg/L	61 (e)	--	--	--	--	61	4.9	--
VOC	67-64-1	ACETONE	µg/L	564000 (e)	--	--	--	--	564000	1700	--
VOC	71-43-2	BENZENE	µg/L	109 (b)	--	109	--	110	110	114	--
VOC	75-27-4	BROMODICHLOROMETHANE	µg/L	6400 (d)	--	--	--	6400	--	--	--
VOC	75-25-2	BROMOFORM	µg/L	640 (b)	--	640	--	--	640	230	--
VOC	74-83-9	BROMOMETHANE	µg/L	120 (b)	--	120	--	--	120	16	--
VOC	78-93-3	2-BUTANONE	µg/L	2200 (f)	--	--	--	--	--	2200	--
VOC	75-15-0	CARBON DISULFIDE	µg/L	15 (f)	--	--	--	--	--	15	--
VOC	56-23-5	CARBON TETRACHLORIDE	µg/L	1500 (b)	--	1500	--	5000	1500	240	--
VOC	108-90-7	CHLOROBENZENE	µg/L	105 (b)	--	105	--	--	25	47	--
VOC	124-48-1	CHLORODIBROMOMETHANE	µg/L	6400 (d)	--	--	--	6400	--	--	--
VOC	75-00-3	CHLOROETHANE	µg/L	NSV	--	--	--	--	--	--	--
VOC	67-66-3	CHLOROFORM	µg/L	815 (b)	--	815	--	--	815	140	--
VOC	74-87-3	CHLOROMETHANE	µg/L	2700 (b)	--	2700	--	--	2700	--	--
VOC	96-12-8	1,2-DIBROMO-3-CHLOROPROPANE	µg/L	NSV	--	--	--	--	--	--	--
VOC	110-82-7	CYCLOHEXANE	µg/L	NSV	--	--	--	--	--	--	--
VOC	106-93-4	1,2-DIBROMOETHANE	µg/L	NSV	--	--	--	--	--	--	--
VOC	95-50-1	1,2-DICHLOROBENZENE	µg/L	19.7 (b)	--	19.7	--	--	42	14	--
VOC	541-73-1	1,3-DICHLOROBENZENE	µg/L	28.5 (b)	--	28.5	--	--	28.5	38	--
VOC	106-46-7	1,4-DICHLOROBENZENE	µg/L	19.9 (b)	--	19.9	--	129	19.9	9.4	--
VOC	75-71-8	DICHLORODIFLUOROMETHANE	µg/L	NSV	--	--	--	--	--	--	--
VOC	75-34-3	1,1-DICHLOROETHANE	µg/L	47 (f)	--	--	--	--	--	47	--
VOC	107-06-2	1,2-DICHLOROETHANE	µg/L	1130 (b)	--	1130	--	11300	1130	910	--
VOC	75-35-4	1,1-DICHLOROETHENE	µg/L	2240 (b)	--	2240	--	--	2240	65	--
VOC	156-59-2	CIS-1,2-DICHLOROETHENE [3]	µg/L	680 (e)	--	--	--	--	680 [s]	--	--
VOC	156-60-5	TRANS-1,2-DICHLOROETHENE [3]	µg/L	680 (e)	--	--	--	--	680 [s]	970	--
VOC	78-87-5	1,2-DICHLOROPROPANE	µg/L	2400 (b)	--	2400	--	3040	2400	360	--
VOC	10061-01-5	CIS-1,3-DICHLOROPROPENE [3]	µg/L	7.9 (b)	--	7.9 [s]	--	--	7.9 [s]	--	--
VOC	10061-02-6	TRANS-1,3-DICHLOROPROPENE [3]	µg/L	7.9 (b)	--	7.9 [s]	--	--	7.9 [s]	--	--
VOC	100-41-4	ETHYLBENZENE	µg/L	4.3 (b)	--	4.3	--	25	25	14	--
VOC	87-68-3	HEXACHLOROBUTADIENE	µg/L	0.32 (b)	--	0.32	--	3.2	0.3	0.053	--
VOC	591-78-6	2-HEXANONE	µg/L	99 (f)	--	--	--	--	--	99	--
VOC	98-82-8	ISOPROPYLBENZENE	µg/L	NSV	--	--	--	--	--	--	--
VOC	1634-04-4	METHYL TERT-BUTYL ETHER	µg/L	5000 (d)	--	--	--	5000	--	--	--
VOC	108-10-1	4-METHYL-2-PENTANONE	µg/L	123000 (e)	--	--	--	--	123000	170	--
VOC	79-20-9	METHYL ACETATE	µg/L	NSV	--	--	--	--	--	--	--

ATTACHMENT A
Table A-2
Focused OU1 SLERA
Selection of Ecological Screening Values - Surface Water/Pore Water
Terry Creek Site - Brunswick, Georgia

CLASS	CAS	CONSTITUENT	UNITS	Selected Surface Water/Pore Water ESV (Source) (1)	NRWQC (a)	USEPA MW Region IV (b)	OSWER EcoTox Thresholds MW (c)	NOAA MW Chronic (d)	USEPA, MW Region III (e)	USEPA Region V (f)	Conversion Factor for Diss. Metals (2)
VOC	108-87-2	METHYLCYCLOHEXANE	µg/L	NSV	--	--	--	--	--	--	--
VOC	75-09-2	METHYLENE CHLORIDE	µg/L	2560 (b)	--	2560	--	6400	2560	940	--
VOC	91-20-3	NAPHTHALENE	µg/L	23.5 (b)	--	23.5	--	1.4	1.4	13	--
VOC	100-42-5	STYRENE	µg/L	910 (e)	--	--	--	--	910	32	--
VOC	79-34-5	1,1,2,2-TETRACHLOROETHANE	µg/L	90.2 (b)	--	90.2	--	902	90.2	380	--
VOC	127-18-4	TETRACHLOROETHENE	µg/L	45 (b)	--	45	--	450	45	45	--
VOC	108-88-3	TOLUENE	µg/L	37 (b)	--	37	--	215	215	253	--
VOC	120-82-1	1,2,4-TRICHLOROBENZENE	µg/L	4.5 (b)	--	4.5	--	5.4	5.4	30	--
VOC	71-55-6	1,1,1-TRICHLOROETHANE	µg/L	312 (b)	--	312	--	3120	312	76	--
VOC	79-00-5	1,1,2-TRICHLOROETHANE	µg/L	1900 (d)	--	--	--	1900	550	500	--
VOC	79-01-6	TRICHLOROETHENE	µg/L	200 (d)	--	--	--	200	1940	47	--
VOC	76-13-1	1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE (FREON 113)	µg/L	NSV	--	--	--	--	--	--	--
VOC	75-69-4	TRICHLOROFLUOROMETHANE	µg/L	6400 (d)	--	--	--	6400	--	--	--
VOC	75-01-4	VINYL CHLORIDE	µg/L	930 (f)	--	--	--	--	--	930	--
VOC	1330-20-7	XYLENES, TOTAL	µg/L	19 (e)	--	--	--	--	19	27	--

Table A-2 Notes:

(1) Ecological Screening Values (ESVs) were selected in the following order of priority:

(a) USEPA National Recommended Water Quality Criteria (NRWQC) for saltwater, April 1999. Office of Water, EPA 822-Z-99-001.
Surrogates: • total chromium uses hexavalent chromium as a surrogate • individual Aroclors use total PCBs as a surrogate

(b) USEPA Region IV Ecological Risk Assessment Bulletin - Supplement to RAGS. August 11, 1999. Saltwater Screening Values for Hazardous Waste Sites. Website updated 30 November 2001. Available on-line: http://www.epa.gov/region4/superfund/programs/riskassess/ecolbul.html#tbl2
Surrogates: • total chromium uses hexavalent chromium as a surrogate • individual Aroclors uses Total PCBs as a surrogate
• acenaphthylene uses acenaphthene as a surrogate

(c) EPA. 1996. ECO Update: EcoTox Thresholds. Surface Water Ambient Water Quality Criteria (AWQC) or USEPA-derived final chronic values (FCV) - Marine Water. Office of Emergency and Remedial Response. Intermittent Bulletin (3): 2. January. Available on-line:
Surrogates: • total chromium uses hexavalent chromium as a surrogate • endrin aldehyde and endrin ketone use endrin as a surrogate

(d) NOAA (National Oceanic and Atmostpheric Administration) 2002. Screening Quick Reference Tables (SQuiRTs). Available on-line:
http://archive.orr.noaa.gov/book_shelf/122_NEW-SQuiRTs.pdf.
Surrogates: • total chromium uses trivalent chromium as a surrogate • endrin aldehyde and endrin ketone use endrin as a surrogate
• individual Aroclors uses Total PCBs as a surrogate • endosulfan sulfate uses endosulfan as a surrogate
• 2,6-dinitrotoluene uses 2,4-dinitrotoluene as a surrogate • alpha- and gamma-chlordane use chlordane as a surrogate
• beta-, and delta-BHC use total BHC as a surrogate

(e) USEPA Region III Ecological Risk Assessment Marine Screening Benchmarks. Website updated 15 January 2013. Available on-line:
http://www.epa.gov/reg3hwmd/risk/eco/btag/sbv/marine/screenbench.htm
Surrogates: • total chromium uses hexavalent chromium as a surrogate • endosulfan I and II use endosulfan as a surrogate
• endrin aldehyde and endrin ketone use endrin as a surrogate

(f) EPA Region V. 2003. Ecological Screening Levels (ESLs) for RCRA Appendix IX Hazardous Constituents. August. Available on-line:
http://epa.gov/region05/waste/cars/pdfs/ecological-screening-levels-200308.pdf. Note that Region V values are not marine-specific.
Surrogates: • individual PCBs use Total PCBs as a surrogate • alpha- and gamma-chlordane use chlordane as a surrogate

(2) For certain metals (As, Cd, Cr, Cu, Pb, Hg, Ni, Se, Zn), ESVs are specific to dissolved results; if the screening concentration was from an unfiltered (total) sample, the ESV was divided by the appropriate conversion factor.
(3) Selected ESV is based on a surrogate compound.

Table A-2 Definitions:

OU1 = Operable Unit 1 (Outfall Ditch)
SLERA = Screening Level Ecological Risk Assessment
CAS - chemical abstract number
ESV - ecological screening value
NSV - no screening value
"--" - value not available
µg/L - microgram per liter
PAH - polycyclic aromatic hydrocarbon
PEST - pesticide
PCB - polychlorinated biphenyl
SVOC - semivolatile organic compound
VOC - volatile organic compound
(s) - surrogate ESV (see footnotes)
(F) - Value is based on the marketability of fish.

ATTACHMENT B

ATTACHMENT B
Table B-1
OU1 Focused SLERA
Summary of Analytical Results for Non-Detect Constituents - Outfall Ditch Surficial Sediment
Terry Creek Superfund Site - Brunswick, Georgia

Class	Non-Detect Constituents	CAS No.	Units	Minimum MDL	Maximum MDL	Number of Samples	SLERA ND EPC (1)	SLERA ESV (2) (Source)		EPC > ESV
METAL	Antimony	7440-36-0	mg/kg	1.8	18	7	9	2	(a)	**Yes**
METAL	Cyanide, Total	74-90-8	mg/kg	0.8	4.5	7	2.25	0.1	(e)	**Yes**
METAL	Selenium	7782-49-2	mg/kg	3.4	22	7	11	1	(f)	**Yes**
METAL	Thallium	7440-28-0	mg/kg	3.4	22	7	11	NSV	--	--
PCB	Aroclor 1016 (3)	12674-11-2	µg/kg	5.5	1,200	8	600	21.6	(a)	**Yes**
PCB	Aroclor 1221 (3)	11104-28-2	µg/kg	9.1	2,400	8	1,200	21.6	(a)	**Yes**
PCB	Aroclor 1232 (3)	11141-16-5	µg/kg	6.3	1,200	8	600	21.6	(a)	**Yes**
PCB	Aroclor 1242 (3)	53469-21-9	µg/kg	5.3	1,200	8	600	21.6	(a)	**Yes**
PCB	Aroclor 1248 (3)	12672-29-6	µg/kg	14	1,200	8	600	21.6	(a)	**Yes**
PCB	Aroclor 1254 (3)	11097-69-1	µg/kg	4.4	1,200	8	600	21.6	(a)	**Yes**
PCB	Aroclor 1260 (3)	11096-82-5	µg/kg	13	1,200	8	600	21.6	(a)	**Yes**
PCB	Aroclor 1268 (3)	11100-14-4	µg/kg	3.2	1,200	8	600	21.6	(a)	**Yes**
PEST	alpha-BHC	319-84-6	µg/kg	0.24	310	8	155	1,360	(d)	No
PEST	Aldrin	309-00-2	µg/kg	0.99	310	8	155	2	(e)	**Yes**
PEST	beta-BHC	319-85-7	µg/kg	0.24	310	8	155	5	(e)	**Yes**
PEST	Chlordane (cis) (3)	5103-71-9	µg/kg	0.31	310	8	155	0.5	(a)	**Yes**
PEST	Chlordane (trans) (3)	5103-74-2	µg/kg	0.35	310	8	155	0.5	(a)	**Yes**
PEST	delta-BHC	319-86-8	µg/kg	0.29	310	8	155	71,500	(e)	No
PEST	DDT	50-29-3	µg/kg	0.51	600	8	300	1.19	(a)	**Yes**
PEST	Dieldrin	60-57-1	µg/kg	0.62	600	8	300	0.02	(a)	**Yes**
PEST	Endosulfan I	959-98-8	µg/kg	0.33	310	8	155	2.9	(b)	**Yes**
PEST	Endosulfan II	33213-65-9	µg/kg	0.51	600	8	300	14	(b)	**Yes**
PEST	Endosulfan sulfate (3)	1031-07-8	µg/kg	0.53	600	8	300	2.9	(b)	**Yes**
PEST	Endrin	72-20-8	µg/kg	1.6	600	8	300	0.02	(a)	**Yes**
PEST	Endrin aldehyde (3)	7421-93-4	µg/kg	0.66	600	8	300	0.02	(a)	**Yes**
PEST	Endrin ketone (3)	53494-70-5	µg/kg	0.59	600	8	300	0.02	(a)	**Yes**
PEST	Heptachlor (3)	76-44-8	µg/kg	0.18	310	8	155	0.6	(c)	**Yes**
PEST	Heptachlor epoxide	1024-57-3	µg/kg	0.31	310	8	155	0.6	(c)	**Yes**
PEST	Methoxychlor	72-43-5	µg/kg	0.77	600	8	300	19	(b)	**Yes**
PAH	2-Methylnaphthalene	91-57-6	µg/kg	120	610	8	305	20.2	(a)	**Yes**
PAH	Acenaphthene	83-32-9	µg/kg	120	610	8	305	6.71	(a)	**Yes**
PAH	Anthracene	120-12-7	µg/kg	120	610	8	305	46.9	(a)	**Yes**
PAH	Benz(a)anthracene	56-55-3	µg/kg	120	610	8	305	74.8	(a)	**Yes**
PAH	Benzo(a)pyrene	50-32-8	µg/kg	46	610	8	305	88.8	(a)	**Yes**

ATTACHMENT B
Table B-1
OU1 Focused SLERA
Summary of Analytical Results for Non-Detect Constituents - Outfall Ditch Surficial Sediment
Terry Creek Superfund Site - Brunswick, Georgia

Class	Non-Detect Constituents	CAS No.	Units	Minimum MDL	Maximum MDL	Number of Samples	SLERA ND EPC (1)	SLERA ESV (2) (Source)		EPC > ESV
PAH	Benzo(b)fluoranthene	205-99-2	µg/kg	120	610	8	305	130	(c)	**Yes**
PAH	Benzo(g,h,i)perylene	191-24-2	µg/kg	120	610	8	305	67	(c)	**Yes**
PAH	Benzo(k)fluoranthene	207-08-9	µg/kg	77	610	8	305	70	(c)	**Yes**
PAH	Chrysene	218-01-9	µg/kg	120	610	8	305	108	(a)	**Yes**
PAH	Dibenz(a,h)anthracene	53-70-3	µg/kg	120	610	8	305	6.22	(a)	**Yes**
PAH	Fluorene	86-73-7	µg/kg	120	610	8	305	21.2	(a)	**Yes**
PAH	Indeno(1,2,3-c,d)pyrene	193-39-5	µg/kg	120	610	8	305	68	(c)	**Yes**
SVOC	2,4,5-Trichlorophenol	95-95-4	µg/kg	290	3,000	8	1,500	819	(d)	**Yes**
SVOC	2,4,6-Trichlorophenol	88-06-2	µg/kg	300	3,000	8	1,500	2,650	(d)	No
SVOC	2,4-Dichlorophenol	120-83-2	µg/kg	280	3,000	8	1,500	81.7	(e)	**Yes**
SVOC	2,4-Dimethylphenol	105-67-9	µg/kg	290	6,000	8	3,000	304	(e)	**Yes**
SVOC	2,4-Dinitrophenol	51-28-5	µg/kg	650	30,000	8	15,000	6.21	(e)	**Yes**
SVOC	2,4-Dinitrotoluene	121-14-2	µg/kg	290	3,000	8	1,500	14.4	(e)	**Yes**
SVOC	2,6-Dinitrotoluene	606-20-2	µg/kg	300	3,000	8	1,500	39.8	(e)	**Yes**
SVOC	2-Chloronaphthalene	91-58-7	µg/kg	230	3,000	8	1,500	417	(e)	**Yes**
SVOC	2-Chlorophenol	95-57-8	µg/kg	200	3,000	8	1,500	344	(d)	**Yes**
SVOC	2-Nitroaniline	88-74-4	µg/kg	270	16,000	8	8,000	NSV	--	--
SVOC	2-Nitrophenol (3)	88-75-5	µg/kg	220	3,000	8	1,500	13.3	(e)	**Yes**
SVOC	3,3-Dichlorobenzidine	91-94-1	µg/kg	650	2,700	4	1,350	2,060	(d)	No
SVOC	3-Nitroaniline	99-09-2	µg/kg	260	16,000	8	8,000	NSV	--	--
SVOC	4,6-Dinitro-2-methylphenol	534-52-1	µg/kg	650	16,000	8	8,000	104	(e)	**Yes**
SVOC	4-Bromophenyl phenyl ether	101-55-3	µg/kg	270	3,000	8	1,500	1,300	(b)	**Yes**
SVOC	4-Chloro-3-methylphenol	59-50-7	µg/kg	270	3,000	8	1,500	388	(e)	**Yes**
SVOC	4-Chloroaniline	106-47-8	µg/kg	200	6,000	8	3,000	146	(e)	**Yes**
SVOC	4-Chlorophenyl phenyl ether (3)	7005-72-3	µg/kg	250	3,000	8	1,500	1,300	(b)	**Yes**
SVOC	4-Nitroaniline	100-01-6	µg/kg	320	16,000	8	8,000	NSV	--	--
SVOC	4-Nitrophenol	100-02-7	µg/kg	2,800	16,000	8	8,000	13.3	(e)	**Yes**
SVOC	Atrazine	1912-24-9	µg/kg	290	3,000	8	1,500	NSV	--	--
SVOC	Bis(2-chloroethoxy) methane	111-91-1	µg/kg	250	3,000	8	1,500	NSV	--	--
SVOC	Bis(2-chloroethyl)ether	111-44-4	µg/kg	250	3,000	8	1,500	3,520	(e)	No
SVOC	Bis(2-chloroisopropyl) ether	39638-32-9	µg/kg	280	3,000	8	1,500	NSV	--	--
SVOC	Bis(2-ethylhexyl) phthalate	117-81-7	µg/kg	230	6,000	8	3,000	182	(a)	**Yes**
SVOC	Butyl benzyl phthalate	85-68-7	µg/kg	210	3,000	8	1,500	11,000	(b)	No
SVOC	Caprolactam	105-60-2	µg/kg	270	3,000	8	1,500	NSV	--	--

ATTACHMENT B
Table B-1
OU1 Focused SLERA
Summary of Analytical Results for Non-Detect Constituents - Outfall Ditch Surficial Sediment
Terry Creek Superfund Site - Brunswick, Georgia

Class	Non-Detect Constituents	CAS No.	Units	Minimum MDL	Maximum MDL	Number of Samples	SLERA ND EPC (1)	SLERA ESV (2) (Source)		EPC > ESV
SVOC	Carbazole	86-74-8	µg/kg	260	3,000	8	1,500	NSV	--	--
SVOC	Dibenzofuran	132-64-9	µg/kg	260	3,000	8	1,500	2,000	(b)	No
SVOC	Diethyl phthalate	84-66-2	µg/kg	280	3,000	8	1,500	630	(b)	**Yes**
SVOC	Dimethyl phthalate (3)	131-11-3	µg/kg	290	3,000	8	1,500	630	(b)	**Yes**
SVOC	Di-n-butyl phthalate	84-74-2	µg/kg	650	16,000	8	8,000	11,000	(b)	No
SVOC	Di-n-octyl phthalate	117-84-0	µg/kg	140	3,000	8	1,500	40,600	(e)	No
SVOC	Hexachlorobenzene	118-74-1	µg/kg	290	3,000	8	1,500	20	(e)	**Yes**
SVOC	Hexachlorobutadiene	87-68-3	µg/kg	260	3,000	8	1,500	26.5	(e)	**Yes**
SVOC	Hexachlorocyclopentadiene	77-47-4	µg/kg	140	6,000	8	3,000	139	(d)	**Yes**
SVOC	Hexachloroethane	67-72-1	µg/kg	220	3,000	8	1,500	1,000	(b)	**Yes**
SVOC	Isophorone	78-59-1	µg/kg	270	3,000	8	1,500	432	(e)	**Yes**
SVOC	Nitrobenzene	98-95-3	µg/kg	250	3,000	8	1,500	145	(e)	**Yes**
SVOC	N-nitrosodi-n-propylamine	621-64-7	µg/kg	290	3,000	8	1,500	NSV	--	--
SVOC	n-Nitrosodiphenylamine	86-30-6	µg/kg	230	3,000	8	1,500	422,000	(d)	No
SVOC	Pentachlorophenol	87-86-5	µg/kg	650	16,000	8	8,000	7,970	(d)	**Yes**
VOC	1,1,1-Trichloroethane	71-55-6	µg/kg	2.1	27	5	13.5	170	(b)	No
VOC	1,1,2,2-Tetrachloroethane	79-34-5	µg/kg	5.6	27	5	13.5	940	(b)	No
VOC	1,1,2-Trichloroethane	79-00-5	µg/kg	4.6	27	5	13.5	570	(d)	No
VOC	1,1-Dichloroethane	75-34-3	µg/kg	3.9	27	5	13.5	0.575	(e)	**Yes**
VOC	1,1-Dichloroethene	75-35-4	µg/kg	5.3	27	5	13.5	2,780	(d)	No
VOC	1,2,4-Trichlorobenzene	120-82-1	µg/kg	3.1	27	5	13.5	9,200	(b)	No
VOC	1,2-Dibromo-3-chloropropane	96-12-8	µg/kg	16	55	5	27.5	NSV	--	--
VOC	1,2-Dibromoethane	106-93-4	µg/kg	5.3	27	5	13.5	NSV	--	--
VOC	1,2-Dichlorobenzene	95-50-1	µg/kg	4.6	27	5	13.5	340	(b)	No
VOC	1,2-Dichloroethane	107-06-2	µg/kg	3.9	27	5	13.5	260	(e)	No
VOC	1,2-Dichloropropane	78-87-5	µg/kg	3	27	5	13.5	333	(e)	No
VOC	1,3-Dichlorobenzene	541-73-1	µg/kg	5.6	27	5	13.5	1,700	(b)	No
VOC	1,4-Dichlorobenzene	106-46-7	µg/kg	2.6	27	5	13.5	350	(b)	No
VOC	2-Hexanone (MIBK)	591-78-6	µg/kg	12	140	5	70	58.2	(e)	**Yes**
VOC	4-Methyl-2-pentanone	108-10-1	µg/kg	15	140	5	70	25.1	(e)	**Yes**
VOC	Benzene	71-43-2	µg/kg	2.6	27	5	13.5	57	(b)	No
VOC	Bromodichloromethane	75-27-4	µg/kg	3.4	27	5	13.5	NSV	--	--
VOC	Bromoform	75-25-2	µg/kg	5.3	27	5	13.5	650	(b)	No
VOC	Bromomethane	74-83-9	µg/kg	5.3	27	5	13.5	1.37	(e)	**Yes**

