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Kuwait Environmental Remediation Program (KERP)

**Issues Associated with the Excavation and Transportation of
Highly Contaminated Soil- Case Study**

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*** Kuwait oil Company-Team leader Soil Remediation Project -II**

Main Topics

- Introduction
- Scope of Works
- Overall Achievements
- Engineered Landfill
- UXO- unexploded ordinance
- Site Soil Characterization
- Excavation & Transportation activities
- Lesson Learned
- Conclusion



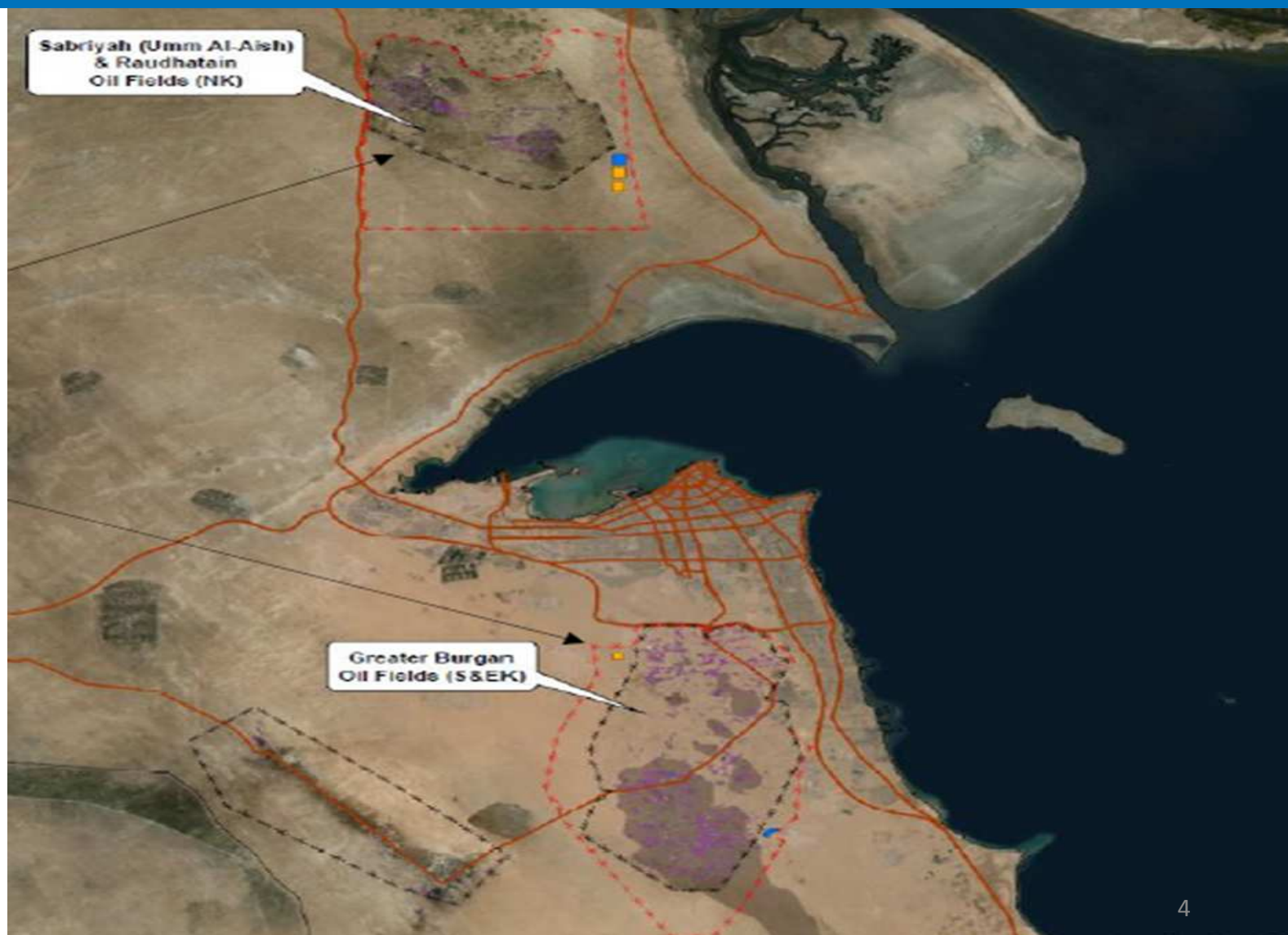
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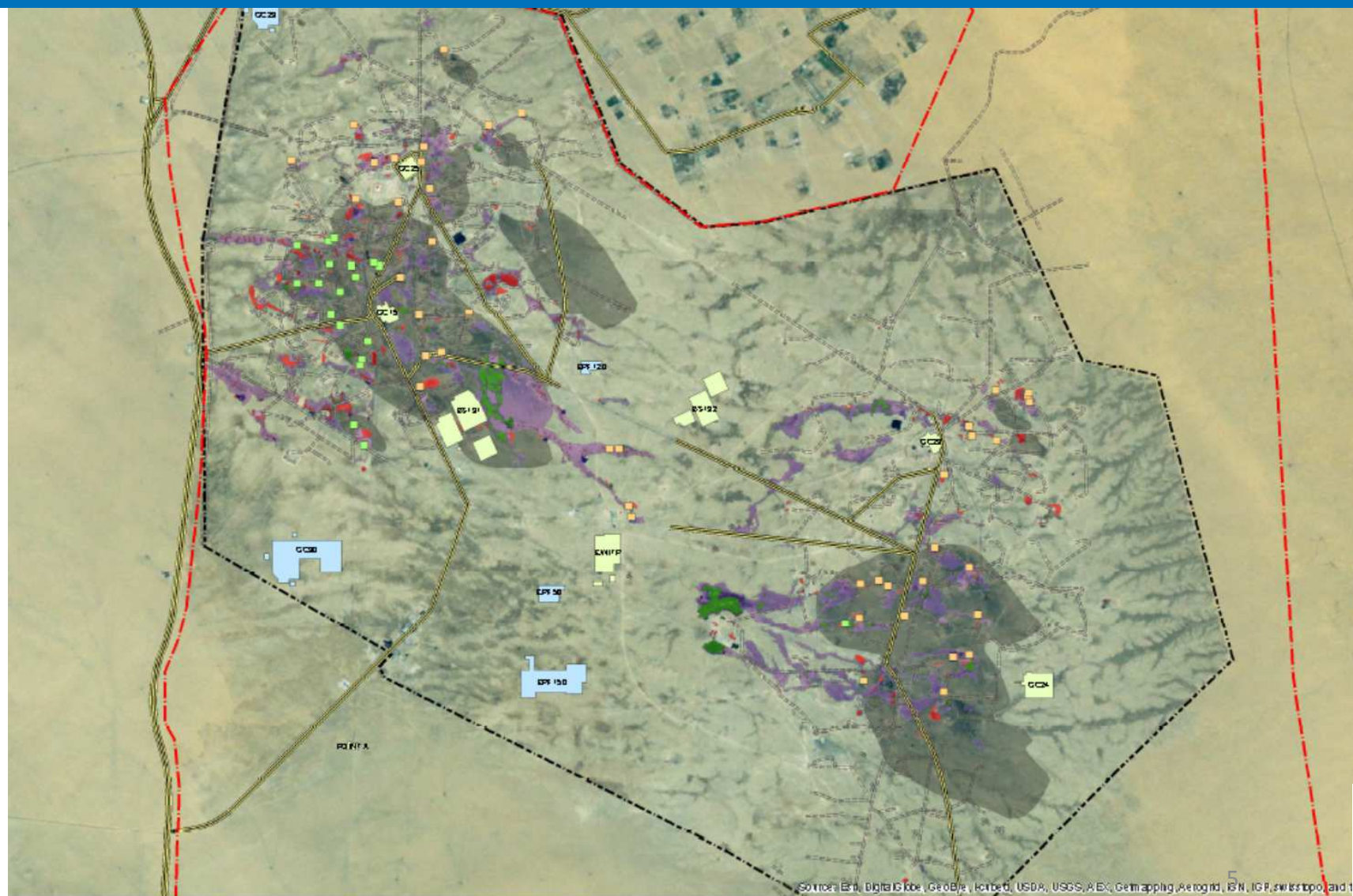
What is Our Goal?

