

## **Kuwait Environmental Remediation Program: Fresh Groundwater Risk Assessment from Tarcrete Material across the Raudhatain and Sabriyah Oil Fields, North Kuwait**

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**Abstract :** Kuwait Oil Company (KOC) under the supervision of Kuwait National Focal Point (KNFP) is planning to remediate 26 million (M) m<sup>3</sup> of oil-contaminated soil in oil fields of Kuwait as a direct and indirect fallout of the Gulf War during 1990-1991. This project is funded by the United Nations Compensation Commission (UNCC) under the Kuwait Environmental Remediation Program (KERP). Oil-contamination of the soil occurred due to the destruction of the oil wells and spilled crude oil across the land surface and created 'oil lakes' in low lying land. Aerial fall-out from oil spray and combustion products from oil fires combined with the sand and gravel on the ground surface to form a layer of hardened 'Tarcrete'. The unique fresh groundwater lenses present in the Raudhatain and Sabriyah subsurface areas had been impacted by the discharge and/or spills of dissolved petroleum constituents. These fresh groundwater aquifers were used for drinking water purposes until 1990, prior to invasion. This has significantly damaged altered the landscape, ecology and habitat of the flora and fauna and in Kuwait Desert. Under KERP, KOC is fully responsible for the planning and execution of the remediation and restoration projects in KOC oil fields. After the initial recommendation of UNCC to construct engineered landfills for containment and disposal of heavily contaminated soils, two landfills were constructed, one in North Kuwait and another in South East Kuwait of capacity 1.7 million m<sup>3</sup> and 0.5 million m<sup>3</sup> respectively. KOC further developed the Total Remediation Strategy in conjunction with KNFP and has obtained UNCC approval. The TRS comprises of elements such as Risk Based Approach (RBA), Bioremediation of low Contaminated Soil levels, Remediation Treatment Technologies, Sludge Disposal via Beneficial Recycling or Re-use and Engineered landfills for Containment of untreatable materials. Risk Based Assessment as a key component to avoid any unnecessary remedial works, where it can be demonstrated that human health and the environment are sufficiently protected in the absence of active remediation. This study demonstrates on the risks of tarcrete materials spread over areas 20 Km<sup>2</sup> on the fresh Ground water lenses/catchment located beneath the Sabriyah and Raudhatain oil fields in North Kuwait. KOC's primary objective is to provide justification of using RBA, to support a case with the Kuwait regulators to leave the tarcrete material in place, rather than seek to undertake large-scale removal and remediation. The large-scale coverage of the tarcrete in the oil fields and perception that the residual contamination associated with this source is present in an environmentally sensitive area essentially in ground water resource. As part of this assessment, conceptual site model (CSM) and complete risk-based and fate and transport modelling was carried out which includes derivation of site-specific assessment criteria (SSAC) and quantification of risk to identified waters resource receptors posed by tarcrete impacted areas. The outcome of this assessment was determined that the residual tarcrete deposits across the site area shall not create risks to fresh groundwater resources and the remedial action to remove and remediate the surficial tarcrete deposits is not warranted.

**Keywords :** conceptual site model, fresh groundwater, oil-contaminated soil, tarcrete, risk based assessment

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