ATTACHMENT B
Table B-1
OU1 Focused SLERA
Summary of Analytical Results for Non-Detect Constituents - Outfall Ditch Surficial Sediment
Terry Creek Superfund Site - Brunswick, Georgia

Class	Non-Detect Constituents	CAS No.	Units	Minimum MDL	Maximum MDL	Number of Samples	SLERA ND EPC (1)	SLERA ESV (2) (Source)		EPC > ESV
VOC	Carbon tetrachloride	56-23-5	µg/kg	2.9	27	5	13.5	1,200	(b)	No
VOC	Chlorobenzene	108-90-7	µg/kg	3.4	27	5	13.5	820	(b)	No
VOC	Chlorodibromomethane	124-48-1	µg/kg	6	27	5	13.5	1.114	(e)	**Yes**
VOC	Chloroethane	75-00-3	µg/kg	9.5	27	5	13.5	NSV	--	--
VOC	Chloroform	67-66-3	µg/kg	3.9	27	5	13.5	121	(e)	No
VOC	Chloromethane	74-87-3	µg/kg	3.5	27	5	13.5	NSV	--	--
VOC	cis-1,2-Dichloroethene (3)	156-59-2	µg/kg	4.9	27	5	13.5	654	(e)	No
VOC	cis-1,3-Dichloropropene (3)	10061-01-5	µg/kg	2.9	27	5	13.5	7.31	(d)	**Yes**
VOC	Cyclohexane	110-82-7	µg/kg	4.6	55	5	27.5	NSV	--	--
VOC	Dichlorodifluoromethane	75-71-8	µg/kg	3.3	27	5	13.5	NSV	--	--
VOC	Methylene chloride	75-09-2	µg/kg	3.5	27	5	13.5	159	(e)	No
VOC	Ethylbenzene	100-41-4	µg/kg	4.6	27	5	13.5	3,600	(b)	No
VOC	1,1,2-Trichloro-1,2,2-trifluoroethane (Freon 113)	76-13-1	µg/kg	4.6	27	5	13.5	NSV	--	--
VOC	Methyl acetate	79-20-9	µg/kg	18	55	5	27.5	NSV	--	--
VOC	Methylcyclohexane	108-87-2	µg/kg	3	55	5	27.5	NSV	--	--
VOC	MTBE	1634-04-4	µg/kg	3.5	55	5	27.5	NSV	--	--
VOC	Styrene	100-42-5	µg/kg	3.3	27	5	13.5	7,070	(d)	No
VOC	Tetrachloroethene	127-18-4	µg/kg	6.7	27	5	13.5	530	(b)	No
VOC	Toluene	108-88-3	µg/kg	3	27	5	13.5	670	(b)	No
VOC	trans-1,2-Dichloroethene	156-60-5	µg/kg	2.2	27	5	13.5	654	(e)	No
VOC	trans-1,3-Dichloropropene (3)	10061-02-6	µg/kg	3.1	27	5	13.5	7.31	(d)	**Yes**
VOC	Trichloroethene	79-01-6	µg/kg	4.6	27	5	13.5	1,600	(b)	No
VOC	Trichlorofluoromethane	75-69-4	µg/kg	4.2	27	5	13.5	NSV	--	--
VOC	Vinyl chloride	75-01-4	µg/kg	5.3	27	5	13.5	202	(e)	No
VOC	Xylenes, Total (3)	1330-20-7	µg/kg	3.9	55	5	27.5	25	(b)	**Yes**

Notes:
(1) SLERA non-detect exposure point concentration (EPC) is one-half the maximum method detection limit (MDL).
(2) Ecological screening values were selected using the following hierarchy (see Attachment A):
(a) USEPA Region IV ecological effects values, sediment
(b) USEPA EcoTox Thresholds (SQC/SQB) for marine sediment
(c) NOAA SQuiRTs for marine sediment (minimum of T_{20}, TEL, ERL, T_{50}, PEL, and ERM)
(d) USEPA Region III BTAG ecological screening benchmarks for marine sediment
(e) USEPA Region V ESLs for freshwater sediment
(f) Apparent effects threshold (NOAA)
(3) Surrogate ESVs were utilized as follows:

Definitions:
OU1 = Operable Unit 1 (Outfall Ditch)
SLERA = Screening Level Ecological Risk Assessment
CAS = chemical abstract number
MDL = method detection limit
ND EPC = non-detect exposure point concentration
ESV = ecological screening value
mg/kg = milligram per kilogram
µg/kg = microgram per kilogram
PCB = polychlorinated biphenyl

ATTACHMENT B
Table B-1
OU1 Focused SLERA
Summary of Analytical Results for Non-Detect Constituents - Outfall Ditch Surficial Sediment
Terry Creek Superfund Site - Brunswick, Georgia

Class	Non-Detect Constituents	CAS No.	Units	Minimum MDL	Maximum MDL	Number of Samples	SLERA ND EPC (1)	SLERA ESV (2) (Source)	EPC > ESV

Pesticides/PCBs
individual Aroclors use total PCBs as a surrogate
cis- and trans-chlordane use chlordane as a surrogate
endosulfan sulfate uses endosulfan as a surrogate
endrin aldehyde and endrin ketone use endrin as a surrogate
heptachlor uses heptachlor epoxide as a surrogate
SVOCs
dimethyl phthalate uses diethyl phthalate as a surrogate
2-nitrophenol uses 4-nitrophenol as a surrogate
4-chlorophenyl phenyl ether uses 4-bromophenyl phenyl ether as a surrogate
VOCs
cis-1,2-dichloroethene uses trans-1,2-dichloroethene as a surrogate
cis- and trans-1,3-dichloropropene use 1,3-dichloropropene as a surrogate
xylenes, total use m-xylene as a surrogate

PEST = pesticide
SVOC = semivolatile organic compound
PAH = polynuclear aromatic hydrocarbon
VOC = volatile organic compound

ATTACHMENT B
Table B-2
OU1 Focused SLERA
Summary of Analytical Results for Non-Detect Constituents - Outfall Ditch Surface Water
Terry Creek Superfund Site - Brunswick, Georgia

Class	Constituent [1]	CAS No.	Units	Minimum MDL	Maximum MDL	Number of Samples	SLERA ND EPC [2]	SLERA ESV [3] (Source)		EPC > ESV
METAL	Antimony	7440-36-0	µg/L	2	10	13	5	500	(d)	No
METAL	Beryllium	7440-41-7	µg/L	0.15	0.6	13	0.3	100	(d)	No
METAL	Silver	7440-22-4	µg/L	0.18	0.9	13	0.45	0.23	(b)	**Yes**
METAL	Thallium	7440-28-0	µg/L	0.25	0.5	13	0.25	21.3	(b)	No
PCB	Aroclor 1016 [5]	12674-11-2	µg/L	0.066	0.077	14	0.0385	0.03	(a)	**Yes**
PCB	Aroclor 1221 [5]	11104-28-2	µg/L	0.26	0.3	14	0.15	0.03	(a)	**Yes**
PCB	Aroclor 1232 [5]	11141-16-5	µg/L	0.1	0.12	14	0.06	0.03	(a)	**Yes**
PCB	Aroclor 1242 [5]	53469-21-9	µg/L	0.17	0.2	14	0.1	0.03	(a)	**Yes**
PCB	Aroclor 1248 [5]	12672-29-6	µg/L	0.33	0.39	14	0.195	0.03	(a)	**Yes**
PCB	Aroclor 1254 [5]	11097-69-1	µg/L	0.24	0.28	14	0.14	0.03	(a)	**Yes**
PCB	Aroclor 1260 [5]	11096-82-5	µg/L	0.18	0.22	14	0.11	0.03	(a)	**Yes**
PCB	Aroclor 1268 [5]	11100-14-4	µg/L	0.24	0.28	14	0.14	0.03	(a)	**Yes**
PEST	4,4-DDE	72-55-9	µg/L	0.0071	0.0084	14	0.0042	0.14	(b)	No
PEST	alpha-BHC	319-84-6	µg/L	0.0053	0.0062	14	0.0031	1,400	(b)	No
PEST	Aldrin	309-00-2	µg/L	0.0065	0.0076	14	0.0038	0.13	(b)	No
PEST	beta-BHC [5]	319-85-7	µg/L	0.0062	0.0073	14	0.00365	0.034	(d)	No
PEST	Chlordane (cis) [5]	5103-71-9	µg/L	0.0055	0.0065	14	0.00325	0.004	(a)	No
PEST	Chlordane (trans) [5]	5103-74-2	µg/L	0.0047	0.0056	14	0.0028	0.004	(a)	No
PEST	delta-BHC [5]	319-86-8	µg/L	0.0044	0.0052	14	0.0026	0.034	(d)	No
PEST	DDD	72-54-8	µg/L	0.006	0.0071	14	0.00355	0.025	(b)	No
PEST	DDT	50-29-3	µg/L	0.009	0.011	14	0.0055	0.001	(a)	**Yes**
PEST	Dieldrin	60-57-1	µg/L	0.0084	0.0099	14	0.00495	0.0019	(a)	**Yes**
PEST	Endosulfan I	959-98-8	µg/L	0.0039	0.0046	14	0.0023	0.0087	(a)	No
PEST	Endosulfan II	33213-65-9	µg/L	0.0091	0.011	14	0.0055	0.0087	(a)	No
PEST	Endosulfan sulfate [5]	1031-07-8	µg/L	0.0063	0.0074	14	0.0037	0.0087	(b)	No
PEST	Endrin	72-20-8	µg/L	0.009	0.011	14	0.0055	0.0023	(a)	**Yes**
PEST	Endrin aldehyde [5]	7421-93-4	µg/L	0.015	0.017	14	0.0085	0.0023	(a)	**Yes**
PEST	Endrin ketone [5]	53494-70-5	µg/L	0.0078	0.0091	14	0.00455	0.0023	(a)	**Yes**
PEST	g-BHC (Lindane)	58-89-9	µg/L	0.0055	0.0064	14	0.0032	0.016	(b)	No
PEST	Heptachlor	76-44-8	µg/L	0.0065	0.0076	14	0.0038	0.0036	(a)	**Yes**
PEST	Heptachlor epoxide	1024-57-3	µg/L	0.0055	0.0065	14	0.00325	0.0036	(a)	No
PEST	Methoxychlor	72-43-5	µg/L	0.012	0.014	14	0.007	0.03	(a)	No
PEST	Toxaphene [4]	8001-35-2	µg/L	0.24	0.54	14	0.27	0.0002	(a)	**Yes**
PAH	2-methylnaphthalene	91-57-6	µg/L	0.092	0.11	14	0.055	4.2	(e)	No

ATTACHMENT B
Table B-2
OU1 Focused SLERA
Summary of Analytical Results for Non-Detect Constituents - Outfall Ditch Surface Water
Terry Creek Superfund Site - Brunswick, Georgia

Class	Constituent [1]	CAS No.	Units	Minimum MDL	Maximum MDL	Number of Samples	SLERA ND EPC [2]	SLERA ESV [3] (Source)		EPC > ESV
PAH	Acenaphthene	83-32-9	µg/L	0.092	0.11	14	0.055	9.7	(b)	No
PAH	Acenaphthylene [5]	208-96-8	µg/L	0.092	0.11	14	0.055	9.7	(b)	No
PAH	Anthracene	120-12-7	µg/L	0.092	0.11	14	0.055	0.18	(e)	No
PAH	Benz(a)anthracene	56-55-3	µg/L	0.092	0.11	14	0.055	0.025	(f)	**Yes**
PAH	Benzo(a) pyrene	50-32-8	µg/L	0.092	0.11	14	0.055	0.014	(f)	**Yes**
PAH	Benzo(b)fluoranthene	205-99-2	µg/L	0.092	0.11	14	0.055	9.07	(f)	No
PAH	Benzo(g,h,i)perylene	191-24-2	µg/L	0.092	0.11	14	0.055	7.64	(f)	No
PAH	Benzo(k)fluoranthene	207-08-9	µg/L	0.092	0.11	14	0.055	NSV		--
PAH	Chrysene	218-01-9	µg/L	0.042	0.05	14	0.025	NSV		--
PAH	Dibenz(a,h)anthracene	53-70-3	µg/L	0.092	0.11	14	0.055	NSV		--
PAH	Fluoranthene	206-44-0	µg/L	0.092	0.11	14	0.055	1.6	(b)	No
PAH	Fluorene	86-73-7	µg/L	0.092	0.11	14	0.055	2.5	(e)	No
PAH	Indeno(1,2,3-c,d)pyrene	193-39-5	µg/L	0.092	0.11	14	0.055	4.31	(f)	No
PAH	Phenanthrene	85-01-8	µg/L	0.092	0.11	14	0.055	8.3	(c)	No
PAH	Pyrene	129-00-0	µg/L	0.092	0.11	14	0.055	0.24	(e)	No
SVOC	1,1-Biphenyl	1667-11-4	µg/L	0.092	0.11	14	0.055	NSV		--
SVOC	2,4,5-Trichlorophenol	95-95-4	µg/L	0.11	0.13	14	0.065	12	(e)	No
SVOC	2,4,6-Trichlorophenol	88-06-2	µg/L	0.16	0.19	14	0.095	61	(e)	No
SVOC	2,4-Dichlorophenol	120-83-2	µg/L	0.092	0.11	14	0.055	11	(f)	No
SVOC	2,4-Dimethylphenol	105-67-9	µg/L	0.64	0.77	14	0.385	100	(f)	No
SVOC	2,4-Dinitrophenol	51-28-5	µg/L	1	1.2	14	0.6	48.5	(b)	No
SVOC	2,4-Dinitrotoluene	121-14-2	µg/L	0.11	0.13	14	0.065	370	(d)	No
SVOC	2,6-Dinitrotoluene [5]	606-20-2	µg/L	0.12	0.14	14	0.07	370	(d)	No
SVOC	2-Chloronaphthalene	91-58-7	µg/L	0.092	0.11	14	0.055	0.396	(f)	No
SVOC	2-Chlorophenol	95-57-8	µg/L	0.11	0.13	14	0.065	265	(e)	No
SVOC	2-Methylphenol	95-48-7	µg/L	0.68	0.82	14	0.41	1,020	(e)	No
SVOC	2-Nitroaniline	88-74-4	µg/L	0.15	0.18	14	0.09	NSV		--
SVOC	2-Nitrophenol	88-75-5	µg/L	0.092	0.11	14	0.055	2,940	(e)	No
SVOC	3 & 4 Methylphenol [5]	TTNUS042	µg/L	0.61	0.73	14	0.365	25	(f)	No
SVOC	3,3-Dichlorobenzidine	91-94-1	µg/L	1.8	2.2	13	1.1	73	(e)	No
SVOC	3-Nitroaniline	99-09-2	µg/L	0.15	0.18	13	0.09	NSV		--
SVOC	4,6-Dinitro-2-methylphenol	534-52-1	µg/L	0.12	0.14	14	0.07	23	(f)	No
SVOC	4-Bromophenyl phenyl ether	101-55-3	µg/L	0.11	0.13	14	0.065	1.5	(f)	No

ATTACHMENT B
Table B-2
OU1 Focused SLERA
Summary of Analytical Results for Non-Detect Constituents - Outfall Ditch Surface Water
Terry Creek Superfund Site - Brunswick, Georgia

Class	Constituent [1]	CAS No.	Units	Minimum MDL	Maximum MDL	Number of Samples	SLERA ND EPC [2]	SLERA ESV [3] (Source)		EPC > ESV
SVOC	4-Chloro-3-Methylphenol	59-50-7	µg/L	0.11	0.13	14	0.065	34.8	(f)	No
SVOC	4-Chloroaniline	106-47-8	µg/L	0.33	0.4	13	0.2	129	(d)	No
SVOC	4-Chlorophenyl phenyl ether [5]	7005-72-3	µg/L	0.092	0.11	14	0.055	1.5	(f)	No
SVOC	4-Nitroaniline	100-01-6	µg/L	0.46	0.56	13	0.28	NSV		--
SVOC	4-Nitrophenol	100-02-7	µg/L	0.46	0.56	14	0.28	71.7	(b)	No
SVOC	Atrazine	1912-24-9	µg/L	0.32	0.39	14	0.195	10	(d)	No
SVOC	Bis(2-chloroethoxy) methane	111-91-1	µg/L	0.092	0.11	14	0.055	6,400	(d)	No
SVOC	Bis(2-chloroethyl)ether	111-44-4	µg/L	0.092	0.11	14	0.055	1,900	(f)	No
SVOC	Bis(2-chloroisopropyl) ether	39638-32-9	µg/L	0.092	0.11	14	0.055	NSV		--
SVOC	Bis(2-ethylhexyl) phthalate	117-81-7	µg/L	0.59	0.71	14	0.355	360	(d)	No
SVOC	Butyl benzyl phthalate	85-68-7	µg/L	0.11	0.13	14	0.065	29.4	(b)	No
SVOC	Carbazole	86-74-8	µg/L	0.092	0.11	14	0.055	NSV		--
SVOC	Dibenzofuran	132-64-9	µg/L	0.092	0.11	14	0.055	65	(e)	No
SVOC	Dimethyl phthalate	131-11-3	µg/L	0.092	0.11	14	0.055	580	(b)	No
SVOC	Di-n-butyl phthalate	84-74-2	µg/L	0.36	0.43	14	0.215	3.4	(b)	No
SVOC	Di-n-octyl phthalate	117-84-0	µg/L	0.16	0.19	14	0.095	3.4	(d)	No
SVOC	Hexachlorobenzene	118-74-1	µg/L	0.092	0.11	14	0.055	129	(d)	No
SVOC	Hexachlorobutadiene	87-68-3	µg/L	0.092	0.11	14	0.055	0.32	(b)	No
SVOC	Hexachlorocyclopentadiene	77-47-4	µg/L	0.46	0.56	14	0.28	0.07	(b)	**Yes**
SVOC	Hexachloroethane	67-72-1	µg/L	0.46	0.56	14	0.28	9.4	(b)	No
SVOC	Isophorone	78-59-1	µg/L	0.092	0.11	14	0.055	129	(b)	No
SVOC	Nitrobenzene	98-95-3	µg/L	0.092	0.11	14	0.055	66.8	(b)	No
SVOC	N-Nitrosodi-n-propylamine	621-64-7	µg/L	0.12	0.14	14	0.07	120	(e)	No
SVOC	n-Nitrosodiphenylamine	86-30-6	µg/L	0.34	0.41	14	0.205	33,000	(b)	No
SVOC	Pentachlorophenol	87-86-5	µg/L	0.37	0.44	14	0.22	7.9	(a)	No
SVOC	Phenol	108-95-2	µg/L	0.12	0.14	14	0.07	58	(b)	No
VOC	1,1,1-Trichloroethane	71-55-6	µg/L	0.5	0.5	5	0.25	312	(b)	No
VOC	1,1,2,2-Tetrachloroethane	79-34-5	µg/L	0.18	0.18	5	0.09	90.2	(b)	No
VOC	1,1,2-Trichloroethane	79-00-5	µg/L	0.13	0.13	5	0.065	1,900	(d)	No
VOC	1,1-Dichloroethane	75-34-3	µg/L	0.25	0.25	5	0.125	47	(f)	No
VOC	1,1-Dichloroethene	75-35-4	µg/L	0.11	0.11	5	0.055	2,240	(b)	No
VOC	1,2,4-Trichlorobenzene	120-82-1	µg/L	0.25	0.25	5	0.125	4.5	(b)	No
VOC	1,2-Dibromo-3-chloropropane	96-12-8	µg/L	0.44	0.44	5	0.22	NSV		--

ATTACHMENT B
Table B-2
OU1 Focused SLERA
Summary of Analytical Results for Non-Detect Constituents - Outfall Ditch Surface Water
Terry Creek Superfund Site - Brunswick, Georgia

Class	Constituent [1]	CAS No.	Units	Minimum MDL	Maximum MDL	Number of Samples	SLERA ND EPC [2]	SLERA ESV [3] (Source)		EPC > ESV
VOC	1,2-Dibromoethane	106-93-4	µg/L	0.25	0.25	5	0.125	NSV		--
VOC	1,2-Dichlorobenzene	95-50-1	µg/L	0.21	0.21	5	0.105	19.7	(b)	No
VOC	1,2-Dichloroethane	107-06-2	µg/L	0.1	0.1	5	0.05	1,130	(b)	No
VOC	1,2-Dichloropropane	78-87-5	µg/L	0.13	0.13	5	0.065	2,400	(b)	No
VOC	1,3-Dichlorobenzene	541-73-1	µg/L	0.25	0.25	5	0.125	28.5	(b)	No
VOC	1,4-Dichlorobenzene	106-46-7	µg/L	0.28	0.28	5	0.14	19.9	(b)	No
VOC	2-Hexanone (MBK)	591-78-6	µg/L	1	1	5	0.5	99	(f)	No
VOC	4-Methyl-2-pentanone	108-10-1	µg/L	1	1	5	0.5	123,000	(e)	No
VOC	Bromodichloromethane	75-27-4	µg/L	0.25	0.25	5	0.125	6,400	(d)	No
VOC	Bromoform	75-25-2	µg/L	0.5	0.5	5	0.25	640	(b)	No
VOC	Bromomethane	74-83-9	µg/L	0.8	0.8	5	0.4	120	(b)	No
VOC	Carbon disulfide	75-15-0	µg/L	0.6	0.6	5	0.3	15	(f)	No
VOC	Chlorodibromomethane	124-48-1	µg/L	0.1	0.1	5	0.05	6,400	(d)	No
VOC	Chloroethane	75-00-3	µg/L	1	1	5	0.5	NSV		--
VOC	Chloromethane	74-87-3	µg/L	0.33	0.33	5	0.165	2,700	(b)	No
VOC	cis-1,2-Dichloroethene [5]	156-59-2	µg/L	0.15	0.15	5	0.075	680	(e)	No
VOC	cis-1,3-Dichloropropene [5]	10061-01-5	µg/L	0.11	0.11	5	0.055	7.9	(b)	No
VOC	Cyclohexane	110-82-7	µg/L	0.25	0.25	5	0.125	NSV		--
VOC	Dichlorodifluoromethane	75-71-8	µg/L	0.25	0.25	5	0.125	NSV		--
VOC	Dichloromethane	75-09-2	µg/L	1	1	5	0.5	2,560	(b)	No
VOC	Freon 113	76-13-1	µg/L	0.5	0.5	5	0.25	NSV		--
VOC	Methyl acetate	79-20-9	µg/L	0.19	0.19	5	0.095	NSV		--
VOC	Methyl Ethyl Ketone	78-93-3	µg/L	1	1	5	0.5	2,200	(f)	No
VOC	Methylcyclohexane	108-87-2	µg/L	0.1	0.1	5	0.05	NSV		--
VOC	Methyl tert-Butyl Ether (MTBE)	1634-04-4	µg/L	0.2	0.2	5	0.1	5,000	(d)	No
VOC	Styrene	100-42-5	µg/L	0.11	0.11	5	0.055	910	(e)	No
VOC	trans-1,2-Dichloroethene [5]	156-60-5	µg/L	0.2	0.2	5	0.1	680	(e)	No
VOC	trans-1,3-Dichloropropene [5]	10061-02-6	µg/L	0.21	0.21	5	0.105	7.9	(b)	No
VOC	Trichloroethene	79-01-6	µg/L	0.13	0.13	5	0.065	200	(d)	No
VOC	Trichlorofluoromethane	75-69-4	µg/L	0.25	0.25	5	0.125	6,400	(d)	No
VOC	Vinyl chloride	75-01-4	µg/L	0.18	0.18	5	0.09	930	(f)	No

Notes:
(1) Both unfiltered (total) and filtered (dissolved) surface water samples were analyzed for chemical constituents. Filtered and unfiltered results were generally comparable and, therefore, combined for screening purposes.