- Remediating/Removal of Oil Contaminated Soil from contaminated Areas
 - In line with UNCC Decision 258 on the following claims:
 - 5000450 (Tarcrete, Wellhead Pits, Revegetation)
 - 5000259 (Coastal Trench/Deposits)
 - 5000454 (oil lakes, oil-contaminated piles, oil trenches and oil spills)
- Original Directive received was to transfer contamination to 17 Landfills in North Kuwait and South East Kuwait.
 - This project was developed to Excavate and transport contaminated soil located over the natural aquifer and catchment areas and it was of high priority to be remediated to minimize/prevent contamination of the underground aquifer reserve.

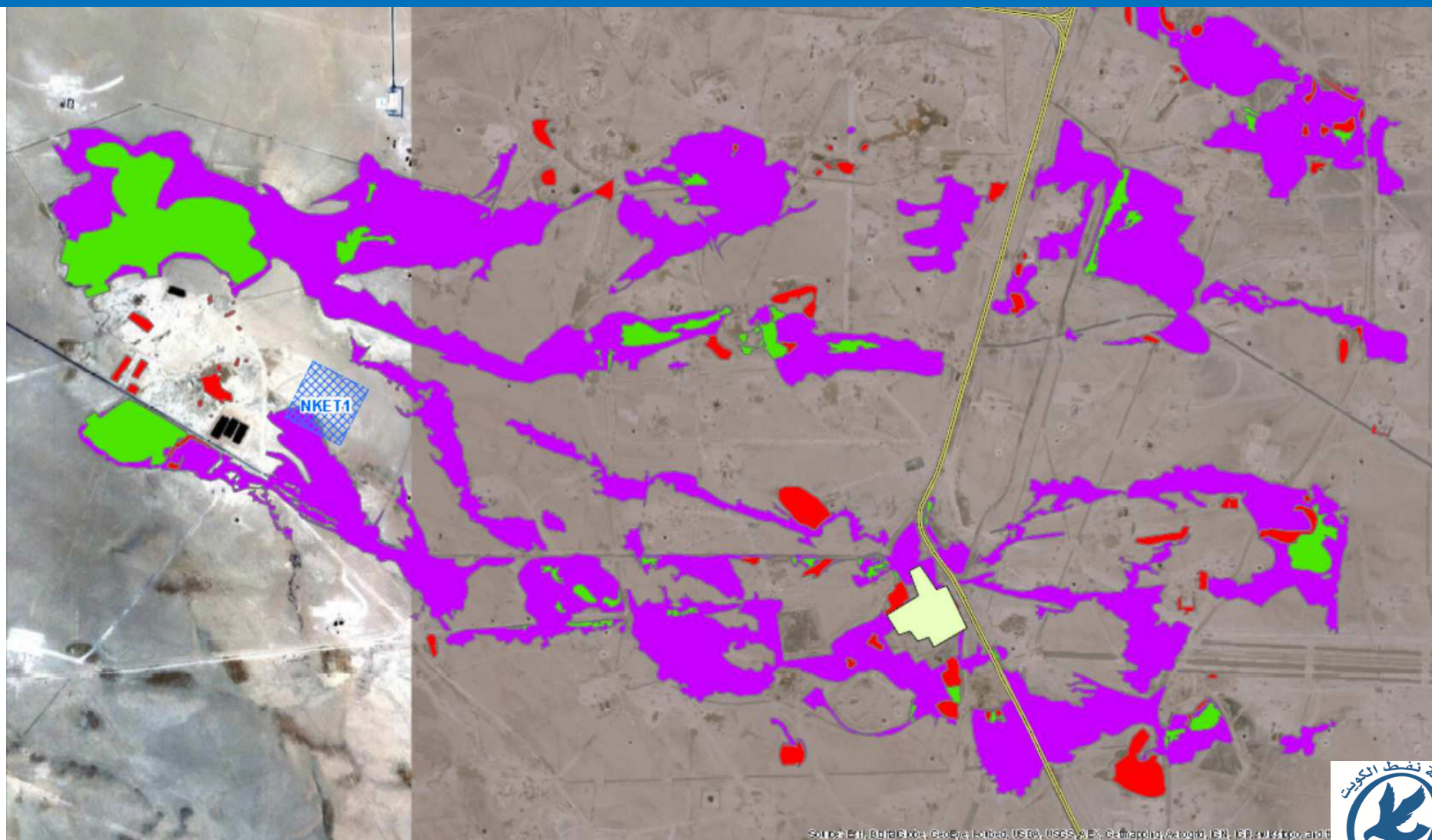
Contamination sites and Landfills



Contamination sites and Landfills



Contamination sites and Landfills



Source: ERI, Big Data, Google, Yahoo!, USA, USGS, W, E, Geomapping, Aerial, GIS, ISP, W, K, and IT

What do we have?

- Approximately 26 million m³ of contaminated soil, spanning a 114 km².
- Contaminated features within Sabriya (Umm Al-Aish area) oil fields:
 - Dry Oil Lakes 1,300,000 m³
 - Wet Oil Lakes 480,000 m³
 - Contaminated Piles 2,200,000 m³
 - Well Head Pits 70,000 m³
 - Coastal Trench & deposits 36,000 m³
 - Tarcrete 250,000 m³
- Total volume of 4,356,000 m³ as per latest estimates.

Scope of Work

What are the portions of the work?

- Engineered Landfill – completed
- UXO
- Site Soil Characterization
- Excavation & Transportation
- Landfill soil filling and compaction

What control Measures?

- HSE & Management of risk
- QA/QC
- Weigh bridges & Bar code system
- Documentation

Equipment Mobilization - UXO

What Is UXO

- Battle Area Clearance
- Geophysical Survey
- Geophysical Data analysis
- Dig List
- UXO Clearance
- Clearance certificate



