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MCAS CHERRY POINT
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CORRECTIVE ACTION PLAN FOR THE RECOVERY OF FREE PRODUCT AND THE RESTORATION OF PETROLEUM CONTAMINATED SOIL AND GROUNDWATER BUILDINGS 130 AND 3996 AND PIT 4 AREA VOLUME 1 OF 2 MCAS CHERRY POINT NC

1/1/1997

LAW ENGINEERING AND ENVIRONMENTAL SERVICES, INC.

LAW
ENGINEERING AND ENVIRONMENTAL SERVICES, INC.

CORRECTIVE ACTION PLAN FOR THE RECOVERY OF FREE PRODUCT AND THE RESTORATION OF PETROLEUM CONTAMINATED SOIL AND GROUNDWATER

BUILDING 130, BUILDING 3996, AND PIT 4 AREA MARINE CORPS AIR STATION CHERRY POINT, CRAVEN COUNTY, NORTH CAROLINA

VOLUME I of II

Prepared For:

Commander
Naval Facilities Engineering Command
Atlantic Division
1510 Gilbert Street
Norfolk, Virginia 25311-6287

Prepared By:

Law Engineering and Environmental Services, Inc.
3301 Atlantic Avenue
Raleigh, North Carolina 27604

January 1997

LAW Job No: 30740-5-0500/Phases 0076/0142

RESPONSES TO COMMENTS
CORRECTIVE ACTION PLAN
BUILDING 130, BUILDING 3996, AND PIT 4 AREA
MARINE CORPS AIR STATION
CHERRY POINT, NORTH CAROLINA

LO 1/13/97
DHN 1/13/97

Responses to Comments by Mr. Bill Powers and Mr. Ken Cobb

	Location	*Responses*
1.	General	Modified As Requested
2.	Para 1.2.a.iii	Modified As Requested
3.	Para 1.3.a.iii	Modified As Requested
4.	Para 1.4	Conversation with Bill Powers on 1/10/97 indicated that the column should be left blank to expedite submittal of the CAP.
5.	Para 2.0.c	The table in the draft report showed target cleanup levels that were higher than existing conditions because the interim groundwater quality standards were not approved. We anticipate that these interim standards will eventually be finalized and on this basis, concentrations of petroleum constituents which are lower than the interim standard have been dropped from the table.
6.	Para 2.0.d.i	The text in the CAP has been modified as requested. Submittal of modifications to the NPDES permit application will be submitted by the RAC contractor according to a schedule proposed by MCAS, Cherry Point.
7.	Para 4.5.a.iv	It is our understanding that modification of the building size or changes in selection of remediation equipment will be handled by the RAC contractor. The flow rates for the Pit 4 Area are specified in the CAP and the design submittal for the Pit 4 Area project. It is possible that the RAC contractor may choose to add the flow rates from the Pit 4 Area to the flow rates chosen for the Building 4075 design project.
8.	Para 4.5.b	Please see the response to Comment No. 6.

Responses to Comments by Mr. Bill Powers and Mr. Ken Cobb

Location		*Responses*
9.	Para 5.1	Sentences have been added regarding treatment of extracted fluids.
10.	Page 24	In the future, it will be our policy to use effective porosity as determined by a soils textural classification triangle instead of the more conservative choice specified in this report. For the purposes of finalizing this CAP, it is not practical to change effective porosity from 0.25 to 0.35. If the value was changed from 0.25 to 0.35, there would be no modifications in the positions advocated in this report because the effect on receptors is unchanged. The modeling for each of the three locations has been performed and considerable effort would be required to run the program using new values of porosity. For the sake of consistency with results of the computer modeling, the 0.25 value of effective porosity is being maintained for contaminant time-distance calculations based on geohydrochemical processes of sorption-desorption . It is recognized that the 0.25 value of effective porosity is very conservative for this location. For the purposes of design (i.e. recovery well spacing), it may be reasonable to employ porosity values ranging from 0.25 to 0.45.
11.	Page 25	The fourth sentence seems clear but a problem was found in the third sentence. Removal of the word "that" makes the third sentence read correctly.
12.	Page 25	The reference for the Pit 4 area has been corrected as Attachment DI. A labeled tab has been inserted for each Appendix and Attachment as requested.
13.	Page 25	Modified As Requested
14.	Page 27	The table has been corrected.

Responses to Comments by Mr. Bill Powers and Mr. Ken Cobb

Location		*Responses*
15.	Para 5.5	A sentence was added at the end of the paragraph to address a solution for growth of organisms in sparge wells. The systems should remain effective over the projected system lifetimes with proper maintenance. The effectiveness of the air sparge system is dependent on injecting air into the aquifer. A reading of the pressure gauge at each wellhead will provide information as to whether there is sufficient pressure to inject air into the aquifer. The RAC contractor will be responsible for these evaluations during the first six months of system operation. It is our understanding and recommendation that following the six month start-up phase, a private company will be contracted to perform system operation and maintenance. Periodic gauge readings are a standard aspect of system operation and maintenance. Your comments have been passed to the engineer who will be reviewing the workplan.
16.	Page 31	Annual reports will contain semi-annual groundwater sampling information.
17.	Page 31	Text has been modified to address the NPDES permit as requested.
18.	Tables	Shading has been removed from all tables in the CAP. Shading has been removed from tables that were part of previous reports to the extent possible.
19.	Table 3.2	Modified As Requested
20.	General	Modified As Requested

LAW

ENGINEERING AND ENVIRONMENTAL SERVICES, INC.

CORRECTIVE ACTION PLAN FOR THE RECOVERY OF FREE PRODUCT AND THE RESTORATION OF PETROLEUM CONTAMINATED SOIL AND GROUNDWATER

BUILDING 130, BUILDING 3996, AND PIT 4 AREA MARINE CORPS AIR STATION CHERRY POINT, CRAVEN COUNTY, NORTH CAROLINA

VOLUME I of II

Prepared For:

Commander
Naval Facilities Engineering Command
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1510 Gilbert Street
Norfolk, Virginia 25311-6287

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3301 Atlantic Avenue
Raleigh, North Carolina 27604

January 1997

LAW Job No: 30740-5-0500/Phases 0076/0142

LAW
ENGINEERING AND ENVIRONMENTAL SERVICES, INC.

January 13, 1997

Commander
Atlantic Division
Naval Facilities Engineering Command
1510 Gilbert Street
Norfolk, Virginia 23511-6287

Attention: Mr. John H. Keresky
Navy Technical Representative
Code 18213

Subject: **CORRECTIVE ACTION PLAN FOR THE RECOVERY OF FREE PRODUCT AND THE RESTORATION OF PETROLEUM CONTAMINATED SOIL AND GROUNDWATER BUILDING 130, BUILDING 3996, AND PIT 4 AREA MARINE CORPS AIR STATION CHERRY POINT CRAVEN COUNTY, NORTH CAROLINA LANTDIV CONTRACT NO. N62470-93-D-4020 DELIVERY ORDER NOS. 0076 and 0142 LAW JOB NO. 30740-5-0500/PHASES 0076/0142**

Dear Mr. Keresky:

Law Engineering and Environmental Services, Inc. (LAW) is pleased to submit this Corrective Action Plan for the Recovery of Free Product and the Restoration of Petroleum Contaminated Groundwater for Building 130, Building 3996, and Pit 4 Area located at the Marine Corps Air Station in Cherry Point, North Carolina. The Corrective Action Plan was developed in general accordance with sections 15.3, "Corrective Action Plan", and 15.4 "Corrective Action Plan (CAP) Report Guidelines", of the North Carolina Division of Water Quality document *Groundwater Section Guidelines for the Investigation and Remediation of Soils and Groundwater* (the Guidelines), dated March 1993. The Division of Water Quality (DWQ) was formerly known as the Division of Environmental Management (DEM). The Corrective Action Plan is intended to comply with the requirements the North Carolina Administrative Code, Chapter 15, Subchapter 2L, Section .0106, "Corrective Action".

This report is intended for the exclusive use of Naval Facilities Engineering Command, Atlantic Division. The contents should not be relied upon by any other parties without the expressed written consent of LAW. The findings are relevant to the dates of our site work and should not be relied upon to represent site conditions on other dates.

3301 ATLANTIC AVENUE • RALEIGH, NC 27604
P.O. BOX 18288 • RALEIGH, NC 27619
(919) 876-0416 • FAX (919) 872-3253

We appreciate the opportunity to provide environmental services on this project. If any questions arise, please contact us at (919) 876-0416.

Sincerely,

LAW ENGINEERING & ENVIRONMENTAL SERVICES, INC.

Luis Turner

Luis Turner, P.G., E.I.T.
Project Engineer

Daniel H. Nielsen, P.E.
Principal Engineer

Attachments: Form [NCDWQ GW-100 (c)]
Corrective Action Plan

cc: Bill Powers, MCAS, Cherry Point
Kathy Molino - Cover Letter Only

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

Responsible Party: Marine Corps Air Station, Cherry Point
Address: Highway 70 and 101
City: Cherry Point **State:** NC **Zip Code:** 28533-0006

Site Name: Building 130, Building 3996, and Pit 4 Area
Address: MCAS, Cherry Point
City: Cherry Point **County:** Craven **Zip Code:** 28533-0006

Groundwater Section Incident Number: _____

I, Daniel H. Nielsen, a (Professional Engineer) Licensed Geologist (circle one) for Law Engineering & Env. Svcs. Inc (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. DHN 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. DHN 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. DHN 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. DHN A description of the proposed corrective action and supporting justification is enclosed.

5. DHN 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. DHN A schedule for the implementation and operation of the CAP is enclosed.

(OVER)

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TABLES

DRAWINGS

APPENDICES

1.0 BACKGROUND

This Corrective Action Plan (CAP) was developed in accordance with Title 15A, NCAC, Subchapter 2L, Section .0106(c). In response to regulatory requirements outlined in 15A NCAC 2L .0106(c) and NCDEHNR *Groundwater Section Guidelines For The Investigation and Remediation of Soils and Groundwater*, LAW compiled the following background information for the project site.

1.1 General Information

a.	Site Name:	Building 130, Building 3996, and Pit 4 Area
b.	Location:	MCAS, Cherry Point. For the purpose of presenting information, the project site was divided into three areas: Building 130, Building 3996, and the Pit 4 Area. For individual site location maps, see Drawing 1.1 from previous reports located in Appendix B.
c.	Owner/Operator:	Marine Corps Air Station, Cherry Point, North Carolina

1.2 Purpose of Corrective Action Plan

a. Release source(s)/cause(s):

(i) Sources that have apparently released petroleum products in the vicinity of Building 130 include a portion of an abandoned underground pipeline system. The pipeline system was installed during the 1940's with subsequent additions and modifications prior to being taken out of service in 1983. A release from the pipeline has occurred at Building 130 as evident by the plume of free product to the west of the building. Other likely releases from the abandoned pipeline system include two petroleum hydrocarbon dissolved-phase plumes to the northwest and north of Building 130. Two lubrication oil/waste oil underground storage tanks (USTs) may have contributed to the release near Building 130.

(ii) Sources that have apparently released petroleum products in the vicinity of Building 3996 include the abandoned underground pipeline system referenced above. The primary release most likely results from a fueling station that was formerly connected to the pipeline located adjacent to northwest side of Building 131. USTs 3996-1, 3996-2, and 3996-3 located on the north side of Building 3996 and two hydraulic lift pits located inside Building 3996 have also contributed to the release in the vicinity of Building 3996. Vadose zone soil has been impacted by a suspected UST located inside the northeastern end of Building 131.

(iii) Sources that have apparently released petroleum products at the Pit 4 Area include two underground pipeline systems. The abandoned pipeline system was taken out of service in 1983 when the currently active pipeline system was installed. The active pipeline system is periodically checked for leaks using a Tracer Tight Leak Test in conjunction with the collection and analysis of soil gas samples. Results of the October 1995 study detected a leak from the pipeline system at the junction

("T" connection) on the grass island adjacent to the northwest side of Pit 4. The lines were retested in February 1996 after repairs and no leaks were indicated.

b. Applicable State Regulations:

(i) The Oil Pollution and Hazardous Substance Control Act of 1978;
(ii) *Groundwater Section Guidelines for the Investigation and Remediation of Soils and Groundwater* (the Guidelines);
(iii) North Carolina Administrative Code (NCAC) Title 15A, Subchapter 2L, Section .0106; and
(iv) 15A NCAC 2N Section .0700.

c. Petroleum-derived Compounds Exceeding Groundwater Quality Standards:

(i) At Building 130:

Benzene	Chrysene
Ethylbenzene	Flourene
Xylenes	Indeno(1,2,3-cd)pyrene
Acenaphthene	1-Methylnaphthalene
Acenaphthylene	2-Methylnaphthalene
Benzo(k)flouranthene	Naphthalene

(ii) At Building 3996:

Benzene	Xylenes
Ethylbenzene	Naphthalene
Toluene	

(iii) At Pit 4 Area:

1-Methylnaphthalene	2-Methylnaphthalene
Benzo(b)flouranthene	Naphthalene

d. State Groundwater Classification: GA

e. Petroleum Fractions Exceeding State Soil Guidelines:

(i) At Building 130, concentrations of volatile and semi-volatile total petroleum hydrocarbons (TPH) as measured by EPA Methods 3550/8015 and 5030/8015 were indicated in vadose zone soils as high as 49.4 mg/kg and 1,330 mg/kg, respectively.

(ii) At Building 3996, concentrations of volatile and semi-volatile TPH, and oil and grease as measured by EPA Methods 3550/8015 and 5030/8015 and 9071 were

indicated in vadose zone soils as high as 209 mg/kg, 106 mg/kg and 5,880 mg/kg, respectively.

(iii) At Pit 4 Area, concentrations of volatile and semi-volatile TPH as measured by EPA Methods 3550/8015 and 5030/8015 were indicated in vadose zone soils as high as 124 mg/kg and 74.8 mg/kg, respectively.

f. Free product:

(i) At Building 130, free product has been measured at a thickness of 2.68 feet in monitoring well 72GW15 in front of Building 130.

(ii) At Building 3996, free product has been measured at a thickness of 0.12 feet in monitoring well 74GW10. Free product was not measured in this well until the removal of USTs 3996-1 through 3996-3 during July 1995.

(iii) At Pit 4 Area, free product thickness has been reported at 11.5 feet in the existing free product recovery well.

See Drawing 5.2 (Appendix B) for the spatial extent of free product.

1.3 Initial Remedial Actions

a. Primary Source Abatement:

(i) At Building 130, the former aviation fuel pipeline system has been abandoned. The two lubrication oil/waste oil USTs are believed to be abandoned in-place.

(ii) At Building 3996 the former aviation fuel pipeline system has been abandoned. USTs 3996-1, 3996-2, and 3996-3 were removed July 1995. Contaminated soil around hydraulic lift Pit No. 1 and Pit No. 2 has been removed to the extent possible. Further excavation of contaminated soil in the vicinity of Pits No. 1 and No. 2 may threaten the stability of Building 3996. The suspected UST in the northeastern end of Building 131 is located beneath an office area and removal of soils would require demolition of that portion of the building.

(iii) At Pit 4 Area, the aviation fuel pipeline installed in the 1940's was abandoned in 1983. The leaking pipeline junction for the active pipeline system located on the grass island adjacent to the northwest side of Pit 4 has been repaired by MCAS personnel.

b. Secondary Source Abatement:

(i) At Building 130, free product is recovered by hand bailing. The amount of free product recovered to date is not known.

(ii) At Pit 4 Area, free product is recovered by hand bailing. The amount of free product recovered to date is not known.

1.4 Previous Investigations/Reports

REPORT TITLE	REPORT AUTHOR	REPORT DATE	DATE SUBMITTED TO STATE
UST Closure Report, UST 3996-4 and UST 3996-6	Remediation Services, Inc.	November 1994	
UST Closure Report, USTs 3996-1 through 3996-3	Froehling & Robertson, Inc.	September 14, 1995	
Comprehensive Site Assessment Report, Building 130, Volumes I-II	Law Engineering and Environmental Services, Inc.	June 21, 1995	
Leaking Underground Storage Tank Site Assessment Report, UST 3996-4, Volumes I-II	Law Engineering and Environmental Services, Inc.	October 5, 1995	
Leaking Underground Storage Tank Site Assessment Report, UST 3996-6, Volumes I-II	Law Engineering and Environmental Services, Inc.	October 5, 1995	
Addendum Comprehensive Site Assessment Report, Building 130, Volumes I-III	Law Engineering and Environmental Services, Inc.	March 15, 1996	
Addendum Comprehensive Site Assessment Report, Building 3996, Volumes I-III	Law Engineering and Environmental Services, Inc.	March 28, 1996	
Final Report, Engineering Evaluation, Aviation Fuel Distribution System Integrity Testing, MCAS, Cherry Point	Dames & Moore, Inc.	February 9, 1996	
Draft Comprehensive Site Assessment Report, Pit 4 Area, Volumes I-II	Law Engineering and Environmental Services, Inc.	July 15, 1996	
Remedial Strategies/Pilot Study Recommendations Letter	Law Engineering and Environmental Services, Inc.	July 19, 1996	Submitted with CAP

1.5 Summary of Tables (Appendix A) and Drawings (Appendix B) From Previous Reports

TABLE/DRAWING NO.	TITLE
Building 130	
Table 4.1.1	Summary of Laboratory Analytical Results - Soil Samples
Table 5.1.1	Summary of Laboratory Analytical Results - Groundwater Samples (Hydropunch)
Table 5.3.1	Summary of Laboratory Analytical Results - Groundwater Samples (Monitoring Wells)
Building 130 Addendum	
Table 4.1.2	Summary of Laboratory Analytical Results - Soil Samples
Table 5.1.2	Summary of Laboratory Analytical Results - Groundwater Samples (Hydropunch)
Table 5.3.2	Summary of Laboratory Analytical Results - Groundwater Samples (Monitoring Wells)
Building 3996	
Table 4.1.1	Summary of Laboratory Analytical Results - Soil Samples
Table 5.3.1	Summary of Laboratory Analytical Results - Groundwater Samples (Monitoring Wells)
Building 3996 Addendum	
Table 4.1.2	Summary of Laboratory Analytical Results - Soil Samples
Table 5.2	Summary of Laboratory Analytical Results - Groundwater Samples (Hydropunch)
Table 5.3.2	Summary of Laboratory Analytical Results - Groundwater Samples (Monitoring Wells)
Pit 4 Area	
Table 4.1	Summary of Laboratory Analytical Results - Soil Samples
Table 5.2	Summary of Laboratory Analytical Results - Groundwater Samples (Power Probes)
Table 5.3	Summary of Laboratory Analytical Results - Groundwater Samples (Monitoring Wells)
Building 130	
Drawing 1.1	Topographic Site Map
Drawing 3.1	Water Supply Well Location Map
Drawing 4.2	Cross-Section Location Map
Drawing 4.3	Subsurface Cross-Sections
Building 3996	
Drawing 1.1	Topographic Site Map
Drawing 3.1	Water Supply Well Location Map
Drawing 4.2	Cross-Section Location Map
Drawing 4.3	Sub-surface Cross-Sections
Pit 4 Area	
Drawing 1.1	Topographic Site Map
Drawing 1.2	Contaminant Source Inventory, Utility and Sample Location Map
Drawing 3.1	Water Supply Well Location Map
Drawing 4.1	Cross Section Location Map
Drawing 4.2	Subsurface Cross Sections
Drawing 4.3	Estimated Extent of Soil Contamination
Drawing 5.1	Water-Table Elevation Contour Map
Drawing 5.2	Estimated Extent of Free Product
Drawing 5.3	Benzene Concentrations (Water) - Isopleth Map
Drawing 5.4	Total BTEX Concentrations (Water) - Isopleth Map
Drawing 5.5	Total Semi-Volatile Concentrations (Water) - Isopleth Map

2.0 OBJECTIVES OF THE CORRECTIVE ACTION PLAN

For the development of this CAP, the following objectives were established:

a. Primary Source:

(i) Primary sources at Building 130, Building 3996, and the Pit 4 Area have been abandoned in-place, repaired or removed. See Section 1.3 for details.

b. Secondary Sources:

(i) Free Product: Remove free product to less than or equal to 1/8 inch as measured in the proposed free product recovery wells and groundwater monitoring wells.

(ii) Vadose Zone Soils: Reduce concentrations of petroleum hydrocarbons in soil to 10 mg/kg, 40 mg/kg and 250 mg/kg, as measured by EPA Methods 5030/8015, 3550/8015, and 9071, respectively.

(iii) Dissolved-Phase Groundwater Contamination: Restore groundwater adversely impacted by petroleum fuel releases to a quality consistent with North Carolina Groundwater Quality Standards.

(iv) Receptor Protection: Conduct groundwater monitoring activities to document the low risk of exposure to receptors.

c. Target Cleanup Concentrations:

MEDIUM	COMPONENT	EXISTING CONDITIONS (MAXIMUM CONCENTRATIONS)	TARGET CLEANUP
BUILDING 130			
Free Product	Aviation Fuels	2.68 feet was measured in monitoring well 72GW15 on 9/1/95	≤ 1/8"
Vadose Zone Soils	Volatile and Semi-volatile TPH	49.4 mg/kg by EPA Method 3550 1,330 mg/kg by EPA Method 5030	40 mg/kg by 3550, and 10 mg/kg by 5030
Groundwater	Benzene	383 µg/l	1 µg/l
	Ethylbenzene	921 µg/l	29 µg/l
	Xylenes	2,900 µg/l	530 µg/l
	Acenaphthene	5,060 µg/l	80 µg/l
	Acenaphthylene	2,890 µg/l	210 µg/l*
	Benzo(k)flouranthene	65.1 µg/l	**
	Chrysene	6.18 µg/l	5 µg/l*
	Flourene	1,180 µg/l	210 µg/l
	Indeno(1,2,3-cd)pyrene	405 µg/l	**
	1-Methylnaphthalene	2,010 µg/l	**
	2-Methylnaphthalene	1,510 µg/l	**
	Naphthalene	5,430 µg/l	21 µg/l\
BUILDING 3996			
Free Product	Diesel Fuel	0.12 feet was measured in monitoring well 74GW10 on 5/8/96	≤ 1/8"
Vadose Zone Soils	Volatile and Semi-volatile TPH, Oil and Grease	209 mg/kg by EPA Method 3550 106 mg/kg by EPA Method 5030 5,880 mg/kg by EPA Method 9071	40 mg/kg by 3550, 10 mg/kg by 5030, and 250 mg/kg by 9071
Groundwater	Benzene	55,700 µg/l	1 µg/l
	Ethylbenzene	1,910 µg/l	29 µg/l
	Toluene	41,500µg/l	1,000 µg/l
	Xylenes	16,530 µg/l	530 µg/l
	Naphthalene	1,190 µg/l	21 µg/l
PIT 4 AREA			
Free Product	Aviation Fuels	11.5 feet of product has been reported in the monitoring well at the center of the free product plume.	≤ 1/8"
Vadose Zone Soils	Volatile and Semi-volatile TPH	49.4 mg/kg by EPA Method 3550 1,330 mg/kg by EPA Method 5030	40 mg/kg by 3550, and 10 mg/kg by 5030
Groundwater	Benzo(b)flouranthene	1.30 µg/l	**
	1-Methylnaphthalene	29.8 µg/l	**
	2-Methylnaphthalene	3.36 µg/l	**
	Naphthalene	47.9 µg/l	21 µg/l

* Interim Groundwater Quality Standard
** The Groundwater Quality Standard for these compounds is the laboratory detection limit.

d. Target Schedule:

(i) Permit Applications: A permit application for the installation of recovery wells will be submitted within one month after finalizing system design. The Pit 4 area will use the Building 4075 remediation system for the total fluids treatment and treated water will be disposed of under the conditions of the Building 4075 NPDES permit. MCAS is seeking a modification to the Building 4075 permit.

(ii) System Installation/Activation: Twelve months after Groundwater Section approval of CAP. See Drawing 2.1 for the CAP schedule.

(iii) Monitoring: August 1998 through August 2018

(iv) Project Completion: Free product removal lifetime is estimated to be four years. Lifetime of the project is estimated to be 21 years. However, if laboratory results from four consecutive sampling events indicate that contaminant concentration levels are less than or equal to target clean up levels, monitoring will be terminated upon approval by Groundwater Section.

3.0 EXPOSURE ASSESSMENT

Petroleum fuels are composed of many different compounds consisting primarily of hydrocarbons. Each of the compounds exhibit individual physical and chemical properties in the environment and, therefore, it is difficult to predict the behavior of all the fuel components. However, the biodegradation rate, toxicity and physical properties of benzene, ethylbenzene, toluene, p-xylene, acenaphthene, acenaphthylene, anthracene, benzo(b)flouranthene, benzo(k)flouranthene, chrysene, flourene, indeno(1,2,3-cd)pyrene, 1-methylnaphthalene, 2-methylnaphthalene and naphthalene are summarized in Table 3.1. Mobility of the compounds can be interpreted by reviewing the values of the octanol/water partition coefficient (K_{ow}) and water solubility columns in Table 3.1. Compounds with lower values of K_{ow} and higher values of water solubility are generally more mobile than compounds with higher values of K_{ow} and lower values of solubility. Values for toxicity of individual compounds are referenced in Table 3.1 and are assigned on the basis of toxicological studies.

The problems created by the presence of petroleum constituents in groundwater may be viewed in terms of health and safety concerns and environmental concerns. Fuel contamination, in any one of four physical states or "phases" (residual, vapor, liquid, dissolved) may be transmitted to receptors via ingestion, inhalation and adsorption. Receptors may be exposed to contamination found in the soil primarily through the inhalation of volatilized compounds and dermal contact with soil. Exposure via ingestion most commonly occurs from consumption of drinking water obtained from contaminated wells or contaminated public water supplies. An evaluation of exposure pathways at Building 130, Building 3996, and Pit 4 Area is summarized in Table 3.2.

There are no water supply wells or apparent surface water receptors within 1,500 feet of the Building 130, Building 3996, and Pit 4 Area sites. The closest receptor associated with the Building 130 site is a water

supply well (USGS No. 74) located approximately 3,700 feet to the west-northwest. Drawing 3.1 (Appendix B - Attachment BA) shows proximal water supply well locations. The closest surface water receptor associated with the Building 130 site is an unnamed tributary of Slocum Creek located over 4,000 feet to the northwest. Please see Drawing 1.1 (Appendix B-Attachment BA) for surface water receptor locations. According to the Water-Table Elevation Contour Map (Drawing 5.1 located in Appendix B - Attachment BC), the general direction of groundwater flow at the Building 130 and the Pit 4 Area is to the northwest.

The closest receptor associated with the Building 3996 site is a water supply well (USGS No. 82) located approximately 5,000 feet to the west. The closest surface water receptor associated with the Building 3996 site is an unnamed tributary of East Prong Slocum Creek located approximately one mile to the southwest. According to Drawing 5.1 (located in Appendix B - Attachment BC), the general direction of groundwater flow at the Building 3996 site is to the west-southwest. Water supply well (USGS No. 100) and Sandy Branch are located west-southwest at a distance of approximately 5,800 feet and 6,000 feet respectively. USGS Well No. 100 and Sandy Branch appear to be directly downgradient of petroleum fuel contaminants at the Building 3996 site.

The closest receptor associated with the Pit 4 Area is a tributary of Mill Creek located approximately 1,900 feet to the north-northwest. The closest water supply well (USGS No. 12) associated with the Pit 4 Area is located approximately one mile to the north-northwest. According to Drawing 5.1 (located in Appendix B - Attachment BC), the general direction of groundwater flow in this area is to the north-northwest.

With respect to environmental concerns, the presence of free product in the vicinity of Building 130, Building 3996, and Pit 4 Area is an environmental concern because the free product serves as a potential source for the continued degradation of groundwater beneath the project sites.

In addition, the plume of dissolved-phase contamination will potentially enlarge under the influence of natural groundwater movement, thus increasing the area adversely impacted by the petroleum release. However, based on current site conditions, the existing concentrations and anticipated movement of subsurface contaminants, apparent risk to potential receptors in the vicinity of Building 130, Building 3996, and Pit 4 Area would be minimal if the planned remedial action is taken.

4.0 EVALUATION OF REMEDIAL ALTERNATIVES AT THE BUILDING 130/BUILDING 3996 SITES AND BASIS OF DECISION FOR REMEDIAL SOLUTION AT THE PIT 4 AREA

LAW conducted a cursory evaluation of remedial technologies associated with the remediation of petroleum contaminated groundwater at Building 130 and Building 3996. The feasibility of each technology was evaluated with respect to application at the subject sites. From the cursory evaluation, two alternative remedial approaches were considered further to remediate contaminated soils and groundwater Building 130 and Building 3996 sites. Each alternative is described below followed by a cost evaluation of the alternative. An explanation of the chosen remedial solution for the Pit 4 Area is provided in Section 4.5.

4.1 Alternative 1: Pump Free Product/Soil Vapor Extraction/Air Sparging/Naturally Attenuate Fringes of Dissolved-Phase Plume

Overview

Pump free product from the free product plume area with discriminating pumps in the vicinity of Building 130. Recover free product in the vicinity of Building 3996 by placing a canister with an oil absorbent pad within monitoring well 74GW10. The remaining corrective action technologies used to remediate the saturated and unsaturated zones at Building 130 and Building 3996 are similar. Restore dissolved-phase petroleum constituents within the surficial aquifer by air sparging. Petroleum vapors liberated by sparging will be captured and controlled by soil vapor extraction. The fringes of the dissolved-phase petroleum plume (generally considered to be those areas with less than 100 µg/l of benzene) will be remediated by natural attenuation and degradation. Sampling and analysis of groundwater for dissolved-phase petroleum constituents will be performed to monitor overall performance of the remedial technologies.

System Components

(a) Free Product

(i) Eight six-inch diameter recovery wells installed to a depth of approximately 27 feet.
(ii) Eight discriminating free product pumps.
(iii) Subsurface conduit connecting pumps to surface equipment.
(iv) One air compressor.
(v) One aboveground storage tank.
(vi) One canister containing an oil absorbent pad to be placed in monitoring well 74GW10.

(b) Dissolved-Phase

(i) 36 vertical air sparge wells to inject air into the surficial aquifer; 18 sparge wells in the vicinity of Building 130 and 18 sparge wells in the vicinity of Building 3996.
(ii) Two air sparge blowers to provide pressurized air to the sparge wells.
(iii) Subsurface conduit connecting sparge wells to surface equipment.
(iv) Two remediation equipment buildings (one building in the vicinity of Building 130 and one building in the vicinity of Building 3996) to house surface equipment.

(c) Vadose Zone Soil

(i) 38 vertical SVE wells to remove petroleum vapors from vadose zone soils; 18 SVE wells paired with sparge wells in the vicinity of Building 130 and 20 SVE wells (18 wells paired with sparge wells and two unpaired SVE wells near Building 3745) in the general vicinity of Building 3996.
(ii) Two SVE blowers to pull vacuum at SVE wells.
(iii) Subsurface conduit connecting SVE wells to surface equipment.

Discharges

(a) Free product recovered by discriminating pumps will be piped to an aboveground storage tank will be collected and recycled as part of the MCAS recycling program.
(b) Free product recovered by an oil absorbent pad within a canister will be removed manually and recycled as part of the MCAS recycling program.
(c) Petroleum vapors extracted by the SVE system will be discharged to the atmosphere.
(d) Nuisance water collected by the SVE system will be collected and disposed of properly.

Permits

(a) Well construction permit for recovery wells.

Estimated Lifetime

(i) Free Product
Lifetime: 4 years operation

(ii) Soils
Lifetime: 16 years operation

(iii) Groundwater
Lifetime: 16 years operation to begin after completion of free product recovery, plus 1 year post shutdown monitoring.

Estimated Cost

Capital:	$ 901,000
Operation and Maintenance:	$ 2,352,000
TOTAL LIFETIME COST:	**$ 3,253,000**

4.2 Alternative 2: Pump Free Product/Pump and Treat Groundwater/Soil Vapor Extraction/Naturally Attenuate Fringes of Dissolved-Phase Plume

Overview

Free product and dissolved-phase groundwater will be pumped from the subsurface via total fluid pumps, and routed to an oil/water separator, air stripper and through activated carbon prior to storm water system discharge. Free product will be contained in an aboveground storage tank. Contaminated vadose zone soils will be remediated by a soil vapor extraction (SVE) system that will be vented to the atmosphere. A central remediation equipment building will be located adjacent to Building 3745. The fringes of the dissolved-phase petroleum plume (generally considered to be those areas with less than 100 µg/l of benzene) will be remediated by natural attenuation and degradation. Sampling and analysis of groundwater for dissolved-phase petroleum constituents will be performed to monitor overall system performance.

System Components

(a) Free Product/Groundwater
  (i) 15 six-inch diameter recovery wells installed to a depth of approximately 35 feet.
  (ii) 15 total fluids pumps.
  (iii) One air compressor.
  (iv) One oil/water separator
  (v) One aboveground storage tank.
  (vi) One surge tank.
  (vii) One air stripper for removal of volatile compounds from groundwater.
  (vii) Two activated carbon vessels for removal of compounds not amenable to air stripping.
  (ix) One equipment building to house surface equipment.

(b) Vadose Zone Soil

  (i) 24 vertical SVE wells to remediate petroleum contaminated soils.
  (ii) One SVE blower to pull vacuum at SVE wells.
  (iii) Subsurface conduit connecting SVE wells to surface equipment.

Discharges

(a) Free product will be pumped to an aboveground storage tank.
(b) Exhaust from the air stripper will be discharged to the atmosphere.
(c) Treated groundwater will be discharged to the storm water system.
(d) Petroleum vapors extracted by the SVE system will be discharged to the atmosphere.

Permits

(a) Well construction permit for recovery well
(b) NPDES permit.

Estimated Lifetime

(i) Free Product
Lifetime: 4 years operation

(ii) Soils
Lifetime: 20 years operation

(iii) Groundwater
Lifetime: 20 years operation to begin after completion of free product recovery, plus 1 year post shutdown monitoring.

Estimated Cost

Capital:	$ 1,129,000
Operation and Maintenance:	$ 3,207,000
TOTAL LIFETIME COST:	**$ 4,336,000**

With respect to lifetimes shown above for the various alternative strategies, the stated values are gross estimates for purposes of cost estimation. Because of multiple site-specific characteristics which affect the ultimate success of a remedial effort, the time required for achievement of remediation endpoints cannot be predicted with a high degree of accuracy. As a result, actual system lifetimes will vary from those stated herein.

4.3 Summary Table of Alternatives and Costs

PROBLEM	ALTERNATIVE 1	ALTERNATIVE 2
Free Product	Remove Free Product in the Vicinity of Building 130 with Discriminating Pumps. Remove Free Product in the Vicinity of Building 3996 with a Canister Containing an Oil Absorbent Pad Located in Monitoring Well 74GW10	Remove Free Product in the Vicinity of Building 130 and Building 3996 using Total Fluids Pumps with Free Product Storage and Water Treatment by Oil/Water Separation, Air Stripping, and Carbon Adsorption with Disposal to Surface Waters
Vadose Zone Soils	Soil Vapor Extraction for Building 130 and Building 3996 to Control Vapors Generated by Air Sparging.	Soil Vapor Extraction for Building 130 and Building 3996 Limited to Areas of Contaminated Vadose Zone Soils
Dissolved-Phase Groundwater Contamination	Natural Attenuation and Degradation Along the Fringes of the Dissolved-Phase Plume and Air Sparging in the Heart of the Plume for Building 130 and Building 3996	Natural Attenuation and Degradation Along the Fringes of the Dissolved-Phase Plume and Pump and Treat the Heart of the Plume as described above for Building 130 and Building 3996
Initial Cost	$901,000	$1,129,000
Lifetime Cost	$2,352,000	$3,207,000
Total Cost	$3,253,000	$4,336,000
Lifetime	21 years	25 years

The chosen method of corrective action will meet the requirements listed in 15A NCAC 2L .0106(c) on the following basis:

(1) The Groundwater Section has been notified of the activity causing an increase in contaminant concentrations above the groundwater quality standards;
(2) The source of contamination will be controlled;
(3) Site assessment reports have been submitted to the Groundwater Section;
(4) This corrective action plan for restoration of groundwater quality is submitted with a schedule prior to implementation of remedial activities. See Appendix E for copies of letters sent to individuals per notification requirements of Rule .0114(a).

4.4 Statement of Recommendation

We recommend the selection of Alternative 1 for the removal of free product and for the restoration of vadose zone soils and groundwater quality at Building 130 and Building 3996 based on the following:

- The estimated cost and lifetime for Alternative 1 are less than for the other Alternative.

- Natural attenuation and degradation is feasible based on site specific data that include availability of dissolved oxygen and nutrients, type of contaminant, soil type, hydraulic gradient and hydraulic conductivity. In addition, criteria outlined in 15A NCAC 2L .0106(l), regarding the migration of contaminated groundwater appear to be met. Results of contaminant transport modeling suggest a shorter period of time to achieve acceptable contaminant levels than that used to estimate the cost for this option.

4.5 Basis of Decision for the Remedial Solution at the Pit 4 Area

Overview

At the Pit 4 Area, LAW evaluated the available information and chose a remedial strategy similar to the approach selected for the Corrective Action Plan (CAP) associated with the nearby Building 4075 Pipeline/Tank Farm A site for reasons as follows:

- The pipeline system is considered to be the source of contamination at the Building 4075 Pipeline/tank Farm A site and the Pit 4 Area;
- The majority of the release at each site is composed of aviation fuel;
- Subsurface hydrogeologic conditions appear to be relatively uniform at each location;
- The free product plumes at each location are close, separated by a distance of less than 300 feet as illustrated in Drawing 5.1;
- An individual remediation equipment building used to house surface equipment for the Pit 4 Area would have to be located away from the flightline and would require extensive trenching and long runs of conduit;
- Substantial cost savings for trenching, purchase of remediation equipment, and construction of the remediation equipment building should be realized by expanding the proposed remediation system for Building 4075 Pipeline/Tank Farm A to include the remediation of the Pit 4 Area contaminants versus creating an independent remediation system for the Pit 4 Area.

System Components

(a) Free Product/Groundwater
  (i) 22 six-inch diameter recovery wells.
  (ii) 22 total fluids pumps.
  (iii) Subsurface conduit connecting recovery wells to surface equipment.

(iv) The proposed Building 4075 Pipeline/Tank Farm A remediation system may have to be enlarged to accommodate remediation of the Pit 4 Area. Some of the equipment that may be affected is listed as follows:

- Air compressor
- Oil/water separator
- Product storage tank
- Surge tank
- Air stripper
- Activated carbon vessels
- Remediation equipment building

(b) Vadose Zone Soil

(i) 22 vertical SVE wells to remove petroleum vapors from vadose zone soils.
(ii) Subsurface conduit connecting SVE wells to surface equipment.
(iii) The size of the SVE blower may have to be increased to account for increased pressure and flow requirements.

Discharges

(a) Free product will be piped to an aboveground storage tank.
(b) Exhaust from the air stripper will be discharged to the atmosphere.
(c) Treated groundwater will be discharged to the storm water system.
(d) Petroleum vapors extracted by the SVE system will be discharged to the atmosphere.

Permits

(a) Well construction permit for recovery wells
(b) NPDES permit.

Estimated Lifetime

(i) Free Product
Lifetime: 4 years operation

(ii) Soils
Lifetime: 16 years operation

(iii) Groundwater
Lifetime: 20 years operation to begin after completion of free product recovery, plus 1 year post shutdown monitoring.

Estimated Cost

Capital:	$ 575,000
Operation and Maintenance:	$ 1,922,000
TOTAL LIFETIME COST:	**$ 2,497,000**

With respect to lifetimes shown above for the various alternative strategies, the stated values are gross estimates for purposes of cost estimation. Because of multiple site-specific characteristics which affect the ultimate success of a remedial effort, the time required for achievement of remediation endpoints cannot be predicted with a high degree of accuracy. As a result, actual system lifetimes will vary from those stated herein.

Summary Table of Costs for the Pit 4 Area

PROBLEM	STRATEGY
Free Product	Remove Free Product in the Pit 4 Area using Total Fluids Pumps with Free Product Storage and Water Treatment by Oil/Water Separation, Air Stripping, and Carbon Adsorption with Disposal to Surface Waters
Vadose Zone Soils	Soil Vapor Extraction Limited to Areas of Contaminated Vadose Zone Soils
Dissolved-Phase Groundwater Contamination	Natural Attenuation and Degradation of the Fringes of the Dissolved-Phase Plume
Initial Cost	$575,000
Lifetime Cost	$1,922,000
Total Cost	$2,497,000
Lifetime	20 years

The chosen method of corrective action will meet the requirements listed in 15A NCAC 2L .0106(c) on the following basis:

(1) The Groundwater Section has been notified of the activity causing an increase in contaminant concentrations above the groundwater quality standards;
(2) The source of contamination will be controlled;
(3) Site assessment reports have been submitted to the Groundwater Section;
(4) This corrective action plan for restoration of groundwater quality is submitted with a schedule prior to implementation of remedial activities. See Appendix E for copies of letters sent to individuals per notification requirements of Rule .0114(a).

5.0 PROPOSED CORRECTIVE ACTION STRATEGY

5.1 General Description of System

The selected technology for remediation at Building 130 and Building 3996 consists of the recovery of free product, remediation of dissolved-phase contaminated groundwater within the contamination plume via air sparging, treatment of contaminated soils within the contamination plume via soil vapor extraction, and of dissolved-phase contaminated groundwater via natural attenuation and degradation within the outlying fringes of the contamination plume.

The selected technology for remediation at the Pit 4 Area consists of the recovery of free product, treatment of contaminated soils within the free product plume by soil vapor extraction, and remediation of dissolved-phase petroleum constituents by natural attenuation and degradation. Free product will be recovered using total fluids pumps. The fluids will be routed through an oil/water separator. The product will be piped to a product tank and the extracted groundwater will be treated via air stripping and carbon adsorption prior to surface discharge.

5.1.1 Free Product Recovery

- Building 130

  At Building 130, free product has been measured at a thickness of 2.68 feet. The free product recovery system at Building 130 will use discriminating pumps to extract only free product from eight recovery wells to an aboveground storage tank near Building 130. Recovery well locations are indicated in Drawing 5.1 and were selected according to the measured presence of free product. The recovered free product will be collected and included as part of the Marine Corps Air Station's recycling program.

- Building 3996

  At Building 3996, free product has been measured at a thickness of 0.12 feet. Monitoring well 74GW10 will be equipped with a canister containing an oil adsorbent pad to collect free product present within the well. A more aggressive approach to free product recovery will be evaluated if warranted by field data. The recovered free product will be collected and included as part of the Marine Corps Air Station's recycling program.

- Pit 4 Area

  At the Pit 4 Area, free product has been measured at a thickness of approximately 11.5 feet. The free product recovery system in the vicinity of Pit 4 Area will connect to the proposed remediation system at the Building 4075 Pipeline/Tank Farm A site. Twenty-two recovery wells will use total fluids pumps. In general, the recovery wells will be installed to depths ranging from 22 to 27 feet below land surface (bls). However, six of

the recovery wells along the downgradient edge of the Pit 4 Area plume will be installed to a depth of 45 feet bls. The pumps in these wells may be lowered to 45 feet in an effort to impede the movement of the dissolved phase plume, if necessary. Recovery wells will be spaced as shown in Drawing 5.1. The free product recovery well spacing (approximately 100 feet) was derived from pump test data but closer well spacing is used where product thickness is greater anticipating that the time required to recover free product will be shorter. Compressed air and fluid return lines between wells will be installed by trenchless drilling in all locations except in the grass islands where conventional trenching will be used. Where SVE wells are coincident with free product recovery wells; both wells will be accessed through the same manhole.

Pneumatic pumps will draw free product floating on top of the water table through a pipe system and deliver it to the aboveground storage tank as shown in the treatment system schematic (Drawing 5.3). The recovered free product will be collected and included as part of the Marine Corps Air Station's recycling program. Nuisance water, generated during total fluids pumping, will be treated by air stripping and activated carbon and then, discharged to the grass drainage swale located north of the project site by an NPDES permit.

The free product recovery systems will operate concurrently with the SVE systems unless it is found during operation that a SVE system is affecting the performance of a free product recovery system. Then, vacuum flow rates of the SVE system may be adjusted or the system may be shut down temporarily.

5.1.2 Air Sparging

Air sparging facilitates volatilization of adsorbed and dissolved VOCs in the surficial aquifer by forcing pressurized air below the water table. VOCs which may be released into the vadose zone will then be removed by the soil vapor extraction system. The increased oxygen content within the surficial aquifer will promote biological activity which is expected to result in the degradation of semi-volatile petroleum fuel constituents present in the groundwater. The air sparge wells will be constructed of two-inch diameter PVC and will be screened over a two and one-half feet interval. Air sparge wells are paired with soil vapor extraction wells that are to be placed in a single borehole and accessed through one wellhead.

- Building 130

18 air sparge wells will be located in the vicinity of Building 130. The locations of the sparge wells and the anticipated zones of influence for the sparge wells are shown in Drawing 5.2. The sparge wells will be connected to an air sparger assembly that will consist of a blower, motor, inlet silencer, inlet filter and discharge silencer as depicted in the treatment system schematic (Drawing 5.3). The equipment listed above will be housed in a remediation equipment building designated Building A and located to the north of Building 130. The proposed location of Building A is shown in Drawing 5.2.

The bottom of the air sparge well screens should be set approximately at the top of the Yorktown formation. In the general vicinity of Building 130, the depth to the Yorktown is approximately 38 to 40 feet below land surface (bls). The depth of the proposed group of four air sparge wells to the north of Building 130 shall be such that the bottom of the wells are located 15 feet below the water table or approximately 26 feet bls. This depth will be sufficient because as shown in Table 5.3.2 of Appendix A, concentrations of petroleum constituents are relatively low in the nearby Type III monitoring well 72GW19.

- Building 3996

18 additional sparge wells will be located near Building 3996. As with Building 130 the locations of the sparge wells and the anticipated zones of influence are shown in Drawing 5.2. The sparge wells will be connected to a second air sparger assembly similar to the unit described above. The equipment connected to the sparge wells in the vicinity of Building 3996 will be housed in a second remediation equipment building designated Building B. The proposed location of Building B is shown in Drawing 5.2.

The bottom of the air sparge well screens should be set approximately at the top of the Yorktown formation. In the vicinity of Building 131, the depth to the Yorktown appears to be approximately 33 feet bls according to a boring log from monitoring well 74GW24. Along 6th Avenue, in the vicinity of monitoring well 72GW29, the Yorktown appears to be at a depth of approximately 38 feet bls.

5.1.3 Soil Vapor Extraction

The soil vapor extraction (SVE) system will operate by extracting volatile petroleum compounds from the vadose zone and enhancing the biological degradation of semi-volatile organic compounds. A vacuum will be applied to the SVE wells and a capture zone will be created in the vicinity of each well. The air removed from the vadose zone will be discharged to the atmosphere.

The SVE wells will be constructed of 2-inch diameter PVC pipe (Schedule 40 with flush-threaded joints with 0.02 inch slots, screened over a two and one-half feet interval approximately 3.5 to 6 feet below land surface (bls). The screened interval shall allow clearance for a wellhead and a proper well seal while being higher than the groundwater table rise created by the air sparging activities.

- Building 130

18 SVE wells will be located in the vicinity of Building 130. The locations of the SVE wells and the anticipated zones of influence for the SVE wells are shown in Drawing 5.2. The SVE wells will be connected to a vacuum blower assembly that will consist of a blower, motor, moisture separator, separator drain and exhaust silencer as depicted in the

treatment system schematic (Drawing 5.3). The equipment listed above will be housed in a remediation equipment building designated Building A and located to the north of Building 130. The proposed location of Building A is shown in Drawing 5.2.

- Building 3996

20 SVE wells will be located near Building 3996. The locations of the SVE wells and the anticipated zones of influence are shown in Drawing 5.2. It should be noted that for Building 3996 there are two more SVE wells than air sparge wells because there is an area of petroleum contaminated soil to the south of Building 3745 where the groundwater is not sufficiently contaminated to require air sparging. The SVE wells will be connected to a second vacuum blower assembly similar to the unit for Building 130 as described above. The equipment connected to the SVE wells in the vicinity of Building 3996 will be housed in a second remediation equipment building designated Building B. The proposed location of Building B is shown in Drawing 5.2.

- Pit 4 Area

22 SVE wells will be located in the vicinity of the Pit 4 Area. The locations of the SVE wells and the anticipated zones of influence are shown in Drawing 5.2. The soil vapor extraction system in the vicinity of Pit 4 Area will connect to the proposed remediation system at the Building 4075 Pipeline/Tank Farm A site. The treatment system schematic is shown in Drawing 5.3. Where SVE wells are coincident with free product recovery wells; both wells will be accessed through the same manhole.

We estimate that up to 20 gallons of water per day consisting of condensed vapor and moisture collected from the capillary fringe will be collected in the moisture separation unit of each system. As the SVE systems operate, field observations may indicate a need for the water to be pumped to a holding tank where it will be retrieved and handled by a disposal service or alternatively treated by activated carbon prior to on-site discharge.

5.1.4 Natural Attenuation and Degradation

Elevated concentrations of petroleum constituents associated with the dissolved-phase plumes at Building 130, Building 3996 and the Pit 4 Area will be remediated by the chosen technology at each location. The fringes of the dissolved-phase petroleum constituent plumes at Building 130, Building 3996 and the Pit 4 Area will be remediated by natural attenuation and degradation. At Building 130 and Building 3996, the fringes of the petroleum constituent plume are considered to be the areas where concentrations of benzene are equal to 100 µg/l or less. At the Pit 4 Area, the objective of active remediation is to remove free product to a 0.01 foot thickness and allow the remaining dissolved-phase petroleum constituents to naturally attenuate and degrade. As discussed in the following paragraphs, project site characteristics meet criteria established by NCDWQ at 15A NCAC 2L .0106 (l) for approval of such corrective action through natural processes.

Due to complexities associated with multi-phase transport of subsurface contaminants in heterogeneous environments and the lack of information regarding the date(s) and volume of contaminant release, the accuracy of fate and transport studies is highly dependent upon the availability of empirical field data and the sophistication of models used to predict contaminant behavior. In some cases, we relied upon parameter values obtained from published literature to define input parameters for our modeling effort. Our choice of a fate and transport model was based, in part, upon the level of complexity of the site and the level of accuracy required for the predictions. Therefore, our predictions may vary somewhat from actual future conditions as a result of variances between actual field conditions and input parameter values as well as limitations in the model utilized.

- *Criterion (1): Source Removal and/or Control*

  All sources of contamination and free product have been removed or controlled.

  Building 130

  At Building 130, the former aviation fuel pipeline has been abandoned. The two lubrication oil/waste oil USTs are believed to be abandoned in-place. As previously discussed, free product will be removed by a system of discriminating pumps.

  Building 3996

  At Building 3996, the former aviation fuel pipeline has been abandoned and USTs 3996-1, 3996-2 and 3996-3 were removed in July 1995. Around the hydraulic lift pits, contaminated soils have been removed to the extent possible without threatening the stability of Building 3996. As previously discussed, free product will be removed by a canister containing an oil absorbent pad to be placed in monitoring well 74GW10.

  Pit 4 Area

  At the Pit 4 Area, the former aviation fuel pipeline has been abandoned. The active aviation fuel pipeline in the vicinity of Pit 4 has been repaired. As previously discussed, free product will be removed by a system of total fluids pumps.

- *Criterion (2): Capacity to Degrade or Attenuate*

  The contaminant has the capacity to degrade or attenuate under the site-specific conditions.

  Building 130

  Petroleum fuel is composed of many hydrocarbon compounds, most of which have been shown to be amenable to destruction by biological pathways. At the Building 130

location, benzene has been identified as the petroleum constituent having the highest estimated contaminant velocity. As discussed in the literature (ASTM ES 38), benzene degrades aerobically and has a half-life cycle of about 99 days. A half-life is the time required to reduce the original constituent concentration by one-half. The lowest dissolved oxygen concentration measured at Building 130 during the site suitability study was 4.77 mg/l indicating that aerobic conditions exist at the site (Table 5.1.1 and Appendix D-Attachment DD). The total plate count reported in the results of the site suitability study (Table 5.1.1) indicates the presence of microbial colonies in the vicinity of monitoring well 72GW14 at a concentration of 7,950 CFU/ml. This level is greater than those measured in other wells indicating increased or above average biological activity and is likely due to the degradation of contaminants.

Building 3996

Benzene has also been identified at Building 3996 as the petroleum constituent with the highest estimated contaminant velocity. The lowest dissolved oxygen concentration measured at Building 3996 during the site suitability study was 2.27 mg/l indicating that aerobic conditions exist at the site (Table 5.1.2 and Appendix D-Attachment DD). The total plate count reported in the results of the site suitability study (Table 5.1.2) indicates the presence of microbial colonies in the vicinity of monitoring well 74GW15 at a concentration of 4,300 CFU/ml. This level is greater than those measured in other wells indicating increased or above average biological activity and is likely due to the degradation of contaminants.

Pit 4 Area

Naphthalene has been identified at the Pit 4 Area as the petroleum constituent with the highest estimated contaminant velocity. Naphthalene degrades aerobically and has a half-life cycle of about 258 days (ASTM ES 38). The lowest dissolved oxygen concentration measured at the Pit 4 Area during the site suitability study was 5.37 mg/l indicating that aerobic conditions exist at the site (Table 5.1.3 and Appendix D-Attachment DD). The total plate count reported in the results of the Site Suitability Study (Table 5.1) indicates the presence of microbial colonies in the vicinity of monitoring well 72GW43 at a concentration of 2,220,000 CFU/ml. This level is greater than those measured in other wells indicating increased or above average biological activity and is likely due to the degradation of contaminants.

- *Criterion (3): Time and Direction of Contaminant Travel*

  The time and direction of contaminant travel can be predicted with reasonable certainty.

  Building 130

  The direction of groundwater flow is established in LAW's Leaking Underground Storage Tank Site Assessment Report for Building 130 and is estimated to be toward the northwest. The rate of groundwater flow was obtained using a hydraulic conductivity (66 ft/day) determined from a pumping test, the hydraulic gradient (0.0035) and an estimate of effective porosity (0.25). The transport rate of benzene was used to predict the downgradient extent of petroleum constituents at the site because it is the most mobile of the compounds detected at this site. Calculations found in Appendix D-Attachment DC, based solely on the geohydrochemical processes of sorption-desorption, indicate that benzene is expected to travel 0.190 feet per day or 70 feet per year. At this rate, approximately 53 years would be required for benzene to reach the nearest receptor (water supply well USGS No. 74), if it did not degrade.

  Since active remediation will be performed where benzene concentrations are greater than 100 µg/l, the modeling of benzene migration was conducted such that contaminant concentrations for only the fringes of the benzene plume were input as parameters into the fate and transport computer model Biotrans™. The computer model considers biodegradation and predicts that the fringes of the benzene plume will expand and then contract to acceptable levels within approximately 11 years as shown in the sequence of drawings in Appendix D and Drawing 5.4.

  Building 3996

  The direction of groundwater flow is established in LAW's Leaking Underground Storage Tank Site Assessment Report for Building 3996 and is estimated to be toward the west-southwest. The rate of groundwater flow was obtained using a hydraulic conductivity (96 ft/day) determined from a pumping test, the hydraulic gradient (0.0013) and an estimate of effective porosity (0.25). Benzene was used to predict the rate of transport of the petroleum contaminants because it is the most mobile of the compounds detected at the project site. Calculations found in Appendix D-Attachment DC, based solely on the geohydrochemical processes of sorption-desorption, indicate that benzene is expected to travel approximately 0.105 feet per day or 39 feet per year. At this rate, approximately 128 years would be required for benzene to reach the nearest receptor (water supply well USGS No. 82), if it did not degrade.

  As with Building 130, active remediation will be performed where benzene concentrations are greater than 100 µg/l and only the fate of the benzene plume fringes were modeled using Biotrans™. The sequence of drawings in Appendix D and Drawing

5.4 show that the fringes of the benzene plume will spread and then recede to acceptable concentrations within approximately 13 years.

Pit 4 Area

The direction of groundwater flow is established in LAW's Leaking Underground Storage Tank Site Assessment Report for the Pit 4 Area and is estimated to be toward the north-northwest. The rate of groundwater flow was obtained using a hydraulic conductivity (61 ft/day) determined from a nearby pumping test, the hydraulic gradient (0.0019) and an estimate of effective porosity (0.25). Naphthalene was used to predict the rate of transport of the petroleum constituents because it is the most mobile of the compounds detected at the project site. Calculations found in Appendix D-Attachment DI, based solely on the geohydrochemical processes of sorption-desorption, indicate that naphthalene is expected to travel approximately 2.2 feet per year. At this rate, approximately 864 years would be required for naphthalene to reach Mill Creek, the nearest receptor.

Free product recovery using total fluids pumps will be performed at the Pit 4 Area, reducing free product to a 0.01 foot thickness over time. The migration of naphthalene was based on its mobility and magnitude of concentrations that were reported in groundwater samples collected at the site. Groundwater analytical data is limited for two reasons: (1) groundwater assessment activities did not begin until March 1996; and (2) only two monitoring wells show the presence of naphthalene since the remaining wells contain free product or are free of contaminants because they are located outside the contaminant plume. On this basis, only two groundwater samples containing naphthalene have been collected and analyzed. The concentration of naphthalene in those two samples is very high (49.5%) relative to the total contaminant concentrations. (See Appendix D - Attachment DI for the calculation). Published sources indicate that jet fuel typically contains approximately 0.14% naphthalene. The higher percentage of naphthalene was used because it is site specific and errs on the side of being very conservative. The sequence of drawings in Appendix D and Drawing 5.4 shows that the size of the naphthalene plume initially increases and then decreases to concentrations below the groundwater quality standard of 21 μg/l within 48 years. It is believed that the time required for naphthalene concentrations to fall below the groundwater quality standard would much less if a lower value of initial mass fraction was used to model the fate of naphthalene in this area.

- *Criterion (4): Violation of Standards at a Receptor*

  Contaminant migration will not result in any violation of applicable groundwater standards at any existing or foreseeable receptor.

  Building 130

  The closest downgradient receptor would be water supply well USGS No. 74, approximately 3,700 feet west-northwest of the site. To date, the extent of petroleum fuel contamination does not extend outside the monitoring well network installed during the previous assessment, nor to known potential receptors. Based on the sequence of drawings generated by the fate and transport computer model Biotrans (Appendix D), the maximum travel distance of benzene from the previous source location would be approximately 420 feet before degradation processes reduce concentrations to the groundwater quality standard of 1 µg/l. Therefore, based of this model, we do not expect that detectable levels of benzene from the site would reach water supply well USGS No. 74.

  Building 3996

  The closest downgradient receptor would be water supply well USGS No. 82, located approximately 5,000 feet west of the site. To date, the extent of petroleum fuel contamination does not extend outside the monitoring well network installed during the previous assessment, nor to known potential receptors. Based on the sequence of drawings generated by the fate and transport computer model Biotrans™ (Appendix D), the maximum travel distance of benzene from the previous source location would be approximately 490 feet before degradation processes reduce concentrations to the groundwater quality standard of 1 µg/l. Therefore, based on the results of this model, we do not expect that detectable levels of benzene from the site would reach water supply well USGS No. 82.

  Pit 4 Area

  The closest downgradient receptor from this site would be a tributary of Mill Creek, located approximately 1,900 feet north-northwest of the site. To date, the extent of petroleum fuel contamination does not extend outside the monitoring well network installed during the assessment, nor to known potential receptors. Based on drawings generated by the fate and transport computer model Biotrans (Appendix D), the maximum travel distance of naphthalene from the previous source location would be approximately 190 feet before degradation processes reduce concentrations to below the groundwater quality standard of 21 µg/l. Therefore, based on this model, we do not expect that detectable levels of naphthalene from the site would reach the unnamed tributary of Mill Creek.

- *Criterion (5): Contaminant Will Not Migrate Onto Adjacent Properties*

  Contaminants have not and will not migrate onto adjacent properties or that (a) such properties are served by an existing public water supply system dependent on surface waters or hydraulically isolated groundwater, or (b) the owners of such properties have consented in writing to the request.

  Using the fate and transport groundwater computer model Biotrans, we estimate that contaminants will not migrate onto adjacent properties at Building 130, Building 3996 or the Pit 4 Area as illustrated in Drawing 5.4. Biotrans models the advection, dispersion and biodegradation of contaminants as a function of time. Input parameters include but are not limited to longitudinal dispersivity, transverse dispersivity, oil-water transfer coefficient, absorption coefficient, contaminant molecular weight and solubility (Tables 5.2.1, 5.2.2, 5.2.3, 5.2.4, and 5.2.5, and Appendix D). Results of the model simulation suggest the distances of contaminant travel before receding to acceptable levels would be as follows:

LOCATION	CONTAMINANT	DISTANCE (feet)	TIME (years)
Building 130	Benzene	420	11
Building 3996	Benzene	490	13
Pit 4 Area	Naphthalene	190	48

The MCAS property extends greater than two miles in all directions from contaminant plumes at Building 130, Building 3996, and Pit 4 Area.

- *Criterion (6): Violations of Surface Water Quality Standards*

  If the contaminant plume is expected to intercept surface waters, the groundwater discharge will not possess contaminant concentrations that would result in violations of standards for surface waters contained in 15A NCAC 2B .0200.

  Building 130

  As discussed in Section 3.0, the nearest surface water to Building 130 downgradient of contaminant plume is an unnamed tributary of Slocum Creek located approximately 4,000 feet northwest of the site. The extent of the dissolved phase plume was defined during previous studies but is expected to travel approximately 420 feet from the source before it degrades to a concentration of 1 µg/l, the Groundwater Quality Standard. A review of Drawing 5.3 (Appendix B) indicates that downgradient monitoring wells 13GW12, 13GW13, and 72GW18 do not contain detectable concentrations of benzene.

Continued monitoring of these downgradient wells will provide adequate detection of plume migration toward surface water receptors.

Building 3996

As discussed in Section 3.0, the nearest downgradient surface water to the Building 3996 contaminant plume is Sandy Branch located approximately 5,800 feet to the west-southwest. The extent of the dissolved phase plume was defined during previous studies but is expected to travel approximately 490 feet from the source before it degrades to a concentration of 1 µg/l, the groundwater quality standard. Groundwater analytical results presented in Table 5.3.1 indicate the that concentrations of benzene are below the Groundwater Quality Standard of 1 µg/l in downgradient Type II monitoring wells 74GW05, 74GW09, 74GW18, 74GW19, and 72GW35. Continued monitoring of these downgradient wells will provide adequate detection of plume migration toward surface water receptors.

Pit 4 Area

As discussed in Section 3.0, the nearest downgradient surface water to the Pit 4 Area is a tributary of Mill Creek located approximately 1,900 feet north-northwest of the site. The extent of the dissolved phase naphthalene plume was defined during previous studies but is expected to travel approximately 190 feet from the source before it degrades to a concentration of 1 µg/l. The groundwater quality standard for naphthalene is 21 µg/l. Groundwater analytical results presented in Table 5.2 (Appendix A) indicate that concentrations of naphthalene are below the groundwater quality standard of 21 µg/l in downgradient monitoring wells 72GW38, 72GW39, 72GW40, 72GW41, 72GW43, and 72GW44. Continued monitoring of these downgradient wells will provide adequate detection of plume migration toward surface water receptors.

- *Criterion (7): Groundwater Monitoring Program*

The person making the request will put in place a groundwater monitoring program sufficient to track the degradation and attenuation of contaminants and contaminant by-products within and down gradient of the plume and to detect contaminants and contaminant by-products prior to their reaching any existing or foreseeable receptor at least one year's time of travel upgradient of the receptor and no greater than the distance the groundwater at the contaminated site is predicted to travel in five years.

Building 130

Monitoring wells 72GW06, 13GW4, 13GW5, 13GW12, 13GW13, and 13GW23 are located upgradient and over 2,000 feet east-southeast of water supply well USGS No. 74, the nearest downgradient receptor. The transport velocity of benzene according to Biotrans is approximately 39 feet per year. The monitoring wells listed above are

located at greater than one year's travel distance upgradient from the nearest potential receptor. The existing monitoring well network is sufficient to track the degradation and attenuation of the contaminants at the present point in time.

Building 3996

Monitoring wells 74GW03, 74GW05, 74GW18, 74GW19, and 72GW35 are located upgradient and over 4,000 feet east-southeast of water supply well USGS No. 82, the nearest downgradient receptor. The transport velocity of benzene according to Biotrans is approximately 38 feet per year. The monitoring wells listed above are located at greater than one year's travel distance upgradient from the nearest potential receptor. The existing monitoring well network is sufficient to track the degradation and attenuation of the contaminants at the present point in time.

Pit 4 Area

Monitoring wells 72GW38, 72GW40, 72GW41, and 13GW15 are located upgradient and over 800 feet southeast of the tributary of Mill Creek, the nearest downgradient receptor. The transport velocity of naphthalene according to Biotrans is approximately 4 feet per year. The monitoring wells listed above are located at greater than one year's travel distance upgradient from the nearest potential receptor. The existing monitoring well network is sufficient to track the degradation and attenuation of the contaminants at the present point in time.

- *Criterion (8): Access Agreements*

  All necessary access agreements needed to monitor groundwater quality pursuant to (7) above have been or can be obtained.

  Access agreements are not necessary at this time because the extent of groundwater contamination and monitoring systems are within the property boundaries for the Marine Corps Air Station.

- *Criterion (9): Public Notification*

  Public notice of the request has been provided in accordance with Rule .0114(b) of 15A NCAC 2L.

  MCAS Cherry Point has notified the appropriate agencies. Letters of public notification and return receipts are included in Appendix F.

- *Criterion (10): Consistency With Environmental Laws*

  The proposed corrective action plan would be consistent with all other environmental laws.

  We know of no inconsistencies between the proposed corrective action and other environmental laws.

5.2 Basis For Selection of Remediation

Field testing was performed and a contaminant transport modeling program was used to determine the feasibility of the chosen remediation technologies at Building 130, Building 3996, and the Pit 4 Area.

5.3 Pilot Studies

An air sparge pilot study was conducted by LAW at the in the vicinity of Building 3996 area on June 4, 1996. Soil vapor extraction pilot studies were conducted at the in the vicinity of Building 3996 area and the Pit 4 Area on April 4, 1996 and June 6, 1996, respectively. These pilot studies are discussed in Appendix C.

Individual site suitability pilot studies for natural attenuation and degradation of the fringes of the petroleum constituent plumes were performed for Building 130, Building 3996 and the Pit 4 Area. Details of the natural attenuation studies are included in Appendix D.

5.4 System Security, Safety and Operations

Monitoring wells and system wellheads located at the sites will be safely secured with well covers, and properly locked for public safety. Each of the remediation systems will be housed within a protective structure which will be locked. The systems will be outfitted with system failure controls and alarms (visible and/or audible) designed to detect high levels of free product in the product storage tank or high levels of water in the vacuum blower assembly's moisture separation chamber. If high fluid levels are detected, the system shut-off controls will prevent accidental discharges of liquids.

5.5 System Limitations

Air sparge and soil vapor extraction technologies are proven and the pilot tests indicate that they may be applied appropriately at the sites. Because active air sparging increases the dissolved oxygen content in the saturated zone, a risk of fouling, or the growth of biological organisms in the sparge wells exists. The organisms associated with biofouling may be destroyed by introducing biocides into the sparge well and agitating the water column.

Free product recovery using discriminating pumps depends on the aquifer conditions which move free product into the system. Therefore, the time required for free product recovery may need to be adjusted. These limitations will be evaluated as the system is put into operation.

6.0 MONITORING AND REPORTING

In accordance with 15A NCAC 2L .0106 (l)(7), a monitoring program will be initiated in order to assess the effectiveness of the remediation system performance and to assess natural attenuation and degradation as a means to restore groundwater quality.

Components of the monitoring program will include:

- Weekly evaluation of free product recovery system effectiveness including water level measurements, records of product thickness and product recovered volumes.
- Groundwater sampling from existing wells on a quarterly basis for the first year and semi-annually thereafter.
- Laboratory analysis of collected samples. Laboratory testing will be performed for purgeable aromatic hydrocarbons and polynuclear aromatic hydrocarbons by EPA Methods 602 and 610.
- Monthly inspection of system components (air compressor, piping, pneumatic pump product storage tank, etc.) and performance of preventative maintenance tasks on system equipment.
- Quarterly reporting for the first year and annual reporting, thereafter. The sampling reports will include groundwater and contaminant contour drawings, and graphical representations of contaminant concentrations versus time.

Should Groundwater Quality Standards be achieved in less than 20 years, monitoring will be terminated after four consecutive quarters of laboratory analytical results which indicate the contaminant concentrations less than or equal to Groundwater Quality Standards and approval has been granted by the Groundwater Section.

7.0 PERMIT

A permit for the recovery wells will be obtained from the DWQ Groundwater Section prior to well installation. A modification to the NPDES permit application for the Pit 4 area will be submitted to the Division of Water Quality. An air discharge permit is not required for operation of the soil vapor extraction systems, but the Division of Air Quality should be notified prior to system operations. An erosion control/stormwater permit is required if one acre, or greater, of soil is disturbed or at the Activity's discretion.

8.0 REFERENCES

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TABLES

TABLE 3.1
PHYSICAL AND CHEMICAL PROPERTIES OF SELECT PETROLEUM HYDROCARBONS
BUILDING 130, BUILDING 3996 and PIT 4 AREA
CHERRY POINT, CRAVEN COUNTY, NORTH CAROLINA
LAW JOB NO. 30740-5-0500/PHASES 0076/0142

PARAMETER	TOXICITY µg/l[1]	BIOLOGICAL DEGRADATION (DAYS)[7]	WATER SOLUBILITY[4] (mg/L)	VAPOR PRESSURE[5] (mm Hg at 25°C)	K_{ow}[6]
Benzene	0.0[2]	99	1791	95.19	100
Ethylbenzene	1,400[1]	228	161	9.53	1400
Toluene	1,000	1400	431	30.3	596
p-Xylenes	6000[3]	Limited Information [8]	156	8.7	1413
Acenaphthene	20	Limited Information [8]	3.4	.001	21,000
Acenaphthylene	0.028	Limited Information [8]	3.93	.001	12,000
Anthracene	0.028	Limited Information [8]	0.05	$2.0x10^{-4}$	28,000
Benzo(b)flouranthene	Incomplete Data	Limited Information [8]	$3.79x10^{-3}$	1563	$7x10^{6}$
Benzo(k)fluoranthene	Incomplete Data	Limited Information [8]	-	$9.6x10^{-11}$	$7x10^{6}$
Chrysene	Incomplete Data	Limited Information [8]	0.016	$5.8x10^{-9}$	668,118
Flourene	Incomplete Data	Limited Information [8]	Incomplete Data	Incomplete Data	Incomplete Data
1-Methynaphthalene	Incomplete Data	Limited Information [8]	Incomplete Data	Incomplete Data	Incomplete Data
2-Methynaphthalene	Incomplete Data	Limited Information [8]	Incomplete Data	Incomplete Data	Incomplete Data
Naphthalene	0.028	258	31.7	0.082	2,300
Indeno(1,2,3-cd)pyrene	Incomplete Data	Limited Information [8]	-	10^{-10}	$5x10^{7}$

Notes:

(1) Maximum concentration to protect human health permissible in water.
(2) An additional lifetime risk of 1 in 100,000 results from a concentration of 6.6 µg/l.
(3) No criteria has been set, but EPA suggests a permissible goal of 6,000 µg/l.
(4) Water solubilities also provide insight to the fate and transport of chemicals. Relatively high water soluble chemicals, such as benzene, have the tendency to remain dissolved in water and not partition to the soil.
(5) The form in which a chemical will be found in the environment is partially dependent upon the vapor pressure; chemicals having a vapor pressure less than 10^{-6} mm Hg will be mostly found associated with solid matter such as soil.
(6) The K_{ow} is the Octanol water partition coefficient and the ratio of the chemical concentration in octanol divided by its concentration in water. It provides insight to its fate and transport in the environment.
(7) The time required for a chemical to degrade to one-half's its original concentration.
(8) Current literature based on laboratory experiments tend to overestimate the biodegradation of these compounds with respect to the subject site. Reported values include half-lives of less than 2 days under aerobic conditions.
(-) Relatively insoluble

TABLE 3.2
SUMMARY OF EXPOSURE PATHWAYS
BUILDING 130, BUILDING 3996 and PIT 4 AREA
CHERRY POINT, CRAVEN COUNTY, NORTH CAROLINA
LAW JOB NO. 30740-5-0500/PHASES 0076/0142

CONTAMINATED MEDIUM	INGESTION (EATING)	INGESTION (DRINKING)	INHALATION	ADSORPTION
Free Product	NA	Exposure Unlikely (1)	NA	Contingent Exposure (6)
Soil	Contingent Exposure (2)	NA	NA	Contingent Exposure (2)
Groundwater	NA	Exposure Possible (3)	NA	NA
Surface Water	NA	Exposure Unlikely (4)	NA	NA
Vapor	NA	NA	Exposure Possible (5)	NA

NOTES:

NA Not Applicable
(1) Free product detected in surficial groundwaters; free product has not been detected in the vicinity of the Yorktown aquifer.
(2) Exposure through soil is contingent upon activities at the project site, such as construction, which would expose the subsurface to the atmosphere.
(3) Exposure to contaminated groundwater through water-supply wells is possible in the event that the Yorktown Formation does not sufficiently impede the migration of contaminants into the Castle Hayne.
(4) Discharge of contaminated groundwater into surface waters has not been observed, and appears unlikely.
(5) Limited assessment indicates subsurface vaults, manways, or other exposure routes in vicinity of known soil/product contamination may provide an exposure route. However, vapors have not been observed at the project site.
(6) Exposure through free product is contingent upon activities at the project site, such as construction, which would expose the free product to the surface

TABLE 5.1.1
LABORATORY RESULTS OF SITE SUITABILITY STUDY
BUILDING 130
CHERRY POINT, CRAVEN COUNTY, NORTH CAROLINA
LAW JOB NO. 30740-5-0500 PHASES 0076/0142

	METHOD CODE	72GW02	72GW05	72GW10	72GW14	72GW14 (DUP)
pH (field)	EPA 150.1	5.97	6.17	6.06	6.03	6.03
pH (lab)*	EPA 150.1	5.51	6.06	5.62	6.37	6.10
DISSOLVED OXYGEN (ppm)	EPA 360.1	7.60**	8.30	4.77	6.17**	5.74**
CARBON DIOXIDE (ppm)	SM4500B	320	113	380	70.9	128
IRON (Fe) (ppm)	3030c & EPA 236.1	32.5	56.2	14.6	23.9	23.2
MANGANESE (Mn) (ppm)	3030c & EPA 243.1	0.430	0.131	0.156	0.344	0.350
CALCIUM HARDNESS (CaCO3/L)	SM2340C	64	80	80	194	90
PHOSPHOROUS (P) (ppm)	EPA365.2	0.25	1.86	0.25	0.50	0.64
TOTAL PLATE COUNT (Colony Forming Units/ml)	SM9215B	190 est.	5550	530	7950	6000
SULFATE (SO4) (ppm)	EPA 375.4	60.8	24.1	20.3	48.8	41.4
NITRATE (NO3) (ppm)	EPA 353.3 & 334.1	<0.02	<0.02	<0.02	<0.02	<0.02
BOD5 as O2 (ppm)	EPA 405.1	<1	<1	<1	1.9	<1
COD as O2 (ppm)	EPA 410.4	97.3	56.8	54.5	31.9	45.5
ALKALINITY (mgCaCO3/L)	EPA 310.1	51.0	63.7	78.0	81.9	79.6
TSS (ppm)	EPA 160.2	6.7	7.1	16	10	6.0
VSS (ppm)	EPA 160.4	3.3	1.3	1.0	1.3	<1
TOC (ppm)	EPA 415.1	6.31	9.43	8.16	4.22	3.63
TEMPERATURE (C) (field)		16.4	16.6	16.4	16.3	16.3

* = Holding time exceeded for reporting to DEM

** = Bottle not full; therefore, DO reading may not be representative of well

SM = Standard Methods for the Examination of Water and Wastewater, 18 Edition 1992

TABLE 5.1.2
LABORATORY RESULTS OF SITE SUITABILITY STUDY
BUILDING 3996
CHERRY POINT, CRAVEN COUNTY, NORTH CAROLINA
LAW JOB NO. 30740-5-0500 PHASES 0076/0142

	METHOD CODE	72GW33	74GW15	74GW15 (DUP)	74GW19
pH (field)	EPA 150.1	5.81	6.13	6.13	5.29
pH (lab)*	EPA 150.1	5.50	5.76	5.86	5.23
DISSOLVED OXYGEN (ppm)	EPA 360.1	2.27	7.00**	6.10**	6.45
CARBON DIOXIDE (ppm)	SM4500B	13.1	533	434	88.3
IRON (Fe) (ppm)	3030c & EPA 236.1	12.3	5.58	3.42	7.32
MANGANESE (Mn) (ppm)	3030c & EPA 243.1	0.121	0.062	0.025	0.097
CALCIUM HARDNESS (CaCO3/L)	SM2340C	18	120	135	110
PHOSPHOROUS (P) (ppm)	EPA365.2	0.34	0.47	0.40	0.25
TOTAL PLATE COUNT (Colony Forming Units/ml)	SM9215B	4200	4300	1300	1100
SULFATE (SO4) (ppm)	EPA 375.4	28.0	15.4	19.1	116
NITRATE (NO3) (ppm)	EPA 353.3 & 334.1	<0.02	<0.02	0.03	<0.02
BOD5 as O2 (ppm)	EPA 405.1	<1	10.6	16.2	1.3
COD as O2 (ppm)	EPA 410.4	43.2	216	227	92.8
ALKALINITY (mgCaCO3/L)	EPA 310.1	2.04	151	155	7.39
TSS (ppm)	EPA 160.2	42	4.5	123	1.0
VSS (ppm)	EPA 160.4	2.3	3.0	19	<1
TOC (ppm)	EPA 415.1	4.52	33.8	32.3	5.56
TEMPERATURE (C) (field)		16.4	16.8	16.8	16.7

* = Holding time exceeded for reporting to DEM

** = Bottle not full; therefore, DO reading may not be representative of well

SM = Standard Methods for the Examination of Water and Wastewater, 18 Edition 1992

TABLE 5.1.3
LABORATORY RESULTS OF SITE SUITABILITY STUDY
PIT 4 AREA
CHERRY POINT, CRAVEN COUNTY, NORTH CAROLINA
LAW JOB NO. 30740-5-05000 PHASES 0076/0142

	METHOD CODE	13GW19	72GW37	72GW43	72GW43 (DUP)	72GW44
pH (field)	EPA 150.1	4.72	6.01	7.09	7.09	6.22
pH (lab)*	EPA 150.1	4.64	5.84	7.00	7.08	6.22
DISSOLVED OXYGEN (ppm)	EPA 360.1	5.70**	5.84	6.34	6.84**	5.37
CARBON DIOXIDE (ppm)	SM4500B	23.3	133	66.0	55.0	161
IRON (Fe) (ppm)	3030c & EPA 236.1	11.2	29.9	0.26	0.71	1.60
MANGANESE (Mn) (ppm)	3030c & EPA 243.1	0.141	0.078	0.073	0.041	0.089
CALCIUM HARDNESS (CaCO3/L)	SM2340C	76	36	118	126	160
PHOSPHOROUS (P) (ppm)	EPA365.2	1.19	0.46	0.10	0.06	0.25
TOTAL PLATE COUNT (Colony Forming Units/ml)	SM9215B	10 est.	670	1,960,000	2,220,000	173,000
SULFATE (SO4) (ppm)	EPA 375.4	146	28.7	236	303	58.2
NITRATE (NO3) (ppm)	EPA 353.3 & 334.1	<0.02	<0.02	<0.02	<0.02	0.17
BOD5 as O2 (ppm)	EPA 405.1	<1	<1	<1	1.7	<1
COD as O2 (ppm)	EPA 410.4	42.1	45.5	34.2	22.9	40.9
ALKALINITY (mgCaCO3/L)	EPA 310.1	<0.5	45.4	325	326	132
TSS (ppm)	EPA 160.2	204	3.0	11	13	2.5
VSS (ppm)	EPA 160.4	19	1.5	7.5	10	1.0
TOC (ppm)	EPA 415.1	13.8	13.9	6.31	8.39	8.24
TEMPERATURE (C) (field)		16.4	16.6	16.8	16.8	16.3

* = Holding time exceeded for reporting to DEM

** = Bottle not full; therefore, DO reading may not be representative of well

SM = Standard Methods for the Examination of Water and Wastewater, 18 Edition 1992

TABLE 5.2
TRANSPORT MODEL INPUT PARAMETERS FOR THE BUILDING 130, BUILDING 3996, AND THE PIT 4 AREA
CHERRY POINT, CRAVEN COUNTY, NORTH CAROLINA
LAW JOB NO. 30740-5-0500 PHASES 0076/0142

PARAMETER	BUILDING 130 *(BENZENE)*	BUILDING 3996 *(BENZENE)*	PIT 4 AREA *(NAPHTHALENE)*
EFFECTIVE POROSITY	0.25	0.25	0.25
BULK DENSITY (g/cm^3)	1.62	1.62	1.62
OIL DENSITY (g/cm^3)	0.84	0.84	0.86
LONGITUDINAL DISPERSIVITY (ft)	30.12	27.05	35.57
TRANSVERSE DISPERSIVITY (ft)	8.28	7.44	9.78
OIL-WATER MASS TRANSFER COEFFICIENT	0.15	0.10	0.11
MOLECULAR WEIGHT OF INERT NAPL (g/mole)	210	210	210
IMMOBILE ZONE PORE FRACTION	0	0	0
MOBILE-IMMOBILE MASS TRANSFER COEFFICIENT (1/day)	0	0	0
AQUIFER THICKNESS (ft)	28	38	43
HYDRAULIC GRADIENT	0.0035	0.0012	0.0019
HYDRAULIC CONDUCTIVITY (ft/day)	66.0	96.0	61

1. See Appendix D for references
2. NAPL Non-aqueous Phase Liquid

TABLE 5.3
CHEMICAL PROPERTIES OF PETROLEUM CONSTITUENTS USED FOR NATURAL ATTENUATION MODELING AT THE BUILDING 130, BUILDING 3996, AND THE PIT 4 AREA CHERRY POINT, CRAVEN COUNTY, NORTH CAROLINA LAW JOB NO. 30740-5-0500/PHASES 0076/0142

PARAMETER	BUILDING 130 *(BENZENE)*	BUILDING 3996 *(BENZENE)*	PIT 4 AREA *(NAPHTHALENE)*
INITIAL MASS FRACTION	0.05	0.05	.495
MOLECULAR WEIGHT (g/mole)	78.11	78.11	128.16
SOLUBILITY (mg/L)	1791	1791	80.319
ADSORPTION COEFFICIENT (cm^3/g)	0.59	0.58	11.90
AQUEOUS DECAY COEFFICIENT (1/day)	.007	.007	.0027
VOLATILIZATION LOSS COEFFICIENT (ft/day)	0	0	0
INITIAL CONCENTRATION (mg/L)	0	0	0
INITIAL THICKNESS = VOLUME OF OIL/AREA (ft)	.0001	.0002	.000175

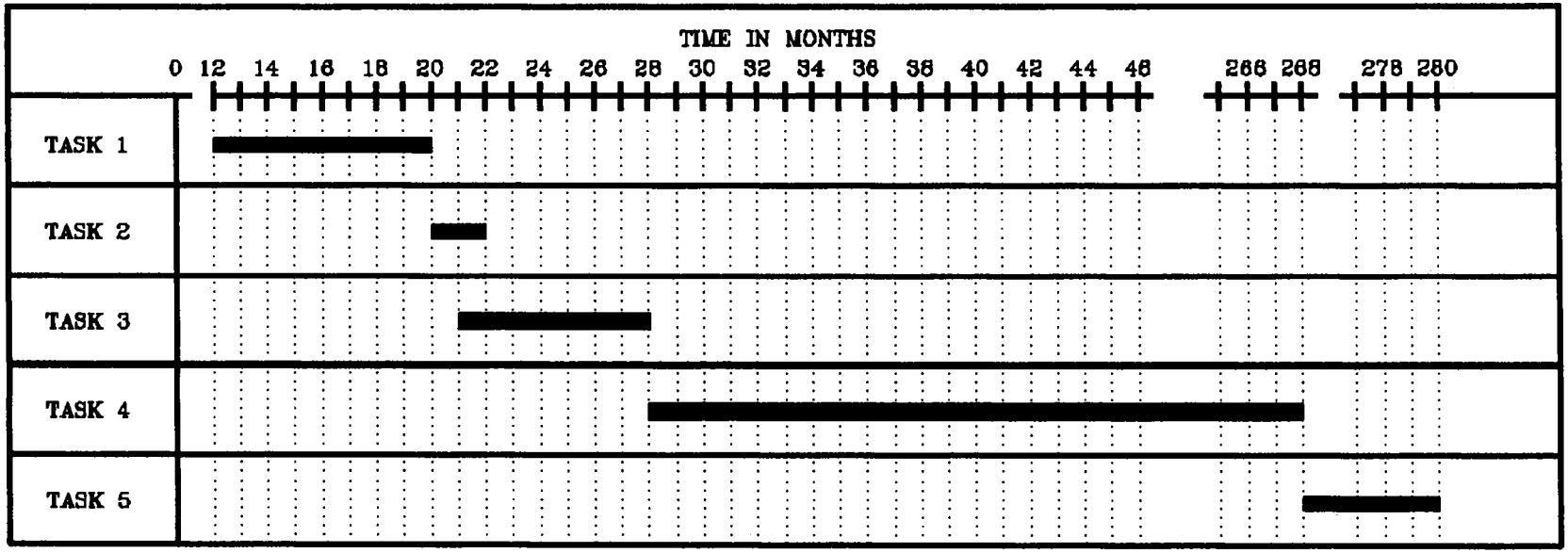
1 See Appendix D for references

DRAWINGS

DRAWING NO. 2.1

CORRECTIVE ACTION PLAN SCHEDULE
BUILDING 130/BUILDING 3996/PIT 4 AREA
MARINE CORPS AIR STATION
CHERRY POINT, NORTH CAROLINA

LAW JOB NO.: 30740-5-0500 PHASES 0076/0142



SCHEDC01

TASK 1: AWARD CONSTRUCTION CONTRACT
TASK 2: EQUIPMENT DELIVERY
TASK 3: INSTALLATION OF REMEDIATION SYSTEM AND STARTUP
TASK 4: REMEDIATION SYSTEM START UP AND OPERATION (TO 20 YEARS)/SYSTEM EFFECTIVENESS MONITORING
TASK 5: POST SHUT-DOWN MONITORING