Definitions:
OU1 = Operable Unit 1 (Outfall Ditch)
SLERA = Screening Level Ecological Risk Assessment

ATTACHMENT B
Table B-2
OU1 Focused SLERA
Summary of Analytical Results for Non-Detect Constituents - Outfall Ditch Surface Water
Terry Creek Superfund Site - Brunswick, Georgia

Class	Constituent [1]	CAS No.	Units	Minimum MDL	Maximum MDL	Number of Samples	SLERA ND EPC [2]	SLERA ESV [3] (Source)	EPC > ESV

(2) SLERA non-detect exposure point concentration (EPC) is one-half the maximum method detection limit (MDL).
(3) Ecological screening values were selected using the following hierarchy (see Attachment A):
(a) USEPA NRWQC for the protection of aquatic life, saltwater
(b) USEPA Region IV chronic ecological effects values, saltwater
(c) USEPA EcoTox Thresholds (SQC/SQB) for marine water
(d) NOAA SQuiRTs for marine water
(d) USEPA Region III BTAG ecological screening benchmarks for marine surface water
(e) USEPA Region V ESLs for freshwater
(4) Per the Work Plan, the SLERA utilizes only toxaphene samples analyzed using Method 1.
(5) Surrogate ESVs were utilized as follows:
Pesticides/PCBs
individual Aroclors use total PCBs as a surrogate
beta- and delta-BHC use total BHC as a surrogate
cis- and trans-chlordane use chlordane as a surrogate
endosulfan sulfate uses endosulfan as a surrogate
endrin aldehyde and endrin ketone use endrin as a surrogate
SVOCs/PAHs
acenaphthylene uses acenaphthene as a surrogate
4-chlorophenyl phenyl ether uses 4-bromophenyl phenyl ether as a surrogate
2,6-dinitrotoluene uses 2,4-dinitrotoluene as a surrogate
3&4-methylphenol use 4-methylphenol as a surrogate
VOCs
cis- and trans-1,2-dichloroethene uses 1,2-dichloroethene as a surrogate
cis- and trans-1,3-dichloropropene use 1,3-dichloropropene as a surrogate

CAS = chemical abstract number
MDL = method detection limit
ND EPC = non-detect exposure point concentration
ESV = ecological screening value
µg/L = microgram per liter
PCB = polychlorinated biphenyl
PEST = pesticide
SVOC = semivolatile organic compound
PAH = polynuclear aromatic hydrocarbon
VOC = volatile organic compound

ATTACHMENT B
Table B-3
OU1 Focused SLERA
Summary of Analytical Results for Non-Detect Constituents - Outfall Ditch Pore Water
Terry Creek Superfund Site - Brunswick, Georgia

Class	Constituent	CAS No.	Units	Minimum MDL (1)	Maximum MDL (1)	Number of Samples	SLERA EPC (2)	SLERA ESV (3) (Source)		EPC > ESV
METAL	Antimony	7440-36-0	µg/L	4	4	4	2	500	(d)	No
METAL	Beryllium	7440-41-7	µg/L	0.15	0.15	4	0.075	100	(d)	No
METAL	Cadmium	7440-43-9	µg/L	0.13	0.13	4	0.065	8.8	(a)	No
METAL	Cyanide Total	74-90-8	µg/L	5	5	4	2.5	1	(a)	**Yes**
METAL	Mercury	7439-97-6	µg/L	0.091	0.091	4	0.0455	0.94	(a)	No
METAL	Selenium	7782-49-2	µg/L	2.2	2.2	4	1.1	71	(a)	No
METAL	Silver	7440-22-4	µg/L	0.18	0.18	4	0.09	0.23	(b)	No
METAL	Thallium	7440-28-0	µg/L	0.25	0.25	4	0.125	21.3	(b)	No
PCB	Aroclor 1016 (5)	12674-11-2	µg/L	0.069	1.3	4	0.65	0.03	(a)	**Yes**
PCB	Aroclor 1221 (5)	11104-28-2	µg/L	0.27	5.3	4	2.65	0.03	(a)	**Yes**
PCB	Aroclor 1232 (5)	11141-16-5	µg/L	0.11	2.1	4	1.05	0.03	(a)	**Yes**
PCB	Aroclor 1242 (5)	53469-21-9	µg/L	0.18	3.4	4	1.7	0.03	(a)	**Yes**
PCB	Aroclor 1248 (5)	12672-29-6	µg/L	0.35	6.8	4	3.4	0.03	(a)	**Yes**
PCB	Aroclor 1254 (5)	11097-69-1	µg/L	0.25	4.9	4	2.45	0.03	(a)	**Yes**
PCB	Aroclor 1260 (5)	11096-82-5	µg/L	0.19	3.8	4	1.9	0.03	(a)	**Yes**
PCB	Aroclor 1268 (5)	11100-14-4	µg/L	0.25	4.9	4	2.45	0.03	(a)	**Yes**
PEST	4,4-DDE	72-55-9	µg/L	0.0075	0.15	4	0.075	0.14	(b)	No
PEST	alpha-BHC	319-84-6	µg/L	0.0056	0.11	4	0.055	1400	(b)	No
PEST	Aldrin	309-00-2	µg/L	0.0068	0.14	4	0.07	0.13	(b)	No
PEST	beta-BHC (5)	319-85-7	µg/L	0.0065	0.13	4	0.065	0.034	(d)	**Yes**
PEST	Chlordane (cis) (5)	5103-71-9	µg/L	0.0058	0.12	4	0.06	0.004	(a)	**Yes**
PEST	Chlordane (trans) (5)	5103-74-2	µg/L	0.005	0.099	4	0.0495	0.004	(a)	**Yes**
PEST	delta-BHC (5)	319-86-8	µg/L	0.0047	0.093	4	0.0465	0.034	(d)	**Yes**
PEST	DDD	72-54-8	µg/L	0.0063	0.13	4	0.065	0.025	(b)	**Yes**
PEST	DDT	50-29-3	µg/L	0.0094	0.19	4	0.095	0.001	(a)	**Yes**
PEST	Dieldrin	60-57-1	µg/L	0.0089	0.18	4	0.09	0.0019	(a)	**Yes**
PEST	Endosulfan I	959-98-8	µg/L	0.0041	0.082	4	0.041	0.0087	(a)	**Yes**
PEST	Endosulfan II	33213-65-9	µg/L	0.0095	0.19	4	0.095	0.0087	(a)	**Yes**
PEST	Endosulfan sulphate (5)	1031-07-8	µg/L	0.0066	0.13	4	0.065	0.0087	(b)	**Yes**
PEST	Endrin	72-20-8	µg/L	0.0094	0.19	4	0.095	0.0023	(a)	**Yes**
PEST	Endrin aldehyde (5)	7421-93-4	µg/L	0.016	0.31	4	0.155	0.0023	(a)	**Yes**
PEST	Endrin ketone (5)	53494-70-5	µg/L	0.0082	0.16	4	0.08	0.0023	(a)	**Yes**
PEST	g-BHC (Lindane)	58-89-9	µg/L	0.0057	0.11	4	0.055	0.016	(b)	**Yes**
PEST	Heptachlor	76-44-8	µg/L	0.0068	0.14	4	0.07	0.0036	(a)	**Yes**

ATTACHMENT B
Table B-3
OU1 Focused SLERA
Summary of Analytical Results for Non-Detect Constituents - Outfall Ditch Pore Water
Terry Creek Superfund Site - Brunswick, Georgia

Class	Constituent	CAS No.	Units	Minimum MDL (1)	Maximum MDL (1)	Number of Samples	SLERA EPC (2)	SLERA ESV (3) (Source)		EPC > ESV
PEST	Heptachlor epoxide	1024-57-3	µg/L	0.0058	0.12	4	0.06	0.0036	(a)	**Yes**
PEST	Methoxychlor	72-43-5	µg/L	0.013	0.25	4	0.125	0.03	(a)	**Yes**
SVOC	1,1-Biphenyl	1667-11-4	µg/L	0.1	0.12	4	0.06	NSV		--
SVOC	2,4,5-trichlorophenol	95-95-4	µg/L	0.12	0.14	4	0.07	12	(e)	No
SVOC	2,4,6-trichlorophenol	88-06-2	µg/L	0.17	0.2	4	0.1	61	(e)	No
SVOC	2,4-dichlorophenol	120-83-2	µg/L	0.1	0.12	4	0.06	11	(f)	No
SVOC	2,4-dimethylphenol	105-67-9	µg/L	0.7	0.81	4	0.405	100	(f)	No
SVOC	2,4-dinitrophenol	51-28-5	µg/L	1.1	1.3	4	0.65	48.5	(b)	No
SVOC	2,4-Dinitrotoluene	121-14-2	µg/L	0.12	0.14	4	0.07	370	(d)	No
SVOC	2,6-dinitrotoluene (5)	606-20-2	µg/L	0.13	0.15	4	0.075	370	(d)	No
SVOC	2-chloronaphthalene	91-58-7	µg/L	0.1	0.12	4	0.06	0.396	(f)	No
SVOC	2-chlorophenol	95-57-8	µg/L	0.12	0.14	4	0.07	265	(e)	No
SVOC	2-methylnaphthalene	91-57-6	µg/L	0.1	0.12	4	0.06	4.2	(e)	No
SVOC	2-methylphenol	95-48-7	µg/L	0.76	0.86	4	0.43	1020	(e)	No
SVOC	2-nitroaniline	88-74-4	µg/L	0.16	0.19	4	0.095	NSV		--
SVOC	2-nitrophenol	88-75-5	µg/L	0.1	0.12	4	0.06	2940	(e)	No
SVOC	3 & 4 Methylphenol (5)	TTNUS042	µg/L	0.67	0.77	4	0.385	25	(f)	No
SVOC	3,3-Dichlorobenzidine	91-94-1	µg/L	2	2.3	4	1.15	73	(e)	No
SVOC	3-nitroaniline	99-09-2	µg/L	0.16	0.19	4	0.095	NSV		--
SVOC	4,6-Dinitro-2-methylphenol	534-52-1	µg/L	0.13	0.15	4	0.075	23	(f)	No
SVOC	4-bromophenyl phenyl ether	101-55-3	µg/L	0.12	0.14	4	0.07	1.5	(f)	No
SVOC	4-chloro-3-methylphenol	59-50-7	µg/L	0.12	0.14	4	0.07	34.8	(f)	No
SVOC	4-chloroaniline	106-47-8	µg/L	0.37	0.42	4	0.21	129	(d)	No
SVOC	4-chlorophenyl phenyl ether (5)	7005-72-3	µg/L	0.1	0.12	4	0.06	1.5	(f)	No
SVOC	4-nitroaniline	100-01-6	µg/L	0.51	0.58	4	0.29	NSV		--
SVOC	4-nitrophenol	100-02-7	µg/L	0.51	0.58	4	0.29	71.7	(b)	No
SVOC	Acenaphthene	83-32-9	µg/L	0.1	0.12	4	0.06	9.7	(b)	No
SVOC	Acenaphthylene (5)	208-96-8	µg/L	0.1	0.12	4	0.06	9.7	(b)	No
SVOC	Acetophenone	98-86-2	µg/L	1	1.2	4	0.6	NSV		--
SVOC	Anthracene	120-12-7	µg/L	0.1	0.12	4	0.06	0.18	(e)	No
SVOC	Atrazine	1912-24-9	µg/L	0.36	0.41	4	0.205	10	(d)	No
SVOC	Benz(a)anthracene	56-55-3	µg/L	0.1	0.12	4	0.06	0.025	(f)	**Yes**
SVOC	Benzo(a) pyrene	50-32-8	µg/L	0.1	0.12	4	0.06	0.014	(f)	**Yes**

ATTACHMENT B
Table B-3
OU1 Focused SLERA
Summary of Analytical Results for Non-Detect Constituents - Outfall Ditch Pore Water
Terry Creek Superfund Site - Brunswick, Georgia

Class	Constituent	CAS No.	Units	Minimum MDL (1)	Maximum MDL (1)	Number of Samples	SLERA EPC (2)	SLERA ESV (3) (Source)		EPC > ESV
SVOC	Benzo(b)fluoranthene	205-99-2	µg/L	0.1	0.12	4	0.06	9.07	(f)	No
SVOC	Benzo(g,h,i)perylene	191-24-2	µg/L	0.1	0.12	4	0.06	7.64	(f)	No
SVOC	Benzo(k)fluoranthene	207-08-9	µg/L	0.1	0.12	4	0.06	NSV		--
SVOC	Bis(2-chloroethoxy) methane	111-91-1	µg/L	0.1	0.12	4	0.06	6400	(d)	No
SVOC	Bis(2-chloroethyl)ether	111-44-4	µg/L	0.1	0.12	4	0.06	1900	(f)	No
SVOC	Bis(2-chloroisopropyl) ether	39638-32-9	µg/L	0.1	0.12	4	0.06	NSV		--
SVOC	Bis(2-ethylhexyl) phthalate	117-81-7	µg/L	0.65	0.75	4	0.375	360	(d)	No
SVOC	Butyl benzyl phthalate	85-68-7	µg/L	0.12	0.14	4	0.07	29.4	(b)	No
SVOC	Caprolactam	105-60-2	µg/L	0.13	0.15	4	0.075	NSV		--
SVOC	Carbazole	86-74-8	µg/L	0.1	0.12	4	0.06	NSV		--
SVOC	Chrysene	218-01-9	µg/L	0.046	0.053	4	0.0265	NSV		--
SVOC	Dibenz(a,h)anthracene	53-70-3	µg/L	0.1	0.12	4	0.06	NSV		--
SVOC	Dibenzofuran	132-64-9	µg/L	0.1	0.12	4	0.06	65	(e)	No
SVOC	Dimethyl phthalate	131-11-3	µg/L	0.1	0.12	4	0.06	580	(b)	No
SVOC	Di-n-butyl phthalate	84-74-2	µg/L	0.4	0.46	4	0.23	3.4	(b)	No
SVOC	Di-n-octyl phthalate	117-84-0	µg/L	0.17	0.2	4	0.1	3.4	(d)	No
SVOC	Fluoranthene	206-44-0	µg/L	0.1	0.12	4	0.06	1.6	(b)	No
SVOC	Fluorene	86-73-7	µg/L	0.1	0.12	4	0.06	2.5	(e)	No
SVOC	Hexachlorobenzene	118-74-1	µg/L	0.1	0.12	4	0.06	129	(d)	No
SVOC	Hexachlorobutadiene	87-68-3	µg/L	0.1	0.12	4	0.06	0.32	(b)	No
SVOC	Hexachloroethane	67-72-1	µg/L	0.51	0.58	4	0.29	9.4	(b)	No
SVOC	Indeno(1,2,3-c,d)pyrene	193-39-5	µg/L	0.1	0.12	4	0.06	4.31	(f)	No
SVOC	Isophorone	78-59-1	µg/L	0.1	0.12	4	0.06	129	(b)	No
SVOC	Nitrobenzene	98-95-3	µg/L	0.1	0.12	4	0.06	66.8	(b)	No
SVOC	N-nitrosodi-n-propylamine	621-64-7	µg/L	0.13	0.15	4	0.075	120	(e)	No
SVOC	n-Nitrosodiphenylamine	86-30-6	µg/L	0.38	0.43	4	0.215	33000	(b)	No
SVOC	Pentachlorophenol	87-86-5	µg/L	0.41	0.47	4	0.235	7.9	(a)	No
SVOC	Phenanthrene	85-01-8	µg/L	0.1	0.12	4	0.06	8.3	(c)	No
SVOC	Pyrene	129-00-0	µg/L	0.1	0.12	4	0.06	0.24	(e)	No
VOC	1,1,1-trichloroethane	71-55-6	µg/L	0.5	0.5	4	0.25	312	(b)	No
VOC	1,1,2,2-tetrachloroethane	79-34-5	µg/L	0.18	0.18	4	0.09	90.2	(b)	No
VOC	1,1,2-trichloroethane	79-00-5	µg/L	0.13	0.13	4	0.065	1900	(d)	No
VOC	1,1-dichloroethane	75-34-3	µg/L	0.25	0.25	4	0.125	47	(f)	No

ATTACHMENT B
Table B-3
OU1 Focused SLERA
Summary of Analytical Results for Non-Detect Constituents - Outfall Ditch Pore Water
Terry Creek Superfund Site - Brunswick, Georgia

Class	Constituent	CAS No.	Units	Minimum MDL (1)	Maximum MDL (1)	Number of Samples	SLERA EPC (2)	SLERA ESV (3) (Source)		EPC > ESV
VOC	1,1-dichloroethene	75-35-4	µg/L	0.11	0.11	4	0.055	2240	(b)	No
VOC	1,2,4-trichlorobenzene	120-82-1	µg/L	0.25	0.25	4	0.125	4.5	(b)	No
VOC	1,2-dibromo-3-chloropropane	96-12-8	µg/L	0.44	0.44	4	0.22	NSV		--
VOC	1,2-dibromoethane	106-93-4	µg/L	0.25	0.25	4	0.125	NSV		--
VOC	1,2-dichlorobenzene	95-50-1	µg/L	0.21	0.21	4	0.105	19.7	(b)	No
VOC	1,2-dichloroethane	107-06-2	µg/L	0.1	0.1	4	0.05	1130	(b)	No
VOC	1,2-dichloropropane	78-87-5	µg/L	0.13	0.13	4	0.065	2400	(b)	No
VOC	1,3-dichlorobenzene	541-73-1	µg/L	0.25	0.25	4	0.125	28.5	(b)	No
VOC	1,4-dichlorobenzene	106-46-7	µg/L	0.28	0.28	4	0.14	19.9	(b)	No
VOC	2-hexanone (MBK)	591-78-6	µg/L	1	1	4	0.5	99	(f)	No
VOC	4-Methyl-2-pentanone	108-10-1	µg/L	1	1	4	0.5	123000	(e)	No
VOC	Benzene	71-43-2	µg/L	0.25	0.25	4	0.125	109	(b)	No
VOC	Bromodichloromethane	75-27-4	µg/L	0.25	0.25	4	0.125	6400	(d)	No
VOC	Bromoform	75-25-2	µg/L	0.5	0.5	4	0.25	640	(b)	No
VOC	Bromomethane	74-83-9	µg/L	0.8	0.8	4	0.4	120	(b)	No
VOC	Carbon disulfide	75-15-0	µg/L	0.6	0.6	4	0.3	15	(f)	No
VOC	Carbon tetrachloride	56-23-5	µg/L	0.5	0.5	4	0.25	1500	(b)	No
VOC	Chlorobenzene	108-90-7	µg/L	0.25	0.25	4	0.125	105	(b)	No
VOC	Chlorodibromomethane	124-48-1	µg/L	0.1	0.1	4	0.05	6400	(d)	No
VOC	Chloroethane	75-00-3	µg/L	1	1	4	0.5	NSV		--
VOC	Chloroform	67-66-3	µg/L	0.14	0.14	4	0.07	815	(b)	No
VOC	Chloromethane	74-87-3	µg/L	0.33	0.33	4	0.165	2700	(b)	No
VOC	cis-1,2-dichloroethene (5)	156-59-2	µg/L	0.15	0.15	4	0.075	680	(e)	No
VOC	cis-1,3-dichloropropene (5)	10061-01-5	µg/L	0.11	0.11	4	0.055	7.9	(b)	No
VOC	Cyclohexane	110-82-7	µg/L	0.25	0.25	4	0.125	NSV		--
VOC	Dichlorodifluoromethane	75-71-8	µg/L	0.25	0.25	4	0.125	NSV		--
VOC	Dichloromethane	75-09-2	µg/L	1	1	4	0.5	2560	(b)	No
VOC	Ethylbenzene	100-41-4	µg/L	0.11	0.11	4	0.055	4.3	(b)	No
VOC	Freon 113	76-13-1	µg/L	0.5	0.5	4	0.25	NSV		--
VOC	Isopropylbenzene	98-82-8	µg/L	0.1	0.1	4	0.05	NSV		--
VOC	Methyl acetate	79-20-9	µg/L	0.19	0.19	4	0.095	NSV		--
VOC	Methyl Ethyl Ketone	78-93-3	µg/L	1	1	4	0.5	2200	(f)	No
VOC	Methylcyclohexane	108-87-2	µg/L	0.1	0.1	4	0.05	NSV		--

ATTACHMENT B
Table B-3
OU1 Focused SLERA
Summary of Analytical Results for Non-Detect Constituents - Outfall Ditch Pore Water
Terry Creek Superfund Site - Brunswick, Georgia

Class	Constituent	CAS No.	Units	Minimum MDL (1)	Maximum MDL (1)	Number of Samples	SLERA EPC (2)	SLERA ESV (3) (Source)		EPC > ESV
VOC	Styrene	100-42-5	µg/L	0.11	0.11	4	0.055	910	(e)	No
VOC	Tetrachloroethene	127-18-4	µg/L	0.15	0.15	4	0.075	45	(b)	No
VOC	trans-1,2-dichloroethene (5)	156-60-5	µg/L	0.2	0.2	4	0.1	680	(e)	No
VOC	trans-1,3-dichloropropene (5)	10061-02-6	µg/L	0.21	0.21	4	0.105	7.9	(b)	No
VOC	Trichloroethene	79-01-6	µg/L	0.13	0.13	4	0.065	200	(d)	No
VOC	Trichlorofluoromethane	75-69-4	µg/L	0.25	0.25	4	0.125	6400	(d)	No
VOC	Vinyl chloride	75-01-4	µg/L	0.18	0.18	4	0.09	930	(f)	No
VOC	Xylene Total	1330-20-7	µg/L	0.2	0.2	4	0.1	19	(e)	No

Notes:
(1) Both unfiltered (total) and filtered (dissolved) pore water samples were analyzed for chemical constituents. Filtered and unfiltered results were generally comparable and, therefore, combined for screening purposes.
(2) SLERA non-detect exposure point concentration (EPC) is one-half the maximum method detection limit (MDL).
(3) Ecological screening values were selected using the following hierarchy (see Attachment A):
(a) USEPA NRWQC for the protection of aquatic life, saltwater
(b) USEPA Region IV chronic ecological effects values, saltwater
(c) USEPA EcoTox Thresholds (SQC/SQB) for marine water
(d) NOAA SQuiRTs for marine water
(d) USEPA Region III BTAG ecological screening benchmarks for marine surface water
(e) USEPA Region V ESLs for freshwater
(4) Per the Work Plan, the SLERA utilizes only toxaphene samples analyzed using Method 1.
(5) Surrogate ESVs were utilized as follows:
Pesticide/PCBs
individual Aroclors use total PCBs as a surrogate
beta- and delta-BHC use total BHC as a surrogate
cis- and trans-chlordane use chlordane as a surrogate
endosulfan sulfate uses endosulfan as a surrogate
endrin aldehyde and endrin ketone use endrin as a surrogate
SVOCs/PAHs
acenaphthylene uses acenaphthene as a surrogate
4-chlorophenyl phenyl ether uses 4-bromophenyl phenyl ether as a surrogate
2,6-dinitrotoluene uses 2,4-dinitrotoluene as a surrogate
3&4-methylphenol use 4-methylphenol as a surrogate
VOCs
cis- and trans-1,2-dichloroethene uses 1,2-dichloroethene as a surrogate
cis- and trans-1,3-dichloropropene use 1,3-dichloropropene as a surrogate

Definitions:
OU1 = Operable Unit 1 (Outfall Ditch)
SLERA = Screening Level Ecological Risk Assessment
CAS = chemical abstract number
MDL = method detection limit
ND EPC = non-detect exposure point concentration
ESV = ecological screening value
µg/L = microgram per liter
PCB = polychlorinated biphenyl
PEST = pesticide
SVOC = semivolatile organic compound
PAH = polynuclear aromatic hydrocarbon
VOC = volatile organic compound