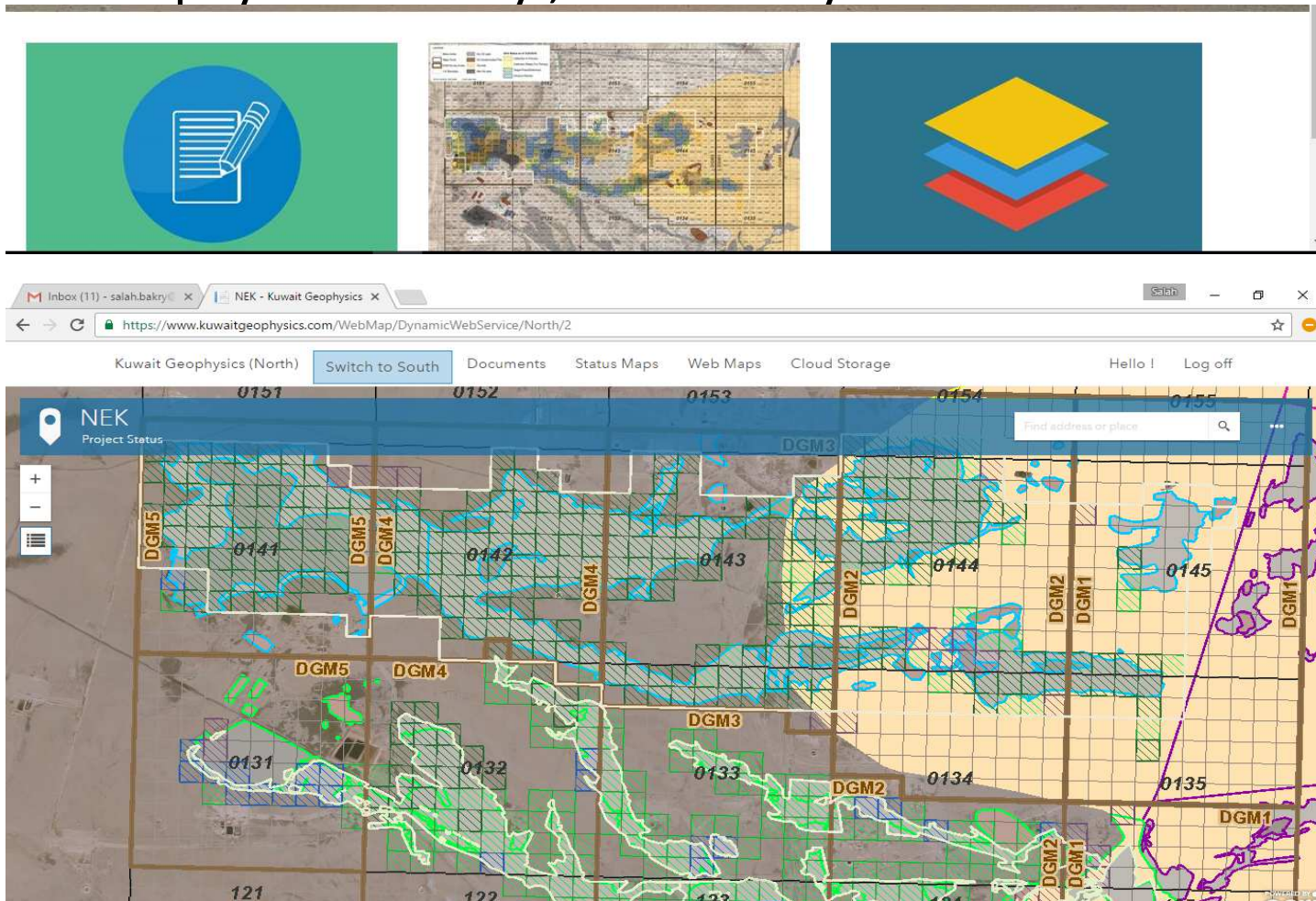
UXO detection



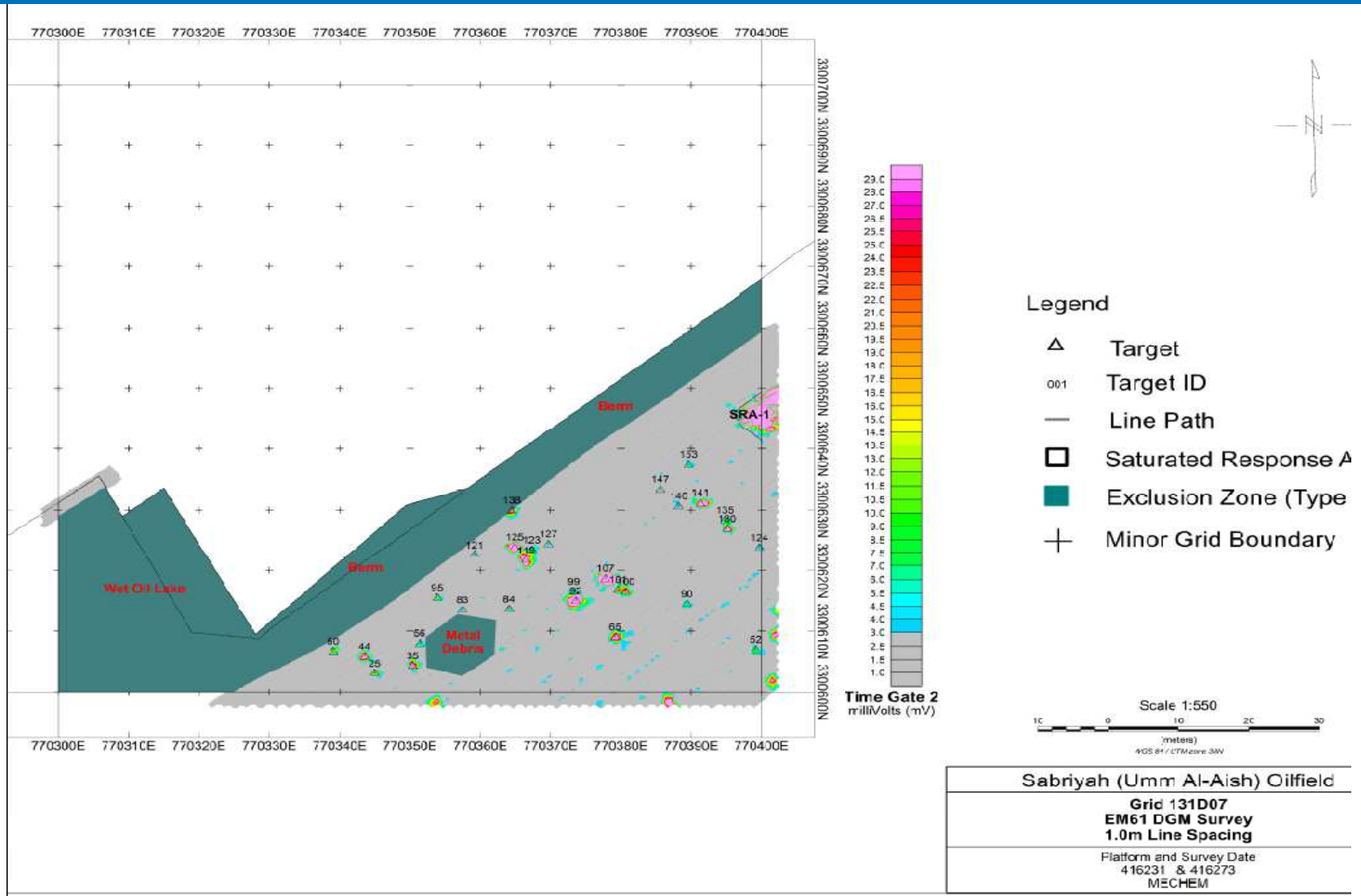
Armored Equipment With Anti-explosive Wind Shields

