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REMEDIAL ACTION PLAN ADDENDUM 2 FOR NORTH FUEL FARM NAS CECIL FIELD FL
3/24/2004
TETRA TECH NUS INC

Rev. 0
03/24/04

Remedial Action Plan Addendum
for
North Fuel Farm

Naval Air Station Cecil Field
Jacksonville, Florida

Southern Division
Naval Facilities Engineering Command
Contract Number N62467-94-D-0888
Contract Task Order 0168

March 2004

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REMEDIAL ACTION PLAN ADDENDUM
FOR
NORTH FUEL FARM

NAVAL AIR STATION CECIL FIELD
JACKSONVILLE, FLORIDA

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

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The professional opinions rendered in this document identified as Remedial Action Plan Addendum for North Fuel Farm, Naval Air Station Cecil Field, Jacksonville, Florida were developed in accordance with commonly accepted procedures consistent with applicable standards of practice. This document is based on information obtained from others and under the supervision of the signing engineer. 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 report.

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ACRONYMS

AS	Air Sparging
bgs	below ground surface
BS	Biosparging
BTEX	Benzene, Toluene, Ethylbenzene, and Xylenes
CAR	Contamination Assessment Report
CH2MHill	CH2MHill Constructors, Inc.
CLEAN	Comprehensive Long-Term Environmental Action Navy
COC	Chemical of Concern
Cs	Concentration in the soil
CTO	Contract Task Order
Cw	Concentration in the water
DO	Dissolved Oxygen
DPT	Direct Push Technology
FAC	Florida Administrative Code
FDEP	Florida Department of Environmental Protection
ft	feet/foot
ft^2	square feet
FID	Flame-Ionization Detector
F_{oc}	Fraction organic carbon
GAC	Granular Activated Carbon
GCTL	Groundwater Cleanup Target Level
hp	horse power
IDW	Investigated Derived Waste
JP-5	Jet Propellant 5
K_d	Distribution coefficient
K_{oc}	Organic carbon partitioning coefficient
lb	pound
LI	Lower Intermediate
MIP	Membrane Interface Probe
MN	Methylnaphthalene
MNA	Monitored Natural Attenuation
NAS	Naval Air Station
NFF	North Fuel Farm
NPW	Net Present Worth
O&M	Operations and Maintenance

ORC	Oxygen-Releasing Compound
PAH	Polynuclear Aromatic Hydrocarbon
PFD	Process Flow Diagram
psi	pounds per square inch
psig	pounds per square inch gauge
PVC	Polyvinyl Chloride
RAC	Remedial Action Contractor
RAP	Remedial Action Plan
RAPA	Remedial Action Plan Addendum
ROI	Radius of Influence
SARA	Site Assessment Report Addendum
scfm	standard cubic feet per minute
NAVFAC EFD SOUTH	United States Navy Southern Division Naval Facilities Engineering Command
SRR	Source Removal Report
SVE	Soil Vapor Extraction
TRPH	Total Recoverable Petroleum Hydrocarbons
TSP	Trisodium Phosphate
TtNUS	Tetra Tech NUS, Inc.
µg/L	microgram per Liter
UI	Upper Intermediate
VOC	Volatile Organic Compound
WT	Water Table

1.0 INTRODUCTION

Tetra Tech NUS, Inc. (TtNUS), under contract to Southern Division Naval Facilities Engineering Command (NAVFAC EFD SOUTH), has conducted the Remedial Action Plan Addendum (RAPA) for the North Fuel Farm (NFF) at Naval Air Station (NAS) Cecil Field in Jacksonville, Florida. This program was conducted under the Comprehensive Long-Term Environmental Action Navy (CLEAN) III Program, Contract Number N62467-94-D-0888, Contract Task Order (CTO) 0168. This RAPA summarizes the existing data, screens remedial alternatives, and recommends a remedial alternative to treat groundwater at the NFF. This remedial action is being performed according the Florida Administrative Code (F.A.C.) regulations covering leaks and discharges of petroleum products as described in Chapter 62-770, F.A.C.

1.1 SCOPE

The NFF consisted of six 595,000 gallon earth-mounded steel tanks that contained jet propellant (JP-5). The tanks and contaminated soils were removed in 2000 and 2001. Previous investigations of the site identified a petroleum hydrocarbon contaminated groundwater plume that is addressed by the RAPA.

1.2 REPORT ORGANIZATION

This RAPA is organized into eight sections. Below is a list of the sections and a brief description of their purpose:

Section 1.0	Introduction	Summarizes the report's purpose, scope, and report organization.
Section 2.0	Site Description	Provides a brief site description and summary of previous investigations and findings.
Section 3.0	RAPA Goals	Establishes the groundwater treatment objectives for the remedial system.
Section 4.0	Estimate of Contaminant Quantity	Estimates the mass of contaminants in the groundwater.
Section 5.0	Screening of Alternatives	Presents the alternatives for remediation, evaluates the suitability for the site, and develops budgetary costs for each.

Section 6.0	Remedial System Design	Presents all of the assumptions made and provides the conceptual design of the recommended remedial alternative.
Section 7.0	Operations and Maintenance (O&M)	Describes start-up and O&M procedures and provides a monitoring plan for the remediation system and sampling frequencies to evaluate the system's effectiveness.
Section 8.0	RAPA Summary	Refers to the Florida Department of Environmental Protection (FDEP) summary checklist.
	References	Lists references used.

2.0 SITE DESCRIPTION

2.1 SITE DESCRIPTION

The NFF is located at the northeast corner of Aviation Avenue (formerly A Avenue) and Loop Road. There were six 595,000 gallon interior-lined, asphalt-coated, steel, earth-mounded tanks that contained JP-5 jet fuel. The tanks were numbered 76 and 76-A through 76-E. All six tanks were covered under a common mound. Two tanks were installed in 1952 and the other four were installed in 1954. Tank 76-E was taken out of service in 1991 when it was determined to be leaking (ABB-ES, 1997). In 2000 and 2001, all the tanks, the earth mound, and contaminated soils were removed. Figure 2-1 shows the site arrangement.

Previous investigations of the site identified contaminated soil, free-product floating on the groundwater table, and a petroleum hydrocarbon contaminated groundwater plume. These investigations generally consisted of soil sampling and analyses, and the installation of monitoring wells and groundwater analyses. These investigations began in 1991 and continued until 2003. Significant reports included a Contamination Assessment Report (CAR) (ABB-ES, 1994), CAR Addendum (ABB-ES, 1996), Remedial Action Plan (RAP) (ABB-ES, 1997), RAPA (TtNUS, 1999), and Source Removal Report (SRR) (CH2MHill, 2001).

In 1999, a RAPA was submitted that recommended replacing the recirculation well system described in the 1997 RAP with an air sparging (AS) system, and excavation of the mound and tank removal in addition to the excavation described in the 1997 RAP. The soil vapor extraction (SVE) system and the bioslurping system described in the 1997 RAP were deleted. The biosparging (BS) system, natural attenuation, and monitoring aspects described in the 1997 RAP were unchanged. In 2000 and 2001, approximately 93,000 cubic yards (yd^3) of contaminated soil were removed (CH2MHill, 2001).

The most recent investigation included a direct push technology (DPT) and membrane interface probe (MIP) analysis to aid in the final delineation of the plume. A Site Assessment Report Addendum (SARA) (TtNUS, 2003b) that describes the DPT/MIP investigation and subsequent monitoring well installation and sampling will be available in mid-2003.

The former Truck Stand Site (Facility 372) is located about 300 feet (ft) southeast of the NFF. This site has been investigated separately, and the conclusion of the most recent investigation is that treatment of a relatively small groundwater plume [8,000 square feet (ft^2)] is required (TtNUS, 2003a). Because of the close proximity to the NFF, the treatment of the Truck Stand plume is included in this RAPA.

2.2 EXTENT OF CONTAMINATION

Previous investigations prior to 2002 determined benzene, toluene, ethylbenzene, xylenes (BTEX), naphthalene, 1-methylnaphthalene (MN), 2-MN, and total recoverable petroleum hydrocarbons (TRPH) exist in the groundwater at concentrations greater than FDEP groundwater cleanup target levels (GCTLs). However, the horizontal and vertical extent of contamination was not fully delineated.

Based on the DPT/MIP investigation and subsequent monitoring well installation in 2002 and 2003, the extent of groundwater contamination was delineated horizontally and vertically in the surficial aquifer. The extent of contamination extends vertically through the surficial aquifer from the water table at a depth of 5 ft below ground surface (bgs) to the top of the confining layer, at a depth of 100 to 110 ft bgs. The overall dimensions of the plume are nearly 1,400 ft long and 600 ft wide. To aid in visualizing the vertical extent of the plume, the surficial aquifer wells have been grouped by depth into four zones: water table (WT) (5 to 20 ft bgs), upper intermediate (UI) (20 to 50 ft bgs), lower intermediate (LI) (50 to 90 ft bgs), and deep (90 to 110 ft bgs). BTEX have been detected in all of the groundwater zones. The highest concentrations of polycyclic aromatic hydrocarbons (PAHs) and TRPH were found primarily in the WT zone, with lower concentrations in the UI and LI zones. Figure 2-1 shows the wells at the site. Figures 2-2 through 2-11 show the extent of contamination of volatile organic compounds (VOCs), PAHs, and TRPH in each of the four zones.

3.0 RAPA GOALS

The objective of this RAPA is to present relevant and cost-effective technologies to:

- Remediate contaminated groundwater.
- Protect human health and the environment by reducing the concentrations of groundwater contamination at the site to GCTLs.

The goal and expected accomplishment of the RAPA includes:

- Identify a method to remediate contaminated groundwater.

The target cleanup concentrations for the groundwater at the site are based on analytes detected in the groundwater in exceedance of Chapter 62-777, F.A.C. Table 3-1 presents the groundwater remediation goals for the site-specific chemicals of concern (COCs).

TABLE 3-1

GROUNDWATER CHEMICALS OF CONCERN
NORTH FUEL FARM REMEDIAL ACTION PLAN ADDENDUM
NAVAL AIR STATION CECIL FIELD
JACKSONVILLE, FLORIDA

Chemical of Concern	GCTL, µg/L [(1)]
Benzene	1
Toluene	40
Ethylbenzene	30
Xylenes	20
Naphthalene	20
1-Methylnaphthalene	20
2-Methylnaphthalene	20
TRPH	5,000

[1] = FDEP GCTLs, per Chapter 62-777, F.A.C.
ug/L = microgram per Liter

4.0 ESTIMATE OF CONTAMINANT QUANTITY

The estimate of the mass of contaminants includes contaminants dissolved in the groundwater and sorbed to soil in the saturated zone. Because of the extent of the plume, the calculation was simplified as described below.

1. The plume was divided into four depth zones: WT, UI, LI, and deep. The vertical thickness of each zone was established.

2. In each zone, isoconcentration contour lines for benzene were estimated based on groundwater analytical results. Benzene was selected because the GCTL for benzene is the most stringent and the 1 µg/L benzene contour line encloses the GCTL contour lines of all the other contaminants. Contour lines were determined for 1 µg/L, 10 µg/L, 100 µg/L, and 1,000 µg/L benzene.

3. The areas enclosed by adjacent contour lines (for example, 10 µg/L and 100 µg/L) were determined using a planimeter. The area within the innermost contour line was similarly determined.

4. Using the thickness for each zone and the areas determined in step 3, individual volumes for each plume subsection were calculated.

5. The average concentration of benzene in each plume subsection was calculated as the geometric mean of the inside and outside contour line (for example, 10 µg/L and 100 µg/L), or the maximum concentration and the outside contour line for the innermost contour line (for example, 1,000 µg/L).

6. The concentrations of the other compounds within each subsection were estimated in proportion to benzene using proportions of concentrations from wells located within the subsections. For example, in a subsection bound by 10 µg/L and 100 µg/L benzene, the benzene concentration based on the geometric average is 31.6 µg/L. If a well in that subsection had a benzene concentration of 50 µg/L and a xylenes concentration of 500, then the average xylenes concentration was assumed to be 500/50 x 31.6 = 316 µg/L.

7. Using the individual concentrations calculated above and the subsection volumes, the mass in the aqueous phase of each individual contaminant was calculated. A porosity of 0.3, typical of NAS Cecil Field, was used to adjust the volume to water volume.

8. The mass of each contaminant sorbed to the soil was calculated using distribution coefficients (K_d). The concentration in the soil (Cs) equals the concentration in water (Cw) times K_d, and K_d = organic

carbon partitioning coefficient (K_{oc}) x fraction organic carbon (F_{oc}). F_{oc} was assumed to be 1 percent, based on other Cecil Field projects. The soil density was assumed to be 110 lb per cubic foot. 1-MN, 2-MN, and TRPH were assumed to have K_{oc} values similar to naphthalene.

9. The total mass of each contaminant per subsection is the sum of the mass in the aqueous phase and in the soil phase. The mass in the plume or a zone can be calculated from the subsections.

These calculations are provided in Appendix A. The total mass in pounds (lbs) of each contaminant per zone is summarized below:

Zone	Benzene	Toluene	EB	Xylenes	Naph	1-MN	2-MN	TRPH
WT	18	123	179	169	150	97	97	2,338
UI	750	208	7,135	7,239	836	495	495	59,373
LI	482	35	2,131	2,173	248	71	71	14,163
Deep	73	1	30	19	2	2	2	2,419
Total	1,323	367	9,475	9,600	1,236	665	665	78,596

EB - ethylbenzene

Naph - naphthalene

MN - methylnaphthalene

5.0 SCREENING OF ALTERNATIVES

TtNUS conducted a screening of available technologies to recommend a suitable remedial alternative for the site. Potential remedial technologies and process options for groundwater remediation have been identified and evaluated based on their ability to meet clean-up objectives (effectiveness), applicability based on site conditions, feasibility of implementation, reliability, anticipated duration, and cost.

Based on the existing data, the extent of the plume (based on the 1 µg/L benzene contour line) is about 917,000 ft^2 and extends from a depth of 5 ft bgs to 110 ft bgs. TtNUS has investigated alternative methods for groundwater treatment. The following alternatives have been identified as potentially applicable for the site. Unless otherwise stated, "plume" refers to the footprint of the groundwater contamination as defined by the 1 µg/L benzene contour line.

- AS with SVE of entire plume.
- AS/SVE of high concentration areas with BS of rest of plume.
- AS/SVE of high concentration (greater than 1,000 µg/L benzene) part of plume, BS with nutrient addition of the part of the plume between 1,000 µg/L and 100 µg/L benzene, and monitored natural attenuation (MNA) of the balance. The area treated by AS will have SVE. (AS/BS/nutrient/ SVE/MNA).
- In situ chemical oxidation of the entire plume with Fenton's reagent.
- In situ biological degradation of the entire plume with injection of oxygen releasing compound (ORC).

The following sections briefly discuss each of these soil remedial actions with respect to their suitability for implementation at this site.

5.1 ALTERNATIVE 1 - AS/SVE

The entire plume, based on 1 µg/L benzene, is sparged. Due to changes in stratigraphy at about 50 ft bgs, there are two sparging depths: 50 ft bgs (shallow), and 80 ft or 100 ft bgs (deep). To determine the number of wells, two aggregate plumes were developed: one for the WT and UI zones for the Shallow, and another for the LI and the deep zones for the Deep. A SVE would be superimposed on the entire AS area. The ROI of each AS well is assumed to be of 30 ft, as is typical for other sites at NAS

Cecil Field. Each AS well would be sparged at 10 standard cubic feet per minute (scfm), based on other NAS Cecil Field sites. A pressure regulator and flow meter would be provided at each well for control.

Using the aggregate plume figures, the array of AS wells was estimated. An radius of influence (ROI) of 30 ft was assumed yield circles with diameters of 60 ft. The circles were arranged tangentially and a hexagonal arrangement on the plume. An axis of the arrangement runs roughly northwest to southeast. With this arrangement, there are 138 Shallow wells and 312 Deep wells.

For the SVE system, the effective distance for the horizontal wells is assumed to be the same as for the vertical wells: 40 ft based on the 1997 RAP (ABB-ES, 1997). Using a maximum horizontal length of 50 ft per well, 216 wells are required. These would be operated continuously. Five 1500 scfm vacuum pumps are required. The off-gas from the SVE would be treated through granular activated carbon (GAC) during the first year. It is expected that the TRPH and VOC emission rate will drop to acceptable levels within one year. After that, the GAC and SVE will be turned off.

The duration is based on AS vapor rate times vapor concentration. The vapor concentration is based on Henry's law and an efficiency factor has been assumed. Since the concentration of contaminants in the groundwater changes with time during treatment, an exponential equation was derived to calculate the treatment time:

$t = \ln(C_{goal} / C_o) / [-(Q*H*f / V)]$, where:

t is time of treatment, minutes.
C_{goal} is the target concentration, typically the GCTL, µg/L.
C_o is the initial average concentration of the area being treated, µg/L.
Q is the air flow rate, standard cubic feet per minute.
H is Henry's law constant, concentration in air/concentration in water, "dimensionless".
V is the volume being treated, cubic feet.
f is an efficiency factor to account for poor mixing, incomplete air-water contact, and non-equilibrium conditions, unitless and less than 1.

The treatment time derived by this method has been adjusted to 5 years on the assumption that biological activity will also reduce some of the contaminants. The spreadsheet calculations are in Appendix B.

The AS piping is assumed to be arranged as follows, starting at the treatment building. The treatment building is assumed to be outside the plume and near the midpoint of the length of the Deep plume, near the former Truck Stand.

- Main Headers (6 inch diameter) extend to the Northeast, roughly bisecting the plumes.

- Subheaders (4 inch diameter) extend from the main headers to the northwest and southeast along the wells described above. There is a subheader between every other row of AS wells.

- Wells are arranged in "cells" of about six wells. A sub-sub header (cell subheader) branches off the subheader to the wells in each cell. Typically, the cell subheader is parallel to the subheader.

- Air lines to each well branch off the cell subheader. The wells are arranged in cells of six to improve balance and control of the air flow.

SVE piping would have a similar arrangement of 6 inch headers, 4 inch subheaders and 4 inch horizontal well lines.

The AS will be operated in a pulsed mode. That is, air will be fed to the wells for a period of time, then the air will be turned off for a period of time. The off period allows contaminated water to return to the soil that was occupied by the air channels. When the air is turned back on, the air will be in contact with contaminated water that can be stripped out. The on-off cycle will be controlled manually, with one week on and one week off. Thus, only one half of the wells will be sparged at any time. Based on the number of wells, three 750 scfm compressors [each 200 horse power (hp)] are required.

Compressors, vacuum pumps, and GAC units will be housed inside a building. All piping will be buried. Each week, an operator will come to the site and manually change which cells are being sparged and which are not being sparged. Off-gas samples will be collected as needed, both upstream and downstream of the GAC.

The estimated capital cost of this alternative is $5,900,000. The annual operating costs vary from $412,000 to $830,000. The net present worth (NPW), based on 5 years of operation, is $8,100,000. A detailed cost estimate is included in Appendix C.

5.2 ALTERNATIVE 2 - AS/SVE/BS

In this alternative, only the portion of the plume defined by the benzene contour line of 1,000 µg/L is treated by AS/SVE. The rest of the plume is treated by BS. The BS wells would be identical to the AS wells described in the alternative above, except the air would be sparged for only 12 hour per day followed by 36 hours with the sparging air off. This will allow for the groundwater to be oxygenated for biological degradation. Oxygen would be consumed during the periods when the AS is turned off. The

sparging rate of both AS and BS wells is 10 scfm. With this arrangement, there are 138 Shallow wells and 312 Deep wells. Of these, 82 are AS and the balance is BS.

The SVE system would only cover the AS area. Thus, only 54 horizontal SVE wells are required. Two 300 scfm vacuum pumps are required. The off-gas from the SVE will be treated through GAC during the first year. It is expected that the TRPH and VOC emission rate will drop to acceptable levels within one year. After that, the GAC and SVE will be turned off.

The piping arrangement in the BS system would be as described for the AS system above, except motor-actuated valves would be installed for each cell. These actuators would be controlled by a timer to maintain the proper on and off periods. Based on the number of wells, two 500 scfm compressor (125 hp) is required.

The AS will be operated in a pulsed mode. The on-off cycle will be controlled manually, with one week on and one week off. Thus, only one half of the wells will be sparged at any time. Based on the number of wells, one 450 scfm compressor (125 hp) are required.

Compressors, vacuum pumps, and GAC units will be housed inside a building. All piping will be buried. Each week, an operator will come to the site and manually change which cells are being sparged and which are not being sparged. Off-gas samples will be collected as needed, both upstream and downstream of the GAC.

Since the alternative is dominated by biological process, it is assumed that the time for treatment is twice that of the AS alternative. Thus, the estimated treatment time is 10 years.

The estimated capital cost of this alternative is $5,200,000. The annual operating costs vary from $230,000 to $577,000. The NPW, based on 10 years of operation, is $7,200,000. A detailed cost estimate is included in Appendix C.

5.3 ALTERNATIVE 3 - AS/SVE/BS WITH NUTRIENT ADDITION/MNA

This alternative is like Alternative 2, but only the portion of the plume defined by the benzene contour line of 1,000 µg/L is treated by AS/SVE. The plume between 100 µg/L and 1,000 µg/L benzene will be treated by BS without SVE. The rest of the plume is treated by MNA.

In addition, this alternative includes the provisions for the injection of nitrogen and phosphorus nutrients with the air. In this case, the PHOSter process has been assumed that provides nitrogen and

phosphorus in a gaseous form for easier handling and injection. Nitrogen is in the form of nitrous oxide, and phosphorus is in the form of trisodium phosphate (TSP).

The sparging rate of the AS and BS wells is 10 scfm. With this arrangement, there are 48 Shallow AS wells, 34 Deep AS wells, 22 Shallow BS wells, and 110 Deep BS wells.

The SVE system would only cover the AS area. Thus, 54 horizontal SVE wells are required. Two 300 scfm vacuum pumps are required. The off-gas from the SVE will be treated through GAC during the first year. It is expected that the TRPH and VOC emission rate will drop to acceptable levels within one year. After that, the GAC and SVE will be turned off.

The piping arrangement for the BS system would be as described for the AS system above, except motor-actuated valves would be installed for each cell. These actuators would be controlled by a timer to maintain the proper on and off periods. Based on the number of wells, one 330 scfm BS compressor (75 hp) is required.

The AS will be operated in a pulsed mode. The on-off cycle will be controlled manually, with one week on and one week off. Thus, only one half of the wells will be sparged at any time. Based on the number of wells, one 410 scfm AS compressor (100 hp) is required.

Compressors, vacuum pumps, and GAC units will be housed inside a building. All piping will be buried. Each week, an operator will come to the site and manually change which cells are being sparged and which are not being sparged. Off-gas samples will be collected as needed, both upstream and downstream of the GAC.

The active treatment portion of this alternative is dominated by a biological process, but the nutrients will enhance the rate of the process, so it is assumed that the duration will be less than Alternative 2, but greater than Alternative 1 for an estimated time of 7 years. Based on the previous RAP (ABB-ES, 1997) and RAPA (TtNUS, 1999), the estimated MNA time is 30 years. Thus, the overall treatment time is 30 years.

The estimated capital cost of this alternative is $2,900,000. The annual operating costs vary from $22,000 to $525,000. The NPW, based on 7 years of operation, is $4,600,000. A detailed cost estimate is included in Appendix C.

5.4 ALTERNATIVE 4 – IN SITU CHEMICAL OXIDATION

Oxidizing chemicals, such as Fenton's reagent (hydrogen peroxide with an iron catalyst), react with organic compounds and quickly convert them to carbon dioxide and water. A solution of Fenton's reagent would be injected into the entire plume through a series of DPT borings. Because of uncertainties in the permeabilities, an ROI of 5 ft has been assumed for this alternative. Based on this ROI, about 9,000 borings would be required to treat the entire plume. This number of borings would require multiple rigs and would require six months to a year to complete. However, the reaction time is fast and treatment would be completed within a year of injection. Monitoring would continue for two years to confirm that remediation is complete.

Oxidizing chemicals will react with most organics, including much of the TRPH. Thus, the longer chain TRPH components will act as a sink for the oxidizing chemicals, and about 660,000 pounds of Fenton's reagent would be required.

The estimated capital cost of this alternative is $13,300,000. The annual operating costs vary from $59,000 to $117,000. The NPW, based on 2 years of operation, is $13,500,000. A detailed cost estimate is included in Appendix C.

5.5 ALTERNATIVE 5 – IN SITU BIOLOGICAL TREATMENT - ORC

ORC in a liquid solution is injected into the ground and gradually releases oxygen for biological activity. Like the Fenton's reagent, the ROIs are assumed to be 5 ft, and about 9,000 borings would be required. This number of borings would require multiple rigs and would require six months to a year to complete. Monitoring would continue for five years to confirm that remediation is complete. Based on vendor literature, it is assumed that treatment can be completed in 5 years.

ORC will promote the biological degradation of most organics. However, the longer chain TRPH components are assumed to be generally unaffected by biological activity, at least over the course of the treatment time. Based on a calculation spreadsheet provided by the ORC vendor (Regenesis), about 6,000,000 lbs of ORC would be required.

The estimated capital cost of this alternative is $37,500,000. The annual operating costs vary from $40,000 to $161,000. The NPW, based on 5 years of operation, is $37,900,000. A detailed cost estimate is included in Appendix C.

5.6 COMPARISON OF THE ALTERNATIVES AND SELECTION OF ALTERNATIVE

All alternatives are technically feasible and will meet the treatment goals. Alternatives 4 and 5 were eliminated due to the high costs compared to the other three alternatives. Of the remaining alternatives, Alternative 3 has the lowest overall cost. The treatment times for Alternatives 1 and 2 are less than Alternative 3, however, the time for treatment of Alternative 3 is acceptable.