APPENDIX F

Option 2 Sheetpile Re-Routed
Terry Creek ROM Cost Options

Item Description	Quantity	Unit	Unit Rate	Total	Subtotal	Comment
Oversight & Other Third Party Services						
CM/CQA oversight	23	Week	$9,730	$223,790		See Detail
				Subtotal	**$223,790**	
Pre-Mobilization						
Work Plans	1	LS	$10,000	$10,000		Eng. Est.
HASP	1	LS	$2,000	$2,000		Eng. Est.
Bonds	$3,924,919	%	1.0%	$39,249		01 31 13.90 0190
				Subtotal	**$51,249**	
Contractor's Project Management, Site Set-up, Admin.						
Project Manager	23	Week	$3,350	$77,050		01 31 13.20 0200
Home Office Costs	$3,777,593	%	3.90%	$147,326		01 31 13.40 0300
Insurance	$3,754,316	%	0.62%	$23,277		01 31 13.30 0250
Site Trailer	6	Mth	$375	$2,250		01 52 13.20 0700 - 50' x 12' rental
Utilities, Furniture, ODC's	6	Mth	$894	$5,361		See Detail
Survey						
Initial Layout	40	Hr	$144	$5,750		Eng. Est. - incl. 15% markup on raw cost for GC pass through/markup
On-Going	184	Hr	$144	$26,450		Eng. Est. Assumed to be one day per week.
As-Built	40	Hr	$144	$5,750		Eng. Est.
				Subtotal	**$293,214**	
Initial Site Preparation and Controls						
Mobilization/Demobilization						
General Contractor / Earthwork	1	LS	$14,655	$14,655		See Detail
Sheetpile	2	LS	$30,000	$60,000		Per J. Duffey est., 21 Aug 2013. One for main channel, under new weir structure, and at end of new weir structure to prevent water intrusion. One for transition at completion.
Concrete	1	LS	$8,130	$8,130		See Detail
Construction Entrance / Access Roads	2,000	LF	$13	$26,577		See Detail
Truck Wash / Decon Station, Materials only	3	Each	$6,000	$18,000		http://www.dultmeier.com/products/0.165.2399/996. portable truck wash pad, assume 3 used for project (semi-disposable)
Clearing & Grubbing	1.7	Acre	$6,675	$11,493		See Detail. Assume 500 LF x 100 FT on S. Side (incl. laydown area) and 500 x 50 ft on north side for access
Construction Fencing / Security	2,500	LF	$4	$9,650		02 58 13.10 7001
Silt Fencing / E&S	2,500	LF	$1.20	$3,000		31 25 14.16 1100
Turbidity Curtain	500	LF	$28.00	$14,000		http://www.ctre.iastate.edu/erosion/manuals/construction/3.6_floatation_silt.pdf
Laydown Area Preparation	1	Acre	$38,962	$38,962		See Detail
				Subtotal	**$204,466**	
Dewatering / By-Pass Pumping / Water Management						
Water Management at Triple Box Culvert						
Pump Systems	10	Day	$3,321	$33,214		18" pump with 400 feet hose, $ based on NS rate from Hertz Equipment Rental, 24hr/day operation, NO wellpoint
Dam / Diversion Structures	0	SF	$39	$0		31 52 16.10 0060 - Barge, Driven Sheetpile Cofferdam. Walls to prevent intrusion. 40 LF wide by 20 ft deep sheet
Dewatering of Outfall Ditch	30	Day	$1,575	$47,250		31 23 19.20 1100 & 1120 (2nd pump)
Routine Storm Water Management - Excavations, etc.	86	Day	$1,200	$103,500		31 23 19.20 1100 at 75% utilization - i.e., days not operated have not labor or fuel charges but rent is still incurred
				Subtotal	**$183,964**	
Earthwork - Excavation & Removal						
Sediment Removal within Existing Triple Box Culvert						
Excavation & Removal	300	CY	$120	$36,127		See Detail. Assumed removal area, 3 ft deep sediment, 150 LF x 18 ft wide
Solidification	300	CY	$4	$1,204		31 32 13.19 2060 - Lime Soil Stabilization in prep for T&D. Unit converted $/SY to $/CY, based on 2% mix, 12" deep. $12.05/SY @ 1 Foot = $12.05*.333 CY
Transportation & Disposal, non-haz	512	Ton	$28	$14,541		May 2013 Quotation for RSI Broadhurst Landfill: $16.90/T disposal. Transportation quoted at $23/ton but quoted cycle distance is 2X this estimate (260 miles vs. 130mile). Use 1/2 quoted rate.
Sediment Removal at Box Culvert / New Construction Transition						
Excavation & Removal	900	CY	$23	$20,334		See Detail. 3 foot removal across area.
Solidification	900	CY	$4	$3,611		31 32 13.19 2060 - Lime Soil Stabilization in prep for T&D. Unit converted $/SY to $/CY, based on 2% mix, 12" deep. $12.05/SY @ 1 Foot = $12.05*.333 CY
Transportation & Disposal, non-haz	1,440	Ton	$28	$40,896		May 2013 Quotation for RSI Broadhurst Landfill: $16.90/T disposal. Transportation quoted at $23/ton but quoted cycle distance is 2X this estimate (260 miles vs. 130mile). Use 1/2 quoted rate.
Outfall Ditch Excavation						
Excavation & Removal	0	CY	$28	$0		See Detail. No over-excavation. Outfall is only filled.
Solidification	0	CY	$4	$0		31 32 13.19 2060 - Lime Soil Stabilization in prep for T&D. Unit converted $/SY to $/CY, based on 2% mix, 12" deep. $12.05/SY @ 1 Foot = $12.05*.333 CY
Transportation & Disposal, non-haz	0	Ton	$28	$0		May 2013 Quotation for RSI Broadhurst Landfill: $16.90/T disposal. Transportation quoted at $23/ton but quoted cycle distance is 2X this estimate (260 miles vs. 130mile). Use 1/2 quoted rate.
Excavation within Sheetpile Structure (incl. over-excavation beneath concrete lining)						
Excavation & Removal	16,400	CY	$10	$161,379		See detail. For Option 1A, assumes Outfall is backfilled to outside of sheetpile and excavtion occurs from on grade into sheetpile area. All excavated materials are suitable as backfill in outfall ditch.
Solidification	0	CY	$4	$0		31 32 13.19 2060 - Lime Soil Stabilization in prep for T&D. Unit converted $/SY to $/CY, based on 2% mix, 12" deep. $12.05/SY @ 1 Foot = $12.05*.333 CY
Transportation & Disposal, non-haz	0	Ton	$28	$0		May 2013 Quotation for RSI Broadhurst Landfill: $16.90/T disposal. Transportation quoted at $23/ton but quoted cycle distance is 2X this estimate (260 miles vs. 130mile). Use 1/2 quoted rate.
Box Culvert Excavation, incl. over-excavation						
Excavation & Removal	0	CY	$10	$0		See detail.
Solidification	0	CY	$4	$0		31 32 13.19 2060 - Lime Soil Stabilization in prep for T&D. Unit converted $/SY to $/CY, based on 2% mix, 12" deep. $12.05/SY @ 1 Foot = $12.05*.333 CY
Transportation & Disposal, non-haz	0	Ton	$28	$0		May 2013 Quotation for RSI Broadhurst Landfill: $16.90/T disposal. Transportation quoted at $23/ton but quoted cycle distance is 2X this estimate (260 miles vs. 130mile). Use 1/2 quoted rate.
Excavation - Diversion Channel (incl. over-excavation beneath concrete lining)						

Option 2 Sheetpile Re-Routed
Terry Creek ROM Cost Options

Item Description	Quantity	Unit	Unit Rate	Total	Subtotal	Comment
Excavation & Removal	0	CY	$10	$0		See Detail. Not Applicable
Solidification	0	CY	$4	$0		31 32 13.19 2060 - Lime Soil Stabilization in prep for T&D. Unit converted $/SY to $/CY, based on 2% mix, 12" deep. $12.05/SY @ 1 Foot = $12.05*.333 CY
Transportation & Disposal, non-haz	0	Ton	$28	$0		May 2013 Quotation for RSI Broadhurst Landfill: $16.90/T disposal. Transportation quoted at $23/ton but quoted cycle distance is 2X this estimate (260 miles vs. 130mile). Use 1/2 quoted rate.
Earthwork - Rip Rap Preparation - Dupree Creek	5	Day	$7,584	$37,921		See Detail. Preparation of areas along Dupree Creek for installation of rip rap armoring.
				Subtotal	**$316,013**	
Earthwork - Backfill & Compaction						
Backfill Outfall Ditch						
Geotextile Installation	20,000	SY	$2	$43,800		32 11 23.23 6000. 6 oz/SY fabric. Adjust for difficult installation location. RSMeans provide +50% for small or irregular areas
Import Backfill, Procure & Deliver	10,800	CY	$3	$36,288		31 23 23.20 4040. Ave cycle 4 miles @ 25 mph. Assume $0 to purchase backfill. Assumes that excavated materials within sheetpile and over-excavation under new weir structure can be used as backfill to offset import.
Backfill & Compaction	26,000	CY	$8	$196,820		See Detail
Fine Grading	17,067	SY	$0.2	$3,413		31 22 16.10 3300
Backfill Culvert Installation						
Geotextile Installation	0	SY	$2	$0		32 11 23.23 6000. 6 oz/SY fabric. Adjust for difficult installation location. RSMeans provide +50% for small or irregular areas
Import Backfill, Procure & Deliver	0	CY	$3	$0		31 23 23.20 4040. Ave cycle 4 miles @ 25 mph. Assume $0 to purchase backfil
Bedding Placement	0	CY	43.1	$0		See Detail
Backfill & Compaction	0	CY	$8	$0		See Detail
Fine Grading	0	SY	$0.2	$0		31 22 16.10 3300
				Subtotal	**$280,321**	
Earthwork - Sub-Aqueous Cap Installation						
Sub-Aqueous Cap	0	SF	$4	$0		See Detail. Not applicable.
				Subtotal	**$0**	
Earthwork - Aggregates and Armoring						
Rip Rap Armor - Dupree Creek						
Geotextile Underlayment	0	SY	$1	$0		32 11 23.23 6000. 6 oz/SY fabric.
Rip Rap Placement	6,300	Ton	$56	$355,212		See Detail
Sub-Aqueous Rip Rap Armor - Outfall Ditch						
Geotextile Underlayment	0	SY	$2	$0		32 11 23.23 6000. 6 oz/SY fabric. Adjust for difficult installation location. RSMeans provide +50% for small or irregular areas. Not
Rip Rap Placement	0	Ton	$56	$0		See Detail. Not applicable
Sub-Aqueous "Fabri-Form" Armor - Outfall Ditch						
Geotextile Underlayment	0	SY	$2	$0		32 11 23.23 6000. 6 oz/SY fabric. Adjust for difficult installation location. RSMeans provide +50% for small or irregular areas. Not
Armor System Placement	0	SF	$7	$0		See Detail. Not applicable
				Subtotal	**$355,212**	
Systems Construction / De-Construction						
Demolition						
Existing Weir Structure	70	LF	$406	$28,407		See Detail
Existing Box Culvert/Wing Wall Structures	12	LF	$406	$4,870		See Detail
Cast In Place Concrete						
Box Culvert Transition	5	CY	$380	$1,900		03 30 53.40 4260 - 10' wall, 12" thick, free standing, cast in place. Not applicable.
Sheetpile Channel Bottom	30,750	SF	$8	$238,097		See Detail
Concrete Lined Channel	0	SF	$8	$0		See Detail
GC Markup	$239,997	%	15%	$36,000		GC markup on subcontracted costs
Pre-Cast Culverts	0	LF	$2,110	$0		See Detail. Need to adjust production for in or out of ditch. Not applicable.
Sheetpile Installation						
Work Over Water, Additive Cost	0	% base cost	$11	$0		31 06 60.14 1600. All work provided from land surface
Channel Walls, Steel	46,600	SF	$36	$1,677,600		Sheetpile installed plus $6/SF accomodation for bracing. J. Duffey, WRSCompass 21 August 2013.
GC Markup	$1,677,600	%	10%	$167,760		GC markup on subcontracted costs
				Subtotal	**$2,154,634**	
Final Restoration, Stabilization, Protection						
Permanent Security Fencing						
Fencing	2,500	LF	$28	$70,000		032 31 13.20 0200
Double Swing Gate	3	Each	$1,100	$3,300		032 31 13.20 5060
GC Markup	$73,300	%	15%	$10,995		GC markup on subcontracted costs
Permanent E&S Measures						
Silt Fencing / E&S	1,000	LF	$1.20	$1,200		31 25 14.16 1100
Drainage Ditches	1,000	LF	$0.30	$300		31 23 19.10 0020 (30 ft wide x 1 ft deep)
Checks Dams or Other BMP	50	Ton	$56	$2,819		See Detail
Site Restoration / Revegetation	10	Acre	$3,612	$36,481		See Detail
				Subtotal	**$125,095**	
			TOTAL	**$4,187,958**		

Notes:

General Approach

Site Preparation is followed by installation of sheet pile channel.
Sheetpile temporarily installed across Dupree Creek end of new weir structure to mitigate water instrusion during construction.
Excavate soil within new sheetpile leaving soil plug at upper end of sheetpile to prevent water intrusion from culverts.
Use excavated soil to backfill outfall ditch- stockpiled following excavation, then placed in ditch followingre-routing into the outfall ditch.
Construct armoring at end of new channel.
Outfall is re-routed; backfill outfall ditch; install armoring at end of outfall ditch.

Option 2A Sheetpile Channel
Terry Creek ROM Cost Options

Item Description	Quantity	Unit	Unit Rate	Total	Subtotal	Comment
Oversight & Other Third Party Services						
CM/CQA oversight	30	Week	$9,730	$291,900		See Detail
				Subtotal	**$291,900**	
Pre-Mobilization						
Work Plans	1	LS	$10,000	$10,000		Eng. Est.
HASP	1	LS	$2,000	$2,000		Eng. Est.
Bonds	$3,974,110	%	1.0%	$39,741		01 31 13.90 0190
				Subtotal	**$51,741**	
Contractor's Project Management, Site Set-up, Admin.						
Project Manager	30	Week	$3,350	$100,500		01 31 13.20 0200
Home Office Costs	$3,824,938	%	3.90%	$149,173		01 31 13.40 0300
Insurance	$3,801,369	%	0.62%	$23,568		01 31 13.30 0250
Site Trailer	8	Mth	$375	$3,000		01 52 13.20 0700 - 50' x 12' rental
Utilities, Furniture, ODC's	8	Mth	$894	$7,148		See Detail
Survey						
Initial Layout	40	Hr	$144	$5,750		Eng. Est. - incl. 15% markup on raw cost for GC pass through/markup
On-Going	240	Hr	$144	$34,500		Eng. Est. Assumed to be one day per week.
As-Built	40	Hr	$144	$5,750		Eng. Est.
				Subtotal	**$329,389**	
Initial Site Preparation and Controls						
Mobilization/Demobilization						
General Contractor / Earthwork	1	LS	$14,655	$14,655		See Detail
Sheetpile	2	LS	$30,000	$60,000		Per J. Duffey est., 21 Aug 2013. One for main channel, under new weir structure, and at end of new weir structure to prevent water intrusion. One for transition at completion.
Concrete	1	LS	$8,130	$8,130		See Detail
Construction Entrance / Access Roads	2,000	LF	$13	$26,577		See Detail
Truck Wash / Decon Station, Materials only	3	Each	$6,000	$18,000		http://www.dultmeier.com/products/0.165.2399/996. portable truck wash pad, assume 3 used for project (semi-disposable).
Clearing & Grubbing	1.7	Acre	$6,675	$11,493		See Detail. Assume 500 LF x 100 FT on S. Side (incl. laydown area) and 500 x 50 ft on north side for access.
Construction Fencing / Security	2,500	LF	$4	$9,650		02 58 13.10 7001
Silt Fencing / E&S	2,500	LF	$1.20	$3,000		31 25 14.16 1100
Turbidity Curtain	500	LF	$28.00	$14,000		http://www.ctre.iastate.edu/erosion/manuals/construction/3.6_floatation_silt.pdf
Laydown Area Preparation	1	Acre	$38,962	$38,962		See Detail
				Subtotal	**$204,466**	
Dewatering / By-Pass Pumping / Water Management						
Water Management at Triple Box Culvert						
Pump Systems	10	Day	$3,321	$33,214		18" pump with 400 feet hose, $ based on NS rate from Hertz Equipment Rental, 24hr/day operation, NO wellpoint
Dam / Diversion Structures	800	SF	$39	$31,200		31 52 16.10 0060 - Barge, Driven Sheetpile Cofferdam. Walls to prevent intrusion. 40 LF wide by 20 ft deep sheet
Dewatering of Outfall Ditch	20	Day	$1,575	$31,500		31 23 19.20 1100 & 1120 (2nd pump)
Routine Storm Water Management - Excavations, etc.	128	Day	$1,200	$153,600		31 23 19.20 1100 at 75% utilization - i.e., days not operated have not labor or fuel charges but rent is still incurred.
				Subtotal	**$249,514**	
Earthwork - Excavation & Removal						
Sediment Removal within Existing Triple Box Culvert						
Excavation & Removal	300	CY	$120	$36,127		See Detail. Assumed removal area, 3 ft deep sediment, 150 LF x 18 ft wide
Solidification	300	CY	$4	$1,204		31 32 13.19 2060 - Lime Soil Stabilization in prep for T&D. Unit converted $/SY to $/CY, based on 2% mix, 12" deep. $12.05/SY @ 1 Foot = $12.05*.333 CY
Transportation & Disposal, non-haz	512	Ton	$28	$14,541		May 2013 Quotation for RSI Broadhurst Landfill: $16.90/T disposal. Transportation quoted at $23/ton but quoted cycle distance is 2X this estimate (260 miles vs. 130mile). Use 1/2 quoted rate.
Sediment Removal at Box Culvert / New Construction Transition						
Excavation & Removal	900	CY	$23	$20,334		See Detail. 3 foot removal across area.
Solidification	900	CY	$4	$3,611		31 32 13.19 2060 - Lime Soil Stabilization in prep for T&D. Unit converted $/SY to $/CY, based on 2% mix, 12" deep. $12.05/SY @ 1 Foot = $12.05*.333 CY
Transportation & Disposal, non-haz	1,440	Ton	$28	$40,896		May 2013 Quotation for RSI Broadhurst Landfill: $16.90/T disposal. Transportation quoted at $23/ton but quoted cycle distance is 2X this estimate (260 miles vs. 130mile). Use 1/2 quoted rate.
Outfall Ditch Excavation						
Excavation & Removal	741	CY	$28	$20,996		See Detail. Excavation effort to re-route water to north side of the outfall ditch. Assume 10 foot ditch, 2 feet deep, 1,000 LF completed with long reach, T&D needed.
Solidification	741	CY	$4	$2,972		31 32 13.19 2060 - Lime Soil Stabilization in prep for T&D. Unit converted $/SY to $/CY, based on 2% mix, 12" deep. $12.05/SY @ 1 Foot = $12.05*.333 CY
Transportation & Disposal, non-haz	1,185	Ton	$28	$33,659		May 2013 Quotation for RSI Broadhurst Landfill: $16.90/T disposal. Transportation quoted at $23/ton but quoted cycle distance is 2X this estimate (260 miles vs. 130mile). Use 1/2 quoted rate.
Shaping						
Excavation within Sheetpile Structure						
(incl. over-excavation beneath concrete lining)						
Excavation & Removal,backfill soil within sheetpile	6,167	CY	$10	$60,681		See detail. For Option 1A, assumes Outfall is backfilled to outside of sheetpile and excavtion occurs from on grade into sheetpile area. One half ditch is a 2 foot fill, one half ditch is a 4.5 foot fill.
Excavation & Removal, overexcavation within sheetpile	6,750	CY	$15	$100,296		See detail. For Option 1A, assumes Outfall is backfilled to outside of sheetpile and excavtion occurs from on grade into sheetpile area.
Solidification	6,750	CY	$4	$27,085		31 32 13.19 2060 - Lime Soil Stabilization in prep for T&D. Unit converted $/SY to $/CY, based on 2% mix, 12" deep. $12.05/SY @ 1 Foot = $12.05*.333 CY
Transportation & Disposal, non-haz	12,000	Ton	$28	$340,800		May 2013 Quotation for RSI Broadhurst Landfill: $16.90/T disposal. Transportation quoted at $23/ton but quoted cycle distance is 2X this estimate (260 miles vs. 130mile). Use 1/2 quoted rate.
Box Culvert Excavation, incl. over-excavation						
Excavation & Removal	0	CY	$7	$0		See detail. Not applicable
Solidification	0	CY	$4	$0		31 32 13.19 2060 - Lime Soil Stabilization in prep for T&D. Unit converted $/SY to $/CY, based on 2% mix, 12" deep. $12.05/SY @ 1 Foot = $12.05*.333 CY
Transportation & Disposal, non-haz	0	Ton	$28	$0		May 2013 Quotation for RSI Broadhurst Landfill: $16.90/T disposal. Transportation quoted at $23/ton but quoted cycle distance is 2X this estimate (260 miles vs. 130mile). Use 1/2 quoted rate.
Excavation - Diversion Channel						
(incl. over-excavation beneath concrete lining)						
Excavation & Removal	0	CY	$7	$0		See Detail.
Solidification	0	CY	$4	$0		31 32 13.19 2060 - Lime Soil Stabilization in prep for T&D. Unit converted $/SY to $/CY, based on 2% mix, 12" deep. $12.05/SY @ 1 Foot = $12.05*.333 CY

Option 2A Sheetpile Channel
Terry Creek ROM Cost Options

Item Description	Quantity	Unit	Unit Rate	Total	Subtotal	Comment
Transportation & Disposal, non-haz	0	Ton	$28	$0		May 2013 Quotation for RSI Broadhurst Landfill: $16.90/T disposal. Transportation quoted at $23/ton but quoted cycle distance is 2X this estimate (260 miles vs. 130mile). Use 1/2 quoted rate.
Earthwork - Rip Rap Preparation - Dupree Creek	5	Day	$7,584	$37,921		See Detail. Preparation of areas along Dupree Creek for installation of rip rap armoring.
				Subtotal	**$741,124**	
Earthwork - Backfill & Compaction						
Backfill Outfall Ditch						
Geotextile Installation	20,000	SY	$2	$43,800		32 11 23.23 6000. 6 oz/SY fabric. Adjust for difficult installation location. RSMeans provide +50% for small or irregular areas.
Import Backfill, Procure & Deliver	20,000	CY	$3	$67,200		31 23 23.20 4040. Ave cycle 4 miles @ 25 mph. Assume $0 to purchase backfill.
Backfill & Compaction	26,167	CY	$8	$198,082		See Detail. This will be completed in two stages - south half (for sheetpile installation) followed by north side (following re-routing). Backfill located within sheetpile will be double handled for backfilling. Intial fill followed by excavation from within sheetpile then backfilled into north side of outfall ditch fill.
Fine Grading	15,400	SY	$0.2	$3,080		31 22 16.10 3300
Backfill Culvert Installation						
Geotextile Installation	0	SY	$2	$0		32 11 23.23 6000. 6 oz/SY fabric. Adjust for difficult installation location. RSMeans provide +50% for small or irregular areas.
Import Backfill, Procure & Deliver	0	CY	$3	$0		31 23 23.20 4040. Ave cycle 4 miles @ 25 mph. Assume $0 to purchase backfill
Bedding Placement	0	CY	43.1	$0		See Detail
Backfill & Compaction	0	CY	$8	$0		See Detail
Fine Grading	0	SY	$0.2	$0		31 22 16.10 3300
Backfill within Sheetpile						
Geotextile Installation	0	SY	$2	$0		32 11 23.23 6000. 6 oz/SY fabric. Adjust for difficult installation location. RSMeans provide +50% for small or irregular areas.
Import Backfill, Procure & Deliver	3,000	CY	$3	$10,080		31 23 23.20 4040. Ave cycle 4 miles @ 25 mph. Assume $0 to purchase backfill
Bedding Placement	3,000	CY	$1	$3,000		See Detail
Backfill & Compaction	4,500	CY	$8	$34,065		See Detail
Fine Grading	1,667	SY	$0.2	$333		31 22 16.10 3300
				Subtotal	**$359,640**	
Earthwork - Sub-Aqueous Cap Installation						
Sub-Aqueous Cap	0	SF	$4	$0		See Detail
				Subtotal	**$0**	
Earthwork - Aggregates and Armoring						
Rip Rap Armor - Dupree Creek						
Geotextile Underlayment		SY	$1	$0		32 11 23.23 6000. 6 oz/SY fabric.
Rip Rap Placement	4,500	Ton	$56	$253,723		See Detail
Sub-Aqueous Rip Rap Armor - Outfall Ditch						
Geotextile Underlayment	0	SY	$2	$0		32 11 23.23 6000. 6 oz/SY fabric. Adjust for difficult installation location. RSMeans provide +50% for small or irregular areas. Not applicable.
Rip Rap Placement	0	Ton	$56	$0		See Detail. Not applicable
Sub-Aqueous "Fabri-Form" Armor - Outfall Ditch						
Geotextile Underlayment	0	SY	$2	$0		32 11 23.23 6000. 6 oz/SY fabric. Adjust for difficult installation location. RSMeans provide +50% for small or irregular areas. Not applicable.
Armor System Placement	0	SF	$7	$0		See Detail. Not applicable
				Subtotal	**$253,723**	
Systems Construction / De-Construction						
Demolition						
Existing Weir Structure	70	LF	$406	$28,407		See Detail
Existing Box Culvert/Wing Wall Structures	11	LF	$406	$4,464		See Detail
Cast In Place Concrete						
Box Culvert Transition	5	CY	$380	$1,900		03 30 53.40 4260 - 10' wall, 12" thick, free standig, cast in place
Concrete Lined Channel	0	SF	$8	$0		See Detail
Sheetpile Channel Bottom	27,000	SF	$8	$209,061		See Detail
Concrete Apron - Post New Weir	2,250	SF	$8	$17,422		See Detail
GC Markup	$228,383	%	15%	$34,257		GC markup on subcontracted costs
Pre-Cast Culverts	0	LF	$2,110	$0		See Detail. Need to adjust production for in or out of ditch
Sheetpile Installation						
Work Over Water, Additive Cost	0	% base cost	$11	$0		31 06 60.14 1600
Channel Walls, Steel	36,000	SF	$36	$1,296,000		Sheetpile installed plus $6/SF accomodation for bracing. J. Duffey, WRSCompass 21 August 2013.
GC Markup	$1,296,000	%	10%	$129,600		GC markup on subcontracted costs
				Subtotal	**$1,721,111**	
Final Restoration, Stabilization, Protection						
Permanent Security Fencing						
Fencing	2,050	LF	$28	$57,400		032 31 13.20 0200
Double Swing Gate	3	Each	$1,100	$3,300		032 31 13.20 5060
GC Markup	$60,700	%	15%	$9,105		GC markup on subcontracted costs
Permanent E&S Measures						
Silt Fencing / E&S	1,000	LF	$1.20	$1,200		31 25 14.16 1100
Drainage Ditches	1,000	LF	$0.30	$300		31 23 19.10 0020 (30 ft wide x 1 ft deep)
Checks Dams or Other BMP	50	Ton	$56	$2,819		See Detail
Site Restoration / Revegetation	8	Acre	$3,612	$29,019		See Detail
				Subtotal	**$103,143**	
			TOTAL	**$4,305,751**		

Notes:

General Approach

Site Preparation is followed by backfilling southern side of the existing outfall. Stormwater is allowed to tranverse north side of outfall ditch. Some grading needed to re-route natural flow to north.
Install sheetpile through backfilled portion of outfall.
Excavate soil within new sheetpile leaving soil plug at upper end of sheetpile to prevent water intrusion from culverts.
Use excavated soil to backfill outfall ditch- stockpiled following excavation, then placed in ditch followingre-routing into the outfall ditch.
Construct armoring at end of new channel.
Remob sheetpile rig. Install sheetpile at transition area.
Outfall is re-routed; backfill north side of outfall ditch; install armoring at end of outfall ditch.

