Final Treatability Study Work Plan

San Jacinto River Waste Pits Site
Harris County, Texas

International Paper Corporation
McGinnes Industrial Maintenance Corporation

100017197

GHD | 5551 Corporate Boulevard Suite 200 Baton Rouge Louisiana 70808 | 11187072 | Report No 5 | May 20 2019

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List of Acronyms

AOC	-	Administrative Settlement Agreement and Order on Consent for Remedial Design
ARAR	-	Applicable or Relevant and Appropriate Requirement
ASTM	-	American Society for Testing and Materials
BOD	-	Biological Oxygen Demand
CERCLA	-	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	-	Code of Federal Regulations
CO	-	Carbon Monoxide
COD	-	Chemical Oxygen Demand
COC	-	Constituent of Concern
CWA	-	Clean Water Act
EBCT	-	Empty Bed Contact Time
EPA	-	Environmental Protection Agency
ESL	-	Effects Screening Level
GAC	-	Granular Activated Carbon
GHD	-	GHD Services Inc.
I-10	-	Interstate Highway 10
ICR	-	Ignitability, Corrosivity, and Reactivity
IPC	-	International Paper Company
MAL	-	Minimum Analytical Levels
mg/L	-	Milligrams per Liter
MIMC	-	McGinnes Industrial Maintenance Corporation
mL/min	-	Milliliters per Minute
NNSR	-	Non-Attainment New Source Review
ng/kg	-	Nanograms per Kilogram
NOx	-	Nitrogen Oxides
NSR	-	New Source Review
OSWER	-	Office of Solid Waste and Emergency Response
PBR	-	Permit by Rule
PCBs	-	Polychlorinated Biphenyls
PCDD	-	Polychlorinated Dibenzodioxins
PCDF	-	Polychlorinated Dibenzofurans
PDI-1	-	First Phase Pre-Design Investigation
PDI-2	-	Second Phase Pre-Design Investigation
PDIWP-2	-	Second Phase Pre-Design Investigation Work Plan
ppq	-	Parts per quadrillion
PSD	-	Prevention of Significant Deterioration
psi	-	Pounds per square inch
QAPP	-	Quality Assurance Project Plan
RA	-	Remedial Action
RCRA	-	Resource Conservation and Recovery Act
RD	-	Remedial Design
ROD	-	Record of Decision
RPM	-	Rotations per Minute
SM	-	Standard Methods for the Examination of Water and Wastewater
SOP	-	Standard Operating Procedure

SOW - Statement of Work
SVOC - Semi-volatile Organic Compound
TAC - Texas Administrative Code
TCDD - Tetrachlorinated dibenzo-p-dioxin
TCEQ - Texas Commission on Environmental Quality
TCLP - Toxicity Characteristic Leaching Procedure
TCRA - Time Critical Removal Action
TDS - Total Dissolved Solids
$TEQ_{DF,M}$ - TCDD toxicity equivalents for mammals
TEF - Toxic Equivalency Factor
TPDES - Texas Pollutant Discharge Elimination System
TPY - Tons per Year
TSWP - Treatability Study Work Plan
TSWQS - Texas Surface Water Quality Standards
TWG - Technical Working Group
UCS - Unconfined Compressive Strength
USACE - United States Army Corps of Engineers
µg/L - Micrograms per Liter
VOC - Volatile Organic Compound
WLA - Waste Load Allocations
WQBEL - Water Quality Based Effluent Limits

1. Introduction

GHD Services Inc. (GHD), on behalf of the International Paper Company (IPC) and McGinnes Industrial Maintenance Corporation (MIMC; collectively referred to as the Respondents), submits to the United States Environmental Protection Agency (EPA) this *Final Treatability Study Work Plan (TSWP)* for the San Jacinto River Waste Pits Superfund Site in Harris County, Texas (Site). This work plan is being submitted in connection with the Administrative Settlement Agreement and Order on Consent for Remedial Design (AOC), Docket No. 06-02-18 agreed to by the Respondents and by the EPA with an effective date of April 11, 2018 (EPA, 2018). The AOC includes a Statement of Work (SOW) which describes the requirements for implementing the Remedial Design (RD) for the Site and states that the Respondents may perform treatability studies for the purpose of developing information in support of the RD. As specified in the SOW, this work plan was prepared in accordance with the EPA's *Guidance for Conducting Treatability Studies under CERCLA* (EPA, 1992) and the *Remedial Design/Remedial Action Handbook* (EPA, 1995).

The Respondents submitted the *Draft Treatability Study Work Plan* to the EPA on February 11, 2019, and the EPA provided written review comments on April 18, 2019. Representatives of the EPA, Texas Commission on Environmental Quality (TCEQ), the United States Army Corps of Engineers (USACE), the Respondents, and GHD participated in a meeting on May 3, 2019, at the TCEQ offices in Austin, Texas. The meeting included discussion of the *Draft TSWP* agency review comments and proposed revisions. A table that outlines all of the *Draft TSWP* agency review comments, responses, and references to the location of the revisions is included as Appendix A.

1.1 Site Description and Summary of Selected Remedy

The AOC includes a description of impoundments located on the western side of the San Jacinto River, in Harris County, Texas, north and south of Interstate Highway 10 (I-10). In 1965 and 1966, pulp and paper mill waste was reportedly transported by barge from the Champion Paper Inc. paper mill in Pasadena, Texas, and deposited in the impoundments. The Preliminary Site Perimeter described in Appendix C of the AOC encompasses these impoundments and the surrounding in-water and upland areas. The location of the Preliminary Site Perimeter is shown on the Vicinity Map included as Figure 1 and a Site Plan is included as Figure 2.

1.1.1 Northern Impoundment Remedy

In 2011, a time critical removal action (TCRA) was implemented by the Respondents under an Administrative Order on Consent with EPA (Docket No. 06-12-10, April, 2010; EPA, 2010). Construction elements of the TCRA in the Northern Impoundment included placement of a stabilizing geotextile barrier over the eastern cell, construction of a low-permeability geomembrane and geotextile barrier in the western cell, and placement of a rock cap over both cells.

The remedy selected in the Record of Decision (ROD) for the Northern Impoundment includes excavation and off-Site disposal of wastes above a cleanup level of 30 nanograms per kilogram (ng/kg) for 2,3,7,8-tetrachlorinated dibenzo-p-dioxin (TCDD) toxicity equivalents for mammals ($TEQ_{DF,M}$).

According to the ROD, the work area would be isolated with an engineered barrier, as determined during the RD. The existing armored cap, which currently isolates and contains impacted material, would be removed prior to beginning excavation activities. These actions would be done in sections so that only the immediate area to be removed would be uncovered at any one time. Similarly, upland excavation may require dewatering to allow excavation of impacted sediment in relatively dry conditions. Excavated sediment may be further dewatered and solidified as required for transportation and disposal.

1.1.2 Southern Impoundment Remedy

According to the ROD, the selected remedy for the Southern Impoundment involves excavation and replacement of soil that is above the 240 ng/kg $TEQ_{DF,M}$ clean-up level. Soil may be removed within impacted areas to a depth of up to 10 feet below grade. Excavated soil may be dewatered, as necessary, and potentially treated to eliminate free liquids prior to transport for disposal. Effluent from excavation and subsequent dewatering would need to be handled appropriately, potentially including treatment prior to disposal. Excavated soil exceeding 240 ng/kg $TEQ_{DF,M}$, would be disposed of at an existing permitted disposal facility, the excavation would be backfilled with imported soil and/or excavated soil which is below the designated clean-up level, and vegetation would be re-established.

1.1.3 Remedy Implementation Approach

To design the remedy as identified in the ROD, the Respondents have developed a preliminary technical approach to the remedial action (RA). To evaluate this approach requires the collection of data and information during the Second Phase Pre-Design Investigation (PDI-2) and the treatability study to inform the design process. Elements of the technical approach relevant to the treatability study are identified below and discussed throughout this TSWP in connection with specific aspects of this treatability study.

Northern Impoundment

- Estimation of the horizontal and vertical limits of waste to 30 ng/kg $TEQ_{DF,M}$ during the First Phase PDI (PDI-1) and PDI-2 to inform the design of the cell size, BMP alignment, and potential seasonal execution of the RA. The RD will seek to maximize efficiency of the RA by designing multiple BMP cells, taking into account the volume of material to be removed and seasonal variations in the San Jacinto River water levels and optimally designing the BMP cell's alignment and top elevation accordingly.
- Installation of engineered barriers around cells, as necessary, to efficiently manage the amount of waste material, water, and supporting labor and equipment required.
- After installation of engineered barrier(s), return of non-contact river water from inside the engineered barrier (river water that has not come in contact with waste material) back to the river.

- Re-use of contact water (seepage and/or rainwater that has contacted the waste material) for the in-situ solidification of the waste material.
- In-situ solidification of the waste material to prepare the waste material for transport and eliminate the need for double-handling.
- Reduction of the volume of contact water via thermal evaporation.
- Excavation of solidified waste material, direct load and transport to a disposal facility.

Southern Impoundment

- Delineation of the horizontal and vertical limits of waste to 240 ng/kg $TEQ_{DF,M}$ to a depth of 10 feet during PDI-1 and PDI-2.
- Potential re-use of contact water (seepage and/or rainwater that has contacted the waste material) for in-situ solidification of the waste material.
- Excavation of the solidified soil and direct load for transport to a disposal facility.
- Backfill with clean fill and/or excavated soil which is below the designated clean-up level.

1.2 Treatability Study Overview

Waste Material

It is anticipated that waste material in the Northern and Southern Impoundments can be solidified in-situ by mixing it with a reagent (e.g., Portland cement). A laboratory treatability study will be performed to evaluate options for solidification of the waste material. Representative samples of the waste material will be collected from each impoundment for treatability testing, as described in Section 4.1. Solidification testing will include testing of various proprietary and non-proprietary solidification agents to identify the appropriate mix design that allows the samples to meet requirements for Class 1 and/or Class 2 non-hazardous industrial waste disposal (in accordance with 30 Texas Administrative Code [TAC] 335.505-506).

Water Management

Installation of an engineered barrier has the potential to entrap bulk river water (surface water) behind the engineered barrier. Under the approach being developed, river water that becomes contained within an engineered barrier, and that has not come in contact with the waste material due to the presence of the existing cap, will be returned to the river untreated (i.e., the river water will return to the river). As a result, treatability testing is not proposed to be conducted on river water.

During the RA, as sections of the armor cap are removed, it is anticipated that surface water will come into contact with the waste material through seepage or storm water and will require management. Preliminary water balance calculations indicate that such contact water could be utilized in the solidification process as water for slurry preparation of the solidification reagent. In the event that there is a surplus volume of contact water, or if volume reduction is necessary for storage or treatment purposes, contact water reduction through thermal evaporation may be utilized. As part of this TSWP, emissions from the evaporation process will be evaluated to ensure that they comply with air quality Applicable or Relevant and Appropriate Requirements (ARARs).

Contact water reuse during solidification and volume reduction through evaporation may be able to sufficiently utilize the contact water without having to treat and discharge large volumes of effluent. However, the treatability study will also evaluate the treatment of contact water to meet water quality ARARs.

Armored Cap Material

The Northern Impoundment is covered with an armored cap constructed of a geomembrane/geotextile barrier and recycled concrete or natural rock armor. As part of the treatability study, the armored cap materials will be evaluated for potential reuse on-Site either during or post-remedy implementation.

1.3 Treatability Study Objectives

The objectives of the treatability study include:

1. Evaluate the re-use of contact water on-Site in the solidification mix design as slurry to reduce water requiring management.
2. Evaluate optimum solidification mix designs to solidify the waste material for transportation and disposal.
3. Evaluate optimum solidification mix designs to meet requirements for Class 1 and/or Class 2 non-hazardous industrial waste disposal, in accordance with 30 TAC 335.505-506 and 335.508.
4. Characterize the water quality of anticipated contact water for evaluation of treatment alternatives.
5. Evaluate evaporation technology, including processing capacities, fuel consumption, evaluation of the characteristics of the brine produced by the evaporation process, and air emissions.
6. Determine the optimum method for solidification of brine resulting from the evaporation process and thickened solids from a clarifier or filter.
7. Determine the optimum treatment alternatives for contact water to comply with ARARs, if necessary.
8. Evaluate the armored cap materials at the Site to determine whether such materials can be reused on-Site during or post-remedy implementation.

1.4 Document Organization

The remaining sections of this Draft TSWP are organized as follows:

- Section 2 provides descriptions of the technologies that will be evaluated during the treatability study.

- Section 3 provides a discussion of ARARs that are relevant to the remedy implementation and therefore the treatability study.
- Section 4 provides a summary of the planned laboratory treatability testing.
- Section 5 provides information about quality assurance for treatability testing, (further detailed in the Quality Assurance Procedures for Laboratory Treatability Studies provided in Appendix B).
- Section 6 provides information about data analysis and how the data will be interpreted and utilized to inform development of the RD.
- Section 7 provides information about reporting of the data from the treatability testing.
- Section 8 provides a discussion of the treatability study schedule and duration.
- Section 9 provides a list of references cited in this TSWP.

2. Technology Descriptions

2.1 Solidification

Solidification is a process that turns a material with a high moisture content into a solid material, capable of meeting landfill acceptance criteria, by adding an amendment to the material. A secondary result of solidification is the minimization of leaching potential. Solidification can be accomplished by mechanical processes or by a chemical reaction between a waste and binding (solidifying) reagents, such as cement, kiln dust, or lime/fly ash. The desired changes usually include an increase in the compressive strength, a decrease of permeability, and encapsulation of hazardous constituents.

In-situ solidification typically involves the addition of binding agents to an area of sludge or soils and addition of water where necessary, followed by repeated in-place mixing with the bucket of a backhoe or similar excavator to mix and solidify the sludges or soils in place. In this case, in-situ solidification would take place in preparation for subsequent excavation and off-Site disposal of waste materials or soils. The excavator also can be equipped with a mixing head. In addition, in-situ mixing can be accomplished using large, flighted, rotary augers, six to eight or more feet in diameter, that are capable of injecting a slurry mixture through the auger flights. Ex-situ solidification field processes involve excavation and staging of solids, screening to remove materials too large in diameter to be treated effectively, blending the binding agents and water with solids when appropriate, and stockpiling treated solids for testing prior to shipment off-Site.

Both in-situ and ex-situ solidification can be used to form a solid matrix to encapsulate constituents of concern (COCs) so they are immobilized and are at no risk of leaching. The amounts and types of solidification reagents required to treat the material containing COCs are typically confirmed by conducting a treatability study. During this treatability study, samples of the waste/soil will be mixed with various amounts of solidification reagents. Each mixture will then be left to chemically react. When the chemical reaction is considered complete, a sample will be taken and analyzed for toxicity characteristic leaching procedure (TCLP) concentration to determine the stability of contaminants within the solidified sample.

2.2 Water Management

Water that contacts the waste material (contact water) and cannot be discharged to the river without treatment is planned to be stored and used in the slurry mixture for solidification of waste materials. If the volume of contact water generated exceeds the amount needed for solidification, it is anticipated that the volume of water could be reduced using thermal evaporation technology. The evaporation technology will use a fuel (propane or natural gas) to sustain a flame that is in direct communication with the contact water to reduce its volume by creating steam. The evaporation process produces a concentrated water (brine), which could then potentially be used in the slurry mixture for the solidification process. The treatability study will evaluate the potential for brine reuse.

Depending on the volume of contact water generated, treatment and discharge of contact water to the river may be necessary. The treatability study will also evaluate treatment of the contact water for potential discharge to the San Jacinto River. Treatment technologies that may be evaluated include aeration and pH adjustment, precipitation, coagulation/flocculation, organic compound removal, filtration, and/or adsorption or ion exchange, as well as, reduction of volume in order to minimize the volume requiring management.

A baseline characterization of the water chemistry will determine which water treatability technologies will be evaluated. Descriptions of treatment technologies that may be evaluated in this treatability study are included in the following sections.

2.2.1 Ferrous Iron Oxidation through Aeration and pH Adjustment

Oxidation of ferrous iron with dissolved oxygen through aeration is a common technique used in iron bearing waters. The ferrous iron is oxidized with dissolved oxygen and then the resulting ferric oxide floc is removed by sedimentation or filtration. The pH may be adjusted to a slightly basic pH in order to reduce the aeration reaction time.

This treatment method could be utilized to convert soluble ferric iron, which can clog piping, pumps, and treatment processes as it precipitates following exposure to air.

2.2.2 Metals Precipitation

Precipitation processes are characterized by the solubility of the metal to be removed. They are generally designed to precipitate trace metals to their solubility limits and obtain additional removal by co-precipitation and adsorption during the precipitation reaction. Optimum pH and chemicals used, and the dose of the chemical, are the primary variables that affect removal of constituents. Each of these variables directly influences treatment objectives. This treatment method could also be utilized if a reduction in metal(s) concentration is required prior to discharge.

2.2.3 Solids Coagulation and Flocculation

Coagulant chemicals with charges opposite those of the suspended solids can be added to the water to neutralize the negative charges on non-settable solids (such as clay and color-producing organic substances). Once the charge is neutralized, the small suspended particles are capable of coagulating. These slightly larger particles are called microflocs, and are not visible to the naked eye. A high-energy, rapid-mix to properly disperse coagulant and promote particle collisions is needed to achieve good coagulation. Over-mixing does not affect coagulation, but insufficient mixing will leave this step incomplete. Flocculation, a gentle mixing stage, increases the particle size from submicroscopic microfloc to visible suspended particles. Microfloc particles collide, causing them to bond to produce larger, visible flocs called pinflocs. Flocculation requires careful attention to the mixing velocity and amount of mix energy. To prevent floc from tearing apart or shearing, the mixing velocity and energy are usually tapered off as the size of floc increases. Once flocs are torn apart, it is difficult to get them to reform to their optimum size and strength.

Flocculation would be utilized to remove suspended solids that are not removed by filtration media. Flocculation and coagulation could be utilized to remove metals, phosphorous, chemical oxygen demand (COD), and biological oxygen demand (BOD), if necessary.

2.2.4 Activated Carbon Adsorption of Organic Compounds

Activated carbon utilizes its extremely high surface area to remove constituents in the process of physical adsorption. At the submicroscopic level, the surface of the carbon pores exerts attractive forces. For certain volatile organic compounds (VOCs), the attractive force of the carbon surface is stronger than the attractive forces keeping them dissolved in the liquid solution or vapor stream. For these compounds, the VOC molecule adheres or sticks or adsorbs to the surface of the carbon, thereby removing them from the treated effluent stream. Compounds that are ideal for activated carbon adsorption tend to be organic and non-polar and have high molecular weights and boiling points. This treatment method could be utilized to remove dioxins and furans from the water.

2.2.5 Ammonia Removal by Adsorption or Ion Exchange

Ion exchange may offer an alternative to additional biological treatment for ammonia removal. Possible advantages include good response to shock loading, and low sensitivity to variations in temperature, pH, and anti-microbial activity. This treatment method could be utilized to reduce ammonia levels, if necessary.

2.2.6 Thermal Evaporation

The volume of contact water may be reduced using a modular thermal evaporation technology. The technology utilizes a fuel source (propane or natural gas) to generate a flame that will be in direct contact with the water to create steam which is discharged to the atmosphere. Evaporation technology has the ability to reduce an influent water stream to approximately 10 percent of its original volume, thereby significantly reducing the amount of water requiring management. This results in a residual wastewater (or brine) that can be either disposed of or reused.

3. ARAR Consideration

3.1 Permit Equivalency

In general, Site remediation conducted under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) is not subject to federal or state environmental permitting requirements. As the response action for the Site is being initiated under a ROD in compliance with Section 121 of CERCLA, response action activities conducted completely on the Site are not subject to any otherwise applicable permitting requirement of local, state, or federal regulatory programs. Guidance on this provision of CERCLA consistently upholds the EPA's assertion that the progress or cost of remediation of CERCLA sites not be impacted or held up by surrogate or "permit equivalency" procedures on the part of other regulatory agencies (*Permits and Permit "Equivalency" Processes for CERCLA On-Site Response Actions",* EPA Office of Solid Waste and Emergency Response [OSWER] Directive 9355.7-03, February 19, 1992). As discussed in the following sections, all response action activities will be developed with the objective of complying with the pertinent ARARs.

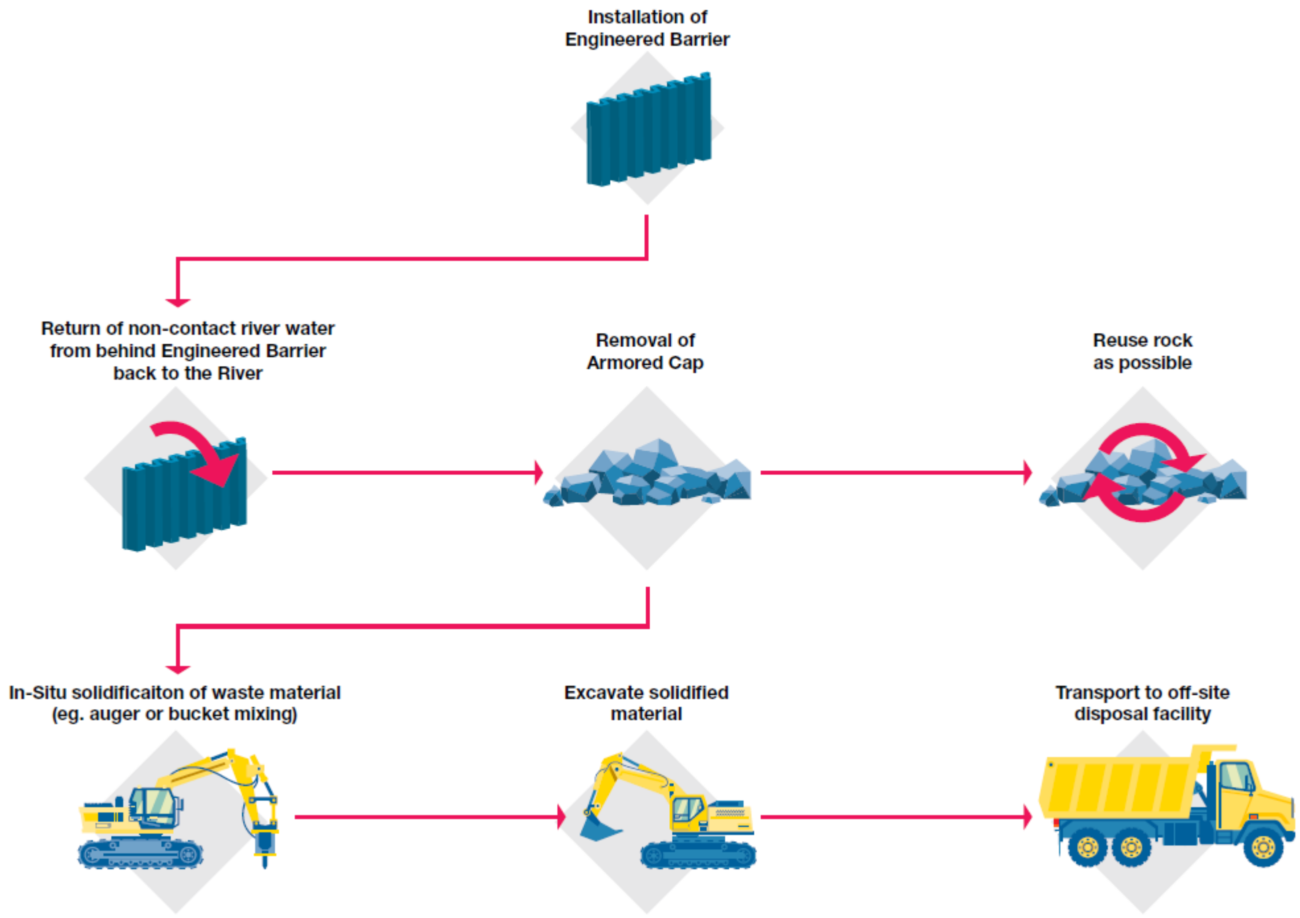
In addition, as part of the Technical Working Group (TWG) process, EPA participants have stated that potential staging area(s) located within an approximately one-mile radius of the Preliminary Site Perimeter can be used for RA activities without triggering a separate permitting process. This conclusion was reiterated in a verbal communication between Anchor QEA and the EPA on June 14, 2018.

