CORRECTIVE ACTION PLAN

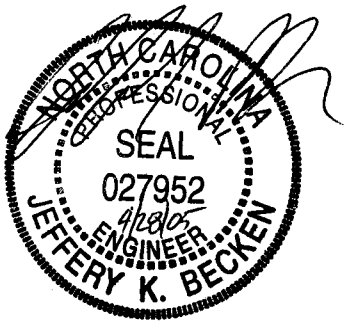
FOR

BUILDING AS-840
MARINE CORPS AIR STATION
NEW RIVER, NORTH CAROLINA

NCDENR INCIDENT NO. PENDING

APRIL 28, 2005

CONTRACT NO. N62470-01-D-3009
DELIVERY ORDER NO. 0122
CATLIN PROJECT NO. 204-045



PREPARED BY:

CATLIN ENGINEERS AND SCIENTISTS
P. O. BOX 10279
WILMINGTON, NORTH CAROLINA 28404-0279
(910) 452-5861

DIVISION OF WATER QUALITY
Certification for the Submittal of a Corrective Action Plan
Under 15A NCAC 2L .0106(c)

Responsible Party: COMMANDING OFFICER, ENVIRONMENTAL AFFAIRS DEPT.
Address: MCAS NEW RIVER, PSC BOX 21001
City: JACKSONVILLE **State:** NC **Zip Code:** 28545-1001

Site Name: BUILDING AS-840
Address: CURTIS ROAD, MCAS NEW RIVER
City: JACKSONVILLE **County:** ONSLOW **Zip Code:** 28545

Groundwater Section Incident Number: PENDING

I, JEFFERY K. BECKEN, a Professional Engineer/Licensed Geologist (circle one) for CATLIN ENGINEERS & SCIENTISTS (firm or company of employment), do hereby certify that the information indicated below is enclosed as part of the required Corrective Action Plan (CAP) and that to the best of my knowledge the data, site assessments, engineering plans and other associated materials are correct and accurate.

Each item must be initialed by hand by the certifying licensed professional.

1. Seperate Cover A listing of the names and addresses of those individuals required to be notified to meet the notification requirements of 15A NCAC 2L .0114(a) is enclosed. Copies of letters and certified mail receipts are also enclosed.

2. ____ A Professional Engineer or Licensed Geologist has prepared, reviewed, and certified all applicable parts of the CAP in accordance with 15A NCAC 2L .0103(e).

3. ____ A site assessment is attached or on file at the appropriate Regional Office which provides the information required by 15A NCAC 2L .0106(g).

4. ____ A description of the proposed corrective action and supporting justification is enclosed.

5. N/A Specific plans and engineering details are enclosed and propose the use of the best available technology for the restoration of groundwater quality to the levels of the groundwater standards prescribed in 15A NCAC 2L .0202.

6. ____ A schedule for the implementation and operation of the CAP is enclosed.

(OVER)

GW-100(c) Rev.7/00

7. _____ A monitoring plan is enclosed which has the capacity to evaluate the effectiveness of the remedial activity and the movement of the contaminant plume, and which meets the requirements of 15A NCAC 2L .0110.

8. _____ The activity which resulted in the contamination incident is not permitted by the State as defined in 15A NCAC 2L .0106(e).

(Please Affix Seal and Signature)

NOTE: Any modifications made to this form may result in the return of your submittal.

NORTH CAROLINA PROFESSIONAL SEAL 027952 ENGINEER JEFFERY K. BECKEN

9/28/05

TABLE OF CONTENTS

		PAGE
LIST OF ACRONYMS		**i**
EXECUTIVE SUMMARY		**iv**
1.0	**INTRODUCTION**	**1**
	1.1 AUTHORIZATION	***1***
	1.2 PURPOSE OF CORRECTIVE ACTION PLAN	***1***
	1.3 SITE INFORMATION SUMMARY	***1***
	1.4 PREVIOUS REPORTS OR PERMITS	***4***
	1.5 SUMMARY OF CORRECTIVE ACTIONS TO DATE	***4***
2.0	**RECEPTOR INFORMATION**	**5**
	2.1 POTENTIAL RECEPTORS AT RISK	***5***
3.0	**OBJECTIVES OF CORRECTIVE ACTION PLAN**	**5**
	3.1 GENERAL DESCRIPTION	***5***
	3.2 GOALS OF CORRECTIVE ACTION PLAN	***6***
4.0	**EVALUATION OF REMEDIATION ALTERNATIVES**	**6**
	4.1 SCREENING OF REMEDIATION ALTERNATIVES	***6***
	4.2 REMEDIATION TECHNOLOGY SELECTION	***9***
5.0	**PROPOSED REMEDIATION**	**10**
6.0	**MONITORING PLAN**	**11**
	6.1 GOALS OF MONITORING PLAN	***11***
	6.2 MONITORING ACTIVITIES AND SCHEDULE	***11***
7.0	**PERMITS**	**12**
8.0	**PUBLIC NOTICE**	**12**
9.0	**REFERENCES**	**13**

TABLES

TABLE 1	**SUMMARY OF MONITORING WELL CONSTRUCTION INFORMATION AND NOVEMBER 2004 GROUNDWATER ELEVATIONS**
TABLE 2	**SUMMARY OF NATURAL ATTENUATION SITE PARAMETERS**
TABLE 3A	**SUMMARY OF GROUNDWATER LABORATORY RESULTS – EPA METHOD 602**
TABLE 3B	**SUMMARY OF GROUNDWATER LABORATORY RESULTS – EPA METHOD 625**
TABLE 4	**SITE REHABILITATION GOALS**
TABLE 5	**TARGET DATES OF CORRECTIVE ACTION PLAN**
TABLE 6	**SCREENING OF APPLICABLE REMEDIAL TECHNOLOGIES**
TABLE 7	**PRELIMINARY REMEDIAL TECHNOLOGY RANKING MATRIX**

FIGURES

FIGURE 1	**GENERAL LOCATION USGS TOPOGRAPHIC MAP**
FIGURE 2	**SOIL BORING, MONITORING WELL, AND POWER PROBE LOCATION MAP**
FIGURE 3	**ESTIMATED EXTENT OF FREE-PHASE PRODUCT AS OF NOVEMBER 23, 2004**
FIGURE 4	**ESTIMATED EXTENT OF SOIL CONTAMINATION AS OF OCTOBER 6, 2003**
FIGURE 5	**ESTIMATED EXTENT OF GROUNDWATER CONTAMINATION AS OF OCTOBER 9, 2003**
FIGURE 6	**SITE MAP WITH UTILITIES AND PROPOSED SOIL EXCAVATION AREA**

APPENDICES

APPENDIX A	**SITE SPECIFIC DATA FROM COMPREHENSIVE SITE ASSESSMENT AND COMPREHENSIVE SITE ASSESSMENT ADDENDUM REPORTS (TABLES AND FIGURES)**
APPENDIX B	**AGGRESSIVE FLUID VAPOR RECOVERY DATA**
APPENDIX C	**SOIL EXCAVATION CALCULATIONS**
APPENDIX D	**GROUNDWATER MODELING RESULTS**
APPENDIX E	**LABORATORY ANALYTICAL REPORTS AND CHAIN OF CUSTODY DOCUMENTATION FOR NATURAL ATTENUATION PARAMETERS**
APPENDIX F	**OXYGEN RELEASING COMPOUND (ORC) PROJECT EVALUATION**

LIST OF ACRONYMS

2000 Guidelines	Groundwater Section Guidelines for Investigation and Remediation of Soil and Groundwater.
2001 Guidelines	Guidelines for Assessment and Corrective Action, North Carolina Underground Storage Tank Section (Effective July 1, 2001)
2L GWQS	NCAC T15A:02L Groundwater Quality Standards
ARO	Asheville Regional Office
AS	Air Sparge
AST	Aboveground Storage Tank
BDL	Below Detection Limit
BN	Base/Neutral (extractables)
BNA	Base/Neutral/Acid (extractables)
BQL	Below Quantitation Limit
BLS	Below Land Surface
BTEX	Benzene, Toluene, Ethylbenzene, Xylenes
CAP	Corrective Action Plan
CATLIN	CATLIN Engineers and Scientists (Formerly RC&A)
CFR	Code of Federal Regulations
Cr	Chromium
CSA	Comprehensive Site Assessment
CNP	Carbon Nitrogen Phosphorous
CPT	Cone Penetrometer Test
DEM	Division of Environmental Management
DIPE	Diisopropyl Ether
DO	Dissolved Oxygen
DOD	Department of Defense
DPT	Direct Push Technology
DWQ	Division of Water Quality
DWM	Division of Waste Management
DTW	Depth to Water
EAD	Environmental Affairs Department
EDB	Ethylene di-bromide
EMD	Environmental Management Division
EPA	Environmental Protection Agency
EPH	Extractable Petroleum Hydrocarbons
EQB	Environmental Quality Branch
Fe	Iron
FID	Flame Ionization Detector
FOD	Foreign Object Debris
FRO	Fayetteville Regional Office
FT	Feet
GCL	Gross Contaminant Level
GIS	Geographic Information System
GPS	Global Positioning System

Guidelines Vol. I	Groundwater Section Guidelines for Investigation and Remediation of Soil and Groundwater, Volume I, Sources Other Than Petroleum Underground Storage Tanks (May 1998)
Guidelines Vol. II	Groundwater Section Guidelines for Investigation and Remediation of Soil and Groundwater, Volume II, Petroleum Underground Storage Tanks (January 2, 1998)
HDPE	High Density Polyethylene
I/C	Industrial/Commercial
ID	Identification
I&E	Installations and Environment Department
IGWQS	Interim Groundwater Quality Standards
IPE	Isopropyl Ether
LSA	Limited Site Assessment
LUST	Leaking Underground Storage Tank
m-	meta
m	meter
MADEP	Massachusetts Department of Environmental Protection
MCALF	Marine Corps Auxiliary Landing Field
MCAS	Marine Corps Air Station
MCB	Marine Corps Base
MCOLF	Marine Corps Outlying Landing Field
MDL	Method Detection Limit
mg/Kg	Milligrams per Kilogram
mg/L	Milligrams per Litre
MRO	Mooresville Regional Office
MSCC	Maximum Soil Contaminant Concentration
MSL	Mean Sea Level
MTBE	Methyl tertiary butyl ether
µg/Kg	Micrograms per Kilogram
µg/L	Micrograms per Litre
NA	Not Analyzed
N/A	Not Applicable
NAVFAC Atlantic	Naval Facilities Atlantic Division
NC	North Carolina
NCAC	North Carolina Administrative Code
NCDENR	North Carolina Department of Environment and Natural Resources
NCDOC	North Carolina Department of Corrections
NCDOT	North Carolina Department of Transportation
NCSP	North Carolina State Plane
NCSPA	North Carolina State Ports Authority
NE	None Established
NM	Not Measured
NMT	No Measurable Thickness
NS	Not Sampled
o-	ortho
OVA	Organic Vapor Analyzer
p-	para
PAH	Polynuclear Aromatic Hydrocarbons
Pb	Lead
PPB	Parts Per Billion

PPM	Parts Per Million
PID	Photo Ionization Detector
PQL	Practical Quantitation Limit
PVC	Polyvinyl chloride
RBCA	Risk-Based Corrective Action
RCRA	Resource Conservation and Recovery Act
Res	Residential
ROI	Radius of Influence
RRO	Raleigh Regional Office
SOW	Scope of Work
STGW	Soil-to-Groundwater
SVE	Soil Vapor Extraction
SVOC	Semi Volatile Organic Compound
TDHF	Toxicologically Defined Hydrocarbons Fractions
TCLP	Toxicity Characteristic Leaching Procedure
TIC	Tentatively Identified Compound
TKN	Total Kjeldahl Nitrogen
TOC	Top of Casing
TPH	Total Petroleum Hydrocarbons
US	United States
USCS	Unified Soil Classification System
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
UST	Underground Storage Tank
VOC	Volatile Organic Compounds
VPH	Volatile Petroleum Hydrocarbons
WaRO	Washington Regional Office
WiRO	Wilmington Regional Office
WSRO	Winston-Salem Regional Office

CORRECTIVE ACTION PLAN

FOR

BUILDING AS-840
MARINE CORPS AIR STATION
NEW RIVER, NORTH CAROLINA

APRIL 28, 2005

EXECUTIVE SUMMARY

The Building AS-840 project site is located on the Marine Corps Air Station (MCAS) New River, North Carolina. The project area is in the vicinity of Building AS-840 and the Building AS-840 Radar Tower Area (Building SAS-839). An existing 2,900-gallon capacity aboveground storage tank (AST) located south of Building AS-840 supplies diesel fuel to a boiler system located within the building. An underground pipeline is utilized to transfer fuel from the AST to the boiler system.

In the spring of 2000, Building AS-840 personnel reported observing petroleum sheen in water puddles on the ground surface following periods of heavy rain. Subsequently, J.A. Jones Environmental Services (J.A. Jones) investigated the integrity of the fuel transfer system by excavation and confirmed a leak in the pipeline in April 2000. Consequently, the leaking pipeline was replaced with a new, self-contained, double-walled fuel distribution line.

Following initial assessment activities, LAW Engineering and Environmental Services, Inc. (LAW) was retained to complete a Comprehensive Site Assessment (CSA). The findings of this investigation were summarized in a report dated August 14, 2002. CATLIN Engineers and Scientists (CATLIN) subsequently completed a Comprehensive Site Assessment Addendum (CSAA) report dated January 6, 2004 to summarize additional site information. A review of previous reports indicates the presence of soil contamination, free-phase product and dissolved-phase groundwater contamination in excess of applicable state action levels.

Based on the information presented within this report, CATLIN is proposing soil excavation with accelerated natural attenuation for the soil and groundwater contamination on site. The goals of this Corrective Action Plan (CAP) are to: 1) remediate soil contaminant concentrations to below Soil-to-Groundwater (STGW) Maximum Soil Contaminant Concentrations (MSCCs) by excavation; 2) remediate free-phase product to a thickness of less than 1/8 inch by excavation; 3) remediate groundwater contaminant concentrations to below 2L GWQS by accelerated natural attenuation; and 4) detail a monitoring plan with the capacity to evaluate the effectiveness of natural attenuation of contamination at this site and to monitor movement of the contaminant plume.

CORRECTIVE ACTION PLAN

FOR

BUILDING AS-840
MARINE CORPS AIR STATION
NEW RIVER, NORTH CAROLINA

APRIL 28, 2005

1.0 INTRODUCTION

1.1 AUTHORIZATION

CATLIN was authorized to prepare this CAP by the Naval Facilities Atlantic Division (NAVFAC Atlantic) in accordance with Order for Supplies and Services Contract No. N62470-01-D-3009, Delivery Order Number 0122 dated August 26, 2004.

This CAP was authorized based on the findings and recommendations of a CSA performed by LAW, dated August 14, 2002 and a CSAA performed by CATLIN, dated January 6, 2004.

1.2 PURPOSE OF CORRECTIVE ACTION PLAN

This CAP evaluates various remedial approaches to address the presence of free-phase product, soil contamination and groundwater contamination at the Building AS-840 project site aboard the MCAS, New River, North Carolina as documented herein and in previous reports. This CAP provides conceptual plans for corrective actions in accordance with Title 15A North Carolina Administrative Code (NCAC) Subchapter 2L Section .0106, and Aquifer Protection Section (formerly Groundwater Section) Guidelines for the Investigation and Remediation of Soil and Groundwater, dated July 2000.

1.3 SITE INFORMATION SUMMARY

The site information discussed within is based on a site reconnaissance and site specific data presented within the CSA and CSAA. Pertinent data is summarized in the following sections.

1.3.1 Location

The site is located aboard the MCAS, New River, North Carolina. Refer to Figures 1 and 2 for the general site location map and site layout, respectively.

The project area is in the vicinity of Building AS-840 and the Building AS-840 Radar Tower Area (Building SAS-839). Specifically, the site is in the vicinity

of the former underground piping associated with an existing 2,900-gallon capacity non-regulated, non-commercial diesel fuel AST located south of Building AS-840 (See Figure 2). This former pipeline transferred fuel from the AST to a boiler system located within Building AS-840.

1.3.2 Source and Type of Contamination

Site reconnaissance and research conducted as part of the CSA Report by LAW revealed that personnel from the radar facility observed a petroleum sheen in water puddles on the ground surface during periods of heavy rain. Subsequently, J.A. Jones investigated the integrity of the former piping by excavating and exposing the piping. A leak was observed within the piping during this investigation in April 2000. It is believed that the petroleum contamination observed at the Building AS-840 project site is from this leak. Please note that a new, self-contained, double-walled fuel distribution line has replaced the leaking pipeline.

1.3.3 Soil Contamination

Soil samples collected during CSA and CSAA activities were analyzed for selected volatile organic compounds, semi-volatile organic compounds, and hydrocarbon fractions per EPA Methods 8260, 8270, and MADEP VPH/EPH. Resulting laboratory analysis revealed concentrations of 2-methylnaphthalene, naphthalene, and aromatic fraction C_9-C_{22} Aromatics in excess of NCDENR STGW MSCCs at a portion of the locations sampled.

Refer to Figure 4 for the estimated extent of soil contamination that was utilized in the development of this CAP. This estimated extent is based on CATLIN's interpretation of the reported laboratory analysis with concentrations above the STGW MSCCs as presented in Appendix A.

1.3.4 Groundwater Contamination

Groundwater samples collected during the CSA and CSAA activities were analyzed for selected volatile organic compounds, semi-volatile organic compounds, and hydrocarbon fractions per EPA Methods 602, 625 and MADEP VPH/EPH. Resulting laboratory analysis revealed concentrations of benzene, ethylbenzene, naphthalene, C_5-C_8 Aliphatics and C_9-C_{22} Aromatics in excess of the North Carolina Administrative Code (NCAC) Title 15A, Subchapter 2L Groundwater Quality Standards (2L GWQS).

CATLIN conducted an additional sampling event on November 18, 2004 in order to evaluate natural attenuation parameters at the AS-840 project site. As part of this evaluation, additional groundwater samples were collected from selected monitoring wells and analyzed for volatile organic compounds and semi-volatile organic compounds per EPA Methods 602 and 625.

Resulting laboratory analysis revealed a concentration of benzene in excess of the 2L GWQS.

Refer to Tables 3A and 3B for the November 2004 groundwater laboratory results. Figure 5 illustrates CATLIN's interpretation of the estimated extent of groundwater contamination that was utilized in the development of this CAP. This estimated extent is based on CATLIN's interpretation of the reported laboratory results with concentrations in exceedance of the 2L GWQS as presented in Appendix A.

1.3.5 Groundwater Information

Classification

The groundwater aquifer is classified as GA groundwaters according to NCAC Title 2L Subchapter 15A, Section .0201 Groundwater Classification.

Groundwater Elevation

On June 22, 2001, gauging data collected as part of CSA investigations revealed groundwater elevations at the Building AS-840 project site ranging from 7.34 to 8.05 feet above Mean Sea Level (MSL). Refer to Appendix A for a summary of this data.

On October 23, 2003, gauging data collected as part of CSAA investigations revealed groundwater elevations ranging from 8.41 to 9.50 feet above MSL.

The most recent gauging data from an event conducted on November 23, 2004 revealed groundwater elevations ranging from 6.00 to 6.67 feet above MSL. Refer to Table 1 for a summary of the gauging data from this event.

Direction of Flow

Local groundwater, as determined from the water level measurements, has historically exhibited a general flow pattern towards the northeast, which is towards the New River. Hydraulic head differences between shallow and deep monitoring wells indicated a slight upward component of groundwater flow within the surficial aquifer.

Aquifer Characteristics

Based on in-situ hydraulic conductivity tests conducted at four monitoring wells, grain size distribution tests, and groundwater flow maps completed as part of the CSA; LAW estimated the hydraulic parameters for the surficial aquifer. The following summarizes these estimations:

Average Hydraulic Conductivity (K) = 30 feet/day

Effective Porosity = 0.40
Hydraulic Gradient = 0.0047
Groundwater Flow Velocity = 0.353 feet/day

1.3.6 Free-Phase Product Contamination

Free-phase product has been observed at the Building AS-840 project site as early as April 2000 during the performance of the initial site assessment activities. LAW initially determined the estimated extent of free-phase product as part of the CSA activities. Free-phase product has historically been observed in monitoring well MW-02. The most recent gauging event, summarized in Table 1 and illustrated on Figure 3 of this report revealed a free-phase product thickness of 0.41 feet in MW-02 on November 23, 2004.

Please note that a number of Aggressive Fluid Vapor Recovery (AFVR) events have been periodically conducted on MW-02 between July 2001 and November 17, 2004. For additional information on these AFVR events, please refer to Section 1.5 of this report.

1.4 PREVIOUS REPORTS OR PERMITS

1. LAW Engineering and Environmental Services, Inc., *Comprehensive Site Assessment Report, Aboveground Storage Tank Fuel Distribution Line Release, Building AS-840, Aircraft Hangar Facility, Marine Corps Air Station New River, North Carolina*, August 14, 2002.

2. CATLIN Engineers and Scientists, *Comprehensive Site Assessment Addendum for Building AS-840, Aircraft Hangar Facility, Aboveground Storage Tank Distribution Fuel Line Release, Marine Corps Air Station New River, North Carolina*, January 6, 2004.

1.5 SUMMARY OF CORRECTIVE ACTIONS TO DATE

According to the CSA, OHM/IT Remediation Services Corporation, now known as Shaw Environmental, Inc. (Shaw), was contracted to periodically recover free-phase product at the project site by use of AFVR events. Shaw has reportedly completed 58 AFVR events at the project site from July 2001 through November 17, 2004. During this time, Shaw has reported the recovery of 598.6 gallons of free-phase product as vapor and liquid.

Refer to Appendix B for the available AFVR data for the AS-840 project site.

2.0 RECEPTOR INFORMATION

2.1 POTENTIAL RECEPTORS AT RISK

LAW conducted a receptor survey as part of the CSA and identified the following potential receptors within 1,500 feet of the project site:

- Underground utilities were found to exist within the area of concern. These utilities included underground electrical, water, and fuel distribution lines, as well as an unknown utility line.

- The closest surface water body to the source area as shown on Figure 1 is the New River, approximately 1,300 feet to the east of the project site.

- As stated in the CSA, the State of North Carolina had not designated wellhead protection areas that include the MCAS New River. However, the source area is not located within a designated wellhead protection area based on information presented within the Wellhead Protection Plan – 2002 Update by AH Environmental Consultants. The nearest water supply well appears to be PSWA-4150, located approximately 7,000 feet west of the Building AS-840 source area.

Based on information provided by the MCB Camp Lejeune, these potential receptors have not been reported to be impacted by the potentially contaminated soils and/or groundwater.

3.0 OBJECTIVES OF CORRECTIVE ACTION PLAN

3.1 GENERAL DESCRIPTION

The objectives of this CAP are to present a proposed remedial method to address the presence of free-phase product, soil contamination and dissolved-phase groundwater contamination at the Building AS-840 project site. Refer to Table 4 of this report for the site rehabilitation goals and a summary of current maximum contaminant concentrations (or most recent results).

3.1.1 Soil Contamination

One of the remedial objectives presented within this CAP is to describe proposed mechanisms by which contaminated soils above the applicable STGW MSCCs can be removed in order to satisfy the requirements of the NCAC Title 15A, Subchapter 2L, paragraph .0106.

3.1.2 Free-Phase Product

An additional objective of this CAP is to describe proposed mechanisms by which free-phase product can be removed from the subsurface at the subject site.

3.1.3 Groundwater Contamination

Additionally, the CAP will present remedial objectives for addressing dissolved-phase groundwater contamination at the Building AS-840 project site. Based on a review of the historical laboratory data, there appear to be five contaminant concentrations detected in groundwater samples collected from temporary piezometers PZ-02, PZ-03 and permanent monitoring well MW-07 in excess of the 2L GWQS.

3.2 GOALS OF CORRECTIVE ACTION PLAN

The goals of this CAP are:

- Removal of free-phase product from the site sub-surface to meet the site rehabilitation goals. Specifically, the goal of remediation is to reduce the presence of free-phase product in all wells to a thickness of less than 1/8 of an inch or to no measurable thickness.

- Remediate the soil to the site rehabilitation goals. Specifically, the goal of remediation is to reduce vadose zone soil contaminant concentrations to below their respective STGW MSCCs.

- Remediate the groundwater to the site rehabilitation goals. Specifically, the goal of remediation is to reduce groundwater contaminant concentrations to below their respective 2L GWQS.

- Provide a schedule for the implementation and operation of the proposed corrective actions.

- Detail a monitoring plan with the capacity to evaluate the effectiveness of the proposed corrective actions at this site and to monitor movement of the contaminant plume.

4.0 EVALUATION OF REMEDIATION ALTERNATIVES

4.1 SCREENING OF REMEDIATION ALTERNATIVES

Numerous technologies that address the remediation of petrochemically contaminated soil and groundwater are available. Some of the technologies have demonstrated an acceptable level of success when implemented in the field, while others appear to have been ineffective. In certain instances, implementation of any available remediation

technology by itself will not suffice. Hence, a combination of treatment technologies is at times more effective. Site specific conditions, nature and extent of contamination together with an analysis of a particular remediation technology's record of success with similar sites, allows the screening of technically feasible alternative technologies. The "best" remedial strategy is the one that can fulfill the established remediation objectives at the least cost.

Table 6 summarizes a screening of remediation technologies that are currently in common use.

Table 7 has been prepared to rank the technologies shown as applicable in Table 6 in order to select the most appropriate technology or combination of technologies for the Building AS-840 project site.

Based on our experience, screening costs within Table 6, the technology ranking within Table 7 and the site specific conditions discussed in Sections 1 and 2 of this report, CATLIN evaluated in detail three remedial technologies for meeting the goals of this CAP. Those technologies included excavation, enhanced natural attenuation by use of Oxygen Release Compound (ORC®) and natural attenuation. The following sections are a brief summary of CATLIN's screening/evaluation of these technologies:

4.1.1 Excavation

One remedial alternative considered in the preparation of this CAP was to remediate soil contamination and the presence of free-phase product by excavation. Based on the relatively small estimated horizontal extent of free-phase product and soil contamination illustrated on Figures 3 and 4 respectively, remediation by excavation is a feasible option.

Excavation of contaminated soils will include excavating and disposing of approximately 295 cubic yards of soil, refer to Appendix C for soil excavation volume calculations. The soils should be excavated to a depth of approximately two (2) feet below the water table and should include the estimated free-phase product plume illustrated on Figure 3. The excavation quantity is estimated and is based on interpretation between data points and may require adjustments during excavation activities.

Soil sampling is to be performed during excavation to confirm removal of soil to a concentration below the applicable STGW MSCCs.

4.1.2 Enhanced Natural Attenuation by use of Oxygen Release Compound®

CATLIN contacted Regenesis, the manufacturer of the ORC® product, to assist with the evaluation of the use of ORC® to enhance natural attenuation of the groundwater only. Please note that ORC® is not a viable approach for the remediation of free-phase product or soil contamination. Regenesis utilized site-specific conditions to evaluate the use of ORC®. Additionally,

CATLIN collected field and laboratory geochemical parameters (Natural Attenuation Site Parameters) on November 23, 2004 in order to assist with the evaluation of ORC®. A summary of the geochemical laboratory data is provided in Table 2 and the laboratory report is included in Appendix E. Regenesis provided CATLIN with a proposal that detailed the recommended approach for the use of ORC® along with the cost for their approach. A copy of this proposal is within the attached Appendix F.

Based on our evaluation of the information provided by Regenesis, it appears that ORC® is a viable remedial approach for meeting the remedial objectives for groundwater upon removal of the free-phase product and/or soil contamination. Additionally, the use of ORC® to enhance natural attenuation of the groundwater plume appears to be a cost-beneficial remedial approach based on a comparison of the estimated life cycle costs for enhanced versus non-enhanced natural attenuation as presented in Appendix F. Please note that the life cycle costs are based on an estimated remedial time frame and reducing the time of natural attenuation in half which would result in completion of the Enhanced Natural Attenuation activities within 5 years.

4.1.3 Natural Attenuation

Suitability Study

Preliminary field activities associated with the preparation of this report included sampling for groundwater geochemical parameters at the Building AS-840 project site. On November 23, 2004, CATLIN personnel collected groundwater samples from three selected monitoring wells (MW-01, MW-04, MW-07) utilizing low-flow sampling techniques. Please note that MW-04 and MW-07 have historically shown detectable concentrations of the targeted contaminants of concern. MW-07 represents a "hot spot" as groundwater samples have been shown to contain contaminants in excess of the 2L GWQS. MW-04 represents "fringe" conditions. Please also note that MW-01 is located geographically up gradient of the contaminant plume and was selected for sampling to represent "background" conditions. Samples were analyzed for field and laboratory geochemical parameters summarized in Table 2 of this report. Laboratory analytical reports and chain-of-custody documentation are presented in Appendix E. This data, in addition to historical contaminant concentrations does indicate that the site is naturally attenuating.

Contaminant Travel

Groundwater travel time or average linear groundwater velocity serves as the basis for estimating the rate of contaminant migration at the site. Groundwater velocity rates should represent the maximum rate of contaminant migration with variations among contaminants due to geohydrochemical processes including molecular diffusion, mechanical mixing, sorption-desorption, ion-exchange, hydrolysis, and biodegradation. However,

due to the difficulties in estimating the effects of many of the processes on contaminant migration rates and the desire to produce relatively conservative (higher) estimates, the geohydrochemical processes are not incorporated into rate calculations.

According to the CSA, estimates of hydraulic conductivity were determined from in-situ recovery tests conducted at the site. The hydraulic gradient was calculated based on the groundwater table elevations from well MW-02 to MW-03.

For estimation of groundwater velocity, an average K value of 30 feet per day was used. Calculation of the maximum groundwater velocity was determined to be 0.353 feet per day to the northeast.

The average velocity of the petroleum contaminant constituents was then calculated. Using benzene, contaminant velocity was found to be 0.115 feet per day to the northeast. Refer to Appendix D for contaminant velocity calculations.

Based on our evaluation, it appears that natural attenuation is a viable approach for meeting the groundwater remedial goals. However, natural attenuation will likely take approximately 10 years to meet the remedial goals.

4.2 REMEDIATION TECHNOLOGY SELECTION

Based upon the remedial technology screening process in Section 4.1, it appears that a combination of remedial technologies is the best approach for this project site. CATLIN recommends that the combination of the following remediation technologies be implemented at the subject site:

- Soil excavation for the remediation of the contaminated soils. The excavation will be of sufficient size to eliminate or greatly reduce the extent of the free-phase product plume.

- Application of an Oxygen Releasing Compound (ORC®) prior to backfill of the excavation area to promote accelerated natural attenuation of dissolved-phase groundwater contamination.

- Natural attenuation of the outer limits of the dissolved-phase groundwater contamination plume.

This recommendation is based on the following observations:

- All free-phase product will be removed as part of the excavation activities.

- Soil excavation is a cost-effective option for remediation of the small volume of contaminated soils on site.

- Excavation of contaminated soils would include excavation of any free-phase product still present at the site.

- Excavation of contaminated soils would eliminate the source of any further groundwater contamination.

- No active water supply wells have been located within a 1,500-foot radius of the site.

- The project site is located in a large area owned by the United States Marine Corps and the migration of the petroleum hydrocarbon contaminant plume onto adjacent properties is not anticipated.

