

# Recovery of weathered crude from large oil pits: Case Study

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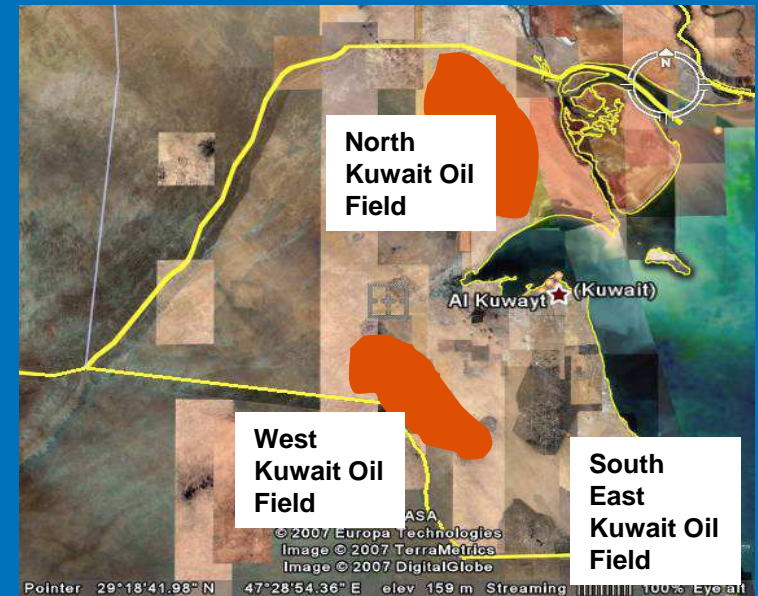
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# Regional Settings

- 3 million Bbls/day production
- Harsh climate (21-129 °CF)
- High Wind speeds
  - Sand erosion
  - Sand storms
- Prior oil recovery projects
  - Limited pilots/demo studies
  - No in-country vendors/labs
- Unfavorable site conditions
  - Weathered contamination
  - Heavier fractions/Ashphaltin/Paraffins/Waxes
  - Operational constraints



# Historical Practices

Crude Oil Pits (needed for operational reasons)

- During periods of shutdown and maintenance for the disposal of oil and sludge;
- To dispose of oil resulting from spills & leaks

Crude Oil Pits (Historic) turned Weathered Oil Pits

- Excess disposal/Filled full resulted into discarded pits over period of decades.
- Legacy of previous KOC operational practices (30-40 Yrs ago with limited technologies available)

In-house recovery plants installed for daily operational needs and to solve the build up of oil levels in pits .



**Sludge Pit**



**Oil Recovery Plant**

# KOC's in-house oil recovery plants

Two oil recovery units exists within the company's field areas

- Mostly deal with fresh crude oil disposed in pits
- Basic Treatment : Filtration, Settling, pumping
- Heat Treatment done in winter and as needed.
- Criteria followed is BS&W
- Capacity of first plant : 1000 Bbls/day
- Capacity of second plant : 2000-3000 Bbls/day
- Some times oil disposal far exceeds the in-house recovery plants.



Sludge Pit



Oil Recovery Plant

# Characteristics of Crude Oil Pits



## Oil Pits

- Large Size with a size ranging from :
- 80m \* 100 m
- 300 m X 300 m
- Depths ranging from 1-5m
- 33 sludge pits of varying size



- Earthen bunded features
- The Pits consists of free/floating oil on the surface, saline effluent underneath and oily sludge at the base of the feature and contaminated soil.
- Seen significant reduction in creation of new pits due to improved technologies of new facilities.