3.2 Excavated Solids

During the treatability study, methods and technologies that may be used during the RA will be evaluated. Therefore, the ARARs applicable to the RA are relevant to inform the treatability study because they require consideration of standards, criteria, or permit equivalencies that may influence technology consideration, effectiveness, and selection. The section below outlines potential ARARs that require consideration during the treatability study.

A conceptual process flow diagram giving an overview of the waste management strategy is shown below on Figure 3.1.

Figure 3.1 Waste Management Strategy



3.2.1 Waste Characterization

Based on the origin of waste material in the Northern and Southern Impoundments, the waste is not listed as hazardous under 40 Code of Federal Regulations (CFR) Part 261, Subpart D. Further, waste characterization samples collected during the PDI-1 were analyzed for the ignitability, corrosivity, reactivity (ICR), and toxicity, as defined in Title 40 of CFR Part 261, Subpart C, to determine if they were characteristically hazardous or non-hazardous. The results indicate that the material is not a characteristic hazardous waste under Resource Conservation and Recovery Act (RCRA) or TCEQ regulations. Validated PDI-1 waste characterization data are included in Table 1. Analytical laboratory reports and data validation reports will be included with the complete PDI-1 dataset in the Final Second Phase Pre-Design Investigation Work Plan (PDIWP-2), to be submitted under separate cover.

Additional testing will be conducted during the treatability study to further classify the non-hazardous waste under applicable TCEQ rules. In addition, the material will be tested in accordance with EPA Method SW-846 Test Method 9095B (i.e., paint filter test), to determine the presence of free liquids, which would prevent the material from being disposed without solidification.

Non-Hazardous Industrial Solid Waste

Regulations governing the classification of non-hazardous industrial solid waste in Texas are codified in Title 30 (Environmental Quality) of the TAC, Part 1 (TCEQ), Chapter 335 (Industrial Solid Waste and Municipal Hazardous Waste) 30 TAC 335.

Three categories of non-hazardous industrial solid waste are identified in 30 TAC 335.1. The first two classes are applicable to the waste on-Site and are summarized below:

- *Class 1 Wastes* - Any industrial solid waste or mixture of industrial solid wastes which, because of its concentration, or physical or chemical characteristics, is toxic, corrosive, flammable, a strong sensitizer or irritant, a generator of sudden pressure by decomposition, heat, or other means, or may pose a substantial present or potential danger to human health or the environment when improperly processed, stored, transported, or disposed of or otherwise managed, as further defined in 30 TAC 335.505 (relating to Class 1 Waste Determination).
- *Class 2 Wastes* - Any individual solid waste or combination of industrial solid waste which cannot be described as hazardous, Class 1, or Class 3, as defined in 30 TAC 335.506 (relating to Class 2 Waste Determination). The acceptable TCLP regulatory levels for disposal in a Class 2 landfill are shown in Table 2.

Samples that pass the paint filter test or that have been solidified such that they pass the paint filter test will be analyzed further to determine whether they meet TCEQ Class 1 or Class 2 non-hazardous landfill disposal requirements.

3.2.2 Treatment

As discussed in Section 3.1, remediation at the Site conducted under CERCLA is not subject to federal or state environmental permitting requirements. It is therefore, anticipated that a RCRA permit will not be required for on-Site waste treatment prior to off-Site disposal.

3.2.3 Disposal

Based upon the waste characterization results obtained during the PDI-1, the waste in the Northern Impoundment and the soil/waste in the Southern Impoundment is not characteristically hazardous under RCRA or TCEQ regulations and should be eligible for disposal in a Subtitle D (non-hazardous industrial solid waste) disposal facility. Further evaluation during the treatability study will determine whether the material can be disposed of in a Class 1 or Class 2 landfill. The Class 2 landfill constituent list is included as Table 2.

3.3 Water

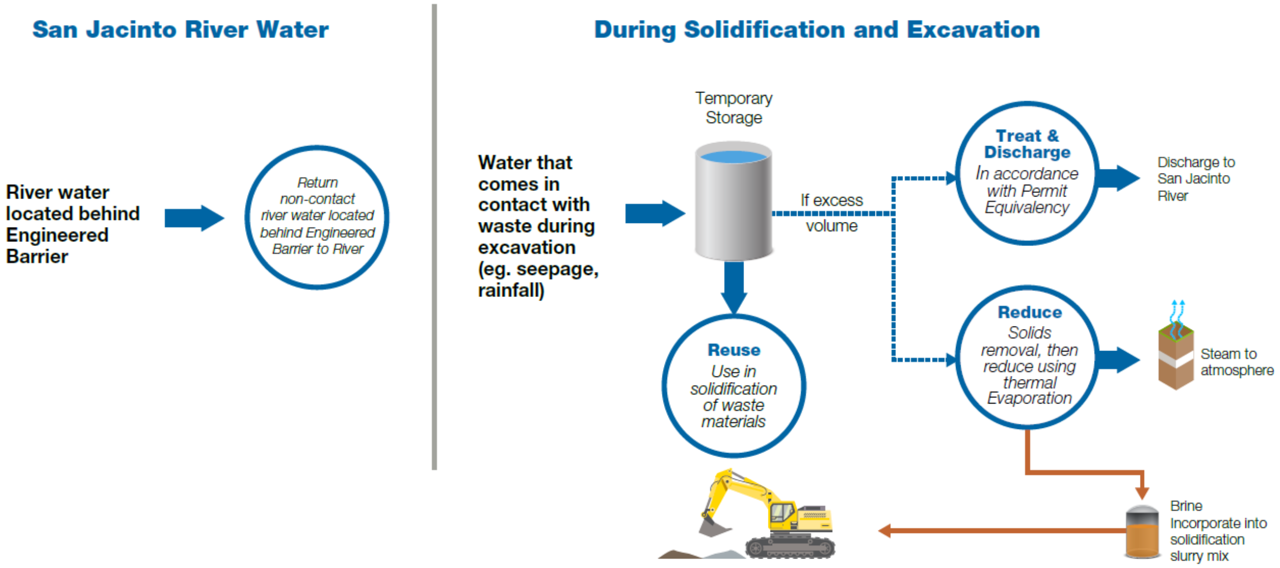
As described in Section 1.2, seepage water and rainwater that comes into contact with the waste material (contact water) may be generated during the RA which may require management. Any water that cannot be directly returned to the river may be managed through one or more of the following methods:

1. ***Reuse:*** Store and use in solidification of waste materials on-Site.
2. ***Discharge:*** Treat, as necessary, and discharge to surface water.

3. ***Reduce:*** Reduce the volume prior to reuse in solidification.

A conceptual process flow diagram giving an overview of the water management strategy is shown below on Figure 3.2.

Figure 3.2 Water Management Strategy



3.3.1 Northern Impoundment

For the Northern Impoundment, the volume of water generated during remediation may exceed the volume that can be used for solidification of solid materials. Therefore, Management Alternatives 1 through 3, discussed below, will be evaluated.

3.3.1.1 Management Alternative 1

For Management Alternative 1, contact water will be stored (in large containers, tanks, or barges) and used in the solidification process.

3.3.1.2 Management Alternative 2

For Management Alternative 2, applicable federal and state regulations allow the direct discharge to surface water, if the discharge does not cause or contribute to an impairment of water quality in the receiving stream. Discharges could occur into either Segment 1001-San Jacinto River Tidal or Segment 1005 - Houston Ship Channel / San Jacinto Tidal, as the Preliminary Site Perimeter is located at the junction of these two segments. ARARs include the following:

- Clean Water Act (CWA) §§ 301, 304, and 401 (33 United States Code Sections 1331, 1314, and 1341) - mandates that dischargers must comply with EPA-approved state water quality standards.
- Texas Surface Water Quality Standards (TSWQS) 30 TAC 307 - establishes Texas water quality standards for individual receiving streams. Water Quality Standards of particular interest

in this treatability study will be those for dioxins/furans (TCDD Equivalents), Arsenic, Mercury, Nickel, Polychlorinated Biphenyls (PCBs), and 2,4,5-Trichlorophenol. During treatability testing, the methodology outlined in the 2010 TCEQ Procedures to Implement the Texas Surface Water Quality Standards (Implementation Procedures) will be utilized to calculate water quality based effluent limits (WQBELs) for these constituents.

- The Implementation Procedures discuss the implementation of the TSWQS and approaches to development of permit limits to protect aquatic life and human health, and set Minimum Analytical Levels (MALs) for effluent sampling. In general, determination of final effluent limitations involves calculation of the effluent fraction at the edge of the stream's mixing zone and zone of initial dilution, followed by the comparison of the in-stream waste concentration against both the chronic and acute criteria. Once this is completed, the TCEQ determines the long-term average of the treatment system's performance that is needed to meet the Waste Load Allocations (WLA) within a given probability.

For dioxins/furans, Toxic Equivalency Factors (TEFs) are used by TCEQ to address differences in relative toxicity of the various dioxin/furan congeners. Fifteen compounds and their respective TEFs, as developed by the World Health Organization, have been adopted by the TCEQ. TEFs range from 0.0001 to 1.0. Each compound's concentration in an effluent analysis is multiplied by the TEF of the compound, as described in pages 130 to 142 of the Implementation Procedures.

The Implementation Procedures, Appendix E, Table E-2, set MALs for use in effluent testing. MALs are defined in the Implementation Procedures as "the lowest concentration at which a particular substance can be quantitatively measured with a defined accuracy and precision level, using approved analytical methods." The MALs for dioxin/furans range from 10 parts per quadrillion (ppq) to 100 ppq as TCDD Equivalents. MALs for PCBs range from 0.0005 to 0.2 micrograms per liter (µg/L). Further, the Implementation Procedures state: "MALs are used to allow an applicant or permittee to submit analytical results as non-detect. Non-detect analytical results are assumed to represent a concentration of zero (0) milligrams per liter (mg/L) (or µg/L as appropriate)."

Using this approach, discharge limits for toxic pollutants are estimated based on the in-stream waste concentration in the receiving stream, and the TSWQS. If the estimated limit is less than the MAL identified in the Implementation Procedures, then the MAL would be used for reporting purposes. Based on the guidance outlined in the Implementation Procedures, the Respondents anticipate that the appropriate ARAR for discharge of water would be the TSWQS for dioxins and that determination of compliance with this standard will be based upon the MALs for dioxin congeners. Therefore, the testing and water treatment technology evaluation proposed in this treatability study for discharges to the river is based on this assumption.

3.3.1.3 Management Alternative 3

For Management Alternative 3, contact water will be reduced via evaporation technology. The evaporation process will convert a portion of the water to steam which will be vented to the atmosphere, leaving a residual stream of water (brine) that can be either disposed or reused in solidification. The steam emissions will be evaluated as discussed in Section 3.4.

3.3.2 Southern Impoundment

For the Southern Impoundment, preliminary investigation results indicate that groundwater may not be encountered significantly during the planned RA due to the shallow excavations planned and the lower groundwater table elevation. In the event that groundwater requires management, preliminary calculations indicate that water generated during remediation can be stored and used in solidification of the soils. Therefore, Management Alternative 1 is the assumed path forward for the Southern Impoundment, and no discharge is anticipated.

3.4 Air

The water management treatability study will evaluate the effectiveness of thermal evaporation technology to reduce the volume of contact water. As part of this evaluation, emissions resulting from discharging evaporated steam and from combustion of natural gas or propane will be estimated and evaluated in a pilot test.

Emissions estimates based on vendor data from a representative evaporator unit being considered are approximately 25 tons per year (TPY) of Nitrogen Oxides (NOx) and 4.4 TPY of Carbon Monoxide (CO). Since the major source threshold for Title V Operating Permits is 100 TPY, permit equivalency for the Title V program would not be applicable for this Site. In addition to traditional air quality parameters, the pilot test will compare concentrations of Site-specific COCs in the influent water with concentrations in the brine, condensate, and vapor emissions to ensure there are no emissions above potentially applicable air quality thresholds.

Emissions from similar projects not managed under CERCLA require authorization under New Source Review (NSR) (30 TAC 116) prior to commencement of construction. Emissions of CO from the evaporative devices, at approximately four TPY, are anticipated to be well below the thresholds for Prevention of Significant Deterioration (PSD) NSR review in 30 TAC 116.12.

Harris County is a moderate/marginal non-attainment area for ozone and is therefore subject to Non-attainment New Source Review (NNSR) instead of PSD for NOx. The major source thresholds for NOx and VOCs as precursors for ground level ozone for Harris County are 100 TPY. Therefore, this Site would qualify as a minor source and should not require permit equivalency for NNSR permitting.

The TCEQ offers several permits by rule (PBR), codified in 30 TAC 106, which may be considered a permit equivalency for emissions of combustion products and dust sources associated with this Site, if necessary. Because the Site likely meets requirements for authorization by PBR(s), permit equivalency with a minor source air permit will not be required. The PBRs were written to be protective considering air toxics and incorporate requirements protective of human health and the environment. The Remediation PBR (106.533(f)(1)(A)(iii)), in conjunction with 30 TAC 106.262, limits total emissions of air toxics by their short-term effects screening levels (ESLs). The TCEQ uses the toxicity equivalents for dioxins, compared to 2,3,7,8-TCDD. As there is no ESL or L value for dioxins under 30 TAC 106.262, emissions will be authorized under PBR 30 TAC 106.261(a)(3).

A pilot test of the thermal evaporation process will be conducted during the treatability study to understand the fate of dioxins throughout the process, as described in Section 4.3.2.5.

3.5 Armored Cap Material

The armored cap material may be reused on-Site if it is not found to be impacted by any COCs. Rinsate samples from the TCRA cap will be analyzed and compared to appropriate ARARs to evaluate the potential for reuse on-Site.

4. Laboratory Treatability Testing

4.1 Sample Acquisition

The treatability study will be performed on representative samples of soil/waste material, contact water, and armored cap material collected from the Site. Sample collection will take place as part of the PDI-2 field sampling event. Further detail on field sampling procedures and methodology for the treatability sample acquisition will be included in the PDIWP-2, to be submitted under separate cover. During the PDI-2 field event, the following samples will be collected for use in the treatability study.

4.1.1 Solids Samples

The treatability study will evaluate the effectiveness of in-situ solidification in the Northern and Southern Impoundments.

The potential for varying conditions within the Northern Impoundment and the Southern Impoundment will be evaluated by collecting approximately four composite samples in the Northern Impoundment and three composite samples in the Southern Impoundment for treatability testing. The Northern Impoundment was divided into quadrants, based upon anticipated characteristics for each quadrant (i.e., moisture and grain size and the preliminary waste characterization data collected during PDI-1). The waste characterization data collected during PDI-1 indicates that the material is not leachable; therefore treatability analyses will focus primarily on physical characteristics. Composite samples will be collected from each quadrant to account for potential variability in soil/waste material type, moisture conditions, and dioxin concentration. This approach will allow the samples collected to capture the variability (both chemically and physically) of the material across the Impoundments, such that the selected solidification reagent mixture design will result in the solidified material having an acceptable composition for disposal.

An initial baseline analysis of chemical and physical properties will be performed to determine if there is significant variation within each impoundment. Baseline chemical and physical characterization data on the material from the different quadrants will be evaluated to understand the degree of variability. The treatability testing that will follow will be dependent on these results and may be subject to change as the testing is an iterative process whereby each step builds upon the prior step.

The solids samples to be used in the treatability study will be collected during the PDI-2 fieldwork utilizing many of the boring locations planned for PDI-2. The sample taken from the southwestern quadrant of the Northern Impoundment will be taken from the excavation that will be installed to create contact water for the pilot test (as described in Section 4.1.2). Each composite sample will contain approximately 20 to 30 gallons of solid material comprised of waste material and soil exhibiting $TEQ_{DF,M}$ concentrations above 30 ng/kg in the north and 240 ng/kg in the south, and thus representative of material requiring removal. Proposed treatability sampling locations for the Northern and Southern Impoundments are shown on Figures 3 and 4, respectively. Exact locations are subject to change based upon field conditions.

4.1.2 Water Samples

The treatability study will evaluate the ability to reuse contact water in the solidification mixture. It will also evaluate the ability to treat water to levels identified during ARAR evaluation for potential discharge and to thermally evaporate water.

Northern Impoundment

As part of treatability testing, the thermal evaporation technology described in Section 2.2.6 will be evaluated in an off-Site laboratory controlled pilot test. For the laboratory pilot test, approximately 10,000 gallons of representative contact water will be necessary to adequately evaluate the reduction technology and characterize potential steam emissions. To acquire a sufficient volume of representative contact water, during the PDI-2 fieldwork, a hole will be excavated in waste material on the western side of the Northern Impoundment. Potable water from an off-Site source will be pumped into the excavation using a high pressure nozzle. Water will be sprayed against the walls of the excavation to mix the waste material and water and create representative contact water. Contact water will then be transferred to a tank for pilot testing, as described in Section 4.3.2.4.

Approximately 100 gallons of the contact water from this excavation will also be collected for baseline characterization and laboratory treatability testing.

Southern Impoundment

To provide a representative sample of potential contact water that may be generated during the RA and require treatment, borehole water (if encountered) will be collected from approximately three soil boring locations in the Southern Impoundment. These samples will be analyzed to establish baseline characterization and provide a good representation of the potential contact water, including its potential variation, or lack thereof, from the Northern Impoundment.

Following this baseline characterization, a surrogate batch of water will be created in the laboratory for use in the treatability testing related to the Southern Impoundments. The surrogate water will have representative conditions similar in physical and chemical properties to water collected in the field and will provide the necessary volume to accommodate the entirety of the planned testing. To prepare these surrogates, approximately 6 gallons of soil from the Southern Impoundment will be mixed with approximately 25 gallons of potable water.

4.1.3 Armored Cap Material Samples

The treatability study will evaluate the ability to reuse the rock from the existing armored cap in the Northern Impoundment. Composite samples of the armor stone will be collected from three different locations in the Northern Impoundment. These locations will be the west side of the Impoundment, the east side of the Impoundment and the bermed areas. The samples will be collected only from areas in which a geotextile and/or geosynthetic liner separates the rock from the waste material. Sample locations will include submerged and non-submerged areas. Figure 5 shows the approximate locations at which the composite samples will be collected.

After results of the baseline characterization of the contact water are obtained, as described in Section 4.3.1, a composite elutriate sample from the armored cap samples will be generated according to the Standard Operating Procedures (SOP) included as Exhibit A. Elutriate samples will be analyzed for any constituents from the baseline parameters list (Section 4.3.1; Table 3) that exhibit exceedances in the contact water.

With the exception of the water necessary for the pilot testing of the evaporation technology, all treatability samples will be shipped to the GHD Innovative Solutions Treatability Laboratory in Niagara Falls, New York (GHD Treatability Lab). The number, location, and nature of treatability samples are summarized in Table 4.1 below.

Table 4.1 Treatability Study Sample Collection Locations

Sample Media	Location	Number of Samples	Volume	Purpose
Waste/Soil Material	Northern Impoundment	4 Composite Samples	1 gallon	Baseline Characterization
			20 gallons	Solidification Testing
	Southern Impoundment	3 Composite Samples	1 gallon	Baseline Characterization
			6 gallons	To create contact water
			20 gallons	Solidification Testing
Potable water	Water supply truck	1 per tanker	To be determined	Baseline characterization prior to use to create contact water
Contact Water	Northern Impoundment	1 sample	100 gallons	Treatability Testing
		2 samples	10,000 gallons	Thermal Evaporation Pilot Testing
	Southern Impoundment	3 Borehole Water Samples[1]	1 gallon	Baseline Characterization
Armored Cap Material	Northern Impoundment	3 Composite Samples	Approximately 5 to 6 pieces of armored cap material per composite sample	Armored cap rinsate elutriate testing

Note:
[1] Borehole water will be collected if possible.

4.2 Waste Treatability Testing

4.2.1 Baseline Characterization

Upon receipt, the waste samples will be analyzed to establish the baseline or reference conditions in the samples. Each waste sample received will be analyzed for the following parameters that are pertinent to treatability testing for disposal:

1. Percent Solids - Standard Methods for the Examination of Water and Wastewater (SM) 2540G*
2. Paint Filter - EPA-SW846-9095B*

3. TCLP VOC - EPA-SW846-1311/8260D/5030B
4. TCLP Semi-Volatile Organic Compounds (SVOC) - EPA-SW846-1311/8270E/3510C*
5. TCLP Pesticides - EPA-SW846-1311/8081B/3510C
6. TCLP Metals including RCRA-8 Metals - EPA-SW846-1311/6010D/3010A/7470A*
7. TCLP - PCB - EPA-SW846- 1311/8082A/3550C
8. TCLP - Polychlorinated Dibenzodioxins / Polychlorinated Dibenzofurans (PCDD/PCDF) - EPA-SW846 1311/1613B/3510C HRMS Specific

*Analyses to be completed by the GHD Treatability Lab; all others to be performed by a selected third-party analytical laboratory.

The waste material will be determined to be Class 1 or Class 2 based on the results of the TCLP analyses for a Class 2 landfill (shown in Table 2). If results are below these criteria, the material can be disposed of as Class 2 non-hazardous waste. If results are above these criteria, the material can be disposed of as Class 1 non-hazardous waste. For either scenario, if the waste sample fails the paint filter test, then solidification testing will be conducted.

4.2.2 Solidification Reagent Screening Tests

Solidification testing will be performed on the waste material to evaluate the level of solidification necessary to ensure that the material passes the paint filter test and achieves a workable strength. The reagents to be tested may include Portland cement, clay, lime, fly ash, RemBind, Granular Activated Carbon (GAC), trisodium phosphate, or other various amendments. Different cure times will be evaluated to determine the optimum curing duration necessary to meet strength and landfill acceptance criteria.

The incorporation of brine/thickened solids from the evaporation technology pilot test and/or from filtration to the solidification mix design will also be evaluated to determine whether brine/thickened solids from the evaporation of water and/or filtration technology can effectively be added to the solidification mixes. The solidification of the brine and thickened solids alone will also be evaluated to determine potential disposal options.

The tests will be prepared by placing 300 grams of waste material with the appropriate amount of solidification agent and water in a mechanical mixer. The waste, water, and solidification agent will be mixed for five minutes and then placed in a plastic mold. The increase in sample volume due to the treatment will be noted. The sample will be allowed to cure for up to one week. During curing, the hardness of the sample will be evaluated using a pocket penetrometer three times per week. The SOP for bench scale solidification testing is included as Exhibit B and the SOP for bench scale hardness measurement is included as Exhibit C

4.2.2.1 Characterization Testing

After curing, the samples will be analyzed in accordance with the paint filter test. If samples pass the paint filter test, the reagents will undergo optimization tests. If the samples fail the paint filter test, the solidification screening tests will be performed again. This process is an iterative process that uses the results of one stage to develop the planned testing for the next stage.

4.2.2.2 Optimization Tests

Further testing to better simulate field conditions will be performed using the reagents tested during the screening tests that solidified the waste such that it met paint filter disposal criteria. These reagents will be slurried using the amount of water identified in the screening tests and then added to waste in a mechanical mixer to replicate the process that will be used in the field. Doses will be varied as necessary to optimize results. The slurry and waste will be mixed for one minute and then placed in plastic molds, and allowed to cure for 1, 2, 4, or 7 days and after curing will be analyzed using the paint filter test and for unconfined compressive strength (UCS). Cure times may be adjusted based on pocket penetrometer data from the screening tests. This set of samples will also be analyzed for any of the parameters in Table 2 that were not met prior to solidification to determine whether it will meet criteria for disposal in a Class 2 facility. Testing with the optimum set(s) of reagents and moisture may be performed on all samples, if necessary, to determine the applicability of the treatment to all areas of the Site.

