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ENHANCED NATURAL ATTENUATION TREATABILITY STUDY WORK PLAN FOR UNDERGROUND STORAGE TANK 26 NAS PENSACOLA FL

7/1/2002

TETRA TECH

Enhanced Natural Attenuation Treatability Study Work Plan

for

UST Site 26

Naval Air Station Pensacola

Pensacola, Florida

Southern Division
Naval Facilities Engineering Command

Contract Number N62467-94-D-0888
Contract Task Order 0241

July 2002

02JAX0166

TREATABILITY STUDY WORK PLAN
FOR
UST SITE 26

NAVAL AIR STATION PENSACOLA
PENSACOLA, FLORIDA

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

Submitted to:
Southern Division
Naval Facilities Engineering Command
2155 Eagle Drive
North Charleston, South Carolina 29406

Submitted by:
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CONTRACT NUMBER N62467-94-D-0888
CONTRACT TASK ORDER 0241

JULY 2002

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The professional opinions rendered in this decision document identified as Enhanced Natural Attenuation Treatability Study Work Plan for Underground Storage Tank Site 26, Naval Air Station Pensacola, Pensacola, Florida were developed in accordance with commonly accepted procedures consistent with applicable standards of practice. This document was prepared under the supervision of the signing engineer and is based on information obtained from others. If conditions are determined to exist differently than those described in this document, then the undersigned professional engineer should be notified to evaluate the effects of any additional information on the project described in this document.

7/16/02

Gregory S. Root, P.E.
Professional Engineering Number 50842
Tetra Tech NUS, Inc. Engineering No. 7986

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ACRONYMS

bls	Below Land Surface
°C	Degrees Celsius
CLEAN	Comprehensive Long-term Environmental Action Navy
CompQAP	Comprehensive Quality Assurance Plan
DPT	Direct Push Technology
FAC	Florida Administrative Code
FDEP	Florida Department of Environmental Protection
FOL	Field Operations Leader
ft	Feet/Foot
GCTLs	Groundwater Cleanup Target Levels
HASP	Health and Safety Plan
HCl	Hydrochloric Acid
HDPE	High Density Polyethylene
HSM	Health and Safety Manager
IDW	Investigation-Derived Waste
µg/L	Micrograms per Liter
Mg/O_2	Magnesium Peroxide
ml	Milliliter
$Mg(OH)_2$	Magnesium Hydroxide
MSDS	Material Safety Data Sheet
NA	Not Analyzed
NADC	Natural Attenuation Default Concentration
NAS	Naval Air Station
Navy	United States Navy
ORC®	Oxygen Releasing Compounds
ORP	Oxidation-Reduction Potential
PPE	Personal Protective Equipment
QA	Quality Assurance
QC	Quality Control
RPM	Remedial Project Manager
SAR	Site Assessment Report
SC	Specific Conductance
SOPs	Standard Operating Procedures
SOUTHNAVFACENGCOM	Southern Division, Naval Facilities Engineering Command
TOC	Total Organic Carbon

ACRONYMS

TtNUS	Tetra Tech NUS, Inc.
USEPA	United States Environmental Protection Agency
UST	Underground Storage Tank
UST 26	UST Site 26
VOCs	Volatile Organic Compounds

1.0 INTRODUCTION

This Enhanced Natural Attenuation Treatability Study Work Plan has been prepared by Tetra Tech NUS, Inc. (TtNUS) under the Comprehensive Long-term Environmental Action Navy (CLEAN) Contract Number N62467-94-D-0888 Contract Task Order 0241. This work plan has been prepared to develop an application and testing methodology to evaluate if enhanced natural attenuation is an appropriate remedial technology for Underground Storage Tank (UST) Site 26 (UST 26) – Refueler Repair Shop at Naval Air Station (NAS) Pensacola, Pensacola, Florida. The scope of this Treatability Study is limited to the documented groundwater contamination that had been previously identified at this site.

The purpose of this Treatability Study is to determine if the application of Oxygen Releasing Compounds (ORC®) can significantly reduce petroleum impacted groundwater. This work plan incorporates data presented in the Site Assessment Report (SAR) (Ensafe, 1998) and the Initial Semi-annual Groundwater Monitoring for Natural Attenuation Letter Report: UST 26 (TtNUS, 2001).

1.1 DOCUMENT ORGANIZATION

Section 1.0 of this report presents this introduction, a detailed site description, the project scope, and project goals. Section 2.0 describes the proposed field investigation activities. Section 3.0 describes the environmental sampling and analysis activities. Section 4.0 describes management aspects of the project such as management structure, reporting requirements, and quality assurance (QA) activities. ORC® Material Safety Data Sheets (MSDS) and the manufacturer-provided ORC® mixing and injection instructions are included in Appendices A and B, respectively.

1.2 SITE DESCRIPTION

UST 26 is located southwest of the intersection of John Tower Road and Taylor Road near the approximate center of the installation as shown in Figure 1-1, Site Location Map, and Figure 1-2, UST 26 Vicinity Map. Crushed oyster shell, hard-packed gravel or soil, and weedy vegetation largely cover this irregularly shaped site, an approximately 300- by 400-foot (ft) open area. The site's southwestern edge is paved and Building 1659 occupies its southwest corner. The site is currently used for equipment and vehicle parking. A large waste debris pile is located near the center of the site. The debris is comprised of discolored sand and silt with abundant woody organic material. UST 26 is generally flat with a land surface elevation averaging 29 ft above mean sea level (Ensafe, 1998).

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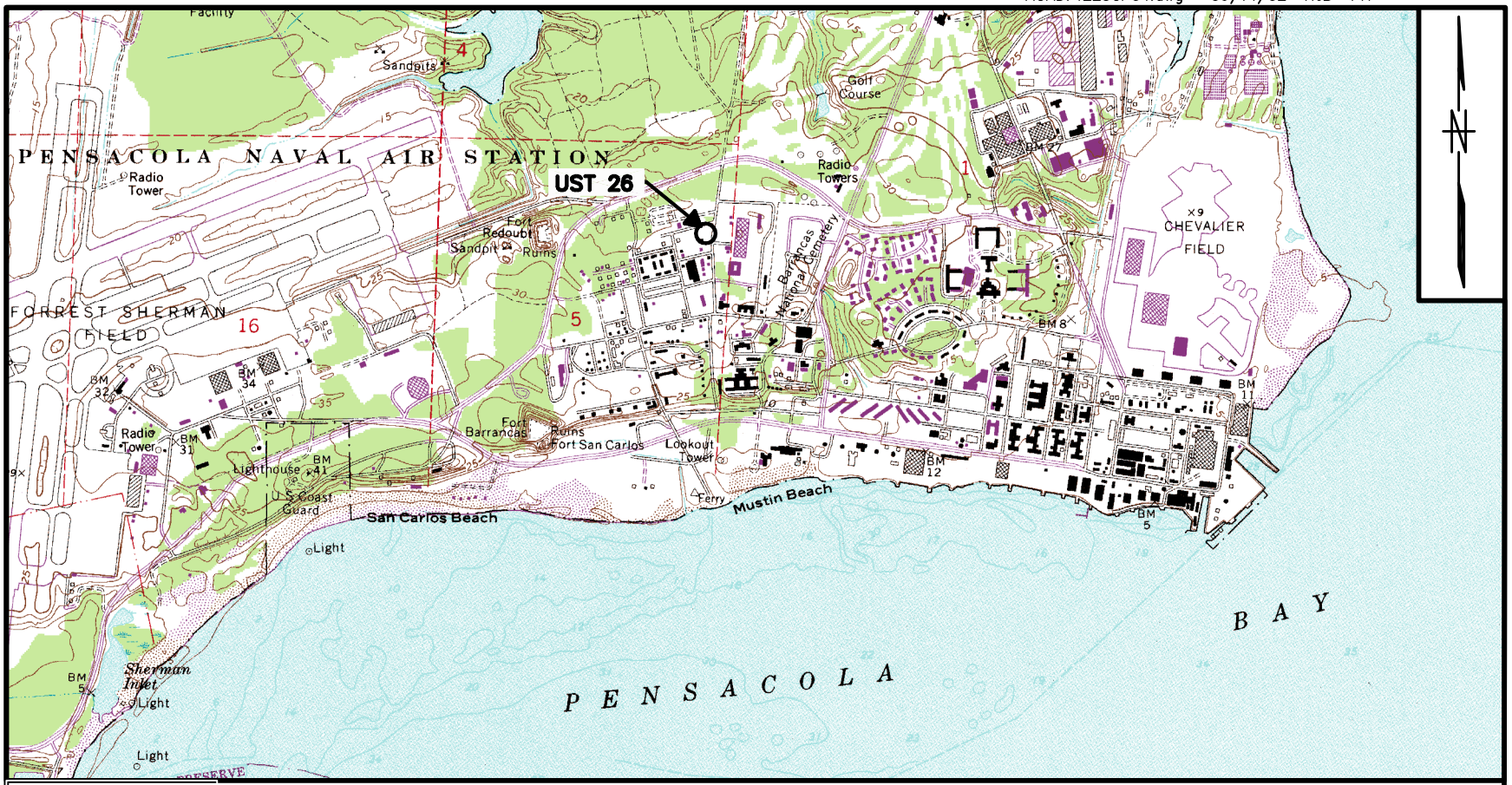

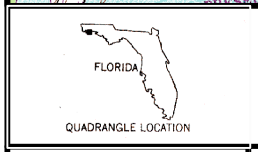

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SOURCE: U.S.G.S. TOPOGRAPHIC QUADRANGLE FORT BARRANCAS, FLORIDA (1970 EDITION–PHOTOREVISED 1987).

