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FINAL PLAN OF ACTION MOBILE ENHANCED MULTI-PHASE EXTRACTION WITH TRANSMITTAL MILLINGTON SUPPACT TN
1/14/1999
BAT ASSOCIATES, INC.

BAT

BAT Associates, Inc.

ENVIRONMENTAL HEALTH & SAFETY SERVICES

704 S. Illinois Avenue, Suite C-202
Oak Ridge, TN 37830
(423) 481-8105 • FAX (423) 481-0899

January 14, 1999

Mr. John Karlyk
ATTN: Code 1846 SOUTHDIV
Naval Facilities Engineering Command
2155 Eagle Drive, P.O. Box 190010
North Charleston, South Carolina 29419-9010

SUBJECT: FINAL PLAN OF ACTION FOR THE MOBILE ENHANCE MULTI-PHASE EXTRACTION (MEME), NAVAL EXCHANGE SERVICE STATION, NAVAL SUPPORT ACTIVITY, MILLINGTON, TENNESSEE

REFERENCE: CONTRACT NO. N62467-99-R-0867

Dear Mr. Karlyk:

BAT Associates, Inc. (BAT) is pleased to submit one (1) copy of the final Plan of Action (POA) for the above referenced project. The POA also includes a site specific Health and Safety Plan. Comments from the draft POA have been received from your organization, and have been incorporated into the final submittal.

We look forward to working with the Navy on this project. Should you have any questions please call me or Craig Aurin at (423)481-8105.

Sincerely,
BAT Associates Inc.

James R. Summers
Project Manager

MF:CA

Enclosures

cc: R. Hess - Dept. of the Navy
R. Wilson - Dept. of the Navy
N. Athens - ECOVAC
Project File - 983019

ECOVAC SERVICES

November 6, 1998

Mr. John Karlyk
Commanding Officer
JK, 1846
South NAVFAC Eng Com
P.O. Box 190010
North Charleston, South Carolina 29419-9010

Subject: **Proposal to Provide Enhanced Fluid Recovery (EFR®)**
NAS Memphis
NEX (Navy Exchange) Auto Part/Fuel Lock
757 Old Navy Road
Millington, Tennessee

Dear Mr. Karlyk:

It was my pleasure to have had the opportunity to visit with you on the telephone October 28, 1998 regarding this site. I have closely reviewed the data resultant from the four EFR® events at this site and have concluded that this site may not be an ideal candidate for an abbreviated (four hour) extraction event. My conclusion is based upon the following:

- The number of extraction wells (as many as eight at this site) will be difficult to extract from during this brief time period

- Groundwater drawdowns at this site increase with time and did not appear to have reached a steady state even after eight hours of extraction

- The offgas concentrations generally did not decrease significantly during the latter portion of the events (for example the final and ending offgas concentrations were the same during one event and remained at the same concentration during the final 4.5 to 5 hours during two of the other events)

- Additional influx of oxygen (for aerobic biodegredation) and additional mobilization of petroleum hydrocarbons is achieved during longer extraction times

- The extraction well vacuums were not particularly high. Extraction events of shorter duration are generally suited for "tight" sites (i.e. high extraction well vacuums) that have experienced a significant decrease in offgas concentration

We are concerned with the possibility of partially incapacitating the effects of EFR® at this site by decreasing the extraction time. The constraints of the base operating hours, having to dispose onsite (i.e. we must be certain to arrive at the site "empty"), the 8 hour minimum

charge from our vacuum truck subcontractor, and the distance to other work in Memphis will also adversely impact the cost of conducting two four-hour events at this site.

Our estimated cost to perform two four-hour EFR® events at this site (in the morning hours one day and in the afternoon the following day) is $3,100.

Please contact me should you have any questions.

Sincerely,

EcoVac Services

Nick Athens

ENHANCED FLUID RECOVERY™

Enhanced Fluid Recovery (EFR™) is an innovative and cost effective remediation method that utilizes high vacuum pressures and flow rates to remove multiple phase (i.e. vapor, adsorbed, dissolved, and free phase) volatile organic compounds (VOCs) from the subsurface. This proprietary technology was developed by the principals of EcoVac Services and is a variation of what is commonly referred to as dual-phase extraction, multi-phase extraction, and vacuum enhanced recovery. The principals of EcoVac Services have conducted and/or have provided technical oversight of over 2,000 individual EFR™ events throughout the United States and Puerto Rico.

EFR™ is a cost effective and mobile system that is particularly effective in the removal of free product (e.g. gasoline and diesel). EFR™ utilizes high vacuum (as much as 28 inches of mercury) and high flow rates (vacuum pumps are rated as high as 3,000 CFM) simultaneously connected to as many as eight monitoring or recovery wells. EFR™ is normally conducted for an eight hour period per event. EFR™ can remove as much as 1,500 equivalent gallons of gasoline or diesel during a single eight hour extraction event.

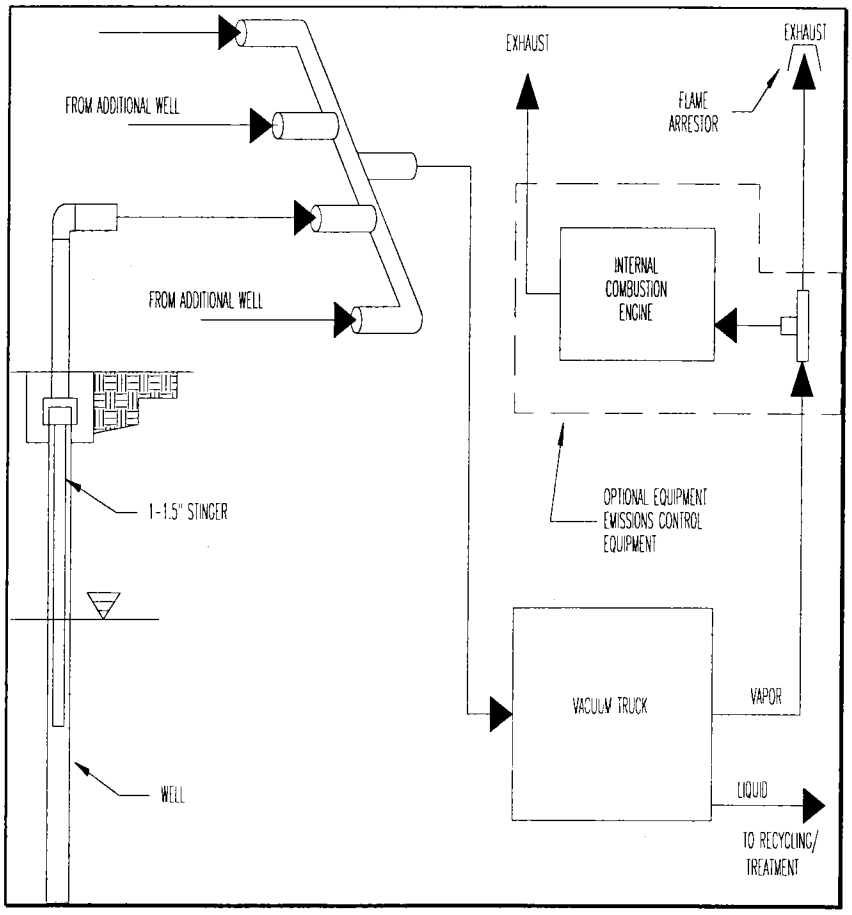
EFR™ simultaneously removes vapors, free product, and groundwater from the subsurface. It volatilizes adsorbed and free phase VOCs through a process similar to soil vapor extraction, but with a much higher vacuum and radius of influence. EFR™ is also very unique in that it can treat adsorbed phase VOCs existing within the "smear zone" (i.e. the zone of seasonal or climatic groundwater fluctuation) that act as a source for dissolved phase VOCs. EFR™ dewaters and exposes the smear zone to the effects of "high rate" soil vapor extraction. EFR™ has also been well documented to be effective in the reduction in dissolved phase concentrations. Importantly, EFR™ also introduces oxygen to the vadose zone and saturated zones, thereby enhancing aerobic biodegradation.

EFR™ is an important tool, particularly for source removal. As such, it is an excellent compliment to risk based corrective action (RBCA) since adsorbed, dissolved, and free phase VOCs can be removed, thereby potentially allowing a risk based decision to then be rendered resulting in "monitoring only," or a reduced size remediation system. EFR™ is also applicable at sites where rapid remediation is necessary (e.g. real estate transfers, off-site plume migration, emergency response, etc.) and can be introduced at any time during the "life cycle" of a site.

EFR™ is a "pay as you go" remediation method that involves no capital cost investment or operation and maintenance (O&M) and is recognized and recommended by numerous state regulatory agencies.

EcoVac Services only provides EFR™ services and, hence, is not in competition with environmental consultants. EcoVac Services' staff consists of a multidisciplinary group of geologists, engineers, and scientists that have conducted over 2,000 EFR™ events at underground storage tank sites, terminals, refineries, air fields, industrial facilities, and chemical plants for well over 100 major oil companies, environmental consulting firms, independent oil companies, and other clients.

The principals of EcoVac Services are David M. Goodrich, P.G. and Nick Athens, who collectively have over 30 years of broad range experience in the environmental and energy fields. Mr. Goodrich originated the technology in 1989.



EFR™ RESULTS SUMMARY BY SITE TYPE

DRAFT

	Number of Sites	Number of Events	Equiv. Gal./ Event	Cost/ Eq.Gal.
FREE PRODUCT - Gasoline	261	860	108	**$26**
FREE PRODUCT - Diesel	47	112	94	**$34**
FREE PRODUCT - Gas/Diesel	31	68	50	**$57**
DISSOLVED PHASE - Gas	120	284	27	**$107**
DISSOLVED - Gas/Diesel	19	30	18	**$145**
DISSOLVED PHASE - Diesel	14	24	5	**$582**
ALL SITES	492	1,378	89	**$34**

ENHANCED FLUID RECOVERY PROJECT SUMMARIES

Client: Environmental Consulting Firm
Type of Facility: Service Station
Location: Atlanta, Georgia

EcoVac Services was contacted by a state trust fund contractor to initiate EFR™ on an emergency response basis. High levels of gasoline vapors were detected in a sanitary sewer line near downtown Atlanta and approximately two city blocks were partially evacuated (including a nursing home) as a precautionary measure. EFR™ was implemented at seven monitor wells, which resulted in the gasoline vapors being completely removed from the sanitary sewer within hours. Consequently, the 24 hour police and fire department surveillance was discontinued. In excess of an estimated 2,700 equivalent gallons of gasoline were recovered during the initial 47 hours of EFR™ at a cost of approximately $17,173. A calculated total of 8,997 equivalent gallons of gasoline have been removed from the site (through 12/31/97).

Client: Trucking Company
Type of Facility: Former Trucking Facility
Location: Jackson, Mississippi

An estimated total of 1,886 equivalent gallons of diesel were removed during a single 8 hour EFR™ event. Separate phase diesel exists in four monitor wells at a maximum thickness of 6 feet. An estimated total of 4,328 equivalent gallons of diesel have been removal during four EFR™ events, which have been implemented at a cost of $15,578 (including a significant cost for disposal), or $3.60 per removed gallon of diesel. A surfactant was introduced into the subsurface several months prior to the initial EFR™ event, which appears to have dramatically enhanced the diesel recovery volumes.

Client: Major Oil Company
Type of Facility: Refinery
Location: Puerto Rico

EcoVac Services was retained to conduct a feasibility study to assess the efficacy of free product removal by EFR™. This site is under U.S. EPA administrative order. Pilot testing was conducted at various locations throughout the refinery. The site did not appear to be an ideal candidate for EFR™ due to a shallow water table and the lack of an impervious surface cover. Offgas concentrations >100,000 ppm were prevalent during most of the pilot test period and >9,200 pounds of VOCs were removed over a 54 hour pilot testing period. On the basis of the results of the feasibility study, the client is purchasing a vacuum truck and an internal combustion engine (to treat the offgases) and EFR™ was subsequently implemented as a corrective action measure at this site. Initial results indicate that product is being removed at a cost of approximately $0.96/gallon, even considering the acquisition cost of a vacuum truck and dual internal combustion engines (ICEs) to treat the offgases.

Client: National Environmental Consulting Firm
Type of Facility: Service Station (Major Oil Company)
Location: Stone Mountain, Georgia

EcoVac Services was contacted regarding a significant subsurface release of gasoline. EcoVac Services arrived at the site within three hours and initially performed EFR™ for a thirty hour period. In excess of 2,200 equivalent gallons of gasoline was recovered during this 30 hour period. EcoVac Services mobilized to the site four additional times during the following week and recovered an additional >3,900 equivalent gallons of gasoline.

Client: Environmental Consulting Firm
Type of Facility: Service Station Sites
Location: Marietta, Holly Springs and Conyers, Georgia

A total of eight 8 hour EFR™ events were conducted at three active gas stations during a six week period. A total of five monitor wells at the three sites contained between 0.17 to 3.31 feet of free product. Free product was no longer present at any of the three sites two months following these EFR™ events. The total cost of EFR™ at the three sites was $24,323.

Client: Environmental Consulting Firm
Type of Facility: Snack Food Manufacturing Facility
Location: Gentry, Arkansas

A single 8 hour EFR™ event was conducted at a site where diesel fuel had persisted in three monitor wells at a thickness of 0.07 to 0.20 feet. Free product was removed from site and was absent one year after this extraction event, which was conducted at a cost of $3,560. Site closure was obtained for the site.