Option 3 Concrete Re-Routed
Terry Creek ROM Cost Options

Item Description	Quantity	Unit	Unit Rate	Total	Subtotal	Comment
Oversight & Other Third Party Services						
CM/CQA oversight	25	Week	$9,730	$243,250		See Detail
				Subtotal	**$243,250**	
Pre-Mobilization						
Work Plans	1	LS	$10,000	$10,000		Eng. Est.
HASP	1	LS	$2,000	$2,000		Eng. Est.
Bonds	$2,355,261	%	1.0%	$23,553		01 31 13.90 0190
				Subtotal	**$35,553**	
Contractor's Project Management, Site Set-up, Admin.						
Project Manager	25	Week	$3,350	$83,750		01 31 13.20 0200
Home Office Costs	$2,266,853	%	3.90%	$88,407		01 31 13.40 0300
Insurance	$2,252,885	%	0.62%	$13,968		01 31 13.30 0250
Site Trailer	7	Mth	$375	$2,625		01 52 13.20 0700 - 50' x 12' rental
Utilities, Furniture, ODC's	7	Mth	$894	$6,255		See Detail
Survey						
Initial Layout	40	Hr	$144	$5,750		Eng. Est. - incl. 15% markup on raw cost for GC pass through/markup
On-Going	200	Hr	$144	$28,750		Eng. Est. Assumed to be one day per week.
As-Built	60	Hr	$144	$8,625		Eng. Est.
				Subtotal	**$238,130**	
Initial Site Preparation and Controls						
Mobilization/Demobilization						
General Contractor / Earthwork	1	LS	$14,655	$14,655		See Detail
Concrete	2	LS	$8,130	$16,260		See Detail. One each for weir, lining, and transistion tie-in
Construction Entrance / Access Roads	2,000	LF	$13	$26,577		See Detail
Truck Wash / Decon Station, Materials only	3	Each	$6,000	$18,000		http://www.dultmeier.com/products/0.165.2399/996. portable truck wash pad, assume 3 used for project (semi-disposable).
Clearing & Grubbing	1.7	Acre	$6,675	$11,493		See Detail. Assume 500 LF x 100 FT on S. Side (incl. laydown area) and 500 x 50 ft on north side for access.
Construction Fencing / Security	2,500	LF	$4	$9,650		02 58 13.10 7001
Silt Fencing / E&S	2,500	LF	$1.20	$3,000		31 25 14.16 1100
Turbidity Curtain	500	LF	$28.00	$14,000		http://www.ctre.iastate.edu/erosion/manuals/construction/3.6_floatation_silt.pdf
Laydown Area Preparation	1	Acre	$38,962	$38,962		See Detail
				Subtotal	**$152,596**	
Dewatering / By-Pass Pumping / Water Management						
Water Management at Triple Box Culvert						
Pump Systems	10	Day	$3,321	$33,214		18" pump with 400 feet hose, $ based on NS rate from Hertz Equipment Rental, 24hr/day operation, NO wellpoint
Dam / Diversion Structures	1500	SF	$39	$58,500		31 52 16.10 0060 - Barge, Driven Sheetpile Cofferdam. Walls to prevent intrusion. 40 LF wide by 20 ft deep sheet
Dewatering of Outfall Ditch	30	Day	$1,575	$47,250		31 23 19.20 1100 & 1120 (2nd pump)
Routine Storm Water Management - Excavations, etc.	94	Day	$1,200	$112,500		31 23 19.20 1100 at 75% utilization - i.e., days not operated have not labor or fuel charges but rent is still incurred.
				Subtotal	**$251,464**	
Earthwork - Excavation & Removal						
Sediment Removal within Existing Triple Box Culvert						
Excavation & Removal	300	CY	$120	$36,127		See Detail. Assumed removal area, 3 ft deep sediment, 150 LF x 18 ft wide
Solidification	300	CY	$4	$1,204		31 32 13.19 2060 - Lime Soil Stabilization in prep for T&D. Unit converted $/SY to $/CY, based on 2% mix, 12" deep. $12.05/SY @ 1 Foot = $12.05*.333 CY
Transportation & Disposal, non-haz	512	Ton	$28	$14,541		May 2013 Quotation for RSI Broadhurst Landfill: $16.90/T disposal. Transportation quoted at $23/ton but quoted cycle distance is 2X this estimate (260 miles vs. 130mile). Use 1/2 quoted rate.
Sediment Removal at Box Culvert / New Construction Transition						
Excavation & Removal	900	CY	$23	$20,334		See Detail. 3 foot removal across area.
Solidification	900	CY	$4	$3,611		31 32 13.19 2060 - Lime Soil Stabilization in prep for T&D. Unit converted $/SY to $/CY, based on 2% mix, 12" deep. $12.05/SY @ 1 Foot = $12.05*.333 CY
Transportation & Disposal, non-haz	1,440	Ton	$28	$40,896		May 2013 Quotation for RSI Broadhurst Landfill: $16.90/T disposal. Transportation quoted at $23/ton but quoted cycle distance is 2X this estimate (260 miles vs. 130mile). Use 1/2 quoted rate.
Outfall Ditch Excavation						
Excavation & Removal	0	CY	$28	$0		See Detail
Solidification	0	CY	$4	$0		31 32 13.19 2060 - Lime Soil Stabilization in prep for T&D. Unit converted $/SY to $/CY, based on 2% mix, 12" deep. $12.05/SY @ 1 Foot = $12.05*.333 CY
Transportation & Disposal, non-haz	0	Ton	$28	$0		May 2013 Quotation for RSI Broadhurst Landfill: $16.90/T disposal. Transportation quoted at $23/ton but quoted cycle distance is 2X this estimate (260 miles vs. 130mile). Use 1/2 quoted rate.
Shaping						
Excavation within Sheetpile Structure (incl. over-excavation beneath concrete lining)						
Excavation & Removal	0	CY	$10	$0		See detail. Not applicable.
Solidification	0	CY	$4	$0		31 32 13.19 2060 - Lime Soil Stabilization in prep for T&D. Unit converted $/SY to $/CY, based on 2% mix, 12" deep. $12.05/SY @ 1 Foot = $12.05*.333 CY
Transportation & Disposal, non-haz	0	Ton	$28	$0		May 2013 Quotation for RSI Broadhurst Landfill: $16.90/T disposal. Transportation quoted at $23/ton but quoted cycle distance is 2X this estimate (260 miles vs. 130mile). Use 1/2 quoted rate.
Box Culvert Excavation, incl. over-excavation						
Excavation & Removal	0	CY	$10	$0		See detail. For Option 1A, assumes Outfall is backfilled to outside of sheetpile and excavtion occurs from on grade into sheetpile area.
Solidification	0	CY	$4	$0		31 32 13.19 2060 - Lime Soil Stabilization in prep for T&D. Unit converted $/SY to $/CY, based on 2% mix, 12" deep. $12.05/SY @ 1 Foot = $12.05*.333 CY
Transportation & Disposal, non-haz	0	Ton	$28	$0		May 2013 Quotation for RSI Broadhurst Landfill: $16.90/T disposal. Transportation quoted at $23/ton but quoted cycle distance is 2X this estimate (260 miles vs. 130mile). Use 1/2 quoted rate.
Excavation - Diversion Channel (incl. over-excavation beneath concrete lining)						

Option 3 Concrete Re-Routed
Terry Creek ROM Cost Options

Item Description	Quantity	Unit	Unit Rate	Total	Subtotal	Comment
Excavation & Removal	15,400	CY	$10	$151,539		See Detail.
Solidification	0	CY	$4	$0		31 32 13.19 2060 - Lime Soil Stabilization in prep for T&D. Unit converted $/SY to $/CY, based on 2% mix, 12" deep. $12.05/SY @ 1 Foot = $12.05*.333 CY
Transportation & Disposal, non-haz	0	Ton	$28	$0		May 2013 Quotation for RSI Broadhurst Landfill: $16.90/T disposal. Transportation quoted at $23/ton but quoted cycle distance is 2X this estimate (260 miles vs. 130mile). Use 1/2 quoted rate.
Earthwork - Rip Rap Preparation - Dupree Creek	5	Day	$7,584	$37,921		See Detail. Preparation of areas along Dupree Creek for installation of rip rap armoring.
				Subtotal	**$306,173**	
Earthwork - Backfill & Compaction						
Backfill Outfall Ditch						
Geotextile Installation	20,000	SY	$2	$43,800		32 11 23.23 6000. 6 oz/SY fabric. Adjust for difficult installation location. RSMeans provide +50% for small or irregular areas.
Import Backfill, Procure & Deliver	10,600	CY	$3	$35,616		31 23 23.20 4040. Ave cycle 4 miles @ 25 mph. Assume $0 to purchase backfill.
Backfill & Compaction	26,000	CY	$8	$196,820		See Detail
Fine Grading	15,400	SY	$0.2	$3,080		31 22 16.10 3300
Backfill Culvert Installation						
Geotextile Installation	0	SY	$2	$0		32 11 23.23 6000. 6 oz/SY fabric. Adjust for difficult installation location. RSMeans provide +50% for small or irregular areas.
Import Backfill, Procure & Deliver	0	CY	$3	$0		31 23 23.20 4040. Ave cycle 4 miles @ 25 mph. Assume $0 to purchase backfill
Bedding Placement	0	CY	43.1	$0		See Detail
Backfill & Compaction	0	CY	$8	$0		See Detail
Fine Grading	0	SY	$0.2	$0		31 22 16.10 3300
				Subtotal	**$279,316**	
Earthwork - Sub-Aqueous Cap Installation						
Sub-Aqueous Cap	0	SF	$4	$0		See Detail
				Subtotal	**$0**	
Earthwork - Aggregates and Armoring						
Rip Rap Armor - Dupree Creek						
Geotextile Underlayment		SY	$1	$0		32 11 23.23 6000. 6 oz/SY fabric.
Rip Rap Placement	6,300	Ton	$56	$355,212		See Detail
Sub-Aqueous Rip Rap Armor - Outfall Ditch						
Geotextile Underlayment	0	SY	$2	$0		32 11 23.23 6000. 6 oz/SY fabric. Adjust for difficult installation location. RSMeans provide +50% for small or irregular areas. Not applicable.
Rip Rap Placement	0	Ton	$56	$0		See Detail. Not applicable
Sub-Aqueous "Fabri-Form" Armor - Outfall Ditch						
Geotextile Underlayment	8,600	SY	$2	$18,834		32 11 23.23 6000. 6 oz/SY fabric. Adjust for difficult installation location. RSMeans provide +50% for small or irregular areas. Not applicable.
Armor System Placement	77,400	SF	$7	$579,984		See Detail.
				Subtotal	**$954,030**	
Systems Construction / De-Construction						
Demolition						
Existing Weir Structure	70	LF	$406	$28,407		See Detail.
Existing Box Culvert/Wing Wall Structures	0	LF	$406	$0		See Detail
Cast In Place Concrete						
Box Culvert Transition	0	CY	$380	$0		03 30 53.40 4260 - 10' wall, 12" thick, free standig, cast in place
Sheetpile Channel Bottom	0	SF	$8	$0		See Detail
Concrete Lined Channel	0	SF	$8	$0		See Detail
GC Markup	$0	%	15%	$0		GC markup on subcontracted costs
Pre-Cast Culverts	0	LF	$2,110	$0		See Detail. Need to adjust production for in or out of ditch
Sheetpile Installation						
Work Over Water, Additive Cost	0	% base cost	$11	$0		31 06 60.14 1600
Channel Walls, Steel	0	SF	$36	$0		Sheetpile installed plus $6/SF accomodation for bracing. J. Duffey, WRSCompass 21 August 2013.
GC Markup	$0	%	10%	$0		GC markup on subcontracted costs
				Subtotal	**$28,407**	
Final Restoration, Stabilization, Protection						
Permanent Security Fencing						
Fencing	2,750	LF	$28	$77,000		032 31 13.20 0200
Double Swing Gate	3	Each	$1,100	$3,300		032 31 13.20 5060
GC Markup	$80,300	%	15%	$12,045		GC markup on subcontracted costs
Permanent E&S Measures						
Silt Fencing / E&S	1,000	LF	$1.20	$1,200		31 25 14.16 1100
Drainage Ditches	1,000	LF	$0.30	$300		31 23 19.10 0020 (30 ft wide x 1 ft deep)
Checks Dams or Other BMP	50	Ton	$56	$2,819		See Detail
Site Restoration / Revegetation	10	Acre	$3,612	$36,481		See Detail
				Subtotal	**$133,145**	
			TOTAL	**$2,622,063**		

General Approach

Site Preparation is followed by installation of lined channel.
Soil bermed temporarily installed across Dupree Creek to mitigate water instrusion during construction.
Excavate soil within new channel leaving soil plug at upper end to prevent water intrusion from culverts.
Use excavated soil to backfill outfall ditch- stockpiled following excavation, then placed in ditch followingre-routing into the outfall ditch.
Construct armoring at end of new channel.
Outfall is re-routed; Have to construct final wing wall and transistion tie-in in wet conditions (pump around to mitigate).
Backfill outfall ditch; install armoring at end of outfall ditch.

Option 3A Concrete Channel
Terry Creek ROM Cost Options

Item Description	Quantity	Unit	Unit Rate	Total	Subtotal	Comment
Oversight & Other Third Party Services						
CM/CQA oversight	32	Week	$9,730	$311,360		See Detail
				Subtotal	**$311,360**	
Pre-Mobilization						
Work Plans	1	LS	$10,000	$10,000		Eng. Est.
HASP	1	LS	$2,000	$2,000		Eng. Est.
Bonds	$3,079,070	%	1.0%	$30,791		01 31 13.90 0190
				Subtotal	**$42,791**	
Contractor's Project Management, Site Set-up, Admin.						
Project Manager	32	Week	$3,350	$107,200		01 31 13.20 0200
Home Office Costs	$2,963,494	%	3.90%	$115,576		01 31 13.40 0300
Insurance	$2,945,234	%	0.62%	$18,260		01 31 13.30 0250
Site Trailer	8	Mth	$375	$3,000		01 52 13.20 0700 - 50' x 12' rental
Utilities, Furniture, ODC's	8	Mth	$894	$7,148		See Detail
Survey						
Initial Layout	40	Hr	$144	$5,750		Eng. Est. - incl. 15% markup on raw cost for GC pass through/markup
On-Going	256	Hr	$144	$36,800		Eng. Est. Assumed to be one day per week.
As-Built	60	Hr	$144	$8,625		Eng. Est.
				Subtotal	**$302,360**	
Initial Site Preparation and Controls						
Mobilization/Demobilization						
General Contractor / Earthwork	1	LS	$14,655	$14,655		See Detail
Concrete	2	LS	$8,130	$16,260		See Detail. One each for weir, lining, and transistion tie-in
Construction Entrance / Access Roads	2,000	LF	$13	$26,577		See Detail
Truck Wash / Decon Station, Materials only	3	Each	$6,000	$18,000		http://www.dultmeier.com/products/0.165.2399/996. portable truck wash pad, assume 3 used for project (semi-disposable).
Clearing & Grubbing	1.7	Acre	$6,675	$11,493		See Detail. Assume 500 LF x 100 FT on S. Side (incl. laydown area) and 500 x 50 ft on north side for access.
Construction Fencing / Security	2,500	LF	$4	$9,650		02 58 13.10 7001
Silt Fencing / E&S	2,500	LF	$1.20	$3,000		31 25 14.16 1100
Turbidity Curtain	500	LF	$28.00	$14,000		http://www.ctre.iastate.edu/erosion/manuals/construction/3.6_floatation_silt.pdf
Laydown Area Preparation	1	Acre	$38,962	$38,962		See Detail
				Subtotal	**$152,596**	
Dewatering / By-Pass Pumping / Water Management						
Water Management at Triple Box Culvert						
Pump Systems	10	Day	$3,321	$33,214		18" pump with 400 feet hose, $ based on NS rate from Hertz Equipment Rental, 24hr/day operation, NO wellpoint
Dam / Diversion Structures	800	SF	$39	$31,200		31 52 16.10 0060 - Barge, Driven Sheetpile Cofferdam. Walls to prevent intrusion. 40 LF wide by 20 ft deep sheet
Dewatering of Outfall Ditch	35	Day	$1,575	$55,125		31 23 19.20 1100 & 1120 (2nd pump)
Dam / Diversion Structures	800	SF	$39	$31,200		31 52 16.10 0060 - Barge, Driven Sheetpile Cofferdam. Walls to prevent intrusion. 40 LF wide by 20 ft deep sheet
Routine Storm Water Management - Excavations, etc.	120	Day	$1,200	$144,000		31 23 19.20 1100 at 75% utilization - i.e., days not operated have not labor or fuel charges but rent is still incurred.
				Subtotal	**$294,739**	
Earthwork - Excavation & Removal						
Sediment Removal within Existing Triple Box Culvert						
Excavation & Removal	300	CY	$120	$36,127		See Detail. Assumed removal area, 3 ft deep sediment, 150 LF x 18 ft wide
Solidification	300	CY	$4	$1,204		31 32 13.19 2060 - Lime Soil Stabilization in prep for T&D. Unit converted $/SY to $/CY, based on 2% mix, 12" deep. $12.05/SY @ 1 Foot = $12.05*.333 CY
Transportation & Disposal, non-haz	512	Ton	$28	$14,541		May 2013 Quotation for RSI Broadhurst Landfill: $16.90/T disposal. Transportation quoted at $23/ton but quoted cycle distance is 2X this estimate (260 miles vs. 130mile). Use 1/2 quoted rate.
Sediment Removal at Box Culvert / New Construction Transition						
Excavation & Removal	900	CY	$23	$20,334		See Detail. 3 foot removal across area.
Solidification	900	CY	$4	$3,611		31 32 13.19 2060 - Lime Soil Stabilization in prep for T&D. Unit converted $/SY to $/CY, based on 2% mix, 12" deep. $12.05/SY @ 1 Foot = $12.05*.333 CY
Transportation & Disposal, non-haz	1,440	Ton	$28	$40,896		May 2013 Quotation for RSI Broadhurst Landfill: $16.90/T disposal. Transportation quoted at $23/ton but quoted cycle distance is 2X this estimate (260 miles vs. 130mile). Use 1/2 quoted rate.
Outfall Ditch Excavation						
Excavation & Removal	741	CY	$28	$20,996		See Detail. Excavation effort to re-route water to north side of the outfall ditch. Assume 10 foot ditch, 2 feet wide, 1,000 LF completed with long reach, T&D needed.
Solidification	741	CY	$4	$2,972		31 32 13.19 2060 - Lime Soil Stabilization in prep for T&D. Unit converted $/SY to $/CY, based on 2% mix, 12" deep. $12.05/SY @ 1 Foot = $12.05*.333 CY
Transportation & Disposal, non-haz	1,185	Ton	$28	$33,659		May 2013 Quotation for RSI Broadhurst Landfill: $16.90/T disposal. Transportation quoted at $23/ton but quoted cycle distance is 2X this estimate (260 miles vs. 130mile). Use 1/2 quoted rate.
Shaping						
Excavation within Sheetpile Structure (incl. over-excavation beneath concrete lining)						
Excavation & Removal	0	CY	$10	$0		See detail. Not Applicable.
Solidification	0	CY	$4	$0		31 32 13.19 2060 - Lime Soil Stabilization in prep for T&D. Unit converted $/SY to $/CY, based on 2% mix, 12" deep. $12.05/SY @ 1 Foot = $12.05*.333 CY
Transportation & Disposal, non-haz	0	Ton	$28	$0		May 2013 Quotation for RSI Broadhurst Landfill: $16.90/T disposal. Transportation quoted at $23/ton but quoted cycle distance is 2X this estimate (260 miles vs. 130mile). Use 1/2 quoted rate.
Box Culvert Excavation, incl. over-excavation						
Excavation & Removal	0	CY	$10	$0		See detail. Not Applicable.
Solidification	0	CY	$4	$0		31 32 13.19 2060 - Lime Soil Stabilization in prep for T&D. Unit converted $/SY to $/CY, based on 2% mix, 12" deep. $12.05/SY @ 1 Foot = $12.05*.333 CY
Transportation & Disposal, non-haz	0	Ton	$28	$0		May 2013 Quotation for RSI Broadhurst Landfill: $16.90/T disposal. Transportation quoted at $23/ton but quoted cycle distance is 2X this estimate (260 miles vs. 130mile). Use 1/2 quoted rate.
Excavation - Diversion Channel (incl. over-excavation)						