Project systems

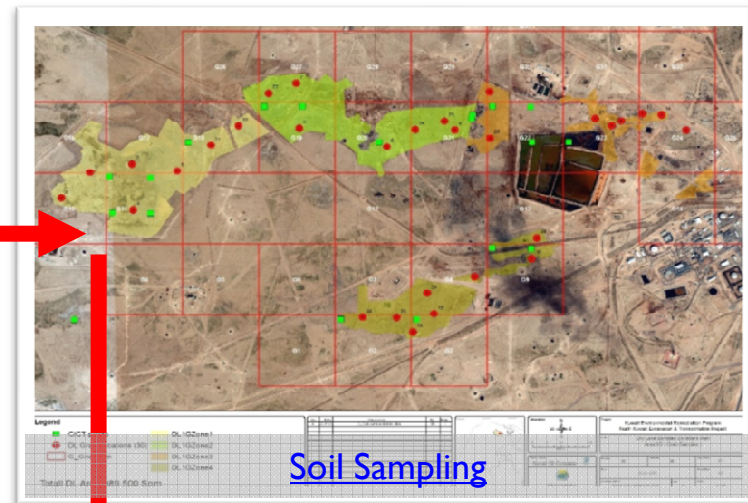
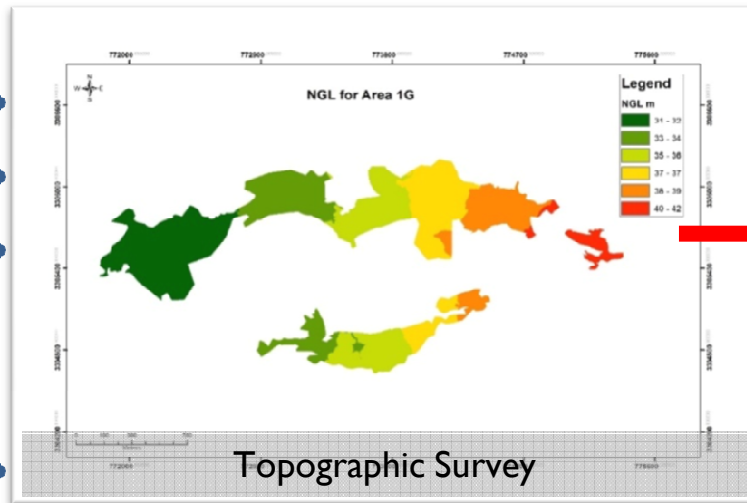
- UXO Geophysical Survey , Web GIS System