Client: Environmental Consulting Firm
Type of Facility: Service Station
Location: Knoxville, Tennessee

EcoVac Services was contacted to address an "emergency response" action, which was prompted by the threat of a third party lawsuit. EcoVac personnel mobilized to the site the same evening and conducted EFR™ at three existing wells for a period of ten hours. Groundwater sampling was conducted prematurely (i.e. 5 days following the event) and dissolved phase concentrations actually increased in some of the wells. Sampling was then conducted 30 days later and the laboratory data indicated reductions in dissolved phase concentrations as much as 99%. Consequently, "monitoring only" status was requested following this single event since the dissolved phase concentrations were well below the site specific standard established for the site. Total cost for EFR™ (inclusive of disposal) was only $3,916. (fox)

Client: Passenger Bus Line Company
Type of Facility: Former Terminal
Location: Charleston, South Carolina

A former bus line terminal in the historic district of Charleston, South Carolina was slated for development as a high rise hotel. Four EFR™ events (total of 36 hours of extraction) were conducted at the site which had shallow groundwater conditions (<5 feet below surface) and as much as 0.63 feet of diesel product in two monitor wells. The separate phase product was completely removed following the four EFR™ events, which was confirmed by a subsequent subsurface investigation (conducted by the purchaser), as well as verified during foundation excavation at the site. A no further action (NFA) letter was issued. The total EFR™ cost was $15,113.

Client: Environmental Consulting Firm
Type of Facility: Carpet Mill
Location: Lafayette, Georgia

A sheen to 0.04 feet of diesel existed in three monitor wells under shallow water table conditions (i.e. 5 to 10 feet below surface). Five 8 hour EFR™ events were conducted at a cost of $15,713 (including disposal), after which the separate phase diesel was removed and dissolved phase benzene was reduced to 10 ppb in one well and <5 ppb in all of the other site monitor wells. (astro)

Client: Environmental Consulting Firm
Type of Facility: Service Station
Location: Memphis, Tennessee

Two events of EFR™ were performed at a site where an active groundwater pump and treatment system had been operating for a period of years. Very good vacuum influence and recoveries of petroleum hydrocarbons were achieved at the site. Not only were the two treatments successful in removing the free product (as much as 0.08 feet), EFR™ also significantly reduced dissolved phase TPH-GRO to "monitoring only" limits of <1,000 ppb (compared to >100,000 ppb prior to EFR™) and benzene to <70 ppb. The client did not think that these closure limits were achievable at this site with any technology, given the challenging hydrogeologic conditions at the site. The client has since requested "monitoring only" and discontinued operation of the remediation system. Total cost for EFR™ was only $5,074. (pmi)

Client: Environmental Consulting Firm
Type of Facility: Service Station
Location: Jackson, Tennessee

EcoVac Services teamed with a small environmental consulting firm to reduce dissolved phase petroleum hydrocarbon concentrations at a former auto repair shop / service station from greater than 20 ppm to below "monitoring only" criterion (i.e. <1 ppm). Two EFR™ events were conducted and the environmental consulting firm also employed oxygen release compound (ORC) in the monitor wells. Dissolved phase petroleum hydrocarbon concentrations were successfully reduced to beneath the "monitoring only" criterion. The cost to implement EFR™ was $7,208. (emc2)

Client: Major Oil Company
Type of Facility: Service Station
Location: Memphis, Tennessee

Over 10 feet of free product was discovered in a downgradient monitor well located at an active service station site. Four EFR™ events were performed (within a period of 45 days) at an approximate cost of $10,000 and the free product was reduced to 0.00 feet. (a767)

Client: Environmental Consulting Firm
Type of Facility: Apartment Complex
Location: Washington, D.C.

A single EFR™ event was conducted at a former fuel oil UST site at which free product was unsuccessfully addressed by prior remedial efforts. The site was widely known within the environmental community as a result of the prior unsuccessful efforts. The site posed particular logistical challenges, for example, having to perform EFR™ on multiple levels of a parking garage. Offgas treatment was implemented and the fuel oil free product was removed from all four monitor wells following a single nine hour EFR™ event.

Client: National Environmental Consulting Firm
Type of Facility: Service Stations
Location: Chattanooga, Tennessee

Separate phase kerosene and degraded gasoline existed at two different active gasoline stations owned by a major oil company. A total of nine and five 8 hour EFR™ events were conducted at kerosene and gasoline free product sites, respectively, at a total cost of $39,153 for both sites. Although only 0.20 to 0.25 feet of product existed at the site, the low mobility of the kerosene and degraded gasoline posed a challenge. Free product was successfully removed from both sites. (c42075/90)

Client: Major Oil Company
Type of Facility: Former Service Station
Location: Fort Valley, Georgia

EcoVac Services was retained to conduct two EFR™ events at a former UST site where a small amount of free product existed. After two EFR™ events not only was the free product removed, but the dissolved phase concentrations were significantly reduced, to the extent that site closure was requested by the client. A total of approximately $5,000 for expended for EFR™. (a978)

Client: Environmental Consulting Firm
Type of Facility: Petroleum Bulk Storage Facility
Location: Bainbridge, Georgia

Dissolved phase petroleum hydrocarbon concentrations existed in a UST field where free product is believed to have previously existed. A total of 12 monitor wells were utilized as extraction wells during a single eight hour EFR™ event, conducted at a cost of $3,441. The dissolved phase contamination was successfully removed following the single treatment, after which the USTs were excavated. The site subsequently received closure.

Client: Major Oil Company
Type of Facility: Former Service Station
Location: Battle Creek, Michigan

A single EFR™ event was conducted at a closed service station site where two monitor wells contained 0.37 to 0.45 feet of product. Approximately 213 equivalent gallons of gasoline were removed and product was not present in the monitor wells during subsequent gauging events. The cost to implement EFR™ was $2,456, including product and groundwater disposal. (e6316)

Client: Major Oil Company
Type of Facility: Service Station
Location: Waynesville, North Carolina

A single eight hour EFR™ event was conducted at an active service station site as an emergency response action. A release of approximately 2,000 gallons of unleaded gasoline via an overfill/overspill was documented. Approximately 1,000 gallons were removed prior to implementation of EFR™. Offgas concentration exceeded 100,000 ppm during the initial five hours of the event and an estimated >998 equivalent gallons of gasoline were removed at a total cost of $3,272, inclusive of the cost to dispose of product and groundwater. (e8134)

Client: Major Oil Company
Type of Facility: Active Service Station
Location: Memphis, Tennessee

An estimated total of over 35,000 pounds of petroleum hydrocarbons (approximately equivalent to 5,900 equivalent gallons of gasoline) were removed during 40 EFR™ events conducted over a 30 month period. The last EFR™ event recovered an estimated 168 equivalent gallons of gasoline. Free product was removed from the monitor wells and the site went into "monitoring only" status. (a318)

Client: Environmental Consulting Firm
Type of Facility: Active Service Station
Location: Columbia, South Carolina

Two EFR™ events were conducted at a dissolved phase site, achieving "monitoring only" status after a cost of only $6,540. The dissolved phase benzene concentrations in the downgradient wells were reduced to nondetect (ND) from 30 to 100 ppb. EFR™ was conducted at the site after 11 p.m. to minimize interruption to facility operations. (sme)

Client: Environmental Consulting Firm
Type of Facility: Service Station (Independent Oil Company)
Location: Summerville, South Carolina

EcoVac Services was contacted to perform an "emergency response" action, prompted by a 1,000 gallons gasoline release near the tankfield. A 0.5 ft. layer of product was measured in three tankpit monitor wells. A 25 hour EFR™ event was conducted at a total cost of $7,860 and removed over an estimated 700 equivalent gallons of gasoline. Free product was not detected during the following month and a second EFR™ event performed one month later to reduce dissolved phase petroleum hydrocarbons.

Client: Independent Oil Company
Type of Facility: Petroleum UST Site
Location: Ft. Wayne, Indiana

Free phase gasoline existed in one recovery well and two tank pit observation wells at a thickness of as much as 0.6 feet. Four 6 hour EFR™ events were conducted at a cost of less than $10,000. Free product was no longer detected at the site 9 months following the final EFR™ event. (e6147)

Client: Environmental Consulting Firm
Type of Facility: Service Station
Location: Brookhaven, Mississippi

A fixed remediation system had been installed at an active convenience store and had recovered only approximately 100 gallons of product over a 36 month period. Free product remained in the four monitor and recovery wells and approximately $200,000 was expended in capital, installation, and operation/maintenance costs. EFR™ was performed at the facility and removed 60 equivalent gallons of product during the initial 6.5 hour event at a cost of approximately $3,500.

Client: Environmental Consulting Firm
Type of Facility: Convenience Store
Location: Acworth, Georgia

A pump and treat system was previously installed at this site at a total cost of >$200,000, which reportedly recovered only ~200 gallons of gasoline. Over 3 feet of product persisted onsite and >1.5 feet of product existed offsite (across a highway) near a creek. Five 8 hour EFR™ events have been implemented at the site utilizing offgas treatment. A calculated total of 203 gallons of product have been removed at a total cost of $14,822. Product in the onsite well (which has been subjected to three of the five EFR™ events) has been reduced from 3.31 feet to 0.06 feet and in the offsite well (two EFR™ events) from 1.65 feet to 0.19 feet.

Client: National Environmental Consulting Firm
Type of Facility: Service Station
Location: Charlotte, North Carolina

Free product (0.5 feet of gasoline) existed in a single monitor well, which was screened to a clayey to sandy silt surficial aquifer. The free product was removed after two 8 hour EFR™ events which were conducted at a total cost of $6,326. (c33004)

Client: Independent Oil Company
Type of Facility: Service Station
Location: Hopkinsville, Kentucky

Separate phase gasoline was present in five monitor wells at an active gasoline station at a maximum thickness of 1.7 feet. Separate phase product was absent following three 8 hour EFR™ events, which were conducted at a cost of $8,415. A fourth EFR™ event was subsequently conducted to further reduce dissolved phase concentrations.

Client: Environmental Consulting Firm
Type of Facility: Pharmaceutical Distribution
Location: Memphis, Tennessee

Separate phase gasoline (as much as 2.8 feet) existed in three monitor wells and one soil vapor extraction well. The vertical geologic profile at the site posed a challenge to the remedial efforts. A drastic vertical difference in the lithiology wherein a sandy silty clay immediately graded to a well sorted sand with gravel created a possible semi-confined aquifer condition. Such aquifer conditions, along with multiple perched aquifer conditions, are not unusual in the Memphis area. A recognition of these geologic conditions was necessary for the effective removal of the free product at this site. The free product was removed from the site and dissolved phase concentrations were also reduced, to the extent that the client is expecting to go to a site specific standard for the site, allowing a "monitoring only" period prior to closure. The cost of EFR™ at the site was $9,640. (s-p)

Client: Environmental Consulting Firm
Type of Facility: Car Rental Facility
Location: Alcoa, Tennessee

A small amount of separate phase gasoline (0.16 feet) existing in a single monitor well was removed after a single 8 hour EFR™ event at a cost of $2,778. Two additional EFR™ events were conducted to reduce dissolved phase concentrations. The client is initiating a modeling effort to take the site to "monitoring only" status.

Client: Environmental Consulting Firm
Type of Facility: Service Station
Location: Bristol, Tennessee

A small amount of free product (i.e. 0.01 feet of gasoline) existed at a country convenience store. EFR™ was conducted at two monitor wells during a single 8 hour EFR™ event (approximate total cost of $3,200). Dissolved phase TPH-GRO was reduced from ~20 ppm to $\leq$10 ppm. (empe)

Client: Environmental Consulting Firm
Type of Facility: Cemetery (former UST site)
Location: Memphis, Tennessee

A single monitor well at a cemetery/funeral home property previously contained free product. Two 8 hour EFR™ events were conducted at a cost of $4,900. Free product was absent and dissolved phase benzene was reduced to 15 ppb and TPH to 5.9 ppm (from 431 ppm). Based upon the success of EFR™ at the site, a site specific standard is being sought by the client to allow the site to transition to "monitoring only."

Client: Environmental Consulting Firm
Type of Facility: Truck Stop
Location: Commerce, Georgia

A pump and treat/soil vapor extraction system was implemented at site, which was unsuccessful in fully removing free product from three monitor wells. As much as >1 feet of free product persisted at the site. Three EFR™ events were conducted at the site at a cost of $7,961, after which free product was no longer detected.