Based on cost considerations, Alternative 3 is the recommended alternative. The duration of treatment, though greater than the other alternatives, is reasonable.

6.0 REMEDIAL SYSTEM DESIGN

The preferred remedial alternative presented in this RAPA was selected based on it being a cost-effective method for treatment of contaminated groundwater. The potential remedial technologies and process options were identified and screened, and the results were presented in Section 5.0. The selected alternative is AS/SVE of high concentration areas with MNA (AS/SVE/MNA).

6.1 AS/SVE/MNA

The major components of the treatment system include the following:

- AS/BS well installation
- AS/BS piping system
- Air compressor system
- SVE well installation
- SVE piping system
- Vacuum system/off-gas treatment
- Nutrient feed system
- MNA

Figure 6-1 shows a process flow diagram (PFD) of the treatment system.

6.1.1 AS/BS Well Installation

AS wells are to be installed in areas where the benzene concentration is greater than 1,000 µg/L. BS wells are to be installed in areas where the benzene concentration is between 100 µg/L and 1,000 µg/L. The shallow AS/BS wells will be installed to a depth of about 50 ft bgs, and the Deep AS/BS wells would be installed to a depth of 80 ft (where contamination is no deeper than the LI zone) or about 100 to 110 ft bgs (where contamination is no deeper than the deep zone). The wells will be installed using a Rotosonic drill rig to minimize the generation of investigated derived waste (IDW). The well casing will be constructed of 2 inch diameter schedule 80 polyvinyl chloride (PVC) pipe with 2 inch diameter schedule 80, 0.010 inch slot PVC screen. Screen lengths will be 2 ft. A small concrete vault will be installed at the top of the well to house the rotameter, pressure regulator, pressure gauge, sample port, and shut-off valve. There are 48 shallow AS wells (including 2 wells at the Truck Stand), 34 deep AS wells, 22 shallow BS wells, and 110 deep BS wells. Figures 6-2 and 6-3 show the arrangement of the AS and BS wells.

6.1.2 AS/BS Piping System

The AS piping is assumed to be arranged as follows, starting at the treatment building. The treatment building is assumed to be within a fenced area outside the plume and near the midpoint of the length of the deep zone plume, near the former Truck Stand.

- Main Headers (6 inch diameter) extend to the northeast, roughly bisecting the plumes.

- Subheaders (4 inch diameter) extend from the main headers to the northwest and southeast along the wells described above. There is a subheader between every other row of AS wells.

- Wells are arranged in "cells" of about six wells. A sub-sub header (cell subheader) (4 inch diameter) branches off the subheader to the wells in each cell. Typically, the cell subheader is parallel to the subheader.

- Air lines (2 inch diameter) to each well branch off the cell subheader. The wells are arranged in cells of six to improve balance and control of the air flow.

The AS will be operated in a pulsed mode. That is, air will be fed to the wells for a period of time, then the air will be turned off for a period of time. The off period allows for contaminated water to return to the soil that was occupied by the air channels. When the air is turned back on, the air will be in contact with contaminated water that can be stripped out. The on-off cycle will be controlled manually opening or closing a valve on the selected cell header, with one week on and one week off. Thus, only one half of the wells will be sparged at any time.

The BS piping will have a similar arrangement to the AS well piping system. The BS will be operated in a pulsed mode. That is, air will be fed to the wells for a period of time, then the air will be turned off for a period of time. The off period allows for contaminated water to return to the soil that was occupied by the air channels and for biological activity to consume the oxygen. When the air is turned back on, the air will be in contact with contaminated water that can be stripped out. The on-off cycle will be controlled automatically by a motor actuated opening or closing a valve on the selected cell header, with 12 hours on and 36 hours off. Thus, only one quarter of the wells will be sparged at any time.

6.1.3 AS/BS Compressors

The air flow rate to each AS and BS well is 10 scfm. The pressure losses in the compressed air system are from static losses in the sparging wells and friction losses in the pipe and fittings. The highest well loss is in the Deep wells and equals 110 ft – 5 ft = 105 ft or 45 pounds per square inch (psi). Friction

losses are minor and are less than 1 psi per 100 ft of pipe. For the longest run of pipe (about 1,300 ft), this corresponds to about 13 psi. The total pressure losses are about 58 psi, and allowing a safety factor of another 10 psi, the total pressure drop is about 70 psi. Thus, a screw compressor will be required.

With 82 wells at half the time, the AS flow rate is 410 scfm. There will be one AS compressor. The compressor will be an oil-free compressor that will provide 410 scfm at 100 pounds per square inch gauge (psig), with a 100 hp motor. A pressure regulator will reduce the output pressure to about 70 psig. The compressed air will pass through a receiver tank and then through a refrigerated dryer to minimize condensate in the lines. A particulate filter will remove traces of oil and solids.

With 132 wells at a quarter of the time, the BS flow rate is 330 scfm. There will be one BS compressor. The compressor will be an oil-free compressor that will provide 330 scfm at 100 psig, with a 75 hp motor. A pressure regulator will reduce the output pressure to about 70 psig. The compressed air will pass through a receiver tank and then through a refrigerated dryer to minimize condensate in the lines. A particulate filter will remove traces of oil and solids.

6.1.4 SVE Well Installation

The horizontal SVE wells will be installed to a depth of approximately 5 ft bgs or the top of the water table. The wells will be installed in trenches. The wells will be constructed of 4 inch diameter schedule 80 PVC, 0.010 inch slot screen, each 50 feet long. A small concrete vault will be installed at the head of the well to house a pressure gauge, sample port, and shut-off valve. There are 54 SVE wells. Figure 6-4 shows the coverage of the SVE wells.

6.1.5 SVE Piping System

The SVE piping is assumed to be arranged as follows, starting at the treatment building.

- Main Headers (6 inch diameter) extend to the northeast, roughly bisecting the plumes.

- Subheaders (4 inch diameter) extend from the main headers to the northwest and south east along the wells described above. The subheader spacing is about 100 ft. The wells are spaced at intervals of 80 ft.

- Wells are arranged in “cells” of about six wells. A sub-sub header (cell subheader) (4 inch diameter) branches off the subheader to the wells in each cell. Typically, the cell subheader is parallel to the subheader.

- The wells (4 inch diameter) branch off the cell subheader. The wells are arranged in cells of six to improve balance and control of the air flow.

The SVE system will be operated continuously. That is, air will be withdrawn from all the wells all the time.

6.1.6 SVE Vacuum System/Off-Gas Treatment

The total flow rate for the SVE system is based on 1.5 times the AS rate. Therefore, the total SVE rate is 1.5 x 410 scfm = 615 scfm. Based on the 1997 RAP, a vacuum pressure of 60 inches of water is assumed. Two 300 scfm vacuum blowers, each with a 10 hp motor will be provided.

A moisture separator located upstream of each blower will be provided to collect water that condenses in the system. The water will be discharged to a storage tank and disposed of off-site.

The estimated mass of contaminants with the area affected by the SVE system is 25,000 lbs. This estimate assumes that only 10 percent of the TRPH is volatile. It is assumed that in the first year, 80 percent of the contaminants, about 22,000 lbs, will be removed. The average daily mass rate then is:

$$M = 22{,}000 \text{ lb}/365 \text{ days} = 60 \text{ lb/day}$$

This exceeds the limit of 13.7 lb/day, so treatment of the off-gas is required. The off-gas from the SVE system will be treated with GAC. Based on a typical loading rate 10 lb GAC per lb of contaminants, the total amount of GAC required is 10 x 22,000 lb = 220,000 lb. Assume two 10,000 lb GAC units will be used in a lead-lag series configuration. Spent GAC would be disposed of off-site and would be replaced at a rate of about 10,000 lb per month.

After 1 year, the emission rate of hydrocarbons in the off-gas will be less than 13.7 lb/day, so the SVE and GAC system will not be needed.

6.1.7 Nutrient Feed System

The PHOSter process has been assumed that provides nitrogen and phosphorus in a gaseous form for easier handling and injection. Nitrogen is in the form of nitrous oxide, and phosphorus is in the form of TSP. The injection would be controlled by a timer and chemical feed would occur about half the time. The estimated nitrous oxide rate is 4.4 lb per day, and the estimated TSP rate is 2.8 lb per day. The feed fate would be adjusted based on field observations. .

6.1.8 Monitored Natural Attenuation

Monitoring for natural attenuation would consist of routinely sampling an analyzing several well for VOCs, PAHs, and TRPH. The source of contamination in the groundwater is petroleum-based fuel and the concentrations after AS/SVE treatment will be less than the natural attenuation default concentrations listed in Chapter 62-770, F.A.C. The following wells will be sampled as part of the MNA program. Wells in the AS/SVE area are not included because that area will be monitored during treatment and the concentrations are expected to be less than GCTLs at the completion of treatment.

Well	Zone	Notes
76-95S	WT	Upgradient
76-49S	UI	
76-57S	UI	
76-61I	LI	
76-100D	D	
76-11Xc	D	Final number to be designated at a later date
76-99D	D	
76-104D	D	Monitor plume migration

7.0 OPERATIONS AND MAINTENANCE

The following sections establish procedures for the start-up of the system, routine operation and maintenance of the remediation equipment, monitoring of the AS/SVE/BS operating parameters, and final system deactivation.

7.1 SYSTEM START-UP

Following final inspection and acceptance by NAVFAC EFD SOUTH, the system will be set for initial start-up. Approximately one week prior to start-up, a full round of water levels and dissolved oxygen (DO) measurements will be collected. During this event the AS and vapor extraction wells in the area will also be surveyed in reference to elevation to establish a baseline top of casing elevation for each remedial well. Following collection of water levels, the following wells will be sampled:

- 372-13R (Truck Stand)
- 76-94S (WT)
- 76-113S (UI)
- 76-93S (UI)
- 76-70I (LI)
- 76-50I (LI)
- 76-110D (Deep)
- 76-98D (Deep)

The samples will be analyzed for VOCs, PAHs, and TRPH. The initial round of measurements and groundwater analytical results will establish the baseline contaminant profiles and comparable monitoring parameters.

System start-up will commence approximately one week following the initial round of sampling. The following steps outline the start-up procedures.

1. Prior to any testing, bump and check each motor for proper rotation.

2. Inspect all equipment and ensure that all moving parts are free from obstructions.

3. Energize the control panel disconnect switch. Confirm that the voltage supplied to the panel is as specified.

4. Check all control sensors, alarms, and control logic by forcing alarm conditions, e.g., filling holding tank with potable water to check operation of the high-high sensor and the interlocked logic.

5. Check all motor amp loads against manufacturer's specified operating loads provided in the operations manual. Any motors found to be exceeding full load amp draw will undergo troubleshooting activities and the cause will be determined and rectified.

6. Energize the soil vapor extraction blowers. Check vacuum of each blower to ensure that it operates to manufacturer's specifications.

7. Adjust the air bleed valve such that the specified vacuum is achieved.

8. Let the SVE blowers operate for at least two hours. During this period monitor the amount of water accumulated in the moisture separator. If water accumulation in the moisture separator is significant, bleed dilution air to reduce vacuum levels until water take up is minimized.

9. Measure and record the vacuum at each vapor extraction well.

10. After the SVE system has stabilized and is operating normally, energize the AS blowers. Check the discharge pressure of the blowers to ensure that it operates to manufacturer's specifications.

11. Adjust the air bleed valve on the AS system until the specified discharge pressure and system airflow rate is reached.

12. Set/adjust temperature, pressure, and vacuum sensors and cut-out switches.

13. Monitor the AS/SVE system for two hours and record the flow rate, pressure/vacuum, and temperatures.

14. Balance the flow rates for half of the AS well cells to ensure equivalent remedial stress.

15. Measure and record the outlet pressure of the flow regulator mounted at each AS well. The measured pressure at each AS well should be equal to or greater than 19 psig for shallow wells, 32 psig for 80 ft wells, and 41 psig for 100 ft wells to evacuate the water from each well. If not, increase the discharge pressure at the AS blower or pressure regulators until the pressure at the each AS well is at an appropriate level.

16. Allow the system to operate for approximately two hours without adjustment, and then record the pressure, vacuum, and flow rate measurements.

17. Allow the system to run for 24 hours. Record all pressures, vacuums, and flows for future comparison to monthly visits. Repeat the above procedures to balance the flows to the wells in the other cells. Readjust as necessary.

18. Set chemical feed rates and chemical feed controllers

7.2 DESIGNATION OF OBSERVATION WELLS

Based on the configuration of the dissolved hydrocarbon plume and the hydraulic gradient, the following wells will be used to monitor the effectiveness of the remedial system efforts:

- 372-13R (Truck Stand)
- 76-94S (WT)
- 76-113S (UI)
- 76-93S (UI)
- 76-70I (LI)
- 76/50I (LI)
- 76/110D (Deep)
- 76-98D (Deep)

Groundwater samples will be collected from these wells on a quarterly basis during the first year, semi-annually during the second and third years, and then annually thereafter. Samples will be analyzed for VOCs, PAHs, and TRPH.

7.3 MONITORING PLAN

A monitoring program is anticipated to be initiated upon approval of this RAPA and subsequent installation and startup of the remedial action system. The monitoring plan has three main objectives:

- To monitor the overall effectiveness of the remedial system in removing hydrocarbons from the soil and groundwater;

- To monitor the progress of natural attenuation, and

- To monitor the performance of the remedial equipment.

The proposed monitoring plan includes the following:

- Measurements of groundwater levels and DO in the monitoring wells to determine groundwater mounding and to verify the ROI measurements will be taken weekly for the first month, monthly for the next two months, and quarterly thereafter. Measurement will be performed using a water level indicator and a DO meter.

- Measurements of pressure, vacuum, and AS and vacuum extraction flow rates will be performed weekly for the first month and monthly thereafter. Measurement will be performed using pressure/vacuum gauges and flow meters mounted on the remedial system. A portable flow meter may also be used to check the airflow at the wells.

- Measurements of the pressure at each AS well will be performed weekly for the first month, monthly for the next two months, and quarterly thereafter. Measurement will be performed using a magnehelic pressure gauge (or approved equal).

- Measurements of vacuum at each vapor extraction well will be performed weekly for the first month, monthly for the next two months, and quarterly thereafter. Measurement will be performed using a magnehelic vacuum gauge (or approved equal).

- Field measurements of hydrocarbon concentrations between carbon vessels and from the soil vapor extraction effluent stack will be taken, using flame ionization detector (FID), weekly for the first month and monthly thereafter.

- Sampling and laboratory testing of groundwater from the selected monitor wells to document remediation of the groundwater plume will be performed as described above. Sampling for MNA will be performed as described in Section 6.0 and as approved by the FDEP.

- Sampling influent and effluent vapor from the soil vapor extraction system will be performed weekly for the first month, monthly for the next two months, and quarterly thereafter. The air samples will be collected using TedlarTM bags and analyzed for BTEX using EPA Method TO18.

- The results of quarterly sampling will be reported every quarter in a status report (See Section 7.6)

7.4 MONITORING REMEDIATION PROGRESS

The performance-monitoring program will be re-evaluated after six months of sampling and testing and will be modified as necessary to maximize the effectiveness of the remediation system. The overall effectiveness of the proposed remediation system and cleanup progress will be monitored by evaluating the following monitoring data:

- The mass rate of hydrocarbons removed by the SVE system in comparison with the estimated mass removal rates (emission rates).
- The cumulative mass of hydrocarbons recovered by the AS/SVE system in comparison with the estimated cumulative mass of contaminants present (see Section 4.0).
- The trend of DO concentrations as the remedial system progresses.
- The trend of hydrocarbon concentrations in groundwater as the remedial system progresses.
- The trend of hydrocarbon concentrations in MNA wells.

These monitoring data will be used to determine if the objectives of the RAPA and standards of the design criteria are being met. The remedial system will be modified if the monitoring data indicates that the cleanup goals can not be met in the time frame as specified in the RAPA. Modifications of the remedial system will be based on the site-specific monitoring data.

7.5 SYSTEM OPERATIONS AND MAINTENANCE

The proposed remedial system is designed to operate continually and automatically with minimal maintenance or operator attendance. Site visits for system inspection and maintenance and for changing which cells are being sparged will be performed by a trained and qualified technician and will be performed in conjunction with system monitoring to reduce costs.

Each week, the valves on each cell header will be turned so that different wells are being sparged. One half of the wells will be sparged at one time.

The following O&M items are scheduled to be performed weekly for the first month and monthly thereafter:

1. Record the AS, BS, and SVE equipment hour meter readings, flow rates, pressures, vacuum, and the amount (if any) of water collected in the wastewater tank. Record chemical usage.

2. If there is significant condensate in the wastewater tank, arrangements must be made for disposal of the water.

3. Inspect the AS compressors and vacuum extraction blowers. Add oil if needed, then lubricates the bearings as necessary. Visually check the particle filters for signs of dust or debris accumulation and replace if necessary. Record the amount of oil added and the condition of the filters. Periodically replace the oil per manufacturer's instructions. Fully inspect the condition of the entire blower units (belt tension, rust, etc.).

4. Adjust the pressures, vacuums, and flow rates to the original operational levels established during system startup.

5. Maintain good housekeeping measures for the entire remediation system compound, picking up trash, cutting weeds as necessary.

6. Log all inspection activities and repairs performed.

An O&M Manual will be provided with all equipment and systems acquired. The manual will have at a minimum, sections covering the unloading, installation, set-up, operation instruction, and maintenance instruction for each component of the system.

7.6 STATUS REPORTS

During the implementation and operation of the remedial system described in this RAPA, quarterly status reports will be prepared and submitted to NAVFAC EFD SOUTH. The reports will summarize all remedial activities and will contain at a minimum the following information:

- Startup date.

- Hydrocarbon constituent concentrations in groundwater as measured from monitoring wells, together with water table elevations.

- DO in the groundwater.

- Hydrocarbon constituent concentrations in recovered vapors.

- Cumulative mass of hydrocarbon removed by the AS/SVE/BS system.
- Recent hydrocarbon plume and groundwater contour maps.
- A graph of cumulative mass removed versus operation time.
- A graph of vapor concentration versus operation time.
- Summary of system operational data.
- Conclusions as to the effectiveness of the remedial system and recommendations on further monitoring and operations of the system.

7.7 SYSTEM DEACTIVATION

The following criteria must be met for active remediation to be deemed complete and prior to deactivation of the AS/SVE/BS system:

- No Further Action criteria as defined in Chapter 62-770.680, F.A.C. have been met.
- Natural Attenuation criteria established in Chapter 62-770.690, F.A.C. has been achieved.
- Concentrations of COC in the designated monitoring wells have “leveled off” as defined in Chapter 62-770.700, F.A.C.

After the site meets one the above criteria and NAVFAC EFD SOUTH and FDEP agrees with the decision to deactivate the AS/SVE/BS system, the system will be deactivated. The following steps shall be followed during system deactivation:

1. Deactivate the AS and BS blowers and allow to cool down.
2. Deactivate the SVE blowers and allow to cool down.
3. Bleed the moisture separator tank of excess vacuum and condensate.
4. Seal the tops of the GAC tanks, if any.

5. De-energize the control panel via the service disconnect.

6. Properly transport and dispose of the condensate water and GAC.

7. AS/SVE/BS equipment will remain on site until after the post-closure monitoring verifies that the site has been properly remediated, at which point it will be removed from the site as directed by NAVFAC EFD SOUTH.

Following AS/SVE/BS system deactivation, a Post Active Remediation Monitoring Plan must be developed for the site and approved by the FDEP. The contents of this plan are included in Chapter 62-770.750, F.A.C. This monitoring shall occur for a minimum of one year. This sampling will be performed in conjunction with the MNA sampling.

8.0 REMEDIAL ACTION PLAN ADDENDUM SUMMARY

The RAPA Summary is included in Appendix D.

REFERENCES

ABB-ES (ABB Environmental Services, Inc.), 1994. Contamination Assessment Report, North Fuel Farm Area Sites, Naval Air Station Cecil Field, Jacksonville, Florida. Prepared for SOUTHNAVFACENGCOM, North Charleston, South Carolina, July.

ABB-ES, 1996. Contamination Assessment Report Addendum, North Fuel Farm Area Sites, Naval Air Station Cecil Field, Jacksonville, Florida. Prepared for SOUTHNAVFACENGCOM, North Charleston, South Carolina, April.

ABB-ES, 1997. Remedial Action Plan, North Fuel Farm Site, Naval Air Station Cecil Field, Jacksonville, Florida. Prepared for SOUTHNAVFACENGCOM, North Charleston, South Carolina, January.

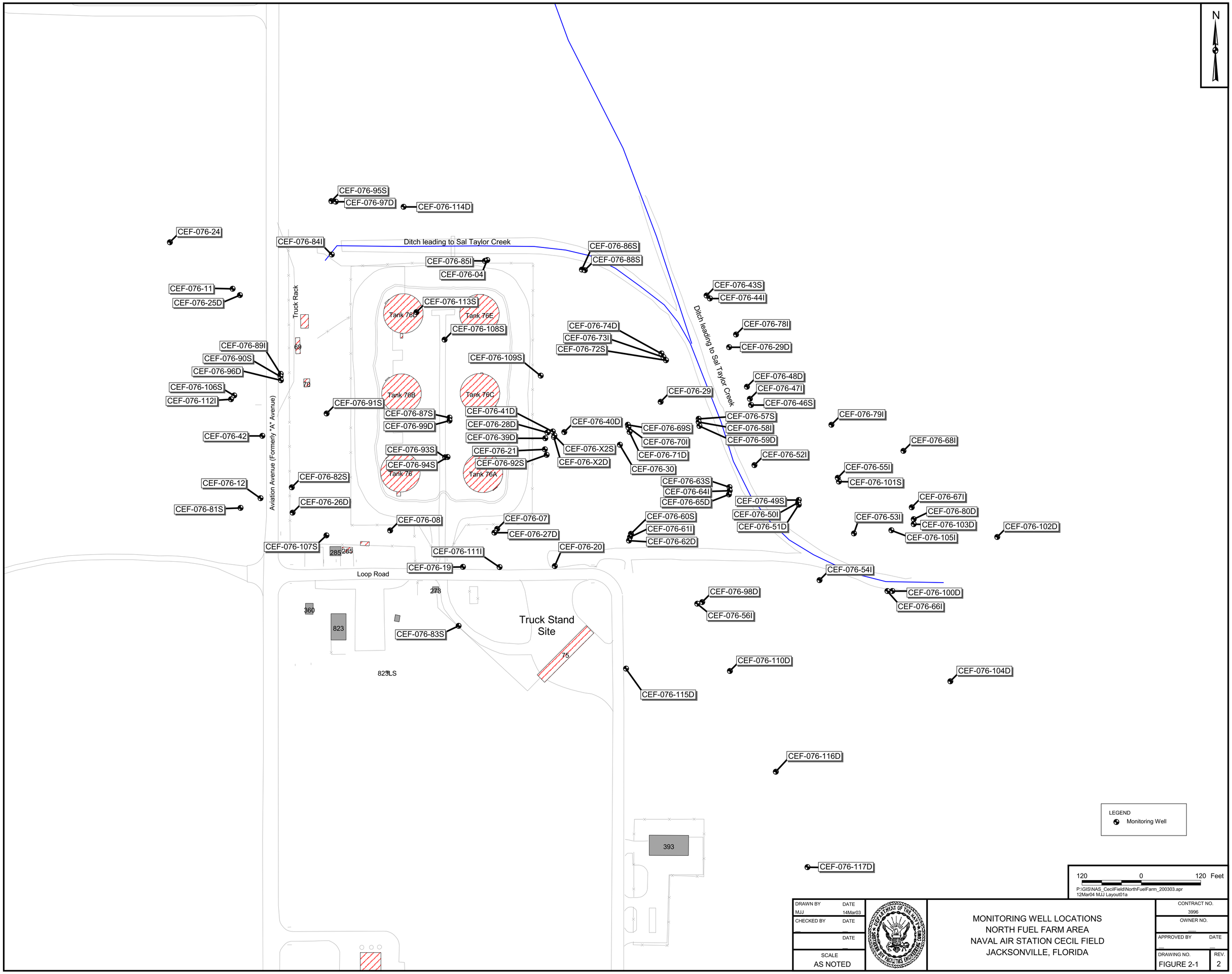
CH2MHill (CH2MHill Constructors, Inc.), 2001. Source Removal Report, Soil and Aboveground Tank Removal at North Tank Fuel Farm, Tanks Numbers 76, 76A, 76B, 76C, 76D, and 76E, Naval Air Station Cecil Field, Jacksonville, Florida. Prepared for SOUTHNAVFACENGCOM, North Charleston, South Carolina, November.

TtNUS (Tetra Tech NUS, Inc.), 1999. Remedial Action Plan Addendum, North Fuel Farm Site, Naval Air Station Cecil Field, Jacksonville, Florida. Prepared for SOUTHNAVFACENGCOM, North Charleston, South Carolina, August.

TtNUS, 2003a. Supplemental Assessment Letter Report, Truck Stand Site, Facility 372, Naval Air Station Cecil Field, Jacksonville, Florida. Prepared for SOUTHNAVFACENGCOM, North Charleston, South Carolina, June.

TtNUS, 2003b. Site Assessment Report Addendum, North Fuel Farm Site, Naval Air Station Cecil Field, Jacksonville, Florida. Prepared for SOUTHNAVFACENGCOM, North Charleston, South Carolina.