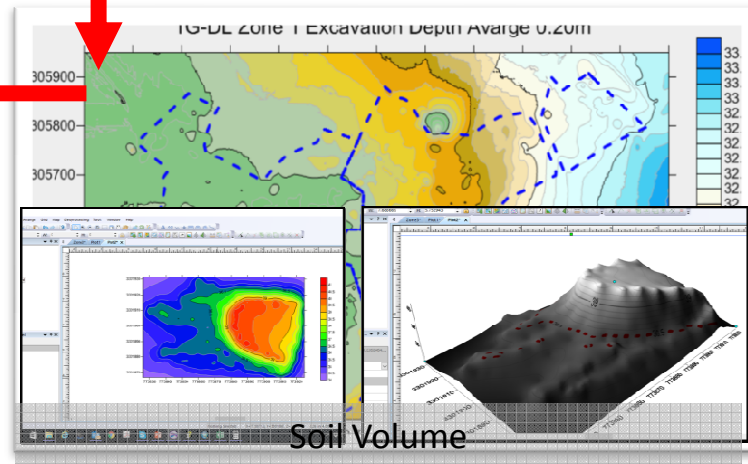
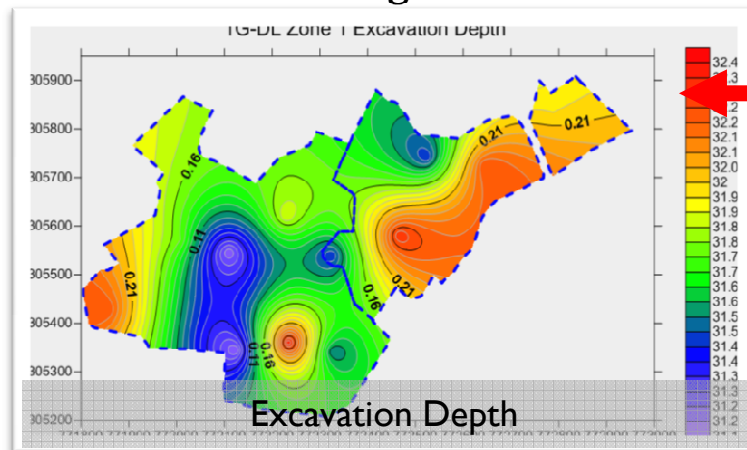
UXO Geophysical survey results