4.2.3 Brine/Thickened Solids Solidification Tests

If evaporation technology is used during the RA, brine will be produced as a byproduct. Following the evaporation technology off-Site laboratory pilot test, the generated brine material from the pilot test will be shipped to the GHD Treatability Lab for testing. The brine is planned to be incorporated into the solidification mixture with the waste material. Similarly, thickened solids from a clarifier or filter would also be incorporated into the solidification mixtures. Batch tests will be prepared that include different combinations of waste material, reagents, and brine or thickened solids to evaluate the potential for these materials to be used in the solidification mix. Although it is not anticipated, the possibility exists that the brine and/or thickened solids would be disposed of at an off-Site disposal facility. To evaluate disposal, solidification reagent screening tests will be performed on the raw brine/thickened solids material, as described in Section 4.2.2. Baseline samples and solidification mix samples will be analyzed for TCLP metals, TCLP SVOCs, TCLP VOCs, and ICR (liquids only) to determine whether the material is hazardous or non-hazardous. The paint filter test will also be performed to ensure that the material meets disposal criteria.

4.3 Water Management Testing

4.3.1 Baseline Characterization

Water samples will be collected from the Site and analyzed to establish the baseline or reference water quality conditions in the samples. Each water sample received will be analyzed for the following parameters:

1. pH - EPA 9040C*
2. VOC - EPA-SW846-8260D/5030B*
3. SVOC - EPA-SW846-8270E/3510C*
4. PCB - EPA-SW846-8082A/3510C
5. Pesticides - SW-846-8081
6. Herbicides - SW-846-8151

7. PCDD/PCDF - EPA-SW846-8280B
8. Total and dissolved metals - EPA-SW846-6010D/3005A/3010A/7470A*
9. Ammonia nitrogen - EPA-SW846-350.2
10. Total phosphorus - EPA-SW846-6010D/3050B/7471B*
11. BOD - SM 5210B
12. COD - SM 5220B*
13. Total Organic Carbon - SM 5310C*
14. Total Suspended Solids - SM2540D*
15. Total Dissolved Solids (TDS) - SM2540C*

*Analyses to be completed by the GHD Treatability Lab all others to be performed by a selected third-party analytical laboratory. A detailed list of all water treatability characterization parameters is included in Table 3.

4.3.2 Water Treatment Testing

The water management options outlined in Section 3.2 will be evaluated to determine the treatment method for reuse, discharge, or reduction of the water. Treatment testing may include the following:

- Jar testing for iron oxidation, metals precipitation, solids coagulation, and/or flocculation
- Filtration
- Rapid scale small column test for GAC treatment
- Rapid scale small column test for ammonia adsorption or ion exchange
- Thermal evaporation pilot test

4.3.2.1 Jar Testing

Solids separation may be required for either water treatment or evaporation. A series of jar tests will be performed on water to determine the optimum concentration of ferric chloride and polymer for solids coagulation and flocculation. If metals removal is required, jar testing will also include organosulfide addition for metals precipitation. Prior to jar testing, the water will be analyzed for ferrous iron. If ferrous iron is present, pH will be adjusted to 7.5 using sodium hydroxide and aerated for 15 minutes. If ferrous iron remains after this period, a second test will be performed where the pH is adjusted to eight followed by aeration for 15 minutes. Ferrous iron will be analyzed at the end of this second test to confirm removal.

Jars will be set up containing contact water and varying concentrations of organosulfide (if required), ferric chloride and polymer along with a control sample with no chemical added. Jars will be stirred at 45 rotations per minute (rpm) for 15 minutes and then allowed to settle. Solids flocculation and settling will be evaluated qualitatively in order to select coagulant and polymer doses in the event that it is required for the thermal evaporation pilot test. Supernatant will be filtered for analysis. Samples will be analyzed for any compounds that are above water quality ARARs. The SOP for bench scale water jar testing is included as Exhibit D.

4.3.2.2 Filtration Testing

In order to determine the size of the particles in the contact water that are associated with the dioxins and furans, a filtration test will be performed. A sample of contact water will be filtered through a series of filters of different pore sizes ranging from 100 micrometer (µm) down to 0.1 µm. After each filtration step, a sample of the filtrate water will be analyzed for dioxins and furans. This information will be used to estimate dioxin/furan removal with different filtration technologies which vary on the size of particles removed. The SOP for bench scale sequential filtration testing is included as Exhibit E.

4.3.2.3 Granular Activated Carbon Testing

If there are organic compounds remaining in the water following jar testing, then GAC testing will be performed. Up to three identical columns (length: 11.8 inches and width: 0.75 inch) will be packed with different types of GAC. Each column will be filled with the appropriate media at a packing length of eight inches. The water will initially be pumped through the columns at a flow rate of 1.8 milliliters per minute (mL/min), which provides an empty bed contact time (EBCT) of 20 minutes in each of the columns. The flow rate from the columns will be monitored to assure that an EBCT of 20 minutes is maintained. After treatment, effluent will be analyzed for the constituents listed in Section 4.3.1 if they were present following jar testing.

If concentrations remain above discharge criteria, the EBCT will be adjusted to provide a longer contact time in the follow-up testing.

Longer term tests may be performed on one column to monitor for breakthrough.

4.3.2.4 Ammonia Removal Column Testing (If Necessary)

If ammonia concentrations exceed discharge limits, then column testing using either an adsorbent or ion exchange material will be performed. Up to two identical columns (length: 11.8 inches and width: 0.75 inch) will be packed with adsorption or ion exchange material. Each column will be filled with the appropriate media at a packing length of eight inches. The water will initially be pumped through the columns at a flow rate of 1.8 mL/minute, which provides an EBCT of 20 minutes in each of the columns. The flow rate from the columns will be monitored to ensure that an EBCT of 20 minutes is maintained. After treatment, effluent will be analyzed for ammonia. If concentrations remain above discharge or disposal criteria, the EBCT will be adjusted to provide a longer contact time in follow-up testing.

4.3.2.5 Water Evaporation Evaluation

GHD Treatability Lab Evaluation

The borehole water samples from the Southern Impoundment, as well as, the excavation contact water in the Northern Impoundment (see Section 4.1.2) received by the GHD Treatability Lab will be analyzed for the following parameters (in addition to the parameters listed in Section 4.3.1) in order to evaluate the evaporation process:

- Major cations (calcium, magnesium, sodium, potassium, silica, iron)
- Major anions (chloride, bromide, nitrate, sulfate, phosphate)
- TDS
- pH
- Alkalinity

Based on the water chemistry analysis, the amount and characteristics of solids formed and the boiling point of the mixture will be estimated using a water chemistry model. Laboratory testing may be performed to verify modeling and could include:

- Boiling point estimation
- Characteristics of brine
- Solids formation characterization

Based on the amount of water that will be reduced, the quantity of fuel required will be determined, and emissions of criteria pollutants will be estimated.

Thermal Evaporation Pilot Test

To fully evaluate the effectiveness of the proposed thermal evaporation technology and to characterize emissions, the vendor will conduct a pilot test of the system using representative contact water. Figure 6 presents a process flow diagram and sampling plan for the evaporation pilot test. Contact water will be created in an excavation in the Northern Impoundment, as described in Section 4.1.2. Contact water will be transferred from the excavation to a mixed storage tank. Effluent from this tank will be sampled and analyzed for baseline characterization prior to transferring the water to a settling tank or clarifier for solids removal. The settled effluent will be sampled prior to being transferred to a tanker truck for transport to the evaporation pilot test facility.

A preliminary bench-scale boil down test will first be performed on a small sample (approximately five gallons) to observe the behavior of the water as it is heated. This test will identify whether solids are formed during heating, variations with temperature ranges, and the characteristics of the brine that remains after evaporation.

Following the initial bench-scale boil down test, a full pilot test will be conducted using a 1/10th scale laboratory replica of a commercial evaporation unit. The test unit is designed to replicate the equipment, fuel, burner and temperature regime of the full-scale unit. In addition, the stack on the pilot unit can be accessed for emissions testing in accordance with prescribed EPA and American Society for Testing and Materials (ASTM) protocols. Approximately 10,000 gallons of contact water will be collected and trucked to the test facility. There, a five-day test (operating 24 hours per day) will be conducted to identify potential operational issues and to allow for continuous emissions testing. Emissions will be tested for air quality ARARs. EPA Method 23 will be utilized to evaluate dioxins and furans.

Brine that is produced during the pilot test will be collected and shipped to the GHD Treatability Lab to incorporate into the solidification test mixtures, as described in Section 4.2.3.

While the initial pilot test is being conducted, a batch of contact water will be tested at the GHD Treatability Lab to evaluate the need for filtration technologies. Depending upon the results of the initial evaporation pilot test and evaluation of dioxin/furans particle size, a second evaporation pilot test may be performed. The procedures presented above will be followed with the addition of filtration of the contact water, as presented in Figure 6.

5. Quality Assurance

Quality assurance procedures for the GHD Treatability Lab will be implemented according to the Quality Assurance Procedures for Laboratory Treatability Studies provided in Appendix B. A separate Quality Assurance Project Plan (QAPP) will be included in the PDIWP-2 that will cover all treatability testing analyses conducted by an outside laboratory.

6. Data Analysis and Interpretation

Waste

The results of the treatability study for the waste material will be evaluated to determine the optimum reagent mix design for in-situ solidification such that the resulting solidified material meets off-Site disposal requirements. The mix design including amendment type, quantity, delivery mechanism, cure time, and procurement will all be considered and evaluated. This evaluation will inform the remedial design as to the alternatives for solidification that may be utilized and designed.

Water

The results of the treatability study for the contact water will be evaluated to determine its potential for reuse in the in-situ solidification mix, treatment and discharge to surface water, and reduction in volume through thermal evaporation. This evaluation will inform the RD as to potential water management alternatives that may be utilized.

7. Reporting

Upon completion of the treatability study tasks, the data will be compiled and analyzed. The results will be used to determine the design parameters for solidification of waste and treatment of any water. A report will be prepared describing the tests conducted, results obtained, and conclusions and recommendations regarding reagents and doses. The report will also provide an estimate of the reagent quantities that will be necessary. The report will be included in the 30 percent Remedial Design, in accordance with the AOC.

8. Schedule

Upon completion of treatability testing activities, results will be incorporated into the 30 percent remedial design.

9. References

Baumgarten, 2018. Correspondence from the EPA dated December 18, 2018, Regarding the Submission Date - Treatability Study Work Plan and Second Phase Pre-Design Investigation Work Plan. December 18, 2018.

EPA, 2018. Response to Respondents' Letter Dated December 13, 2018, Regarding the Submission Date - Draft Second Phase Pre-Design Investigation Work Plan and Draft Treatability Study Work Plan. December 18, 2018.

Integral and Anchor QEA, 2018. First Phase Pre-Design Investigation Work Plan. San Jacinto River Waste Pits Superfund Site. 2018.

EPA, 1992. Guidance for Conducting Treatability Studies under CERCLA. Final. EPA/540/R-92/071A; OSWER 93980.3-10. November 1992.

EPA, 1995. Remedial Design/Remedial Action Handbook. EPA 540/R-95/059; OSWER 9355.0-04B. June 1995.

EPA, 2010. *Administrative Settlement Agreement and Order on Consent for Removal Action*. U.S. EPA Region 6 CERCLA Docket. No. 06-12-10. In the matter of: San Jacinto River Waste Pits Superfund Site Pasadena, Texas. International Paper Company, Inc. & McGinnes Industrial Maintenance Corporation, Respondents.

Signature Page

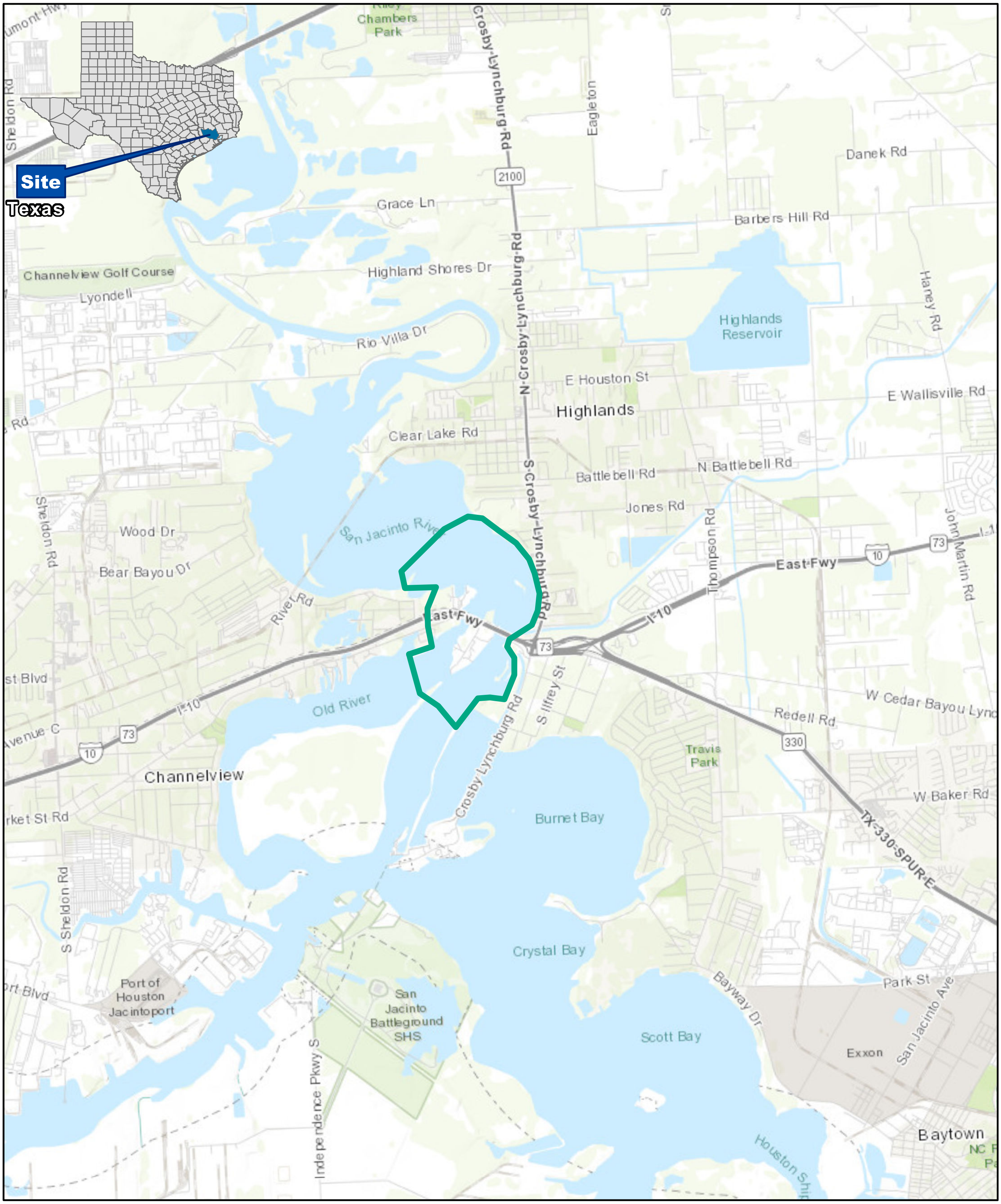
All of Which is Respectfully Submitted,

GHD

Charles W. Munce, P.E.

Janie T. Smith

Janie T. Smith



Source: ESRI World Topographic Maps.

0 0.5 1

Miles

Coordinate System:
NAD 1983 UTM Zone 14N

N

GHD

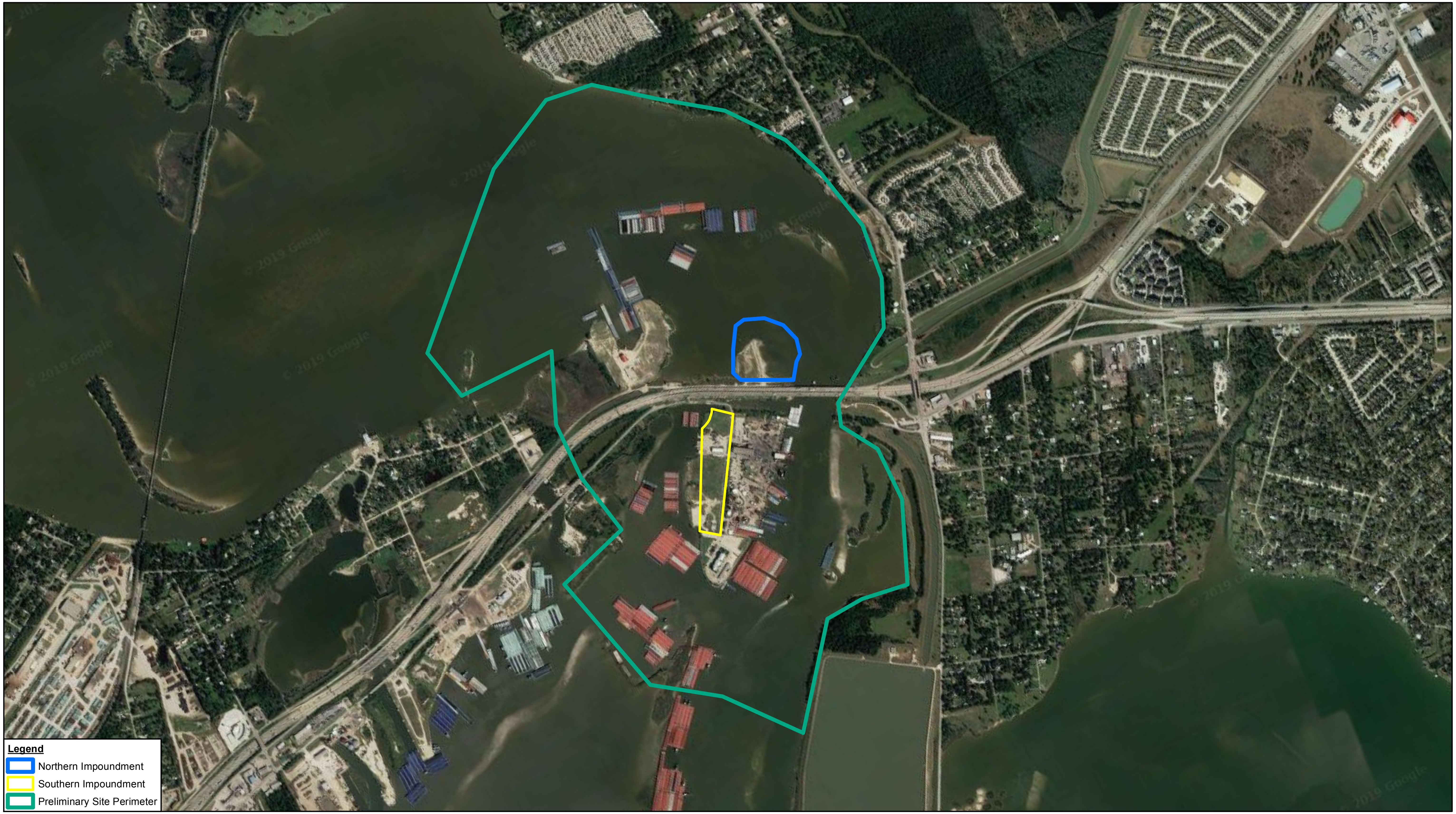
SAN JACINTO RIVER WASTE PITS SITE
HARRIS COUNTY, TEXAS
FINAL TREATABILITY STUDY WORK PLAN

11187072
May 10, 2019

VICINITY MAP

FIGURE 1

GIS File: I:\GIS\GIS\Projects\11180000s\11187072\Layouts\005\11187072-00(005)GIS-BR001.mxd



Source: ESRI World Imagery Basemap Services. 9/9/2017.

0 625 1,250
Feet

Coordinate System:
NAD 1983 UTM Zone 15N

N

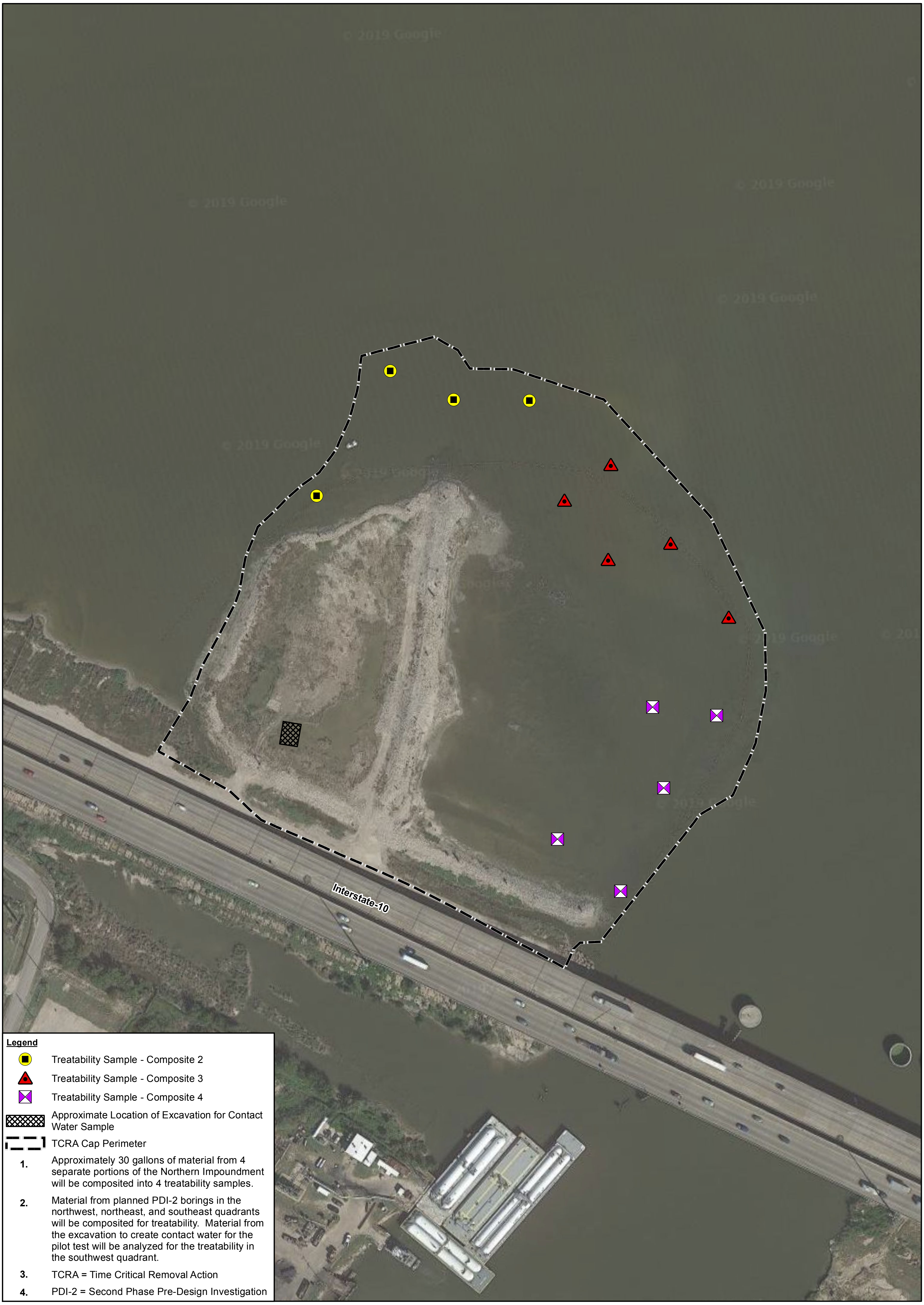
SAN JACINTO RIVER WASTE PITS SITE
HARRIS COUNTY, TEXAS
FINAL TREATABILITY STUDY WORK PLAN

SITE PLAN

11187072
May 10, 2019

FIGURE 2

GIS File: I:\GIS\GIS\Projects\11180000s\11187072\Layouts\005\11187072-00(005)GIS-BR002.mxd



Legend

- ● Treatability Sample - Composite 2
- ▲ Treatability Sample - Composite 3
- ⧓ Treatability Sample - Composite 4
- ▨ Approximate Location of Excavation for Contact Water Sample
- - - - TCRA Cap Perimeter

1. Approximately 30 gallons of material from 4 separate portions of the Northern Impoundment will be composited into 4 treatability samples.
2. Material from planned PDI-2 borings in the northwest, northeast, and southeast quadrants will be composited for treatability. Material from the excavation to create contact water for the pilot test will be analyzed for the treatability in the southwest quadrant.
3. TCRA = Time Critical Removal Action
4. PDI-2 = Second Phase Pre-Design Investigation

Source: Image ©2019 Google, Imagery date: 10/28/2017

0 75 150
Feet

Coordinate System:
NAD 1983 StatePlane Texas South Central FIPS 4204 Feet

N

GHD

SAN JACINTO RIVER WASTE PITS SITE
HARRIS COUNTY, TEXAS
FINAL TREATABILITY STUDY WORK PLAN

PROPOSED TREATABILITY STUDY SAMPLE LOCATIONS - NORTHERN IMPOUNDMENT

11187072
May 10, 2019

FIGURE 3

GIS File: I:\GIS\GIS\Projects\11180000s\11187072\Layouts\005\11187072-00(005)GIS-BR003.mxd

Source: Image ©2019 Google, Imagery date: 10/28/2017

0 62.5 125
Feet

Coordinate System:
NAD 1983 StatePlane Texas South
Central FIPS 4204 Feet

SAN JACINTO RIVER WASTE PITS SITE
HARRIS COUNTY, TEXAS
FINAL TREATABILITY STUDY WORK PLAN

PROPOSED TREATABILITY SAMPLE LOCATIONS - SOUTHERN IMPOUNDMENT

11187072
May 10, 2019

FIGURE 4

GIS File: I:\GIS\GIS\Projects\11180000s\11187072\Layouts\005\11187072-00(005)GIS-BR004.mxd

Notes:
1. Sample locations approximate
2. These composite samples will be collected to represent the different areas of the armored cap.