FIGURES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MONITORING WELL LOCATIONS
NORTH FUEL FARM AREA
NAVAL AIR STATION CECIL FIELD
JACKSONVILLE, FLORIDA
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OWNER NO.
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REV. 2

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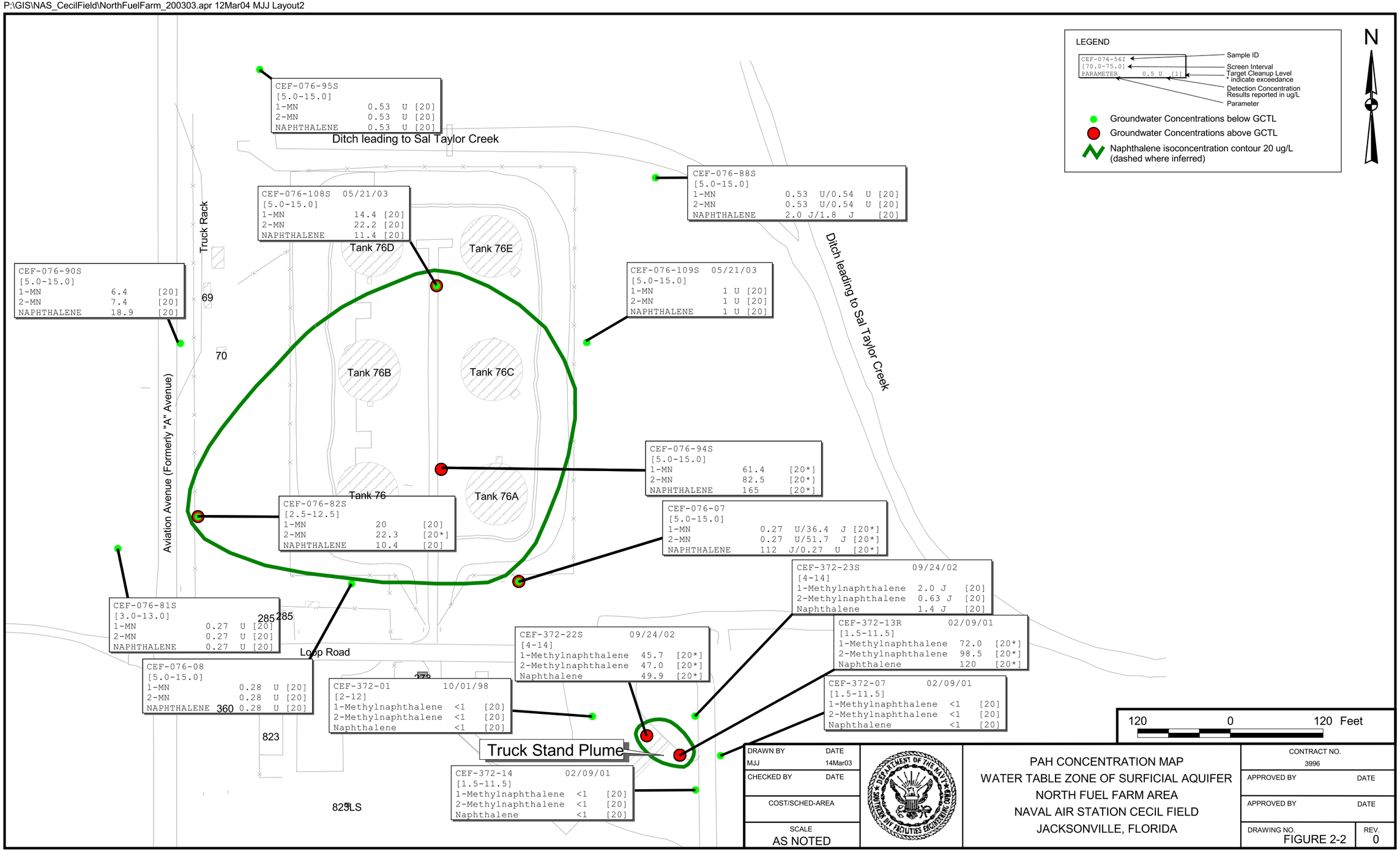

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CHECKED BY	DATE		APPROVED BY / DATE
COST/SCHED-AREA			APPROVED BY / DATE
SCALE AS NOTED			DRAWING NO. FIGURE 2-2 / REV. 0

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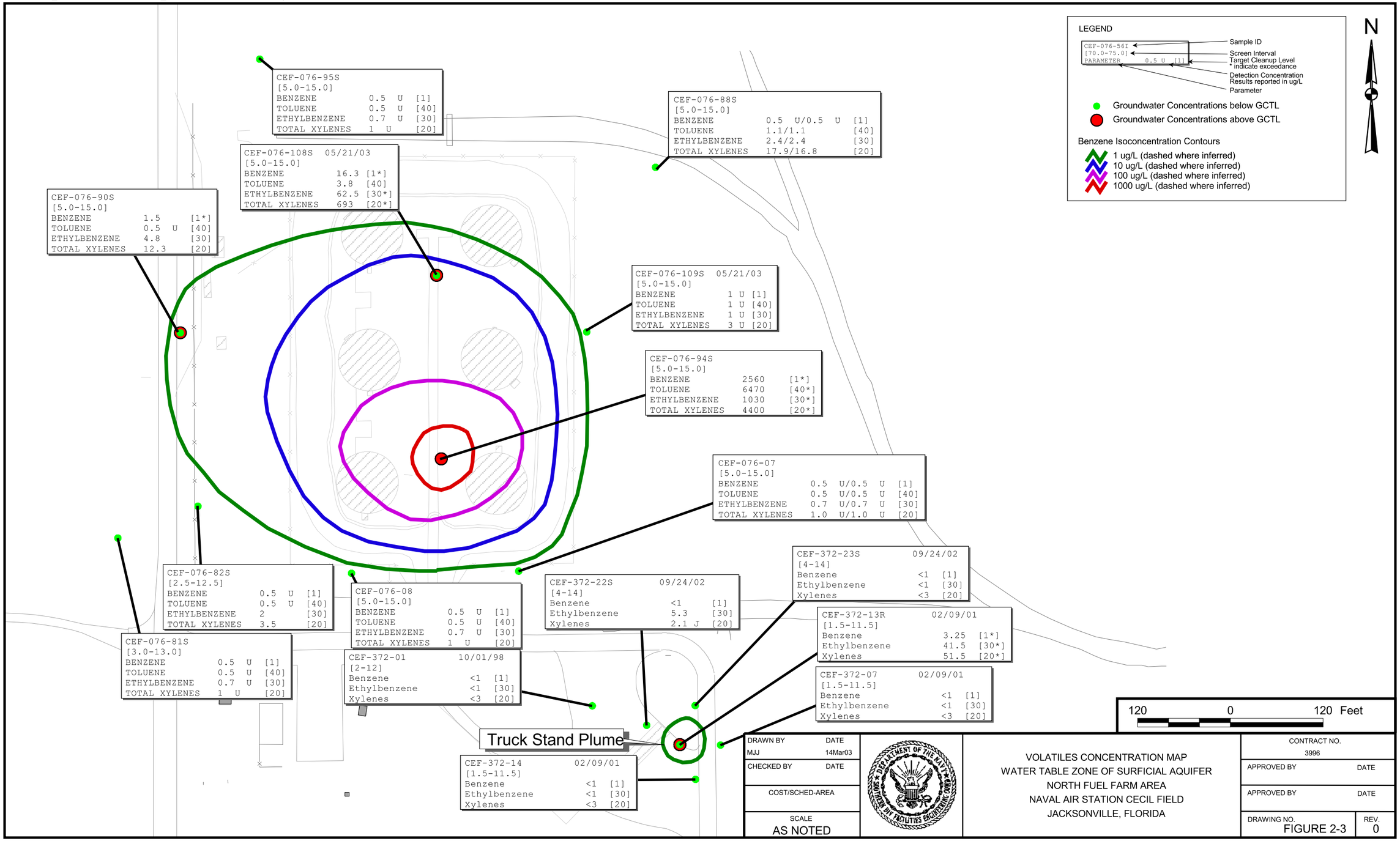

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COST/SCHED-AREA	
SCALE	AS NOTED

VOLATILES CONCENTRATION MAP
WATER TABLE ZONE OF SURFICIAL AQUIFER
NORTH FUEL FARM AREA
NAVAL AIR STATION CECIL FIELD
JACKSONVILLE, FLORIDA

CONTRACT NO.	
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DRAWING NO. FIGURE 2-3	REV. 0

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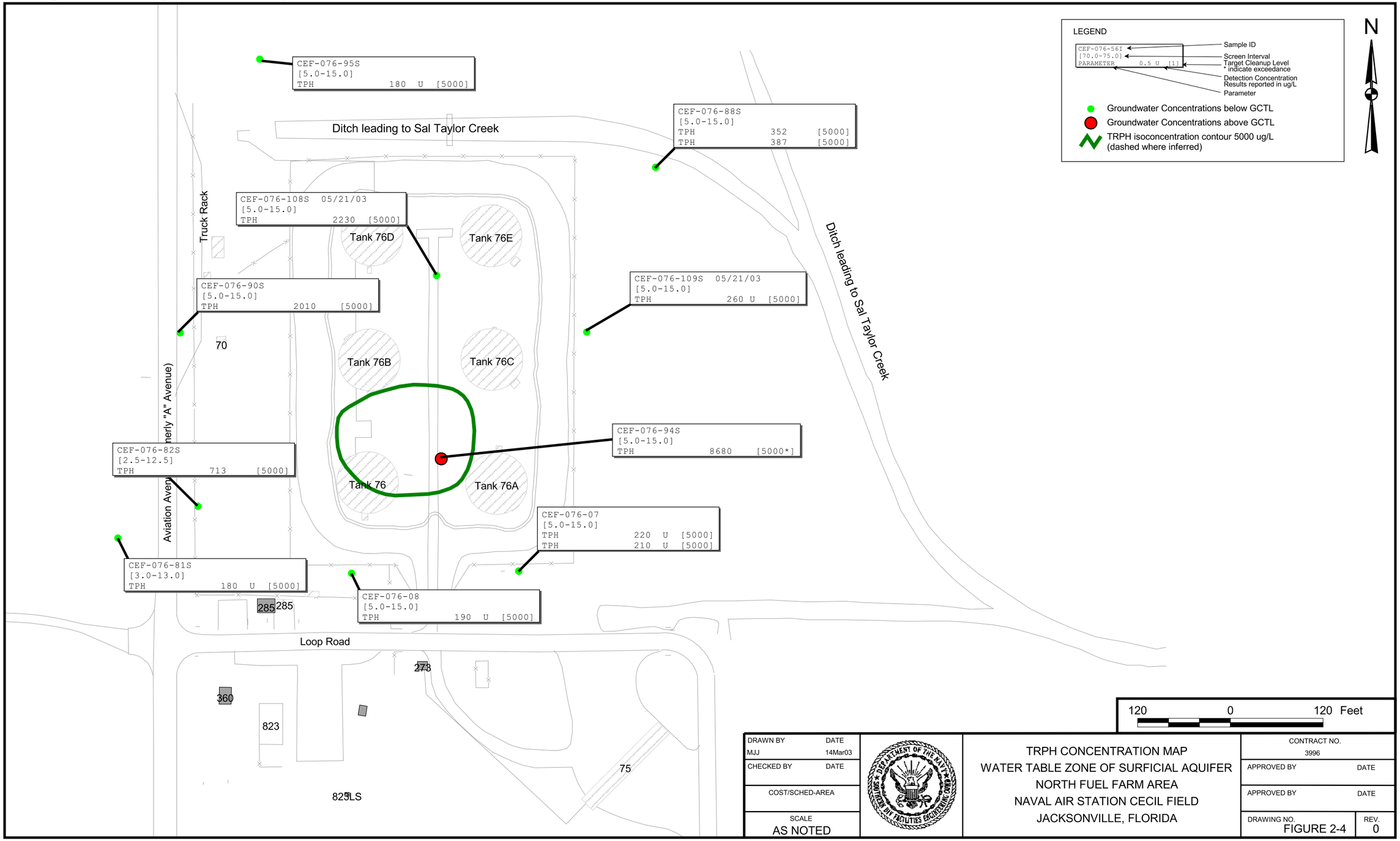
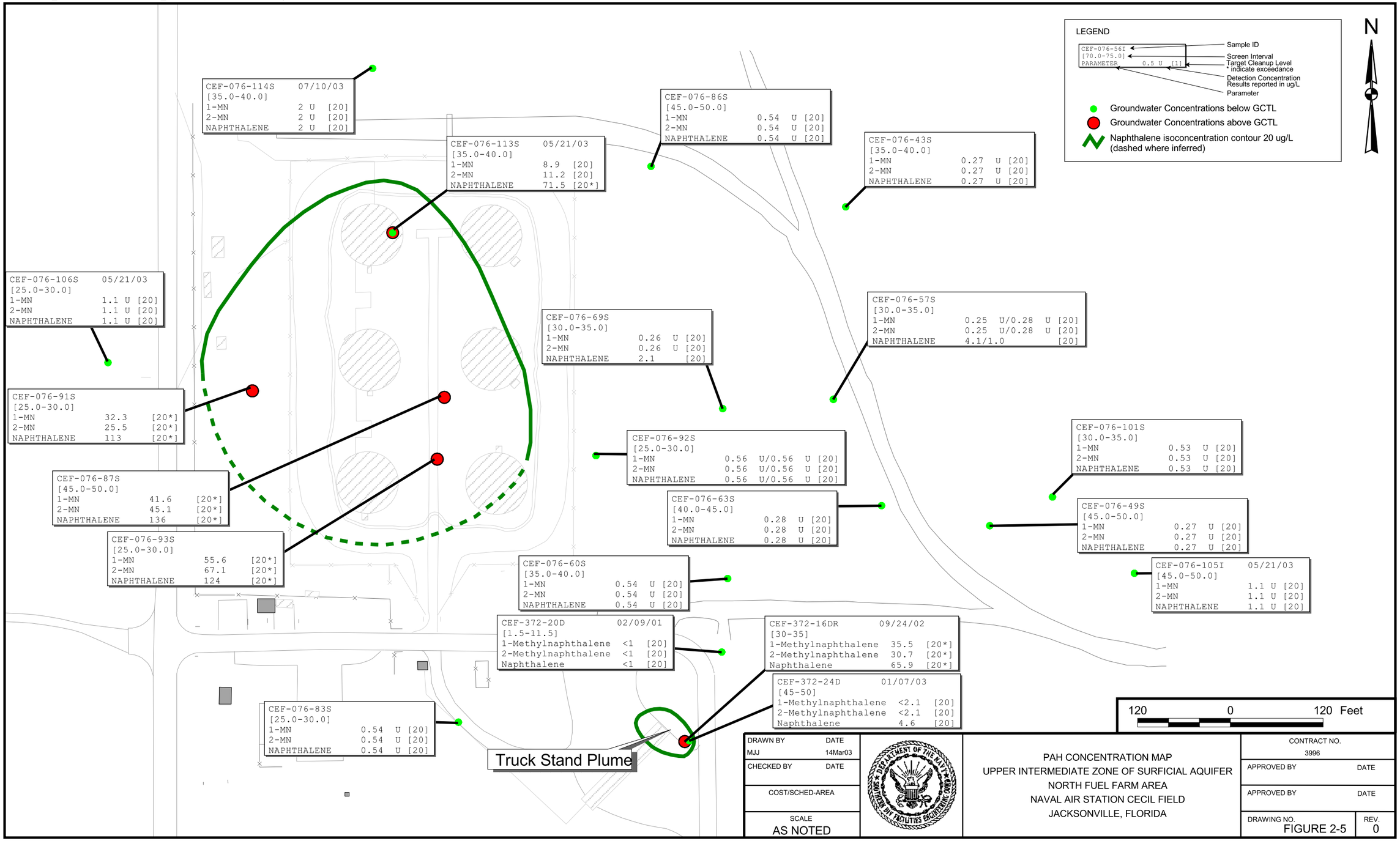


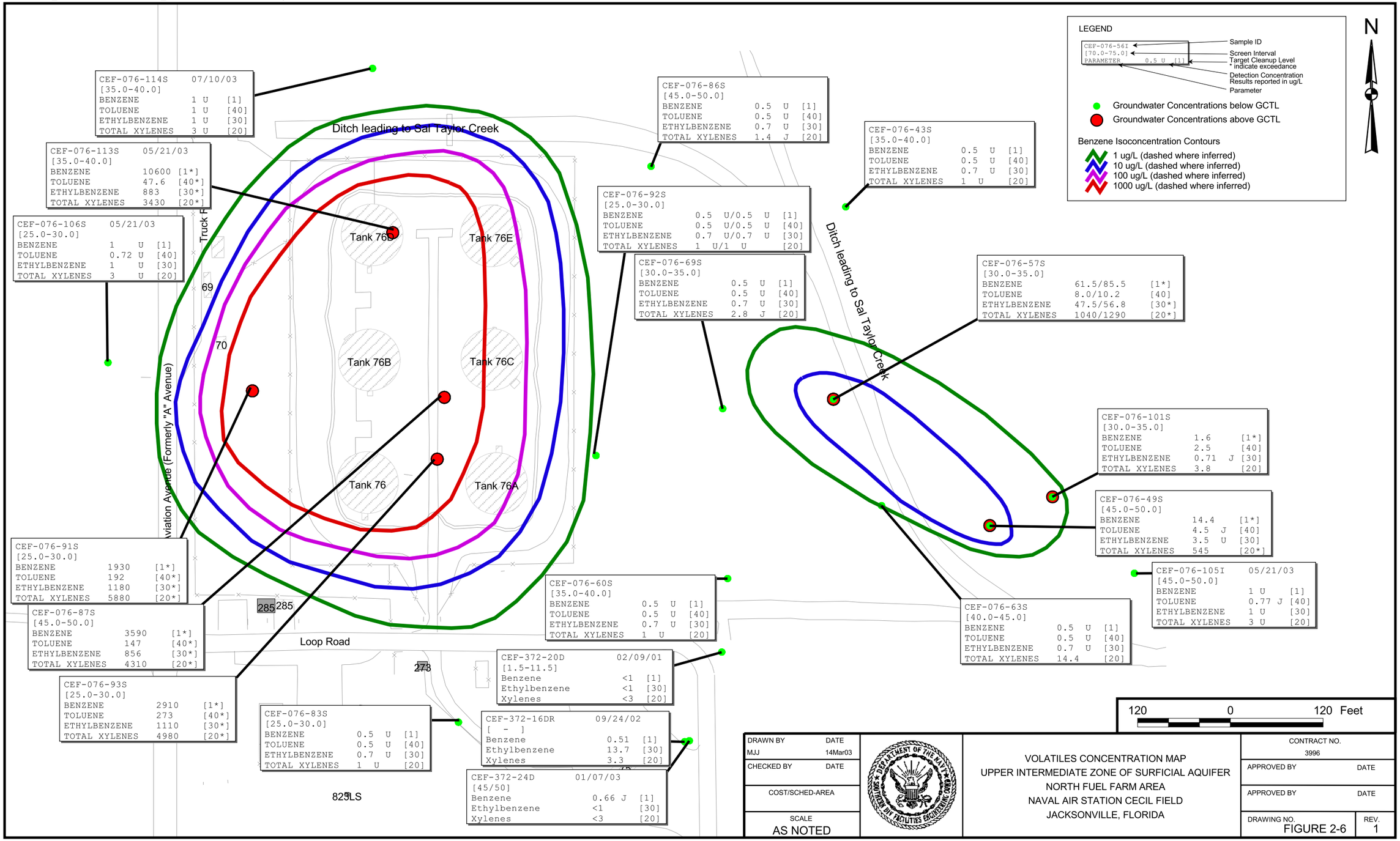
DRAWN BY MJJ	DATE 14Mar03	TRPH CONCENTRATION MAP WATER TABLE ZONE OF SURFICIAL AQUIFER NORTH FUEL FARM AREA NAVAL AIR STATION CECIL FIELD JACKSONVILLE, FLORIDA	CONTRACT NO. 3996
CHECKED BY	DATE		APPROVED BY / DATE
COST/SCHED-AREA			APPROVED BY / DATE
SCALE AS NOTED			DRAWING NO. FIGURE 2-4 / REV. 0

P:\GIS\NAS_CecilField\NorthFuelFarm_200303.apr 12Mar04 MJJ Layout5



DRAWN BY MJJ	DATE 14Mar03	PAH CONCENTRATION MAP UPPER INTERMEDIATE ZONE OF SURFICIAL AQUIFER NORTH FUEL FARM AREA NAVAL AIR STATION CECIL FIELD JACKSONVILLE, FLORIDA	CONTRACT NO. 3996
CHECKED BY	DATE		APPROVED BY DATE
COST/SCHED-AREA			APPROVED BY DATE
SCALE AS NOTED			DRAWING NO. FIGURE 2-5 / REV. 0

P:\GIS\NAS_CecilField\NorthFuelFarm_200303.apr 12Mar04 MJJ Layout6

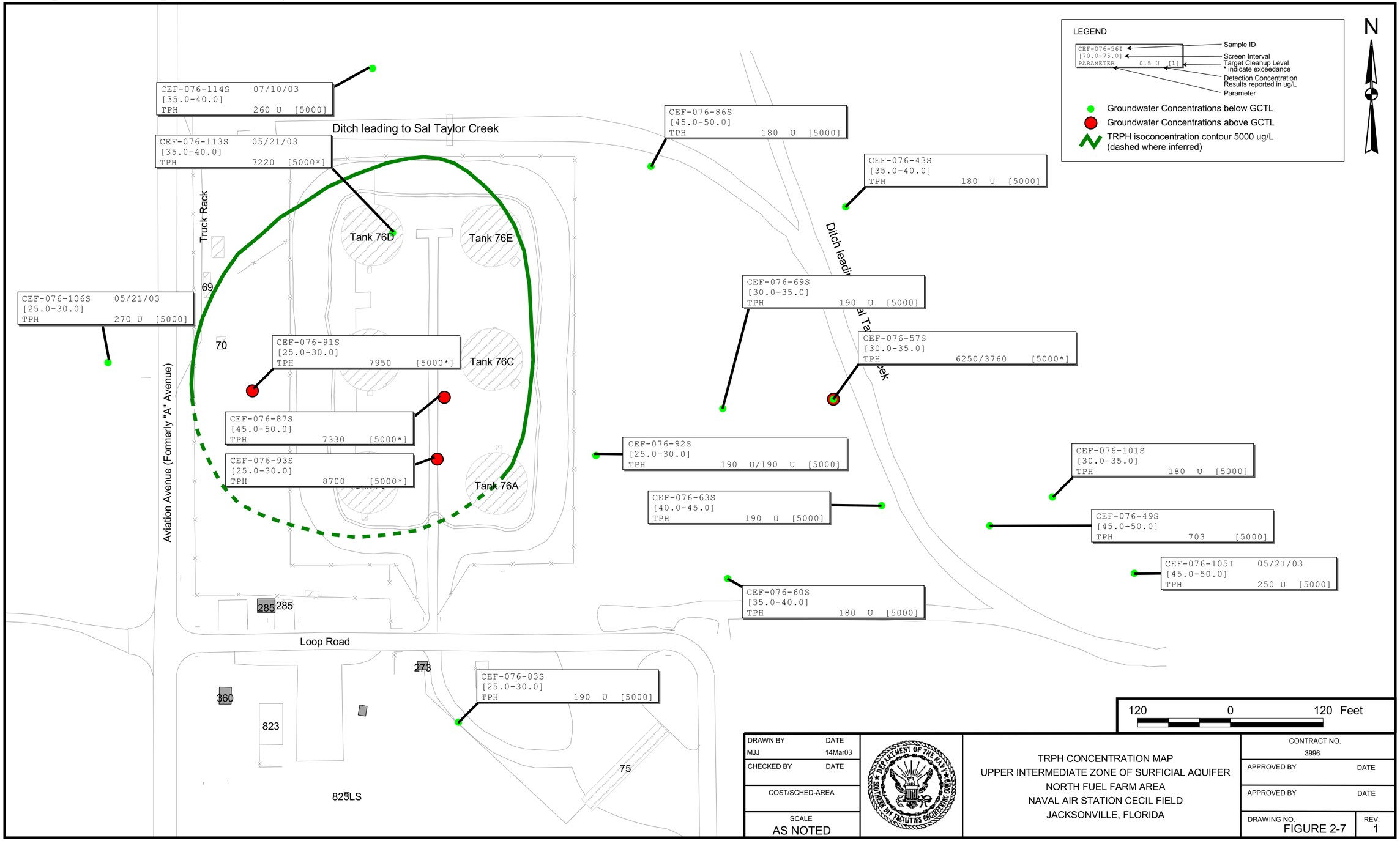


DRAWN BY	DATE
MJJ	14Mar03
CHECKED BY	DATE
COST/SCHED-AREA	
SCALE	AS NOTED

VOLATILES CONCENTRATION MAP
UPPER INTERMEDIATE ZONE OF SURFICIAL AQUIFER
NORTH FUEL FARM AREA
NAVAL AIR STATION CECIL FIELD
JACKSONVILLE, FLORIDA