Client: Environmental Consulting Firm
Type of Facility: Service Station
Location: Atlanta, Georgia

EFR™ has been implemented at a state trust fund site with as much as two feet of free phase gasoline in fourteen monitor wells. As many as eight wells have been simultaneously utilized for extraction. An estimated total of over 5,257 equivalent gallons of gasoline have been recovered during 16 EFR™ events at a cost of $49,680 (i.e. ~$9.50 per equivalent gallon). (jacksonf)

Client: Major Oil Company
Type of Facility: Service Station
Location: Columbus, Georgia

Free product had persisted at two service station sites in south Georgia for a long period of time. The objective at the sites was to remove free product (as much as 0.25 to 0.55 feet was present), as well as to reduce dissolved phase petroleum hydrocarbon concentrations, in an effort to move the site towards risk based closure. Measurable free product was removed from both sites after a total of six EFR™ events at a total cost of approximately $17,172 for both sites. (91012/3)

Client: Major Oil Company
Type of Facility: Service Station
Location: Millington, Tennessee

As much as >6 feet of product was present in nine monitor wells located on- and off- site at an active service station site. The free product plume measured approximately 200 feet long. EFR™ was conducted on Sundays since the site and the adjacent animal hospital was closed during that time. Nine EFR™ events were conducted over a period of 14 months at a cost of $21,010. Product was only observed in three of the nine wells prior to the ninth EFR™ event at a thickness of 0.01 to 0.04 feet. (23582)

Client: Major Oil Company
Type of Facility: Service Station
Location: Birmingham, Alabama

EFR™ was implemented at an active service station site as an immediate response action due to nuisance gasoline odors present in an adjacent fast food restaurant. EcoVac Services was mobilized to the site the day following the initial contact by the client, inclusive of negotiating a first time contract with this major oil company. The site conditions did not qualify it as an ideal candidate due to a shallow water table (1 to 6 feet below ground surface), known manmade subsurface conduits, and a land surface partially lacking an impervious cover. Nearly 2,000 pounds of petroleum hydrocarbons (an estimated 310 equivalent gallons of gasoline) were recovered during the initial eight hour EFR™ event and EcoVac Services personnel were successful in determining the conduit for the nuisance odors present at the adjacent restaurant (i.e. a breach in a sanitary sewer line that serviced the restaurant). The amount of free product was significantly reduced after the initial EFR™ event in terms of the thickness of free product, as well as the number of wells which contained free product. A second event of EFR™ was performed ten days later, after which an interim (fixed) remediation system was installed. (24292)

Client: Major Oil Company
Type of Facility: Service Station
Location: Memphis, Tennessee

As much as 0.53 feet of product was detected in two monitor wells adjacent to the dispenser islands and diesel USTs at a closed service station property. Product was absent following the second EFR™ event, although a rise in the water table may have contributed to the absence of product. A total of $11,350 was expended for EFR™, inclusive of recovered fluids disposal. (24424)

Client: Major Oil Company
Type of Facility: Service Station
Location: Memphis, Tennessee

As much as 2.5 feet of product was detected in four monitor points at a former service station. The monitor wells used for extraction were located at, and downgradient to, the former UST area. Four EFR™ events were conducted over a 16 month period at a cost of $11,350. Product was absent prior to the fourth event, however, a climatic rise in the water table may have contributed to the absence of product. (23578)

Client: Major Oil Company
Type of Facility: Service Station
Location: Memphis, Tennessee

Two EFR™ events were conducted at a former service station site to address a sheen of product and dissolved phase petroleum hydrocarbons, at a cost of $5,750. The sheen was removed and dissolved phase TPH-GRO/DRO and benzene were reduced by a minimum of 50% to as much as nondetect (ND) levels. (24362)

Client: Environmental Consulting Firm
Type of Facility: Casino/Restaurant (Former Service Station)
Location: Latta, South Carolina

Over 2 feet of free phase gasoline existed at a former petroleum UST site, which had been converted to a gambling facility. Despite shallow groundwater conditions (2.5 to 6 feet below surface), the product was completely removed following a single eight hour EFR™ event at a cost of only $3,495.

Client: Environmental Consulting Firm
Type of Facility: Truck Stop
Location: Sweetwater, Tennessee

A groundwater pump and treat system operated at a site for over three years and pumped over 1,200,000 gallons of groundwater. Approximately 6 and 23 equivalent gallons of benzene and TPH-GRO, respectively, were removed by pump and treat during this three year period. A sheen of separate phase product existed on the top of the water table, which existed at 5 to 7 feet below ground surface. A single 8 hour EFR™ event was conducted at the site at a cost of $2,863, during which a calculated 33 equivalent gallons of gasoline (233 pounds of vapor phase petroleum hydrocarbons) were removed. The client reported that a >90% reduction in dissolved phase TPH-GRO (i.e. from 25-30 ppm to 2 ppm) and dissolved phase benzene (i.e. from 2,000-3,000 ppb to ~200 ppb) was achieved.

Client: Environmental Consulting Firm
Type of Facility: Service Station Site
Location: Little Rock, Arkansas

A single eight hour EFR™ event was conducted at a petroleum UST site that had historically contained about 2 inches of free phase product. The product was removed after the single event, at a cost of less than $3,500, and the site is expected to be "closed out" after going to a site specific (dissolved phase) standard. (efwill)

Client: Environmental Consulting Firm
Type of Facility: Army National Guard Facility
Location: Greeneville, Tennessee

An armory had a monitor well, screened to the underlying shale bedrock, with over 1.5 feet of free phase diesel. Diesel was no longer present in the monitor well following four 8 hour EFR™ extraction events, conducted at a cost of $12,690.

Client: Environmental Consulting Firm
Type of Facility: Trucking Facility
Location: Nashville, Tennessee

A small amount (0.04 feet) of separate phase diesel was present in a single monitor well under shallow water table conditions (i.e. 5 feet below surface). The product was removed following a single 8 hour EFR™ event, conducted at an approximate cost of $2,936. (ust)

Client: Environmental Consulting Firm
Type of Facility: Service Station
Location: Memphis, Tennessee

Seven 8 hour EFR™ events were conducted at an active gasoline station during a two year period. Separate phase gasoline initially existed in three monitor wells at a thickness of as much as 2.5 feet. Free product was removed from the monitor wells at this site. A total of $18,255 was expended for EFR™ at this site. (T2279)

Client: Environmental Consulting Firm
Type of Facility: Service Station
Location: Nashville, Tennessee

Two 8 hour EFR™ events successfully removed 0.25 feet of product. A third extraction event was conducted to reduce the dissolved phase concentrations, which was successful and the site currently is in "monitoring only" phase. Total cost for EFR™ was $10,115. (s28)

Client: Environmental Consulting Firm
Type of Facility: Electrical Contractor
Location: Memphis, Tennessee

Groundwater existed at a depth of 75 feet below surface at a site where 0.34 feet of free product existed. Two 8 hour events were conducted (at an approximate cost of $4,800) after which the free product was successfully removed. The site went to a site specific standard and is currently in the "monitoring only" phase prior to site closure. (summer)

Client: National Environmental Consulting Firm
Type of Facility: Pet Food Processing Facility
Location: Huntsville, Alabama

EFR™ was utilized at an UST site at a pet food processing facility where the primary contaminant was diesel. Twelve monitor wells contain as much as 4 feet of free product. Despite the fact that the client felt as if EFR™ would recover a minimal amount of groundwater, over 2,000 gallons of groundwater and 760 gallons of diesel were recovered during the initial eight hour EFR™ event. A total of seven EFR™ events have been implemented, resulting in the removal of an estimated 1,763 equivalent gallons of diesel at a cost of $25,271.

Client: Environmental Consulting Firm
Type of Facility: Service Station
Location: Memphis, Tennessee

EcoVac Services conducted two EFR™ events at an active retail gasoline dispensing facility during a three month period. Free floating product existed in six monitor wells (ranging from a sheen to >1 feet). Only a sheen (i.e. <0.01 feet) existed in only two monitor wells following these two EFR™ events.

Client: Environmental Consulting Firm
Type of Facility: Service Station
Location: Chattanooga, Tennessee

The EFR™ process was suggested by state regulators to be implemented at an active service station. A maximum of 0.20 feet of free product existed in six monitor wells at this site. EFR™ was performed four times (8 hour events) at a cost of $12,532 and free product was thereafter absent in the monitor wells. (dupre)

Client: Major Oil Company
Type of Facility: Service Station
Location: Memphis, Tennessee

EFR™ was implemented at an active service station, under which a free product plume existed entirely across the site at a thickness as much as 1.9 feet of product. EFR™ was conducted at night and involved placing hoses over the top of the car wash (to allow access to one of the extraction wells), so as to minimize interruption to customer fueling and service bay operations. Approximately 3,000 pounds of petroleum hydrocarbons (500 equivalent gallons of gasoline) were removed during the four EFR™ events conducted over a period of 14 months. Product was not present prior to the fifth EFR™ event and a total of $13,400 was expended for these EFR™ treatments.

Client: Environmental Consulting Firm
Type of Facility: Building Supply
Location: Memphis, Tennessee

Five EFR™ events were conducted during a two year time period, which successfully removed minor amounts of gasoline/diesel free product from three monitor wells. Dissolved phase TPH was also reduced from 350 ppm to 57 ppm in the primary extraction well. A site specific (dissolved phase) standard is being sought by the client to transition the site into "monitoring only" status. (owen)

Client: Environmental Consulting Firm
Type of Facility: Service Station
Location: Nashville, Tennessee

As much as 11.5 feet of free product existed in five monitor wells. The free product plume had a minimum dimension of 180 feet by 50 feet. The product was reduced to a sheen to 0.23 feet after six 8 hour EFR™ events, conducted at a cost of $14,152. Future EFR™ will be conducted at this site in an attempt to completely remove the free product and reduce dissolved phase concentrations. (s1088)

Client: Major Oil Company
Type of Facility: Service Station
Location: Ypsilanti, Michigan

EFR™ was implemented for four events (total of 24 hours of extraction) at a site at which four monitor wells contained as much as 2.3 feet of free product. Offgas concentrations exceeding 100,000 ppm were recorded during the initial 18 hours of extraction. An estimated total of 3,040 pounds of petroleum hydrocarbons (approximately 550 equivalent gallons of gasoline) was removed at a total cost of $6,416. (2368)

Client: Independent Oil Company
Type of Facility: Service Station
Location: Tupelo, Mississippi

A total of nine monitor wells contained free floating gasoline at a retail gasoline dispensing facility. Eight wells were extracted from simultaneously. Six EFR™ events were conducted at the facility, resulting in significant reductions in product thickness and the removal of a calculated 2,068 equivalent gallons of gasoline at a cost of $20,539. A state regulator onsite observing the technology for the first time during the initial event, understanding the cost effectiveness of the technique, promptly departed the site to cease operation of a vacuum truck "pump out" of monitor wells at another site in the same city.

Client: Major Oil Company
Type of Facility: Service Station
Location: Memphis, Tennessee

As much as 1.3 feet of product was present in eight monitor wells entirely across a site (the monitor wells with product were as much as 110 feet by 100 feet apart) that is now a family style restaurant. Seven EFR™ events were conducted over a 12 month time period at a cost of $20,225, during which 11,500 pounds of petroleum hydrocarbons (over 1,900 equivalent gallons of gasoline) were removed. A maximum of 0.15 feet of product was present prior to the seventh event. (24431)

Client: National Environmental Consulting Firm
Type of Facility: Snack Food Distribution
Location: Chamblee, Georgia

As much as 6 feet of a diesel and gasoline free product mixture existed in 4 monitor wells. EFR™ was implemented utilizing offgas control, consisting of a trailer mounted dual internal combustion engines (ICEs). A total of 443 equivalent gallons of gasoline/diesel were removed during the initial EFR™ event, and a 99.99% vapor emission destruction efficiency was achieved by the ICEs. Four subsequent eight hour EFR™ events were conducted. A total of over 1,500 equivalent gallons of gasoline/diesel have been removed at a cost of $20,562, including the cost of offgas treatment. (F-L)

Client: Environmental Consulting Firm
Type of Facility: Active Truck Stop/Service Station
Location: Doraville, Georgia

EFR™ was implemented at a site impacted by diesel, which was present in four tankpit wells at a thickness of ~0.25 feet. An estimated total 1,400 gallons of diesel were removed during two (eight hour) EFR™ event at a cost of $8,130, inclusive of the cost to dispose of free product and groundwater. Offgas treatment of the offgases was achieved through the use of a computer controlled dual internal combustion engine (ICE). A total of only 0.26 pound of VOCs was emitted during the two events. (qt)

Client: Environmental Consulting Firm
Type of Facility: Service Station
Location: Memphis, Tennessee

EcoVac Services was contracted to perform EFR™ at an underground storage tank site where the offgas from a soil vapor extraction system had reached asymptotic levels and free product remained in six wells (ranging from 0.2 to 2.9 feet). Free product was reduced to a maximum of 0.15 feet after only two EFR™ events. (efwill elvis)

Client: Environmental Consulting Firm
Type of Facility: Active Truck Stop/Service Station
Location: Gainesville, Georgia

An initial EFR™ event was conducted at the subject facility for only 1 hour at flow rates approaching 500 CFM before the regulatory limit of 550 pounds of VOCs were removed/emitted (approximately equivalent to 91 gallons of gasoline). Two additional EFR™ events were undertaken using a computer controlled dual internal combustion engine (ICE) to abate the offgases. An estimated total of 784 equivalent gallons of gasoline have been removed during the three EFR™ events (17 hours of extraction) at a cost of $9,309, including the cost of offgas treatment. A destruction efficiency of 99.98% was attained.

Client: Environmental Consulting Firm
Type of Facility: Service Station
Location: Memphis, Tennessee

EcoVac Services was retained by an environmental consulting firm to remove gasoline contamination from a site where the depth to groundwater exceeded 100 feet below land surface. Not only were liquids removed from this depth, but 1,400 pounds of petroleum hydrocarbons were removed from the "deep" and perched aquifers and vadose soils. Free product has been present in six monitor wells at a maximum thickness of four feet, which has been reduced to a sheen to 0.30 feet of free product in two monitor wells after four EFR™ events at a cost of $10,796. (2260)

Client: Environmental Consulting Firm
Type of Facility: Air/Ground Transportation Facility
Location: Memphis, Tennessee

An active airport facility for an overnight delivery firm was affected with up to 3 feet of mixed product (believed to be jet fuel, diesel, and gasoline) at a depth of 25 to 30 feet. Previous pilot testing by a consultant indicated no influence on surrounding wells and slow fluid recovery rates. An eight hour initial EFR™ event, using three wells for extraction, recovered a calculated 356 equivalent gallons of product. A total of approximately 787 equivalent gallons of product were removed during six EFR™ events at a cost of $19,564. Vacuum influence of 5 to 12 inches of water was recorded at monitor wells in all directions surrounding the extraction wells at distances of 70 to 180 feet.

Client: Environmental Consulting Firm
Type of Facility: Service Station
Location: Caro, Michigan

EFR™ was conducted for a total of 30 hours over a two week period at a site in east central Michigan. Free product levels were reduced by approximately one-half following three EFR™ events (24 hours of extraction) and a calculated total of over 1,200 equivalent gallons of gasoline were removed.