Option 3A Concrete Channel
Terry Creek ROM Cost Options

Item Description	Quantity	Unit	Unit Rate	Total	Subtotal	Comment
Excavation & Removal of backfill soil	10,833	CY	$10	$106,602		See detail. For Option 2A, assumes Outfall is backfille. Excavation of channel profile.
Excavation & Removal, over-excavation within new channel profile	7,750	CY	$28	$219,672		See detail. For Option 1A, assumes Outfall is backfilled, channel profile is excavated. Sediment excavated, solidified, and T&D
Solidification	7,750	CY	$4	$31,098		31 32 13.19 2060 - Lime Soil Stabilization in prep for T&D. Unit converted $/SY to $/CY, based on 2% mix, 12" deep. $12.05/SY @ 1 Foot = $12.05*.333 CY
Transportation & Disposal, non-haz	12,400	Ton	$28	$352,160		May 2013 Quotation for RSI Broadhurst Landfill: $16.90/T disposal. Transportation quoted at $23/ton but quoted cycle distance is 2X this estimate (260 miles vs. 130mile). Use 1/2 quoted rate.
Earthwork - Rip Rap Preparation - Dupree Creek	5	Day	$7,584	$37,921		See Detail. Preparation of areas along Dupree Creek for installation of rip rap armoring.
				Subtotal	**$921,794**	
Earthwork - Backfill & Compaction						
Backfill Outfall Ditch						
Geotextile Installation	27,750	SY	$2	$60,773		32 11 23.23 6000. 6 oz/SY fabric. Adjust for difficult installation location. RSMeans provide +50% for small or irregular areas.
Import Backfill, Procure & Deliver	15,167	CY	$3	$50,960		31 23 23.20 4040. Ave cycle 4 miles @ 25 mph. Assume $0 to purchase backfill.
Backfill & Compaction	38,417	CY	$8	$290,814		See Detail. This will be completed in two stages - south half (for channel construction) followed by north side (following re-routing). Backfill located within new channel will be double handled for backfilling. Intial fill followed by excavation from within channel contour then backfilled into north side of outfall ditch fill.
Fine Grading	22,400	SY	$0.2	$4,480		31 22 16.10 3300
Backfill Culvert Installation						
Geotextile Installation	0	SY	$2	$0		32 11 23.23 6000. 6 oz/SY fabric. Adjust for difficult installation location. RSMeans provide +50% for small or irregular areas.
Import Backfill, Procure & Deliver	0	CY	$3	$0		31 23 23.20 4040. Ave cycle 4 miles @ 25 mph. Assume $0 to purchase backfill
Bedding Placement	0	CY	43.1	$0		See Detail
Backfill & Compaction	0	CY	$8	$0		See Detail
Fine Grading	0	SY	$0.2	$0		31 22 16.10 3300
				Subtotal	**$407,027**	
Earthwork - Sub-Aqueous Cap Installation						
Sub-Aqueous Cap	0	SF	$4	$0		See Detail
				Subtotal	**$0**	
Earthwork - Aggregates and Armoring						
Rip Rap Armor - Dupree Creek						
Geotextile Underlayment	0	SY	$1	$0		32 11 23.23 6000. 6 oz/SY fabric.
Rip Rap Placement	4,500	Ton	$56	$253,723		See Detail
Sub-Aqueous Rip Rap Armor - Outfall Ditch						
Geotextile Underlayment	0	SY	$2	$0		32 11 23.23 6000. 6 oz/SY fabric. Adjust for difficult installation location. RSMeans provide +50% for small or irregular areas. Not applicable.
Rip Rap Placement	0	Ton	$56	$0		See Detail. Not applicable
Sub-Aqueous "Fabri-Form" Armor - Outfall Ditch						
Geotextile Underlayment	8,600	SY	$2	$18,834		32 11 23.23 6000. 6 oz/SY fabric. Adjust for difficult installation location. RSMeans provide +50% for small or irregular areas. Not applicable.
Armor System Placement	77,400	SF	$7	$579,984		See Detail. Not applicable
				Subtotal	**$852,541**	
Systems Construction / De-Construction						
Demolition						
Existing Weir Structure	70	LF	$406	$28,407		See Detail.
Existing Box Culvert/Wing Wall Structures	11	LF	$406	$4,464		See Detail
Cast In Place Concrete						
Box Culvert Transition	0	CY	$380	$0		03 30 53.40 4260 - 10' wall, 12" thick, free standig, cast in place
Sheetpile Channel Bottom	0	SF	$8	$0		See Detail
Concrete Lined Channel	0	SF	$8	$0		See Detail
GC Markup	$0	%	15%	$0		GC markup on subcontracted costs
Pre-Cast Culverts	0	LF	$2,110	$0		See Detail. Need to adjust production for in or out of ditch
Sheetpile Installation						
Work Over Water, Additive Cost	0	% base cost	$11	$0		31 06 60.14 1600
Channel Walls, Steel	0	SF	$36	$0		Sheetpile installed plus $6/SF accomodation for bracing. J. Duffey, WRSCompass 21 August 2013.
GC Markup	$0	%	10%	$0		GC markup on subcontracted costs
				Subtotal	**$32,871**	
Final Restoration, Stabilization, Protection						
Permanent Security Fencing						
Fencing	2,050	LF	$28	$57,400		032 31 13.20 0200
Double Swing Gate	3	Each	$1,100	$3,300		032 31 13.20 5060
GC Markup	$60,700	%	15%	$9,105		GC markup on subcontracted costs
Permanent E&S Measures						
Silt Fencing / E&S	1,000	LF	$1.20	$1,200		31 25 14.16 1100
Drainage Ditches	1,000	LF	$0.30	$300		31 23 19.10 0020 (30 ft wide x 1 ft deep)
Checks Dams or Other BMP	50	Ton	$56	$2,819		See Detail
Site Restoration / Revegetation	8	Acre	$3,612	$29,019		See Detail
				Subtotal	**$103,143**	
			TOTAL	**$3,421,221**		

General Approach

Site Preparation is followed by installation of lined channel.
Soil berming temporarily installed across Dupree Creek end to mitigate water instrusion during construction.
Excavate soil within new channel leaving soil plug at upper end of sheetpile to prevent water intrusion from culverts.
Use excavated soil to backfill outfall ditch- stockpiled following excavation, then placed in ditch followingre-routing into the outfall ditch.
Construct armoring at end of new channel.
Outfall is re-routed; Have to construct final wing wall and transistion tie-in in wet conditions (pump around to mitigate).
Backfill outfall ditch; install armoring at end of outfall ditch.

Option 4 Culvert Re-Routed
Terry Creek ROM Cost Options

Item Description	Quantity	Unit	Unit Rate	Total	Subtotal	Comment
Oversight & Other Third Party Services						
CM/CQA oversight	28	Week	$9,730	$272,440		See Detail
				Subtotal	**$272,440**	
Pre-Mobilization						
Work Plans	1	LS	$10,000	$10,000		Eng. Est.
HASP	1	LS	$2,000	$2,000		Eng. Est.
Bonds	$4,077,869	%	1.0%	$40,779		01 31 13.90 0190
				Subtotal	**$52,779**	
Contractor's Project Management, Site Set-up, Admin.						
Project Manager	28	Week	$3,350	$93,800		01 31 13.20 0200
Home Office Costs	$3,924,802	%	3.90%	$153,067		01 31 13.40 0300
Insurance	$3,900,618	%	0.62%	$24,184		01 31 13.30 0250
Site Trailer	7	Mth	$375	$2,625		01 52 13.20 0700 - 50' x 12' rental
Utilities, Furniture, ODC's	7	Mth	$894	$6,255		See Detail
Survey						
Initial Layout	40	Hr	$144	$5,750		Eng. Est. - incl. 15% markup on raw cost for GC pass through/markup
On-Going	224	Hr	$144	$32,200		Eng. Est. Assumed to be one day per week.
As-Built	40	Hr	$144	$5,750		Eng. Est.
				Subtotal	**$323,631**	
Initial Site Preparation and Controls						
Mobilization/Demobilization						
General Contractor / Earthwork	1	LS	$14,655	$14,655		See Detail
Concrete	1	LS	$8,130	$8,130		See Detail
Construction Entrance / Access Roads	2,000	LF	$13	$26,577		See Detail
Truck Wash / Decon Station, Materials only	3	Each	$6,000	$18,000		http://www.dultmeier.com/products/0.165.2399/996. portable truck wash pad, assume 3 used for project (semi-disposable).
Clearing & Grubbing	1.7	Acre	$6,675	$11,493		See Detail. Assume 500 LF x 100 FT on S. Side (incl. laydown area) and 500 x 50 ft on north side for access.
Construction Fencing / Security	2,500	LF	$4	$9,650		02 58 13.10 7001
Silt Fencing / E&S	2,500	LF	$1.20	$3,000		31 25 14.16 1100
Turbidity Curtain	500	LF	$28.00	$14,000		http://www.ctre.iastate.edu/erosion/manuals/construction/3.6_floatation_silt.pdf
Laydown Area Preparation	1	Acre	$38,962	$38,962		See Detail
				Subtotal	**$144,466**	
Dewatering / By-Pass Pumping / Water Management						
Water Management at Triple Box Culvert						
Pump Systems	10	Day	$3,321	$33,214		18" pump with 400 feet hose, $ based on NS rate from Hertz Equipment Rental, 24hr/day operation, NO wellpoint
Dam / Diversion Structures	1500	SF	$39	$58,500		31 52 16.10 0060 - Barge, Driven Sheetpile Cofferdam. Walls to prevent intrusion. 40 LF wide by 20 ft deep sheet
Dewatering of Outfall Ditch	20	Day	$1,575	$31,500		31 23 19.20 1100 & 1120 (2nd pump)
Routine Storm Water Management - Excavations, etc.	115	Day	$1,200	$138,000		31 23 19.20 1100 at 75% utilization - i.e., days not operated have not labor or fuel charges but rent is still incurred.
				Subtotal	**$261,214**	
Earthwork - Excavation & Removal						
Sediment Removal within Existing Triple Box Culvert						
Excavation & Removal	300	CY	$120	$36,127		See Detail. Assumed removal area, 3 ft deep sediment, 150 LF x 18 ft wide
Solidification	300	CY	$4	$1,204		31 32 13.19 2060 - Lime Soil Stabilization in prep for T&D. Unit converted $/SY to $/CY, based on 2% mix, 12" deep. $12.05/SY @ 1 Foot = $12.05*.333 CY
Transportation & Disposal, non-haz	512	Ton	$28	$14,541		May 2013 Quotation for RSI Broadhurst Landfill: $16.90/T disposal. Transportation quoted at $23/ton but quoted cycle distance is 2X this estimate (260 miles vs. 130mile). Use 1/2 quoted rate.
Sediment Removal at Box Culvert / New Construction Transition						
Excavation & Removal	900	CY	$23	$20,334		See Detail. 3 foot removal across area.
Solidification	900	CY	$4	$3,611		31 32 13.19 2060 - Lime Soil Stabilization in prep for T&D. Unit converted $/SY to $/CY, based on 2% mix, 12" deep. $12.05/SY @ 1 Foot = $12.05*.333 CY
Transportation & Disposal, non-haz	1,440	Ton	$28	$40,896		May 2013 Quotation for RSI Broadhurst Landfill: $16.90/T disposal. Transportation quoted at $23/ton but quoted cycle distance is 2X this estimate (260 miles vs. 130mile). Use 1/2 quoted rate.
Outfall Ditch Excavation						
Excavation & Removal	0	CY	$28	$0		See Detail
Solidification	0	CY	$4	$0		31 32 13.19 2060 - Lime Soil Stabilization in prep for T&D. Unit converted $/SY to $/CY, based on 2% mix, 12" deep. $12.05/SY @ 1 Foot = $12.05*.333 CY
Transportation & Disposal, non-haz	0	Ton	$28	$0		May 2013 Quotation for RSI Broadhurst Landfill: $16.90/T disposal. Transportation quoted at $23/ton but quoted cycle distance is 2X this estimate (260 miles vs. 130mile). Use 1/2 quoted rate.
Shaping						
Excavation within Sheetpile Structure (incl. over-excavation beneath concrete lining)						
Excavation & Removal	0	CY	$10	$0		See detail. Not applicable
Solidification	0	CY	$4	$0		31 32 13.19 2060 - Lime Soil Stabilization in prep for T&D. Unit converted $/SY to $/CY, based on 2% mix, 12" deep. $12.05/SY @ 1 Foot = $12.05*.333 CY
Transportation & Disposal, non-haz	0	Ton	$28	$0		May 2013 Quotation for RSI Broadhurst Landfill: $16.90/T disposal. Transportation quoted at $23/ton but quoted cycle distance is 2X this estimate (260 miles vs. 130mile). Use 1/2 quoted rate.
Box Culvert Excavation, incl. over-excavation						
Excavation & Removal	25,000	CY	$10	$246,005		See detail.
Solidification	0	CY	$4	$0		31 32 13.19 2060 - Lime Soil Stabilization in prep for T&D. Unit converted $/SY to $/CY, based on 2% mix, 12" deep. $12.05/SY @ 1 Foot = $12.05*.333 CY
Transportation & Disposal, non-haz	0	Ton	$28	$0		May 2013 Quotation for RSI Broadhurst Landfill: $16.90/T disposal. Transportation quoted at $23/ton but quoted cycle distance is 2X this estimate (260 miles vs. 130mile). Use 1/2 quoted rate.
Excavation - Diversion Channel (incl. over-excavation beneath concrete lining)						

Option 4 Culvert Re-Routed
Terry Creek ROM Cost Options

Item Description	Quantity	Unit	Unit Rate	Total	Subtotal	Comment
Excavation & Removal	0	CY	$10	$0		See Detail.
Solidification	0	CY	$4	$0		31 32 13.19 2060 - Lime Soil Stabilization in prep for T&D. Unit converted $/SY to $/CY, based on 2% mix, 12" deep. $12.05/SY @ 1 Foot = $12.05*.333 CY
Transportation & Disposal, non-haz	0	Ton	$28	$0		May 2013 Quotation for RSI Broadhurst Landfill: $16.90/T disposal. Transportation quoted at $23/ton but quoted cycle distance is 2X this estimate (260 miles vs. 130mile). Use 1/2 quoted rate.
Earthwork - Rip Rap Preparation - Dupree Creek	5	Day	$7,584	$37,921		See Detail. Preparation of areas along Dupree Creek for installation of rip rap armoring.
				Subtotal	**$400,639**	
Earthwork - Backfill & Compaction						
Backfill Outfall Ditch						
Geotextile Installation	20,000	SY	$2	$43,800		32 11 23.23 6000. 6 oz/SY fabric. Adjust for difficult installation location. RSMeans provide +50% for small or irregular areas.
Import Backfill, Procure & Deliver	12,489	CY	$3	$41,963		31 23 23.20 4040. Ave cycle 4 miles @ 25 mph. Assume $0 to purchase backfill.
Backfill & Compaction	26,000	CY	$8	$196,820		See Detail
Fine Grading	15,400	SY	$0.2	$3,080		31 22 16.10 3300
Backfill Culvert Installation						
Geotextile Installation	0	SY	$2	$0		32 11 23.23 6000. 6 oz/SY fabric. Adjust for difficult installation location. RSMeans provide +50% for small or irregular areas.
Import Backfill, Procure & Deliver	0	CY	$3	$0		31 23 23.20 4040. Ave cycle 4 miles @ 25 mph. Assume $0 to purchase backfill. Re-use excavated material
Bedding Placement	1,478	CY	$43	$63,692		See Detail. 42 foot trench width, 1 foot thick
Backfill & Compaction	13,178	CY	$8	$99,756		See Detail. (2) foot wide trenches 4.5 feet high x 950 feet long. Cover over culverts = 42 feet x 2 feet thick x 950 feet
Fine Grading	6,333	SY	$0.2	$1,267		31 22 16.10 3300
				Subtotal	**$450,377**	
Earthwork - Sub-Aqueous Cap Installation						
Sub-Aqueous Cap	0	SF	$4	$0		See Detail
				Subtotal	**$0**	
Earthwork - Aggregates and Armoring						
Rip Rap Armor - Dupree Creek						
Geotextile Underlayment	0	SY	$1	$0		32 11 23.23 6000. 6 oz/SY fabric.
Rip Rap Placement	6,300	Ton	$56	$355,212		See Detail
Sub-Aqueous Rip Rap Armor - Outfall Ditch						
Geotextile Underlayment	0	SY	$2	$0		32 11 23.23 6000. 6 oz/SY fabric. Adjust for difficult installation location. RSMeans provide +50% for small or irregular areas. Not applicable.
Rip Rap Placement	0	Ton	$56	$0		See Detail. Not applicable
Sub-Aqueous "Fabri-Form" Armor - Outfall Ditch						
Geotextile Underlayment	0	SY	$2	$0		32 11 23.23 6000. 6 oz/SY fabric. Adjust for difficult installation location. RSMeans provide +50% for small or irregular areas. Not applicable.
Armor System Placement	0	SF	$7	$0		See Detail. Not applicable
				Subtotal	**$355,212**	
Systems Construction / De-Construction						
Demolition						
Existing Weir Structure	70	LF	$406	$28,407		See Detail
Existing Box Culvert/Wing Wall Structures	12	LF	$406	$4,870		See Detail
Cast In Place Concrete						
Box Culvert Transition	75	CY	$380	$28,500		03 30 53.40 4260 - 10' wall, 12" thick, free standig, cast in place
Sheetpile Channel Bottom	0	SF	$8	$0		See Detail
Concrete Lined Channel	0	SF	$8	$0		See Detail
GC Markup	$28,500	%	15%	$4,275		GC markup on subcontracted costs
Pre-Cast Culverts	950	LF	$2,110	$2,004,848		See Detail. Need to adjust production for in or out of ditch
Sheetpile Installation						
Work Over Water, Additive Cost	0	% base cost	$13	$0		31 06 60.14 1600
Channel Walls, Steel	0	SF	$44	$0		31 41 16.10 1800
GC Markup	$0	%	10%	$0		GC markup on subcontracted costs
				Subtotal	**$2,070,900**	
Final Restoration, Stabilization, Protection						
Permanent Security Fencing						
Fencing	500	LF	$28	$14,000		032 31 13.20 0200
Double Swing Gate	2	Each	$1,100	$2,200		032 31 13.20 5060
GC Markup	$16,200	%	15%	$2,430		GC markup on subcontracted costs
Permanent E&S Measures						
Silt Fencing / E&S	1,000	LF	$1.20	$1,200		31 25 14.16 1100
Drainage Ditches	1,000	LF	$0.30	$300		31 23 19.10 0020 (30 ft wide x 1 ft deep)
Checks Dams or Other BMP	50	Ton	$56	$2,819		See Detail
Site Restoration / Revegetation	10	Acre	$3,612	$36,481		See Detail
				Subtotal	**$59,430**	
			TOTAL	**$4,391,088**		

Notes:

General Approach

Site Preparation is followed by excavation and installation of culvert.
Soil berming temporarily installed across Dupree Creek end to mitigate water instrusion during construction.
Leaving soil plug at upper end of culvert to prevent water intrusion from culverts.
Use excavated soil to backfill new culvert. Outfall ditch backfilled with remaining soil - stockpiled following excavation, then placed in ditch followingre-routing into the outfall ditch
Construct armoring at end of new channel.
Construct new transition area. Note - dewatering and pump around needed. Form and pour will be with wet conditions.

Option 4A Culvert
Terry Creek ROM Cost Options

Item Description	Quantity	Unit	Unit Rate	Total	Subtotal	Comment
Oversight & Other Third Party Services						
CM/CQA oversight	35	Week	$9,730	$340,550		See Detail
				Subtotal	**$340,550**	
Pre-Mobilization						
Work Plans	1	LS	$10,000	$10,000		Eng. Est.
HASP	1	LS	$2,000	$2,000		Eng. Est.
Bonds	$4,259,033	%	1.0%	$42,590		01 31 13.90 0190
				Subtotal	**$54,590**	
Contractor's Project Management, Site Set-up, Admin.						
Project Manager	35	Week	$3,350	$117,250		01 31 13.20 0200
Home Office Costs	$4,099,166	%	3.90%	$159,867		01 31 13.40 0300
Insurance	$4,073,907	%	0.62%	$25,258		01 31 13.30 0250
Site Trailer	9	Mth	$375	$3,375		01 52 13.20 0700 - 50' x 12' rental
Utilities, Furniture, ODC's	9	Mth	$894	$8,042		See Detail
Survey						
Initial Layout	40	Hr	$144	$5,750		Eng. Est. - incl. 15% markup on raw cost for GC pass through/markup
On-Going	280	Hr	$144	$40,250		Eng. Est. Assumed to be one day per week.
As-Built	40	Hr	$144	$5,750		Eng. Est.
				Subtotal	**$365,542**	
Initial Site Preparation and Controls						
Mobilization/Demobilization						
General Contractor / Earthwork	1	LS	$14,655	$14,655		See Detail
Sheetpile	1	LS	$30,000	$30,000		Per J. Duffey est., 21 Aug 2013. One for main channel, under new weir structure, and at end of new weir structure to prevent water intrusion. One for transition at completion.
Concrete	1	LS	$8,130	$8,130		See Detail
Construction Entrance / Access Roads	2,000	LF	$13	$26,577		See Detail
Truck Wash / Decon Station, Materials only	3	Each	$6,000	$18,000		http://www.dultmeier.com/products/0.165.2399/996. portable truck wash pad, assume 3 used for project (semi-disposable).
Clearing & Grubbing	2	Acre	$6,675	$11,493		See Detail. Assume 500 LF x 100 FT on S. Side (incl. laydown area) and 500 x 50 ft on north side for access.
Construction Fencing / Security	2,500	LF	$4	$9,650		02 58 13.10 7001
Silt Fencing / E&S	2,500	LF	$1.20	$3,000		31 25 14.16 1100
Turbidity Curtain	500	LF	$28.00	$14,000		http://www.ctre.iastate.edu/erosion/manuals/construction/3.6_floatation_silt.pdf
Laydown Area Preparation	2	Acre	$38,962	$77,924		See Detail
				Subtotal	**$213,428**	
Dewatering / By-Pass Pumping / Water Management						
Water Management at Triple Box Culvert						
Pump Systems	10	Day	$3,321	$33,214		18" pump with 400 feet hose, $ based on NS rate from Hertz Equipment Rental, 24hr/day operation, NO wellpoint
Dam / Diversion Structures	800	SF	$39	$31,200		31 52 16.10 0060 - Barge, Driven Sheetpile Cofferdam. Walls to prevent intrusion. 40 LF wide by 20 ft deep sheet
Dewatering of Outfall Ditch	35	Day	$1,575	$55,125		31 23 19.20 1100 & 1120 (2nd pump)
Dam / Diversion Structures	130	SF	$39	$5,070		
Routine Storm Water Management - Excavations, etc.	131	Day	$1,200	$157,500		31 23 19.20 1100 at 75% utilization - i.e., days not operated have not labor or fuel charges but rent is still incurred.
				Subtotal	**$282,109**	
Earthwork - Excavation & Removal						
Sediment Removal within Existing Triple Box Culvert						
Excavation & Removal	300	CY	$120	$36,127		See Detail. Assumed removal area, 3 ft deep sediment, 150 LF x 18 ft wide
Solidification	300	CY	$4	$1,204		31 32 13.19 2060 - Lime Soil Stabilization in prep for T&D. Unit converted $/SY to $/CY, based on 2% mix, 12" deep. $12.05/SY @ 1 Foot = $12.05*.333 CY
Transportation & Disposal, non-haz	512	Ton	$28	$14,541		May 2013 Quotation for RSI Broadhurst Landfill: $16.90/T disposal. Transportation quoted at $23/ton but quoted cycle distance is 2X this estimate (260 miles vs. 130mile). Use 1/2 quoted rate.
Sediment Removal at Box Culvert / New Construction Transition						
Excavation & Removal	900	CY	$23	$20,334		See Detail. 3 foot removal across area.
Solidification	900	CY	$4	$3,611		31 32 13.19 2060 - Lime Soil Stabilization in prep for T&D. Unit converted $/SY to $/CY, based on 2% mix, 12" deep. $12.05/SY @ 1 Foot = $12.05*.333 CY
Transportation & Disposal, non-haz	1,440	Ton	$28	$40,896		May 2013 Quotation for RSI Broadhurst Landfill: $16.90/T disposal. Transportation quoted at $23/ton but quoted cycle distance is 2X this estimate (260 miles vs. 130mile). Use 1/2 quoted rate.
Outfall Ditch Excavation						
Excavation & Removal	741	CY	$28	$20,996		See Detail. Excavation effort to re-route water to north side of the outfall ditch. Assume 10 foot ditch, 2 feet wide, 1,000 LF completed with long reach, T&D needed.
Solidification	741	CY	$4	$2,972		31 32 13.19 2060 - Lime Soil Stabilization in prep for T&D. Unit converted $/SY to $/CY, based on 2% mix, 12" deep. $12.05/SY @ 1 Foot = $12.05*.333 CY
Transportation & Disposal, non-haz	1,185	Ton	$28	$33,659		May 2013 Quotation for RSI Broadhurst Landfill: $16.90/T disposal. Transportation quoted at $23/ton but quoted cycle distance is 2X this estimate (260 miles vs. 130mile). Use 1/2 quoted rate.
Shaping						
Excavation within Sheetpile Structure (incl. over-excavation beneath concrete lining)						
Excavation & Removal	0	CY	$4	$0		See Detail. Excavation effort to re-route water to north side of the outfall ditch. Assume 10 foot ditch, 2 feet wide, 1,000 LF completed with long reach, T&D needed.
Solidification	0	CY	$4	$0		31 32 13.19 2060 - Lime Soil Stabilization in prep for T&D. Unit converted $/SY to $/CY, based on 2% mix, 12" deep. $12.05/SY @ 1 Foot = $12.05*.333 CY
Transportation & Disposal, non-haz	0	Ton	$28	$0		May 2013 Quotation for RSI Broadhurst Landfill: $16.90/T disposal. Transportation quoted at $23/ton but quoted cycle distance is 2X this estimate (260 miles vs. 130mile). Use 1/2 quoted rate.
Excavation - Diversion Channel [b)]						
(incl. over-excavation beneath concrete lining)						
Excavation & Removal	0	CY	$15	$0		See Detail.
Solidification	0	CY	$4	$0		31 32 13.19 2060 - Lime Soil Stabilization in prep for T&D. Unit converted $/SY to $/CY, based on 2% mix, 12" deep. $12.05/SY @ 1 Foot = $12.05*.333 CY
Box Culvert Excavation, incl. over-excavation						
Excavation & Removal,backfill soil within culvert area	7,870	CY	$10	$77,446		See detail. For Option 1A, assumes Outfall is backfilled to outside of sheetpile and excavtion occurs from on grade into sheetpile area