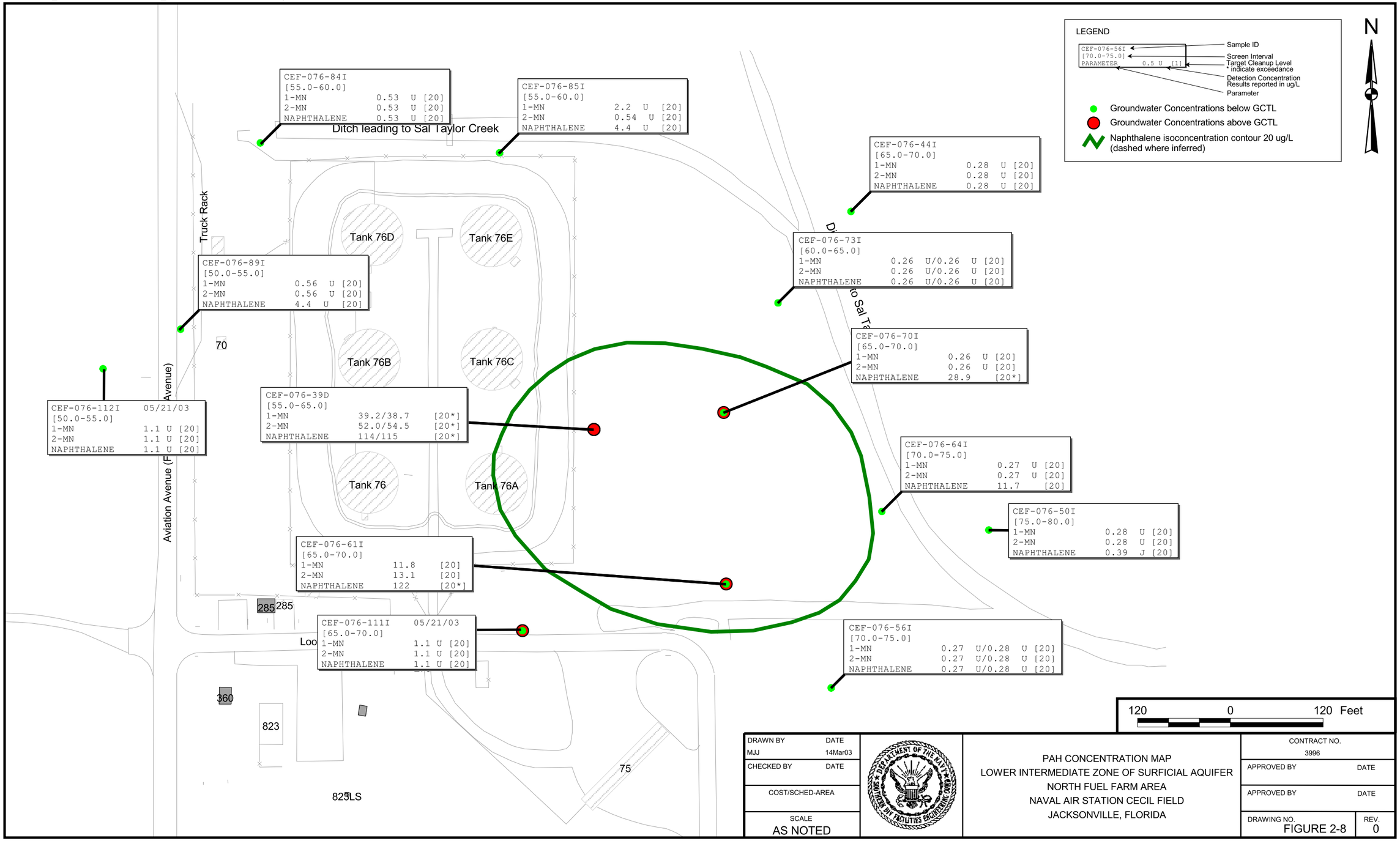
CONTRACT NO.	
3996	
APPROVED BY	DATE
APPROVED BY	DATE
DRAWING NO. FIGURE 2-6	REV. 1

P:\GIS\NAS_CecilField\NorthFuelFarm_200303.apr 12Mar04 MJJ Layout7



DRAWN BY MJJ	DATE 14Mar03	TRPH CONCENTRATION MAP UPPER INTERMEDIATE ZONE OF SURFICIAL AQUIFER NORTH FUEL FARM AREA NAVAL AIR STATION CECIL FIELD JACKSONVILLE, FLORIDA	CONTRACT NO. 3996
CHECKED BY	DATE		APPROVED BY / DATE
COST/SCHED-AREA			APPROVED BY / DATE
SCALE AS NOTED			DRAWING NO. FIGURE 2-7 / REV. 1

P:\GIS\NAS_CecilField\NorthFuelFarm_200303.apr 12Mar04 MJJ Layout8

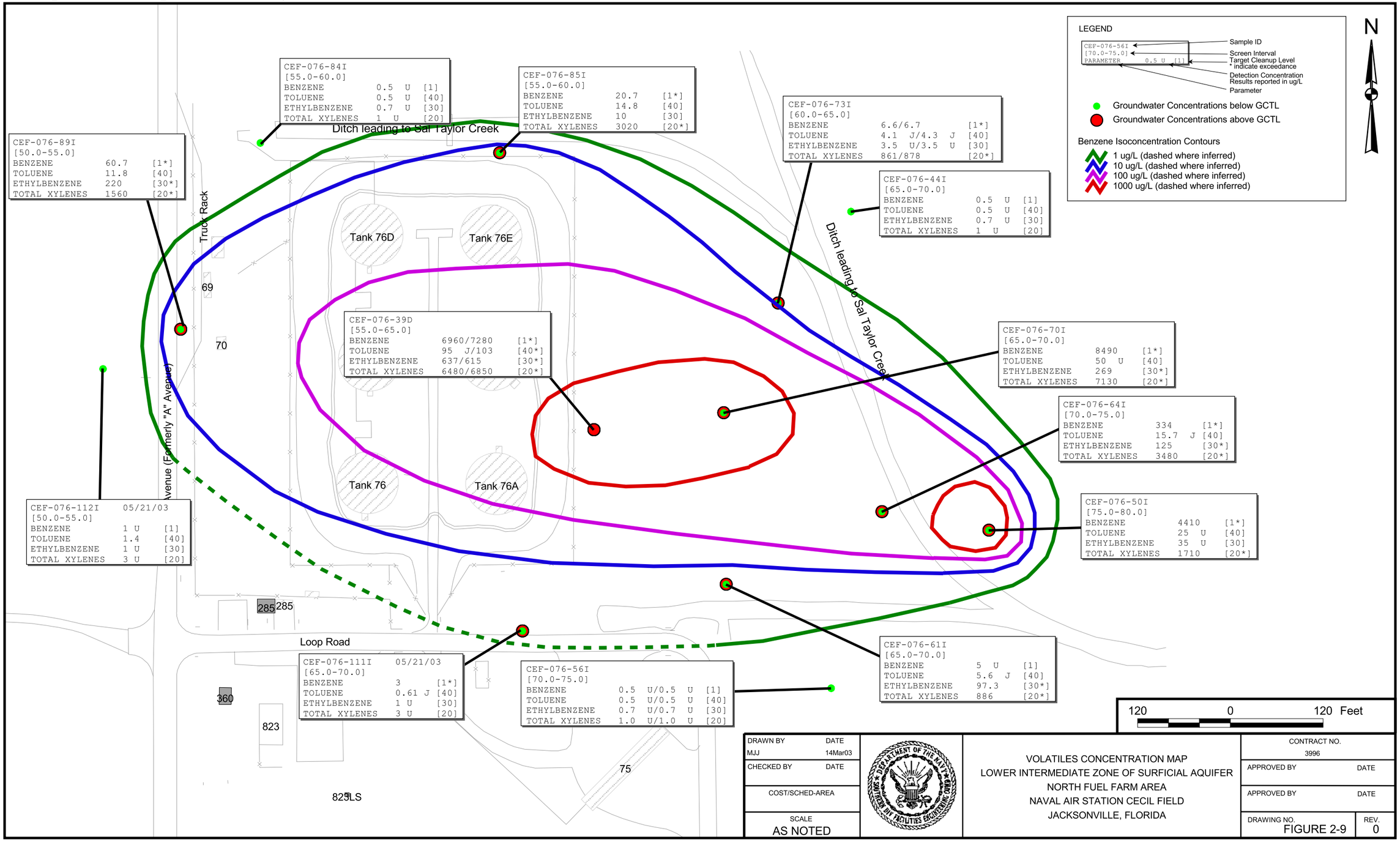


DRAWN BY	DATE
MJJ	14Mar03
CHECKED BY	DATE
COST/SCHED-AREA	
SCALE	AS NOTED

PAH CONCENTRATION MAP
LOWER INTERMEDIATE ZONE OF SURFICIAL AQUIFER
NORTH FUEL FARM AREA
NAVAL AIR STATION CECIL FIELD
JACKSONVILLE, FLORIDA

CONTRACT NO.	
3996	
APPROVED BY	DATE
APPROVED BY	DATE
DRAWING NO. FIGURE 2-8	REV. 0

P:\GIS\NAS_CecilField\NorthFuelFarm_200303.apr 12Mar04 MJJ Layout9

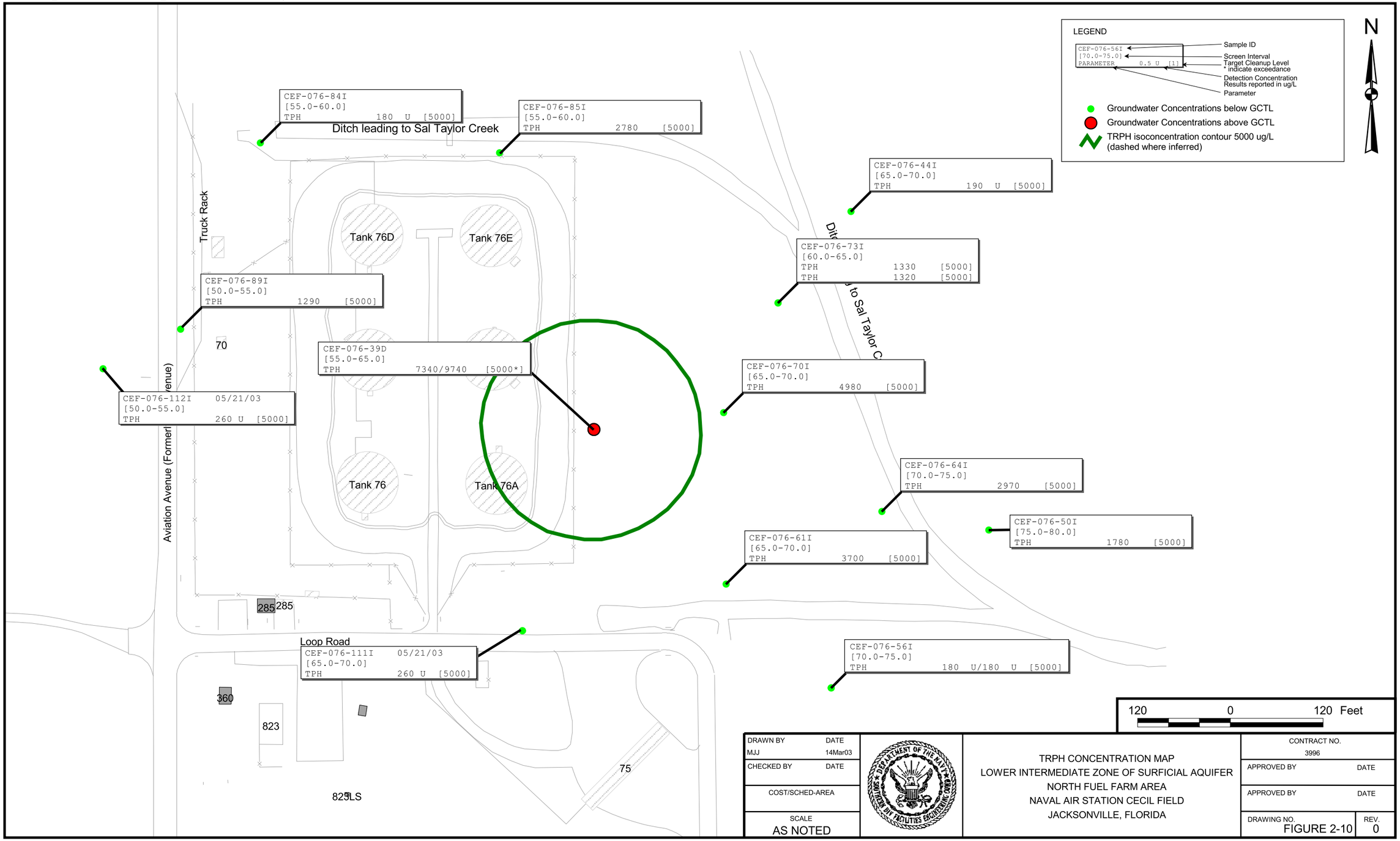


DRAWN BY	DATE
MJJ	14Mar03
CHECKED BY	DATE
COST/SCHED-AREA	
SCALE	AS NOTED

VOLATILES CONCENTRATION MAP
LOWER INTERMEDIATE ZONE OF SURFICIAL AQUIFER
NORTH FUEL FARM AREA
NAVAL AIR STATION CECIL FIELD
JACKSONVILLE, FLORIDA

CONTRACT NO. 3996	
APPROVED BY	DATE
APPROVED BY	DATE
DRAWING NO. FIGURE 2-9	REV. 0

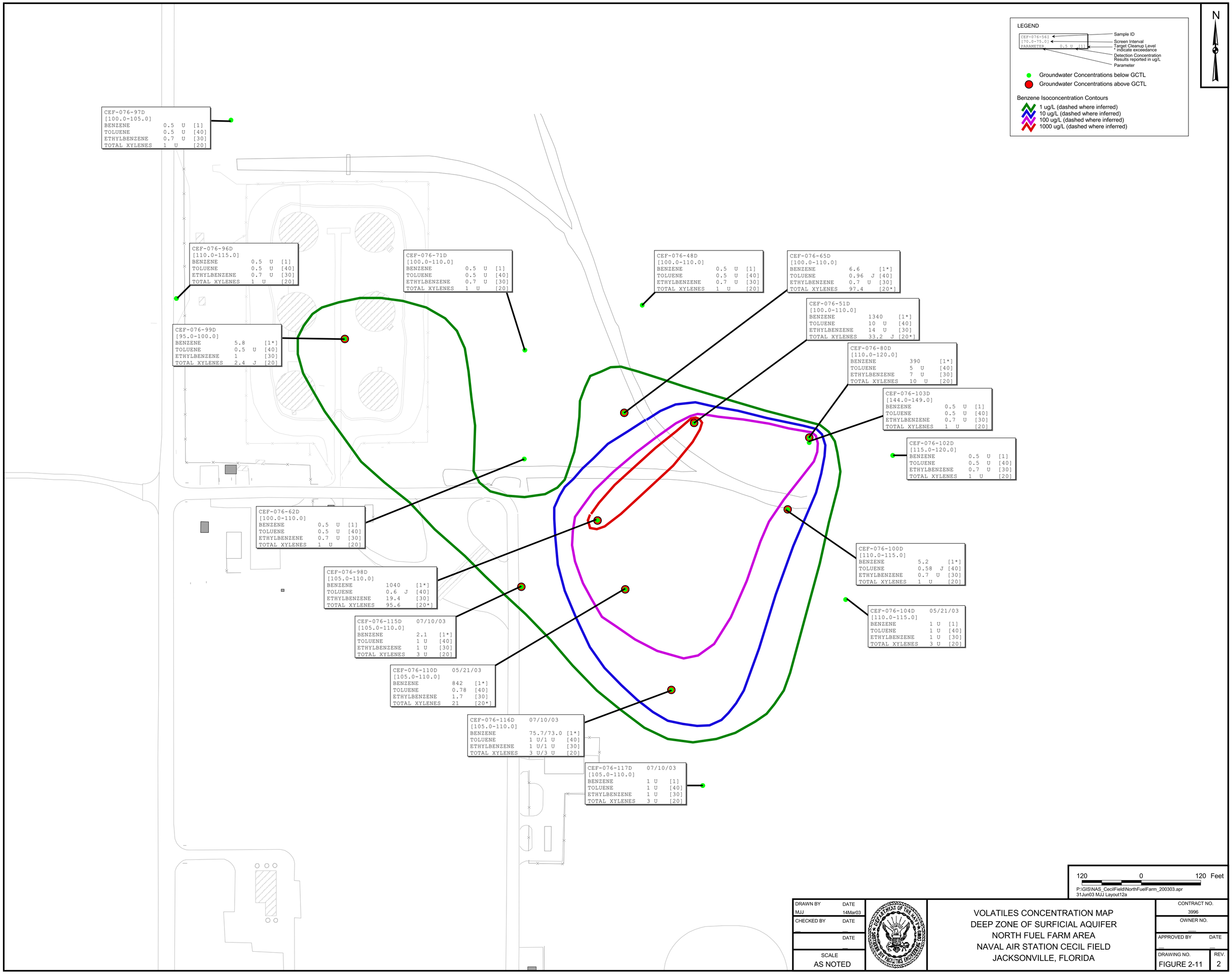
P:\GIS\NAS_CecilField\NorthFuelFarm_200303.apr 12Mar04 MJJ Layout10



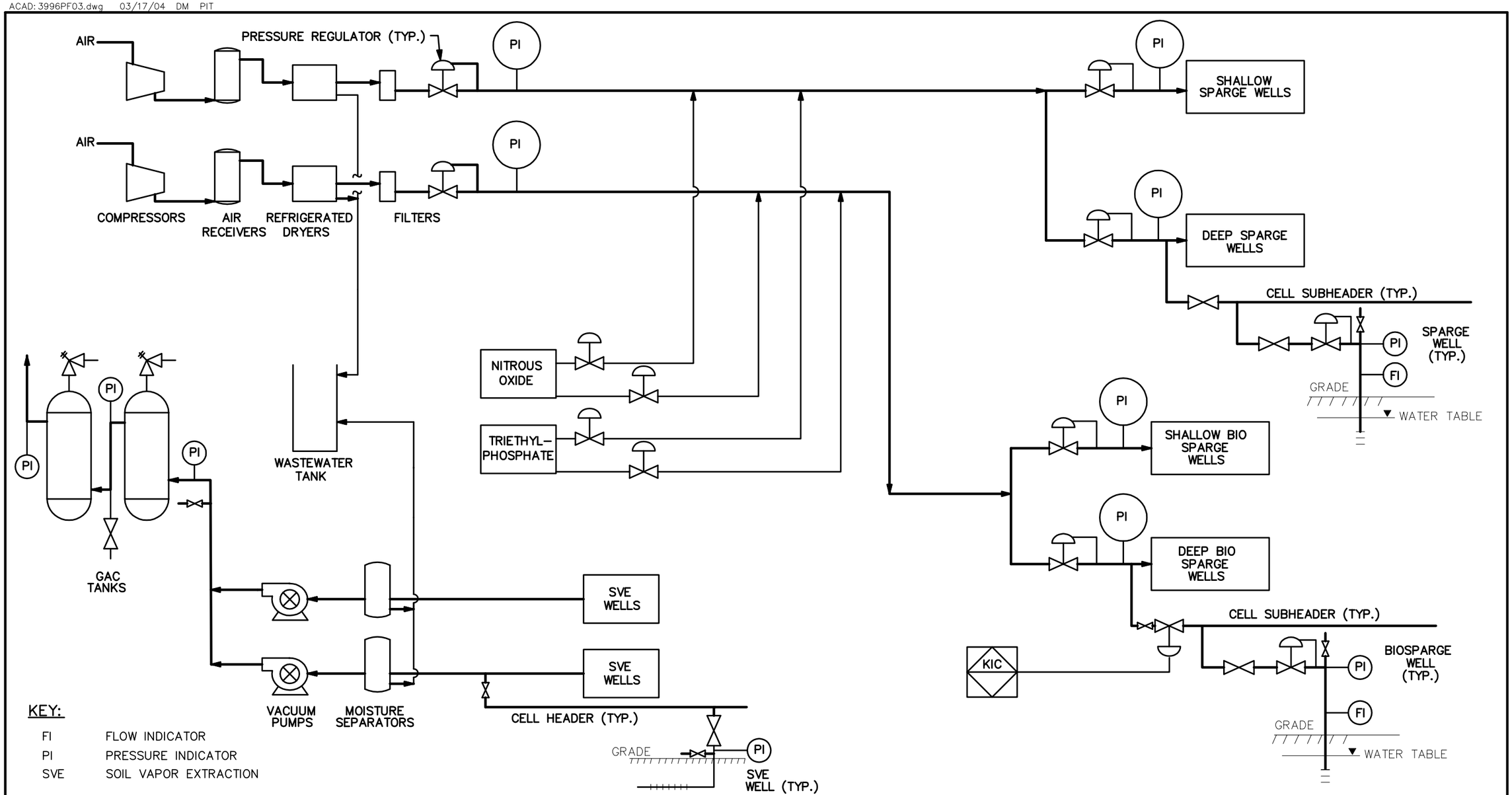
DRAWN BY	DATE
MJJ	14Mar03
CHECKED BY	DATE
COST/SCHED-AREA	
SCALE	AS NOTED

TRPH CONCENTRATION MAP
LOWER INTERMEDIATE ZONE OF SURFICIAL AQUIFER
NORTH FUEL FARM AREA
NAVAL AIR STATION CECIL FIELD
JACKSONVILLE, FLORIDA

CONTRACT NO.	
3996	
APPROVED BY	DATE
APPROVED BY	DATE
DRAWING NO. FIGURE 2-10	REV. 0


LEGEND
CEF-076-56I
[70.0-75.0]
PARAMETER 0.5 U [1]
Sample ID
Screen Interval
Target Cleanup Level
* indicate exceedance
Detection Concentration
Results reported in ug/L
Parameter
Groundwater Concentrations below GCTL
Groundwater Concentrations above GCTL
Benzene Isoconcentration Contours
1 ug/L (dashed where inferred)
10 ug/L (dashed where inferred)
100 ug/L (dashed where inferred)
1000 ug/L (dashed where inferred)
N
CEF-076-97D
[100.0-105.0]
BENZENE 0.5 U [1]
TOLUENE 0.5 U [40]
ETHYLBENZENE 0.7 U [30]
TOTAL XYLENES 1 U [20]
CEF-076-96D
[110.0-115.0]
BENZENE 0.5 U [1]
TOLUENE 0.5 U [40]
ETHYLBENZENE 0.7 U [30]
TOTAL XYLENES 1 U [20]
CEF-076-71D
[100.0-110.0]
BENZENE 0.5 U [1]
TOLUENE 0.5 U [40]
ETHYLBENZENE 0.7 U [30]
TOTAL XYLENES 1 U [20]
CEF-076-48D
[100.0-110.0]
BENZENE 0.5 U [1]
TOLUENE 0.5 U [40]
ETHYLBENZENE 0.7 U [30]
TOTAL XYLENES 1 U [20]
CEF-076-65D
[100.0-110.0]
BENZENE 6.6 [1*]
TOLUENE 0.96 J [40]
ETHYLBENZENE 0.7 U [30]
TOTAL XYLENES 97.4 [20*]
CEF-076-51D
[100.0-110.0]
BENZENE 1340 [1*]
TOLUENE 10 U [40]
ETHYLBENZENE 14 U [30]
TOTAL XYLENES 33.2 J [20*]
CEF-076-99D
[95.0-100.0]
BENZENE 5.8 [1*]
TOLUENE 0.5 U [40]
ETHYLBENZENE 1 [30]
TOTAL XYLENES 2.4 J [20]
CEF-076-80D
[110.0-120.0]
BENZENE 390 [1*]
TOLUENE 5 U [40]
ETHYLBENZENE 7 U [30]
TOTAL XYLENES 10 U [20]
CEF-076-103D
[144.0-149.0]
BENZENE 0.5 U [1]
TOLUENE 0.5 U [40]
ETHYLBENZENE 0.7 U [30]
TOTAL XYLENES 1 U [20]
CEF-076-102D
[115.0-120.0]
BENZENE 0.5 U [1]
TOLUENE 0.5 U [40]
ETHYLBENZENE 0.7 U [30]
TOTAL XYLENES 1 U [20]
CEF-076-62D
[100.0-110.0]
BENZENE 0.5 U [1]
TOLUENE 0.5 U [40]
ETHYLBENZENE 0.7 U [30]
TOTAL XYLENES 1 U [20]
CEF-076-100D
[110.0-115.0]
BENZENE 5.2 [1*]
TOLUENE 0.58 J [40]
ETHYLBENZENE 0.7 U [30]
TOTAL XYLENES 1 U [20]
CEF-076-98D
[105.0-110.0]
BENZENE 1040 [1*]
TOLUENE 0.6 J [40]
ETHYLBENZENE 19.4 [30]
TOTAL XYLENES 95.6 [20*]
CEF-076-104D 05/21/03
[110.0-115.0]
BENZENE 1 U [1]
TOLUENE 1 U [40]
ETHYLBENZENE 1 U [30]
TOTAL XYLENES 3 U [20]
CEF-076-115D 07/10/03
[105.0-110.0]
BENZENE 2.1 [1*]
TOLUENE 1 U [40]
ETHYLBENZENE 1 U [30]
TOTAL XYLENES 3 U [20]
CEF-076-110D 05/21/03
[105.0-110.0]
BENZENE 842 [1*]
TOLUENE 0.78 [40]
ETHYLBENZENE 1.7 [30]
TOTAL XYLENES 21 [20*]
CEF-076-116D 07/10/03
[105.0-110.0]
BENZENE 75.7/73.0 [1*]
TOLUENE 1 U/1 U [40]
ETHYLBENZENE 1 U/1 U [30]
TOTAL XYLENES 3 U/3 U [20]
CEF-076-117D 07/10/03
[105.0-110.0]
BENZENE 1 U [1]
TOLUENE 1 U [40]
ETHYLBENZENE 1 U [30]
TOTAL XYLENES 3 U [20]
120 0 120 Feet
P:\GIS\NAS_CecilField\NorthFuelFarm_200303.apr
31Jun03 MJJ Layout12a
DRAWN BY MJJ
DATE 14Mar03
CHECKED BY
DATE
DATE
SCALE AS NOTED
DEPARTMENT OF THE NAVY
SOUTHERN DIV FACILITIES ENGINEERING COMD
VOLATILES CONCENTRATION MAP
DEEP ZONE OF SURFICIAL AQUIFER
NORTH FUEL FARM AREA
NAVAL AIR STATION CECIL FIELD
JACKSONVILLE, FLORIDA
CONTRACT NO. 3996
OWNER NO.
APPROVED BY
DATE
DRAWING NO. FIGURE 2-11
REV. 2