Plan of Action

MOBILE ENHANCED MULTI-PHASE EXTRACTION (MEME) AT THE NAVAL EXCHANGE SERVICE STATION; NAVAL SUPPORT ACTIVITY MID-SOUTH, MILLINGTON, TENNESSEE

January 11, 1998

Prepared by:

BAT Associates, Inc.
704 South Illinois Ave, Suite C-202
Oak Ridge, Tennessee 37830

Prepared for:

Department of the Navy
Southern Division
Under Contract No. N62467-98-D-0938
Naval Facilities Engineering Command
2155 Eagle Drive
P.O. Box 190010
North Charleston, South Carolina 29419-1910

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1.0 PROJECT DESCRIPTION AND BACKGROUND

1.1 Project Description

BAT Associates, Inc. (BAT), under contract number N62467-98-D-0938, has been tasked by the Department of the Navy, Southern Division Engineering Facilities Command to perform mobile enhanced multi-phase extraction (MEME) technology at the Naval Exchange Service Station (NXSS) at the Naval Support Activity (NSA) MID-South, Millington, Tennessee.

BAT has developed this plan of action to describe procedures, schedules, health and safety, and other required work activities to complete the MEME technology. This plan of action was developed in accordance with the Tennessee Department of Environment and Conservation (TDEC) Division of Underground Storage Tanks Technical Guidance Document No. 016

The application of the MEME events are intended to be an abatement initiative to reduce the levels of dissolved benzene, toluene, ethyl benzene, and xylene (BTEX), and total petroleum hydrocarbons (TPH) petroleum constituents in groundwater. To date, two (2) MEME events have been performed at this site. These events were conducted January 15-16, and January 29-30, 1998.

1.2 Project Background

The NXSS is located in the northwestern quadrant of NSA Memphis. The site encompasses approximately three acres, is flat, drains surfacially to the west, and is covered with asphalt pavement.

A loss of gasoline was discovered in February 1986 by Exchange Service Station personnel. The initial release was reported to TDEC in March 1986. A preliminary investigation of this leak by Navy personnel revealed that a pipe joint on the regular unleaded gasoline fuel line was leaking. As part of former site assessments, twenty-two (22) groundwater monitoring wells were installed.

Several groundwater monitoring events performed between 1987 and 1998 indicate that the contaminated groundwater has not moved from the immediate vicinity of the fuel line leak. TDEC has established that cleanup levels for groundwater for the "non-drinking water" classification is 0.070 ppm for benzene and 1.0 ppm for TPH. TPH and Benzene concentrations in the groundwater did exceed TDEC action levels for a non-drinking aquifer in ten (10) monitoring wells (MEM-757-1 through -3, MEM-757-6 through -8, MEM-757-12 through -14, and MEM-757-B3. Therefore, only these ten (10) wells will be used for the MEME events. Location of the wells is shown on Figure 1-1.

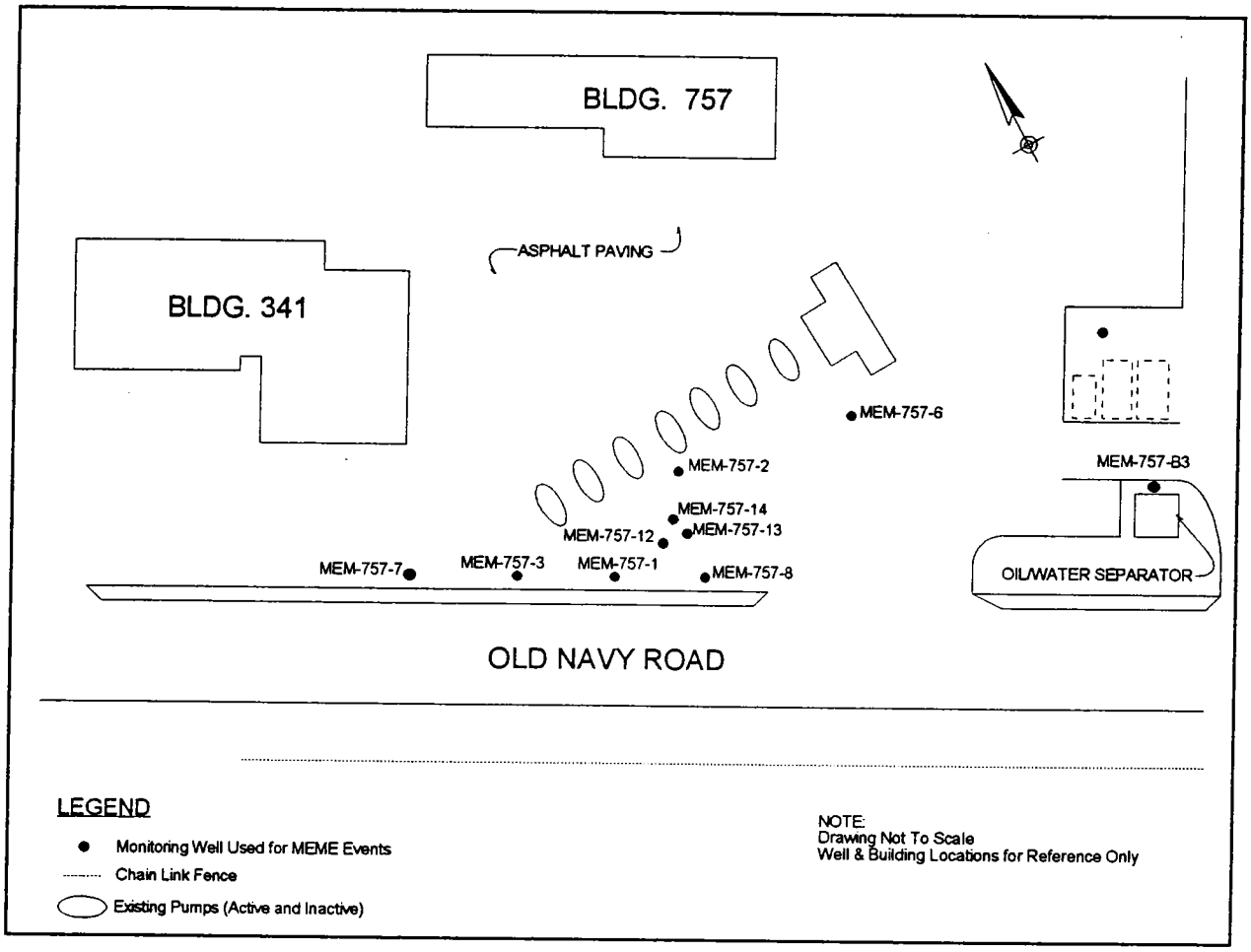

Figure 1-1 NXSS Site Map and Monitoring Well Locations

The result of slug tests indicate an average hydraulic conductivity of 3.45 E-4 cm/sec. The average hydraulic conductivity appears uncharacteristic for silts and clays encountered at the site. An average hydraulic conductivity for clayey silts and silty clays is 5.0 E-6 cm/sec. This value more likely characterizes the shallow aquifer at the NXSS than the slug test results, and could be used as a hydraulic design parameter.

Based on historical groundwater sampling data, monitoring wells at the NXSS are considered low yield wells. Historical data indicates that the water withdrawal rate from the total site would be within the range of two gallons per minute. It has been estimated that a total of 1,500 gallons or less of groundwater should be recovered during each MEME event. An event is defined as eight (8) hours of operation. Water level measurements taken April 11, 1996 are shown for reference in Table 1-1.

1.3 MEME Technology to be Employed

BAT's subcontractor will utilize Enhanced Fluid Recovery (EFR™), a mobile variation of what is commonly referred to as multi-phase extraction, dual-phase extraction, and vacuum enhanced recovery. EFR™ is a remediation method that utilizes high vacuum pressures and flow rates to remove multiple phase (i.e. vapor, absorbed, dissolved, and free phase) volatile organic compounds (VOCs) from the subsurface. EFR™ utilizes high vacuum and high flow rates simultaneously connected to as many as eight monitoring or recovery wells. EFR™ is normally conducted for an eight hour period per event.

EFR™ simultaneously removes vapors, free product, and groundwater from the subsurface. It volatizes adsorbed and free phase VOCs through a process similar to soil vapor extraction, but with much higher vacuum and radius of influence. EFR™ can also treat adsorbed phase VOCs existing in the "smear zone" (i.e. the zone of seasonal or climatic groundwater fluctuation) that act as a source for dissolved phase VOCs. EFR™ dewaters and exposes the smear zone to the effects of 'high rate" soil vapor extraction. EFR™ also introduces oxygen to the vadose zone and saturated zones, thereby enhancing aerobic biodegradation.

TABLE 1-1
WATER TABLE ELEVATIONS
Naval Exchange Service Station
NAS Memphis

Monitoring Well	Total Depth (ft./btoc)*	Top of Casing Elevation	DATE OF MEASUREMENTS	
			April 11, 1996	
			Depth to Water (ft./btoc)*	Water Level Elevation
MEM-757-1	19.60	270.78	5.38	265.4
MEM-757-2	19.22	270.98	5.53	265.45
MEM-757-3	19.46	270.66	4.92	265.74
MEM-757-4	19.27	269.14	4.72	264.42
MEM-757-5	19.68	271.54	7.54	264.00
MEM-757-6	17.61	271.82	5.60	266.22
MEM-757-7	25.77	270.51	4.91	265.60
MEM-757-8	25.19	271.24	6.09	265.15
MEM-757-9	25.05	271.36	6.70	264.66
MEM-757-10	24.92	271.6	6.77	264.83
MEM-757-11	25.74	271.51	6.11	265.40
MEM-757-12	28.60	**	5.43	**
MEM-757-13	29.42	**	5.49	**
MEM-757-14	28.86	**	5.41	**
MEM-757-16	14.25	**	4.43	**
MEM-757-17	14.0	**	3.76	**
MEM-757-18	13.95	**	3.97	**
MEM-757-19	14.02	**	2.76	**
MEM-757-B1	14.78	272.83	4.67	268.16
MEM-757-B2	15.19	272.73	3.97	268.76
MEM-757-B3	14.16	272.68	4.61	268.07
MEM-757-B4	13.68	271.78	5.48	266.30

Note: Reference datum for elevations is Mean Sea Level
* ft./btoc = feet below top of casing
** Elevation data unavailable for these wells

2.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

2.1 Project Team

The BAT Associates, Inc. (BAT) project team is composed of in-house, full-time BAT staff. The project organization chart is shown in Figure 2-1. Mr. James Summers will serve as Project Manager, and Mr. Craig Aurin as Environmental Engineer, who will be responsible for coordination of all field activities. BAT will utilize the efforts of project team member EcoVac Services to provide the labor and equipment required to perform the eight MEME events. Laboratory analysis will be performed by Environmental Testing & Consulting, Inc.

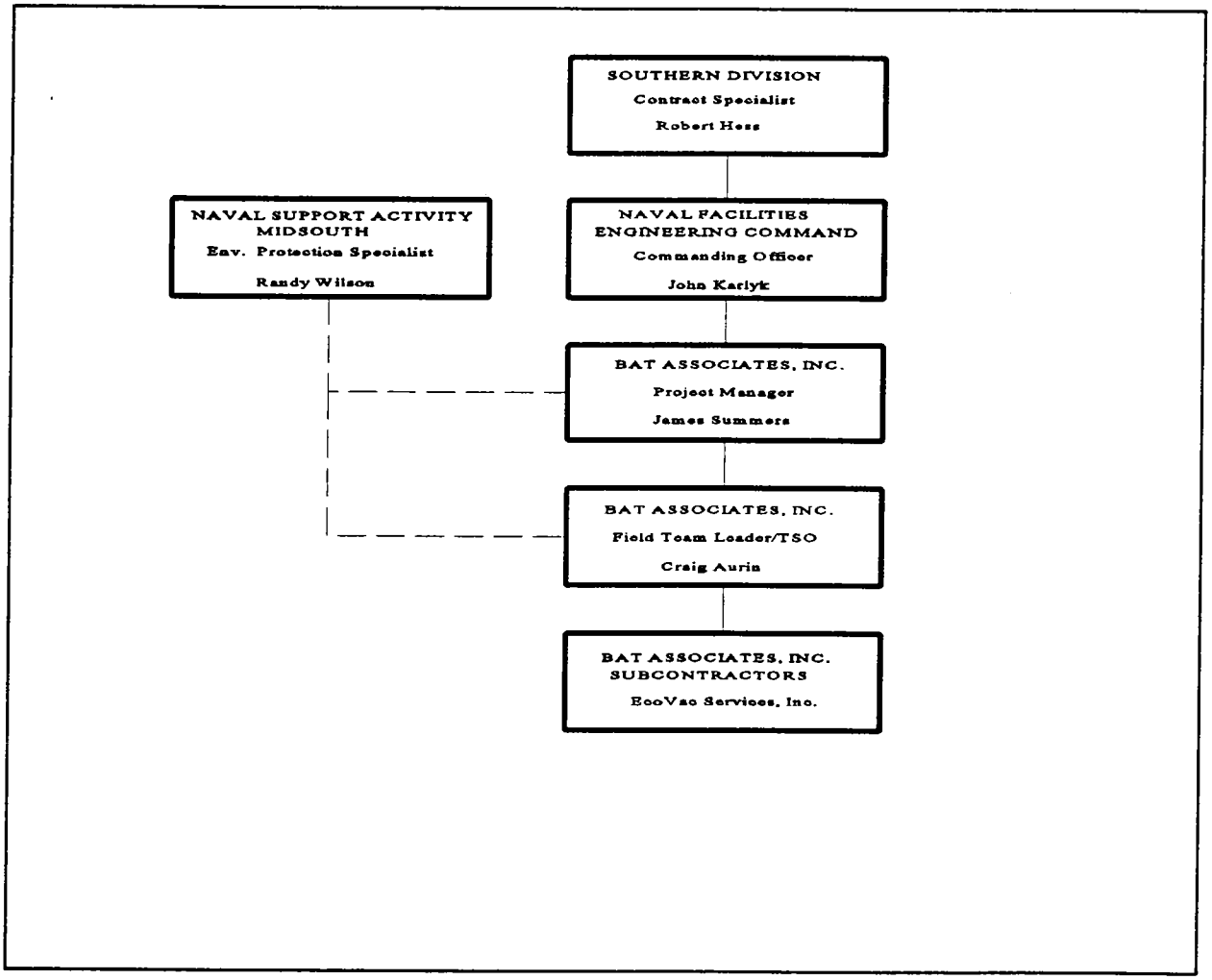

Figure 2-1 Project Organization Chart

2.1 Project Personnel Contacts

The project team contacts are as follows:

Mr. James Summers
Project Manager
BAT Associates, Inc.
704 South Illinois Ave, Suite C-202
Oak Ridge, Tennessee 37830
(423) 481-8105
(423) 481-0899 (fax)
email: batassoc@mail.tds.net

Mr. Craig Aurin
Field Team Leader
BAT Associates, Inc.
704 South Illinois Ave, Suite C-202
Oak Ridge, Tennessee 37830
(423) 481-8105
(423) 481-0899 (fax)
(423) 806-2763 (mobile)
email: batassoc@mail.tds.net

Mr. John Karlyk
Commanding Officer
ATTN: Code 1846
Southern Division
Naval Facilities Engineering Command
2155 Eagle Drive, P.O. Box 190010
North Charleston, South Carolina 29419-9010
(843) 820-5624

Mr. Randy Wilson
Environmental Protection Specialist
Naval Support Activity, MIDSOUTH
ATTN Code: 0101
DPW-Environmental Department
5720 Integrity Drive
Millington, Tennessee 38054-0306
(901) 874-5902
email: randy.wilson@smtp.cnet.navy.mil

3.0 FIELD ACTIVITIES

3.1 Work Scope

All work will be in strict accordance with the site specific Health and Safety Plan (HASP) (Appendix A). All activities required to perform the MEME events will be in accordance with TDEC Division of Underground Storage Tanks Technical Guidance Document No. 016 (TGD016) (Appendix B).

