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ENHANCED NATURAL ATTENUATION TREATABILITY STUDY EVALUATION REPORT FOR BP WELLS SITE NAS CECIL FIELD FL

4/8/2004

TETRA TECH NUS INC

Rev. 1
04/08/04

Enhanced Natural Attenuation Treatability Study Evaluation Report

for

BP Wells Site

Naval Air Station Cecil Field

Jacksonville, Florida

Southern Division
Naval Facilities Engineering Command

Contract Number N62467-94-D-0888

Contract Task Order 0248

April 2004

The professional opinions rendered in this decision document identified as Enhanced Natural Attenuation Treatability Study Evaluation Report for BP Wells Site, NAS Cecil Field, Jacksonville, 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.

April 6, 2004
Gregory S. Roof, P.E.
Professional Engineering Number 50842
Tetra Tech NUS, Inc. Engineering No. 7988

Rev. 1
04/08/04

ENHANCED NATURAL ATTENUATION TREATABILITY STUDY EVALUATION REPORT FOR BP WELLS SITE

NAVAL AIR STATION CECIL FIELD
JACKSONVILLE, FLORIDA

COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

Submitted to:
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Naval Facilities Engineering Command
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ACRONYMS

bgs	Below ground surface
°C	Degrees Celsius
CLEAN	Comprehensive Long-term Environmental Action Navy
COC	Chemicals of Concern
CTO	Contract Task Order
DO	Dissolved oxygen
ENATS	Enhanced Natural Attenuation Treatability Study
FDEP	Florida Department of Environmental Protection
ft	Feet/foot
ft^3	cubic feet
FE^{2+}	Ferrous Iron
FE^{3+}	Ferric Iron
GCTL	Groundwater Cleanup Target Level
HDPE	High Density Polyethylene
iSOC™	In-situ Oxygen Curtain
iTi	inVentures Technologies, Inc.
lb	pound/pounds
µg/L	Micrograms per liter
mg/L	Milligrams per liter
MNA	Monitored Natural Attenuation
MNAP	Monitored Natural Attenuation Plan
mS/cm	Microsiemens per centimeter
mV	Millivolts
NAS	Naval Air Station
NAMPAO	Natural Attenuation Monitoring Plan Approval Order
NAVFAC EFD SOUTH	United Sates Navy Southern Division Naval Facilities Engineering Command
ORP	Oxidation-Reduction Potential
PAH	Polycyclic aromatic hydrocarbon
PVC	Polyvinyl chloride
RAP	Remedial Action Plan
SAR	Site Assessment Report
SC	Specific conductance
SOPs	Standard Operating Procedures
TMB	Trimethylbenzene

TOC	Total organic carbon
TRPH	Total recoverable petroleum hydrocarbons
TtNUS	Tetra Tech NUS, Inc.
USEPA	United States Environmental Protection Agency

EXECUTIVE SUMMARY

Tetra Tech NUS, Inc. (TtNUS) prepared this Enhanced Natural Attenuation Treatability Study Evaluation Report for the BP Wells Site at Naval Air station (NAS) Cecil Field, Jacksonville, Florida. This report was prepared for the United States Navy (Navy) Southern Division, Naval Facilities Engineering Command under Contract Task Order (CTO) 0248 for the Comprehensive Long-term Environmental Action Navy (CLEAN) Contract Number N62467-94-D-0888. This report provides the results of the fourth quarter treatability study groundwater sampling event conducted in October 2003 at BP Wells, and evaluates the effectiveness of the In-situ Oxygen Curtain (iSOC™) technology selected for the treatability study.

From 1999 to 2000, contamination assessment activities were performed at the BP Wells site, located to the north of Building 838, to determine the extent of petroleum-impacted soil and groundwater at the site. The site assessment confirmed the presence of contaminated groundwater and identified the groundwater flow direction to the southwest. A Natural Attenuation Monitoring Plan was implemented in 2001, but the analytical results after one year of semi-annual sampling an analysis showed that concentrations of contaminants in the source area well were greater than the applicable natural attenuation default source concentrations. Based on the these results, the monitoring was suspended and the preparation of a Remedial Action Plan (RAP) was proposed. Subsequently, TtNUS recommended that a treatability study be performed to evaluate the effectiveness of in-situ enhanced bioremediation at the site. The in-situ oxygen curtain (iSOC™) technology would be evaluated to perform this test. In June 2002, TtNUS submitted an Enhanced Natural Attenuation Treatability Study (ENATS) Work Plan for the BP Wells site.

As part of the treatability study, three iSOC™ diffusers were installed in three new injection wells located about 10 to 15 feet from the existing monitoring wells. To monitor the effect of the iSOC™ system, groundwater samples were collected quarterly from three selected monitoring wells and analyzed for constituents of concern (COCs) (specifically ethylbenzene; total xylenes; 1,2,4-trimethylbenzene; and 1,3,5-trimethylbenzene) and natural attenuation parameters. The three wells included in the monitoring program were CEF-BP-1S (source well), CEF-BP-2S (background well), and CEF-BP-6S (downgradient well). Three injection wells were constructed as standard monitoring wells. Each injection well was installed to a total depth of 15 feet (ft) below ground surface (bgs).

The individual iSOC™ systems were installed on October 9, 2002. Each system consists of one 40 ft^3 (cubic feet) oxygen tank, a low-flow regulator, a control panel, and an oxygen diffuser. The regulator was attached to the oxygen tank to control the flow of gas to the control panel. The control panel was used to control the pressure and flow rate of the gas entering the diffuser. The diffuser was lowered directly to the bottom of the injection well. On October 9, 2002, the flow rate at each iSOC™ injection point was adjusted to 15 cubic centimeters per minute according to the manufacturer's specifications. The 40 ft^3 tanks were later replaced by 80 ft^3 tanks.

The monitoring wells were sampled and analyzed quarterly for ethylbenzene, total xylenes, 1,2,4-trimethylbenzene, 1,3,5-trimethylbenzene, and natural attenuation parameters. The natural attenuation parameters included pH, conductivity, temperature, dissolved oxygen (DO), and oxidation-reduction potential (ORP), ferrous iron, alkalinity, carbon dioxide, hydrogen sulfide, sulfate, nitrate, nitrite, phosphate, total organic carbon (TOC) , and methane. The system was inspected monthly and oxygen tanks were replaced as needed.

Over the first three quarters, COC concentrations in the source well decreased, but increased significantly in the fourth event. However, the DO concentrations in the any of the monitoring wells did not increase significantly, as expected. The trends of the natural attenuation parameters suggested anaerobic conditions.

The TOC concentrations of the source well, background, and downgradient wells suggest the presence of a high mass of hydrocarbons. The mass of TOC in the aqueous and sorbed phases is estimated to be 108 pounds. However, based on the oxygen used and typical TOC to oxygen ratios, the maximum amount of TOC that could be consumed by the oxygen that was injected was 28 pounds. Thus, the absence of increased concentrations of dissolved oxygen in the monitoring wells could have been a result of the oxygen being consumed before reaching the observation wells.

The following conclusions are based on the treatability study data:

- The radius of aerobic conditions around the iSOCTM injection wells appears to be limited, and the results are inconclusive as to the ability of the system to provide sufficient oxygen to enhance biodegradation processes. The estimated oxygen demand of the organic material appears to be significantly greater than the oxygen injected. Based on the positions of the monitoring well compared to the oxygen-injection wells, the radius of influence is less than 15 ft.

- The MNA parameter measurements suggest that the groundwater is in an anaerobic condition, and that iSOCTM was not effective at dispersing oxygen to the monitoring wells under the site conditions.
- Compared to the baseline measurements, COC concentrations have increased in source area well.
- The concentrations of COCs in the source well still exceed the FDEP GCTLs.

The extent of the plume is also uncertain. Contaminants have only been measured in one well, although TOC concentrations are significant in all three wells. The width of the plume is uncertain, so the mass of hydrocarbons in the groundwater and sorbed to the soil in the saturated zone is uncertain.

Another uncertainty in the contaminant distribution is whether there is a high concentration smear zone. If the source of the groundwater contamination was by the release of fuel, then a high concentration free-product layer may be present that could account for a relatively significant source of hydrocarbons.

Oxygen could also be lost to the atmosphere or to deeper depths. In addition to diffusion in a radial direction, oxygen will also diffuse upward and downward. Oxygen that diffuses upward will be lost to the atmosphere and oxygen that diffuses downward will not contact the contaminants. The amount of oxygen lost to depth or to atmosphere is uncertain.

The secondary line of evidence, the MNA parameter information, suggests that the iSOC™ system has not increased the DO available in the subsurface. The changes in the MNA parameters are all suggestive of an anaerobic environment.

Because concentrations of COCs have increased during the treatability study and no increase in the DO concentrations were observed in the monitoring wells, TtNUS concludes that the technology was not effective for these specific site conditions. Therefore, TtNUS recommends that the treatability study at the BP Wells Site be discontinued and further assessment of the site be performed in order to obtain more complete data for preparation of a RAP.

The supplemental assessment will be conducted in two phases. The first phase includes the following tasks:

Groundwater samples will be collected from the site monitoring wells and from the iSOC™ injection wells and analyzed for VOCs and TOC. This will provide information on the extent of remediation in the immediate vicinity of the oxygen injection points. The injection wells are constructed like monitoring wells and, therefore, are suitable for environmental sampling.

Perform a pilot-scale air sparging treatability study at the site in conjunction with the upcoming air sparging treatability study at the G82 site, located approximately 100 feet to the south. Air sparging may be a more effective process in that VOCs will be physically stripped in a relatively short period of time, along with the benefit of creating aerobic conditions for biological activity.

Upon completion of the first phase, if the results indicate that further assessment is required, the second phase will include:

Further delineation of the plume, particularly to the south and upgradient.

Further characterization of the distribution of contaminants in the smear zone (adsorbed phase vs. dissolved phase).

Further characterization of the contaminants, such as for PAHs, such as naphthalenes, and TRPH. Characterization should also consider biochemical oxygen demand, chemical oxygen demand, and total organic carbon.

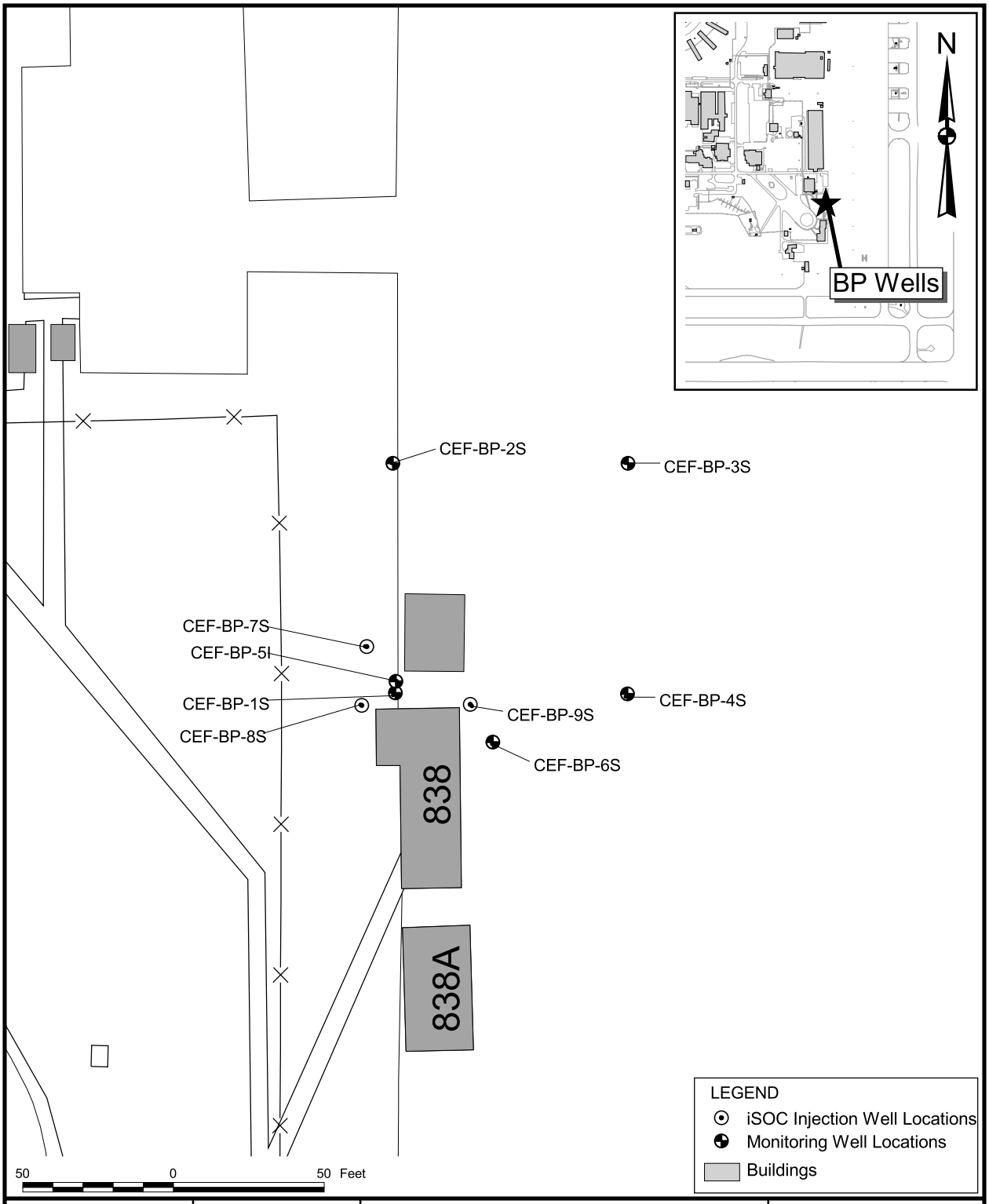
Upon completion of the supplemental assessment, a SAR Addendum should be prepared and submitted to the FDEP for review. Upon approval of the SAR Addendum, a RAP may be prepared to evaluate remedial alternatives for the site.

1.0 INTRODUCTION

TtNUS is pleased to submit this ENATS Evaluation Report for the BP Wells Site at NAS Cecil Field, Jacksonville, Florida. This report was prepared for the NAVFAC EFD SOUTH under CTO 0248 for the CLEAN III Contract Number N62467-94-D-0888. This report provides the results of the fourth quarter treatability study groundwater sampling event conducted in October 2003 at BP Wells, and evaluates the effectiveness of the iSOC™ technology selected for the treatability study.

1.1 SITE SUMMARY

From 1999 to 2000, contamination assessment activities were performed at the BP Wells site, located to the north of Building 838, to determine the extent of petroleum-impacted soil and groundwater at the site (see Figure 1-1). A due diligence investigation was conducted by Golder Associates, Inc. (1999) for the new property tenants (Jacksonville Airport Authority and Air Kaman). The reported results indicated the presence of petroleum-impacted groundwater at the site. Subsequently, the Navy directed TtNUS to conduct a site assessment. The site assessment confirmed the presence of contaminated groundwater and identified the groundwater flow direction to the southwest. A SAR (2000) was submitted to the FDEP recommending that a natural attenuation monitoring plan be implemented at the site. The FDEP approved the plan and issued a Natural Attenuation Monitoring Plan Approval Order (NAMPAO) on August 31, 2000. In accordance with the NAMPAO, TtNUS performed the first two semi-annual groundwater sampling events in April and October of 2001. Since the contaminant concentrations at the source well were greater than the applicable natural attenuation default source concentrations, and because the contaminant concentrations were increasing, the second monitoring report recommended that the semi-annual monitoring program be suspended and that a RAP be prepared for the site. On February 20, 2002, the FDEP agreed that a RAP was warranted. Subsequently, TtNUS recommended that a treatability study be performed to evaluate the effectiveness of in-situ enhanced bioremediation at the site. The iSOC™ technology would be evaluated to perform this test. In June 2002, TtNUS submitted an ENATS Work Plan for the BP Wells site.



DRAWN BY MJJ	DATE 24Mar03	SITE PLAN BP WELLS SITE TREATABILITY STUDY NAVAL AIR STATION CECIL FIELD JACKSONVILLE, FLORIDA	CONTRACT NUMBER 4248
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COST/SCHEDULE-AREA			APPROVED BY DATE
SCALE AS NOTED			DRAWING NO. FIGURE 1-1 / REV 0

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2.0 TREATABILITY STUDY

2.1 TREATABILITY STUDY OBJECTIVE

The objective of the ENATS was to determine the effectiveness of an iSOC™ system in reducing hydrocarbon concentrations in groundwater at the BP Wells Site. The treatability study was designed to reduce the contaminant concentrations within the source area. This strategy relies on maintaining consistently high DO levels to increase the microbial activity, thereby increasing contaminant destruction through aerobic respiration.

iSOC™ is a specially designed micro porous mass transfer device invented and manufactured by inVentures Technologies, Inc. (iTi) for use in groundwater remediation. iSOC™ is based on iTi's proprietary Gas inFusion™ technology. The iSOC™ technology dissolves oxygen into the groundwater without bubbles through an iSOC™ diffuser. As reported by the manufacturer, this technology can increase DO concentrations in the groundwater 50 to 70 parts per million. The increase in DO in the aquifer creates aerobic conditions that can stimulate in-situ bioremediation of the petroleum hydrocarbon plume.

As part of the treatability study, three iSOC™ diffusers were installed in three new injection wells (Figure 1-1). To monitor the effect of the iSOC™ system, a baseline-sampling event was completed prior to the injection well installation and four quarters of groundwater sampling were conducted while the iSOC™ system was in operation. Groundwater samples were collected from the three selected monitoring wells and analyzed for COCs previously specified in the NAMPAO (specifically ethylbenzene; total xylenes; 1,2,4-TMB; and 1,3,5-TBM). The three wells included in the monitoring program were CEF-BP-1S (source well), CEF-BP-2S (background well), and CEF-BP-6S (downgradient well).

2.2 iSOC™ SYSTEM INSTALLATION

TtNUS personnel mobilized to the site on October 9, 2002, to install the iSOC™ system. The injection wells, designated CEF-BP-7S through CEF-BP-9S, were installed at the locations shown on Figure 1-1. The three injection wells were constructed as standard monitoring wells. Each well was installed to a total depth of 15 ft bgs. The injection wells were constructed of 2 inch polyvinyl chloride (PVC) riser with 10 ft lengths of 0.010 inch slot PVC screen. The injection wells were finished at the surface with a 24.5 inch diameter manhole. A diagram depicting the well construction details and photographs of the well installation are included in Appendix A.

On September 12, 2002, the three injection wells were developed. Field parameters [pH, temperature, and specific conductance (SC)] were measured at equally spaced time intervals during well development. The wells were developed by pumping until the field measurements became stable and the development water was visibly clear. Approximately 50 gallons of water were removed from each injection well during development. The well development records are included in Appendix A.

After development of the injection wells, the individual iSOC™ systems were installed on October 9, 2002. Each system consists of one 40 ft^3 oxygen tank, a low-flow regulator, a control panel, and an oxygen diffuser. The oxygen tank was placed in the well vault adjacent to the control panel. The regulator was attached to the oxygen tank to control the flow of gas to the control panel. High-density polyethylene (HDPE) tubing was used to connect the regulator to the control panel. The control panel was used to control the pressure and flow rate of the gas entering the diffuser. HDPE tubing was used to connect the control panel to the oxygen diffuser. The diffuser was lowered directly to the bottom of the injection well. On October 9, 2002, the flow rate at each iSOC™ injection point was adjusted to 15 cubic centimeters per minute according to the manufacturer's specifications.

After approximately one month of operation, the rate of oxygen feed depleted the oxygen supply in the tank in injection point CEF-BP-8S. As a result, the 40 ft^3 tanks were replaced with 80 ft^3 tanks. To accommodate the larger tanks, the vaults were modified by excavating a hole in the bottom of each vault and installing an 8 inch diameter PVC sleeve to a depth of approximately 3 ft bgs next to each injection well. The 80 ft^3 oxygen tanks were then installed within the PVC sleeves.