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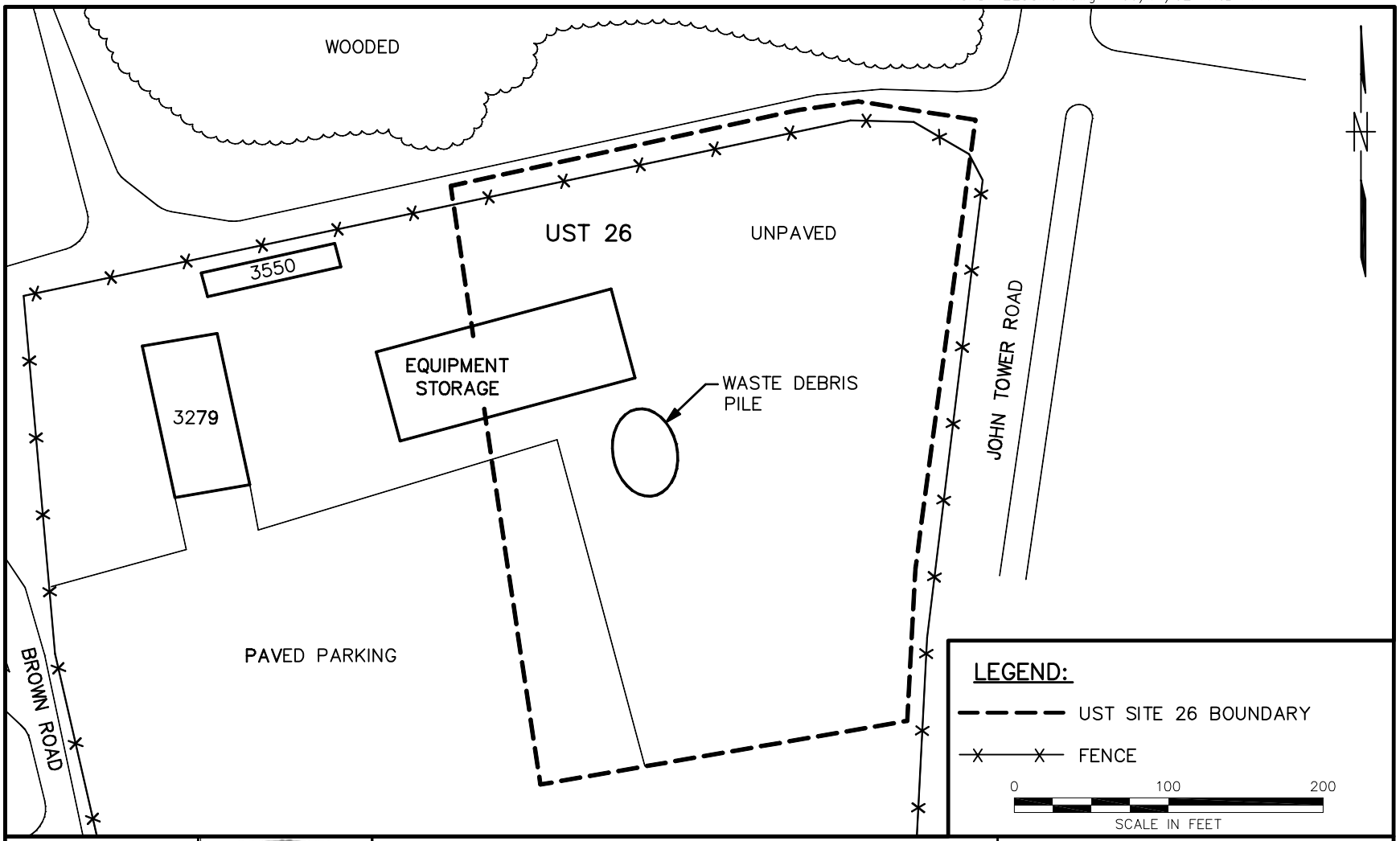

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1.2.1 Site Operations and History

UST 26 is the location of the Refueler Repair Shop at NAS Pensacola, Pensacola, Florida. The site history indicated that petroleum fuel might have been released in the past as refueling trucks underwent repair. During the initial assessment of the site, aerial photographs were reviewed and indicated that the site use as an equipment storage and vehicle parking area for Public Works Center has not changed since the 1960's. A SAR was completed for the site on October 30, 1998. The conclusion of the SAR recommended a Natural Attenuation Monitoring Plan for the site with monitoring wells GS01, GS10, and GS12 being sampled for volatile organic compounds (VOCs) semi-annually for a period of one year. In a letter report dated October 3, 2001, TtNUS reported the results of the initial semi-annual groundwater monitoring event for natural attenuation. Results of the initial groundwater monitoring event indicated that detected concentrations of benzene exceeded the Florida Department of Environmental Protection (FDEP) Natural Attenuation Default Concentration (NADC). Subsequently, TtNUS recommended that a Treatability Study be completed at the site with the injection of ORC® for enhanced natural attenuation.

1.2.2 Site Investigation Summary

The following reports have previously been prepared to investigate contamination resulting from the operations at the site and were extensively used in the development of this Treatability Study Work Plan:

SAR for UST 26, NAS Pensacola, Pensacola, Florida (Ensafe, 1998). This investigation was initiated in 1997 when the NAS Pensacola Partnering Team decided that because only petroleum-related constituents were present, the site would be transitioned to the petroleum program. The SAR reported the chemical analysis of soil and groundwater samples collected during site assessment activities. The SAR concluded that contaminated groundwater [benzene concentrations of 95 to 125 micrograms per liter (µg/L)] was not moving off site and was limited vertically to the upper surficial zone of the sand and gravel aquifer. Soil samples indicated little residual petroleum mass that could serve as a continuing source of contamination. The chemical analysis of groundwater samples indicated that the plume was degrading through natural processes. Thus, a monitoring-only proposal was prepared with groundwater samples to be taken semi-annually from monitoring wells GS01, GS10, and GS12 and tested for VOCs. On-site temporary wells were to be properly abandoned and permanent wells were to be installed at recommended monitoring locations.

Initial Semi-annual Groundwater Monitoring for Natural Attenuation Letter Report: UST 26, NAS Pensacola, Pensacola, Florida (TtNUS, 2001). This letter report presented the results of the initial semi-annual groundwater-monitoring event for natural attenuation completed by TtNUS as recommended in the FDEP-approved SAR completed by Ensafe on October 30, 1998. The FDEP-approved the Natural Attenuation Monitoring Plan, which proposed that monitoring wells GS01, GS10, and GS12 be sampled

for VOCs semi-annually for a period of one year. On May 15, 2001, three permanent micro wells were installed adjacent to temporary monitoring wells GS01, GS10, and GS12. Four of the seven temporary monitoring wells were properly abandoned. The remaining temporary monitoring wells could not be located for abandonment. The three permanent wells were given the same name as the temporary wells they replaced. The location of the three permanent monitoring wells is indicated on Figure 1-3. Groundwater samples were collected on June 7, 2001 from permanent monitoring well GS01 (source well) and point of compliance wells GS10 and GS12 and analyzed for VOCs. On August 9, 2001, monitoring well GS10 was resampled for VOCs. Depth-to-water and top-of-casing elevations were recorded on June 7 and August 9, 2001, and used to calculate groundwater elevations and flow direction. Groundwater flow was primarily in a northwesterly direction. Results of the monitoring event indicated monitoring well GS10 exceeded FDEP NADCs for benzene on June 7, 2001, but equaled the NADC upon resampling on August 9, 2001. Table 1-1 provides a summary of analytes detected in groundwater from the initial semi-annual monitoring event. As a result of the detections in site groundwater during the monitoring event, it was proposed that a Treatability Study be completed at this site. A Treatability Study was proposed to use a grid system of Direct Push Technology (DPT) soil borings for ORC® injection into the groundwater.

1.3 NATURE AND EXTENT OF GROUNDWATER CONTAMINATION

1.3.1 Groundwater Contamination

Groundwater contamination has been documented at the site during both of the above-referenced assessment activities. The groundwater contaminant plume appears to be fuel related and is located near monitoring well GS01 (source well) and extends downgradient to perimeter well GS10 (Figure 1-3). Figure 1-4 indicates the estimated location of the groundwater contaminant plume and groundwater flow direction. Benzene is the primary chemical of concern in the contaminant plume. The highest levels of benzene were found at source monitoring well GS01 and extended downgradient to perimeter monitoring well GS10, at concentrations in excess of the FDEP Groundwater Cleanup Target Levels (GCTLs). The Treatability Study will be addressing this groundwater contamination plume.

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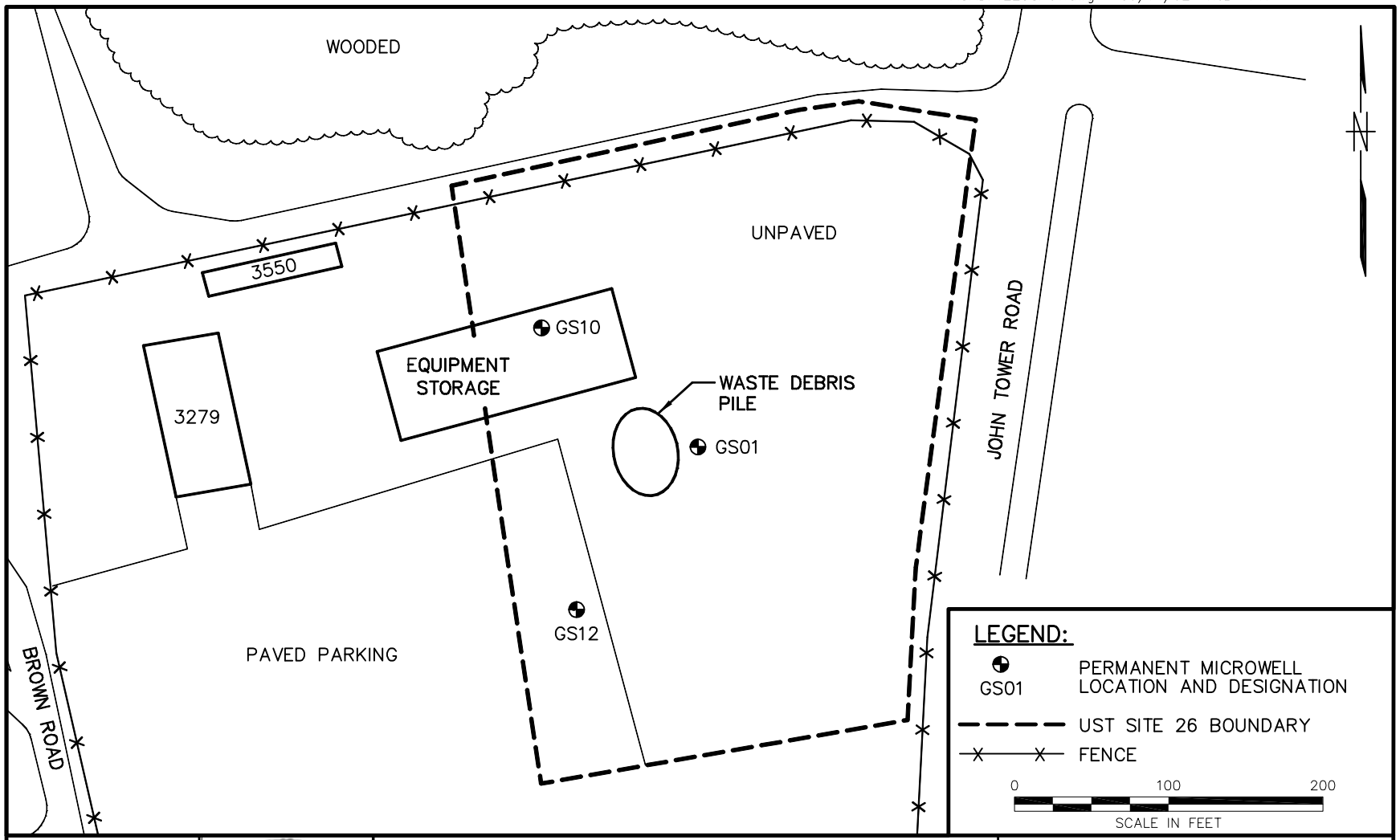