- Natural attenuation studies have been performed at numerous sites with similar subsurface characteristics that indicate favorable conditions for natural processes of contaminant attenuation/degradation.

- Migration of the dissolved-phase contaminant plume is not expected to impact nearby surface waters.

5.0 PROPOSED REMEDIATION

As discussed above, a combination of the use of excavation, application of ORC® and natural attenuation is the recommended remedial approach for this site. The schedule for remediation and related activities are illustrated in Table 5. The schedule is preliminary and may be revised based on the approval of this plan by NCDENR.

The excavation activities should be implemented within one year of CAP approval. AFVR events should continue to be implemented on a monthly basis until excavation activities are implemented. In the event that free-phase product is observed within the excavation, then AFVR technology should be utilized to remove any free-phase product prior to backfilling. Monitoring well MW-02 will likely need to be removed prior to excavation. If this occurs, then the monitoring well should be properly abandoned then replaced upon completion of backfill activities.

The ORC® application should be implemented prior to backfill of the excavation.

Natural attenuation monitoring will be conducted as indicated in Section 6.0 of this report.

6.0 MONITORING PLAN

6.1 GOALS OF MONITORING PLAN

The goals of the monitoring plan are to track the plume migration and the attenuation/degradation of the contaminants.

6.2 MONITORING ACTIVITIES AND SCHEDULE

6.2.1 Proposed Monitoring Activities

The following monitoring activities are proposed upon completion of excavation activities:

- Gauging of all monitoring wells will be performed in order to confirm the presence or absence of free-phase product, as well as confirm the direction and rate of groundwater and contaminant flow.

- Sampling of selected monitoring wells for groundwater analysis per EPA Methods 602 and 625 parameters and MADEP EPH/VPH parameters will be performed to confirm contamination degradation and attenuation.

6.2.2 Proposed Monitoring Schedule

The monitoring activities are proposed after the soil excavation activities, and then on a quarterly basis for one year and then semi-annually thereafter until remediation objectives illustrated in Table 4 are met. With State approval, this monitoring schedule should be revised as necessary when groundwater samples from select wells have been historically below 2L GWQS for a period of one year. The monitoring schedule should be evaluated annually.

Groundwater samples will be collected and analyzed per EPA Methods 602 (volatiles) and 625 (semi-volatiles) and MADEP EPH/VPH. The continual need for the analysis of the parameters should be evaluated as part of the Annual Monitoring Report.

Termination of monitoring and site closeout will be requested when all contaminated soil has been removed and petroleum-related constituents dissolved in groundwater are below 2L GWQS and have remained so for at least one year.

6.2.3 Reporting

Preparation of a monitoring report for submission to the NCDENR is proposed once annually to summarize monitoring activities.

7.0 PERMITS

No permits are required.

8.0 PUBLIC NOTICE

In accordance with NCAC T15A:02L .0114, public notification is required by any person submitting a Corrective Action Plan under T15A:02L .106(l). The following parties are required to be notified:

- The local health director
- The chief administrative officer of each political jurisdiction in which the contamination occurs

Copies of public notification letters and certified mail receipts will be submitted under separate cover.

9.0 REFERENCES

Bedavary, S., Editor; 1989, The Merck Index, Merck & Co., Inc., Rahway, New Jersey.

CATLIN Engineers and Scientists, January 6, 2004, *Comprehensive Site Assessment Addendum for Building AS-840, Aircraft Hangar Facility, Aboveground Storage Tank Distribution Fuel Line Release, Marine Corps Air Station New River, North Carolina*.

Code of Federal Regulation 29, Part 1910, Revised as of July 1990, Office of the Federal Register National Archives and Records Administration.

Committee on In-Situ Bioremediation, Water Science and Technology Board, Commission on Engineering Technical Systems, National Research Council; 1993. "In Situ Bioremediation, When Does It Work?" National Academy Press, Washington, D.C.

LAW Engineering and Environmental Services, August 14, 2002, *Comprehensive Site Assessment Report, Aboveground Storage Tank Fuel Distribution Line Release, Building AS-840, Aircraft Hangar Facility, Marine Corps Air Station New River, North Carolina*.

Lewis, J.R., Sr.; 1994, Hazardous Chemicals in the Workplace, Van Nostrand Reinhold, N.Y.

Madsen, E.; 1991, "In Situ Biodegradation", Environmental Science and Technology, Vol. 25, No. 10.

McAllister, P.M., and Chang, C.Y.; 1994. "A Practical Approach to Evaluating Natural Attenuation of Contaminants in Ground Water." Ground Water Monitoring Review, Spring Issue, pp. 161-173.

New Jersey Department of Health; 1988, Hazardous Substance Fact Sheets.

Tchobanoglous, G.; Schroeder, E.D.; 1985, "Water Quality", Addison-Wesley Publishing Company, Reading, Massachusetts.

United States Environmental Protection Agency; 1994, "How to Evaluate Alternative Cleanup Technologies For Underground Storage Tank Sites. A guide For Corrective Action Plan Reviewers", Solid Waste and Energy Response 5403W, EPA 510-B-94-003.

Wiedemier, T.T.; Downey, D.C.; Wilson, J.T.; Kampbell, D.H.; Miller, R.N. and Hansen, J.E.; 1994. "Technical Protocol for Implementing the Intrinsic Remediation with Long-Term Monitoring Option for Natural Attenuation of Dissolved-Phase Fuel Contamination in Ground Water." Prepared for Air Force Center for Environmental Excellence, Brooks Air Force Base, San Antonio, Texas.

TABLES

TABLE 1

SUMMARY OF MONITORING WELL CONSTRUCTION INFORMATION AND NOVEMBER 2004 GROUNDWATER ELEVATIONS

CORRECTIVE ACTION PLAN
BUILDING AS-840
MARINE CORPS AIR STATION
NEW RIVER, NORTH CAROLINA

WELL ID	DATE INSTALLED (mm/dd/yy)	DATE WATER LEVEL MEASURED (mm/dd/yy)	WELL CASING DEPTH (ft. BLS)	SCREENED INTERVAL (ft. BLS)	BOTTOM OF WELL (ft. BLS)	GROUND SURFACE ELEVATION (ft.)	TOP OF CASING ELEVATION (ft.)	DEPTH TO WATER FROM TOP OF CASING (ft.)	FREE PRODUCT THICKNESS (ft.)	GROUNDWATER ELEVATION* (ft.)	COMMENTS
MW-01	6/19/2001	11/23/2004	3.0	3.0 - 18.0	18.0	14.08	13.70	7.03	0.00	6.67	
MW-02	6/19/2001	11/23/2004	3.0	3.0 - 18.0	18.0	14.15	13.83	7.76	0.41	6.42	Diesel Fuel**
MW-03	6/20/2001	11/23/2004	22.0	22.0 - 27.0	27.0	14.34	13.97	7.68	0.00	6.29	Sorbent in well
MW-04	6/20/2001	11/23/2004	3.0	3.0 - 18.0	18.0	15.33	14.70	8.29	0.00	6.41	
MW-05	6/20/2001	11/23/2004	3.0	3.0 - 18.0	18.0	15.03	14.20	8.07	0.00	6.13	
MW-06	6/20/2001	11/23/2004	3.0	3.0 - 18.0	18.0	14.36	13.84	7.50	0.00	6.34	
MW-07	10/6/2003	11/23/2004	4.0	4.0 - 14.0	14.0	15.40	14.88	8.53	0.00	6.35	
MW-08	10/6/2003	11/23/2004	4.0	4.0 - 14.0	14.0	15.38	14.94	8.94	0.00	6.00	

* Reference Point for Elevation Measurements: MCAS Geodetic Monuments Heinz and Flyboy.

** Groundwater Elevation calculated using Specific Gravity Adjustment for Diesel Fuel (0.86); Elev. = (Top of Casing - Depth to Water) + (Free Product Thickness * 0.86)

ft. BLS = Feet Below Land Surface

Shading indicates a measurable thickness of free-phase product.

TABLE 2

SUMMARY OF NATURAL ATTENUATION SITE PARAMETERS

CORRECTIVE ACTION PLAN
BUILDING AS-840
MARINE CORPS AIR STATION
NEW RIVER, NORTH CAROLINA

PARAMETER	METHOD NUMBER	ASTAS840-MW01 +	ASTAS840-MW04 ++	ASTAS840-MW07 +++
pH, Standard Units	Field Measurement	4.87	4.98	5.74
Conductivity, ms/cm	Field Measurement	0.067	0.087	0.135
Temperature, °C	Field Measurement	17.00	17.43	17.30
Redox Potential, mv	Field Measurement	358.1	321.4	4.2
Dissolved Oxygen, DO mg/L	Field Measurement	1.41	0.83	0.55
Calcium, Ca mg/L	6010B	2.27	0.858	13.8
Iron, Fe mg/L	6010B	1.37	7.73	3.14
Manganese, Mn mg/L	6010B	<0.0100	<0.0100	<0.0100
Calcium Hardness, as $CaCO_3$ mg/L	6010B	12.8	8.62	45.3
Total Organic Carbon, TOC mg/L	415.1	4.3	4.6	2.2
Total Plate Count, colonies	9215B	795	200 est*	300
Phosphorus, as P mg/L	365.2	0.05	0.10	0.04
Nitrate Nitrogen, NO_3-N mg/L	353.3	0.025	<0.025	0.04
Sulfate, SO_4 mg/L	375.4	10	11	17
Alkalinity, as $CaCO_3$ mg/L	310.1	<2.0	<2.0	<2.0

NOTE: + Background
++ Fringe
+++ Hot Spot
*est = Estimated Value
mg/L = Milligrams Per Liter
TOC = Total Organic Carbon
Refer to Appendix E for Laboratory Reports and Chain-of-Custody Documentation

TABLE 3A SUMMARY OF GROUNDWATER LABORATORY RESULTS

Date: November 2004 Incident Number and Name: Pending - AS-840 Facility ID#: N/A

Analytical Method: EPA Method 602

Well ID	Contaminant of Concern →		Benzene	Ethylbenzene	All Other Analytes
	Sample ID	Date Collected			
2L GWQS (µg/L)			1	29	Varies
ASTAS840-MW01	MW-01	11/23/2004	<1.00	<1.00	BQL
ASTAS840-MW01 DUP	MW-01 DUP	11/23/2004	<1.00	<1.00	BQL
ASTAS840-MW04	MW-04	11/23/2004	<1.00	<1.00	BQL
ASTAS840-MW07	MW-07	11/23/2004	1.99	1.39	BQL

All results in µg/L

BQL = Below Quantitation Limit

Shading indicates concentration in excess of NCAC 2L GWQS.

TABLE 3B SUMMARY OF GROUNDWATER LABORATORY RESULTS

Date: November 2004 Incident Number and Name: Pending - AS-840 Facility ID#: N/A

Analytical Method: EPA Method 625

Well ID	Contaminant of Concern →		All Analytes
	Sample ID	Date Collected	
2L GWQS (µg/L)			Varies
ASTAS840-MW01	MW-01	11/23/2004	BQL
ASTAS840-MW04	MW-04	11/23/2004	BQL
ASTAS840-MW07	MW-07	11/23/2004	BQL

All results in µg/L

BQL = Below Quantitation Limit

Shading indicates concentration in excess of NCAC 2L GWQS.

TABLE 4

SITE REHABILITATION GOALS

CORRECTIVE ACTION PLAN
BUILDING AS-840
MARINE CORPS AIR STATION
NEW RIVER, NORTH CAROLINA

MEDIUM	COMPONENT	CURRENT MAXIMUM CONCENTRATIONS	TARGET CLEANUP	
Free-Phase Product	Diesel	0.41 Feet	< 1/8"	
Vadose Zone Soil [1]			*STGW*	*Residential*
	Benzene	< 0.0072	0.0056	22
	Naphthalene	2.2	0.58	63
	2-Methylnaphthalene	10.0	3	63
	C_9-C_{22} Aromatics	134	34	469
Groundwater			*2L GWQS*	
	Benzene	140	1	
	Ethylbenzene	130	29	
	Naphthalene	300	21	
	C_5-C_8 Aliphatics	800	420	
	C_9-C_{22} Aromatics	< 3,100*	210	

* Result equals the sum of the C_{11}-C_{22} fraction result (3,000 µg/L) and the C_9-C_{10} fraction quantitation limit (< 100 µg/L).

STGW = North Carolina Soil-to-Groundwater Maximum Soil Contaminant Concentrations

Residential = North Carolina Residential Maximum Soil Contaminant Concentrations

2L GWQS = North Carolina 2L Groundwater Quality Standards

All Vadose Zone Soil results in milligrams per kilogram (mg/Kg)

All Groundwater results in micrograms per liter (µg/L)

1 - Please note that laboratory results of soil samples collected from within the apparent seasonal high water table zone have not been considered representative of subsurface vadose zone soil contamination.

TABLE 5

TARGET DATES OF CORRECTIVE ACTION PLAN

CORRECTIVE ACTION PLAN
BUILDING AS-840
MARINE CORPS AIR STATION
NEW RIVER, NORTH CAROLINA

ITEM	DATE*
Submittal of Necessary Permit Applications	WITHIN ONE YEAR OF CAP APPROVAL
Soil Excavation and Enhanced Natural Attenuation by use of ORC	WITHIN ONE YEAR OF CAP APPROVAL
Commencement of Monitoring Activities	WITHIN 3 MONTHS OF COMPLETION OF EXCAVATION
Achievement of Cleanup Goals	WITHIN 5 YEAR OF COMPLETION OF EXCAVATION
Project Completion Date	WITHIN 1 YEAR OF ACHIEVING CLEAN-UP GOALS

* All dates are estimated

TABLE 6

SCREENING OF APPLICABLE REMEDIAL TECHNOLOGIES

CORRECTIVE ACTION PLAN
BUILDING AS-840
MARINE CORPS AIR STATION
NEW RIVER, NORTH CAROLINA

REMEDIAL TECHNOLOGY	MEDIA APPLICABILITY			DESCRIPTION	TYPICAL CAPITAL COST	TYPICAL LIFETIME O&M COST	ESTIMATED CLEANUP TIME	CONTAMINANTS MOST AFFECTED	PERMITS REQUIRED
	FREE-PHASE PRODUCT	SOIL	GROUND WATER						
Air Sparging (AS)			X	Air is injected through a series of wells installed below the deepest known point of groundwater contamination to volatilize the contaminants.	$40,000 - $100,000	$100,000 - $200,000	5 - 10 years	VOCs	None
Pump and Treat			X	Free product (if present) and groundwater are extracted via a series of extraction wells, treated via and above ground treatment system and recycled, disposed or discharged in a manner consistent with relevant regulations.	$75,000 - $150,000	$200,000 - $400,000	10 - 20 years	Volatile, Semi-Volatile and Chlorinated Compounds	Air Quality Notification Recovery Well Discharge Permit
In-Situ Bioremediation			X	A series of injection and extraction wells introduce oxygen, nutrients and sometimes specific bacterial species to degrade subsurface contamination.	$40,000 - $100,000	$400,000 - $500,000	15 - 20 years	Volatile and Semi-Volatile Compounds	Injection Well Permit
Natural Attenuation			X	Natural forces are allowed to reduce dissolved contaminants over time.	$5,000 - $10,000	$100,000 - $150,000	15 years	Volatile and Semi-Volatile Compounds	None
Biosparging			X	A series of injection wells are used to introduce small amounts of air into the saturated zone to promote natural biodegradation.	$40,000 - $100,000	$200,000 - $300,000	10 - 15 years	Volatile and Semi-Volatile Compounds	Well Permit
Soil Flushing		X		Contaminated soil is flushed with water and contaminated groundwater is typically extracted from a down-gradient location.	$75,000 - $150,000	$200,000 - $300,000	5 - 10 years	Volatile and Semi-Volatile Compounds	Non Dicharge & Well Permits
Bioventing		X		Clean air is provided throughout the vadose zone to promote aerobic biodegradation of contaminants.	$20,000 - $150,000	$200,000 - $300,000	10 - 15 years	Volatile and Semi-Volatile Compounds	Air Quality Notification
Soil Vapor Extraction (SVE)		X		Free product and/or adsorbed phase hydro-carbons are transferred to the vapor phase and vapor phase contaminants are extracted from the vadose zone through a system of slotted collection lines and subsequently released to the atmosphere.	$20,000 - $150,000	$100,000 - $200,000	5 - 10 years	VOCs	Air Quality Notification
Excavation and Disposal		X		Contaminated soil above the water table is excavated, hauled away and ultimately remediated.	$10,000 - $150,000	$0	6 months	Volatile, Semi-Volatile and Chlorinated Compounds	Soil Disposal

Note: An "X" indicates applicability to the subject site.

TABLE 7

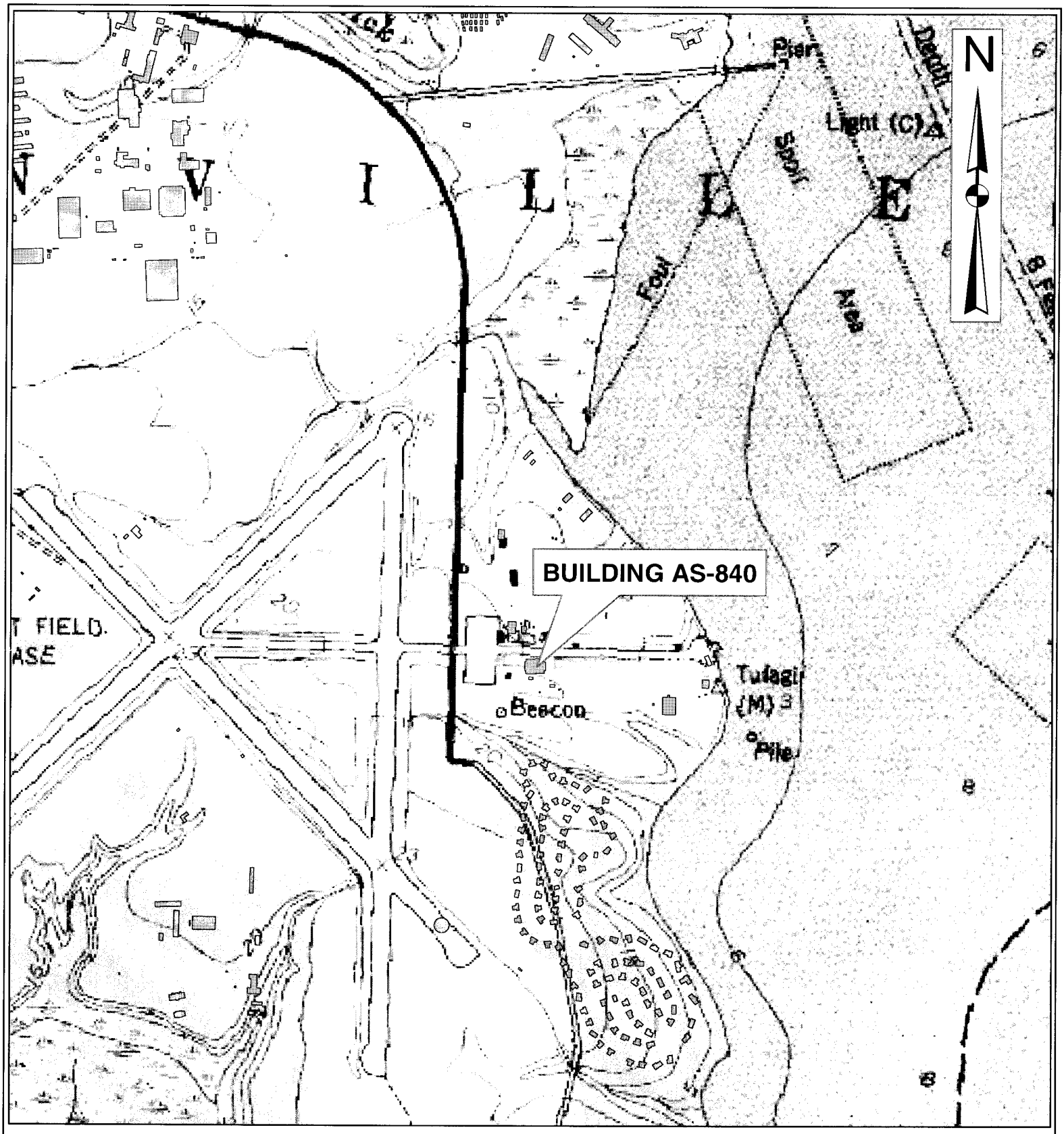
PRELIMINARY REMEDIAL TECHNOLOGY RANKING MATRIX

CORRECTIVE ACTION PLAN
BUILDING AS-840
MARINE CORPS AIR STATION
NEW RIVER, NORTH CAROLINA

POTENTIAL FOR SUCCESS		*RELATIVE COST*		
		LOW	**MODERATE**	**HIGH**
HIGH	**SOIL**		• Excavation and Disposal	
	GROUND WATER			
MODERATE	**SOIL**		• Soil Vapor Extraction • Bioventing	
	GROUND WATER	• Natural Attenuation	• Air Sparging • Biosparging	• Pump and Treat • In-Situ Bio-Remediation
LOW	**SOIL**			• Soil Flushing
	GROUND WATER			

= Technologies with low benefit/cost ratios.

FIGURES



Data Sources: USGS Topographic Quadrangles, Jacksonville South (1952, Photorevised 1988). Buildings data provided by Camp Lejeune GIS Department.

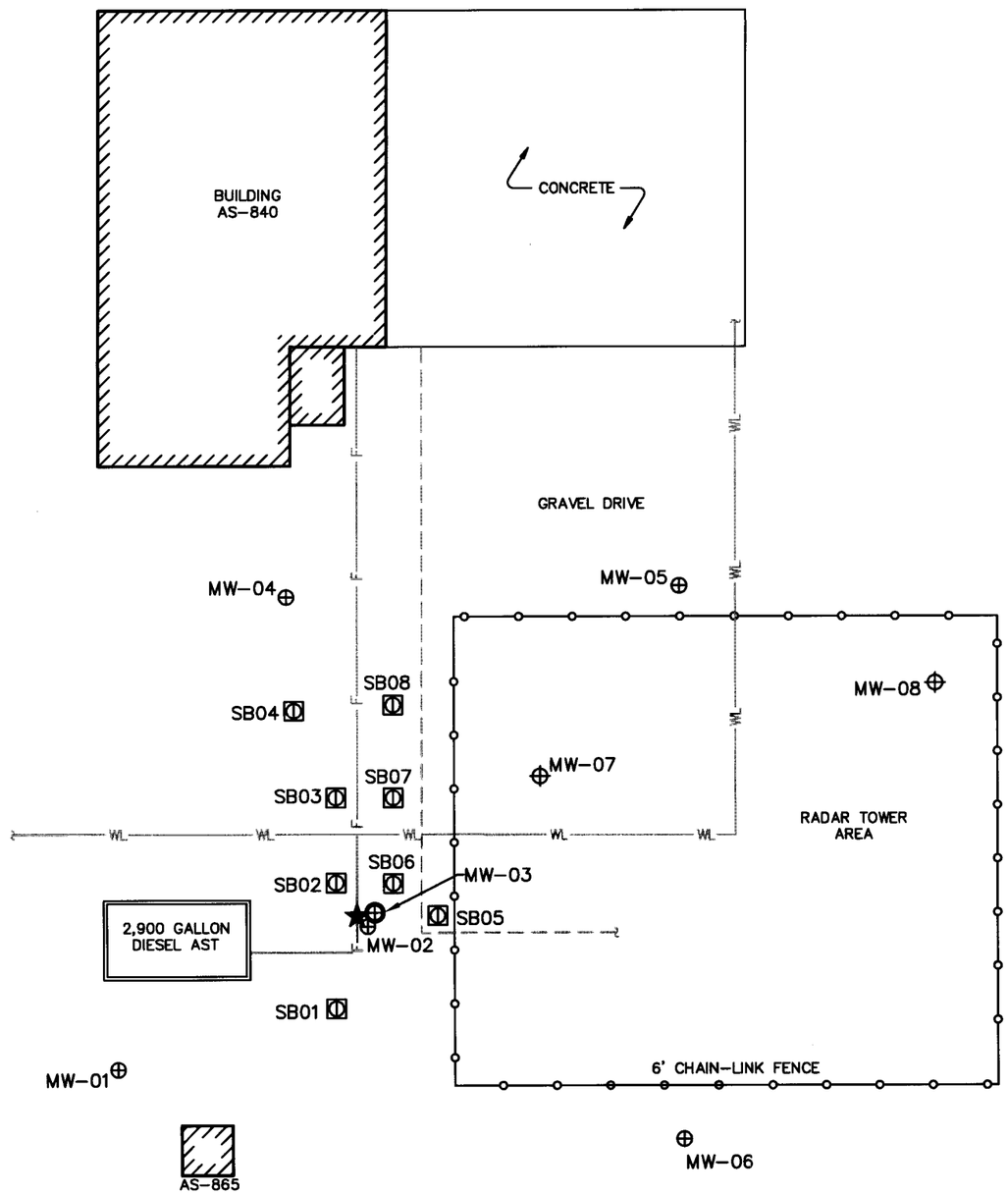
1,000 500 0 1,000 Feet

SCALE

CATLIN ENGINEERS and SCIENTISTS

PROJECT	TITLE	FIGURE
CORRECTIVE ACTION PLAN BUILDING AS-840 MARINE CORPS AIR STATION NEW RIVER, NORTH CAROLINA	GENERAL LOCATION USGS TOPOGRAPHIC MAP	1

JOB NO.	DATE	SCALE	DRAWN BY	CHECKED BY
204-045	DEC 2004	AS SHOWN	SAC	JKB



N

LEGEND

EXISTING	DESCRIPTION
	BUILDING
	APPROXIMATE POINT OF DIESEL FUEL RELEASE
	TYPE II MONITORING WELL
	TYPE II MONITORING WELL AND SOIL BORING
	TYPE III MONITORING WELL
	SOIL BORING (DPT)
F	FORMER FUEL DISTRIBUTION LINE
WL	WATER LINE
	UNKNOWN UTILITY

30 15 0 30

SCALE IN FEET

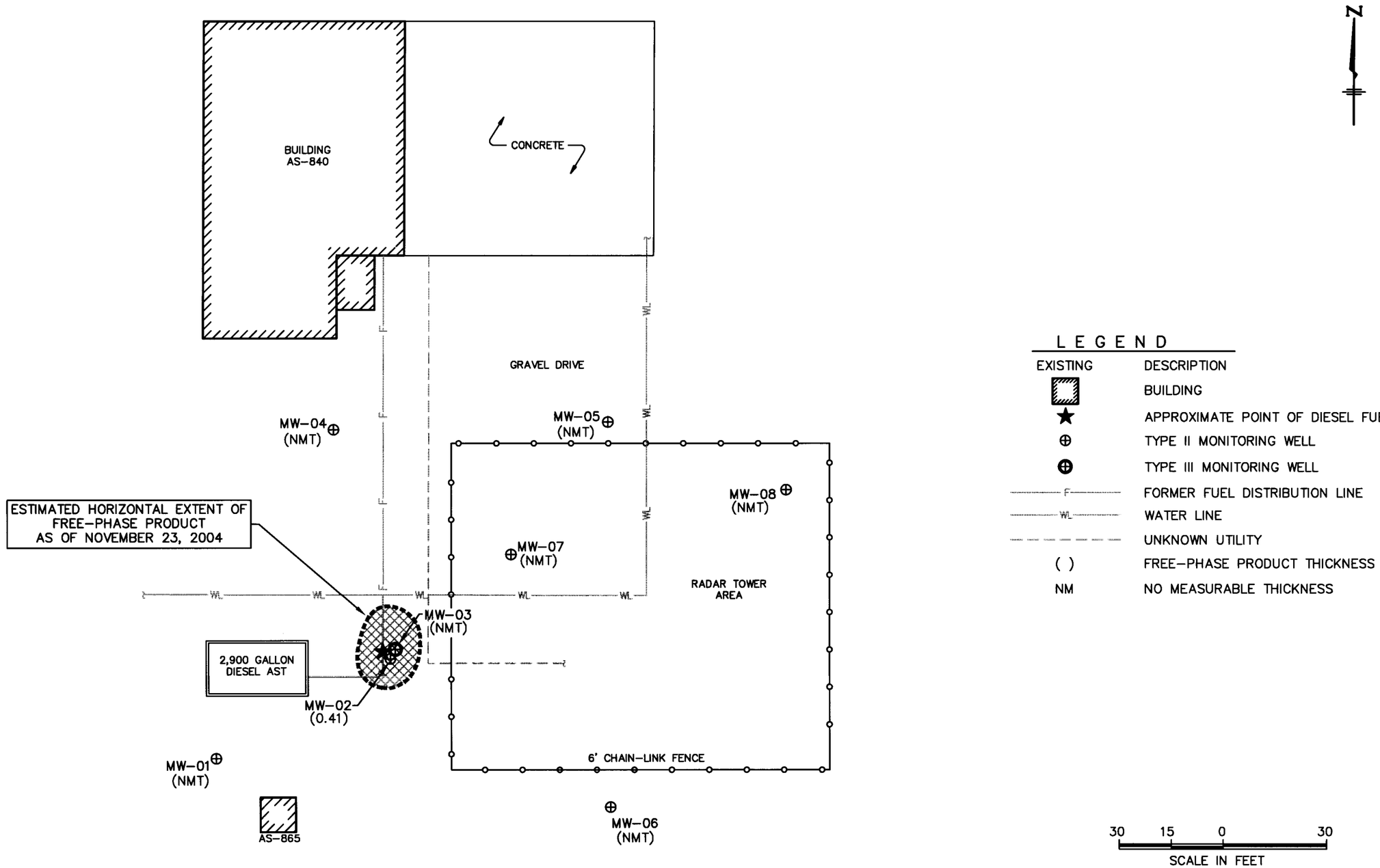
NOTE:
1. MODIFIED FROM ORIGINAL BASE MAP BY TAYLOR, WISEMAN & TAYLOR, PROVIDED BY LAW ENGINEERING AND ENVIRONMENTAL SERVICES, INC.