Legend

- ◐ Armor Rock Sample Locations
- ○ Western Composite
- ○ Berm Composite
- ○ Eastern Composite
- ▭ Non-impacted Berm Area
- ▭ Approximate Area for Armored Cap Reuse
- ⌐¬ TCRA Cap Perimeter

Source: Image ©2019 Google, Imagery date: 10/28/2017

0 70 140
Feet

Coordinate System:
NAD 1983 StatePlane Texas South
Central FIPS 4204 Feet

N

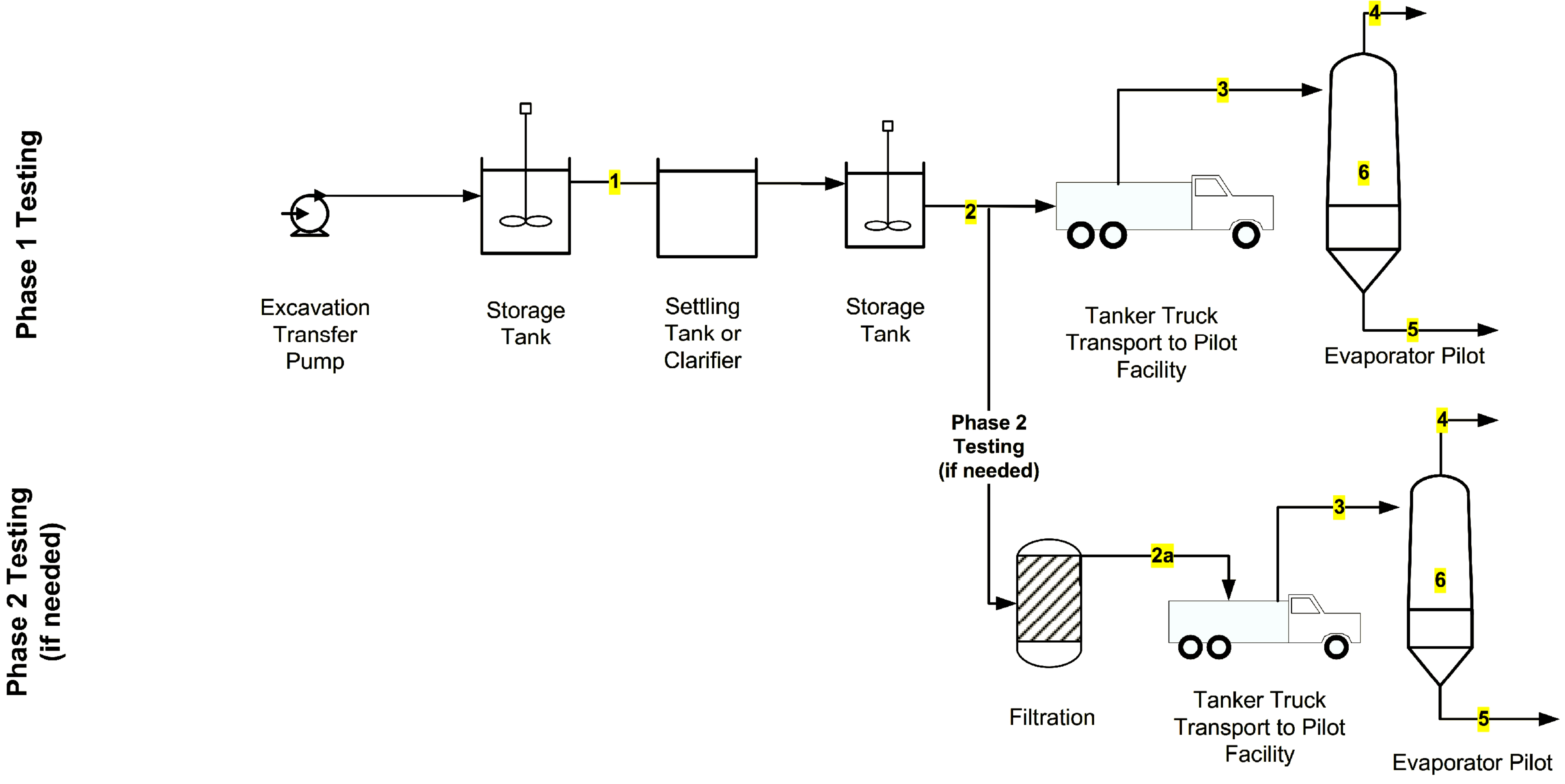
SAN JACINTO RIVER WASTE PITS SITE
HARRIS COUNTY, TEXAS
FINAL TREATABILITY STUDY WORK PLAN

11187072
May 10, 2019

ARMORED CAP SAMPLE LOCATIONS

FIGURE 5

GIS File: I:\GIS\GIS\Projects\11180000s\11187072\Layouts\005\11187072-00(005)GIS-BR005.mxd



	Stream						
	1	**2**	**2A**	**3**	**4**	**5**	**6**
Parameter	**Equalized Contact Water**	**Settled Effluent**	**Filter Effluent (if needed)**	**Evaporator Feed**	**Evaporator Steam**	**Evaporator Brine**	**Evaporator Wall (if possible)**
Total Dioxins	X	X	X	X	X	X	X
Dissolved Dioxins	X	X	X	X		X	
Total PCBs	X	X	X	X	X	X	X
Dissolved PCBs	X	X	X	X		X	
Total Suspended Solids	X	X	X	X		X	
Total Dissolved Solids	X	X		X		X	
Major Cations/Anions	X	X		X		X	
COCs from Table 3	X				X*		

* Emissions will be analyzed for only COCs from Table 3 that are present in the baseline characterization (Sample Point 1)

SAN JACINTO RIVER WASTE PITS SITE
HARRIS COUNTY, TEXAS
FINAL TREATABILITY STUDY WORK PLAN

11187072
May 10, 2019

THERMAL EVAPORATION PILOT TEST CONCEPTUAL DIAGRAM

FIGURE 6

GIS File: I:\GIS\GIS\Projects\11180000s\11187072\Layouts\005\11187072-00(005)GIS-BR006.mxd

Table 1

PDI-1 Waste Characterization Analytical Results
Final Treatability Study Work Plan
San Jacinto River Waste Pits Site
Harris County, Texas

Parameters			Sample Location:	Northern Impoundment - West	Northern Impoundment - East	Northern Impoundment - East	Southern Impoundment	Southern Impoundment	Southern Impoundment	Southern Impoundment	Southern Impoundment	Southern Impoundment
			Sample Identification:	SJSB038	SJSB037	SJSB036	SJSB025	SJSB023	SJSB023 DUP	SJSB019	SJSB008	SJSB012
			Sample Date:	12/18/2018	11/15/18	11/16/18	11/8/18	11/6/18	11/6/18	11/13/2018	11/13/18	11/13/18
			Sample Depth:	(0-9) ft bgs	-	-	-	-	-	-	-	-
	Units	TCLP Regulatory Levels[1]	Method Detection Limits[2]	-	-	-	-	-	-	-	-	-
TCLP-Volatile Organic Compounds (VOCs)												
1,1-Dichloroethene	mg/L	0.7	0.00008	0.20 U	0.032 U	0.032 U	0.032 U	0.032 U	0.032 U	0.032 U	0.032 U	0.032 U
1,2-Dichloroethane	mg/L	0.5	0.00008	0.20 U	0.032 U	0.032 U	0.032 U	0.032 U	0.032 U	0.032 U	0.032 U	0.032 U
1,4-Dichlorobenzene	mg/L	7.5	0.00032	0.20 U	0.048 U	0.048 U	0.048 U	0.048 U	0.048 U	0.048 U	0.048 U	0.048 U
2-Butanone (Methyl ethyl ketone) (MEK)	mg/L	200.0	0.0019	8.0 U	0.76 U	0.76 U	0.76 U	0.76 U	0.76 U	0.76 U	0.76 U	0.76 U
Benzene	mg/L	0.5	0.000062	0.20 U	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U
Carbon tetrachloride	mg/L	0.5	0.000096	0.20 U	0.039 U	0.039 U	0.039 U	0.039 U	0.039 U	0.039 U	0.039 U	0.039 U
Chlorobenzene	mg/L	100.0	0.00011	0.20 U	0.044 U	0.044 U	0.044 U	0.029 U	0.029 U	0.029 U	0.044 U	0.044 U
Chloroform (Trichloromethane)	mg/L	6.0	0.000072	0.20 U	0.029 U	0.029 U	0.029 U	0.029 U	0.029 U	0.029 U	0.029 U	0.029 U
Tetrachloroethene	mg/L	0.7	0.000099	0.20 U	0.040 U	0.040 U	0.040 U	0.040 U	0.040 U	0.040 U	0.040 U	0.040 U
Trichloroethene	mg/L	0.5	0.0001	0.20 U	0.040 U	0.040 U	0.040 U	0.040 U	0.040 U	0.040 U	0.040 U	0.040 U
Vinyl chloride	mg/L	0.2	0.000075	0.080 U	0.030 U	0.030 U	0.030 U	0.030 U	0.030 U	0.030 U	0.030 U	0.030 U
TCLP-Semi-Volatile Organic Compounds (SVOCs)												
2,4,5-Trichlorophenol	mg/L	400.0	0.000018	0.10 U	0.013 U	0.013 U	0.0087 U	0.0087 U	0.0087 U	0.0087 U	0.011 U	0.014 U
2,4,6-Trichlorophenol	mg/L	2.0	0.000014	0.10 U	0.011 U	0.0099 U	0.0069 U	0.0069 U	0.0069 U	0.0069 U	0.0084 U	0.011 U
2,4-Dinitrotoluene	mg/L	0.13	0.00027	0.10 U	0.020 U	0.019 U	0.013 U	0.013 U	0.013 U	0.013 U	0.016 U	0.021 U
2-Methylphenol	mg/L	200.0	0.00033	0.10 U	0.013 U	0.013 U	0.0086 U	0.0086 U	0.0086 U	0.0086 U	0.011 U	0.014 U
4-Methylphenol	mg/L	200.0	0.00048	0.10 U	0.0070 U	0.0067 U	0.0047 U	0.0047 U	0.0047 U	0.0047 U	0.0058 U	0.0074 U
Hexachlorobenzene	mg/L	0.13	0.00063	0.10 U	0.014 U	0.014 U	0.0094 U	0.0094 U	0.0094 U	0.0094 U	0.012 U	0.015 U
Hexachlorobutadiene	mg/L	0.5	0.00029	0.10 U	0.0095 U	0.0091 U	0.0064 U	0.0064 U	0.0064 U	0.0064 U	0.0078 U	0.010 U
Hexachloroethane	mg/L	3.0	0.00029	0.10 U	0.0071 U	0.0068 U	0.0048 U	0.0048 U	0.0048 U	0.0048 U	0.0058 U	0.0075 U
Nitrobenzene	mg/L	2.0	0.00057	0.10 U	0.012 U	0.012 U	0.0079 U	0.0079 U	0.0079 U	0.0079 U	0.0097 U	0.013 U
Pentachlorophenol	mg/L	100.0	0.0024	0.25 U	0.016 U	0.016 U	0.011 U	0.011 U	0.011 U	0.011 U	0.014 U	0.017 U
Pyridine	mg/L	5.0	0.0075	0.50 U	0.38 U	0.36 U	0.25 U	0.25 U	0.25 U	0.25 U	0.31 U	0.40 U
TCLP-Pesticides												
Chlordane	mg/L	0.03	0.0001	0.0010 U	0.0010 U	0.0010 U	0.0010 U	0.0010 U	0.0010 U	0.0010 U	0.0010 U	0.0010 U
Endrin	mg/L	0.02	0.00000069	0.00010 U	0.00010 U	0.00010 U	0.00010 U	0.00010 U	0.00010 U	0.00010 U	0.00010 U	0.00010 U
gamma-BHC (Lindane)	mg/L	0.3	0.00000036	0.00010 U	0.00010 U	0.00010 U	0.00010 U	0.00010 U	0.00010 U	0.00010 U	0.00010 U	0.00010 U
Heptachlor	mg/L	0.008	0.00000068	0.00010 U	0.00010 U	0.00010 U	0.00010 U	0.00010 U	0.00010 U	0.00010 U	0.00010 U	0.00010 U
Heptachlor epoxide	mg/L	0.04	0.00000084	0.00010 U	0.00010 U	0.00010 U	0.00010 U	0.00010 U	0.00010 U	0.00010 U	0.00010 U	0.00010 U
Methoxychlor	mg/L	10.0	0.0000001	0.00010 U	0.00010 U	0.00010 U	0.00010 U	0.00010 U	0.00010 U	0.00010 U	0.00010 U	0.00010 U
Toxaphene	mg/L	0.5	0.0002	0.0020 U	0.0020 U	0.0020 U	0.0020 U	0.0020 U	0.0020 U	0.0020 U	0.0020 U	0.0020 U
TCLP-Metals												
Arsenic	mg/L	5.0	0.005	0.020 U	0.021 J	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U	0.020 U
Barium	mg/L	100.0	0.0006	0.9 J	1.6	1.4	1.1	1.3	1.3	0.9 J	0.9 J	0.7 J
Cadmium	mg/L	1.0	0.0005	0.050 U	0.002 J	0.001 J	0.002 J	0.003 J	0.003 J	0.011 J	0.004 J	0.001 U
Chromium	mg/L	5.0	0.0009	0.050 U	0.010 U	0.010 U	0.01 U	0.001 U	0.001 U	0.001 U	0.010 U	0.010 U
Lead	mg/L	5.0	0.005	0.050 U	0.015 U	0.015 U	0.015 U	0.024 J	0.025 J	0.015 U	0.015 U	0.015 U
Mercury	mg/L	0.2	0.00002	0.0010 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U
Selenium	mg/L	1.0	0.009	0.10 U	0.02 U	0.02 J	0.02 U	0.02 J	0.02 U	0.02 U	0.02 U	0.02 J
Silver	mg/L	5.0	0.002	0.050 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U
TCLP-Herbicides												
2,4,5-TP (Silvex)	mg/L	1.0	0.000036	0.020 U	0.030 U	0.029 U	0.020 U	0.020 U	0.020 U	0.020 U	0.025 U	0.032 U
2,4-Dichlorophenoxyacetic acid (2,4-D)	mg/L	10.0	0.000045	0.100 U	0.150 U	0.150 U	0.100 U	0.100 U	0.100 U	0.100 U	0.130 U	0.160 U

Table 1

PDI-1 Waste Characterization Analytical Results
Final Treatability Study Work Plan
San Jacinto River Waste Pits Site
Harris County, Texas

Parameters			Sample Location:	Northern Impoundment - West	Northern Impoundment - East	Northern Impoundment - East	Southern Impoundment	Southern Impoundment	Southern Impoundment	Southern Impoundment	Southern Impoundment	Southern Impoundment
			Sample Identification:	SJSB038	SJSB037	SJSB036	SJSB025	SJSB023	SJSB023 DUP	SJSB019	SJSB008	SJSB012
			Sample Date:	12/18/2018	11/15/18	11/16/18	11/8/18	11/6/18	11/6/18	11/13/2018	11/13/18	11/13/18
			Sample Depth:	(0-9) ft bgs	-	-	-	-	-	-	-	-
	Units	TCLP Regulatory Levels[1]	Method Detection Limits[2]	-	-	-	-	-	-	-	-	-
General Chemistry												
Flash point (closed cup)	°C	> 60°C	NA	> 110	> 110	> 110	> 110	> 110	> 110	> 110	> 110	> 110
Percent solids	%	NA	NA	45.9 J	67.1 J	70.0 J	77.5	74.9	65.3	76.7	82.0	65.2
pH, lab	s.u.	>2 or <12	NA	7.84	8.09 J	8.54 J	8.13 J	8.15	8.29	8.52 J	8.33 J	9.62 J
Reactive cyanide	mg/kg	NA	17.4	17 U	100 U	100 U	22 U	23 U	27 U	23 U	100 U	100 U
Reactive sulfide	mg/kg	NA	0.2	70 U	48 U	46 U	32 U	32 U	32 U	32 U	39 U	98
Sulfur	mg/kg	NA	0.46	---	---	---	---	---	---	---	2600	6.6
Total Petroleum Hydrocarbons (TPH)												
Gasoline Range Organics (GRO)	mg/kg	>1500[3]	0.62	---	---	---	1.7 J	8.3	14	---	1.4 J	52
Diesel Range Organics (DRO)	mg/kg	>1500[3]	0.79	---	---	---	33 J	340	430	---	8.1 J	1,300
Residual Range Organics (RRO)	mg/kg	>1500[3]	2.9	---	---	---	130	510	600	---	60	1,500
Polychlorinated Biphenyls (PCBs)												
Aroclor 1016	mg/kg	NA	2.1	---	---	---	---	---	---	---	0.0032 U	---
Aroclor 1221	mg/kg	NA	2.1	---	---	---	---	---	---	---	0.0032 U	---
Aroclor 1232	mg/kg	NA	2.1	---	---	---	---	---	---	---	0.0032 U	---
Aroclor 1242	mg/kg	NA	2.1	---	---	---	---	---	---	---	0.010 J	---
Aroclor 1248	mg/kg	NA	2.1	---	---	---	---	---	---	---	0.0032 U	---
Aroclor 1254	mg/kg	NA	2.1	---	---	---	---	---	---	---	0.021	---
Aroclor 1260	mg/kg	NA	2.1	---	---	---	---	---	---	---	0.019	---
Aroclor 1262	mg/kg	NA	2.1	---	---	---	---	---	---	---	0.0032 U	---
Aroclor 1268	mg/kg	NA	2.1	---	---	---	---	---	---	---	0.0032 U	---

Notes:
U - Not detected at the associated reporting limit
J - Estimated concentration
NA - Not Applicable
CFR - Code of Federal Regulations
--- - Not analyzed
ft bgs - Feet below ground surface
°C - Degree Celsius
s.u. - Standard Units
mg/kg - Milligrams per kilogram
mg/L - Milligrams per liter
% - Percent
PDI-1 - Preliminary Design Investigation-1
TCLP - Toxicity Characteristic Leaching Procedure

[1] - TCLP Regulatory Levels from the *Guidelines for the Classification and Coding of Industrial and Hazardous Wastes* , November 2014, and Table 1 - Maximum Concentration of Contaminants for the Toxicity Characteristic 40 CFR 261.24

[2] - Method Detection Limits were taken from Table 9 *Analyte, Method Reporting Limits, and Method Detection Limits for Waste Characterization Samples* from the Pre-Design Investigation Quality Assurance Project Plan, August 2018.

[3] - TPH Regulatory Standard is a Total value, not a TCLP.

1. Data presented in the attached table was validated according to the Data Validation Reports, included as Appendix X, dated February 4, 2019, and February 20, 2019.

Table 2

Class 2 Landfill TCLP Regulatory Levels
Final Treatability Study Work Plan
San Jacinto River Waste Pits Site
Harris County, Texas

