Design of Remediation Program for Soils Impacted with Landmines, Weathered Crude, Salt and Effluent

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BACKGROUND

- Presented two papers in last two IPEC conferences which dealt with planning and conceptual stages of remediation work.
- The project has commenced this year and am going to talk about :
 - History
 - Remediation Programme overview
 - Results so far
 - Lesson Learnt
 - Way forward

The Company has established new department Soil Remediation to oversee the various programs.





THE ISSUE

- Historical legacy of KOC Oil & Gas Exploration & Production operations have given rise to environmental pollution and damage to the natural desert environment.
- Typical non-operational redundant polluted features include the following:
 - Effluent Pits (produced water)
 - Sludge Pits (recovered oil from spills/leaks)
 - Contaminated Soil Piles (oil soaked soil)
 - Gatch Quarry Pits (construction purposes)
- In addition, UXO remnants of war are potentially associated with polluted areas.





Inventory of Contaminated Sites

Feature Type	Field Survey	Satellite Image ¹	Total
Effluent Pits	28	27	55
Sludge Pits	33	0	33
Gatch Pits	71	12	83
Contaminated Piles	66	301	367
Disposal Pits	54	5318	5372
Oil Based Mud Cutting Pits	5	16	21
Spills or Leaks	14	896	910
Total	271	6570	6841

Notes

- 1. Satellite image review provided additional features to those identified during the field survey.
- 2. Simplified Inventory of Contaminated Sites



CONTAMINATED FEATURES



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Impacts

- Damaged / Polluted Environment
- Local Contamination of Groundwater
- On-going threat to Migratory Birds
- Workers complaining about hydrocarbon fumes during excavations
- Flow lines & other infra re-routing
- Desertification / Sand Encroachment (e.g. operations risk / facility integrity, health effects, management cost, loss of natural ecology)
- International perception/KOC Image







PROJECT (SEED) OBJECTIVE

SEED (Sustainable Environmental Economic Development) project is launched with the high level objectives of :

- To remediate a number of contaminated features to acceptable levels and restore ecological function.
 - Remediate Treatment to remove contaminants (Hydrocarbon & Salt)
 - Acceptable Level Contamination not reduced to zero but to a level not harmful to human health / environment
 - Ecological Function Following remediation, soil to be capable of supporting native plant growth



Project (SEED) Approach

1. Site Preparations / Logistics EOD Infrastructure Protection Asset Agreement

2. Viable Oil Recovery Use of innovative technologies to recover oil back into the Production system.

5. Project Evaluation for Phase 2 Lessons learnt from Phase 1 to be incorporated into Phase 2, incorporating a ramping up of proven technologies.

able Environmental Economical Development تبعة المعينية الاقتصادية المستعدامة

4. Environmental Rehabilitation Initiation of the natural ecological recovery of the damaged land. 3. Soil Remediation Use of practical technologies to remediate soils under international best practice.



SEED Clean-Up Program : Long Term





SEED Phase-1 SCOPE

- Phase 1 split into 3 distinct 'Lots' all within the South & East Kuwait Asset.
 - Lot A

Lot B

Lot C

Lot	Effluent Pits	Sludge Pits	Gatch Pits	Contamin ated Soil Piles	Total Pits	
А	5	2	2		9	
В	3	2	2	1	8	
С	6	1		1	8	
Total					25	

- Each Lot consists of a selection of "features" of large size to have an equal representation:
 - Sludge Pits;
 - Effluent Pits;
 - Gatch Pits; and
 - Contaminated Soil Piles.
- Total = 25 features

SEED – Phase 1 : Scale of Treatment



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CONTRACTOR SCOPE OF WORKS



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SEED Project : GIS – Project Management Database

The GIS PMD has been developed to manage the progress of the remediation and rehabilitation works.

- Web mapping interface
- Sample Data Interface;
- Project Management Dashboard;

The Key elements are :

- User Interface; and
- Document Archive.







