

**MIDDLE EAST  
BULK PETROLUMEM TERMINAL REMEDIATION STRATEGY**

**(Confidential Client)**

**November 9, 2016**

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Louisville, Kentucky**

WE ARE A 14-PERSON FIRM AND JUST WON A \$1,200,000  
5-YEAR PROJECT IN A MIDDLE EASTERN COUNTRY;

WHERE WE DON'T KNOW THE CULTURE OR ANY COMPANIES;

AND BEEN ASSIGNED A PARTNERING COMPANY BY THE FOREIGN  
GOVERNMENT AGENT WE KNOW NOTHING ABOUT....

AND DIRECTING A CLIENT OF PROFESSIONAL PHD ENGINEERS THAT HAVE  
NEVER INSTALLED A GROUNDWATER REMEDIATION SYSTEM

OK....ON TO THE MIDDLE EAST...

## THE PROBLEM

**Construct a U.S.-Designed Vacuum-Enhanced, Dual Phase Extraction (VEDPE)/Air Sparge (AS) Groundwater Remediation System and accomplish the following:**

- **Successfully install the first pilot study system EVER in the country**
- **Re-capture an off-site downgradient dissolved fraction plume**
- **Overcome a rather large on-site upgradient free product plume**
- **Satisfy the environmental regulators of the Middle Eastern country by demonstrating how a U.S. built system can be utilized to remediate their country-wide petroleum bulk oil terminal environmentally-impaired sites**

## PROJECT LOGISTICS CHALLENGES/CONSIDERATIONS:

- **How are we going to transport a remediation box from Durham, NC to the Middle East (plane, barge, truck etc.)?**
- **Who are we going to send over to install the system (passports, visas, travel arrangement, accommodations etc.)**
- **What equipment are we going to need install the system and who is going to operate/maintain the system for up to 4 years (US, locals etc.)?**
- **Where is the system going to enter into the country and how do we get it from the dock to the site (i.e. permits)?**