Site Soil Characterization Works

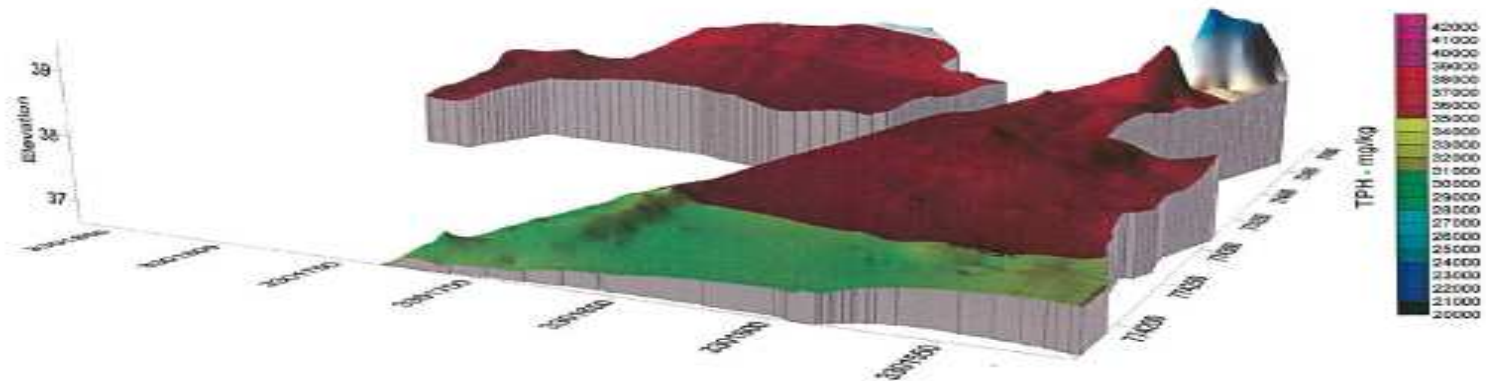


- 3D Modelling

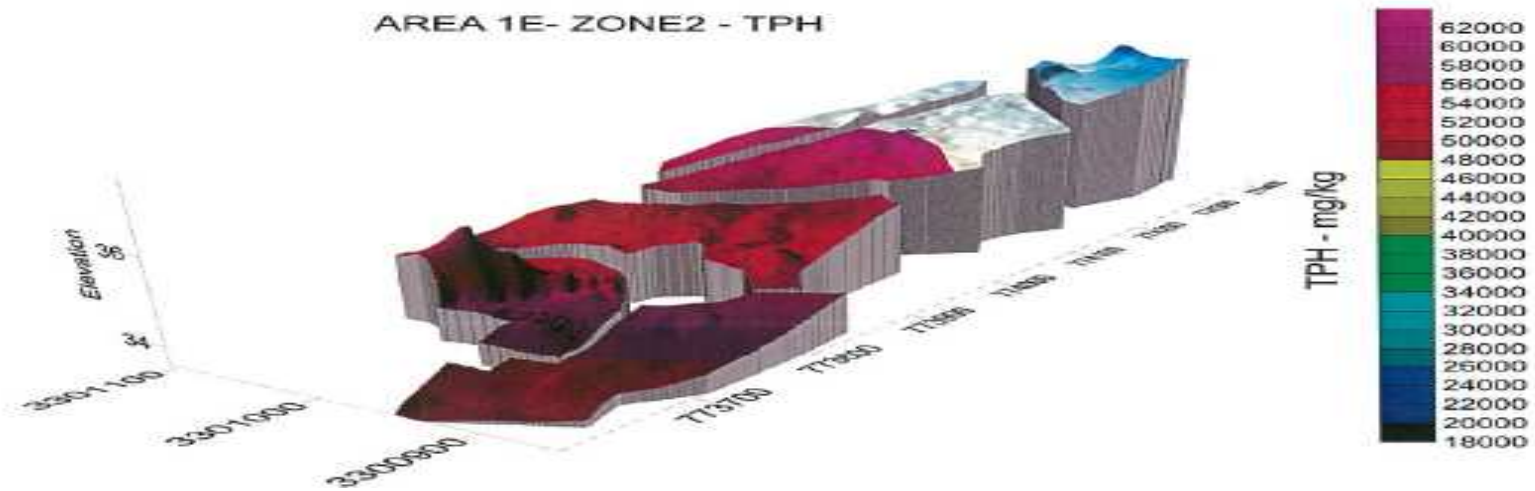


Contamination Profile and TPH Level

AREA 1E- ZONE1 - TPH



AREA 1E- ZONE2 - TPH



Pre & Post Excavation Characterisation



Wet oil lake sample



Dry oil lake sample



PetroFlag



Field Sampling Analysis

Excavation & Transportation Works

- Dig contaminated soil only
- Traffic Management Plan
- Establishing transportation roads
- Route optimization – fence
- Transported soil monitoring
 - Weigh bridge
 - Bar code system
- Soil Mix for wet oil lake
- Offloading in Landfill and compaction to proper density and maximizing benefit



Summary of Trips & Volume A. Contaminated Soil Transported to Landfill Excavate, Load, Transport & Dispose (To Landfill)

Date	NUMBER OF TRIPS	COMPACTED VOLUME (Based on WEIGHBRIDGE READING)
	TOTAL TRIPS	TOTAL VOLUME (m ³)
Dec 31, 2015	109	2,181.18
Jan 31, 2016	499	11,199.91
Feb 29, 2016	1,317	30,146.29
Mar 31, 2016	3,858	83,259.21
Apr 30, 2016	3,516	71,290.22
May 31, 2016	4,201	83,806.74
Jun 30, 2016	3,543	64,432.08
Jul 31, 2016	2,789	46,857.18
Aug 31, 2016	5,126	91,293.62
Sep 30, 2016	4,308	79,249.60
Oct 29, 2016	5,975	114,262.55
Cumulative	35,241	677,978.58

Compaction Levels

Density of Soil at source and what is assumption included in Weigh Bridge? example of calculations / assumptions at weighbridge.

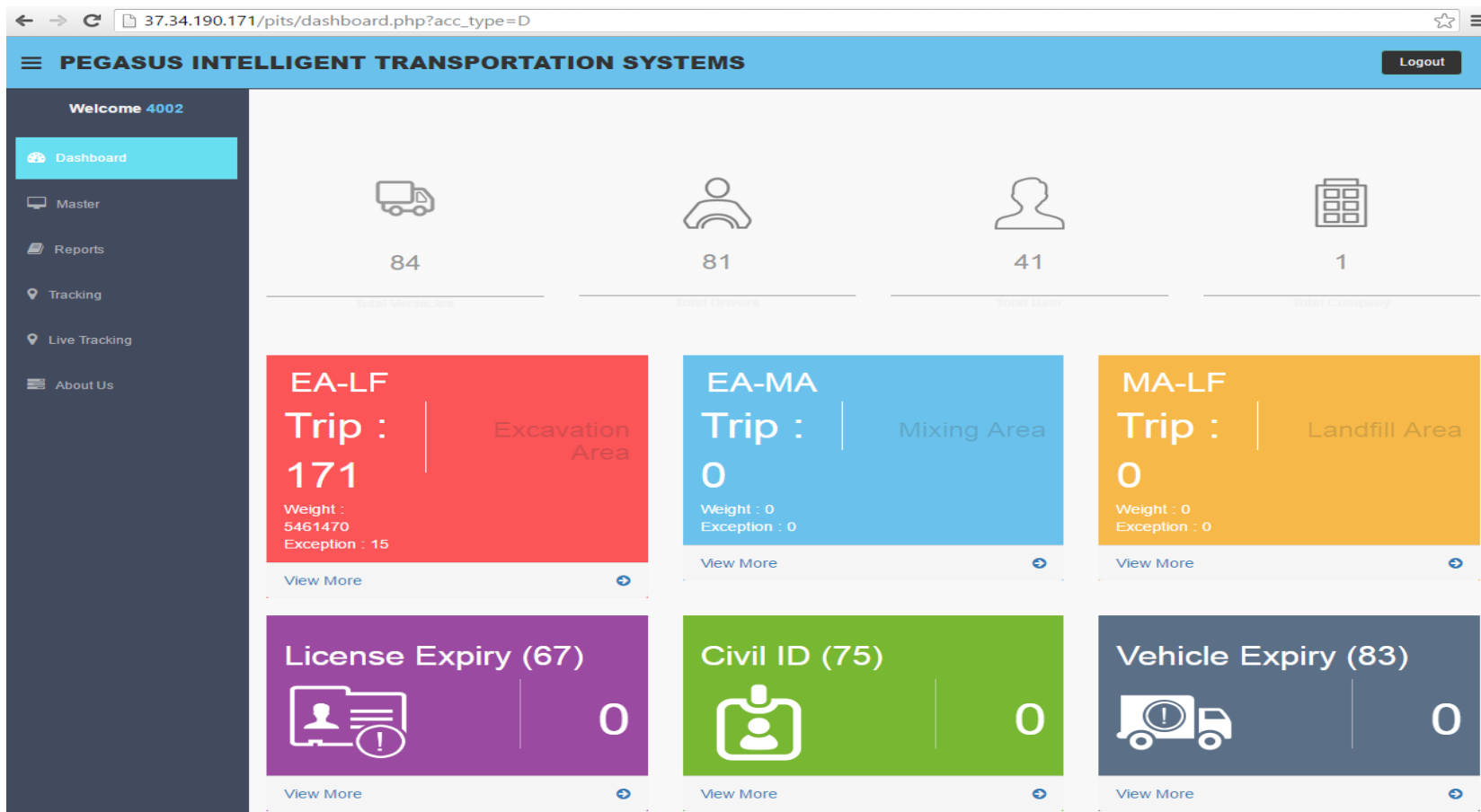
- Please see below sample calculations and steps using Densities.
- Maximum Dry density has been taken from different soil sample/feature at the site.
- Compaction requirement is 90% of MDD.
- Compacted Volume Calculation is the weight of Soil transported(Taken from weigh bridge) divided by the Compaction requirement (90% of MDD).