# Oil Pits taken up for recovery - Quantification



**Weathered Crude Pit A**

**Free Phase Oil =  
100,000 Bbls**

**Sludge = 25,000 cu.m**

**Contaminated Soil =  
60,000 cu.m**



**Weathered Crude Pit B**

**Free Phase Oil =  
750,000 Bbls**

**Sludge = 100,000 cu.m**

**Contaminated Soil =  
150,000 cu.m**



**Weathered Crude Pit C**

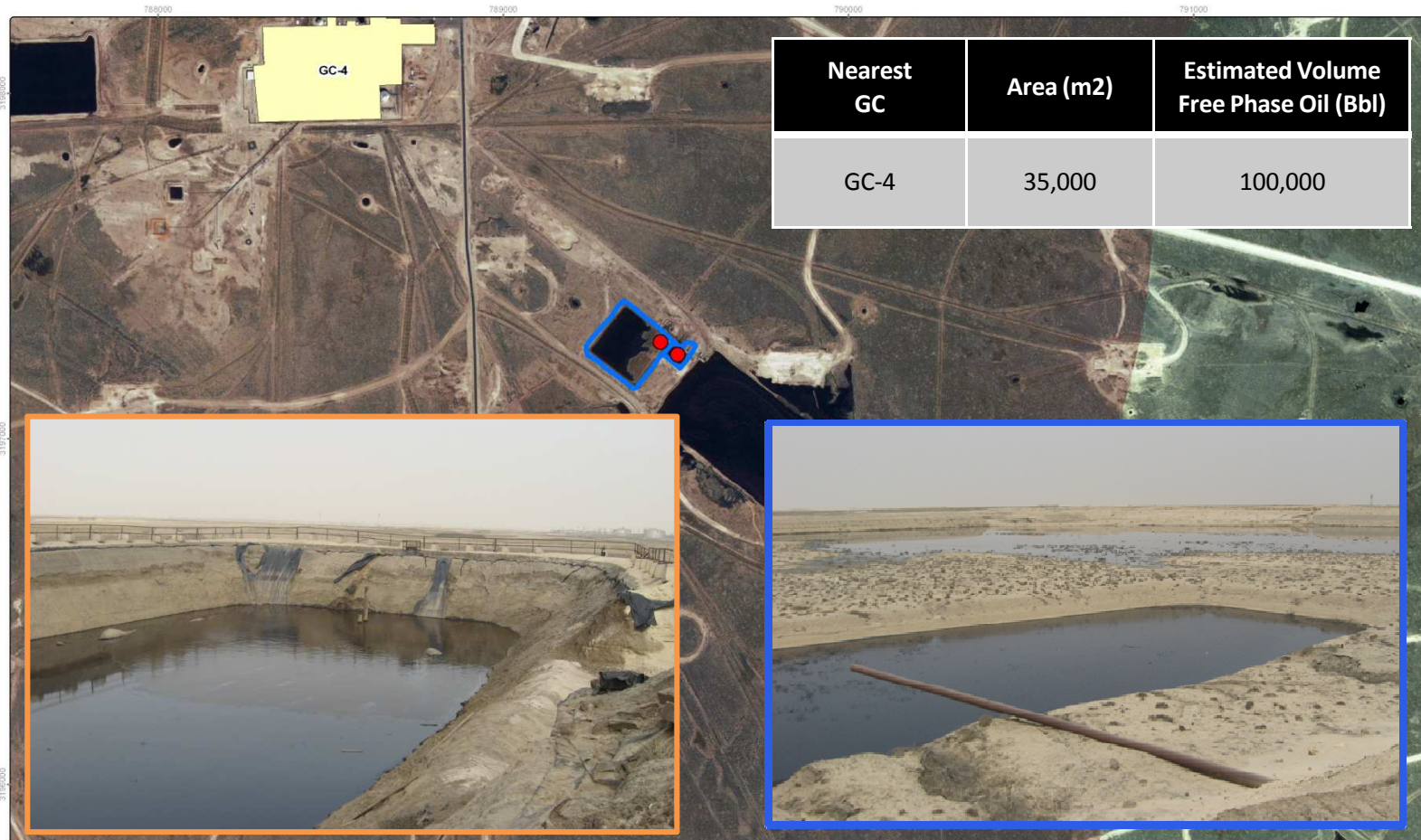
**Free Phase Oil =  
150,000 Bbls**

**Sludge = 30,000 cu.m**

**Contaminated Soil =  
75,000 cu.m**

**Estimated Recoverable Free Phase Oil : 1 million BBlS**

# Weathered Crude Pit - Aerial View



Nearest GC	Area (m2)	Estimated Volume Free Phase Oil (Bbl)
GC-4	35,000	100,000

**Legend**

- Feature Boundary
- Gathering Centres
- Location for Free Phase Oil Removal

Coordinate System: UTM 38N, WGS 1984. All rights reserved.

Rev	Date	Description	By	Drawn
01	11/7/11	Issued for Comments	CS	1



**Orientation**

Scale: 0 100 200 meters

**Client Name**  
Kuwait Oil Company

<b>Project</b> EF1784 Free Phase Oil Removal and Delivery			
<b>Title</b> Sludge Pit A1 93667267			
<b>Drawn</b> OG	<b>Checked</b> GC	<b>Approved</b> M/4	
<b>Date</b> Jul 13, 2011		<b>Sheet Size</b> A3	
<b>Drawing Number</b> EF1784/05/000/GIS/0052.001	<b>Rev</b> R1	<b>Scale</b> 1:10,000	

# Impacts





# WATER RESOURCES

## Groundwater

Shallow, unconfined perched aquifer

Saline –

Well depth: 13m - 26m ■

Groundwater: 4.40m bgl – 21.00m bgl ■



## Surface Water

No natural features –

Spirit of the Desert and Desert Oasis –

Considered to be out of the zone of influence