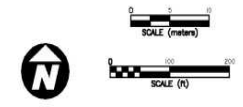




**LEGEND**



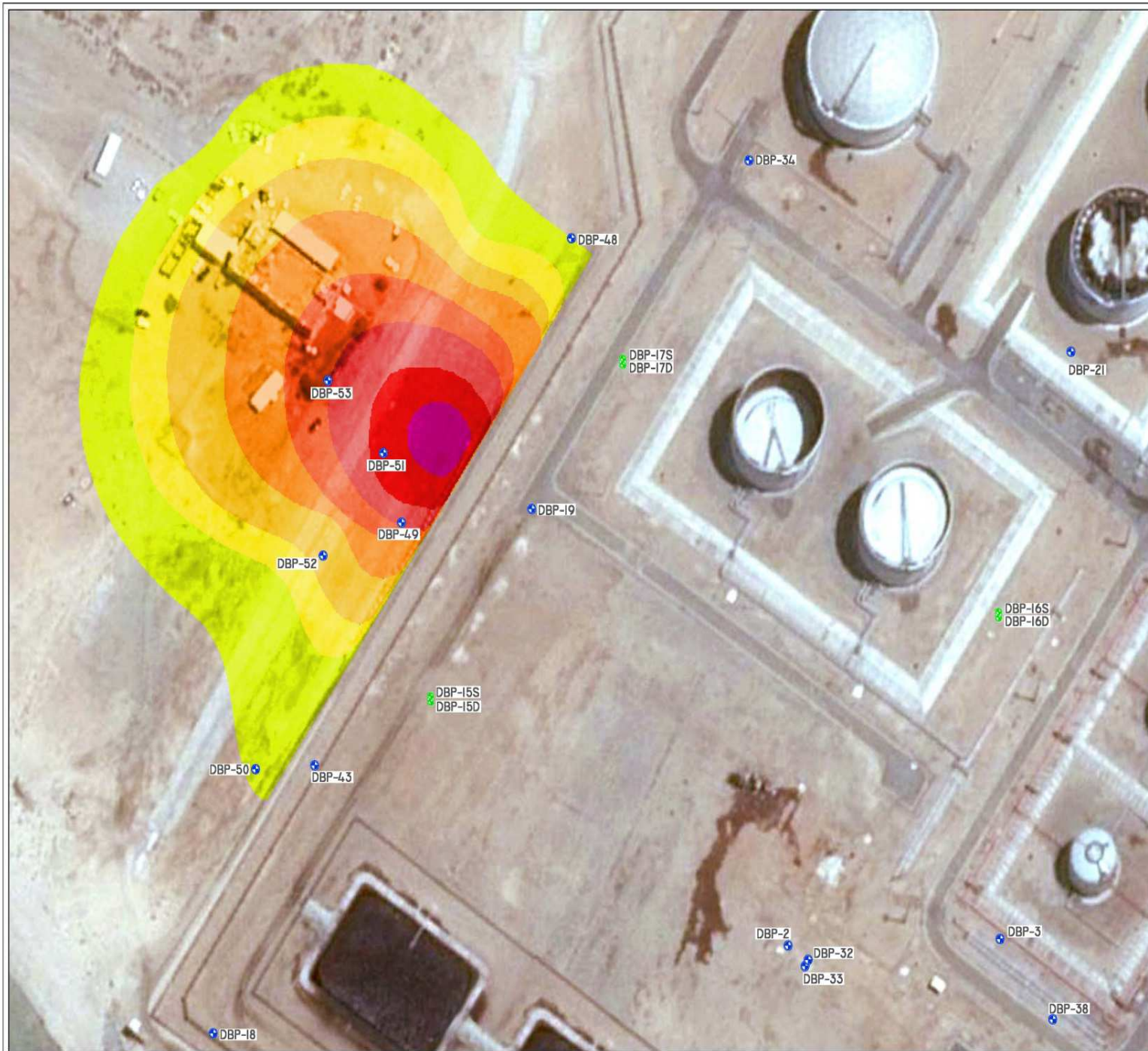
- MONITORING WELL
  - RECOMMENDED MONITORING WELL LOCATION
  - NESTED MONITORING WELLS
  - RECOVERY WELLS
  - DESTROYED OR ABANDONED MONITOR WELLS
- PRODUCT THICKNESSES IN MILLIMETERS (DASHED WHERE INFERRED)
- 0.0
  - 50
  - 100
  - 150
  - 200
  - 250



<b>AERIAL PHOTOGRAPH SHOWING INTERPRETED PRODUCT THICKNESS</b>	SCALE: 1"=200'	<b>FIGURE</b>
	DATE: 11/16/15	
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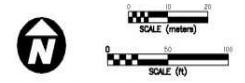
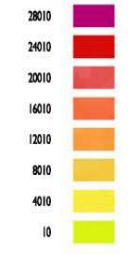


**LEGEND**



- MONITORING WELL
- NESTED MONITORING WELLS
- DESTROYED OR ABANDONED MONITOR WELLS
- STORM SEWER MANHOLE
- RECOVERY WELLS
- PROPOSED INFLUENT PIPING TRENCH (UNDERGROUND)
- PROPOSED DISCHARGE PIPING (ABOVE GROUND)
- PROPOSED SYSTEM LOCATION

**TOTAL BTEX CONCENTRATIONS  $\mu\text{g/L}$**



SOURCE: Google Earth, Imagery Date: January 14, 2012

<b>AERIAL PHOTOGRAPH SHOWING TOTAL BTEX CONCENTRATIONS IN GROUNDWATER</b>	SCALE: 1"=150'	FIGURE
	DATE: 1/13/15	
	PROJ#: 000	
	DRAWN BY: MIKA	
	CHECKED BY:	





## BACKGROUND DATA REVIEW

**LFI evaluated the following documents as provided by the Client that were generated by a DIFFERENT CONSULTANT:**

- **Site Infrastructure Drawings**
  - **Risk Assessment Report**
  - **Site Investigation Report**
- **Risk Assessment Off-Site Report**
  - **Pilot Test Report**
  - **Remedial Action Report**

## THE TEAM

## **LFI had to secure the assistance of the following entities:**

- **LFI (domestic) Louisville, KY**
- **Product Recovery Management (PRM), Durham, NC**
- **Talco Technical Services, Taylorsville, KY (i.e. MacGyver)**