ACAD: 3996PF03.dwg 03/17/04 DM PIT



NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

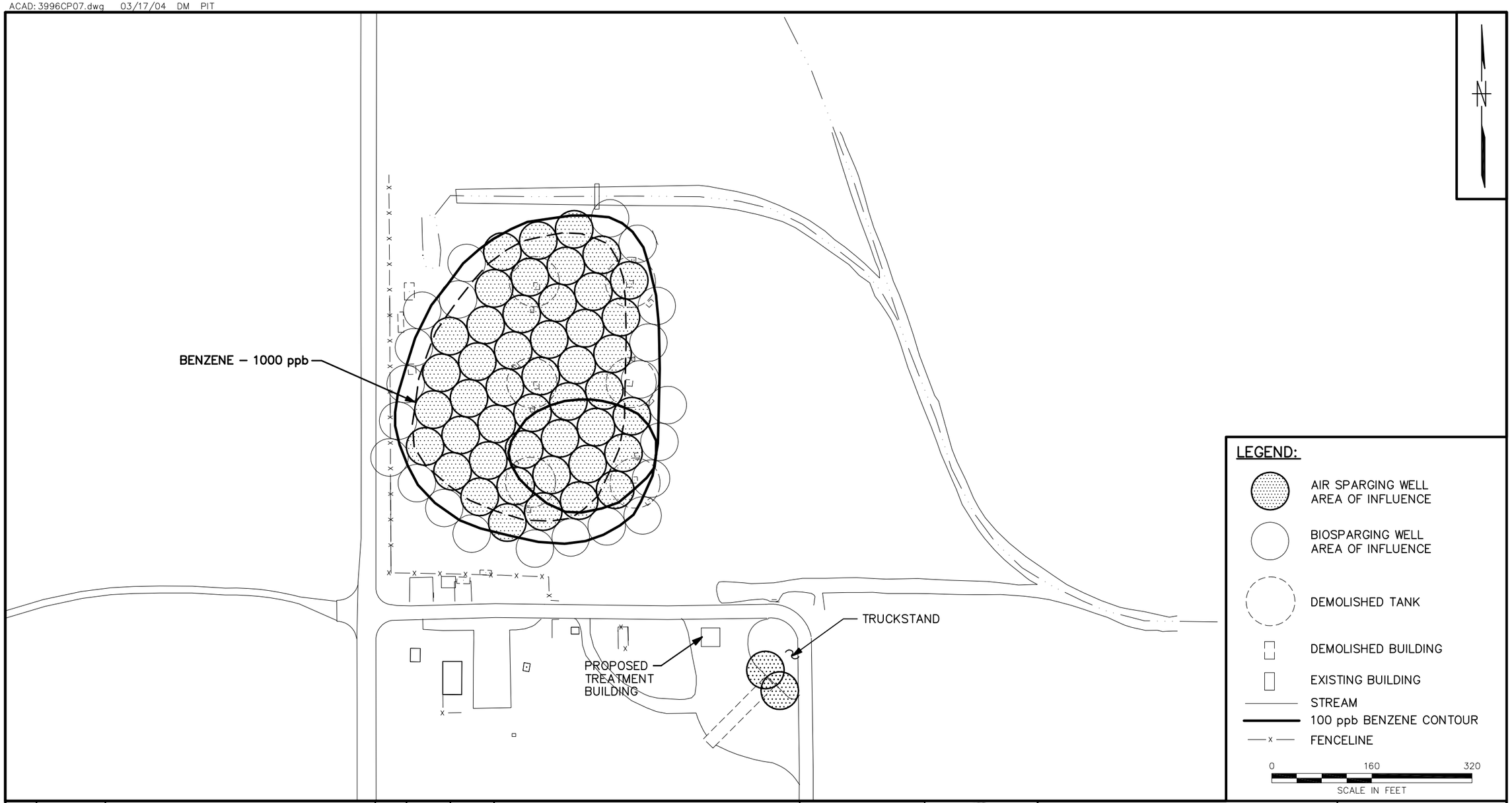
DRAWN BY DM DATE 3/17/04
CHECKED BY DATE
COST/SCHED-AREA
SCALE NOT TO SCALE

PROCESS FLOW DIAGRAM
AIR SPARGING/BIOSPARGING/
SOIL VAPOR EXTRACTION SYSTEM
NORTH FUEL FARM RAPA
NAS CECIL FIELD

CONTRACT NO. 3996
APPROVED BY DATE
APPROVED BY DATE
DRAWING NO. FIGURE 6-1
REV. 1

FORM CADD NO. SDIV_BH.DWG - REV 0 - 1/20/98

ACAD: 3996CP07.dwg 03/17/04 DM PIT



NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY DM DATE 3/17/04
CHECKED BY DATE
COST/SCHED–AREA
SCALE AS NOTED

SPARGING WELL LOCATIONS–SHALLOW
NORTH FUEL FARM AREA
NAVAL AIR STATION CECIL FIELD
JACKSONVILLE, FLORIDA

CONTRACT NO. 3996
APPROVED BY DATE
APPROVED BY DATE
DRAWING NO. FIGURE 6–2
REV. 2

FORM CADD NO. SDIV_BH.DWG – REV 0 – 1/20/98

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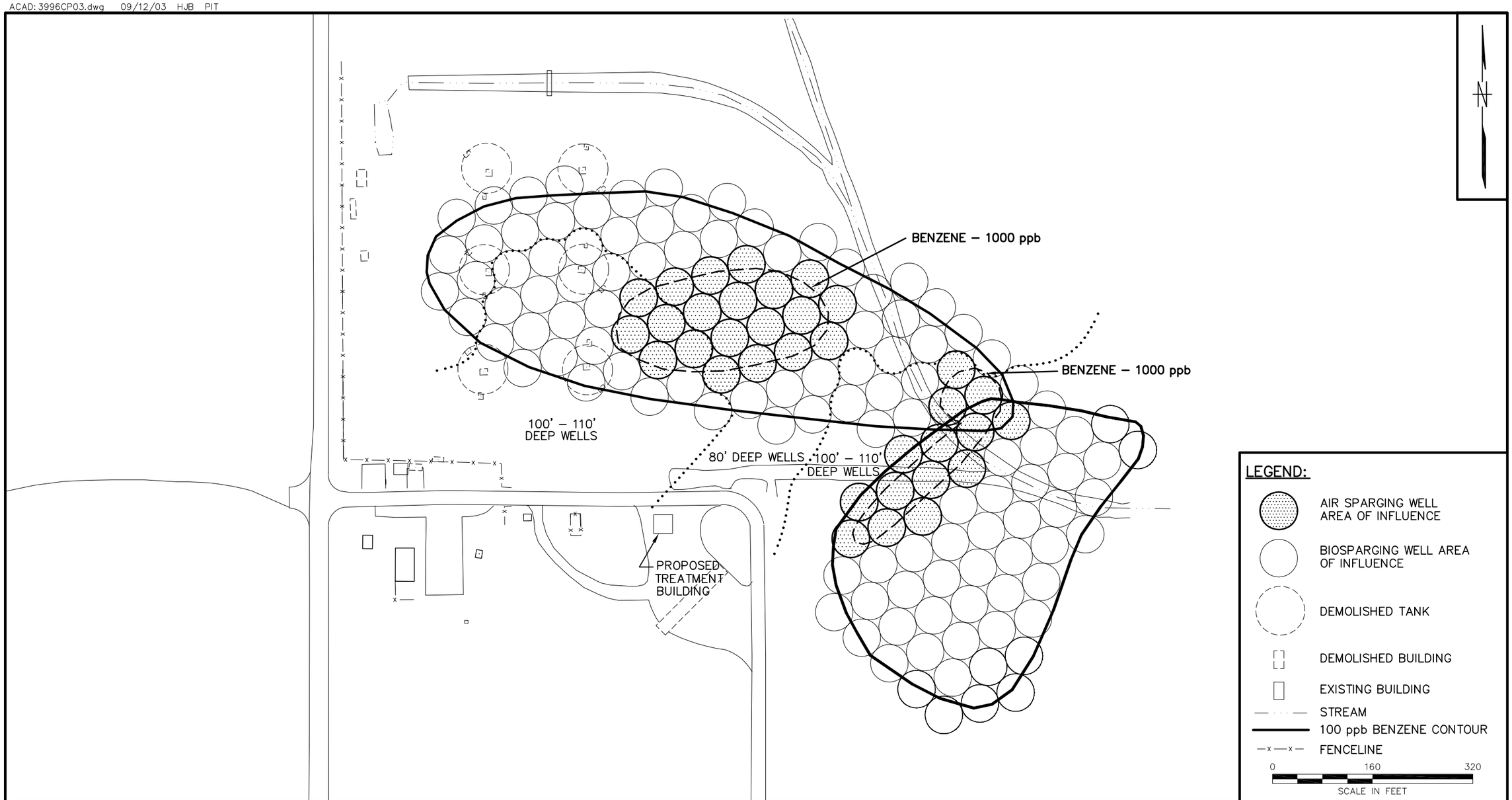


NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

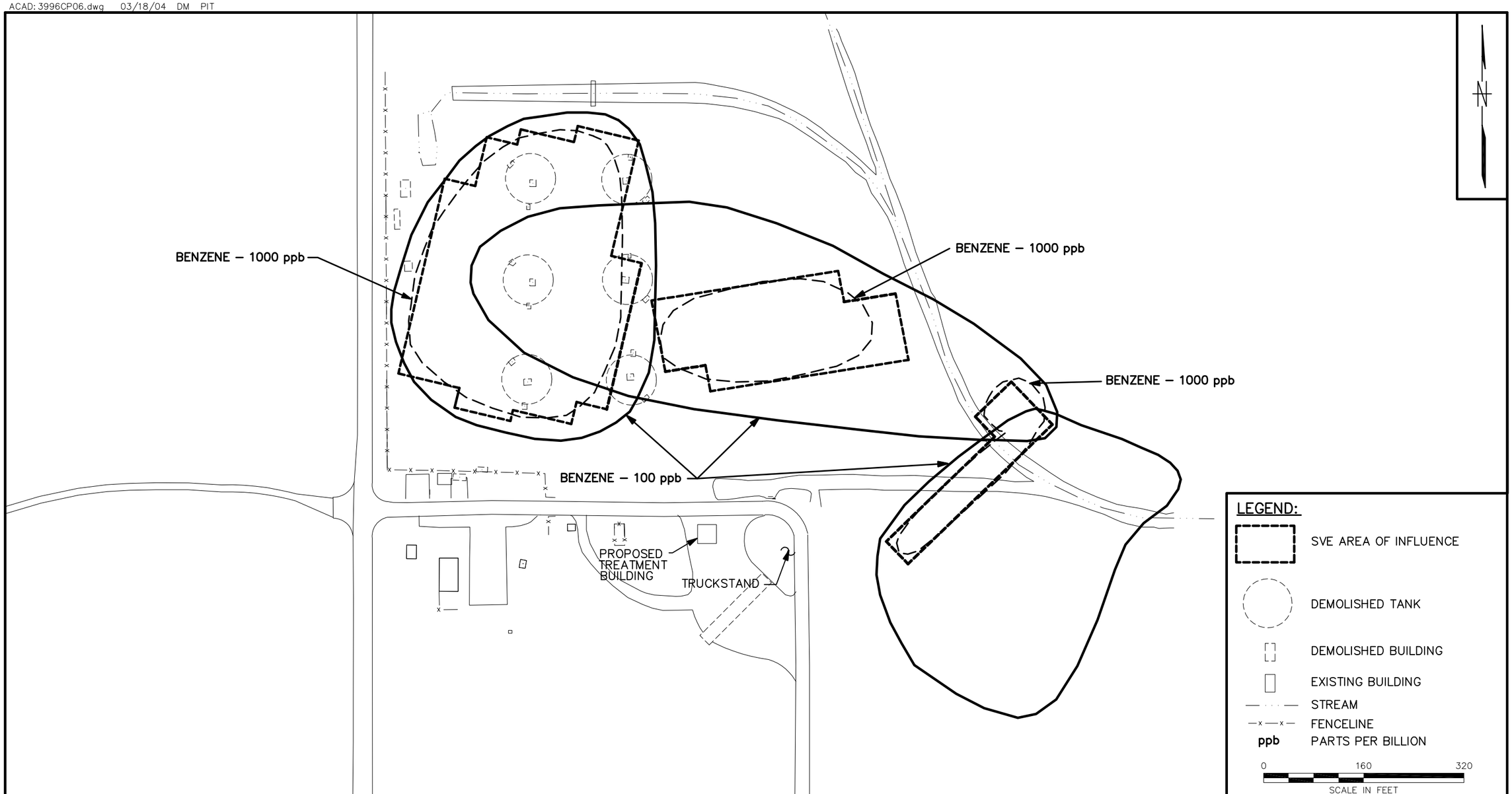
DRAWN BY DM DATE 7/2/03
CHECKED BY DATE
COST/SCHED–AREA
SCALE AS NOTED

SPARGING WELL LOCATIONS–DEEP
NORTH FUEL FARM AREA
NAVAL AIR STATION CECIL FIELD
JACKSONVILLE, FLORIDA

CONTRACT NO. 3996
APPROVED BY DATE
APPROVED BY DATE
DRAWING NO. FIGURE 6–3
REV. 2

FORM CADD NO. SDIV_BH.DWG – REV 0 – 1/20/98

ACAD: 3996CP06.dwg 03/18/04 DM PIT



NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY DM DATE 3/17/04
CHECKED BY DATE
COST/SCHED–AREA
SCALE AS NOTED

SVE WELL LOCATIONS
NORTH FUEL FARM AREA
NAVAL AIR STATION CECIL FIELD
JACKSONVILLE, FLORIDA

CONTRACT NO. 3996
APPROVED BY DATE
APPROVED BY DATE
DRAWING NO. FIGURE 6–4
REV. 3

FORM CADD NO. SDIV_BH.DWG – REV 0 – 1/20/98

APPENDIX A

CONTAMINANT MASS CALCULATION

NAS CECIL FIELD
NFF RAPA
GROUNDWATER VOLUMES
3/17/2004

Interval	Depth, feet	Area, feet^2	Volume, feet^3	Porosity	Water Volume, feet^3	Water Volume, gal	Bulk dry density, ton/cy	Mass dry soil, lb
Water Table 1 - 10	15	86,000	1,290,000	0.3	387,000	2,895,147	1.5	143,333,333
Water Table 10 - 100	15	84,000	1,260,000	0.3	378,000	2,827,818	1.5	140,000,000
Water Table 100 - 1000	15	27,000	405,000	0.3	121,500	908,942	1.5	45,000,000
Water Table 1000	15	5,000	75,000	0.3	22,500	168,323	1.5	8,333,333
Upper Intermediate 1 - 10 east	30	75,000	2,250,000	0.3	675,000	5,049,675	1.5	250,000,000
Upper Intermediate 10 east	30	52,000	1,560,000	0.3	468,000	3,501,108	1.5	173,333,333
Upper Intermediate 1 - 10 west	30	69,000	2,070,000	0.3	621,000	4,645,701	1.5	230,000,000
Upper Intermediate 10 - 100 west	30	55,000	1,650,000	0.3	495,000	3,703,095	1.5	183,333,333
Upper Intermediate 100 - 1000 west	30	50,000	1,500,000	0.3	450,000	3,366,450	1.5	166,666,667
Upper Intermediate 1000 west	30	120,000	3,600,000	0.3	1,080,000	8,079,480	1.5	400,000,000
Lower intermediate 1 - 10	40	150,000	6,000,000	0.3	1,800,000	13,465,800	1.5	666,666,667
Lower intermediate 10 - 100	40	163,000	6,520,000	0.3	1,956,000	14,632,836	1.5	724,444,444
Lower intermediate 100 - 1000	40	174,000	6,960,000	0.3	2,088,000	15,620,328	1.5	773,333,333
Lower intermediate 1000 east	40	7,000	280,000	0.3	84,000	628,404	1.5	31,111,111
Lower intermediate 1000 west	40	42,000	1,680,000	0.3	504,000	3,770,424	1.5	186,666,667
Deep 1 - 10	20	289,000	5,780,000	0.3	1,734,000	12,972,054	1.5	642,222,222
Deep 10 - 100	20	77,000	1,540,000	0.3	462,000	3,456,222	1.5	171,111,111
Deep 100 - 1000	20	109,000	2,180,000	0.3	654,000	4,892,574	1.5	242,222,222
Deep 1000	20	19,000	380,000	0.3	114,000	852,834	1.5	42,222,222

Total		1,653,000	46,980,000		14,094,000	105,437,214		5,220,000,000

NAS CECIL FIELD
NFF RAPA
CONTAMINANT MASS
3/17/2004

1. Enter data from tag maps (Figures 2-1 through 2-11)
Use 1/2 DL for U
Concentrations in ug/L

Water Table

Compound	90S	82S	94S	07	108S	Geo mean	Mean	max	Geomean of max and 1
Benzene	1.5	0.25	2560	0.25	16.3	5.2	515.66	2560	51
Toluene	0.25	0.25	6470	0.25	3.8	3.3	1294.91	6470	80
Ethylbenzene	4.8	2	1030	0.35	62.5	11.7	219.93	1030	32
Xylenes	12.3	3.5	4400	0.5	693	36.6	1021.86	4400	66
Naphthalene	18.9	10.4	165	56	11.4	29.1	52.34	165	13
1-MN	6.4	20	61.4	18.2	14.4	18.3	24.08	61	8
2-MN	7.4	22.3	82.5	25.8	22.2	23.9	32.04	83	9
TRPH	2010	713	8680	110	2230	1250.0	2748.6	8680	93

UI

Compound	91S	87S	93S	92S	69S	57S	101S	49S	113S	63S	Geo mean	Mean
Benzene	1930	3590	2910	0.25	0.25	73.5	1.6	14.4	10600	0.25	37.6	1912
Toluene	192	147	273	0.25	0.25	9.1	2.5	4.5	47.6	0.25	7.5	68
Ethylbenzene	1180	856	1110	0.35	0.35	52.15	0.71	1.75	883	0.35	17.5	408
Xylenes	5880	4310	4980	0.5	2.8	1165	3.8	545	3430	14.4	170.7	2033
Naphthalene	113	136	124	0.28	1	2.6	0.26	0.14	71.5	0.14	3.7	44.9
1-MN	32.3	41.6	55.6	0.28	0.13	0.13	0.26	0.14	8.9	0.14	1.3	13.9
2-MN	25.5	45.1	67.1	0.28	0.13	0.13	0.26	0.14	11.2	0.14	1.4	15.0
TRPH	7950	7330	8700	95	95	5009.5	90	703	7220	95	999.5	3728.8

LI

Compound	89I	85I	39D	73I	70I	64I	111I	50I	Geo mean	Mean	max	Geomean of max and 1
Benzene	60.7	20.7	7120	6.65	8490	334	3	4410	197	2556	8490	92
Toluene	11.8	14.8	99	4.2	25	15.7	0.61	12.5	11	23	99	10
Ethylbenzene	220	10	626	1.75	269	125	0.5	17.5	30	159	626	25
Xylenes	1560	3020	6665	869.5	7130	3480	1.5	1710	1072	3055	7130	84
Naphthalene	2.2	2.2	114	0.13	28.9	11.7	0.5	0.39	3	20	114	11
1-MN	0.28	1.1	38.95	0.13	0.13	0.14	0.5	0.14	0	5	38.95	6
2-MN	0.28	0.27	53.25	0.13	0.13	0.14	0.5	0.14	0	7	53.25	7
TRPH	1290	2780	8540	1325	4980	2970	130	1780	1853	2974	8540	92

Deep

Compound	99D	98D	65D	51D	103D	110D	80D	100D	Geo mean	Mean	max	Geomean of max and 1
Benzene	5.8	1040	6.6	1340	0.25	842	390	5.2	47	454	1340	37
Toluene	0.25	0.6	0.96	5	0.25	0.78	2.5	0.58	1	1	5	2
Ethylbenzene	1	19.4	0.35	7	0.35	1.7	3.5	0.35	2	4	19.4	4
Xylenes	2.4	95.6	97.4	33.2	0.5	21	5	0.5	8	32	97.4	10
Naphthalene	0.13	0.13	0.13	0.13	0.13	0.5	0.13	0.13	0	0	0.5	1
1-MN	0.13	0.13	0.13	0.13	0.13	0.5	0.13	0.13	0	0	0.5	1
2-MN	0.13	0.13	0.13	0.13	0.13	0.5	0.13	0.13	0	0	0.5	1
TRPH	95	95	95	95	95	264	95	95	108	116	264	16

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.)

WT - normalized to benzene

Compound	90S	82S	94S	07	108S
Benzene	1.5	0.25	2560	0.25	16.3
Benzene	1	1	1	1	1
Toluene	0.2	1	2.5	1	0.2
Ethylbenzene	3.2	8	0.4	1.4	3.8
Xylenes	8.2	14	1.7	2	42.5
Naphthalene	12.6	41.6	0.1	224	0.7
1-MN	4.3	80.0	0.02	72.8	0.9
2-MN	4.9	89.2	0.03	103.2	1.4
TRPH	1340.0	2852.0	3.4	440	136.8

UI - Normalized to benzene

Compound	91S	87S	93S	92S	69S	57S	101S	49S	63S	113S
Benzene	1930	3590	2910	0.25	0.25	73.5	1.6	14.4	0.25	10600
Benzene	1	1	1	1	1	1	1	1	1	1
Toluene	0.1	0.04	0.1	1	1	0.1	1.6	0.3	1	0.004
Ethylbenzene	0.6	0.2	0.4	1.4	1.4	0.7	0.4	0.1	1.4	0.083
Xylenes	3.0	1.2	1.7	2	11.2	15.9	2.4	37.8	57.6	0.324
Naphthalene	0.06	0.04	0.04	1.12	4.00	0.04	0.16	0.01	0.56	0.007
1-MN	0.02	0.01	0.02	1.12	0.52	0.00	0.16	0.01	0.56	0.001
2-MN	0.01	0.01	0.02	1.12	0.52	0.00	0.16	0.01	0.56	0.001
TRPH	4.12	2.04	2.99	380.00	380.00	68.16	56.25	48.82	380.00	0.681

LI - Normalized to benzene

Compound	89I	85I	39D	73I	70I	64I	50I	111I
Benzene	60.7	20.7	7120	6.65	8490	334	4410	3
Benzene	1	1	1	1	1	1	1	1
Toluene	0.2	0.7	0.01	0.6	0.003	0.05	0.003	0.20
Ethylbenzene	3.6	0.5	0.1	0.3	0.03	0.4	0.00	0.17
Xylenes	25.7	145.9	0.9	130.8	0.8	10.4	0.4	0.50
Naphthalene	0.04	0.11	0.02	0.02	0.00	0.04	0.00	0.17
1-MN	0.00	0.05	0.01	0.02	0.00	0.00	0.00	0.17
2-MN	0.00	0.01	0.01	0.02	0.00	0.00	0.00	0.17
TRPH	21.25	134.30	1.20	199.25	0.59	8.89	0.40	43.33

Deep - Normalized to benzene

Compound	99D	98D	65D	51D	103D	80D	100D	110D
Benzene	5.8	1040	6.6	1340	0.25	390	5.2	842
Benzene	1	1	1	1	1	1	1	1
Toluene	0.04	0.00	0.15	0.00	1.00	0.01	0.11	0.001
Ethylbenzene	0.17	0.02	0.05	0.01	1.40	0.01	0.07	0.002
Xylenes	0.41	0.09	14.76	0.02	2.00	0.01	0.10	0.025
Naphthalene	0.02	0.0001	0.02	0.0001	0.52	0.0003	0.03	0.001
1-MN	0.02	0.0001	0.02	0.0001	0.52	0.0003	0.03	0.001
2-MN	0.02	0.0001	0.02	0.0001	0.52	0.0003	0.03	0.001
TRPH	16.38	0.09	14.39	0.07	380.00	0.24	18.27	0.314

3. Estimate the aqueous concentrations in ug/L of other compounds, by scaling to benzene. Scale factor is about the average value. and adjusting factors based on observed lab results (see notes at right).