**Gach Pit surface water** –

Exposed groundwater •

Supports flora & fauna •

[www.kockw.com](http://www.kockw.com)

# RESULTS OF WATER SAMPLING PROGRAM GROUNDWATER

- Saline
  - Elevated concentrations but attributed to background conditions (saline groundwater):
    - Sodium
    - Manganese
    - Chloride
- Non-detectable or not present to any substantial degree:
  - Metals (exception B, Ba)
  - PAH
  - TPH
  - VOCs
- Elevated concentrations but potentially naturally occurring
  - Boron
  - Barium



# WEATHERED CRUDE CHARACTERISTICS

S.No	Parameter	Unit	Results			Representation of no. samples	Period of sampling
			Min.	Max.	Avg.		
1	API Gravity	°	7.00	15.40	12.68	11	Jun 2013 - Aug 2014
2	Olefins	mg/kg	n.d.	n.d.	n.d.	92	Jun 2014 - Apr 2015
3	Salt	PTB	78	912	312	92	Jun 2014 - Apr 2015
4	BS&W	% v/v	1.20	6.00	3.22	92	Jun 2014 - Apr 2015
5	Total Sulfur	mass%	3.65	3.74	3.69	7	Apr 2015
6	Bacteria (Heterotrophic Plate Count)	cfu/L	n.d.	n.d.	n.d.	7	Apr 2015

**n.d = Non Detect**

# DETAILED WEATHERED CRUDE CHARACTERISTICS

S.No	Parameter	Unit	Value
1	API Gravity	°	14.17
2	Density @ 25	Gm/cu.cm	0.964
3	Salt	PTB	>150
4	Water content	% wt	1.234
5	Total Sulfur	% wt	3.94
6	Dissolved H <sub>2</sub> S	ppm	<0.01
7	Saturates	% wt	33.65
8	Aromatics	% wt	47.01
9	Resins	% wt	9.09
10	Ashphaltene	% wt	10.25
11	Wax content	% wt	9.59

Kinematic Viscosity	Value (cSt)
@20°C	23378
@40°C	1659
@60°C	352
@80°C	117
@100°C	51

# OIL RECOVERY SCOPE

## What to do with the treated oil?

- To be handed back to Company as per Senior Management Directive.