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TABLE 1-1
SUMMARY OF ANALYTES DETECTED IN GROUNDWATER
UST SITE 26

Treatability Study Work Plan
Naval Air Station Pensacola
Pensacola, Florida

		Perimeter Wells				Source Well	
Sample Number Sample Location Collection Date		22GS1001 GS10 6/7/2001	NASP-22-GS10 GS10 8/9/2001	NASP-22-GS10 GS12 6/7/2001	FDEP Action Levels UST 26 Perimeter Wells	22GS0101 GS01 6/7/2001	FDEP Action Levels UST 26 Source Wells
VOCs[2] (µg/L)	**GCTL Criteria[1] (µg/L)**						
tert-Butylbenzene	NA	NA	1.0	NA	NA	NA	NA
Ethylbenzene	30	--	--	--	30	12	300
Benzene	1.0	**11**	**1.0**	--	1.0	**68**	100
Xylenes, total	20	8.4	--	--	20	9.3	200
Toluene	40	--	--	--	40	1.2	400

Notes:

[1] GCTL criteria as provided in Chapter 62-777, Florida Administrative Code (FAC).

[2] United States Environmental Protection Agency (USEPA) Method SW-846 8021 was the analytical method used for samples collected on 6/7/01. Samples collected on 8/9/01 were analyzed using USEPA Method SW846 8260B.

-- = Analyte was not detected above instrument detection limits.

Bold indicates an exceedance of action levels.

NA = not analyzed

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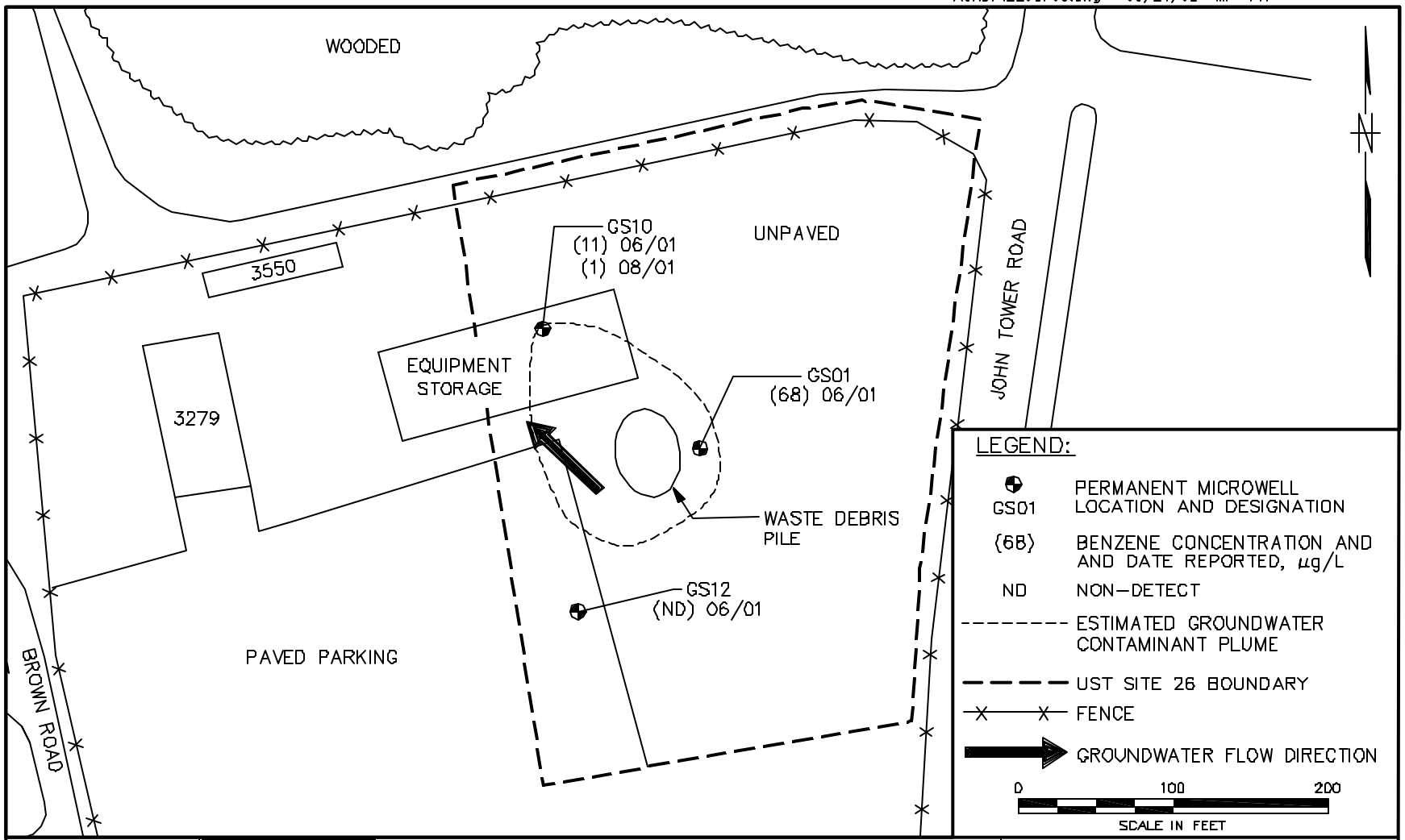

DRAWN BY MF DATE 6/24/02		BENZENE GROUNDWATER CONTAMINANT PLUME JUNE AND AUGUST 9, 2001 UST SITE 26 NAS PENSACOLA PENSACOLA, FLORIDA	CONTRACT NO. 4225
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1.4 SCOPE AND GOALS

ORC® is a proprietary product produced by Regenesis Bioremediation Products, of San Clemente, California. ORC® is a patented formulation of magnesium peroxide (MgO_2) intercalated with food-grade phosphate that slowly releases molecular oxygen into the aquifer when hydrated. The phosphate gives it the time-release properties that are critical in a passive, low-cost oxygen application system. The hydrated product becomes magnesium hydroxide [$Mg(OH)_2$]. The oxygen consumption rate is dependent upon the level of the contaminant flux. This allows ORC® to release oxygen at a relatively constant rate over an extended period of time. The increase in dissolved oxygen in the aquifer creates aerobic conditions that will stimulate in-situ bioremediation of the petroleum hydrocarbon plume.

During this Treatability Study, an ORC® and water mixture (slurry) will be injected into the area of impacted groundwater that is above the FDEP GCTLs for benzene to provide dissolved oxygen in the "source" area.

A baseline sampling event and four quarters of groundwater sampling will be conducted from on-site monitoring wells GS01, GS10, and GS12. Quarterly performance monitoring letter reports will be prepared and a Final Treatability Study Evaluation Report will be submitted after the post-injection sampling. These sampling events and reports are explained in greater detail in Sections 2.0, 3.0, and 4.0 of this Treatability Study Work Plan.

The objective of the Treatability Study is to determine the effectiveness of ORC® at reducing the contaminant concentrations within the source area. This strategy is relying on the released dissolved oxygen to increase the microbial activity, thereby increasing contaminant reduction through aerobic respiration.

2.0 FIELD OPERATIONS

2.1 FIELD OPERATIONS SUMMARY

The treatability study consists of the following field activities:

- Sampling and analysis of three selected monitoring wells (GS01, GS10, and GS12) to evaluate baseline contaminant and geochemistry concentrations.

- Installation of 56 ORC® injection borings in the source area.

- Injection of an ORC® enriched slurry into each of the above-referenced points.

- Quarterly sampling and analysis of three selected monitoring wells (GS01, GS10, and GS12) to evaluate water quality parameters and contaminant concentrations.

This Treatability Study will target the groundwater contaminant plume previously identified at the site. The plume, as illustrated on Figure 1-4, is defined as the approximate boundary of the detectable benzene plume. For this Treatability Study, TtNUS is focusing on treating the entire estimated contamination plume to achieve significant reductions in benzene concentrations.

This pilot-scale study involves installation of nine banks of ORC® injection borings that will create zones of passive treatment. Each of the banks will have several injection borings installed cross-gradient to the groundwater plume. These banks will be installed in the approximate locations shown on Figure 2-1. A detailed plan view of the typical injection point bank, as well as a cross-section of a typical injection point, is presented as Figure 2-2. These banks are intended to create an oxygen-enriched barrier and an aerobic reaction zone to reduce petroleum hydrocarbon concentrations in the areas where benzene concentrations are anticipated to be greater than 1 µg/L. The dry ORC® powder (4 pounds per ft or approximately 40 pounds per injection point) will be mixed into a slurry with potable water and injected into the ORC® borings for a one-time treatment. Based on the recommendations of Regenesis, sugar will also be added at two percent per weight of ORC® to provide a carbon source for the microbial population. The site geochemistry will be monitored for changes in water quality parameters indicative of increased microbial activity along with laboratory analysis of COCs to detect reductions in dissolved petroleum concentrations. Details of the sampling and analysis program are presented in Section 3.0.