	Benzene	Toluene	Ethylbenz	Xylenes	Naph	1-MN	2-MN	TRPH	
scaler* =>	2.5	0.4	2	0.1	0.02	0.02	3		
WT 1 - 10	3	8	6	13	10	10	10	190	EBx5;Xx2,n,1mn,2mn=10;TPH=190
WT 10 - 100	32	79	13	63	32	19	19	190	Nx10;1MN,2MNx30'TPHx2
WT 100 - 1000	316	791	126	632	95	63	63	1897	Nx3;1MN,2MNx10;TPHx2
WT 1000	1600	4000	640	3200	160	64	64	4800	1MN,2MNx2

	Benzene	Toluene	Ethylbenz	Xylenes	Naph	1-MN	2-MN	TRPH	
scaler* =>	0.1	0.4	2	0.04	0.02	0.02	3		
UI 1 - 10 east	3.2	0.3	1.3	6.3	0.6	0.3	0.3	190.0	N,1MN,2MNx5;TPH=190
UI 10 east	27.1	2.7	10.8	542.2	0.3	0.3	0.3	813.3	Xx10,N/4;1MN,2MN/2TPHx10
UI 1 - 10 west	3.2	0.3	1.3	6.3	0.3	0.1	0.1	190.0	N,1MN,2MNx2,TPH=190
UI 10 - 100 west	31.6	3.2	12.6	63.2	6.3	6.3	6.3	948.7	Nx5;1mn,2MNx10;TPHx10
UI 100 - 1000 west	316.2	31.6	126.5	632.5	63.2	63.2	63.2	1423.0	Nx5;1MN,2MNx10;TPHx1.5
UI 1000 west	3255.8	325.6	1302.3	6511.5	130.2	65.1	65.1	9767.3	

	Benzene	Toluene	Ethylbenz	Xylenes	Naph	1-MN	2-MN	TRPH	
scaler* =>	0.05	0.2	1	0.01	0.01	0.01	1		
LI 1 - 10	3.2	0.2	0.6	3.2	0.0	0.0	0.0	190.0	Xx30;TPH=190
LI 10 - 100	31.6	1.6	6.3	31.6	0.3	0.3	0.3	190.0	Xx10;TPH=190
LI 100 - 1000	316.2	15.8	63.2	316.2	3.2	3.2	3.2	316.2	Xx30
LI 1000 east	2100.0	10.5	21.0	1050.0	0.2	0.2	0.2	1050.0	T/10;EB/20;X/2;N,1MN,2MN/100;TPH/2
LI 1000 west	2913.8	48.6	582.8	2913.8	87.4	14.6	14.6	2913.8	T/3;Nx3;1MN,2MN/2

	Benzene	Toluene	Ethylbenz	Xylenes	Naph	1-MN	2-MN	TRPH	
scaler* =>	0.01	0.02	0.05	0.001	0.001	0.001	0.2		
Deep 1 - 10	3.2	0.0	0.3	1.6	0.1	0.1	0.1	190.0	EBx5;Xx10;N,1MN,2MN=.13;TPH=190
Deep 10 - 100	31.6	0.3	0.6	1.6	0.1	0.1	0.1	190.0	N,1MN,2MN=.13;TPH=190
Deep 100 - 1000	316.2	3.2	6.3	15.8	0.1	0.1	0.1	190.0	N,1MN,2MN=.13;TPH=190
Deep 1000	1157.6	1.2	11.6	57.9	0.1	0.1	0.1	190.0	T/10;EB/2;N,1MN,2MN=.13;TPH=190

scaler - the scale factor to benzene

4. Calculate mass in aqueous phase in each layer, 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

WT

	Benzene	Toluene	Ethylbenz	Xylenes	Naph	1-MN	2-MN	TRPH	water vol,gal
WT 1 - 10	0.1	0.2	0.2	0.3	0.2	0.2	0.2	4.6	2,895,147
WT 10 - 100	0.7	1.9	0.3	1.5	0.7	0.4	0.4	4.5	2,827,818
WT 100 - 1000	2.4	6.0	1.0	4.8	0.7	0.5	0.5	14.4	908,942
WT 1000	2.2	5.6	0.9	4.5	0.2	0.1	0.1	6.7	168,323
Total in layer	5.5	13.7	2.3	11.1	1.9	1.3	1.3	30.2	

UI

	Benzene	Toluene	Ethylbenz	Xylenes	Naph	1-MN	2-MN	TRPH	
UI 1 - 10 east	0.1	0.0	0.1	0.3	0.0	0.0	0.0	8.0	5,049,675
UI 10 east	0.8	0.1	0.3	15.8	0.0	0.0	0.0	23.7	3,501,108
UI 1 - 10 west	0.1	0.0	0.0	0.2	0.0	0.0	0.0	7.4	4,645,701
UI 10 - 100 west	1.0	0.1	0.4	2.0	0.2	0.2	0.2	29.3	3,703,095
UI 100 - 1000 west	8.9	0.9	3.6	17.8	1.8	1.8	1.8	39.9	3,366,450
UI 1000 west	219.3	21.9	87.7	438.6	8.8	4.4	4.4	657.9	8,079,480
Total in layer	230.2	23.0	92.1	474.6	10.8	6.4	6.4	766.2	

LI

	Benzene	Toluene	Ethylbenz	Xylenes	Naph	1-MN	2-MN	TRPH	
LI 1 - 10	0.4	0.0	0.1	0.4	0.0	0.0	0.0	21.3	13,465,800
LI 10 - 100	3.9	0.2	0.8	3.9	0.0	0.0	0.0	23.2	14,632,836
LI 100 - 1000	41.2	2.1	8.2	41.2	0.4	0.4	0.4	41.2	15,620,328
LI 1000 east	11.0	0.1	0.1	5.5	0.0	0.0	0.0	5.5	628,404
LI 1000 west	91.6	1.5	18.3	91.6	2.7	0.5	0.5	91.6	3,770,424
Total in layer	148.0	3.9	27.5	142.5	3.2	0.9	0.9	182.8	

Deep

	Benzene	Toluene	Ethylbenz	Xylenes	Naph	1-MN	2-MN	TRPH	
Deep 1 - 10	0.3	0.0	0.0	0.2	0.0	0.0	0.0	20.5	12,972,054
Deep 10 - 100	0.9	0.0	0.0	0.0	0.0	0.0	0.0	5.5	3,456,222
Deep 100 - 1000	12.9	0.1	0.3	0.6	0.0	0.0	0.0	7.7	4,892,574
Deep 1000	8.2	0.0	0.1	0.4	0.0	0.0	0.0	1.4	852,834
Total in layer	22.4	0.1	0.4	1.3	0.0	0.0	0.0	35.1	

Total in plume, aq	406.0	40.7	122.3	629.5	15.9	8.6	8.6	1014.3	2245.9

5. Calculate concentrations in soil using typical Koc and Foc values.
Use Foc = 1% as a typical value for Cecil, from 36/37 RI.
Koc values of 1MN, 2MN and TRPH as naphthalene.
Kd = Koc x Foc

	Benzene	Toluene	Ethylbenz	Xylenes	Naph	1-MN	2-MN	TRPH
Koc, L/kg	38	135	1288	240	1288	1288	1288	1288
Foc, kg/kg	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Kd, L/kg	0.38	1.35	12.88	2.4	12.88	12.88	12.88	12.88

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.

	Benzene	Toluene	Ethylbenz	Xylenes	Naph	1-MN	2-MN	TRPH
WT 1 - 10	1.2	10.7	81.5	30.4	128.8	128.8	128.8	2447.2
WT 10 - 100	12.0	106.7	162.9	151.8	407.3	244.4	244.4	2443.8
WT 100 - 1000	120.2	1067.3	1629.2	1517.9	1221.9	814.6	814.6	24438.1
WT 1000	608.0	5400.0	8243.2	7680.0	2060.8	824.3	824.3	61824.0

	Benzene	Toluene	Ethylbenz	Xylenes	Naph	1-MN	2-MN	TRPH
UI 1 - 10 east	1.2	0.4	16.3	15.2	8.1	4.1	4.1	2447.2
UI 10 east	10.3	3.7	139.7	1301.3	3.5	3.5	3.5	10475.6
UI 1 - 10 west	1.2	0.4	16.3	15.2	3.3	1.6	1.6	2447.2
UI 10 - 100 west	12.0	4.3	162.9	151.8	81.5	81.5	81.5	12219.0
UI 100 - 1000 west	120.2	42.7	1629.2	1517.9	814.6	814.6	814.6	18328.6
UI 1000 west	1237.2	439.5	16773.7	15627.7	1677.4	838.7	838.7	125802.7

	Benzene	Toluene	Ethylbenz	Xylenes	Naph	1-MN	2-MN	TRPH
LI 1 - 10	1.2	0.2	8.1	7.6	0.4	0.4	0.4	2447.2
LI 10 - 100	12.0	2.1	81.5	75.9	4.1	4.1	4.1	2447.2
LI 100 - 1000	120.2	21.3	814.6	758.9	40.7	40.7	40.7	4073.0
LI 1000 east	798.0	14.2	270.5	2520.0	2.7	2.7	2.7	13524.0
LI 1000 west	1107.2	65.6	7505.8	6993.0	1125.9	187.6	187.6	37529.2

	Benzene	Toluene	Ethylbenz	Xylenes	Naph	1-MN	2-MN	TRPH
Deep 1 - 10	1.2	0.0	4.1	3.8	1.7	1.7	1.7	2447.2
Deep 10 - 100	12.0	0.4	8.1	3.8	1.7	1.7	1.7	2447.2
Deep 100 - 1000	120.2	4.3	81.5	37.9	1.7	1.7	1.7	2447.2
Deep 1000	439.9	1.6	149.1	138.9	1.7	1.7	1.7	2447.2

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

	Benzene	Toluene	Ethylbenz	Xylenes	Naph	1-MN	2-MN	TRPH	soil mass, lb
WT 1 - 10	0	2	12	4	18	18	18	351	143,333,333
WT 10 - 100	2	15	23	21	57	34	34	342	140,000,000
WT 100 - 1000	5	48	73	68	55	37	37	1100	45,000,000
WT 1000	5	45	69	64	17	7	7	515	8,333,333
Total in layer	12	109	176	158	148	96	96	2308	

	Benzene	Toluene	Ethylbenz	Xylenes	Naph	1-MN	2-MN	TRPH	soil mass, lb
UI 1 - 10 east	0	0	4	4	2	1	1	612	250,000,000
UI 10 east	2	1	24	226	1	1	1	1816	173,333,333
UI 1 - 10 west	0	0	4	3	1	0	0	563	230,000,000
UI 10 - 100 west	2	1	30	28	15	15	15	2240	183,333,333
UI 100 - 1000 west	20	7	272	253	136	136	136	3055	166,666,667
UI 1000 west	495	176	6709	6251	671	335	335	50321	400,000,000
Total in layer	519	185	7043	6765	825	488	488	58606	

	Benzene	Toluene	Ethylbenz	Xylenes	Naph	1-MN	2-MN	TRPH	soil mass, lb
LI 1 - 10	1	0	5	5	0	0	0	1631	666,666,667
LI 10 - 100	9	2	59	55	3	3	3	1773	724,444,444
LI 100 - 1000	93	17	630	587	31	31	31	3150	773,333,333
LI 1000 east	25	0	8	78	0	0	0	421	31,111,111
LI 1000 west	207	12	1401	1305	210	35	35	7005	186,666,667
Total in layer	334	31	2104	2031	245	70	70	13980	

	Benzene	Toluene	Ethylbenz	Xylenes	Naph	1-MN	2-MN	TRPH	soil mass, lb
Deep 1 - 10	1	0	3	2	1	1	1	1572	642,222,222
Deep 10 - 100	2	0	1	1	0	0	0	419	171,111,111
Deep 100 - 1000	29	1	20	9	0	0	0	593	242,222,222
Deep 1000	19	0	6	6	0	0	0	103	42,222,222
Total in layer	51	1	30	18	2	2	2	2686	

Total sorbed	916	326	9353	8972	1219	656	656	77581	99680

Total in aq	406	41	122	629	16	9	9	1014	2246
Grand Total	1322	367	9476	9601	1235	665	665	78595	101926

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

(Rightmost column show the masses for treated by the Alternative 4 AS/MNA system.)

	Benzene	Toluene	Ethylbenz	Xylenes	Naph	1-MN	2-MN	TRPH	AS/MNA
WT 1 - 10	0.2	2	12	5	19	19	19	355	
WT 10 - 100	2	17	23	23	58	35	35	347	
WT 100 - 1000	8	54	74	73	56	37	37	1114	451
WT 1000	7	51	70	68	17	7	7	522	280
Total in layer	18	123	179	169	150	97	97	2338	
	Benzene	Toluene	Ethylbenz	Xylenes	Naph	1-MN	2-MN	TRPH	
UI 1 - 10 east	0.4	0.1	4	4	2	1.0	1.0	620	
UI 10 east	3	0.7	25	241	1	0.6	0.6	1840	
UI 1 - 10 west	0.4	0.1	4	4	1	0.4	0.4	570	
UI 10 - 100 west	3	0.9	30	30	15	15	15	2269	
UI 100 - 1000 west	29	8	275	271	138	138	138	3095	1305
UI 1000 west	714	198	6797	6690	680	340	340	50979	20856
Total in layer	750	208	7135	7239	836	495	495	59373	
	Benzene	Toluene	Ethylbenz	Xylenes	Naph	1-MN	2-MN	TRPH	
LI 1 - 10	1.2	0.2	6	5	0.3	0.3	0.3	1653	
LI 10 - 100	13	2	60	59	3	3	3	1796	
LI 100 - 1000	134	19	638	628	32	32	32	3191	1834
LI 1000 east	36	0.5	9	84	0.1	0.1	0.1	426	172
LI 1000 west	298	14	1419	1397	213	35	35	7097	4122
Total in layer	482	35	2131	2173	248	71	71	14163	
	Benzene	Toluene	Ethylbenz	Xylenes	Naph	1-MN	2-MN	TRPH	
Deep 1 - 10	1.1	0.03	3	3	1.1	1.1	1.1	1592	
Deep 10 - 100	3	0.1	1.4	0.7	0.3	0.3	0.3	424	
Deep 100 - 1000	42	1.2	20	10	0.4	0.4	0.4	601	134
Deep 1000	27	0.1	6	6	0.1	0.1	0.1	105	50
Total in layer	73	1.4	30	19	1.9	1.9	1.9	2722	
Grand Total	1322	367	9476	9601	1235	665	665	78595	29203

9. Subtotals of mass of contaminants in aqueous and sorbed phase, per layer, as a percentage of total in plume

	Benzene	Toluene	Ethylbenz	Xylenes	Naph	1-MN	2-MN	TRPH
WT 1 - 10	0.02	0.5	0.1	0.05	1.5	3	3	0
WT 10 - 100	0.2	5	0.2	0.2	5	5	5	0
WT 100 - 1000	0.6	15	0.8	0.8	5	6	6	1.4
WT 1000	0.6	14	0.7	0.7	1.4	1.0	1.0	0.7
Total in layer	1.3	34	1.9	1.8	12	15	15	3

	Benzene	Toluene	Ethylbenz	Xylenes	Naph	1-MN	2-MN	TRPH
UI 1 - 10 east	0.03	0.03	0.04	0.04	0.2	0.2	0.2	0.8
UI 10 east	0.2	0.2	0.3	3	0.05	0.1	0.1	2
UI 1 - 10 west	0.03	0.03	0.04	0.04	0.1	0.1	0.1	0.7
UI 10 - 100 west	0.2	0.2	0.3	0.3	1.2	2	2	3
UI 100 - 1000 west	2	2	3	3	11	21	21	4
UI 1000 west	54	54	72	70	55	51	51	65
Total in layer	57	57	75	75	68	74	74	76

	Benzene	Toluene	Ethylbenz	Xylenes	Naph	1-MN	2-MN	TRPH
LI 1 - 10	0.1	0.04	0.1	0.1	0.02	0.04	0.04	2
LI 10 - 100	1.0	0.5	0.6	0.6	0.2	0.4	0.4	2
LI 100 - 1000	10	5	7	7	3	5	5	4
LI 1000 east	3	0.1	0.1	0.9	0.01	0.01	0.01	0.5
LI 1000 west	23	4	15	15	17	5	5	9
Total in layer	36	9	22	23	20	11	11	18

	Benzene	Toluene	Ethylbenz	Xylenes	Naph	1-MN	2-MN	TRPH
Deep 1 - 10	0.1	0.01	0.03	0.03	0.1	0.2	0.2	2.0
Deep 10 - 100	0.2	0.02	0.01	0.01	0.02	0.04	0.04	0.5
Deep 100 - 1000	3	0.3	0.2	0.1	0.03	0.1	0.1	0.8
Deep 1000	2.0	0.02	0.1	0.1	0.01	0.01	0.01	0.1
Total in layer	5.5	0.4	0.3	0.2	0.2	0.3	0.3	3.5

Grand Total, lb	1322	367	9476	9601	1235	665	665	78595

Grand total, %	100	100	100	100	100	100	100	100

check of subtotals	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

NAS CECIL FIELD
NFF RAP - TRUCKSTAND
CONTAMINANT MASS
6/6/2003

1. Calculate Volume of water and soil

Interval	Depth, feet	Area, feet^2	Volume, feet^3	Porosity	Water Volume, feet^3	Water Volume, gal	Bulk dry density, ton/cy	Mass dry soil, lb
Plume 1 - 20 Naph	50	4,500	225,000	0.3	67,500	504,968	1.5	25,000,000
Plume 20 Naph	50	3,200	160,000	0.3	48,000	359,088	1.5	17,777,778

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

Compound	22S	23S	16DR	13R	Geo mean	Mean	max	Geomean of max and 1
Benzene	0.5	0.5	0.51	3.2	0.8	1.1775	3	2
Ethylbenzene	5.3	0.5	13.7	41.5	6.2	15	42	6
Xylenes	2.1	1.5	3.3	51.5	4.8	14.6	52	7
Naphthalene	49.9	1.4	65.9	120	27.3	59.3	120	11
1-MN	45.7	2	35.5	72	22.0	38.8	72	8
2-MN	47	0.63	30.7	98.5	17.3	44.2075	99	10

3. Estimate the aqueous concentrations in ug/L of all compounds.

	Benzene	Ethylbenz	Xylenes	Naph	1-MN	2-MN	
Plume 1 - 20 Naph	0.5	0.5	1.5	4	4	4	PAHs based on geo means, VOCs on average
Plume 20 Naph	2	15	15	49	38	44	

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

	Benzene	Ethylbenz	Xylenes	Naph	1-MN	2-MN	water vol,gal
Plume 1 - 20 Naph	0.002	0.002	0.006	0.019	0.019	0.019	504,968
Plume 20 Naph	0.006	0.045	0.045	0.147	0.114	0.133	359,088
Total, aqueous	0.008	0.047	0.1	0.2	0.1	0.2	

5. Calculate concentrations in soil using typical Koc and Foc values.
Use Foc = 1% as a typical value for Cecil, from 36/37 RI.
Koc values of 1MN, 2MN and TRPH as naphthalene.
Kd = Koc x Foc

	Benzene	Ethylbenz	Xylenes	Naph	1-MN	2-MN
Koc, L/kg	38	1288	240	1288	1288	1288
Foc, kg/kg	0.01	0.01	0.01	0.01	0.01	0.01
Kd, L/kg	0.38	12.88	2.4	12.88	12.88	12.88

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

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

	Benzene	Ethylbenz	Xylenes	Naph	1-MN	2-MN
Plume 1 - 20 Naph	0.2	6.4	3.6	57.6	57.6	57.6
Plume 20 Naph	0.76	193	36	631	489	573

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

	Benzene	Ethylbenz	Xylenes	Naph	1-MN	2-MN	soil mass, lb
Plume 1 - 20 Naph	0.00	0	0.1	1	1	1	25,000,000
Plume 20 Naph	0.01	3	0.6	11	9	10	17,777,778
Total sorbed	0.02	4	0.7	13	10	12	
Total, aqueous	0.01	0.05	0.05	0.17	0.13	0.15	
Grand Total	0.03	4	0.8	13	10	12	

APPENDIX B

REMEDIATION TIME

NAS CECIL FIELD
NORTH FUEL FARM RAPA
AVERAGE CONCENTRATIONS TO CALCULATE AIR SPARGE TIMES
6/13/2003

Concentrations in ug/L
Shallow source

Compound	94S	108S	91S	87S	93S	113S	Ave
Benzene	2560	16.3	1930	3590	2910	10600	3809
Toluene	6470	3.8	192	147	273	47.6	133
Ethylbenzene	1030	62.5	1180	856	1110	883	818
Xylenes	4400	693	5880	4310	4980	3430	3859
Naphthalene	165	11.4	113	136	124	71.5	91
1-MN	61.4	14.4	32.3	41.6	55.6	8.9	31
2-MN	82.5	22.2	25.5	45.1	67.1	11.2	34
TRPH	8680	2230	7950	7330	8700	7220	6686

Deep Source

Compound	89I	85I	39D	99D	Ave
Benzene	60.7	20.7	7120	5.8	1802
Toluene	11.8	14.8	99	0.25	31
Ethylbenzene	220	10	626	1	214
Xylenes	1560	3020	6665	2.4	2812
Naphthalene	2.2	2.2	114	0.13	30
1-MN	0.28	1.1	38.95	0.13	10
2-MN	0.28	0.27	53.25	0.13	13
TRPH	1290	2780	8540	95	3176

Shallow down plume

Compound	57S	101S	49S	Ave
Benzene	73.5	1.6	14.4	30
Toluene	9.1	2.5	4.5	5
Ethylbenzene	52.15	0.71	1.75	18
Xylenes	1165	3.8	545	571
Naphthalene	2.6	0.26	0.14	1
1-MN	0.13	0.26	0.14	0
2-MN	0.13	0.26	0.14	0
TRPH	5009.5	90	703	1934

Deep down plume - low concentration wells

Compound	110D	80D	100D	61I	Ave
Benzene	842	390	5.2	2.5	310
Toluene	0.78	2.5	0.58	5.6	2
Ethylbenzene	1.7	3.5	0.35	97.3	26
Xylenes	2.1	5	0.5	886	223
Naphthalene	1.4	0.13	0.13	122	31
1-MN	0.5	0.13	0.13	11.8	3
2-MN	0.5	0.13	0.13	13.1	3
TRPH	264	95	95	3700	1039

Deep down plume

Compound	70I	64I	50I	98D	51D	80D	Ave
Benzene	8490	334	4410	1040	1340	390	2667
Toluene	25	15.7	12.5	0.6	5	2.5	10
Ethylbenzene	269	125	17.5	19.4	7	3.5	74
Xylenes	7130	3480	1710	95.6	33.2	5	2076
Naphthalene	28.9	11.7	0.39	0.13	0.13	0.13	7
1-MN	0.13	0.14	0.14	0.13	0.13	0.13	0
2-MN	0.13	0.14	0.14	0.13	0.13	0.13	0
TRPH	4980	2970	1780	95	95	95	1669

NAS CECIL FIELD
NFF RAPA
LENGTH OF TREATMENT BASED ON REMOVAL
6/26/2003

This approach uses the assumption that the vapor phase concentration can be calculated from Henry's Law and the flow rate.

The efficiency factor is an estimate that recognizes the equilibrium is not reached, that full contact/mixing is not attained, and that contaminants de-sorb from soil.
Entries are made into the shaded boxes.

SEE NOTES SHEET
The equation is:

$$t = \frac{\ln(C_{goal} / C_o)}{-(Q*H*f / V)}$$

Shallow Source Area

ROI, feet	30
Thickness of water, feet	50
Q, Flow rate, scfm	10
f, efficiency factor	0.3
V, Treated volume, ft3	141,372

Compound	benzene	toluene	ethylbenzene	xylenes	naphthalene	1-MN	2-MN		
H, ug/L[vap]/ug/l[aq]	0.225	0.279	0.275	0.25	0.0188	0.0188	0.0188		
C_o, ug/L	3,809	133	818	3,859	91	31	34		
Cgoal, ug/L	1	40	30	20	20	20	20		
initial mass, lb	33.6	1.2	7.2	34.0	0.8	0.3	0.3	0.0	0.0

t, minutes	1,726,858	202,932	566,459	991,947	3,797,811	1,098,528	1,330,071	#DIV/0!	#DIV/0!
t, days	1,199	141	393	689	2,637	763	924	#DIV/0!	#DIV/0!
t, years	3	0	1	2	7	2	3	#DIV/0!	#DIV/0!

Deep Source Area

ROI, feet	30
Thickness of water, feet	50
Q, Flow rate, scfm	10
f, efficiency factor	0.3
V, Treated volume, ft3	141,372

Compound	benzene	toluene	ethylbenzene	xylenes	naphthalene	1-MN	2-MN		
H, ug/L[vap]/ug/l[aq]	0.225	0.279	0.275	0.25	0.0188	0.0188	0.0188		
C_o, ug/L	1,802	31	214	2,812	30	10	13		
Cgoal, ug/L	1	40	30	20	20	20	20		
initial mass, lb	15.9	0.3	1.9	24.8	0.3	0.1	0.1	0.0	0.0

t, minutes	1,570,099	-43,052	336,684	932,286	1,016,337	-1,737,440	-1,079,799	#DIV/0!	#DIV/0!
t, days	1,090	-30	234	647	706	-1,207	-750	#DIV/0!	#DIV/0!
t, years	3	0	1	2	2	-3	-2	#DIV/0!	#DIV/0!

Shallow Down Plume Area

ROI, feet	30
Thickness of water, feet	50
Q, Flow rate, scfm	10
f, efficiency factor	0.3
V, Treated volume, ft3	141,372

Compound	benzene	toluene	ethylbenzene	xylenes	naphthalene	1-MN	2-MN		
H, ug/L[vap]/ug/l[aq]	0.225	0.279	0.275	0.25	0.0188	0.0188	0.0188		
C_o, ug/L	30	5	18	571	1	0	0		
Cgoal, ug/L	1	40	30	20	20	20	20		
initial mass, lb	0.3	0.0	0.2	5.0	0.0	0.0	0.0	0.0	0.0

t, minutes	712,347	-351,224	-87,535	631,774	-7,509,090	-13,280,740	-13,280,740	#DIV/0!	#DIV/0!
t, days	495	-244	-61	439	-5,215	-9,223	-9,223	#DIV/0!	#DIV/0!
t, years	1	-1	0	1	-14	-25	-25	#DIV/0!	#DIV/0!

Deep Down Plume - Low concentration wells

ROI, feet	30
Thickness of water, feet	50
Q, Flow rate, scfm	10
f, efficiency factor	0.3
V, Treated volume, ft3	141,372

Compound	benzene	toluene	ethylbenzene	xylenes	naphthalene	1-MN	2-MN		
H, ug/L[vap]/ug/l[aq]	0.225	0.279	0.275	0.25	0.0188	0.0188	0.0188		
C_o, ug/L	310	2	26	223	31	3	3		
Cgoal, ug/L	1	40	30	20	20	20	20		
initial mass, lb	2.7	0.0	0.2	2.0	0.3	0.0	0.0	0.0	0.0

t, minutes	1,201,468	-505,989	-24,522	454,547	1,098,528	-4,755,313	-4,755,313	#DIV/0!	#DIV/0!
t, days	834	-351	-17	316	763	-3,302	-3,302	#DIV/0!	#DIV/0!
t, years	2	-1	0	1	2	-9	-9	#DIV/0!	#DIV/0!