Compaction Levels


S N	AREA	FROM	TO	NO. OF TRIPS	NET WEIGHT (T)	AVE. MDD (KG/M3) (100%)	COMPACTED DENSITY (KG/M3) 90%	COMPACTED VOLUME (m ³)
1	1E	Excavation Area	Landfill Area	13228	436,159	1.96	1,764	247,255
2	1E	Mixing Area	Landfill Area	2010	67,488	2.02	1,817	37,141
3	1E	Excavation Area	Landfill Area	17617	647,189	2.05	1,847	350,335
4	1E	Excavation Area	Mixing Area	1113	35,622	2.05	1,847	19,283
5	1E	Excavation Area	Mixing Area	286	9,475	1.95	1,755	5,399

Transportation Systems

- Bar Code System: Precise equipment
- Monitoring Procedure



Certification of Completion Portion 1 (30%)


KUWAIT OIL COMPANY (K.S.C.)
 2. Superintendent of Contract Copy C 2

CERTIFICATE OF COMPLETION

For Works carried out by Contractor on Portion 1 of the Excavation and Transportation of Heavily Oil Contaminated Soil to Landfill in North Kuwait Area

In compliance with the Completion requirements as defined in Clause 35.D of the General Conditions of Contract, we hereby certify that the Works for Portion 1 of the Excavation and Transportation of Heavily Oil Contaminated Soil to Landfill in North Kuwait Area have been satisfactorily completed in accordance with drawings, specifications and instructions except works noted in item 3 below.

- Pertinent Contract Data:**
 - Contract No: 14050822 Dated: 25th December 2014
 - Contractor's Name: Alghanim International General Trading & Contracting Co. W.L.L.
 - Title of Contract:

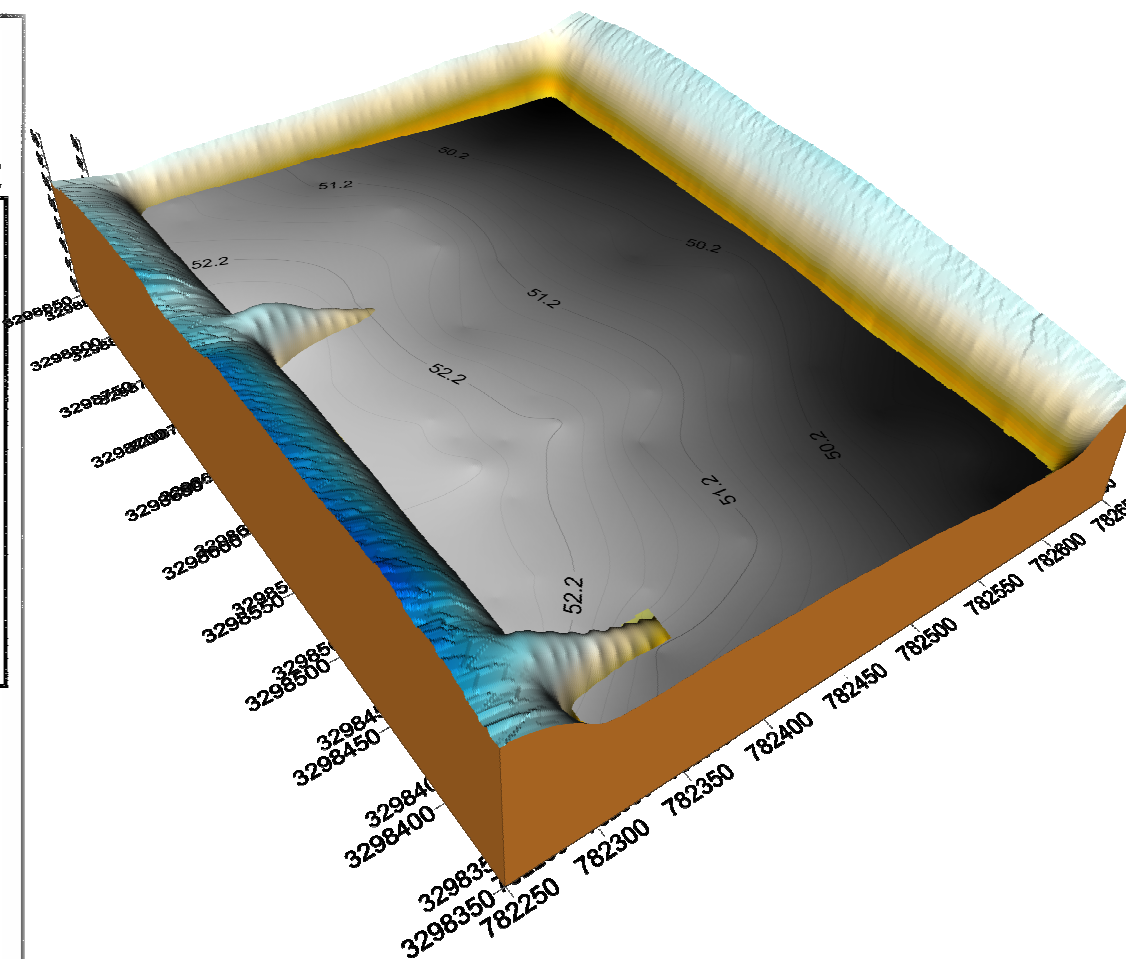
ENVIRONMENT REHABILITATION PROGRAM UNDER UN LEGISLATION FOR INDEMNIFICATION
 Excavation and Transportation of Heavily Oil Contaminated Soil to Landfill in North Kuwait Area
 - Contract Date for Commencement: 20th January 2015
 - Scheduled Completion Date: 30th August 2016 (Portion 1)
- I certify that Portion 1 of the Excavation and Transportation of Heavily Oil Contaminated Soil to Landfill in North Kuwait Area has been completed on 30th August 2016 in accordance with the drawings and specifier with the exceptions noted in item 3 below.
- Approved Minor Works List: Punch list items.