Analyte	Regulatory Level for Class 2 Landfill (mg/L)	Analytical Method Name	Analytical Method Number
Acenaphthene	210	TCLP SVOC	EPA-SW846-1311/8270E/3510C
Acetone	400	TCLP VOC	EPA-SW846-1311/8260D/5030B
Acetonitrile	20	TCLP VOC	EPA-SW846-1311/8260D/5030B
Acetophenone	400	TCLP SVOC	EPA-SW846-1311/8270E/3510C
Acrylamide	0.08	TCLP SVOC	EPA-SW846-1311/8270E/3510C
Acrylonitrile	0.6	TCLP VOC	EPA-SW846-1311/8260D/5030B
Aniline	60	TCLP SVOC	EPA-SW846-1311/8270E/3510C
Anthracene	1050	TCLP SVOC	EPA-SW846-1311/8270E/3510C
Antimony	1	TCLP Metals	EPA-SW846-1311/6010D/3010A
Arsenic	1.8	TCLP Metals	EPA-SW846-1311/6010D/3010A
Barium	100	TCLP Metals	EPA-SW846-1311/6010D/3010A
Benzene	0.5	TCLP VOC	EPA-SW846-1311/8260D/5030B
Benzidine	0.002	TCLP SVOC	EPA-SW846-1311/8270E/3510C
Beryllium	0.08	TCLP Metals	EPA-SW846-1311/6010D/3010A
Bis(2-chloroethyl)ether	0.3	TCLP SVOC	EPA-SW846-1311/8270E/3510C
Bis(2-ethylhexyl)phthalate	30	TCLP SVOC	EPA-SW846-1311/8270E/3510C
Bromodichloromethane	0.3	TCLP VOC	EPA-SW846-1311/8260D/5030B
Bromomethane	5	TCLP VOC	EPA-SW846-1311/8260D/5030B
Butylbenzyl phthalate	700	TCLP SVOC	EPA-SW846-1311/8270E/3510C
Cadmium	0.5	TCLP Metals	EPA-SW846-1311/6010D/3010A
Carbon disulfide	400	TCLP VOC	EPA-SW846-1311/8260D/5030B
Carbon tetrachloride	0.5	TCLP VOC	EPA-SW846-1311/8260D/5030B
Chlordane	0.03	TCLP Pesticides	EPA-SW846-1311/8081B/3510C
Chlorobenzene	70	TCLP VOC	EPA-SW846-1311/8260D/5030B
Chloroform	6	TCLP VOC	EPA-SW846-1311/8260D/5030B
Chloro-m-cresol, p	7000	TCLP SVOC	EPA-SW846-1311/8270E/3510C
2-Chlorophenol	20	TCLP SVOC	EPA-SW846-1311/8270E/3510C
Chromium	5	TCLP Metals	EPA-SW846-1311/6010D/3010A
m-Cresol	200*	TCLP SVOC	EPA-SW846-1311/8270E/3510C
o-Cresol	200*	TCLP SVOC	EPA-SW846-1311/8270E/3510C
p-Cresol	200*	TCLP SVOC	EPA-SW846-1311/8270E/3510C
DDD	1	TCLP Pesticides	EPA-SW846-1311/8081B/3510C
DDE	1	TCLP Pesticides	EPA-SW846-1311/8081B/3510C
DDT	1	TCLP Pesticides	EPA-SW846-1311/8081B/3510C
Dibutyl Phthalate	400	TCLP SVOC	EPA-SW846-1311/8270E/3510C
1,4-Dichlorobenzene	7.5	TCLP VOC	EPA-SW846-1311/8260D/5030B
3,3-Dichlorobenzidine	0.8	TCLP SVOC	EPA-SW846-1311/8270E/3510C
1,2-Dichloroethane	0.5	TCLP VOC	EPA-SW846-1311/8260D/5030B
Dichlorodifluoromethane	700	TCLP VOC	EPA-SW846-1311/8260D/5030B
1,1-Dichloroethylene	0.6	TCLP VOC	EPA-SW846-1311/8260D/5030B
1,3-Dichloropropene	1	TCLP VOC	EPA-SW846-1311/8260D/5030B
2,4-Dichlorophenol	10	TCLP SVOC	EPA-SW846-1311/8270E/3510C
2,4-Dichlorophenoxy-Acetic Acid (2.4-D)	10	TCLP Herbicides	EPA-SW846-1311/8151A/3510C
Dieldrin	0.02	TCLP Pesticides	EPA-SW846-1311/8081B/3510C
Diethyl phthalate	3000	TCLP SVOC	EPA-SW846-1311/8270E/3510C
Dimethoate	70	TCLP SVOC	EPA-SW846-1311/8270E/3510C
2,4-Dimethylphenol	70	TCLP SVOC	EPA-SW846-1311/8270E/3510C
2,6-Dimethylphenol	21	TCLP SVOC	EPA-SW846-1311/8270E/3510C
m-Dinitrobenzene	0.4	TCLP SVOC	EPA-SW846-1311/8270E/3510C
2,4-Dinitrophenol	7	TCLP SVOC	EPA-SW846-1311/8270E/3510C
2,4 -Dinitrotoluene and 2,6-mixture	0.13	TCLP SVOC	EPA-SW846-1311/8270E/3510C
Dinoseb	3.5	TCLP Herbicides	EPA-SW846-1311/8151A/3510C
1,4-Dioxane	30	TCLP SVOC	EPA-SW846-1311/8270E/3510C
Dioxins (Poly chlorinated dibenzo-p-dioxins)			
2,3,7,8-TCDD	0.005	TCLP Dioxins/Furans	EPA-1311/1613B/3510C HRMS Specific
1,2,3,7,8-PeCDD	0.01	TCLP Dioxins/Furans	EPA-1311/1613B/3510C HRMS Specific
1,2,3,4,7,8-HxCDD	0.05	TCLP Dioxins/Furans	EPA-1311/1613B/3510C HRMS Specific
1,2,3,6,7,8-HxCDD	0.05	TCLP Dioxins/Furans	EPA-1311/1613B/3510C HRMS Specific
1,2,3,7,8,9-HxCDD	0.05	TCLP Dioxins/Furans	EPA-1311/1613B/3510C HRMS Specific
Diphenylamine	90	TCLP SVOC	EPA-SW846-1311/8270E/3510C
1,2-Diphenylhydrazine	0.4	TCLP SVOC	EPA-SW846-1311/8270E/3510C
Disulfoton	0.1	TCLP SVOC	EPA-SW846-1311/8270E/3510C
Endosulfan	0.2	TCLP Pesticides	EPA-SW846-1311/8081B/3510C
Endrin	0.02	TCLP Pesticides	EPA-SW846-1311/8081B/3510C
2-Ethoxyethanol	1400	TCLP Nonhalogenated Organic	EPA-SW846-1311/8015
Ethylbenzene	400	TCLP VOC	EPA-SW846-1311/8260D/5030B
Ethylene Dibromide	0.004	TCLP VOC	EPA-SW846-1311/8260D/5030B
Ethylene Glycol	7000	TCLP Nonhalogenated Organic	EPA-SW846-1311/8015
Fluoranthene	140	TCLP SVOC	EPA-SW846-1311/8270E/3510C
Fluorene	140	TCLP SVOC	EPA-SW846-1311/8270E/3510C
Furans (Polychlorinated dibenzo furans)			
2,3,7,8-TCDF	0.05	TCLP Dioxins/Furans	EPA-1311/1613B/3510C HRMS Specific

Table 2

Class 2 Landfill TCLP Regulatory Levels
Final Treatability Study Work Plan
San Jacinto River Waste Pits Site
Harris County, Texas

Analyte	Regulatory Level for Class 2 Landfill (mg/L)	Analytical Method Name	Analytical Method Number
1,2,3,7,8-PeCDF	0.1	TCLP Dioxins/Furans	EPA-1311/1613B/3510C HRMS Specific
2,3,4,7,8-PeCDF	0.01	TCLP Dioxins/Furans	EPA-1311/1613B/3510C HRMS Specific
1,2,3,4,7,8-HxCDF	0.05	TCLP Dioxins/Furans	EPA-1311/1613B/3510C HRMS Specific
1,2,3,6,7,8-HxCDF	0.05	TCLP Dioxins/Furans	EPA-1311/1613B/3510C HRMS Specific
1,2,3,7,8,9-HxCDF	0.05	TCLP Dioxins/Furans	EPA-1311/1613B/3510C HRMS Specific
Heptachlor and its hydroxide	0.008	TCLP Pesticides	EPA-SW846-1311/8081B/3510C
Heptachlor Epoxide	0.04	TCLP Pesticides	EPA-SW846-1311/8081B/3510C
Hexachlorobenzene	0.13	TCLP SVOC	EPA-SW846-1311/8270E/3510C
Hexachloro-1,3-butadiene	0.4	TCLP VOC	EPA-SW846-1311/8260D/5030B
Hexachlorocyclopentadiene	20	TCLP SVOC	EPA-SW846-1311/8270E/3510C
Hexachloroethane	3	TCLP SVOC	EPA-SW846-1311/8270E/3510C
Hexachlorophene	1	TCLP SVOC	EPA-SW846-1311/8270E/3510C
Isobutyl alcohol	1000	TCLP VOC	EPA-SW846-1311/8260D/5030B
Isophorone	90	TCLP SVOC	EPA-SW846-1311/8270E/3510C
Lead	1.5	TCLP Metals	EPA-SW846-1311/6010D/3010A
Lindane	0.3	TCLP Pesticides	EPA-SW846-1311/8081B/3510C
Mercury	0.2	TCLP Metals	EPA-SW846-1311/6010D/3010A/7470A
Methacrylonitrile	0.4	TCLP VOC	EPA-SW846-1311/8260D/5030B
Methomyl	90	TCLP HPLC/TS/MS or UV	EPA-SW846-1311/8321
Methoxychlor	10	TCLP Pesticides	EPA-SW846-1311/8081B/3510C
2-Methoxyethanol	14	TCLP Nonhalogenated Organic	EPA-SW846-1311/8015
Methyl Ethyl Ketone	200	TCLP VOC	EPA-SW846-1311/8260D/5030B
Methyl Isobutyl Ketone	200	TCLP VOC	EPA-SW846-1311/8260D/5030B
Methylene chloride	50	TCLP VOC	EPA-SW846-1311/8260D/5030B
Methyl parathion	0.9	TCLP SVOC	EPA-SW846-1311/8270E/3510C
Mirex	0.7	TCLP Pesticides	EPA-SW846-1311/8081B/3510C
Nickel	70	TCLP Metals	EPA-SW846-1311/6010D/3010A
Nitrobenzene	2	TCLP SVOC	EPA-SW846-1311/8270E/3510C
N-Nitroso-di-n-butylamine	0.06	TCLP SVOC	EPA-SW846-1311/8270E/3510C
N-Nitrosodiphenylamine	70	TCLP SVOC	EPA-SW846-1311/8270E/3510C
N-Nitrosomethylethylamine	0.02	TCLP SVOC	EPA-SW846-1311/8270E/3510C
N-Nitroso-n-propylamine	0.05	TCLP SVOC	EPA-SW846-1311/8270E/3510C
N-Nitrosopyrrolidine	0.2	TCLP SVOC	EPA-SW846-1311/8270E/3510C
p-Phenylene diamine	20	TCLP SVOC	EPA-SW846-1311/8270E/3510C
Parathion	20	TCLP SVOC	EPA-SW846-1311/8270E/3510C
Pentachlorobenzene	3	TCLP SVOC	EPA-SW846-1311/8270E/3510C
Pentachloronitrobenzene	10	TCLP SVOC	EPA-SW846-1311/8270E/3510C
Pentachlorophenol	100	TCLP SVOC	EPA-SW846-1311/8270E/3510C
Phenol	2000	TCLP SVOC	EPA-SW846-1311/8270E/3510C
Pronamide	300	TCLP SVOC	EPA-SW846-1311/8270E/3510C
Pyrene	5.9	TCLP SVOC	EPA-SW846-1311/8270E/3510C
Pyridine	4	TCLP SVOC	EPA-SW846-1311/8270E/3510C
Selenium	1	TCLP Metals	EPA-SW846-1311/6010D/3010A
Silver	5	TCLP Metals	EPA-SW846-1311/6010D/3010A
Styrene	700	TCLP VOC	EPA-SW846-1311/8260D/5030B
1,1,1,2-Tetrachloroethane	10	TCLP VOC	EPA-SW846-1311/8260D/5030B
1,1,2,2-Tetrachloroethane	2	TCLP VOC	EPA-SW846-1311/8260D/5030B
Tetrachloroethylene	0.7	TCLP VOC	EPA-SW846-1311/8260D/5030B
2,3,4,6-Tetrachlorophenol	100	TCLP SVOC	EPA-SW846-1311/8270E/3510C
Toluene	1000	TCLP VOC	EPA-SW846-1311/8260D/5030B
Total Petroleum Hydrocarbons (TPH	1500	Total TPH	TX1005
Toxaphene	0.3	TCLP Pesticides	EPA-SW846-1311/8081B/3510C
trans-1,3-Dichloro-propene	1	TCLP VOC	EPA-SW846-1311/8260D/5030B
Tribromomethane (bromoform)	70	TCLP VOC	EPA-SW846-1311/8260D/5030B
1,2,4-Trichlorobenzene	70	TCLP SVOC	EPA-SW846-1311/8270E/3510C
1,1,1-Trichloroethane	300	TCLP VOC	EPA-SW846-1311/8260D/5030B
Trichloroethylene	0.5	TCLP VOC	EPA-SW846-1311/8260D/5030B
1,1,2-Trichloroethane	6	TCLP VOC	EPA-SW846-1311/8260D/5030B
Trichlorofluoromethane	1000	TCLP VOC	EPA-SW846-1311/8260D/5030B
2,4,5-Trichlorophenoxy-propionic acid (2.4.5-TP or Silvex)	1	TCLP Herbicides	EPA-SW846-1311/8151A/3510C
1,2,3-Trichloropropane	20	TCLP VOC	EPA-SW846-1311/8260D/5030B
2,4,5-Trichlorophenol	400	TCLP SVOC	EPA-SW846-1311/8270E/3510C
2,4,6-Trichlorophenol	2	TCLP SVOC	EPA-SW846-1311/8270E/3510C
Vanadium Pentoxide	30	TCLP Metals	EPA-SW846-1311/6010D/3010A
Vinyl chloride	0.2	TCLP VOC	EPA-SW846-1311/8260D/5030B
Xylenes (all isomers)	7000	TCLP VOC	EPA-SW846-1311/8260D/5030B

Notes:

TCLP - Toxicity Characteristic Leaching Procedure

VOC - Volatile Organic Carbon

SVOC - Semi-Volatile Organic Carbon

mg/L - milligrams per liter

*If o-, m-, and p-Cresol concentrations cannot be differentiated, the total cresol concentration is used. The Maximum Concentration for total cresol is 200.0 mg/L.

Table 3

Water Treatability Characterization Parameters
Final Treatability Study Work Plan
San Jacinto River Waste Pits Site
Harris County, Texas

General Chemistry for Water

Analysis	pH	Ammonia Nitrogen	Total Phosphorus	BOD	COD	Total Organic Carbon	Total Suspended Solids (TSS)	Total Dissolved Solids (TDS)
Method	EPA 9040C	EPA-SW846-350.2	EPA-SW846-6010 D/3050B/7471B	SM 5210B	SM 5220B	SM 5310C	SM 2540D	SM 2540C

Characterization for Water

Analysis	VOC	SVOC	PAH	PCB	Pesticides	Herbicides	PCDD/PCDF	Total and Dissolved Metals
Method	EPA-SW846-8260D/5030B	EPA-SW846-8270E/3510C	EPA-SW846-8270E/3510C	EPA-SW846-8082A/3510C	SW-846-8081	SW-846-8151	EPA-SW846-8280B	EPA-SW846-6010D/ 3005A/3010A/7470A
Constituents	*Benzene* *Carbon disulfide* *Carbon tetrachloride* *Chlorobenzene* *Chloroform* *1,4-Dichlorobenzene* *1,2-Dichloroethane* *1,1-Dichloroethylene* *Hexachloro-1,3-butadiene* *Methyl Ethyl Ketone* *Tetrachloroethylene* *Trichloroethylene* *Vinyl chloride* *Xylenes (all isomers)*	*m-Cresol* *o-Cresol* *p-Cresol* *2,4 -Dinitrotoluene and 2,6-mixture* *Hexachlorobenzene* *Hexachlorobutadiene* *Hexachloroethane* *Nitrobenzene* *Pentachlorophenol* *Pyridine* *2,4,5-Trichlorophenol* *2,4,6-Trichlorophenol*		*Aroclor 1016* *Aroclor 1221* *Aroclor 1232* *Aroclor 1242* *Aroclor 1248* *Aroclor 1254* *Aroclor 1260*	*Chlordane* *Endrin* *Heptachlor* *Heptachlor epoxide* *Hexachlorobenzene* *Lindane* *Methoxychlor* *Toxaphene*	*2,4-Dichlorophenoxy-acetic Acid (2.4-D)* *2,4,5-Trichlorophenoxy-propionic acid (2.4.5-TP or Silvex)*	*2,3,7,8-TCDD* *1,2,3,7,8-PeCDD* *1,2,3,4,7,8-HxCDD* *1,2,3,6,7,8-HxCDD* *1,2,3,7,8,9-HxCDD* *2,3,7,8-TCDF* *1,2,3,7,8-PeCDF* *2,3,4,7,8-PeCDF* *1,2,3,4,7,8-HxCDF* *1,2,3,6,7,8-HxCDF* *1,2,3,7,8,9-HxCDF*	*Arsenic* *Barium* *Cadmium* *Chromium* *Lead* *Mercury* *Nickel* *Selenium* *Silver* *Vanadium* *Zinc*

Appendices

Appendix A
Draft Treatability Study Work Plan Review Comment Response Table

Appendix A

Draft Treatability Study Work Plan Comment Response Table
Final Treatability Study Work Plan
San Jacinto River Waste Pits Superfund Site
Harris County, Texas

Item No.	Reference	Comment	Response	A Revision is Included in the Final Report in the Location Cited Below
Specific Comments from the EPA				
1	Page 11, Section 3.3.1.2	In the second bullet, remove "or TEQs" in parentheses after "TCDD Equivalents."	The text has been modified to reflect this change.	- Text updated in Section 3.3.1.2; Second Bullet
2	Page 11, Section 3.3.1.2	In the third bullet: a. Abbreviate the Procedures to Implement the Texas Surface Water Quality Standards as "Implementation Procedures" instead of "Implementation Plan"; b. MALs is the abbreviation for Minimum Analytical Levels; and c. The description of calculating permit limits to protect aquatic life and human health is incomplete. It is recommended that the text instead make reference to pages 130-142 of the Implementation Procedures.	a - c. The text has been modified to reflect these changes.	a. Text updated to "Implementation Procedures" in Section 3.3.1.2 - Third Bullet, and in the three paragraphs following b. Text updated in Section 3.3.1.2, Third Bullet and in the "List of Acronyms", Page i c. Text updated in Section 3.3.1.2, First full paragraph
3	Page 11, Section 3.3.1.2, First Full Paragraph	Please update the text to reflect that TEFs is the abbreviation for Toxic Equivalency Factors. Also, please update the abbreviation for TEF in the "List of Acronyms"	The text has been modified to reflect this change.	- Text updated in Section 3.3.1.2, First Full Paragraph, and in the "List of Acronyms", Page i
4	Page 11, Section 3.3.1.2, Paragraphs 2 and 3	Because of the existing water quality impairments for dioxin/furans and PCBs in both Segments 1001 and 1005, it is recommended that the testing and water treatment technology evaluation be based on the assumption of meeting the applicable human health criteria in the Texas Surface Water Quality Standards for dioxin (0.0797 picograms per liter) and PCBs (0.64 nanograms per liter) at the point of discharge (i.e., end-of-pipe). A Total Maximum Daily Load (TMDL) is currently in effect for nickel in the Houston Ship Channel (including Segments 1001 and 1005), therefore it is recommended that the applicable aquatic life criterion for this constituent (13.1 micrograms per liter) be used as the treatability target to preclude additional loading. For the remaining constituents of interest (arsenic, mercury, and 2,4,5-Trichlorophenol), targets can be calculated, with TCEQ assistance, using the appropriate permit limit determination methodology in the Implementation Procedures.	The TCEQ has established the 2010 TCEQ Procedures to Implement the Texas Surface Water Quality Standards (TSWQS) (Implementation Procedures), approved by the EPA, to provide established methodology for use in translating TSWQS into discharge limitations for specific pollutants at specific sources. To this effect, Appendix E, Table E 2 has established Minimum Analytical Levels (MALs), listed in the 2010 Procedures that are required for analytical characterization of pollutant concentrations in effluent discharge. MALs are defined in the Implementation Procedures as “the lowest concentration at which a particular substance can be quantitatively measured with a defined accuracy and precision level, using approved analytical methods.” The MALs for dioxin/furans range from 10 parts per quadrillion (ppq) to 100 ppq. MALs for PCBs range from 0.0005 to 0.2 micrograms per liter (µg/L). Further, the Implementation Procedures states “MALs are used to allow an applicant or permittee to submit analytical results as non detect. Non detect analytical results are assumed to represent a concentration of zero (0) milligrams per liter (mg/L) (or µg/L as appropriate).” Discharge limits for toxic pollutants are estimated based on the in stream waste concentration in the receiving stream, and the TSWQS. If the estimated limit is less than the MAL identified in the Implementation Procedures, then the MAL would be used for reporting purposes. The Respondents anticipate that the appropriate ARAR for discharge of water would be the TSWQS for dioxins and that determination of compliance with this standard will be based upon the MAL for dioxins. The Respondents agree that nickel, arsenic, mercury, and 2,4,5-trichlorophenol should be added to the target COCs to evaluate during treatability testing. The "Implementation Plan for Dissolved Nickel in the Houston Ship Channel System" (HSC) published by the Texas Natural Resources Conservation Commission (TNRCC) indicates that "Modern clean data have indicated that nickel criteria are being met in the HSC system. Any exceedances that may have occurred historically were apparently very localized and/or of short duration - but there is significant doubt that any such exceedances ever truly existed." The guidance also says that reallocation of the AFG [allowance for future growth] to specific permits will be reviewed using the QUAL-TX model to assure that the location or magnitude of the discharges will not cause cumulative exceedance of the water quality standard." Nickel was also not included on the most recent 303D list for impaired water bodies for these river segments. The Respondents will therefore utilize the methodology outlined in the Implementation Procedures to calculate water quality based effluent limits (WQBELs) for nickel for TCEQ review and acceptance. The Respondents will utilize the same methodology to calculate WQBELs for arsenic, mercury, and 2,4,5-trichlorophenol.	- Text updated in Section 3.3.1.2, Second Bullet. - Text updated in Section 3.3.1.2, Third full paragraph - Added "WQBEL" to the "List of Acronyms", page i

Appendix A

Draft Treatability Study Work Plan Comment Response Table
Final Treatability Study Work Plan
San Jacinto River Waste Pits Superfund Site
Harris County, Texas

Item No.	Reference	Comment	Response	A Revision is Included in the Final Report in the Location Cited Below
5	Page 13, Section 3.4	a. Dioxin doesn't have an ESL or L Value under Permit by Rule (PBR) 30 TAC §106.262 so the emissions can be authorized under PBR 30 TAC §106.261(a)(3). If the emissions limits in the MACT standard are applicable and more stringent, those limits would need to be met as well. b. The Agency needs to ensure that site contaminants of concern (COCs) are not being transferred from the liquid phase to the vapor phase. Therefore, a mass balance on dioxins and/or other site COCs should be performed for the thermal evaporation test, showing the ultimate disposition of the dioxins from the water sample during treatment, including the walls of the treatment system, brine, treated water, vapor, and aerosol phases. c. 40 CFR 63.1203 discusses emission limits for new sources. In addition to dioxins and furans, section (b) also has the following emission limits: • Mercury in excess of 45 µg/dscm corrected to 7 percent oxygen; • Lead and cadmium in excess of 120 µg/dscm, combined emissions, corrected to 7 percent oxygen; • Arsenic, beryllium, and chromium in excess of 97 µg/dscm, combined emissions, corrected to 7 percent oxygen; If the baseline characterization of water being tested in the thermal unit has detectable levels of mercury, lead, cadmium, arsenic, beryllium or chromium, an evaluation of the above emission limits needs to be evaluated as part of the treatability study.	a. The evaporator units are not hazardous waste combustion units as that source is defined in the MACT (40 CFR 63.1203). The Respondents were simply proposing the dioxins emissions standard in the MACT standard as a benchmark for comparison. The Respondents agree that this standard is not applicable and therefore agree to utilize the PBR 30 TAC §106.261(a)(3) to authorize emissions. b. To ensure that dioxins and other Site COCs are not being transferred to the vapor phase, the Respondents are planning to conduct a pilot test with stack testing of the emissions. The Respondents plan to measure concentrations of the contact water, settled water, vapor emissions, brine, and the walls of the treatment system. The pilot test will be performed to understand the fate of dioxins. c. As noted in response (a) above, the Respondents agree that the MACT standard for hazardous waste incinerators (40 CFR 63.1203) is not applicable to the proposed process. The Respondents agree that the emissions should be in authorized under permit equivalency with PBR 30 TAC §106.261(a)(3). Therefore, the emissions limits included in 40 CFR 63.1203 are not applicable.	a. - Text updated in Section 3.4; removed "MACT from the "List of Acronyms", page i
6	Page 14, 2nd Full Paragraph, Section 4.1.1	In-situ solidification/stabilization (S/S) will mix reagents over a small volume relative to the total volume requiring removal. Compositing should be representative of an actual batch volume that will be conducted during remedial action. The treatability study does not examine smaller scale variability. Please provide additional justification for the composite testing approach proposed in the work plan.	The Respondents recognize that the chemical and physical characteristics of the material vary across the impoundment. In designing the approach, the Respondents divided the Impoundment into quadrants, based upon anticipated characteristics for each quadrant; i.e.: the material in the southwest quadrant is expected to have less moisture content, but higher chemical concentrations and larger grain size than the material in the northeast quadrant. Obtaining baseline chemical and physical characterization data on the material from the different quadrants will allow the Respondents to better understand the degree of variability and design the reagent mixture to be effective for the anticipated extremes, and/or tailor the mix ratio to the target conditions. Based upon the waste characterization data collected during PDI-1, the material is not a hazardous waste and will not be leachable. Solidification will be implemented solely to dry the material in order to meet landfill acceptance criteria. That said, the Respondents feel that the solidification treatability testing proposed in the work plan will sufficiently capture the variability (both chemically and physically) of the material across the impoundment, such that the selected solidification reagent mixture design will result in an acceptable composition for disposal.	- Text updated in Section 4.1.1 - Changed all mention of "stabilization/ solidification (S/S)" or "stabilization" to "solidification" throughout Work Plan
7	Page 15, Section 4.1.3	Crushing the armor stone does not yield a concentration that is representative of the exposure concentration. The interior mass of the armor stone is not exposed to receptors. An elutriate test would be more representative of the exposure concentration and the risk imposed by the armor stone. During remedy implementation, would the armored cap material be cleaned or rinsed in some fashion? If so, there should be a step being included in the treatability test that would simulate this process? How will the rinsate samples be generated? SOPs for this testing should be provided.	The Respondents had proposed to analyze crushed armor stone in addition to conducting elutriate tests, to be overly conservative. The Respondents acknowledge the EPA's comment and agree that elutriate testing will sufficiently characterize any exposure concentration. Mention of the rock crushing test has been removed from the text. The Respondents do not plan to utilize a cleaning/rinsing process during remedy implementation. Only rock that is not in direct contact with waste material will be considered for reuse during the remedial action. Final end use of the armor stone is unknown at this time. Rinsate elutriate tests will be performed on rock samples from three areas of the Northern Impoundment (the east, west, and berm areas) during the Treatability Study to help to inform that evaluation. A Standard Operating Procedure (SOP) for bench scale elutriate preparation has been added to the Work Plan.	- Text updated in Section 4.1.3 - Added a SOP for Bench Scale Elutriate Preparation (Exhibit A) - Added Figure 5 to show approximate armored cap sample locations