Deep Down Plume - High concentration wells

ROI, feet	30
Thickness of water, feet	50
Q, Flow rate, scfm	10
f, efficiency factor	0.3
V, Treated volume, ft3	141,372

Compound	benzene	toluene	ethylbenzene	xylenes	naphthalene	1-MN	2-MN		
H, ug/L[vap]/ug/l[aq]	0.225	0.279	0.275	0.25	0.0188	0.0188	0.0188		
C_o, ug/L	2,667	10	74	2,076	7	0	0		
Cgoal, ug/L	1	40	30	20	20	20	20		
initial mass, lb	23.5	0.1	0.7	18.3	0.1	0.0	0.0	0.0	0.0

t, minutes	1,652,211	-234,150	154,715	875,086	-2,631,480	-13,280,740	-13,280,740	#DIV/0!	#DIV/0!
t, days	1,147	-163	107	608	-1,827	-9,223	-9,223	#DIV/0!	#DIV/0!
t, years	3	0	0	2	-5	-25	-25	#DIV/0!	#DIV/0!

It can be demonstrated that:

$$C_{goal} = C_o \times e^{-(Q*H*f/V)\,t}$$

Where:
C_{goal} = target concentration at time t in ug/L, equal to GCTL
C_o = intital concentration, ug/L
Q = the flow rate per well in scfm
H = Henry's Law constant in **ug/L [air]/ug/L[aqueous]**
f = an efficiency factor to account for not reaching equilibrium and incomplete mixing/contact (dimensionless, less than 1).
V = volume treated per well, cubic feet. $(2*ROI)^2$ x pi /4 x thickness of water treated
t = time to reach C_{goal} in minutes

Since ROI and water thickness are known, V is calculated.
Q is given.
H is looked up - WATCH UNITS
C_{goal} is given as the GCTL.
C_o is calculated for the treatment area.
f has to be assumed, and about 0.2 seems reasonable.

Re-arranging:

$$t = \frac{\ln(C_{goal} / C_o)}{-(Q*H*f / V)}$$

with t in minutes

The contaminant removal rate, based on the air sparge rate can be estimated as follows:

$$M = Q \times H \times Cw \times f \times (\text{conversion factors})$$

Where:

Q = air flow rate per well, scfm.
H = Henry's Law constant, concentration-air/concentration-water ("dimensionless").
Cw = contaminant concentration in water.
f = an efficiency factor to recognize non-equilibrium and liquid diffusion.
(conversion factors) = appropriate values, based on units being used.
M = mass loss rate from water.

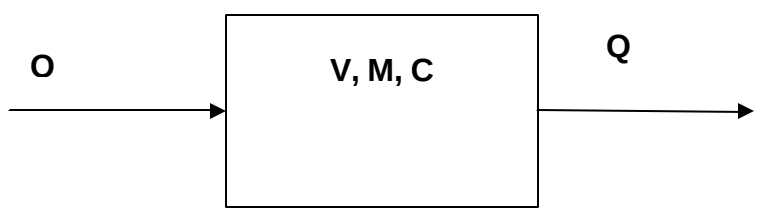
For a given well of known radius of influence (ROI) and saturated depth (D), a volume per well, V, can be calculated as:

$$V = [(2 \times ROI)2 / 4] \times p \times D$$

Then, based on an initial concentration, Co, an initial mass, Mo, can be calculated by:

$$Mo = Co \times V$$

Using the approach described in "Basic Principles and Calculation in Chemical Engineering", by Himmelblau, the following sketch describes the operation. Air, at a rate of Q, is sparged through the volume V. C is the concentration of the contaminant in V, and M is the mass of the contaminant in the volume V.



Let x = mass of contaminant at time t.

So at t = 0, $x = M_o$.

and $M = C \times V$.

Re-arranging :

$$C = M / V$$

And substituting with x,

$$C = x / V$$

Contaminant Mass Balance:

$$X_{t+?t} - x_t = \text{in} - \text{out} = 0 - (Q \times H \times f)/V$$

Converting to an integral form:

$$dx/dt = -(Q \times H \times f)/V$$

$$dx/x = [-(Q \times H \times f)/V]\, dt$$

$$\left(\frac{dx}{x}\right)_{M_o}^{x_t} = \left(-\frac{QHf}{V}\, dt\right)_0^t$$

$$\ln (x_t / M_o) = -(t - 0)(QHf) / V$$

$$x_t / M_o = e^{-(QHf/V)\, t}$$

$$\mathbf{x_t = M_o\, e^{-(QHf/V)\, t}}$$

Now, this form can be converted to concentrations by dividing both sides by V:

$$x_t / V = M_o / V\ [e^{-(QHf/V)\, t}]$$

Since $C_o = M_o / V$ and $C = C_t = x_t / V$:

$$\mathbf{C_t = C_o\ [e^{-(QHf/V)\, t}]}$$

To determine the time to reach the GCTL (or any other target concentration), substitute the GCTL for C_t, and then solve for t.

APPENDIX C

COST ESTIMATES

ALTERNATIVE 1 – AS/SVE

NAVAL AIR STATION CECIL FIELD
Jacksonville, Florida
NFF
Alt 1 - AS Treatment + SVE
Capital Cost

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
1 PROJECT PLANNING											
1.1 Prepare Construction Completion Report	100	hr			$30.00		$0	$0	$3,000	$0	$3,000
2 MOBILIZATION/DEMOBILIZATION											
2.1 Construction Survey	1	ls	$1,200.00				$1,200	$0	$0	$0	$1,200
2.2 Equipment Mobilization/Demobilization	5	ea			$96.00	$396.00	$0	$0	$480	$1,980	$2,460
2.3 Field Construction Mgt. (3p * 5 days/week)	26	mwk			$2,400.00		$0	$0	$62,400	$0	$62,400
3 DECONTAMINATION											
3.1 Decontamination Services	6	mo	$3,400.00				$20,400	$0	$0	$0	$20,400
3.2 Temporary Equipment Decon Pad	1	ls		$1,500.00	$2,000.00	$200.00	$0	$1,500	$2,000	$200	$3,700
3.3 Decon Water	6,000	gal		$0.20			$0	$1,200	$0	$0	$1,200
3.4 Decon Water Storage Tank, 6,000 gallon	6	mo				$600.00	$0	$0	$0	$3,600	$3,600
3.5 Clean Water Storage Tank, 4,000 gallon	6	mo				$540.00	$0	$0	$0	$3,240	$3,240
3.6 PPE (4 p * 5 days * 26 weeks)	520	day		$30.90			$0	$16,068	$0	$0	$16,068
3.7 Disposal of Decon Waste (liquid & solid)	6	mo	$900.00				$5,400	$0	$0	$0	$5,400
4 AIR SPARGING SYSTEM											
4.1 Install Air Sparging Wells (445 wells)	35,100	lf	$24.00				$842,400	$0	$0	$0	$842,400
4.2 Install SVE wells (as piping)	0	lf	$25.00				$0	$0	$0	$0	$0
4.3 Well Covers/ vaults	450	ea	$180.00				$81,000	$0	$0	$0	$81,000
4.4 SVE well vaults	216	ea	$200.00				$43,200	$0	$0	$0	$43,200
4.5 Well Development	450	ea	$60.00				$27,000	$0	$0	$0	$27,000
4.6 Collect/Containerize IDW - tank	3	mo	$1,100.00				$3,300	$0	$0	$0	$3,300
4.7 Transport/Dispose IDW	68,000	gal	$1.00				$68,000	$0	$0	$0	$68,000
4.8 Valves/appurtances at wells	450	ea	$400.00				$180,000	$0	$0	$0	$180,000
4.9 Other valves	80	ea	$350.00				$28,000	$0	$0	$0	$28,000
4.10 Excavate/Backfill Pipe Trench for 2" pipe	14,000	lf			$2.00	$0.96	$0	$0	$28,000	$13,440	$41,440
4.11 PVC 2" Pressure Pipe	14,000	lf		$2.60	$4.00		$0	$36,400	$56,000	$0	$92,400
4.12 Excavate/Backfill Pipe Trench for 4" pipe	21,000	lf			$2.00	$0.96	$0	$0	$42,000	$20,160	$62,160
4.13 PVC 4" Pressure Pipe	21,000	lf		$5.00	$3.00		$0	$105,000	$63,000	$0	$168,000
4.14 Excavate/Backfill Pipe Trench for 4" pipe - SVE	23,000	lf			$2.00	$0.96	$0	$0	$46,000	$22,080	$68,080
4.15 PVC 4" Pressure Pipe -SVE	23,000	lf		$5.00	$3.00		$0	$115,000	$69,000	$0	$184,000
4.16 Excavate/Backfill Pipe Trench for 6" pipe	2,000	lf			$2.00	$0.96	$0	$0	$4,000	$1,920	$5,920
4.17 PVC 6" Pressure Pipe	2,000	lf		$10.00	$5.00		$0	$20,000	$10,000	$0	$30,000
4.18 Excavate/Backfill Pipe Trench for 6" pipe - SVE	2,000	lf			$2.00	$0.96	$0	$0	$4,000	$1,920	$5,920
4.19 PVC 6" Pressure Pipe - SVE	2,000	lf		$10.00	$5.00		$0	$20,000	$10,000	$0	$30,000
4.20 Building	1,000	sqft	$75.00				$75,000	$0	$0	$0	$75,000
4.21 Electrical	1	ea	$95,000.00				$95,000	$0	$0	$0	$95,000
4.22 Air Compressor, 750 cfm/200 hp, w/ tank	3	ea		$74,000.00	$488.00		$0	$222,000	$1,464	$0	$223,464
4.23 Vac pump, 1500 scfm 30 hp	5	ea		$31,000.00	$621.00		$0	$155,000	$3,105	$0	$158,105
4.24 Moisture separator	5	ea		$15,400.00	$490.00		$0	$77,000	$2,450	$0	$79,450
4.25 GAC unit	4	ea		$22,000.00	$990.00	$165.00	$0	$88,000	$3,960	$660	$92,620
4.26 Instruments and Controls	1	ls		$28,050.00	$7,590.00		$0	$28,050	$7,590	$0	$35,640
4.27 Systems Start-up and Testing	1	ls		$2,000.00	$3,000.00		$0	$2,000	$3,000	$0	$5,000
Subtotal							$1,469,900	$887,218	$421,449	$69,200	$2,847,767
Local Area Adjustments							100.0%	99.9%	70.3%	88.0%	

NAVAL AIR STATION CECIL FIELD
Jacksonville, Florida
NFF
Alt 1 - AS Treatment + SVE
Capital Cost

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
							$1,469,900	$886,331	$296,279	$60,896	$2,713,405
Overhead on Labor Cost @ 30%									$88,884		$88,884
G & A on Labor Cost @ 10%									$29,628		$29,628
G & A on Material Cost @ 10%								$88,633			$88,633
G & A on Subcontract Cost @ 10%							$146,990				$146,990
Total Direct Cost							$1,616,890	$974,964	$414,790	$60,896	$3,067,540

NAVAL AIR STATION CECIL FIELD
Jacksonville, Florida
NFF
Alt 1 - AS Treatment + SVE
Capital Cost

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
Indirects on Total Direct Cost @	35%										$1,073,639
Profit on Total Direct Cost @	10%										$306,754
Subtotal											$4,447,933
Health & Safety Monitoring @	2%										$88,959
Total Field Cost											$4,536,892
Contingency on Total Field Costs @	20%										$907,378
Engineering on Total Field Cost @	10%										$453,689
TOTAL CAPITAL COST											**$5,897,959**

NAVAL AIR STATION CECIL FIELD
Jacksonville, Florida
NFF
Alt 1 - AS Treatment + SVE
Operation and Maintenance Cost

	Item	Quantity	Unit	Unit Cost	Subtotal	Notes
YEARS 1 and 2						
1	Energy - Electric	5,000,000	kWh	$0.06	$300,000	
2	System Maintenance	1	ls	$83,046	$83,046	15% of Installation Cost
3	Routine Operating Labor	416	hour	$50	$20,800	Weekly, one day
4	Sampling labor, travel & living, supplies	12	ea	$2,730	$32,760	2 at 2 day trip per month
5	Analysis of Offgas sampling	26	ea	$650	$16,900	BTEX, chlorinated VOCs one per year
6	Quarterly Reports	4	ea	$4,000	$4,000	
			O & M per year for years 1 & 2		**$457,506**	
YEAR 3						
1	Energy - Electric	4,000,000	kWh	$0.06	$240,000	
2	System Maintenance	1	ls	$83,046	$83,046	15% of Installation Cost
3	Routine Operating Labor	416	hour	$50	$20,800	Weekly, one day
4	Sampling labor, travel & living, supplies	12	ea	$2,730	$32,760	2 at 2 day trip per month
5	Analysis of Offgas sampling	0	ea	$650	$0	BTEX, chlorinated VOCs one per year
6	Quarterly Reports	4	ea	$4,000	$4,000	
			O & M per year for year 3		**$380,606**	

NAVAL AIR STATION CECIL FIELD

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Jacksonville, Florida

NFF

Alt 1 - AS Treatment + SVE

Annual Cost

Item	Item Cost year 1	Item Cost years 2 and 3	Item Cost years 4 and 5	Item Cost every 5 years	Notes
LUC Inspection and Sampling	$44,000	$22,000	$11,000		Labor, Field Supplies, Local Travel
GAC	$248,000	$0	$0		
Analysis/Water(1) (Performance)	$26,112	$13,056	$6,528		Analyze twelve groundwater sample for TCL VOCs, TCL SVOCs, TRPH, and including blanks and duplicates for years 1 through 5.
Analysis/Water(1) (Migration)	$23,936	$11,968	$5,984		Analyze eleven groundwater sample for TCL VOCs, TCL SVOCs, and TRPH including blanks and duplicates. Monitor for 5 years.
Report	$32,000	$16,000	$8,000		Document site inspections, sampling events and results.
Site Review				$7,500	Perform 5-Year review (10% of total cost)
TOTALS	$374,048	$63,024	$31,512	$7,500	

(1) Sampling frequency will occur quarterly the first year, semi-annual for years 2 & 3, and annually for years 4 & 5.

NAVAL AIR STATION CECIL FIELD

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Jacksonville, Florida

NFF

Alt 1 - AS Treatment + SVE

Present Worth Analysis

Year	Capital Cost	Operation & Maintenance Cost	Annual Cost	Total Year Cost	Annual Discount Rate at 7%	Present Worth
0	$5,897,959			$5,897,959	1.000	$5,897,959
1		$457,506	$374,048	$831,554	0.935	$777,503
2		$457,506	$63,024	$520,530	0.873	$454,423
3		$380,606	$63,024	$443,630	0.816	$362,002
4		$380,606	$31,512	$412,118	0.763	$314,446
5		$380,606	$39,012	$419,618	0.713	$299,188
					TOTAL PRESENT WORTH	**$8,105,520**

ALTERNATIVE 2 – AS/BS/SVE

NAVAL AIR STATION CECIL FIELD
Jacksonville, Florida
NFF
Alt 2 - AS+BS Treatment + SVE
Capital Cost

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Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
1 PROJECT PLANNING											
1.1 Prepare Construction Completion Report	100	hr			$30.00		$0	$0	$3,000	$0	$3,000
2 MOBILIZATION/DEMOBILIZATION											
2.1 Construction Survey	1	ls	$1,200.00				$1,200	$0	$0	$0	$1,200
2.2 Equipment Mobilization/Demobilization	5	ea			$96.00	$396.00	$0	$0	$480	$1,980	$2,460
2.3 Field Construction Mgt. (3p * 5 days/week)	26	mwk			$2,400.00		$0	$0	$62,400	$0	$62,400
3 DECONTAMINATION											
3.1 Decontamination Services	6	mo	$3,400.00				$20,400	$0	$0	$0	$20,400
3.2 Temporary Equipment Decon Pad	1	ls		$1,500.00	$2,000.00	$200.00	$0	$1,500	$2,000	$200	$3,700
3.3 Decon Water	6,000	gal		$0.20			$0	$1,200	$0	$0	$1,200
3.4 Decon Water Storage Tank, 6,000 gallon	6	mo				$600.00	$0	$0	$0	$3,600	$3,600
3.5 Clean Water Storage Tank, 4,000 gallon	6	mo				$540.00	$0	$0	$0	$3,240	$3,240
3.6 PPE (4 p * 5 days * 26 weeks)	520	day		$30.90			$0	$16,068	$0	$0	$16,068
3.7 Disposal of Decon Waste (liquid & solid)	6	mo	$900.00				$5,400	$0	$0	$0	$5,400
4 AIR SPARGING SYSTEM											
4.1 Install Air and Bio Sparging Wells (450 wells)	35,100	lf	$24.00				$842,400	$0	$0	$0	$842,400
4.2 Install SVE wells -as piping	0	lf	$25.00				$0	$0	$0	$0	$0
4.3 Well Covers/vaults	450	ea	$180.00				$81,000	$0	$0	$0	$81,000
4.4 Well covers - SVE	54	ea	$200.00				$10,800	$0	$0	$0	$10,800
4.5 Well Development	450	ea	$60.00				$27,000	$0	$0	$0	$27,000
4.6 Collect/Containerize IDW - tank	3	mo	$1,100.00				$3,300	$0	$0	$0	$3,300
4.7 Transport/Dispose IDW	68,000	gal	$1.00				$68,000	$0	$0	$0	$68,000
4.8 Valves/appurtances at wells	450	ea	$400.00				$180,000	$0	$0	$0	$180,000
4.9 Other valves	80	ea	$350.00				$28,000	$0	$0	$0	$28,000
4.10 Excavate/Backfill Pipe Trench for 2" pipe	14,000	lf			$2.00	$0.96	$0	$0	$28,000	$13,440	$41,440
4.11 PVC 2" Pressure Pipe	14,000	lf		$2.60	$4.00		$0	$36,400	$56,000	$0	$92,400
4.12 Excavate/Backfill Pipe Trench for 4" pipe	21,000	lf			$2.00	$0.96	$0	$0	$42,000	$20,160	$62,160
4.13 PVC 4" Pressure Pipe	21,000	lf		$5.00	$3.00		$0	$105,000	$63,000	$0	$168,000
4.14 Excavate/Backfill Pipe Trench for 4" pipe - SVE	5,700	lf			$2.00	$0.96	$0	$0	$11,400	$5,472	$16,872
4.15 PVC 4" Pressure Pipe - SVE	5,700	lf		$5.00	$3.00		$0	$28,500	$17,100	$0	$45,600
4.16 Excavate/Backfill Pipe Trench for 6" pipe	2,000	lf			$2.00	$0.96	$0	$0	$4,000	$1,920	$5,920
4.17 PVC 6" Pressure Pipe	2,000	lf		$10.00	$5.00		$0	$20,000	$10,000	$0	$30,000
4.18 Excavate/Backfill Pipe Trench for 6" pipe - SVE	1,200	lf			$2.00	$0.96	$0	$0	$2,400	$1,152	$3,552
4.19 PVC 6" Pressure Pipe - SVE	1,200	lf		$10.00	$5.00		$0	$12,000	$6,000	$0	$18,000
4.20 Building	875	sqft	$75.00				$65,625	$0	$0	$0	$65,625
4.21 Electrical	1	ea	$75,000.00				$75,000	$0	$0	$0	$75,000
4.22 Air Compressor, 550 cfm/120 hp, w/tank	3	ea		$63,000.00	$488.00		$0	$189,000	$1,464	$0	$190,464
4.23 Vac pump, 300 scfm 10 hp	2	ea		$24,000.00	$621.00		$0	$48,000	$1,242	$0	$49,242
4.24 Moisture separator	1	ea		$15,400.00	$490.00		$0	$15,400	$490	$0	$15,890
4.25 GAC unit	2	ea		$22,000.00	$990.00	$165.00	$0	$44,000	$1,980	$330	$46,310
4.26 Instruments and Controls	1	ls		$22,440.00	$6,072.00		$0	$22,440	$6,072	$0	$28,512
4.27 Additional controls and actuators for BS wells.	1	ls	##########				$194,000	$0	$0	$0	$194,000
4.28 Systems Start-up and Testing	1	ls		$2,000.00	$3,000.00		$0	$2,000	$3,000	$0	$5,000
Subtotal							$1,602,125	$541,508	$322,028	$51,494	$2,517,155
Local Area Adjustments							100.0%	99.9%	70.3%	88.0%	

NAVAL AIR STATION CECIL FIELD
Jacksonville, Florida
NFF
Alt 2 - AS+BS Treatment + SVE
Capital Cost

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
							$1,602,125	$540,966	$226,386	$45,315	$2,414,792
Overhead on Labor Cost @ 30%									$67,916		$67,916
G & A on Labor Cost @ 10%									$22,639		$22,639
G & A on Material Cost @ 10%								$54,097			$54,097
G & A on Subcontract Cost @ 10%							$160,213				$160,213

NAVAL AIR STATION CECIL FIELD
Jacksonville, Florida
NFF
Alt 2 - AS+BS Treatment + SVE
Capital Cost

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Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
Total Direct Cost							$1,762,338	$595,063	$316,940	$45,315	$2,719,655
Indirects on Total Direct Cost @	35%										$951,879
Profit on Total Direct Cost @	10%										$271,966
Subtotal											$3,943,500
Health & Safety Monitoring @	2%										$78,870
Total Field Cost											$4,022,370
Contingency on Total Field Costs @	20%										$804,474
Engineering on Total Field Cost @	10%										$402,237
TOTAL CAPITAL COST											**$5,229,081**

NAVAL AIR STATION CECIL FIELD
Jacksonville, Florida
NFF
Alt 2 - AS+BS Treatment + SVE
Operation and Maintenance Cost

	Item	Quantity	Unit	Unit Cost	Subtotal	Notes
YEARS 1						
1	Energy - Electric	1,800,000	kWh	$0.06	$108,000	
2	System Maintenance	1	ls	$45,286	$45,286	15% of Installation Cost
3	Routine Operating labor	416	hours	$50	$20,800	weekly, one day
4	Sampling labor, travel & living, supplies	12	ea	$2,730	$32,760	2 at 2 day trip per month
5	Analysis of Offgas sampling	26	ea	$650	$16,900	BTEX, chlorinated VOCs one per year
6	Quarterly Reports	4	ea	$4,000	$4,000	
			O & M per year for years 1 & 2		**$227,746**	
YEAR 2-10						
1	Energy - Electric	1,600,000	kWh	$0.06	$96,000	
2	System Maintenance	1	ls	$45,286	$45,286	15% of Installation Cost
3	Routine Operating labor	416	hours	$50	$20,800	weekly, one day
4	Sampling labor, travel & living, supplies	12	ea	$2,730	$32,760	2 at 2 day trip per month
5	Analysis of Offgas sampling	0	ea	$650	$0	BTEX, chlorinated VOCs one per year
6	Quarterly Reports	4	ea	$4,000	$4,000	
			O & M per year for year 3		**$198,846**	

NAVAL AIR STATION CECIL FIELD

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Jacksonville, Florida

NFF

Alt 2 - AS+BS Treatment + SVE

Annual Cost

Item	Item Cost year 1	Item Cost years 2 and 3	Item Cost years 4 to 10	Item Cost every 5 years	Notes
LUC Inspection and Sampling	$44,000	$22,000	$11,000		Labor, Field Supplies, Local Travel
GAC	$223,000	$0	$0		
Analysis/Water(1) (Performance)	$26,112	$13,056	$6,528		Analyze twelve groundwater sample for TCL VOCs, TCL SVOCs, TRPH, and including blanks and duplicates for years 1 through 5.
Analysis/Water(1) (Migration)	$23,936	$11,968	$5,984		Analyze eleven groundwater sample for TCL VOCs, TCL SVOCs, and TRPH including blanks and duplicates. Monitor for 5 years.
Report	$32,000	$16,000	$8,000		Document site inspections, sampling events and results.
Site Review				$7,500	Perform 5-Year review (10% of total cost)
TOTALS	$349,048	$63,024	$31,512	$7,500	

(1) Sampling frequency will occur quarterly the first year, semi-annual for years 2 & 3, and annually for years 4 & 5.