## What quality it should be treated to?

- Export Quality : Not feasible with BAT
- Well head Crude Quality : Dilution with fresh crude

## What are the treatment capacities to build?

- Verification of volumes & quality
- Storage requirements

## How would the mixing be carried out

- Maximum allowed dilution factor
- Location of tie-in

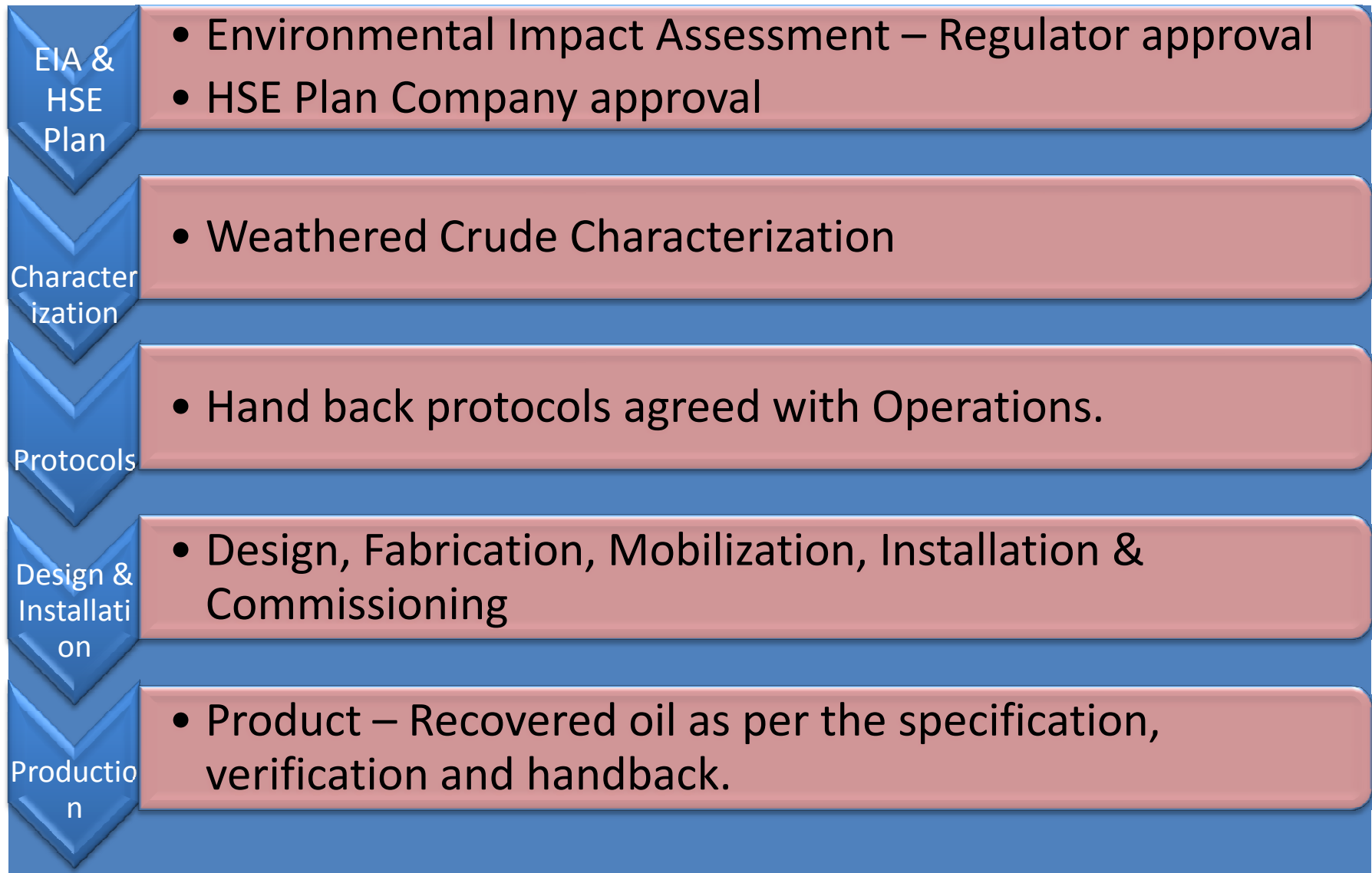
# Oil Recovery Specifications given by KOC

