Data Overview

KERP
Kuwait Environmental Remediation Projects

“Restoring Kuwait Treasures”
Kuwait Environmental Remediation Projects
Available Data Overview

1. Historic Data
2. Recent Data
3. Future Data
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Available Data Overview

1. Historic (CIC) Data

PRELIMINARY INVESTIGATION

- CIC (2002)
  - Random distributed sampling
  - 3900 samples for 26M m³
  - 1300 locations over 114 km²
  - 6000 additional inspection pits

Industry Standard Approach

Risk reduction

Supplementary
Main
Preliminary
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Areas of interest
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South Kuwait (Burgan)
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What does the CIC data tell us?

Layers
- Wet Oil Lakes, Dry Oil Lakes, Contaminated Piles
- Sludges, crusts, oil contaminated sands

Features
- Particle Size: Ranging from <1% to ~70%
- Depth: Sand (max 95%), Fines (max 40%)

TPH
- Metals
  - PAH: 25%
  - PSD: 8%
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- Typical wet oil lake feature
- Example of Layering
- Transition area between wet and dry oil lake features
Wet Oil Lake (WOL) Features – Summary

• No UXO assessment or clearance resulting in limited data. CIC assessment predominantly from edges of WOL

• Comprises either a sludge, oil or variable crust at surface (bituminous/soft to hard), known as Layer 1, of 0.02m to 0.9m thickness

• Can contain discrete water / emulsion lenses within Layer 1

• Underlying oil contaminated sand with general decreasing concentrations of TPH, known as Layer 2

• Average depth of contamination estimated as 0.65m (though the combined depth of Layer 1 and Layer 2 can range from as little as 0.08m to 2.32m, the latter is not common)

• Coverage: 7.18 km² of the 114 km²

• Layer 1: Typical concentration is >10%. (TPH concentration range: 18,100 mg/kg (1.8%) to 679,000 mg/kg (67.9%).)

• Layer 2: Typical concentration is <10%. (TPH concentration range: 1,040 (1%) mg/kg to 349,000 mg/kg (34.9%))
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- Typical Dry Oil Feature

- Typical Dry Oil Cross-Section
Dry Oil Lake Features - Summary

- Variable crust at surface (from soft bituminous to cemented) known as Layer 1

- Underlying oil contaminated sand with general decreasing concentrations of TPH, known as Layer 2

- Average depth: 0.27m (Burgan), 0.17m (North Kuwait) - (though the combined depth of Layer 1 and Layer 2 can range from as little as 0.01m to 2.88m, the latter is not common)

- Estimated land coverage 98 km² of the 114km²

- Layer 1: Typical concentration is >5-20% (TPH concentration range 447 mg/kg to 694,000 mg/kg (69.4%))

- Layer 2: Typical concentrations are between 1% and 10% (TPH concentration range 420 mg/kg to 413,000 mg/kg (41.3%))
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- Oil Contaminated Piles
Oil Contaminated Piles

- Highly variable composition (heterogeneous) – clean through to highly contaminated
- Height of piles range from 0.45m to 7.0m
- Estimated land coverage of 8.6 km² of the 114 km²

- TPH concentration range: 470 mg/kg to 258,000 mg/kg
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What does the CIC data _not_ tell us?

**Variation**
- Spatial distribution
- Layer Thickness
- TPH Concentration
- Physicality

**Inaccurate**
- Feature Boundaries
- Volumetric Estimations
- Concentrations
- Expectations
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Other CIC work

Limited Bench Scale Studies

“Oil Lakes”
Monitoring and Assessment Report

Marine and Coastal Monitoring and Assessment Report

Oil Lakes Volume 2, Appendix E:

Marine and Coastal Appendix M:

Results of Laboratory Scale, Field Demonstration, and Comparative Studies of Effective Technologies

Monitoring and Assessment of the Environmental Damages and Rehabilitation in the Terrestrial Environment (Cluster 3) and in the Coastal and Marine Resources (Cluster 2)

UNCC Claims 5000432 and 5000398

27 August 2003
2. Current Data

Industry Standard Approach

Risk reduction

- Supplementary
- Main
- Preliminary

LIMITED SCOPE INVESTIGATION
Burgan - South East Kuwait

KERP (Nov 2014)

Data gap analysis
Feature Radials
Discrete sampling
205 sample locations
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Wet oil lake feature hand-dug inspection pits (Nov 2014)
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Dry oil lake feature hand dug inspection pits (Nov 2014)

Thin crust (Layer 1)

Contaminated Sand (Layer 2)

‘Clean’ Sand (Layer 3)
Dry oil lake feature hand dug inspection pits (Nov 2014)

Consistent thickness of contamination

Variable thickness of contamination
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During site investigation (Nov 2014)

During sample collection (Jan 2015)
Key findings to date:
- TPH is dominated by >EC34
- PSD confirms fines content
- Resins and asphaltines are present within higher TPH concentrations
- A hard crust, known as tarcrete, derived from aerial deposition of crude oil from wells, can be mistaken for dry oil contamination.
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3. Future Data

Main Investigation:
Site Soil Characterization

- Extent & Depth
- Volumetric
- Contaminant Concentrations

Risk Assessments
Remediation Design
Baseline Information

2016 - 2017
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Further information is available on the KOC website.
www.kockw.com

The data provided in this presentation is for information only.