Appendix A

Draft Treatability Study Work Plan Comment Response Table
Final Treatability Study Work Plan
San Jacinto River Waste Pits Superfund Site
Harris County, Texas

Item No.	Reference	Comment	Response	A Revision is Included in the Final Report in the Location Cited Below
8	Page 16, Section 4.2.1	TCLP for dioxins/furans is not included in the list of parameters for treatability testing for disposal, although 30 Texas Administrative Code (TAC) §§335.505(1) and 335.521(a)(l) include dioxins and furans in the list of constituents of concern and their maximum leachable concentrations for non-hazardous waste classification. Please include TCLP in for dioxins/furans for the baseline characterization. The regulatory levels are presented in Table 2 of the work plan.	Waste characterization data collected during PDI-1 indicates that the material is non-hazardous. Therefore, the TCLP dioxins/furans analysis was not included in the list of constituents of concern (COCs) to test as part of the baseline analysis, but instead was included in Table 2 as part of the COCs to evaluate for Class 1 versus Class 2 non-hazardous waste determination. For clarity, TCLP dioxins/furans analysis has been added to the baseline characterization analyte list in the work plan.	- Text updated in Section 4.2.1
9	Page 16, Section 4.2.2	a. Some of the proposed reagents work through cementitious processes, but most organic compounds like dioxins and PCBs do not bond with cementitious minerals produced by hydration of the reagents. Therefore, these reagents may not efficiently prevent leaching of these organic compounds from the waste material. Additives such as organoclay or activated carbon, which have sorptive properties, may be mixed with cement to improve the stabilization of organic contaminants. b. It is stated that the treated samples will be allowed to cure for up to two weeks. There may be significant advantages to the construction schedule and on-site logistics if cure times are shorter. Shorter cure times should be evaluated as part of the optimization testing.	a. Solidification treatment during the remedial action will be implemented to ensure that the material meets transport and landfill acceptance criteria. Waste characterization data collected during PDI-1 indicates that the material is not leachable; therefore, adsorption of organics on organoclay or carbon will not be necessary. b. The Respondents agree that there may be significant advantages to the construction schedule and on-site logistics if cure times are shorter. Cure time optimization will be evaluated as part of treatability testing and the evaluation of different cure times has been added to the Work Plan.	b. Text updated in Section 4.2.1, Section 4.2.2, and Section 4.2.2.2. - Added "UCS" and "psi" to the "List of Acronyms", page i - Added SOP for Bench Scale Hardness Measurement Procedure (Exhibit C)
10	Page 17, Section 4.2.2.1	Although a disposal facility has not been identified, the Work Plan should consider other landfill disposal requirements such as "workability" and/or "stackability". It is recommended that additional geotechnical data be collected during the treatability study to answer such potential disposal facility acceptance criteria. In addition to, or in lieu of the paint filter test, the treatability study should consider using the pressure filtration test (Method 1311). The pressure filtration test may better evaluate the solidified/stabilized material as it is placed in a disposal facility.	As mentioned in the response to comment 9b above, the Respondents will evaluate cure time optimization during treatability testing. As part of this testing, unconfined compressive strength (UCS) with be evaluated at periodic intervals. The industry standard for evaluating landfill acceptance is the Paint Filter Test.	- Text updated in Section 4.2.1, Section 4.2.2, and Section 4.2.2.2. - Added "UCS" and "psi" to the "List of Acronyms", page i - Added SOP for Bench Scale Hardness Measurement Procedure (Exhibit C)
11	Page 20, Thermal Evaporation Pilot Test	The Work Plan states that the sand pack in the monitoring wells will simulate the filtration process that would take place before the water is run through the thermal unit. Since filtration of particulate is an important step in thermal evaporation, it is recommended that the water should be filtered in the testing lab prior to feeding the water to the thermal unit.	The Respondents agree that solids removal is an important pretreatment step for thermal evaporation. The Respondents have updated the text of the Work Plan to reflect changes in the thermal evaporation pilot test and added a conceptual process flow diagram. An excavation will be created in the Northern Impoundment. Water will be sprayed into the excavation to create contact water. Due to the volume of water required for the pilot test, solids removal will be performed in the field. Since the concentration of suspended solids using this method is unknown, a solids separation step will be performed first, and filtration will be used if needed. Please see revised Work Plan for details.	- Text updated in Section 4.1.2, Section 4.2.3, Section 4.3.2.1, and Section 4.3.2.5. - Section 4.3.2.2 added to text to address Filtration Testing - Added Figure 6 to show Thermal Evaporation Pilot Test Conceptual Diagram - Added SOP for Bench Scale Sequential Filtration Testing (Exhibit E)
Additional Changes to the Treatability Study Work Plan				
12			The locations of the composite treatability samples were adjusted to correlate with revisions to the Second Phase Pre-Design Investigation sample locations.	Figure 3
13			Table 1 was revised to include the validated waste characterization data. The data validation reports will be submitted as part of the Final Second Phase Pre-Design Investigation Work Plan under a separate cover.	Table 1
14			The text of Section 1.1.2 and Section 1.1.3 was amended slightly based upon comments received on the *Draft Second Phase PDI-2 Work Plan* .	Section 1.1.2 and Section 1.1.3

Appendix B
Quality Assurance Procedures for Laboratory Treatability Studies

Appendix B
Quality Assurance Procedures for Laboratory Treatability Studies

International Paper Company and
McGinnes Industrial
Maintenance Corporation

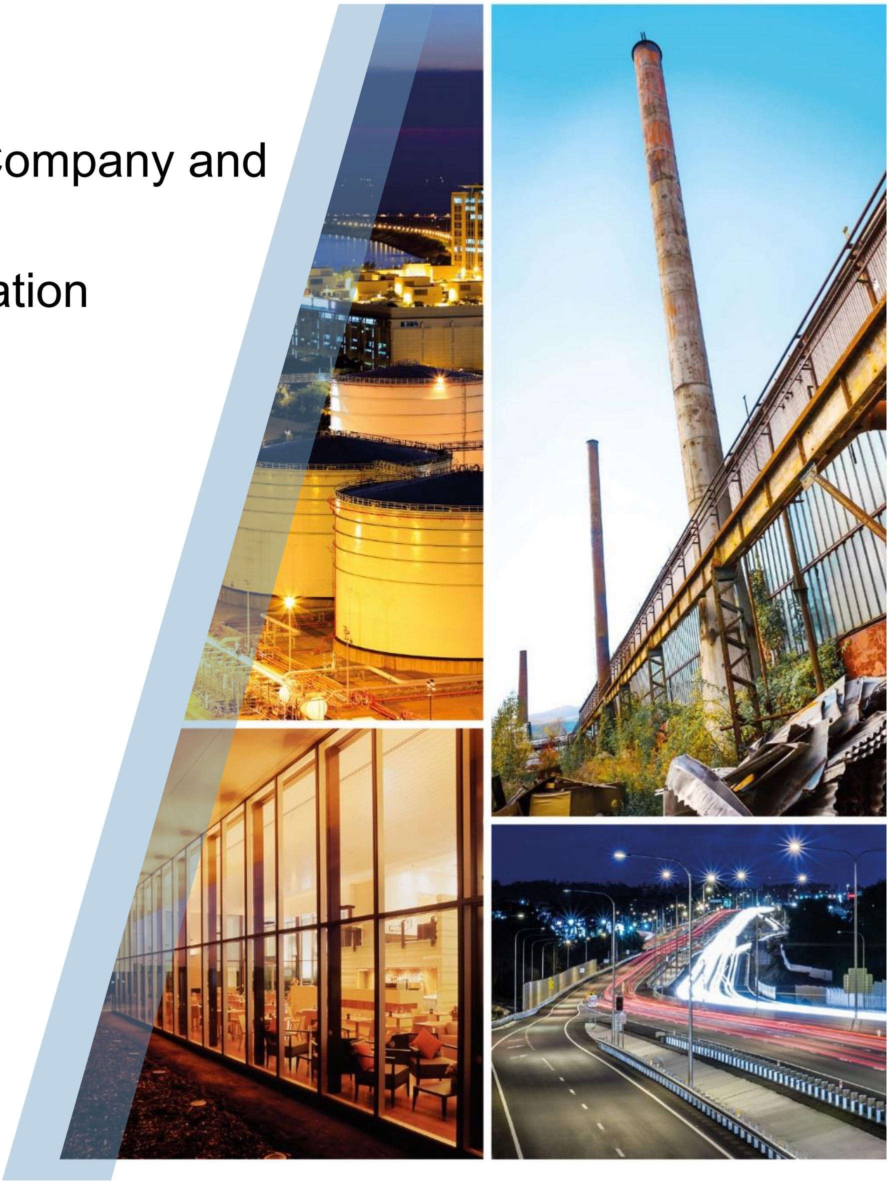


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Table Index

1. Introduction

This document has been prepared for laboratory treatability studies performed in the GHD Services Inc. (GHD) Niagara Falls laboratory.

1.1 Project Objectives and Intended Data Usage

The overall objective of a laboratory study is evaluate data on the effectiveness and/or efficiency of the potential solids treatment processes and determine and optimize required treatment chemical dosages in order to design and optimize full-scale processes.

1.2 Parameters

In support of a laboratory treatability study, analyses will be performed in the GHD in-house laboratory.

Table 1 In-House Laboratory Parameters

Parameter	Soil/Sediment Method	Water Method
pH		EPA-9040C
Percent Solids	SM 2540G	
Volatile Organic Compounds (VOC)	EPA-SW846-8260D/5035	EPA-SW846-8260D/5030B
Semi-volatile Organic Compounds (SVOC)	EPA-SW846-8270E/3550C	EPA-SW846-8270E/3510C
Metals	EPA-SW846-6010D/3050B/7471B	EPA-SW846-6010D/3005A/ 3010A/7470A
Paint Filter	EPA-SW846-9095B	
Toxicity Characteristic Leachate Procedure (TCLP) SVOC/PAH	EPA-SW846-1311/8270E/3510C	
TCLP Metals including RCRA-8 Metals	EPA-SW846-1311/6010D/3010A/7470A	
Corrosivity - pH	EPA-SW846-9045D	
Ammonia Nitrogen		EPA-350.2
Total Phosphorus		EPA-SW846-6010D/3050B
Chemical Oxygen Demand (COD)		SM 5220B
Total Organic Carbon (TOC)		SM 5310C
Total Suspended Solids (TSS)		SM 2540D
Total Dissolved Solids (TDS)		SM 2540C

All soil/sediment samples will be reported on a dry weight basis.

A summary of the parameters is provided in Table A-1 (soil/sediment) and Table A-2 (water).

1.3 Data Quality Objectives

Since the analytical data will be used for remedy selection, quantitative Data Quality Objectives (DQOs) have been established. The DQOs are as follows:

DQO 1 - Representativeness: Samples will be thoroughly mixed prior to analysis. For each test, soil will be weighed into the treatment vessel using a laboratory balance. The variability of individual soil quantities for the treatments in the same test will be + or - 0.1 percent.

DQO 2 - Reproducibility: For each treatment, a duplicate sample will be prepared for every ten samples generated. Duplicate sample data will be assessed against a criteria of + or - 20 relative percent difference (RPD).

DQO 3 - Completeness: At least 80 percent of the treatment tests will be accepted and the data will be included in the report.

2. Quality Assurance Objectives for Measurement Data

The laboratory treatability study will involve small-scale tests. These tests will contain as little as 100 grams (g) of soil and 100 milliliters (mL) of water; therefore, the amount of sample available for Quality Assurance/Quality Control (QA/QC) samples will be small. The QA/QC procedures outlined below will be performed but will be applied taking into account the limited sample availability.

Specific procedures for laboratory instrument calibration, laboratory analysis, and corrective action are described below.

2.1 Level of Quality Control Effort

Specific QC parameters will be collected, prepared, and analyzed to evaluate the quality of the data generated to support the investigation. Section 8 of this Quality Assurance Project Plan (QAPP) summarizes the type and quantity of QC samples.

2.2 Sensitivity - Reporting Limit Requirements

The sensitivity or reporting limit requirements for this project was defined to meet the investigation requirements. Tables A-1 and A-2 list the potential analytes, the medium to be sampled and analyzed, and the expected reporting limits for the level of detection.

Note that the achievable reporting limits in the samples may be affected by matrix interferences.

2.3 Compound Identification

For gas chromatograph/mass spectrometer (GC/MS) determination of specific analytes, the compounds will be identified based on the atomic mass of the compounds and the fragmentation pattern, which will then be identified by the library present in the Chemstation software used with the instrument.

For metals analysis by inductively coupled plasma-optical emission spectrometry (ICP-OES), the metal will be identified based on the wavelength of electromagnetic radiation. Different wavelengths are characteristic of different metals.

3. Sample Custody

3.1 Chain-of-Custody

Chain-of-custody forms will be completed for all samples to document the transfer of samples from the field to the GHD laboratory or from the GHD laboratory to the outside analytical laboratory that will be used for some of the analyses. Custody seals will be placed on each cooler/container. The cooler/container will then be sealed with packing tape. Sample container labels will include sample number, place of collection, and date and time of collection.

The chain-of-custody record, completed at the time of sampling, will contain, but not be limited to, the sample number, date and time of sampling, and the name of the sampler. The chain-of-custody document will be signed, timed, and dated by the sampler when transferring the samples.

Each sampler cooler/container being shipped will contain a chain-of-custody form. The chain-of-custody form will consist of four copies which will be distributed as follows: the shipper will maintain a copy while the other three copies will be enclosed in a waterproof envelope within the cooler/container with the samples. The cooler/container will then be sealed properly for shipment. For samples received by the GHD laboratory, the laboratory will complete the three remaining copies, log the samples into their database, and maintain the copies of the chain-of-custody form. For samples sent to an outside laboratory, the laboratory, upon receiving the samples, will complete the three remaining copies. The laboratory will maintain one copy for their records. The laboratory will return one copy to GHD. One copy will be returned with the data deliverables package.

3.2 Sample Shipment

All samples will be sent to the GHD laboratory by commercial courier.

3.3 Sample Documentation in the Laboratory

Upon receipt of samples at the laboratory, laboratory personnel will inspect the shipping container. The personnel will note the condition of the container on the chain-of-custody record sheet. The laboratory personnel will document the date and time of receipt of the container and sign the form.

If damage or discrepancies are noticed, they will be recorded. Any damage or discrepancies will be reported to the laboratory director and/or the project manager.

3.4 Project Documentation

The laboratory will be responsible for maintaining analytical log books and laboratory data, as well as, a sample (on hand) inventory. Raw laboratory data produced from the analysis of samples submitted for this program will be inventoried and maintained by the laboratory for a period of 5 years.

4. Calibration Procedures and Frequency

All instruments used to perform chemical measurements will be properly calibrated prior and during use to ensure acceptable and valid results. The accuracy and traceability of all calibration standards used will be properly documented.

The methodologies selected for use in this investigation specify the types and frequency of calibrations. The specific analytical methods to be used are provided in Table 1.

5. Analytical Procedures

This section describes a brief overview of the analytical methodologies to be used during the treatability study.

5.1 Laboratory Analytical Procedures

5.1.1 Soil/Sediment and Water Methods

Using the methods summarized in Table 1, the laboratories will perform analysis of soil/sediment and water samples. The full list of potential analytes and project required reporting limits are listed in Table A-1 (soil/sediment) and Table A-2 (water).

6. Internal Quality Control Checks

6.1 Laboratory Analysis

Criteria that the laboratory must meet are presented in the analytical methods.

6.2 Laboratory Quality Control

Specific procedures related to internal laboratory QC samples are detailed in the analytical methods. The following QC samples will be analyzed, and the results will be used to assess overall analytical accuracy and precision.

6.2.1 Reagent (Method) Blanks

A reagent blank will be analyzed by the laboratory at a frequency of at least one blank per analytical batch. The reagent blank, an aliquot of analyte-free water or sand, will be carried through the entire sample preparation and analytical procedure including all clean-up procedures. The reagent blank is used to document contamination resulting from the analytical process.

6.2.2 Laboratory Control Sample/Blank Spike Analyses

The Laboratory Control Sample (LCS) or blank spike serves as a monitor of the overall performance of all steps in the analysis, including the sample preparation. LCS or blank spikes will be analyzed for each method using the same sample preparation and analytical procedures employed for the investigative samples.

6.2.3 Surrogate Analyses

Surrogates are organic compounds which are similar to the analytes of interest, but which are not normally found in environmental samples. Surrogates are added to samples to monitor the effect of the matrix on the accuracy of the analysis. Every blank, standard, and environmental sample analyzed by GC or GC/MS will be spiked with surrogate compounds prior to sample preparation. The compounds that will be used as surrogates and the levels of recommended spiking are specified in the methods. Surrogate spike recoveries must fall within the laboratory control limits. If surrogate recoveries are excessively low (<10 percent), the laboratory personnel will notify the laboratory director.

Dilution of samples to bring the analyte concentration into the linear range of calibration may dilute the surrogates out of the quantification limit. Reanalysis of these samples is not required. Assessment of analytical quality in these cases will be based on other QA/QC parameters.

6.2.4 Retention Time Window Determination

For GC analyses, determination of the target analyte retention time window will be made based on the procedure specified in the methods of analysis. Positive identification of an analyte will be made when its retention time falls within the window established during calibration.

6.2.5 Calibration Verification Standards

For ICP analyses, a calibration verification (CCV) standard is run before any samples are analyzed. The CCV is used to ensure the ICP is properly calibrated. If any elements in the CCV produce a result greater than ±20 percent of the true value, the ICP is recalibrated. A CCV standard is also run after every ten samples to ensure QA/QC.

7. Laboratory Data Reduction Procedures

QC data (e.g., laboratory duplicates, surrogates) will be compared to the method acceptance criteria. Data considered to be acceptable will be entered into the laboratory computer system. Data summaries will be sent to the laboratory coordinator for review. If approved, data will be used for generation of the treatability study report. Unacceptable data shall be appropriately qualified in the project report. Case narratives will be prepared, which will include information concerning data that fell outside acceptance limits and any other anomalous conditions encountered during sample analysis.

7.1 Data Validation

The data assessment will include a review of all technical holding times, instrument performance check sample results, initial and continuing calibration results, and all batch and matrix QC including rinse blanks, field duplicates, matrix spike/matrix spike duplicate (MS/MSD), matrix duplicates, surrogate recoveries, method blanks, LCS results, continuing and initial calibration checks, and the identification and quantitation of specific analytes of interest. Assessment of analytical and in-house data will include checks on data consistency by looking for comparability of duplicate analyses, adherence to accuracy and precision control criteria detailed in this QAPP, and anomalously high or low parameter values. The results of these data validations will be reported to the project manager and the contract laboratory, noting any discrepancies and their effect upon acceptability of the data.

Data validation reports will summarize the samples reviewed, parameters reviewed, any nonconformance with the established criteria, and validation actions (including data qualifiers). Data qualifiers will be consistent with the validation guidelines and will consist of the following:

- J - The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.
- UJ - The analyte was not detected above the sample reporting limit; however, the reporting limit is approximate.
- U - The sample was analyzed for, but was not detected above the sample reporting limit.
- R - The sample result is rejected due to serious deficiencies. The presence or absence of the analyte cannot be verified.

8. Specific Routine Procedures to Assess Data Precision, Accuracy, Representativeness, and Completeness (PARC)

The laboratory and the project QA/QC officer will evaluate data precision, accuracy, and completeness.

The purpose of this Section is to define the goals for the level of QA effort; namely, accuracy; precision and sensitivity of analyses; and completeness, representativeness, and comparability of measurement data from the analytical laboratories. QA objectives for field measurements are also discussed.

DQOs have been established to ensure that the database developed during the monitoring activities meet the objectives and quality necessary for its intended use.

8.1 Precision

8.1.1 Definition

Precision is a measure of degree to which two or more measurements are in agreement.

$$Precision = \frac{D_2 - D_1}{\frac{(D_1 + D_2)}{2}} \times 100$$

D_1 = original result

D_2 = duplicate result

8.1.2 Precision Objectives

The method(s) precision (reproducibility between duplicate analyses) will be determined based on the duplicate analysis of matrix spike samples for organic parameters and duplicate sample analyses for inorganic parameters. Precision will be reported as RPD between duplicate analyses. Sampling precision will be addressed through analysis of duplicate samples during the treatability study. Precision will be evaluated using the laboratory control limits.

8.2 Accuracy

8.2.1 Definition

Accuracy is the degree of agreement between an observed or measured value and an accepted reference or true value.

$$Accuracy = \frac{A - B}{C} \times 100$$

A = The analyte determined experimentally from the spike sample

B = The background level determined by a separate analysis of the unspiked sample

C = The amount of spike added

8.2.2 Accuracy Objectives

The method accuracy (percent recovery) for leachate and soil samples will be determined by spiking selected samples (matrix spikes) with all representative spiking compounds as specified in the analytical methods. Accuracy will be reported as the percent recovery of the spiking compound(s) and will be evaluated using the laboratory control limits.

8.3 Completeness

8.3.1 Definition

Completeness is a measure of the amount of valid (usable) data obtained from a measurement system compared to the amount that was expected to be obtained under normal conditions.

$$Completeness = \frac{usable\ data\ obtained}{total\ data\ planned} \times 100\ percent$$

8.3.2 Completeness Objective

Completeness is a measure of the amount of valid measurements obtained from all the measurements taken in the project. Laboratory completeness for this project will be 80 percent or greater.

9. Corrective Actions

Corrective action is the process of identifying, recommending, approving, and implementing measures to counter unacceptable procedures or outlying QC performance that can affect data quality and usability. Corrective actions, if necessary, will be implemented in accordance with the procedures presented below and the laboratory standard operating procedures (SOPs).

Corrective actions may be required for two classes of problems: analytical and equipment problems and noncompliance problems. Analytical and equipment problems may occur during laboratory instrumental analysis and data review.

For noncompliance problems, for example, noncompliance with United States Environmental Protection Agency (EPA) methods or QC defined in this QAPP, a formal corrective action will be implemented at the time the problem is identified. The person who identifies the problem is responsible for notifying the laboratory director.

Any nonconformance with the established QC procedures in this QAPP will be identified and corrected.

9.1 Laboratory Analysis

Corrective actions are required whenever an out-of-control event or potential out-of-control event is noted. The investigative action taken is dependent on the analysis and the event. Laboratory corrective actions may be necessary if:

i) QC data are outside the warning or acceptable windows for precision and accuracy.

ii) Blanks contain analytes of interest, as listed in Table 1 in Section 1 of this QAPP, above acceptable levels.

iii) Undesirable trends are detected in spike recoveries or RPD between duplicates.

iv) There are unusual changes in detection limits.

v) Deficiencies are detected by the laboratory QA department during internal or external audits or from the results of performance evaluation samples.

vi) Enquiries concerning data quality are received.

Corrective action procedures are often handled at the bench level by the analyst, who reviews the preparation or extraction procedure for possible errors, checks the instrument calibration, spike and calibration mixes, instrument sensitivity, and so on. If the problem persists or cannot be identified, the matter is referred to the laboratory director for further investigation.

Corrective action may include:

i) Reanalyzing the samples, if holding time criteria permits

ii) Resampling and analyzing

iii) Evaluating and amending analytical procedures

iv) Accepting data and acknowledging the level of uncertainty as documented in the laboratory data package case narrative

10. References

"RCRA Quality Assurance Project Plan Guidance", New York State Department of Environmental Conservation (NYSDEC), August 1989.

EPA. "USEPA Region II CERCLA Quality Assurance Manual", Revision 1, October 1989.