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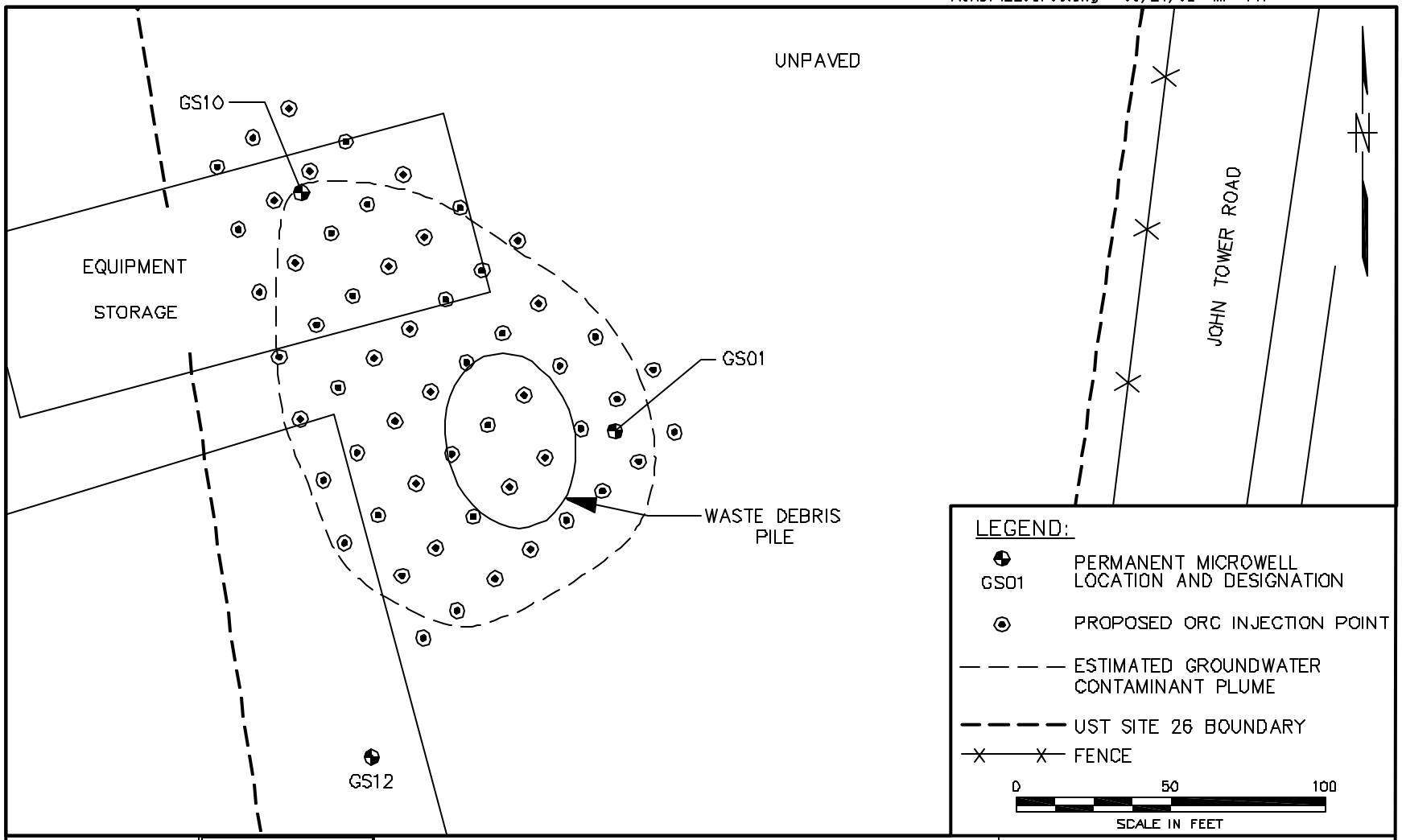

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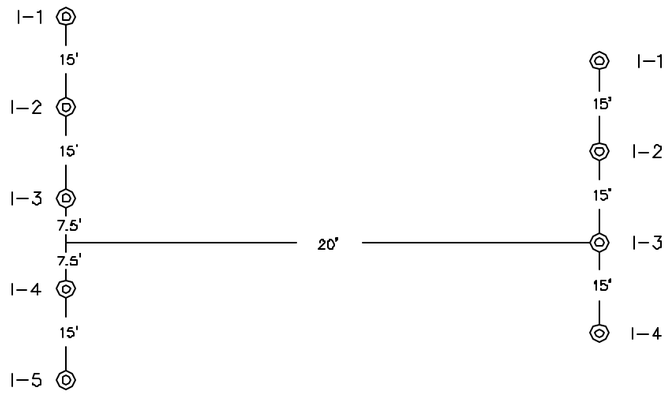
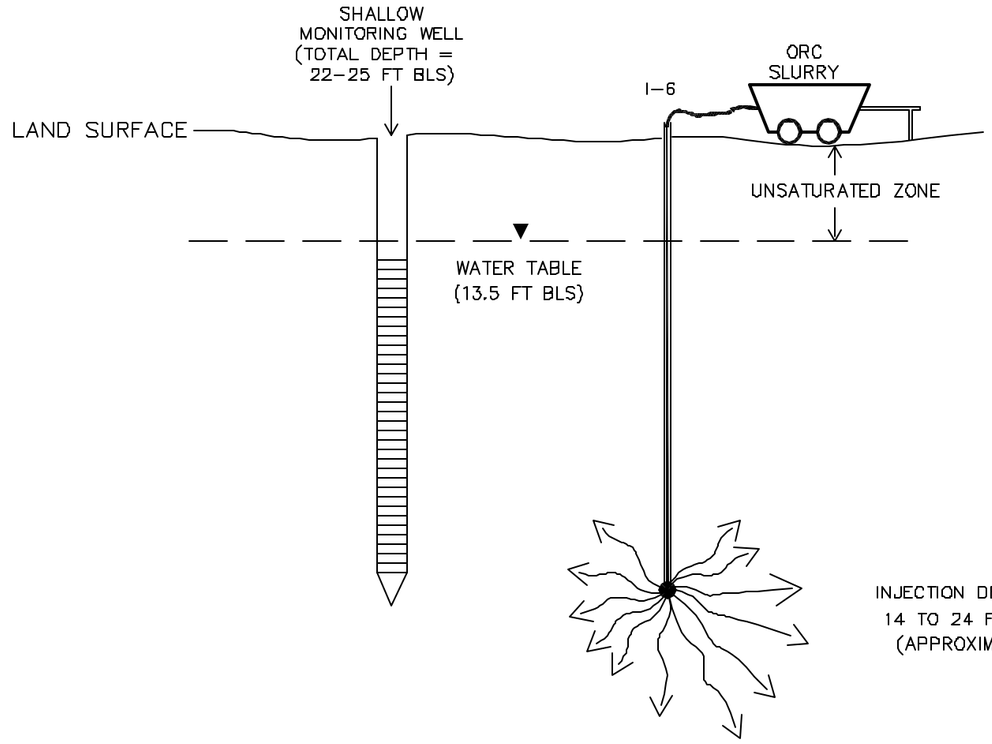


PLAN VIEW SHOWING TYPICAL ADJACENT PAIR
OF PROPOSED ORC INJECTION POINT BANKS

I-4 ◎ ORC INJECTION POINT AND DESIGNATION (Typ.)

NOTES:

1) 56 total injection points: 9 rows spaced approximately 20 ft apart
2) See previous figure (Figure 2-1) for proposed locations of injection points relative to monitoring wells and hydrocarbon plume
3) 40 lbs. ORC slurry to be injected at each point one time only
4) Injection point radius of influence assumed to be 10 ft



CROSS-SECTIONAL VIEW SHOWING TYPICAL INJECTION
POINT AND MONITORING WELL WITHIN TREATMENT ZONE

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PROPOSED ORC SLURRY INJECTION PLAN
UST 26
TREATABILITY STUDY WORK PLAN
NAS PENSACOLA
PENSACOLA, FLORIDA

CONTRACT NO. 0241
APPROVED BY DATE
APPROVED BY DATE
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2.2 MOBILIZATION/DEMOBILIZATION

Following approval of this work plan, TtNUS will procure the required subcontractors and begin mobilization activities. Mobilization/demobilization includes the following:

- Obtain utility clearance in the proposed boring areas.
- Mobilize subcontractors, equipment, and materials to the site.
- Obtain drilling and/or well permits via subcontractor.
- Conduct an approximately 1-hour long site-specific health and safety review meeting.
- Delineate the work zones (exclusion zone, contamination reduction zone, and support zone) as required by the Health and Safety Plan (HASP).
- Arrange an area to perform decontamination procedures.
- Demobilize equipment and materials from the site.
- Perform general site clean-up and removal of trash.
- Submit boring logs in accordance with applicable regulations (by DPT subcontractor).

Field team members will review the work plan, the Site Emergency Procedures Plan, and the HASP. Mobilization includes attendance at a site-specific health and safety meeting during the initiation of on-site activities. This meeting will also include field team orientation in order to familiarize personnel with the scope of the field activities.

The Field Operations Leader (FOL) will coordinate the mobilization activities. These include responsibilities such as initiating and conducting equipment inventories to ensure equipment is available, purchasing equipment as required, staging equipment for efficient loading and transport from the TtNUS Tallahassee office to the site, and after field activities are completed, demobilizing the equipment.

The DPT subcontractor will furnish a truck-mounted DPT rig, support crew, all necessary tools required, personal protective equipment (PPE) for their crew, and any miscellaneous equipment and materials required to complete the described activities. The down-hole DPT equipment, sampling tools, and the rear of the DPT rig will be steam-cleaned prior to arrival on site. Safety shut-off equipment will be in full working condition and will be tested by the FOL prior to initiating DPT activities.

2.3 INJECTION POINT INSTALLATION

The 56 injection points will be installed using DPT (e.g., Geoprobe) and will be divided into eight banks. Each source-area cluster will typically contain seven injection points as depicted in Figure 2-1. Shallow groundwater contamination is assumed to extend to approximately 24 ft below land surface (bls), based on the depth of the shallow monitoring wells previously installed at the site. Therefore, each of the injection

points will be installed to a depth of 24 ft bls and the ORC® slurry injected across the wetted depth of the injection point (approximately 10 ft).

2.4 ORC MIXING AND INJECTION

The ORC® bulk powder will be drop-shipped from the Regenesis manufacturing facility in Inwood, New York. For the ORC® injection borings, approximately 0.63 gallons of potable water are required per 10 pounds of ORC® powder for a 65% mixture. As recommended by Regenesis, two percent sugar by weight will also be added to the mixture to provide a carbon source. Mixing and injection of ORC® will be performed in general accordance with the Regenisis instructions in Appendix B. Mixing will be performed in a 55-gallon drum and will be injected through the DPT rig's pump or any slurry/grout pump. The mixed ORC® powder is a thin liquid, similar in chemical composition to diluted Milk of Magnesia. A hand-held drill with a paint or stucco mixer will be used to mix the slurry. Standard environmental slurry mixers/grout pumps may also be used. The ORC® slurry must be mixed immediately before using. It cannot be allowed to stand for more than 30 minutes, since it will settle and eventually harden. MSDSs for the ORC® powder are provided in Appendix A.

2.5 WATER LEVEL MEASUREMENTS

A round of groundwater level measurements will be obtained during the each sampling event from the following UST 26 monitoring wells: GS01, GS10, and GS12 (as shown on Figure 1-3). The synoptic measurements will be taken within a 2-hour period of consistent weather conditions to minimize atmospheric/precipitation effects on groundwater levels. Measurements will be taken with an electronic water level indicator or interface probe using the marked location on the top of the well casing as the reference point. Groundwater level measurements will be recorded to the nearest 0.01-ft on the appropriate field log. This information will be used to confirm groundwater flow direction.