Parameter	Export Crude	Inlet to Gathering Center for Treatment
• API	28-32	-
• Salt	10 PTB	1470 PTB
• BS&W	0.1%	2
• Hydrocarbon	99.9%	98%
• Olefins	Nil	Nil
• RVP	10 PSI	-

**Quantity for GCs : Upto 2000 Barrels of recovered Oil /day**

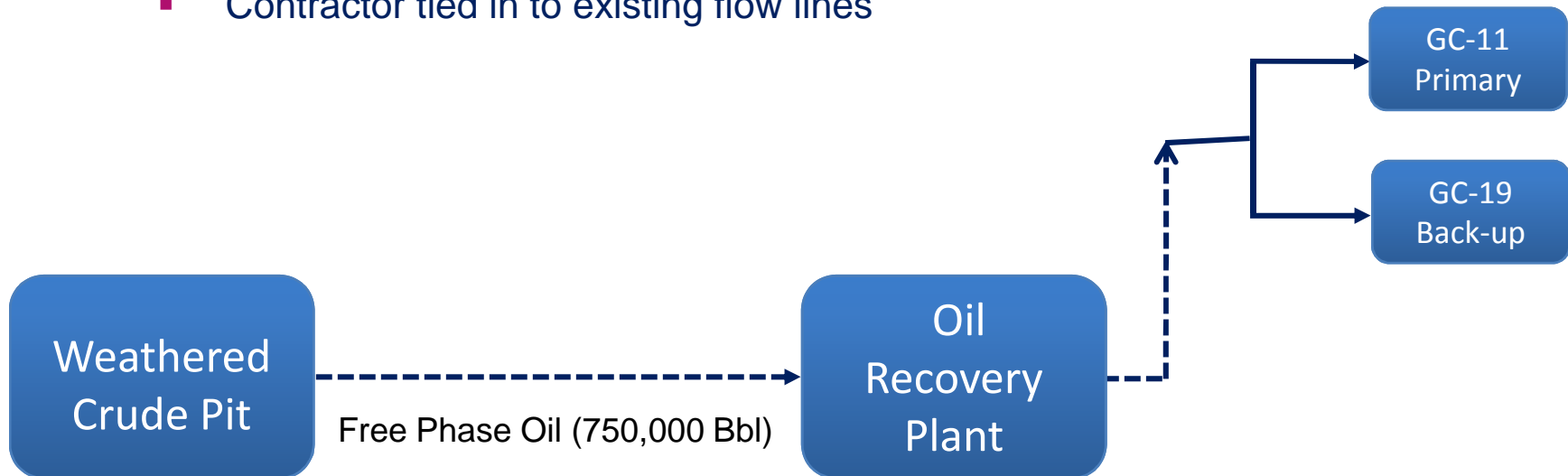
**At this rate of throughput, it would take 1.5 years to treat entire amount of 1 million Bbls of Oil.**

# Recovery of Oil : Preparatory Issues



# Weathered Crude recovery – Contract

- **Oil within Pit**
  - If characterized as “Free Phase Oil” ( $\leq 20\%$  BS&W) shall be treated and handed back to the Company.
- **Quality**
  - Contractor to treat oil to GC inlet quality.
    - BS&W  $\leq 2\%$
    - Salt - 1470 PTB (max)
    - Olefins - Nil
- **Quantity**
  - Maximum discharge to the Company of 4000 bbls / day
- **Delivery**
  - Pumped to Company’s production facility via flow line into low pressure header.
  - Contractor tied in to existing flow lines