EPA. "EPA Requirements for Quality Assurance Project Plans", EPA QA/R-5, March 2001.

EPA. "USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review". USEPA 540/R-94-013, February 1994.

EPA. "Test Methods for Evaluating Solid Waste", Office of Solid Waste, USEPA, SW-846, November 1986, with updates.

New York State Department of Environmental Conservation. "Analytical Services Protocol", 10/95 edition and subsequent revisions.

EPA. "Methods for the Chemical Analysis of Water and Wastes", EPA-600/4-79-220, March 1983 (with revisions).

Uniform Federal Policy for Quality Assurance Project Plans (UFP-QAPP) EPA-505-B-04-900A, March 2005.

Appendix B-1

Analyte List and Quantitation Limits for Soil/Sediment
Final Treatability Study Work Plan
San Jacinto River Waste Pits Superfund Site
Harris County, Texas

Parameter	Units	Targeted [1] Quantitation Limits Soil/Sediment
pH	(S.U.)	n/a
Percent Solids	(%)	0.004
Volatile Organic Compounds (VOC)		
2-Butanone (Methyl Ethyl Ketone)	(µg/kg)	250
1,1-Dichloroethane	(µg/kg)	50
1,1-Dichloroethene	(µg/kg)	50
1,2-Dichlorobenzene	(µg/kg)	50
1,2-Dichloroethane	(µg/kg)	50
1,2-Dichloropropane	(µg/kg)	50
1,3-Dichlorobenzene	(µg/kg)	50
1,4-Dichlorobenzene	(µg/kg)	50
1,1,1-Trichloroethane	(µg/kg)	50
1,1,2-Trichloroethane	(µg/kg)	50
1,2,4-Trichlorobenzene	(µg/kg)	50
Benzene	(µg/kg)	50
Bromodichloromethane	(µg/kg)	50
Bromoform	(µg/kg)	50
Carbon Tetrachloride	(µg/kg)	50
Chlorobenzene	(µg/kg)	50
Chloroethane	(µg/kg)	50
Chloroform	(µg/kg)	50
cis-1,2-Dichloroethene	(µg/kg)	50
cis-1,3-Dichloropropene	(µg/kg)	50
Ethylbenzene	(µg/kg)	50
m/p-Xylenes	(µg/kg)	100
Methyl Tert Butyl Ether	(µg/kg)	50
Methylene chloride	(µg/kg)	50
o-Xylene	(µg/kg)	50
Tetrachloroethene	(µg/kg)	50
Toluene	(µg/kg)	50
trans-1,2-Dichloroethene	(µg/kg)	50
trans-1,3-Dichloropropene	(µg/kg)	50
Trichloroethene	(µg/kg)	50
Vinyl Chloride	(µg/kg)	50
Semi-Volatile Organic Compounds (SVOC)/PAHs		
1,1-Biphenyl	(µg/kg)	100
2,2'-Oxybis(2-chloropropane) (bis(2-Chloroisopropyl) ethe	(µg/kg)	100
2,4,5-Trichlorophenol	(µg/kg)	100
2,4,6-Trichlorophenol	(µg/kg)	100
2,4-Dichlorophenol	(µg/kg)	100
2,4-Dimethylphenol	(µg/kg)	100
2,4-Dinitrophenol	(µg/kg)	100

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Analyte List and Quantitation Limits for Soil/Sediment
Final Treatability Study Work Plan
San Jacinto River Waste Pits Superfund Site
Harris County, Texas

Parameter	Units	Targeted [1] Quantitation Limits Soil/Sediment
2,4-Dinitrotoluene	(µg/kg)	100
2,6-Dinitrotoluene	(µg/kg)	100
2-Chloronaphthalene	(µg/kg)	100
2-Chlorophenol	(µg/kg)	100
2-Methylnaphthalene	(µg/kg)	100
2-Methylphenol (o-Cresol)	(µg/kg)	100
3&4-Methylphenol (m/p-Cresol)	(µg/kg)	200
2-Nitroaniline	(µg/kg)	100
2-Nitrophenol	(µg/kg)	100
3,3'-Dichlorobenzidine	(µg/kg)	100
3-Nitroaniline	(µg/kg)	100
4,6-Dinitro-2-methylphenol	(µg/kg)	100
4-Bromophenyl phenyl ether	(µg/kg)	100
4-Chloro-3-methylphenol	(µg/kg)	100
4-Chloroaniline	(µg/kg)	100
4-Chlorophenyl phenyl ether	(µg/kg)	100
4-Nitroaniline	(µg/kg)	100
4-Nitrophenol	(µg/kg)	100
Acenaphthene	(µg/kg)	100
Acenaphthylene	(µg/kg)	100
Acetophenone	(µg/kg)	100
Anthracene	(µg/kg)	100
Atrazine	(µg/kg)	100
Benzaldehyde	(µg/kg)	100
Benzo(a)anthracene	(µg/kg)	100
Benzo(a)pyrene	(µg/kg)	100
Benzo(b)fluoranthene	(µg/kg)	100
Benzo(g,h,i)perylene	(µg/kg)	100
Benzo(k)fluoranthene	(µg/kg)	100
bis(2-Chloroethoxy)methane	(µg/kg)	100
bis(2-Chloroethyl)ether	(µg/kg)	100
bis(2-Ethylhexyl)phthalate (DEHP)	(µg/kg)	100
Butyl benzyl phthalate	(µg/kg)	100
Caprolactam	(µg/kg)	100
Carbazole	(µg/kg)	100
Chrysene	(µg/kg)	100
Dibenz(a,h)anthracene	(µg/kg)	100
Dibenzofuran	(µg/kg)	100
Diethyl phthalate	(µg/kg)	100
Dimethyl phthalate	(µg/kg)	100
Di-n-butylphthalate (DBP)	(µg/kg)	100
Di-n-octyl phthalate (DnOP)	(µg/kg)	100

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Analyte List and Quantitation Limits for Soil/Sediment
Final Treatability Study Work Plan
San Jacinto River Waste Pits Superfund Site
Harris County, Texas

Parameter	Units	Targeted [1] Quantitation Limits Soil/Sediment
Fluoranthene	(µg/kg)	100
Fluorene	(µg/kg)	100
Hexachlorobenzene	(µg/kg)	100
Hexachlorobutadiene	(µg/kg)	100
Hexachlorocyclopentadiene	(µg/kg)	100
Hexachloroethane	(µg/kg)	100
Indeno(1,2,3-cd)pyrene	(µg/kg)	100
Isophorone	(µg/kg)	100
Naphthalene	(µg/kg)	100
Nitrobenzene	(µg/kg)	100
N-Nitrosodi-n-propylamine	(µg/kg)	100
N-Nitrosodiphenylamine	(µg/kg)	100
Pentachlorophenol	(µg/kg)	100
Phenol	(µg/kg)	100
Phenanthrene	(µg/kg)	100
Pyrene	(µg/kg)	100
Pyridine	(µg/kg)	100
Metals		
Aluminum	(mg/kg)	4
Antimony	(mg/kg)	4
Arsenic	(mg/kg)	4
Barium	(mg/kg)	0.4
Beryllium	(mg/kg)	0.4
Cadmium	(mg/kg)	0.8
Calcium	(mg/kg)	4
Chromium	(mg/kg)	2
Cobalt	(mg/kg)	0.8
Copper	(mg/kg)	0.8
Iron	(mg/kg)	4
Lead	(mg/kg)	4
Magnesium	(mg/kg)	4
Manganese	(mg/kg)	0.8
Mercury[2]	(mg/kg)	0.1
Molybdenum	(mg/kg)	4
Nickel	(mg/kg)	0.8
Potassium	(mg/kg)	8
Selenium	(mg/kg)	2
Silver	(mg/kg)	0.2
Sodium	(mg/kg)	4
Strontium	(mg/kg)	0.4
Thallium	(mg/kg)	2
Vanadium	(mg/kg)	0.8

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Analyte List and Quantitation Limits for Soil/Sediment
Final Treatability Study Work Plan
San Jacinto River Waste Pits Superfund Site
Harris County, Texas

Parameter	Units	Targeted [1] Quantitation Limits Soil/Sediment
Zinc	(mg/kg)	2
TCLP-SVOCs/PAHs		
TCLP-1,1-Biphenyl	(µg/L)	2
TCLP-2,2'-Oxybis(2-chloropropane) (bis(2-Chloroisopropy	(µg/L)	2
TCLP-2,4,5-Trichlorophenol	(µg/L)	2
TCLP-2,4,6-Trichlorophenol	(µg/L)	2
TCLP-2,4-Dichlorophenol	(µg/L)	2
TCLP-2,4-Dimethylphenol	(µg/L)	2
TCLP-2,4-Dinitrophenol	(µg/L)	2
TCLP-2,4-Dinitrotoluene	(µg/L)	2
TCLP-2,6-Dinitrotoluene	(µg/L)	2
TCLP-2-Chloronaphthalene	(µg/L)	2
TCLP-2-Chlorophenol	(µg/L)	2
TCLP-2-Methylnaphthalene	(µg/L)	2
TCLP-2-Methylphenol (o-Cresol)	(µg/L)	2
TCLP-3&4-Methylphenol (m/p-Cresol)	(µg/L)	4
TCLP-2-Nitroaniline	(µg/L)	2
TCLP-2-Nitrophenol	(µg/L)	2
TCLP-3,3'-Dichlorobenzidine	(µg/L)	2
TCLP-3-Nitroaniline	(µg/L)	2
TCLP-4,6-Dinitro-2-methylphenol	(µg/L)	2
TCLP-4-Bromophenyl phenyl ether	(µg/L)	2
TCLP-4-Chloro-3-methylphenol	(µg/L)	2
TCLP-4-Chloroaniline	(µg/L)	2
TCLP-4-Chlorophenyl phenyl ether	(µg/L)	2
TCLP-4-Nitroaniline	(µg/L)	2
TCLP-4-Nitrophenol	(µg/L)	2
TCLP-Acenaphthene	(µg/L)	2
TCLP-Acenaphthylene	(µg/L)	2
TCLP-Acetophenone	(µg/L)	2
TCLP-Anthracene	(µg/L)	2
TCLP-Atrazine	(µg/L)	2
TCLP-Benzaldehyde	(µg/L)	2
TCLP-Benzo(a)anthracene	(µg/L)	2
TCLP-Benzo(a)pyrene	(µg/L)	2
TCLP-Benzo(b)fluoranthene	(µg/L)	2
TCLP-Benzo(g,h,i)perylene	(µg/L)	2
TCLP-Benzo(k)fluoranthene	(µg/L)	2
TCLP-bis(2-Chloroethoxy)methane	(µg/L)	2
TCLP-bis(2-Chloroethyl)ether	(µg/L)	2
TCLP-bis(2-Ethylhexyl)phthalate (DEHP)	(µg/L)	2
TCLP-Butyl benzyl phthalate	(µg/L)	2

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Analyte List and Quantitation Limits for Soil/Sediment
Final Treatability Study Work Plan
San Jacinto River Waste Pits Superfund Site
Harris County, Texas

Parameter	Units	Targeted [1] Quantitation Limits Soil/Sediment
TCLP-Caprolactam	(µg/L)	2
TCLP-Carbazole	(µg/L)	2
TCLP-Chrysene	(µg/L)	2
TCLP-Dibenz(a,h)anthracene	(µg/L)	2
TCLP-Dibenzofuran	(µg/L)	2
TCLP-Diethyl phthalate	(µg/L)	2
TCLP-Dimethyl phthalate	(µg/L)	2
TCLP-Di-n-butylphthalate (DBP)	(µg/L)	2
TCLP-Di-n-octyl phthalate (DnOP)	(µg/L)	2
TCLP-Fluoranthene	(µg/L)	2
TCLP-Fluorene	(µg/L)	2
TCLP-Hexachlorobenzene	(µg/L)	2
TCLP-Hexachlorobutadiene	(µg/L)	2
TCLP-Hexachlorocyclopentadiene	(µg/L)	2
TCLP-Hexachloroethane	(µg/L)	2
TCLP-Indeno(1,2,3-cd)pyrene	(µg/L)	2
TCLP-Isophorone	(µg/L)	2
TCLP-Naphthalene	(µg/L)	2
TCLP-Nitrobenzene	(µg/L)	2
TCLP-N-Nitrosodi-n-propylamine	(µg/L)	2
TCLP-N-Nitrosodiphenylamine	(µg/L)	2
TCLP-Pentachlorophenol	(µg/L)	2
TCLP-Phenol	(µg/L)	2
TCLP-Phenanthrene	(µg/L)	2
TCLP-Pyrene	(µg/L)	2
TCLP-Pyridine	(µg/L)	2
TCLP Metals		
TCLP-Aluminum	(µg/L)	40
TCLP-Antimony	(µg/L)	40
TCLP-Arsenic	(µg/L)	40
TCLP-Barium	(µg/L)	4
TCLP-Beryllium	(µg/L)	4
TCLP-Cadmium	(µg/L)	8
TCLP-Calcium	(µg/L)	40
TCLP-Chromium	(µg/L)	20
TCLP-Cobalt	(µg/L)	8
TCLP-Copper	(µg/L)	8
TCLP-Iron	(µg/L)	40
TCLP-Lead	(µg/L)	40
TCLP-Magnesium	(µg/L)	40
TCLP-Manganese	(µg/L)	8
TCLP-Mercury[2]	(µg/L)	0.2

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Analyte List and Quantitation Limits for Soil/Sediment
Final Treatability Study Work Plan
San Jacinto River Waste Pits Superfund Site
Harris County, Texas

Parameter	Units	Targeted [1] Quantitation Limits Soil/Sediment
TCLP-Molybdenum	(µg/L)	40
TCLP-Nickel	(µg/L)	8
TCLP-Potassium	(µg/L)	80
TCLP-Selenium	(µg/L)	20
TCLP-Silver	(µg/L)	2
TCLP-Sodium	(µg/L)	40
TCLP-Strontium	(µg/L)	4
TCLP-Thallium	(µg/L)	20
TCLP-Vanadium	(µg/L)	8
TCLP-Zinc	(µg/L)	20

Notes:

PAHs - Polycyclic Aromatic Hydrocarbons
QA/QC - Quality Assurance/Quality Control
TCLP - Toxicity Characteristic Leaching Procedure
µg/L - micrograms per Liter
mg/kg - milligrams per kilogram

[1] - Please note that these are targeted quantitation limits and are presented for guidance only. Actual quantitation limits are highly matrix dependent and may be elevated due to matrix effects, QA/QC problems, and high concentrations of target and non-target analytes.

[2] - Mercury analysis will be performed by an external laboratory. The targeted quantitation limits listed are the external laboratories' limit.

Appendix B-2

Analyte List and Quantitation Limits for Water
Final Treatability Study Work Plan
San Jacinto River Waste Pits Superfund Site
Harris County, Texas

Parameter	Units	Targeted [1] Quantitation Limits Water
pH	(S.U.)	n/a
Ammonia-Nitrogen	mg/L	1
Total Phosphorus	mg/L	0.03
Chemical Oxygen Demand	mg/L	3 mg/L
Total Organic Carbon	mg/L	15 mg/L
Total Suspended Solids	mg/L	1 mg/L
Total Dissolved Solids	mg/L	1 mg/L
Volatile Organic Compounds (VOCs)		
2-Butanone (Methyl Ethyl Ketone)	(µg/L)	10
1,1-Dichloroethane	(µg/L)	2
1,1-Dichloroethene	(µg/L)	2
1,2-Dichlorobenzene	(µg/L)	2
1,2-Dichloroethane	(µg/L)	2
1,2-Dichloropropane	(µg/L)	2
1,3-Dichlorobenzene	(µg/L)	2
1,4-Dichlorobenzene	(µg/L)	2
1,1,1-Trichloroethane	(µg/L)	2
1,1,2-Trichloroethane	(µg/L)	2
1,2,4-Trichlorobenzene	(µg/L)	2
Benzene	(µg/L)	2
Bromodichloromethane	(µg/L)	2
Bromoform	(µg/L)	2
Carbon Tetrachloride	(µg/L)	2
Chlorobenzene	(µg/L)	2
Chloroethane	(µg/L)	2
Chloroform	(µg/L)	2
cis-1,2-Dichloroethene	(µg/L)	2
cis-1,3-Dichloropropene	(µg/L)	2
Ethylbenzene	(µg/L)	2
m/p-Xylenes	(µg/L)	4
Methyl Tert Butyl Ether	(µg/L)	2
Methylene chloride	(µg/L)	2
o-Xylene	(µg/L)	2
Tetrachloroethene	(µg/L)	2
Toluene	(µg/L)	2
trans-1,2-Dichloroethene	(µg/L)	2
trans-1,3-Dichloropropene	(µg/L)	2
Trichloroethene	(µg/L)	2
Vinyl Chloride	(µg/L)	2
Semi-Volatile Organic Compounds (SVOCs)/PAH		
1,1-Biphenyl	(µg/L)	2
2,2'-Oxybis(2-chloropropane) (bis(2-Chloroisopropyl) eth	(µg/L)	2

Appendix B-2

Analyte List and Quantitation Limits for Water
Final Treatability Study Work Plan
San Jacinto River Waste Pits Superfund Site
Harris County, Texas

Parameter	Units	Targeted [1] Quantitation Limits Water
2,4,5-Trichlorophenol	(µg/L)	2
2,4,6-Trichlorophenol	(µg/L)	2
2,4-Dichlorophenol	(µg/L)	2
2,4-Dimethylphenol	(µg/L)	2
2,4-Dinitrophenol	(µg/L)	2
2,4-Dinitrotoluene	(µg/L)	2
2,6-Dinitrotoluene	(µg/L)	2
2-Chloronaphthalene	(µg/L)	2
2-Chlorophenol	(µg/L)	2
2-Methylnaphthalene	(µg/L)	2
2-Methylphenol (o-Cresol)	(µg/L)	2
3&4-Methylphenol (m/p-Cresol)	(µg/L)	4
2-Nitroaniline	(µg/L)	2
2-Nitrophenol	(µg/L)	2
3,3'-Dichlorobenzidine	(µg/L)	2
3-Nitroaniline	(µg/L)	2
4,6-Dinitro-2-methylphenol	(µg/L)	2
4-Bromophenyl phenyl ether	(µg/L)	2
4-Chloro-3-methylphenol	(µg/L)	2
4-Chloroaniline	(µg/L)	2
4-Chlorophenyl phenyl ether	(µg/L)	2
4-Nitroaniline	(µg/L)	2
4-Nitrophenol	(µg/L)	2
Acenaphthene	(µg/L)	2
Acenaphthylene	(µg/L)	2
Acetophenone	(µg/L)	2
Anthracene	(µg/L)	2
Atrazine	(µg/L)	2
Benzaldehyde	(µg/L)	2
Benzo(a)anthracene	(µg/L)	2
Benzo(a)pyrene	(µg/L)	2
Benzo(b)fluoranthene	(µg/L)	2
Benzo(g,h,i)perylene	(µg/L)	2
Benzo(k)fluoranthene	(µg/L)	2
bis(2-Chloroethoxy)methane	(µg/L)	2
bis(2-Chloroethyl)ether	(µg/L)	2
bis(2-Ethylhexyl)phthalate (DEHP)	(µg/L)	2
Butyl benzyl phthalate	(µg/L)	2
Caprolactam	(µg/L)	2
Carbazole	(µg/L)	2
Chrysene	(µg/L)	2
Dibenz(a,h)anthracene	(µg/L)	2

Appendix B-2

Analyte List and Quantitation Limits for Water
Final Treatability Study Work Plan
San Jacinto River Waste Pits Superfund Site
Harris County, Texas

Parameter	Units	Targeted [1] Quantitation Limits Water
Dibenzofuran	(µg/L)	2
Diethyl phthalate	(µg/L)	2
Dimethyl phthalate	(µg/L)	2
Di-n-butylphthalate (DBP)	(µg/L)	2
Di-n-octyl phthalate (DnOP)	(µg/L)	2
Fluoranthene	(µg/L)	2
Fluorene	(µg/L)	2
Hexachlorobenzene	(µg/L)	2
Hexachlorobutadiene	(µg/L)	2
Hexachlorocyclopentadiene	(µg/L)	2
Hexachloroethane	(µg/L)	2
Indeno(1,2,3-cd)pyrene	(µg/L)	2
Isophorone	(µg/L)	2
Naphthalene	(µg/L)	2
Nitrobenzene	(µg/L)	2
N-Nitrosodi-n-propylamine	(µg/L)	2
N-Nitrosodiphenylamine	(µg/L)	2
Pentachlorophenol	(µg/L)	2
Phenol	(µg/L)	2
Phenanthrene	(µg/L)	2
Pyrene	(µg/L)	2
Pyridine	(µg/L)	2
Metals		
Aluminum	(µg/L)	40
Antimony	(µg/L)	40
Arsenic	(µg/L)	40
Barium	(µg/L)	4
Beryllium	(µg/L)	4
Cadmium	(µg/L)	8
Calcium	(µg/L)	40
Chromium	(µg/L)	20
Cobalt	(µg/L)	8
Copper	(µg/L)	8
Iron	(µg/L)	40
Lead	(µg/L)	40
Magnesium	(µg/L)	40
Manganese	(µg/L)	8
Mercury[2]	(µg/L)	0.2
Molybdenum	(µg/L)	40
Nickel	(µg/L)	8
Potassium	(µg/L)	80
Selenium	(µg/L)	20

Appendix B-2

Analyte List and Quantitation Limits for Water
Final Treatability Study Work Plan
San Jacinto River Waste Pits Superfund Site
Harris County, Texas

Parameter	Units	Targeted [1] Quantitation Limits Water
Silver	(µg/L)	2
Sodium	(µg/L)	40
Strontium	(µg/L)	4
Thallium	(µg/L)	20
Vanadium	(µg/L)	8
Zinc	(µg/L)	20

Notes:

PAHs - Polycyclic Aromatic Hydrocarbons
QA/QC - Quality Assurance/Quality Control
µg/L - micrograms per Liter
mg/kg - milligrams per kilogram

[1] - Please note that these are targeted quantitation limits and are presented for guidance only. Actual quantitation limits are highly matrix dependent and may be elevated due to matrix effects, QA/QC problems, and high concentrations of target and non-target analytes.

[2] - Mercury analysis will be performed by an external laboratory. The targeted quantitation limits listed are the external laboratories' limit.

Exhibits

Exhibit A
Standard Operating Procedure for Bench Scale Elutriate Preparation

1. Identification of the Method

This method is for generation of an elutriate sample from solid material. This method is taken from the Standard Elutriate Preparation from Section 10.1.2.1 of the Evaluation of Dredged Material Proposed for Discharge in Waters of the United States (U.S.) - Testing Manual - Inland Testing. USEPA/USACE, February 1998

2. Applicable Matrix or Matrices

Rock, soil, sediment, sand, or clay.

3. Limits of Detection and Quantification

The applicable calibration range is limited to the calibration range of the laboratory balance used. The range is 0.01 grams (g) to 300 g. Higher values may be obtained with a different balance.

4. Scope and Application

This method is used to generate an elutriate in the laboratory from rock, soil, sediment, sand, or clay.

5. Summary of Method

This method describes the required steps to generate an elutriate in the laboratory from rock, soil, sediment, sand, or clay.

6. Interferences

- None.

7. Safety

Lab staff are required to implement the GHD Services Inc. (GHD) Safety Means Responsibility Awareness Teamwork (SMART) program as follows:

- A Job Safety Analysis (JSA) for each task has been reviewed, modified for the specific Site conditions, and communicated to all appropriate personnel.

- Incorporate Stop Work Authority; Stop, Think, Act, Review (STAR) process; Safe Task Evaluation Process (STEP); Observations process; Near Loss and incident Management process in the day-to-day operations of the job.
- Review and implement applicable sections of the GHD Safety and Health Policy Manual.
- Be prepared for emergency situations, locating safety showers, fire protection equipment, evacuation route, rally point, and first aid equipment before being working, and make sure that the equipment is in good working order.
- Each staff member should review the Laboratory Chemical Hygiene Plan and take the Laboratory Safety Training annually.
- Be prepared to call the GHD Incident Hotline at 1 (866) 529-4886 for all involving injury/illness, property damage, vehicle incident, and/or significant Near Loss.
- It is the responsibility of the Project Manager to ensure that all GHD personnel have received the appropriate health and safety and laboratory training and are qualified to complete the work.