BAT will perform eight MEME events under this contract. The enhanced fluid recovery activities will be performed on ten wells located at the NXSS. These wells are identified as follows:

MEM-757-1
MEM-757-2
MEM-757-3
MEM-757-6
MEM-757-7
MEM-757-8
MEM-757-12
MEM-757-13
MEM-757-14
MEM-757-B3

The eight MEME events are scheduled as follows:

TABLE 3-1 MEME Event Schedule

Event Number	Scheduled MEME Event Date
1	January 19, 1999
2	February 10, 1999
3	March 15, 1999
4	April 15, 1999
5	May 17, 1999
6	June 18, 1999
7	July 12, 1999
8	August 2, 1999

3.2 Permits and Authorizations

Prior to conducting the initial MEME event, BAT will obtain all necessary permits and authorizations required to perform the MEME events. This will include, but may not be limited to, proper notification to TDEC, submission of the TDEC application to perform MEME events, coordination of all field work with the NSA activity representative, and obtaining permission and clearance from the appropriate station security personnel for entrance into the applicable work areas.

BAT will meet with the NSA environmental coordinator at the site to initiate the field work. The final HASP will be approved by RPM prior to the meeting.

3.3 Enhanced Fluid Recovery Operation

EFR™ will be performed using a high vacuum truck (capable of high vacuum as much as 28 inches of mercury and flow rates as high as 3,000 cubic feet maximum). Because the vacuum truck can service only six wells at a time, the MEME event will be ran on five wells (MEM-757-2,-6,-13,-14, and -B3) for the first four hours, and ran on the remaining five wells (MEM-757-1,-3,-7,-8, and -12) for the last four hours.

3.4 Collection of Field Data

Field measurements will be collected and recorded on the MEME Field Monitoring Log (Appendix B) and will be taken every fifteen minutes for the first two hours, and every thirty minutes thereafter. BAT will collect the following data in strict compliance with TGD016.

- Groundwater/product levels (before and after the EFR™)
- Flow rates
- VOC removal rate and total removal (mass and volume)
- Extraction well vacuum concentrations
- Offgas concentrations
- Groundwater and free product recoveries
- Limited vacuum influence and groundwater level drawdown data.

3.5 Groundwater Collection, Sampling and Disposal

All groundwater collected during each MEME event will be transported to the Publicly Owned Treatment Works (POTW) and will be discharged to an oil water separator at the station. Historically, groundwater collected from past on-base MEME events has been discharged to POTW. It is anticipated that groundwater collected during these MEME events will also be disposed of in the same manner. Prior to disposal, BAT will coordinate with PTOW/City of Millington officials on disposal requirements and discharge rates. If it is determined by POTW that sampling is required for

disposal, BAT will collect and analyze collected groundwater for BTEX, GRO-TPH, oil/grease, or other parameters as required by the POTW.

3.6 Documentation

BAT will prepare a report of activities and data collected during each of the MEME events. A letter report, summarizing the event will be prepared and submitted with the completed MEME Field Monitoring Logs. The information will include an explanation of the disposition of the extracted fluids. The document will be submitted within 20 days of the event to the Department of the Navy's Environmental Protection Specialist (Mr. Randy Wilson) in accordance with TGD016.

APPENDIX A

HEALTH AND SAFETY PLAN

FOR

MOBILE ENHANCED MULTI-PHASE EXTRACTION NAVAL EXCHANGE SERVICE STATION, NAVAL SUPPORT ACTIVITY, MIDSOUTH, MILLINGTON, TENNESSEE

Mobile Enhanced Multi-Phase Extraction at the
Naval Exchange Service Station (NXSS),
Naval Support Activity (NSA),
MidSouth, Millington, Tennessee
Health and Safety Plan
Contract: N62467-99-R-0867

Douglas J. Milton, CIH Date: 1/11/99
Douglas J. Milton, CIH
BAT Corporate Health & Safety Coordinator
Project Health and Safety Officer

Date: 1/12/99
Craig M. Aurin
Field Team Safety Officer

James Summers Date: 1/12/99
James Summers
Project Manager

James Summers for
John Kalk per phone conversation Date: 1/12/99
Department of the Navy Concurrence 1/12/99

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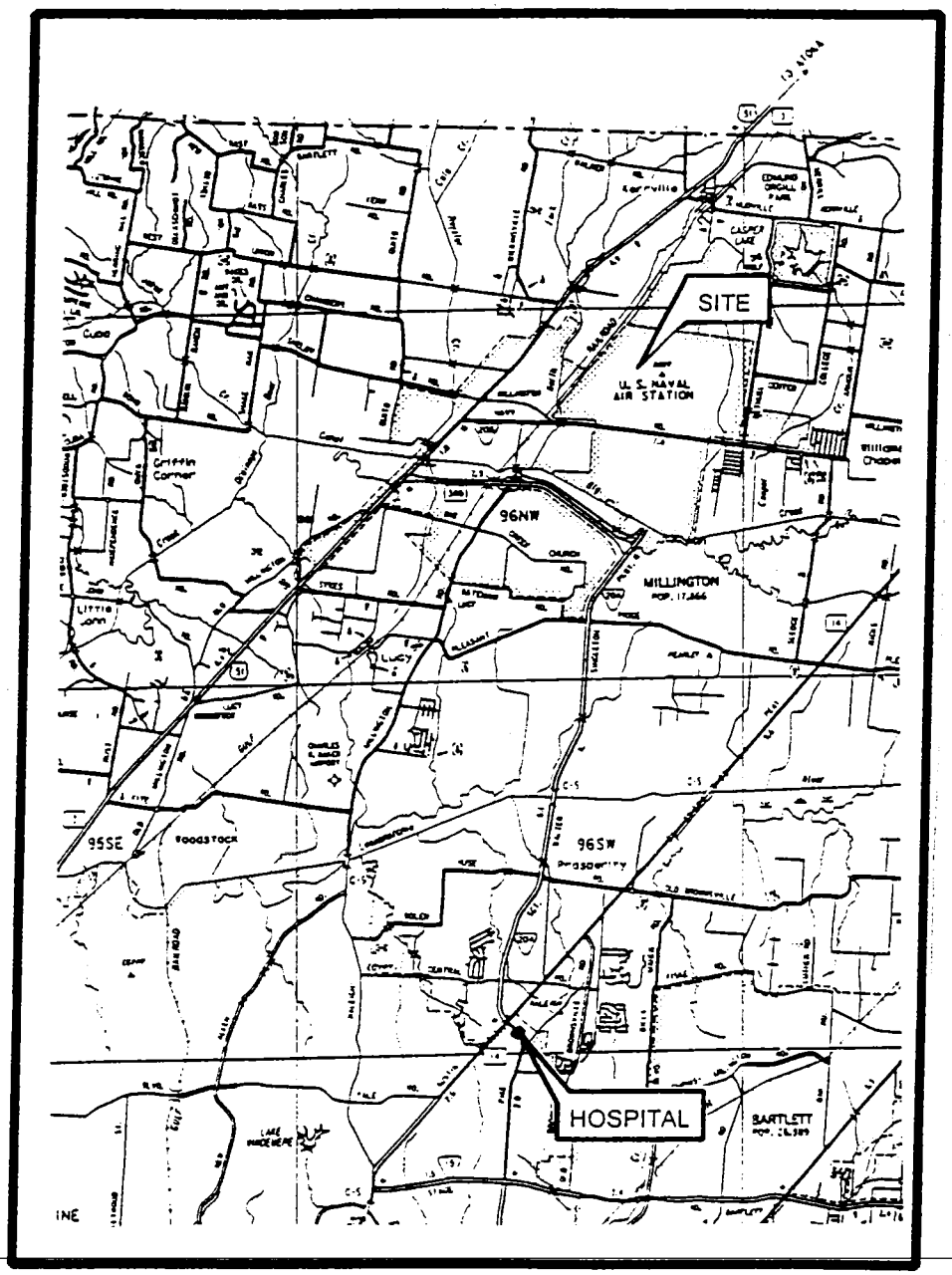
ATTACHMENTS

QUICK REFERENCE OF EMERGENCY CONTACTS

Emergency Medical Care

The Methodist Hospital North telephone number is (901)384-5200. The address of the hospital is 3960 New Covington Pike, Memphis, Tennessee. Local ambulance service is available by dialing 911. Directions to the Methodist North Hospital are as follows:

From the NXSS, turn east onto Navy Road. Proceed through Singleton Gate onto Singleton Boulevard. Continue on Singleton Boulevard until you reach the traffic light at the intersection of Austin Peay Highway (HWY 14). Methodist North Hospital will be on the left. Travel distance is approximately ten miles.



Accident Reporting

All emergencies, including fire and security, may be handled through the NSA - Environmental Office Office. The telephone number is (901) 874-5902, or dial 911.

- The NSA-Environmental Office - Commander Randy Wilson - (901) 874-5902.
- The PHSO BAT Atlanta Office - Mr. Doug Milton - (770)242-3908.
- The BAT Oak Ridge Office - Mr. James Summers - (423) 481-8105.

Evacuation Procedures

- Each Field Team Member shall be responsible for becoming familiar with any evacuation routes that are designated (verbally or posted) by the NSA.
- In the event of an evacuation, proceed to the predetermined assembly point and wait for further instructions.
- Field Team Members shall follow instructions given by the Emergency Response Team upon its arrival.

INTRODUCTION

BAT Associates, Inc. (BAT) has been tasked under the Department of the Navy, Southern Division to perform Mobile Enhanced Multi-Phase Extraction (MEME) technology at the Naval Exchange Service Station (NXSS), Naval Support Activity (NSA) MID-South, Millington, Tennessee. The application of the MEME events are to be an abatement initiative to reduce the levels of dissolved benzene, toluene, ethyl benzene, and xylene (BTEX), and total petroleum hydrocarbons (TPH) petroleum constituents in groundwater. **The overall Risk Assessment Code (RAC) for this project is a 4 due to the potential exposure to petroleum hydrocarbons and benzene.**

During the MEME events, a potential for exposures to hydrocarbons and benzene may exist. There may also be the possibility that other hazards such as heat stress, fire, explosion, excessive lifting, slips, trips and falls could be encountered, though these are not expected. If these hazards are encountered, the Project Health and Safety Officer (PHSO) shall modify this plan to address those hazards before work is conducted in the areas where these hazards may exist. This Health and Safety (H&S) Plan covers all field activities conducted by BAT and its subcontractors.

The BAT Field Team (including subcontractors) will meet with the NSA environmental coordinator at the site to perform a pre-project walk-through and conduct a meeting with the NSA environmental personnel to become familiar with each well site and their potential hazards before work begins. Safety concerns shall be discussed with these representatives to gain their input on dealing with any potential H&S hazards. The Field Team shall not begin field activities until this H&S Plan is approved and signed by the appropriate NSA representatives, BAT's Project Manager and Health and Safety Officer.

A log will be kept to document visitors to the work areas. The name of the visitor, date, and the time in and out will be recorded.

In addition to this H&S Plan, the BAT Field Team shall follow all applicable NSA H&S, Occupational Safety and Health Administration (OSHA) and BAT Corporate H&S Plan requirements.

1.0 PROJECT ORGANIZATION

BAT's project organization is designed to promote ease in communication. The Project Manager has overall responsibility for quality, performance, cost scheduling and reporting. Each Field Team Member, including BAT subcontractors, has the responsibility to report to the Field Team Leader or Project Manager any H&S concerns necessary to perpetuate a safe working environment. The BAT Field Team has a Team Leader who shall coordinate field activities as well as act as the Team Safety Officer (TSO). The TSO communicates with the Project H&S Officer (PHSO) on project H&S issues as they arise. The TSO is responsible for maintaining day-to-day H&S issues as they arise. The PHSO's responsibilities shall include conducting routine safety assessments on the Field Teams to ensure compliance with the project H&S Plan.