RESTRICTIONS TO REMEDIATION APPROACHES

Remediation approaches <u>not</u> considered acceptable with respect to achieving the project objectives:

- Landfilling The use of engineered land filling with impermeable membranes for burial of contaminated material on-Site or off-Site.
 Exception – Salt Crust Disposal
- Dilution Dilution, mixing or blending of contaminated soils of varying concentrations to reduce contaminant concentrations throughout the soil profile.

Exception - To reduce in-situ salinity through dilution. Only after PHC remediation standards are achieved.

Capping – The placement of imported clean fill material over the contaminated soil.
 Exception - Following attainment of the applicable remediation standards, inert or uncontaminated soil that may be contained within the bunds surrounding each feature, may be used for re-grading purposes.

CONTRACT TYPE

Particular features of the proposed contracts are:

Measurable - Bill of Quantities with a Not to Exceed Value

Monthly payment on work performed

Acceptance certificate at end of the 2 year maintenance period.

Contract Award Strategy – Three Lots were awarded to 3 separate contractors

- Reduces risk of failure, increases project success
- Increases potential range of technologies to be proven in Phase 1
- Phase-1 to be considered as 'Contractor Evaluation Phase'



SEED Phase 1 Works : Lesson Learnt

Site Characterization

 Prior to Contract, client is unable to conduct detailed site characterization due to EOD /UXO issues

Pilot study

• Even the pilot study could not be undertaken due to EOD/UXO and contractual issues.

EOD/UXO

• Delineation of the EOD/UXO scope from the remediation contract and company could have implemented it as separate contract

Technologies

- Core technologies by the Contractors got changed after the site characterization
- Posed a contractual risk of implementing new technologies





REMEDIATION COSTS FOR SOIL

				Contractor-A	Contractor-B	Contractor-C
ltem	MoM Ref	Description	Unit	Unit Price \$	Unit Price \$	Unit Price \$
1	2.5.13	Primary Ecotoxicity - 5,580 mg / kg	M3	60.865	84.91	61.425
2	2.5.13	Alternative Ecotoxicity - 10,000 mg / kg	M3	60.865	84.91	61.425
3	2.5.13	Commercial /Industrial - 30,000 mg /kg	M3	38.395	84.91	8.75

Irrespective of remediation standard, same costs are seen.



EOD/UXO posed considerable challenge to the remediation contractors



Site Characterization

Not much variation seen in the contract soil volumes upon characterization



Sample Collection Using Hand Auger



Composite Sampling at Various Depths



Contractor technologies - Soil Washing Unit

Water intensive technologies posed a new challenge of sourcing enormous quantity of fresh water

Struggled to source water in summer months and had to scout for recycled water



Contractor technologies – Thermal Desorption Unit

Used plants mobilization had run into commissioning issues

Installation also had taken more time.



www.kockw.com TDU Plant No.1 (Indirect Fired)

Contractor technologies – Oil Recovery Unit

- New plant took considerable time as design, fabrication and assembly took considerable time.
- No precedence that this technology and design worked elsewhere



Lot A (HERA) – Technology for Soil Remediation

Plant Type	Capacity
Thermal Desorption Unit (near GC-10)	30 T/hour
<image/>	

Lot B (GS Eng) – Technology for Soil

Plant Type	Capacity
Soil Washing Plant No. 1 (near GC-02)	Soil: 90T/h (max) ; Sludge:30T/h
Soil Washing Plant No. 2 (near GC-11)	Soil: 90T/h (max) ; Sludge:30T/h



SEED Phase-1 : CONCLUSIONS

Phase	Known	Unknown
Mobilization Phase	 Key personnel Risk studies Main Documentation Fencing, site offices 	Handover and Decommissioning of these post project
Early Technical Works	 Radiological Survey EOD/UXO - Partial Site Characterization - Partial 	 EOD/UXO - Partial Site Characterization - Partial
Main Remediation Works	_	 Soil Remediation – TPH Soil Remediation-Salt Oil Recovery Planting on cleaned up soil



Thank You

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