8. Equipment and Supplies

8.1 Personal Protective Equipment

- Safety Glasses.
- Closed toed shoes.
- Nitrile gloves.
- Lab coat.

8.2 Test Equipment and Supplies

- Sample of rock, soil, sediment, sand or clay.
- 2 or 4-liter (L) beakers.
- Magnetic stir plates.
- Magnetic stir bars.
- Balance.
- Weight paper.
- Graduated cylinders.
- Tubing for syphon.

Bottles and preservatives for analytical samples.

9. Reagents and Standards

- None.

10. Quality Control (QC)

Data generated with QC samples (calibrated weights for the laboratory balance) that fall within the prescribed acceptance limits indicated the test method was in control. The acceptance limits for this Standard Operating Procedures (SOP) are +/- 0.01 g. When the weight falls outside of the accepted limits, the test method is out-of-control. The out-of-control data is considered suspect and the corresponding samples are reanalyzed. If the samples cannot be reanalyzed, then the results are reported with qualifiers (or flags) in the report.

A QC program should be developed on a project specific basis.

11. Calibration and Standardization

11.1 Calibrating the Laboratory Balance

1. Make sure all doors are fully closed, and then zero the balance without a weight by hitting the rezero button.
2. Press and hold the rezero button on the balance until CAL appears on the display then release the button.
3. When the display reads CAL 0, press the rezero button - the display will read CAL 200.
4. Slide the door of the balance open, place a 200 g calibrated weight on the balance using the supplied glove.
5. Close the side door and press the rezero button - the display will then read CAL End.
6. Place calibration weight back into the storage case.
7. The calibration process is then checked with 3 different calibration weights to check the linearity of the calibration.
8. If the linearity of the calibration is in the acceptable range, the results are recorded and the calibration is noted in the daily balance check logbook.

12. Procedure

1. Combine rock, soil, sediment, sand or clay with unfiltered water from the site in a ratio of 1:4 on a volume basis at room temperature. This is best accomplished by volumetric displacement.
2. Stir mixture vigorously for 30 minutes with a mechanical or magnetic stirrer.

3. At 10 minute intervals, the mixture is also stirred manually to ensure complete mixing.
4. After the 30 minute mixing period, allow the mixture to settle for 1 hour.
5. After 1 hour, syphon off the supernatant without disturbing the settled solids.
6. Centrifuge the supernatant at 2,000 revolutions per minute (rpm) for 30 minutes to remove any visible particulate.
7. Bottle and preserved the supernatant as necessary for chemical analyses.

13. Data Analysis and Calculations

See relevant EPA methods.

14. Method Performance

Laboratory Balances - Data generated with QC samples (calibrated weights for the laboratory balance) that fall within the prescribed acceptance limits indicated the test method was in control. The acceptance limits for this SOP are +/- 0.01 g.

15. Pollution Prevention

Any leftover samples will be disposed of into the correct waste container. All glassware will be rinsed into the correct waste container. The waste containers will be disposed of by a waste disposal company upon completion of the project.

Exhibit B
Standard Operating Procedure for Bench Scale Solidification Testing

1. Identification of the Method

This method is used to set up a solidification test. This test involves the addition of stabilization agents to a soil, sediment, sand, or clay. This test is analyzed in the laboratory.

2. Applicable Matrix or Matrices

Soil, sediment, sand, or clay.

3. Limits of Detection and Quantification

The applicable calibration range is limited to the calibration range of the laboratory balance used. The range is 0.01 grams (g) to 300 g. Higher values may be obtained with a different balance.

4. Scope and Application

This method is used to set up a solidification in the laboratory using soil, sediment, sand, or clay.

5. Summary of Method

This method describes the required steps to set up a solidification in the laboratory.

6. Definitions

Not Applicable.

7. Interferences

None.

8. Safety

Lab staff are required to implement the GHD Services Inc. (GHD) Safety Means Responsibility Awareness Teamwork (SMART) program as follows:

- A Job Safety Analysis (JSA) for each task has been reviewed, modified for the specific Site conditions, and communicated to all appropriate personnel.

- Incorporate Stop Work Authority; Stop, Think, Act, Review (STAR) process; Safe Task Evaluation Process (STEP); Observations process; Near Loss and incident Management process in the day-to-day operations of the job.
- Review and implement applicable sections of the GHD Safety and Health Policy Manual.
- Be prepared for emergency situations, locating safety showers, fire protection equipment, evacuation route, rally point, and first aid equipment before being working, and make sure that the equipment is in good working order.
- Each staff member should review the Laboratory Chemical Hygiene Plan and take the Laboratory Safety Training annually.
- Be prepared to call the GHD Incident Hotline at 1 (866) 529-4886 for all involving injury/illness, property damage, vehicle incident, and/or significant Near Loss.
- It is the responsibility of the Project Manager to ensure that all GHD personnel have received the appropriate health and safety and laboratory training and are qualified to complete the work.

9. Equipment and Supplies

9.1 Personal Protective Equipment

- Safety Glasses.
- Closed toed shoes.
- Nitrile gloves.
- Lab coat.

9.2 Test Equipment and Supplies

- Gas Chromatograph / Mass Spectrograph (GC/MS) and GC.
- Inductively Coupled Plasma (ICP).
- Soil Sample.
- Mechanical Mixer.
- Mechanical Mixing Bowl.
- Solidification reagents.
- Balance.
- Weight Paper.
- Deionized (DI) Water-if sample is very dry.
- Plastic or Glass Molds.
- Spoons.
- Paper Towels.

- Cooler to store samples in.

10. Reagents and Standards

- Portland Cement.
- Cement Kiln Dust.
- Fly Ash.
- Lime.
- Other reagents-project specific.

11. Sample Collection, Preservation, Shipment, and Storage

11.1 Samples Containing Volatile Organic Compounds (VOCs)

Water samples can be collected in glass one gallon jugs. The containers should be thoroughly rinsed before placing sample in. Samples should be stored at 4°Celcius (C). Microcosms should be stored at room temperature and analyzed at intervals determined by project scope.

Soil samples can be collected in glass one gallon jars or plastic bags. The containers should be thoroughly rinsed before placing sample in. Samples should be stored at 4°C. Microcosms should be stored at room temperature and analyzed at intervals determined by project scope.

11.2 Samples Containing Semi-Volatile Organic Compounds (SVOCs)

Water samples can be collected in glass one gallon jugs. The containers should be thoroughly rinsed before placing sample in. Samples should be stored at 4°C. Microcosms should be stored at room temperature and analyzed at intervals determined by project scope.

Soil samples can be collected in glass one gallon sized jars or plastic bags. The containers should be thoroughly rinsed before placing sample in. Samples should be stored at 4°C. Microcosms should be stored at room temperature and analyzed at intervals determined by project scope.

11.3 Samples Containing Metals

Water samples for total metals can be collected in glass one gallon jugs and preserved with nitric acid (HNO_3) to pH below 2. The containers should be thoroughly rinsed before placing sample in. Samples should be stored at 4°C and analyzed at intervals determined by the project.

Water samples for dissolved metals can be collected in glass one gallon jugs. The containers should be thoroughly rinsed before placing sample in. Samples should be stored at 4°C and analyzed at intervals determined by the project.

Soil samples can be collected in glass one gallon jars or plastic bags. The containers should be thoroughly rinsed before placing sample in. Samples should be stored at 4°C and analyzed at intervals determined by the project.

12. Quality Control (QC)

Data generated with QC samples (calibrated weights for the laboratory balance) that fall within the prescribed acceptance limits indicated the test method was in control. The acceptance limits for this SOP are +/- 0.01 g. When the weight falls outside of the accepted limits, the test method is out-of-control. The out-of-control data is considered suspect and the corresponding samples are reanalyzed. If the samples cannot be reanalyzed, then the results are reported with qualifiers (or flags) in the report.

A QC program should be developed on a project specific basis.

13. Calibration and Standardization

13.1 Calibrating the Laboratory Balance

1. Make sure all doors are fully closed, and then zero the balance without a weight by hitting the rezero button.
2. Press and hold the rezero button on the balance until CAL appears on the display then release the button.
3. When the display reads CAL 0, press the rezero button - the display will read CAL 200.
4. Slide the door of the balance open, place a 200 g calibrated weight on the balance using the supplied glove.
5. Close the side door and press the rezero button - the display will then read CAL End.
6. Place calibration weight back into the storage case.
7. The calibration process is then checked with 3 different calibration weights to check the linearity of the calibration.
8. If the linearity of the calibration is in the acceptable range, the results are recorded and the calibration is noted in the daily balance check logbook.

14. Procedure

1. Place mechanical mixer, bowl, spoons, and balance into the hood.
2. Measure out desired amount of soil into the bowl and put the bowl on the mixer.
3. Add the required solidification reagents-the amount and type of reagents are all project dependent.

4. If the sample is too dry, add some DI Water/Site water-just a little and record the amount that is added.
5. Once the sample is mixed well (usually mix for about 5 minutes), put the sample into the plastic or glass mold, depending on what type of contaminates are present.
6. Put the mold into a cooler so it is in a dark, humid environment.
7. Repeat steps for every sample-cleaning the bowl and spoons in between samples.
8. After incubation period, measure the compressive strength with the Pocket Penetrometer:
    a. Remove pocket penetrometer from the box along with the foot and wrench to attach foot.
    b. Make sure the red ring on the scale part of the penetrometer is pushed all the way to the bottom of the scale (bottom of handle).
    c. Place penetrometer on top of sample and press down on it until the tip of the penetrometer is pushed into the soil up to the mark:
        i. If penetrometer pushes through the sample without moving the ring, use the foot.
        ii. Place the foot on the tip of the penetrometer and tighten with wrench.
        iii. Put penetrometer back on top of soil and push down.
        iv. Record the number on top of the ring and divide by 16.
        v. Rinse foot off before using again.
9. Read the number on top of the ring and record.
10. Push the ring back to the top, rinse-off tip and repeat for each sample.
11. When putting the data into the table, be sure to convert the reading from kilograms per centimeter squared (km/cm^2) to pounds per square inch (psi).
12. At the end of the incubation period the sample can be analyzed for paint filter and/or unconfined compressive strength, as required by the project.
13. Leach tests can also be performed, if relevant.
14. Clean everything with the correct solvents into the correct waste contains.
15. Put all materials away.

15. Data Analysis and Calculations

See relevant United States Environmental Protection Act (EPA) methods.

16. Method Performance

Laboratory Balances - Data generated with QC samples (calibrated weights for the laboratory balance) that fall within the prescribed acceptance limits indicated the test method was in control. The acceptance limits for this SOP are +/- 0.01 g.

17. Pollution Prevention

Any leftover samples will be disposed of into the correct waste container. All glassware will be rinsed into the correct waste container. The waste containers will be disposed of by a waste disposal company upon completion of the project.

18. Data Assessment and Acceptance Criteria for QC Measures

Refer to Section 12 of this SOP.

19. Corrective Actions for Out-of-Control Data or Unaccepted Data

Refer to Section 12 of this SOP.

20. Contingencies for Handling Out-of-Control Data

Refer to Section 12 of this SOP.

21. Waste Management

Refer to Section 17 of this SOP.

Exhibit C
Standard Operating Procedure for Bench Scale Hardness Measurement Procedure

1. Identification of the Method

This method is for the measurement of hardness using the ELE International 29-3729 Pocket Penetrometer.

2. Applicable Matrix or Matrices

Soil, sediment sand.

3. Limits of Detection and Quantification

0.016 tons per square foot.

4. Scope and Application

This method is used measure the hardness of solidified or untreated soil, sediment or sand.

5. Summary of Method

This method describes the use of a pocket penetrometer to measure hardness.

6. Interferences

- The presence of small rocks or heterogeneities in the samples to be measured.

7. Safety

Lab staff are required to implement the GHD Services Inc. (GHD) Safety Means Responsibility Awareness Teamwork (SMART) program as follows:

- A Job Safety Analysis (JSA) for each task has been reviewed, modified for the specific Site conditions, and communicated to all appropriate personnel.
- Incorporate Stop Work Authority; Stop, Think, Act, Review (STAR) process; Safe Task Evaluation Process (STEP); Observations process; Near Loss and incident Management process in the day-to-day operations of the job.
- Review and implement applicable sections of the GHD Safety and Health Policy Manual.

- Be prepared for emergency situations, locating safety showers, fire protection equipment, evacuation route, rally point, and first aid equipment before being working, and make sure that the equipment is in good working order.
- Each staff member should review the Laboratory Chemical Hygiene Plan and take the Laboratory Safety Training annually.
- Be prepared to call the GHD Incident Hotline at 1 (866) 529-4886 for all involving injury/illness, property damage, vehicle incident, and/or significant Near Loss.
- It is the responsibility of the Project Manager to ensure that all GHD personnel have received the appropriate health and safety and laboratory training and are qualified to complete the work.

8. Equipment and Supplies

8.1 Personal Protective Equipment

- Safety Glasses.
- Closed toed shoes.
- Nitrile gloves.
- Lab coat.

8.2 Test Equipment and Supplies

- Soil/sand/sediment sample.
- ELE International 29-3929 Pocket Penetrometer.
- ELE International 29-3929/10 Pocket Penetrometer Adapter Foot.

9. Reagents and Standards

- None.

10. Quality Control (QC)

Several readings will be taken and outliers will be discarded.

11. Procedure

1. Slide the red ring on the barrel of the Penetrometer down against the instrument handle.
2. Hold the Penetrometer at right angled so the surface being tested.

3. Grip the knurled portion of the handle and push the tip of the Penetrometer into the soil to the groove located ¼ inch from the tip.
4. Read the hardness directly in tons per square foot (TSF) of kilograms per square centimeter (kg/cm^2) from the scale.
5. The reading is located on the lower side of the red ring - side closest to the knurled handle.
6. If soil is too soft for above procedure use adapter foot.
7. Mount the adapter food by unscrewing the fixing screw on the adapter foot and slipping the adapter foot onto the penetrometer piston as far as it can go and tightening the fixing screw.
8. Slide the red ring on the barrel of the Penetrometer down against the instrument handle.
9. Hold the Penetrometer at right angled so the surface being tested.
10. Grip the knurled portion of the handle and push piston with steady pressure into the soil (test material) up to the full ¼ inch thickness of the adaptor foot.
11. Take the readings in tons per square foot or kilograms per square centimeter on the low load side of the red ring. Divide it by 16 to get the hardness of the test material.

12. Data Analysis and Calculations

If adapter foot is used, divide the hardness by 16 to get the hardness of the test material in tons per square foot or kilograms per square centimeter.

13. Pollution Prevention

Any leftover samples will be disposed of into the correct waste container. All glassware will be rinsed into the correct waste container. The waste containers will be disposed of by a waste disposal company upon completion of the project.

Exhibit D
Standard Operating Procedure for Bench Scale Water Jar Testing

1. Identification of the Method

This method is used to set up perform bench scale jar testing. This testing will take place in the laboratory.

2. Applicable Matrix or Matrices

- Drinking, ground, surface, or saline water.

3. Limits of Detection and Quantification

Not Applicable.

4. Scope and Application

- This method is used to perform bench scale jar testing in the laboratory on drinking, ground, surface, or salne water to determine parameters for removal of dissolved and suspended metals and suspended solids from the water. Metals are precipitated by an organosulfide compound and/or by ferric chloride and then suspended metals and other suspended solids are coagulated and removed by the ferric chloride coagulant and/or a polymer.

5. Summary of Method

This method describes the required steps to perform the bench scale jar testing in the laboratory.

6. Definitions

Not Applicable.

7. Interferences

- Extremely high concentrations of contaminants.
- The sample pH.

8. Safety

Lab staff are required to implement the GHD Service Inc. (GHD) Safety Means Responsibility Awareness Teamwork (SMART) program as follows:

- A Job Safety Analysis (JSA) for each task has been reviewed, modified for the specific Site conditions, and communicated to all appropriate personnel.
- Incorporate Stop Work Authority; Stop, Think, Act, Review (STAR) process; Safe Task Evaluation Process (STEP); Observations process; Near Loss and incident Management process in the day-to-day operations of the job.
- Review and implement applicable sections of the GHD Safety and Health Policy Manual.
- Be prepared for emergency situations, locating safety showers, fire protection equipment, evacuation route, rally point, and first aid equipment before being working, and make sure that the equipment is in good working order.
- Each staff member should review the Laboratory Chemical Hygiene Plan and take the Laboratory Safety Training, annually.
- Be prepared to call the GHD Incident Hotline at 1 (866) 529-4886 for all involving injury/illness, property damage, vehicle incident, and/or significant Near Loss.
- It is the responsibility of the Project Manager to ensure that all GHD personnel have received the appropriate health and safety and laboratory training and are qualified to complete the work.

9. Equipment and Supplies

9.1 Personal Protective Equipment

- Safety Glasses.
- Closed Toed Shoes.
- Nitrile Gloves.
- Lab Coat.

9.2 Test Equipment and Supplies

- Jar Testing Paddle Mixer.
- Sample Beakers.
- Water Sample.
- Disposable Plastic Syringes.
- Plastic Bottles.
- Glass Sample Bottles and Vials.
- Vacuum Filtration Flask.

- Glass Fiber Filters.
- Stopwatch.
- Paper Towels.
- Thermometer.
- Camera.

10. Reagents and Standards

- Organosulfide reagent(s).
- Ferric Chloride.

Polymers to be tested may include the following:

- Nalco Coreshel 71301.
- Nalco Coreshel 71303.
- Nalco Coreshel 71315.
- Nalco Nalclear 7767.
- Nalco Nalclear 7768.
- Nalco 7194 Plus.

11. Sample Collection, Preservation, Shipment, and Storage

11.1 Samples containing Volatile Organic Compounds (VOCs)

Water samples can be collected in metal drums. The containers should be thoroughly rinsed before placing sample in. Samples should be stored at 4°Celcius (C) and analyzed at intervals determined by the project.

11.2 Samples containing Semi Volatile Organic Compounds (SVOCs)

Water samples can be collected in metal drums. The containers should be thoroughly rinsed before placing sample in. Samples should be stored at 4°C and analyzed at intervals determined by the project.

11.3 Samples containing Pesticides

Water samples can be collected in metal drums. The containers should be thoroughly rinsed before placing sample in. Samples should be stored at 4°C and analyzed at intervals determined by the project.

11.4 Samples containing Polychlorinated Biphenyls

Water samples can be collected in metal drums. The containers should be thoroughly rinsed before placing sample in. Samples should be stored at 4°C and analyzed at intervals determined by the project.

11.5 Samples containing Metals

Water samples can be collected in poly drums. The containers should be thoroughly rinsed before placing sample in. Samples should be stored at 4°C and analyzed at intervals determined by the project.

12. Procedure

1. Prepare stock solutions for each of the organosulfide reagent and coagulants/polymers according to vendor specifications.
2. 3 doses of each organosulfide reagent will be tested to determine the optimum dose for metals precipitation.
3. Prepare 100 milliliter (mL) bottles with water that has previously been treated for ferrous iron treat each bottle with a different dose of organosulfide reagent. Allow the reagent to react for 20 minutes and then filter the water and analyze for dissolved metals.
4. Set up the Phipps and Bird 6 paddle jar testing mixer.
5. Place 500 mL of water sample into four separate 600 mL beakers.
6. Three different doses of ferric chloride/polymer will be tested along with an untreated beaker containing the water only which will be used as a reference.
7. The beakers will be mixed for 2 minutes using a mechanical mixer at 100 revolutions per minute (rpm) for mixtures with coagulant(s) only and 45 rpm for mixtures with a polymer only. For mixtures containing coagulant(s) and polymer, the coagulant will be added and mixed at 100 rpm for 2 minutes, the polymer will be added and the mixing rate will be reduced to 45 rpm and mixed for 15 minutes. The mixtures will be allowed to settle for 5 minutes.
8. During the flocculation and settling the beakers will be observed. The samples that exhibit best flocculation and settling could be subject to further dose optimization.
9. Supernatant water will be analyzed for pertinent parameters.

13. Method Performance

Not Applicable.

14. Pollution Prevention

Any leftover samples will be disposed of into the correct waste container. All glassware will be rinsed into the correct waste container. The waste containers will be disposed of by a waste disposal company upon completion of the project.

15. Waste Management

Refer to Section 14 of this Standard Operating Procedures (SOP).

16. Tables, Diagram, Flowcharts, and Validation Data

Not Applicable.

Exhibit E
Standard Operating Procedure for Bench Scale Sequential Filtration Testing

1. Identification of the Method

This method is for sequential filtration of water to determine the particle size of particles associated with a contaminant. In this case the water will be analyzed for polychlorinated dibenzodioxins and polychlorinated dibenzofurans (PCDD/PCDF).

2. Applicable Matrix or Matrices

Groundwater, surface water or wastewater.

3. Limits of Detection and Quantification

Detection limit of analytical method used for the analysis of the contaminant of concern. Analysis for PCDD/PCDF will be performed by an outside laboratory.

4. Scope and Application

This method is used to identify the particle size associated with a contaminant of concern.

5. Summary of Method

This method describes the use of a series of filters of different sizes to filter a water sample. After each filtration step the water is sampled and analyzed to determine the effect of filtration on the concentration of a contaminant of concern.

6. Interferences

- Matrix interferences with the analytical method.

7. Safety

Lab staff are required to implement the GHD Services Inc. (GHD) Safety Means Responsibility Awareness Teamwork (SMART) program as follows:

- A Job Safety Analysis (JSA) for each task has been reviewed, modified for the specific site conditions, and communicated to all appropriate personnel.
- Incorporate Stop Work Authority; Stop, Think, Act, Review (STAR) process; Safe Task Evaluation Process (STEP); Observations process; Near Loss and incident Management process in the day-to-day operations of the job.

- Review and implement applicable sections of the GHD Safety and Health Policy Manual.
- Be prepared for emergency situations, locating safety showers, fire protection equipment, evacuation route, rally point, and first aid equipment before being working, and make sure that the equipment is in good working order.
- Each staff member should review the Laboratory Chemical Hygiene Plan and take the Laboratory Safety Training annually.
- Be prepared to call the GHD Incident Hotline at 1 (866) 529-4886 for all involving injury/illness, property damage, vehicle incident, and/or significant Near Loss.
- It is the responsibility of the Project Manager to ensure that all GHD personnel have received the appropriate health and safety and laboratory training and are qualified to complete the work.

8. Equipment and Supplies:

8.1 Personal Protective Equipment

- Safety Glasses.
- Closed toed shoes.
- Nitrile gloves.
- Lab coat.

8.2 Test Equipment and Supplies

- Water sample.
- Vacuum filtration apparatus.
- Filter paper with pore sizes ranging from 0.1 micrometers (µm) to 100 µm.
- Bottle and preservatives for analytical testing.

9. Reagents and Standards

- None.

10. Quality Control (QC)

QC will be associated with the analytical methods used by an outside analytical lab.

11. Procedure

1. Determine the volume of water required based on the volume required for the analytical testing and the number of filters to be used.
2. Place the filter with the largest pore size on the filtration apparatus.
3. Filter all of the water through this filter.
4. Remove a sample of the filtrate water and preserve and bottle as required for analytical testing.
5. Place the filter with the next largest pore size on the filtration apparatus.
6. Filter the remaining sample through this filter.
7. Remove a sample of the filtrate water and preserve and bottle as required for analytical testing.
8. Repeat filtration and sampling steps until all filters have been used.
9. Send the bottled, preserved samples for analysis at an outside lab.

12. Data Analysis and Calculations

None.

13. Pollution Prevention

Any leftover samples will be disposed of into the correct waste container. All glassware will be rinsed into the correct waste container. The waste containers will be disposed of by a waste disposal company upon completion of the project.

about GHD

GHD is one of the world's leading professional services companies operating in the global markets of water, energy and resources, environment, property and buildings, and transportation. We provide engineering, environmental, and construction services to private and public sector clients.

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