CATLIN ENGINEERS and SCIENTISTS
WILMINGTON, NORTH CAROLINA

PROJECT	TITLE	FIGURE
CORRECTIVE ACTION PLAN BUILDING AS-840 MARINE CORPS AIR STATION NEW RIVER, NC	SOIL BORING, MONITORING WELL AND POWER PROBE LOCATION MAP	2

JOB NO.	DATE	SCALE	DRAWN BY	CHECKED BY
204-045	JAN 2005	1"=30'	HCS	JKB

204045-2014-02



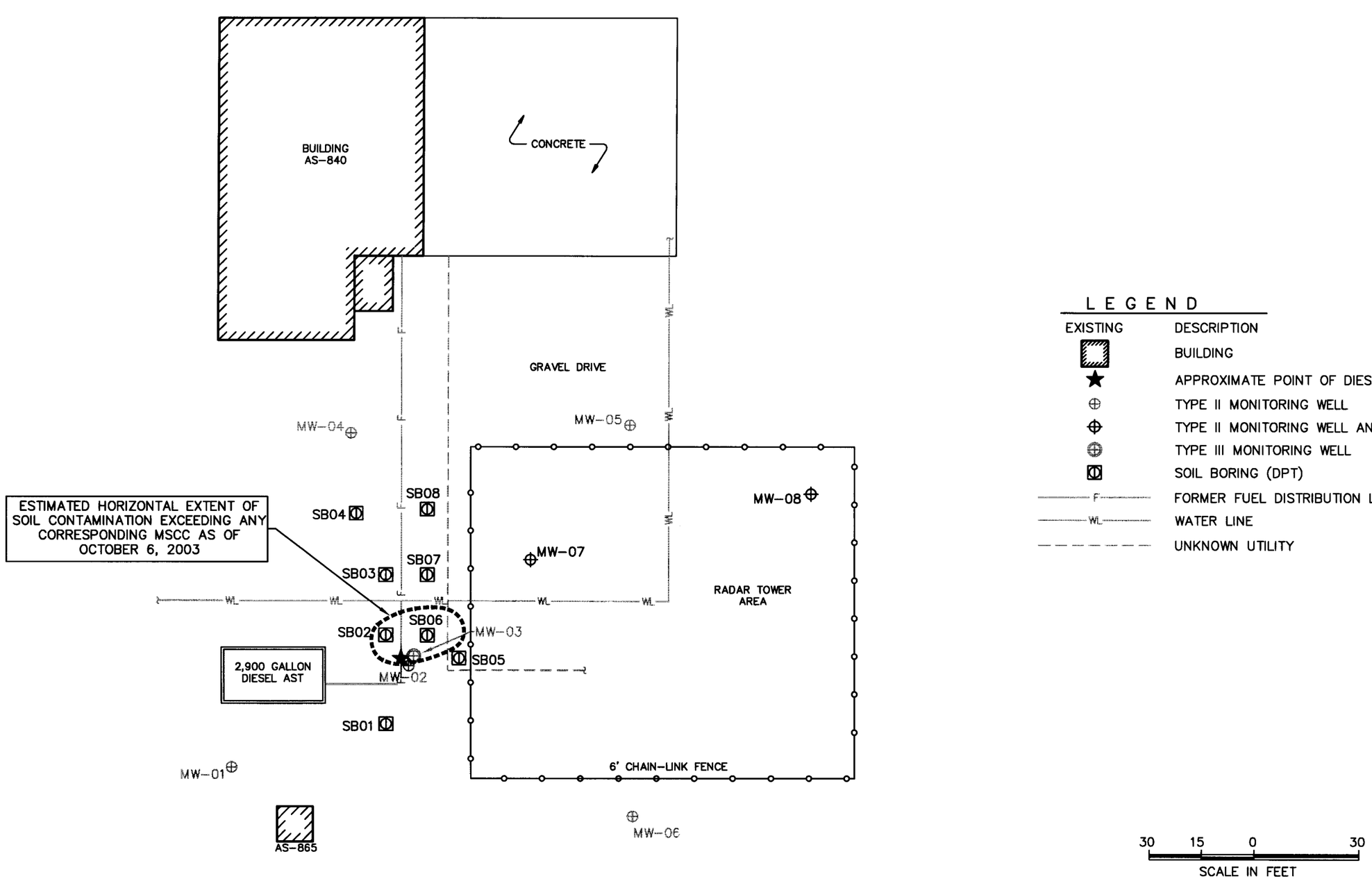
NOTE:
1. MODIFIED FROM ORIGINAL BASE MAP BY TAYLOR, WISEMAN & TAYLOR, PROVIDED BY LAW ENGINEERING AND ENVIRONMENTAL SERVICES, INC.
2. ESTIMATED HORIZONTAL EXTENT BASED ON FIELD DATA COLLECTED AS PART OF THE CAP ON NOVEMBER 23, 2004.

CATLIN ENGINEERS and SCIENTISTS
WILMINGTON, NORTH CAROLINA

PROJECT	TITLE	FIGURE
CORRECTIVE ACTION PLAN BUILDING AS-840 MARINE CORPS AIR STATION NEW RIVER, NC	ESTIMATED EXTENT OF FREE-PHASE PRODUCT AS OF NOVEMBER 23, 2004	3

JOB NO.	DATE	SCALE	DRAWN BY	CHECKED BY
204-045	JAN 2005	1"=30'	HCS	JKB

204045-2014-03

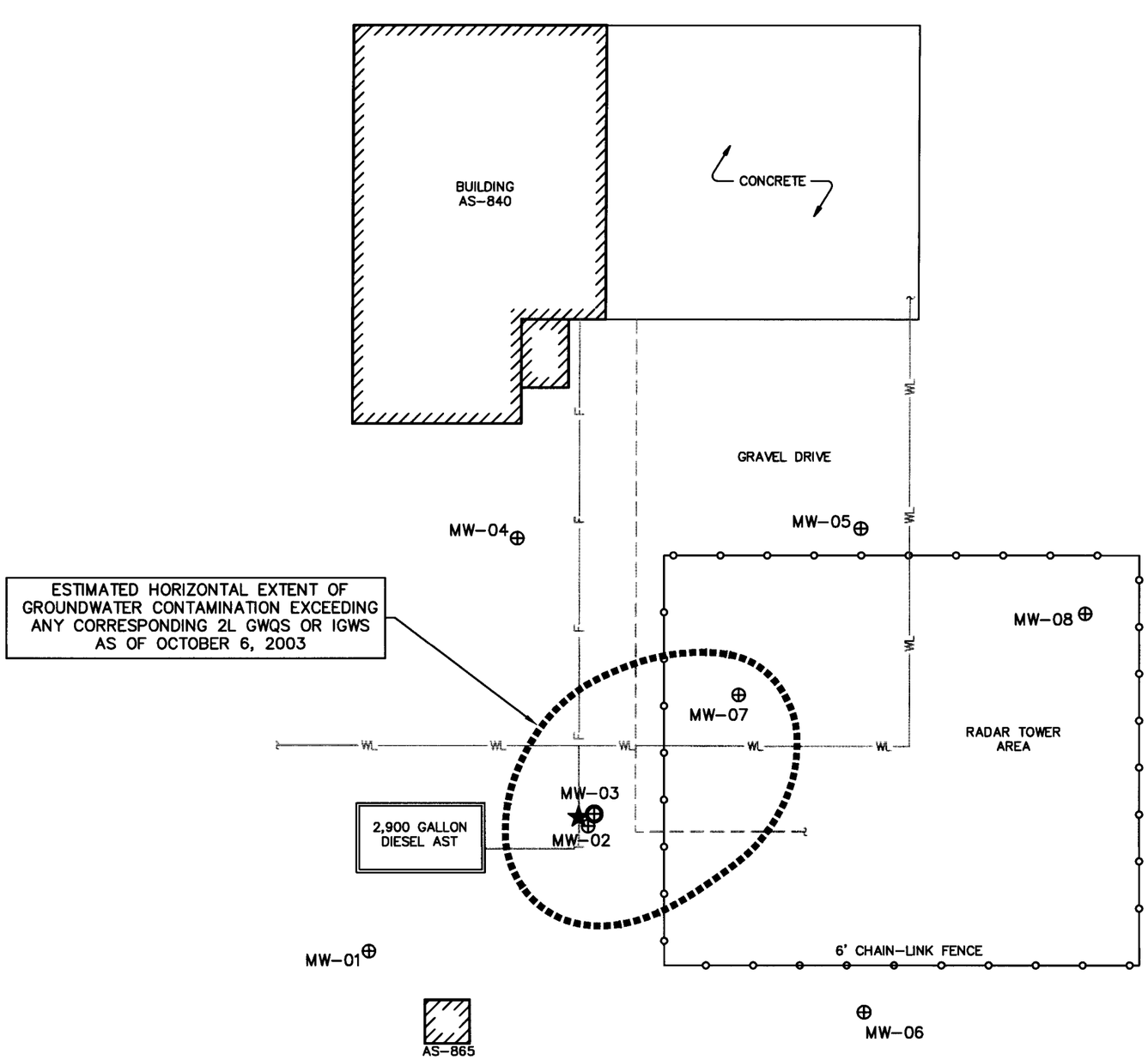


NOTE:
1. MODIFIED FROM ORIGINAL BASE MAP BY TAYLOR, WISEMAN & TAYLOR, PROVIDED BY LAW ENGINEERING AND ENVIRONMENTAL SERVICES, INC.
2. ESTIMATED HORIZONTAL EXTENT OF SOIL CONTAMINATION WAS BASED ON DATA OBTAINED FROM FIGURES 3, 4 AND 5 OF THE CSA ADDENDUM REPORT BY CATLIN, DATED NOVEMBER 2003.
3. REFER TO THE CSA ADDENDUM REPORT FOR A COMPLETE LIST OF ANAYTES AND RESULTS.

CATLIN ENGINEERS and SCIENTISTS
WILMINGTON, NORTH CAROLINA

PROJECT: CORRECTIVE ACTION PLAN BUILDING AS-840 MARINE CORPS AIR STATION NEW RIVER, NC	TITLE: ESTIMATED EXTENT OF SOIL CONTAMINATION AS OF OCTOBER 6, 2003		FIGURE 4
JOB NO. 204-045 DATE: JAN 2005	SCALE: 1"=30'	DRAWN BY: HCS	CHECKED BY: JKB

204045-2014-04



N

LEGEND

EXISTING	DESCRIPTION
	BUILDING
★	APPROXIMATE POINT OF DIESEL FUEL RELEASE
⊕	TYPE II MONITORING WELL
⊕	TYPE III MONITORING WELL
F	FORMER FUEL DISTRIBUTION LINE
WL	WATER LINE
	UNKNOWN UTILITY

30 15 0 30

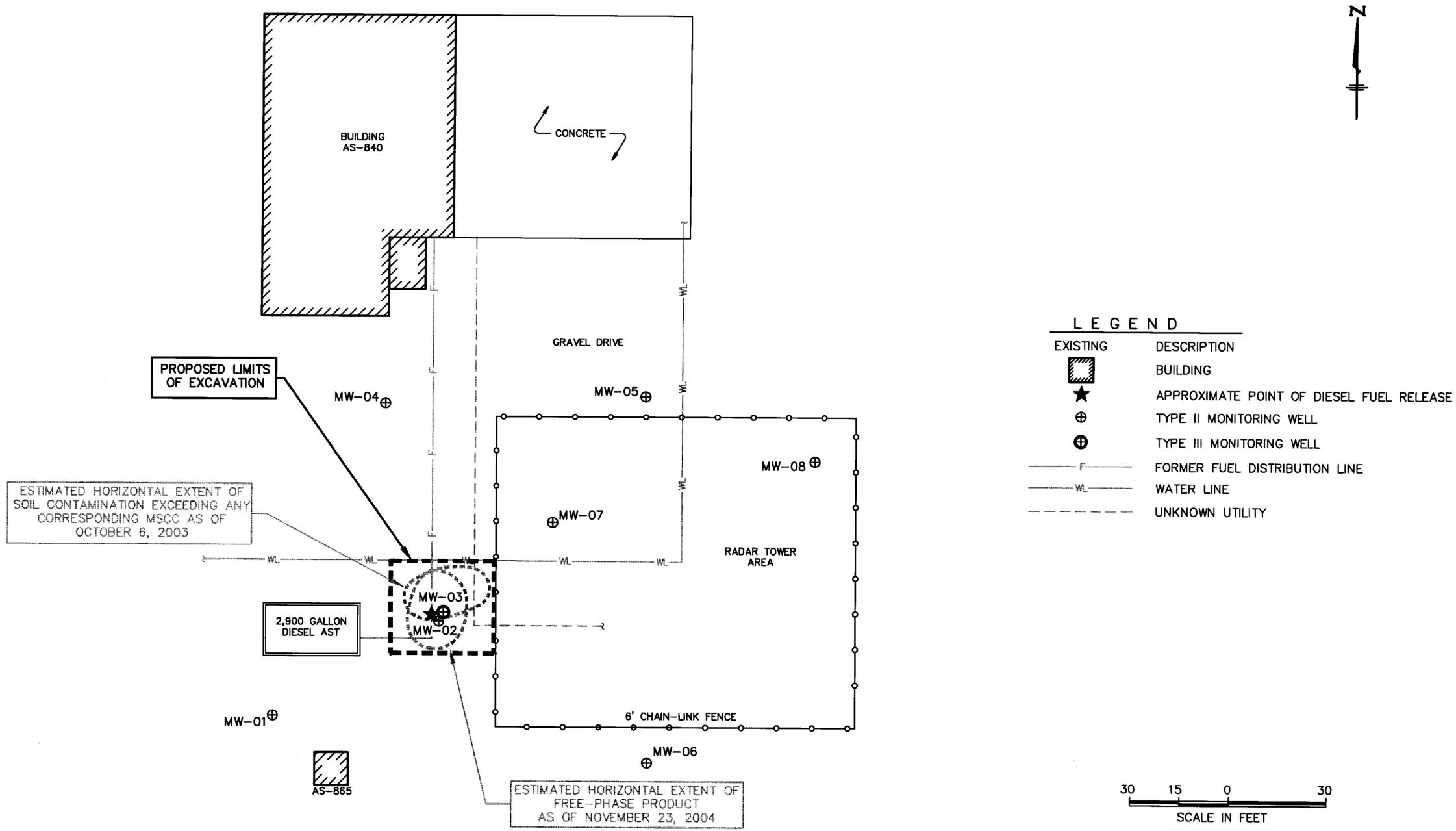
SCALE IN FEET

NOTE:
1. MODIFIED FROM ORIGINAL BASE MAP BY TAYLOR, WISEMAN & TAYLOR, PROVIDED BY LAW ENGINEERING AND ENVIRONMENTAL SERVICES, INC.
2. ESTIMATED HORIZONTAL EXTENT OF GROUNDWATER CONTAMINATION WAS BASED ON DATA OBTAINED FROM FIGURES 6, 7 AND 8 OF THE CSA ADDENDUM REPORT BY CATLIN, DATED NOVEMBER 2003.
3. REFER TO THE CSA ADDENDUM REPORT FOR A COMPLETE LIST OF ANAYTES AND RESULTS.

CATLIN ENGINEERS and SCIENTISTS
WILMINGTON, NORTH CAROLINA

PROJECT: CORRECTIVE ACTION PLAN BUILDING AS-840 MARINE CORPS AIR STATION NEW RIVER, NC	TITLE: ESTIMATED EXTENT OF GROUNDWATER CONTAMINATION AS OF OCTOBER 9, 2003		FIGURE 5
JOB NO. 204-045 / DATE: JAN 2005	SCALE: 1"=30'	DRAWN BY: HCS	CHECKED BY: JKB

204045-2014-05



NOTE:
1. MODIFIED FROM ORIGINAL BASE MAP BY TAYLOR, WISEMAN & TAYLOR, PROVIDED BY LAW ENGINEERING AND ENVIRONMENTAL SERVICES, INC.

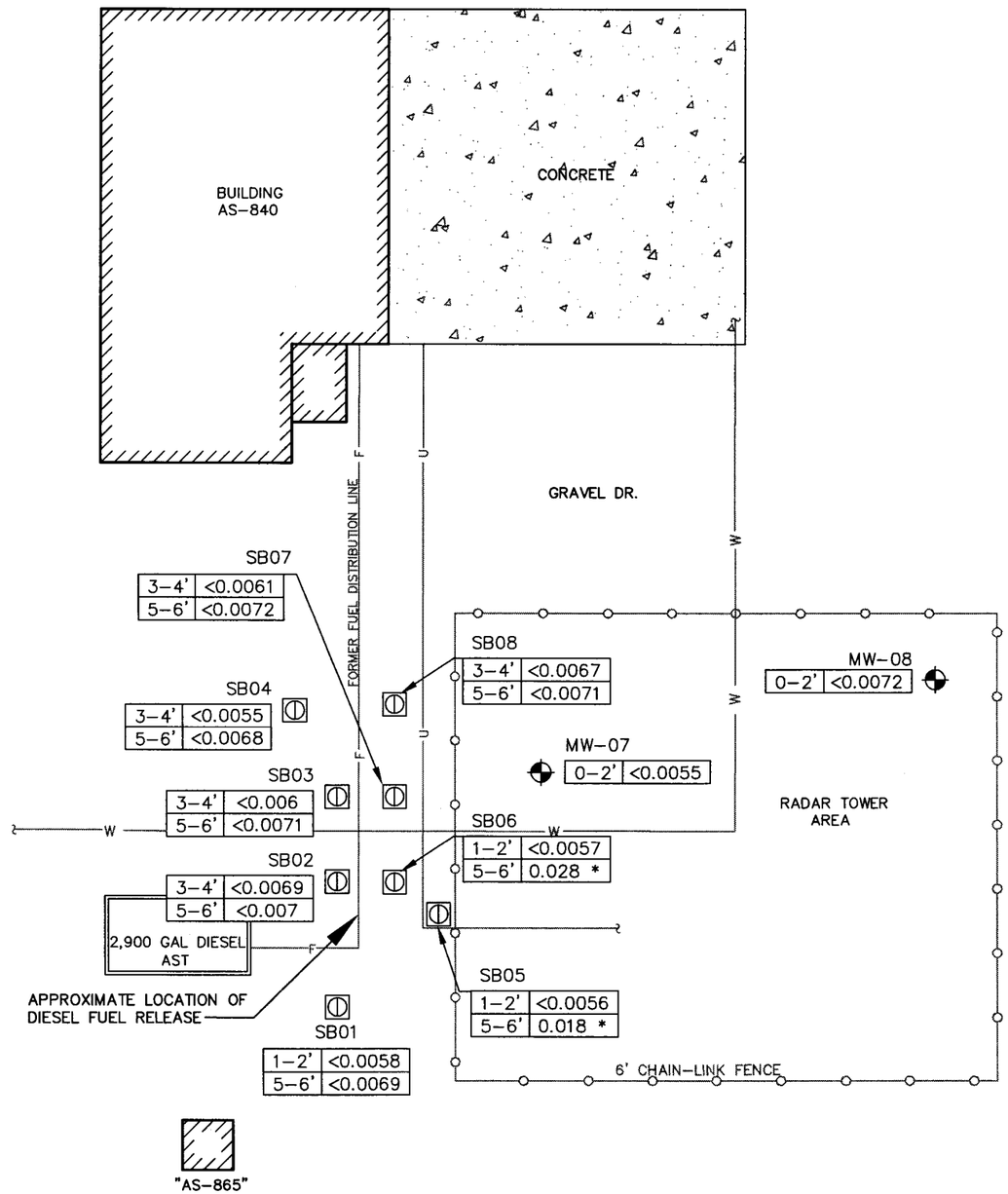
CATLIN ENGINEERS and SCIENTISTS
WILMINGTON, NORTH CAROLINA

PROJECT: CORRECTIVE ACTION PLAN BUILDING AS-840 MARINE CORPS AIR STATION NEW RIVER, NC	TITLE: SITE MAP WITH UTILITIES AND PROPOSED SOIL EXCAVATION AREA		FIGURE 6
JOB NO. 204-045 DATE: JAN 2005	SCALE: 1"=30'	DRAWN BY: HCS	CHECKED BY: JKB

204045-2014-06

FIGURES FROM

COMPREHENSIVE SITE ASSESSMENT ADDENDUM REPORT



LEGEND

EXISTING	NEW	DESCRIPTION
—F—		FORMER FUEL DISTRIBUTION LINE
—W—		WATER LINE
—U—		UNKNOWN UTILITY
⦶		SOIL BORING (DPT)
	⌖	SOIL BORING (DRILL)
mg/Kg		MILLIGRAMS PER KILOGRAM

SAMPLE DEPTH IN FEET	BENZENE CONCENTRATION (mg/Kg)

30 15 0 30

SCALE IN FEET

NOTE:

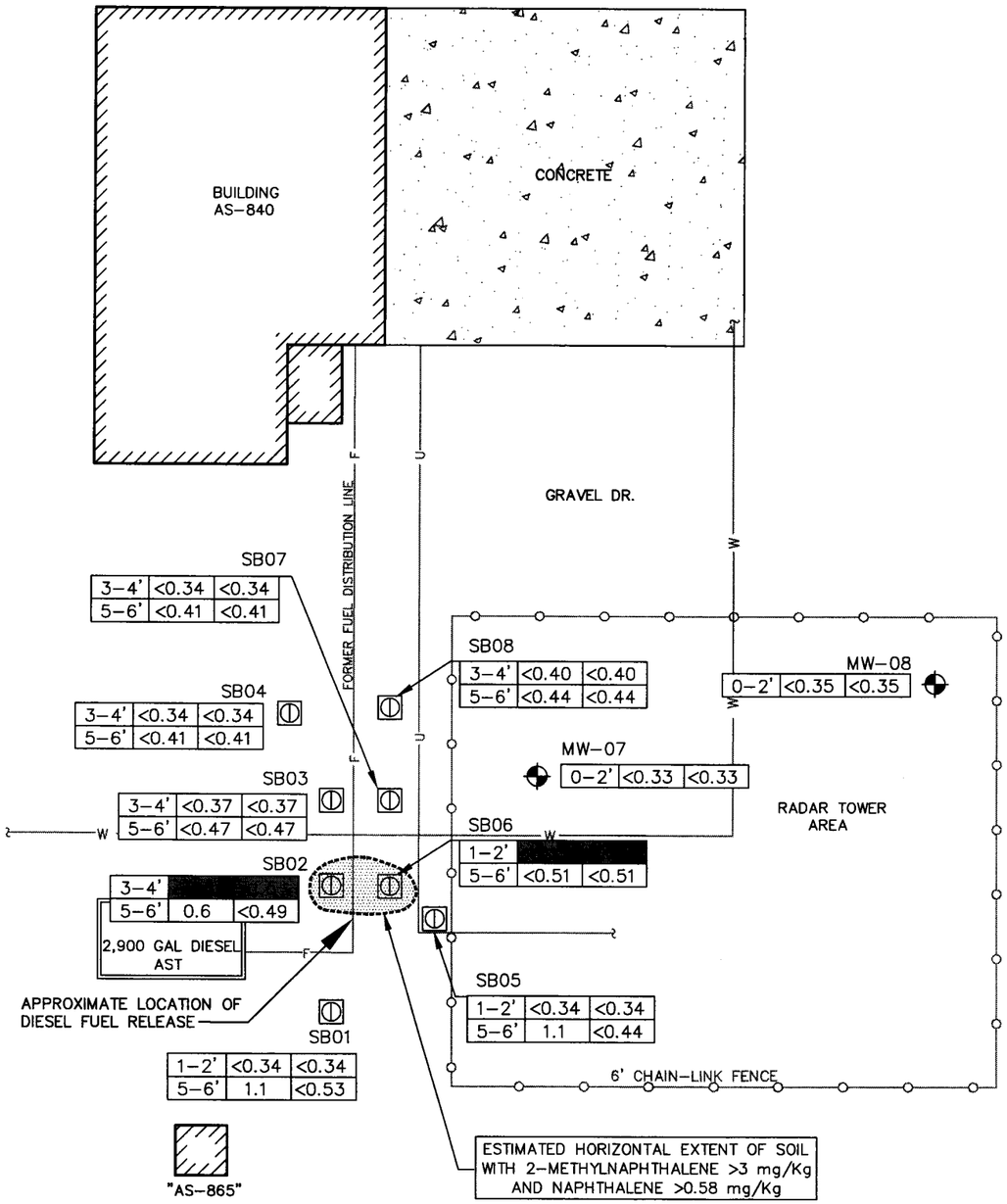
1. MODIFIED FROM ORIGINAL BASE MAP BY TAYLOR, WISEMAN & TAYLOR, PROVIDED BY LAW ENGINEERING AND ENVIRONMENTAL SERVICES, INC.
2. SOIL ANALYSIS PER EPA METHOD 8260B/5035, REVEALED BENZENE AS THE ONLY COMPOUND OF CONCERN. DATA FOR THE REMAINING EPA METHOD 8260B/5035 COMPOUNDS WERE EITHER COMPLIANT OR BQL
3. SHADED CONCENTRATIONS EXCEED BENZENE SOIL-TO-GROUNDWATER MSCC OR 0.0056 mg/Kg
4. * SOIL SAMPLE LOCATION IS WITHIN THE APPARENT SEASONAL HIGH WATER TABLE ZONE AND, THEREFORE, HAS NOT BEEN CONSIDERED REPRESENTATIVE OF SUBSURFACE VADOZE ZONE SOIL CONTAMINATION.

CATLIN ENGINEERS and SCIENTISTS
WILMINGTON, NORTH CAROLINA

PROJECT	TITLE	FIGURE
BUILDING AS-840 MARINE CORPS AIR STATION NEW RIVER, NC	SITE MAP WITH SUMMARY OF SOIL SAMPLE ANALYSIS RESULTS – EPA METHOD 8260B/5035	3

JOB NO.	DATE:	SCALE:	DRAWN BY:	CHECKED BY:
203060	NOV 2003	1"=30'	HCS	ST

203060-1047-03



LEGEND

EXISTING	NEW	DESCRIPTION
—F—		FORMER FUEL DISTRIBUTION LINE
—W—		WATER LINE
—U—		UNKNOWN UTILITY
		SOIL BORING (DPT)
		SOIL BORING (DRILL)
mg/Kg		MILLIGRAMS PER KILOGRAM
BQL		BELOW QUANTITATION LIMIT
DPT		DIRECT PUSH TECHNOLOGY

SAMPLE DEPTH IN FEET	2-METHYLNAPHTHALENE CONCENTRATION (mg/Kg)	NAPHTHALENE CONCENTRATION (mg/Kg)
SOIL-TO-GROUNDWATER MSCC	3	0.58

30 15 0 30

SCALE IN FEET

NOTE:

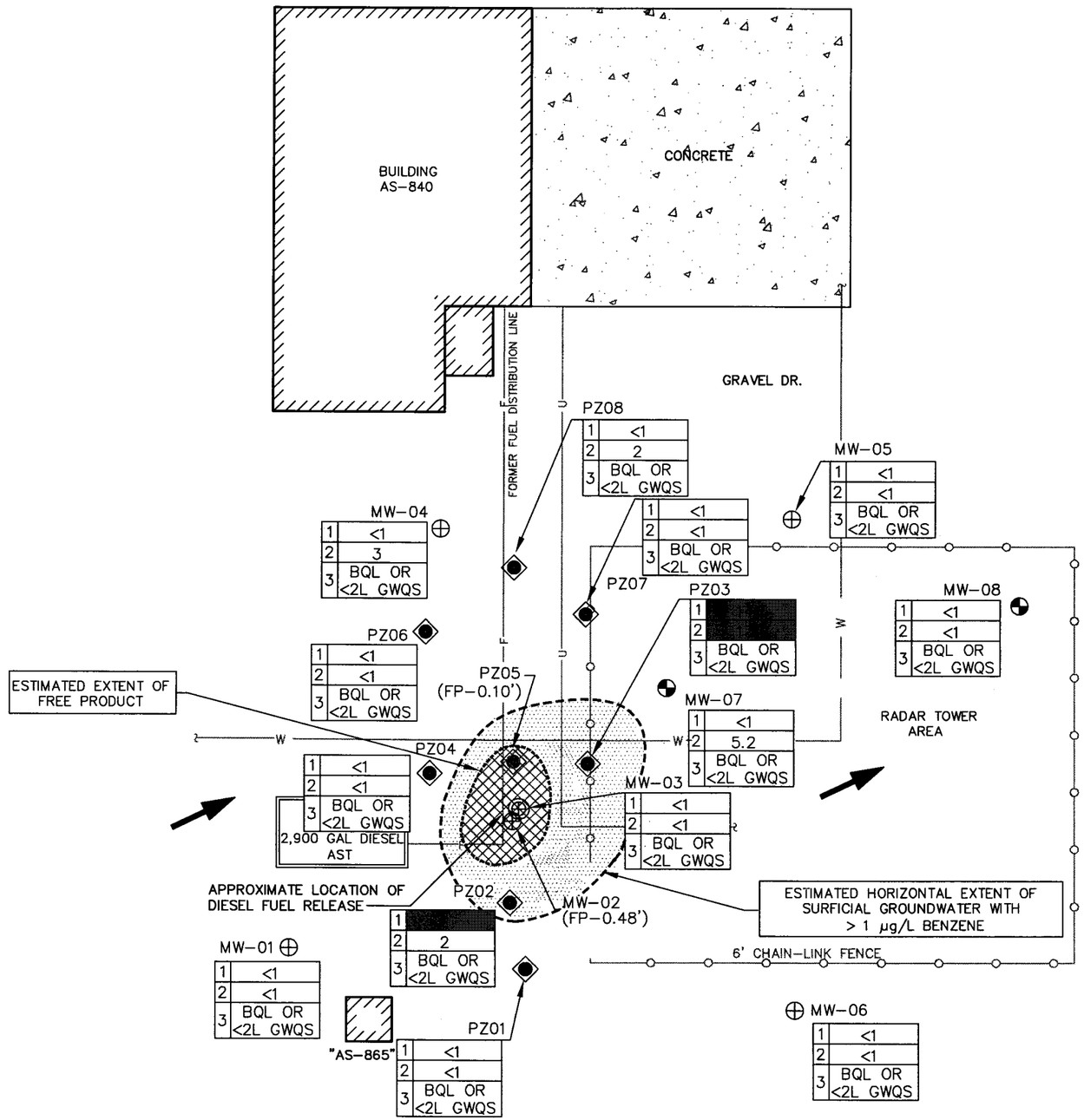
1. MODIFIED FROM ORIGINAL BASE MAP BY TAYLOR, WISEMAN & TAYLOR, PROVIDED BY LAW ENGINEERING AND ENVIRONMENTAL SERVICES, INC.
2. SOIL ANALYSIS PER EPA METHOD 8270, REVEALED 2-METHYLNAPHTHALENE AND NAPHTHALENE AS THE ONLY COMPOUNDS OF CONCERN. DATA FOR THE REMAINING EPA METHOD 8270 COMPOUNDS WERE EITHER COMPLIANT OR BQL.
3. SHADED CONCENTRATIONS EXCEED SOIL-TO-GROUNDWATER MSCC.