2.6 INVESTIGATION-DERIVED WASTE (IDW) MANAGEMENT

All IDW accumulated during DPT installation, well purging and sampling, and decontamination proceedings will be collected, containerized, and stored in Department of Transportation (17C)/UN (1A2)-approved, 55-gallon drums. The drums will be labeled as soon as possible after they are filled. The drums will be left on site pending analytical results.

Upon receipt of the analytical results (approximately 35 days after completion of sampling), TtNUS will mobilize a certified waste management contractor, as required, to dispose of the IDW. NAS Pensacola personnel will sign all manifests and bills of lading prior to transportation off site. TtNUS will coordinate with station personnel for this activity.

2.7 DECONTAMINATION

The field team's PPE will be disposed as required. These items, such as Tyvek™ suits, disposable latex gloves and paper towels, will be temporarily stored in plastic bags with daily transfer to 55-gallon drums (with lids) at the end of each workday. Personnel will also perform decontamination procedures as required by the HASP before any departure from the site.

The equipment involved in field sampling activities will be decontaminated prior to and upon completion of drilling and sampling activities. This equipment includes drilling rigs, down-hole tools, augers, and all non-dedicated sampling equipment.

Major Equipment

All down-hole DPT equipment and sampling tools will be decontaminated by the DPT crew prior to beginning work and at the completion of the DPT installation/injection program. The decontamination procedures will comply with the FDEP Standard Operating Procedures (SOPs). Due to the nature of this study and previous delineation of impacted groundwater, the DPT equipment will not be decontaminated between injection points.

Sampling Equipment

Sampling equipment used for collecting the groundwater samples will be disposable equipment. Therefore, no decontamination of this equipment will be required. Field analytical equipment such as water level probes, and water quality meters will be first wiped down with lab-grade detergent solution, then rinsed with a isopropanol and analyte free water mix, and then with a final rinse of analyte free water.

3.0 ENVIRONMENTAL SAMPLING

3.1 SAMPLE ANALYSIS SUMMARY

Both field and laboratory analyses will be conducted in order to quantify any increase in the rate of microbial activity within the aerobic reaction zones and to determine the contaminant reduction rates.

3.1.1 Laboratory Sample Analysis Summary

A certified laboratory will be subcontracted by TtNUS to perform the routine chemical analyses for the environmental samples collected for UST 26 during the treatability study.

The laboratory analytical methods, bottle requirements, preservation requirements, and holding times are as follows:

Laboratory Groundwater Analyses

Parameter	Analytical Method	Bottle/Preservation Requirements	Holding Time
Total Organic Carbon (TOC)	USEPA 415.1	One 250 milliliter (ml) high density polyethylene (HDPE); sulfuric acid (H_2SO_4) < 2; cool to 4 degrees Celsius (°C)	28 days to analysis
Sulfate	USEPA 300	One 250 ml HDPE; cool to 4°C	28 days to analysis
VOCs	USEPA SW846 8260	Three 40 ml VOA vials with Teflon® septum; hydrochloric acid (HCl) to pH < 2; cool to 4°C	14 days to analysis

3.1.2 Field Analysis Summary

Field geochemical analyses will be performed during field sampling activities on the five selected monitoring wells for the parameters specified as follows:

Field Analyses

Parameter	Analytical Method	Holding Time	Analyze
Dissolved oxygen	CHEMetrics K-7501/7512	Analyze immediately	Field
Carbon dioxide	CHEMetrics K-1910/1920/1925	Analyze immediately	Field
Alkalinity	CHEMetrics K-9810/9815/9820	Analyze immediately	Field
Ferrous iron	HACH IR-18C	Analyze immediately	Field
Hydrogen sulfide	HACH HS-C	Analyze immediately	Field
Temperature	Horiba U-22	Analyze immediately	Field
pH	Horiba U-22	Analyze immediately	Field
Conductivity	Horiba U-22	Analyze immediately	Field
Turbidity	Horiba U-22	Analyze immediately	Field
Oxydation Reduction Potential (ORP)	Horiba U-22	Analyze immediately	Field

3.2 GROUNDWATER SAMPLING PROCEDURES

Groundwater samples will be obtained from three-selected groundwater monitoring wells (GS01, GS10, and GS12) during the baseline sampling and four quarters of sampling. Samples will be collected quarterly for the above laboratory groundwater analyses and reference field analytical tests. Groundwater sampling will be conducted under the Comprehensive Quality Assurance Plan (CompQAP) provisions since this site predates the new FDEP SOPs.

Prior to obtaining samples, water levels will be measured and the wells will be purged using a low-flow peristaltic pump. A minimum of three well volumes will be purged prior to sample collection. If the wells are purged dry with less than three well volumes removed, the water level in the well will be allowed to recover to at least 80 percent of the original capacity prior to sampling. During well purging, field measurements of pH, temperature, specific conductance (SC), turbidity, and dissolved oxygen will be recorded for each well volume. Stabilization is defined as follows: temperature ±1°C; pH ±0.2 units; and SC ±5 percent. If these parameters do not stabilize after three volumes, up to five volumes may be removed as determined by the FOL.

Teflon® and surgical-grade silicon tubing will be used for sample collection. Groundwater samples will be collected using the "straw method" and discharged into the appropriate sample bottles for analysis. Samples requiring preservation will be collected in prepreserved bottles provided by the laboratory.

Pertinent sampling data will be recorded using the appropriate sample log sheet and field logbook. (See Appendix C for forms to be used during the Treatability Study.)

3.3 SAMPLE HANDLING

Sample handling including the field-related considerations concerning sample identification, packaging, and shipping will be addressed throughout this section.

3.3.1 Sampling Identification System

Each sample collected will be assigned a unique sample tracking number. The sample tracking number will consist of a four-segment, alphanumeric code that identifies the site, sample location, and sample round. The groundwater samples collected during the initial groundwater monitoring event for natural attenuation were designated as the first round; therefore, baseline samples will be designated as the second sample round. Therefore, the quarterly sampling rounds for the ORC® Treatability Study will be designated as the third through sixth rounds. Pertinent information regarding sample identification will be recorded in the field logbooks.

The appropriate alphanumeric sample identification code is explained as follows:

(Site Location) - (Site) - (Sample Number) – (Sample round)

Site Location: NASP (Naval Air Station Pensacola)

Site: 26 (UST 26)

Sample Number: Groundwater sample = well identifier. For duplicate samples the sample number should be the alphanumeric Dx, where D doesn't change and x is a number beginning at 1 and progressing for each subsequent duplicate sample (e.g., D1, D2, and D3).

Sample Round: For groundwater samples = designated sample round number (e.g., 03, 04, 05, and 06)

For example, a groundwater sample collected from monitoring well GS01 during the baseline sampling before the ORC® Treatability Study will be designated as NASP26GS0102.

A duplicate of the sample listed above would be as NASP26D102.

3.3.2 Sample Packaging and Shipping

The FOL will be responsible for completion of the following forms:

- Sample labels
- Chain-of-custody forms
- Appropriate labels applied to shipping coolers
- Chain-of-custody seals
- Federal Express air bills

All samples will be packaged and shipped in accordance with FDEP SOPs.

3.4 SAMPLE CUSTODY

Custody of samples must be maintained and documented at all times. Chain-of-custody begins with the collection of the samples in the field. TtNUS SOP SA-6.3 provides a description of the chain-of-custody procedures to be followed.

3.5 QUALITY CONTROL (QC) SAMPLES

Work at UST 26 will be conducted under the CompQAP provisions since this site predates the new FDEP SOPs. In addition to regular calibration of field equipment and appropriate documentation, minimal QC samples will be collected during the Treatability Study sampling activities, since dedicated and/or disposable equipment is to be used for sampling. One field duplicate sample will be collected during each sampling event. One trip blank will be sent with each cooler containing samples that are being analyzed for VOCs. One initial equipment blank will be collected during the baseline sampling event to confirm that the Teflon® tubing is free of contaminants. No other QC samples are proposed.

Field duplicates for groundwater are defined as two samples collected independently at a sampling location. Duplicates are obtained during a single act of sampling and are used to assess the overall precision of the sampling and analysis program. Ten percent of all environmental samples are required by the FDEP SOPs to be duplicated. Duplicates will be analyzed for the same parameters as the original sample.

3.6 EQUIPMENT CALIBRATION

Several monitoring instruments may be used during field activities including the following:

- Photoionization or flame ionization detector
- Horiba U-22 water quality meter/probe
- Electronic water-level meter

Calibration will be documented on an equipment calibration log (Appendix C). During calibration, an appropriate maintenance check will be performed on each piece of equipment. If damaged or defective parts are identified during the maintenance check and it is determined that the damage could have an impact on the instrument's performance, the instrument will be removed from service until the defective parts are repaired or replaced.

3.7 EQUIPMENT MAINTENANCE

Measuring equipment used in environmental monitoring or analysis and test equipment used for calibration and maintenance shall be maintained by established procedures.

TtNUS maintains an inventory of sampling and measurement equipment. In the event that failed equipment cannot be repaired, replacement equipment will be shipped to the site by overnight carrier to minimize downtime.

3.8 RECORD KEEPING

In addition to chain-of-custody records, certain standard forms will be completed for sample description and documentation. These shall include sample log sheets, boring logs, daily record of subsurface investigation reports, and logbooks. Field documentation and example field log forms are provided in Appendix C.

A bound/weatherproof site logbook shall be maintained by the FOL. All information related to sampling or field activities will be recorded in the site logbook. This information will include, but is not limited to, sampling time, weather conditions, unusual events, field measurements, descriptions of photographs, etc.

4.0 PROJECT MANAGEMENT

The management and technical aspects of this project are the ultimate responsibility of TtNUS. Each contractor assigned to individual tasks has the responsibility to fulfill the objectives of that task and to ensure the quality of the data generated by the task. At the direction of the United States Navy (Navy), TtNUS has overall responsibility for the investigations to be performed at UST 26.

4.1 PROJECT ORGANIZATION

The various quality assurance and management responsibilities of key TtNUS project personnel are defined in the following paragraphs.

CLEAN Program Manager - The TtNUS Program Manager is responsible for the execution of all contractual obligations. The Program Manager serves as the primary point of contact for the client and provides an interface between the Navy and the project staff. The TtNUS CLEAN Program Manager is Ms. Debbie Wroblewski.

CLEAN Project Manager - The Project Manager is responsible for project performance, budget, and schedule, and for ensuring the availability of necessary personnel, equipment, subcontractors, and services. He/she will direct the development of the field program, evaluation of findings, determination of conclusions and recommendations, and preparation of technical reports. The TtNUS Project Manager is Mr. Gerald Walker, Professional Geologist.