# Return on Investment of this Oil Treatment

Scenario	Volume	Cost
Weathered Crude Oil Treatment & Transfer to Company	840,000 Bbls	\$ 29.4 million
Recovered Oil Value	840,000 Bbls	\$ 84 million (assumed \$ 100 Bbl)
Net gain to the Company	840,000 Bbls	\$ 54 million

**Not only the cost savings but green option as well.**

# Treatment Concept applied for Weathered Crude

## Untreated Material

Oil + Water + Sediments



Heat + Demulsifier + Treatment



# Installation & Commencement of Oil Recovery

- Contractor commenced treatment and hand back of oil on 14<sup>th</sup> August 2014.
- Process Plant had initial problem meeting BS&W criteria, initially operated with a capacity of 1,500 Bbls / day to Contract Specification. Further enhancements were done and increased the capacity to 2,500 Bbls / day.
- Operational constraints led to handback of only 250 – 500 Bbls / day.
- Processed and handed back only 45,000 Bbls out of 1 million Bbls



# Oil Recovery Strategy : Handover Protocols

Recovery Activities	CONTRACTOR	CONTROLLING TEAM	Company LAB	Receiver CONTROL
1. Quality Verification at Storage Tank	Formal Request to witness oil sampling	Verify sampling & transport 100% duplicate samples to KOC Lab	Analysis of Samples & Results to Controlling Team	No Action
2. Transfer Notification (Quality, Time & Quantity)	Issue Transfer Notification Request (c/w Contractor Lab Results)	Review all results. If compliant issue to Section Head POEK (II) and GC Shift Controller	No Action	Review request & all results. GC Operator to issue Permit to Work
3. Discharge to GC & sampling of discharge	Discharge Oil to GC & Request witness of oil sampling	Verify sampling & volumes. Transport 100% duplicate samples to KOC Lab	Analysis of Samples & Results to Controlling Team	No Action
4. Reporting (Daily, Bi-Weekly)	Prepare report (Daily Volumes & Lab Results) & Issue to Controlling Team	Verify volumes (flow meter) and quality. Issue to Section Head POEK (II) and GC Shift Controller	No Action	Review Reports

# OIL RECOVERY CHALLENGES

## Company operations (mixed with fresh crude from well heads)

- Returned only 20,000 BBls
- Problems faced with Crude Processing facilities even with dilution of 1-2%.

## Export Manifold (mixed with downstream of crude processing facilities)

- Returned another 25,000 Bbls
- Microbial contamination cited
- Tampering with flow meters (sensitive instrumentation).

## Company's recovery facilities

- Smaller capacity plants could not offer enough dilution
- Mixing highly viscous oil such as weathered crude posed a problem.

# OIL RECOVERY CONCLUSIONS

## Lack of prior testing (dilution mechanisms)

- No testing was carried out with trial runs to identify any problems in processing with company facilities.

## Detailed analysis of crude samples

- Crude Assay, SARA test, Wax content etc., was not done

## Limited back-up options?

- Only handback with dilution was planned and not explored other options.

## Researching for the feasible & viable option.

- Company handback options dried up and exploring solutions with new vendors. Drop in oil prices compounded the problem.

# WEATHERED CRUDE RECOVERY – WAY FORWARD

## Descoping of weathered crude works from the current contract

- Contractor installed facility and stoppage costs to be paid.

## Compensation to Contractor

- Contractor installed facility and stoppage costs to be paid.