Option 4A Culvert
Terry Creek ROM Cost Options

Item Description	Quantity	Unit	Unit Rate	Total	Subtotal	Comment
Excavation & Removal, overexcavation within culvert area	7,870	CY	$15	$116,943		See detail. Excavation occurs from on grade into sheetpile area.
Solidification	7,870	CY	$4	$31,581		31 32 13.19 2060 - Lime Soil Stabilization in prep for T&D. Unit converted $/SY to $/CY, based on 2% mix, 12" deep. $12.05/SY @ 1 Foot = $12.05*.333 CY
Transportation & Disposal, non-haz	12,593	Ton	$28	$357,630		May 2013 Quotation for RSI Broadhurst Landfill: $16.90/T disposal. Transportation quoted at $23/ton but quoted cycle distance is 2X this estimate (260 miles vs. 130mile). Use 1/2 quoted rate.
Earthwork - Rip Rap Preparation - Dupree Creek	5	Day	$7,584	$37,921		See Detail. Preparation of areas along Dupree Creek for installation of rip rap armoring.
				Subtotal	**$795,861**	
Earthwork - Backfill & Compaction						
Backfill Outfall Ditch						
Geotextile Installation	20,000	SY	$2	$43,800		32 11 23.23 6000. 6 oz/SY fabric. Adjust for difficult installation location. RSMeans provide +50% for small or irregular areas.
Import Backfill, Procure & Deliver	19,333	CY	$3	$64,960		31 23 23.20 4040. Ave cycle 4 miles @ 25 mph. Assume $0 to purchase backfill.
Backfill & Compaction	26,000	CY	$8	$196,820		See Detail. This included placement of fill in South side of outfall ditch. Secnod fill effort to fill north side of outfall after installing culvert
Fine Grading	15,400	SY	$0.2	$3,080		31 22 16.10 3300
Backfill Culvert Installation						
Geotextile Installation	4,200	SY	$2	$9,198		32 11 23.23 6000. 6 oz/SY fabric. Adjust for difficult installation location. RSMeans provide +50% for small or irregular areas.
Import Backfill, Procure & Deliver	4,200	CY	$3	$14,112		31 23 23.20 4040. Ave cycle 4 miles @ 25 mph. Assume $0 to purchase backfill
Bedding Placement	1,400	CY	43.1	$60,340		See Detail
Backfill & Compaction	4,200	CY	$8	$31,794		See Detail. Bacfilling effort is backfilling following excavation through imported fill placement
Fine Grading	4,200	SY	$0.2	$840		31 22 16.10 3300
				Subtotal	**$424,944**	
Earthwork - Sub-Aqueous Cap Installation						
Sub-Aqueous Cap		SF	$4	$0		See Detail
				Subtotal	**$0**	
Earthwork - Aggregates and Armoring						
Rip Rap Armor - Dupree Creek						
Geotextile Underlayment	0	SY	$1	$0		32 11 23.23 6000. 6 oz/SY fabric.
Rip Rap Placement	4,500	Ton	$56	$253,723		See Detail
Sub-Aqueous Rip Rap Armor - Outfall Ditch						
Geotextile Underlayment	0	SY	$2	$0		32 11 23.23 6000. 6 oz/SY fabric. Adjust for difficult installation location. RSMeans provide +50% for small or irregular areas. Not applicable.
Rip Rap Placement	0	Ton	$56	$0		See Detail. Not applicable
Sub-Aqueous "Fabri-Form" Armor - Outfall Ditch						
Geotextile Underlayment	0	SY	$2	$0		32 11 23.23 6000. 6 oz/SY fabric. Adjust for difficult installation location. RSMeans provide +50% for small or irregular areas. Not applicable.
Armor System Placement	0	SF	$7	$0		See Detail. Not applicable
				Subtotal	**$253,723**	
Systems Construction / De-Construction						
Demolition						
Existing Weir Structure	70	LF	$406	$28,407		See Detail
Existing Box Culvert/Wing Wall Structures	11	LF	$406	$4,464		See Detail
Cast In Place Concrete						
Box Culvert Transition	75	CY	$380	$28,500		03 30 53.40 4260 - 10' wall, 12" thick, free standig, cast in place
Sheetpile Channel Bottom	0	SF	$8	$0		See Detail
Concrete Lined Channel	0	SF	$8	$0		See Detail
GC Markup	$28,500	%	15%	$4,275		GC markup on subcontracted costs
Pre-Cast Culverts	850	LF	$2,110	$1,793,812		See Detail. Need to adjust production for in or out of ditch
Sheetpile Installation						
Work Over Water, Additive Cost	0	% base cost	$13	$0		31 06 60.14 1600
Channel Walls, Steel	0	SF	$44	$0		31 41 16.10 1800
GC Markup	$0	%	10%	$0		GC markup on subcontracted costs
				Subtotal	**$1,859,458**	
Final Restoration, Stabilization, Protection						
Permanent Security Fencing						
Fencing	500	LF	$28	$14,000		032 31 13.20 0200
Double Swing Gate	2	Each	$1,100	$2,200		032 31 13.20 5060
GC Markup	$16,200	%	15%	$2,430		GC markup on subcontracted costs
Permanent E&S Measures						
Silt Fencing / E&S	1,000	LF	$1.20	$1,200		31 25 14.16 1100
Drainage Ditches	1,000	LF	$0.30	$300		31 23 19.10 0020 (30 ft wide x 1 ft deep)
Checks Dams or Other BMP	50	Ton	$56	$2,819		See Detail
Site Restoration / Revegetation	8	Acre	$3,612	$29,019		See Detail
				Subtotal	**$51,968**	
			TOTAL	**$4,642,173**		

Notes:
Coffer dam may be constructed using soil excavated for diversion channel.
Soil excavated for diversion channel and/or gate structure may also be used as structural fill behind retaining walls or compacted fill within the existing channel.
Use on-site materials for embankment to the extent possible.

Option 5 Isolation Cap
Terry Creek ROM Cost Options

Item Description	Quantity	Unit	Unit Rate	Total	Subtotal	Comment
Oversight & Other Third Party Services						
CM/CQA oversight	34	Week	$9,730	$330,820		See Detail
				Subtotal	**$330,820**	
Pre-Mobilization						
Work Plans	1	LS	$10,000	$10,000		Eng. Est.
HASP	1	LS	$2,000	$2,000		Eng. Est.
Bonds	$3,657,694	%	1.0%	$36,577		01 31 13.90 0190
				Subtotal	**$48,577**	
Contractor's Project Management, Site Set-up, Admin.						
Project Manager	34	Week	$3,350	$113,900		01 31 13.20 0200
Home Office Costs	$3,520,398	%	3.90%	$137,296		01 31 13.40 0300
Insurance	$3,498,706	%	0.62%	$21,692		01 31 13.30 0250
Site Trailer	8	Mth	$375	$3,000		01 52 13.20 0700 - 50' x 12' rental
Utilities, Furniture, ODC's	8	Mth	$894	$7,148		See Detail
Survey						
Initial Layout	40	Hr	$144	$5,750		Eng. Est. - incl. 15% markup on raw cost for GC pass through/markup
On-Going	272	Hr	$144	$39,100		Eng. Est. Assumed to be one day per week.
As-Built	60	Hr	$144	$8,625		Eng. Est.
				Subtotal	**$336,511**	
Initial Site Preparation and Controls						
Mobilization/Demobilization						
General Contractor / Earthwork	1	LS	$14,655	$14,655		See Detail
Sheetpile	1	LS	$30,000	$30,000		Per J. Duffey est., 21 Aug 2013. One for main channel, under new weir structure, and at end of new weir structure to prevent water intrusion. One for transition at completion.
Concrete	1	LS	$8,130	$8,130		See Detail. One each for weir, lining, and transistion tie-in
Construction Entrance / Access Roads	1,000	LF	$13	$13,288		See Detail
Truck Wash / Decon Station, Materials only	3	Each	$6,000	$18,000		http://www.dultmeier.com/products/0.165.2399/996. portable truck wash pad, assume 3 used for project (semi-disposable).
Clearing & Grubbing	1.7	Acre	$6,675	$11,493		See Detail. Assume 500 LF x 100 FT on S. Side (incl. laydown area) and 500 x 50 ft on north side for access.
Construction Fencing / Security	2,500	LF	$4	$9,650		02 58 13.10 7001
Silt Fencing / E&S	2,500	LF	$1.20	$3,000		31 25 14.16 1100
Turbidity Curtain	500	LF	$28.00	$14,000		http://www.ctre.iastate.edu/erosion/manuals/construction/3.6_floatation_silt.pdf
Laydown Area Preparation	1	Acre	$38,962	$38,962		See Detail
				Subtotal	**$161,178**	
Dewatering / By-Pass Pumping / Water Management						
Water Management at Triple Box Culvert						
Pump Systems	10	Day	$3,321	$33,214		18" pump with 400 feet hose, $ based on NS rate from Hertz Equipment Rental, 24hr/day operation, NO wellpoint
Dam / Diversion Structures	800	SF	$39	$31,200		31 52 16.10 0060 - Barge, Driven Sheetpile Cofferdam. Walls to prevent intrusion. 40 LF wide by 20 ft deep sheet
Dewatering of Outfall Ditch	20	Day	$1,575	$31,500		31 23 19.20 1100 & 1120 (2nd pump)
Dam / Diversion Structures	800	SF	$39	$31,200		
Routine Storm Water Management - Excavations, etc.	143	Day	$1,200	$171,000		31 23 19.20 1100 at 75% utilization - i.e., days not operated have not labor or fuel charges but rent is still incurred.
				Subtotal	**$298,114**	
Earthwork - Excavation & Removal						
Sediment Removal within Existing Triple Box Culvert						
Excavation & Removal	300	CY	$120	$36,127		See Detail. Assumed removal area, 3 ft deep sediment, 150 LF x 18 ft wide
Solidification	300	CY	$4	$1,204		31 32 13.19 2060 - Lime Soil Stabilization in prep for T&D. Unit converted $/SY to $/CY, based on 2% mix, 12" deep. $12.05/SY @ 1 Foot = $12.05*.333 CY
Transportation & Disposal, non-haz	512	Ton	$28	$14,541		May 2013 Quotation for RSI Broadhurst Landfill: $16.90/T disposal. Transportation quoted at $23/ton but quoted cycle distance is 2X this estimate (260 miles vs. 130mile). Use 1/2 quoted rate.
Sediment Removal at Box Culvert / New Construction Transition						
Excavation & Removal	900	CY	$23	$20,334		See Detail. 3 foot removal across area.
Solidification	900	CY	$4	$3,611		31 32 13.19 2060 - Lime Soil Stabilization in prep for T&D. Unit converted $/SY to $/CY, based on 2% mix, 12" deep. $12.05/SY @ 1 Foot = $12.05*.333 CY
Transportation & Disposal, non-haz	1,440	Ton	$28	$40,896		May 2013 Quotation for RSI Broadhurst Landfill: $16.90/T disposal. Transportation quoted at $23/ton but quoted cycle distance is 2X this estimate (260 miles vs. 130mile). Use 1/2 quoted rate.
Outfall Ditch Excavation						
Excavation & Removal	741	CY	$28	$20,996		See Detail. Excavation effort to re-route water to north side of the outfall ditch. Assume 10 foot ditch, 2 feet wide, 1,000 LF completed with long reach, T&D needed.
Solidification	741	CY	$4	$2,972		31 32 13.19 2060 - Lime Soil Stabilization in prep for T&D. Unit converted $/SY to $/CY, based on 2% mix, 12" deep. $12.05/SY @ 1 Foot = $12.05*.333 CY
Transportation & Disposal, non-haz	1,185	Ton	$28	$33,659		May 2013 Quotation for RSI Broadhurst Landfill: $16.90/T disposal. Transportation quoted at $23/ton but quoted cycle distance is 2X this estimate (260 miles vs. 130mile). Use 1/2 quoted rate.
Shaping						
Excavation within Sheetpile Structure (incl. over-excavation beneath concrete lining)						
Excavation & Removal	0	CY	$15	$0		See detail. Not Applicable.
Solidification	0	CY	$4	$0		31 32 13.19 2060 - Lime Soil Stabilization in prep for T&D. Unit converted $/SY to $/CY, based on 2% mix, 12" deep. $12.05/SY @ 1 Foot = $12.05*.333 CY
Transportation & Disposal, non-haz	0	Ton	$28	$0		May 2013 Quotation for RSI Broadhurst Landfill: $16.90/T disposal. Transportation quoted at $23/ton but quoted cycle distance is 2X this estimate (260 miles vs. 130mile). Use 1/2 quoted rate.
Box Culvert Excavation, incl. over-excavation						
Excavation & Removal	0	CY	$15	$0		See detail. Not Applicable.
Solidification	0	CY	$4	$0		31 32 13.19 2060 - Lime Soil Stabilization in prep for T&D. Unit converted $/SY to $/CY, based on 2% mix, 12" deep. $12.05/SY @ 1 Foot = $12.05*.333 CY
Transportation & Disposal, non-haz	0	Ton	$28	$0		May 2013 Quotation for RSI Broadhurst Landfill: $16.90/T disposal. Transportation quoted at $23/ton but quoted cycle distance is 2X this estimate (260 miles vs. 130mile). Use 1/2 quoted rate.
Excavation - Diversion Channel (incl. over-excavation)						

Option 5 Isolation Cap
Terry Creek ROM Cost Options

Item Description	Quantity	Unit	Unit Rate	Total	Subtotal	Comment
Excavation & Removal of backfill soil	11,583	CY	$10	$113,982		See detail. For Option 2A, assumes Outfall is backfille. Excavation of channel profile.
Excavation & Removal, over-excavation within new channel profile	11,250	CY	$28	$318,879		See detail. For Option 1A, assumes Outfall is backfilled, channel profile is excavated. Sediment excavated, solidified, and T&D
Solidification	11,250	CY	$4	$45,142		31 32 13.19 2060 - Lime Soil Stabilization in prep for T&D. Unit converted $/SY to $/CY, based on 2% mix, 12" deep. $12.05/SY @ 1 Foot = $12.05*.333 CY
Transportation & Disposal, non-haz	18,000	Ton	$28	$511,200		May 2013 Quotation for RSI Broadhurst Landfill: $16.90/T disposal. Transportation quoted at $23/ton but quoted cycle distance is 2X this estimate (260 miles vs. 130mile). Use 1/2 quoted rate.
Earthwork - Rip Rap Preparation - Dupree Creek	5	Day	$7,584	$37,921		See Detail. Preparation of areas along Dupree Creek for installation of rip rap armoring.
				Subtotal	**$1,201,465**	
Earthwork - Backfill & Compaction						
Backfill Outfall Ditch						
Geotextile Installation	20,000	SY	$2	$43,800		32 11 23.23 6000. 6 oz/SY fabric. Adjust for difficult installation location. RSMeans provide +50% for small or irregular areas.
Import Backfill, Procure & Deliver	37,250	CY	$3	$125,160		31 23 23.20 4040. Ave cycle 4 miles @ 25 mph. Assume $0 to purchase backfill.
Backfill & Compaction	48,083	CY	$8	$363,991		See Detail. This will be completed in two stages - south half (for channel construction) followed by north side (following re-routing). Backfill located within new channel will be double handled for backfilling. Intial fill followed by excavation from within channel contour then backfilled into north side of outfall ditch fill.
Fine Grading	22,400	SY	$0.2	$4,480		31 22 16.10 3300
Backfill Culvert Installation						
Geotextile Installation	0	SY	$2	$0		32 11 23.23 6000. 6 oz/SY fabric. Adjust for difficult installation location. RSMeans provide +50% for small or irregular areas.
Import Backfill, Procure & Deliver	0	CY	$3	$0		31 23 23.20 4040. Ave cycle 4 miles @ 25 mph. Assume $0 to purchase backfill
Bedding Placement	0	CY	43.1	$0		See Detail
Backfill & Compaction	0	CY	$8	$0		See Detail
Fine Grading	0	SY	$0.2	$0		31 22 16.10 3300
				Subtotal	**$537,431**	
Earthwork - Sub-Aqueous Cap Installation						
Sub-Aqueous Cap	63,000	SF	$4	$247,643		See Detail
				Subtotal	**$247,643**	
Earthwork - Aggregates and Armoring						
Rip Rap Armor - Dupree Creek						
Geotextile Underlayment		SY	$1	$0		32 11 23.23 6000. 6 oz/SY fabric.
Rip Rap Placement	4,500	Ton	$56	$253,723		See Detail
Sub-Aqueous Rip Rap Armor - Outfall Ditch						
Geotextile Underlayment	0	SY	$2	$0		32 11 23.23 6000. 6 oz/SY fabric. Adjust for difficult installation location. RSMeans provide +50% for small or irregular areas. Not applicable.
Rip Rap Placement	8,400	Ton	$56	$473,616		See Detail
Sub-Aqueous "Fabri-Form" Armor - Outfall Ditch						
Geotextile Underlayment	0	SY	$2	$0		32 11 23.23 6000. 6 oz/SY fabric. Adjust for difficult installation location. RSMeans provide +50% for small or irregular areas. Not applicable.
Armor System Placement	0	SF	$7	$0		See Detail. Not applicable
				Subtotal	**$727,339**	
Systems Construction / De-Construction						
Demolition						
Existing Weir Structure	70	LF	$406	$28,407		See Detail
Existing Box Culvert/Wing Wall Structures	11	LF	$406	$4,464		See Detail
Cast In Place Concrete						
Box Culvert Transition	0	CY	$380	$0		03 30 53.40 4260 - 10' wall, 12" thick, free standig, cast in place
Sheetpile Channel Bottom	0	SF	$8	$0		See Detail
Concrete Lined Channel	0	SF	$8	$0		See Detail
GC Markup	$0	%	15%	$0		GC markup on subcontracted costs
Pre-Cast Culverts	0	LF	$2,110	$0		See Detail. Need to adjust production for in or out of ditch
Sheetpile Installation						
Work Over Water, Additive Cost	0	% base cost	$13	$0		31 06 60.14 1600
Channel Walls, Steel	0	SF	$44	$0		31 41 16.10 1800
GC Markup	$0	%	10%	$0		GC markup on subcontracted costs
				Subtotal	**$32,871**	
Final Restoration, Stabilization, Protection						
Permanent Security Fencing						
Fencing	2,050	LF	$28	$57,400		032 31 13.20 0200
Double Swing Gate	3	Each	$1,100	$3,300		032 31 13.20 5060
GC Markup	$60,700	%	15%	$9,105		GC markup on subcontracted costs
Permanent E&S Measures						
Silt Fencing / E&S	1,000	LF	$1.20	$1,200		31 25 14.16 1100
Drainage Ditches	1,000	LF	$0.30	$300		31 23 19.10 0020 (30 ft wide x 1 ft deep)
Checks Dams or Other BMP	50	Ton	$56	$2,819		See Detail
Site Restoration / Revegetation	8	Acre	$3,612	$29,019		See Detail
				Subtotal	**$103,143**	
			TOTAL	**$4,025,091**		

General Approach

Site Preparation is followed by installation of lined channel.
Sheetpile temporarily installed across Dupree Creek end of new weir structure to mitigate water instrusion during construction.
Excavate soil within new channel leaving soil plug at upper end of sheetpile to prevent water intrusion from culverts.
Use excavated soil to backfill outfall ditch- stockpiled following excavation, then placed in ditch followingre-routing into the outfall ditch.
Construct new weir structure and rip rap line channel.
Construct armoring at end of new channel.
Outfall is re-routed; Have to construct final wing wall and transistion tie-in in wet conditions (pump around to mitigate).
Backfill outfall ditch; install armoring at end of outfall ditch.