1.1 Project Health and Safety Officer (PHSO)

The PHSO shall be responsible for reviewing and approving the project H&S Plan. The PHSO shall also be responsible for reviewing and approving any and all changes made to the plan after the start of the project. The PHSO shall be responsible for the execution of H&S procedures. This individual shall serve as the point of contact for H&S during field activities and shall provide technical information and support regarding any H&S issues to the Field Team. The PHSO shall have *stop-work* authority if conditions are determined to be potentially hazardous to area occupants, visitors, contractors, or the environment.

1.2 Team Safety Officer (TSO)

The Team Leader shall also serve as the TSO. The TSO shall direct or perform visual pre-and post-surveys of each work area as well as visual pre-and post-surveys of personnel and equipment used at each work site. All necessary zoning and posting shall be placed around each site and maintained by the TSO, and all H&S monitoring shall be conducted by this individual. Other duties include: ensuring that personnel don appropriate Personal Protective Equipment (PPE), periodically checking the condition of all H&S equipment, and advising the PHSO of on-site conditions as necessary. If any hazardous conditions are encountered the TSO shall stop work and contact the PHSO for instructions and technical advice before resuming work.

2.0 HAZARD ASSESSMENT

2.1 Evaluation and Risk Assessment

Strict compliance with all applicable standards and regulations will ensure a safety program that provides a generally acceptable level of risk. However, strict compliance with all standards, regulations, and guidelines is not always feasible. The PHSO and the TSO have the responsibility of identifying potential risks to personnel, property and related environment associated with a project before the project gets started. The risk should be assessed to determine and predict exposures. Then either training, engineering controls, administrative controls, and Personal Protective Equipment (PPE) should be used to effectively reduce the potential exposures.

Each potential hazard shall be assigned a Risk Assessment Code (RAC) based on the following tables:

HAZARD SEVERITY

RANKING	HAZARD SEVERITY	PERSONNEL	IMPORTANCE OF MISSION	EXPECTED TIME PERIOD
1	Catastrophic	Death	Critical	Total Mission Loss or More than 6 Weeks
2	Major	Severe Injury	Critical or Major	Less than 6 Weeks and More than 1 Month
3	Minor	Minor Injury	Major or Minor	Less than 1 Month and More than 2 Weeks
4	Negligible	None/or Insignificant Injury/Illness	Minor or Negligible	Less than 2 Weeks

MISHAP PROBABILITY

RANKING	MISHAP PROBABILITY
A	Likely to occur immediately or in a short period of time.
B	Probable to occur in time.
C	Possible to occur in time.
D	Unlikely to occur.

RISK ASSESSMENT CODES (RAC)

HAZARD SEVERITY	MISHAP PROBABILITY			
	A	B	C	D
I.	1	1	2	4
II.	1	2	3	4
III.	1	1	2	4
IV.	4	4	5	5

RISK ASSESSMENT CODES

1. Imminent Danger
2. Serious Danger
3. Moderate Danger
4. Minor Danger
5. Negligible Danger

The potential H&S hazards of concern for this project include: heat stress; exposure to petroleum hydrocarbons and benzene contaminants, as well as mechanical and physical safety hazards. Potential hazards shall be identified during each MEME event meeting with the NSA representative. These hazards shall, in turn, be communicated to the Field Team Members. A H&S meeting shall be conducted by the Field Team Leader daily and should be documented in the project log book. This meeting shall cover H&S concerns for daily sampling activities.

2.2 Toxic Atmospheres

Section 4.0 contains a list of required PPE during enhanced fluid recovery activities. The list addresses the potential health or exposure concerns.

The time of greates exposure potential to petroleum hydrocarbons/benzene will be during the initial uncapping of monitoring wells. Care should be taken to avoid breathing the gases, vapors, and fumes when uncapping each well.

2.3 Radiological

The RAC for radiological exposure is 5. No potential for exposure to radiological hazards shall be encountered by the Field Team Personnel during the course of activities under this contract.

2.4 Biological

The RAC for biological exposures is 5. Field Team Members are not anticipated to encounter biological contaminants that could potentially cause illness or injury during the course of sampling and non-sampling activities under this contract.

2.5 Petroleum Hydrocarbons/Benzene

The RAC for hydrocarbons and benzene is a 4, which could be reduced to a 5 with the proper awareness training, an accurate Standard Operating Procedure (SOP), and appropriate PPE.

Benzene, a carcinogen, is the major component of concern of gasoline/diesel fuel. Therefore, the potential for exposure exists. However, since benzene has a high vapor pressure, it is assumed that the majority of benzene at each well site will have dissipated, making airborne exposures minimal. Air monitoring for benzene shall be conducted during field activities and as needed, as well as during subsequent MEME events. Monitoring will be documented using the vapor monitoring form (Attachment A). Material safety data sheets for the anticipated contaminants are provided in Attachment B.

A low potential for exposure to petroleum hydrocarbons/benzene through skin contact also exists. This exposure will be minimized with the use of protective clothing, polyvinyl alcohol (PVA) boots and gloves, and protective eye-wear. Any hand to mouth contact such as eating, drinking and the use of tobacco products shall not be performed without exiting the worksite and properly decontaminating hands by washing with soap and water.

Exposure to benzene via skin, eye contact, ingestion, or inhalation produces a variety of symptoms. These symptoms include irritation of the eyes, nose, and/or respiratory system; giddiness; headache, nausea and/or staggered gait; fatigue, anorexia and lassitude; dermatitis; and bone marrow depression (carcinogenic characteristic). The OSHA Permissible Exposure Limit (PEL) for benzene is 1 ppm over an 8-hour Time Weighted Average (TWA).

PPE shall include chemical splash resistant Tyvek™ suites, boot covers, gloves, and goggles or full face respirator. The clothing will be used to protect against accidental skin contact while the respirator will be used to protect against the inhalation of benzene fumes.

2.6 Temperature Extremes

The RAC for temperature extreme exposures is 4, and could be lowered to a 5 with proper awareness training, an appropriate SOP and PPE for temperature extreme exposures. Heat stress is the aggregate of environmental and physical work factors that constitute the total heat load imposed on the body. The two types of heat stress are excessive heat and excessive cold. The environmental factors of heat stress are air temperature, radiant heat exchange, air movement, and humidity. Physical work contributes to the total heat stress of the job by producing metabolic heat in the body in proportion to the intensity of the work.

2.6.1 Heat Exposure

PPE worn on this activity can add to the total heat load imposed on the body. To minimize excessive heat exposure, the following work practices shall be followed:

- Liquids, such as water, shall be readily available for drinking. Field Team Members shall be trained to ensure that lost body fluids are replenished.

- Each Field Team Member shall be responsible for watching the signs of excessive heat exposure to himself and to other Field Team Members.

- The following information is provided as a guide for assessing excessive heat exposure:

A. Heat cramps:
Caused by heavy sweating and inadequate water and electrolyte replacement.

Symptoms:
Muscle spasms
Pain in the hands, feet and abdomen.

Treatment:
Drink natural fruit juices to replace fluids and electrolytes. Coffee, tea and soft drinks have a dehydrative effect and should not be used for fluid replenishment.

B. Heat exhaustion:
Caused by sustained exertion in a heated environmental. Lack of acclimatization and failure to properly rehydrate may contribute.

Symptoms:
Clammy skin
Heavy sweating
Dizziness
Nausea
Fainting

Treatment:

Promptly remove individual to a cooler environment and give water or natural fruit juices to replace fluids and electrolytes. If medical assistance is needed, use the procedures outlined in Section 7.

C. Heat stroke:

The most serious form of heat stress occurs when temperature regulation fails and the body temperature rises to critical levels.

Symptoms:

Red, hot, and dry skin
Lack of, or reduced perspiration
Nausea
Dizziness or confusion
Strong rapid pulse
Coma

Treatment:

Immediately summon emergency services by following emergency procedures as outlined in Section 7.1. While waiting for NSA site emergency services to arrive, and if facilities are available.
Cool person by immersion in cold water or by wrapping in a wet sheet and vigorously fan with cool dry air.

2.6.2 Cold Exposure

The general cooling of the human body is known as hypothermia. Exposure to cold reduces body heat. With time, the body is unable to maintain its proper internal temperature. Prolonged exposure to combinations of low air temperatures (below 65°F or 18°C), air movement (above 5 miles per hour), water (temperature relative to air temperature), as well as physical conditions such as poor diet and lack of exercise contribute to hypothermia.

To minimize excessive cold exposure to the body, the following work practices shall be followed:

- Wear appropriate thermal clothing (including coats, gloves, hats, thick socks, and thermal underwear) for the anticipated cool or cold weather conditions. Approximately 80% of body heat loss is through the head. When hands and feet get cold, additional thermal head gear should be worn.

- Liquids such as water shall be readily available for drinking.

- Provide additional dry clothes, especially gloves and socks, to change into when the original clothing gets wet.

- Provide shelter, such as vehicles, to protect Field Team Members when excessive cold exposure is present.

- Each Field Team Member will be responsible for watching for signs of excessive cold exposure to himself and other Field Team Members.

The following information is provided as a guide for assessing excessive cold exposures:

A. General hypothermia

Symptoms:

Shivering
Feelings of numbness
Drowsiness and not willing to perform even the simplest of activities
Slow breathing and pulse rate (in prolonged hypothermia)
Failing sight (in prolonged hypothermia)
Unconsciousness, usually with "glassy stare"
Freezing body parts

Treatment:

Determine extent of problem
Keep person dry
Slowly apply heat to raise the body temperature
Give liquids
Do not allow person to return to cold environment

B. Frostnip:

Frostnip can be brought about by direct contact with cold objects, temperatures, moisture and wind. Damage to tissues is minor and the recovery time is short.

Symptoms:

Slow onset
Unawareness by the affected person
Affected area of the skin becomes white or pale, the color change takes place very quickly
Affected area will feel numb

Treatment:

Warm the affected area(s)
Make sure feeling comes back to the affected area(s)
If person does not respond to simple treatment, treat for frostbite

C. Frostbite:

There are two types of frostbite, superficial and deep. Another term for frostbite is freezing. Frostbite is serious and will require professional medical attention.

Symptoms:

Affected area(s) appear to be white and waxy
Affected area(s) will feel frozen on the surface. Tissue below the surface must be "bouncy".

Treatment:

Protect the frostbitten area(s) by covering.
Handle the affected area(s) gently
Apply a steady source of external warmth (not hot)
Arrange for transportation to the medical facility

D. Freezings:

Local freezing, or deep frostbite requires careful handling to avoid further injury to the affected body part.

Symptoms:

Affected area will turn spotted (mottled) or blotchy. Its color will turn to white and then grayish yellow and finally grayish blue.
Affected area will feel frozen (the surface and the tissues below the surface)

Treatment:

Arrange for immediate transportation to the local medical facility
Provide treatment similar to frostbite.

2.7 General Safety Hazards

The RAC for general safety hazards is 5, no specific hazards have been identified; however, accidents can occur with every task. Prior to project field work, the BAT TSO shall inspect each monitoring well location for potential hazards. Additionally, BAT Field Team Members are responsible for bringing H&S concerns to the attention of the TSO. The TSO shall resolve the issue or report H&S unresolvable concerns/problems to the PHSO. No further work shall be performed until the H&S concern/problem has been addressed and corrected.

The following are general safety hazards that may be encountered:

- If noise hazards are encountered, it should be reported to the PHSO, who shall provide training and hearing protection. The ACGIH 8-Hour TWA Threshold Limit Values (TLV) for noise is 85 dBA, which shall be complied with, as well as BAT's Corporate H&S Plan guidelines.

  Hearing protection shall be required to be worn by project personnel when working in areas identified as noise hazardous. All requirements of 29 CFR 1910.95 and BAT's Corporate H&S Plan shall be followed.

- Electrically powered hand tools and other equipment shall be used only when connected to Ground Faults Circuit Interrupter (GFCI) equipped outlets or extension cords.

- In potentially explosive environments, only intrinsically safe tools shall be used.

- Uneven ground surfaces may be encountered. Appropriate precautions shall be taken to avoid slips, trips and/or falls.

- No hoisting or rigging work shall be performed by project personnel under this contract. If any such work is required, the NSA project technical representative shall be contacted to arrange for qualified NSA personnel to perform this work. No hoisting or rigging work is anticipated.

3.0 HAZARDOUS WASTE ISSUES

The requirements of any federal, state, and local laws and regulations referred to in this section shall be superseded if more current regulatory requirements exist.

The following constitutes BAT's Standard Operating Procedures (SOPs) for managing hazardous waste/materials on the project site.

3.1 Identification of Hazardous Waste

The regulatory and technical definition of hazardous material is lengthy and complex. However, a practical definition of hazardous material which govern this document is:

Hazardous Material is *any* material (solid, liquid or gas) that poses a substantial present or potential physical or chemical hazard to human health or the environment. The term includes all hazardous wastes, as well as nonwaste materials, which are hazardous and regulated by DOT (such as gasoline). Hazardous materials which are used at project sites typically become a hazardous waste when disposed of.

3.2 Designation of Materials/Waste

The waste originator, with assistance from the NSA Environmental Coordinator, will determine the waste designation of materials used or waste generated on a project site.

Designated hazardous waste materials falls into four major categories as follows:

I. Lists: EPA maintains lists (e.g. RCRA) of certain wastes which have been determined to be hazardous based on their composition or on the manufacturing processes that resulted in their generation. Examples include spent solvents, and certain pesticide wastes. These types of wastes are termed "listed wastes" and are regulated as RCRA-listed hazardous wastes, regardless of chemical concentration.

II. Characteristics: RCRA regulation defines a waste to be hazardous if it exhibits any one of four specific characteristics: ignitability; corrosivity; reactivity; or toxicity.