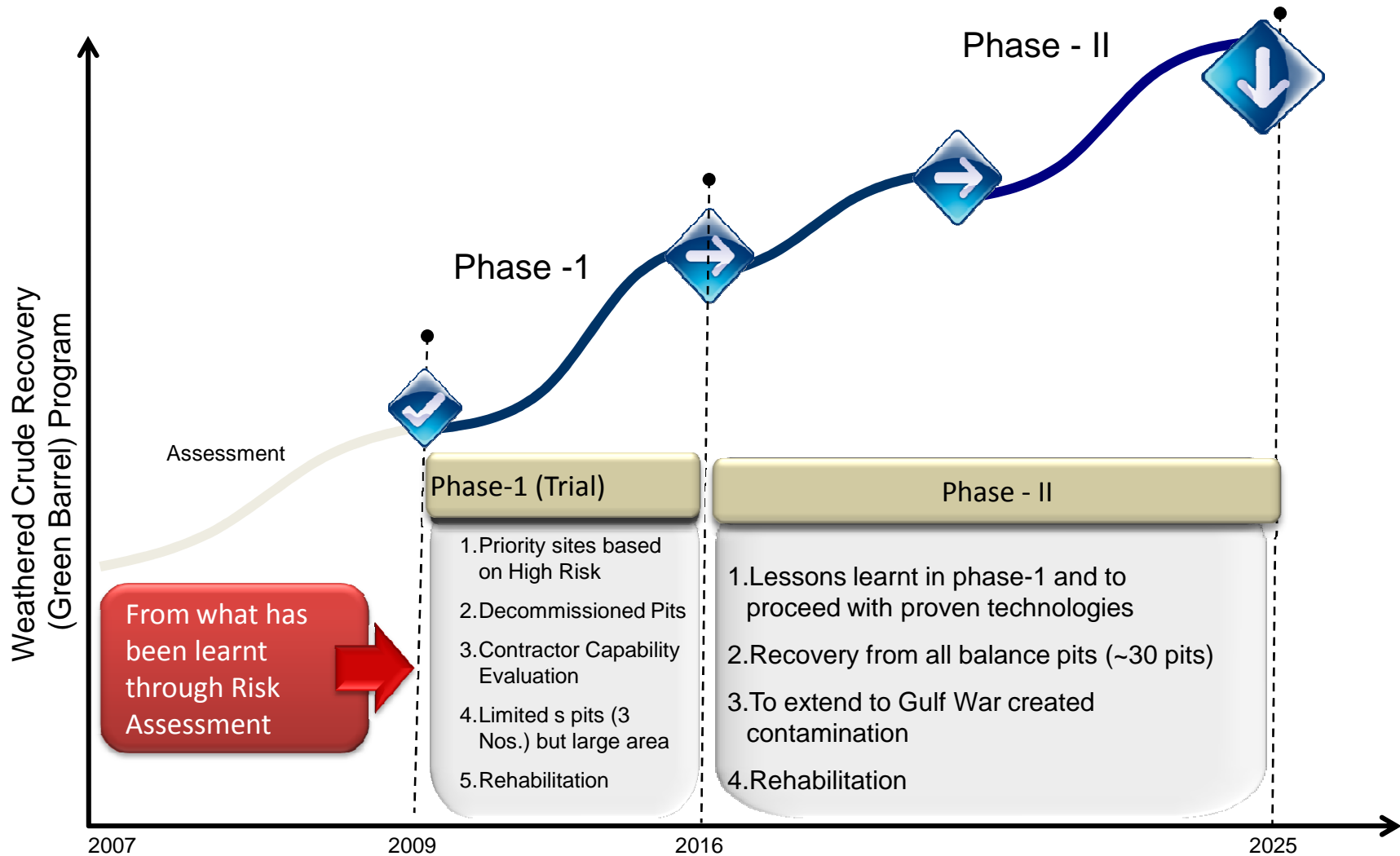
## Exploring options outside the company

- Bunker-6 Fuel Oil production with cutter stock blending, Local power generation, Cement kilns etc..

## Export, Auction, Search for proven technologies.

- To explore new markets, vendors and products.

# Weathered Crude Recovery(Green Barrel) Program : Long Term







# Thank You and Q&A

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