Option 5A Carbon Amended Cap
Terry Creek ROM Cost Options

Item Description	Quantity	Unit	Unit Rate	Total	Subtotal	Comment
Oversight & Other Third Party Services						
CM/CQA oversight	34	Week	$9,730	$330,820		See Detail
				Subtotal	**$330,820**	
Pre-Mobilization						
Work Plans	1	LS	$10,000	$10,000		Eng. Est.
HASP	1	LS	$2,000	$2,000		Eng. Est.
Bonds	$3,666,170	%	1.0%	$36,662		01 31 13.90 0190
				Subtotal	**$48,662**	
Contractor's Project Management, Site Set-up, Admin.						
Project Manager	34	Week	$3,350	$113,900		01 31 13.20 0200
Home Office Costs	$3,528,556	%	3.90%	$137,614		01 31 13.40 0300
Insurance	$3,506,814	%	0.62%	$21,742		01 31 13.30 0250
Site Trailer	8	Mth	$375	$3,000		01 52 13.20 0700 - 50' x 12' rental
Utilities, Furniture, ODC's	8	Mth	$894	$7,148		See Detail
Survey						
Initial Layout	40	Hr	$144	$5,750		Eng. Est. - incl. 15% markup on raw cost for GC pass through/markup
On-Going	272	Hr	$144	$39,100		Eng. Est. Assumed to be one day per week.
As-Built	60	Hr	$144	$8,625		Eng. Est.
				Subtotal	**$336,879**	
Initial Site Preparation and Controls						
Mobilization/Demobilization						
General Contractor / Earthwork	1	LS	$14,655	$14,655		See Detail
Sheetpile	1	LS	$30,000	$30,000		Per J. Duffey est., 21 Aug 2013. One for main channel, under new weir structure, and at end of new weir structure to prevent water intrusion. One for transition at completion.
Concrete	1	LS	$8,130	$8,130		See Detail. One each for weir, lining, and transistion tie-in
Construction Entrance / Access Roads	1,000	LF	$13	$13,288		See Detail
Truck Wash / Decon Station, Materials only	3	Each	$6,000	$18,000		http://www.dultmeier.com/products/0.165.2399/996. portable truck wash pad, assume 3 used for project (semi-disposable).
Clearing & Grubbing	1.7	Acre	$6,675	$11,493		See Detail. Assume 500 LF x 100 FT on S. Side (incl. laydown area) and 500 x 50 ft on north side for access.
Construction Fencing / Security	2,500	LF	$4	$9,650		02 58 13.10 7001
Silt Fencing / E&S	2,500	LF	$1.20	$3,000		31 25 14.16 1100
Turbidity Curtain	500	LF	$28.00	$14,000		http://www.ctre.iastate.edu/erosion/manuals/construction/3.6_floatation_silt.pdf
Laydown Area Preparation	1	Acre	$38,962	$38,962		See Detail
				Subtotal	**$161,178**	
Dewatering / By-Pass Pumping / Water Management						
Water Management at Triple Box Culvert						
Pump Systems	10	Day	$3,321	$33,214		18" pump with 400 feet hose, $ based on NS rate from Hertz Equipment Rental, 24hr/day operation, NO wellpoint
Dam / Diversion Structures	800	SF	$39	$31,200		31 52 16.10 0060 - Barge, Driven Sheetpile Cofferdam. Walls to prevent intrusion. 40 LF wide by 20 ft deep sheet
Dewatering of Outfall Ditch	20	Day	$1,575	$31,500		31 23 19.20 1100 & 1120 (2nd pump)
Dam / Diversion Structures	800	SF	$39	$31,200		
Routine Storm Water Management - Excavations, etc.	143	Day	$1,200	$171,000		31 23 19.20 1100 at 75% utilization - i.e., days not operated have not labor or fuel charges but rent is still incurred.
				Subtotal	**$298,114**	
Earthwork - Excavation & Removal						
Sediment Removal within Existing Triple Box Culvert						
Excavation & Removal	300	CY	$120	$36,127		See Detail. Assumed removal area, 3 ft deep sediment, 150 LF x 18 ft wide
Solidification	300	CY	$4	$1,204		31 32 13.19 2060 - Lime Soil Stabilization in prep for T&D. Unit converted $/SY to $/CY, based on 2% mix, 12" deep. $12.05/SY @ 1 Foot = $12.05*.333 CY
Transportation & Disposal, non-haz	512	Ton	$28	$14,541		May 2013 Quotation for RSI Broadhurst Landfill: $16.90/T disposal. Transportation quoted at $23/ton but quoted cycle distance is 2X this estimate (260 miles vs. 130mile). Use 1/2 quoted rate.
Sediment Removal at Box Culvert / New Construction Transition						
Excavation & Removal	900	CY	$23	$20,334		See Detail. 3 foot removal across area.
Solidification	900	CY	$4	$3,611		31 32 13.19 2060 - Lime Soil Stabilization in prep for T&D. Unit converted $/SY to $/CY, based on 2% mix, 12" deep. $12.05/SY @ 1 Foot = $12.05*.333 CY
Transportation & Disposal, non-haz	1,440	Ton	$28	$40,896		May 2013 Quotation for RSI Broadhurst Landfill: $16.90/T disposal. Transportation quoted at $23/ton but quoted cycle distance is 2X this estimate (260 miles vs. 130mile). Use 1/2 quoted rate.
Outfall Ditch Excavation						
Excavation & Removal	741	CY	$28	$20,996		See Detail. Excavation effort to re-route water to north side of the outfall ditch. Assume 10 foot ditch, 2 feet wide, 1,000 LF completed with long reach, T&D needed.
Solidification	741	CY	$4	$2,972		31 32 13.19 2060 - Lime Soil Stabilization in prep for T&D. Unit converted $/SY to $/CY, based on 2% mix, 12" deep. $12.05/SY @ 1 Foot = $12.05*.333 CY
Transportation & Disposal, non-haz	1,185	Ton	$28	$33,659		May 2013 Quotation for RSI Broadhurst Landfill: $16.90/T disposal. Transportation quoted at $23/ton but quoted cycle distance is 2X this estimate (260 miles vs. 130mile). Use 1/2 quoted rate.
Shaping						
Excavation within Sheetpile Structure (incl. over-excavation beneath concrete lining)						
Excavation & Removal	0	CY	$15	$0		See detail. Not Applicable.
Solidification	0	CY	$4	$0		31 32 13.19 2060 - Lime Soil Stabilization in prep for T&D. Unit converted $/SY to $/CY, based on 2% mix, 12" deep. $12.05/SY @ 1 Foot = $12.05*.333 CY
Transportation & Disposal, non-haz	0	Ton	$28	$0		May 2013 Quotation for RSI Broadhurst Landfill: $16.90/T disposal. Transportation quoted at $23/ton but quoted cycle distance is 2X this estimate (260 miles vs. 130mile). Use 1/2 quoted rate.
Box Culvert Excavation, incl. over-excavation						
Excavation & Removal	0	CY	$15	$0		See detail. Not Applicable.
Solidification	0	CY	$4	$0		31 32 13.19 2060 - Lime Soil Stabilization in prep for T&D. Unit converted $/SY to $/CY, based on 2% mix, 12" deep. $12.05/SY @ 1 Foot = $12.05*.333 CY
Transportation & Disposal, non-haz	0	Ton	$28	$0		May 2013 Quotation for RSI Broadhurst Landfill: $16.90/T disposal. Transportation quoted at $23/ton but quoted cycle distance is 2X this estimate (260 miles vs. 130mile). Use 1/2 quoted rate.
Excavation - Diversion Channel (incl. over-excavation)						

Option 5A Carbon Amended Cap
Terry Creek ROM Cost Options

Item Description	Quantity	Unit	Unit Rate	Total	Subtotal	Comment
Excavation & Removal of backfill soil	11,583	CY	$10	$113,982		See detail. For Option 2A, assumes Outfall is backfille. Excavation of channel profile.
Excavation & Removal, over-excavation within new channel profile	11,250	CY	$28	$318,879		See detail. For Option 1A, assumes Outfall is backfilled, channel profile is excavated. Sediment excavated, solidified, and T&D
Solidification	11,250	CY	$4	$45,142		31 32 13.19 2060 - Lime Soil Stabilization in prep for T&D. Unit converted $/SY to $/CY, based on 2% mix, 12" deep. $12.05/SY @ 1 Foot = $12.05*.333 CY
Transportation & Disposal, non-haz	18,000	Ton	$28	$511,200		May 2013 Quotation for RSI Broadhurst Landfill: $16.90/T disposal. Transportation quoted at $23/ton but quoted cycle distance is 2X this estimate (260 miles vs. 130mile). Use 1/2 quoted rate.
Earthwork - Rip Rap Preparation - Dupree Creek	5	Day	$7,584	$37,921		See Detail. Preparation of areas along Dupree Creek for installation of rip rap armoring.
				Subtotal	**$1,201,465**	
Earthwork - Backfill & Compaction						
Backfill Outfall Ditch						
Geotextile Installation	20,000	SY	$2	$43,800		32 11 23.23 6000. 6 oz/SY fabric. Adjust for difficult installation location. RSMeans provide +50% for small or irregular areas.
Import Backfill, Procure & Deliver	37,250	CY	$3	$125,160		31 23 23.20 4040. Ave cycle 4 miles @ 25 mph. Assume $0 to purchase backfill.
Backfill & Compaction	48,083	CY	$8	$363,991		See Detail. This will be completed in two stages - south half (for channel construction) followed by north side (following re-routing). Backfill located within new channel will be double handled for backfilling. Intial fill followed by excavation from within channel contour then backfilled into north side of outfall ditch fill.
Fine Grading	22,400	SY	$0.2	$4,480		31 22 16.10 3300
Backfill Culvert Installation						
Geotextile Installation	0	SY	$2	$0		32 11 23.23 6000. 6 oz/SY fabric. Adjust for difficult installation location. RSMeans provide +50% for small or irregular areas.
Import Backfill, Procure & Deliver	0	CY	$3	$0		31 23 23.20 4040. Ave cycle 4 miles @ 25 mph. Assume $0 to purchase backfill
Bedding Placement	0	CY	43.1	$0		See Detail
Backfill & Compaction	0	CY	$8	$0		See Detail
Fine Grading	0	SY	$0.2	$0		31 22 16.10 3300
				Subtotal	**$537,431**	
Earthwork - Sub-Aqueous Cap Installation						
Sub-Aqueous Cap	2,200	CY	$116	$255,750		See GAC
				Subtotal	**$255,750**	
Earthwork - Aggregates and Armoring						
Rip Rap Armor - Dupree Creek						
Geotextile Underlayment		SY	$1	$0		32 11 23.23 6000. 6 oz/SY fabric.
Rip Rap Placement	4,500	Ton	$56	$253,723		See Detail
Sub-Aqueous Rip Rap Armor - Outfall Ditch						
Geotextile Underlayment	0	SY	$2	$0		32 11 23.23 6000. 6 oz/SY fabric. Adjust for difficult installation location. RSMeans provide +50% for small or irregular areas. Not applicable.
Rip Rap Placement	8,400	Ton	$56	$473,616		See Detail
Sub-Aqueous "Fabri-Form" Armor - Outfall Ditch						
Geotextile Underlayment	0	SY	$2	$0		32 11 23.23 6000. 6 oz/SY fabric. Adjust for difficult installation location. RSMeans provide +50% for small or irregular areas. Not applicable.
Armor System Placement	0	SF	$7	$0		See Detail. Not applicable
				Subtotal	**$727,339**	
Systems Construction / De-Construction						
Demolition						
Existing Weir Structure	70	LF	$406	$28,407		See Detail
Existing Box Culvert/Wing Wall Structures	11	LF	$406	$4,464		See Detail
Cast In Place Concrete						
Box Culvert Transition	0	CY	$380	$0		03 30 53.40 4260 - 10' wall, 12" thick, free standig, cast in place
Sheetpile Channel Bottom	0	SF	$8	$0		See Detail
Concrete Lined Channel	0	SF	$8	$0		See Detail
GC Markup	$0	%	15%	$0		GC markup on subcontracted costs
Pre-Cast Culverts	0	LF	$2,110	$0		See Detail. Need to adjust production for in or out of ditch
Sheetpile Installation						
Work Over Water, Additive Cost	0	% base cost	$13	$0		31 06 60.14 1600
Channel Walls, Steel	0	SF	$44	$0		31 41 16.10 1800
GC Markup	$0	%	10%	$0		GC markup on subcontracted costs
				Subtotal	**$32,871**	
Final Restoration, Stabilization, Protection						
Permanent Security Fencing						
Fencing	2,050	LF	$28	$57,400		032 31 13.20 0200
Double Swing Gate	3	Each	$1,100	$3,300		032 31 13.20 5060
GC Markup	$60,700	%	15%	$9,105		GC markup on subcontracted costs
Permanent E&S Measures						
Silt Fencing / E&S	1,000	LF	$1.20	$1,200		31 25 14.16 1100
Drainage Ditches	1,000	LF	$0.30	$300		31 23 19.10 0020 (30 ft wide x 1 ft deep)
Checks Dams or Other BMP	50	Ton	$56	$2,819		See Detail
Site Restoration / Revegetation	8	Acre	$3,612	$29,019		See Detail
				Subtotal	**$103,143**	
			TOTAL	**$4,033,651**		

General Approach

Site Preparation is followed by installation of lined channel.
Sheetpile temporarily installed across Dupree Creek end of new weir structure to mitigate water instrusion during construction.
Excavate soil within new channel leaving soil plug at upper end of sheetpile to prevent water intrusion from culverts.
Use excavated soil to backfill outfall ditch- stockpiled following excavation, then placed in ditch followingre-routing into the outfall ditch.
Construct new weir structure and rip rap line channel.
Construct armoring at end of new channel.
Outfall is re-routed; Have to construct final wing wall and transistion tie-in in wet conditions (pump around to mitigate).
Backfill outfall ditch; install armoring at end of outfall ditch.

Option 6 Rip Rap Channel
Terry Creek ROM Cost Options

Item Description	Quantity	Unit	Unit Rate	Total	Subtotal	Comment
Oversight & Other Third Party Services						
CM/CQA oversight	34	Week	$9,730	$330,820		See Detail
				Subtotal	**$330,820**	
Pre-Mobilization						
Work Plans	1	LS	$10,000	$10,000		Eng. Est.
HASP	1	LS	$2,000	$2,000		Eng. Est.
Bonds	$3,398,798	%	1.0%	$33,988		01 31 13.90 0190
				Subtotal	**$45,988**	
Contractor's Project Management, Site Set-up, Admin.						
Project Manager	34	Week	$3,350	$113,900		01 31 13.20 0200
Home Office Costs	$3,271,220	%	3.90%	$127,578		01 31 13.40 0300
Insurance	$3,251,064	%	0.62%	$20,157		01 31 13.30 0250
Site Trailer	8	Mth	$375	$3,000		01 52 13.20 0700 - 50' x 12' rental
Utilities, Furniture, ODC's	8	Mth	$894	$7,148		See Detail
Survey						
Initial Layout	40	Hr	$144	$5,750		Eng. Est. - incl. 15% markup on raw cost for GC pass through/markup
On-Going	272	Hr	$144	$39,100		Eng. Est. Assumed to be one day per week.
As-Built	60	Hr	$144	$8,625		Eng. Est.
				Subtotal	**$325,257**	
Initial Site Preparation and Controls						
Mobilization/Demobilization						
General Contractor / Earthwork	1	LS	$14,655	$14,655		See Detail
Sheetpile	1	LS	$30,000	$30,000		Per J. Duffey est., 21 Aug 2013. One for main channel, under new weir structure, and at end of new weir structure to prevent water intrusion. One for transition at completion.
Concrete	1	LS	$8,130	$8,130		See Detail. One each for weir, lining, and transistion tie-in
Construction Entrance / Access Roads	1,000	LF	$13	$13,288		See Detail
Truck Wash / Decon Station, Materials only	3	Each	$6,000	$18,000		http://www.dultmeier.com/products/0.165.2399/996. portable truck wash pad, assume 3 used for project (semi-disposable).
Clearing & Grubbing	1.7	Acre	$6,675	$11,493		See Detail. Assume 500 LF x 100 FT on S. Side (incl. laydown area) and 500 x 50 ft on north side for access.
Construction Fencing / Security	2,500	LF	$4	$9,650		02 58 13.10 7001
Silt Fencing / E&S	2,500	LF	$1.20	$3,000		31 25 14.16 1100
Turbidity Curtain	500	LF	$28.00	$14,000		http://www.ctre.iastate.edu/erosion/manuals/construction/3.6_floatation_silt.pdf
Laydown Area Preparation	1	Acre	$38,962	$38,962		See Detail
				Subtotal	**$161,178**	
Dewatering / By-Pass Pumping / Water Management						
Water Management at Triple Box Culvert						
Pump Systems	10	Day	$3,321	$33,214		18" pump with 400 feet hose, $ based on NS rate from Hertz Equipment Rental, 24hr/day operation, NO wellpoint
Dam / Diversion Structures	800	SF	$39	$31,200		31 52 16.10 0060 - Barge, Driven Sheetpile Cofferdam. Walls to prevent intrusion. 40 LF wide by 20 ft deep sheet
Dewatering of Outfall Ditch	20	Day	$1,575	$31,500		31 23 19.20 1100 & 1120 (2nd pump)
Dam / Diversion Structures	800	SF	$39	$31,200		
Routine Storm Water Management - Excavations, etc.	143	Day	$1,200	$171,000		31 23 19.20 1100 at 75% utilization - i.e., days not operated have not labor or fuel charges but rent is still incurred.
				Subtotal	**$298,114**	
Earthwork - Excavation & Removal						
Sediment Removal within Existing Triple Box Culvert						
Excavation & Removal	300	CY	$120	$36,127		See Detail. Assumed removal area, 3 ft deep sediment, 150 LF x 18 ft wide
Solidification	300	CY	$4	$1,204		31 32 13.19 2060 - Lime Soil Stabilization in prep for T&D. Unit converted $/SY to $/CY, based on 2% mix, 12" deep. $12.05/SY @ 1 Foot = $12.05*.333 CY
Transportation & Disposal, non-haz	512	Ton	$28	$14,541		May 2013 Quotation for RSI Broadhurst Landfill: $16.90/T disposal. Transportation quoted at $23/ton but quoted cycle distance is 2X this estimate (260 miles vs. 130mile). Use 1/2 quoted rate.
Sediment Removal at Box Culvert / New Construction Transition						
Excavation & Removal	900	CY	$23	$20,334		See Detail. 3 foot removal across area.
Solidification	900	CY	$4	$3,611		31 32 13.19 2060 - Lime Soil Stabilization in prep for T&D. Unit converted $/SY to $/CY, based on 2% mix, 12" deep. $12.05/SY @ 1 Foot = $12.05*.333 CY
Transportation & Disposal, non-haz	1,440	Ton	$28	$40,896		May 2013 Quotation for RSI Broadhurst Landfill: $16.90/T disposal. Transportation quoted at $23/ton but quoted cycle distance is 2X this estimate (260 miles vs. 130mile). Use 1/2 quoted rate.
Outfall Ditch Excavation						
Excavation & Removal	741	CY	$28	$20,996		See Detail. Excavation effort to re-route water to north side of the outfall ditch. Assume 10 foot ditch, 2 feet wide, 1,000 LF completed with long reach, T&D needed.
Solidification	741	CY	$4	$2,972		31 32 13.19 2060 - Lime Soil Stabilization in prep for T&D. Unit converted $/SY to $/CY, based on 2% mix, 12" deep. $12.05/SY @ 1 Foot = $12.05*.333 CY
Transportation & Disposal, non-haz	1,185	Ton	$28	$33,659		May 2013 Quotation for RSI Broadhurst Landfill: $16.90/T disposal. Transportation quoted at $23/ton but quoted cycle distance is 2X this estimate (260 miles vs. 130mile). Use 1/2 quoted rate.
Shaping						
Excavation within Sheetpile Structure (incl. over-excavation beneath concrete lining)						
Excavation & Removal	0	CY	$15	$0		See detail. Not Applicable.
Solidification	0	CY	$4	$0		31 32 13.19 2060 - Lime Soil Stabilization in prep for T&D. Unit converted $/SY to $/CY, based on 2% mix, 12" deep. $12.05/SY @ 1 Foot = $12.05*.333 CY
Transportation & Disposal, non-haz	0	Ton	$28	$0		May 2013 Quotation for RSI Broadhurst Landfill: $16.90/T disposal. Transportation quoted at $23/ton but quoted cycle distance is 2X this estimate (260 miles vs. 130mile). Use 1/2 quoted rate.
Box Culvert Excavation, incl. over-excavation						
Excavation & Removal	0	CY	$15	$0		See detail. Not Applicable.
Solidification	0	CY	$4	$0		31 32 13.19 2060 - Lime Soil Stabilization in prep for T&D. Unit converted $/SY to $/CY, based on 2% mix, 12" deep. $12.05/SY @ 1 Foot = $12.05*.333 CY
Transportation & Disposal, non-haz	0	Ton	$28	$0		May 2013 Quotation for RSI Broadhurst Landfill: $16.90/T disposal. Transportation quoted at $23/ton but quoted cycle distance is 2X this estimate (260 miles vs. 130mile). Use 1/2 quoted rate.
Excavation - Diversion Channel [b)] (incl. over-excavation)						

Option 6 Rip Rap Channel
Terry Creek ROM Cost Options

Item Description	Quantity	Unit	Unit Rate	Total	Subtotal	Comment
Excavation & Removal of backfill soil	11,583	CY	$10	$113,982		See detail. For Option 2A, assumes Outfall is backfille. Excavation of channel profile.
Excavation & Removal, over-excavation within new channel profile	11,250	CY	$28	$318,879		See detail. For Option 1A, assumes Outfall is backfilled, channel profile is excavated. Sediment excavated, solidified, and T&D
Solidification	11,250	CY	$4	$45,142		31 32 13.19 2060 - Lime Soil Stabilization in prep for T&D. Unit converted $/SY to $/CY, based on 2% mix, 12" deep. $12.05/SY @ 1 Foot = $12.05*.333 CY
Transportation & Disposal, non-haz	18,000	Ton	$28	$511,200		May 2013 Quotation for RSI Broadhurst Landfill: $16.90/T disposal. Transportation quoted at $23/ton but quoted cycle distance is 2X this estimate (260 miles vs. 130mile). Use 1/2 quoted rate.
Earthwork - Rip Rap Preparation - Dupree Creek	5	Day	$7,584	$37,921		See Detail. Preparation of areas along Dupree Creek for installation of rip rap armoring.
				Subtotal	**$1,201,465**	
Earthwork - Backfill & Compaction						
Backfill Outfall Ditch						
Geotextile Installation	20,000	SY	$2	$43,800		32 11 23.23 6000. 6 oz/SY fabric. Adjust for difficult installation location. RSMeans provide +50% for small or irregular areas.
Import Backfill, Procure & Deliver	37,250	CY	$3	$125,160		31 23 23.20 4040. Ave cycle 4 miles @ 25 mph. Assume $0 to purchase backfill.
Backfill & Compaction	48,083	CY	$8	$363,991		See Detail. This will be completed in two stages - south half (for channel construction) followed by north side (following re-routing). Backfill located within new channel will be double handled for backfilling. Intial fill followed by excavation from within channel contour then backfilled into north side of outfall ditch fill.
Fine Grading	22,400	SY	$0.2	$4,480		31 22 16.10 3300
Backfill Culvert Installation						
Geotextile Installation	0	SY	$2	$0		32 11 23.23 6000. 6 oz/SY fabric. Adjust for difficult installation location. RSMeans provide +50% for small or irregular areas.
Import Backfill, Procure & Deliver	0	CY	$3	$0		31 23 23.20 4040. Ave cycle 4 miles @ 25 mph. Assume $0 to purchase backfill
Bedding Placement	0	CY	43.1	$0		See Detail
Backfill & Compaction	0	CY	$8	$0		See Detail
Fine Grading	0	SY	$0.2	$0		31 22 16.10 3300
				Subtotal	**$537,431**	
Earthwork - Sub-Aqueous Cap Installation						
Sub-Aqueous Cap	0	SF	$4	$0		See Detail
				Subtotal	**$0**	
Earthwork - Aggregates and Armoring						
Rip Rap Armor - Dupree Creek						
Geotextile Underlayment		SY	$1	$0		32 11 23.23 6000. 6 oz/SY fabric.
Rip Rap Placement	4,500	Ton	$56	$253,723		See Detail
Sub-Aqueous Rip Rap Armor - Outfall Ditch						
Geotextile Underlayment	0	SY	$2	$0		32 11 23.23 6000. 6 oz/SY fabric. Adjust for difficult installation location. RSMeans provide +50% for small or irregular areas. Not applicable.
Rip Rap Placement	8,400	Ton	$56	$473,616		See Detail
Sub-Aqueous "Fabri-Form" Armor - Outfall Ditch						
Geotextile Underlayment	0	SY	$2	$0		32 11 23.23 6000. 6 oz/SY fabric. Adjust for difficult installation location. RSMeans provide +50% for small or irregular areas. Not applicable.
Armor System Placement	0	SF	$7	$0		See Detail. Not applicable
				Subtotal	**$727,339**	
Systems Construction / De-Construction						
Demolition						
Existing Weir Structure	70	LF	$406	$28,407		See Detail
Existing Box Culvert/Wing Wall Structures	11	LF	$406	$4,464		See Detail
Cast In Place Concrete						
Box Culvert Transition	0	CY	$380	$0		03 30 53.40 4260 - 10' wall, 12" thick, free standig, cast in place
Sheetpile Channel Bottom	0	SF	$8	$0		See Detail
Concrete Lined Channel	0	SF	$8	$0		See Detail
GC Markup	$0	%	15%	$0		GC markup on subcontracted costs
Pre-Cast Culverts	0	LF	$2,110	$0		See Detail. Need to adjust production for in or out of ditch
Sheetpile Installation						
Work Over Water, Additive Cost	0	% base cost	$13	$0		31 06 60.14 1600
Channel Walls, Steel	0	SF	$44	$0		31 41 16.10 1800
GC Markup	$0	%	10%	$0		GC markup on subcontracted costs
				Subtotal	**$32,871**	
Final Restoration, Stabilization, Protection						
Permanent Security Fencing						
Fencing	2,050	LF	$28	$57,400		032 31 13.20 0200
Double Swing Gate	3	Each	$1,100	$3,300		032 31 13.20 5060
GC Markup	$60,700	%	15%	$9,105		GC markup on subcontracted costs
Permanent E&S Measures						
Silt Fencing / E&S	1,000	LF	$1.20	$1,200		31 25 14.16 1100
Drainage Ditches	1,000	LF	$0.30	$300		31 23 19.10 0020 (30 ft wide x 1 ft deep)
Checks Dams or Other BMP	50	Ton	$56	$2,819		See Detail
Site Restoration / Revegetation	8	Acre	$3,612	$29,019		See Detail
				Subtotal	**$103,143**	
			TOTAL	**$3,763,606**		

General Approach

Site Preparation is followed by installation of lined channel.
Sheetpile temporarily installed across Dupree Creek end of new weir structure to mitigate water instrusion during construction.
Excavate soil within new channel leaving soil plug at upper end of sheetpile to prevent water intrusion from culverts.
Use excavated soil to backfill outfall ditch- stockpiled following excavation, then placed in ditch followingre-routing into the outfall ditch.
Construct new weir structure and rip rap line channel.
Construct armoring at end of new channel.
Outfall is re-routed; Have to construct final wing wall and transistion tie-in in wet conditions (pump around to mitigate).
Backfill outfall ditch; install armoring at end of outfall ditch.