CATLIN ENGINEERS and SCIENTISTS
WILMINGTON, NORTH CAROLINA

PROJECT	TITLE	FIGURE
BUILDING AS-840 MARINE CORPS AIR STATION NEW RIVER, NC	SITE MAP WITH SUMMARY OF SOIL SAMPLE ANALYSIS RESULTS – EPA METHOD 8270	4

JOB NO. 203060 | DATE: NOV 2003 | SCALE: 1"=30' | DRAWN BY: HCS | CHECKED BY: ST

203060-1047-04



LEGEND

EXISTING	NEW	DESCRIPTION
—F—		FORMER FUEL DISTRIBUTION LINE
—W—		WATER LINE
—U—		UNKNOWN UTILITY
⊕	◕	SHALLOW (TYPE II) MONITORING WELL
⊕		DEEP (TYPE III) MONITORING WELL
◆		PIEZOMETER
		ESTIMATED HORIZINTAL EXTENT OF FREE PRODUCT AS OF 10/23/03
FP		FREE PRODUCT
µg/L		MICROGRAMS PER LITER
BQL		BELOW QUANTITATION LIMIT
2L GWQS		GROUNDWATER QUALITY STANDARD
→		SURFICIAL GROUNDWATER FLOW DIRECTION AS OF 10/23/03

RESULTS KEY		
#	ANALYTE	2L GWQS
1	BENZENE	1
2	ETHYL BENZENE	29
3	ALL OTHER ANALYTES	VARIES

30 15 0 30

SCALE IN FEET

NOTE:

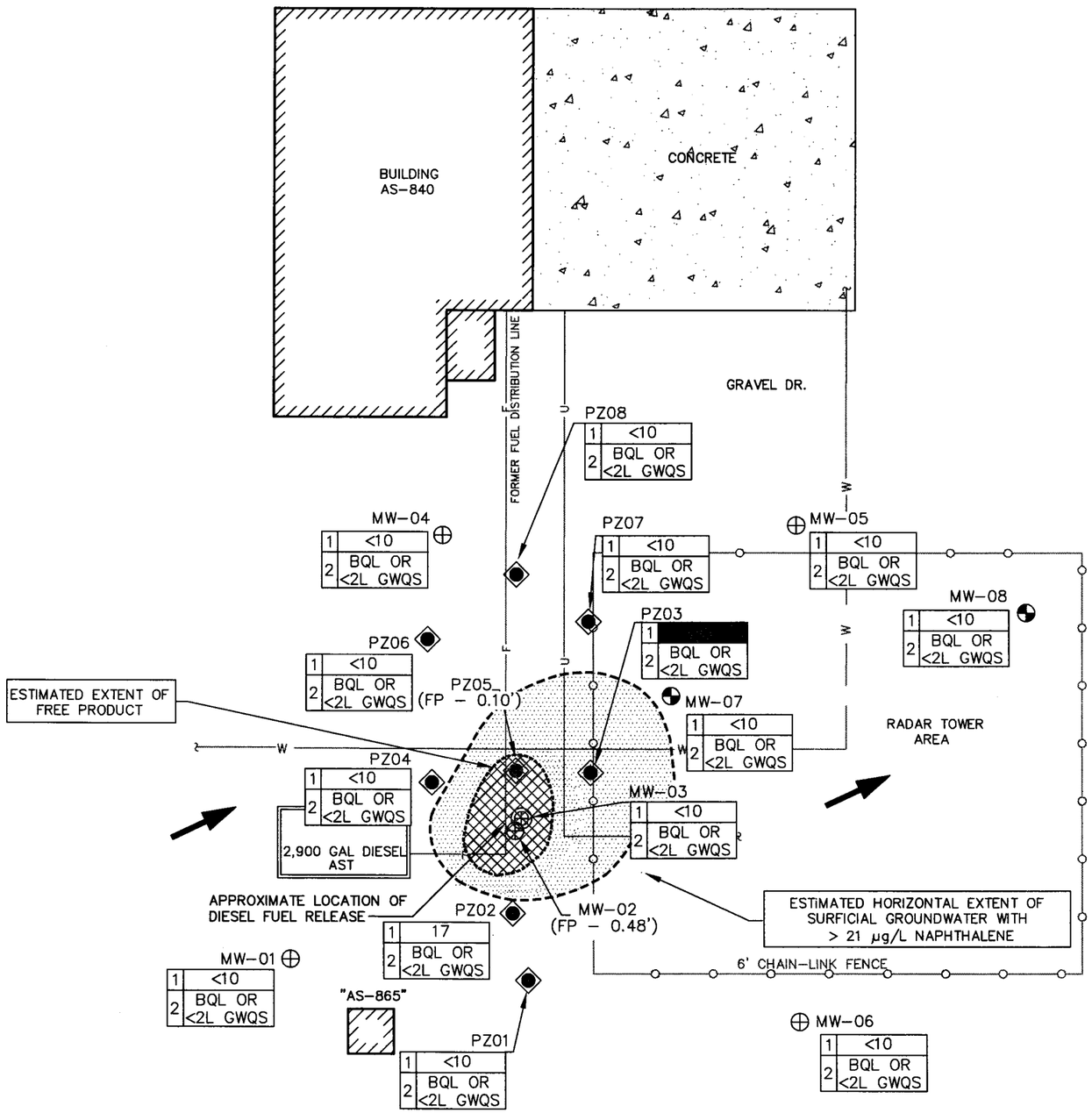
1. ALL RESULTS IN µg/L
2. MODIFIED FROM ORIGINAL BASE MAP BY TAYLOR, WISEMAN & TAYLOR, PROVIDED BY LAW ENGINEERING AND ENVIRONMENTAL SERVICES, INC.
3. GROUNDWATER ANALYSES PER EPA METHOD 602 + MTBE REVEALED BENZENE AND ETHYLBENZENE AS THE COMPOUNDS OF CONCERN. THE REMAINING 602 COMPOUNDS WERE EITHER COMPLIANT OR BQL.
4. SHADED CONCENTRATIONS EXCEED CORRESPONDING 2L GWQS.
5. MW-02 AND PZ05 WERE NOT SAMPLED DUE TO THE PRESENCE OF FREE PRODUCT.
6. MW-02 LAST GAUGED ON 10/23/02.
7. PZ05 LAST GAUGED ON 4/20/01.

CATLIN ENGINEERS and SCIENTISTS
WILMINGTON, NORTH CAROLINA

PROJECT	TITLE	FIGURE
BUILDING AS-840 MARINE CORPS AIR STATION NEW RIVER, NC	SITE MAP WITH SUMMARY OF GROUNDWATER SAMPLE ANALYSIS RESULTS – EPA METHOD 602	6

JOB NO. 203060 | DATE: NOV 2003 | SCALE: 1"=30' | DRAWN BY: HCS | CHECKED BY: ST

203060-1047-06



LEGEND

EXISTING	NEW	DESCRIPTION
—F—		FORMER FUEL DISTRIBUTION LINE
—W—		WATER LINE
—U—		UNKNOWN UTILITY
⊕	◕	SHALLOW (TYPE II) MONITORING WELL
⊕		DEEP (TYPE III) MONITORING WELL
◆		PIEZOMETER
▨		ESTIMATED HORIZINTAL EXTENT OF FREE PRODUCT AS OF 10/23/03
(FP)		FREE PRODUCT THICKNESS IN FEET
µg/L		MICROGRAMS PER LITER
BQL		BELOW QUANTITATION LIMIT
2L GWQS		GROUNDWATER QUALITY STANDARD
→		SURFICIAL GROUNDWATER FLOW DIRECTION AS OF 10/23/03

RESULTS KEY		
#	ANALYTE	2L GWQS
1	NAPHTHALENE	21
2	ALL OTHER ANALYTES	VARIES

30 15 0 30

SCALE IN FEET

NOTE:

1. ALL RESULTS IN µg/L
2. MODIFIED FROM ORIGINAL BASE MAP BY TAYLOR, WISEMAN & TAYLOR, PROVIDED BY LAW ENGINEERING AND ENVIRONMENTAL SERVICES, INC.
3. GROUNDWATER ANALYSES REVEALED NAPHTHALENE AS THE COMPOUND OF CONCERN. THE REMAINING 625 COMPOUNDS WERE EITHER COMPLIANT OR BQL.
4. SHADED CONCENTRATIONS EXCEED CORRESPONDING 2L GWQS.
5. MW-02 AND PZ05 WERE NOT SAMPLED DUE TO THE PRESENCE OF FREE PRODUCT.
6. MW-02 LAST GAUGED ON 10/23/02.
7. PZ05 LAST GAUGED ON 4/20/01.

CATLIN ENGINEERS and SCIENTISTS
WILMINGTON, NORTH CAROLINA

PROJECT	TITLE	FIGURE
BUILDING AS-840 MARINE CORPS AIR STATION NEW RIVER, NC	SITE MAP WITH SUMMARY OF GROUNDWATER SAMPLE ANALYSIS RESULTS – EPA METHOD 625	7

JOB NO.	DATE	SCALE	DRAWN BY	CHECKED BY
203060	NOV 2003	1"=30'	HCS	ST

203060-1047-07

APPENDIX A

SITE SPECIFIC DATA FROM

COMPREHENSIVE SITE ASSESSMENT
AND
COMPREHENSIVE SITE ASSESSMENT ADDENDUM REPORTS

(TABLES AND FIGURES)

TABLES FROM

COMPREHENSIVE SITE ASSESSMENT REPORT

Table 2 **Well Construction Information**

Date: 12/06/01 **Incident No. and Name: No. Pending, MCAS Building AS-840** **Facility ID#: Not Applicable**

Well ID	Date Installed	Date Water Level Measured	Well Casing Depth (ft. BLS)	Screened Interval (ft. BLS)	Bottom of Well (ft. BLS)	Ground Surface Elevation* (ft.)	Top of Casing Elevation* (ft.)	Depth to Water from Top of Casing (ft.)	Free Product Thickness** (ft.)	Ground-water Elevation (ft.)
MW01	6/19/01	6/22/01	3	3 to 18	18	14.08	13.70	5.65	Not Present	8.05
MW02	6/19/01	6/22/01	3	3 to 18	18	14.15	13.83	6.30	0.22	7.72
MW03	6/20/01	6/22/01	22	22 to 27	27	14.34	13.97	6.20	Not Present	7.77
MW04	6/20/01	6/22/01	3	3 to 18	18	15.33	14.70	7.02	Not Present	7.68
MW05	6/20/01	6/22/01	3	3 to 18	18	15.03	14.20	6.86	Not Present	7.34
MW06	6/20/01	6/22/01	3	3 to 18	18	14.36	13.84	6.28	Not Present	7.56

* Elevations determined by Taylor Wiseman & Taylor 8/01/01.
Reference Point for Elevation Measurements: MCAS geodetic monuments Heinz and Flyboy.

** If free product is present in a well, groundwater elevation calculated as follows:
[Top of Casing Elevation – depth to Water] + [free product thickness x 0.8581]

ft. BLS = feet below land surface

Table 3
Date: 12/06/01

Summary of Soil Sampling Results: Comprehensive Site Assessment (Page 1 of 2)
Incident No. and Name: No. Pending, MCAS Building AS 840

Facility ID#: Not Applicable

			Analytical Method →	*Volatile Organic Compounds by EPA Method 8260*											
			Contaminant of Concern →	Benzene	n-Butylbenzene	sec-Butylbenzene	Ethylbenzene	Isopropylbenzene	4-Isopropyltoluene	Methyl-tert-butyl-ether (MTBE)	Naphthalene	n-Porpylbenzene	1,2,4-Trimethylbenzene	1,3,5-Trimethylbenzene	Total Xylenes
Probe ID	**Sample ID**	**Date Collected**	**Sample Depth (ft. bls)**												
SB01	ASTAS840 -SB01-01	4/19/01	1-2	<0.0058	<0.0058	<0.0058	<0.0058	<0.0058	<0.0058	<0.0058	<0.0058	<0.0058	<0.0058	<0.0058	<0.012
SB01	ASTAS840 -SB01-03	4/19/01	5-6	<0.0069	<0.0069	<0.0069	<0.0069	<0.0069	<0.0069	<0.0069	0.034	<0.0069	0.02	<0.0069	<0.014
SB02	ASTAS840 -SB02-02	4/19/01	3-4	<0.0069	<0.0069	<0.0069	0.0071	<0.0069	<0.0069	0.018	0.017	<0.0069	0.019	0.0084	0.02
SB02	ASTAS840 -SB02-03	4/19/01	5-6	<0.007	<0.007	<0.007	0.014	<0.007	<0.007	0.054	0.11	<0.007	0.049	0.011	0.016
SB03	ASTAS840 -SB03-02	4/19/01	3-4	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	0.0064	<0.006	<0.006	<0.006	<0.006
SB03	ASTAS840 -SB03-03	4/19/01	5-6	<0.0071	<0.0071	<0.0071	<0.0071	<0.0071	<0.0071	<0.0071	0.017	<0.0071	<0.0071	<0.0071	<0.0071
SB04	ASTAS840 -SB04-02	4/19/01	3-4	<0.0055	<0.0055	<0.0055	<0.0055	<0.0055	<0.0055	<0.0055	0.014	<0.0055	0.011	0.0058	<0.011
SB04	ASTAS840 -SB04-03	4/19/01	5-6	<0.0068	<0.0068	<0.0068	<0.0068	<0.0068	<0.0068	<0.0068	0.058	<0.0068	0.041	0.010	<0.014
SB05	ASTAS840 -SB05-01	4/19/01	1-2	<0.0056	<0.0056	<0.0056	<0.0056	<0.0056	<0.0056	<0.0056	<0.0056	<0.0056	<0.0056	<0.0056	<0.011
SB05	ASTAS840 -SB05-03	4/19/01	5-6	[illegible]	<0.0073	0.011	0.045	0.014	0.0075	0.044	0.19	0.024	0.15	0.035	0.039
SB06	ASTAS840 -SB06-01	4/19/01	1-2	<0.0057	<0.0057	0.01	0.016	0.0082	0.0089	<0.0057	0.06	0.012	0.08	0.03	0.096
SB06	ASTAS840 -SB06-03	4/19/01	5-6	[illegible]	<0.0072	0.012	0.057	0.015	0.0083	0.047	0.22	0.025	0.15	0.037	0.163
SB07	ASTAS840 -SB07-02	4/19/01	3-4	<0.0061	<0.0061	<0.0061	<0.0061	<0.0061	<0.0061	<0.0061	<0.0061	<0.0061	<0.0061	<0.0061	<0.012
SB07	ASTAS840 -SB07-03	4/19/01	5-6	<0.0072	0.0092	0.017	0.042	0.016	0.013	0.029	0.28	0.031	0.21	0.05	0.124
SB08	ASTAS840 -SB08-02	4/19/01	3-4	<0.0067	<0.0067	<0.0067	<0.0067	<0.0067	<0.0067	<0.0067	<0.0067	<0.0067	<0.0067	<0.0067	<0.013
SB08	ASTAS840 -SB08-03	4/19/01	5-6	<0.0071	<0.0071	<0.0071	<0.0071	<0.0071	<0.0071	<0.0071	0.076	<0.0071	0.032	<0.0071	0.011
			Soil-to-Groundwater MSCC →	*0.0056*	*4*	*3*	*0.24*	*2*	*	*0.92*	*0.58*	*2*	*8*	*7*	*5*
			Residential MSCC →	22	156	156	1,560	1,564	*	156	63	156	782	782	32,000

All laboratory results and Maximum Soil Contaminant Concentrations (MSCCs) are reported in milligrams per kilogram (mg/Kg)
Unshaded cells listing laboratory detection limit indicate compound not detected
Shaded cell indicates concentration identified above laboratory detection limit
Shaded cell with bold numbers indicate detected concentration exceeds the Soil to Groundwater MSCC
* A soil to groundwater MSCC for 4-isopropyltoluene cannot be determined because an octanol-water partitioning coefficient has not been established for this compound. Similarly, residential or commercial/industrial MSCCs cannot be established for this compound due to a lack of health-based risk information (reference dose or cancer slope factor) for 4-isopropyltoluene
ft. bls = Feet below land surface

Prepared By: [illegible] Date: 12/6/01
Checked By: WJD Date: 12/6/01

0681BB12

Table 3
Date: 12/06/01

Summary of Soil Sampling Results: Comprehensive Site Assessment (Page 2 of 2)
Incident No. and Name: No. Pending, MCAS Building AS 840

Facility ID#: Not Applicable

				Semi-Volatile Organic Compounds, Base Neutral Acid Extractables by EPA Method 8270						*Hydrocarbon Fractions by the Massachusetts Department of Environmental Protection (MADEP) Method*							
Analytical Method →										*MADEP VPH Compounds*			*MADEP EPH Compounds*			*Combined MADEP Compounds*	
Contaminant of Concern →				Acenaphthene	Fluorene	2-Methylnaphthalene	Naphthalene	Phenanthrene	Pyrene	C5-C8 Aliphatics	C9-C12 Aliphatics	C9-C10 Aromatics	C9-C18 Aliphatics	C19-C36 Aliphatics	C11-C22 Aromatics	C9-C18 Aliphatics	C9-C22 Aromatics
Probe ID	**Sample ID**	**Date Collected**	**Sample Depth (ft. bls)**														
SB01	ASTAS840 -SB01-01	4/19/01	1-2	<0.34	<0.34	<0.34	<0.34	<0.34	<0.34	<10	<10	<10	<10	<10	<10	<10	<10
SB01	ASTAS840 -SB01-03	4/19/01	5-6	<0.53	<0.53	1.1	<0.53	<0.53	<0.53	<10	14	<10	<10	<10	<10	14	<10
SB02	ASTAS840 -SB02-02	4/19/01	3-4	<0.47	0.78			1.3	0.47	39	410	46	<10	<10	<10	410	
SB02	ASTAS840 -SB02-03	4/19/01	5-6	<0.49	<0.49	0.6	<0.49	<0.49	<0.49	<10	<10	<10	<10	<10	<10	<10	<10
SB03	ASTAS840 -SB03-02	4/19/01	3-4	<0.37	<0.37	<0.37	<0.37	<0.37	<0.37	<10	<10	<10	<10	<10	<10	<10	<10
SB03	ASTAS840 -SB03-03	4/19/01	5-6	<0.47	<0.47	<0.47	<0.47	<0.47	<0.47	<10	31	<10	<10	<10	<10	31	<10
SB04	ASTAS840 -SB04-02	4/19/01	3-4	<0.34	<0.34	<0.34	<0.34	<0.34	<0.34	<10	<10	<10	<10	<10	<10	<10	<10
SB04	ASTAS840 -SB04-03	4/19/01	5-6	<0.41	<0.41	<0.41	<0.41	<0.41	<0.41	<10	60	<10	<10	<10	<10	60	<10
SB05	ASTAS840 -SB05-01	4/19/01	1-2	<0.34	<0.34	<0.34	<0.34	<0.34	<0.34	<10	<10	<10	<10	<10	<10	<10	<10
SB05	ASTAS840 -SB05-03	4/19/01	5-6	<0.44	<0.44	1.1	<0.44	<0.44	<0.44	<10	64	<10	39	15	60	103	
SB06	ASTAS840 -SB06-01	4/19/01	1-2	<0.35	1.9			3.2	0.92	24	310	34	140	52	100	450	
SB06	ASTAS840 -SB06-03	4/19/01	5-6	<0.51	<0.51	<0.51	<0.51	<0.51	<0.51	<10	27	<10	<10	<10	<10	27	<10
SB07	ASTAS840 -SB07-02	4/19/01	3-4	<0.37	<0.37	0.41	<0.37	<0.37	<0.37	<10	79	<10	20	12	22	99	22
SB07	ASTAS840 -SB07-03	4/19/01	5-6	<0.44	<0.44	<0.44	<0.44	<0.44	<0.44	10	31	<10	<10	<10	<10	31	<10
SB08	ASTAS840 -SB08-02	4/19/01	3-4	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<10	<10	<10	<10	<10	<10	<10	<10
SB08	ASTAS840 -SB08-03	4/19/01	5-6	<0.44	<0.44	<0.44	<0.44	<0.44	<0.44	<10	<10	<10	<10	<10	<10	<10	<10
Soil-to-Groundwater MSCC →				8	44	3	0.58	60	286	72	*See combined totals*	*See combined totals*	*See combined totals*	*Immobile*	*See combined totals*	*3,255*	*34*
Residential MSCC →				940	620	63	63	469	469	939				93,860		9,386	469

All laboratory results and Maximum Soil Contaminant Concentrations (MSCCs) are reported in milligrams per kilogram (mg/Kg)
Unshaded cells listing laboratory detection limit indicate compound not detected
Shaded cell indicates concentration identified above laboratory detection limit
Shaded cell with bold numbers indicate detected concentration exceeds the Soil to Groundwater MSCC
VPH = Volatile Petroleum Hydrocarbons
EPH = Extractable Petroleum Hydrocarbons
HBL = Health Based Level
ft. bls = Feet below land surface

Prepared By: LK Date: 11/6/01
Checked By: WSD Date: 12/6/01

Table 4
Date: 12/06/01

Summary of Groundwater Sampling Results: Comprehensive Site Assessment (Page 1 of 1)
Incident No. and Name: No. Pending, MCAS Building AS 840

Facility ID#: Not Applicable

		Analytical Method →	*Purgeable Aromatic Hydrocarbons modified to include Xylenes by EPA Method 602*					*Semi-Volatile Organic Compounds, Base/Neutral Extractables by EPA Method 625*					*Hydrocarbon Fractions by the Massachusetts Department of Environmental Protection (MADEP) Method*							
		Contaminant of Concern →	Benzene	Ethylbenzene	Methyl-tert-butyl-ether (MTBE)	Toluene	Total Xylenes	Acenaphthene	Fluorene	Naphthalene	*TICs*		*MADEP VPH Compounds*			*MADEP EPH Compounds*			*Combined MADEP Compound Totals*	
Well ID	**Sample ID**	**Date Collected**									Known	Unknown	C5-C8 Aliphatics	C9-C12 Aliphatics	C9-C10 Aromatics	C9-C18 Aliphatics	C19-C36 Aliphatics	C11-C22 Aromatics	C9-C18 Aliphatics	C9-C22 Aromatics
PZ01	ASTAS840 -PZ01-01B	4/20/01	<1	<1	<2	<1	<2	<10	<10	<10			<100	<100	<100	<100	<100	<100	<100	<100
PZ02	ASTAS840 -PZ02-01B	4/20/01	2	2	<2	<1	4	<10	<10	17			<100	140	<100	<100	<100	<100	140	<100
PZ03	ASTAS840 -PZ03-01B	4/20/01			<16	160	230	11	12				[illegible]	2,600	620	<100	<100	400	2,600	[illegible]
PZ04	ASTAS840 -PZ04-01B	4/20/01	<1	1	<2	<1	3	<10	<10	<10			<100	<100	<100	<100	<100	<100	<100	<100
PZ06	ASTAS840 -PZ06-01B	4/20/01	<1	<1	<2	<1	<2	<10	<10	<10			<100	<100	<100	<100	<100	<100	<100	<100
PZ07	ASTAS840 -PZ07-01B	4/20/01	<1	<1	<2	<1	<2	<10	<10	<10			<100	<100	<100	<100	<100	<100	<100	<100
PZ08	ASTAS840 -PZ08-01B	4/20/01	<1	2	<2	<1	3	<10	<10	<10			<100	<100	<100	<100	<100	<100	<100	<100
MW01	ASTAS840 -GW01-01B	6/22/01	<1	<1	<2	<1	<2	<10	<10	<10	NCD	NCD	<100	<100	<100	<100	<100	<100	<100	<100
MW03	ASTAS840 -GW03-01B	6/22/01	<1	<1	<2	<1	<2	<10	<10	<10	NCD	NCD	<100	<100	<100	<100	<100	<100	<100	<100
MW04	ASTAS840 -GW04-01B	6/22/01	<1	3	<2	<1	<2	<10	<10	<10	22.8	54.8	<100	100	<100	230	120	200	330	200
MW05	ASTAS840 -GW05-01B	6/22/01	<1	<1	<2	<1	<2	<10	<10	<10	NCD	NCD	<100	<100	<100	<100	<100	<100	<100	<100
MW06	ASTAS840 -GW06-01B	6/22/01	<1	<1	<2	<1	<2	<10	<10	<10	NCD	NCD	<100	<100	<100	<100	<100	<100	<100	<100
		2L Standard→	*1*	*29*	*200*	*1,000*	*530*	*80*	*280*	*21*	*Not Established*		*420*	*See Totals*	*See Totals*	*See Totals*	*42,000*	*See Totals*	*4,200*	*210*

All laboratory results, 2L Standards, and Gross Contamination Levels (GCLs) are reported in micrograms per liter (• g/L)
Unshaded cells listing laboratory detection limit indicate compound not detected
Shaded cell indicates concentration identified above laboratory detection limit
Shaded cell with bold numbers indicate detected concentration exceeds the 2L Standard
Blank spaces indicate that the sample was not analyzed by the referenced method
NCD = No compounds detected
VPH = Volatile Petroleum Hydrocarbons
EPH = Extractable Petroleum Hydrocarbons
HBL = Health Based Level

Prepared By: WSB Date: 12/6/01
Checked By: WBD Date: 12/6/01

TABLES FROM

COMPREHENSIVE SITE ASSESSMENT ADDENDUM REPORT

TABLE 1 SUMMARY OF SOIL LABORATORY RESULTS

Date: October 2003 Incident Number and Name: Pending - AS-840 Facility ID#: N/A

Analytical Method: EPA Method 8260B/5035

Sample ID	Contaminant of Concern →		Toluene	All Other Analytes
	Date Collected	Sample Depth (ft. BGS)		
Residential MSCC (mg/kg)			3,200	Varies
Soil to Groundwater MSCC (mg/kg)			7	Varies
ASTAS840-MW-07 (0-2)	10/6/2003	0-2	<0.0055	BQL
ASTAS840-MW-08 (0-2)	10/6/2003	0-2	0.018	BQL
ASTAS840-MW-08 (0-2) D	10/6/2003	0-2	0.01	BQL

All results in mg/kg.

TABLE 2 SUMMARY OF SOIL LABORATORY RESULTS

Date: October 2003 Incident Number and Name: Pending - AS-840 Facility ID#: N/A

Analytical Method: EPA Method 8270

Sample ID	Contaminant of Concern →		All Analytes
	Date Collected	Sample Depth (ft. BGS)	
Residential MSCC (mg/kg) **Soil to Groundwater MSCC (mg/kg)**			Varies Varies
ASTAS840-MW-07 (0-2)	10/6/2003	0-2	BQL
ASTAS840-MW-08 (0-2)	10/6/2003	0-2	BQL

All results in mg/kg.

TABLE 3A SUMMARY OF SOIL LABORATORY RESULTS

Date: October 2003 Incident Number and Name: Pending - AS-840 Facility ID#: N/A

Analytical Method: MADEP VPH/EPH

Sample ID	Contaminant of Concern →		C9-C18 Aliphatics	C19-C36 Aliphatics	C11-C22 Aromatics	C5-C8 Aliphatics	C9-C12 Aliphatics	C9-C10 Aromatics
	Date Collected	Sample Depth (ft. BGS)						
ASTAS840-MW-07 (0-2)	10/6/2003	0-2	<10	<10	<10	<10	<10	<10
ASTAS840-MW-08 (0-2)	10/6/2003	0-2	<10	<10	<10	<10	<10	<10

All results in mg/kg.

TABLE 3B SUMMARY OF SOIL LABORATORY RESULTS

Date: October 2003 Incident Number and Name: Pending - AS-840 Facility ID#: N/A

Analytical Method: MADEP VPH/EPH AS COMPARED TO NCDENR MSCCs

Sample ID	Contaminant of Concern →		C5-C8 Aliphatics	C9-C18 Aliphatics	C19-C36 Aliphatics	C9-C22 Aromatics
	Date Collected	Sample Depth (ft. BGS)				
Residential MSCC (mg/kg) **Soil to Groundwater MSCC (mg/kg)**			939 72	9,386 3,255	93,860 ##	469 34
ASTAS840-MW-07 (0-2)	10/6/2003	0-2	<10	<20	<10	<20
ASTAS840-MW-08 (0-2)	10/6/2003	0-2	<10	<20	<10	<20

Considered immobile

All results in mg/kg.

TABLE 4 SUMMARY OF GROUNDWATER LABORATORY RESULTS

Date: October 2003 Incident Number and Name: Pending - AS-840 Facility ID#: N/A

Analytical Method: EPA Method 602

Well ID	Contaminant of Concern →		Ethylbenzene	All Other Analytes
	Sample ID	Date Collected		
2L GWQS (µg/L)			29	Varies
ASTAS840-MW-7	ASTAS840-MW-7	10/9/2003	5.2	BQL
ASTAS840-MW-8	ASTAS840-MW-8	10/9/2003	<1.0	BQL
ASTAS840-MW-8D	ASTAS840-MW-8D	10/9/2003	<1.0	BQL
Trip Blank	Trip Blank	10/9/2003	<1.0	BQL

All results in µg/L

TABLE 5 SUMMARY OF GROUNDWATER LABORATORY RESULTS

Date: October 2003 Incident Number and Name: Pending - AS-840 Facility ID#: N/A

Analytical Method: EPA Method 625

Well ID	Contaminant of Concern →		Acenaphthene	Fluorene	Phenanthrene	Pyrene	All Other Analytes
	Sample ID	Date Collected					
2L GWQS (µg/L)			80	280	210	210	Varies
ASTAS840-MW-7	ASTAS840-MW-7	10/9/2003	18	20	48	12	BQL
ASTAS840-MW-8	ASTAS840-MW-8	10/9/2003	<10	<10	<10	<10	BQL

All results in µg/L

TABLE 6A SUMMARY OF GROUNDWATER LABORATORY RESULTS

Date: October 2003 Incident Number and Name: Pending - AS-840 Facility ID#: N/A

Analytical Method: MADEP VPH/EPH

Well ID	Contaminant of Concern →		C9-C18 Aliphatics	C19-C36 Aliphatics	C11-C22 Aromatics	C5-C8 Aliphatics	C9-C12 Aliphatics	C9-C10 Aromatics
	Sample ID	Date Collected						
ASTAS840-MW-7	ASTAS840-MW-7	10/9/2003	780	280	3,000	<100	190	<100
ASTAS840-MW-8	ASTAS840-MW-8	10/9/2003	<100	<100	<100	<100	<100	<100

All results in µg/L

TABLE 6B SUMMARY OF GROUNDWATER LABORATORY RESULTS

Date: October 2003 Incident Number and Name: Pending - AS-840 Facility ID#: N/A

Analytical Method: MADEP VPH/EPH AS COMPARED TO NCDENR IGWQS

Well ID	Contaminant of Concern →		C5-C8 Aliphatics	C9-C18 Aliphatics	C19-C36 Aliphatics	C9-C22 Aromatics
	Sample ID	Date Collected				
IGWQS(µg/L)			420	4,200	42,000	210
ASTAS840-MW-7	ASTAS840-MW-7	10/9/2003	<100	970	280	**<3,100***
ASTAS840-MW-8	ASTAS840-MW-8	10/9/2003	<100	<200	<100	<200

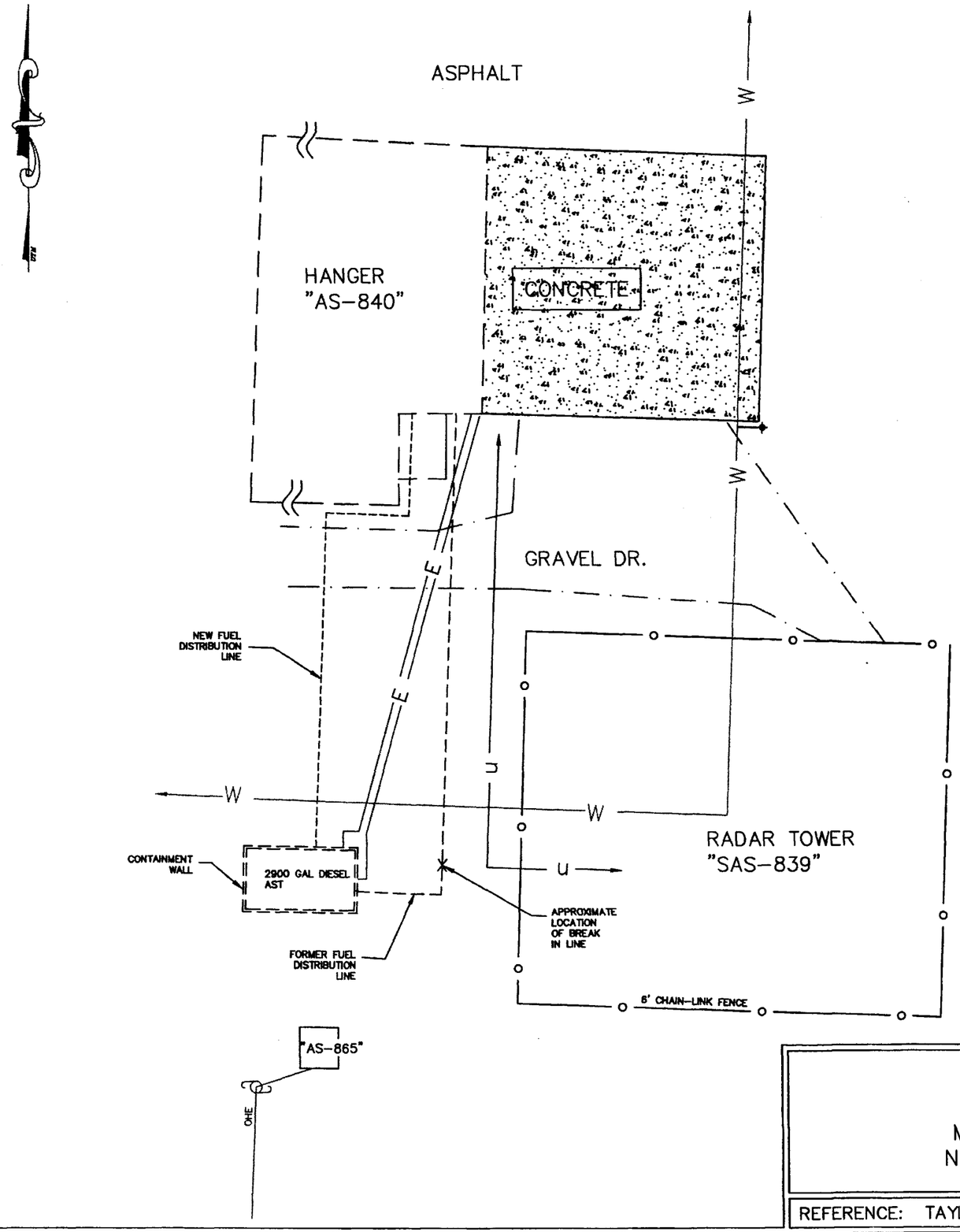
All results in µg/L.