2.3 GROUNDWATER SAMPLING AND SYSTEM OPERATION ACTIVITIES

The iSOC™ system was operated from October 2002 through November 2003. TtNUS personnel visited the site on a monthly basis to inspect the iSOC™ system and ensure that it was operating in accordance with the parameters specified in the work plan. TtNUS personnel conducted the following sampling events as part of the treatability study:

October 3, 2002 – Baseline groundwater monitoring event
January 6, 2003 – First quarter groundwater monitoring event
April 17, 2003 – Second quarter groundwater monitoring event
July 17, 2003 – Third quarter groundwater monitoring event
October 16, 2003 – Fourth quarter groundwater monitoring event

Each groundwater monitoring event included the measurement of depth to groundwater and collection of groundwater samples from the site monitoring wells. TtNUS personnel also collected DO measurements from the three injection wells and checked the status of the iSOC™ system. The purpose of the sampling

was to measure concentrations of both COCs and natural attenuation parameters. During the quarterly sampling events, groundwater samples were collected from monitoring wells CEF-BP-01S, CEF-BP-02S, and CEF-BP-06S (Figure 1-1) and analyzed for COCs, TOC, sulfate, and field and laboratory natural attenuation parameters.

Groundwater samples were collected from the three wells in general accordance with the current FDEP Standard Operating Procedures (SOPs). Depth-to-water was measured, and the wells were purged prior to sample collection. Purging was accomplished with a peristaltic pump using low flow purge technique. During purging, field parameters [pH, conductivity, temperature, DO, and ORP] were measured at approximately 5 to 10 minute intervals using a YSI® Model 556. The instrument was calibrated according to the manufacturer's specifications at the beginning of the day. A Field Calibration Log for the fourth quarter sampling event is provided in Appendix B. In addition, turbidity was monitored using a La Motte Turbidimeter.

Following the well purging activities, the groundwater samples were analyzed in the field for the following natural attenuation parameters: Fe^{2+}, alkalinity, carbon dioxide, DO, and hydrogen sulfide. Groundwater Sample Log Sheets, Low Flow Purge Data Sheets, and Natural Attenuation Parameter Sheets compiled during purging and sampling at each location for the fourth quarter sampling event are also provided in Appendix B.

Additional groundwater samples were collected for off-site analysis of the COCs by United States Environmental Protection Agency (USEPA) Method SW846 8260; TOC by USEPA Method 415.1; methane by RSK SOP 147/175, and sulfate by USEPA Method 300. After collection, groundwater samples were placed on ice and shipped overnight via Federal Express to approved and certified laboratories for analysis. The validated laboratory data for the fourth quarter sampling event is included in Appendix C.

3.0 TREATABILITY STUDY RESULTS AND DISCUSSION

3.1 iSOC™ SYSTEM PERFORMANCE

DO measurements were taken from the iSOC™ injection wells following system installation and during each of the quarterly sampling events (Table 3-1). The DO data from the injection wells indicates that elevated concentrations of DO are present in the groundwater in the injection wells and frequently exceeded the equilibrium solubility limit of atmospheric oxygen in groundwater, which would range from approximately 7.5 to 9.1 milligram per liter (mg/L) at the groundwater temperatures measured during the treatability study. This suggests that the iSOC™ units were effectively providing DO to groundwater in the injection wells at levels that can promote biodegradation of petroleum constituents. However, no significant changes in the DO concentration were observed in groundwater samples from wells CEF-BP-1S, which was about 12 ft away from the nearest injection well, and CEF-BP-6S, which was about 15 ft away from the nearest injection well. Thus, the radius of influence of the injection wells was less than 15 ft.

3.2 GROUNDWATER FLOW AND ELEVATION

Depth to water measurements were collected during each quarterly groundwater monitoring event (Table 3-2). Groundwater elevations were calculated from the depth to water measurements and monitoring wells top of casing elevations referenced to an arbitrary site specific datum of 20 ft. Groundwater flow direction was determined from the groundwater elevations calculated for each sampling event.

Groundwater elevations during September 2002 (baseline) ranged from 65.98 to 66.36 ft. Groundwater gradient appears to be relatively flat in this area (Figure 3-1). The overall groundwater flow across the site appears to be generally to the southeast.

Groundwater elevations during January 2003 (first quarter) ranged from 65.15 to 65.37 ft, approximately 1 ft lower than during the previous sampling event. Groundwater flow during this sampling event was generally to the east-southeast, which is consistent with the groundwater flow reported during the baseline sampling event (Figure 3-2).

Groundwater elevations during April 2003 (second quarter) ranged from 65.32 to 65.64 ft, approximately the same levels present during the previous sampling event. This groundwater flow direction appears to be generally to the east-southeast, which is similar to the groundwater flow reported during previous monitoring events (Figure 3-3).

TABLE 3-1

DISSOLVED OXYGEN RESULTS
BP WELLS SITE TREATABILITY STUDY
NAVAL AIR STATION CECIL FIELD
JACKSONVILLE, FLORIDA

Sample Location	Well Type	Collection Dates[3]								
		9/24/2002	10/3/2002	1/6/2003	1/29/2003	1/30/2003	3/14/2003	4/17/2003	7/17/2003	10/16/2003
CEF-BP-1S (1)	Monitoring Well	0.9	0.05	0.62	NC	0.062	NC	0.26	0.25	0.11
CEF-BP-2S (1)	Monitoring Well	7.8	0.77	3.2	NC	2.0	NC	2.5	4.7	1.9
CEF-BP-6S (1)	Monitoring Well	0.9	NC	0.96	NC	0.86	NC	0.64	0.96	0.59
CEF-BP-7S (2)	Injection Well	NC	NC	NC	31.5	NC	39.03	13.4	39.5	3.7
CEF-BP-8S (2)	Injection Well	NC	NC	NC	18.8	NC	40.33	13.7	40.6	34.6
CEF-BP-9S (2)	Injection Well	NC	NC	NC	41.5	NC	39.00	15.0	40.2	34.5

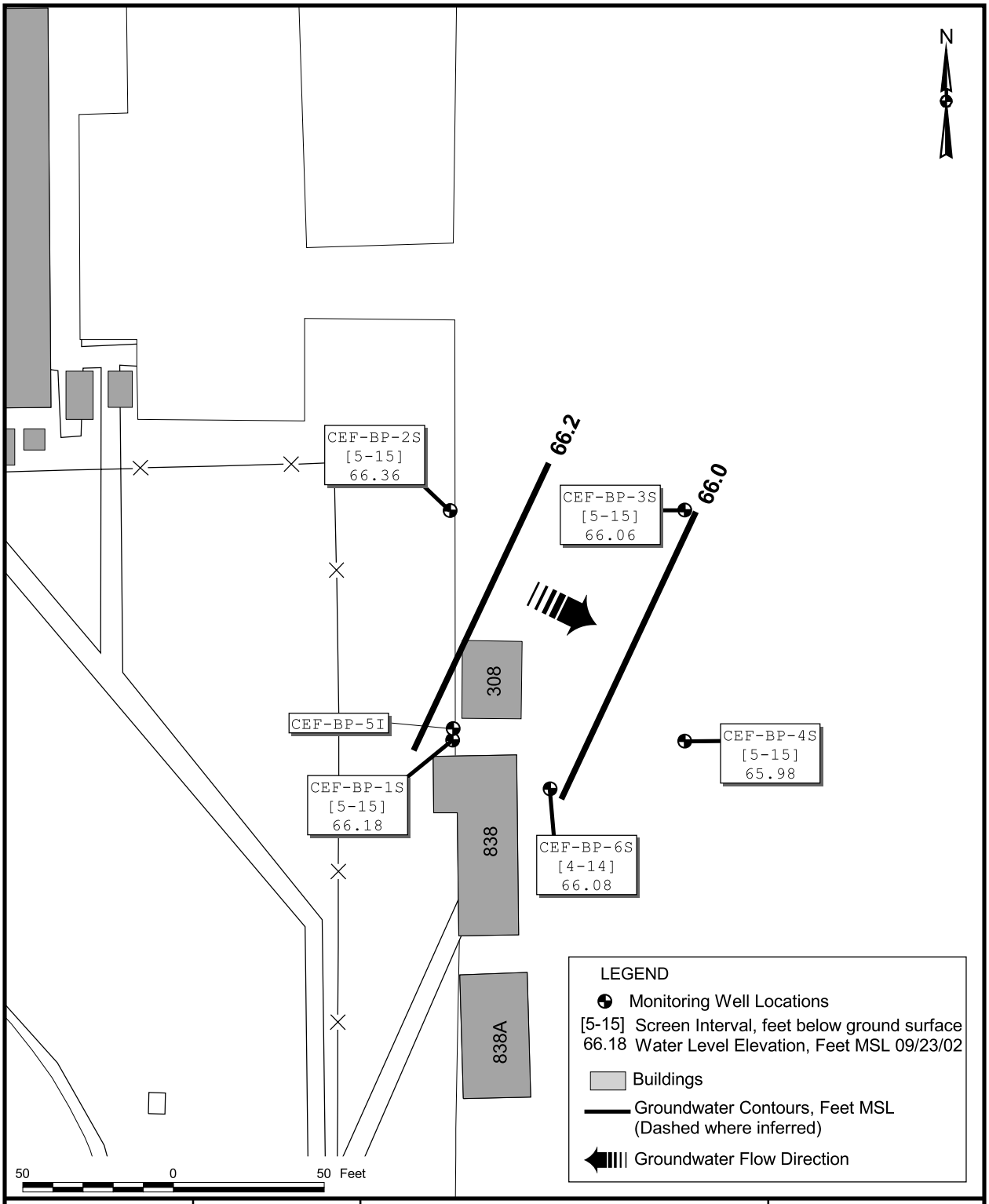
Notes:
DO units are in miligrams per liter (mg/L).
NC = not collected.
[1] - Measurements collected by meter in a flow cell; thus, may be subject to outside influences and fluctuation.
[2] - Measurements collected by meter in the well.
[3] - iSOC™ began discharging oxygen on October 9, 2002.

TABLE 3-2

GROUNDWATER ELEVATION SUMMARY
BP WELLS SITE TREATABILITY STUDY
NAVAL AIR STATION CECIL FIELD
JACKSONVILLE, FLORIDA

Well Number	Total Depth of Well (ft, btoc)	Top of Casing Elevation (ft, NAVD)	9/23/2002		1/6/2003		4/17/2003		7/17/2003		10/16/2003	
			Depth to Water (ft, btoc)	Groundwater Elevation (ft, msl)	Depth to Water (ft, btoc)	Groundwater Elevation (ft, msl)	Depth to Water (ft, btoc)	Groundwater Elevation (ft, msl)	Depth to Water (ft, btoc)	Groundwater Elevation (ft, msl)	Depth to Water (ft, btoc)	Groundwater Elevation (ft, msl)
CEF-BP-1S	14.72	71.28	5.10	66.18	6.00	65.28	5.75	65.53	4.63	66.65	7.57	63.71
CEF-BP-2S	14.48	71.78	5.42	66.36	6.41	65.37	6.14	65.64	5.02	66.76	6.93	64.85
CEF-BP-3S	14.57	72.38	6.32	66.06	NM	NM	6.98	65.40	5.90	66.48	7.72	64.66
CEF-BP-4S	14.75	72.28	6.30	65.98	NM	NM	6.96	65.32	5.86	66.42	7.74	64.54
CEF-BP-5I	34.39	71.63	5.45	66.18	NM	NM	6.11	65.52	5.01	66.62	6.92	64.71
CEF-BP-6S	14.20	71.87	5.79	66.08	6.72	65.15	6.44	65.43	5.35	66.52	7.26	64.61

Notes:
btoc = below top of casing.
msl = mean sea level.
NA = not available.
NAVD = North American Vertical Datum, 1988.
NM = not measured.
ft = foot/feet



DRAWN BY MJJ — DATE 24Mar03	BASELINE	CONTRACT NUMBER 4248	
CHECKED BY — DATE	GROUNDWATER FLOW MAP (09/23/02)	APPROVED BY — DATE	
COST/SCHEDULE-AREA	BP WELLS SITE	APPROVED BY — DATE	
SCALE AS NOTED	TREATABILITY STUDY NAVAL AIR STATION CECIL FIELD JACKSONVILLE, FLORIDA	DRAWING NO. FIGURE 3-1	REV 0

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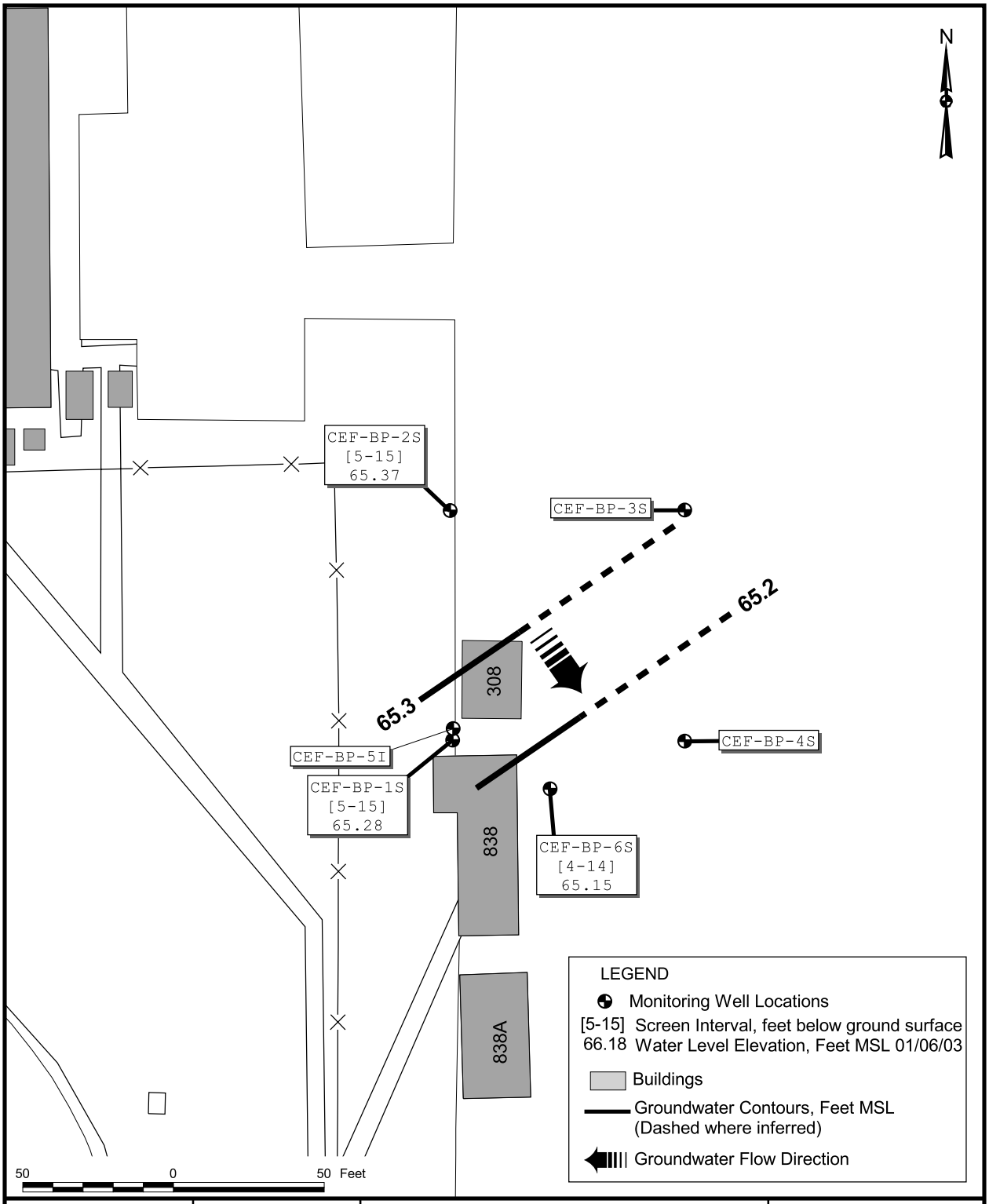

DRAWN BY MJJ	DATE 24Mar03	GROUNDWATER FLOW MAP (01/06/03) BP WELLS SITE TREATABILITY STUDY NAVAL AIR STATION CECIL FIELD JACKSONVILLE, FLORIDA	CONTRACT NUMBER 4248
CHECKED BY	DATE		APPROVED BY DATE
COST/SCHEDULE-AREA			APPROVED BY DATE
SCALE AS NOTED			DRAWING NO. FIGURE 3-2 / REV 0

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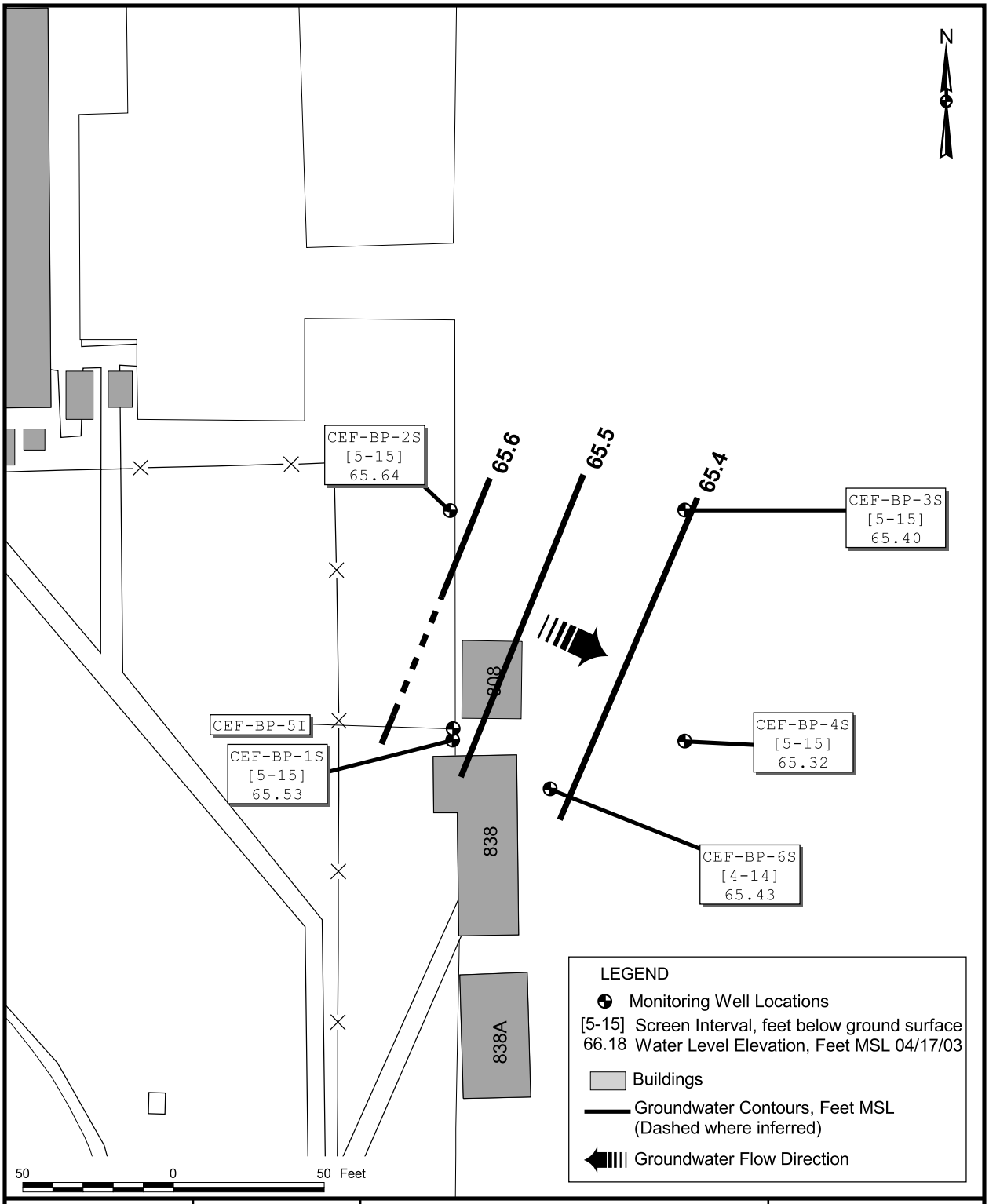

DRAWN BY MJJ	DATE 24Mar03	GROUNDWATER FLOW MAP (04/17/03) BP WELLS SITE TREATABILITY STUDY NAVAL AIR STATION CECIL FIELD JACKSONVILLE, FLORIDA	CONTRACT NUMBER 4248
CHECKED BY	DATE		APPROVED BY DATE
COST/SCHEDULE-AREA			APPROVED BY DATE
SCALE AS NOTED			DRAWING NO. FIGURE 3-3 / REV 0

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Groundwater elevations during July 2003 (third quarter) ranged from 66.42 to 66.76 ft. Groundwater elevations increased by approximately 1 ft from the previous sampling event. Groundwater flow during this sampling event was generally to the east-southeast, which is consistent with the groundwater flow reported during previous monitoring events (Figure 3-4).