***Team LFI had over 25 years of remediation system design and installation experience in the US; however, with no Middle East experience, in fact, had never been in the country!***





## THE CONSIDERATIONS

Team LFI evaluated had to fully rely on pertinent site information generated by others to design the optimum remediation system based on the:

- Hydrogeologic regime of the Shallow Water-Bearing Zone  
(i.e. tidal fluctuations of the Red Sea)
  - Groundwater chemistry data
- Minimum/maximum estimated horizontal hydraulic conductivities
  - Groundwater flow direction
- Extent of free product and dissolved fraction plumes along and beyond the downgradient western property boundary



## THE CONSTRAINTS

Team LFI had to consider the following site specific and bid specification constraints relative to the project including:









- No off-site access within free product or dissolved fraction contaminant plumes
- Remediation system design limited to 15 recovery wells and bid specification values and locations were limited by infrastructure constraints
- Recovery wells could not be placed any farther than 14 meters apart based on radius of influence for both soil vapor and groundwater
  - Recovery well maximum depths of 9 meters
- System design specifications relative to flow rates versus system capacity
  - Oh yeah, a no change orders!

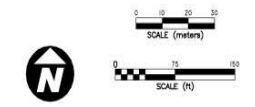
**So we finally get our initial look at the site....**



### LEGEND



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- NESTED MONITORING WELLS 
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- PROPOSED SYSTEM LOCATION 



SOURCE: Google Earth, Imagery Date: January 14, 2012

<b>AERIAL PHOTOGRAPH SHOWING RECOVERY WELL LOCATIONS</b>	SCALE:	1"=150'	FIGURE
	DATE:	11/13/15	
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## THE APPROACH

**Team LFI completed the following preliminary work to create a modified version of this same presentation to the client PRIOR to initiating the work and following the initial site visit:**

- **Prepared a DRAFT Site Map Showing Proposed Recovery Well Locations  
(based on provided information)**
  - **Utilized Google Earth to assist with well placement**
  - **Completed initial design drawings and specifications  
(BOTH for Base Bid and Enhancement Recommendations)**
- **Provided *Technical Proposal For Groundwater Remediation Services Report***

**Information obtained by Team LFI during initial site visit  
(attended by our Middle East Partner, Myself, MacGyver and Terminal Manager):**

- **Met with Site Personnel: Terminal Foreman, Operations Foreman, Terminal Engineer, Maintenance Supervisor**
- **Established an initial positive relationship with site personnel**
  - **Geocoded proposed locations on a DRAFT Site Map**
- **Confirmed on-site system supplied power sources for system compatibility**
  - **Evaluated site logistics and infrastructure**

## THE PRIMARY OBJECTIVES



## REMEDIAL SYSTEM INSTALLATION OBJECTIVES

- Team LFI assumed that the overall project objective/GOAL was to eliminate/prevent further migration of free-phase and dissolved phase contaminant plumes and vapor intrusion beneath the  
**Government-Controlled Building**
- Construct the most efficient and cost effective remediation system in consideration of site/budgetary/specification constraints
- Develop a final remedial system design to accomplish these objectives PRIOR TO installation

To this end, Team LFI discussed the design specifications point by point and offered enhancement recommendations during the initial meeting to the Middle East Client's Technical Personnel and Project Managers

## THE ENHANCEMENTS

**We suggested enhancing the specified “Base Bid” system with the following components which would create a more robust treatment system that would allow the operator higher throughput and less potential for downtime.**

- **Upsizing the Groundwater Treatment system to increase the hydraulic capacity**
- **Increase the system voltage capacity**
- **Upgrade the VE System for increased air sparging performance**
- **Upgrade the control room to include an HVAC system specifically designed for protecting the system’s sensitive electronics and motor drives from extreme heat temperatures encountered in a desert environment**

## **Items To Consider/Points of Discussion:**

- **Local Air Emissions**
- **Product Discharge into Existing Oil/Water Separator and into the Red Sea**
  - **Discharge Line Underground (Site Logistics)**
- **Internet Access/Remote System Interfacing For Troubleshooting to assist an on-site technician from the U.S.**



## THE INSTALLATION







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## Comments/Questions

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