* = Result equals the sum of the C11-C22 fraction result (3,000 µg/L) and the C9-C10 fraction quantitation limit (<100 µg/L).

Bold result indicates concentration is greater than the IGWQS.

FIGURES FROM

COMPREHENSIVE SITE ASSESSMENT REPORT



EXPLANATION

═E═	ELECTRICITY
—u—	UNKNOWN UTILITY
—W—	WATER
—●—	HYDRANT
—o—o—o—	CHAIN LINK FENCE
OHE	OVERHEAD ELECTRICITY

NOTE: LAND MARK LOCATIONS SURVEYED IN THE FIELD BY TAYLOR WISEMAN & TAYLOR.
SUBSURFACE UTILITIES LOCATED IN THE FIELD BY PROFESSIONAL LOCATING SERVICES.

GRAPHIC SCALE – IN FEET

30 15 0 30 60

G:\CADD\40-60600\AS840CSA\FIGURE 3

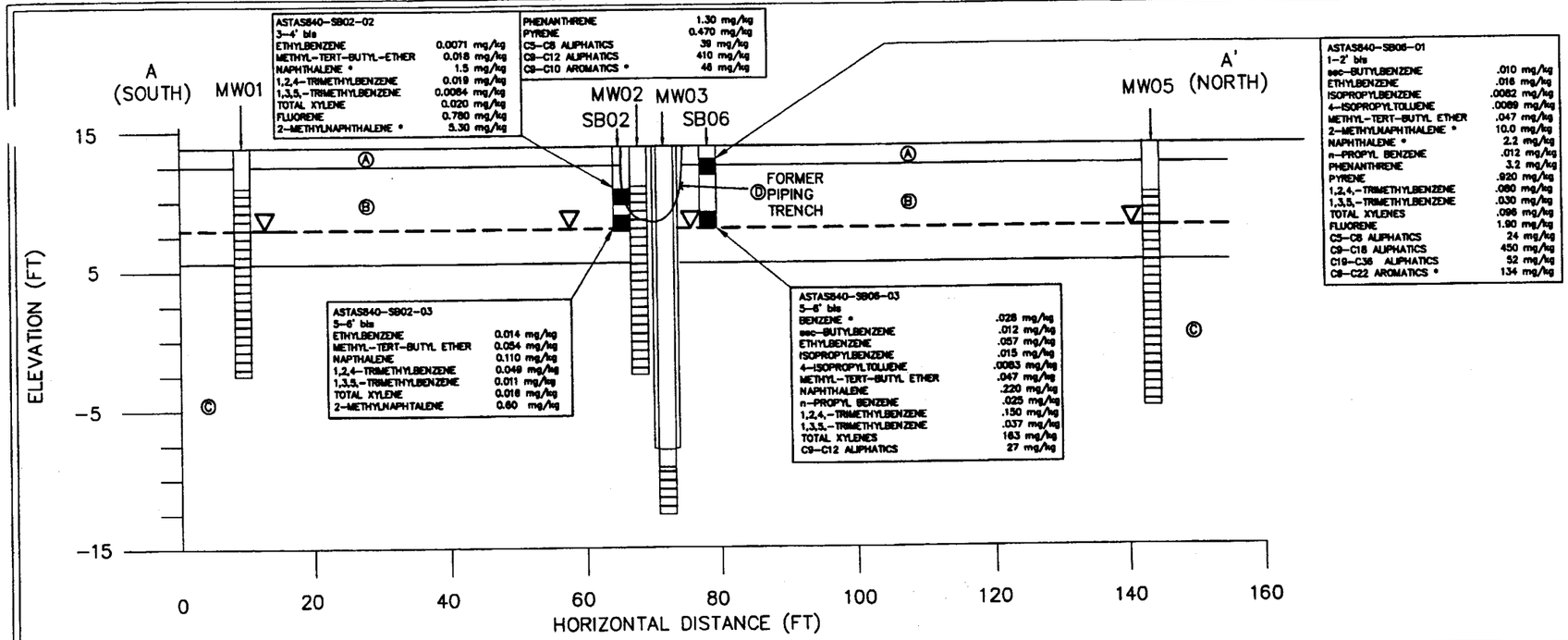
LAW ENGINEERING AND ENVIRONMENTAL SERVICES, INC.
RALEIGH, NORTH CAROLINA

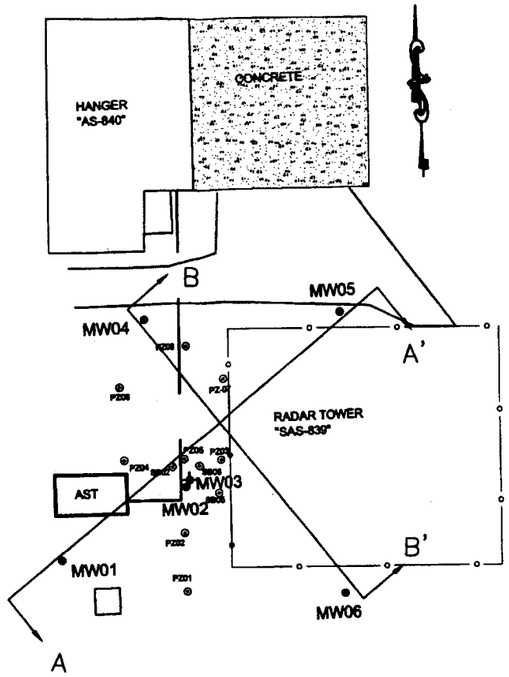
SITE LOCATION MAP
BUILDING AS-840
MARINE CORPS AIR STATION
NEW RIVER, NORTH CAROLINA

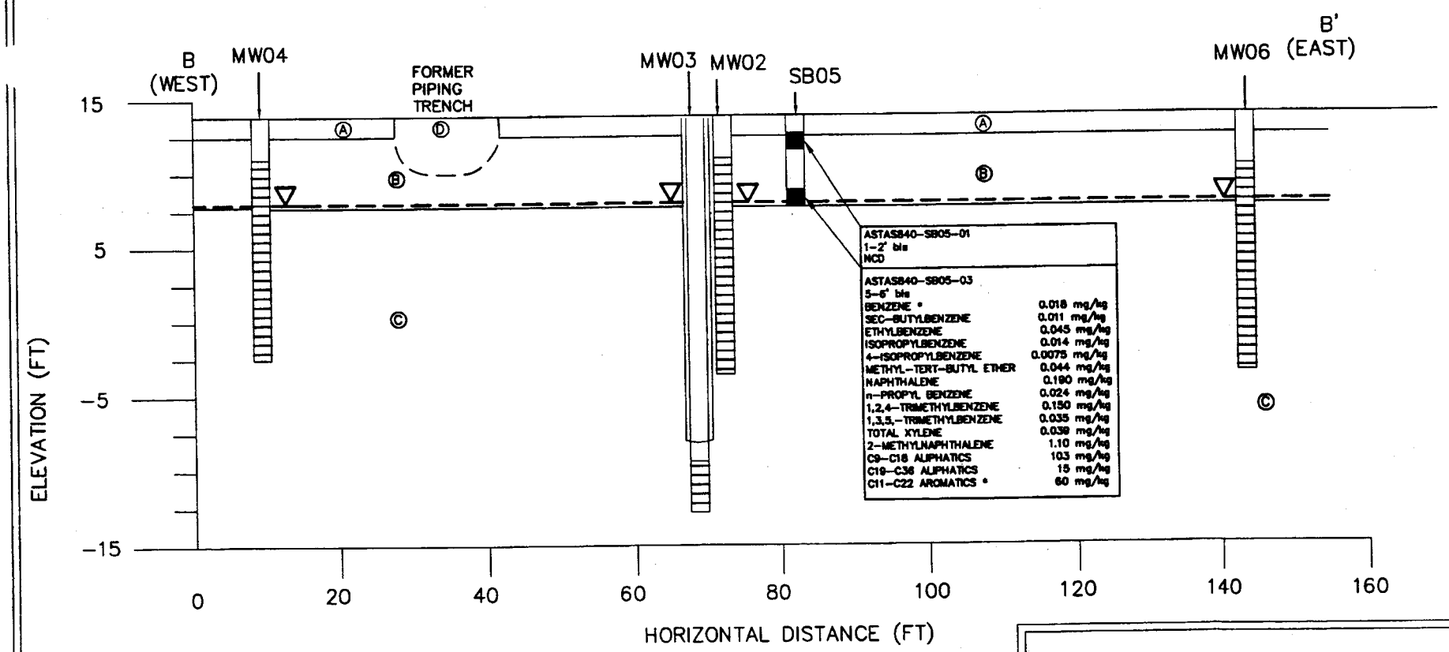
DRAWN: C.M.	DATE: AUGUST 2002
DFT CHECK: WBD	SCALE: 1" = 30'
ENG CHECK: WSV	JOB: 30740-6-0600-113
APPROVAL: BAB	FIGURE: 3

REFERENCE: TAYLOR, WISEMAN, AND TAYLOR WELL LOCATION DRAWING; FIELD NOTES

06 01 BB B07







EXPLANATION

Ⓐ TAN TO DARK BROWN, SLIGHTLY CLAYEY, SILTY FINE TO COARSE SAND (SM) WITH ORGANICS AND GRAVEL.

Ⓑ TAN AND GRAY, SILTY, FINE SANDY CLAY (CL)

Ⓒ TAN AND GRAY, SILTY, FINE TO COARSE SAND (SM)

Ⓓ FILL: GRAY, SILTY, FINE SAND (SM)

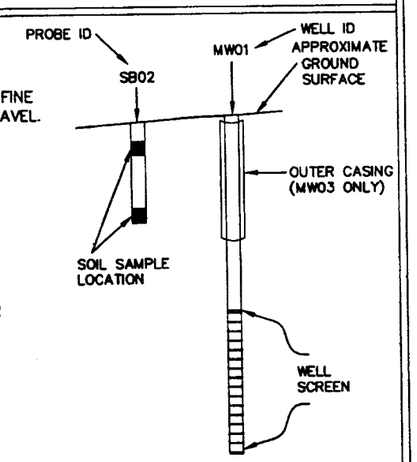
APPROXIMATE POSITION OF WATER TABLE ON JUNE 22, 2001

GROUND SURFACE AT WELLS AND TOP OF CASING ELEVATIONS DETERMINED BY TAYLOR WISEMAN & TAYLOR

bls BELOW LAND SURFACE

NCD NO COMPOUNDS DETECTED

* CONCENTRATION EXCEEDS SOIL-TO-GROUNDWATER MSCC



SCALE:
VERTICAL 1"=10'
HORIZONTAL 1"=20'

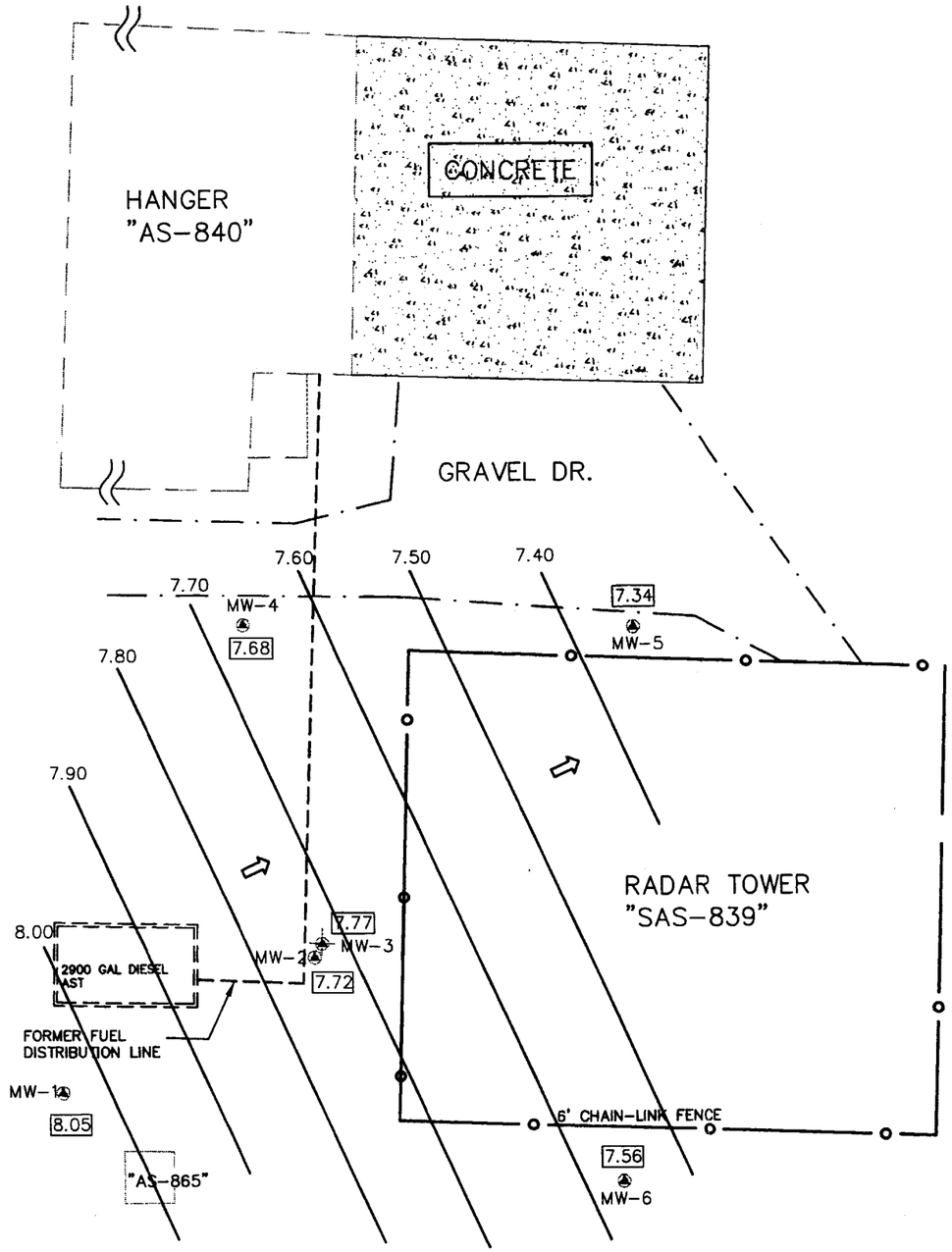
G:\CADD\40-60600\AS840CSA\FIGURE 4

LAW ENGINEERING AND ENVIRONMENTAL SERVICES, INC.
RALEIGH, NORTH CAROLINA

HYDROGEOLOGIC CROSS-SECTIONS
BUILDING AS-840
MARINE CORPS AIR STATION
NEW RIVER, NORTH CAROLINA

DRAWN: KRT	DATE: NOVEMBER 2001
DFT CHECK: WBT	SCALE: AS SHOWN
ENG CHECK: GAW	JOB:30740-6-0600-113
APPROVAL: RJB	FIGURE: 4

REFERENCE: TAYLOR WISEMAN & TAYLOR WELL LOCATION DRAWING; FIELD NOTES



EXPLANATION

- TYPE II MONITORING WELL
- TYPE III MONITORING WELL
- POWER PROBE GROUNDWATER SAMPLE LOCATION
- ND — ETHYLBENZENE NOT DETECTED
- 8.05 — GROUNDWATER ELEVATION AT MONITORING WELL LOCATION
- DIRECTION OF GROUNDWATER FLOW

NOTE: GROUNDWATER ELEVATIONS MEASURED 6/22/01. TYPE III WELL NOT CONSIDERED FOR GROUNDWATER CONTOURS.

GRAPHIC SCALE – IN FEET

30 15 0 30 60

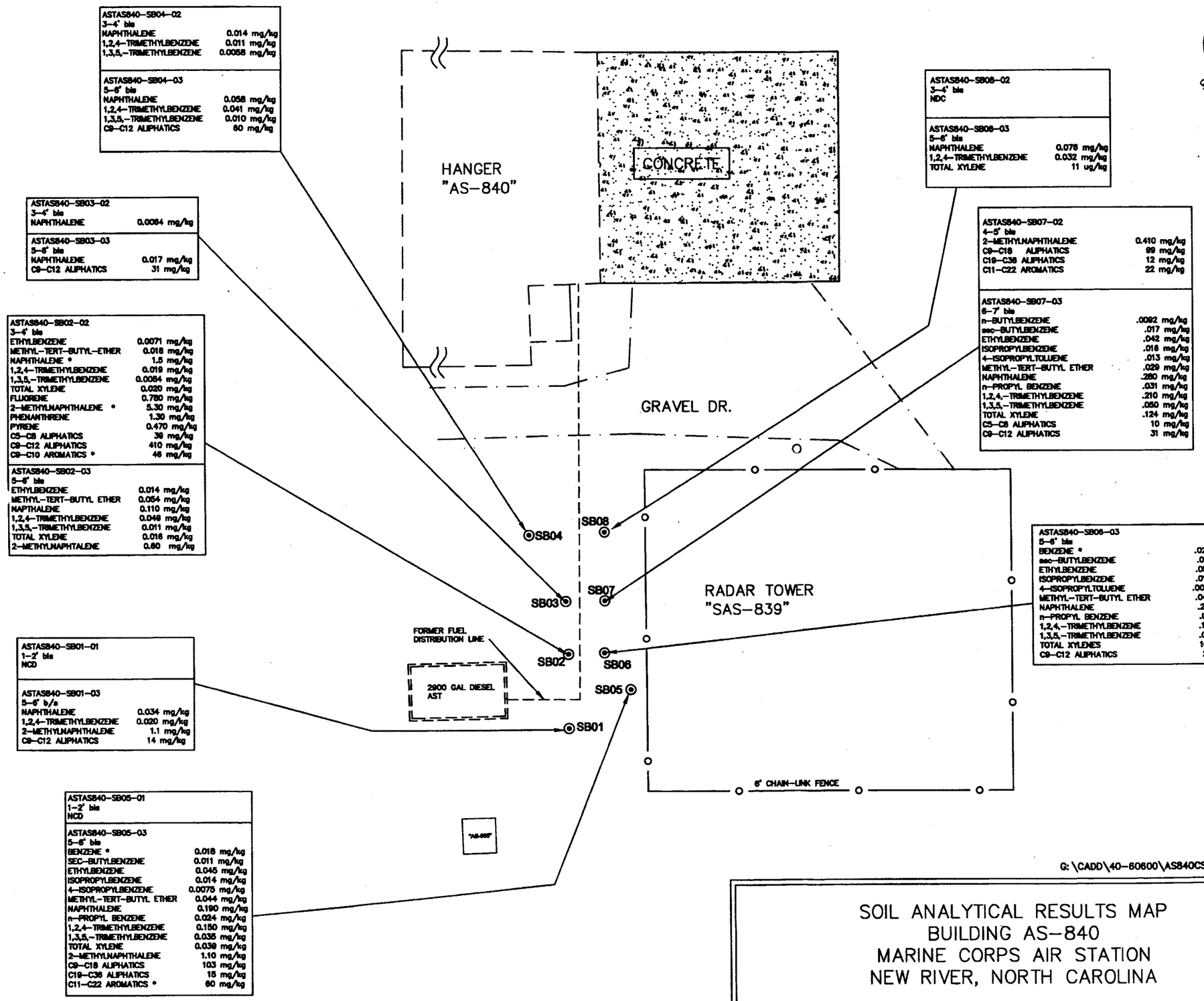
LAW ENGINEERING AND ENVIRONMENTAL SERVICES, INC.
RALEIGH, NORTH CAROLINA

G:\CADD\40-60600\AS840CSA\FIGURE5

GROUND WATER ELEVATION MAP
BUILDING AS-840
MARINE CORPS AIR STATION
NEW RIVER, NORTH CAROLINA

DRAWN: C.M.	DATE: OCTOBER 2001
DFT CHECK: WTD	SCALE: 1" = 30'
ENG CHECK: GKM	JOB: 30740-6-0600-113
APPROVAL: RJB	FIGURE: 5

REFERENCE: TAYLOR, WISEMAN, AND TAYLOR WELL LOCATION DRAWING; FIELD NOTES



EXPLANATION

⊙ POWER PROBE SOIL SAMPLE LOCATION ON 4/19/01

NDC NO COMPOUNDS DETECTED

bls SAMPLE DEPTH "BELOW LAND SURFACE"

ASTAS840-SB01-03 SAMPLE IDENTIFICATION

* CONCENTRATION EXCEEDS SOIL-TO-GROUNDWATER MSCC

NOTE: POWER PROBE LOCATIONS SURVEYED IN THE FIELD BY TAYLOR WISEMAN & TAYLOR

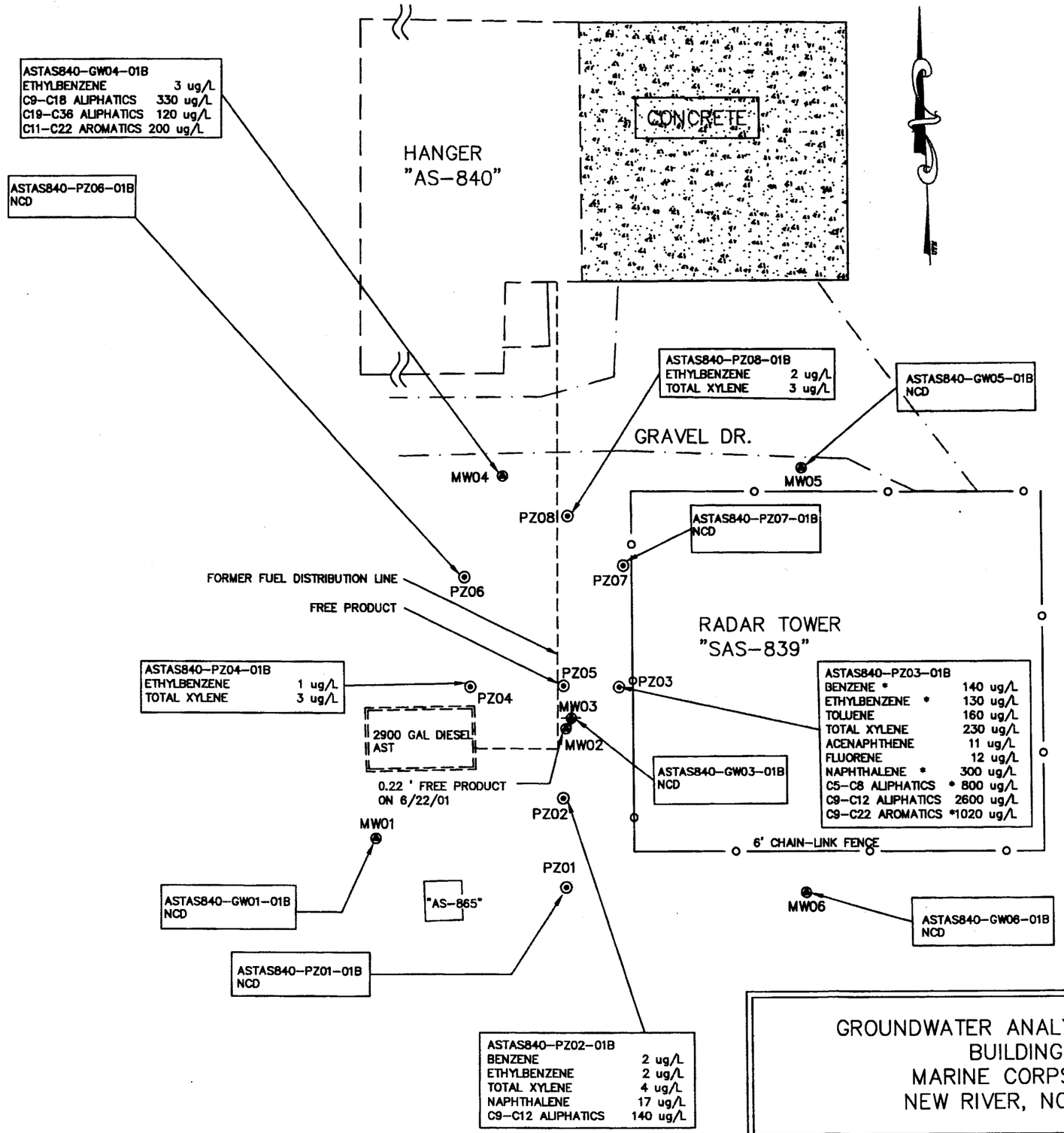
G:\CADD\40-60600\AS840CSA\FIGURE 6

LAW ENGINEERING AND ENVIRONMENTAL SERVICES, INC.
RALEIGH, NORTH CAROLINA

SOIL ANALYTICAL RESULTS MAP
BUILDING AS-840
MARINE CORPS AIR STATION
NEW RIVER, NORTH CAROLINA

DRAWN: C.M.	DATE: AUGUST 2002
DFT CHECK: WBD	SCALE: 1" = 30'
ENG CHECK: WSB	JOB: 30740-6-0600-113
APPROVAL: BJB	FIGURE: 6

REFERENCE: TAYLOR, WISEMAN, AND TAYLOR WELL LOCATION DRAWING; FIELD NOTES



EXPLANATION

▲	TYPE II MONITORING WELL
◆	TYPE III MONITORING WELL
⊙	POWER PROBE GROUNDWATER SAMPLE LOCATION
NCD	NO COMPOUNDS DETECTED
ASTAS840-PZ01-01B	PIEZOMETER SAMPLE ID; SAMPLED 4/20/01
ASTAS840-GW01-01B	MONITORING WELL SAMPLE ID; SAMPLED 6/22/01
*	CONCENTRATION EXCEEDS 2L STANDARD

NOTE: POWER PROBE AND WELL LOCATIONS SURVEYED IN THE FIELD BY TAYLOR WISEMAN & TAYLOR

GRAPHIC SCALE – IN FEET

30 15 0 30 60

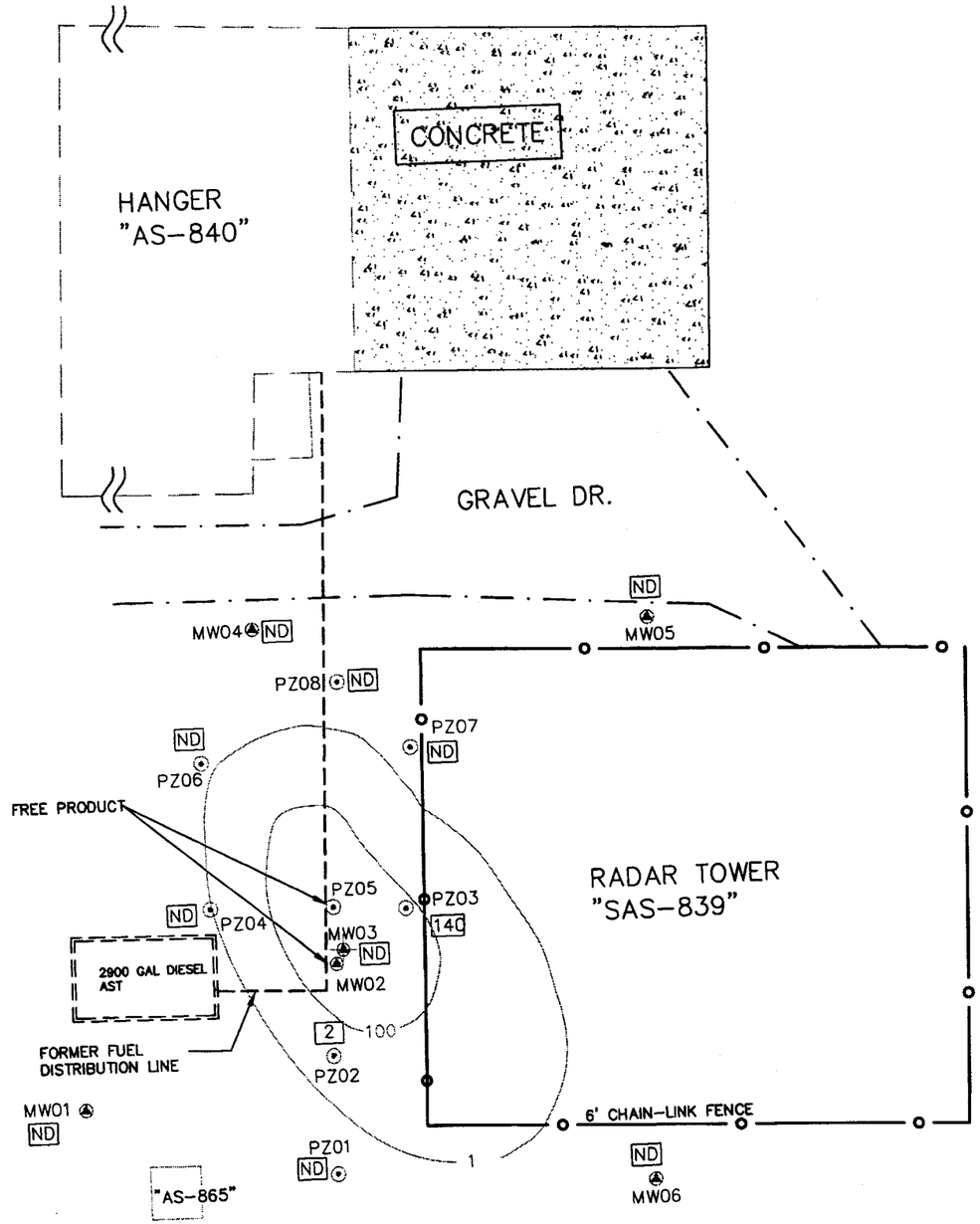
G:\CADD\40-60600\AS840CSA\FIGURE7

LAW ENGINEERING AND ENVIRONMENTAL SERVICES, INC.
RALEIGH, NORTH CAROLINA

GROUNDWATER ANALYTICAL RESULTS MAP
BUILDING AS-840
MARINE CORPS AIR STATION
NEW RIVER, NORTH CAROLINA

DRAWN: C.M.	DATE: AUGUST 2002
DFT CHECK: WBD	SCALE: 1" = 30'
ENG CHECK: WSL	JOB: 30740-6-0600-113
APPROVAL: BJB	FIGURE: 7