FOL - The FOL is responsible for providing on-site supervision of day-to-day activities on the project. The FOL serves as the primary on-site contact with the client and subcontractors. In addition, the FOL is responsible for all field QA/QC and safety-related issues as defined in the HASP. The FOL for this project will be designated later by the Project Manager.

Health and Safety Manager (HMS) - The Program HSM will review and internally approve the HASP tailored to the specific needs of the investigation. In consultation with the Project Manager/FOL, the HSM will ensure that an adequate level of personal protection exists for anticipated potential hazards for all field personnel. As the HSM does not report to either the Program or Project Manager, his/her actions are not dictated by Program or project constraints (such as budget and schedule) other than the assurance of appropriate safeguards while conducting investigation activities. The TtNUS HSM is Mr. Matthew Soltis, Certified Industrial Hygienist.

QA Manager/Sampling Coordinators - The Project Manager/FOL will coordinate the schedule of field sampling activities with the schedule and capacity requirements of the selected analytical laboratory. All sampling will be coordinated to assure that environmental sampling is conducted in a manner that complies with all QA/QC requirements and is in compliance with holding time and analytical procedure requirements. All Program-wide, QA issues are the responsibility of the QA Manager. The TtNUS QA Manager for Navy CLEAN activities is Mr. Paul Frank.

Project Laboratory – The project laboratory has not been selected at this time.

4.2 PROJECT RESPONSIBILITIES

Throughout the field activities, NAS Pensacola personnel, as described below, will provide various support functions:

- Locate and mark underground utilities and issue digging or other required permits prior to the commencement of digging or drilling operations.

- Take custody of all drill cuttings, well development fluids, decontamination fluids, or drill cuttings.

- Secure staging areas for decontamination operations and for storing equipment and supplies. It is anticipated that access can be gained to UST 26.

- A supply of electricity and potable water for equipment cleaning, slurry mixing, etc.

4.3 CONTINGENCY PLAN

In the event of problems that may be encountered during the site investigation activities, the TtNUS Project Manager will notify the Navy Remedial Project Manager (RPM) and the NAS Pensacola Point of Contact. The Project Manager will determine a course of action so as to minimize impacts to the project schedule and/or budget. Contingency plans will be approved through the Navy RPM and the NAS Pensacola Point of Contact before being enacted.

4.4 REPORTING

During performance of the ORC® Treatability Study, TtNUS will prepare the following reports:

ORC® Application and Baseline Monitoring Report

Upon completion of the Baseline Sampling and ORC® injection, TtNUS will prepare the ORC® Application and Baseline Monitoring Report, which will include the following:

- The results of the pre-installation sampling and ORC® injection activities.
- The ORC® installation procedures, boring logs, and any other data developed as part of the pilot-scale field activities.
- The groundwater sampling procedures and sample results.
- The groundwater flow conditions.
- Any other data collected during the most recent sampling event.

The Baseline Monitoring Report will be prepared in final form to be submitted to Southern Division, Naval Facilities Engineering Command (SOUTHNAVFACENGCOM) and the FDEP.

First, Second, and Third Quarterly Performance Monitoring Results Reports

Upon completion of the first, second, and third quarters of performance monitoring, TtNUS will prepare a brief letter report presenting the sample results.

Treatability Study Evaluation Report

Upon completion of the fourth quarter of performance monitoring, TtNUS will prepare the Treatability Study Evaluation Report. The report will present information on the groundwater flow conditions, sample results, and any other data collected during the performance of the Treatability Study. In addition, the report will present conclusions and recommendations for follow up actions for the site. The Treatability Study Evaluation Report will be prepared in draft form for SOUTHNAVFACENGCOM and NAS Pensacola review and in final form for SOUTHNAVFACENGCOM, NAS Pensacola, and the FDEP.

REFERENCES

Ensafe, 1998. Site Assessment Report, UST 26 – Refueler Repair Shop, Naval Air Station Pensacola, Pensacola, Florida. October.

Tetra Tech NUS, Inc., 2001. Initial Semi-annual Groundwater Monitoring for Natural Attenuation Letter Report: UST 26 – Refueler Repair Shop, Naval Air Station Pensacola, Pensacola, Florida. October.

APPENDIX A

ORC® MSDS

(As retrieved from Regenesis' Website.)

ORC® MATERIAL SAFETY DATA SHEET
Last Revised : April 17, 1998

****
SECTION# 1 - MATERIAL IDENTIFICATION
****

SUPPLIER:

REGENESIS Bioremediation Products

1011 Calle Sombra
San Clemente, CA 92673

Tel: 949-366-8000
Fax: 949-366-8090
Email: orc@regenesis.com

CHEMICAL DESCRIPTION:
A mixture of Magnesium Peroxide [MgO2], Magnesium Oxide [MgO], and Magnesium Hydroxide [Mg(OH)2]

CHEMICAL FAMILY:
Inorganic Chemicals

PRODUCT NAME:
Oxygen Release Compound (ORC®)

PRODUCT USE:
Used for environmental remediation of contaminated soil and groundwater

****
SECTION# 2 - CHEMICAL IDENTIFICATION
****

CHEMICAL CHARACTERIZATION

Magnesium Peroxide [MgO2]: CAS Reg. No. 14452-57-4

Magnesium Oxide [MgO]: CAS Reg. No. 1309-48-4

Magnesium Hydroxide ((Mg(OH)2): CAS Reg. No. 1309-42-8

FORM : powder

COLOR: white

ODOR: odorless

ASSAY: 25 - 35% Magnesium Peroxide (MgO2)

****
SECTION# 3 - PHYSICAL AND TECHNICAL SAFETY DATA
****

MELTING POINT: Not Determined

BOILING POINT: Not Determined

DENSITY: .6 - .8 g/cc

BULK DENSITY: ---

VAPOR PRESSURE: Data not available

VISCOSITY: ---

SOLUBILITY: Reacts with water. Soluble in acid

pH VALUE: Approx. 10 in saturated solution

FLASH POINT: Not applicable

SELF-IGNITION TEMPERATURE: Not applicable

EXPLOSION LIMITS % BY VOLUME: ---

THERMAL DECOMPOSITION: Spontaneous decomposition possible about 150° C

HAZARDOUS DECOMPOSITION PRODUCTS: Not known

HAZARDOUS REACTIONS: Hazardous polymerization will not occur

FURTHER INFORMATION: Non-combustible, but will support combustion

****

SECTION# 4 - REACTIVITY DATA

****

STABILITY: Product is stable unless heated above 150°C. Magnesium Peroxide reacts with water to slowly release oxygen. React by product is magnesium hydroxide

CONDITIONS TO AVOID: Heat above 150°C. Open flames

INCOMPATIBILITY: Strong Acids. Strong chemical agents

HAZARDOUS POLYMERIZATION: None known

****

SECTION# 5 - REGULATIONS

****

PERMISSIBLE EXPOSURE LIMITS IN AIR: Not established. Should be treated as a nuisance dust.

****

SECTION# 6 - PROTECTIVE MEASURES, STORAGE, AND HANDLING

****

TECHNICAL PROTECTIVE MEASURES

STORAGE: Keep container tightly closed. Keep away from combustible material

HANDLING: Use only in well-ventilated areas

PERSONAL PROTECTIVE EQUIPMENT

RESPIRATORY PROTECTION: Recommended (HEPA Filters)

HAND PROTECTION: Wear suitable gloves

EYE PROTECTION: Use chemical safety goggles
OTHER: ---

INDUSTRIAL HYGIENE: Avoid contact with skin and eyes

PROTECTION AGAINST FIRE AND EXPLOSION: ---

DISPOSAL: Dispose via sanitary landfill per state/local authority

FURTHER INFORMATION: Not flammable, but may intensify fire

****
SECTION# 7 - MEASURES IN CASE OF ACCIDENTS AND FIRE
****

AFTER SPILLAGE/LEAKAGE/GAS LEAKAGE: Collect in suitable containers. Wash remainder with copious quantities of water.

EXTINGUISHING MEDIA
SUITABLE: Carbon dioxide, dry chemicals, foam
NOT TO BE USED: ---

FURTHER INFORMATION: Self contained breathing apparatus or approved gas mask should be worn due to small particle size. Use extinguishing media appropriate for surrounding fire.

FIRST AID: After contact with skin, wash immediately with plenty of water and soap. In case of contact with eyes, rinse immediately with plenty of water and seek medical attention.

FURTHER INFORMATION: ---

****
SECTION# 8 - INFORMATION ON TOXICOLOGY
****

TOXICITY DATA: Data not available

****
SECTION# 9 - INFORMATION ON ECOLOGY
****

WATER POLLUTION HAZARD RATING (WGK): 0

****
SECTION# 10 - FURTHER INFORMATION
****

After the reaction of magnesium peroxide to form oxygen the resulting material, magnesium hydroxide is mildly basic. The amounts of magnesium oxide (magnesia) and magnesium hydroxide in the initial product have an effect similar to lime, but with lower alkalinity.

The information contained in this document is the best available to the supplier at the time of writing, but is provided without warranty of any kind. Some possible hazards have been determined by analogy to similar classes of material. The items in this document are subject to change and clarification, as more information becomes available.

APPENDIX B

ORC® MIXING & INJECTING INSTRUCTIONS

(As retrieved from Regenesis' Website.)

DIRECTIONS FOR ORC® SLURRY MIXING

1. OPEN 5 GALLON BUCKET, AND REMOVE PRE-MEASURED BAG OF ORC.

2. MEASURE AND POUR WATER INTO THE 5-GALLON BUCKET ACCORDING TO THE FOLLOWING DESIRED CONSISTENCY:

65% Solids Slurry	Mix .63 gallons of water per 10 pounds of ORC powder.	
	Example:	Mix 20 pounds of ORC with 1.26 gallons of water.
		Mix 30 pounds of ORC with 1.89 gallons of water.

60% Solids Slurry	Mix .79 gallons of water per 10 pounds of ORC powder.	
	Example:	Mix 20 pounds of ORC with 1.58 gallons of water.
		Mix 30 pounds of ORC with 2.37 gallons of water.

50% Solids Slurry	Mix 1.19 gallons of water per 10 pounds of ORC powder.	
	Example:	Mix 20 pounds of ORC with 2.38 gallons of water.
		Mix 30 pounds of ORC with 3.57 gallons of water.

25% Solids Slurry	Mix 3.57 gallons of water per 10 pounds of ORC powder.	
	Example:	Mix 10 pounds of ORC with 3.57gallons of water.

3. ADD THE APPROPRIATE ORC QUANTITY TO THE WATER . Check weight of each bucket (see label). The 5-gallon shipping bucket weighs 2 pounds. An additional 4 pounds of ORC would require one additional quart of water, at the 65% solids level.

4. USE AN APPROPRIATE MIXING DEVICE TO THOROUGHLY MIX ORC AND WATER. A hand held drill with a “jiffy mixer” or a stucco mixer on it may be used in conjunction with a small paddle to scrape the bottom and sides of the container. Standard environmental slurry mixers may also be used, following the equipment instructions for operation. For small quantities a usable slurry can be mixed by hand, if care is taken to blend all lumps into the mixture thoroughly.

CAUTION: ORC MAY SETTLE OUT OF SLURRY IF LEFT STANDING. ALSO, ORC EVENTUALLY HARDENS INTO A CEMENT-LIKE COMPOUND, AND CANNOT BE RE-MIXED AFTER THAT HAS HAPPENED. THEREFORE:
Mix immediately before using. Do not let stand more than 30 minutes, and re-mix immediately before use, to be sure the mixture has not settled out. If a mechanical slurry mixer attached to a pump is being used, the material may be cycled back through the mixer to maintain slurry suspension and consistency.

5. CHECK SLURRY CONSISTENCY FOR POURABILITY. ADD WATER IF NECESSARY (IN 1 CUP INCREMENTS) TO ACHIEVE THE CORRECT CONSISTENCY.

ORC® Slurry Installation Instructions

Geoprobe® Hole Back-Fill Method

SAFETY:
Pure ORC is shipped to you as a fine powder rated at -325 mesh (passes through a 44 micron screen). It is considered to be a mild oxidizer and as such should be handled with care while in the field. Field personnel should take precautions while applying the pure ORC. Typically, the operator should work upwind of the product as well as use appropriate safety equipment. These would include eye and respiratory protection, and gloves as deemed appropriate by exposure duration and field conditions.

Personnel operating the field equipment utilized during the installation process should have appropriate training, supervision and experience.

GENERAL GUIDELINES:
ORC may be installed in the contaminated saturated zone in the ground utilizing hand augered holes, Geoprobe® type hydraulic punch equipment, or hollow stem augers. This set of instructions is specific for Geoprobe equipment. Alternate instructions may be obtained from the Regenesis Technical Support Department.

For optimum results the ORC slurry installation should span the entire vertical contaminated saturated thickness, including the capillary fringe and “smear zone”.

Two general installation approaches are available. The first is to backfill only the probe hole with slurry. This is a simple approach, in that it is easy, straightforward, and the location of the ORC slurry is precisely known after installation. However, this method requires significantly more probe holes than the alternative, and may take more time for the completion of the remediation process. A separate set of instructions for this method utilizing Geoprobe equipment is available from Regenesis.

The second method is to inject the slurry through the probe holes into the contaminated saturated zone. This method requires fewer probe holes, is less disruptive to the site, and aids the spread of oxygen by spreading the ORC source material. However, it may be difficult to know the exact, final disposition of the ORC installed with this method. This is the method described in these instructions.

Note: It is important that the installation method and specific ORC slurry point location be established prior to field installation. It is also important that the ORC slurry volume and solids content for each drive point be predetermined. The Regenesis Technical Service Department is available to discuss these issues, and Helpful Hints at the end of these instructions offers relevant information. Regenesis also has available Technical Bulletins covering source treatments with ORC.

SPECIFIC INSTALLATION PROCEDURES

1. Identify the location of all underground structures, including utilities, tanks, distribution piping, sewers, drains, and landscape irrigation systems.
2. Identify surface and aerial impediments.
3. Adjust planned installation locations for all impediments and obstacles.
4. Pre-mark the installation grid point locations, noting any that have special depth requirements.
5. Set up the Geoprobe unit over each specific point, following manufacturer recommended procedures. Care should be taken to assure approximate vertical probe holes.
6. Penetrate surface pavement, if necessary, following standard Geoprobe procedures.
7. Drive the 1 1/2” (one-and-one-half inch) pre-probe (part #AT-148B) with the expendable tip (part #AT142B) to the desired maximum depth. Standard 1” (one inch) drive rods (part AT104B) should be used, after the pre-probe. (Hint: Pre-counted drive rods should be positioned prior to the installation driving procedure to assure the desired depth is reached.)
8. Disconnect the drive rods from the expendable tip, following standard Geoprobe procedures.

9. Mix the appropriate quantity of ORC slurry for the current drive point. (See separate "Directions for ORC® Slurry Mixing" and Helpful Hints). **Note: Do not mix more slurry than will be used within a 30 minute period.**
10. Set up and operate an appropriate slurry pump according to manufacturer's directions. Based on our experience, a Geoprobe model GS-1000 pump is recommended. Connect the pump to the probe grout pull cap (GS-1054) via a 1 inch diameter delivery hose. The hose is then attached to the 1" drive rod with its quick connector fitting. Upon confirmation of all connections add the ORC slurry to the pump hopper/tank.
11. Withdraw the pre-probe and drive stem 4'(four feet). (Also note Helpful Hints - Operations at end of instructions.)
12. Optional pretreatment step. (See Helpful Hints - Operations at end of instructions). Pump one to two gallons of tap water into the aquifer to enhance dispersion pathways from the probe hole.
13. Pump the predetermined quantity of ORC slurry for the depth interval being injected. Observe pump pressure levels for indications of slurry dispersion or refusal into the aquifer. (Increasing pressure indicates reduced acceptance of material by the aquifer).
14. Remove one 4' section of the 1" drive rod. The drive rod will contain slurry. This slurry should be returned to the ORC bucket for reuse.
15. Repeat steps 11, 13, and 14 until treatment of the entire affected thickness has been achieved. It is generally recommended that the procedure extend to the top of the capillary fringe/smear zone.
16. Install an appropriate seal, such as bentonite, above the ORC slurry through the entire vadose zone. This helps assure that the slurry stays in place and prevents contaminant migration from the surface. Depending on soil conditions and local regulations, a bentonite seal can be pumped through the slurry pump or added via chips or pellets after probe removal.
17. Remove and decontaminate the drive rods and pre-probe.
18. Finish the probe hole at surface as appropriate (concrete or asphalt cap, if necessary).
19. Move to the next probe point, repeating steps 5 through 18.

HELPFUL HINTS:

A. Physical characteristics

B. A1. Slurry

The ORC slurry is made using the dry ORC powder (rated at -325 mesh). It makes a smooth slurry, with a consistency that depends on the amount of water used.

A thick, but pumpable, slurry that approaches a paste can be made by using 65-67% solids. This material would normally be used for back-filling a bore or probe hole. It is especially useful where maximum density is desired such as where ground water is present in the hole or there are heaving sands.

Thinner slurries can be made by using more water. Typical solids for the thinner slurries content will range from 35% to 62%. Such slurries are useful for injecting through a probe or bore hole into the saturated aquifer.

As a rule, it is best to mix the first batch of slurry at the maximum solids content one would expect to use. It can then be thinned by adding additional water in small increments. By monitoring this process, the appropriate quantities of water for subsequent batches can be determined.

The slurry should be mixed at about the time it is expected to be used. It is best to not hold it for more than 30 minutes. Thinner slurries, especially, can experience a separation upon standing. All ORC slurries have a tendency to form cements when left standing. If a slurry begins to thicken too much, it should be mixed again and additional water added if necessary.

Care should be taken with slurry that may be left standing in a grout pump or hose. Problems can generally be avoided by periodically re-circulating the slurry through the pump and hose back into the pump's mixing or holding tank.

A2. Equipment

Most geotechnical grout pumping equipment has a holding tank with a capacity sufficient for injection.

When applying measured volumes of ORC slurry to probe holes, it is sometimes useful to know the volumes and content of the delivery system lines. The following information may be useful in this regard.

Geoprobe pump: At the end of a pump stroke virtually no deliverable slurry remains in the pump.

5/8” O.D. connecting hose (10 feet long):	0.2 gallons (26 fluid ounces).
Four foot (4’) length of 1” drive rod:	.04 gallons (5 fluid ounces).
Three foot (3’) length of 1 1/2” pre-probe:	.03 gallons (4 fluid ounces).

Cleaning and maintenance:

Pumping equipment and drive rods can be lightly cleaned by circulating clear water through them. Further cleaning and decontamination (if necessary due to subsurface conditions) should be performed according to the equipment supplier’s standard procedures and local regulatory requirements.
B. Operating characteristics
B1. Operations - General
Judgment will be needed in the field when injecting ORC slurries. In general, it is relatively easy to inject ORC slurries into sandy soils, and this can usually be accomplished at very moderate pressures. Silts and clays require more pressure, and may accept less slurry.

Careful observation of pressure during slurry pumping is the best indication of the effectiveness of the slurry injection. To test the soil’s ability to accept the slurry and to “precondition” the injection point for the slurry, it is sometimes useful to inject a small volume of plain water prior to the slurry. Normally, one-half (0.5) gallons to two (2) gallons would be appropriate.

During injection, increasing pressure and decreasing flow rate are signs of refusal by the soil matrix to accept the slurry. The site geologist should determine whether to increase pressure, and possibly fracture (“frac”) the soil matrix to achieve ORC slurry installation in a tight site that has refused the slurry at lower pressures.

B2. Fill Volumes
Probe hole back-filling
Probe hole capacities:

Per 10' (Ten Foot) Length			
Theoretical		**Operating Volume**	
(Gallons/Fluid Ounces/Cubic Inches)		**(Gallons/Fluid Ounces)**	
Sand, Silts & Clay		**Sand**	**Silts & Clay**
1" Diameter	.41 gal/52 fl. oz./94.2 cu. in.	.61 gal/78 fl. oz.	.51 gal/65 fl. oz.
1 1/2" Diameter	.92 gal/117 fl. oz./212.0 cu. in.	1.38 gal/176 fl. Oz.	1.15 gal/146 fl. oz.
2" Diameter	1.63 gal/209 fl. oz./376.8 cu. in.	2.44 gal/313 fl. Oz.	2.04 gal/261 fl. oz.
2 1/4" Diameter	2.06 gal/264 fl. oz./476.9 cu. in	3.09 gal/396 fl. Oz.	2.57 gal/330 fl. oz.

Note that the operating volumes include a 50% excess above the theoretical volume in sands and 25% in clays and silts. This is important to successful treatment. The additional material allows for a small degree of infiltration of the slurry into the surrounding soil and fractures, as well as hole diameter variability. It is important to assure that the entire contaminated saturated zone is treated (including the capillary fringe), since this is often the area of highest pollution concentration. Failure to treat this area due to improper installation can undermine an otherwise successful remediation effort.

APPENDIX C

FIELD FORMS

Tetra Tech NUS, Inc.

DAILY ACTIVITIES RECORD

PROJECT NAME: UST SITE 26-NAS PENSACOLA **PROJECT NUMBER:** N4225

CLIENT: SOUTHNAVFACENGCOM **LOCATION:**

DATE: **ARRIVAL TIME:**

Tt NUS PERSONNEL: **DEPARTURE TIME:**

CONTRACTOR: **DRILLER:**

Item	Description	QUANTITY ESTIMATE	QUANTITY TODAY	PREVIOUS TOTAL QUANTITY	CUMULATIVE QUANTITY TO DATE

LOCATION	FOOTAGE		IDW Drum Labels	

COMMENTS:

APPROVED BY:

Tt NUS REPRESENTATIVE

DRILLER

DATE:

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: UST SITE 26 - NAS PENSACOLA BORING NUMBER:
PROJECT NUMBER: N4225 DATE:
DRILLING COMPANY: GEOLOGIST:
DRILLING RIG: DRILLER:

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth/Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	MATERIAL DESCRIPTION: Color	MATERIAL DESCRIPTION: Material Classification	USCS *	Remarks	PID/FID Reading (ppm): Sample	PID/FID Reading (ppm): Sampler BZ	PID/FID Reading (ppm): Borehole**	PID/FID Reading (ppm): Driller BZ**

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Drilling Area
Background (ppm):

Remarks:

Converted to Well: Yes ____ No ____ Well I.D. #:

Tetra Tech NUS, Inc.

GROUNDWATER LEVEL MEASUREMENT SHEET

Project Name: UST SITE 26-NAS PENSACOLA **Project No.:** N4225

Location: **Personnel:**

Weather Conditions: **Measuring Device:**

Tidally Influenced: **Yes** ____ **No** ____ **Remarks:**

Well or Piezometer Number	Date	Time	Elevation of Reference Point (feet)*	Total Well Depth (feet)*	Water Level Indicator Reading (feet)*	Thickness of Free Product (feet)*	Groundwater Elevation (feet)*	Comments

* All measurements to the nearest 0.01 foot

Tetra Tech NUS, Inc.

GROUNDWATER SAMPLE LOG SHEET

Project Site Name: UST SITE 26 - NAS PENSACOLA
Project No.: N4225

[ ] Domestic Well Data
[X] Monitoring Well Data
[ ] Other Well Type:
[ ] QA Sample Type:

Sample ID No.:
Sample Location:
Sampled By:
C.O.C. No.:
Type of Sample:
[X] Low Concentration
[ ] High Concentration

SAMPLING DATA

Date: / Time:	Color Visual	pH Standard	S.C. mS/cm	Temp. °C	Turbidity NTU	DO mg/l	Salinity %	Other
Method: Low Flow Peristaltic								

PURGE DATA

Date:	Time	pH	S.C.	Temp (°C)	Turbidity	DO	Salinity	ORP
Method: Low Flow Peristaltic								
Monitor Reading (ppm):								
Well Casing Diameter:								
Well Casing Material:								
Total Well Depth (TD):								
Static Water Level (WL):								
One Casing Volume(gal/L):								
Start Purge (hrs):								
End Purge (hrs):								
Total Purge Time (min):								
Total Vol. Purged (gal/L):								

SAMPLE COLLECTION INFORMATION

Analysis	Preservative	Container Requirements	Collected

OBSERVATIONS / NOTES

Circle if Applicable:

MS/MSD

Duplicate ID No.:

Signature(s):

FIELD ANALYTICAL LOG SHEET
GEOCHEMICAL PARAMETERS

Tetra Tech NUS, Inc.

Project Site Name: **UST SITE 26 - NAS PENSACOLA**
Sample ID No.:
Project No.: **N4225**
Sample Location:
Sampled By:
Duplicate: ☐
Field Analyst:
Blank: ☐
Field Form Checked as per QA/QC Checklist (initials):

SAMPLING DATA:

Date: / Time:	Color (Visual)	ORP (Eh) (+/- mv)	S.C. (mS/cm)	Temp. (^{0}C)	Turbidity (NTU)	DO (Meter, mg/l)	Sal. (%)	pH (SU)
Method:								

SAMPLE COLLECTION/ANALYSIS INFORMATION:

Dissolved Oxygen:

Equipment: HACH Digital Titrator OX-DT CHEMetrics (Range: _____mg/L) Analysis Time: _____

Range Used:	Range	Sample Vol.	Cartridge	Multiplier
☐	1-5 mg/L	200 ml	0.200 N	0.01
☐	2-10 mg/L	100 ml	0.200 N	0.02

Titration Count	Multiplier	Concentration
_____	x 0.01 =	mg/L
_____	x 0.02 =	mg/L

CHEMetrics: _____mg/L

Notes:

Alkalinity:

Analysis Time: _____

Equipment: HACH Digital Titrator AL-DT CHEMetrics (Range: _____mg/L) Filtered: ☐

Range Used:	Range	Sample Vol.	Cartridge	Multiplier	Titration Count	Multiplier	Concentration
☐	10-40 mg/L	100 ml	0.1600 N	0.1	_____ & _____	x 0.1 =	mg/L
☐	40-160 mg/L	25 ml	0.1600 N	0.4	_____ & _____	x 0.4 =	mg/L
☐	100-400 mg/L	100 ml	1.600 N	1.0	_____ & _____	x 1.0 =	mg/L
☐	200-800 mg/L	50 ml	1.600 N	2.0	_____ & _____	x 2.0 =	mg/L
☐	500-2000 mg/L	20 ml	1.600 N	5.0	_____ & _____	x 5.0 =	mg/L
☐	1000-4000 mg/L	10 ml	1.600 N	10.0	_____ & _____	x 10.0 =	mg/L

Parameter:	Hydroxide	Carbonate	Bicarbonate
Relationship:			

CHEMetrics: _____mg/L

Notes:

Standard Additions: ☐ Titrant Molarity:_____ Digits Required: 1st.:_____ 2nd.:_____ 3rd.:_____

Carbon Dioxide:

Equipment: HACH Digital Titrator CA-DT CHEMetrics (Range: _____mg/L) Analysis Time: _____

Range Used:	Range	Sample Vol.	Cartridge	Multiplier
☐	10-50 mg/L	200 ml	0.3636 N	0.1
☐	20-100 mg/L	100 ml	0.3636 N	0.2
☐	100-400 mg/L	200 ml	3.636 N	1.0
☐	200-1000 mg/L	100 ml	3.636 N	2.0

Titration Count		Concentration
_____	x 0.1 =	mg/L
_____	x 0.2 =	mg/L
_____	x 1.0 =	mg/L
_____	x 2.0 =	mg/L

CHEMetrics: _____mg/L

Notes:

Standard Additions: ☐ Titrant Molarity:_____ Digits Required: 1st.:_____ 2nd.:_____ 3rd.:_____

GROUNDWATER SAMPLE LOG SHEET
NATURAL ATTENUATION PARAMETERS

Tetra Tech NUS, Inc.

Project Site Name: **UST SITE 26 - NAS PENSACOLA**
Project No.: **N4225**
Sample ID No.: _____
Sample Location: Site No.
Sampled By: _____

SAMPLING DATA:

Date: / Time:	Color (Visual)	pH (SU)	S.C. (mS/cm)	Temp. (^{0}C)	Turbidity (NTU)	DO (Meter, mg/l)	Sal. (%)	
Method: Peristaltic pump								

SAMPLE COLLECTION/ANALYSIS INFORMATION:

Sulfide:

Equipment: HACH DR-700 Colorimeter HACH DR-800 Colorimeter HACH HS-C Test Kit

Wave / Program: 610nm / 61.12.1

TtNUS Serial No.: _____

Concentration: _____ mg/L

Ferrous Iron:

Equipment: HACH DR-700 Colorimeter HACH DR-800 Colorimeter HACH IR-18C Test Kit

Wave / Program: 500nm / 50.05.1

TtNUS Serial No.: _____

Concentration: _____ mg/L

Manganese:

Equipment: HACH DR-700 Colorimeter HACH DR-800 Colorimeter

Wave / Program: 525nm / 52.13.1

TtNUS Serial No.: _____

Concentration: _____ mg/L

FIELD ANALYTICAL LOG SHEET
GEOCHEMICAL PARAMETERS

Tetra Tech NUS, Inc.

Project Site Name: **UST SITE 26 - NAS PENSACOLA** Sample ID No.:

Project No.: **N4225** Sample Location:

Sampled By: Duplicate: ☐

Field Analyst: Blank: ☐

Field Form Checked as per QA/QC Checklist (initials): ____

SAMPLE COLLECTION/ANALYSIS INFORMATION:

Manganese (Mn^{2+}):

Equipment: DR-700 DR-8 _ _ HACH MN-5 Other: _____ Analysis Time: _____

Program/Module: 525nm 41

Concentration: _____ mg/L Filtered: ☐

Digestion: ☐

Standard Solution: ☐ Results: _____ Reagent Blank Correction: ☐

Standard Additions: ☐ Digits Required: 0.1ml:_____ 0.2ml:_____ 0.3ml:_____

Notes:

Ferrous Iron (Fe^{2+}):

Equipment: DR-700 DR-8 _ _ IR-18C Color Wheel Other: _____ Analysis Time: _____

Program/Module: 500nm 33

Concentration: _____ mg/L Filtered: ☐

Notes:

Hydrogen Sulfide (H_2S):

Equipment: HS-C Other: _____ Analysis Time: _____

Concentration: _____ mg/L Exceeded 5.0 mg/L range on color chart: ☐

Notes:

QA/QC Checklist:

All data fields have been completed as necessary: ☐

Correct measurement units are cited in the SAMPLING DATA block: ☐

Mulitplication is correct for each *Multiplier* table: ☐

Final calulated concentration is within the appropriate *Range Used* block: ☐

Alkalinity *Relationship* is determined appropriatly as per manufacturer instructions: ☐

QA/QC sample (e.g., Std. Additions, etc.) frequency is appropriate as per the project planning documents: ☐

Nitrite Interference treatment used for Nitrate test if Nitrite was detected: ☐

Title block is initialized by person who performed the QA/QC Ckecklist: ☐

EQUIPMENT CALIBRATION LOG

INSTRUMENT NAME/MODEL : ______________________ PROJECT NAME : **UST SITE 26 - NAS PENSACOLA**

MANUFACTURER : ______________________ PROJECT NUMBER : **N4225**

CALIBRATION DATE	INITIAL SETTINGS	STANDARDS USED	PROCEDURE	ADJUSTMENTS MADE	FINAL SETTINGS	SIGNATURE	COMMENTS