NAVAL AIR STATION CECIL FIELD

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Jacksonville, Florida

NFF

Alt 2 - AS+BS Treatment + SVE

Present Worth Analysis

Year	Capital Cost	Operation & Maintenance Cost	Annual Cost	Total Year Cost	Annual Discount Rate at 7%	Present Worth
0	$5,229,081			$5,229,081	1.000	$5,229,081
1		$227,746	$349,048	$576,794	0.935	$539,302
2		$198,846	$63,024	$261,870	0.873	$228,612
3		$198,846	$63,024	$261,870	0.816	$213,686
4		$198,846	$31,512	$230,358	0.763	$175,763
5		$198,846	$39,012	$237,858	0.713	$169,593
6		$198,846	$31,512	$230,358	0.666	$153,497
7		$198,846	$31,512	$230,358	0.623	$143,455
8		$198,846	$31,512	$230,358	0.582	$134,070
9		$198,846	$31,512	$230,358	0.544	$125,299
10		$198,846	$39,012	$237,858	0.508	$120,915

TOTAL PRESENT WORTH **$7,233,275**

ALTERNATIVE 3 – AS/BS/SVE with NUTRIENT ADDITION/MNA

NAVAL AIR STATION CECIL FIELD
Jacksonville, Florida
NFF
Alt 3 - AS + BS + SVE + phoster + MNA
Capital Cost

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
1 PROJECT PLANNING											
1.1 Prepare Construction Completion Report	100	hr			$30.00		$0	$0	$3,000	$0	$3,000
2 MOBILIZATION/DEMOBILIZATION											
2.1 Construction Survey	1	ls	$1,200.00				$1,200	$0	$0	$0	$1,200
2.2 Equipment Mobilization/Demobilization	5	ea			$96.00	$396.00	$0	$0	$480	$1,980	$2,460
2.3 Field Construction Mgt. (3p * 5 days/week)	13	mwk			$2,400.00		$0	$0	$31,200	$0	$31,200
3 DECONTAMINATION											
3.1 Decontamination Services	3	mo	$3,400.00				$10,200	$0	$0	$0	$10,200
3.2 Temporary Equipment Decon Pad	1	ls		$1,500.00	$2,000.00	$200.00	$0	$1,500	$2,000	$200	$3,700
3.3 Decon Water	2,000	gal		$0.20			$0	$400	$0	$0	$400
3.4 Decon Water Storage Tank, 6,000 gallon	3	mo				$600.00	$0	$0	$0	$1,800	$1,800
3.5 Clean Water Storage Tank, 4,000 gallon	3	mo				$540.00	$0	$0	$0	$1,620	$1,620
3.6 PPE (4 p * 5 days * 26 weeks)	260	day		$30.90			$0	$8,034	$0	$0	$8,034
3.7 Disposal of Decon Waste (liquid & solid)	3	mo	$900.00				$2,700	$0	$0	$0	$2,700
4 AIR SPARGING SYSTEM											
4.1 Install Air Sparging Wells (214 wells)	17,000	lf	$24.00				$408,000	$0	$0	$0	$408,000
4.2 Install SVE wells as piping	0	lf	$25.00				$0	$0	$0	$0	$0
4.3 Well Covers/ vaults	214	ea	$150.00				$32,100	$0	$0	$0	$32,100
4.4 SVE well vaults	54	ea	$200.00				$10,800	$0	$0	$0	$10,800
4.5 Well Development	214	ea	$60.00				$12,840	$0	$0	$0	$12,840
4.6 Collect/Containerize IDW - tank	3	mo	$1,100.00				$3,300	$0	$0	$0	$3,300
4.7 Transport/Dispose IDW	32,000	gal	$1.00				$32,000	$0	$0	$0	$32,000
4.8 Valves/appurtances at wells	214	ea	$400.00				$85,600	$0	$0	$0	$85,600
4.9 Other valves	40	ea	$350.00				$14,000	$0	$0	$0	$14,000
4.10 Excavate/Backfill Pipe Trench for 2" pipe	6,200	lf			$2.00	$0.96	$0	$0	$12,400	$5,952	$18,352
4.11 PVC 2" Pressure Pipe	6,200	lf		$2.60	$4.00		$0	$16,120	$24,800	$0	$40,920
4.12 Excavate/Backfill Pipe Trench for 4" pipe	13,000	lf			$2.00	$0.96	$0	$0	$26,000	$12,480	$38,480
4.13 PVC 4" Pressure Pipe	13,000	lf		$5.00	$3.00		$0	$65,000	$39,000	$0	$104,000
4.14 Excavate/Backfill Pipe Trench for 4" pipe - SVE	5,700	lf			$2.00	$0.96	$0	$0	$11,400	$5,472	$16,872
4.15 PVC 4" Pressure Pipe -SVE	5,100	lf		$5.00	$3.00		$0	$25,500	$15,300	$0	$40,800
4.16 Excavate/Backfill Pipe Trench for 6" pipe	1,000	lf			$2.00	$0.96	$0	$0	$2,000	$960	$2,960
4.17 PVC 6" Pressure Pipe	1,000	lf		$10.00	$5.00		$0	$10,000	$5,000	$0	$15,000
4.18 Excavate/Backfill Pipe Trench for 6" pipe - SVE	1,200	lf			$2.00	$0.96	$0	$0	$2,400	$1,152	$3,552
4.19 PVC 6" Pressure Pipe - SVE	1,200	lf		$10.00	$5.00		$0	$12,000	$6,000	$0	$18,000
4.20 Building	800	sqft	$75.00				$60,000	$0	$0	$0	$60,000
4.21 Electrical	1	ea	$45,000.00				$45,000	$0	$0	$0	$45,000
4.22 AS Compressor, 410 cfm/100 hp, w/ tank plus dryer	1	ea		$53,000.00	$488.00		$0	$53,000	$488	$0	$53,488
4.23 BS Compressor, 330 cfm/75 hp, w/ tank plus dryer	1	ea		$45,000.00	$488.00		$0	$45,000	$488	$0	$45,488
4.24 Vac pump, 300 scfm 10 hp	2	ea		$24,000.00	$621.00		$0	$48,000	$1,242	$0	$49,242
4.25 Moisture separator	2	ea		$12,000.00	$490.00		$0	$24,000	$980	$0	$24,980
4.26 GAC unit	2	ea		$22,000.00	$990.00	$165.00	$0	$44,000	$1,980	$330	$46,310
4.27 Chemical feed system	1	ea	$8,000.00				$8,000	$0	$0	$0	$8,000
4.28 Instruments and Controls	1	ls		$22,440.00	$6,072.00		$0	$22,440	$6,072	$0	$28,512
4.29 Systems Start-up and Testing	1	ls		$2,000.00	$3,000.00		$0	$2,000	$3,000	$0	$5,000
4.30 Additional controls and actuators for BS wells	1	ea	$90,000.00				$90,000	$0	$0	$0	$90,000
Subtotal							$815,740	$376,994	$195,230	$31,946	$1,419,910

NAVAL AIR STATION CECIL FIELD
Jacksonville, Florida
NFF
Alt 3 - AS + BS + SVE + phoster + MNA
Capital Cost

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
Local Area Adjustments							100.0%	99.9%	70.3%	88.0%	
							$815,740	$376,617	$137,247	$28,112	$1,357,716

NAVAL AIR STATION CECIL FIELD
Jacksonville, Florida
NFF
Alt 3 - AS + BS + SVE + phoster + MNA
Capital Cost

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
Overhead on Labor Cost @	30%								$41,174		$41,174
G & A on Labor Cost @	10%								$13,725		$13,725
G & A on Material Cost @	10%							$37,662			$37,662
G & A on Subcontract Cost @	10%						$81,574				$81,574
Total Direct Cost							$897,314	$414,279	$192,145	$28,112	$1,531,851
Indirects on Total Direct Cost @	35%										$536,148
Profit on Total Direct Cost @	10%										$153,185
Subtotal											$2,221,183
Health & Safety Monitoring @	2%										$44,424
Total Field Cost											$2,265,607
Contingency on Total Field Costs @	20%										$453,121
Engineering on Total Field Cost @	10%										$226,561
TOTAL CAPITAL COST											**$2,945,289**

NAVAL AIR STATION CECIL FIELD
Jacksonville, Florida
NFF
Alt 3 - AS + BS + SVE + phoster + MNA
Operation and Maintenance Cost

	Item	Quantity	Unit	Unit Cost	Subtotal	Notes
YEARS 1						
1	Energy - Electric	1,600,000	kWh	$0.06	$96,000	
2	System Maintenance	1	ls	$32,926	$32,926	15% of Installation Cost
3	Routine Operating Labor	416	hour	$50	$20,800	Weekly, one day
4	Sampling labor, travel & living, supplies	12	ea	$2,730	$32,760	2 at 2 day trip per month
5	Analysis of Offgas sampling	26	ea	$650	$16,900	BTEX, chlorinated VOCs one per year
6	Quarterly Reports	4	ea	$4,000	$4,000	
				O & M per year for year 1	**$203,386**	
YEAR 2 - 7						
1	Energy - Electric	1,500,000	kWh	$0.06	$90,000	
2	System Maintenance	1	ls	$32,926	$32,926	15% of Installation Cost
3	Routine Operating Labor	416	hour	$50	$20,800	Weekly, one day
4	Sampling labor, travel & living, supplies	12	ea	$2,730	$32,760	2 at 2 day trip per month
5	Analysis of Offgas sampling	0	ea	$650	$0	BTEX, chlorinated VOCs one per year
6	Quarterly Reports	4	ea	$4,000	$4,000	
				O & M per year for year 3 - 7	**$180,486**	
YEAR 8-30						
1	Energy - Electric	0	kWh	$0.06	$0	
2	System Maintenance	0	ls	$0	$0	15% of Installation Cost
3	Routine Operating Labor	0	hour	$50	$0	Weekly, one day
4	Sampling labor, travel & living, supplies	0	ea	$2,730	$0	1 at 1 day trip per month
5	Analysis of Offgas sampling	0	ea	$650	$0	BTEX, chlorinated VOCs one per year
6	Quarterly Reports	0	ea	$0	$0	
				O & M per year for year 8 - 30	**$0**	

NAVAL AIR STATION CECIL FIELD

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Jacksonville, Florida

NFF

Alt 3 - AS + BS + SVE + phoster + MNA

Annual Cost

Item	Item Cost year 1	Item Cost years 2 and 3	Item Cost years 4 to 7	Item Cost years 8 to 30	Item Cost every 5 years	Notes
MNA/performance Inspection and Sampling	$44,000	$22,000	$11,000	$11,000		Labor, Field Supplies, Local Travel
GAC	$223,000	$0	$0	$0		
Analysis/Water(1) (Performance)	$11,340	$5,670	$2,835	$0		Analyze nine groundwater samples for TCL VOCs, TCL SVOCs, TRPH, and including blanks and duplicates for years 1 through 5.
Analysis/Water(1) (MNA)	$11,340	$5,670	$2,835	$2,835		Analyze nine groundwater sample for TCL VOCs, TCL SVOCs, and TRPH including blanks and duplicates. Monitor for 30 years.
Report	$32,000	$16,000	$8,000	$8,000		Document site inspections, sampling events and results.
Site Review					$7,500	Perform 5-Year review (10% of total cost)
TOTALS	$321,680	$49,340	$24,670	$21,835	$7,500	

(1) Sampling frequency will occur quarterly the first year, semi-annual for years 2 & 3, and annually for years thereafter.

NAVAL AIR STATION CECIL FIELD

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Jacksonville, Florida

NFF

Alt 3 - AS + BS + SVE + phoster + MNA

Present Worth Analysis

Year	Capital Cost	Operation & Maintenance Cost	Annual Cost	Total Year Cost	Annual Discount Rate at 7%	Present Worth
0	$2,945,289			$2,945,289	1.000	$2,945,289
1		$203,386	$321,680	$525,066	0.935	$490,937
2		$180,486	$49,340	$229,826	0.873	$200,638
3		$180,486	$49,340	$229,826	0.816	$187,538
4		$180,486	$24,670	$205,156	0.763	$156,534
5		$180,486	$32,170	$212,656	0.713	$151,621
6		$180,486	$24,670	$205,156	0.666	$136,704
7		$180,486	$24,670	$205,156	0.623	$127,761
8			$21,835	$21,835	0.582	$12,708
9			$21,835	$21,835	0.544	$11,877
10			$29,335	$29,335	0.508	$14,912
11			$21,835	$21,835	0.475	$10,374
12			$21,835	$21,835	0.444	$9,695
13			$21,835	$21,835	0.415	$9,061
14			$21,835	$21,835	0.388	$8,468
15			$29,335	$29,335	0.362	$10,632
16			$21,835	$21,835	0.339	$7,396
17			$21,835	$21,835	0.317	$6,912
18			$21,835	$21,835	0.296	$6,460
19			$21,835	$21,835	0.277	$6,038
20			$29,335	$29,335	0.258	$7,581
21			$21,835	$21,835	0.242	$5,273
22			$21,835	$21,835	0.226	$4,928
23			$21,835	$21,835	0.211	$4,606
24			$21,835	$21,835	0.197	$4,305
25			$29,335	$29,335	0.184	$5,405
26			$21,835	$21,835	0.172	$3,760
27			$21,835	$21,835	0.161	$3,514
28			$21,835	$21,835	0.150	$3,284
29			$21,835	$21,835	0.141	$3,069
30			$29,335	$29,335	0.131	$3,854

TOTAL PRESENT WORTH **$4,561,135**

ALTERNATIVE 4 – CHEMICAL OXIDATION

NAVAL AIR STATION CECIL FIELD
Jacksonville, Florida
NFF
Alt 4 - In-situ Chem ox (Fentons reagent)
Capital Cost

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Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
1 PROJECT PLANNING											
1.1 Prepare Construction Completion Report	50	hr			$30.00		$0	$0	$1,500	$0	$1,500
2 MOBILIZATION/DEMOBILIZATION											
2.1 Construction Survey	1	ls	$2,400.00				$2,400	$0	$0	$0	$2,400
2.2 Equipment Mobilization/Demobilization	2	ea			$96.00	$396.00	$0	$0	$192	$792	$984
2.3 Field Construction Mgt. (3p * 5 days/week)	52	mwk			$2,400.00		$0	$0	$124,800	$0	$124,800
3 DECONTAMINATION											
3.1 Decontamination Services	12	mo	$1,000.00				$12,000	$0	$0	$0	$12,000
3.2 Temporary Equipment Decon Pad	1	ls		$1,500.00	$2,000.00	$200.00	$0	$1,500	$2,000	$200	$3,700
3.3 Decon Water	12,000	gal		$0.20			$0	$2,400	$0	$0	$2,400
3.4 Decon Water Storage Tank, 6,000 gallon	12	mo				$600.00	$0	$0	$0	$7,200	$7,200
3.5 Clean Water Storage Tank, 4,000 gallon	12	mo				$540.00	$0	$0	$0	$6,480	$6,480
3.6 PPE (4 p * 5 days * 52 weeks)	1,040	day		$30.90			$0	$32,136	$0	$0	$32,136
3.7 Disposal of Decon Waste (liquid & solid)	12	mo	$900.00				$10,800	$0	$0	$0	$10,800
4 IN-SITU TREATMENT											
4.1 Treatability Study	1	ls	$10,000.00				$10,000	$0	$0	$0	$10,000
4.2 Subcontractor's Mobilization & Demobilization	1	ea	$2,750.00				$2,750	$0	$0	$0	$2,750
4.3 Probe/Pump/Injection Subcontractor	1,257	day	$2,500.00				$3,142,500	$0	$0	$0	$3,142,500
injectors	11,000	ea	$250.00				$2,750,000	$0	$0	$0	$2,750,000
4.5 Fentons Reagent Cost	660,000	lb	$0.60				$396,000	$0	$0	$0	$396,000
Subtotal							$6,326,450	$36,036	$128,492	$14,672	$6,505,650
Local Area Adjustments							100.0%	120.5%	88.0%	88.0%	
							$6,326,450	$43,423	$113,073	$12,911	$6,495,858
Overhead on Labor Cost @ 30%									$33,922		$33,922
G & A on Labor Cost @ 10%									$11,307		$11,307
G & A on Material Cost @ 10%								$4,342			$4,342
G & A on Subcontract Cost @ 10%							$632,645				$632,645
Total Direct Cost							$6,959,095	$47,766	$158,302	$12,911	$7,178,074
Indirects on Total Direct Cost @ 30%											$2,153,422
Profit on Total Direct Cost @ 10%											$717,807
Subtotal											$10,049,304
Health & Safety Monitoring @ 2%											$200,986
Total Field Cost											$10,250,290
Contingency on Total Field Costs @ 20%											$2,050,058
Engineering on Total Field Cost @ 10%											$1,025,029
TOTAL CAPITAL COST											**$13,325,377**

NAVAL AIR STATION CECIL FIELD
Jacksonville, Florida
NFF
Alt 4 - In-situ Chem ox (Fentons reagent)
Capital Cost

			Unit Cost				Extended Cost				
Item	Quantity	Unit	Subcontract	Material	Labor	Equipment	Subcontract	Material	Labor	Equipment	Subtotal

NAVAL AIR STATION CECIL FIELD

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Jacksonville, Florida

NFF

Alt 4 - In-situ Chem ox (Fentons reagent)

Annual Cost

Item	Item Cost year 1	Item Cost years 2 and 3	Item Cost years 4 and 5	Item Cost every 5 years	Notes
LUC Inspection and Sampling					Labor, Field Supplies, Local Travel
Analysis/Water(1) (Performance)	$61,488	$30,744			Analyze twelve groundwater sample for TCL VOCs, TCL SVOCs, TRPH, natural attenuation and including blanks and duplicates for years 1
Analysis/Water(1) (Migration)	$23,936	$11,968			Analyze eleven groundwater sample for TCL VOCs, TCL SVOCs, TRPH including blanks and duplicates. Monitor for 5 years.
Report	$32,000	$16,000			Document site inspections, sampling events and results.
Site Review				$7,500	Perform 5-Year review (10% of total cost)
TOTALS	$117,424	$58,712	$0	$7,500	

(1) Sampling frequency will occur quarterly the first year, semi-annual for years 2 & 3, and annually for years 4 & 5.

NAVAL AIR STATION CECIL FIELD

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Jacksonville, Florida

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Alt 4 - In-situ Chem ox (Fentons reagent)

Present Worth Analysis

Year	Capital Cost	Annual Cost	Total Year Cost	Annual Discount Rate at 7%	Present Worth
0	$13,325,377		$13,325,377	1.000	$13,325,377
1		$117,424	$117,424	0.935	$109,791
2		$58,712	$58,712	0.873	$51,256

TOTAL PRESENT WORTH **$13,486,424**

ALTERNATIVE 5 – ORC

NAVAL AIR STATION CECIL FIELD
Jacksonville, Florida
NFF
Alt 5 - In-situ Biological Treatment (ORC)
Capital Cost

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Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
1 PROJECT PLANNING & INSTITUTION CONTROLS											
1.1 Prepare Construction Completion Report	50	hr			$30.00		$0	$0	$1,500	$0	$1,500
2 MOBILIZATION/DEMOBILIZATION											
2.1 Construction Survey	1	ls	$2,400.00				$2,400	$0	$0	$0	$2,400
2.2 Equipment Mobilization/Demobilization	2	ea			$96.00	$396.00	$0	$0	$192	$792	$984
2.3 Field Construction Mgt. (3p * 5 days/week)	52	mwk			$2,400.00		$0	$0	$124,800	$0	$124,800
3 DECONTAMINATION											
3.1 Decontamination Services	12	mo	$1,000.00				$12,000	$0	$0	$0	$12,000
3.2 Temporary Equipment Decon Pad	1	ls		$1,500.00	$2,000.00	$200.00	$0	$1,500	$2,000	$200	$3,700
3.3 Decon Water	12,000	gal		$0.20			$0	$2,400	$0	$0	$2,400
3.4 Decon Water Storage Tank, 6,000 gallon	12	mo				$600.00	$0	$0	$0	$7,200	$7,200
3.5 Clean Water Storage Tank, 4,000 gallon	12	mo				$540.00	$0	$0	$0	$6,480	$6,480
3.6 PPE (4 p * 5 days * 52 weeks)	1,040	day		$30.90			$0	$32,136	$0	$0	$32,136
3.7 Disposal of Decon Waste (liquid & solid)	12	mo	$900.00				$10,800	$0	$0	$0	$10,800
4 IN-SITU BIOLOGICAL TREATMENT											
4.1 Treatability Study	1	ls	$10,000.00				$10,000	$0	$0	$0	$10,000
4.2 Subcontractor's Mobilization & Demobilization	1	ea	$2,750.00				$2,750	$0	$0	$0	$2,750
4.3 Probe/Pump/Injection Subcontractor	1,257	day	$2,000.00				$2,514,000	$0	$0	$0	$2,514,000
4.5 ORC Cost	1,620,490	lb		$8.00			$0	##########	$0	$0	$12,963,920
Subtotal							$2,551,950	##########	$128,492	$14,672	$15,695,070
Local Area Adjustments							100.0%	120.5%	88.0%	88.0%	
							$2,551,950	##########	$113,073	$12,911	$18,342,881
Overhead on Labor Cost @ 30%									$33,922		$33,922
G & A on Labor Cost @ 10%									$11,307		$11,307
G & A on Material Cost @ 10%								$1,566,495			$1,566,495
G & A on Subcontract Cost @ 10%							$255,195				$255,195
Total Direct Cost							$2,807,145	##########	$158,302	$12,911	$20,209,800
Indirects on Total Direct Cost @ 30%											$6,062,940
Profit on Total Direct Cost @ 10%											$2,020,980
Subtotal											$28,293,720
Health & Safety Monitoring @ 2%											$565,874
Total Field Cost											$28,859,595
Contingency on Total Field Costs @ 20%											$5,771,919
Engineering on Total Field Cost @ 10%											$2,885,959
TOTAL CAPITAL COST											**$37,517,473**

NAVAL AIR STATION CECIL FIELD

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NFF

Alt 5 - In-situ Biological Treatment (ORC)

Annual Cost

Item	Item Cost year 1	Item Cost years 2 and 3	Item Cost years 4 and 5	Item Cost every 5 years	Notes
LUC Inspection and Sampling	$44,000	$22,000	$11,000		Labor, Field Supplies, Local Travel
Analysis/Water(1) (Performance)	$61,488	$30,744	$15,372		Analyze twelve groundwater sample for TCL VOCs, TCL SVOCs, TRPH, natural attenuation and including blanks and duplicates for years 1
Analysis/Water(1) (Migration)	$23,936	$11,968	$5,984		Analyze eleven groundwater sample for TCL VOCs, TCL SVOCs, TRPH including blanks and duplicates. Monitor for 5 years.
Report	$32,000	$16,000	$8,000		Document site inspections, sampling events and results.
Site Review				$7,500	Perform 5-Year review (10% of total cost)
TOTALS	$161,424	$80,712	$40,356	$7,500	

(1) Sampling frequency will occur quarterly the first year, semi-annual for years 2 & 3, and annually for years 4 & 5.

NAVAL AIR STATION CECIL FIELD

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Alt 5 - In-situ Biological Treatment (ORC)

Present Worth Analysis

Year	Capital Cost	Annual Cost	Total Year Cost	Annual Discount Rate at 7%	Present Worth
0	$37,517,473		$37,517,473	1.000	$37,517,473
1		$161,424	$161,424	0.935	$150,931
2		$80,712	$80,712	0.873	$70,462
3		$80,712	$80,712	0.816	$65,861
4		$40,356	$40,356	0.763	$30,792
5		$47,856	$47,856	0.713	$34,121
				TOTAL PRESENT WORTH	**$37,869,640**

APPENDIX D

RAP SUMMARY

DEP Form # 62-770.900(4)

Form Title: Remedial Action Plan Summary

Effective Date: September 23, 1997

Remedial Action Plan Summary

Site Name _____ **FDEP Facility ID No.** _____

Location _____ **Current Date** ___/___/___

Media Contaminated: ☐ Groundwater ☐ Soil **Date of Last GW Analysis** ___/___/___

Type(s) of Product(s) Discharged:

☐ Gasoline Analytical Group

☐ Kerosene Analytical Group (Diesel)

- Estimated Petroleum Mass (lbs):
  - Groundwater _____
  - Saturated Zone Soil _____
  - Vadose Zone Soil _____
- Area of Plume _____ (ft^2)
- Thickness of Plume _____ (ft)

Groundwater Recovery and Specifications:

- No. of Recovery Wells _____
  - ☐ Vertical ☐ Horizontal
- Design Flow Rate/Well _____ (gpm)
- Total Flow Rate _____ (gpm)
- Hydraulic Conductivity _____ (ft/day)
- Recovery Well Screen Interval _____ (ft)
- Depth to Groundwater _____ (ft)

Method of Groundwater Remediation:

☐ Pump-and-Treat

- ☐ Air Stripper
  - ☐ Low Profile ☐ Packed Tower
- ☐ Diffused Aerator
- ☐ Activated Carbon
  - ☐ Primary Treatment ☐ Polishing

☐ In Situ Air Sparging

- No. of Sparge Points _____
  - ☐ Vertical ☐ Horizontal
- Pressure _____ (psi)
- Design Air Flow Rate/Well _____ (cfm)
- Total Air Flow Rate _____ (cfm)

☐ Biosparging

- No. of Sparge Points _____
  - ☐ Vertical ☐ Horizontal
- Design Air Flow Rate/Well _____ (cfm)

☐ Bioremediation

- ☐ In Situ ☐ Ex Situ

☐ Other _____

Method of Groundwater Disposal:

☐ Infiltration Gallery ☐ Sanitary Sewer

☐ Surface Discharge/NPDES ☐ Injection Well

☐ Other _____

Free Product Present: ☐ Yes ☐ No

- Estimated Volume _____ (gal)
- Maximum Thickness _____ (in)
- Method of Recovery (check all that apply):
  - ☐ Manual Bailing ☐ Skimming Pump
  - ☐ Other _____

Method of Soil Remediation:

☐ Excavation

Volume to be Excavated _____ (yds^3)

- ☐ Thermal Treatment ☐ Land Farming On Site
- ☐ Landfill ☐ Bioremediation
- ☐ Other _____

☐ Vapor Extraction System (VES)

- No. of Venting Wells _____
  - ☐ Vertical ☐ Horizontal
- VES - Applied Vacuum _____ (wg)
- Design Air Flow Rate _____ (cfm)
- Design Radius of Influence _____ (ft)
- Air Emissions Treatment
  - ☐ Thermal Oxidizer ☐ Catalytic Converter
  - ☐ Carbon ☐ Other _____

☐ Soil Bioventing

- No. of Venting Wells _____
  - ☐ Vertical ☐ Horizontal
- Design Air Flow Rate _____ (cfm)

☐ In Situ Bioremediation

☐ Other _____

Natural Attenuation:

- Method of Evaluation
  - ☐ Rule 62-770.690(1)(e), F.A.C.
  - ☐ Rule 62-770.690(1)(f), F.A.C.

Estimated Time of Cleanup: _____ (days)

- Method of Estimation
  - ☐ Pore Volumes (no. of pore vols. = _____)
  - ☐ Exponential Decay (Decay Rate) ____ (day^{-1})
  - ☐ Groundwater Model
  - ☐ Other _____

Estimated Cost:

- Est. Capital Cost (incl. install.) $ _____
- Est. O & M Cost (per year) $ _____
- Est. Total Cleanup Cost $ _____