REFERENCE: TAYLOR, WISEMAN, AND TAYLOR WELL LOCATION DRAWING; FIELD NOTES



EXPLANATION

- TYPE II MONITORING WELL
- TYPE III MONITORING WELL
- POWER PROBE GROUNDWATER SAMPLE LOCATION
- ND — BENZENE NOT DETECTED
- 10 — BENZENE CONCENTRATION IN ug/L WELLS SAMPLED 6/22/01 PIEZOMETERS SAMPLED 4/20/01
- —100— BENZENE CONTOUR IN ug/L

NOTE: POWER PROBE AND WELL LOCATIONS SURVEYED IN THE FIELD BY TAYLOR WISEMAN & TAYLOR

GRAPHIC SCALE – IN FEET

30 15 0 30 60

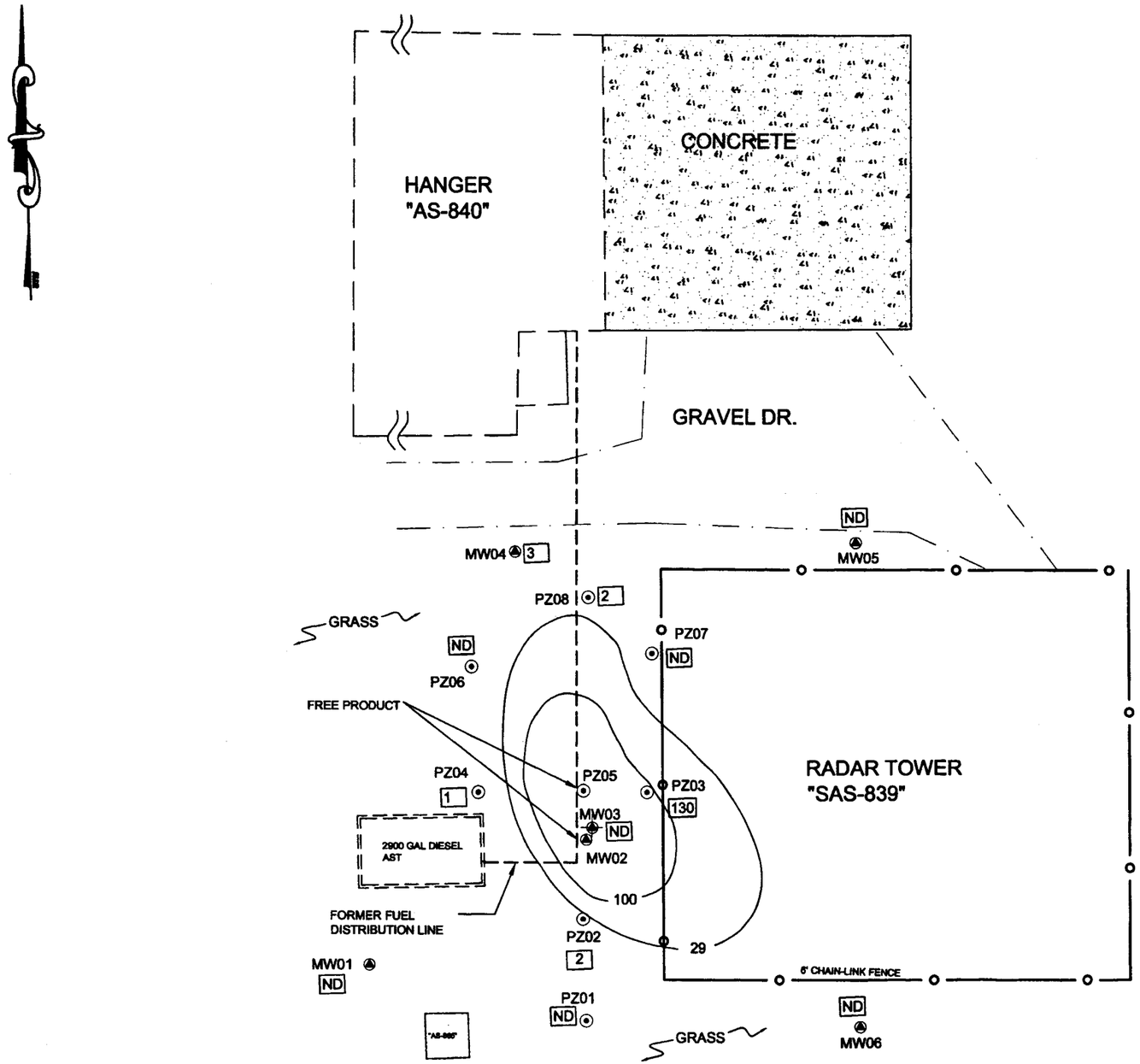
G:\CADD\40-60600\AS840CSA\FIGURE8

LAW ENGINEERING AND ENVIRONMENTAL SERVICES, INC.
RALEIGH, NORTH CAROLINA

BENZENE ISOPLETH MAP
BUILDING AS-840
MARINE CORPS AIR STATION
NEW RIVER, NORTH CAROLINA

DRAWN: C.M.	DATE: OCTOBER 2001
DFT CHECK: WBD	SCALE: 1" = 30'
ENG CHECK: JAM	JOB: 30740-6-0600-113
APPROVAL: EJB	FIGURE: 8

REFERENCE: TAYLOR, WISEMAN, AND TAYLOR WELL LOCATION DRAWING; FIELD NOTES



EXPLANATION

TYPE II MONITORING WELL

TYPE III MONITORING WELL

POWER PROBE GROUNDWATER SAMPLE LOCATION

ND — ETHYLBENZENE NOT DETECTED

10 — ETHYLBENZENE CONCENTRATION IN ug/L
WELLS SAMPLED 6/22/01
PIEZOMETERS SAMPLED 4/20/01

—100— ETHYLBENZENE CONTOUR IN ug/L

NOTE: POWER PROBE AND WELL LOCATIONS SURVEYED IN THE FIELD BY TAYLOR WISEMAN & TAYLOR

GRAPHIC SCALE – IN FEET

30 15 0 30 60

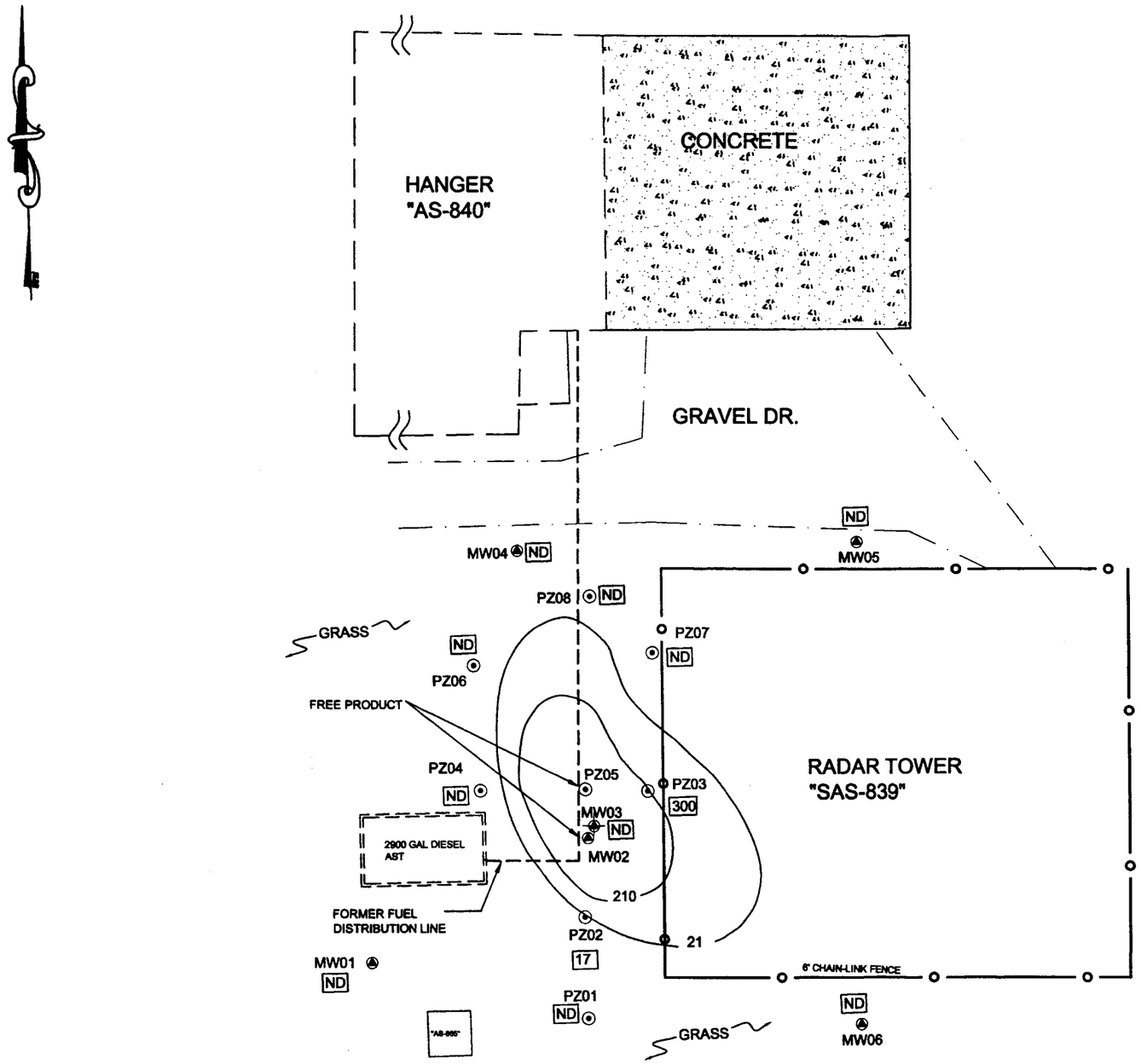
G:\CADD\40-60600\AS840CSA\FIGURE9

LAW ENGINEERING AND ENVIRONMENTAL SERVICES, INC.
RALEIGH, NORTH CAROLINA

ETHYLBENZENE ISOPLETH MAP
BUILDING AS-840
MARINE CORPS AIR STATION
NEW RIVER, NORTH CAROLINA

DRAWN: C.M.	DATE: OCTOBER 2001
DFT CHECK: WBD	SCALE: 1" = 30'
ENG CHECK: JAM	JOB: 30740-6-0600-113
APPROVAL: EJB	FIGURE: 9

REFERENCE: TAYLOR, WISEMAN, AND TAYLOR WELL LOCATION DRAWING; FIELD NOTES



EXPLANATION

TYPE II MONITORING WELL

TYPE III MONITORING WELL

POWER PROBE GROUNDWATER SAMPLE LOCATION

ND — NAPHTHALENE NOT DETECTED

10 — NAPHTHALENE CONCENTRATION IN ug/L
WELLS SAMPLED 6/22/01
PIEZOMETERS SAMPLED 4/20/01

—100— NAPHTHALENE CONTOUR IN ug/L

NOTE: POWER PROBE AND WELL LOCATIONS SURVEYED IN THE FIELD BY TAYLOR WISEMAN & TAYLOR

GRAPHIC SCALE – IN FEET

30 15 0 30 60

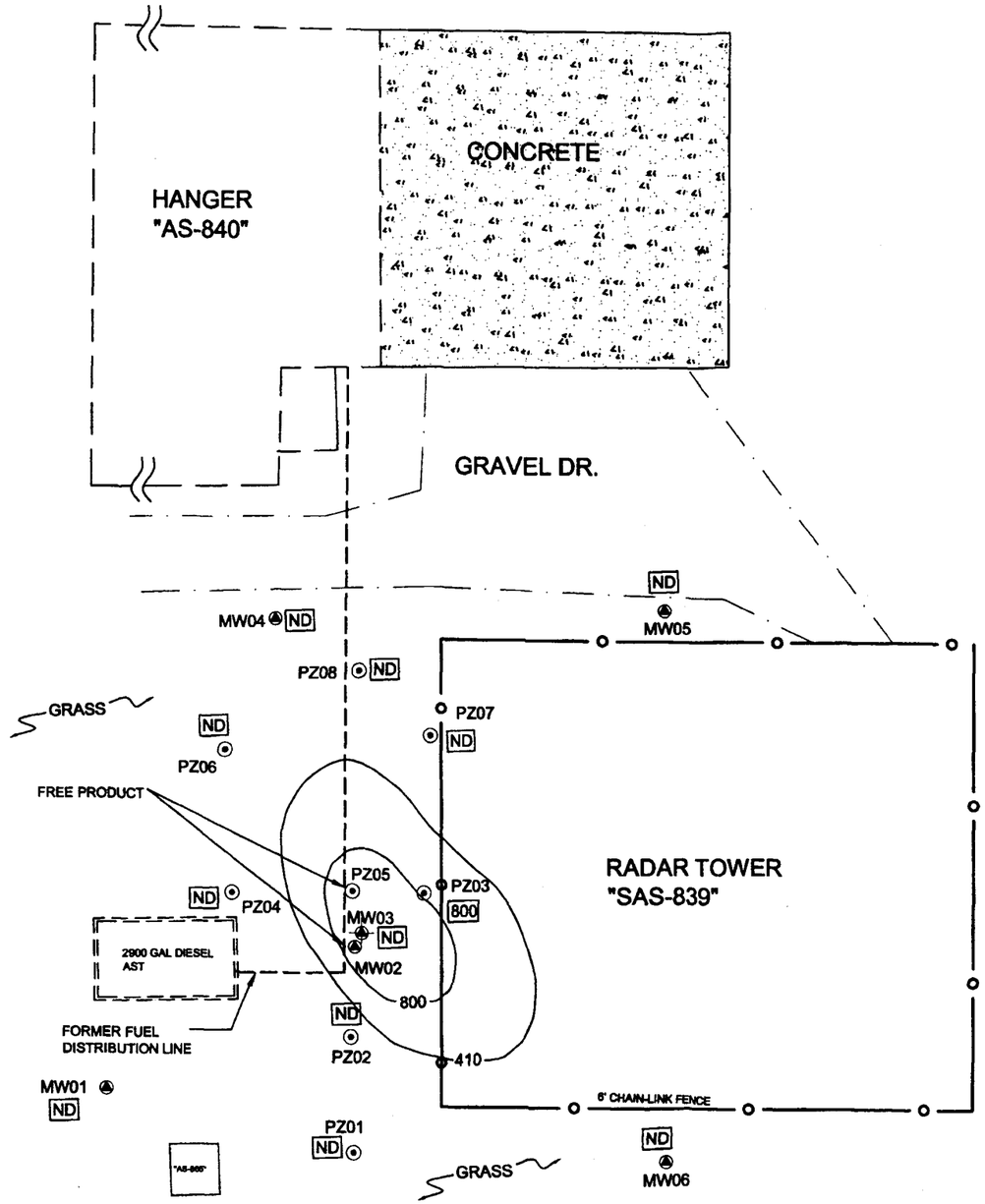
LAW ENGINEERING AND ENVIRONMENTAL SERVICES, INC.
RALEIGH, NORTH CAROLINA

G:\CADD\40-60600\AS840CSA\FIGURE10

NAPHTHALENE ISOPLETH MAP
BUILDING AS-840
MARINE CORPS AIR STATION
NEW RIVER, NORTH CAROLINA

DRAWN: C.M.	DATE: OCTOBER 2001
DFT CHECK: WBD	SCALE: 1" = 30'
ENG CHECK: CAM	JOB: 30740-6-0600-113
APPROVAL:	FIGURE: 10

REFERENCE: TAYLOR, WISEMAN, AND TAYLOR WELL LOCATION DRAWING; FIELD NOTES



EXPLANATION

▲	TYPE II MONITORING WELL
⊕	TYPE III MONITORING WELL
⊙	POWER PROBE GROUNDWATER SAMPLE LOCATION
ND	C5–C8 ALIPHATICS NOT DETECTED
10	C5–C8 ALIPHATICS CONCENTRATION IN ug/L WELLS SAMPLED 6/22/01 PIEZOMETERS SAMPLED 4/20/01
—100—	ALIPHATICS CONTOUR IN ug/L

NOTE: POWER PROBE AND WELL LOCATIONS SURVEYED IN THE FIELD BY TAYLOR WISEMAN & TAYLOR

GRAPHIC SCALE – IN FEET

30 15 0 30 60

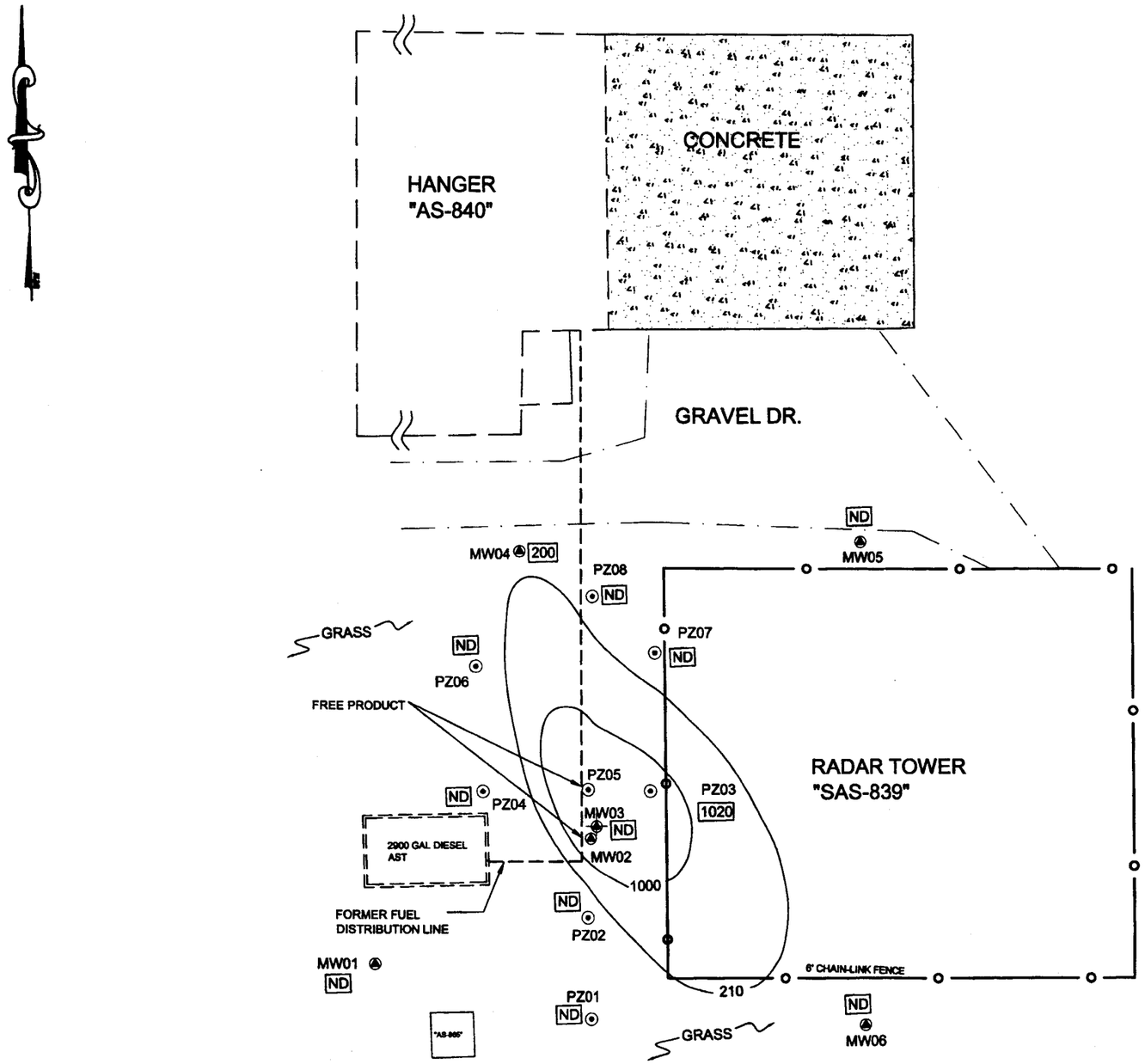
G:\CADD\40–60600\AS840CSA\FIGURE 11

LAW ENGINEERING AND ENVIRONMENTAL SERVICES, INC.
RALEIGH, NORTH CAROLINA

C5–C8 ALIPHATICS ISOPLETH MAP
BUILDING AS–840
MARINE CORPS AIR STATION
NEW RIVER, NORTH CAROLINA

DRAWN: C.M.	DATE: OCTOBER 2001
DFT CHECK: WBD	SCALE: 1" = 30'
ENG CHECK: DAM	JOB: 30740–6–0600–113
APPROVAL: BJB	FIGURE: 11

REFERENCE: TAYLOR, WISEMAN, AND TAYLOR WELL LOCATION DRAWING; FIELD NOTES



EXPLANATION

TYPE II MONITORING WELL

TYPE III MONITORING WELL

POWER PROBE GROUNDWATER SAMPLE LOCATION

ND — C9–C22 AROMATICS NOT DETECTED

1020 — C9–C22 AROMATICS CONCENTRATION IN ug/L
WELLS SAMPLED 6/22/01
PIEZOMETERS SAMPLED 4/20/01

—100— C9–C22 AROMATICS CONTOUR IN ug/L

NOTE: POWER PROBE AND WELL LOCATIONS SURVEYED IN THE FIELD BY TAYLOR WISEMAN & TAYLOR

GRAPHIC SCALE – IN FEET

30 15 0 30 60

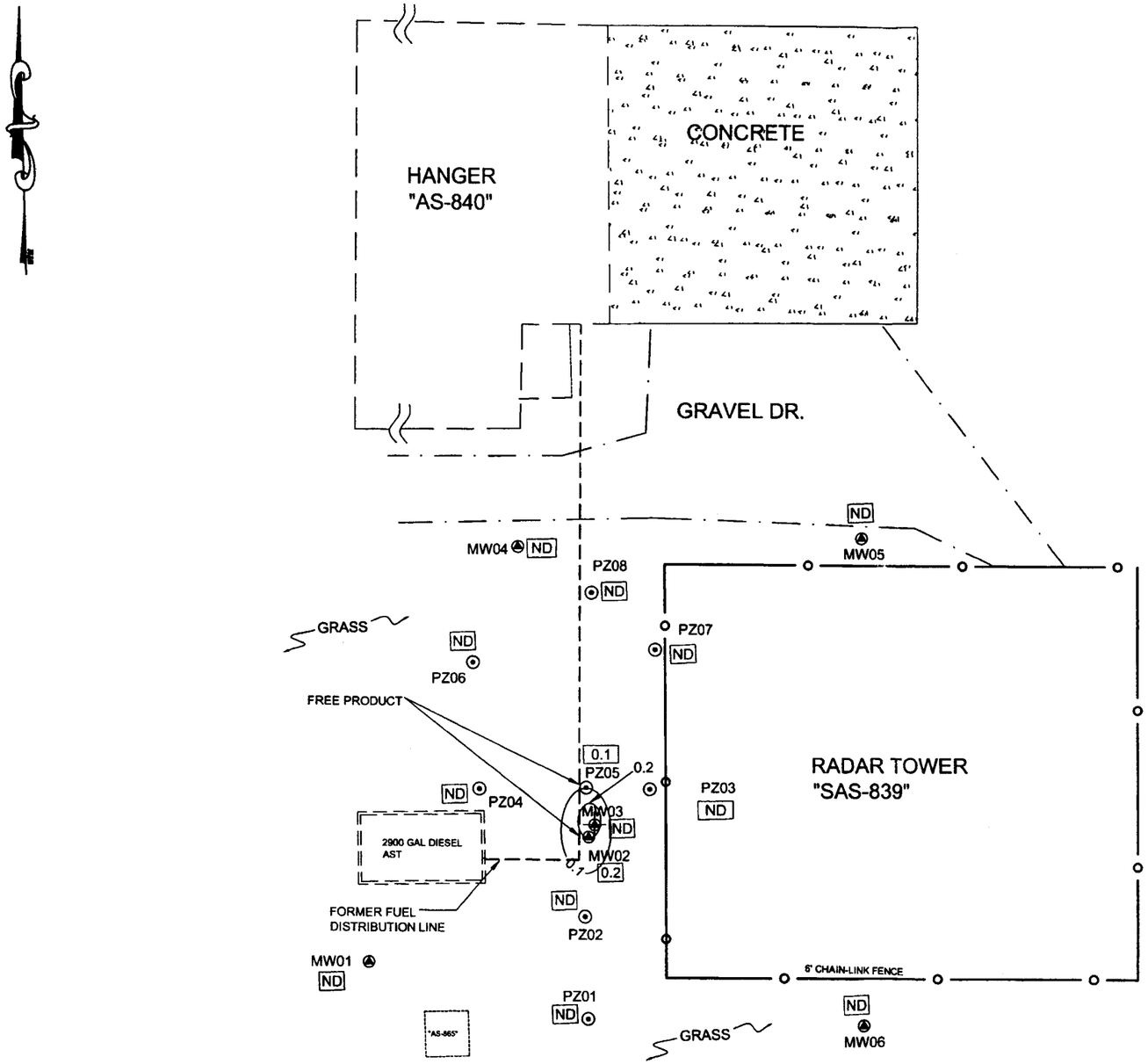
G:\CADD\40-60600\AS840CSA\FIGURE 12

LAW ENGINEERING AND ENVIRONMENTAL SERVICES, INC.
RALEIGH, NORTH CAROLINA

C9–22 AROMATICS ISOPLETH MAP
BUILDING AS–840
MARINE CORPS AIR STATION
NEW RIVER, NORTH CAROLINA

DRAWN: C.M.	DATE: OCTOBER 2001
DFT CHECK: WBT	SCALE: 1" = 30'
ENG CHECK: JAM	JOB: 30740-6-0600-113
APPROVAL: BJB	FIGURE: 12

REFERENCE: TAYLOR, WISEMAN, AND TAYLOR WELL LOCATION DRAWING; FIELD NOTES



EXPLANATION

TYPE II MONITORING WELL

TYPE III MONITORING WELL

POWER PROBE GROUNDWATER SAMPLE LOCATION

ND — FREE PRODUCT NOT DETECTED

0.2 — FREE PRODUCT THICKNESS IN FEET
WELLS GAUGED 6/22/01
PIEZOMETERS GAUGED 4/20/01

—0.2— FREE PRODUCT CONTOUR IN FEET

NOTE: POWER PROBE AND WELL LOCATIONS SURVEYED IN THE FIELD BY TAYLOR WISEMAN & TAYLOR

GRAPHIC SCALE – IN FEET

30 15 0 30 60

G:\CADD\40-60600\AS840CSA\FIGURE 13

LAW ENGINEERING AND ENVIRONMENTAL SERVICES, INC.
RALEIGH, NORTH CAROLINA

FREE PRODUCT THICKNESS MAP
BUILDING AS-840
MARINE CORPS AIR STATION
NEW RIVER, NORTH CAROLINA

DRAWN: C.M.	DATE: OCTOBER 2001
DFT CHECK: WJD	SCALE: 1" = 30'
ENG CHECK: —	JOB: 30740-6-0600-113
APPROVAL: RJB	FIGURE: 13

REFERENCE: TAYLOR, WISEMAN, AND TAYLOR WELL LOCATION DRAWING; FIELD NOTES

APPENDIX B

AGGRESSIVE FLUID VAPOR RECOVERY DATA

DATA OBTAINED FROM

COMPREHENSIVE SITE ASSESSMENT REPORT

Table 5 **Free Product Recovery Results**

Date: 1/08/02 **Incident No. and Name: No. Pending, MCAS Building AS-840** **Facility ID#: NA**

Free Product Recovery Method: Aggressive Fluid Vapor Recovery

Method of Measurement: Interface Probe and Flame Ionization Detector

Well ID	Product Type	Date of Recovery (m/dd/yy)	Well Casing Diameter (inches)	Product Thickness before Recovery (feet)	Product Thickness after Recovery (feet)	Product Recovered as Vapor (gallons)	Product Recovered as Liquid (gallons)	Total Estimated Product Recovered (gallons)	Depth to Water (feet)
MW02	Diesel	7/31/01	2	2.70	Non Detect	8.9	4.0	12.9	8.81
MW02	Diesel	8/08/01	2	1.51	Non Detect	8.6	3.0	11.6	7.93
MW02	Diesel	8/13/01	2	0.61	Non Detect	8.9	3.0	11.9	7.24
MW02	Diesel	8/21/01	2	0.60	Non Detect	8.8	4.0	12.8	7.53
MW02	Diesel	8/27/01	2	0.82	Non Detect	10.0	4.0	14.0	7.70
MW02	Diesel	9/07/01	2	0.86	Non Detect	8.8	3.0	11.8	7.48
MW02	Diesel	9/25/01	2	1.83	Non Detect	8.9	4.0	12.9	8.21
MW02	Diesel	10/11/01	2	0.26	Non Detect	9.1	2.0	11.1	8.45
MW02	Diesel	10/23/01	2	0.43	Non Detect	9.0	3.0	12.0	8.61
MW02	Diesel	10/30/01	2	1.59	Non Detect	9.0	3.5	12.5	9.41
MW02	Diesel	11/03/01	2	0.23	Non Detect	4.7	0.5	5.2	8.24
MW02	Diesel	11/16/01	2	0.44	Non Detect	5.7	1.0	6.7	8.69
MW02	Diesel	12/11/01	2	0.35	Non Detect	6.0	0.5	6.5	9.24
MW02	Diesel	1/13/02	2	1.56	Non Detect	4.6	1.0	5.6	9.55
MW02	Diesel	1/24/02	2	1.41	Non Detect	4.4	1.2	5.6	8.17
MW02	Diesel	2/5/02	2	0.28	Non Detect	5.9	0.5	6.4	7.43
MW02	Diesel	2/25/02	2	0.95	Non Detect	5.9	1.0	6.9	7.62
MW02	Diesel	3/5/02	2	0.49	Non Detect	6.2	0.5	6.7	7.33
MW02	Diesel	3/15/02	2	0.87	Non Detect	5.7	0.8	6.5	6.10
MW02	Diesel	3/26/02	2	1.19	Non Detect	7.0	1.5	8.5	7.42
MW02	Diesel	4/9/02	2	0.84	Non Detect	7.3	1.0	8.3	7.40
MW02	Diesel	4/19/02	2	0.85	Non Detect	8.4	1.3	9.7	7.92
MW02	Diesel	4/29/02	2	0.72	Non Detect	7.2	1.0	8.2	7.78
MW02	Diesel	5/13/02	2	0.87	Non Detect	10.6	1.2	11.8	8.03
MW02	Diesel	5/20/02	2	0.87	Non Detect	11.3	1.2	12.5	8.38
MW02	Diesel	5/28/02	2	0.56	Non Detect	8.6	0.7	9.3	8.44
MW02	Diesel	6/4/02	2	0.48	Non Detect	9.7	0.5	10.2	8.37
MW02	Diesel	6/14/02	2	0.43	Non Detect	9.5	0.5	10.0	8.49
MW02	Diesel	6/25/02	2	0.56	Non Detect	10.7	0.8	11.5	8.70
MW02	Diesel	7/12/02	2	0.70	Non Detect	10.9	1.0	11.9	8.43
MW02	Diesel	7/23/02	2	0.65	Non Detect	10.9	1.0	11.9	8.36
Total Gallons of Product Recovered to through July 2002						251.2	51.5	302.7	

DATA PROVIDED BY SHAW ENVIRONMENTAL, INC.