Signature: <u>J. S. SARIKAN</u> Lead Construction Engineer	Signature: <u>[Signature]</u> Project Construction Manager
Date: <u>30-08-16</u>	Date: <u>30. Aug. 2016</u>
Signature: <u>[Signature]</u> Senior Engineer Projects SRP-II	Signature: <u>[Signature]</u> Team Leader SRP-II
Date: <u>30 Aug. 2016</u>	Date: <u>30/8/16</u>

Contractor's Receipt of Certificate:

Signature: [Signature]

Date: SEP. 09, 2016



Fill and compact 513,000 m³ to Landfill
 By Aug 2016

Completion Portion 1 of E&T

HSE Studies	Pre -Excavation activities	UXO	Excavation & Transportation
FEIA PHSER 3,4,5	Topographic Survey 10,000,000m ²	UXO Geophysical Survey 4,000,000 m ²	Excavate, load and transport 650,000m ³
QRA Traffic Management Plan	Ground-Truthing 10,000,000m ² Site Soil Characterization 650 Soil samples	Total UXO Found and Destroyed: 41 UXO Methodology for all features approved	

Manpower & Equipment

UXO Manpower		UXO Equipment	
UXO Key Positions	5	Towed Array	3
UXO Geo Techs	3	Push Cart	2
Medics	4	Large Loop Detectors	8
Deminers	58	Mine detectors	11
WSS	6	Schonstedtd	8
Total	76	Total	32
E & T Manpower		E & T Equipment	
Operators	22	Dump Trucks	50
Drivers	100	Loader	10
Engineers	15	Dozer	3
labors	50	Excavator	4
WSS	14	Grader	5
Others	20	Others	35
Total	221	Total	107

Lesson Learned

UXO Lessons Learned

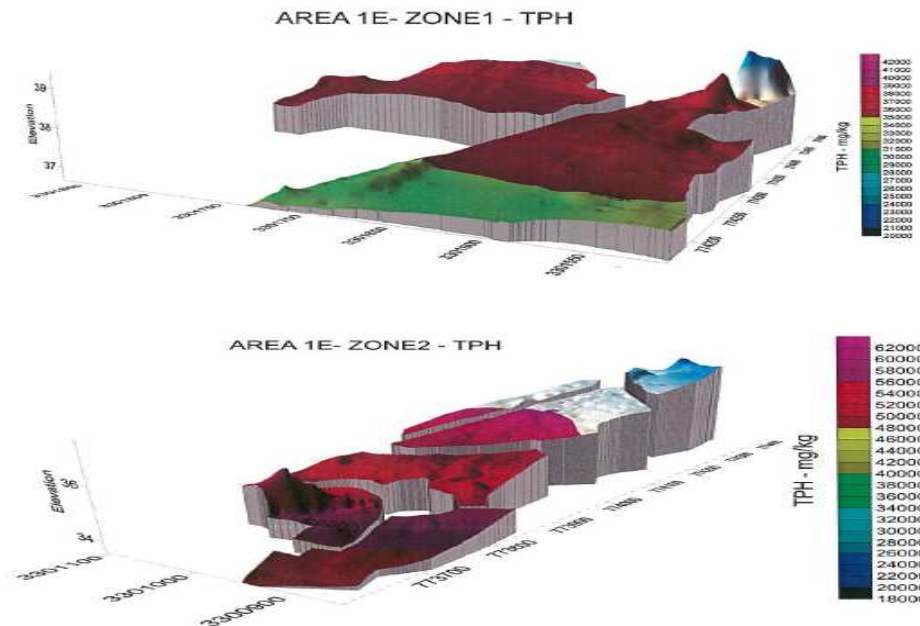
- Armoured equipment better suited for clearance of contaminated soil piles over large area due to ease of mobility from one location to another, and reduced down time associated with tear down set up of conveyor systems.
- Pushing sludge by armoured equipment into trenches within grid to allow geo activities on harder surface proved to be acceptable & practical approach.
- Mixing Wet lake material with cleared contaminated soil from dry lakes or contaminated soil piles will provide a cleared platform to utilize towed arrays and carry out geophysical survey.



Lesson Learned

Site Soil Characterization Lessons Learned

- Optimize Site soil characterization sample numbers to give a reasonable number of data points.
- Based on 3-D profiling, establish a well defined excavation strategy
- Utilization of field test systems for post clean-up inspection to optimize excavation time



Lesson Learned

E&T Lessons Learned

- Identifying Overall access routes and optimize distance between excavation location and landfill at early stage.
- Diverse construction equipment to be mobilized suitable for different features and schedule duration should be supported by Equipment Histogram.
- Maintenance of access routes, and equipment should be considered in overall project duration.
- Restriction in working hours due to extreme temperature and other influences should be considered in planning stage.

Thank you