III. TSCA-Regulated Waste: Polychlorinated biphenyls (PCBs) are regulated by the Toxic Substance and Control Act (TSCA; 40 CFR, Part 761). TSCA regulates the disposal of PCB-contaminated waste materials with the concentration of greater than 50 mg/kg.

Specific designation of waste material must be conducted using all the current and applicable regulations. In addition to waste designation, disposal considerations must also take into account any pre-treatment requirements which are specified at an intended disposal site.

3.3 Collection and Labeling

This section describes the SOPs for the collection, containerization, and labeling of hazardous wastes generated and/or discovered at a project site.

3.3.1 Collection

If the hazardous waste is a result of a project operation, it must be placed immediately into appropriate containers. Each waste stream must be stored in separate containers. Consolidation (mixing) of waste streams is not allowed under any circumstances.

If a hazardous waste is discovered while performing a project operation, the site must be vacated immediately until the Safety Coordinator declares the site safe for resuming project activities.

The Safety Coordinator shall, at a minimum, take the following actions prior to allowing personnel back on a site where a potentially unknown hazardous waste or material has been discovered:

1. Monitor the site for any explosive gases using combustible gas indicators
2. Monitor the oxygen level
3. Monitor for presence of organic and inorganic vapors/gases
4. Monitor for the presence of gamma radiation sources
5. Ensure that the site has been cleaned up to appropriate state and federal regulatory criteria by qualified consultants and contractors

3.3.2 Containers

Containers used for collecting hazardous waste must meet DOT construction standards. They must be in good condition and show no visible signs of deterioration. They must be capable of being completely sealed. The site Health and Safety Coordinator or his designee must approve all containers used in transporting hazardous waste generated as a result of Company project activities.

3.3.3 Container Reuse

Containers can be reused only to transport wastes form the same waste stream. This rule does not include overpack containers that are used to pack smaller containers for transporting; these may be reused only if they are not damaged or have not had direct contact with any hazardous waste or material.

3.3.4 Labeling

All hazardous waste material must be labeled with the following information written legibly in clear English:

- Chemical name and designation number as given in RCRA (e.g. F005, F024, etc.)
- Name, address, and emergency telephone number of contact person who must know specifics of the contents of the container
- Physical hazards
- Health hazards
- Storage and handling recommendations
- Level of protection required in case of spill

Additionally, appropriate DOT-required labels and/or placards must be placed on each container being prepared for transportation on public access roads.

4.0 PERSONAL PROTECTIVE EQUIPMENT

Table 1 presents the OSHA project hazard assessments and PPE required for areas to be entered during this activity. Specific PPE depends on the nature of the work, and requirements of the NSA. The PPE presented in Table 1 shall be used unless situations not covered in the plan are encountered. If a unique situation is encountered, work shall stop until the plan is modified and the Field Team Members have been notified, trained, and provided with the proper personal protective equipment and procedures.

Final determination of the PPE requirements shall be based on NSA Industrial Hygiene Department, and OSHA Standards including 29 CFR 1910, Subpart I: PPE for General Industry, as well as BAT's Corporate H&S Plan. Personal respiratory protection is not anticipated for work activities associated with this task.

Table 1. Personal Protective Equipment

Operations	Area of Site to be Accessed	Hazards	Controls*	Employee Monitoring
Enhanced Fluid Recovery	Areas of Extraction/ Monitoring Wells	Physical • Uneven surfaces • Flying objects • Heat stress Chemical • Petroleum Hydrocarbons • Benzene Radiological None Biological None anticipated	Level "D" • Polyvinyl Alcohol (PVA) gloves • Safety glasses • Safety boots	Initial personnel monitoring for benzene and hydrocarbons using NIOSH 3700 Method, and subsequently as required. Routine monitoring using multi-gas meter for %LEL and/or total hydrocarbon with documentation in project log book.

Note: * Requirements identified in NSA Procedures and Postings, and BAT's Corporate H&S Plan.

5.0 PROJECT HEALTH AND SAFETY PLAN PROCEDURES

Douglas J. Milton, CIH shall be the PHSO and is directly responsible for on-site safety recommendations and implementation of this project H&S Plan. A NSA representative in coordination with the PHSO shall be the only two persons authorized to change the PPE used in this sampling.

5.1 Emergency Procedures

The following emergency procedures shall be used by on-site personnel. The TSOs shall be notified of any on-site emergencies and shall be responsible for ensuring that the appropriate procedures are followed by their assigned teams.

Anything identified as "Abnormal or unusual" shall be reported immediately through the proper channels. "Abnormal" incidents include security violations, spilled liquids, and potential hazards.

If an injury occurs in an exclusion zone, the BAT Field Team Leader shall evaluate the nature of the injury and the possibility of immediate rescue without placing additional team members or the injured person in further danger. In the case of minor injury, i.e., cuts, scrapes, and bruises, the Team Leader shall transport the injured person to the Campbell Army Airfield Medical Department. If the injuries are deemed to be severe or if evaluation is not feasible, the base ambulance service shall be notified. On-site first aid shall be administered, if required. No person shall re-enter the exclusion zone until the cause of the injury or symptoms is determined.

If any site worker experiences a failure or alteration of PPE that affects the protection factor of that piece of equipment, that person and his/her team members shall immediately leave the exclusion zone. Re-entry shall not be permitted until:

- The conditions resulting in the emergency have been corrected;
- The hazards have been reassessed by the PHSO;
- The project H&S Plan has been reviewed; and
- Site personnel have been briefed on any changes in the project H&S Plan, if changes are made.

If an accident occurs, the Field Team Members shall immediately notify:

- The NSA Environmental Office - Commander Randy Wilson - (901)874-5902
- The PHSO BAT Atlanta Office - Mr. Doug Milton - (770) 242-3908
- The BAT Oak Ridge Office - Mr. James Summers - (423) 481-8105

If the PHSO is unavailable, the Project Manager shall be immediately notified along with the any subcontractor POCs. The PHSO shall complete an incident report signed by the PHSO, TSO and the Project Manager. Types of accidents or incidents that are considered reportable include:

- Illness resulting from chemical exposure or unknown causes;
- Physical injury, including an injury that does not require medical attention;
- Heat exhaustion or heat stroke;
- Fire, explosions, and flashes resulting from activities by BAT Field Team Members;
- Infractions of safety rules and requirements; and
- Unexpected chemical exposures.

5.2 Special Requirements/Stipulations

The following special requirements must be followed by all project personnel:

- Daily H&S meetings shall be held before field work begins. The meetings shall include discussion of the day's work plan, any hazards expected to be encountered, how these hazards can be identified, and how these hazards can be eliminated/avoided. Daily H&S meetings shall be documented in the project log. No one shall be allowed to begin project activities on-site without appropriate PPE and without a briefing on the potential hazards from the TSO, Team Leader, or the PHSO.
- In the monitoring well area, the buddy system shall be used at all times on this project. All personnel shall remain in visual or voice contact with at least one other team member.
- The required PPE shall be worn by all on-site project personnel.
- No personnel shall be required to enter an area or perform a task that he/she is uncomfortable with or is untrained to perform.
- BAT plans to complete the sampling on schedule; however, personal health and safety shall remain paramount during project activities and shall not be compromised to maintain the schedule. These issues shall be addressed during daily H&S meetings.
- Modification to this project H&S Plan shall not be made without approval from the NSA Representative and the PHSO.

5.3 Reporting an Emergency

- If a base telephone is accessible, dial 911.
- Describe the emergency.
- Identify the location of the emergency.
- In case of an injury, tell whether an ambulance is needed.
- Listen to and follow any instructions that are given.
- Do not hang up until the emergency response coordinator disconnects first.

5.4 Evacuation Procedures

- Each Field Team Member shall be responsible for becoming familiar with any evacuation routes that are designated (verbally or posted) by Campbell Army Airfield.
- In the event of an evacuation, proceed to the predetermined assembly point and wait for further instructions.
- Field Team Members shall follow instructions given by the Emergency Response Team upon its arrival.

5.5 BAT Project Team Personnel Permitted On-Site

_____	_____ Date
_____	_____ Date
_____	_____ Date
_____	_____ Date
_____	_____ Date
_____	_____ Date
_____	_____ Date
_____	_____ Date
_____	_____ Date
_____	_____ Date

ATTACHMENT A

VAPOR MONITORING LOG

VAPOR MONITORING FORM

ECOVAC SERVICES
VAPOR MONITORING FORM

Project Name:

Project Number:

Known/Suspected Contaminants: Petroleum hydrocarbons (gasoline and/or diesel)

Date	Time	TLV Detector Reading				Location	Purpose	Initials

ATTACHMENT B

MATERIAL SAFETY DATA SHEETS

BOUGHT ACCORDING TO SPECIFICATION -- VV-G-109,GASOLINE,UNLEADED - GASOLINE,UNLEADED
MATERIAL SAFETY DATA SHEET
FSC: 9130
NIIN: 002210679
Manufacturer's CAGE: 81348
Part No. Indicator: A
Part Number/Trade Name: VV-G-109,GASOLINE,UNLEADED

General Information

Item Name: GASOLINE,UNLEADED
Company's Name: BOUGHT ACCORDING TO SPECIFICATION
Record No. For Safety Entry: 001
Tot Safety Entries This Stk#: 001
Date MSDS Prepared: 01JAN85
Safety Data Review Date: 30NOV79
MSDS Serial Number: BDJVF
Specification Number: VV-G-109
Hazard Characteristic Code: F2

Ingredients/Identity Information

Proprietary: NO
Ingredient: GASOLINE
Ingredient Sequence Number: 01
NIOSH (RTECS) Number: LX3300000
CAS Number: 8006-61-9
OSHA PEL: 300 PPM/500 STEL
ACGIH TLV: 300 PPM/500STEL;9192

Physical/Chemical Characteristics

Fire and Explosion Hazard Data

Flash Point: -36F

Reactivity Data

Health Hazard Data

Precautions for Safe Handling and Use

Control Measures

Transportation Data

Trans Data Review Date: 87187
DOT PSN Code: GTN
DOT Proper Shipping Name: GASOLINE
DOT Class: 3
DOT ID Number: UN1203
DOT Pack Group: II
DOT Label: FLAMMABLE LIQUID
IMO PSN Code: HRV
IMO Proper Shipping Name: GASOLINE
IMO Regulations Page Number: 3141
IMO UN Number: 1203
IMO UN Class: 3.1
IMO Subsidiary Risk Label: -
IATA PSN Code: RMF

IATA UN ID Number: 1203
IATA Proper Shipping Name: MOTOR SPIRIT
IATA UN Class: 3
IATA Label: FLAMMABLE LIQUID
AFI PSN Code: MUC
AFI Prop. Shipping Name: GASOLINE
AFI Class: 3
AFI ID Number: UN1203
AFI Pack Group: II
AFI Label: FLAMMABLE LIQUID
AFI Basic Pac Ref: 7-7

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Disposal Data

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Disposal Data Review Date: 88169
Rec # For This Disp Entry: 01
Tot Disp Entries Per NSN: 001
Landfill Ban Item: YES
Disposal Supplemental Data: IN CASE OF ACCIDENTAL EXPOSURE OR DISCHARGE, CONSULT HEALTH AND SAFETY FILE FOR PRECAUTIONS.
1st EPA Haz Wst Code New: D001
1st EPA Haz Wst Name New: IGNITIBLE
1st EPA Haz Wst Char New: IGNITABILITY
1st EPA Acute Hazard New: NO

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Label Data

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Label Required: YES
Label Status: G
Common Name: VV-G-109,GASOLINE,UNLEADED
Label Name: BOUGHT ACCORDING TO SPECIFICATION

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BOUGHT ACCORDING TO SPECIFICATION -- MIL-G-3056,GASOLINE,AUTO.,COMBAT - GASOLINE,AUT
MATERIAL SAFETY DATA SHEET
FSC: 9130
NIIN: 001601817
Manufacturer's CAGE: 81349
Part No. Indicator: A
Part Number/Trade Name: MIL-G-3056,GASOLINE,AUTO.,COMBAT

General Information

Item Name: GASOLINE,AUTOMOTIVE
Company's Name: BOUGHT ACCORDING TO SPECIFICATION
Record No. For Safety Entry: 001
Tot Safety Entries This Stk#: 001
Date MSDS Prepared: 01JAN85
Safety Data Review Date: 30NOV79
MSDS Serial Number: BDDDZ
Specification Number: MIL-G-3056
Hazard Characteristic Code: F3

Ingredients/Identity Information

Proprietary: NO
Ingredient: GASOLINE
Ingredient Sequence Number: 01
NIOSH (RTECS) Number: LX3300000
CAS Number: 8006-61-9
OSHA PEL: 300 PPM/500 STEL
ACGIH TLV: 300 PPM/500STEL;9192

Physical/Chemical Characteristics

Fire and Explosion Hazard Data

Flash Point: -40F

Reactivity Data

Health Hazard Data

Precautions for Safe Handling and Use

Control Measures

Transportation Data

Trans Data Review Date: 88201
DOT PSN Code: GTN
DOT Proper Shipping Name: GASOLINE
DOT Class: 3
DOT ID Number: UN1203
DOT Pack Group: II
DOT Label: FLAMMABLE LIQUID
IMO PSN Code: HRV
IMO Proper Shipping Name: GASOLINE
IMO Regulations Page Number: 3141
IMO UN Number: 1203
IMO UN Class: 3.1
IMO Subsidiary Risk Label: -
IATA PSN Code: RMF

IATA UN ID Number: 1203
IATA Proper Shipping Name: MOTOR SPIRIT
IATA UN Class: 3
IATA Label: FLAMMABLE LIQUID
AFI PSN Code: MUC
AFI Prop. Shipping Name: GASOLINE
AFI Class: 3
AFI ID Number: UN1203
AFI Pack Group: II
AFI Label: FLAMMABLE LIQUID
AFI Basic Pac Ref: 7-7
N.O.S. Shipping Name: INCLUDING CASING-HEAD AND NATORAL