Aggressive Fluid Vapor Recovery (AFVR)
Summary of Free Product Recovery Events
TABLE 3

Facility: Building AS-840
Location: MCB Camp Lejeune, North Carolina
Date: 6/4/2002

Event #	Date	Rec Prod (lbs)	Rec Prod. (gals)	Total Cum (lbs) to date	Level (ft TOC)	AFVR WELLS				MONITORING WELLS			
						MW-2				MW-3			
17	2/25/2002	43.2	6.9	1044.3	Product level	6.67				0			
					Water level	7.62				6.94			
18	3/5/2002	42.0	6.7	1086.3	Product level	6.84				0			
					Water level	7.33				6.13			
19	3/15/2002	40.8	6.5	1127.1	Product level	5.23				0			
					Water level	6.10				5.74			
20	3/26/2002	53.2	8.5	1180.3	Product level	6.23				0			
					Water level	7.42				6.52			
21	4/9/2002	51.8	8.3	1232.1	Product level	6.56				0			
					Water level	7.40				6.78			
22	4/19/2002	60.6	9.7	1292.7	Product level	7.07				0			
					Water level	7.92				7.41			
23	4/29/2002	51.5	8.2	1344.2	Product level	7.06				0			
					Water level	7.78				7.33			
24	5/13/2002	74.3	11.8	1418.5	Product level	7.16				0			
					Water level	8.03				7.39			
25	5/20/2002	78.6	12.5	1497.1	Product level	7.51				0			
					Water level	8.38				7.54			
26	5/28/2002	58.7	9.3	1555.8	Product level	7.88				0			
					Water level	8.44				8.01			
27	6/4/2002	64.4	10.2	1620.2	Product level	7.89				0			
					Water level	8.37				8.08			

NOTE: N = Not Encountered
Product type: Gasoline

Aggressive Fluid Vapor Recovery (AFVR)
Summary of Free Product Recovery Events
TABLE 3

Facility: Building AS-840
Location: MCB Camp Lejeune, North Carolina
Date: 12/10/2002

Event #	Date	Rec Prod (lbs)	Rec Prod. (gals)	Total Cum (lbs) to date	Level (ft TOC)	AFVR WELLS				MONITORING WELLS			
						MW-2				MW-3			
27	6/4/2002	64.4	10.2	1620.2	Product level	7.89				0			
					Water level	8.37				8.08			
28	6/14/2002	64.0	10.0	1682.8	Product level	8.06				0			
					Water level	8.49				8.22			
29	6/25/2002	71.9	11.5	1692.1	Product level	8.14				0			
					Water level	8.70				8.33			
30	7/12/2002	74.6	11.9	1766.7	Product level	7.73				0			
					Water level	8.43				7.91			
31	7/23/2002	74.9	11.9	1841.6	Product level	7.71				0			
					Water level	8.36				7.94			
32	8/2/2002	72.1	11.5	1913.7	Product level	6.71				0			
					Water level	7.28				6.90			
33	8/13/2002	73.1	11.6	1986.8	Product level	7.46				0			
					Water level	8.06				7.95			
34	9/11/2002	71.9	11.4	2058.7	Product level	5.94				0			
					Water level	6.58				6.21			
35	10/4/2002	71.1	11.3	2129.8	Product level	6.14				0			
					Water level	6.68				6.41			
36	11/8/2002	76.7	12.2	2206.5	Product level	6.41				0			
					Water level	7.60				6.78			
37	11/13/2002	53.8	8.6	2260.3	Product level	6.33				0			
					Water level	7.05				6.60			
38	12/10/2002	60.3	9.6	2320.6	Product level	6.89				0			
					Water level	7.40				7.22			

NOTE: N = Not Encountered
Product type: Gasoline

Aggressive Fluid Vapor Recovery (AFVR)
Summary of Free Product Recovery Events
TABLE 3

Facility: Building AS-840
Location: MCB Camp Lejeune, North Carolina
Date: 11/11/2003

Event #	Date	Rec Prod (lbs)	Rec Prod. (gals)	Total Cum (lbs) to date	Level (ft TOC)	AFVR WELLS				MONITORING WELLS			
						MW-2				MW-3			
35	10/4/2002	71.1	11.3	2129.8	Product level	6.14				0			
					Water level	6.68				6.41			
36	11/8/2002	76.7	12.2	2206.5	Product level	6.41				0			
					Water level	7.60				6.78			
37	11/13/2002	53.8	8.6	2260.3	Product level	6.33				0			
					Water level	7.05				6.60			
38	12/10/2002	60.3	9.6	2320.6	Product level	6.89				0			
					Water level	7.40				7.22			
39	1/3/2003	58.5	9.3	2379.1	Product level	5.09				0			
					Water level	5.58				5.56			
40	1/21/2003	60.7	9.7	2439.8	Product level	6.67				0			
					Water level	7.28				6.94			
41	2/14/2003	59.2	9.4	2499.0	Product level	5.78				0			
					Water level	6.47				6.19			
42	6/6/2003	86.9	13.8	2585.9	Product level	4.79				0			
					Water level	5.59				4.98			
43	7/8/2003	87.9	14.0	2673.8	Product level	5.97				0			
					Water level	6.58				6.24			
44	9/3/2003	86.5	13.8	2760.3	Product level	5.63				0			
					Water level	6.23				5.89			
45	10/3/2003	72.7	11.6	2833.0	Product level	5.77				0.00			
					Water level	6.46				6.07			
46	11/11/2003	66.9	10.7	2899.9	Product level	4.86				0			
					Water level	5.51				5.32			

NOTE: N = Not Encountered
Product type: Gasoline

Aggressive Fluid Vapor Recovery (AFVR)
Summary of Free Product Recovery Events
TABLE 3

Facility: Building AS-840
Location: MCB Camp Lejeune, North Carolina
Date: 11/17/2004

Event #	Date	Rec Prod (lbs)	Rec Prod. (gals)	Total Cum (lbs) to date	Level (ft TOC)	AFVR WELLS				MONITORING WELLS			
						MW-2				MW-3			
47	1/21/2004	68.4	10.9	2968.3	Product level	6.19				0			
					Water level	7.09				6.41			
48	3/14/2004	76.0	12.1	3044.3	Product level	5.73				0			
					Water level	6.45				5.94			
49	4/7/2004	38.5	6.1	3082.8	Product level	6.34				0			
					Water level	6.93				6.40			
50	4/23/2004	39.8	6.3	3122.6	Product level	5.86				0			
					Water level	6.72				6.13			
51	6/18/2004	67.6	10.8	3190.2	Product level	7.02				0			
					Water level	7.98				7.65			
52	6/30/2004	70.8	11.3	3261.0	Product level	7.01				0			
					Water level	7.49				7.26			
53	7/9/2004	72.2	11.5	3333.2	Product level	7.31				0			
					Water level	8.05				7.59			
54	8/20/2004	71.4	11.4	3404.6	Product level	3.96				0			
					Water level	4.53				4.19			
55	9/16/2004	71.0	11.3	3475.6	Product level	4.54				0			
					Water level	5.26				4.76			
56	10/13/2004	71.5	11.4	3547.1	Product level	5.87				0			
					Water level	6.43				6.13			
57	10/29/2004	74.1	11.8	3621.2	Product level	6.65				0			
					Water level	7.16				6.92			
58	11/17/2004	74.0	11.8	3695.2	Product level	7.10				0			
					Water level	7.64				7.33			

NOTE: N = Not Encountered
Product type: Gasoline

APPENDIX C

SOIL EXCAVATION CALCULATIONS

CATLIN ENGINEERS and SCIENTISTS
WILMINGTON, NORTH CAROLINA

SKETCH/COMPUTATION SHEET

CATLIN PROJECT: Building AS-840 MCAS New River	Drawn/Calculated by: AMH
	Date: January 2005
CATLIN #: 204-045	Reviewed by:

Soil Excavation Calculations

Soil Excavation Limits
Excavation to Encompass Free-Phase Product Plume + Soil Contamination Plume - Horizontal Limits are illustrated on Figure 6.

Excavation Area = 33' x 28'

Area = 924 sq. ft.

Excavation Depth = 2' below historical water table. Refer to Table 2 of the CSA and Table 7 of the CSAA.

Excavation Depth = (Ground Surface Elev. - GW Elev.) + 2 ft.

Depth = (14.15 ft - 7.72 ft) + 2 ft.

MW-02 6/19/01

Depth = 8.43 ft, Say 8.5 ft

Excavation Volume = $\frac{924\ ft^2 \times 8.5\ ft}{27\ cf/cy}$ = 291 cy

Say 295 cy

APPENDIX D

GROUNDWATER MODELING RESULTS

CONTAMINANT VELOCITY CALCULATIONS

OBTAINED FROM

APPENDIX OF

COMPREHENSIVE SITE ASSESSMENT REPORT

Project Name: AS-840 CSA
Job No.: 30740-6-0600-0113

Prepared By/Date: Bellis/10-15-01
Checked By/Date: Deobald/10-16-01

DETERMINATION OF CONTAMINANT VELOCITY IN GROUNDWATER FOR ORGANIC COMPOUNDS

Based on the mathematical relationship between Kow and Rd, the following spreadsheet determines contaminant velocities in groundwater based on the contaminant's Kow and the groundwater seepage velocity (WQA{EPA}-600/6-85/002a).

Governing Equations:

$$Vc = Vavg/Rd$$

Where: Vc = Contaminant Velocity in groundwater (ft/d)
Vavg = Average groundwater seepage velocity (ft/d)
and: Rd = Retardation factor (unitless)

$$Rd = 1 + (Kd * pb/n)$$

Where: Kd = Distribution coefficient (ml/g)
pb = Bulk soil density (g/ml)
and: n = total porosity (unitless)

$$Kd = Koc * [0.2(1-f)Xsoc + f*Xfoc]$$

Where: f = mass of silt and clay/mass of sand, silt and clay
Xsoc = Organic fraction of sand ($0 < Xsoc < 0.1$)
Xfoc = Organic Fraction of silt and clay ($0 < Xfox < 0.1$)
Kow = Octanol-water partitioning coefficient (unitless)
and: Koc = Organic carbon partitioning coefficient, = 0.63 * Kow (unitless)

Definition of Variables: Contaminant: Benzene

Variable	Value	Units	Reference
Kow =	100	none	Fate and Exposure Data for Organic Chemicals (Howard, 1990)
Koc =	63	none	Calculated from above equation
f	0.05	none	Determined from grain-size data (average silt/clay percentage in samples from MW-01,-03,-05 & -06)
pb	1.62	g/cm^3	Avg of F-M sand mean values, p.314 WQA/EPA-600/6-85/002a Part II, Table VII-2
n	0.4	none	See report
Xsoc	0.025	none	Mean value of sugested ranges, WQA/EPA-600/6-85/002a
Xfoc	0.065	none	Mean value of sugested ranges, WQA/EPA-600/6-85/002a
Kd	0.50	none	Calculated from above equation
Rd	3.04	none	Calculated from above equation
Vavg	0.35	ft/d	Calculated average groundwater seepage velocity (see report)

Vc	1.15E-01	ft/d	Calculated from above equation
Vc	4.20E+01	ft/yr	Calculated from above equation

Spreadsheet designed by Bellis (4/94)

APPENDIX E

LABORATORY ANALYTICAL REPORTS
AND
CHAIN OF CUSTODY DOCUMENTATION

FOR

NATURAL ATTENUATION PARAMETERS

FILE COPY

PARADIGM ANALYTICAL LABORATORIES, INC.
5500 Business Drive
Wilmington, North Carolina 28405
(910) 350-1903
Fax (910) 350-1557

Mr. Jeff Becken
Richard Catlin & Associates
P.O. Box 10280
Wilmington NC 28404-0280

Report Number: G128-1419

Client Project: AS-840

Dear Mr. Becken:

Enclosed are the results of the analytical services performed under the referenced project. The samples are certified to meet the requirements of the National Environmental Laboratory Accreditation Conference Standards. Copies of this report and supporting data will be retained in our files for a period of five years in the event they are required for future reference. Any samples submitted to our laboratory will will be retained for a maximum of thirty (30) days from the date of this report unless other arrangements are requested.

If there are any questions about the report or the services performed during this project, please call Paradigm at (910) 350-1903. We will be happy to answer any questions or concerns which you may have.

Thank you for using Paradigm Analytical Labs for your analytical services. We look forward to working with you again on any additional analytical needs which you may have.

Sincerely,
Paradigm Analytical Laboratories, Inc.

12/8/04

Laboratory Director Date
J. Patrick Weaver

N.C. Certification #481 S.C. Certification #99029

Results for Volatiles
by GC 602

Client Sample ID: MW-01
Client Project ID: AS-840
Lab Sample ID: G128-1419-1A
Lab Project ID: G128-1419

Analyzed By: DCS
Date Collected: 11/23/2004 10:30
Date Received: 11/23/2004
Matrix: Water

Analyte	Result ug/L	RL ug/L	Dilution Factor	Date Analyzed
Benzene	BQL	1.00	1	12/01/2004
Diisopropyl ether (DIPE)	BQL	1.00	1	12/01/2004
Ethylbenzene	BQL	1.00	1	12/01/2004
Methyl-tert butyl ether (MTBE)	BQL	2.00	1	12/01/2004
Toluene	BQL	1.00	1	12/01/2004
m/p-Xylene	BQL	2.00	1	12/01/2004
o-Xylene	BQL	2.00	1	12/01/2004

Surrogate Spike Recoveries	Spike Added	Spike Result	Percent Recovery
Trifluorotoluene	40	36.7	91.9

Comments:
All values corrected for dilution.
BQL = Below quantitation limit.

Reviewed By: _____

Results for Volatiles
by GC 602

Client Sample ID: MW-04
Client Project ID: AS-840
Lab Sample ID: G128-1419-2A
Lab Project ID: G128-1419

Analyzed By: DCS
Date Collected: 11/23/2004 09:45
Date Received: 11/23/2004
Matrix: Water

Analyte	Result ug/L	RL ug/L	Dilution Factor	Date Analyzed
Benzene	BQL	1.00	1	12/01/2004
Diisopropyl ether (DIPE)	BQL	1.00	1	12/01/2004
Ethylbenzene	BQL	1.00	1	12/01/2004
Methyl-tert butyl ether (MTBE)	BQL	2.00	1	12/01/2004
Toluene	BQL	1.00	1	12/01/2004
m/p-Xylene	BQL	2.00	1	12/01/2004
o-Xylene	BQL	2.00	1	12/01/2004

Surrogate Spike Recoveries	Spike Added	Spike Result	Percent Recovery
Trifluorotoluene	40	36.8	91.9

Comments:
All values corrected for dilution.
BQL = Below quantitation limit.

Reviewed By: _____

Results for Volatiles
by GC 602

Client Sample ID: MW-07
Client Project ID: AS-840
Lab Sample ID: G128-1419-3A
Lab Project ID: G128-1419

Analyzed By: DCS
Date Collected: 11/23/2004 11:30
Date Received: 11/23/2004
Matrix: Water

Analyte	Result ug/L	RL ug/L	Dilution Factor	Date Analyzed
Benzene	**1.99**	1.00	1	12/01/2004
Diisopropyl ether (DIPE)	BQL	1.00	1	12/01/2004
Ethylbenzene	**1.39**	1.00	1	12/01/2004
Methyl-tert butyl ether (MTBE)	BQL	2.00	1	12/01/2004
Toluene	BQL	1.00	1	12/01/2004
m/p-Xylene	BQL	2.00	1	12/01/2004
o-Xylene	BQL	2.00	1	12/01/2004

Surrogate Spike Recoveries	Spike Added	Spike Result	Percent Recovery
Trifluorotoluene	40	36.4	90.9

Comments:
All values corrected for dilution.
BQL = Below quantitation limit.

Reviewed By: RJV

Results for Volatiles
by GC 602

Client Sample ID: MW-01 DUP
Client Project ID: AS-840
Lab Sample ID: G128-1419-4A
Lab Project ID: G128-1419

Analyzed By: DCS
Date Collected: 11/23/2004 10:30
Date Received: 11/23/2004
Matrix: Water

Analyte	Result ug/L	RL ug/L	Dilution Factor	Date Analyzed
Benzene	BQL	1.00	1	12/01/2004
Diisopropyl ether (DIPE)	BQL	1.00	1	12/01/2004
Ethylbenzene	BQL	1.00	1	12/01/2004
Methyl-tert butyl ether (MTBE)	BQL	2.00	1	12/01/2004
Toluene	BQL	1.00	1	12/01/2004
m/p-Xylene	BQL	2.00	1	12/01/2004
o-Xylene	BQL	2.00	1	12/01/2004

Surrogate Spike Recoveries	Spike Added	Spike Result	Percent Recovery
Trifluorotoluene	40	36.9	92.1

Comments:
All values corrected for dilution.
BQL = Below quantitation limit.

Reviewed By: RW

Results for Volatiles
by GC 602

Client Sample ID: Trip Blank
Client Project ID: AS-840
Lab Sample ID: G128-1419-5A
Lab Project ID: G128-1419

Analyzed By: DCS
Date Collected: 11/23/2004 00:00
Date Received: 11/23/2004
Matrix: Water

Analyte	Result ug/L	RL ug/L	Dilution Factor	Date Analyzed
Benzene	BQL	1.00	1	12/01/2004
Diisopropyl ether (DIPE)	BQL	1.00	1	12/01/2004
Ethylbenzene	BQL	1.00	1	12/01/2004
Methyl-tert butyl ether (MTBE)	BQL	2.00	1	12/01/2004
Toluene	BQL	1.00	1	12/01/2004
m/p-Xylene	BQL	2.00	1	12/01/2004
o-Xylene	BQL	2.00	1	12/01/2004

Surrogate Spike Recoveries	Spike Added	Spike Result	Percent Recovery
Trifluorotoluene	40	36.7	91.9

Comments:
All values corrected for dilution.
BQL = Below quantitation limit.

Reviewed By: _____

Results for Semivolatiles
by GCMS 625

Client Sample ID: MW-01
Client Project ID: AS-840
Lab Sample ID: G128-1419-1K
Lab Project ID: G128-1419

Analyzed By: MRC
Date Collected: 11/23/2004 10:30
Date Received: 11/23/2004
Date Extracted: 11/30/2004
Matrix: Water

Compound	Result ug/L	Quantitation Limit ug/L	Dilution Factor	Date Analyzed
Acenaphthene	BQL	10.0	1	12/01/2004
Acenaphthylene	BQL	10.0	1	12/01/2004
Anthracene	BQL	10.0	1	12/01/2004
Benzo[a]anthracene	BQL	10.0	1	12/01/2004
Benzo[a]pyrene	BQL	10.0	1	12/01/2004
Benzo[b]fluoranthene	BQL	10.0	1	12/01/2004
Benzo[g,h,i]perylene	BQL	10.0	1	12/01/2004
Benzo[k]fluoranthene	BQL	10.0	1	12/01/2004
Bis(2-chloroethoxy)methane	BQL	10.0	1	12/01/2004
Bis(2-chloroethyl)ether	BQL	10.0	1	12/01/2004
Bis(2-chloroisopropyl)ether	BQL	10.0	1	12/01/2004
Bis(2-ethylhexyl)phthalate	BQL	10.0	1	12/01/2004
4-bromophenyl phenyl ether	BQL	10.0	1	12/01/2004
Butylbenzylphthalate	BQL	10.0	1	12/01/2004
2-Chloronaphthalene	BQL	10.0	1	12/01/2004
2-Chlorophenol	BQL	10.0	1	12/01/2004
4-Chloro-3-methylphenol	BQL	10.0	1	12/01/2004
4-Chlorophenyl phenyl ether	BQL	10.0	1	12/01/2004
Chrysene	BQL	10.0	1	12/01/2004
Dibenzo[a,h]anthracene	BQL	10.0	1	12/01/2004
Di-n-Butylphthalate	BQL	10.0	1	12/01/2004
1,2-Dichlorobenzene	BQL	10.0	1	12/01/2004
1,3-Dichlorobenzene	BQL	10.0	1	12/01/2004
1,4-Dichlorobenzene	BQL	10.0	1	12/01/2004
3,3'-Dichlorobenzidine	BQL	20.0	1	12/01/2004
2,4-Dichlorophenol	BQL	10.0	1	12/01/2004
Diethylphthalate	BQL	10.0	1	12/01/2004
Dimethylphthalate	BQL	10.0	1	12/01/2004
2,4-Dimethylphenol	BQL	10.0	1	12/01/2004
Di-n-octylphthalate	BQL	10.0	1	12/01/2004
4,6-Dinitro-2-methylphenol	BQL	50.0	1	12/01/2004
2,4-Dinitrophenol	BQL	50.0	1	12/01/2004
2,4-Dinitrotoluene	BQL	10.0	1	12/01/2004
2,6-Dinitrotoluene	BQL	10.0	1	12/01/2004
Fluoranthene	BQL	10.0	1	12/01/2004
Fluorene	BQL	10.0	1	12/01/2004
Hexachlorobenzene	BQL	10.0	1	12/01/2004
Hexachlorobutadiene	BQL	10.0	1	12/01/2004
Hexachlorocyclopentadiene	BQL	20.0	1	12/01/2004
Hexachloroethane	BQL	10.0	1	12/01/2004
Indeno(1,2,3-c,d)pyrene	BQL	10.0	1	12/01/2004
Isophorone	BQL	10.0	1	12/01/2004

Results for Semivolatiles
by GCMS 625

Client Sample ID: MW-01
Client Project ID: AS-840
Lab Sample ID: G128-1419-1K
Lab Project ID: G128-1419

Analyzed By: MRC
Date Collected: 11/23/2004 10:30
Date Received: 11/23/2004
Date Extracted: 11/30/2004
Matrix: Water

Compound	Result ug/L	Quantitation Limit ug/L	Dilution Factor	Date Analyzed
Naphthalene	BQL	10.0	1	12/01/2004
Nitrobenzene	BQL	10.0	1	12/01/2004
2-Nitrophenol	BQL	10.0	1	12/01/2004
4-Nitrophenol	BQL	50.0	1	12/01/2004
N-Nitrosodi-n-propylamine	BQL	10.0	1	12/01/2004
N-Nitrosodiphenylamine	BQL	10.0	1	12/01/2004
Pentachlorophenol	BQL	50.0	1	12/01/2004
Phenanthrene	BQL	10.0	1	12/01/2004
Phenol	BQL	10.0	1	12/01/2004
Pyrene	BQL	10.0	1	12/01/2004
1,2,4-Trichlorobenzene	BQL	10.0	1	12/01/2004
2,4,6-Trichlorophenol	BQL	10.0	1	12/01/2004

	Spike Added	Spike Result	Percent Recovered
2-Fluorobiphenyl	10	7.7	77
2-Fluorophenol	10	7.4	74
Nitrobenzene-d5	10	8	80
Phenol-d6	10	8.1	81
2,4,6-Tribromophenol	5	4.1	83
4-Terphenyl-d14	10	9	90

Comments:

Flags:
BQL = Below Quantitation Limits.
J = Detected below the quantitation limit.

Reviewed By: RWD

Results for Semivolatiles
by GCMS 625

Client Sample ID: MW-04
Client Project ID: AS-840
Lab Sample ID: G128-1419-2K
Lab Project ID: G128-1419

Analyzed By: MRC
Date Collected: 11/23/2004 09:45
Date Received: 11/23/2004
Date Extracted: 11/30/2004
Matrix: Water

Compound	Result ug/L	Quantitation Limit ug/L	Dilution Factor	Date Analyzed
Acenaphthene	BQL	10.0	1	12/01/2004
Acenaphthylene	BQL	10.0	1	12/01/2004
Anthracene	BQL	10.0	1	12/01/2004
Benzo[a]anthracene	BQL	10.0	1	12/01/2004
Benzo[a]pyrene	BQL	10.0	1	12/01/2004
Benzo[b]fluoranthene	BQL	10.0	1	12/01/2004
Benzo[g,h,i]perylene	BQL	10.0	1	12/01/2004
Benzo[k]fluoranthene	BQL	10.0	1	12/01/2004
Bis(2-chloroethoxy)methane	BQL	10.0	1	12/01/2004
Bis(2-chloroethyl)ether	BQL	10.0	1	12/01/2004
Bis(2-chloroisopropyl)ether	BQL	10.0	1	12/01/2004
Bis(2-ethylhexyl)phthalate	BQL	10.0	1	12/01/2004
4-bromophenyl phenyl ether	BQL	10.0	1	12/01/2004
Butylbenzylphthalate	BQL	10.0	1	12/01/2004
2-Chloronaphthalene	BQL	10.0	1	12/01/2004
2-Chlorophenol	BQL	10.0	1	12/01/2004
4-Chloro-3-methylphenol	BQL	10.0	1	12/01/2004
4-Chlorophenyl phenyl ether	BQL	10.0	1	12/01/2004
Chrysene	BQL	10.0	1	12/01/2004
Dibenzo[a,h]anthracene	BQL	10.0	1	12/01/2004
Di-n-Butylphthalate	BQL	10.0	1	12/01/2004
1,2-Dichlorobenzene	BQL	10.0	1	12/01/2004
1,3-Dichlorobenzene	BQL	10.0	1	12/01/2004
1,4-Dichlorobenzene	BQL	10.0	1	12/01/2004
3,3'-Dichlorobenzidine	BQL	20.0	1	12/01/2004
2,4-Dichlorophenol	BQL	10.0	1	12/01/2004
Diethylphthalate	BQL	10.0	1	12/01/2004
Dimethylphthalate	BQL	10.0	1	12/01/2004
2,4-Dimethylphenol	BQL	10.0	1	12/01/2004
Di-n-octylphthalate	BQL	10.0	1	12/01/2004
4,6-Dinitro-2-methylphenol	BQL	50.0	1	12/01/2004
2,4-Dinitrophenol	BQL	50.0	1	12/01/2004
2,4-Dinitrotoluene	BQL	10.0	1	12/01/2004
2,6-Dinitrotoluene	BQL	10.0	1	12/01/2004
Fluoranthene	BQL	10.0	1	12/01/2004
Fluorene	BQL	10.0	1	12/01/2004
Hexachlorobenzene	BQL	10.0	1	12/01/2004
Hexachlorobutadiene	BQL	10.0	1	12/01/2004
Hexachlorocyclopentadiene	BQL	20.0	1	12/01/2004
Hexachloroethane	BQL	10.0	1	12/01/2004
Indeno(1,2,3-c,d)pyrene	BQL	10.0	1	12/01/2004
Isophorone	BQL	10.0	1	12/01/2004

Results for Semivolatiles
by GCMS 625

Client Sample ID: MW-04
Client Project ID: AS-840
Lab Sample ID: G128-1419-2K
Lab Project ID: G128-1419

Analyzed By: MRC
Date Collected: 11/23/2004 09:45
Date Received: 11/23/2004
Date Extracted: 11/30/2004
Matrix: Water

Compound	Result ug/L	Quantitation Limit ug/L	Dilution Factor	Date Analyzed
Naphthalene	BQL	10.0	1	12/01/2004
Nitrobenzene	BQL	10.0	1	12/01/2004
2-Nitrophenol	BQL	10.0	1	12/01/2004
4-Nitrophenol	BQL	50.0	1	12/01/2004
N-Nitrosodi-n-propylamine	BQL	10.0	1	12/01/2004
N-Nitrosodiphenylamine	BQL	10.0	1	12/01/2004
Pentachlorophenol	BQL	50.0	1	12/01/2004
Phenanthrene	BQL	10.0	1	12/01/2004
Phenol	BQL	10.0	1	12/01/2004
Pyrene	BQL	10.0	1	12/01/2004
1,2,4-Trichlorobenzene	BQL	10.0	1	12/01/2004
2,4,6-Trichlorophenol	BQL	10.0	1	12/01/2004

	Spike Added	Spike Result	Percent Recovered
2-Fluorobiphenyl	10	7.2	72
2-Fluorophenol	10	8	80
Nitrobenzene-d5	10	8.2	82
Phenol-d6	10	8.3	83
2,4,6-Tribromophenol	5	4.4	87
4-Terphenyl-d14	10	9.3	93

Comments:

Flags:
BQL = Below Quantitation Limits.
J = Detected below the quantitation limit.

Reviewed By: RPP

Results for Semivolatiles
by GCMS 625

Client Sample ID: MW-07
Client Project ID: AS-840
Lab Sample ID: G128-1419-3K
Lab Project ID: G128-1419

Analyzed By: MRC
Date Collected: 11/23/2004 11:30
Date Received: 11/23/2004
Date Extracted: 11/30/2004
Matrix: Water

Compound	Result ug/L	Quantitation Limit ug/L	Dilution Factor	Date Analyzed
Acenaphthene	BQL	10.0	1	12/01/2004
Acenaphthylene	BQL	10.0	1	12/01/2004
Anthracene	BQL	10.0	1	12/01/2004
Benzo[a]anthracene	BQL	10.0	1	12/01/2004
Benzo[a]pyrene	BQL	10.0	1	12/01/2004
Benzo[b]fluoranthene	BQL	10.0	1	12/01/2004
Benzo[g,h,i]perylene	BQL	10.0	1	12/01/2004
Benzo[k]fluoranthene	BQL	10.0	1	12/01/2004
Bis(2-chloroethoxy)methane	BQL	10.0	1	12/01/2004
Bis(2-chloroethyl)ether	BQL	10.0	1	12/01/2004
Bis(2-chloroisopropyl)ether	BQL	10.0	1	12/01/2004
Bis(2-ethylhexyl)phthalate	BQL	10.0	1	12/01/2004
4-bromophenyl phenyl ether	BQL	10.0	1	12/01/2004
Butylbenzylphthalate	BQL	10.0	1	12/01/2004
2-Chloronaphthalene	BQL	10.0	1	12/01/2004
2-Chlorophenol	BQL	10.0	1	12/01/2004
4-Chloro-3-methylphenol	BQL	10.0	1	12/01/2004
4-Chlorophenyl phenyl ether	BQL	10.0	1	12/01/2004
Chrysene	BQL	10.0	1	12/01/2004
Dibenzo[a,h]anthracene	BQL	10.0	1	12/01/2004
Di-n-Butylphthalate	BQL	10.0	1	12/01/2004
1,2-Dichlorobenzene	BQL	10.0	1	12/01/2004
1,3-Dichlorobenzene	BQL	10.0	1	12/01/2004
1,4-Dichlorobenzene	BQL	10.0	1	12/01/2004
3,3'-Dichlorobenzidine	BQL	20.0	1	12/01/2004
2,4-Dichlorophenol	BQL	10.0	1	12/01/2004
Diethylphthalate	BQL	10.0	1	12/01/2004
Dimethylphthalate	BQL	10.0	1	12/01/2004
2,4-Dimethylphenol	BQL	10.0	1	12/01/2004
Di-n-octylphthalate	BQL	10.0	1	12/01/2004
4,6-Dinitro-2-methylphenol	BQL	50.0	1	12/01/2004
2,4-Dinitrophenol	BQL	50.0	1	12/01/2004
2,4-Dinitrotoluene	BQL	10.0	1	12/01/2004
2,6-Dinitrotoluene	BQL	10.0	1	12/01/2004
Fluoranthene	BQL	10.0	1	12/01/2004
Fluorene	BQL	10.0	1	12/01/2004
Hexachlorobenzene	BQL	10.0	1	12/01/2004
Hexachlorobutadiene	BQL	10.0	1	12/01/2004
Hexachlorocyclopentadiene	BQL	20.0	1	12/01/2004
Hexachloroethane	BQL	10.0	1	12/01/2004
Indeno(1,2,3-c,d)pyrene	BQL	10.0	1	12/01/2004
Isophorone	BQL	10.0	1	12/01/2004

Results for Semivolatiles
by GCMS 625

Client Sample ID: MW-07
Client Project ID: AS-840
Lab Sample ID: G128-1419-3K
Lab Project ID: G128-1419

Analyzed By: MRC
Date Collected: 11/23/2004 11:30
Date Received: 11/23/2004
Date Extracted: 11/30/2004
Matrix: Water

Compound	Result ug/L	Quantitation Limit ug/L	Dilution Factor	Date Analyzed
Naphthalene	BQL	10.0	1	12/01/2004
Nitrobenzene	BQL	10.0	1	12/01/2004
2-Nitrophenol	BQL	10.0	1	12/01/2004
4-Nitrophenol	BQL	50.0	1	12/01/2004
N-Nitrosodi-n-propylamine	BQL	10.0	1	12/01/2004
N-Nitrosodiphenylamine	BQL	10.0	1	12/01/2004
Pentachlorophenol	BQL	50.0	1	12/01/2004
Phenanthrene	BQL	10.0	1	12/01/2004
Phenol	BQL	10.0	1	12/01/2004
Pyrene	BQL	10.0	1	12/01/2004
1,2,4-Trichlorobenzene	BQL	10.0	1	12/01/2004
2,4,6-Trichlorophenol	BQL	10.0	1	12/01/2004

	Spike Added	Spike Result	Percent Recovered
2-Fluorobiphenyl	10	7.2	72
2-Fluorophenol	10	7.5	75
Nitrobenzene-d5	10	7.7	78
Phenol-d6	10	7.7	77
2,4,6-Tribromophenol	5	4.1	82
4-Terphenyl-d14	10	9.3	93

Comments:

Flags:
BQL = Below Quantitation Limits.
J = Detected below the quantitation limit.

Reviewed By: RHV

Results for Metals

Client Sample ID:	MW-01	Analyzed By:	PSW
Client Project ID:	AS-840	Date Collected:	11/23/2004 10:30
Lab Sample ID:	G128-1419-1	Date Received:	11/23/04
Lab Project ID:	G128-1419	Matrix:	WATER
Batch ID:	2051		

Metals	Result	RL	DF	Units	Method	Date Analyzed
Calcium	**2.27**	0.100	1	MG/L	6010B	11/30/04
Iron	**1.37**	0.100	1	MG/L	6010B	11/30/04
Manganese	BQL	0.0100	1	MG/L	6010B	11/30/04

Comments
BQL = Below Quantitation Limits
DF = Dilution Factor
J = Between MDL and RL

Reviewed By: PSW

Results for Metals

Client Sample ID:	MW-04	Analyzed By:	PSW
Client Project ID:	AS-840	Date Collected:	11/23/2004 09:45
Lab Sample ID:	G128-1419-2	Date Received:	11/23/04
Lab Project ID:	G128-1419	Matrix:	WATER
Batch ID:	2051		

Metals	Result	RL	DF	Units	Method	Date Analyzed
Calcium	**0.858**	0.100	1	MG/L	6010B	11/30/04
Iron	**7.73**	0.100	1	MG/L	6010B	11/30/04
Manganese	BQL	0.0100	1	MG/L	6010B	11/30/04

Comments
BQL = Below Quantitation Limits
DF = Dilution Factor
J = Between MDL and RL

Reviewed By: RHP

Results for Metals

Client Sample ID:	MW-07	Analyzed By:	PSW
Client Project ID:	AS-840	Date Collected:	11/23/2004 11:30
Lab Sample ID:	G128-1419-3	Date Received:	11/23/04
Lab Project ID:	G128-1419	Matrix:	WATER
Batch ID:	2051		

Metals	Result	RL	DF	Units	Method	Date Analyzed
Calcium	**13.8**	0.100	1	MG/L	6010B	11/30/04
Iron	**3.14**	0.100	1	MG/L	6010B	11/30/04
Manganese	BQL	0.0100	1	MG/L	6010B	11/30/04

Comments
BQL = Below Quantitation Limits
DF = Dilution Factor
J = Between MDL and RL

Reviewed By: _____

Results for Hardness

Client Sample ID:	MW-01	Analyzed By:	PSW
Client Project ID:	AS-840	Date Collected:	11/23/2004 10:30
Lab Sample ID:	G128-1419-1	Date Received:	11/23/04
Lab Project ID:	G128-1419	Matrix:	WATER
Batch ID:	2051		

Metals	Result	RL	DF	Units	Method	Date Analyzed
Hardness	**12.8**	0.662	1	MG/L	6010B	11/30/04

Comments
BQL = Below Quantitation Limits
DF = Dilution Factor

Reviewed By: [illegible]

Results for Hardness

Client Sample ID:	MW-04	Analyzed By:	PSW
Client Project ID:	AS-840	Date Collected:	11/23/2004 09:45
Lab Sample ID:	G128-1419-2	Date Received:	11/23/04
Lab Project ID:	G128-1419	Matrix:	WATER
Batch ID:	2051		

Metals	Result	RL	DF	Units	Method	Date Analyzed
Hardness	**8.62**	0.662	1	MG/L	6010B	11/30/04

Comments
BQL = Below Quantitation Limits
DF = Dilution Factor

Reviewed By: _____

Results for Hardness

Client Sample ID:	MW-07	Analyzed By:	PSW
Client Project ID:	AS-840	Date Collected:	11/23/2004 11:30
Lab Sample ID:	G128-1419-3	Date Received:	11/23/04
Lab Project ID:	G128-1419	Matrix:	WATER
Batch ID:	2051		

Metals	Result	RL	DF	Units	Method	Date Analyzed
Hardness	**45.3**	0.662	1	MG/L	6010B	11/30/04

Comments
BQL = Below Quantitation Limits
DF = Dilution Factor

Reviewed By: BW

PARADIGM ANALYTICAL LABORATORIES, INC.

Analytical Results

Client Sample ID:	MW-01	Date Collected:	11/23/04
Client Project ID:	AS-840	Date Received:	11/23/04
Lab Sample ID:	G128-1419-1	Matrix:	Water
Lab Project ID:	G128-1419		

Analyte	Result	RL	Units	Method	Date Analyzed	Analyst
TOC	**4.3**	0.5	mg/L	415.1	12/2/04	EnviroChem
Total Plate Count	**795**	1.0	colonies	9215B	11/24/04	EnviroChem
Phosphorus	**0.05**	0.02	mg/L	365.2	12/1/04	EnviroChem
Nitrate	**0.025**	0.025	mg/L	353.3	11/30/04	EnviroChem
Sulfate	**10**	5	mg/L	375.4	11/30/04	EnviroChem
Alkalinity	BQL	2.0	mg/L	310.1	11/29/04	EnviroChem

Comments
BQL = Below Quantitation Limits
DF = Dilution Factor
RL = Report Limit

Reviewed By: _____

Analytical Results

Client Sample ID:	MW-04	Date Collected:	11/23/04
Client Project ID:	AS-840	Date Received:	11/23/04
Lab Sample ID:	G128-1419-2	Matrix:	Water
Lab Project ID:	G128-1419		

Analyte	Result	RL	Units	Method	Date Analyzed	Analyst
TOC	**4.6**	0.5	mg/L	415.1	12/2/04	EnviroChem
Total Plate Count	**200 est.**	1.0	colonies	9215B	11/24/04	EnviroChem
Phosphorus	**0.10**	0.02	mg/L	365.2	12/1/04	EnviroChem
Nitrate	BQL	0.025	mg/L	353.3	11/30/04	EnviroChem
Sulfate	**11**	5	mg/L	375.4	11/30/04	EnviroChem
Alkalinity	BQL	2.0	mg/L	310.1	11/29/04	EnviroChem

Comments
BQL = Below Quantitation Limits
DF = Dilution Factor
RL = Report Limit

Reviewed By: _____

PARADIGM ANALYTICAL LABORATORIES, INC.

Analytical Results

Client Sample ID:	MW-07	Date Collected:	11/23/04
Client Project ID:	AS-840	Date Received:	11/23/04
Lab Sample ID:	G128-1419-3	Matrix:	Water
Lab Project ID:	G128-1419		

Analyte	Result	RL	Units	Method	Date Analyzed	Analyst
TOC	**2.2**	0.5	mg/L	415.1	12/2/04	EnviroChem
Total Plate Count	**300**	1.0	colonies	9215B	11/24/04	EnviroChem
Phosphorus	**0.04**	0.02	mg/L	365.2	12/1/04	EnviroChem
Nitrate	**0.04**	0.025	mg/L	353.3	11/30/04	EnviroChem
Sulfate	**17**	5	mg/L	375.4	11/30/04	EnviroChem
Alkalinity	BQL	2.0	mg/L	310.1	11/29/04	EnviroChem

Comments
BQL = Below Quantitation Limits
DF = Dilution Factor
RL = Report Limit

Reviewed By: RNP

PARADIGM ANALYTICAL LABORATORIES, INC.
5500 Business Drive, Wilmington, NC 28405
Phone: (910)-350-1903 FAX: (910)-350-1557

Chain-of Custody Record & Analytical Request

COC# 43141

Page 1 of 1

Client: CATLIN
Address:
Address:
Quote #: DOD 101

Project ID: AS-840
Contact: Jeff Beckon
Phone: 452-5861
Fax: 452-7563

Date: 11/23/04
Turnaround: standard
Job Number: 209-645
P.O. Number: 241123-2

Report To: Jeff Beckon
Invoice To: Shirlee CATLIN

PARADIGM ANALYTICAL LABORATORIES, INC.

Sample ID	Date	Time	Matrix	Preservatives: ICE	HNO_3	HCL	H_2SO_4	Analyses: 602	625	Ca Hardness	Fe/Mn	nitrate/sulfate	Alkalinity	TOC	Total Phosphorus Cement	Phosphorus	Comments: Please specify any special reporting requirements
																	**sulfate - charged for while per lab 11/30/04
MW-01	11/23/04	1030	GW	X	X	X	X	X	X	X	X	X	X	X	X	X	*Report Lowest
MW-04	11/23/04	945	GW	X	X	X	X	X	X	X	X	X	X	X	X	X	Runs
MW-07	11/23/04	1130	GW	X	X	X	X	X	X	X	X	X	X	X	X	X	
MW-01 Dup	11/23/04	1030	GW	X		X		X									G128-1419
Trip Blank	11/23/04	-	GW	X		X		X									

Relinquished By	Date	Time	Received By	Date	Time	Temperature	State Certification Requested
John Lascell	11/23/04	1305	Julie Johnson	11/23/04	1305	ON ICE 9.1°C	NC X SC ____ Other ____
						coming down in temp	SEE REVERSE FOR TERMS AND CONDITIONS

ORIGINAL

N.C. Certification #481 S.C. Certification #99029

APPENDIX F

OXYGEN RELEASING COMPOUND (ORC) PROJECT EVALUATION

REGENESIS EVALUATION

REGENESIS

January 3, 2005

Proposal No. ODR0405-91o

Jeffery Becken
Catlin Engineers and Scientists
P.O. Box 10279
Wilmington, NC 28404-0279
E-mail: jeff.becken@catlinusa.com
Ph: 910.452.5861

Subject: Application of Oxygen Release Compound (ORC®) to Accelerate the Natural Attenuation of Contaminants of Concern (COCs) at the Building AS-840, Marine Corps Air Station, New River Site

Dear Mr. Becken:

Thank you for your interest in Regenesis and our Oxygen Release Compound (ORC®) product. We have reviewed the information that you provided for the above-referenced site. In the following sections of this proposal, we will discuss the use of ORC, design and cost information, delivery of ORC to the subsurface, a recommended groundwater monitoring program, and the performance goals for this particular project. In addition, this proposal should be considered preliminary because some assumptions were made regarding the current biogeochemical conditions of the aquifer and the extent of the contaminant plume requiring treatment. We look forward to working with you on developing a site-specific strategy that will help meet your objectives for the site.

Use of Oxygen Release Compound (ORC®) to Accelerate Bioremediation

ORC is a patented formulation of phosphate-intercalated magnesium peroxide that is a timed-released source of oxygen. It releases oxygen in the dissolved-phase when it is hydrated. Numerous studies have shown that the lack of oxygen can limit the ability of naturally occurring microorganisms (aerobes) to degrade certain compounds. ORC provides terminal electron acceptors to support the oxidative biodegradation of many types of aerobically degradable compounds including but not limited to: petroleum-based hydrocarbons (e.g. Benzene) and chlorinated hydrocarbons (e.g. cis-1, 2-Dichloroethene). ORC is manufactured as a fine powder that can be installed in the subsurface in the following ways: (1) mixed with water to form a slurry that can be injected into both the saturated and unsaturated zones, (2) added as a soil amendment to the backfill material used in excavation applications, or (3) placed in specially designed filter socks that are placed in monitoring/source wells. The use of this product is now recognized as a sensible strategy for engineering accelerated bioattenuation at project sites contaminated with aerobically degradable compounds.

Regenesis believes that our ORC product is a good candidate to treat the contaminated soil and/or groundwater at the subject site. When compared to other remediation alternatives, there are two main reasons why it should be the remediation option of choice: time and money. For example, over the life of

a remediation project, ORC can be more cost-effective than monitored natural attenuation (MNA) because it significantly reduces the duration of projects. In addition, when compared to active treatment systems (e.g. Pump & Treat), it becomes even more cost-effective because the initial capital costs are considerably less, and there are no operations and maintenance (O&M) costs. To this end, it is easy to understand why ORC should be used to treat the contamination at this site.

Preliminary Design and Cost Information for Full Scale Remediation

Based on the provided data and our conversation, Regenesis understands that the full-scale treatment at the subject site will be the addition of ORC as a soil amendment to the backfill of the planned remedial soil excavation. Based on the data provided, we have assumed that the remedial soil excavation will cover an area with dimensions roughly 30 feet x 30 feet. An excavation of this size will cover the reported free-phase product plume size of roughly 28 x 20 feet, plus the immediately surrounding dissolved-phase plume area. We understand that if free-phase product is present following excavation activities, it will be removed prior to ORC application. *We highly recommend that ALL free-phase product be removed prior to ORC application as ORC cannot physically remove free-phase product, and was designed for the treatment of dissolved-phase petroleum hydrocarbons.* The approximate excavation area and an ORC estimate spreadsheet are attached. The recommended dosage of ORC for this application is based on the parameters in the following table.

Excavation Application Parameters	Specification
Estimated contaminant concentrations in groundwater prior to excavation activities	0.14 mg/L benzene 0.16 mg/L toluene 0.13 mg/l ethylbenzene 0.23 mg/L total xylenes 0.3 mg/L naphthalene 3.1 mg/L C9 thru C22 aromatic hydrocarbons
Planned excavation dimensions	30 feet x 30 feet x estimate of 10 feet deep
Saturated thickness to be treated	Assumed 5 feet – from 5 to 10 feet below ground surface to cover ground water smear (fluctuation) zone.
ORC material requirement	510 lbs
ORC material cost @ $10/lb	$5,100 plus tax and shipping fees

Total ORC® Project Cost

The total cost of an ORC-accelerated bioremediation project can be estimated using the following items:

- ORC material, shipping fees, and sales tax
- Fieldwork costs associated with the installation of ORC (Customers are responsible for selecting the drilling sub-contractor that will be used for the project.)

- Groundwater monitoring well construction (if additional monitoring wells are needed to properly monitor the performance of the project)
- All fieldwork and laboratory analysis associated with periodic groundwater monitoring events
- Consultant oversight and report generation

The costs presented in this proposal are for ORC material costs for a *one-time application only*. The need to re-apply ORC depends on your plume management strategy, site-specific biodegradation performance, and the ultimate remediation goals for the site. As can be seen, project costs are directly related to the period of time needed to achieve the site-specific goals.

Excavation Application for ORC® projects

Regenesis understands that contaminated soils at the subject site will be removed by excavation activities. We also understand that the application at the subject site will be the addition of ORC® as an amendment to the soil backfill. This product can be installed by the suggested methods outlined below or by other appropriate methods.

- **Method No. 1:** Create an ORC slurry by adding water to the ORC powder. The solids content of the slurry used for this application is essentially irrelevant because the amount of ORC material that needs to be placed in the excavation is a known quantity. Typically, an ORC slurry with a solids content of approximately 20% is used for this application. Based on our experience, we have found that a high volume, low pressure pump can be used to distribute the ORC slurry in the excavation. The ORC slurry can be added simultaneously with the backfill material or can be placed into standing water prior to backfilling.

- **Method No. 2:** The ORC powder or ORC slurry can be mixed with the backfill material before it is placed in the excavation. The "mixed" material can then be placed via backhoe into the excavation.

- **Method No. 3:** ORC powder or an ORC slurry can be added directly to the excavation: ORC can either be added to the bottom of the excavation or it can be added (recommended) to a pre-determined vertical interval as the soil backfilling is being completed. The ORC powder or ORC slurry can also be mixed with backfill material using a backhoe (or equivalent).

Recommended Groundwater Monitoring Program for ORC® Projects

In order to validate the effectiveness of natural attenuation processes (ORC-enhanced treatment), we recommend conducting groundwater monitoring at selected wells. Also, a baseline round of sampling should be performed to identify the aquifer conditions prior to the installation of this material. After ORC has been installed into the subsurface, groundwater samples can be collected on a bi-monthly or quarterly basis. Once the initial biodegradation and geochemical trends have been identified, the monitoring frequency can be changed to a semi-annual or annual program. The groundwater monitoring program should employ low flow groundwater sampling techniques and include the measurement of the following field/chemical parameters:

- All COCs
- Field redox parameters: oxidation-reduction potential (ORP), pH, dissolved oxygen (DO), dissolved manganese, and dissolved (ferrous) iron

- Biochemical Oxygen Demand ($BOD_{5\text{-day}}$) and Chemical Oxygen Demand (COD) at selected groundwater monitoring wells within treatment area

Groundwater Monitoring Locations

The following table outlines the suggested locations and significance of monitoring wells used to monitor the progress of an ORC-based project.

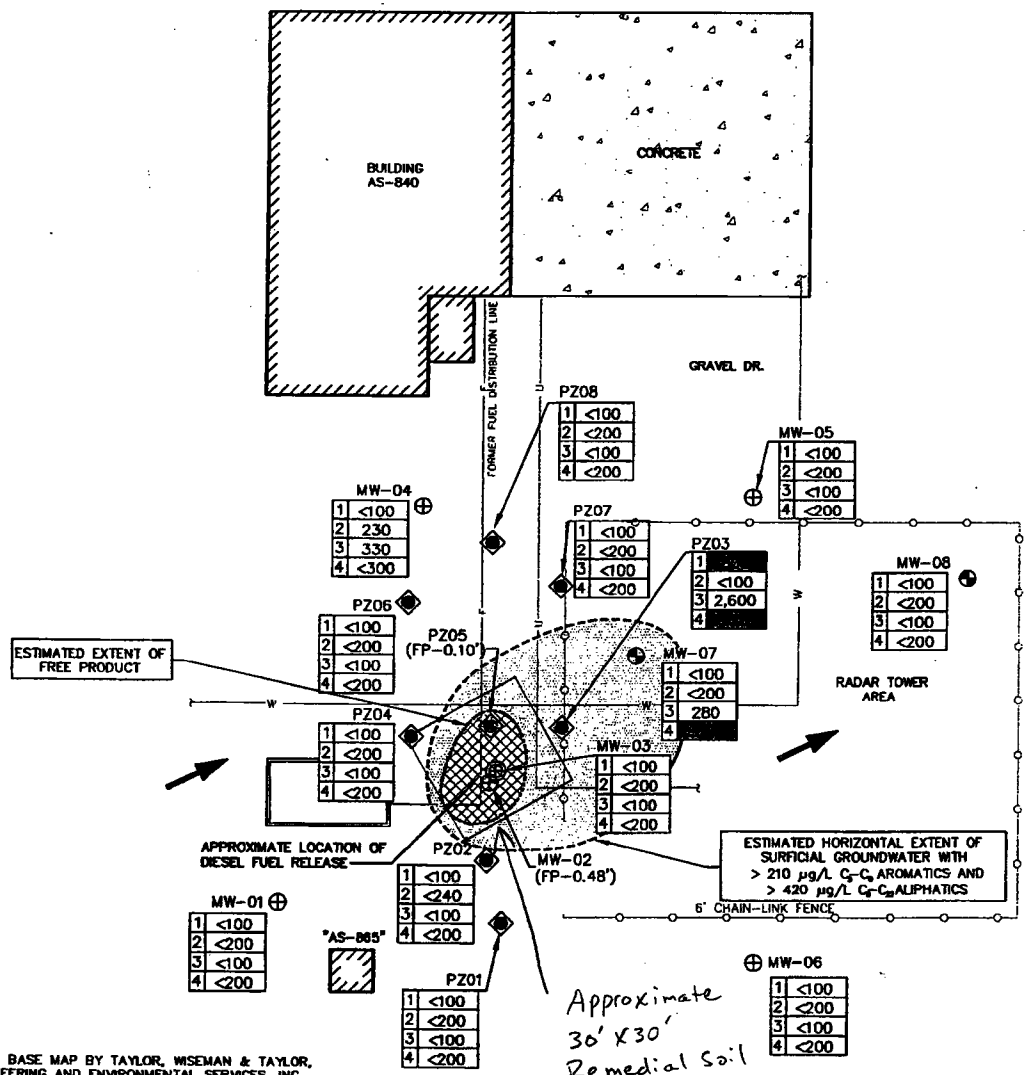
Location	Significance
Background (Outside the groundwater plume)	Allows for the changes in natural attenuation conditions induced by the addition of ORC to be compared to background levels
Upgradient of treatment zone	Provides a measure of contaminant and competing electron acceptor flux entering treatment zone
Inside treatment zone	Provides information on how ORC is affecting the aquifer conditions and contaminant concentrations
Downgradient of treatment zone	Provides information on the effect ORC is having on the biodegradation rates of contaminants and on aquifer conditions and confirms the mitigation migration

Regenesis appreciates the opportunity to provide this information for your project. Please feel free to contact Rick Gillespie, Regenesis's Southeast Regional Manager, at 972.377.7288 (e-mail at rgillespie@regenesis.com) or me at 949.366.8000 (e-mail at dreilly@regenesis.com).

Sincerely,

Dave Reilly
Technical Consultant

Attachments



N

LEGEND

EXISTING	NEW	DESCRIPTION
—F—		FORMER FUEL DISTRIBUTION LINE
—W—		WATER LINE
—U—		UNKNOWN UTILITY
⊕	◕	SHALLOW (TYPE II) MONITORING WELL
⊕		DEEP (TYPE III) MONITORING WELL
◆		PIEZOMETER
▨		ESTIMATED HORIZONTAL EXTENT OF FREE PRODUCT AS OF 10/23/03
(FP)		FREE PRODUCT THICKNESS IN FEET
→		SURFICIAL GROUNDWATER FLOW DIRECTION AS OF 10/23/03
2L IGWQS		INTERIM GROUNDWATER QUALITY STANDARD
µg/L		MICROGRAMS PER LITER

RESULTS KEY		
#	ANALYTE	IGWQS
1	C_5-C_8 ALIPHATICS	420
2	C_9-C_{18} ALIPHATICS	4,200
3	C_{19}-C_{36} ALIPHATICS	42,000
4	C_9-C_{22} AROMATICS	210

30 15 0 30
SCALE IN FEET

NOTE:
1. ALL RESULTS IN µg/L.
2. MODIFIED FROM ORIGINAL BASE MAP BY TAYLOR, WISEMAN & TAYLOR, PROVIDED BY LAW ENGINEERING AND ENVIRONMENTAL SERVICES, INC.
3. GROUNDWATER ANALYSIS PER MADEP VPH/EPH, REVEALED C_9-C_{22} AROMATICS AND C_5-C_8 ALIPHATICS FRACTIONS AS THE ONLY COMPOUNDS OF CONCERN. THE REMAINING VPH/EPH HYDROCARBON FRACTIONS WERE EITHER COMPLIANT OR BQL.
4. SHADED CONCENTRATIONS EXCEED IGWQS.
5. MW-02 AND PZ05 WERE NOT SAMPLED DUE TO THE PRESENCE OF FREE PRODUCT.
6. MW-02 LAST GAUGED ON 10/23/02.
7. PZ05 LAST GAUGED ON 4/20/01.

CATLIN ENGINEERS and SCIENTISTS
WILMINGTON, NORTH CAROLINA

PROJECT: BUILDING AS-840 MARINE CORPS AIR STATION NEW RIVER, NC	TITLE: SITE MAP WITH SUMMARY OF GROUNDWATER SAMPLE ANALYSIS RESULTS – MADEP VPH/EPH AS COMPARED TO NCDENR IGWQS		FIGURE 8
JOB NO. 203060 / DATE: NOV 2003	SCALE: 1"=30'	DRAWN BY: HCS	CHECKED BY: ST

ORC Design Software for Excavation Applications

August 2004

Regenesis Technical Support: USA (949) 366-8000 www.regenesis.com

Site Name: Building AS-840, Marine Corps Air Station, New River, North Carolina
Location: Plume Source/Core Area Remedial Soil Excavation
Consultant: Catlin Engineers & Scientists

Estimated Plume Requiring Treatment

Planned Excavation:	Width of planned excavation	30	ft			
	Length of planned excavation	30	ft	=	900	ft^2
	Thickness of saturated zone to be excavated	5	ft		4,500	ft^3
GW Plume:	Width of plume area containing contaminant	45	ft			
	Length of plume area containing contaminant	55	ft	=	2,475	ft^2
	Thickness of contaminated saturated zone	5	ft		12,375	ft^3
	Total porosity	0.4				
	Nominal aquifer soil (gravel, sand, silty sand, silt, clay)	silty sand				
	Plume pore volume	4,950	ft^3	=	37,031	gallons

Click for unknown contaminant concentations

Dissolved Phase Oxygen Demand (Based on GW Plume Dimensions)	Contaminant Conc. (mg/L)	Contaminant Mass (lb)	Stoichiometry (wt/wt) O_2/contaminant	ORC Dose (lb)
Individual species that represent oxygen demand				
Benzene	0.14	0.0	3.1	1
Toluene	0.16	0.0	3.1	2
Ethylbenzene	0.13	0.0	3.2	1
Xylenes	0.23	0.1	3.2	2
MTBE	0.00	0.0	2.7	0
Naptahlene	0.30	0.1	3.0	3
Total Aromatics C9 to C22	3.10	1.0	3.2	31
Reduced metals: Fe^{+2} and Mn^{+2}	10.00	3.1	0.1	3
1,2,3-trimethylbenzene	<- pull-down menu			
Measures of total oxygen demand				
Total Petroleum Hydrocarbons (see pull-down for Koc)	0.00	0.0	3.1	0
Biological Oxygen Demand (BOD)	0.00	0.0	1.0	0
Chemical Oxygen Demand (COD)	0.00	0.0	1.0	0

Parameters for Sorbed Phase Oxygen Demand:

Soil bulk density	1.92	g/cm^3 =	120	lb/cf
Fraction of organic carbon (foc)	0.004	range: 0.0001 to 0.01		

(Estimated using sorbed phase = foc*Koc*Cgw) (Adjust Koc as necessary to provide realistic estimates)	Koc (L/kg)	Contaminant Conc. (mg/kg)	Contaminant Mass (lb)	Stoichiometry (wt/wt) O_2/contaminant	ORC Dose (lb)
Benzene	123	0.07	0.1	3.1	2
Toluene	267	0.17	0.2	3.1	5
Ethylbenzene	327	0.17	0.2	3.2	5
Xylenes	298	0.27	0.3	3.2	8
MTBE	12	0.00	0.0	2.7	0
Naptahlene	1000	1.20	1.1	3.0	34
Total Aromatics C9 to C22	373	4.63	4.4	3.2	140
Measures of total oxygen demand					
Total Petroleum Hydrocarbons	373	0.00	0.0	3.1	0

Summary of Estimated ORC Requirements	Dissolved Phase ORC Demand (lbs)	Sorbed Phase ORC Demand (lbs)	Additional Demand Factor (1 to 10x)	Total ORC Demand	ORC Cost	
Total BTEX, MTBE, etc.	43	194	2	498	$5,100	<-
Total Petroleum Hydrocarbons	0	0	-	-	-	
Biological Oxygen Demand (BOD)	0	0	-	-	-	
Chemical Oxygen Demand (COD)	0	0	-	-	-	

Required ORC quantity (in 30 lb increments) ----------> 510 pounds ORC

Slurry Mixing Volume

Design solids content for spraying into excav. (20-40% by wt.)	30%	
Total water for mixing slurry (gal)	143	gallons

Project Summary			
ORC bulk material for slurry injection (lbs)			510
Number of 30 lb ORC buckets			17.0
ORC bulk material cost		$	10.00
Cost for bulk ORC material		$	5,100
Shipping and Tax Estimates			
Sales Tax Rate/Cost	0.00%	$	-
Total Material Cost		$	5,100
Shipping (call for amount)		$	-
Total Regenesis Material Cost		**$**	**5,100**

Other Project Cost Estimates		
Design	$	-
Permitting and reporting	$	-
Excavation contractors	$	-
Construction management	$	-
Laboratory costs	$	-
Groundwater monitoring	$	-
Other	$	-
Other	$	-
Total Project Cost	**$**	**5,100**

CATLIN COST BENEFIT ANALYSIS

CATLIN ENGINEERS and SCIENTISTS
WILMINGTON, NORTH CAROLINA

SKETCH/COMPUTATION SHEET

CATLIN PROJECT: Building AS-840 MCAS New River	Drawn/Calculated by: AMH / JKB
CATLIN #: 204-045	Date: January 2005
	Reviewed by:

Cost Analysis

According to information provided by Regenesis (See Appendix F), ORC will accelerate natural attenuation at this site by a factor of 2 at a minimum.

The following assumptions have been made:

1) Under Natural Conditions, the AS-840 site will be monitored for 10 years before site closure.
2) Under Accelerated Natural Attenuation with ORC, the AS-840 site will be monitored for 5 years before site closure.
3) One-Time Application of ORC will cost $10,000 in materials and services. - Refer to Regenesis Proposal
4) The cost of one year of MNA is approximately $20,471. Assumes all wells sampled semi-annually w/ 1 Report Prep.

Estimated Lifetime Costs

	With ORC Application	Without ORC Application
One-Time Chemical Application	$10,000	N/A
5-Yrs Semi-Annual MNA	$102,355	10-Yrs Semi-Annual MNA $204,710
Totals:	$112,355	$204,710

Total Lifetime Savings: $92,355

4 BOXES = 1 INCH