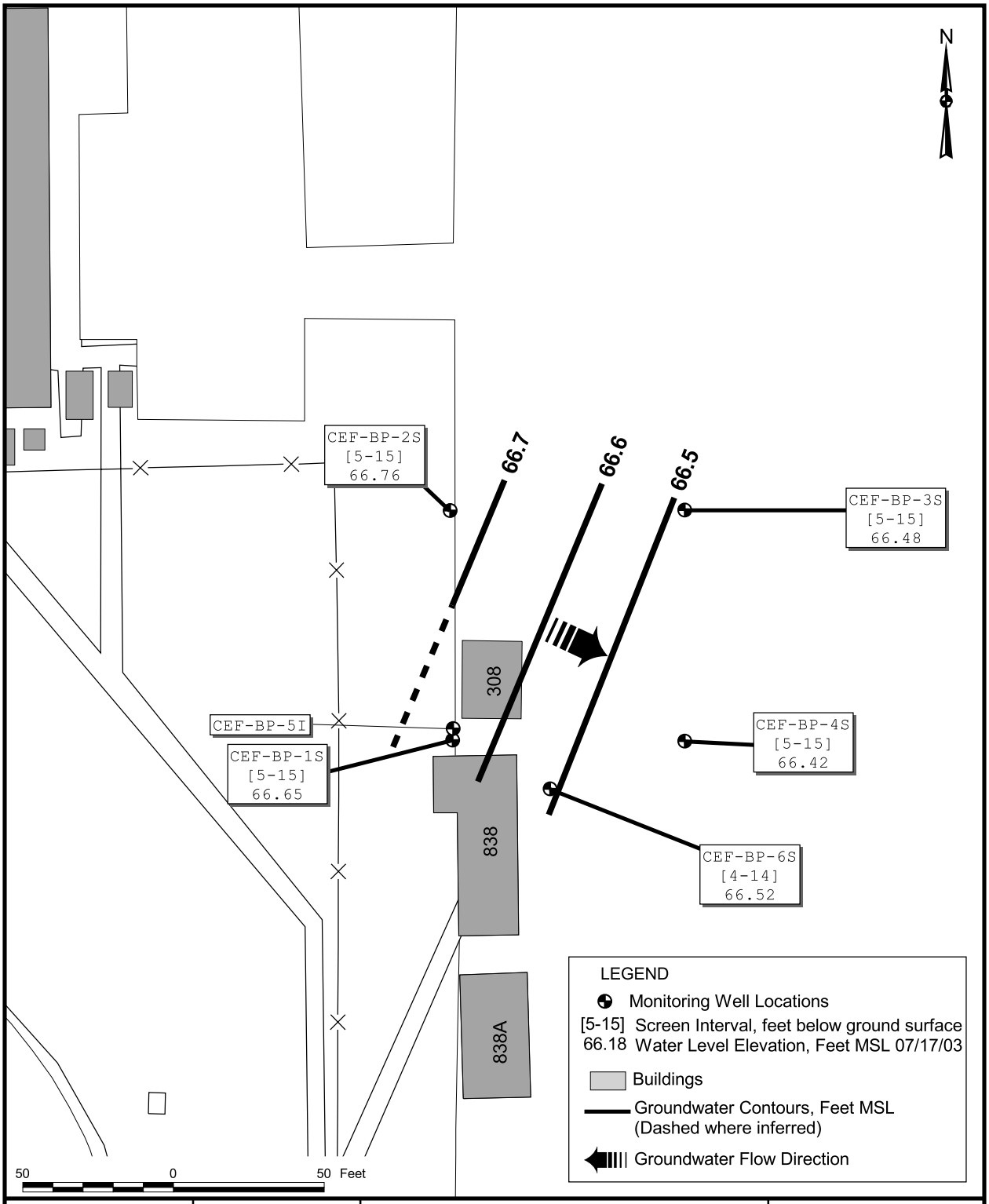
Groundwater elevations during October 2003 (fourth quarter) ranged from 63.71 to 64.85 ft, approximately 1 ft lower than during the previous sampling event in July 2003. Groundwater flow during this sampling event was generally to the east-southeast, which is consistent with the groundwater flow reported during previous monitoring events (Figure 3-5).

3.3 GROUNDWATER ANALYTICAL RESULTS

The laboratory analytical results for the groundwater samples collected during the treatability study are summarized in Table 3-3. The validated laboratory data for the fourth quarter sampling event is included in Appendix C.

Concentrations of ethylbenzene and 1,2,4-TMB in the groundwater samples from the source well CEF-BP-01S generally decreased between the baseline event and the third event but continued to exceed their respective GCTLs. However, the results of the fourth quarter were significantly higher than the previous quarters. The concentration of 1,3,5-TMB increased throughout the treatability study, and xylenes concentrations were generally consistent. The concentrations of COCs in the upgradient and downgradient wells were below detection limits throughout the treatability study with the exception of one estimated value for xylenes in the third quarter. The results from all quarters and the baseline are shown on Figure 3-6. The trend of the concentrations over time in well CEF-BP-1S is also depicted on Figure 3-7.

The fourth quarter groundwater sampling results showed that COC concentrations were less than detection limits in wells CEF-BP-2S and CEF-BP-6S. The concentrations of ethylbenzene, xylenes, 1,2,4-TMB, and 1,3,5-TMB in well CEF-BP-01S exceed GCTLs (See Table 3-3).



DRAWN BY MJJ — DATE 24Mar03		GROUNDWATER FLOW MAP (07/17/03)	CONTRACT NUMBER 4248
CHECKED BY — DATE		BP WELLS SITE	APPROVED BY — DATE
COST/SCHEDULE-AREA		TREATABILITY STUDY	APPROVED BY — DATE
SCALE AS NOTED		NAVAL AIR STATION CECIL FIELD JACKSONVILLE, FLORIDA	DRAWING NO. FIGURE 3-4 — REV 0

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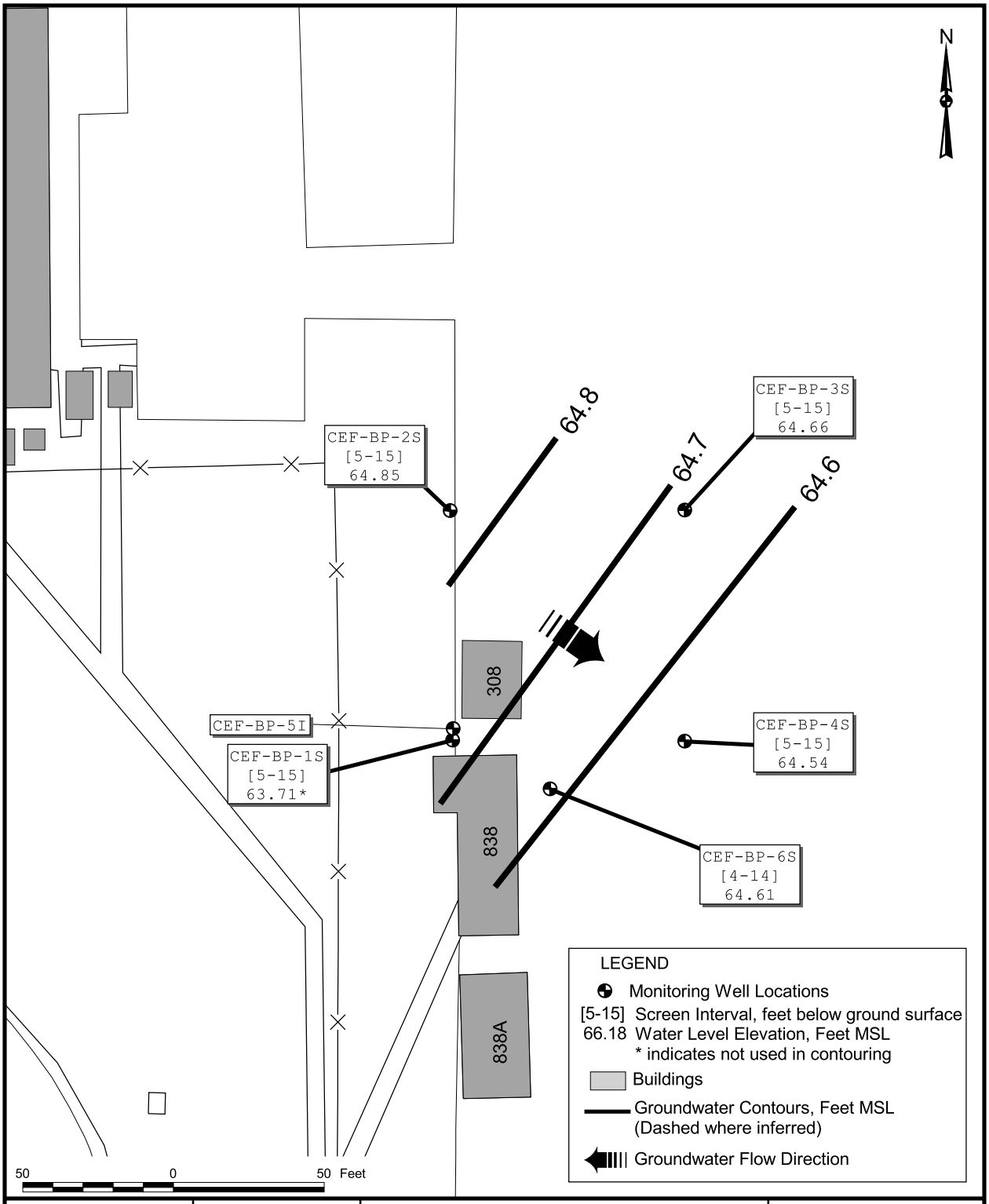

DRAWN BY	DATE			CONTRACT NUMBER
MJJ	24Mar03		GROUNDWATER FLOW MAP (10/16/03)	4248
CHECKED BY	DATE		BP WELLS SITE	APPROVED BY DATE
COST/SCHEDULE-AREA			TREATABILITY STUDY	APPROVED BY DATE
SCALE			NAVAL AIR STATION CECIL FIELD	DRAWING NO. FIGURE 3-5 / REV 0
AS NOTED			JACKSONVILLE, FLORIDA	

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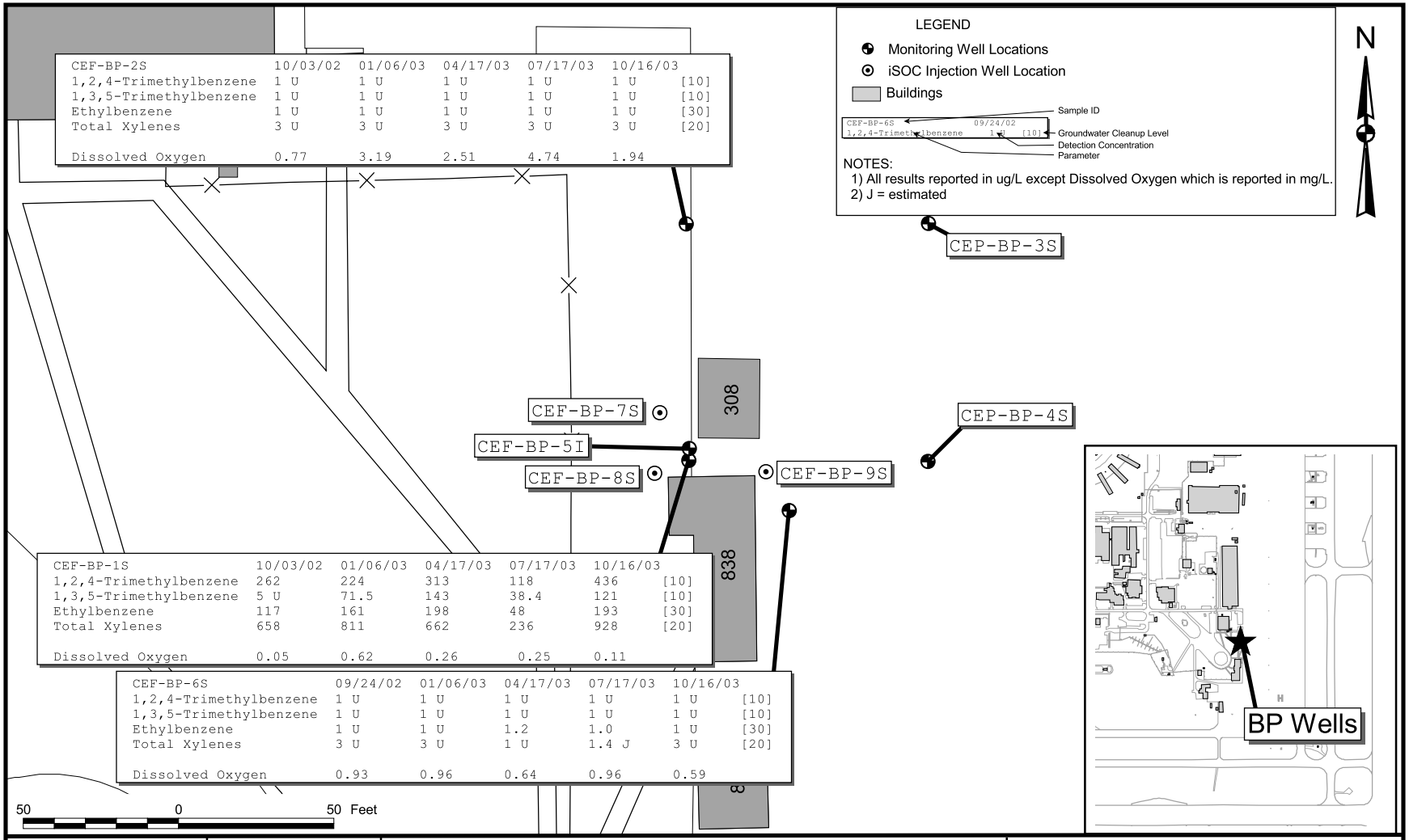
TABLE 3-3

SUMMARY OF GROUNDWATER SAMPLE ANALYTICAL RESULTS
BP WELLS SITE TREATABILITY STUDY
NAVAL AIR STATION CECIL FIELD
JACKSONVILLE, FLORIDA

Sample Location		**CEF-BP-1S**				
Monitoring Well Type		Source Well				
Sample Identification Number CEF-		01S-03	GW-1S-04	GW-01S-05	GW-01S-06	GW-01S-07
Collection Date		10/3/2002	1/6/2003	4/17/2003	7/17/2003	10/16/2003
COCs	**GCTL[1] (µg/L)**	**Baseline Sampling**	**1st Quarter Event**	**2nd Quarter Event**	**3rd Quarter Event**	**4th Quarter Event**
Ethylbenzene	30	**117**	**161**	**198**	**48**	**193**
1,2,4-Trimethylbenzene	10	**262**	**224**	**313**	**118**	**436**
1,3,5-Trimethylbenzene	10	5U	**71.5**	**143**	**38.4**	**121**
Total Xylenes	20	**658**	**811**	**662**	**662**	**928**
Sample Location		**CEF-BP-2S**				
Monitoring Well Type		Background Well				
Sample Identification Number CEF-		02S-3A	GW-2S-04	GW-02S-05	GW-02S-06	GW-02S-07
Collection Date		10/3/2002	1/6/2003	4/17/2003	7/17/2003	10/16/2003
COCs	**GCTL[1] (µg/L)**	**Baseline Sampling**	**1st Quarter Event**	**2nd Quarter Event**	**3rd Quarter Event**	**4th Quarter Event**
Ethylbenzene	30	1U	1U	1U	1U	1U
1,2,4-Trimethylbenzene	10	1U	1U	1U	1U	1U
1,3,5-Trimethylbenzene	10	1U	1U	1U	1U	1U
Total Xylenes	20	3U	3U	3U	3U	3U
Sample Location		**CEF-BP-6S**				
Monitoring Well Type		Downgradient Well				
Sample Identification Number CEF-		06S-03	GW-6S-04	GW-06S-05	GW-06S-06	GW-06S-07
Collection Date		9/24/2002	1/6/2003	4/17/2003	7/17/2003	10/16/2003
COCs	**GCTL[1] (µg/L)**	**Baseline Sampling**	**1st Quarter Event**	**2nd Quarter Event**	**3rd Quarter Event**	**4th Quarter Event**
Ethylbenzene	30	1U	1U	1.2	1.0	1U
1,2,4-Trimethylbenzene	10	1U	1U	1U	1U	1U
1,3,5-Trimethylbenzene	10	1U	1U	1U	1U	1U
Total Xylenes	20	3U	3U	3U	1.4J	3U

Notes:
Bold values shown on table are above respective GCTLs.
COCs = constituents of concern.
GCTL = Groundwater cleanup target level.
J = estimated.
U = value shown adjacent to this letter is the reporting limit concentration.
µg/L = micrograms per liter.
[1] - GCTLs taken from Chapter 62-770, Florida Administrative Code.



CEF-BP-2S	10/03/02	01/06/03	04/17/03	07/17/03	10/16/03	
1,2,4-Trimethylbenzene	1 U	1 U	1 U	1 U	1 U	[10]
1,3,5-Trimethylbenzene	1 U	1 U	1 U	1 U	1 U	[10]
Ethylbenzene	1 U	1 U	1 U	1 U	1 U	[30]
Total Xylenes	3 U	3 U	3 U	3 U	3 U	[20]
Dissolved Oxygen	0.77	3.19	2.51	4.74	1.94	

CEF-BP-1S	10/03/02	01/06/03	04/17/03	07/17/03	10/16/03	
1,2,4-Trimethylbenzene	262	224	313	118	436	[10]
1,3,5-Trimethylbenzene	5 U	71.5	143	38.4	121	[10]
Ethylbenzene	117	161	198	48	193	[30]
Total Xylenes	658	811	662	236	928	[20]
Dissolved Oxygen	0.05	0.62	0.26	0.25	0.11	

CEF-BP-6S	09/24/02	01/06/03	04/17/03	07/17/03	10/16/03	
1,2,4-Trimethylbenzene	1 U	1 U	1 U	1 U	1 U	[10]
1,3,5-Trimethylbenzene	1 U	1 U	1 U	1 U	1 U	[10]
Ethylbenzene	1 U	1 U	1.2	1.0	1 U	[30]
Total Xylenes	3 U	3 U	1 U	1.4 J	3 U	[20]
Dissolved Oxygen	0.93	0.96	0.64	0.96	0.59	

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COC AND DO CONCENTRATIONS IN GROUNDWATER
(09/24/02 - 10/16/03)
BP WELLS SITE
TREATABILITY STUDY
NAVAL AIR STATION CECIL FIELD
JACKSONVILLE, FLORIDA

CONTRACT NUMBER	
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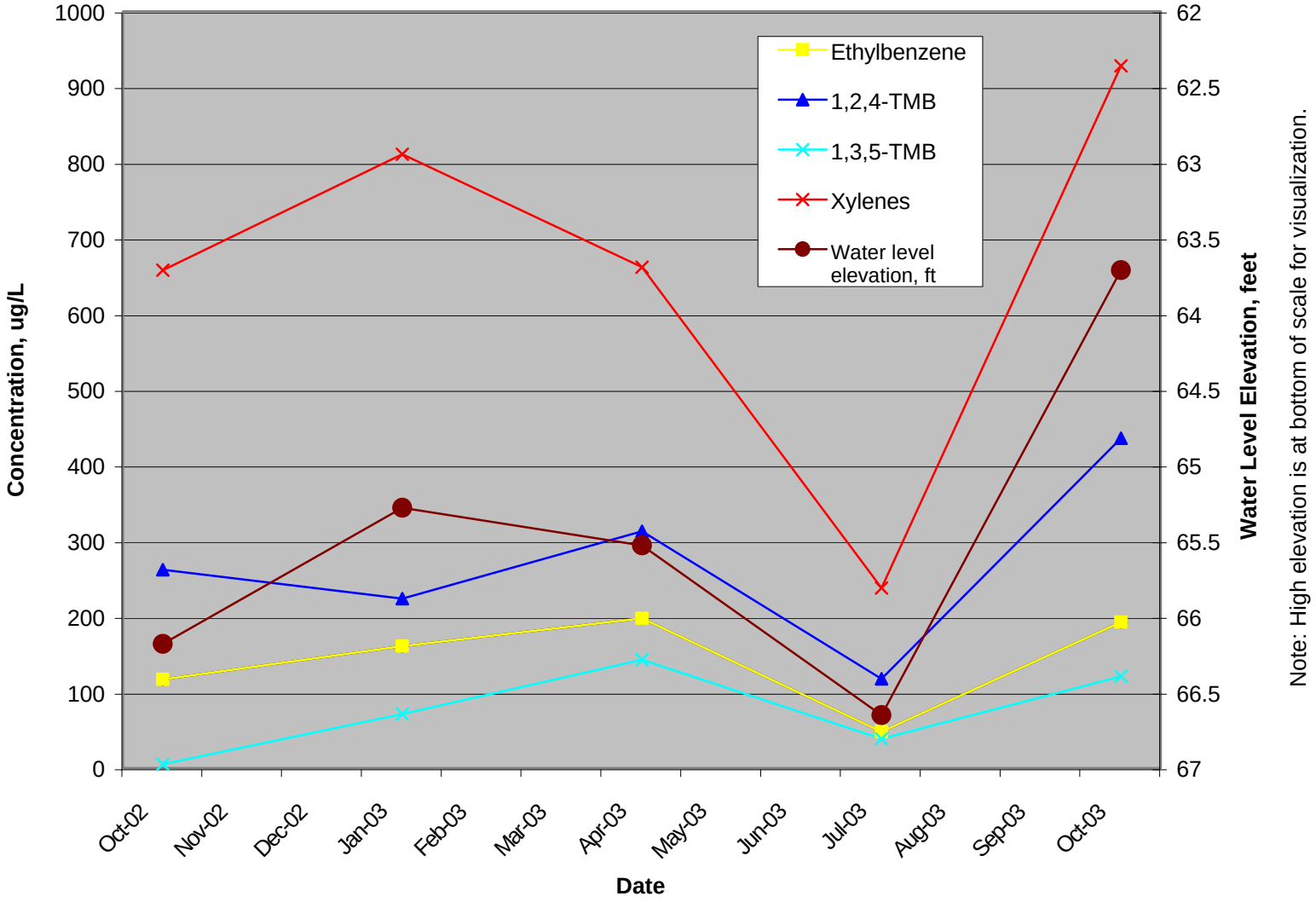
FIGURE 3-7
WELL BP-1S - ANALYTICAL RESULTS AND WATER LEVEL OVER TIME



Note: High elevation is at bottom of scale for visualization.

The COC concentrations in well CEF-BP-1S were plotted with the groundwater elevations (Figure 3-7). This graph generally shows an inverse relationship between the concentrations of COCs and the groundwater elevations. (Note that in Figure 3-7, the water level scale is shown with the high elevation on the bottom for visualization.) That is, when the groundwater elevation is low, the concentrations of COCs are usually high, and vice versa. This may be the result of relatively large volumes of precipitation initially raising the water table and diluting the groundwater near the immediate surface of the water table. Then, over time, the water level drops and contaminants disperse through the groundwater and the dilution effect dissipates. Regardless of the explanation, changes in COC concentrations appear to be the result of changes in the water table, rather than significant degradation by biological activity.

3.4 EVIDENCE FOR BIODEGRADATION

The field and laboratory analytical results for MNA parameters for groundwater samples collected during the treatability study are summarized in Table 3-4. Field data for the fourth quarter sampling event is included in Appendix B.

This natural attenuation discussion is categorized into two regions, namely the source area, generally centered on monitoring well CEF-BP-1S and the downgradient area, characterized by monitoring well CEF-BP-6S. Each area of the plume is briefly described in terms of select natural attenuation parameters and contaminant concentrations. Comparisons are made to a background area well as defined by well CEF-BP-2S. This discussion supplements the discussion about the concentration trends over time that follows, a primary line of evidence in determining if natural attenuation is occurring.

3.4.1 Natural Attenuation Parameter Results

<u>Background</u>

Geochemical and COC characteristics of the background at well CEF-BP-2S are as follows:

- Concentrations of all COCs are less than respective laboratory detection limits.
- DO concentration ranged from 2 to 6 mg/L.
- Low concentrations of TOC (4 to 4.8 mg/L).
- Low alkalinity (54 to 70 mg/L).
- Low concentrations of dissolved carbon dioxide (11 to 30 mg/L).
- Low concentrations of ferrous iron (0.02 to 0.17 mg/L).
- Low concentrations of dissolved methane (less than 0.5 to 12.9 micrograms per liter [µg/L]).

TABLE 3-4

NATURAL ATTENUATION PARAMETER RESULTS
BP WELLS SITE TREATABILITY STUDY
NAVAL AIR STATION CECIL FIELD
JACKSONVILLE, FLORIDA

Sample Location		**CEF-BP-2S**				**CEF-BP-1S**				**CEF-BP-6S**			
Monitoring Well Type		Background Well				Source Well				Downgradient Well			
Sample Identification No. CEF-BP		02S-3A	02S-05	02S-06	02S-07	BP-01S-03	BP-01S-05	BP-01S-06	BP-01S-07	06S-03	06S-05	06S-06	06S-07
Collection Date		1/30/2003	4/17/2003	7/17/2003	10/16/2003	1/30/2003	4/17/2003	7/17/2003	10/16/2003	1/30/2003	4/17/2003	7/17/2003	10/16/2003
	Units	**Fixed-Base Laboratory Results**											
Methane	µg/L	1.40	5.76	0.50U	12.9	14.0	6.62	24.5	31.9	136	149	84.7	738
Total Organic Carbon	mg/L	4.0	4.7	4.8	4.6	12.0	11.6	13.0	11.6	9.0	6.1	6.5	8.5
Nitrogen, Nitrate	mg/L	0.88	0.34	0.10U	0.33	0.41	0.11	0.10U	0.10U	0.13	0.71	0.25	0.34
Nitrogen, Nitrite	mg/L	0.10U	0.10U	0.10U	0.10U	0.10U	0.10U	0.10U	0.10U	0.10U	0.10U	0.10U	0.10U
Phosphate, Ortho	mg/L	0.10U	0.10U	0.10U	0.10U	0.10U	0.10U	0.10U	0.10U	0.10U	0.10U	0.10U	0.10U
Sulfate	mg/L	20U	20U	20U	20U	20U	20U	20U	20U	20U	20U	20U	20U
	Units	**Field Natural Attenuation Results**											
pH	S.U.	6.3	6.6	7.2	6.4	6.3	6.5	6.4	6.6	6.2	6.0	6.2	5.8
Conductivity	mS/cm	0.19	0.17	0.15	0.20	0.32	0.27	0.30	0.33	0.26	0.25	0.25	0.26
DO (by meter in flow cell)	mg/L	1.97	2.51	4.74	1.94	0.06	0.26	0.25	0.11	0.86	0.64	0.96	0.59
DO (by kit)	mg/L	2.0	3.0	6	2.0	0.6	0.8	0.6	1.5	0.4	1.0	1	1.5
Oxidation Reduction Potential	mV	130	140	58	522	-110	-115	-97	-77	26	78	30	91
Carbon Dioxide	mg/L	30	16	11	16	300	70	45	40	50	25	70	35
Alkalinity	mg/L	70	70	54	55	250	130	100	110	80	70	55	62
Ferrous Iron	mg/L	0.08	0.02	0	0.17	0.16	1.41	2.00	1.45	0.18	0.08	0	0.11
Hydrogen Sulfide	mg/L	0	0	0	0	0.3	2.0	0.5	0	0.0	0.1	0	2.0
Sulfide	mg/L	0	0	0	0	0	0.2	0	0.12	0	0	0	0.009
Temperature	^{o}C	21.1	22.1	27.0	27.1	19.1	20.9	25.3	24.99	22.3	22.7	26.8	27.2
Turbidity	NTU	18	18.1	11.9	9.0	0	0.5	1	0.0	14	4.59	0	2.00

Notes:
^{o}C = degrees Celsius.
DO = dissolved oxygen.
mg/L = milligrams per liter.
mS/cm = millisiemens per centimeter.
mV = millivolt.
NTU = nephelometric turbidity units.
S.U. = standard units.
U = value shown adjacent to this letter is the reporting limit concentration.
µg/L = micrograms per liter.

- Nitrate concentrations varied from less than 0.1 to 0.88 mg/L.
- Sulfate concentrations less than 20 mg/L.
- ORP measurements ranged from 58 to 130 millivolts (mV).
- No sulfide or hydrogen sulfide was detected.
- Conductivity varied from 0.15 to 0.20 microsiemens per centimeter (mS/cm).
- Nitrite and phosphate concentrations were less than 0.1 mg/L.
- pH varied from 6.3 to 7.2.
- Temperature varied from 21.1 to 27.1 degrees celsius (°C).

Source Area

Geochemical and COC characteristics of the source area at well CEF-BP-1S are as follows:

- High concentrations of all COCs, greater than GCTLs.
- Low DO concentration ranged from 0.6 to 1.5 mg/L.
- Concentrations of TOC (11.6 to 12 mg/L).
- Alkalinity has varied from 100 to 250 mg/L.
- Increased concentrations of dissolved carbon dioxide (40 to 300 mg/L).
- Increased concentrations of ferrous iron (0.16 to 2 mg/L).
- Increased concentrations of dissolved methane (6.62 to 31.9 µg/L).
- Nitrate concentrations varied from less than 0.1 to 0.41 mg/L.
- Sulfate concentrations less than 20 mg/L.
- ORP measurements ranged from -115 to -77 mV.
- Sulfide concentrations from 0.12 to 0.2 mg/L and hydrogen sulfide from 0.3 to 2 mg/L.
- Conductivity varied from 0.27 to 0.33 mS/cm.
- Nitrite and phosphate concentrations were less than 0.1 mg/L.
- pH varied from 6.3 to 7.6.
- Temperature varied from 19.1 to 25 °C.

Downgradient Area

Geochemical and COC characteristics of the downgradient well CEF-BP-6S are as follows:

- Concentrations of all COCs were usually less than the respective detection limits.
- Low DO concentration ranged from 0.4 to 1.5 mg/L.
- Concentrations of TOC (6.1 to 9 mg/L).
- Alkalinity has varied from 55 to 80 mg/L.
- Decreased concentrations of dissolved carbon dioxide (25 to 70 mg/L).

- Decreased concentrations of ferrous iron (0.08 to 0.18 mg/L).
- Increased concentrations of dissolved methane (84.7 to 738 µg/L).
- Nitrate concentrations varied from 0.13 to 0.71 mg/L.
- Sulfate concentrations less than 20 mg/L.
- ORP measurements ranged from 26 to 91 mV.
- Sulfide concentrations less than 0.01 mg/L and hydrogen sulfide from 0.1 to 2 mg/L.
- Conductivity varied from 0.25 to 0.26 mS/cm.
- Nitrite and phosphate concentrations were less than 0.1 mg/L.
- pH varied from 5.8 to 6.2.
- Temperature varied from 22.3 to 27.2 °C.

3.4.2 Discussion of Natural Attenuation Parameters

The concentration of each parameter and concentration changes between monitoring events, with respect to background levels, indicate whether conditions are satisfactory for biological degradation via naturally present microorganisms. This geochemical data provides a secondary line of evidence to determine if enhanced natural attenuation is occurring. In addition, MNA data from CEF-BP-02S is considered to represent background conditions because CEF-BP-02S is located hydraulically upgradient and sidegradient of the source area and the iSOC™ system. The trends in MNA parameter concentrations over the course of the treatability study and a discussion of how the MNA parameter measurements compare to the background values are discussed below.

DO acts as a primary substrate or co-substrate during aerobic metabolism and is the single most efficient electron acceptor responsible for the biodegradation of natural or anthropogenic organic carbon. Therefore, a decrease in DO in source area wells compared to wells located upgradient of the source could indicate that microbes in the source area are using oxygen in the biodegradation process and that all oxygen has been consumed and anaerobic biodegradation is occurring. The DO levels in background well CEF-BP-2S and the downgradient well CEF-BP-06S were higher than the DO levels in the source well. The DO data from the injection wells indicates that elevated concentrations of DO are present in the groundwater in the injection wells. The DO levels in the source area wells did not increase significantly following the installation of the iSOC™ system and did not reach levels supporting aerobic conditions. This may indicate that the oxygen being introduced by the iSOC™ system is being utilized in organic or inorganic oxidation reactions before reaching the monitoring well, or that oxygen is diffusing to the atmosphere or downward.

Microorganisms will use nitrate and nitrite as an electron acceptor under anaerobic conditions once DO has been depleted. Nitrate was detected at low concentrations in background well CEF-BP-02S and the

downgradient well CEF-BP-06S during most of the sampling events. Lower concentrations of nitrate were detected in source area well CEF-BP-01S, which suggests that nitrate reduction reactions have been occurring within the source area of the plume. No nitrites were detected in groundwater samples from any of the wells.

Ferrous iron (Fe^{2+}) is the soluble end product of the reduction of ferric iron (Fe^{3+}). The presence of Fe^{2+} may indicate that anaerobic conditions exist. Microorganisms will use iron species as an electron acceptor under anaerobic conditions once DO and nitrate containing compounds have been depleted. Fe^{2+} was at low concentrations in background well CEF-BP-02S during most of the sampling events. Fe^{2+} concentrations were highest in source area well CEF-BP-01S and are greater than 1 mg/L which suggests that iron reduction reactions have been occurring within the source area of the plume.

Sulfate can be used as an electron acceptor and is reduced to sulfide containing compounds (hydrogen sulfide). Sulfate was not detected (less than 20 mg/L) in groundwater samples from any of the wells, so no conclusions can be drawn from the sulfate data. Sulfides and hydrogen sulfide were not detected in the background well, but trace concentrations were detected in the source well and downgradient well. The increase in sulfides and hydrogen sulfide in the source area well and the absence in the background well suggests that reducing conditions have been occurring in the source area and that anaerobic conditions are present within of the source area.

The presence of methane in groundwater in excess of background levels may indicate that anaerobic biodegradation is occurring. Methane is a byproduct of anaerobic biological reactions that consume organic compounds. The methane concentrations in the source well and downgradient well have consistently been higher than the methane concentrations in the background well, which suggests anaerobic biological activity in the source area.

The presence of carbon dioxide in groundwater in excess of background levels may indicate that biodegradation is occurring. Carbon dioxide is the daughter product of aerobic and anaerobic biological reactions. The carbon dioxide concentration in the source wells has consistently been higher than the carbon dioxide concentrations in the background well, which suggests biological activity in the source area.

The production of carbon dioxide will also increase alkalinity. The alkalinity levels in the source area well has consistently been greater than the alkalinity levels in the background well. The elevated alkalinity levels in the source area suggest that biodegradation is occurring in this area.

The ORP of groundwater is indicative of the redox state that may be occurring based on the relative tendency of the groundwater to accept or transfer electrons. ORP values in the source area well were generally negative. ORP values in the background well were positive. The ORP values in the source area indicate reducing conditions in this area, suggesting anaerobic biodegradation.

The conductivity of the groundwater is indicative of the dissolved solids in the groundwater. During anaerobic biological activity, iron is often dissolved, and carbonate and bicarbonate ion concentrations increase. The increase in the concentrations on these ions raises the conductivity of the groundwater. The conductivity of the groundwater at the source and downgradient wells in greater than the background well level. This result is consistent with the observations of iron and alkalinity and suggests anaerobic biodegradation.

Microbial activity can be affected by the pH of groundwater. Petroleum metabolizing microorganisms generally prefer pH values between 6 and 8 standard units. Reported pH values from the sampled monitoring wells were generally within the preferred pH range.

The temperature of the groundwater in the wells varied from 19.1 to 27.2 °C. This temperature range is acceptable for biological activity.

No phosphate was detected in any of the wells, so no conclusions can be drawn. Although phosphate is necessary for biological activity, sufficient phosphate may be present, but not at detectable concentrations.

The TOC concentration in the source area well was significantly greater than the TOC level in the background well, as would be expected from the petroleum hydrocarbon contamination. The TOC concentration in the downgradient well is less than at the source area well, but still not as low as the background well. Although no COCs were detected in the downgradient well, the high TOC concentration does suggest the presence of non-COC carbon sources.

3.5 HYDROCARBON LOADING

After reviewing the results of the treatability study, the hydrocarbon mass loading (as measured by TOC) at the site was evaluated for comparison to the amount of injected oxygen (See Appendix D). The overall extent of the plume is uncertain because contaminants were only detected in one well. Using a simplified assumption that the concentrations of contaminants in the groundwater in a 50 ft by 50 ft by 30 ft thick treatment zone are equal to 25 percent of the concentrations of contaminants in CEF-BP-1S, the mass of COCs in the aqueous phase is estimated to be about 0.6 lbs. The mass of COCs sorbed to the soil in the

same zone is estimated to be 6.1 lbs. Thus, the ratio of sorbed contamination to aqueous contamination is about 10:1.

The TOC concentration in the groundwater sample from CEF-BP-1S was 11.6 mg/L, or 11,600 ug/L. Similarly, the average TOC concentration in the downgradient well CEF-BP-6S was 7.5 mg/L or 7,500 ug/L. Using a similar approach as with the COCs, the mass loading of TOC is estimated to be 4 lbs in the aqueous phase and 104 lbs in the sorbed phase.

Approximately 1,320 ft^3, or 110 lbs of oxygen, were injected over the course of the treatability study. Based on the calculation that 4 lbs of oxygen will consume 1 lb of TOC, the total amount of TOC that could have been consumed was 28 lbs (110 ÷ 4). Therefore, the mass of oxygen that was injected was not sufficient to consume the estimated mass of TOC and hydrocarbons present at the site, and therefore, oxygen may not have diffused as far as the observation wells.

4.0 CONCLUSIONS AND RECOMMENDATIONS

This report summarizes the results to date of the Enhanced Natural Attenuation Treatability Study for BP Wells. The data collected during this treatability study are inconclusive as to the ability of the iSOC™ system to enhance biodegradation of the petroleum constituents previously reported in the groundwater. The following conclusions are based on the treatability study data:

- The radius of aerobic conditions around the iSOC™ injection wells appears to be limited, and the results are inconclusive as to the ability of the system to provide sufficient oxygen to enhance biodegradation processes. The estimated oxygen demand of the organic material appears to be significantly greater than the oxygen injected. Based on the positions of the monitoring well compared to the oxygen-injection wells, the radius of influence is less than 15 feet.
- The MNA parameter measurements suggest that the groundwater is in an anaerobic condition, and that iSOC™ was not effective at dispersing oxygen to the monitoring wells under the site conditions.
- Compared to the baseline measurements, COC concentrations have increased in source area well.
- The concentrations of COCs in the source well still exceed the FDEP GCTLs.

Because there has been an increase in the COC concentrations in the source area well, the effectiveness of the iSOC™ system is inconclusive. Although the dissolved oxygen concentration did not change in the observation wells, the mass of petroleum hydrocarbons may be greater than anticipated. The high TOC concentrations in both CEF-BP-1S and CEF-BP-6S suggest a significant mass of organic material. The suspected source of contamination is fuel, and fuels consist of numerous constituents, most of which are not measured in the typical analysis for COCs. In addition, two of the COCs, 1,2,4-TMB and 1,3,5-TMB sorb strongly to the soil. The mass of these compounds sorbed to the soil in equilibrium with groundwater is about 10 times the mass of the compounds in the groundwater. Thus, there appears to be a significantly larger load of hydrocarbons that result in the consumption of the oxygen before the oxygen can travel very far from the injection wells, thus limiting the radius of aerobic conditions around the injection wells.

The extent of the plume is also uncertain. Contaminants have only been measured in one well, although TOC concentrations are significant in all three wells. The width of the plume is uncertain, so the mass of hydrocarbons in the groundwater and sorbed to the soil in the saturated zone is uncertain.

Another uncertainty in the contaminant distribution is whether there is a high concentration smear zone. If the source of the groundwater contamination was by the release of fuel, then a high concentration free-product layer may be present that could account for a relatively significant source of hydrocarbons.

Oxygen could also be lost to the atmosphere or to deeper depths. In addition to diffusion in a radial direction, oxygen will also diffuse upward and downward. Oxygen that diffuses upward will be lost to the atmosphere and oxygen that diffuses downward will not contact the contaminants. The amount of oxygen lost to depth or to atmosphere is uncertain.

The secondary line of evidence, the MNA parameter information, suggests that the iSOC™ system has not increased the DO available in the subsurface. The changes in the MNA parameters are all suggestive of an anaerobic environment.

The objective of the treatability study was to evaluate the effectiveness of the iSOC™ system as a remedial technology for petroleum constituents in groundwater at the BP Wells Site. Because concentrations of COCs have increased during the treatability study and no increase in the DO concentrations were observed in the monitoring wells, TtNUS concludes that the technology was not effective for these specific site conditions. Therefore, TtNUS recommends that the treatability study at the BP Wells Site be discontinued and further assessment of the site be performed in order to obtain more complete data for preparation of a RAP.

The supplemental assessment will be conducted in two phases. The first phase includes the following tasks:

Groundwater samples will be collected from the site monitoring wells and from the iSOC™ injection wells and analyzed for VOCs and TOC. This will provide information on the extent of remediation in the immediate vicinity of the oxygen injection points. The injection wells are constructed like monitoring wells and, therefore, are suitable for environmental sampling.
Perform a pilot-scale air sparging treatability study at the site in conjunction with the upcoming air sparging treatability study at the G82 site, located approximately 100 feet to the south of the BP Wells site. Air sparging may be a more effective process in that VOCs will be physically stripped in a relatively short period of time, along with the benefit of creating aerobic conditions for biological activity.

Upon completion of the first phase, if the results indicate that further assessment is required, the second phase will include:

Further delineation of the plume, particularly to the south and upgradient.

Further characterization of the distribution of contaminants in the smear zone (adsorbed phase vs. dissolved phase).

Further characterization of the contaminants, such as for PAHs, such as naphthalenes, and TRPH. Characterization should also consider biochemical oxygen demand, chemical oxygen demand, and total organic carbon.

Upon completion of the supplemental assessment, a SAR Addendum should be prepared and submitted to the FDEP for review. Upon approval of the SAR Addendum, a RAP may be prepared to evaluate remedial alternatives for the site.

REFERENCES

Tetra Tech NUS, Inc. (TtNUS), 2003a. Third Quarter Treatability Study Letter Report – BP Wells, Naval Air Station Cecil Field, Jacksonville, Florida. Prepared for Southern Division Naval Facilities Engineering Command, North Charleston, South Carolina. November.

TtNUS, 2003b. Second Quarter Treatability Study Letter Report – BP Wells, Naval Air Station Cecil Field, Jacksonville, Florida. Prepared for Southern Division Naval Facilities Engineering Command, North Charleston, South Carolina. November.

TtNUS, 2003c. First Quarter Treatability Study Letter Report – BP Wells, Naval Air Station Cecil Field, Jacksonville, Florida. Prepared for Southern Division Naval Facilities Engineering Command, North Charleston, South Carolina. April.

TtNUS, 2002. Groundwater Monitoring Report, Second Semi-Annual/Annual, First Year – BP Wells Site, Naval Air Station Cecil Field, Jacksonville, Florida. Prepared for Southern Division Naval Facilities Engineering Command, North Charleston, South Carolina. January.

TtNUS, 2000. First Site Assessment Report for BP Wells Area, Naval Air Station Cecil Field, Jacksonville, Florida. Prepared for Southern Division Naval Facilities Engineering Command, North Charleston, South Carolina. August.

APPENDIX A

iSOC™ INSTALLATION AND DEVELOPMENT RECORDS

Tetra Tech NUS, Inc.

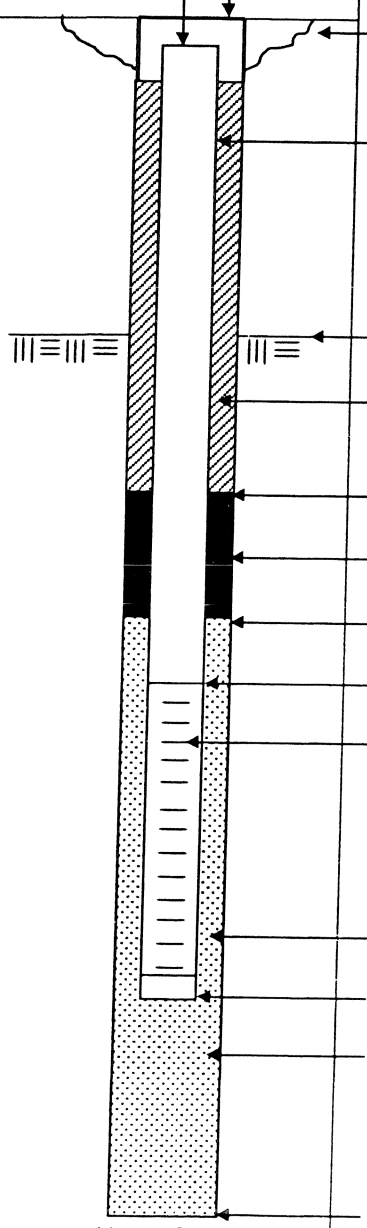
WELL No.: CEF-BP-07S

MONITORING WELL SHEET (SINGLE-CASED)

PROJECT:	Cecil Field	DRILLING Co.:	Partridge	BORING No.:	SB-01
PROJECT No.:	N4248	DRILLER:	Jeff Weatherford	DATE COMPLETED:	9/9/02
SITE:	BP Wells	DRILLING METHOD:	~~H~~ HSA	NORTHING:	
GEOLOGIST:	M Pole C Glotzbach	DEV. METHOD:		EASTING:	

Ground Elevation =

Datum:



Not to Scale

Elevation / Depth of Top of Riser: 1

Elevation / Height of Top of Surface Casing: 1 Ø ft

I.D. of Surface Casing: ~~Ø~~ 24.5"

Type of Surface Casing: Steel

Type of Surface Seal: Concrete

I.D. of Riser: 2 inch

Type of Riser: PVC

Borehole Diameter: 8 inch

Elevation / Depth Top of Rock: N/A

Type of Backfill: Type I-II Portland Cement

Elevation / Depth of Seal: 12 ft

Type of Seal: 30/65 Sand

Elevation / Depth of Top of Filter Pack: 13.5 ft

Elevation / Depth of Top of Screen: 15 ft

Type of Screen: PVC

Slot Size x Length: 0.010 in x 10'

I.D. of Screen: 2 in

Type of Filter Pack: 20/30 Sand

Elevation / Depth of Bottom of Screen: 115 ft

Elevation / Depth of Bottom of Filter Pack: 115 ft

Type of Backfill Below Well: 20/30 Sand

Elevation / Total Depth of Borehole: 115.5 ft

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: SFF, Truck Stand, Site 46, NSAP, DT1
PROJECT NUMBER: N4248MW0050
DRILLING COMPANY: Partridge
DRILLING RIG: Drillmaster 400

BORING NUMBER: ~~CEF-BP-07S~~ CS SB-01
DATE: 9/9/02
GEOLOGIST: M/Dale C Gleaton
DRILLER: Jeff Weatherford

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	Color	Material Classification	USCS *	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
	0-4					Or/Bn	Silty Sand	SM	Dry				
	4-6					Lt Bn	Silty Sand	SM	Moist				
	6-15.5					Lt Bn	Silty Sand	SM	Wet				

* 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: Or-Orange Bn-Brown (Fill Dirt)
@ 7' *PID Not Functional No OVA readings

Converted to Well: Yes X No _____ Well I.D. #: CEF-BP-07S

MONITORING WELL MATERIALS
CERTIFICATE OF CONFORMANCE

Well Designation: CEF-BP-07S
Site Name: BP Wells Cecil Field
Date Installed: 9/9/02
Project Name: Cecil Field

Site Geologist: Mervin Dale / C Gleaton
Drilling Company: Partridge
Driller: Jeff Weatherford
Project Number: N4298MW0050120

Material	Brand/Description	Source/Supplier	Sample Collected ?
Well Casing	Sch 40 PVC 2in Dia	Atlantic Drilling Supply, Jax Fl	No
Well Screen	Sch 40 PVC 2in 0.010 slots	ADS Jax Fl	No
End Cap	Sch 40 PVC 2in 6inch long	ADS Jax Fl	No
Drilling Fluid	None		
Drilling Fluid Additives	None		
Backfill Material	None		
Annular Filter Pack	Standard 20/30 Grade Sand	Standard Sand Jax Fl	No
Bentonite Seal	Standard 30/65 Grade Sand	Standard Sand Jax Fl	No
Annular Grout	Portland Cement Type I-II	Lehigh Cement Allentown, PA	No
Surface Cement	Quikrete Concrete	Quikrete Company Atlanta GA	No
Protective Casing	8in Steel manhole	ADS Jax Fl	No
Paint	None		
Rod Lubricant	None		
Compressor Oil	None		

To the best of my knowledge, I certify that the above described materials were used during installation of this monitoring well.

Signature of Site Geologist: C Gleaton

Flowrate - 18 gallons / 9 minutes
2gal/min.

Tetra Tech NUS, Inc.

MONITORING WELL DEVELOPMENT RECORD

Well: CEF-BP-7S
Site: NAS Cecil Field BP
Date Installed: 9-10-02
Date Developed: 9-12-02
Dev. Method: Submersible
Pump Type: Submersible

Depth to Bottom (ft.): 15 ft
Static Water Level Before (ft.): 6.16
Static Water Level After (ft.): 6.09
Screen Length (ft.): 10 ft
Specific Capacity: N/A
Casing ID (in.): 2in

Responsible Personnel: Mev Dale / Meg Ferguson
Drilling Co.: Partridge
Project Name: NAS CECIL FIELD
Project Number: 4248MW0050 120

Time	Estimated Sediment Thickness (Ft.)	Cumulative Water Volume (Gal.)	Water Level Readings (Ft. below TOC)	Temperature (Degrees C)	pH	Specific Conductance (Units ms/m)	Turbidity (NTU)	Remarks (odor, color, etc.) Background PID=0.0 BZ=0.0 BH=0.0
1330	—	—	6.16	25.9	5.95	25.8	—	
1335		10	6.18	25.5	6.15	20.3	730	
1340		20	6.13	25.5	6.13	19.6	238	
1345		30	6.14	25.5	6.11	18.9	87.6	
1350		40	6.14	25.5	6.1	18.9	37.5	
1355		50	6.12	25.5	6.10	18.3	28.0	Final Reading

Tetra Tech NUS, Inc.

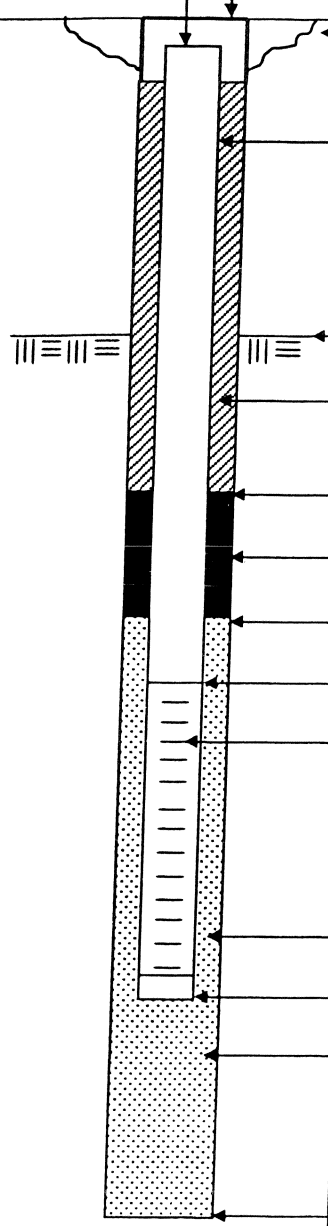
WELL No.: CEF-BP-08S

MONITORING WELL SHEET (SINGLE-CASED)

PROJECT:	Cecil Field	DRILLING Co.:	Portridge	BORING No.:	SB-02
PROJECT No.:	N4248	DRILLER:	Jeff Weatherford	DATE COMPLETED:	9/9/02
SITE:	BP Wells	DRILLING METHOD:	HSA	NORTHING:	
GEOLOGIST:	M. Dale C Gleaton	DEV. METHOD:		EASTING:	

Ground Elevation =

Datum:



Not to Scale

Elevation / Depth of Top of Riser:	/
Elevation / Height of Top of Surface Casing:	1 Ø ft
I.D. of Surface Casing:	~~8~~ 24.5"
Type of Surface Casing:	Steel
Type of Surface Seal:	Concrete
I.D. of Riser:	2 inch
Type of Riser:	PVC
Borehole Diameter:	8 inch
Elevation / Depth Top of Rock:	N/A
Type of Backfill:	Type I-II Portland Cement
Elevation / Depth of Seal:	12 ft
Type of Seal:	30/65 Sand
Elevation / Depth of Top of Filter Pack:	13.5 ft
Elevation / Depth of Top of Screen:	15 ft
Type of Screen:	PVC
Slot Size x Length:	0.010in x 10'
I.D. of Screen:	2 inch
Type of Filter Pack:	20/30 Sand
Elevation / Depth of Bottom of Screen:	115 ft
Elevation / Depth of Bottom of Filter Pack:	115.5 ft
Type of Backfill Below Well:	20/30 Sand
Elevation / Total Depth of Borehole:	115.5 ft

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: SFF, Truck Stand, Site 46, NSAP, DT1
BORING NUMBER: SB-02
PROJECT NUMBER: N4248MW0050
DATE: 9/9/02
DRILLING COMPANY: Partridge
GEOLOGIST: M. Dale / C Gleason
DRILLING RIG: Drilmaster 400
DRILLER: Jeff Weatherford

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	Color	Material Classification	USCS *	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
	0-1.5					Bn	Silty Sand	SM	Dry				
	1.5-2					Gr Bn	Silty Sand	SM	Dry				
	2-5					Lt Bn	Silty Sand	SM	Dry				
	5-6.5					Lt Bn	Silty Sand	SM	Moist Δ 6.5'				
	6.5-15					Lt Bn	Silty Sand	SM	Wet				

* 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: Bn - Brown Gr - Gray (Fill Dirt)
Δ 6.5'

Converted to Well: Yes X No

Well I.D. #: CEF-BP-085

MONITORING WELL MATERIALS
CERTIFICATE OF CONFORMANCE

Well Designation: CEF-BP-085
Site Name: BP Wells
Date Installed: 9/9/02
Project Name: Cecil Field

Site Geologist: M. Dale / C Gleaton
Drilling Company: Partridge
Driller: Jeff Weatherford
Project Number: N9248MW0050120

Material	Brand/Description	Source/Supplier	Sample Collected ?
Well Casing	Sch 40 PVC 2in Dia	Atlantic Drilling Supply, Jax Fl	No
Well Screen	Sch 40 PVC 2in 0.010 slots	ADS Jax Fl	No
End Cap	Sch 40 PVC 2in 6inch long	ADS Jax Fl	No
Drilling Fluid	None		
Drilling Fluid Additives	None		
Backfill Material	None		
Annular Filter Pack	Standard 20/30 Grade Sand	Standard Sand Jax Fl	No
Bentonite Seal	Standard 30/65 Grade Sand	Standard Sand Jax Fl	No
Annular Grout	Portland Cement Type I-II	Lehigh Cement Allentown, PA	No
Surface Cement	Quikrete Concrete	Quikrete Company Atlanta GA	No
Protective Casing	8in Steel manhole	ADS Jax Fl	No
Paint	None		
Rod Lubricant	None		
Compressor Oil	None		

To the best of my knowledge, I certify that the above described materials were used during installation of this monitoring well.

Signature of Site Geologist: C. Gleat

Flow rate 10 gal/9 min
2 gal/minute

Tetra Tech NUS, Inc.

MONITORING WELL DEVELOPMENT RECORD

Well: CEF-BP-8S
Site: BP Wells
Date Installed: 9-10-02
Date Developed: 9-12-02
Dev. Method: Submersible
Pump Type: "

Depth to Bottom (ft.): 15 ft
Static Water Level Before (ft.): 6.4
Static Water Level After (ft.): 6.35
Screen Length (ft.): 10 ft
Specific Capacity: N/A
Casing ID (in.): 2 inches

Responsible Personnel: Men. Dale / Meg Ferguson
Drilling Co.: Partridge
Project Name: NAS CECIL FIELD
Project Number: 4248MW0050 120

Time	Estimated Sediment Thickness (Ft.)	Cumulative Water Volume (Gal.)	Water Level Readings (Ft. below TOC)	Temperature (Degrees C)	pH	Specific Conductance (Units mS/m)	Turbidity (NTU)	Remarks (odor, color, etc.)
1410		—	6.4	27.3	6.22	26.2	—	
1415		10	6.4	25.7	6.13	21.6	—	
1420		20	6.3	25.6	6.15	21.5	834.0	
1425		30	6.3	25.6	6.17	21.4	162.0	
1430		40	6.33	25.6	6.17	21.4	83.1	
1435		50	6.33	25.6	6.19	20.9	62.6	Final Reading

Tetra Tech NUS, Inc.

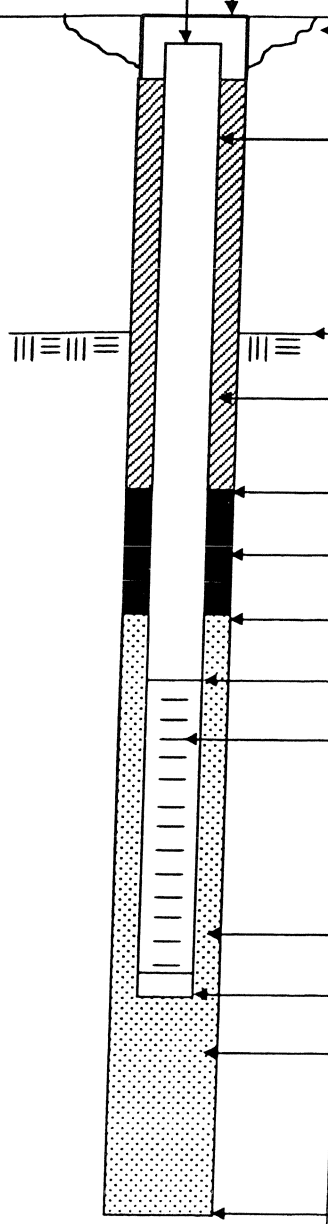
WELL No.: CEF-BP-095

MONITORING WELL SHEET (SINGLE-CASED)

PROJECT:	Cecil Field	DRILLING Co.:	Portridge	BORING No.:	SB-03
PROJECT No.:	N4248	DRILLER:	Jeff Weatherford	DATE COMPLETED:	9/9/02
SITE:	BP Wells	DRILLING METHOD:	HSA	NORTHING:	
GEOLOGIST:	M Dale C Gleaton	DEV. METHOD:		EASTING:	

Ground Elevation =

Datum:



Not to Scale

Elevation / Depth of Top of Riser: 1

Elevation / Height of Top of Surface Casing: 1 Ø ft

I.D. of Surface Casing: Ø 24.5"

Type of Surface Casing: Steel

Type of Surface Seal: Concrete

I.D. of Riser: 2 inch

Type of Riser: PVC

Borehole Diameter: 8 inch

Elevation / Depth Top of Rock: N/A

Type of Backfill: Type I-II Portland Cement

Elevation / Depth of Seal: 12 ft

Type of Seal: 30/65 Sand

Elevation / Depth of Top of Filter Pack: 13.5 ft

Elevation / Depth of Top of Screen: 15 ft

Type of Screen: PVC

Slot Size x Length: 0.010 in X 10'

I.D. of Screen: 2 inch

Type of Filter Pack: 20/30 Sand

Elevation / Depth of Bottom of Screen: 115 ft

Elevation / Depth of Bottom of Filter Pack: 115.5 ft

Type of Backfill Below Well: 20/30 Sand

Elevation / Total Depth of Borehole: 115.5 ft

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: SFF, Truck Stand, Site 46, NSAP, DT1
BORING NUMBER: SB-03
PROJECT NUMBER: N4248MW0050
DATE: 9/9/02
DRILLING COMPANY: Partridge
GEOLOGIST: M. Dale C Gleaton
DRILLING RIG: Drilmaster 400
DRILLER: Jeff Wheatherford

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	Color	Material Classification	USCS*	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
	0-2					Lt Bn	Lime Sand	SP	Dry				
	2-4					~~Or~~ Bn	Silty Sand	SM	Dry				
	4-6					~~Or~~ Bn	Silty Sand	SM	Moist				
	6-10					Bn	Silty Sand	SM	Wet				
	10-15.5					Lt Bn	Silty Sand	SM	Wet				

* 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: Or Orange Δ 6.5
Bn Brown
Lt Light

Converted to Well: Yes X No

Well I.D. #: CEF-BP-095

MONITORING WELL MATERIALS
CERTIFICATE OF CONFORMANCE

Well Designation: CEF-BP-095
Site Name: BP Wells
Date Installed: 9/9/02
Project Name: Cecil Field

Site Geologist: M Dale / C Gleaton
Drilling Company: Partridge
Driller: Jeff Weatherford
Project Number: N9248MW0050120

Material	Brand/Description	Source/Supplier	Sample Collected ?
Well Casing	Sch 40 PVC 2in Dia	Atlantic Drilling Supply, Jax Fl	No
Well Screen	Sch 40 PVC 2in 0.010 slots	ADS Jax Fl	No
End Cap	Sch 40 PVC 2in 6inch long	ADS Jax Fl	No
Drilling Fluid	None		
Drilling Fluid Additives	None		
Backfill Material	None		
Annular Filter Pack	Standard 20/30 Grade Sand	Standard Sand Jax Fl	No
Bentonite Seal	Standard 30/65 Grade Sand	Standard Sand Jax Fl	No
Annular Grout	Portland Cemente Type I-II	Lehigh Cement Allentown, PA	No
Surface Cement	Quikrete Concrete	Quikrete Company Atlanta GA	No
Protective Casing	8in Steel manhole	ADS Jax Fl	No
Paint	None		
Rod Lubricant	None		
Compressor Oil	None		

To the best of my knowledge, I certify that the above described materials were used during installation of this monitoring well.

Signature of Site Geologist: C. Gleaton

Tetra Tech NUS, Inc.

MONITORING WELL DEVELOPMENT RECORD

Well: CEF-BP-95
Site: BP-Xrails
Date Installed: 9/9/02
Date Developed: 9/12/02
Dev. Method: Pump
Pump Type: Submersible

Depth to Bottom (ft.): 15
Static Water Level Before (ft.): 6.34
Static Water Level After (ft.): 6.30
Screen Length (ft.): 10ft
Specific Capacity: N/A
Casing ID (in.): 2in

Responsible Personnel: Mark Dane / C. Gleaton
Drilling Co.: Partridge
Project Name: NAS CECIL FIELD
Project Number: 4248MW0050120

Time	Estimated Sediment Thickness (Ft.)	Cumulative Water Volume (Gal.)	Water Level Readings (Ft. below TOC)	Temperature (Degrees C)	pH	Specific Conductance (Units mS/cm)	Turbidity (NTU)	Remarks (odor, color, etc.) Bkgrd=0.0 BZ=0.0 WrH=0.0
1325		–	6.34	26.9	6.01	19.3	999.0	Milky Brown
1330		7	6.30	26.7	6.09	19.2	626.0	Milky Brown
1335		15	6.30	26.6	6.08	19.0	136	Milky Brown
1340		18	6.30	26.6	6.08	18.9	35.7	Clear
1345		28	6.30	26.6	6.08	18.7	30.0	Clear
1350		38	6.30	26.6	6.07	18.5	26.7	Clear
1355		42	6.30	26.5	6.07	18.4	26.4	Clear
1400		50	6.30	26.5	6.26	18.4	25.6	Clear

APPENDIX B

FIELD DATA FORMS – FOURTH QUARTER

4th Qtr

Page 1 of 2 BP-1

Tetra Tech NUS, Inc. **GROUNDWATER SAMPLE LOG SHEET**

Project / Site:	BP Wells Treatability Study, NASCF	Sample ID No.:	CEF-BP- ~~025~~ 005 -07
Project No.:	N4248MW0050250	Sample Location:	CEF-BP- ~~026~~ 005

[X] Monitoring Well
[ ] Domestic Well
[ ] Other:

Sampler: DS

SAMPLING DATA

Date: 10-16-03	Color	pH S.U.	S.C. mS/cm	Temp. °C	Turbidity NTU	DO mg/L	ORP mV	
Time: 1230								
Method: Peristaltic	CL	6.61	.334	24.99	0.00	0.11	-77	

PURGE DATA

Date:	10-16-03
Method:	Peristaltic
Monitor Reading (ppm):	733
Well Casing Diameter:	2-inch
Well Casing Material:	PVC
Total Well Depth (ft):	14.72
Static Water Level (ft):	7.57
One Casing Volume(gal/L):	4.3
Start Purge (hrs):	1140
End Purge (hrs):	1225
Total Purge Time (min):	45
Total Vol. Purged (gal/L):	18

See Attached Low Flow Purge Data Sheet for Purge Data

SAMPLE COLLECTION INFORMATION

Analysis	Preservative	Container Requirements	Laboratory	Collected
TOC	h2so4	1 - 250 ml amber glass	Accutest	DS
NO3, NO2, PO4, SO4	none	1 - 500 ML HDPE	Accutest	DS
Dissolved Methane	HCL	3 - 40 ml vials	Accutest	DS
Select VOCs	HCL	3 - 40 ml vials	Accutest	DS

OBSERVATIONS / NOTES

Dedicated tubing in situ.

LAB INFO

LAB: Accutest
4405 Vineland Rd., C-15
Orlando, FL 32811

COC #: 2351

Check if Collected:

☐ MS / MSD ☒ DUPLICATE / ID No.: ~~None~~ CEF-BP-GW-DUP1-07

Signature(s): M.W. Dale

Duplicate

Tetra Tech NUS, Inc.

LOW FLOW PURGE DATA SHEET

BP-1

PROJECT SITE NAME: NAS CECIL FIELD
PROJECT NUMBER: N4248MW0050250

WELL ID.: CEF-BP- GW-0~~1~~5-07 DS
DATE:

Time (Hrs.)	Water Level (Ft. below TOC)	~~Cum. Vol.~~ MD ~~(liters)~~	Flow (mL/Min.)	pH (S.U.)	Cond. (mS/cm)	Turb. (NTU)	DO (mg/L)	Temp. (Celsius)	ORP (mV)	Comments
1140	MD	7.57	400							
1150		7.62	400	24.92	.366		-14	24.91	-122	
1215		7.58	400	6.61	.339	0.34	0.05	24.97	-81	
1220		7.58	400	6.60	.332	0.25	0.09	24.95	-78	
1225		7.58	400	6.61	.334	0.00	0.11	24.99	-77	
1230	Sample									

SIGNATURE(S): [illegible]

4th Qtr

Tetra Tech NUS, Inc.

FIELD ANALYTICAL LOG SHEET
GEOCHEMICAL PARAMETERS

Project Site Name: **NAS Cecil Field, BP Wells**

Project No.: **N4248.MW0050250**

Sampled By: D. Sicker

Field Analyst: M. Amr

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

Sample ID No.: **CEF-BP-GW-** 18 **-07**

Sample Location: **CEF-BP-GW-** 15

Duplicate: ☒

Blank: ☐

SAMPLING DATA:

	Color (Visual)	pH (SU)	S.C. (mS/cm)	Turbidity (NTU)	DO (Meter, mg/l)	Temp. (^{0}C)	ORP (Eh) (+/- mv)	
Date: 10/16/03								
Time: 12:30								
Method: Peristaltic	CL	6.61	.334	0.00	0.11	24.98	-77	

SAMPLE COLLECTION/ANALYSIS INFORMATION:

Dissolved Oxygen:

Equipment:

CHEMetrics Range ☒ 0 - 1.0 mg/L ☒ 1 - 12 mg/L

Analysis Time: 1322

CHEMetrics: 1.5 mg/L

Notes:

Sulfide (S^{2-}):

Equipment: Chemetrics (kit # K-9510)

Analysis Time: 1327

Concentration: 0.12 mg/L

Filtered: ☐

Notes:

Carbon Dioxide:

Equipment:

CHEMetrics (Range: 10-100 mg/L)

(1910, 1920, or 1925)

Analysis Time: 1320

CHEMetrics: 40 mg/L

Notes:

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

4th Qtr

Tetra Tech NUS, Inc.

FIELD ANALYTICAL LOG SHEET
GEOCHEMICAL PARAMETERS

Project Site Name: **NAS Cecil Field, BP Wells**
Project No.: **N4248.MW0050250**
Sampled By: Dave Sieg Ken
Field Analyst: Merv Dave
Field Form Checked as per QA/QC Checklist (initials): MWD

Sample ID No.: **CEF-BP-GW-** 15 **-07**
Sample Location: **CEF-BP-GW-** 15
Duplicate: ☒
Blank: ☐

SAMPLE COLLECTION/ANALYSIS INFORMATION:

Alkalinity:

Equipment: —
CHEMetrics (Range: 50-500 mg/L)
Kits: 9810, 9815, 9820
Analysis Time: 1310
Filtered: ☐

Parameter:	Hydroxide	Carbonate	Bicarbonate
Relationship:			

CHEMetrics: 110 mg/L
Notes:
Standard Additions: ☐ Titrant Molarity:_____ Digits Required: 1st.:_____ 2nd.:_____ 3rd.:_____

Ferrous Iron (Fe^{2+}):

Equipment: DR-700 DR-8 90 33 IR-18C Color Wheel Other: _____
Analysis Time: 1328
Program/Module: 500nm
Concentration: 1.45 mg/L
Filtered: ☐
Notes:

Hydrogen Sulfide (H_2S):

Equipment: HS-C Other: _____
Analysis Time: 1326
Concentration: 0 mg/L Exceeded 5.0 mg/L range on color chart: ☐
Notes: No discoloration

QA/QC Checklist:

All data fields have been completed as necessary: ☑
Correct measurement units are cited in the SAMPLING DATA block: ☑
Multiplication is correct for each *Multiplier* table: ☑
Final calculated concentration is within the appropriate *Range Used* block: ☑
QA/QC sample (e.g., Std. Additions, etc.) frequency is appropriate as per the project planning documents: ☑
Title block is initialized by person who performed the QA/QC Checklist: ☑

4th Qtr

Tetra Tech NUS, Inc. GROUNDWATER SAMPLE LOG SHEET

Project / Site: BP Wells Treatability Study, NASCF

Project No.: N4248MW0050250

Sample ID No.: CEF-BP- ~~MW~~ GW 2S ~~OGS~~ DS -07

Sample Location: CEF-BP- 2S ~~OGS~~ DS

[X] Monitoring Well

[ ] Domestic Well

[ ] Other:

Sampler:

SAMPLING DATA

	Color	pH S.U.	S.C. mS/cm	Temp. °C	Turbidity NTU	DO mg/L	ORP mV	
Date: 10-16-03								
Time: 1255								
Method: Peristaltic	CL	6.40	.204	27.01	9.0	1.44	522	

PURGE DATA

Date:	10-16-03
Method:	Peristaltic
Monitor Reading (ppm):	0
Well Casing Diameter:	2-inch
Well Casing Material:	PVC
Total Well Depth (ft):	14.48
Static Water Level (ft):	6.92
One Casing Volume(gal/L):	4.9
Start Purge (hrs):	1130
End Purge (hrs):	1250
Total Purge Time (min):	80
Total Vol. Purged (gal/L):	29.0

See Attached Low Flow Purge Data Sheet for Purge Data

SAMPLE COLLECTION INFORMATION

Analysis	Preservative	Container Requirements	Laboratory	Collected
TOC	h2so4	1 - 250 ml amber glass	Accutest	DS
NO3, NO2, PO4, SO4	none	1 - 500 ML HDPE	Accutest	DS
Dissolved Methane	HCL	3 - 40 ml vials	Accutest	DS
Select VOCs	HCL	3 - 40 ml vials	Accutest	DS

OBSERVATIONS / NOTES

Dedicated tubing in situ.

LAB INFO

LAB: Accutest
4405 Vineland Rd., C-15
Orlando, FL 32811

COC #: 2351

Check if Collected:

☐ MS / MSD ☐ DUPLICATE / ID No.: None

Signature(s):

4th Qtr

Tetra Tech NUS, Inc.

LOW FLOW PURGE DATA SHEET

PROJECT SITE NAME: NAS CECIL FIELD
PROJECT NUMBER: N4248MW0050250

WELL ID.: CEF-BP-02
DATE: 10-16-03

Time (Hrs.)	Water Level (Ft. below TOC)	Cum.Vol. (liters)	Flow (mL/Min.)	pH (S.U.)	Cond. (mS/cm)	Turb. (NTU)	DO (mg/L)	Temp. (Celsius)	ORP (mV)	Comments
1130	6.92		300							
1150	7.01		300	6.68	.205		2.92	26.70	200	
1200	7.01		300	6.52	.209		2.32	26.68	388	
1205	7.01		300	6.51	.210	24	2.30	26.69	392	
1210	7.01		300	6.54	.193	23	2.55	26.82	414	
1215	7.00		300	6.50	.208	13	2.23	26.82	424	
1220	7.00		300	6.45	.207	13	2.09	26.86	449	
1225	7.00		300	6.45	.207	13	2.04	26.87	453	
1230	7.00		300	6.40	.204	9.2	1.94	26.97	490	
1245	7.00		300	6.41	.204	9.1	1.92	26.98	493	
1250	7.00		300	6.40	.204	9.0	1.94	27.01	522	
1255	Stop									

SIGNATURE(S): [illegible]

4th Qtr

Tetra Tech NUS, Inc.

FIELD ANALYTICAL LOG SHEET
GEOCHEMICAL PARAMETERS

Project Site Name: **NAS Cecil Field, BP Wells**

Project No.: **N4248.MW0050250**

Sampled By: D. Siefken

Field Analyst: D. Siefken

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

Sample ID No.: **CEF-BP-GW-** 25 **-07**

Sample Location: **CEF-BP-GW-** 25

Duplicate: ☐

Blank: ☐

SAMPLING DATA:

Date: 10-16-03	Color (Visual)	pH (SU)	S.C. (mS/cm)	Turbidity (NTU)	DO (Meter, mg/l)	Temp. (°C)	ORP (Eh) (+/- mv)	
Time: 1255								
Method: Peristaltic	CL	6.40	.204	9.0	1.94	27.07	522	

SAMPLE COLLECTION/ANALYSIS INFORMATION:

Dissolved Oxygen:

Equipment:

CHEMetrics Range ☒ 0 - 1.0 mg/L ☒ 1 - 12 mg/L

Analysis Time: 1403

CHEMetrics: 2 mg/L

Notes:

Sulfide (S^{2-}):

Equipment: Chemetrics (kit # K-9510)

Analysis Time: 1355

Concentration: 0.08 mg/L

Filtered: ☐

Notes:

Carbon Dioxide:

Equipment:

CHEMetrics (Range: 10-100 mg/L) (1910, 1920, or 1925)

Analysis Time: 1345

CHEMetrics: 16 mg/L

Notes:

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

4th Qt

Tetra Tech NUS, Inc.

FIELD ANALYTICAL LOG SHEET
GEOCHEMICAL PARAMETERS

Project Site Name: **NAS Cecil Field, BP Wells**

Project No.: **N4248.MW0050250**

Sampled By: DS

Field Analyst: DS

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

Sample ID No.: **CEF-BP-GW-** 25 **-07**

Sample Location: **CEF-BP-GW-** 25

Duplicate: ☐

Blank: ☐

SAMPLE COLLECTION/ANALYSIS INFORMATION:

Alkalinity:

Analysis Time: 1354

Equipment: —

CHEMetrics (Range: 50-500 mg/L)

Kits: 9810, 9815, 9820

Filtered: ☐

Parameter:	Hydroxide	Carbonate	Bicarbonate
Relationship:	—	—	—

CHEMetrics: 55 mg/L

Notes:

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

Ferrous Iron (Fe^{2+}):

Equipment: DR-700 DR-8 90 IR-18C Color Wheel Other: _____ Analysis Time: 1356

Program/Module: 500nm 33

Concentration: 0.17 mg/L

Filtered: ☐

Notes:

Hydrogen Sulfide (H_2S):

Equipment: HS-C Other: _____ Analysis Time: 1357

Concentration: 0 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: ☑

Multiplication is correct for each *Multiplier* table: ☑

Final calculated concentration is within the appropriate *Range Used* block: ☑

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

Title block is initialized by person who performed the QA/QC Checklist: ☑

Tetra Tech NUS, Inc. GROUNDWATER SAMPLE LOG SHEET

Project / Site: BP Wells Treatability Study, NASCF
Project No.: N4248MW0050250

Sample ID No.: CEF-BP-GW-~~PS~~ 06 ~~01S~~ -07
Sample Location: CEF-BP- ~~01S~~ 06

[X] Monitoring Well
[ ] Domestic Well
[ ] Other:

Sampler: M. Dale

SAMPLING DATA

	Color	pH S.U.	S.C. mS/cm	Temp. °C	Turbidity NTU	DO mg/L	ORP mV	
Date: 10/16/03								
Time: 1445								
Method: Peristaltic	clear	5.92	.259	27.22	2.0	0.59	90.6	

PURGE DATA

Date:	10.16.03
Method:	Peristaltic
Monitor Reading (ppm):	0
Well Casing Diameter:	2-inch
Well Casing Material:	PVC
Total Well Depth (ft):	14
Static Water Level (ft):	7.20
One Casing Volume(gal/L):	~~4.6~~ 4.3 MD
Start Purge (hrs):	1346
End Purge (hrs):	1440
Total Purge Time (min):	54
Total Vol. Purged (gal/L):	13.5 l

See Attached Low Flow Purge Data Sheet for Purge Data

SAMPLE COLLECTION INFORMATION

Analysis	Preservative	Container Requirements	Laboratory	Collected
TOC	h2so4	1 - 250 ml amber glass	Accutest	MD
NO3, NO2, PO4, SO4	none	1 - 500 ML HDPE	Accutest	↓
Dissolved Methane	HCL	3 - 40 ml vials	Accutest	↓
Select VOCs	HCL	3 - 40 ml vials	Accutest	↓

OBSERVATIONS / NOTES

Dedicated tubing in situ.

LAB INFO

LAB: Accutest
4405 Vineland Rd., C-15
Orlando, FL 32811

COC #: 2351

Check if Collected:

☐ MS / MSD ☐ DUPLICATE / ID No.: ~~CEF-BP-GW-DUP1-07~~ None

Signature(s): M.W. Dale

Tetra Tech NUS, Inc.

LOW FLOW PURGE DATA SHEET

PROJECT SITE NAME: NAS CECIL FIELD
PROJECT NUMBER: N4248MW0050250

WELL ID.: CEF-BP-06
DATE: 10/16/03

Time (Hrs.)	Water Level (Ft. below TOC)	Cum.Vol. (liters)	Flow (mL/Min.)	pH (S.U.)	Cond. (~~mS~~ µS/cm)	Turb. (NTU)	DO (mg/L)	Temp. (Celsius)	ORP (mV)	Comments
1346	7.20	0	—	—	—	—	—	—	—	start
1352	7.40	1.5	250	6.13	263	8.2	0.54 ~~7.0~~	27.31	145	
1400	7.42	3.5	250	6.09	269	5.6	0.47	27.25	116.5	clear
1410	7.42	6	250	6.05	263	4.4	0.45	27.21	84.3	clear
1420	7.42	8.5	250	6.01	259	3.4	0.38	27.05	67.4	clear
1430	7.42	11	250	5.91	259	2.6	0.51	27.18	79.5	clear
1440	7.42	13.5	250	5.92	259	2.0	0.59	27.22	90.6	clear

SIGNATURE(S): M. W. Dale

Tetra Tech NUS, Inc.

FIELD ANALYTICAL LOG SHEET
GEOCHEMICAL PARAMETERS

Project Site Name: **NAS Cecil Field, BP Wells**
Project No.: **N4248.MW0050250**
Sampled By: M. Dave
Field Analyst: D. Sirkem
Field Form Checked as per QA/QC Checklist (initials): MWA

Sample ID No.: **CEF-BP-GW-** 65 **-07**
Sample Location: **CEF-BP-GW-** 65
Duplicate: ☐
Blank: ☐

SAMPLING DATA:

	Color (Visual)	pH (SU)	S.C. (mS/cm)	Turbidity (NTU)	DO (Meter, mg/l)	Temp. (°C)	ORP (Eh) (+/- mv)	
Date: 10/16/03								
Time: 1445								
Method: Peristaltic	clear	5.92	0.259	2.0	0.59	27.22	90.6	

SAMPLE COLLECTION/ANALYSIS INFORMATION:

Dissolved Oxygen:

Equipment:
CHEMetrics Range ☐ 0 - 1.0 mg/L ☒ 1 - 12 mg/L
Analysis Time: 1505
CHEMetrics: 1.5 mg/L
Notes:

Sulfide (S^{2-}):

Equipment: Chemetrics (kit # K-9510)
Analysis Time: 1508
Concentration: 0.009 mg/L
Filtered: ☐
Notes:

Carbon Dioxide:

Equipment:
CHEMetrics (Range: 10-100 mg/L)
(1910, 1920, or 1925)
Analysis Time: 1453
CHEMetrics: 35 mg/L
Notes:

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

Tetra Tech NUS, Inc.

FIELD ANALYTICAL LOG SHEET
GEOCHEMICAL PARAMETERS

Project Site Name: **NAS Cecil Field, BP Wells**
Project No.: **N4248.MW0050250**
Sampled By: M. DAVE
Field Analyst: D. Siefken
Field Form Checked as per QA/QC Checklist (initials): MVD

Sample ID No.: **CEF-BP-GW-** 65 **-07**
Sample Location: **CEF-BP-GW-** 65
Duplicate: ☐
Blank: ☐

SAMPLE COLLECTION/ANALYSIS INFORMATION:

Alkalinity:

Equipment: —

CHEMetrics (Range: 50-500 mg/L)
Kits: 9810, 9815, 9820

Analysis Time: 1459
Filtered: ☐

Parameter:	Hydroxide	Carbonate	Bicarbonate
Relationship:			

CHEMetrics: 62 mg/L

Notes:

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

Ferrous Iron (Fe^{2+}):

Equipment: DR-700 DR-890 ~~33~~ IR-18C Color Wheel Other: _____ Analysis Time: 1507

Program/Module: 500nm

Concentration: 0.11 mg/L

Filtered: ☐

Notes:

Hydrogen Sulfide (H_2S):

Equipment: HS-C Other: _____ Analysis Time: 1454

Concentration: 2 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: ☑
Multiplication is correct for each *Multiplier* table: ☑
Final calculated concentration is within the appropriate *Range Used* block: ☑
QA/QC sample (e.g., Std. Additions, etc.) frequency is appropriate as per the project planning documents: ☑
Title block is initialized by person who performed the QA/QC Checklist: ☑

DN: 4248:4.4:97

Tetra Tech NUS, Inc.

GROUNDWATER LEVEL MEASUREMENT SHEET

Project Name: Cecil Field
Project No.: N4248MW0050250
Location: BP Wells
Personnel: D. Siefken and M. Dale
Weather Conditions: SUNNY
Measuring Device: Heron Dipper-T
Tidally Influenced: Yes ____ No __x__
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 PID
CEF-BP-1S	10/16/2003	1107	71.28	14.72	7.57			733
CEF-BP-2S	10/16/2003	1108	71.78	14.48	6.93			0
CEF-BP-3S	10/16/2003	1110	72.38	14.57	7.72			0
CEF-BP-4S	10/16/2003	1112	72.28	14.75	7.74			0
CEF-BP-5I	10/16/2003	1114	71.63	34.39	6.92			0
CEF-BP-6S	10/16/2003	1115	71.87	14.20	7.26			0

* All measurements to the nearest 0.01 foot

4th Qtr

10-16-03

Tetra Tech NUS, Inc.

DOCUMENTATION OF FIELD CALIBRATION

PROJECT NAME : NAS CECIL FIELD

SITE NAME: BP Wells

PROJECT No.: N4248MW0050250

INSTRUMENT NAME/MODEL: see below

MANUFACTURER: see below

SERIAL NUMBER: see below

Date of Calibration	Instrument Name and Model	Instrument I.D. Number	Person Performing Calibration	Instrument Settings		Instrument Readings		Calibration Standard (Lot No.)	Remarks and Comments
				Pre-calibration	Post-calibration	Pre-calibration	Post-calibration		
				cond	pH 4	pH 7	ORP		
10/16	YSI-6	02G1124	DS	959/1000	3.86/4	7.02/7	232		pH 7 lot 3223 exp 8/04
	YSI-6	01H0711	DS	1064/1000	3.84/4	7.11/7.0	231		pH 4 lot 3190 exp 11/04
									cond lot 4100 exp 8/04
	m-i Run			104	998			115-11-7	ORP 10/05
	Turbidi Meter	2020		0/10	0/10				
	"	"		0/10	0/10				

APPENDIX C

GROUNDWATER ANALYTICAL REPORTS – FOURTH QUARTER

Southeast ACCUTEST Laboratories

01/15/04

Technical Report for

Tetra Tech, NUS

NAS Cecil Field-CTO-248

N4248-WR389

Accutest Job Number: F20112

Report to:

Tetra Tech, NUS

loganj@ttnus.com

ATTN: Joe Logan

Total number of pages in report: 18

ACCREDITED IN ACCORDANCE WITH nelac

Test results contained within this data package meet the requirements of the National Environmental Laboratory Accreditation Conference and/or state specific certification programs as applicable.

Harry Behzadi, Ph.D.
Laboratory Director

Certifications: FL (DOH E83510), NC (573), NJ (FL002), MA (FL946), IA (366), LA (03051), KS (E-10327), SC, AK

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Sample Summary

Tetra Tech, NUS

Job No: F20112

NAS Cecil Field-CTO-248
Project No: N4248-WR389

Sample Number	Collected Date	Time By	Received	Matrix Code	Type	Client Sample ID
F20112-1	10/16/03	12:30 MD	10/17/03	AQ	Ground Water	CEF-BP-GW-1S-07
F20112-2	10/16/03	12:55 MD	10/17/03	AQ	Ground Water	CEF-BP-GW-2S-07
F20112-3	10/16/03	14:45 MD	10/17/03	AQ	Ground Water	CEF-BP-GW-6S-07
F20112-4	10/16/03	00:00 MD	10/17/03	AQ	Ground Water	CEF-BP-GW-DUP1-07

Report of Analysis

Client Sample ID:	CEF-BP-GW-1S-07		
Lab Sample ID:	F20112-1	Date Sampled:	10/16/03
Matrix:	AQ - Ground Water	Date Received:	10/17/03
Method:	SW846 8260B	Percent Solids:	n/a
Project:	NAS Cecil Field-CTO-248		

	File ID	DF	Analyzed	By	Prep Date	Prep Batch	Analytical Batch
Run #1	B018198.D	5	10/23/03	RA	n/a	n/a	VB799
Run #2							

	Purge Volume
Run #1	5.0 ml
Run #2	

VOA Special List

CAS No.	Compound	Result	RL	MDL	Units	Q
100-41-4	Ethylbenzene	193	5.0	2.5	ug/l	
95-63-6	1,2,4-Trimethylbenzene	436	5.0	2.5	ug/l	
108-67-8	1,3,5-Trimethylbenzene	121	5.0	2.5	ug/l	
1330-20-7	Xylene (total)	928	15	5.0	ug/l	

CAS No.	Surrogate Recoveries	Run# 1	Run# 2	Limits
1868-53-7	Dibromofluoromethane	98%		86-115%
17060-07-0	1,2-Dichloroethane-D4	107%		78-125%
2037-26-5	Toluene-D8	107%		87-113%
460-00-4	4-Bromofluorobenzene	99%		84-117%

ND = Not detected MDL - Method Detection Limit
RL = Reporting Limit
E = Indicates value exceeds calibration range

J = Indicates an estimated value
B = Indicates analyte found in associated method blank
N = Indicates presumptive evidence of a compound

ACCUTEST Laboratories

Accutest LabLink@21638 08:25 15-Jan-2004

Report of Analysis

Client Sample ID:	CEF-BP-GW-1S-07		
Lab Sample ID:	F20112-1	Date Sampled:	10/16/03
Matrix:	AQ - Ground Water	Date Received:	10/17/03
Method:	RSKSOP-147/175	Percent Solids:	n/a
Project:	NAS Cecil Field-CTO-248		

	File ID	DF	Analyzed	By	Prep Date	Prep Batch	Analytical Batch
Run #1	XY011680.D	1	10/20/03	CV	n/a	n/a	GXY323
Run #2							

CAS No.	Compound	Result	RL	MDL	Units	Q
74-82-8	Methane	31.9	0.50	0.30	ug/l	

ND = Not detected MDL - Method Detection Limit
RL = Reporting Limit
E = Indicates value exceeds calibration range

J = Indicates an estimated value
B = Indicates analyte found in associated method blank
N = Indicates presumptive evidence of a compound

ACCUTEST

Accutest LabLink@21638 08:25 15-Jan-2004

Report of Analysis

Client Sample ID:	CEF-BP-GW-1S-07		
Lab Sample ID:	F20112-1	Date Sampled:	10/16/03
Matrix:	AQ - Ground Water	Date Received:	10/17/03
		Percent Solids:	n/a
Project:	NAS Cecil Field-CTO-248		

General Chemistry

Analyte	Result	RL	Units	DF	Analyzed	By	Method
Nitrogen, Nitrate	< 0.10	0.10	mg/l	1	10/17/03 14:16	LL	EPA 300/SW846 9056
Nitrogen, Nitrite	< 0.10	0.10	mg/l	1	10/17/03 14:16	LL	EPA 300/SW846 9056
Phosphate, Ortho	< 0.10	0.10	mg/l	1	10/17/03	SJL	EPA 365.3
Sulfate	< 20	20	mg/l	1	10/17/03 14:16	LL	EPA 300/SW846 9056
Total Organic Carbon	11.6	1.0	mg/l	1	11/05/03	SL	EPA 415.1

RL = Reporting Limit

ACCUTEST

Accutest LabLink@21638 08:25 15-Jan-2004

Report of Analysis

Client Sample ID:	CEF-BP-GW-2S-07		
Lab Sample ID:	F20112-2	Date Sampled:	10/16/03
Matrix:	AQ - Ground Water	Date Received:	10/17/03
Method:	SW846 8260B	Percent Solids:	n/a
Project:	NAS Cecil Field-CTO-248		

	File ID	DF	Analyzed	By	Prep Date	Prep Batch	Analytical Batch
Run #1	C0018918.D	1	10/22/03	JG	n/a	n/a	VC829
Run #2							

	Purge Volume
Run #1	5.0 ml
Run #2	

VOA Special List

CAS No.	Compound	Result	RL	MDL	Units	Q
100-41-4	Ethylbenzene	ND	1.0	0.50	ug/l	
95-63-6	1,2,4-Trimethylbenzene	ND	1.0	0.50	ug/l	
108-67-8	1,3,5-Trimethylbenzene	ND	1.0	0.50	ug/l	
1330-20-7	Xylene (total)	ND	3.0	1.0	ug/l	

CAS No.	Surrogate Recoveries	Run# 1	Run# 2	Limits
1868-53-7	Dibromofluoromethane	108%		86-115%
17060-07-0	1,2-Dichloroethane-D4	119%		78-125%
2037-26-5	Toluene-D8	101%		87-113%
460-00-4	4-Bromofluorobenzene	97%		84-117%

ND = Not detected MDL - Method Detection Limit
RL = Reporting Limit
E = Indicates value exceeds calibration range

J = Indicates an estimated value
B = Indicates analyte found in associated method blank
N = Indicates presumptive evidence of a compound

Accutest LabLink@21638 08:25 15-Jan-2004

Report of Analysis

Client Sample ID:	CEF-BP-GW-2S-07		
Lab Sample ID:	F20112-2	Date Sampled:	10/16/03
Matrix:	AQ - Ground Water	Date Received:	10/17/03
Method:	RSKSOP-147/175	Percent Solids:	n/a
Project:	NAS Cecil Field-CTO-248		

	File ID	DF	Analyzed	By	Prep Date	Prep Batch	Analytical Batch
Run #1	XY011682.D	1	10/20/03	CV	n/a	n/a	GXY323
Run #2							

CAS No.	Compound	Result	RL	MDL	Units	Q
74-82-8	Methane	12.9	0.50	0.30	ug/l	

ND = Not detected MDL - Method Detection Limit
RL = Reporting Limit
E = Indicates value exceeds calibration range

J = Indicates an estimated value
B = Indicates analyte found in associated method blank
N = Indicates presumptive evidence of a compound

Accutest LabLink@21638 08:25 15-Jan-2004

Report of Analysis

Client Sample ID:	CEF-BP-GW-2S-07		
Lab Sample ID:	F20112-2	Date Sampled:	10/16/03
Matrix:	AQ - Ground Water	Date Received:	10/17/03
		Percent Solids:	n/a
Project:	NAS Cecil Field-CTO-248		

General Chemistry

Analyte	Result	RL	Units	DF	Analyzed	By	Method
Nitrogen, Nitrate	0.33	0.10	mg/l	1	10/17/03 14:31	LL	EPA 300/SW846 9056
Nitrogen, Nitrite	< 0.10	0.10	mg/l	1	10/17/03 14:31	LL	EPA 300/SW846 9056
Phosphate, Ortho	< 0.10	0.10	mg/l	1	10/17/03	SJL	EPA 365.3
Sulfate	< 20	20	mg/l	1	10/17/03 14:31	LL	EPA 300/SW846 9056
Total Organic Carbon	4.6	1.0	mg/l	1	11/05/03	SL	EPA 415.1

RL = Reporting Limit

Accutest LabLink@21638 08:25 15-Jan-2004

Report of Analysis

Client Sample ID:	CEF-BP-GW-6S-07		
Lab Sample ID:	F20112-3	Date Sampled:	10/16/03
Matrix:	AQ - Ground Water	Date Received:	10/17/03
Method:	SW846 8260B	Percent Solids:	n/a
Project:	NAS Cecil Field-CTO-248		

	File ID	DF	Analyzed	By	Prep Date	Prep Batch	Analytical Batch
Run #1	C0018919.D	1	10/22/03	JG	n/a	n/a	VC829
Run #2							

	Purge Volume
Run #1	5.0 ml
Run #2	

VOA Special List

CAS No.	Compound	Result	RL	MDL	Units	Q
100-41-4	Ethylbenzene	ND	1.0	0.50	ug/l	
95-63-6	1,2,4-Trimethylbenzene	ND	1.0	0.50	ug/l	
108-67-8	1,3,5-Trimethylbenzene	ND	1.0	0.50	ug/l	
1330-20-7	Xylene (total)	ND	3.0	1.0	ug/l	

CAS No.	Surrogate Recoveries	Run# 1	Run# 2	Limits
1868-53-7	Dibromofluoromethane	107%		86-115%
17060-07-0	1,2-Dichloroethane-D4	119%		78-125%
2037-26-5	Toluene-D8	102%		87-113%
460-00-4	4-Bromofluorobenzene	98%		84-117%

ND = Not detected MDL - Method Detection Limit
RL = Reporting Limit
E = Indicates value exceeds calibration range

J = Indicates an estimated value
B = Indicates analyte found in associated method blank
N = Indicates presumptive evidence of a compound

ACCUTEST

Accutest LabLink@21638 08:25 15-Jan-2004

Report of Analysis

Client Sample ID:	CEF-BP-GW-6S-07		
Lab Sample ID:	F20112-3	Date Sampled:	10/16/03
Matrix:	AQ - Ground Water	Date Received:	10/17/03
Method:	RSKSOP-147/175	Percent Solids:	n/a
Project:	NAS Cecil Field-CTO-248		

	File ID	DF	Analyzed	By	Prep Date	Prep Batch	Analytical Batch
Run #1	XY011683.D	1	10/20/03	CV	n/a	n/a	GXY323
Run #2							

CAS No.	Compound	Result	RL	MDL	Units	Q
74-82-8	Methane	738	0.50	0.30	ug/l	

ND = Not detected MDL - Method Detection Limit
RL = Reporting Limit
E = Indicates value exceeds calibration range

J = Indicates an estimated value
B = Indicates analyte found in associated method blank
N = Indicates presumptive evidence of a compound

Accutest LabLink@21638 08:25 15-Jan-2004

Report of Analysis

Client Sample ID:	CEF-BP-GW-6S-07		
Lab Sample ID:	F20112-3	Date Sampled:	10/16/03
Matrix:	AQ - Ground Water	Date Received:	10/17/03
		Percent Solids:	n/a
Project:	NAS Cecil Field-CTO-248		

General Chemistry

Analyte	Result	RL	Units	DF	Analyzed	By	Method
Nitrogen, Nitrate	0.34	0.10	mg/l	1	10/17/03 14:45	LL	EPA 300/SW846 9056
Nitrogen, Nitrite	< 0.10	0.10	mg/l	1	10/17/03 14:45	LL	EPA 300/SW846 9056
Phosphate, Ortho	< 0.10	0.10	mg/l	1	10/17/03	SJL	EPA 365.3
Sulfate	< 20	20	mg/l	1	10/17/03 14:45	LL	EPA 300/SW846 9056
Total Organic Carbon	8.5	1.0	mg/l	1	11/05/03	SL	EPA 415.1

RL = Reporting Limit

ACCUTEST.

Accutest LabLink@21638 08:25 15-Jan-2004

Report of Analysis

Client Sample ID:	CEF-BP-GW-DUP1-07		
Lab Sample ID:	F20112-4	Date Sampled:	10/16/03
Matrix:	AQ - Ground Water	Date Received:	10/17/03
Method:	SW846 8260B	Percent Solids:	n/a
Project:	NAS Cecil Field-CTO-248		

	File ID	DF	Analyzed	By	Prep Date	Prep Batch	Analytical Batch
Run #1	C0018939.D	5	10/23/03	JG	n/a	n/a	VC830
Run #2							

	Purge Volume
Run #1	5.0 ml
Run #2	

VOA Special List

CAS No.	Compound	Result	RL	MDL	Units	Q
100-41-4	Ethylbenzene	207	5.0	2.5	ug/l	
95-63-6	1,2,4-Trimethylbenzene	460	5.0	2.5	ug/l	
108-67-8	1,3,5-Trimethylbenzene	130	5.0	2.5	ug/l	
1330-20-7	Xylene (total)	1040	15	5.0	ug/l	

CAS No.	Surrogate Recoveries	Run# 1	Run# 2	Limits
1868-53-7	Dibromofluoromethane	105%		86-115%
17060-07-0	1,2-Dichloroethane-D4	123%		78-125%
2037-26-5	Toluene-D8	101%		87-113%
460-00-4	4-Bromofluorobenzene	92%		84-117%

ND = Not detected MDL - Method Detection Limit
RL = Reporting Limit
E = Indicates value exceeds calibration range

J = Indicates an estimated value
B = Indicates analyte found in associated method blank
N = Indicates presumptive evidence of a compound

ACCUTEST

Accutest LabLink@21638 08:25 15-Jan-2004

Report of Analysis

Client Sample ID:	CEF-BP-GW-DUP1-07		
Lab Sample ID:	F20112-4	Date Sampled:	10/16/03
Matrix:	AQ - Ground Water	Date Received:	10/17/03
Method:	RSKSOP-147/175	Percent Solids:	n/a
Project:	NAS Cecil Field-CTO-248		

	File ID	DF	Analyzed	By	Prep Date	Prep Batch	Analytical Batch
Run #1	XY011684.D	1	10/20/03	CV	n/a	n/a	GXY323
Run #2							

CAS No.	Compound	Result	RL	MDL	Units	Q
74-82-8	Methane	28.3	0.50	0.30	ug/l	

ND = Not detected MDL - Method Detection Limit
RL = Reporting Limit
E = Indicates value exceeds calibration range

J = Indicates an estimated value
B = Indicates analyte found in associated method blank
N = Indicates presumptive evidence of a compound

ACCUTEST Laboratories

Accutest LabLink@21638 08:25 15-Jan-2004

Report of Analysis

Client Sample ID:	CEF-BP-GW-DUP1-07		
Lab Sample ID:	F20112-4	Date Sampled:	10/16/03
Matrix:	AQ - Ground Water	Date Received:	10/17/03
		Percent Solids:	n/a
Project:	NAS Cecil Field-CTO-248		

General Chemistry

Analyte	Result	RL	Units	DF	Analyzed	By	Method
Nitrogen, Nitrate	< 0.10	0.10	mg/l	1	10/17/03 15:29	LL	EPA 300/SW846 9056
Nitrogen, Nitrite	< 0.10	0.10	mg/l	1	10/17/03 15:29	LL	EPA 300/SW846 9056
Phosphate, Ortho	< 0.10	0.10	mg/l	1	10/17/03	SJL	EPA 365.3
Sulfate	< 20	20	mg/l	1	10/17/03 15:29	LL	EPA 300/SW846 9056
Total Organic Carbon	12.4	1.0	mg/l	1	11/05/03	SL	EPA 415.1

RL = Reporting Limit

ACCUTEST

Misc. Forms

Custody Documents and Other Forms

Includes the following where applicable:

- Chain of Custody

TETRA TECH NUS, INC.

CHAIN OF CUSTODY | NUMBER 2351 | PAGE 1 OF 1

PROJECT NO: N4248, GT0248
FACILITY: BP Wells
SAMPLERS (SIGNATURE): M.W. Dale
PROJECT MANAGER: PAUL CALLIGAN
PHONE NUMBER: 813 806 0202
LABORATORY NAME AND CONTACT: ACCUTEST
FIELD OPERATIONS LEADER: MERV DALE
PHONE NUMBER: 904 636 6125
ADDRESS: 4405 Vineland Rd. C-15
CARRIER/WAYBILL NUMBER: Fedex 8427 1834 5551
CITY, STATE: ORLANDO, FL 32811

STANDARD TAT ☒
RUSH TAT ☐
☐ 24 hr. ☐ 48 hr. ☐ 72 hr. ☐ 7 day ☐ 14 day

F20112

DATE YEAR 2003	TIME	SAMPLE ID	LOCATION ID	TOP DEPTH (FT)	BOTTOM DEPTH (FT)	MATRIX (GW, SO, SW, SD, QC, ETC.)	COLLECTION METHOD GRAB (G) COMP (C)	No. OF CONTAINERS	SW846 8260B *	TOC *	Anions *	Dissolved Methane *				COMMENTS
CONTAINER TYPE PLASTIC (P) or GLASS (G)									G	G	P	G				
PRESERVATIVE USED									HCl	H_2SO_4	None	HCl				
1) 10/16	1230	CEF-BP-GW-15-07				GW	G	8	3	1	1	3				Cool to 4°C
2) 10/16	1255	CEF-BP-GW-25-07				GW	G	8	3	1	1	3				
3) 10/16	1445	CEF-BP-GW-65-07				GW	G	8	3	1	1	3				* See work release
4) 10/16	0000	CEF-BP-GW-DUP1-07				GW	G	8	3	1	1	3				N4248-WR389
																for list of
																full
																analytes + methods!

	DATE	TIME		DATE	TIME
1. RELINQUISHED BY: M.W. Dale	10/16/03	1700	1. RECEIVED BY: Fedex		
2. RELINQUISHED BY: Fedex			2. RECEIVED BY: Muna Mohammed	10/17/03	1030
3. RELINQUISHED BY			3. RECEIVED BY		

COMMENTS

DISTRIBUTION: WHITE (ACCOMPANIES SAMPLE) YELLOW (FIELD COPY) PINK (FILE COPY)

4/02R
FORM NO. TtNUS-001

F20112: Chain of Custody
Page 1 of 2

ACCUTEST

ACCUTEST LABORATORIES SOUTHEAST SAMPLE RECEIPT CONFIRMATION

Accutest's Job Number: F20112

Client: Tetra Tech Project: N4248

Date Received: 10/17/03 Time Received: 1030

# of Coolers Received: 1 Cooler Temperatures: 3.0

Delivery Method: FedEx UPS Accutest Courier Greyhound Delivery Other

Air Bill Number:

Cooler Custody Seals Intact ?	Yes	No	
Chain of Custody Provided ?	Yes	No	
COC Match Bottle Label ID's ?	Yes	No	
Sample Labels Present on all bottles ?	Yes	No	
All Analyses Marked On COC ?	Yes	No	
Are All Bottles Intact ?	Yes	No	
Samples Preserved Correctly ?	Yes	No	
Correct Number of Containers Used ?	Yes	No	
Sufficient Sample Volume ?	Yes	No	
Trip Blank Provided ?	Yes	No	
Trip Blank on COC ?	Yes	No	
Trip Blank Intact ?	Yes	No	N/A
Trip Blank Matrix ?	Soil	Water	N/A
Number of Encores ?	Ø		
Number of Soil Field Kits ?	Ø		

Summary of Comments:

Signature: Muna Mohammed Date: 10/17/03

ASBD/HW 05/11/03

F20112: Chain of Custody
Page 2 of 2

APPENDIX D

CALCULATIONS

Tetra Tech NUS			STANDARD CALCULATION SHEET
CLIENT: SOUTHDIV	FILE No:N4248	BY: JWL	PAGE: 1 of 1
SUBJECT: NAS Cecil Field – BP Wells Treatability Study		CHECKED BY:	DATE: 12/31/03

Purpose: Estimate the quantity of COCs and TOC in the plume.

Based on the layout of the wells, the estimated volume of contaminated groundwater occupies an area 50' x 50' x 30' deep.

Using a porosity of 0.3, typical of Cecil Field, the volume of groundwater is:

$$50 \text{ ft} \times 50 \text{ ft} \times 30 \text{ ft} \times 7.481 \text{ gal/ft}^3 \times 0.3 = 168{,}000 \text{ gal}$$

Using a soil density of tons/cy of 1.5, the mass of soil is:

$$50 \text{ ft} \times 50 \text{ ft} \times 30 \text{ ft} \times \text{cy}/27 \text{ ft}^3 \times 2{,}000 \text{ lb/ton} \times 1.5 \text{ ton/cy} = 8{,}300{,}000 \text{ lb}$$

This information is used in the attached spreadsheet to calculate the mass of COCs and TOC in the aqueous phase and the sorbed phase.

Tetra Tech NUS			STANDARD CALCULATION SHEET
CLIENT: SOUTHDIV	FILE No:N4248	BY: JWL	PAGE: 1 of 1
SUBJECT: NAS Cecil Field – BP Wells Treatability Study		CHECKED BY:	DATE: 12/31/03

Purpose: This calculation compares the oxygen injected during the treatability study to the organic loading.

Based o the field notes, each injection well (three total) used 1 40-ft^3 tank and 5 80-ft^3 tanks. (The volume refers to the amount of oxygen at standard conditions.) At 70 F and 1 atm, the density of oxygen is 0.083 lb/ft^3.

Thus, the total mass of oxygen injected is:

$$(1 \times 40\ ft^3 + 5 \times 80\ ft^3) \times 3 \times 0.083\ lb/ft^3 = 110\ lb\ oxygen.$$

Estimate the mass of oxygen needed per mass of hydrocarbons. Simplistically, this can be represented as:

$$-CH_2- + 3/2\ O_2 \rightarrow CO_2 + H_2O$$

TOC data is available, so the amount of oxygen to the amount of carbon on a mass basis will be calculated:

$-CH_2-$	$3/2\ O_2$
12	3/2 x 32
12	48

Ratio of O_2 to C is

$$48/12 = 4\ lb\ O_2/lb\ C$$

Therefore, at 100% efficiency, the amount of carbon (as TOC) that can be consumed by the oxygen that was injected is:

$$110\ lb\ O_2 \times lb\ C/4\ lb\ O_2 = 28\ lb\ TOC$$

Realistically, the process is not 100% efficient with leaks, escape of oxygen to the atmosphere, dispersion of oxygen to areas outside the treatment zone, and less than complete use of the tank contents. Thus, a lower efficiency, say 75%, may be more representative:

$$28\ lb\ TOC \times 0.75 = 21\ lb\ TOC\ that\ can\ be\ consumed.$$

NAS CECIL FIELD
BP WELLS TREATABILITY STUDY
CONTAMINANT MASS - GROUNDWATER PHASE
12/18/2003

1. Enter data from tag maps
Use 1/2 DL for U
Concentrations in ug/L

Compound	1S, 10/16/03								
Ethylbenzene	193								
1,2,4 TMB	436								
1,3,5 TMB	121								
Xylenes	928								

2. "Normalize" lab data results of other compounds to benzene by dividing by benzene concentration
(Shaded indicates that most compounds were not detected and were not used in later steps.)
normalized to benzene - NOT APPLICABLE

3. Estimate the aqueous concentrations in ug/L of other compounds, based on Maximum.

NOT APPLICABLE

			Ethylbenzene	Xylenes	1,2,4 TMB	1,3,5 TMB		
Plume			193	928	436	121		

4. Calculate mass in aqueous phase , lb.

Where, Mass compound, lb = C (ug/L) x 3.785 L/gal / (1,000,000 ug/g) /(454 g/lb) x Water vol, gal

Note - Based on max concentrations, so its skewed high.

									water vol,gal
			Ethylbenzene	Xylenes	1,2,4 TMB	1,3,5 TMB			
Plume			0.27	1.30	0.61	0.17			168,000
			0.0000	0.0000	0.0000	0.0000			
			0.000	0.0	0.0000	0.0000			
			0.000	0.0	0.0000	0.0000			
0			0.00	0.00	0.0000	0.0000			
Total	0.0	0.0	0.3	1.3	0.6107	0.1695	0.0000	0.0	
							TOTAL	**2.4**	

5. Calculate concentrations in soil using typical Koc and Foc values.

Use Foc = **0.2%** the FDEP default value.

Koc values of 1MN, 2MN and TRPH as naphthalene.

Kd = Koc x Foc

	Benzene	Toluene	Ethylbenz	Xylenes	1,2,4 TMB	1,3,5 TMB		
Koc, L/kg	38	135	260	240	2150	2150		
Foc, kg/kg	0.002	0.002	0.002	0.002	0.002	0.002		
Kd, L/kg	0.076	0.27	0.52	0.48	4.3	4.3		

6. Soil mass concentrations in ug/kg, or ppb.

The aqueous concentrations in the above tables (Step 3) are copied down and multiplied by the above Kd values.

			Ethylbenz	Xylenes	1,2,4 TMB	1,3,5 TMB		
Plume			100.4	445.4	1874.8	520.3		

			0.0	0.0	0.0	0.0		
			0.0	0.0	0.0	0.0		
			0.0	0.0	0.0	0.0		
			0.0	0.0	0.0	0.0		

7. Calculate mass in soil phase, lb
Mass compound, lb = C (ppb) x mass soil, lb / 1,000,000,000

			Ethylbenz	Xylenes	1,2,4 TMB	1,3,5 TMB			soil mass, lb
Plume			0.8	3.7	15.6	4.3			8,300,000
			0.000	0.000	0.000	0.000			
			0.00	0	0.000	0.000			
			0.00	0	0.000	0.000			
			0.0	0	0.000	0.000			
Total	0.0	0.0	0.8	3.7	15.561	4.318	0.000	0	
							TOTAL	**24.4**	

8. Subtotals of mass of contaminants in aqueous and sorbed phase, lb
Note - Based on max concentrations, so its skewed high.

			Ethylbenz	Xylenes	1,2,4 TMB	1,3,5 TMB			
Plume			1.10	5.0	16.2	4.5			26.8
			0.00	0.0	0.00	0.00			0.0
			0.00	0	0.00	0.00			0.0
			0.00	0	0.00	0.00			0.0
			0.0	0	0.00	0.000			0.0
			1.1	5	16.17	4.49			26.8
							TOTAL	**26.8**	

9. Subtotals of mass of contaminants in aqueous and sorbed phase, per layer, as a percentage of total in plume
NOT APPLICABLE

			Ethylbenz	Xylenes	1,2,4 TMB	1,3,5 TMB		
Plume			100.00	100.00	100.00	100.00		
0			0.00	0.00	0.00	0.00		
0			0.00	0.00	0.00	0.00		
0			0.00	0.00	0.00	0.00		
			0.00	0.00	0.00	0.00		
0			100.0	100.0	100.0	100.0		

NAS CECIL FIELD
BP WELLS TREATABILITY STUDY
CONTAMINANT MASS - GROUNDWATER PHASE
12/30/2003

1. Enter data from tag maps
Use 1/2 DL for U
Concentrations in ug/L

Compound	1S, 10/16/03								
Ethylbenzene	193								
1,2,4 TMB	436								
1,3,5 TMB	121								
Xylenes	928								

2. "Normalize" lab data results of other compounds to benzene by dividing by benzene concentration
(Shaded indicates that most compounds were not detected and were not used in later steps.)
normalized to benzene - NOT APPLICABLE

3. Estimate the aqueous concentrations in ug/L of other compounds using 1/4 of the max as the plume average.

NOT APPLICABLE

			Ethylbenzene	Xylenes	1,2,4 TMB	1,3,5 TMB		
Plume			48	232	109	30		

4. Calculate mass in aqueous phase , lb.
Where, Mass compound, lb = C (ug/L) x 3.785 L/gal / (1,000,000 ug/g) /(454 g/lb) x Water vol, gal

									water vol,gal
			Ethylbenzene	Xylenes	1,2,4 TMB	1,3,5 TMB			
Plume			0.07	0.32	0.15	0.04			168,000
			0.0000	0.0000	0.0000	0.0000			
			0.000	0.0	0.0000	0.0000			
			0.000	0.0	0.0000	0.0000			
0			0.00	0.00	0.0000	0.0000			
Total	0.0	0.0	0.1	0.3	0.1527	0.0424	0.0000	0.0	
							TOTAL	**0.6**	

5. Calculate concentrations in soil using typical Koc and Foc values.
Use Foc = **0.2%** the FDEP default value.
Koc values of 1MN, 2MN and TRPH as naphthalene.
Kd = Koc x Foc

	Benzene	Toluene	Ethylbenz	Xylenes	1,2,4 TMB	1,3,5 TMB		
Koc, L/kg	38	135	260	240	2150	2150		
Foc, kg/kg	0.002	0.002	0.002	0.002	0.002	0.002		
Kd, L/kg	0.076	0.27	0.52	0.48	4.3	4.3		

6. Soil mass concentrations in ug/kg, or ppb.
The aqueous concentrations in the above tables (Step 3) are copied down and multiplied by the above Kd values.

			Ethylbenz	Xylenes	1,2,4 TMB	1,3,5 TMB		
Plume			25.1	111.4	468.7	130.1		

			0.0	0.0	0.0	0.0		
			0.0	0.0	0.0	0.0		
			0.0	0.0	0.0	0.0		
			0.0	0.0	0.0	0.0		

7. Calculate mass in soil phase, lb
Mass compound, lb = C (ppb) x mass soil, lb / 1,000,000,000

			Ethylbenz	Xylenes	1,2,4 TMB	1,3,5 TMB			soil mass, lb
Plume			0.2	0.9	3.9	1.1			8,300,000
			0.000	0.000	0.000	0.000			
			0.00	0	0.000	0.000			
			0.00	0	0.000	0.000			
			0.0	0	0.000	0.000			
Total	0.0	0.0	0.2	0.9	3.890	1.080	0.000	0	
							TOTAL	**6.1**	

8. Subtotals of mass of contaminants in aqueous and sorbed phase, lb

			Ethylbenz	Xylenes	1,2,4 TMB	1,3,5 TMB			
Plume			0.28	1.2	4.0	1.1			6.7
			0.00	0.0	0.00	0.00			0.0
			0.00	0	0.00	0.00			0.0
			0.00	0	0.00	0.00			0.0
			0.0	0	0.00	0.000			0.0
			0.3	1	4.04	1.12			6.7
							TOTAL	**6.7**	

9. Subtotals of mass of contaminants in aqueous and sorbed phase, per layer, as a percentage of total in plume
NOT APPLICABLE

			Ethylbenz	Xylenes	1,2,4 TMB	1,3,5 TMB		
Plume			100.00	100.00	100.00	100.00		
0			0.00	0.00	0.00	0.00		
0			0.00	0.00	0.00	0.00		
0			0.00	0.00	0.00	0.00		
			0.00	0.00	0.00	0.00		
0			100.0	100.0	100.0	100.0		

And this does not include the TOC that is not quantified by the COCs.

NAS CECIL FIELD
BP WELLS TREATABILITY STUDY
CONTAMINANT MASS - GROUNDWATER PHASE
12/30/2003

1. Enter data from tag maps
Use 1/2 DL for U
Concentrations in ug/L

Compound	1S, 10/16/03								
Ethylbenzene	193								
1,2,4 TMB	436								
1,3,5 TMB	121								
Xylenes	928								
TOC	11600								

2. "Normalize" lab data results of other compounds to benzene by dividing by benzene concentration
(Shaded indicates that most compounds were not detected and were not used in later steps.)
normalized to benzene - NOT APPLICABLE

3. Estimate the aqueous concentrations in ug/L using 1/4 of the BP-1S as the plume average.

			Ethylbenzene	Xylenes	1,2,4 TMB	1,3,5 TMB	TOC	
Plume			48	232	109	30	2900	

4. Calculate mass in aqueous phase , lb.
Where, Mass compound, lb = C (ug/L) x 3.785 L/gal / (1,000,000 ug/g) /(454 g/lb) x Water vol, gal

									water vol,gal
			Ethylbenzene	Xylenes	1,2,4 TMB	1,3,5 TMB	TOC		
Plume			0.07	0.32	0.15	0.04	4.06		168,000
Total			0.1	0.3	0.1527	0.0424	4.06	0.0	
							TOTAL	**4.6**	

5. Calculate concentrations in soil using typical Koc and Foc values.
Use Foc = **0.2%** the FDEP default value.
Koc values of TOC as TMB
Kd = Koc x Foc

			Ethylbenz	Xylenes	1,2,4 TMB	1,3,5 TMB	TOC	
Koc, L/kg			260	240	2150	2150	2150	
Foc, kg/kg			0.002	0.002	0.002	0.002	0.002	
Kd, L/kg			0.52	0.48	4.3	4.3	4.3	

6. Soil mass concentrations in ug/kg, or ppb.

The aqueous concentrations in the above tables (Step 3) are copied down and multiplied by the above Kd values.

			Ethylbenz	Xylenes	1,2,4 TMB	1,3,5 TMB	TOC	
Plume			25.1	111.4	468.7	130.1	12470.0	

7. Calculate mass in soil phase, lb

Mass compound, lb = C (ppb) x mass soil, lb / 1,000,000,000

			Ethylbenz	Xylenes	1,2,4 TMB	1,3,5 TMB	TOC		soil mass, lb
Plume			0.2	0.9	3.9	1.1	103.5		8,300,000
Total			0.2	0.9	3.9	1.1	103.5		
							TOTAL	**109.6**	

8. Subtotals of mass of contaminants in aqueous and sorbed phase, lb

			Ethylbenz	Xylenes	1,2,4 TMB	1,3,5 TMB	TOC		
Plume			0.28	1.2	4.0	1.1	107.6		114.3
									0.0
									0.0
									0.0
									0.0
			0.3	1	4.0	1.1	107.6		114.3
							TOTAL	**114.3**	