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Disposal Data

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Label Data

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Label Required: YES
Label Status: G
Common Name: MIL-G-3056,GASOLINE,AUTO.,COMBAT
Label Name: BOUGHT ACCORDING TO SPECIFICATION

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BOUGHT ACCORDING TO SPECIFICATION -- DIESEL FUEL - DIESEL FUEL
MATERIAL SAFETY DATA SHEET
FSC: 9140
NIIN: 002865296
Manufacturer's CAGE: 81349
Part No. Indicator: A
Part Number/Trade Name: DIESEL FUEL

General Information

Item Name: DIESEL FUEL
Company's Name: BOUGHT ACCORDING TO SPECIFICATION
Record No. For Safety Entry: 086
Tot Safety Entries This Stk#: 092
Date MSDS Prepared: 01JAN85
Safety Data Review Date: 05DEC79
MSDS Serial Number: BDTVR
Hazard Characteristic Code: F4

Ingredients/Identity Information

Proprietary: NO
Ingredient: DIESEL FUEL
Ingredient Sequence Number: 01
NIOSH (RTECS) Number: 1002022DF

Physical/Chemical Characteristics

Fire and Explosion Hazard Data

Flash Point: 125F

Reactivity Data

Health Hazard Data

Precautions for Safe Handling and Use

Control Measures

Transportation Data

Trans Data Review Date: 79339
DOT PSN Code: GTF
DOT Proper Shipping Name: GAS OIL OR DIESEL FUEL OR HEATING OIL, LIGHT *
DOT Class: 3
DOT ID Number: UN1202
DOT Pack Group: III
DOT Label: FLAMMABLE LIQUID
IMO PSN Code: HIA
IMO Proper Shipping Name: FLAMMABLE LIQUID, N.O.S. *
IMO Regulations Page Number: 3345
IMO UN Number: 1993
IMO UN Class: 3.3
IATA PSN Code: MTX
IATA UN ID Number: 1202
IATA Proper Shipping Name: GAS OIL
IATA UN Class: 3
IATA Label: FLAMMABLE LIQUID
AFI PSN Code: MTX

AFI Prop. Shipping Name: GAS OIL
AFI Class: 3
AFI ID Number: UN1202
AFI Pack Group: III
AFI Label: FLAMMABLE LIQUID
AFI Basic Pac Ref: 7-7

Disposal Data

Label Data

Label Required: YES
Label Status: G
Common Name: DIESEL FUEL
Label Name: BOUGHT ACCORDING TO SPECIFICATION

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APPENDIX B

TDEC TECHNICAL GUIDANCE DOCUMENT TGD016

STATE OF TENNESSEE
DEPARTMENT OF ENVIRONMENT AND CONSERVATION
DIVISION OF UNDERGROUND STORAGE TANKS
TECHNICAL GUIDANCE DOCUMENT - 016
EFFECTIVE DATE - AUGUST 1, 1996

RE: Mobile Enhanced Multi-phase Extraction

The purpose of this document is to provide guidance for applying enhanced multi-phase extraction technology at petroleum underground storage tank sites. Mobile Enhanced Multi-phase Extraction (MEME), also known as dual-phase extraction or vacuum-enhanced extraction, is a cost effective, in-situ technology that utilizes high vacuum pressures and air flow rates. The goal of MEME is to remove vapor, adsorbed, dissolved and free phase volatile organic compounds from the saturated and unsaturated zones. This is most commonly done by using a mobile unit containing a high capacity vacuum pump. MEME may also introduce oxygen to the subsurface to enhance natural biodegradation. Mobile Enhanced Multi-phase Extraction may be applicable at petroleum UST sites to meet the following objectives:

- initial abatement,
- free product removal, or
- reducing levels of dissolved petroleum constituents in soil and ground water.

I. Application and Cost Proposal

A. Complete the following:

1. Application to Perform Mobile Enhanced Multi-phase Extraction (Attachment A)
2. Cost Proposal for Mobile Enhanced Multi-phase Extraction (Attachment B)

B. Submit the completed application and cost proposal to the appropriate Division of Underground Storage Tanks field office for approval (with a copy to the central office) before performing the MEME event.

II. Field Monitoring

Complete the Field Monitoring Log as instructed in Attachment C. During the MEME event, the parameters on the log shall be monitored at fifteen (15) minute intervals for the first two (2) hours, and at thirty (30) minute intervals thereafter. The concentration (emission) readings shall be collected from the system outlet (stack) using a flame ionization detector (FID), thermal conductivity meter or other instrument approved by the Division. All instruments must be equipped with a condensate trap capable of removing moisture. The air flow shall be measured using a device capable of measuring velocity to +/- 5%. Vacuum readings on

surrounding monitoring wells shall be recorded to determine the radius of influence. At a minimum, water level readings in the surrounded monitoring wells shall be taken before and after the event.

III. Reporting Requirements

A cover sheet, summarizing the event, shall be prepared and submitted with the completed MEME Field Monitoring Log. This information must include an explanation of the disposition of the extracted fluids. This document shall be submitted within 20 days of the event.

STATE OF TENNESSEE
DIVISION OF UNDERGROUND STORAGE TANKS

Attachment A
Application to Perform Mobile Enhanced Multi-Phase Extraction (MEME)

Submit the original of this application to the appropriate Division of Underground Storage Tanks field office for approval before performing a MEME event. Attach extra sheets if necessary.

1. Date:_____

2. Facility I.D. Number:_____

3. Facility Name:_____

   Facility Address:_____

   _____

   _____

4. Facility Telephone Number: (____)_____

5. Name of UST System Owner:_____

   Owner Address:_____

   _____

   _____

   Owner Telephone Number: (____)_____

6. Type of Contaminant: _____

7. Number, Date and Length of Events Requested: _____

   _____

   _____

8. If the information is available, provide a table showing the contamination levels in each well. Provide a site map showing the locations of the monitoring wells if this information has not been previously submitted.

9. OBJECTIVE: State the purpose and reasoning for the event(s).

   _____

   _____

   _____

   _____

   _____

   _____

10. List monitoring wells to be used for extraction:

11. List the order and configuration of the extraction wells:

12. Describe the method for determining the vacuum radius of influence:

13. Describe your contingency plans if the wells do not react as predicted:

14. Describe the safeguards for insuring contamination will not spread onsite or be drawn from offsite:

15. Equipment to accomplish the objective.

Type of pump:_____

Horsepower:_____

Vacuum capacity (inches of Hg):_____

CFM capability:_____

16. Provide a diagram detailing the configuration of the wellhead and downhole extraction equipment.

17. Describe the instruments for measuring stack velocities and vapor concentration levels.

18. Describe the calibration procedures for the instruments listed:

19. List the personnel that will be at the site, their job title and anticipated time at the site:

Name	Title	Time On-site

20. Describe the disposal method for the extracted fluids.

Attachment B

Instructions for Cost Proposal for Mobile Enhanced Multi-phase Extraction

Section 1. Field Equipment

This section includes all on-site equipment used for petroleum hydrocarbon extraction and monitoring. Description of equipment should include type, size and brand, whenever possible. Please quote the unit rate and the number of units (hours/day) to be used per event. Extend these to the equipment cost column. Also include mobe/demobe cost of equipment and total all equipment costs.

Section 2. Field Personnel

List all personnel involved with on-site extraction and monitoring. Include name, billing title, description of duties, hourly rate and unit of hours on site. Extend all cost to the personnel cost column. Also include any mileage and per diem relating to these individuals. Total all lines for field personnel, mileage and per diem and record in the proper space provided.

Section 3. Project Management & Report Preparation

List personnel involved with managing the extraction event and preparing the report. Include name, billing title, description of duties, hourly rate and unit of hours on site. Extend all cost to the personnel cost column. Total all personnel cost and record in the proper space provided.

Section 4. Hauling and Disposal

This section includes the cost of the disposal of extracted fluids. If transported to a water treatment facility, include the unit cost and report the units in gallons. Also include any charges relating to hauling the extracted fluids.

Section 5. Total cost for one Multi-phase Extraction Event

Add totals of Sections 1-4 and record in this section. Please double check all math.

ATTACHMENT B

COST PROPOSAL
MOBILE ENHANCED MULTI-PHASE EXTRACTION

SECTION 1.

FIELD EQUIPMENT

EQUIPMENT DESCRIPTION	UNIT RATE	NUMBER OF UNITS	EQUIPMENT COST
Mobe/Demobe of Equipment			
TOTAL COST FOR EQUIPMENT / PER EVENT			

SECTION 2.

FIELD PERSONNEL

NAME & TITLE	UNIT RATE	NUMBER OF UNITS	PERSONNEL COST
Mileage			
Per Diem-Number of Employees			
TOTAL COST FOR FIELD PERSONNEL / PER EVENT			

SECTION 3.

PROJECT MANAGEMENT & REPORT PREPARATION

NAME & TITLE	UNIT RATE	NUMBER OF UNITS	PERSONNEL COST
TOTAL COST FOR PREPARATION OF REPORT			

SECTION 4.

HAULING AND DISPOSAL

DESCRIPTION	UNIT RATE	NUMBER OF UNITS	COST
Disposal of Contaminated Water / Units per Gallon			
TOTAL COST FOR HAULING AND DISPOSAL OF CONTAMINATED WATER			

SECTION 5.

TOTAL COST FOR ONE MULTI-PHASE EXTRACTION EVENT	

Attachment C

Measurements recorded on the attached MEME Field Monitoring Log shall be taken every fifteen (15) minutes for the first two (2) hours, and every thirty (30) minutes thereafter. Field monitoring associated with TGD-016 shall include the following parameters:

1. Event date
2. Event number
3. Facility Name
4. Facility address
5. UST Facility ID number
6. Consultant name
7. Monitoring interval time
8. Extraction well number(s)
9. Vacuum measurements in inches of mercury for each extraction well per time interval
10. Air flow velocity in feet per second at system outlet (stack) per time interval
11. Total flow reported as Dry Standand Cubic Feet per Minute. (See EQUATIONS)
12. Temperature of stack gas at system outlet (stack) per time interval
13. Stack emission readings in parts per million (PPMv) per time interval
14. Pounds of carbon, removed per time interval (See EQUATIONS)
15. Monitoring well number
16. Depth to water (DTW) before the event
17. Depth to product (DTP) before the event
18. Product thickness, in feet, before the event
19. Depth to water (DTW) after the event
20. Depth to product (DTP) after the event
21. Product thickness, in feet, after the event
22. Comments
23. Personnel onsite during the MEME event
24. Stack Diameter (Inside Diameter)
25 Type of calibration gas used
26. Total gallons of water removed during the event
27. Cumulative gallons of water removed to date
28. Total pounds of carbon removed during this event
29. Cumlative pounds of carbon removed to date
30. Total time of event

Periodic adjustments shall be made to insure maximum recovery of hydrocarbons. Any changes or adjustments performed in the field during the MEME event shall be documented in the comments section on the MEME Field Monitoring Log.

EQUATIONS

Equation to determine flow as Dry Standard Cubic Feet Per Minute (DSCFM):

$$Q_{std} = (60 \text{ sec/min})\,(1-B_{ws})\,(V)\,(A)\,(528\ R^\circ / T_s)$$

Q_{std} = flow at DSCFM

B_{ws} = water vapor % by volume, high temp. psychrometric chart for air-water vapor mixtures in *Perry's Chemical Engineers' Handbook*, assume stack gas is saturated

V = velocity in ft/sec, obtain with hot wire anenometer or pitot tube

A = cross sectional area of discharge stack in sq.ft. at sampling location

T_s = stack temperature in degrees Rankin (R°), $R^\circ = F^\circ + 460$

Equations to determine pollutant mass removal rate as carbon (PMR_c):

$$PPM_c = (PPM_{meas})(K)$$

$$C_{c:m} = PPM_c\,(M_c / K_3)$$

$$C_c = C_{c:m}\,(62.43 \times 10^{-9} \text{ lb-m}^3/\text{mg-ft}^3)$$

$$PMR_c = C_c\,(Q_{std})\,(60 \text{ min/hr})$$

PPM_{meas} = obtained directly from instrument

K = number of carbons in calibration gas, methane, K = 1
propane, K = 3
hexane, K = 6

$C_{c:m}$ = mg/dsm^3, mass concentration of Total Gaseous Nonmethane Organic (TGNMO) emissions

PPM_c = PPMv, volumetric concentration of TGNMO emissions as carbon, dry basis, at STP

M_c = 12.01 mg/mg-mole, molecular weight of carbon

K_3 = 24.07 $dsm^3/10^6$ mg-mole, mass to volume conversion factor at STP

C_c = lb/dscf, mass concentration of TGNMO emissions as carbon, dry basis, at STP

PMR_c = lb/hr, pollutant mass removal rate of TGNMO emissions

MEME FIELD MONITORING LOG

1. Date:	3. Facility Name:	5. Facility ID #:
2. Event #:	4. Facility Address:	6. Consultant:

7. Time	8. Extraction Wells	11. Vacuum (in/ Hg) At Extraction Well Head				10. Velocity in Feet per Second	11. Total Flow as DSCFM	12. Temp. of stack gas	13. Conc. in PPMv	14. Pounds of Carbon Removed
		Well #	Well #	Well #	Well #					

Total lbs. Removed

	Before Event			After Event		
15. Well #	16. DTW	17. DTP	18. Prod. (ft)	19. DTW	20. DTP	21. Prod (ft)

22. Comments:	23. Personnel:
	24. Stack Diameter I.D.:
	25. Calibration Gas:
	26. Total Gal. of Water:
	27. Cum. Gal. H_2O :
	28. Total lbs. of Carbon this event. :
	29. Cum. lbs of Carbon removed:
	30. Total hours of event: