KERP

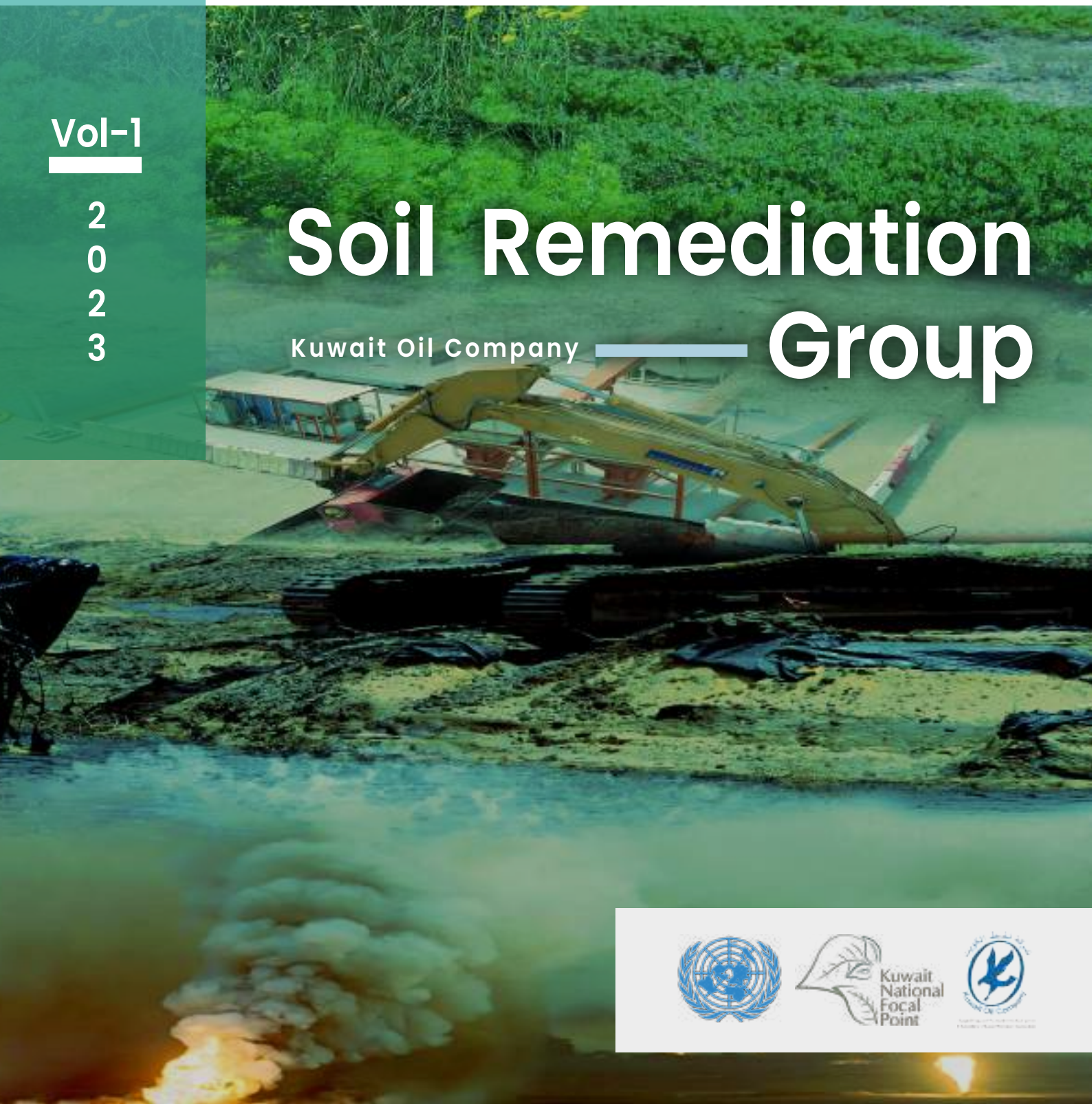
KOC - KERP Journey

Vol-1

2023

Soil Remediation Group

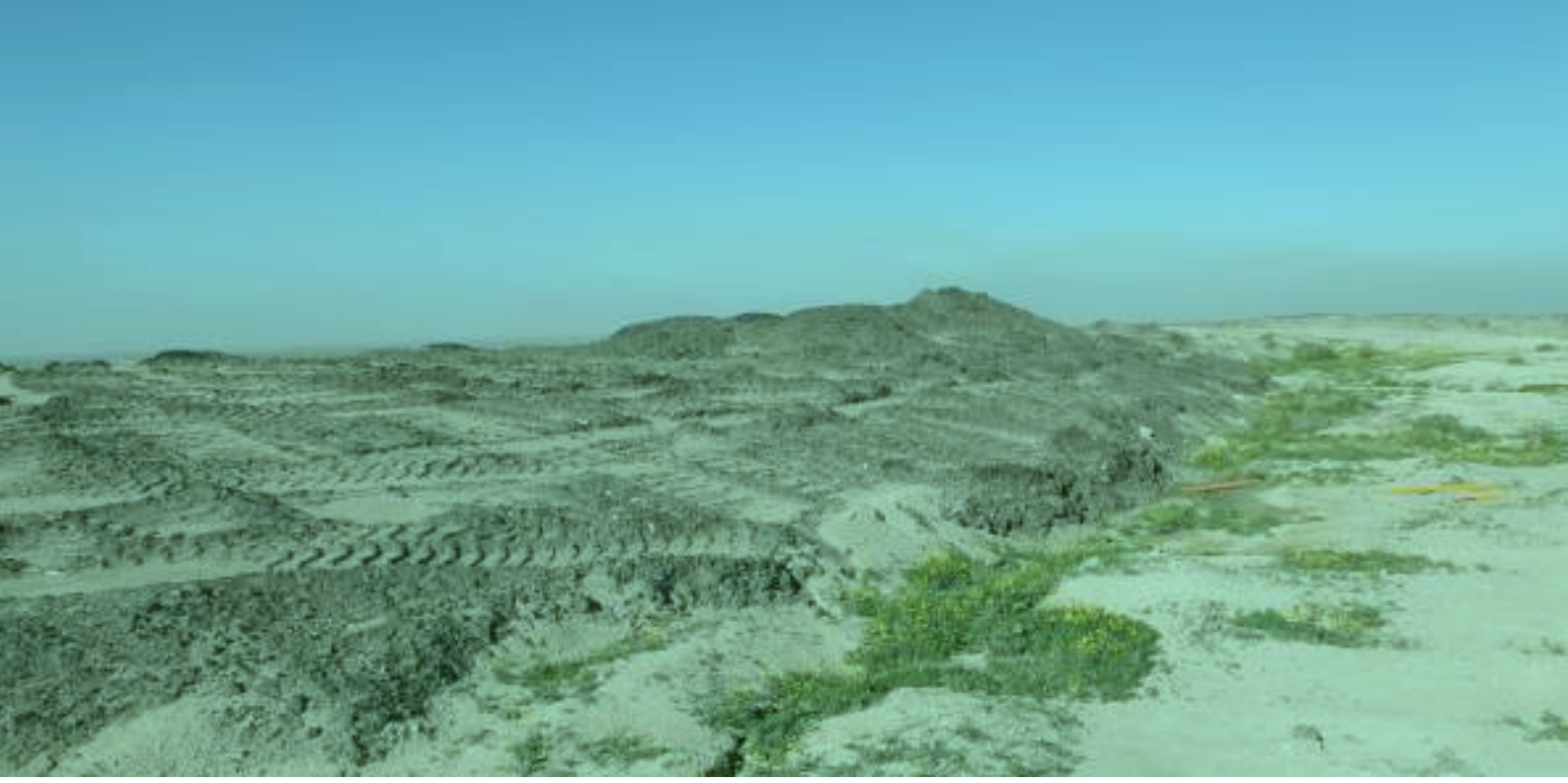
Kuwait Oil Company



Kuwait National Focal Point

His Highness Sheikh Nawaf Al-Ahmad Al-Jaber Al-Sabah,
The Amir of the State of Kuwait

His Highness Sheikh Meshal Al-Ahmad Al-Jaber Al-Sabah,
The Crown Prince of the State of Kuwait



CONTENTS

OVERVIEW

The people of Kuwait still remember the pain and horror they endured when the Iraqi troops invaded their beloved country around 32 years ago.

While handling the Kuwait Environment Remediation Program (KERP) and getting exposed to the gravity of damages caused by invasion and the efforts taken for redress, KOC - Soil Remediation Group was prompted to think about the prospects of documenting such a grave historic event.

This documentation would serve as a testimony of the heroism of the Kuwaiti people while defending their motherland, featuring all those memoirs, environmental damages, and challenges, while celebrating the unique champions who did and those still doing amazing efforts in healing that wound in Kuwaiti environment along with their significant achievements.

This book was created for the future generations, so that the KOC KERP journey with multiple events and vivid portraits and new developments despite the difficulties and obstacles encountered are not forgotten and imprinted deeply in history.

The Soil Remediation Group continues this journey to achieve the full final recovery of Kuwait's golden sands.

This volume will be the first in a series of books to narrate the KOC-KERP journey, step by step from inception to completion and depicting the successful achievements of KERP objectives.

SOIL REMEDIATION GROUP (SRG)

HISTORY

It was in June 2006, that the Government of Kuwait formed the Kuwait National Focal Point (KNFP) as the entity accountable for the overall follow up and fulfillment of the political assurances provided to the Governing Council of the United Nations Compensation Commission (UNCC) by the State of Kuwait regarding the follow-up program for Environmental Awards. Established by Decree of the Council of Ministers, Kuwait National Focal Point for Environmental Projects (KNFP) is responsible for the overall technical and financial oversight of the use of the F4 award funds until such time as all Kuwait's F4 environmental projects have been completed. Actual execution of the projects is the responsibility of different entities of the Government of Kuwait.

KNFP was entrusted to act as a liaison between the UNCC and affected Kuwaiti stakeholders for KERP, which is a UNCC funded program that is responsible for the remediation and rehabilitation of contaminated soil, from the soil contamination caused by the Gulf crises.

In 2012 the KOC Soil Remediation Group was established, to excute these projects following the signing of a Memorandum of understanding between KOC and KNFP in 2010.

RESPONSIBILITY

Soil Remediation Group is responsible for planning and execution of remediation and restoration projects in the KOC oil field areas under Kuwait Environmental Remediation Program (KERP) and for the Sustainable Environmental Economic Development (SEED) project.

VISION OF SRG

To reclaim contaminated land for development projects and re-use or recycle Oil Waste through Environmental Remediation & Rehabilitation (KERP/SEED) programs that promote environmental stewardship, build local expertise, and contribute to national economy through business development and employment creation.

MISSION OF SRG

Environmentally:

- Remediate and Rehabilitate of oil contaminated soil and restore the degraded land to its pre-conditions.
- Conserve natural resources reduce landfill & disposal and long term impacts; and optimize net environmental benefits.

Economically:

- Reclaim contaminated land through the Soil Remediation Projects (KERP/SEED) to make these lands available for Development and Exploration plans.
- Achieve lifecycle cost savings through green remediation and minimal intervention.

Socially:

- Provide an opportunity to build local expertise and contribution to national economy through business development and employment creation.
- Promote public awareness and comply.

Chapter - 1
Introduction

During those fateful days of the invasion in 1990 to 1991, 114 km^2 of Kuwaiti land were severely damaged, as the retreating Iraqi troops ignited more than 700 oil wells, leading to the largest environmental and ecological disaster witnessed in Kuwait's history Crude oil gushed from those damaged wells, forming huge oil lakes, triggering short and long-term adverse impacts on the soil, vegetation, wildlife and threatening precious groundwater resources.

It is to heal this wound that, The United Nations Compensation Commission (UNCC), Kuwait National Focal Point (KNFP), Kuwait Oil Company (KOC), and other stakeholders such as Ministry of Electricity and Water (MEW), Public Authority for Agriculture & Fisheries (PAAF) and Kuwait Institute for Scientific Research (KISR)) joined their hands in a project known as the Kuwait Environmental Remediation Program (KERP) to undertake the comprehensive and collaborative remediation of the contaminated land of an estimated soil volume of around 26 million m^3 Under the KERP program, Kuwait Oil Company is fully responsible for executing the remediation and restoration projects in the KOC oilfield areas according to plans prepared with KNFP and approved by the UNCC.

The historical development of KERP can be chronologically divided into two phases. The period pre-2010, comprised of the filing of claims for environmental damage by the State of Kuwait; review of the claims and award of compensation by the UNCC, and the development of the initial strategy to address the soil contamination issues.

During Post-2010 phase, KOC was tasked as the stakeholder entity of record to undertake and oversee the remediation and restoration works in oil fields.

This eBook provides an overview of more than 32 years of the fascinating KOC-KERP journey from the start till 2022, outlining the KERP vision, mission, history, and progress, in a comprehensive roadmap featuring various approaches, decisions taken, techniques and fundamentals of technologies involved along with the lessons learned, to efficiently meet the objectives set by the UNCC Claims. An inclusive overview of recent advances, along with new and planned developments of the KERP program are also provided within a relevant and accepted framework of Total Remedial Solution (TRS) which was integrated as part of the KERP Program to be the cornerstone for its achievements of the objectives. This eBook will be featuring KOC KERP Journey till the end of 2022, and will be updated later in future as the KOC - KERP activities progress. This Book aims to provide the readers with an elaborate picture of the KERP Program in its current state.

Chapter - 2
KERP History & Background

The State of Kuwait majestically lies towards the Northwestern corner of the Arabian Gulf and covers an area of about 17,818 km^2. The country possesses 10 oil fields across its two main areas: North Kuwait, which comprises the Ratqa, Raudatain, Sabriya, and Bahra oil fields, and South Kuwait, which includes the Greater Burgan, Minagish, and Umm Gudair oil fields (oil wells) Greater Burgan consists of three distinct oil fields, namely, Al-Ahmadi, Burgan, and Magwa.

On 2nd August 1990, the Iraqi troops invaded the State of Kuwait. Although the country was liberated by 26th February 1991 following a brief period of occupation and the historical Gulf War came to an end. More than 700 oil wells, oil lakes and oil filled trenches in Kuwait were set ablaze as part of the Iraqi withdrawal 'scorched earth policy' causing the largest environmental and ecological disaster in its history. Approximately 20-25 million barrels of ignited crude oil were extinguished using 12 billion gallons of seawater collected in artificial ponds to control the fire.

OIL WELL FIRES & EXTINGUISHING, TEAMS

The extent of oil fires was so massive that according to the Kuwait Oil Company's estimate as of September 1991, there were 610 fires, out of a total of 749 facilities damaged or on fire along with an unspecified number of oil-filled low-lying areas, such as "oil lakes" and "fire trenches." It would be astounding to know that this constituted approximately 50% of the total number of oil-well fires in the history of the petroleum industry, and approximately 85% of the wells in every major Kuwaiti oil field were either temporarily damaged or destroyed Various sources estimated that between four and six million barrels of crude oil, and between seventy and one hundred million cubic meters of natural gas were burnt through these wellheads per day.

> "Over 700 oil wells, oil lakes and oil filled trenches in Kuwait were set ablaze as a part of the Iraqi withdrawal 'scorched earth policy' causing the largest environmental and ecological disaster in history."

International support was also extended in extinguishing these unprecedented and concentrated fires to the Kuwaiti firefighting heroes who led the firefighting efforts with valor and might. The companies which initially dowsed the well fires, were Bechtel, Red Adair Company, Boots and Coots, and Wild Well Control Safety Boss was the fourth company to join but ended up extinguishing and capping more wells than any other company: 180 out of 600. Other companies including Cudd Well/Pressure Control, Neal Adams Firefighters, and Kuwait Wild Well Killers also had a great contribution to these efforts.

Almost 90% of all the 1991 fires in Kuwait were put out with nothing but sea water, sprayed out of powerful hoses to the base of the fire.

The water for extinguishing was supplied to the arid desert region by re-purposing the oil pipelines that were previously purposed to pump oil from the wells to the Arabian Gulf. Due to the arson attack the pipeline had been mildly damaged. Once repaired, its flow was reversed to pump Arabian gulf seawater to the burning oil wells.

The extinguishing rate was approximately 1 every 7–10 days at the start of efforts but then with experience gained and the removal of the mine fields that surrounded the burning wells, the rate increased to 2 or more per day.

For those stubborn oil well fires, the use of a gas turbine to blast a large volume of water at high velocity at the fire proved popular among firefighters in Kuwait and was brought to the region by Hungarians equipped with MiG-21 engines mounted originally on a T-34 (later replaced with T-55) tank, called"big wind." It extinguished 9 fires in 43 days.

In fighting a fire at a directly vertically spewing wellhead, high explosives, such as dynamite were used to create a blast wave that pushed the burning fuel and local atmospheric oxygen away from the well (this is a similar principle as blowing out a candle). So that the flame is removed, and the fuel can continue to spill out without burning. Generally, explosives were placed within 55-gallon drums, surrounded by fire retardant chemicals, and then the drums are wrapped with insulating material with a horizontal crane being used to bring the drum as close to the burning area as possible.

The firefighting teams called this procedure as "Operation Desert Hell" and since this activity had a huge magnitude, the fires and its fire extinguishing efforts were the subject of a 1992 IMAX documentary film, "Fires of Kuwait", which was nominated for an Academy Award. The film includes footage of the Hungarian team using their jet turbine extinguisher.

"Lessons of Darkness" is a 1992 film that explores of the ravaged oil fields of post-Gulf War Kuwait.

Bechtel Corporation produced a short documentary titled Kuwait: "Bringing Back the Sun" that summarizes and focuses upon the firefighting efforts.

Figure 2.1 Bursted oil wells

Figure 2.2 Oil lakes from after the fires

CONTAMINATION LEGACY

During the invasion and occupation by Iraq that began on 2nd August 1990, Kuwait sustained significant and wide-spread environmental damages particularly, the oil well fires and the significant amounts of toxic metals and cancer causing agents released into the atmosphere for several months About half of the oil evaporated and more than a million barrels settled.

in large pits in the desert Aside from the release and burning of oil and destruction of oil wells, groundwater deposits were impacted in many places by the seepage of oil and chemicals through the layers of sand.

The following damages were recognized:

- Contamination of freshwater aquifers to an extent of millions of cubic meters in North Kuwait, namely Raudhatain and Umm Al-Aish.
- Over 800 miles of coastal area contaminated with oil.
- A long man-made trench filled with oil (over 4.7 km).
- 6.25 kms of military fortifications obliterated the balance of desert ecosystem.

- 271.5 km² of tarcrete deposition (mixture of desert sand and gravel combined with oil and soot to form a layer of hardened "tarcrete").
- 163 wellhead pits, resulting from blown out oil wells on land.
- 114 km² of desert area severely affected by dozens of oil lakes and over 26 million m³ (cubic meters) of contaminants that needed to be removed into landfills.

In addition to the above, further damage resulted from the disposal of ordnance, unexploded ordnance (UXO), and desert, coastal, and marine ecosystems were disturbed.

Compensations ultimately awarded for the damaged were categorized in different claims as follows. Also indicated in the table are the entities of Kuwait that have been designated for implementing the related projects.

Six Claims were approved by the UNCC mainly.

A detailed overview of the UNCC Claims is provided in Chapter 3 of this eBook.

Claim Number	Description	Value in USD ($)	Responsible stakeholder
5000256	Damage to Groundwater Water Resources	**41,531,463**	MEW
5000259	Damage to Marine Resources	**3,990,152**	KOC
5000450	Damage to Terrestrial Resources	**643,814,034**	PAAF & KOC
	Remediation of areas damaged by military fortifications	9,019,717	
	Remediation of areas in and around wellhead pits	8,252,657	
	Remediation of areas damaged by tarcrete	166,513,110	
	Re-vegetation of damaged terrestrial ecosystems	460,028,550	
5000454	Remediation and rehabilitation of oil lakes	**2,259,285,969**	KOC & KMOD
	Remediation of oil lakes, oil trenches and oil spills	1,975,985,580	
	Re-vegetation of damaged terrestrial ecosystems	283,300,389	
5000460	Loss of natural resources (Marine preserve)	**7,943,030**	PAAF
5000466	Damage to Terrestrial Resources	**162,259**	KMOD & PAAF

Table 2.1 UNCC Claims

UNITED NATIONS

S

Security Council

Distr.
GENERAL

S/AC.26/2003/31
18 December 2003

Original: ENGLISH

UNITED NATIONS
COMPENSATION COMMISSION
GOVERNING COUNCIL

REPORT AND RECOMMENDATIONS MADE BY THE PANEL OF COMMISSIONERS
CONCERNING THE THIRD INSTALMENT OF "F4" CLAIMS

Figure 2.3 2003 UNCC Report Concerning the 3rd Installment of "F4" Claims

Rehabilitation of Kuwait's Environment

KOC Signs an MOU with KNFP

Kuwait Oil Company signed a Memorandum of Understanding with the Central Committee for Supervision over Environment Rehabilitation Projects (Kuwait National Focal Point - KNFP). The MOU will enhance cooperation between the two sides to carry out war-damaged environment rehabilitation projects.

"This MOU represents an excellent start for further cooperation with KNFP in a very important effort for all residents of Kuwait, and that is the rehabilitation of the oil lakes and other areas damaged by the war," C&MD, Sami Al-Rushaid spoke at the signing ceremony.

In turn, the Committee General Secretary, Khalid Al-Mudhaf, said that KOC is a major partner in carrying out the Committees' assigned jobs.

The rehabilitation, which covers the areas which were damaged by the war when hundreds of oil wells were destroyed, falls under Sections II & III of UN Compensation Claims No. 5000450 and 5000454.

The MOU includes cooperation in wider fields, such as forming a technical planning and supervision committee for coordination with other state authorities as well as revision and evaluation of all ecological and technical information regarding the rehabilitation project. It also includes a long-term environment observation plan, exchange of information, providing environmental studies, research and data, documentation, and setting reference conditions for tenders and other technical matters.

2

LEGAL FRAMEWORK

Paragraph 16 of the Security Council Resolution 687 (1991) affirmed that Iraq was liable under international law "for any direct loss, damage, including environmental damage and the depletion of natural resources, or injury to foreign Governments, nationals and corporations, as a result of Iraq's unlawful invasion and occupation of Kuwait."

Approximately US$3 billion was awarded by the UNCC to the Government of the State of Kuwait in relation to environmental remediation and restoration claims based on of the reports of the UNCC (F4) panel of commissioners that not only recommended the award amounts but also the technical elements for projects to be undertaken with the award funds. These technical elements included details such as specific geographical areas for remediation or restoration, technological approaches, and restoration objectives.

Due to the unique nature of the projects, the UNCC Governing Council under decision 258 (2005) established the Follow-up Program for Environmental Awards to monitor both the financial and technical implementation of environmental projects being undertaken by Kuwait and the other countries (Iran, Jordan and Saudi Arabia) with the award funds to ensure financial transparency and technical compliance with the F4 Panel recommendations.

In Kuwait, a separate entity (KNFP) was established to manage the approximately US$3 billion awarded for its six projects subject to the UNCC Follow-up Program, with responsibility for the overall technical and financial oversight of Kuwait's projects, headed by the Kuwait Minister of Oil, and accountable to the Council of Ministers.

In 2011, the Governing Council decided that day to day oversight of the Program would be handed over to the respective Governments upon their (i) establishment of five enumerated structural systems and controls,(ii) the provision of adequate assurances for their maintenance and for the exclusive use of the award funds for the successful completion of the projects and (iii) a determination to that effect by the Governing Council.

In December 2013, the Governing Council having determined that the State of Kuwait had established the requisite systems and controls under decision 269 and received the signed assurances from Kuwait transferred full oversight for the remaining implementation of the KERP to the KNFP Board, supported by the Advisory Panel, on behalf of the Government, but with continuing obligations for reporting to the UN.

Figure 2.4 Early KNFP meetings with F4 panel and UNCC delegations in 2010 and 2011

Figure 2.5 Early KNFP UNCC & IRS delegations in Kuwait January 2013

The F4 panel has outlined the following seven general principles for guidance in the development and implantation of environmental remediation projects (third, fourth and fifth "F4" reports).

A. Remediation approaches or techniques that pose unacceptable risks of ecological harm should be avoided.

B. Remediation activities should be undertaken only if they are likely to result in more positive than negative effects.

C. Remediation techniques that facilitate natural recovery processes should be preferred, and active remediation should build on and enhance natural recovery that has already occurred.

D. Remediation should rely on proven and well-established technologies and techniques in preference to experimental or untested approaches.

E. The effectiveness of remediation activities should be monitored to ensure that remediation targets are met. Remediation programs should be designed to be sufficiently flexible and responsive to new information obtained from such monitoring.

F. Where more than one remediation approach or technique is appropriate to achieve a desired remediation goal, the most cost-effective option should be selected.

G. Remediation decisions should consider both the short-term and long-term effects of remediation activities on neighboring ecosystems, including trans-boundary effects."

The Panel has also stressed (in third "F4" installment report) that "primary emphasis must be placed on restoring the environment to pre-invasion conditions, in terms of its overall ecological functioning rather than removal of specific contaminants or restoration of the environment to a particular condition."

In a report made by the Panel concerning part two of the fourth installment of "F4", the Panel recommended the following:

- Excavation of approximately 26 million m^3 of highly/visually oil-contaminated soils (from dry and wet oil lakes, and oil-contaminated piles) containing an average 19% of oil and transportation and disposal of these soils into number of engineered landfills.
- In-situ bioremediation of the residual soil after excavation through both active and passive means.
- Re-vegetation of selected areas following removal of contaminated material.

A long-term monitoring plan that collects relevant data before, during and after remediation or restoration activities should be carefully integrated into the remediation project In the course of remediation, remediation activities should be adapted in response to data and analysis developed through such a monitoring program. This will provide opportunities to identify and address negative impacts of remediation activities if any arises. It will also assist in identifying successful remediation or restoration approaches.

These elements were subsequently captured in the UNCC Governing Council Decision 258 and continue to apply as a consequence of the 2013 assurances by the State of Kuwait to the UNCC.

KERP HISTORY INITIAL TIMELINE

- 1994 – Kuwait submitted 5 claims through PACC to UNCC and after some years of negotiation UNCC awarded a total claim of $3.003 bn to Kuwait.
- 1998 – The Governing Council (GC) of the UNCC appointed the "F4" Panel.
- December 2003 – Report and recommendations made by the panel of commissioners concerning the third installment of "F4" claims.
- December 2004 – Report and recommendations made by the panel of commissioners concerning part two of the fourth installment of "F4" claims.
- December 2005 – The UNCC issued decision 258 guidelines to establish the follow-up program to monitor the technical and financial progress.
- June 2006 – Kuwait government established KNFP – with the authority to plan and supervise the implementation of projects under KERP.
- August 2010 – MOU signed by both KNFP and KOC and later updated in 2016.
- June 2012 – AMEC was awarded as first PMC Contractor for five years to provide support to KOC for KERP management activities. PMC carried initial consulting works and developments of remediation strategy and initiate project tenders and bidding and overseeing these projects.
- August 2012 – KOC established the Soil Remediation Group to handle Soil Remediation Projects.
- November 2013- KOC bid and awarded construction of two engineered landfills to contain heavy soil contamination from priority areas in North Kuwait (NK) and South Kuwait (SK).
- December 2013 – UNCC dissolved and KERP implementation now transferred to the State of Kuwait and administered by Kuwait NFP for the State of Kuwait.
- November 2014-Two contracts of E&T were awarded in SK and NK to carry out Excavation and Transportation of heavily contaminated soils and be deposited into the constructed landfills.
- January 2015 – Total Remediation Solution (TRS) was developed, presented and approved by KNFP and AP as a part of integrated solutions with UNCC plans for project executions.

From 1991 to 2001 several studies were performed to investigate oil contamination in Kuwait's terrestrial environment. While those initial studies of the oil contamination in Kuwait attempted to differentiate between categories of oil contamination, different studies classified the contamination in different ways and used variable terminology in describing the various types of contamination. These factors made direct comparison of the study results difficult and contributed to confusion. With this understood, the studies suggested useful for to conduct comprehensive damage assessment to the desert surface.

From 2001 to 2003 the Consortium of International Consultants (CIC) was tasked by PACC and conducted extensive Monitoring and Assessment Program of the Environmental Damages and Rehabilitation in the Terrestrial Environment of Kuwait. Such assessment included number of important elements, comprising the following: Overview of studies and publications on oil lakes and oil trenches in Kuwait prior to 2002; Environmental Damage Assessment; Ecological Impact Assessment; Assessment of Oil Lakes; Assessment of Tarcrete; Satellite Imagery and Remote Sensing, etc The CIC Assessments summarized the catastrophic impact on terrestrial environment of Kuwait resulting from oil contamination, described, classified, and categorized the contamination and established baseline conditions by estimating contaminated areas and features at each oilfield.

In June 2006, the Government of Kuwait established the Kuwait National Focal Point (KNFP), referred to formally as the "Central Committee to Supervise the Implementation of Projects Related to Environmental Remediation" KNFP was given the responsibility and authority to plan and supervise the implementation of the projects referred to as the Kuwait Environmental Remediation Program (KERP), for which Kuwait has received awards from the

UNCC, and to liaise with the UNCC to ensure Kuwait's compliance with UNCC decisions, and in particular Decision 258.

KNFP was empowered to plan and supervise the implementation of KERP. Furthermore, KNFP was tasked with ensuring compliance with the UNCC and act as a liaison between the State of Kuwait, the Kuwait Oil Company (KOC), and other major Kuwaiti stakeholders (e.g., Kuwait Ministry of Defense (KMOD), Kuwait Environmental Public Authority (KEPA), Public Authority for Agriculture & Fish Resources (PAAF), (MEW), etc.) for KERP program.

The claimant government recommended experts to the UNCC to act as Independent Reviewers of the projects within KNFP. They are responsible for reporting and responding to all requests for information about ongoing monitoring and assessment projects and remediation and restoration projects. This includes projects reporting at least every six months to the Independent Reviewers, and providing access to documents, project sites, and personnel to the Independent Reviewers and to the UNCC.

Figure 2.6 MOU signature of KOC with KNFP

KOC initiated steps towards the remediation and rehabilitation of its operational areas and to enhance the development of its oil fields. KOC along with KNFP, KISR, EPA, MEW, and KMOD is responsible for the planning and execution of all remediation and restoration projects on properties under the Kuwait Environmental Remediation Program (KERP), which would be implemented through a series of field contracts.

KNFP established the organizational structure for planning and implementation of the remediation and restoration projects. According to this organizational structure, KOC as a stakeholder and acting as Organization Engaging Field Contractors (OEFC) would be responsible for the planning and implementation of the remediation and restoration projects in Kuwait Oil Company. For this purpose as mentioned before, a Memorandum of Understanding was signed between KOC and KNFP in 2010, and the KOC Soil Remediation Group was established in 2012.

PROJECT MANAGEMENT CONSULTANCY (PMC)

The KOC objectives in implementing the KERP are to achieve optimum remediation options with respect to legacy contaminated areas in the Company's oilfields by the most efficient and economical means available. To this effect, KOC requires a comprehensive ongoing program of the remediation projects. These objectives are considered critical to the environmental vision of day-to-day business and future long-term development of KOC.

Hence KOC foresees that by engaging a consultant (PMC), it will ensure that project management, co-ordination, planning, design, contracting, procurement, project controls, field contracts management and other such like skills and activities relating to the remediation of contaminated areas together with such other related expertise as may be required by KOC, are at all times available and sufficient so as to enable KOC to achieve the objectives to meet KOC's long term strategy.

As part of the systematic infusion, dissemination, transfer and deployment of technology, KOC intends to integrate some of the KOC's personnel from SRG into the organization of the PMC for providing the Services for the purpose of knowledge transfer and gaining hands-on experience. The PMC in their regard will focus and direct the performance of their services so as to achieve KOC's objectives and goals in executing the KERP projects.

The PMC will be responsible for management, control and co-ordination, supervision services and assistance for the Assigned Projects inclusive of budget formulation, tender check estimate (TCE), contracting strategy, selection of bidders (KOC's established list/ PQ/shortlisting), cost controls, quality assurance & control, projects control, contracts administration, handling of all Field contractor's submittals including but not limited to letters, transmittals, variation requests, reports, claims and dispute resolution services etc. as required by the KOC.

Figure 2.7 Contract signing ceremony with PMC Amec Foster Wheeler

In doing so, the PMC will prepare economic and viability studies and all other documentation that is required for complying with KOC requirements. Design Services including but not limited to, site investigation, data collection, design concept, detailed design, evaluation of material requirements, preparation of scope of work, technical specifications, tender packages for the execution of work, evaluation criteria, assistance during tendering stage, preparation of supplementary letters, commercial requirements forming part of the tender package and other control documents, technical and commercial evaluation of tenders, quality control and, coordination with different teams in KOC will be also done.

The PMC will also conduct and coordinate effective training schemes for the purpose of enhancing the capabilities of the KOC's personnel with regard to use and application of various software and systems introduced/used by the PMC during execution of the services and providing KOC personnel with "hands-on" experience on the "state-of-the-art systems" including process simulators and application of the latest technology in various fields of engineering.

KOC awarded the first five-year KERP Project Management Consultancy (PMC) contract to Amec Foster Wheeler (AFW) on June 24, 2012.

The PMC role to support the Kuwait Oil Company (KOC) in their management of 26 million m^3 of hydrocarbon contaminated materials and the strategic application of $1.9 billion United Nations Compensation Commission funding was signed. The PMC's responsibility includes the formulation of remediation and contracting strategies, assessment of remedial technologies, tender preparation, and management of the awarded remediation contracts. The PMC team functions included project management, coordination, planning, design, engineering, contracting, procurement, project controls, and field oversight of Contractors including health and safety. Additionally, AFW provided specialized technical skills, knowledge, and experience in the environmental remediation field combined with the experience in Kuwait-based PMC operations and responsibilities. To meet these varied requirements, PMC pulled together a team from across the globe including the United States, United Kingdom, Canada, Philippines, India, Jordan, Algeria, Sri Lanka, Lebanon, and Egypt.

WORLEY AS PMC

In March 2018, Worley was awarded the Project Management Consultancy (PMC) to assist in the efficient and proper implementation of the KOC-KERP projects. As the PMC, the Worley team works with KOC to provide wide ranging multidisciplinary services from strategy development, tender preparation, contract awarding through the contract closure.

One of the challenges faced by Worley was to develop and deliver multiple tenders for the remediation of an initial 13 million m^3 of contaminated soils across a vast 114 km^2 area within active oilfields in North and South Kuwait. Dealing with the contaminated land was only a part of the picture. Being a former battle zone, there always is unexploded ordnance (UXO) clearance to complete and interfacing with other oilfield operations. Worley delivered on this to the satisfaction of KOC.

Figure 2.8 Contract signing ceremony with PMC Worley

THE KERP PROJECT: - SCOPE

The project has high visibility on national and international levels especially because it is an aftermath of a historical catastrophe. The war and subsequent oil fires created unprecedented environmental devastation in Kuwait. Oil mist got sprayed across the deserts, oil lakes blanketed 5% of Kuwait's area, and black rain poured down across the entire nation. As years passed, Wet Oil Lakes were formed in low-lying areas when oily liquid and highly weathered oil from damaged oil wells got accumulated In shallower parts, top oil got evaporated forming a thin and moderately hard dry black tar layer forming Dry Oil Lakes over hydrocarbon contamination beneath. The oil mist which spread around in the air settled down and combined with sand and gravel forming Tarcretes, (a solid top layer that don't allow the plant growth, without underlying hydrocarbon-contaminated soil). Along with that, there are Oil-Contaminated Piles which were initially heaps of soil made to stop the oil flow from the destructed oil wells or to clear the areas with heavy oil contamination during firefighting; and Wellhead Pits, which are excavated pits constructed to store seawater for fighting the oil well fires.

The KERP project's vision is to remediate and restore all these contaminated soils, sprawling across all these different types of features.

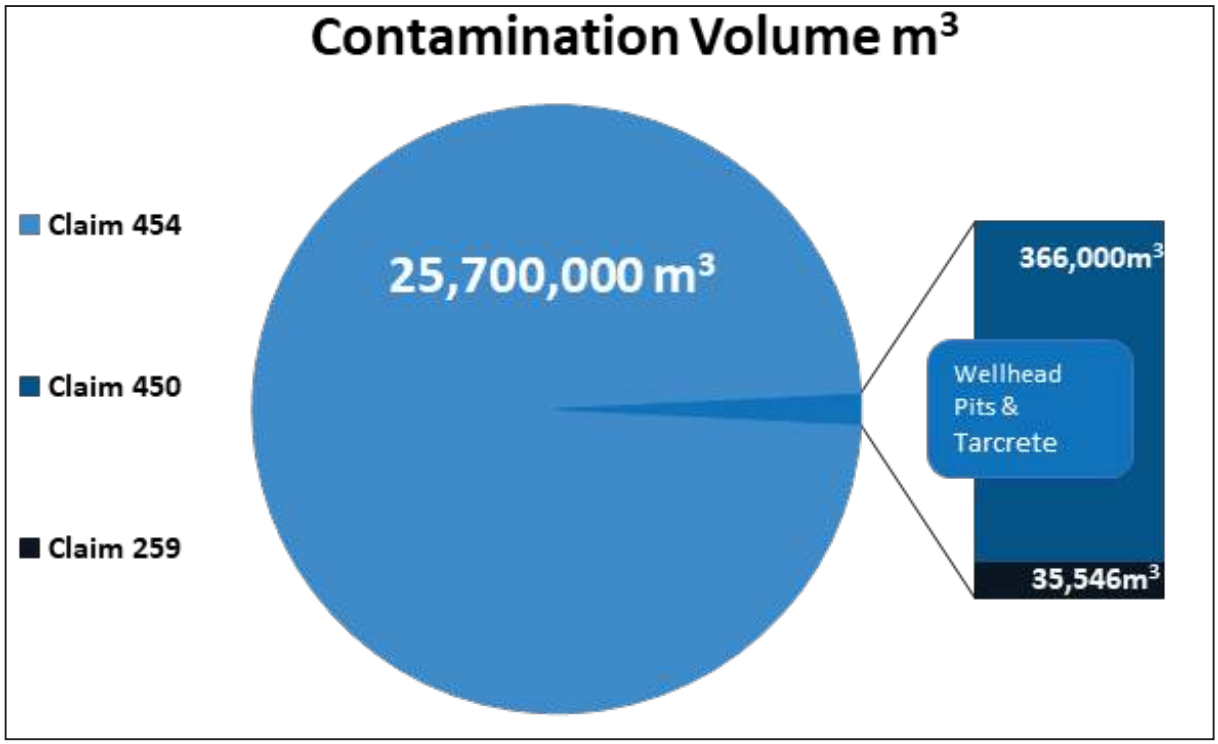


Figure 2.9 Pie Chart: Contamination Volume

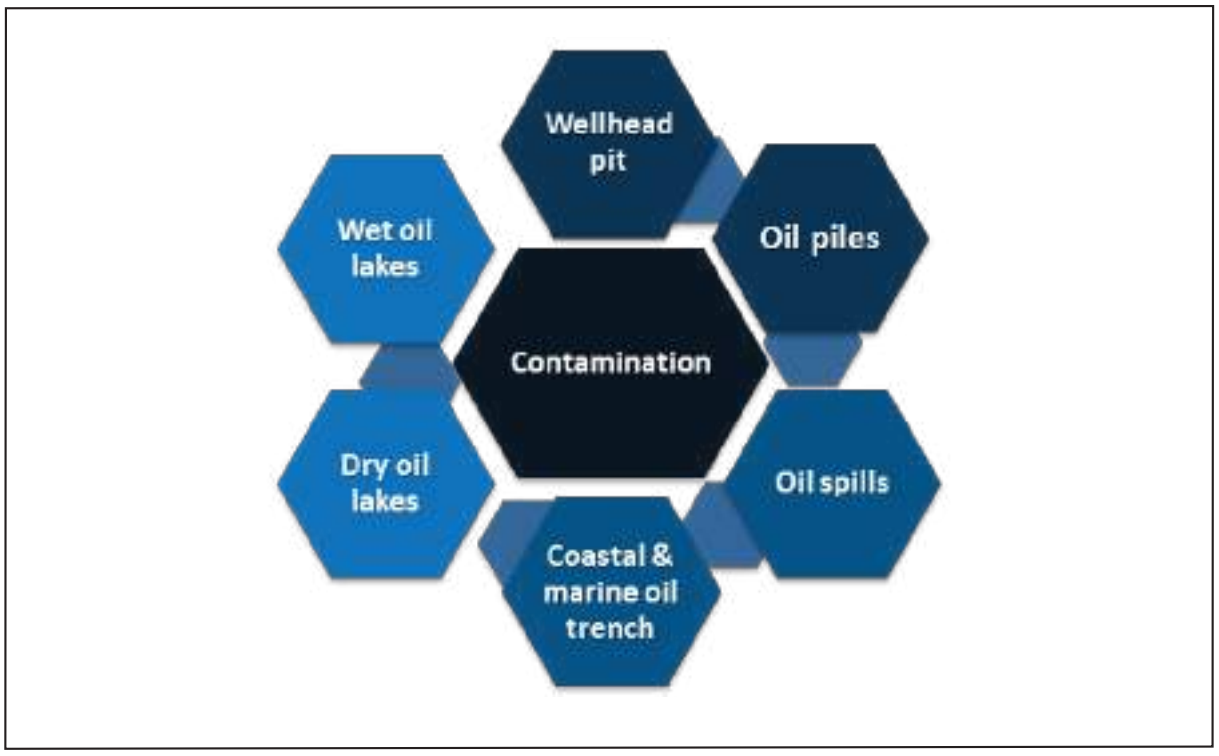


Figure 2.10 Contamination Types

Chapter - 3
Kuwait's UNCC Environmental Claims Awards

KUWAIT'S UNCC ENVIRONMENTAL CLAIMS & AWARDS

Recognizing the need for a large scale environmental remediation and restoration, the UNCC awarded approximately US$3 billion in compensation to the State of Kuwait. Following are the overviews of the projects set out as per claim basis which are being undertaken by Kuwait with these funds awarded.

KERP CLAIMS:

Claim 5000256 – Remediation of damage to Contaminated Groundwater Resources

Kuwait was awarded US$41,531,463 to treat and remediate groundwater within the only two freshwater aquifers in North Kuwait, namely Raudhatain and Umm Al-Aish. Those aquifers were contaminated due to the infiltration of seawater and chemicals which was used to fight oil well fires, contaminants from oil recovery pits, oil lakes, and leakage from damaged oil well heads. The project plan included the cleanup of 5.5 million m^3 of contaminated groundwater at Umm Al-Aish and 9.5 million m^3 at Raudhatain. Its implimentation is in two major phases: Phase I, over a period of five years includes extensive monitoring and evaluation of the best remediation procedures and techniques through pilot scale remediation; and Phase II, over a 15-year period to implement full-scale actual remediation based on the results of Phase I.

The Ministry of Electricity and Water (MEW) is the entity of the Kuwait government responsible OEFC for implementing the groundwater remediation projects, with oversight of KNFP.

Claim 5000259 – Remediation of damage to Marine and Coastal resources

Kuwait was awarded US$3,990,152 to remediate marine and coastal areas because of contamination from more than 12 million barrels of oil released through a combination of offshore oil spills, the creation of a coastal oil-filled trench and oil deposits, wreckage of oil tankers and spills on offshore islands from tipped-over oil-filled tanks Previous studies undertaken have identified a long-length oil trench, formed by the Iraqi army during the Gulf War as a defensive barrier against coalition forces.

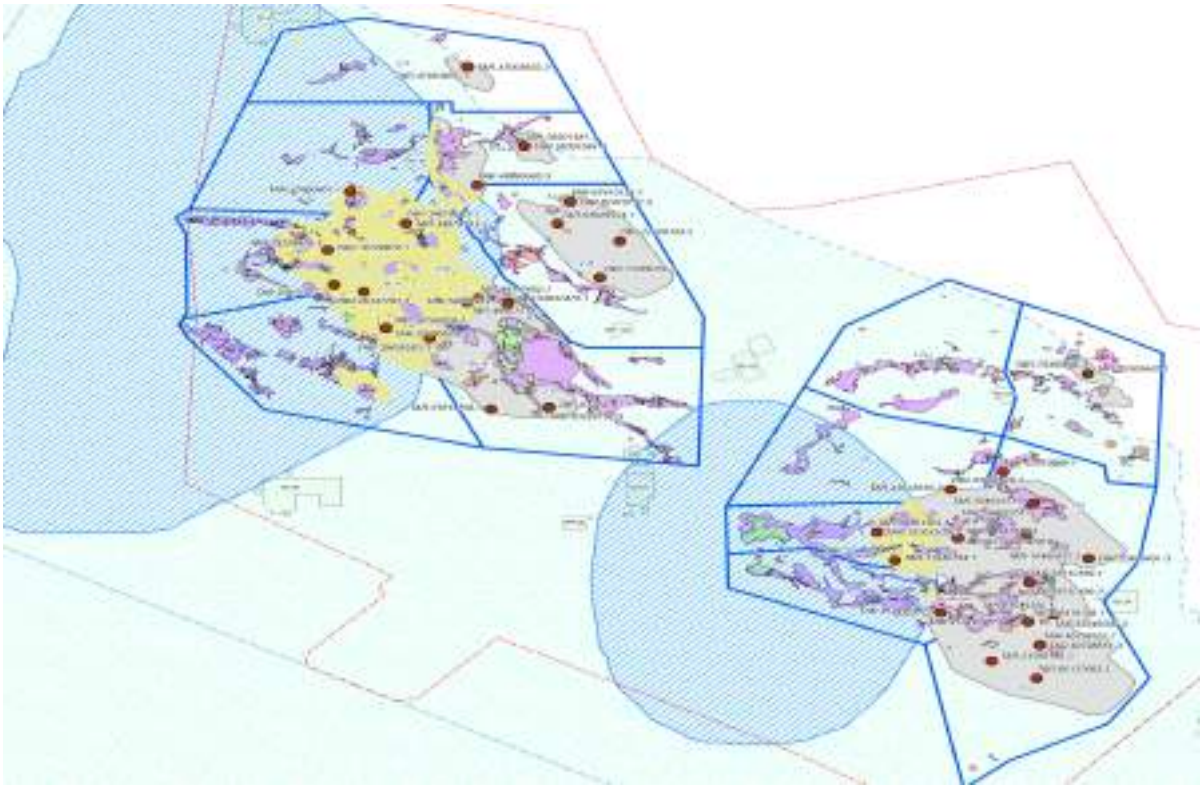


Figure 3.1 North Kuwait Fresh Water Aquifer & Catchment Basin

The coastal oil trench was a 4.7-kilometer-long trench, filled with crude oil along with a 150-meter-long secondary spur trench attached to it. The total volume of material within the trench was estimated to be 8,319 bulk cubic meters (BCM). The average width of the trench was approximately 1.2 m and a depth of 1.3 m. There was also an overspill area that was contaminated with oil, that area was approximately 9,193 m^2. The trench and coastal oil deposits were a danger to the natural terrestrial and marine environments and human health.

The scope of work under the project plan involved the excavation of visibly oil-contaminated materials from the coastal oil deposit area, coastal oil trench and weathered oil layers and depositing the contaminated materials in a landfill facility tilling of for disposal, followed by raking/tilling the remaining soil Detection and clearance of UXOs before excavation was undertaken to ensure the safety of the field workers.

Remediation and restoration of the damage caused to coastal and marine resources by oil contamination was completed by 2017, through excavation, transportation and landfilling of oily contaminated material from coastal oil deposits, coastal oil trenches and weathered oil layers.

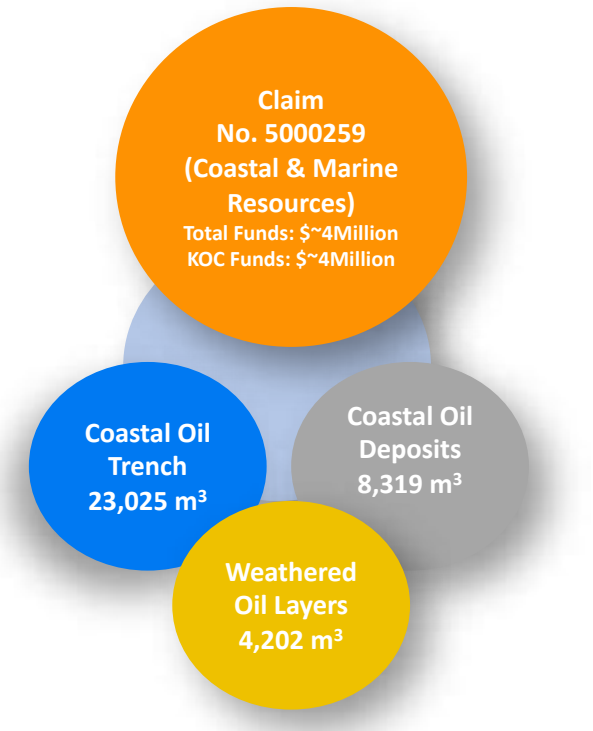


Figure 3.2 Coastal Trench

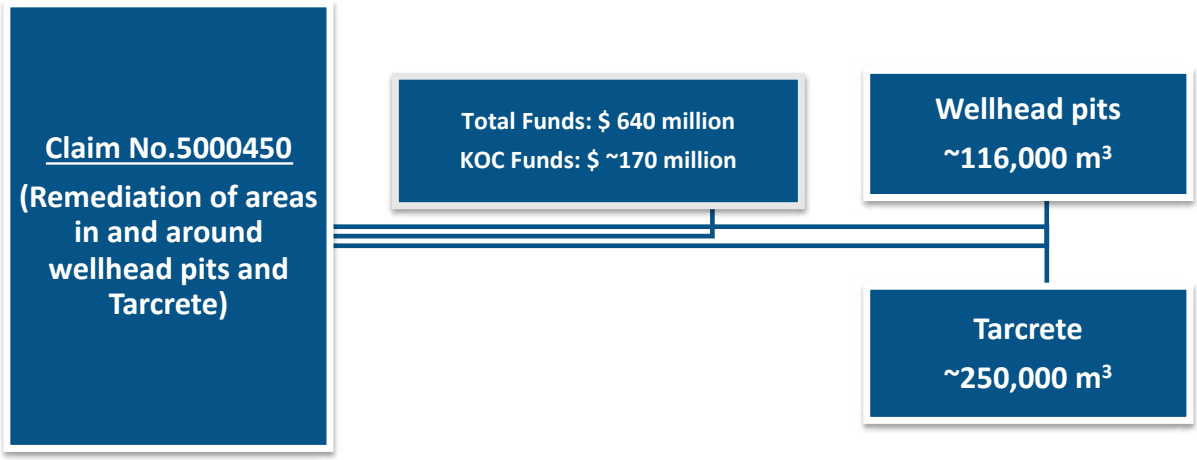
CLAIM 5000450 - TERRESTRIAL RESOURCES RESTORATION

The State of Kuwait was awarded US$ 643,814,034 to remediate vast areas damaged (military fortifications) and effects of damaged oil installations. There are four elements under this award with projects already completed or plans in place for each of the elements.

- Element 1: Remediation of areas damaged by military fortification
- Element 2: Remediation of areas in and around wellhead pits
- Element 3: Remediation of areas damaged by Tarcrete
- Element 4: Re-vegetation of damaged terrestrial ecosystems

ELEMENT 1: MILITARY FORTIFICATIONS (US$9,019,717)

Claim element for the area of 6.25 km² with adversely affected plant growth and soil functioning, and increased wind erosion and sand mobilization. The project plan for the remediation/restoration of the areas damaged by military fortifications included three main activities - site preparation (desk survey and mapping, UXO detection and concrete blocks removal, development of an implementation plan), remediation and re-vegetation of damaged areas, and long-term environmental monitoring.



ELEMENT 2: REMEDIATION OF AREAS IN AND AROUND WELLHEAD PITS (US$8,252,657)

Wellhead pits were constructed approximately 100-200m from previous oil wellheads and were created to either store sea water used to extinguish oil wellhead fires, or as a containment and storage area for released hydrocarbons and associated contaminated soils, from vandalized oil wellheads immediately following the Gulf war period.

Typical construction sizes for the open pits varied from approximately 18m x 8m (144 m²) to 58m x 39m (2,362 m²), with depths ranging from 0.5m to 2.5m, and typically surrounded by clean sand berms of 2-2.5m height and 1m in width. Some wellhead pits were lined with a geo-membrane layer. The integrity of geo-membrane barrier at each pit if present is unknown and may have been compromised.

The current conditions of the wellhead pits are variable, some are either not found or completely backfilled at the coordinates provided. Few of the wellhead pits no longer have berms, or only partial sections of the berms are present. The berms may have been removed, backfilled, or eroded over time into the wellhead pits.

Some of the wellhead pits have a visually observable contaminated oily/sludge or oily crust sitting on top of a moist sand layer. At some open wellhead pits, no impacts were observed inside of the pit confines but were observed within the dry oil lakes. Other wastes may also be present in the pits or associated berms including oil drums, scrap metal and wood piles, etc. Some of the wellhead pits were either filled or not located at the existing coordinates.

Wellhead pits areas contained oil sludge and oil contaminated soil (19 of 163 wellhead pits has potential to contaminate potable groundwater at Raudhatain and Umm Al Aish, while the remaining 144 did not pose a significant groundwater threat). The project plan provided for two strategies – clean closure of wellhead pits in potable aquifer areas (19) and a 'close-in-place' option for all other areas (144).

As part of Element 2 in Claim No 5000450, there are 163 wellhead pits (both in North Kuwait and South Kuwait), of which nineteen (19) where identified as Category 1 and of posing a direct risk to the freshwater aquifer in Raudhatain and Umm Al-Aish areas in North Kuwait (NK). Out of 144 wellhead pits, forty-six (46 are in North Kuwait and ninety-eight (98) are in South Kuwait (SK).

Figure 3.3.1 Wellhead Pits

Figure 3.3.2 Wellhead Pits

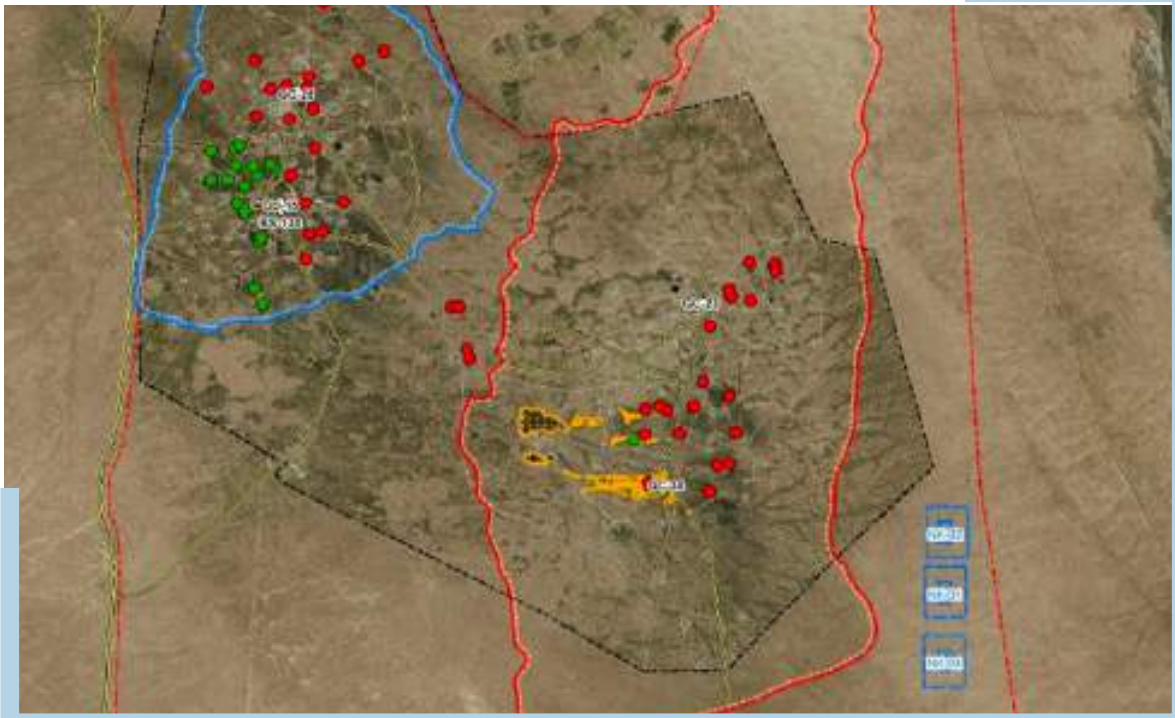


Figure 3.4 Wellhead Pits (Category 1 & 2) in North Kuwait Oil Fields

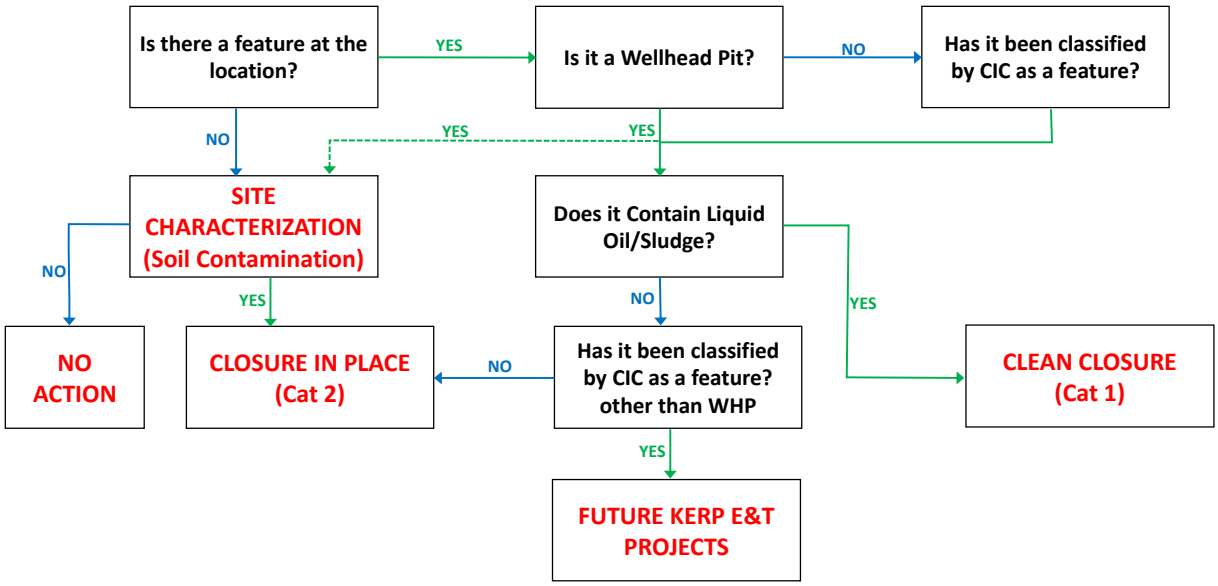


Figure 3.5 Wellhead Pit Remediation Strategy Decision Chart

ELEMENT 3: TARCRETE (US$ 166,513,110)

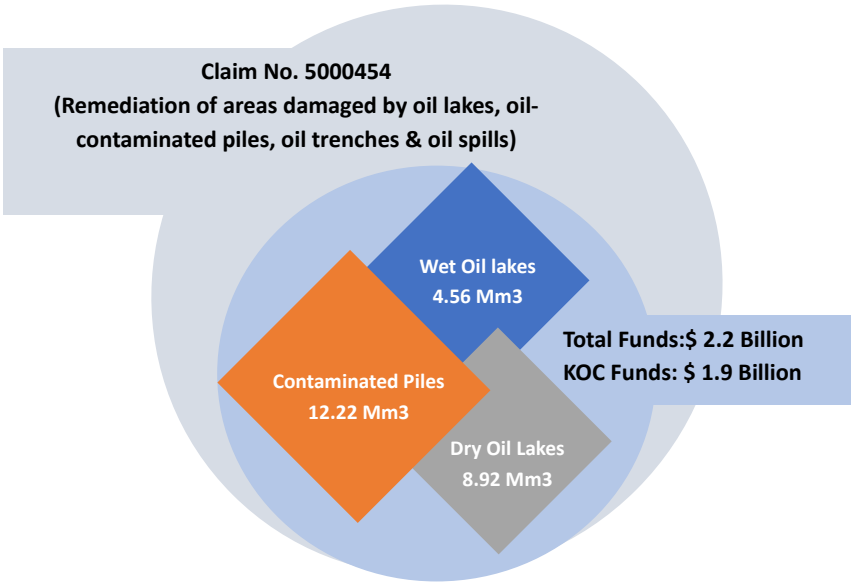
Tarcrete is defined as a thin, cemented layer of dried oil, often less than 15 mm thick that overlies visually clean soil. The tarcrete layer is thought to be the direct result of aerial deposition from damaged oil wells Rather than oil flowing over the ground surface. It was dispersed onto the ground surface as an aerosol (a mist or spray), which over the years, became solidified under the sun to form a thin hard cemented layer. This layer often obscures the lateral extent of the dry oil lake soil.

The "F4" Panel recommended remediation of a total area of 271.5 km^2 with impaired ecological processes damaged/ covered by tarcrete (US$166,513,110 award value). The Execution plan included treatment by fragmentation of the tarcrete, where applicable, and applying organic soil amendment to accelerate and enhance ongoing natural recovery. According to the Panel recommendations, the tarcrete-covered areas inside KOC fences in the oil fields (25 km^2 in the North and 175 km^2 in the South) should be fragmented manually and treated with organic amendments to encourage the recovery of the soil. Regarding the Tarcrete claim element, and in consultation with KNFP the remedial approach was modified based on the current tarcrete conditions and the following was implemented:

- For NK Tarcrete areas (~ 25 km^2) the quantitative risk-based assessment (QRA) was conducted by Worley PMC in 2019-2020 and had determined that the tarcrete deposits across the NK sites are unlikely to cause pollution to the fresh groundwater resources in the Al-Raudhatain and Sabriyah fresh groundwater aquifers. Subsequently, it was concluded that remedial action consisting of removal of the surficial tarcrete deposits is not warranted and the tarcrete deposits will remain undisturbed.
- For SK Tarcrete areas (~175 km^2) the RBA study was conducted in 2017 and concluded that the tarcrete deposits have no impacts on the Environment and Public Health at the present deposit form and no actions on tarcrete deposits are warranted.

Figure 3.6 Tarcrete

As per KOC and KNFP plan, due to KOC operational plans and active developments, no direct seeding with camel pitting can be done as per original UNCC approved plan. However, revegetation in areas outside the tarcrete deposits was recommended. Subsequently KOC plans to revegetate areas of approximately 10-15 km^2 in selected locations not prone for field development In addition, based on the outcomes of the RBA and QRA, KOC and Worley PMC has developed the Tarcrete Handling Procedure to provide guidelines for asset owners for future activities and handling of tarcrete if encountered within the development areas.



CLAIM NO 5000454 (REMEDIATION OF AREAS DAMAGED BY OIL LAKES, OIL-CONTAMINATED PILES, OIL TRENCHES AND OIL SPILLS)

Element 1: Remediation of areas damaged by oil lakes, etc.
Element 2: Re-vegetation of areas damaged by oil lakes, etc.

This claim focuses on the remediation of areas damaged by crude oil contamination within 114 km^2 of KOC's oilfields in the form of:

- Wet Oil Lakes
- Dry Oil lakes
- Oil-contaminated piles

More than 2,200,000 (m^3) of contaminated soil within oil fields have been UXO cleared, excavated, and transported to the two engineered landfills in North & South Kuwait All Wet Oil Lakes in North Kuwait has been cleared.

WET OIL LAKES

These areas occur as covered with black liquid (highly weathered oil) and semi-solid oil-saturated material resulting from oil flow from damaged oil wells. In areas where large volumes of oil accumulated was because of local topography and micro relief. Investigations revealed that the average depth of oil contamination in the wet areas is approximately 63 cm (Figure 3.7).

Figure 3.7 Wet Oil Lakes

DRY OIL LAKES

They are generally found in shallow depressions and/or flat areas. The dry contamination areas cover almost 100 km^2 of the desert, with an average depth of approximately 25 cm (Figure 3.8).

Figure 3.8 Dry Oil Lakes

OIL CONTAMINATED PILES

Soil piles contaminated with oil are found where earth-moving equipment was used to consolidate oil contaminated soil and/or liquid oil into mounds (Figure 3.9).

Figure 3.9 Oil Contaminated Piles

Figure 3.10 TL SRP II Muthanna Al-Momin with AP delegates in the Ceremony of Completion of Landfill Projects in NK and SK

Figure 3.11 SRG Team Members Field Visit in the Ceremony of Completion of Landfill Projects in NK and SK

Figure 3.12 KNFP, AP, KEPA delegates in the Ceremony of Completion of Landfill Projects in NK and SK

DEMO COMMITTEE

As mentioned earlier, "F4" Panel recommended the following in the fourth installment report of 2004:

- Excavation of approximately 26 million m^3 of highly/visually oil-contaminated soils (from dry and wet oil lakes, and oil-contaminated piles) containing an average 19% of oil and transportation and disposal of these soils into a number of engineered landfills.
- In-situ bioremediation of the residual soil after excavation through both active and passive means.
- Re-vegetation of selected areas following removal of contaminated material.

Figure 3.13 KOC DCEO, SRS Team members, KNFP and PMC in the Remediation Technologies Demonstration Workshop in 2014

It was understood that the above-mentioned "F4" Panel recommendations may be modified if appropriate: cost-effective soil remediation solutions can be developed as alternatives to engineered landfills, based on successful implementation of the Remediation Technologies Demonstration Project (or DEMO Project). The budget initially made available for the assessment of treatment technologies was $15 million.

On 3rd March 2014 a steering group referred to as Demonstration of Remediation Technologies Committee ('the DEMO Committee') was formed to review and focus on the remediation/contracting strategies, available options, and "lessons learned" to drive the success for the Demonstration Project and seek alternative solutions to the engineered landfills recommended by the "F4" Panel of the UNCC The Committee had members from Kuwait National Focal Point (KNFP), Kuwait Oil Company (KOC), and AMEC Project Management Consultant (PMC).

THE KEY OBJECTIVES OF THE COMMITTEE WERE:

1. Identify and develop appropriate execution steps that could contribute to the prudent advanced planning and successful implementation of the Demonstration Project;
2. Derive the best possible solution for remediation of large quantities (approximately 24 million m^3) of oil-contaminated soils spread over very large areas (114 km^2) at reasonable costs, when compared to the life-cycle costs of engineered landfills, meeting the required schedules, and the set TPH target concentration.

In December 2014, the DEMO Workshop was held with the following objectives:

- To identify options for the implementation of the DEMO Project within the current funding limit or under the possibility of additional funds made available to the required level.
- Derive the best option/approach for the DEMO Project implementation that could benefit the remediation of large-scale (26 million m^3) of contaminated soils, at comparable costs to the life-cycle costs of engineered landfills.

DEMONSTRATION INITIAL STRATEGY

This is related to the compensation awarded by the UNCC in the claim No: 5000450 (Terrestrial Resources) and 5000454 (Oil Lakes).

The plan to implement Demonstration Project inside the South & East KOC operational area to treat dry oil lakes, wet oil lakes and oil contaminated piles was developed following the 2014 DEMO Workshop.

This concept was developed for demonstration of proven technologies appropriate to manage cost, volume scale and time bound.

- To develop, monitor, and compare the effectiveness of various remediation approaches.
- To select the most successful technologies based on the above-specified criteria.
- To determine the long-term project implementation of soil remediation based on the selected technologies.
- To apply a risk-based methodology of remediation concurrent with recognized international protocols for In-Situ and Ex-Situ remediation.
- To demonstrate proven technologies effectiveness in remediating the oil contaminated soil (to achieve the established RTC) considering cost, volume scale and time.
- To develop, monitor and compare the effectiveness of various remediation approaches, considering costs/expenditures (amounts of water, energy, reagents, etc.) used by contractors.
- To select the most successful technologies based on the above-specified criteria and determine the long-term project implementation of soil remediation strategy based on the selected technologies.

The Contractors were proposed to treat a proportional soil volume (10,000 m^3)and types of features.Technical proposals were collected for KOC's review and approval; including the design and construction of site/facilities for the remediation process in the assigned areas and to carry out a monitoring program for each individual technology across the whole process of remediation.

Figure 3.14 KNFP and PMC in the Remediation Technologies Demonstration Workshop in 2014

5000460 MARINE & COASTAL RESOURCES

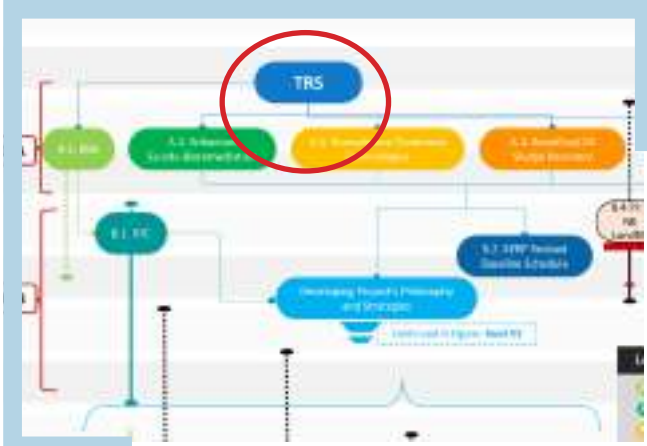
Awarded claim value of approximately 2 billion US Dollars pertains to the works within PAFF.

Chapter - 4

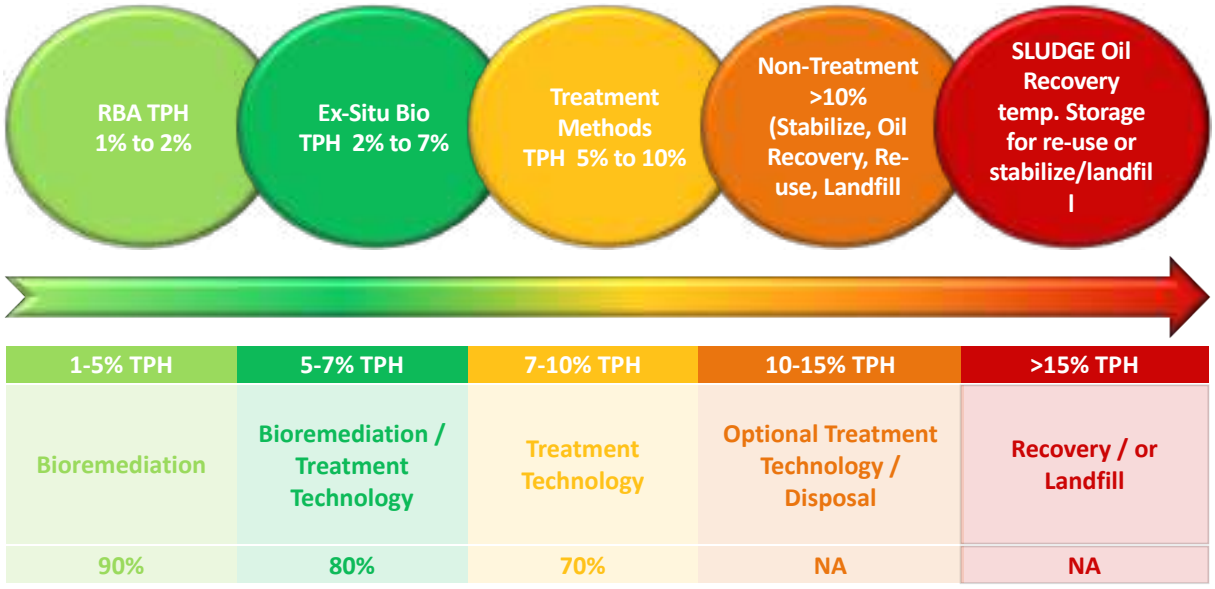
Shaping The KERP Vision & Preparing for the Journey

TOTAL REMEDIATION SOLUTION - OUR KEY TO SUCCESS

During the initial phase, the original plan for contaminated land management in KERP was to focus on excavation of heavily oil contaminated material with long-term storage at landfills facilities specifically constructed for KERP. Later KOC sought more environment friendly alternative approaches to their contaminated land management. Total Remedial Solution or TRS was the resultant strategy of this research. Through the adoption of TRS, a holistic remedial strategy vision was realized to minimize landfills and promote more sustainable and greener remedial solutions. TRS balances the environmental needs while satisfying key stakeholders including the United Nations, KEPA, KNFP and the client, KOC. This approach also seeks to achieve the most cost-effective approach for the remediation of such vast quantities of contaminated materials.



This revised strategy under the PMC contract was developed to conduct the remediation through more sustainable means and therefore reduce the number of landfills. It aims to minimize the need to construct 17 landfills with an ambitious target of reducing the overall landfill capacity from 26 million m^3. This will be achieved by using a combination of alternative remedial solutions that form the 'Total Remedial Solution' (TRS). In principle, the TRS relies on treating certain ranges of TPH contamination with the most appropriate technique and comprises the following five key elements:

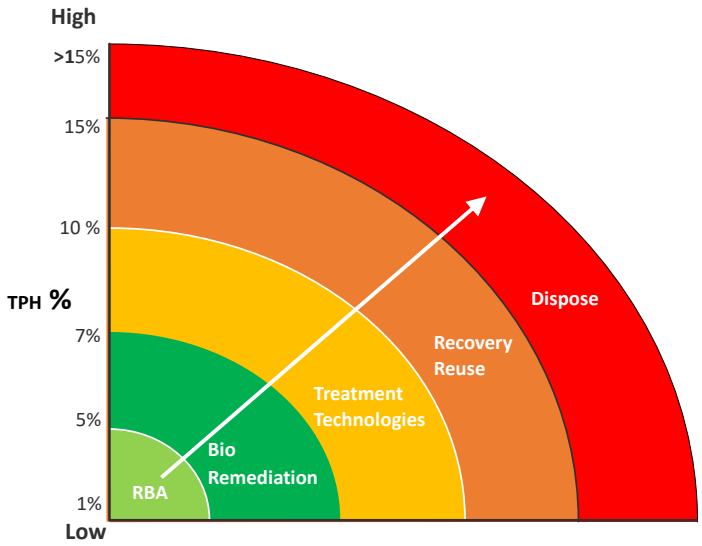


1-5% TPH	5-7% TPH	7-10% TPH	10-15% TPH	>15% TPH
Bioremediation	Bioremediation / Treatment Technology	Treatment Technology	Optional Treatment Technology / Disposal	Recovery / or Landfill
90%	80%	70%	NA	NA

A Risk Based Approach study to determine which areas can be left untreated based on land uses and the risk they represent for Humans, Fauna & Flora.	Some Areas can be remediated via Bioremediation which is a proven and approved method by UNCC.	Portion of the contamination will be treated via Remediation Technologies	Untreatable or non-reusable material must be disposed in a Landfill.	Some soil with high levels of oil content can be re-used or recycled. A study will enable to proceed with this approach.

Figure 4.1 Total Remediation Solution (TRS)

RISK BASED APPROACH (RBA)



1. The RBA provides the understanding of the TPH contamination and therefore provides the justification to minimize the requirement for remedial intervention. The process uses chemical data and combines this with an understanding of the potential harm posed by the varying contaminant concentrations. Where there is limited harm being caused intervention may not be required, however where there are areas of high contamination these get removed and the RBA provides the acceptable levels that may remain. By utilizing internationally recognized risk assessment models, acceptable TPH concentrations for human health and environmental receptors shall be determined RBA is critical to assess the contamination and remediate the land in a way most sustainable and beneficial to human health and the ecology.

Figure 4.1.1 Total Remediation Solution (TRS)

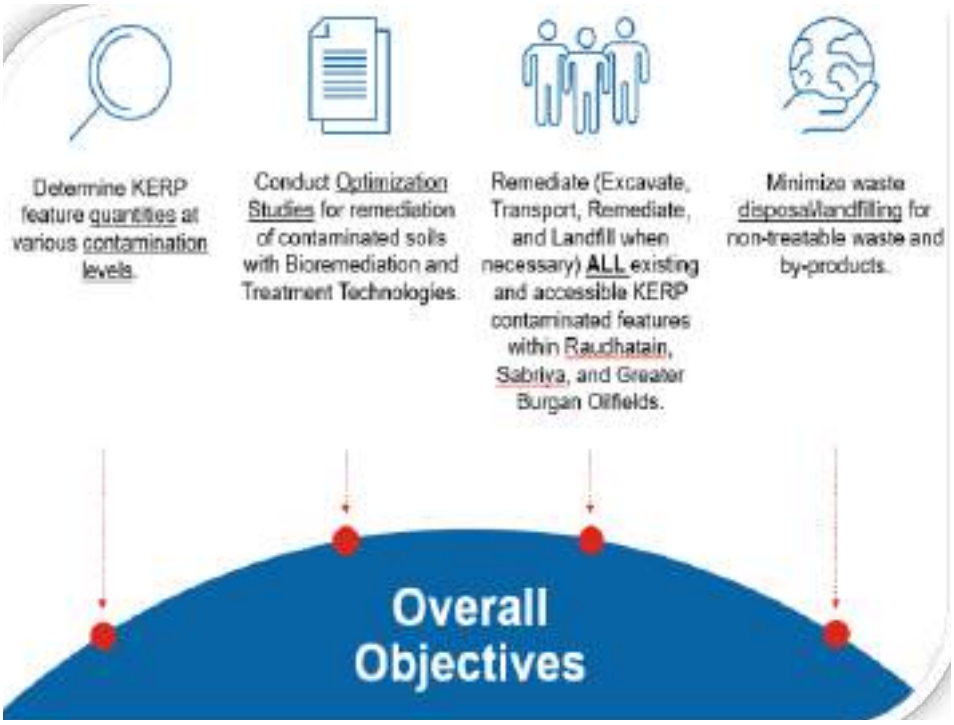


Figure 4.2 Diagram Depicting Projects Strategies Originating from Total Remediation Solution (TRS)

Figure 4.3 Part of RBA Workshops and Meetings between SRG team members with KEPA Officials

ACTIVE/ENHANCED BIOREMEDIATION

2. Soil contaminated with 'low end' TPH concentrations shall be addressed with enhanced active bioremediation. This remedial solution is robust, well proven, and cost-effective approach to address high volumes of oil contaminated soils, demonstrated in the past to be effective in desert environments.

REMEDIATION TREATMENT TECHNOLOGIES

3. Used to treat more challenging TPH concentrations, to address potentially 20% of the total volume of contaminated soils. Sustainability is one criterion for selection of treatment methods.

SLUDGE THOUGH BENEFICIAL RECYCLING OR RE-USE

4. Oil sludge is the most challenging source contaminant to be addressed and it represents potentially 20% of the total volume. Treatment is highly energy intensive and comes at high cost and low output. The approach for sludge includes identifying a disposal outlet through a re-use/recycle option. This will rely on separation from wet oil lake and temporary storage without mixing. Market assessment and construction of temporary storage forms are part of this solution. Where there is no re-use option for some of the product, then the most acceptable disposal route will be identified, minimizing the quantities where possible. This subject area is reliant upon a smart understanding of the material type and variability and utilizes best practices for material management to make the most of this process.

CONTAINMENT IN ENGINEERED LANDFILLS

5. This is the default position that matches the existing strategy but for the most challenging TPH contamination concentrations only. Any untreatable material that requires consignment to landfill will have measures put in place to minimize volumes requiring disposal.These works are to be supported by essential enabling works which are parallel activities that include site soil characterization (SSC) through data acquisition and clearance of unexploded ordnance (UXO), of which there is an abundance in the oilfields. The most important aspect is to ensure that large areas are cleared of UXO to enable the excavation of the volumes required.

The TRS has helped in shaping and defining a more sustainable approach for handling the KERP legacy contaminated soil as shown in the diagram in figure 4.2.

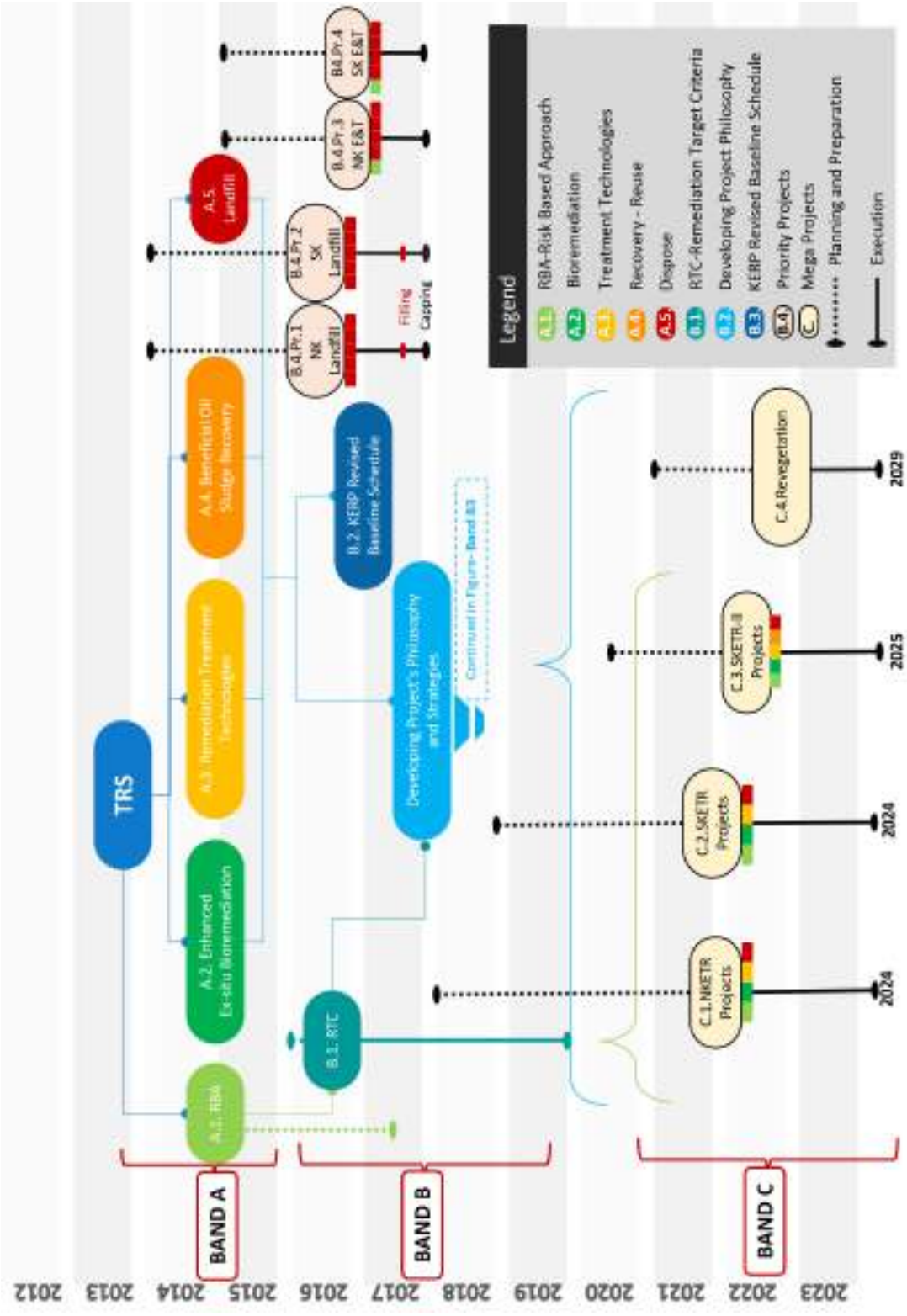


Figure 4.4 Diagram Depicting Total Remediation Solution (TRS) as the Overarching Umbrella for the KERP Projects and their Linkages

TRS CHARTS

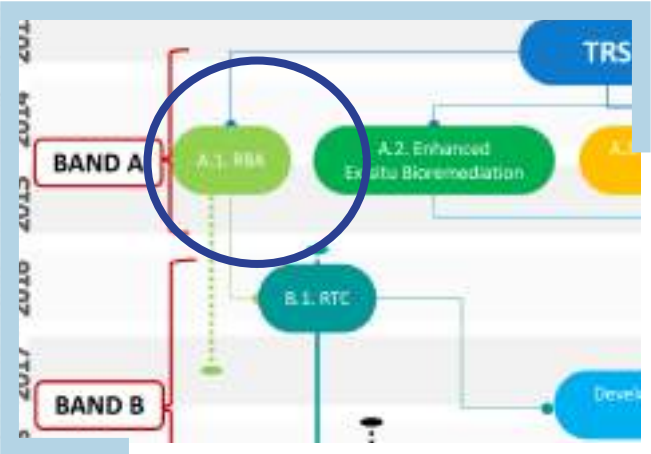
Figure 4.4 depicts the TRS strategy, its elements, results, prerequisites and the activities or projects juxtaposed in a timeline. To follow the process, we have divided it into different bands for the readers to understand. Band A refers to the different elements in TRS while the philosophy/strategy is in its conceptualization stage. Band B refer to the second stage which is the strategy and philosophy Developmental stage. Band C refer to the implementation stage. Each of the stages and its constituent elements are delt in detail along the different chapters of this book.

A ELEMENTS OF TRS IN KERP

As explained before TRS strategy have different elements and the rest of this chapter deal with the development and implementation roadmap of the first element of TRS (please refer to Figure 4.4), the RBA (A.1.) in detail and its resultant, Remediation Target Criteria (RTC) (B.1.) which is the criteria for soil clean up, derived from RBA. The chapter also deals with the Pre-Requisites and enabling activities which facilitated the strategy formation and implementation (B.3.1.) which are Site soil characterization, Spatial and Environmental Data management and UXO Clearance.

A1 RISK BASED APPROACH (RBA)

The first element of TRS strategy incorporated a risk-based approach (RBA) as an important element of implementation. The RBA provides the vehicle to reduce any unnecessary remediation activity where it can be demonstrated, through appropriate risk assessment, that human health and the environment are sufficiently protected in the absence of remediation activity in specific areas or circumstances. To facilitate this, as a first step, KOC-SRG established a committee headed by Soil Remediation Support team (SRS), and various stakeholders (KEPA, MEW, PAAF, KNFP) overlooking the KERP program were invited to a series of workshops, and seminars conducted by the SRS team. These intensive efforts detailed on the objectives of RBA study and shaping the way forward.



During the execution of the RBA study with the support of the PMC and under careful follow-up and guidance from SRG team members several discussions, seminars and presentations were delivered at every step of the work to discuss technical elements like the: Conceptual Site Model (CSM) model, risk assessment, hazard identification, exposure & pathways assessment, toxicity assessment, and risk characterization. Due to the leadership, commitment, and ambition, the efforts undertaken in this main element of the TRS has resulted in achieving KEPA's approval on the CSM model results and outcomes in October 2017.

The RBA approach adopted was in accordance with the internationally recognized Risk-based Corrective Action (RBCA) methodology. This approach had been agreed with Kuwait Environment Public Authority (KEPA) and was according to the widely accepted RBCA framework published by American Society for Testing and Materials (ASTM) and therefore it was considered appropriate for use in the State of Kuwait, where oil contamination is present.

The risk-based approach takes into consideration the physical state of the contaminants together with contaminant concentrations and the potential for exposure of harmful substances. It also takes into consideration, the locality with respect to identified receptors. Through risk assessment this provides justification for areas to be left undisturbed and provides the justification and rationale for reasonable remediation target criteria that govern excavation depths. For post-treatment soil results that are marginal, this risk management tool provides a reasonable and justifiable approach.

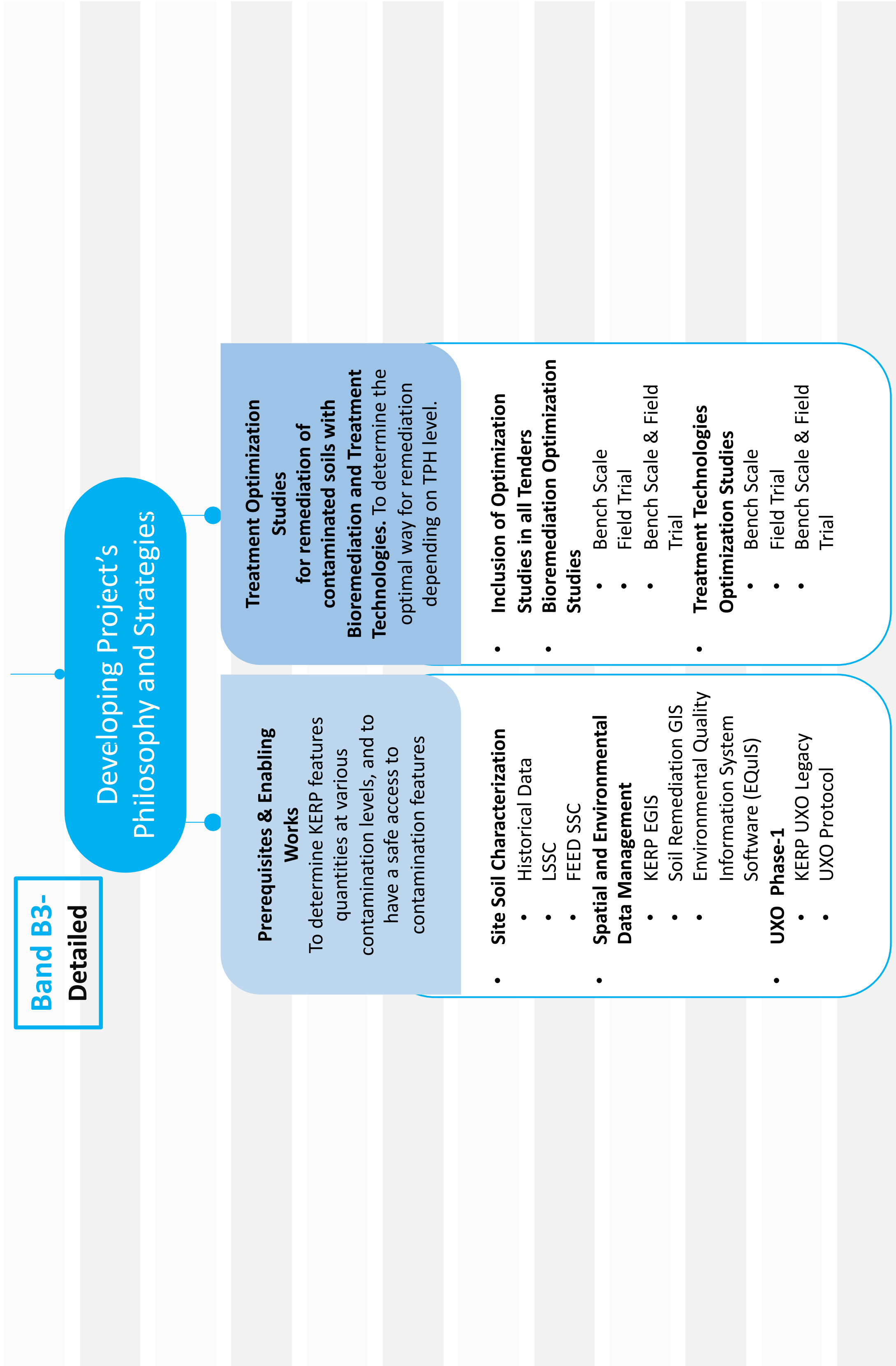
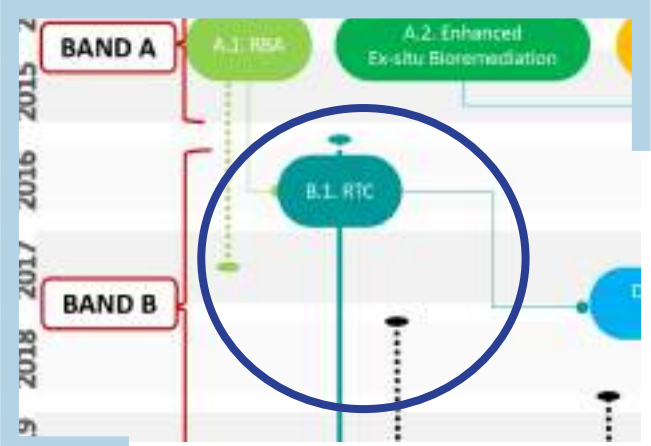


Figure 4.5 Explains in detail Element B3 of TRS which is Developing project's philosophy and strategy, it includes, the enabling works and remediation technologies which aided the development of the strategy and facilitating the implementation of TRS

B.1 RTC- REMEDIATION TARGET CRITERIA [RBA DERIVED SOIL CLEANUP CRITERIA]

Prior to 2009, KOC had adopted one of the most stringent soil remediation standards for petroleum hydrocarbons, which was 0.5% TPH for the majority of contaminated features within its remediation projects. This was because the environmental regulator, Kuwait Environmental Public Authority (KEPA) initially set the remediation target criteria (RTC) to a precautionary 0.5% Total Petroleum Hydrocarbons (TPH) for the treatment of contaminated soil. However, within the context of an industrial environmental setting, KOC realized that the required RTC was stringent compared to similar international oil and gas settings and decided to conduct various studies to determine if the RTC could be revised to a concentration that would not adversely affect human health or the wider environment, specifically within the fenced oilfields. As part of the Total Remedial Solution (TRS) established in 2014, the objective was set to re-assess the potential risks that the oil contamination presents to human health and the environment by means of the Risk Based Approach (RBA).



RBA uses internationally recognized risk assessment models to determine acceptable TPH concentrations for human health, groundwater, and ecology, and curbing the requirement for unnecessary remedial intervention. Consequently, KOC conducted a risk-based assessment, to international standards, developing an initial Conceptual Site Model (CSM) to review contaminant-pathway-receptor pollutant linkages and then modeling risks to human health, ecological and groundwater, utilizing available site-specific data. The outcome of this study identified human health and ecology as the most vulnerable receptors with minimal to no risks to groundwater. The KERP RBA Phase I was established on the basis of site-specific knowledge and available data, establishing contaminant-pathway-receptor pollutant linkages as part of the Conceptual Site Model development, and applying this information into internationally recognized and tested risk assessment models to develop soil and groundwater clean-up criteria that are most appropriate for the KERP program and, potentially, for other KOC projects (i.e SEED).

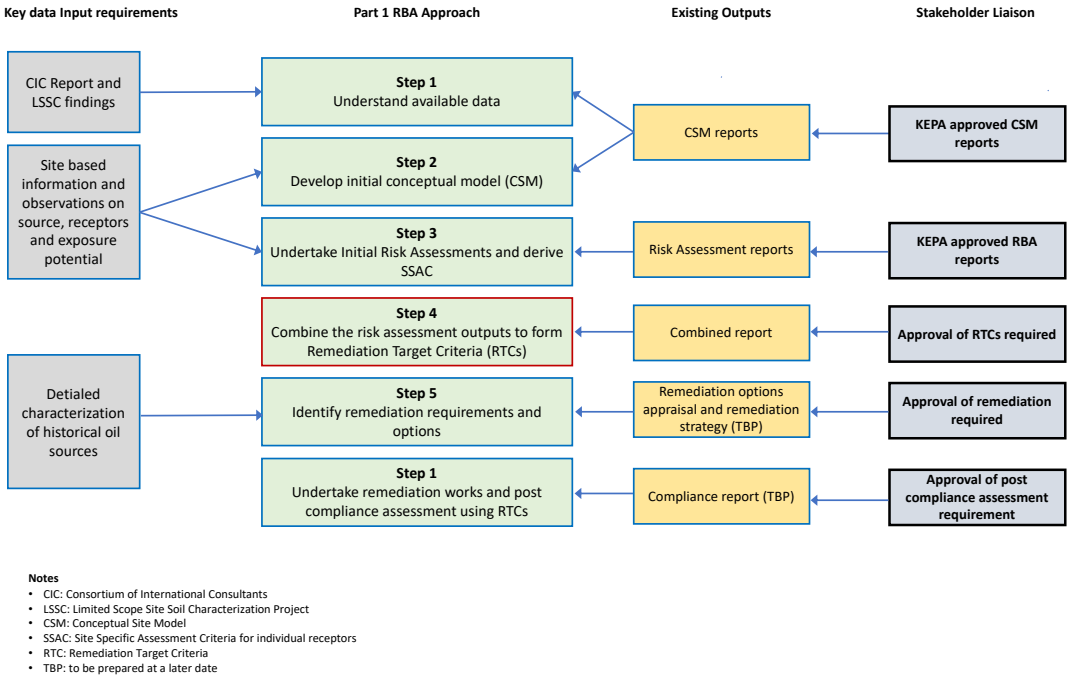


Figure 4.6 Identifies the key steps in the RBA, including key data and stakeholder liaison requirements.

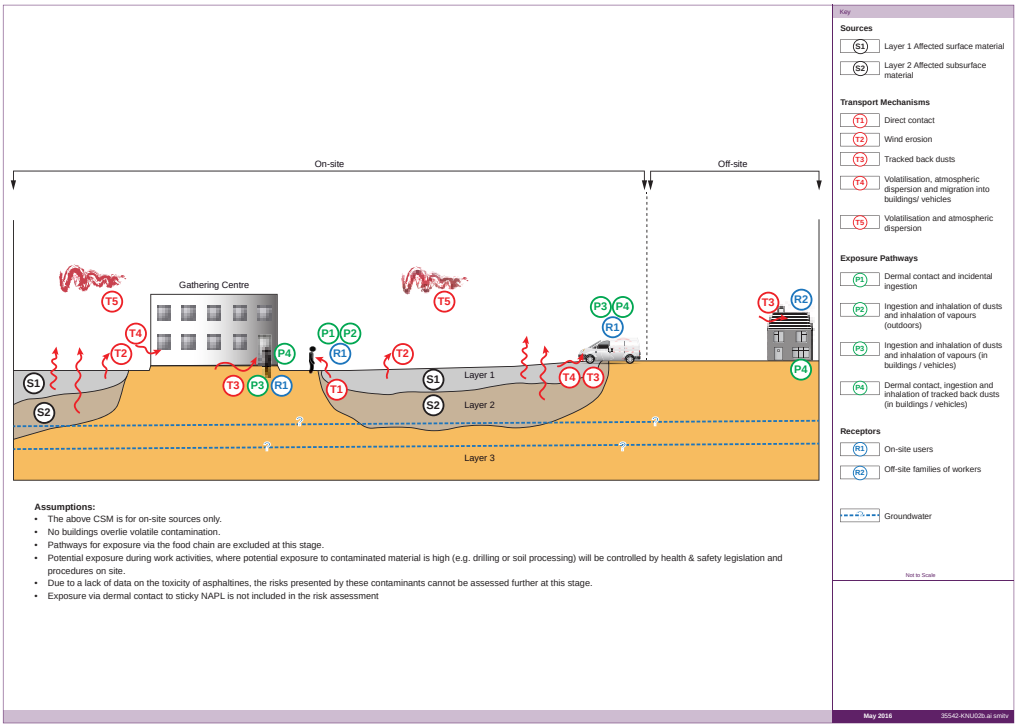


Figure 4.7 Conceptual Site Model for Dry and Wet Oil Lakes in South Burgan Oil Field

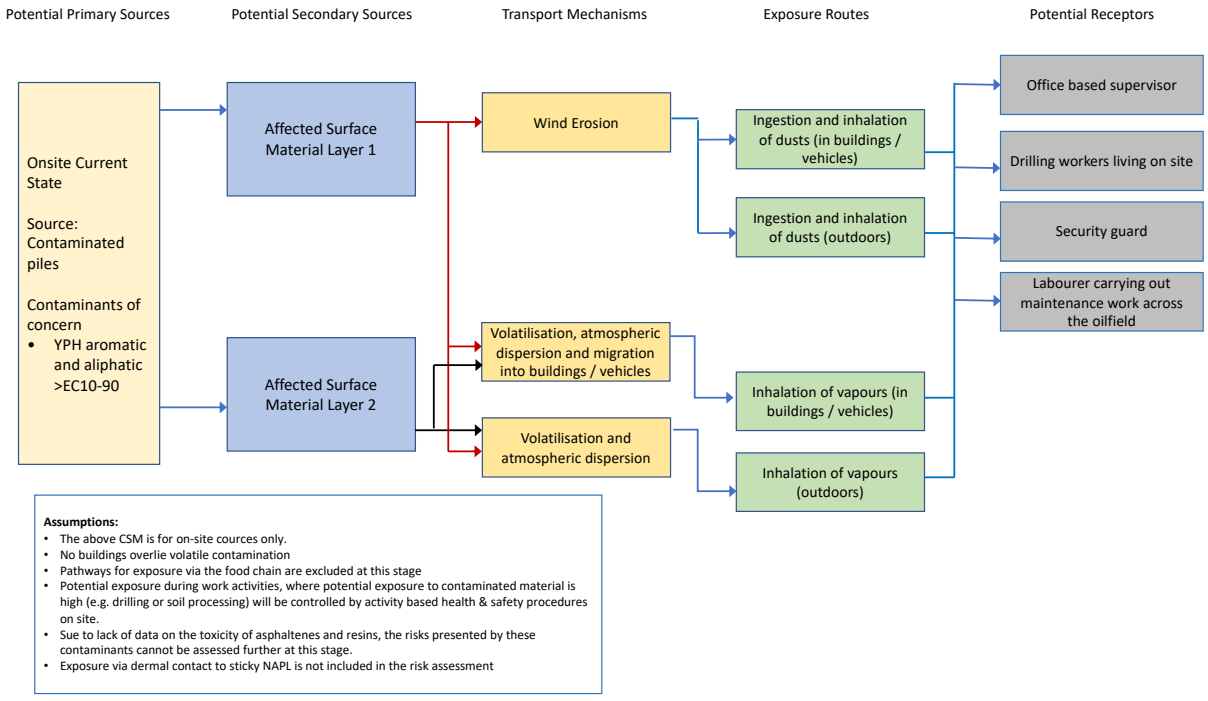


Figure 4.8 Potential Pollutant Linkages for Oil Lakes in South Burgan Oilfield

The output from KERP RBA Phase I indicated that the shallow soil hydrocarbon contamination does not pose a risk to groundwater when degradation was occurring, even at conservatively low rates. KOC conducted an additional study relating to risks to existing ecology (fauna and flora) in the oilfields. This study derived an Alternative Eco-toxicity Remediation Standard of 1% TPH to replace the initially approved Primary Eco-toxicity Remediation Standard. The ecological assessment identified potential risks to flora and fauna, but the risk drivers were noted to be significantly conservative due to the lack of site-specific data. The main risk driver was with respect to human health. The human health risk assessment identified the critical receptor to be oilfield labors with a concentration threshold of 6,100 mg/kg (0.61%) TPH below which was considered as not posing significant risk of significant harm. An upper threshold was not calculated due to the variance in the composition of the hydrocarbon contamination, but a sensitivity analysis estimated remedial criteria could exceed 1% TPH.

In parallel, as part of SEED, the KOC rehabilitation program was designed [1] to measure the effectiveness of the remediation processes for effluent pits, sludge pits and gatch pits in the Burgan Oil Field. Under SEED, SRG tested and compared various ecological functions for native Kuwaiti plant species (plant exposure, establishment, growth, survival, etc.) for both a primary soil remediation standard of 0.5% TPH and alternate soil remediation standard of 1% TPH. This study showed no apparent impact on overall plant survival between primary soil remediation standard and alternate soil remediation standard. The results revealed that plants can successfully tolerate TPHs up to 10,000 mg/kg as indicated in the alternate soil remediation standard or Remediation Target Criterion (RTC). Accordingly, on the basis of all studies done in KERP coupled with the developments/studies done in SEED projects relative to the eco-toxicity remediation levels of 0.5% and 1% TPH, SRG concluded that there was no significant difference between the two approaches. Subsequently, KOC SRG submitted to KEPA all the risk-based studies and their outcomes suggested to revise RTC to 1% TPH. SRG & KEPA has diligently reviewed and agreed on the new remediation standard of 1% TPH (Hexane Extractable Material).

The revision of RTC from 0.5% (former) to 1% TPH will result in the significant reduction of remediation treatment durations and consequential cost savings, thereby providing scope to employ additional technologies to achieve the global remediation goal more efficiently.

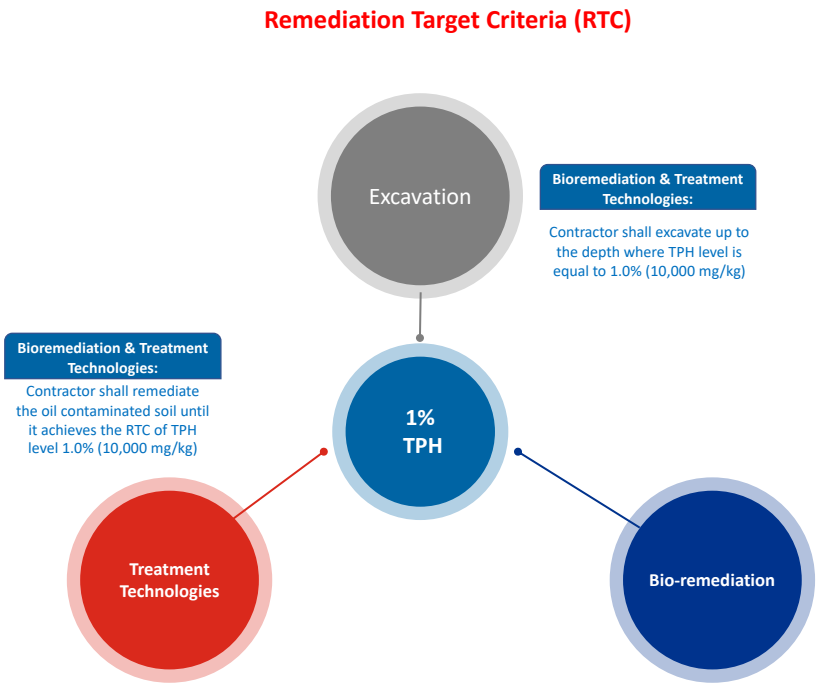


Figure 4.9 Remediation Target Criteria (RTC)

Figure 4.10 SEE Aisha Al-Barood Presenting the Outcomes of the RBA Study

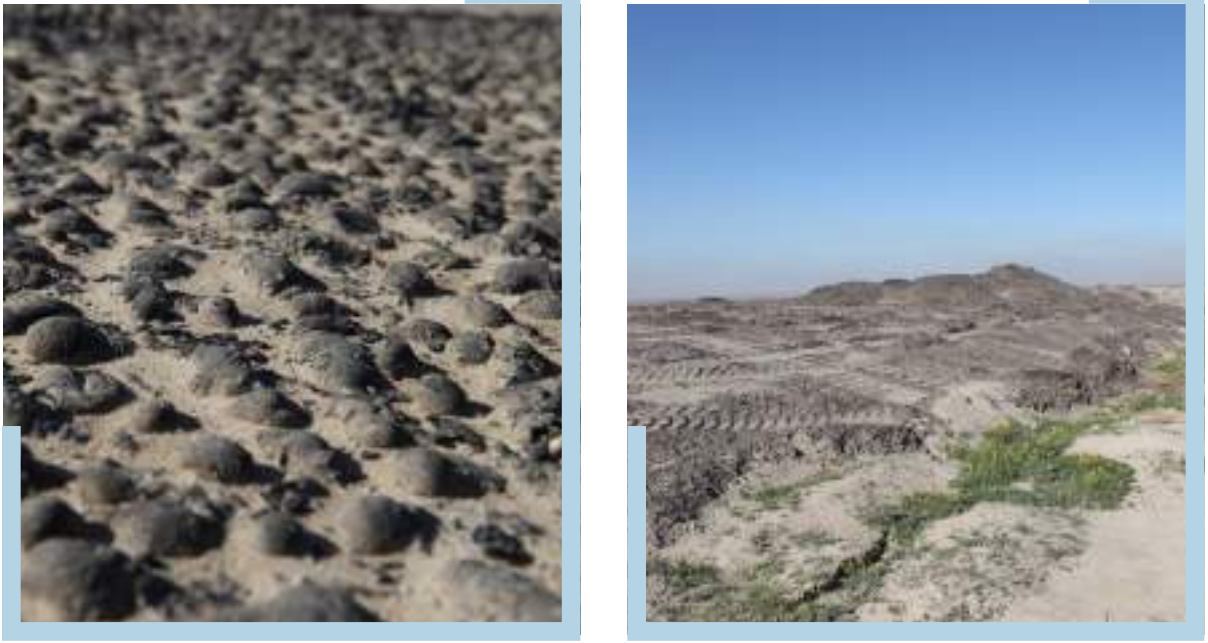


Figure 4.11 Tarcrete Contamination

A.1 2 RBA FOR TARCRETE MATERIAL

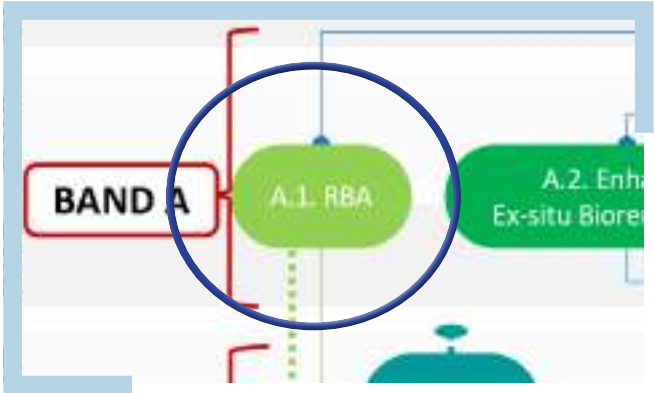
Given the large-scale coverage of the tarcrete in the oil fields and a perception that the residual contamination associated with this tarcrete material of 20 Km^2 is present in an environmentally sensitive area, KOC undertook to support a case with the regulators to determine, using RBA, if the tarcrete poses a significant risk of harm in its current form and distribution.

Advisian (Worley subsidiary) was retained by KOC to undertake the development of a conceptual site model and subsequently to conduct a quantitative risk assessment for water resources potentially impacted by tarcrete deposits located in the Sabriyah and Raudhatain oil fields in North Kuwait (the site).

The objectives of the assessment were to:

- Develop a conceptual site model for tarcrete deposits, groundwater resources and potential pollutant linkages in the site area.
- Complete risk-based modeling including;
  - The parameterization and running of selected risk models.
  - Derivation of site-specific assessment criteria (SSAC) for use on site; and
  - Quantification of the risk to identified waters resource receptors posed by tarcrete impacted soils at the site.
- Present the updated conceptual model relating to risks to water resources;
- Evaluate the significance of the risk posed to water resources from the tarcrete impacted areas of the site.

The assessment was undertaken in accordance with the IPEICA good practice guide 'Management and Remediation of Sites in the Petroleum Industry' (IPEICA, 2014). A defined risk-based corrective action (RBCA) methodology developed by ASTM (ASTM, 2015) for assessment and remediation of petroleum release sites was adopted in the assessment. RBCA combines risk-based decision making with a corrective action process (IPEICA, 2014). The goal of the process is to identify when remedial action is warranted and to select the most practical, cost-effective remedial approach to protect groundwater resources at the site.



PRELIMINARY RISK ASSESSMENT

To form an integrated understanding of the site conditions, the extent of the contamination and the potential impact on receptors, a conceptual site model (CSM) was developed. Available site-specific and regional data were reviewed and used to define an initial CSM. This CSM is a representation of the conditions and the processes that control the transport, migration and potential/actual impacts of tarcrete-related contamination of groundwater receptors at the site. It was considered that sufficient information is available to allow a suitable CSM with clearly defined sources, pathways, and receptors to be developed for the purposes of this project.

The CSM identified multiple complete pollutant linkages at the site which have the potential to pose an unacceptable risk to groundwater resources. Where the risk associated with a linkage was assessed as insignificant, unlikely to be realized, or evaluation of a more probable linkage or potentially more significant linkage was considered suitably protective, the linkage was discounted from further assessment. Following this evaluation, a single pollutant linkage was selected to be investigated further to determine whether the impacts identified during site characterization present unacceptable risks to groundwater receptors. Assessment of this linkage was considered to be suitably protective of the other viable receptors related to groundwater resources at the site.

The linkage selected to be assessed in detail was:

- Contaminated soil/NAPL of the tarcrete source material at the ground surface undergoing leaching/ dissolution during major rainfall events with overland wadi flow and collection in playa lakes.
- Infiltration of contaminated water into the soil profile followed by vertical migration through the unsaturated zone to the water table.
- This water entering and mixing with a significant fresh groundwater receptor, present as lenses within the upper part of the Kuwait Group aquifer.

QUANTITATIVE RISK ASSESSMENT

In the second phase of the assessment quantitative risk assessment (QRA) was used to assess whether pollution of fresh groundwater resources at the site is being caused, or is likely to be caused, by migration of impacted rainfall runoff and aquifer recharge, following interaction with residual surficial tarcrete deposits at the site under current conditions.

The RBCA methodology uses a tiered approach in the assessment of risk, involving increasingly sophisticated levels of data collection and analysis. Tier 1 of the QRA involved the comparison of site data (analytical results for leachate) with published screening criteria. These generic screening criteria were determined based on the contaminant, exposure route and the receptor. The nominated water quality target criteria (WQT) in the assessment are aligned with Kuwait's 'Environment Public Authority Decision No 12-2017. Issuance of Executive By-Law of the Protection of Coastal and Marine Environment from Pollution'. Criteria of treated drainage wastes water used in irrigation and Appendix No.2 Un-bottled Potable water Where site concentrations exceed the Tier 1 generic screening criteria, the contaminants were taken through to the site-specific. Tier 2 assessment and defined as constituents or contaminants of concern (COCs).

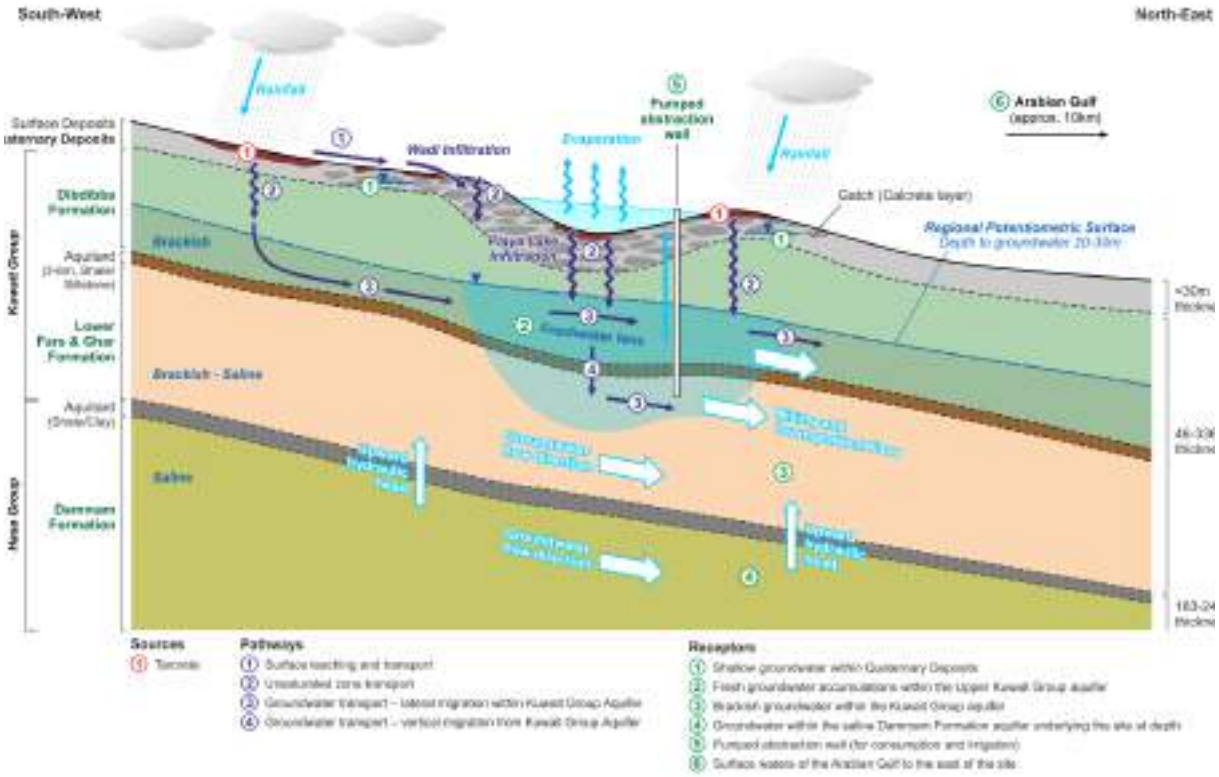


Figure 4.12 Conceptual Site Model for Tarcrete and its Interaction with Groundwater Resources in North Kuwait Oilfield

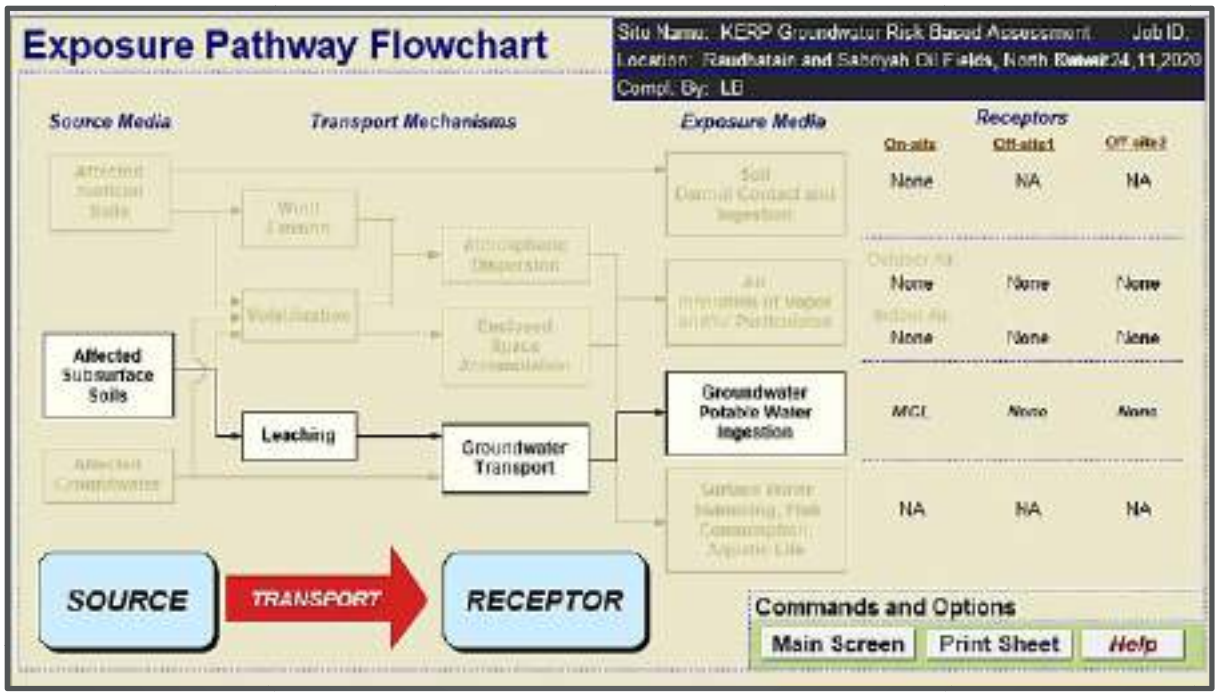


Figure 4.13 Exposure Pathway Flowchart

The Tier 2 detailed Site-Specific Risk Assessment level of assessment involved the use of the RBCA Tool Kit software model to aid in the assessment of risk, using site-specific characteristics and properties, and contaminant transport modeling. This software is a simple one-dimensional analytical model. It enables the simulation of the fate and transport processes involved in the leaching of contaminants from affected soils via vertical migration to the water table, followed by lateral migration within groundwater COCs evaluated in the assessment included soluble environmentally mobile total petroleum hydrocarbon fractions (mid-range aromatic compounds) and metals including copper, chromium, lead, and nickel. The compliance point adopted in the assessment was at the base of the unsaturated zone, at the water table of the freshwater lens.

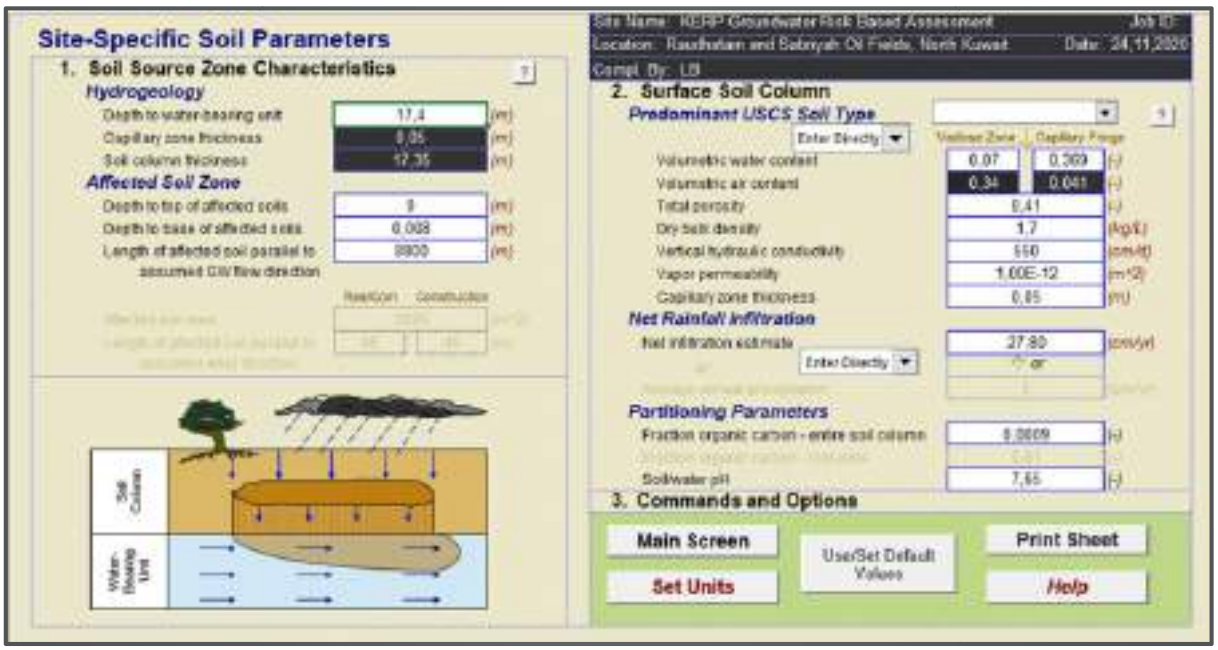


Figure 4.14 Soil Parameters and Leaching Model

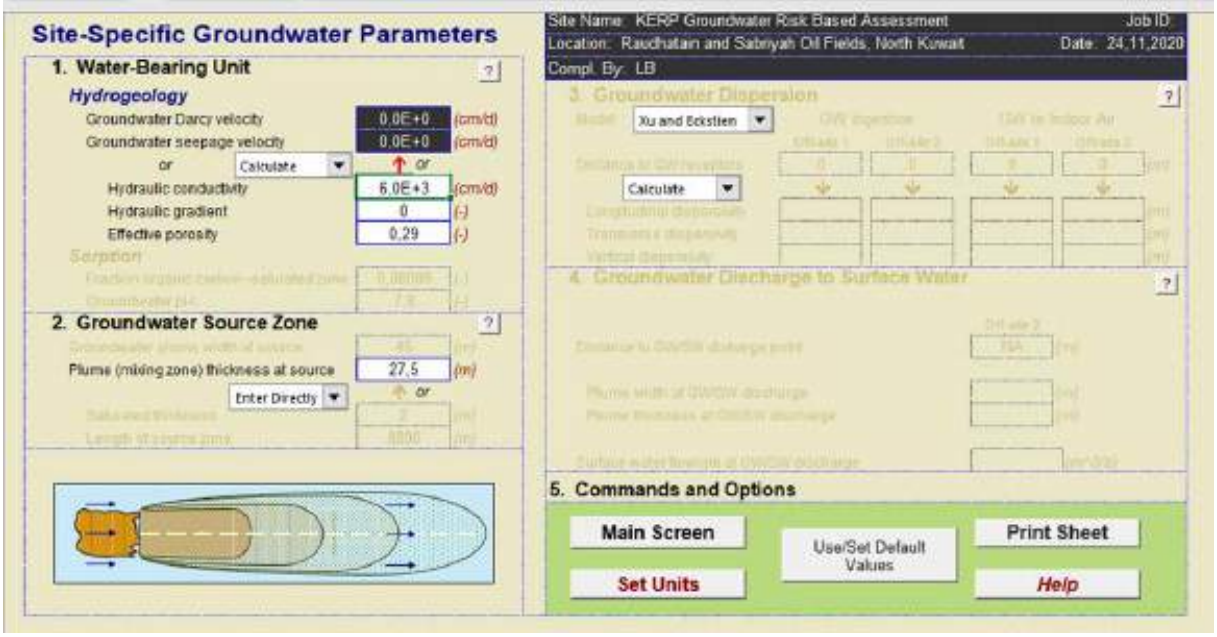


Figure 4.15 Groundwater Parameters and Potentiometric Plume Model

Using maximum concentrations from the leachate analyses of the tarcrete deposits, the RBCA model was used to predict the concentration at the base of the unsaturated zone immediately upon entry to the freshwater aquifer i.e. the compliance point. These predicted concentrations were lower than the WQT nominated as being protective of the drinking water and irrigation water resource. As such, tarcrete deposits at surface are not considered to pose an unacceptable risk to the water resources identified at the site The RBCA model was also used to predict clean-up levels, i.e. site-specific target levels (SSTLs), by using the WQT and backwards modeling to determine the maximum concentrations in the source zone which could be present and not pose a risk to the identified receptor. Recorded soil concentrations within the tarcrete samples collected across the site do not exceed the derived to SSTLs.

In line with best practice, consideration of the natural variability and uncertainty of parameter values was undertaken sensitivity analysis of the model by incorporating a wide range of parameter value variation within the RBCA model was subsequently used to provide greater confidence in the decisions based on the model results. When accounting for the natural variability observed in the field, all findings showed that predicted concentrations remained lower than the nominated WQT.

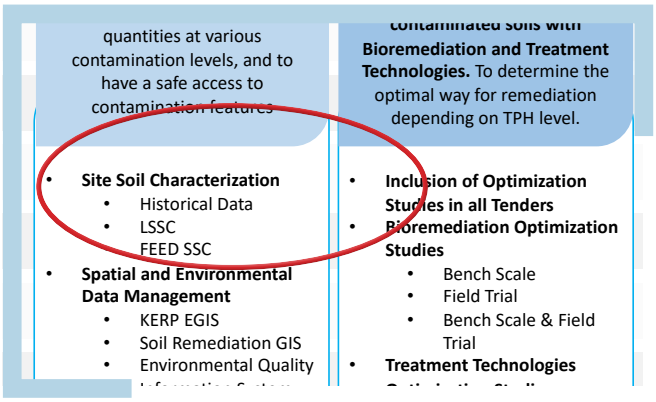
Therefore, based on risk-based assessment, large-scale remedial action to remove the surficial tarcrete deposits is not considered warranted. If the tarcrete is left in situ this study demonstrates no significant risk to groundwater resources.

B.3.1 PRE-REQUISITES AND ENABLING WORKS

Due to the complexity of the KERP program, there are various enabling activities that are to be undertaken according to and in coordination with the TRS strategy. The main Pre-requisite or Enabling works are Site Soil Characterization, Spatial and Environment data Management and UXO Clearance. Before the commencement of any work, a thorough UXO clearance should be done in all feature types to ensure the safety of Company and Contractor employees.

B.3.1.1 SITE SOIL CHARACTERIZATION

Site soil characterization is a key component of the evaluation of oil contaminated sites is to know the contamination level of Total Petroleum Hydrocarbon (TPH) level and address the remediation approach. Site Characterization focused on the Total Petroleum Hydrocarbon (TPH) parameter and is primarily used for the evaluation of oil contaminated sites. These soil investigations were conducted three times in the last decade and the latest detailed site characterization conducted in year 2016 to establish recent baseline and compare the data of earlier site studies.



HISTORIC DATA

In 2003, Kuwait's monitoring and assessment consultants analyzed data and performed mapping and analytical sampling surveys to delineate the extent of the oil lakes (wet and dry). The sampling survey involved collecting soil samples into different depths/ layers (layer 1, contaminated surface; layer 2, subsurface contaminated layer). A total of approximately 850 samples were collected and analyzed from various contaminated features at various locations in South and East Kuwait (S&EK).

LIMITED SCOPE INVESTIGATION- BURGAN – SOUTHEAST KUWAIT

KOC conducted a limited soil characterization study in November and December 2014. The focus of the limited investigation was to characterize soils that may be suitable for treatment technologies and to update the current understanding of soil contaminants and refine the aerial and vertical extent with carbon brandings to support remediation strategy. The sampling was focused on features known as 'Dry Oil Lakes' and 'Wet Oil Lake' features. The summary data for TPH analysis has been split into feature type, (i.e., wet oil and dry oil lake features), and into different layers: Layer 1 and Layer 2 which represents underlying visually clean soils. A total of 252 samples were collected and analyzed from various soil feature locations in South and East Kuwait (S&EK).

RECENT INVESTIGATIONS

The most recent environmental analytical data relates to total petroleum hydrocarbon (TPH) analysis conducted in during the period of 2016 to 2017. The samples were collected from different locations layer 1 & layer 2 in SEK Burgan fields A total of approximately 200 soil samples were collected and analyzed from various soil feature locations in South and East Kuwait (S&EK).

During the Gulf War in 1990, highly contaminated oil lakes were formed covering a large area of Kuwait's desert area As a result of oil presence, soil properties were negatively affected. Moreover, the contamination levels were extremely high that impacted the environmental land and depressed ecological and vegetation were observed throughout the impacted areas; consequently, the contaminated soil needs to be remediated to reduce the adverse environmental impacts. To know the contamination level in different period data analysis have done earlier as well recently in S&EK field.

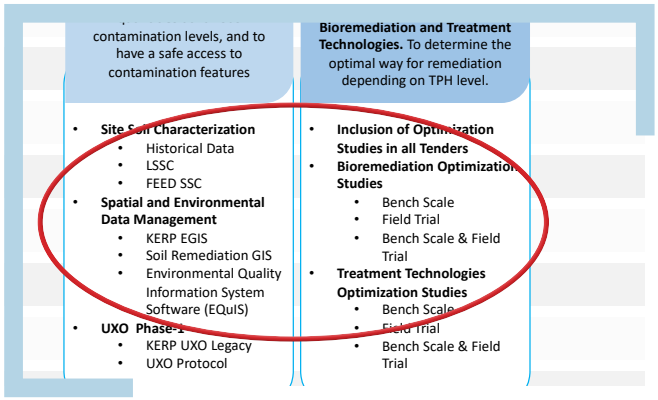
This paper predominantly highlights the recent TPH levels trends over decades and explores the trend patterns to evaluate any natural degradations over the years. No apparent natural degradation has been observed in all crude oil constituents in terms of TPH levels in both WOL and DOL features. Although considerable evaporation, photo-oxidation and weathering processes have taken over the years since the war, subsequently the TPH levels have increased drastically over the studies period. This increase is more pronounced in wet oil lakes material.

Figure 4.16 Site Visit to NK Oilfields with KEPA Representatives as part of RBA Approval and Endorsement by KEPA

Figure 4.17 DOL Soil Investigation and Characterization

B.3.1.2 SPATIAL AND ENVIRONMENTAL DATA MANAGEMENT

KERP EGIS



A Geographic Information System software (GIS) is a system that creates, manages, analyzes, and maps all types of data and aligns them geographically. GIS connects data to a map, integrating location data (where things are) with all types of attribute information (description of things). This provides a foundation for mapping and analysis that is used to inform the science and engineering works within KERP. Rooted in the fields of geography, cartography, environmental science, and computer science, among many others, GIS integrates many types of data. Particularly vector, raster, and tabular datasets. GIS helps users to understand patterns, relationships, and geographic context GIS improves communication and efficiency assists user in better management and decision making.

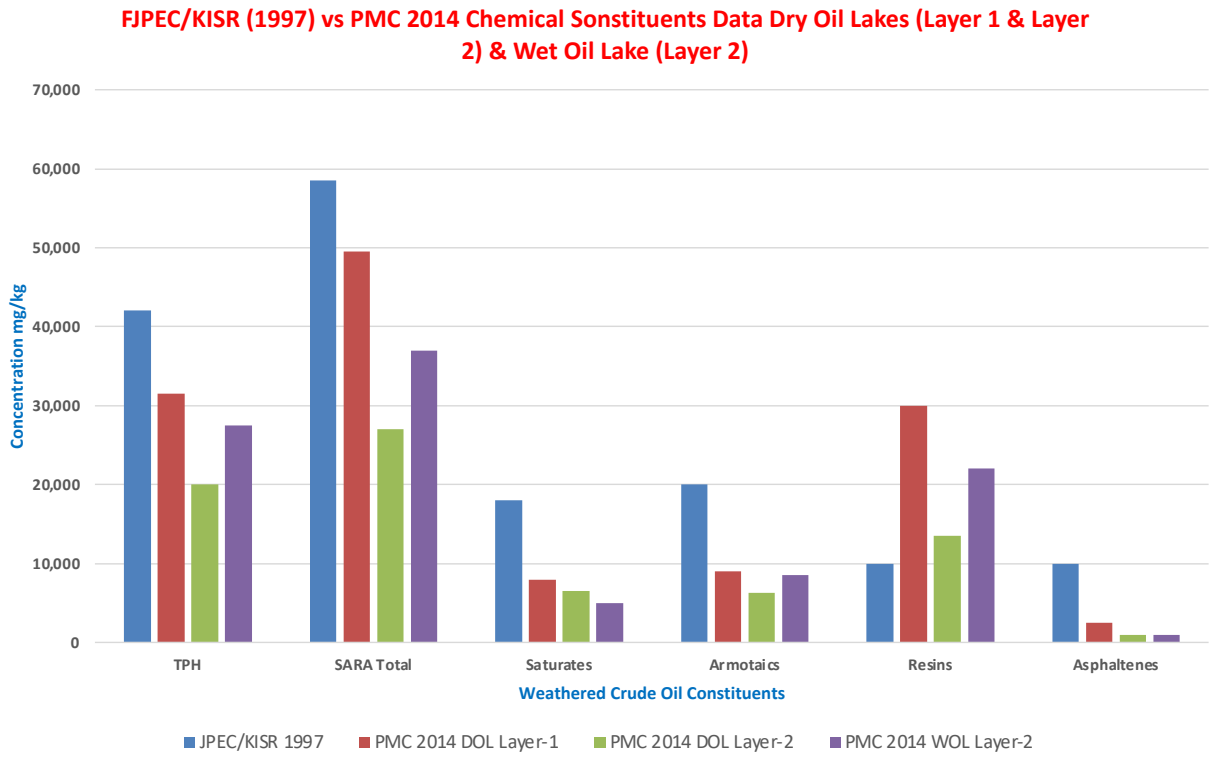
Geographic Information System software (GIS) utilized by well trained and experienced users provides KERP with an extremely powerful analytical tool which informs nearly every aspect of KERP projects from project planning to project execution and advising nearly all disciplines within KERP from construction to remediation.

The KERP Environmental Geographic Information System (EGIS) is a collection of expert users, software tools, databases and analytical results utilized within KERP. The EGIS utilizes key spatial datasets of interest to KERP, vital to the execution of KERP projects, specifically: CIC contaminated feature layer, Unexploded Ordnance Clearance layer, Site Soil Characterization data, Excavation and Transportation data and satellite imagery, among others.

The ability to "overlay" or "stack" different types of spatial data to create a multilayer map allows users to conduct spatial analysis which is a fundamental utility of GIS. The concept of spatial datasets containing different kinds of data and comparing them with each other based on where things are located is the foundational concept of spatial analysis. The layers interlock in the sense that they are all geo-referenced to true geographic space.

Within KERP, spatial analysis provides invaluable information to all disciplines working within all project activities. Spatial analysis allows KERP to establish areas and quantities of interest for a particular task, track site progress and store final results for future review by KERP stakeholders. For example, spatial analysis within the EGIS can show KERP personnel a project scope of work, where UXO clearance has been completed within the scope of work and where UXO clearance is still necessary, helping to keep site workers out of harm's way.

It is used to verify quantities of oil contaminated soils and changes of quantities over time. It is used to provide volumetric measurements and 3-D visualizations of oil contaminated soil layers. `It is used, in collaboration with other Company groups, to alleviate conflicts between Company infrastructure and KERP site works. Analysis of time series satellite imagery shows where KERP areas of interest are prone to flooding, allowing for mitigation plans against rain delays. And, as a final example, spatial analysis within the EGIS will assist KERP in tracking remediation results as the ETR projects progress.



Example of findings from various characterization campaigns

- Surficial DOL Layer 1 (Oil dominated material) general trend in concentration reduction, likely from weathering.
- Underlying DOL Layer 2 remains reasonably consistent across various sampling campaigns

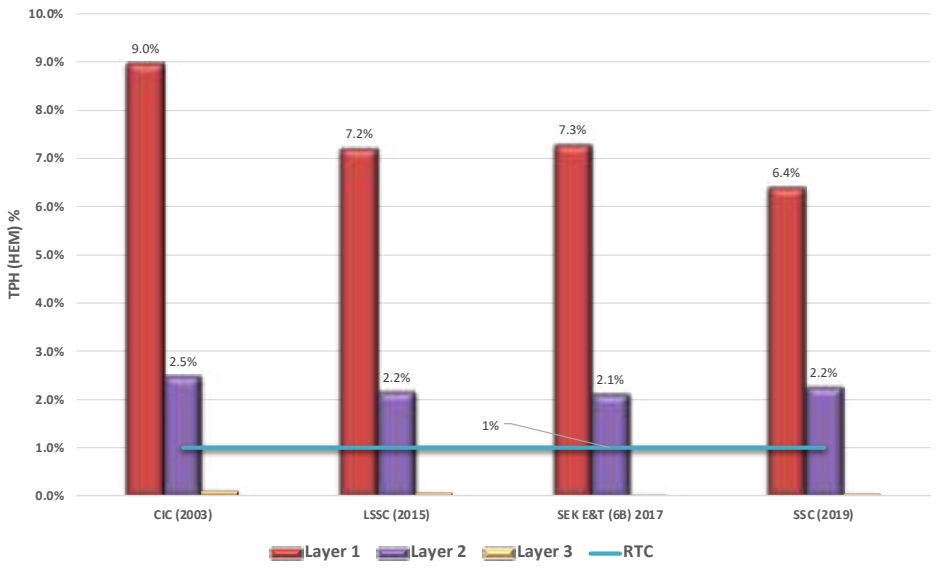


Figure 4.18 & 4.19 Detailed Characterization for more predictive remediation approaches – Presented By SRS in Enviroworkshop, Dubai, UAE

SOIL REMEDIATION GEOGRAPHIC INFORMATION SYSTEM (SRGIS)

Due to the fundamentally spatial nature of KERP projects, Geographic Information Systems (GIS) are some of KERP's most important analytical tools. Understanding the locations and attributes of KERP features and areas of interest in context to other KERP/KOC features of interest at any given time is very important to know and thus nearly every activity in KERP is supported by GIS analysis.

Portal for ArcGIS is a component of ArcGIS Enterprise software that allows GIS professionals to share maps, scenes, apps, and other geographic information with other people in their organization. The content shared is delivered through a customizable website. This provides KERP with an excellent opportunity to provide interactive map access to a wide range of stakeholders and to inform management using high level dashboards/ graphics. Additionally, it allows all users to assist in the GIS process as they can provide feedback on what layers and information, they would like to see displayed and what functionality should be provided.

KERP PMC GIS Team, in collaboration with Company Information Technology Services Team (ITST) and SRG, have developed several Portal applications to meet the goals outlined above. Strong working relationships have been formed between PMC GIS, ITST and SRG which should carry over to further application development within future KERP projects.

ACCOMPLISHMENTS TO NOTE:

- Establishment of Soil Remediation Geoportal, a one stop spot for all SRG related maps and dashboards Hosted within KOC's Geoportal Home Group.
- Creation of the Soil Remediation Group Web Map (SRGIS). This Soil Remediation Geographic Information System (SRGIS), a "general" KERP web-based map that is accessible to SRG, is a base map that shows the location of KERP and KOC features of interest such as contaminated features, UXO works, landfills, worksites, company infrastructure, etc.
- GIS for Flood Prediction and Disaster Risk Analysis. As part of lessons learned from the significant rain and flooding events of Fall, 2018, this application utilized hydrology and stream network modeling, along with satellite imagery classification to identify areas within Kuwait at varying risks of flooding and levels of risk from running water. This analysis has informed planning of site work scheduling, mitigation measures and appropriate locations for KERP remediation construction works.
- Creation of the UXO Operations dashboard, which depicts, at a sub-area scale, progress of UXO clearance activities Provides decision makers with high level details as to where UXO clearance progress is going well and where areas potentially need attention.
- Creation of the Unexploded Ordnance (UXO) Editor. This application depicts the location of all UXO found under KERP projects and allows users to update UXO finds as project site works progress In addition to UXO location information, the editor allows users to upload Explosive Ordnance Disposal (EOD) forms and photos. When a new UXO is added to the editor the SRGIS is automatically updated with the same.

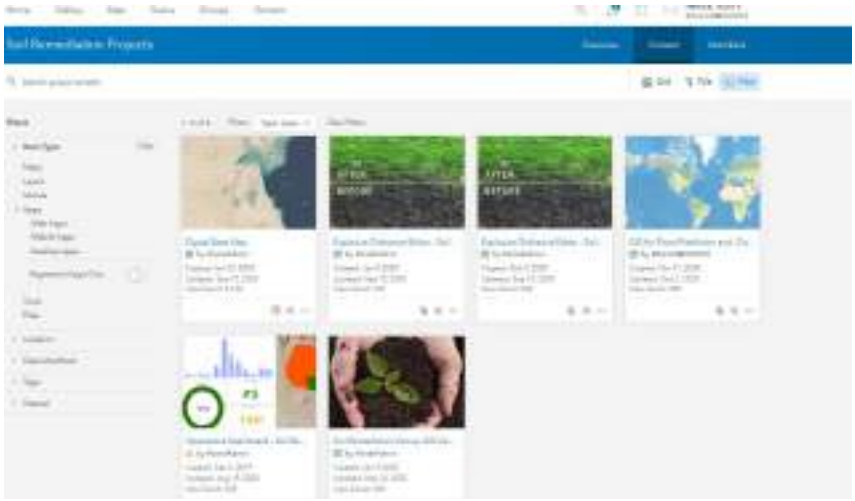


Figure 4.20 Soil Remediation Geoportal

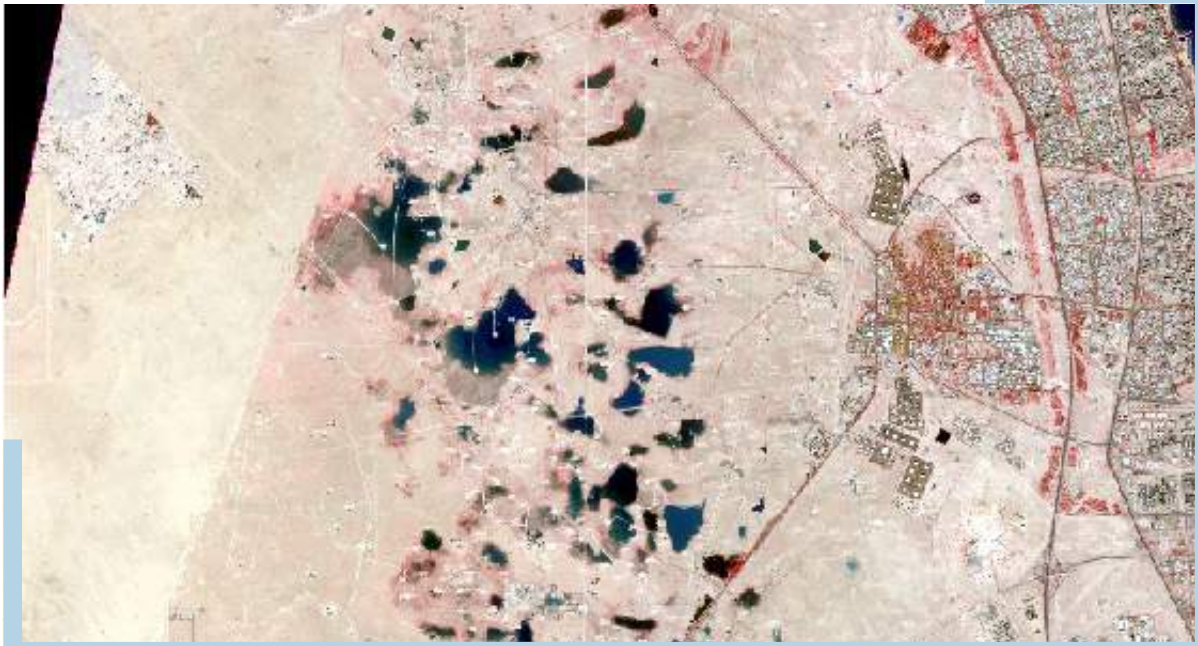


Figure 4.21 Sentinel 2 image acquired December 2018 showing flooded areas within Greater Burgan Oilfield

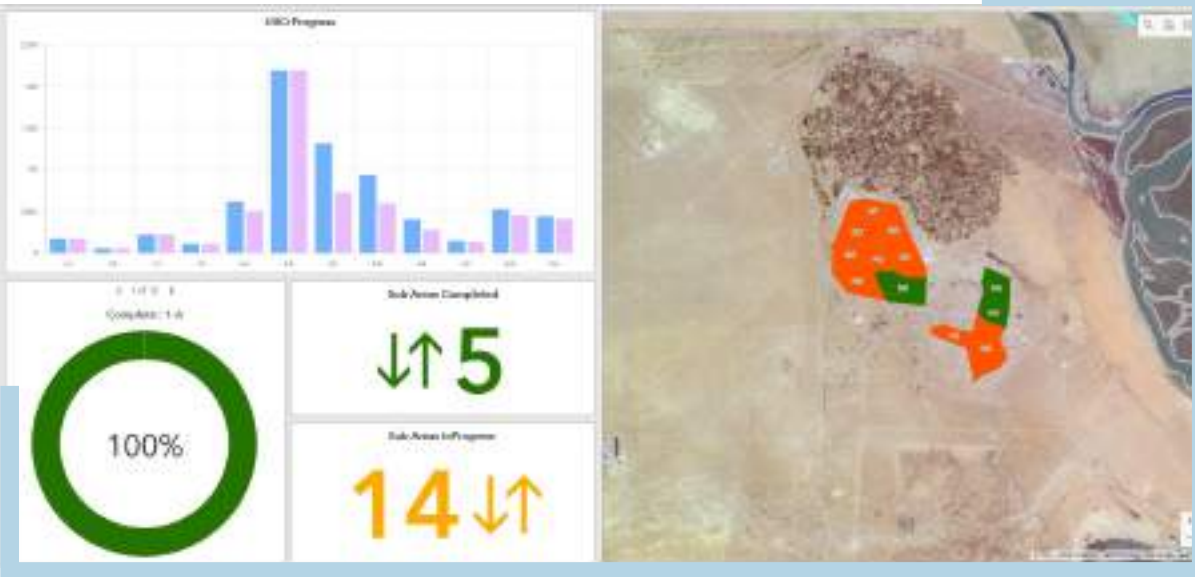


Figure 4.22.1 GIS UXO Operation Dashboard and UXO Register Log Editor

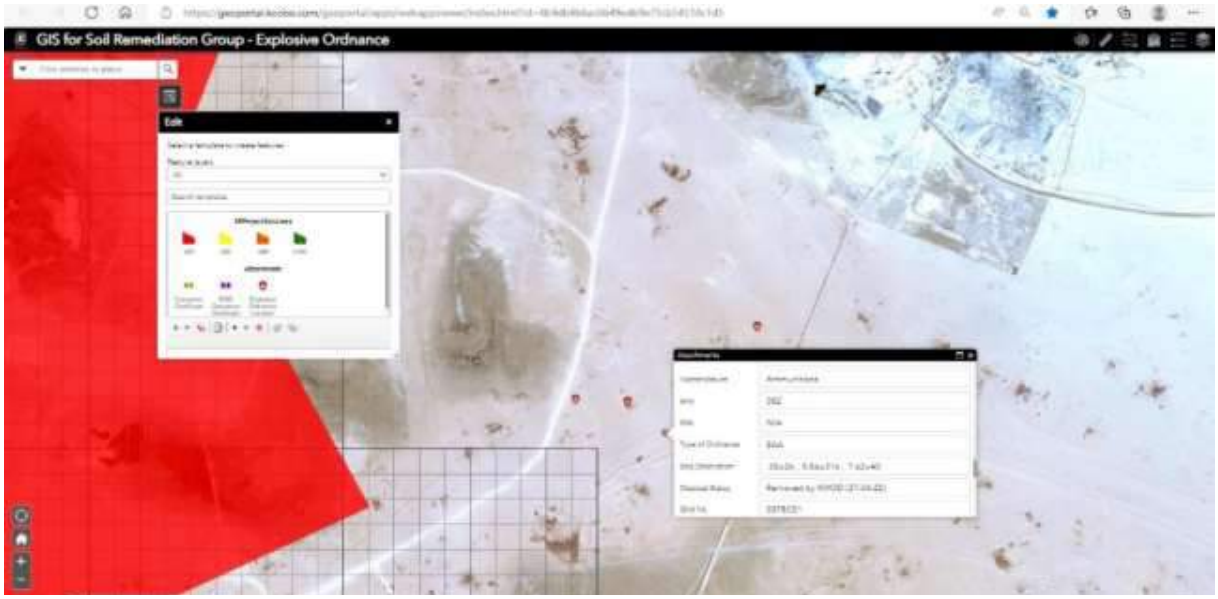


Figure 4.22.2 GIS Database for Soil Remediation Group

ENVIRONMENTAL QUALITY INFORMATION SYSTEM SOFTWARE (EQUIS)

EQUIS is an advanced environmental data management and decision support system which can be used to manage large amounts of data pertaining to environmental chemistry, biology, geology, geotechnical, hydrology, limnology, air, and associated compliance monitoring activities.

EQUIS supports the complete environmental data workflow for a variety of project requirements including task management, field data collection, analytical data checking, data verification and validation, reporting, graphics, and visualization EQUIS also interfaces to Esri, Autodesk, and Bentley software and exports to other third-party software. Additionally, EQUIS is widely considered to be the de facto industry standard because of its very large client base.

EQUIS consists of a suite of software applications. EQUIS Professional is a desktop application that is typically used by trained data managers and scientists for importing and editing data, with advanced data analysis and modeling, providing ultimate power and flexibility EQUIS Enterprise is a web application thin-client that is typically used by managers, auditors, executives, and laboratories.

KERP will collect tens of thousands of environmental samples over its lifetime. These samples inform KERP on two fundamental questions: Where is the contamination and what is the level of contamination? The answer to these fundamental questions will form the basic strategy for remediation under KERP and will guide all site works. Such important data must be properly organized, standardized, and analyzed.

For use within KERP, EQUIS replaces hundreds of individual databases each with thousands of analytical results and replaces them within a single compiled and standardized database which can be queried for results and analysis at any time. Additionally, EQUIS and related workflows improves data integrity through QA/QC and automated error checks, standardizes data collection and reporting, allows user friendly data access, monitoring and analysis via EQUIS Enterprise, and in the end, improves project decisions and assists the project execution.

So far KERP, in collaboration with PMC PO staff within Worley Advisian KERP has completed two distinct phases of data management within EQUIS and is in the midst of a third.

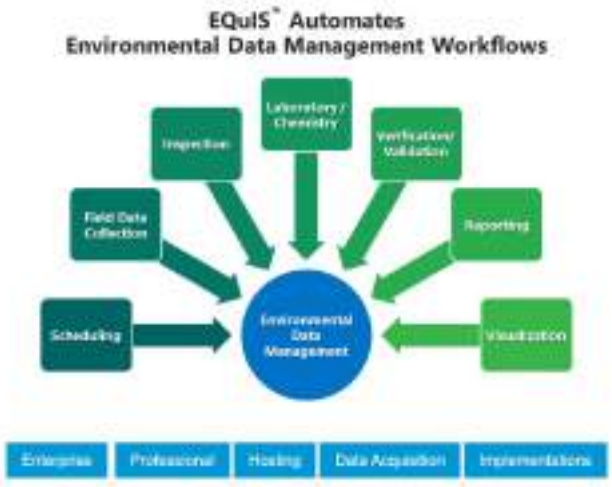


Figure 4.23: EQuIS Data Management Workflow Source: earthsoft.com

PHASE 1 - Consisted of the following Activities

- KERP EQuIS kickoff meeting.
  - High level conversations with PMC PO, HO and KOC personnel which outlined the overall goals and timelines of the project phase.
- Setup of KERP EQuIS database.
  - By PMC PO staff EQuIS expert users.
- Creation of the project data management plan (PDMP) and workflow diagrams.
  - By PMC PO staff EQuIS expert users.
- Historical data migration into the KERP EQuIS database.
  - SSC data from Consortium of International Consultants (CIC) – 8,909 Samples, Limited Site Soil Characterization (LSSC) – 235 Samples and from North and South Kuwait Excavation and Transportation projects – 5,070 samples, were formatted and migrated to the KERP EQuIS database.
- This exercise was especially challenging as this historical data required specialized formatting into standardized electronic data deliverable (EDD) format. Tool sets within EQuIS were utilized to automate this process as much as possible.
- User Training.
  - SRG personnel were provided introduction workshops and several sessions of hands-on entry level training with EQuIS Professional and EQuIS Enterprise Attendees were introduced to the whats and whys of EQuIS use, the key terminologies and EQuIS' web interface. Additionally, high level training was provided in the basics of EQuIS Professional. More in-depth training was provided for EQuIS enterprise where trainees were provided interactive exercises to practice logging into their personal accounts, data conversion, data uploading through Enterprise Data Processor, workflows, creation, and setup of Enterprise dashboards with personalized widgets and data report generation.
  - Trainees were provided wivth the Enterprise User Training Handbook and Certificates of Completion.

PHASE 2 - Consisted of the following activities

- 1,200 Samples and their associated analytic results collected as part of SKETR FEED sampling effort were uploaded to EQuIS database.

PHASE 3- is designed to support the sampling events and SSC analysis within the 5 KERP Excavation, Transportation and Remediation (ETR) projects from November 2021 through June 2023 during which approximately 30,000 samples and their associated analytical results will be collected and processed.This includes the following key tasks which are in progress

- System Preparation, includes Software User Licensing and Architecture Development and Integration.
    - Software User Licensing involves the identification and account creation for all EQuIS software users within SRG, PMC, Contractor and Contractors' analytical laboratories Licenses for EQuIS Professional, Enterprise, EDP and Collect will be provided be in line with users' roles and responsibilities.
    - Architecture Development and Integration involves the work necessary to bring the existing KERP EQuIS database, created during Phase 1 and 2, to a level at which it is in accordance with requirements outlined in ETR Technical Specifications. Further, it involves the development, with Contractor representatives, of standardized EDDs, EQuIS Schema and Enterprise Collect forms which will be utilized during site work sample collection and associated chain of custody forms. Additionally, this task involves the basic setup of Enterprise dashboards, templates, etc., for KOC and PMC and EDP for Contractors and Labs.
- Knowledge Sharing Workshops and Training.
    - Knowledge sharing workshops are being provided to contractors and labs to help prepare them with their necessary tasks regarding documentation of sampling, analytical results, and upload to EQuIS.
- Building on the training provided in Phase 1 referenced above, training programs are planned in Phase 3 to provide refreshers and interactive training to KOC, KNFP and PMC in EQuIS Professional and Enterprise.
- Project Execution Services
- Involves the services required to maintain quality, efficiency, progress and cost-effectiveness of the data upload and data management activities within the Phase 3. This includes standard data management, data issue management and resolution and EQuIS Enterprise user assistance.

Figure 4.24.1,2&3 SRG Team members during EQuIS Training

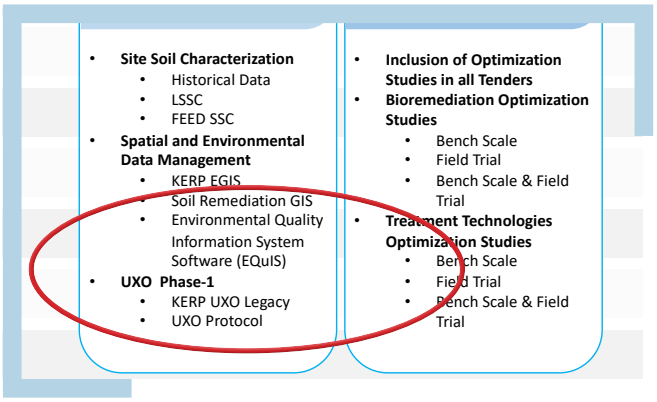
SRG is currently in talks with KOC Information Technology Services team to implement a Geospatial Solution to storage, visualization, and analysis of KERP environmental data. This effort shows promise to provide data migration, web maps application(s) and interactive operational dashboard(s). In the event that utilization of EQuIS within KERP is discontinued, the Geospatial Solution will ensure the integrity of KERP's environmental data for which so much time and resources have been spent collecting. KERP sees this data as not only information for the execution of KERP projects, but as invaluable data for all the State of Kuwait and a significant part of its history.

Figure 4.25 SRG Team members with EQuIS Training Certificates during EQuIS Phase 1 From Left to Right: Fatma Jassim Al-Faresi, Aisha Saleh Fahad Al-Barood, Danah Mohammad Abdulaziz AlAkkari, Kawthar Mahmoud Khajah, Sharefah Waleed Mohammed Al-Hashash, Scott Hetrick, Hussain Abdulnaser Alkandari and Srinivasan Vedhapuri (Not Pictured: Ahmad Alkandari, Batoul Al Shraifi and Hamad Al Enezi)

Figure 4.26 Historical Sample Data Mapped within EQuIS Enterprise and Classified based on TPH Value

Figure 4.27 Historical Sample Data Mapped within EQuIS Enterprise and Classified based on TPH Value with Attribute Data displayed

B.3.1.3 UN EXPLODED ORDNANCE (UXO)S – THE KERP LEGACY



Various deterrents make KERP project exceptionally challenging. The sheer scale of oil contamination, both in quantity and vastness itself is unlike anywhere else on the globe. The multiple contaminated features are spread from South and West Kuwait, near its Saudi Arabian border, all the way till to North, where it borders Iraq. The harsh desert locations with summer temperatures, which can exceed 50°C, makes work difficult. Yet another challenge is the scarcity of water for the treatment of soil and high saline conditions resulting from the use of sea water in the extinguishing well fires. Moreover, most of the areas are located within current operational KOC oilfields, calling for tedious scrutiny regarding permissions, and consistently maintained high HSE standards above all, is the threat from: UXO (unexploded ordnance).

UXO WORKSHOP (2013-2015)

A series of workshops were conducted involving international UXO Clearance Contractors during this period of time. The scope and the extent of the required clearance work was discussed and various methods were proposed and examined and a strategy was formulated.

FORMULATION OF UXO STRATEGY IN KERP PROJECTS

KOC conducted the UXO program strategy as the basis to determine the best methodologies for carrying out the required UXO geophysical surveys, investigations, reacquisition of targeted subsurface anomalies, intrusive investigations, and the minimization of risk by removal of any UXO threat prior to conducting KERP projects. Some of the proposed technologies included the use of helicopters. Unmanned Aerial Vehicles (UAV), winching systems, hovercraft, and towed sensor arrays for use in the survey of oil lakes and to conduct wide area assessment over larger areas.

Figure 4.28 82 mm mortars found in an Oil Contaminated Pile (OCP) in NK

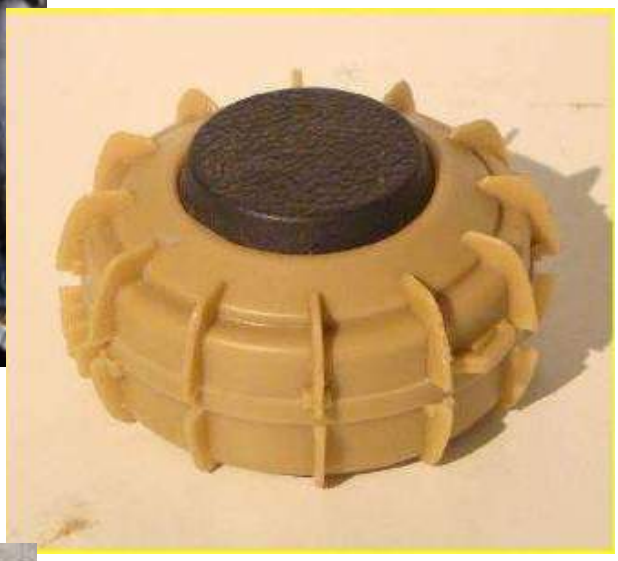


Figure 4.30
Sample of UXOs and mines discovered

Figures 4.29 M60-Rifle grenade

Figures 4.31 Anti Personal Rifle Grenades found Within Contaminated Soils

Figures 4.32 155mm Artillery Projectiles found in Sub area

Figures 4.34 Small arms ammunition

Figures 4.33 M118 Rockeye

Figures 4.35 UXO Clarance Activity

Figures: 4.36 Hand Granade

The helicopter option was never pursued as airspace restrictions prevented this. The UAV and hovercraft were both trialed but abandoned as wind and air temperatures greater than 40C prevented effective operations. The winching system was labor intensive and not productive. The towed sensor arrays were most successful and initially adopted by KERP as the main method of clearance however less competent contractors were unable to capitalize using this system effectively and more labor-intensive methods such as Battle Area Clearance (BAC) were introduced. The other area of concern was the extensive amount of Oil Contaminated Piles (OCP) Mechanical sifting machines, Remu and Rotary Screening Buckets were trialed and met with little success as the oil-soaked material would not break down adequately. The most effective way of dealing with soil was to lay it in pads of various configurations such as (50m x 50 m x 0.5m height) and have manual clearance teams conduct clearance on the pads.

UXO PROTOCOL- KMOD & KOC

The Kuwait Ministry of Defense (KMOD) has a small but efficient Explosive Ordnance Disposal Team which is capable of dealing with routine finds of Unexploded Ordnance (UXO) or landmines reported on a regular basis. The team has limited resources and does not have the capacity to execute large scale and complex UXO or Mine Field clearance operations. Therefore, through various Government Authorities and Agencies competent and experienced Commercial UXO and Demining Contractors will be used to execute the large-scale operations.

KMOD maintains the authority and responsibility for the oversight for all UXO and Demining operations in the State of Kuwait. KMOD has the authority to delegate aspects of the oversight requirements to approved qualified personnel managing UXO or Demining operations on their behalf Kuwait Oil Company (KOC) through PMC services have approved and qualified personnel to conduct the monitoring and oversight of UXO and Demining operations on behalf of KMOD.

The KERP encompasses several different claims approved by the United Nations Compensation Committee nearly all specify that a survey for UXO and mines must be carried out prior to any remedial work, and in some cases during such remedial work, for the protection of the workers. This means that full EOD clearance operations in the specified areas are NOT covered by the claims, apart from Claim N0 5000454 Element 1, Oil Lakes. Any disposal of UXO or mines identified during the surveys must be carried out by the KMOD EOD team or a commercial team paid for by funds outside the Claims award. However, it is essential that all items of ordnance identified during the surveys are destroyed to ensure that they do not remain a danger to future workers or the public.

In general, EOD and de-mining operations should follow the guidelines in International Mine Action Standards (IMAS). However, it must be remembered that the KERP EOD and demining operations are not part of a National Humanitarian de-mining program for which these standards were originally designed, and where it is necessary and prudent to do so, approved site-specific procedures should be used.

In the first 12 months alone, KERP had recovered over 24,000 small arms ammunitions and cleared approximately 150 unexploded ordnances of various types from 1,745,766 m^2 of land, much of which lies in North Kuwait UXO types found in Kuwait include artillery projectiles, rocket propelled/ hand grenades, mortar bombs, anti-personnel & anti-tank landmines, sub munitions along with small arm ammunitions.

FOLLOWING TYPES AND QUANTITIES HAVE BEEN LOCATED ON THE KERP PROJECT.

A total of 840 UXO s and 37305 Small Arms Ammo & Pyrotechnics were found, as of 24th August 2022 this includes;

Item	Count
Submunitions	397
Grenades (Hand, Rocket Propelled, Rifle, Smoke Fuses & Boosters)	154
Projectiles (including Mortars, projectile fuses, & AA)	86
Explosives and Accessories	182
Explosive Remnants of War (ERW)	6
TOTAL UXO	840
Small Arms Ammunition (5.56mm -20mm) & Pyrotechnics	37305

Table 4.1 UXO Count till August 2022

A UXO item is created when an explosive ordnance item fails to function as designed, it should never be assumed that the item is safe handle Explosive ordnance is designed to kill or maim. Great care should be taken when travelling or working in the oilfields. Stay on defined roads and tracks and avoid travelling over un-travelled ground. If you see suspicious items refrain from handling or kicking it them, if they have some of the characteristics of shape like in the photos in this chapter do the following.

- Try and put an obvious marking in the general vicinity of the item.
- Retreat to a known safe area
- Report it.

Keep in mind that larger UXO can have a lethal blast and fragmentation radius of up to 200 meters or more.

CONCLUSIONS.

The revised KERP strategy has an ambitious target of reducing the overall landfill capacity from 26 million m^3 to minimal containment landfills, which is sustainable environmental approaches for KOC. This will be achieved by using a combination of alternative remedial solutions that form the 'Total Remedial Solution' (TRS). In principle the TRS relies on treating certain ranges of Total Petroleum Hydrocarbon (TPH) contamination with the most appropriate treatment technology. There are five key components that include bioremediation, treatment technologies, oil recovery re-use, risk managed approach and if all else fails landfills.

SRG/PMC with its stakeholders (KNFP, UNCC AP, KEPA and KMOD) have taken several steps to implement the revised strategy and provide additional information (technical and management) for the success and completion of KERP projects. The following steps were stemmed from the requirement to evaluate information on remedial technologies suitable for TRS as well as enhancement to ensure feasibility and applications without any impacts to important KOC operational/development, KERP budget and schedule.

These following steps to name few were explored along the years from 2013 up to 2019:

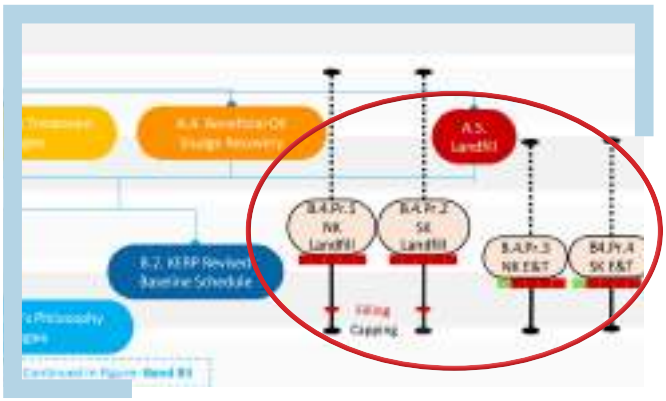
- Implemented FEED & Site Soil Characterization to gather additional chemical and physical parameters of the impacted soils and sludges. Utilization of site soil characterization & FEED data for various contaminated features to enhance and further refine remediation project requirements from contamination and volumetric perspective.
- KOC/KNFP have acknowledged their role to sign off on UXO clearance certificates and to ensure that clearance has been undertaken in compliance with the KNFP Protocol document that was developed specifically for KERP.
- Implemented several Workshops & Questionnaires which provided forums where local and global civil and treatment technology specialists could present their technologies, learn more about KERP, see the Site first-hand, and interface with both KOC and other Contractors to discuss ideas and potential synergies to provide the best possible approaches.

- Provided Representative soil samples were collected from the KOC operational areas and submitting to the contractors who has expressed their willingness to perform bench scale treatability studies during the workshop and provide the detail treatability reports as courtesy to KOC.
- Established network of oil recovery technology providers to test and perform feasibility studies on weathered oil sludge for recovery, oil quality/enhancement and cost analysis performed internal recovery / re-use for oil sludge where possible (to reduce volumes to landfill) and obtain design parameters for long term application as integral part of KOC strategy.
- Worked with KOC Research & Technology (R&T) as a vehicle to explore importunities that will benefit KERP and review/identify proposals for research and developments for the benefits of KOC.
- Lessons learned from the early priority Landfill and E&T projects and SEED projects have been incorporated into the development of the optimized program (i.e., lower mixing ratios, mixing of wet heavy contaminated soil with underlying less contaminated soil to allow for proper UXO clearance, excavation and transportation of contaminants, filter cakes, soil washing technique, bioremediation scheme, etc.).
- Up to 2019 the Remediation Target Criteria (RTC) imposed by KEPA required all oil contaminated soil to be treated to the value of 0.5% (5,000 mg/kg) TPH. Lately, as a result of robust and extensive risk analysis, the Remediation Standard was re-established by KEPA as 1% (10,000 mg/kg) TPH.
- RBA Part II for tarcrete material under fresh groundwater aquifer will be addressed through a Risk Based Approach - Quantitative Risk Analysis (RBA QRA) to provide confidence that this material does not pose any impacts to the below fresh groundwater quality in Raudhatain and Sabriya.
- The KERP benefits for utilizing the new Remediation Standard of 1% TPH compared to the previous KEPA standard of 0.5% TPH. The potential benefits include not only the reduction in soil volumes to undergo remediation, but also time savings, resources savings, environmental impact reduction, and eventually economic benefits by cost reduction of overall remediation activities.
- Developed water supply management strategy with task force. This identified dedicated persons from SRS/SRP-II and PMC to lead as a key component of KERP to supply sources for the KERP projects. Task for water management include the following:
    I. Identified leads and an action plan.
    II. Drafted an outline water management strategy.
    III. Set up meeting with KOC water handling operations.
    IV. Explored external water supply opportunities, either through MPW, MEW or KNPC/K companies.
    V. Explored water handling teams for potential sources on short and long term.
    VI. Determined budgets required to implement.
    VII. Forecasted future annual water demands based on remediation throughput identified on current KERP schedule.
- Incorporated Enhanced Natural Attenuation (ENA) as key component in strategy to consider low TPH levels (>1% to <2%) materials to be bio stimulated with nutrients amendments under SKETR II for short / long term soil remediation scheme. These areas of low contamination levels have been identified in FEED and will be verified to provide information on areas that pose no unacceptable risk to the environment, hence requiring ENA or left in place if budget is not sufficient.
- Defined the proposed oil recovery strategy involving design and construction of temporary oil sludge storage pits, and the design, construction, and commissioning of an oil recovery unit with centrifuge system to be tied-in with one of the crude recovery plants according to the specifications provided by a newly formed Oil Sludge Recovery Task Force, comprising key KOC teams such as KOC SRG and KOC Maintenance, Operations, Export and OTS. The sustainable oil sludge recovery approach is a stand-alone portion of the SKETR-II tender package and has the distinct advantage of catering for Company's future oil spills/discharges.
- Established where KISR would be able to provide benefit to KERP; at Project level. Ecological monitoring program. This would be an immediate benefit as KNFP/KOC have initiated contract agreement to develop baseline data and monitor the progress/success of ecological developments of the areas to be revegetated to increase biodiversity and to promote ecosystem resistance and resilience.

- The Re-vegetation Projects are aimed at transplanting native species of shrubs, grasses and trees inside or outside of the oilfields in South and North Kuwait to restore the land sites back to pre-disturbed status The selected species are ecologically most important and dominant part of the natural ecosystems of Kuwait.
- EQuiS as good data management was essential for a project of this size where vast data sets will be generated Generating data of good quality and conforming to a common system makes for efficiencies in time and future uses as tool for data information KERP EQuiS Phase 1 and 2 completed as KERP Environmental Data Management Services to integrate and support the data collected (CIC, NKET, SKET, FEED, etc) KERP EQuiS Phase 3 as the global standard environmental data management system is planned for all environmental data generated from SKETR, SKETR II and NKETR projects to meet the workflows data edits and analysis of all data projects for integration into KERP GIS for Company's uses.
- Supported KOC's business oil field development needs (early land release requirements) by establishing plans for clearing production well pads/land developments.
- Optimized the program using available resources (current projects) and reduced the gap between current and future projects with large contracts to meet KERP approved timeline schedule.
- The enabling works such as SSC and Geo software implementation, UXO Clearance and RBA are key activities which have hugely facilitated the preparation of Mega project tenders.

Chapter - 5
Commencement of KERP Journey

This chapter deals with the concept of Land fills (A.5), and the initial commencement of the KERP, Priority Landfill and E&T projects (Pr.1, Pr 2 Pr 3 & Pr 4), which were the first phase of executions. They were not executed under the umbrella of TRS but were prioritized due to their company's operations, environmental impacts to fresh groundwater aquifer (NK) and ecological significances. These projects were carried out simultaneously while TRS was being conceptualized. Though these projects were executed, it is being categorized and classified in the conceptualization stage itself, as they were executed to facilitate and make way for a better strategy called TRS.



A.5 LANDFILLS

Landfills are engineered store houses of any contamination, properly isolated from the soil underneath and around to prevent further /lateral contamination. The landfills comprise of

a. single composite liner over an artificially established geological barrier or equivalent,

b. leachate collection system.

c. closure system (geo-membrane liner, soil, gatch, and gravel.

d. leachate management system comprising collection system with perforated pipes, sumps, and submersible pumps, (Note: In the environmental context, leachate is any liquid material that drains from land or stockpiled material and contains significantly elevated concentrations of undesirable material derived from the material that it has passed through), and

e. gas venting system.

PRIORITY AREA PROJECTS

While TRS was being conceptualized and developed in one hand, certain areas with high ecological significance were identified and were set to be handled immediately. As per the plans approved by the UNCC & KNFP, considering the ecological fragility and urgency of removal of contamination priorities were set to handle these highly significant ecological areas. It was decided that these areas had to be excavated and the contamination have to be landfilled according to the initial plan. Hence, the execution of Pr1, Pr2, Pr3 (priority 1, 2, & 3 projects) in Raudhatain, Sabriyah and Southeast Burgan became the first steps in projects execution.

Tenders were prepared, evaluated, and awarded for the construction of engineered landfills to contain the highly contaminated materials (Pr.1 & Pr.2.) This was followed by the tender preparation, evaluation, and award of two further contracts (Pr.3 & Pr.4.) for the excavation and transportation of contaminated materials to the landfills and then capping the landfills.

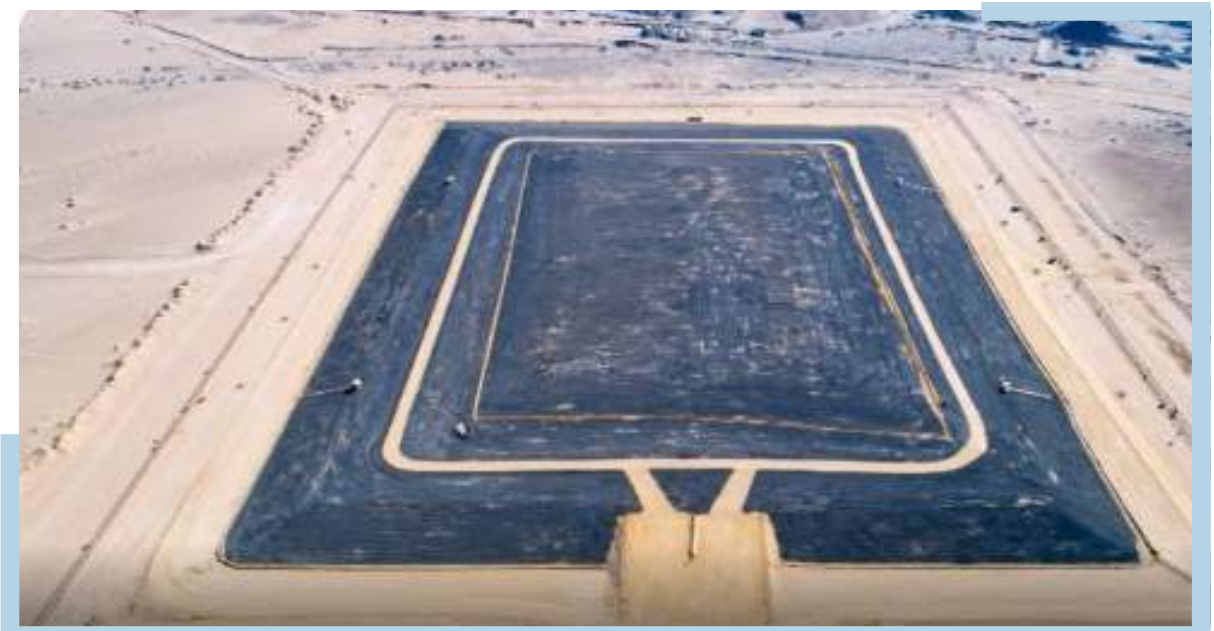


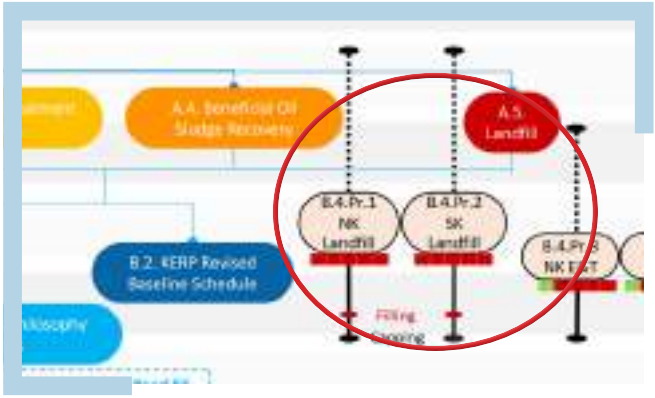
Figure 5.1 South Kuwait Capped Landfill- Top View

Figure 5.2 North Kuwait Capped Landfill- Top View

A.5 PR 1 & A.5 PR 2 CONSTRUCTION LANDFILLS FACILITIES FOR HYDROCARBON CONTAMINATED SOIL IN SOUTH-EAST AND NORTH KUWAIT AREAS

PROJECTS OBJECTIVE

The objective of these projects was to construct landfill facilities together with leachate and gas venting system for the permanent containment of highly contaminated waste soil from wet oil lakes and oil-contaminated piles. The project has been developed pursuant to the United Nations Compensation Commission (UNCC) Governing Council Report on Part Two of the Fourth Installment of 'F4' Claims (Report no S/AC.26/2004/17 issued on 9 Dec 2004). The UNCC report recommends that the appropriate remediation for the oil lakes and oil-contaminated piles is to excavate and dispose of the most contaminated soil in permanent landfills, with the remaining less-contaminated soil in the oil lakes being bioremediated.



Two landfills were constructed to hold the highly contaminated soils, one in South and East area and the other in North Kuwait Area. The constructed landfill facility in SEK area holds a permanent containment of 500,000 cubic meters of waste, while the landfill facility in NK area hold a permanent containment of 1,500,000 cubic meters of waste. The waste in the landfills is highly contaminated soil from oil lakes and oil-contaminated piles. The designed landfill constructed as an "Engineered landfill" with the following elements:

- A liner system at the base and sides of the landfill to prevent migration of leachate and/or gas to the sur rounding soil.
- A leachate management system for collection and extraction of leachate from within the landfill.
- Gas venting system to mitigate gas emissions.
- A final cover system at the top of the landfill, which prevents infiltration of water, supports surface run-off of water, prevents animals from burrowing into the landfills, and supports vegetation growth.
- Removal of surface water drainage from the landfill area.
- Environmental monitoring system.

EXECUTED WORKS

Engineering Design

The overarching landfill design criteria was to meet the objectives of containment and protection of solid waste as per Kuwait and International regulations. The existing landfill has been constructed with single composite liners, each consisting of a synthetic geo-membrane underlain by a geo-synthetic clay liner and a compacted low permeability gatch layer to meet the requirements of an artificially established geological barrier as stipulated in design criteria for protection of the groundwater.

The capping system consists of a geo-membrane with a protective geotextile and a 1m soil cover In addition, pipes and pumps for leachate and gas collection systems are installed within the landfill to monitor and handle leachate and gas emissions.

The containment cells will be an integral part of the landfill facilities (one in North Burgan and one in South Burgan landfills) and will be flexible in design to allow:

- Containment and compaction of segregated WOL Type 1 to 4 materials.
- Containment and compaction of mixed WOL Layer 1 materials (all types), for example, where these are co-located in the oilfield and cannot be efficiently segregated; and
- To allow re-excavation of compacted materials for future re-use/recovery or capping of compacted materials.

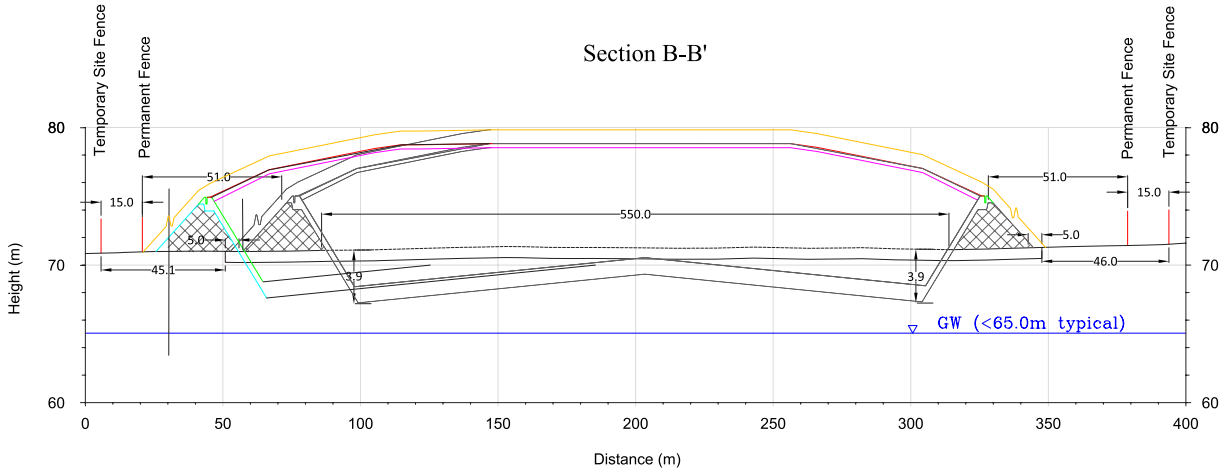


Figure 5.2.1 Landfill Cross Section of the Landfill - Width

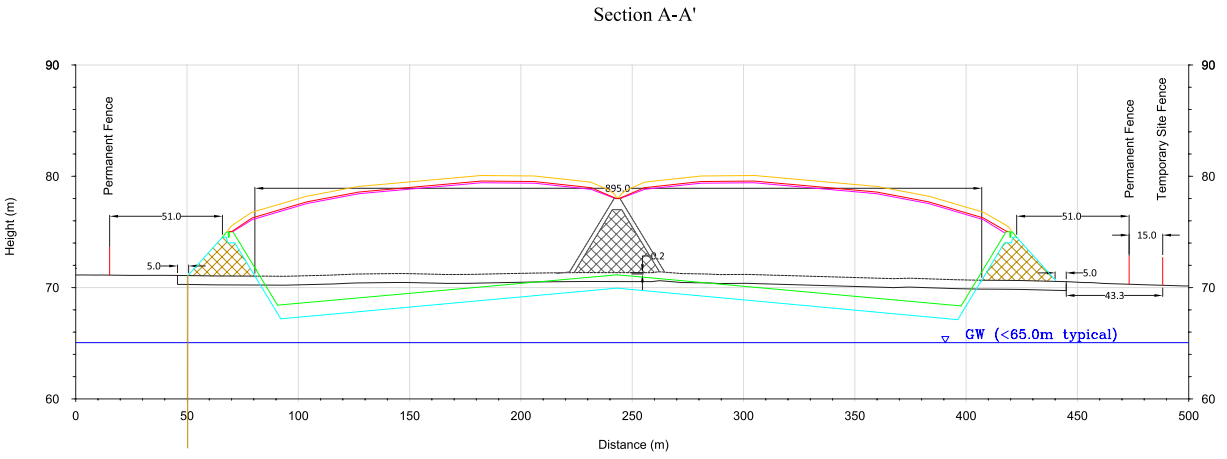


Figure 5.2.2 Landfill Cross Section of the Landfill - Length

The Landfills were designed as several containment cells, located within the constructed landfills, to aid future capping if any material which were scheduled for a re-use/recovery couldn't be so done, and need to be landfilled.

CIVIL AND STRUCTURAL WORKS

Topographical Survey

Detailed topographical survey of the areas and drawings showing coordinates of corner points of the designed landfill pits, fence enclosures, and layout of access roads, rig road crossings, existing facilities, grade levels etc were carried out prior of the commencement of the construction work. Moreover, existing ground elevations were considered.

Slit Trenching

Manual exploratory (slit) trenches were carried out across the locations of new landfill pit facility prior to commencement of any construction works to ascertain presence of existing underground services crossing through areas of new works Slit trenches dimensions were minimum of 1.0 meter wide and 1.5 meters deep. In addition, no existing underground or aboveground services will be allowed to cross through the areas of new landfill pits.

Geotechnical Investigation

Geotechnical investigations were implemented to ascertain the ground water level, water properties, soil properties, permeability of soil, bedrock condition, and type of rock and its properties of the site. The number of boreholes were planned to get a reliable indication of the geological, hydrological and geotechnical character of the ground. Bore holes were located at 100 meters spacing and at each corner. Exploration was carried out for a minimum depth of 30 m.

Figure 5 3 South-East Kuwait Landfill-Grading and Compaction

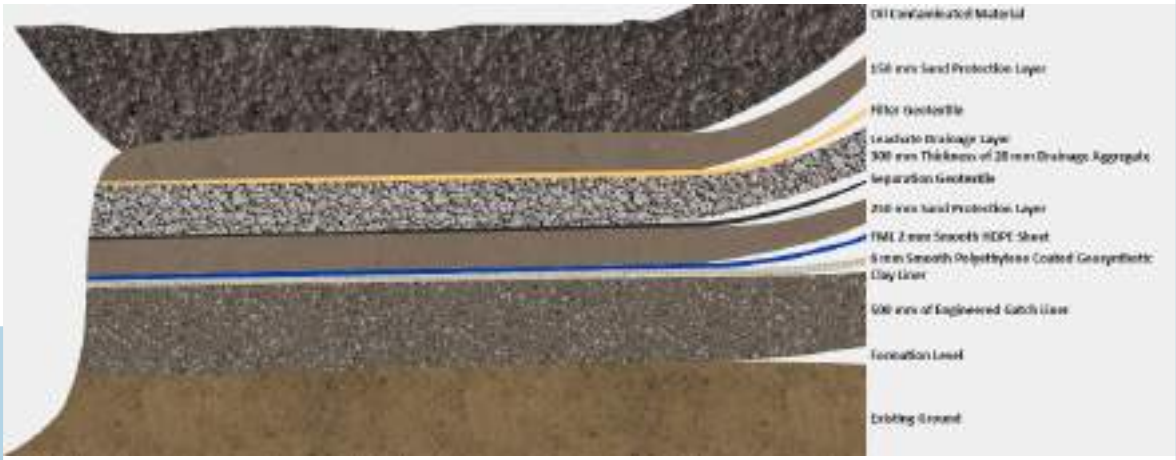


Figure 5.4 Landfill Base Liner System (Texture)

Figure 5.5 Landfill Base Liner System - Materials

Figure 5.6 South-East Kuwait Landfill- Laying down of HDPE Geomembrane

Construction of New Landfill Pit

The landfill pits were designed and constructed as per the approved design drawings. The base and surface of landfill were constructed to have a suitable slope to encourage runoff from the surface and to facilitate leachate collection at the base. Optimum moisture content (O.M.C.) of the soil was identified in order to be compacted in accordance with the prevailing AASHTO specification using the modified Proctor test method prior to compaction Gatch was spread on the prepared base by mechanical equipment and compacted using roller to a maximum of 150 mm compacted thickness for each layer and the correct quantity of water shall be sprayed on the surface thereof, which shall then be raked over to allow thorough penetration and to obtain a homogeneous mix of uniform moisture content The same procedure was carried out to get total compacted gatch thickness. The surface shall then be graded to the profile levels and cross sections as per the drawings.

The bund wall was constructed from approved gatch in layers of 150 mm compacted thicknesses. Each layer will be compacted to a minimum of 95% of the modified proctor density. Top of bund wall was uniformly leveled. The gatch at bunds/sidewalls of the landfill shall meet the permeability requirements of equivalent to 1m at 1x10-9 m/s.

Leveled and compacted the bund walls surfaces, sprayed with two coats of liquid asphalt - medium curing type - MC-70 grade at the rate of 1.5 kg/m^2 for each coat. Prepared the surfaces of the bund walls to receive the asphalt-imposed course by applying a Tack coat of diluted emulsified asphalt to the existing (or new) liquid asphalt layer (MC-70 grade) considered as a prime coat The diluted emulsion was applied at a rate of 0.5 Kg/m^2 Supply and lay 40mm thick – compacted thickness - Asphalt Concrete Wearing Course (Mix Type III) over the prepared base of bund walls properly leveled, sloped and compacted Coated drainage channel was constructed all around the pit for drainage of rainwater. The outlet of drainage channel was 250 meters away from the edge of landfill pit.

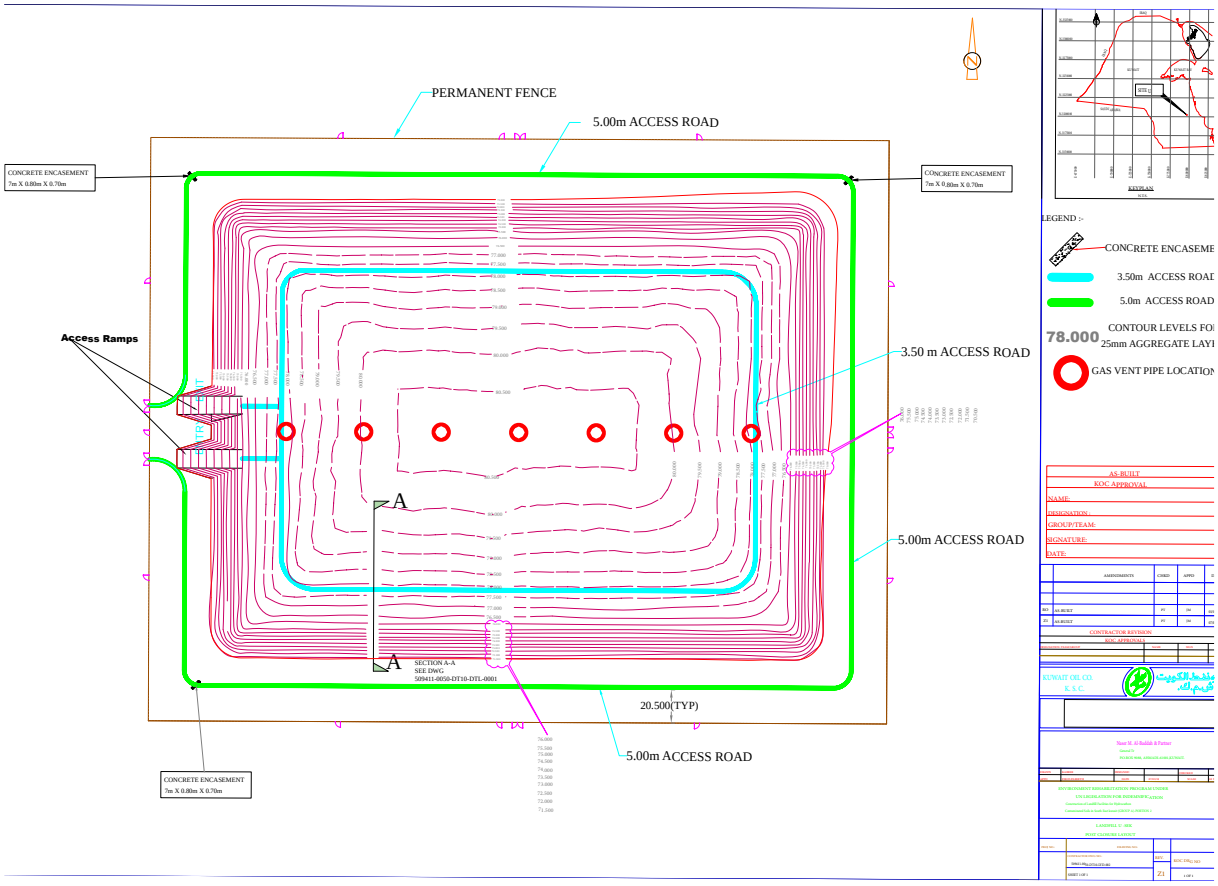


Figure 5.7 South East Landfill Post closure Layout

Construction Method for Liner System

One layer of geo-membrane liner was installed on top of accepted sub-base in accordance with written recommendations of the manufacturer. To prevent tear or damage of the geo-membrane by uplift winds, proper temporary anchorage of the geo-membrane was maintained. A protective geo-textile was placed over the liner to minimize the potential for membrane puncture during placement of the waste material.

The geo-membrane liner and overlying geo-textile was secured permanently by using perimeter anchor trenches The leachate collection system, consisting of permeable gravel with leachate collection pipes was constructed later. The permeable gravel was wrapped with a geo-textile filter to prevent the migration of fines into the gravel.The basic Liner System consisted of the following components (from top to bottom):

Figure 5.8 South-East Kuwait Landfill-Laying down of Leachate Piping Network

Figure 5.9 South-East Kuwait Landfill- Compaction of Gatch Liner

a. Sand base.
b. Non-woven needle punched geo-textile.
c. Permeable gravel.
d. Non-woven needle punched geo-textile.
e. Geo-membrane liner.
f. Gatch.

LEACHATE COLLECTION SYSTEM

Leachate collection system with all associated facilities were constructed The Leachate collection pipes were perforated pipes.

Figure 5.10 South-East Kuwait Landfill- Geomembrane testing

Figure 5.11 South-East Kuwait Landfill- Laying down of HDPE Geomembrane

Figure 5.12 South-East Kuwait Landfill- laying down of Geotextile & Leachate Piping Network

Figure 5.13 South-East Kuwait Landfill Laying Down of Geo Synthetic clay liner

Figure 5.14 North-Kuwait Landfill- Drainage Geotextile/Geomembrane Placement Bottom Base

Figure 5.15.North-Kuwait Landfill Geo-textile Placement Side Slope

GAS VENTS

Gas venting pipes and all associated facilities were constructed Gas pipes were vertically installed.

Figure 5.16 North-Kuwait Landfill- Leachate Collection Riser Pipes

CHAIN LINK FENCE, GATES, AND CRASH BARRIERS

Chain link fence enclosure and double gates, personnel gates and emergency push bar type gates were constructed around the landfill pit In addition, pipe crash barriers were installed around the fenced area of landfill pits.

Figure 5.17 North-Kuwait Landfill- Passive Gas Venting Well

Figure 5.18 South East-Kuwait Landfill- Fence Construction

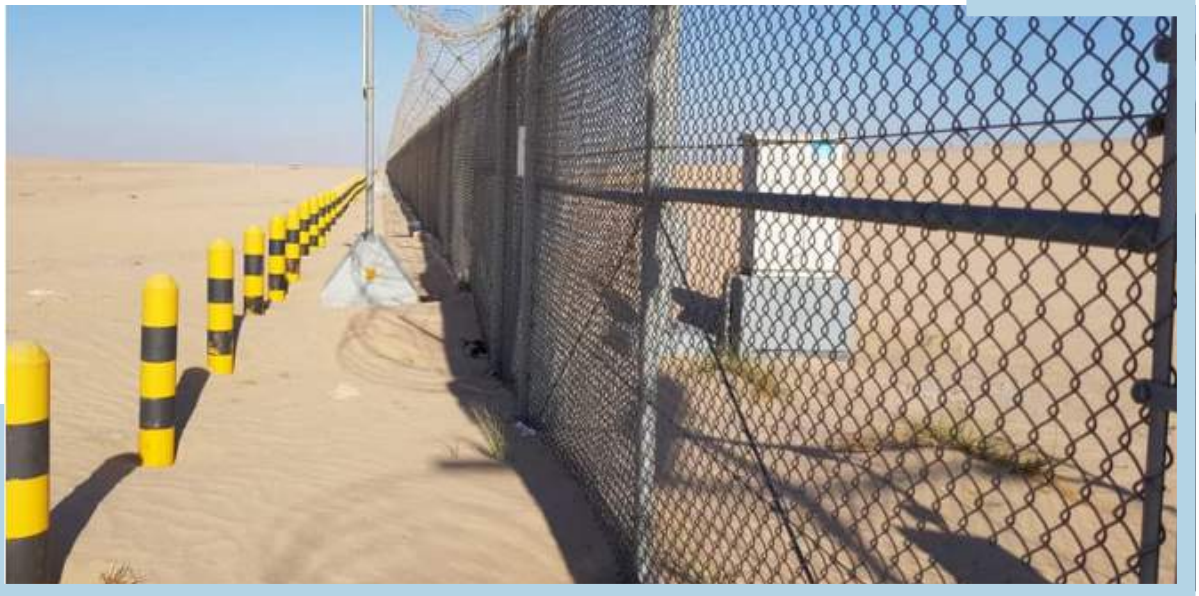


Figure 5.19 South East-Kuwait Landfill- Security Fence & Gate

ENVIRONMENTAL MONITORING WELLS

Monitoring wells were installed at the landfill facility as shown in Figure 5.20.

MECHANICAL WORKS

Figure 5.20 South East-Kuwait Landfill- Groundwater Monitoring Well

Figure 5.21 South East-Kuwait Landfill- Groundwater level monitoring

LINER SYSTEMS FOR LANDFILL PIT

The liner system was designed based on the guidelines provided in Technical Specification.

LEACHATE MANAGEMENT SYSTEM

The leachate piping system were designed based on the guidelines provided in Technical Specification.

SUBMERSIBLE PUMP PACKAGE

Submersible pumps with controllers were installed as per the details provided in Technical Specifications.

Figure 5.22 South East-Kuwait Landfill- Leachate Riser Pipe and Generator

ELECTRICAL WORKS

SOLAR LIGHTING

Lighting was installed at the landfill facility by the fence as per the approved design drawings.

Figure 5.23 South East-Kuwait Landfill- Solar Panel and Light Pole

FIRE SAFETY WORKS

Fire Extinguishers

Fire extinguishers were installed at the landfill facility.

Figure 5.24 NK Landfill Fire extinguishers

Figure 5.25 NK Landfill windsocks

WIND SOCKS

Windsocks were installed at the landfill facility as per the approved design drawings.

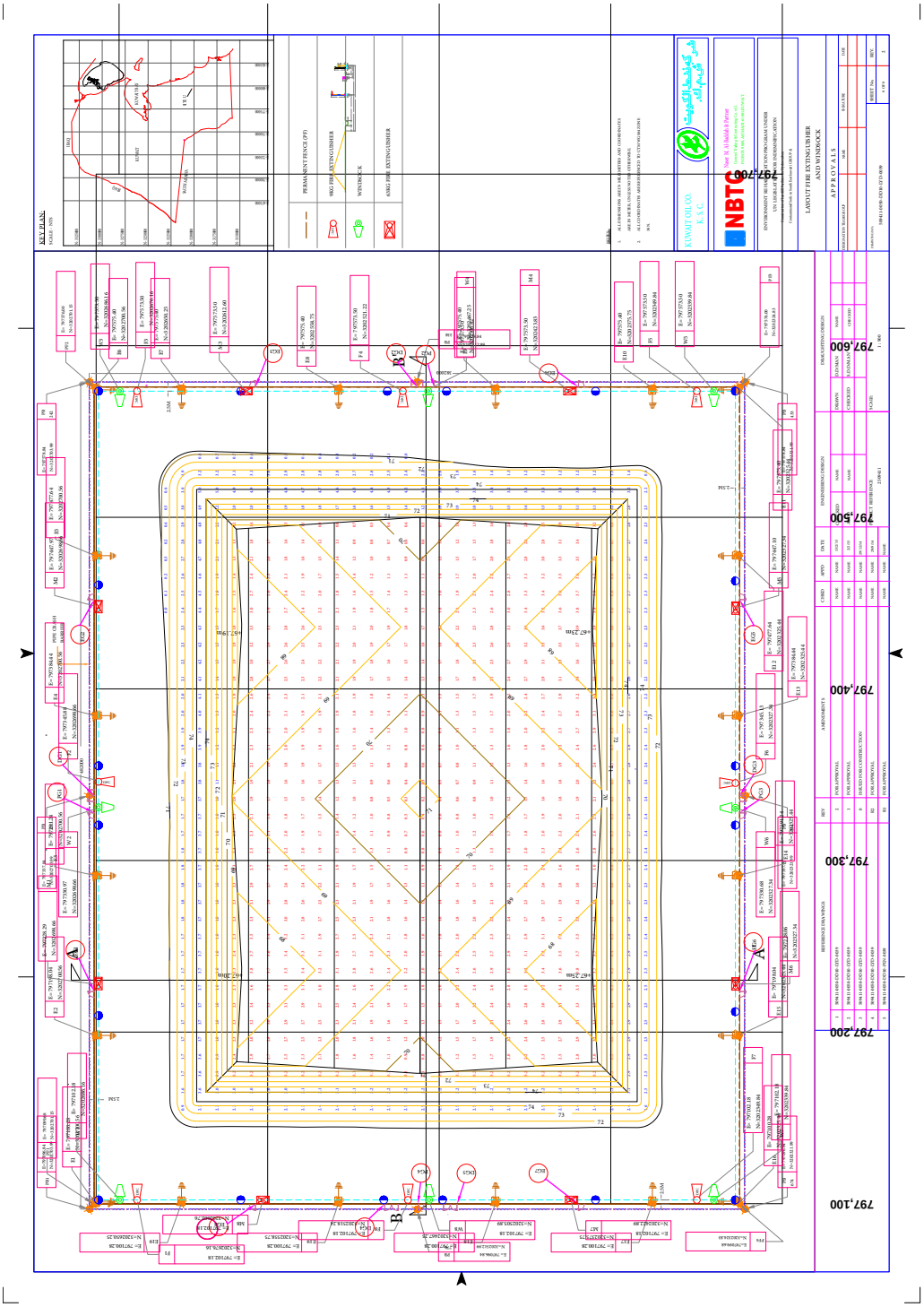


Figure 5.26 South East-Kuwait Landfill- As built Layout

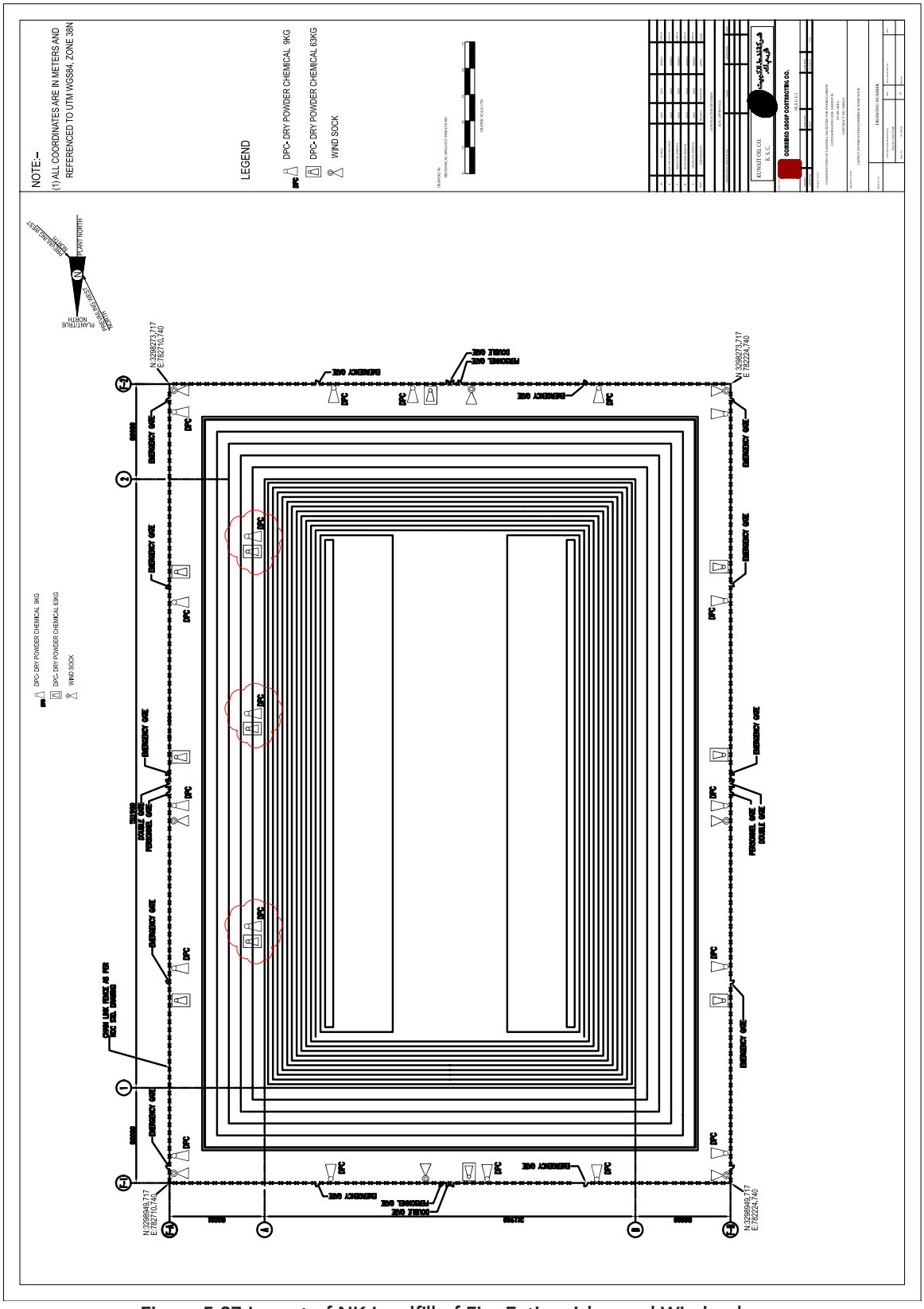


Figure 5.27 Layout of NK Landfill of Fire Extinguisher and Windsocks

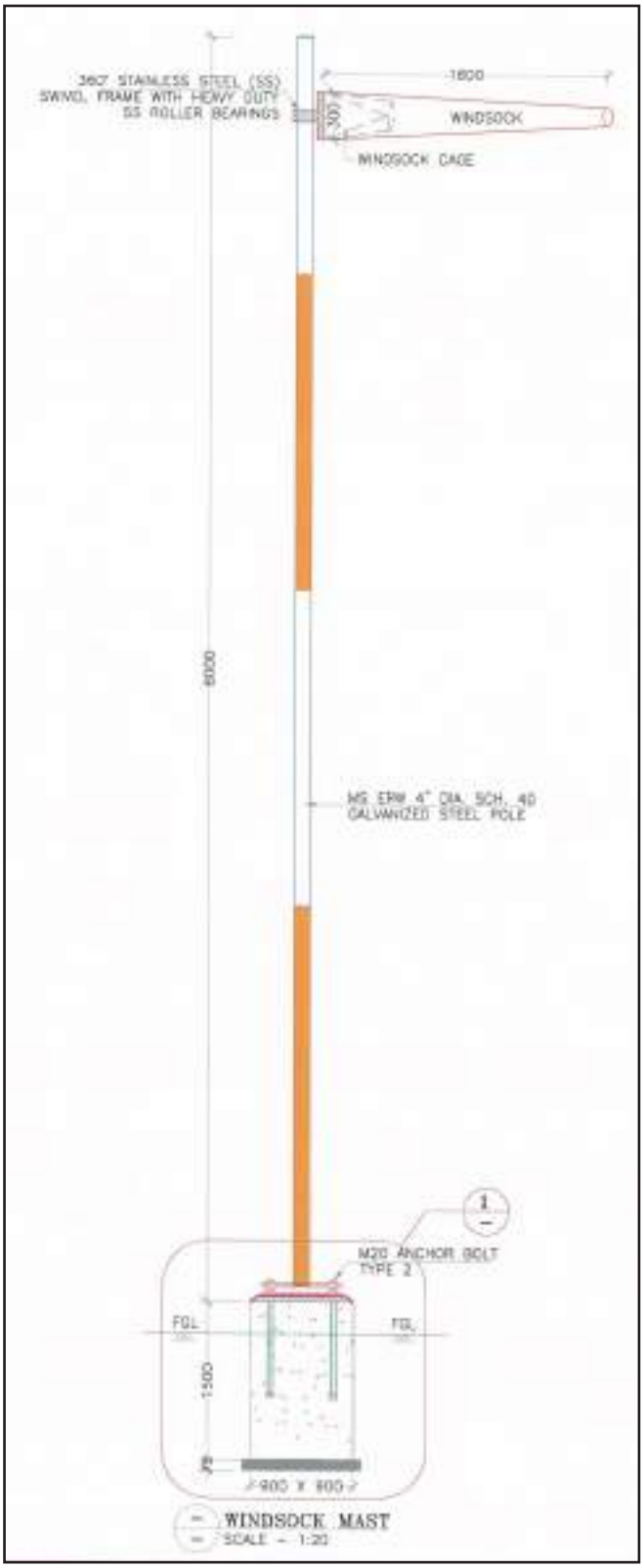
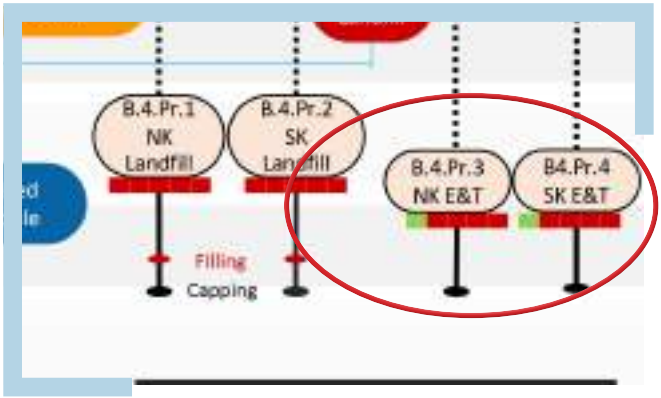


Figure 5.28 Details of windsock at NK Landfill

EXCAVATION AND TRANSPORTATION FOR SOUTH-EAST KUWAIT AND NORTH KUWAIT OIL FIELDS

INTRODUCTION:



In January 2015 the contractor started execution for the Excavation and Transportation (E&T) projects pursuant to the United Nations Compensation Commission (UNCC). The Project cost awarded for this contractor for South East Kuwait is USD 12,252,747 and similarly for North Kuwait is USD 21,429,397.

As part of the Kuwait Environmental Remediation Project (KERP), the Excavation and Transportation (E & T) of the heavily oil contaminated soil (e.g., TPH ~ 20%) in selected areas of Wet oil lakes, Dry oil lakes and Well head pits from South East Kuwait and North Kuwait oil fields located to decontaminate the soil areas impacted as a result of Iraq invasion on Kuwait. The key objectives of these projects recommended soil remediation strategy must comply with UNCC requirements.

EXCAVATION AND TRANSPORTATION SCOPE OF WORKS:

The scope of work provides detail on areas available for the Contractor to carry out geophysical survey, clearance, and disposal of unexploded ordnance (UXO), site preparation civil works for the remediation technologies demonstration project (RTDP) areas, and for excavation, transportation and placement of highly contaminated soil to the landfill facility. The main works listed below were performed by the Contractor.

- Adopted appropriate health and safety protocols for Unexploded Ordnance (UXO) detection, clearance and disposal protocols and methodologies prior to site preparation civil works for remediation technologies demonstration project (RTDP) areas and prior and during soil excavation activities.
- UXO geophysical survey and clearance of all areas (with the exemption of the wellhead pits) where soil remediation (e.g., excavation activities) is planned by other contractors.
- Undertaken site preparatory works well in advance of remediation demonstration contracts for the Burgan oil field.
- Performed site characterization with topographic survey, intrusive sampling, slit trench, boundaries, depths of planned excavation, extent of visually oil contaminated soil features to quantify oil contaminated soil volumes.
- Excavated and removed visibly or heavily contaminated soil and oil/sludge and restored the damaged environment to pre-invasion conditions.
- Transported and disposed of all visible or heavily oil contaminated soil at the assigned landfills.
- Implemented a compliance monitoring program (where required), which consists of post excavation soil samples to verify that excavation activity meets the target Soil Cleanup Criteria.
- Backfilled the excavated areas or features where required.

NK E&T ACHIEVEMENTS

- UXO.
- New Valuable DGM & BAC equipment were used.
- Developed methods to deal with Wet Oil Lakes and Oil Contaminated Piles.
- 253 UXOs found and destroyed.
- Geophysical Survey & clearance of total area of approximately 6,490,000 m^2(6.49 Km^2) WOL & DOL &OCP.
- Investigated and removed contamination from Coastal trench and Coastal Deposits in Closing UN Claim 259.
- Coastal oil deposit of approximately 38,430 m^2 was cleared from UXO/Landmines.
- Coastal trench of approximately 294,160 m^2 was cleared from UXO/Landmines.
- Investigated and removed contamination from the Well Head Pits in closing UN Claim 450 (2) 65 WHPs Investigated.
- 47 WHPs required Excavation and Transport of sludge and oil contaminated soils of 161,600 m^3.
- Cleared 6.4 M m^2 Million m^2 of land from soil contamination.
- Cleared of the largest WOL ~355,000 m^2 in Raudhatain.
- Cleared XXX drilling locations for Field Development.
- Removed and compacted total of 1,700,000 m^3 of heavily contaminated soil into landfill pit.
- Removed 40,000 m^3 of sludge and 393,000 m^3 of mixed soil from the large wet oil lake.
- Removed and compacted approximately 32,800 m^3 of oil contaminated soils from coastal deposits.
- Removed and compacted approximately 6,6650 m^3 of oil contaminated soils from coastal trench.
- Landfill/KOC gate has been closed in order to hand Landfill to the Capping Contractor.

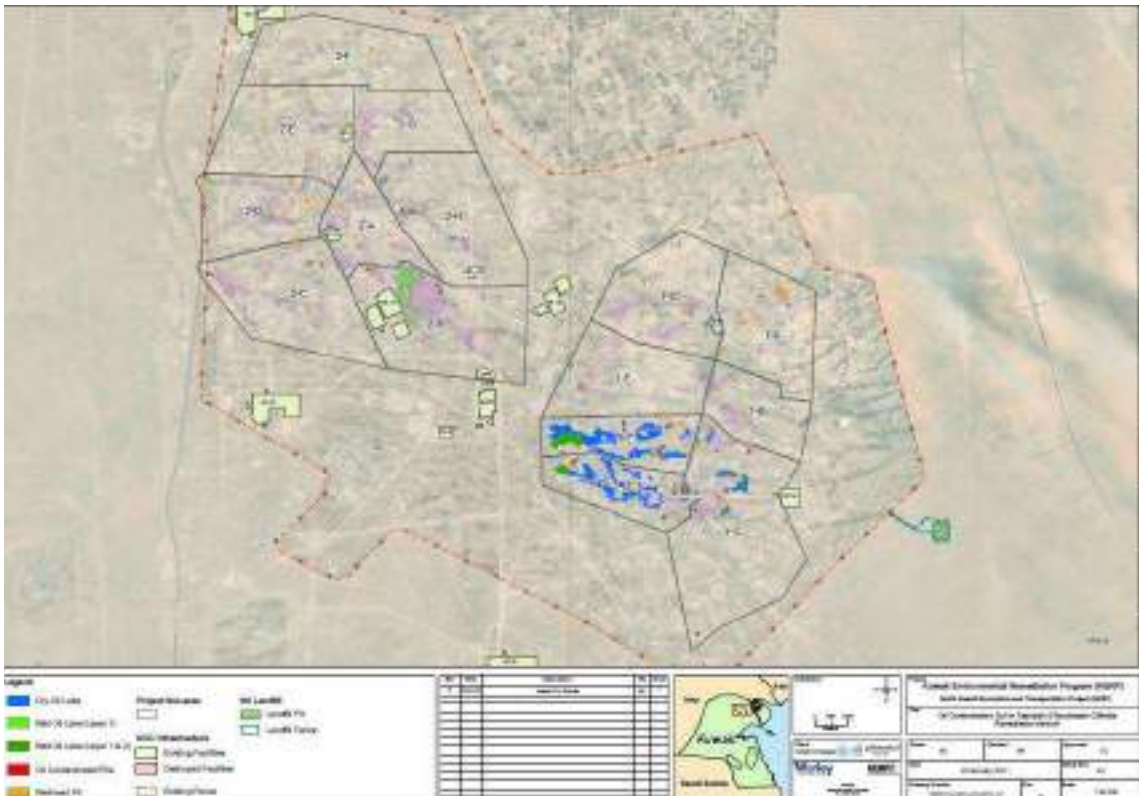
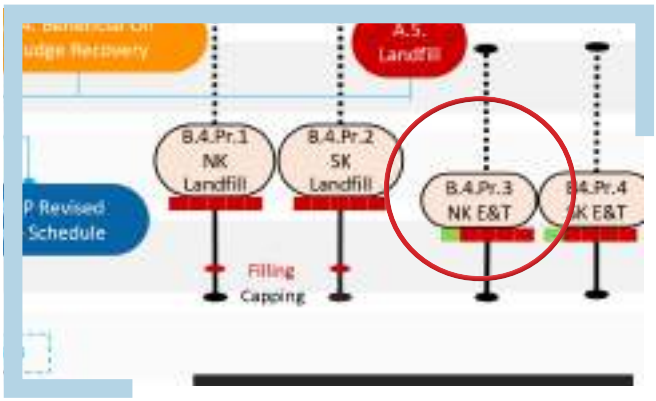


Figure 5.29 Excavation & Transportation work area in NK area

A.5 PR 3 EXCAVATION & TRANSPORTATION IN NK FIELDS:



Excavation and Transportation work was carried out at Umm Al Aish and Al Raudhatain as part of North Kuwait oil fields (refer to Figure 39) Different features like Wet Oil Lakes, Dry Oil Lakes, Wellhead pits, Contaminated Soil Piles and Coastal Trench were removed, and associated land area was handed over to Asset owners for future development of oil fields. The total area excavated was approximately 5,227,993 m^2 and related to tal contaminated soil volume was 1,712,596 m^3 Wet Oil Lake cleared area was 1,308,182 m^2 & volume of compacted to landfill was 831,676 m^3 Similarly, Dry Oil Lake cleared area was 3,305,814 m^2 & volume of compacted to landfill was 495,804 m^3, Wellhead Pits cleared was area 109,414 m^2 & volume of compacted to landfill was 163,526 m^3 and Contaminated Soil Pile piles cleared area was 140,796 m^2 & volume of compacted to landfill in to 182,164 m^3. Additionally, coastal trench contaminants with heavy presence of minefields surrounding coastal trench were cleared during this project Total land release from coastal trench area was 368,787 m^2 which includes costal trench (294,157 m^2) & costal deposits (69,630 m^2), total contaminated soil transferred to landfill was approximately 39,426 m^3.

Furthermore, 9,946 nos of Unexploded Ordnances (UXO) were found in NK field during excavation of contaminated soil and safely disposed with help from Kuwait Ministry of Defense (KMOD).

OPERATION AND FILLING OF THE CONSTRUCTED LANDFILLS WITH CONTAMINATED SOILS

Upon construction of landfill facility, an operation and maintenance manual consisting of operational protocols/ procedures to fill the landfill pit or cell with designated waste (oil contaminated soils) with controls for incoming waste, waste placement, waste delivery records Traffic Management coordination and maintenance and repairs of all elements of constructed landfills as per Engineering Design The following pictures give the reader the infilling operations at different stage of operation.

Figure 5.30 Wet Oil Lake before excavation in NK area

Figure 5.31 Wet Oil Lake after excavation in NK area

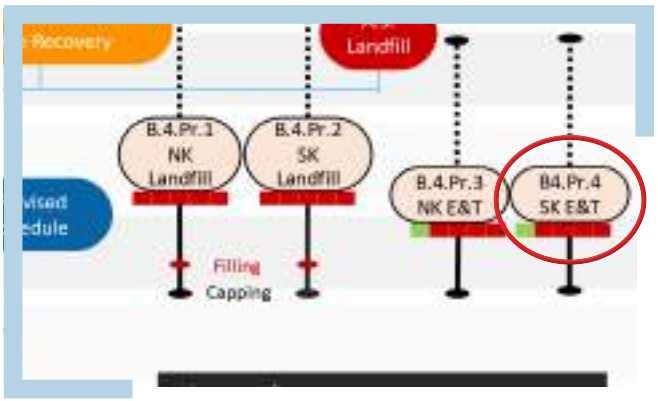
Figure 5.32 Dry Oil Lake during excavation in NK area

Figure 5.33 Dry Oil Lake after excavation in NK area

Figure 5.34 Contaminated Soil Piles before excavation in NK area

Figure 5.35.Contaminated Soil Piles after excavation in NK area

A.5 PR 4 EXCAVATION & TRANSPORTATION IN SEK –BURGAN LOCATION:



The Contractor carried out Excavation and Transportation work in Greater Burgan area as part of South & East Kuwait oil fields. There were different features like Wet Oil Lakes. Dry Oil Lakes, Wellhead Pits and Contaminated Soil Piles were removed, and associated land area was handed over to Asset owners for future development of oil fields The total area excavated was approximately 1,199,304 m^2 and related total contaminated soil volume was 583,738 m^3. The Wet Oil Lake cleared area was 99,652 m^2 & volume of compacted to landfill was 156,861 m^3 Similarly, Dry Oil Lake cleared area was 998,524 m^2 & volume of compacted to landfill was 313,977 m^3, Wellhead Pits cleared land was 39,107 m^2 & volume of compacted to landfill was 59,787 m^3 and Contaminated Soil Pile piles cleared was area 62,021 m^2 & volume of compacted to landfill was 53,113 m^3.

Furthermore, 75 nos. of Unexploded Ordnances (UXO) were found in SEK field during excavation of contaminated soil and safely disposed of with the help from KMOD.

SEKE&T ACHIEVEMENTS

- UXO.
- Valuable DGM & BAC equipment were used.
- Developed methods to deal with Wet Oil Lakes and Oil Contaminated Piles 70 UXO found and destroyed.
- Geophysical Survey & clearance of total area of approximately 3,700,000 m^2(3.7 Km^2) WOL &DOL.
- Battle Area Clearance of 854,000 m^2(0.854 km^2) & 125,000 m^3 of OCPs.
- Investigated and removed contamination from the Well Head Pits in closing UN claim 450 (2).
- 98 WHPs investigated.
- 22 WHPs required excavation and transport of contaminated soils/sludge of approximately 43,900 m^3.
- Cleared 1.2 Million m^2 of land from contamination.
- Cleared the GC32 footprint of contaminated soil.
- Cleared four (4) drilling locations for Field Development.
- Removed and compacted 580,000 m^3 of heavily contaminated soil into landfill pit.
- Removed 40,000 m^3 of sludge and 120,000 m^3 of mixed soil from the large wet oil lake B-4753.
- Landfill/KOC gate has been closed in order to hand Landfill to the Capping Contractor.

CONCLUSIONS

Regardless of all the difficulties and challenges in the early stage and during the execution of the projects. All projects involved parties were pleased and were present for the celebrations for the successful completion infilling of the landfill pits in SEK and NK in accordance with the engineered design & construction as per International Standards and in safety record without incidents.

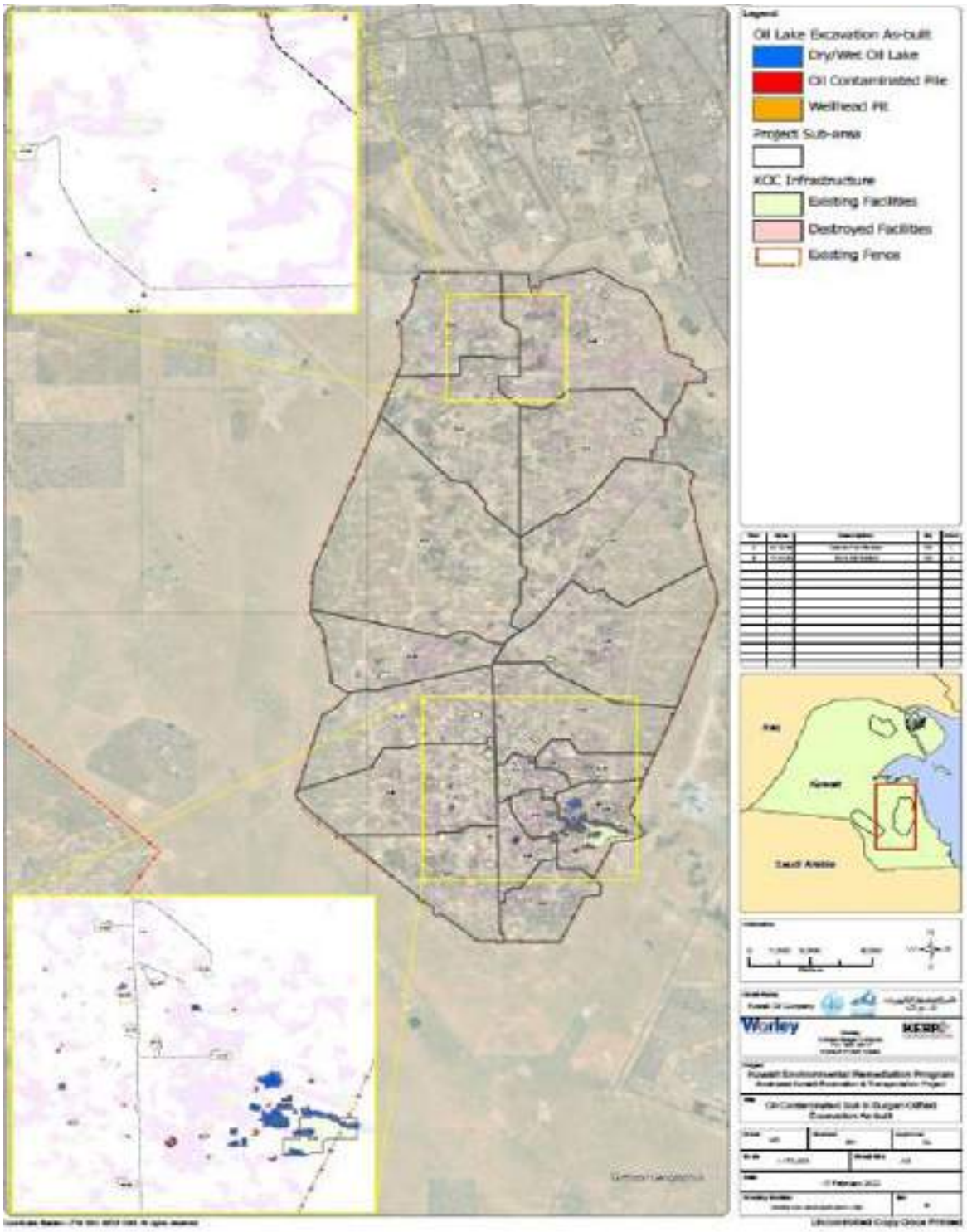


Figure 5.36 Excavation & Transportation work area in SEK area

Figure 5.37 Wet Oil Lake before excavation in SEK area

Figure 5.38 Wet Oil Lake after excavation in SEK area

Figure 5.39 Dry Oil Lake before excavation in SEK area

Figure 5.40 Dry Oil Lake after excavation in SEK area

Figure 5.41 Well Head Pit before excavation in SEK area

Figure 5.42 Wellhead pits after excavation in SEK area

Figure 5.43 Contaminated Soil Piles before excavation in SEK area

Figure 5.44 Contaminated Soil Piles after excavation in SEK area

Figure 5.45 Costal trench during excavation in NK area

Figure 5.46 Coastal trench after excavation in NK area

Below given are the pictures of excavation transportaion of DOL, WOL and of well head pits along and infilling of the landfills

Figure 5.47 Dry Oil lake E&T

Figure 5.48 WHP E&T

Figure 5.49 Wet oil lake E&T in SK area

Figure 5.50 Landfill construction.

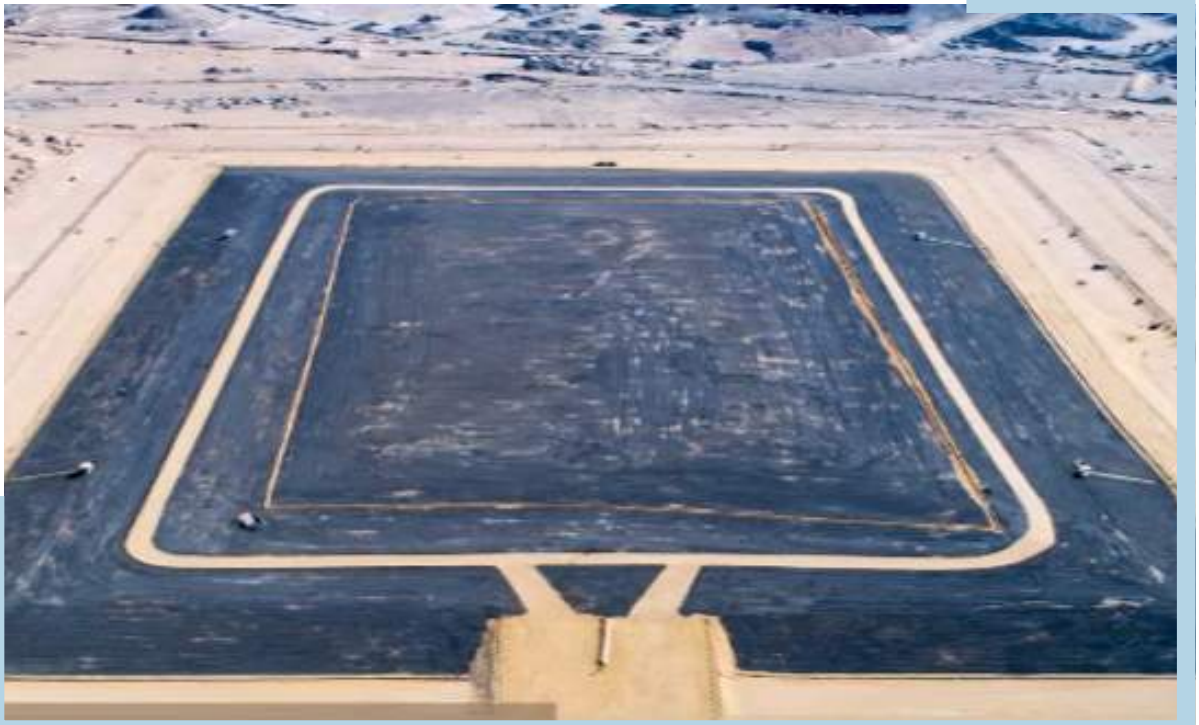


Figure 5.51.South East Kuwait Capped Landfill- Top View

Figure 5.52 Final Day & Celebration of the NKE&T & Infilling of the landfill with Oil Contaminated Soils

CONSTRUCTION OF COVER CAPPING SYSTEM FOR CONSTRUCTED LANDFILL FACILITIES

Upon completion of filling operations, the landfill Contractors returned to the site to execute the cover cap over the landfill pit is installed in accordance with approved designed capping system.

A cover capping over the entire landfill pit in proper slope was constructed to minimize rainwater infiltration and to protect the liner from direct contact with the public and environment. The landfill pit was covered after the landfill reaches its full capacity and completed the landfill works. The cover system consists the following components (in a sloped layers) proceeding from top to bottom:

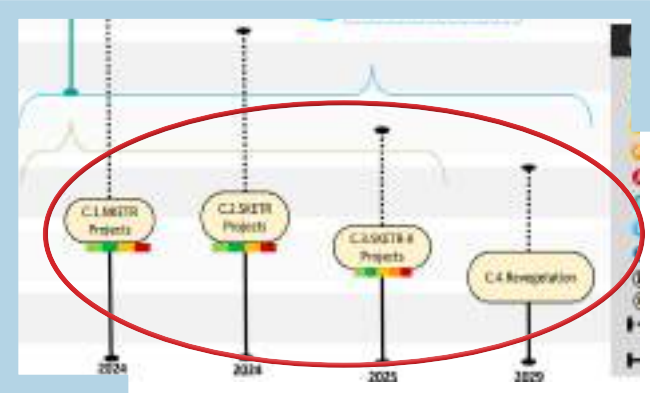
- Top Surface Gravel Layer – A gravel layer was placed over the top of the waste storage facility to protect the cover from wind erosion. This layer consists of gravel in the 5 mm- to 15mm-grain-size range.
- Soil Protective Layer/Growing Medium – An upper soil layer was provided to protect the cover and promote a growing medium for grasses.
- Lower Protective Layer – A lower soil protective layer consisting of compacted gatch was provided to help protect the cover system from burrowing animals In addition, this gatch layer also provided some resistance to infiltration.
- Layer of geo-membrane liner – Installed one layer of geo-membrane over the compacted gatch layer in accordance with written recommendations of the manufacturer.
- Protective layer – An approved gatch was placed on the top surface of the landfill by bulldozer and compacted to form a protective layer prior to installation of geo-membrane over the prepared base.

CONCLUSIONS

Landfill capping activities were completed on record time within 8 to 10 months upon receipt of notice to proceed from Company to the landfills constructors of capping system. Final achievements and celebrations took place to show case the successful completion of early phase of KERP with the engineered 2 landfills constructed, filled and capped as per UNCC claim 454.

Chapter - 6
KERP Mega Projects

According to the revised KERP Strategy and the UNCC-approved phasing plans, TRS as presented in chapter 4 of this Book was approved. Following this in January 2020 KERP witnessed another Milestone; The tenders for North Kuwait Excavation Transportation and Remediation (NKETR) and South Kuwait Excavation, Transportation and Remediation (SKETR) were approved by CAPT and got issued into the Market. An elaborate Pre-bid meeting for SKETR and NKETR was held in January 2020 Hundreds of potential bidders attended the meeting, with numerous questions, queries, and concerns, which the KERP team successfully responded to. The bidders were given information on NKETR and SKETR especially their volume.



This chapter details the execution phase of the TRS which is the 8 mega projects, including C.1 NKETR, C.2 SKETR, C.3 SKETR II and C.4 Revegetation projects. The chapter also demonstrates the types of features of these projects Moreover, it will cover several soil remediation methods and technologies.

Figure 6.1.1 Prebid meeting for SKETR and NKETR

Figure 6.1.2 Prebid meeting for SKETR and NKETR

Figure 6.1.3 Prebid meeting for SKETR and NKETR

SIGNING OF 5 MEGA CONTRACTS

July 2021 is remarkable in the history of KERP as it marked a significant milestone in the journey of KERP. This was when the five mega-remediation contracts were signed for the remediation of 13 million m^3 of contaminated soils. The five contracts were awarded as in below given table.

Figure 6.2.1 Signing of contracts for SKETR and NKETR

Zone	Contract No.	Contractors Details
NKETR Zone-1	21056716	JV/C of Khalid Ali Al Kharafi & Bros Construction, Contracting Co K.S.C.C with Lamor Corporation AB
NKETR Zone-2	21056717	JV/C of The Kuwait Company for Process Plant Construction & Contracting (KCPC) with Environmental Technology Management Company
SKETR Zone-1	21056718	JV/C of Khalid Ali Al Kharafi & Bros Construction, Contracting Co K.S.C.C with Lamor Corporation AB
SKETR Zone-2	21056719	JV/C of Heavy Engineering Industries & Shipbuilding Co KSC, with Hangzhou Zaopin St Co Ltd
SKETR Zone-3	21056720	JV/C of Enshaat Al-Sayer General Trading & Contracting Co WLL with Water & Soil Remediation S.R.L

Table 6.1 Mega KERP Contractors Details

Figure 6.2.2 & 6.2.3 Signing of contracts for SKETR and NKETR

KERP MEGA PROJECTS – OVERALL SUMMARY

KERP Mega Projects consists of NKETR, SKETR I and SKETR II. The overall goal of these projects is to remediate significant amounts of contaminated features to reach acceptable levels and restore ecological function. Being one of the largest environmental projects in the world, the program will have a significant impact on the local environment while recovering some of the lost resources and providing valuable lessons for such projects in future. Apart from this, the project will also generate several job opportunities to Kuwaiti Nationals providing them with experience in the field of soil remediation. Each project was divided into zones, and each zone was awarded to a different contractor.

At first, the contaminated soil is excavated and segregated, after that it is loaded and transported to the stockpiling zone. Then, the contaminated soil is transported either to the treatment area or to a controlled landfill. The soil taken to the treatment area is then treated and remediated to the stipulated quality there. Finally, after the completion of the treatment process, the treated soil is transported back to the previously contaminated area where it will eventually be backfilled and restored as depicted in Figure 6.3.

Figure 6.3 Summary of E &T Works

KERP MEGA PROJECTS- DIVISION INTO ZONES

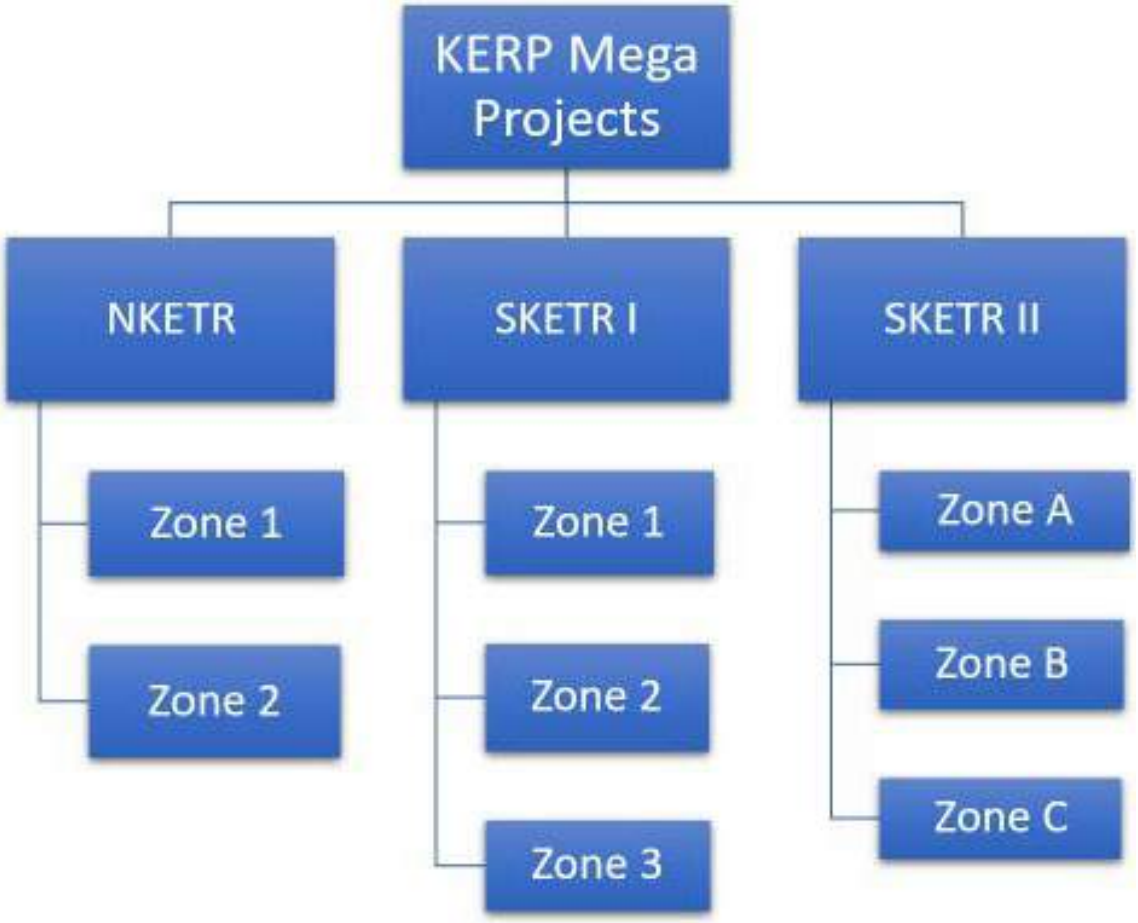


Figure 6.4 Zonal Division of the KERP Mega Projects

ESIA SCOPING REPORTS FOR KEPA APPROVALS (ALL PROJECTS)

All KERP Mega Projects have successfully complied and finished the Environmental and Social Impact Assessment (ESIA) Scoping report which was reviewed and approved by Kuwait Environment Public Authority (KEPA). Upon award and initiation of each of the Mega projects, the awarded contractors have to prepare Environmental and Social Assessment Reports (ESAR) for their Temporary facilities and a comprehensive Environmental and Social Impact Assessment Studies for KEPA's review and approval.

Figure 6.5.1 KEPA Visit to KERP Areas

Figure 6.5.2 KEPA Visit to KERP Areas

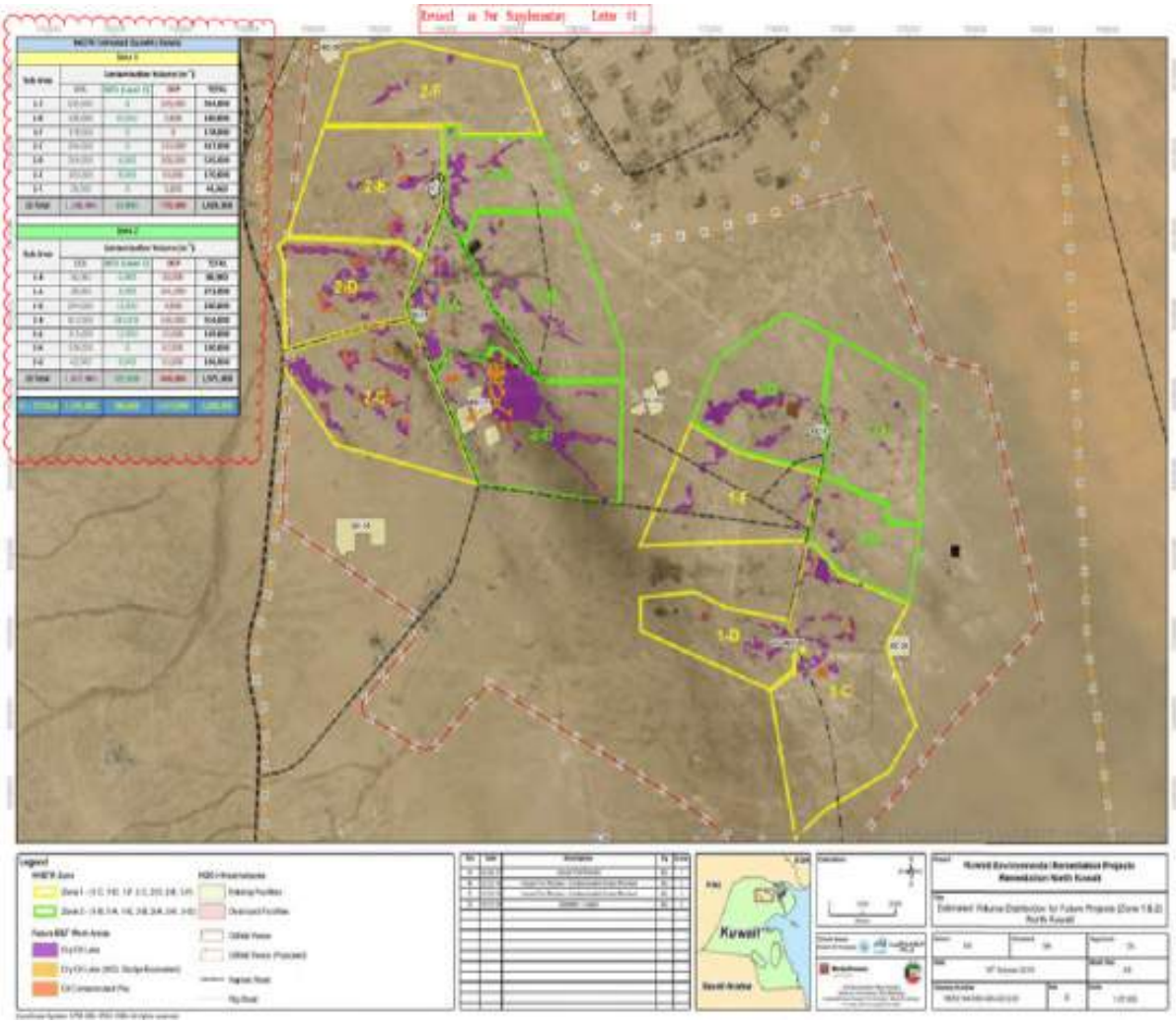
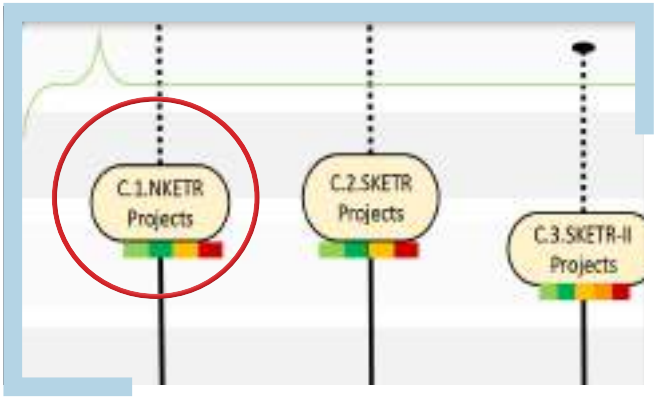


Figure 6.6 North Kuwait Projects, NKETR Zone 1 & NKETR Zone 2

C.1 NKETR (ZONE 1 & 2)



North Kuwait Excavation Transportation and Remediation (NKETR) Project addresses oil contaminated soil located in the Raudhatain and Sabriya oil fields of Kuwait (identified as NK).

NKETR Project has been developed pursuant to the United Nations Compensation Commission (UNCC) Governing Council Report on Part Two of the Fourth Installment of 'F4' Claims (Report no S/AC.26/2004/17 issued on 9 Dec 2004).

This project undertakes environmental remediation of contaminant features in Raudhatain and Sabriya oilfields The areas of KERP features are illustrated in Figure 6.6.

NKETR consists of 788 features with a total area of 14,823,805 m^2 and a total volume of 4,000,000 m^3 of contaminated soil 302 of those features are Dry Oil Lakes (DOL) with an area of 12,359,986 m^2 and a volume of 2,195,000 m^3 of contaminated soil. As for the Wet Oil Lakes (WOL), there are 54 features with an area of 611,963 m^2 and a volume of 386,000 m^3 of contaminated soil. As for the Oil Contaminated Piles (OCP), there are 432 features covering an area of 14,823,805 m^2 and a volume of 1,410,000 m^3.

The scope of Works for the contractors working on North Kuwait's Zone 1 & 2 (as shown in Figure 6.6) includes, but is not limited to, all Works to be executed and services and materials to be provided by the contractor, including but not limited to the engineering design, procurement of materials, conducting studies, expediting, shipping, project management, UXO clearance, topographic survey, ground truthing activities, soil characterization, lab and field remediation trials, optimization studies reports, construction, excavation, transportation, post excavation compliance sampling, remediation using bioremediation and treatment technologies, inspection, expansion of existing landfill facility, site restoration, testing and verification of remediated soil, and all associated works including but not limited to utilities and services, necessary coordination, Temporary Works and facilities, the provision of manpower and resources, and all works and services which could be reasonably deemed necessary to complete the works.

C 1.1 NK ZONE 1:

Zone 1 has a total of 467 features with a total area of 6,436,511 m^2 and a total volume of 2,028,000 m^3 of contaminated soil 204 of those features are Dry Oil Lakes (DOL) with an area of 5,177,453 m^2 and a volume of 1,188,000 m^3 of contaminated soil As for the Wet Oil Lakes (WOL), there are 13 features with an area of 65,460 m^2 and a volume of 61,000 m^3 of contaminated soil As for the Oil Contaminated Piles (OCP), there are 250 features covering an area of 1,193,599 m^2 and a volume of 779,000 m^3.

C.1.2 NK ZONE 2:

Zone 2 has a total of 321 features with a total area of 8,387,294 m^2 and a total volume of 1,972,000 m^3 of contaminated soil 98 of those features are Dry Oil Lakes (DOL) with an area of 7,182,533 m^2 and a volume of 1,007,000 m^3 of contaminated soil. As for the Wet Oil Lakes (WOL), there are 41 features with an area of 546,503 m^2 and a volume of 325,000 m^3 of contaminated soil. As for the Oil Contaminated Piles (OCP), there are 182 features covering an area of 658,258 m^2 and a volume of 640,000 m^3.

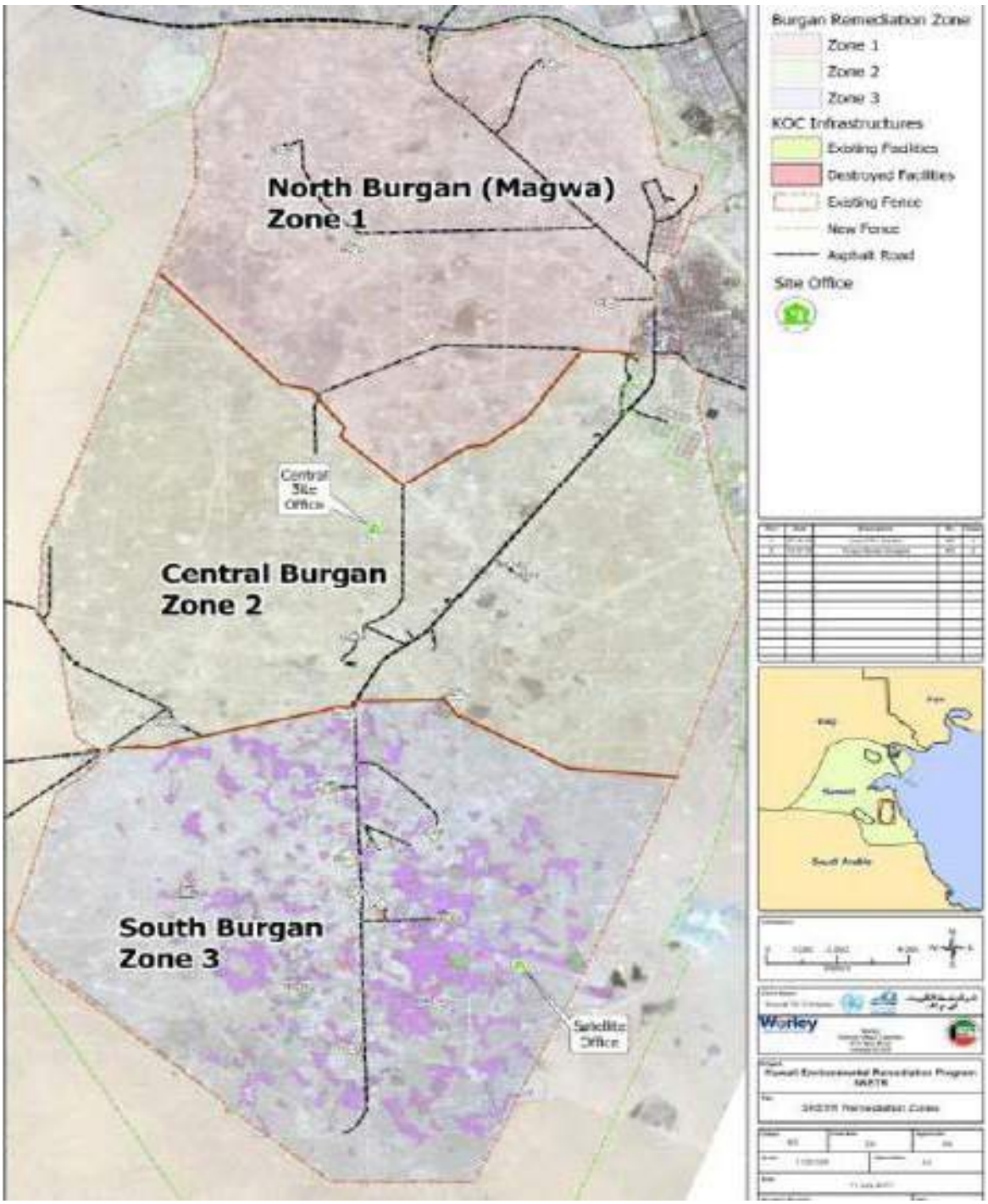
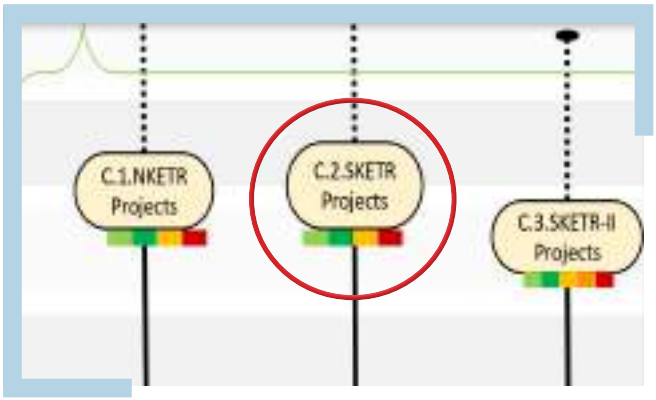


Figure 6.7 South Kuwait Projects, SKETR Zone 1, SKETR Zone 2 & SKETR Zone 3

C 2 SKETR I (ZONE 1, 2 & 3)



The South Kuwait Excavation, Transportation and Remediation Project (SKETR I) consists of 5,508 features with a total area of 58,877,318 m^2 and a total volume of 20,911,000 m^3 of contaminated soil 809 of those features are Dry Oil Lakes (DOL) with an area of 50,050,596 m^2 and a volume of 10,500,000 m^3 of contaminated soil. As for the Wet Oil Lakes (WOL), there are 2,544 features with an area of 7,090,679 m^2 and a volume 4,538,000 m^3 of contaminated soil. As for the Oil Contaminated Piles (OCP), there are 2,155 features covering an area of 1,736,043 m^2 and a volume of 5,873,000 m^3.

The scope of works for South Kuwait's Zone 1, 2 & 3 (as shown in Figure 6.7) shall include but is not limited to all works to be executed and services and/or materials to be provided by the Contractor, including but not limited to the engineering design, procurement of materials, conducting studies, expediting, shipping, project management, UXO clearance, topographic survey, ground truthing activities, soil characterization, lab and field remediation trials, optimization studies reports, construction, excavation, transportation, post excavation compliance sampling, remediation using bioremediation and treatment technologies, inspection, expansion of existing landfill facility, site restoration, testing, and verification and all the associated works including but not limited to utilities and services, necessary coordination, temporary works and facilities, the provision of manpower and resources, and all works and services which could be reasonably deemed necessary to complete the works.

C.2.1 SK ZONE 1:

Zone 1 has a total of 1138 features with a total area of 18,293,390 m^2 and a total volume of 6,176,000 m^3 of contaminated soil 229 of those features are Dry Oil Lakes (DOL) with an area of 15,745,020 m^2 and a volume of 3,300,000 m^3 of contaminated soil As for the Wet Oil Lakes (WOL), there are 258 features with an area of 2,243,850 m^2 and a volume 1,436,000 m^3 of contaminated soil.

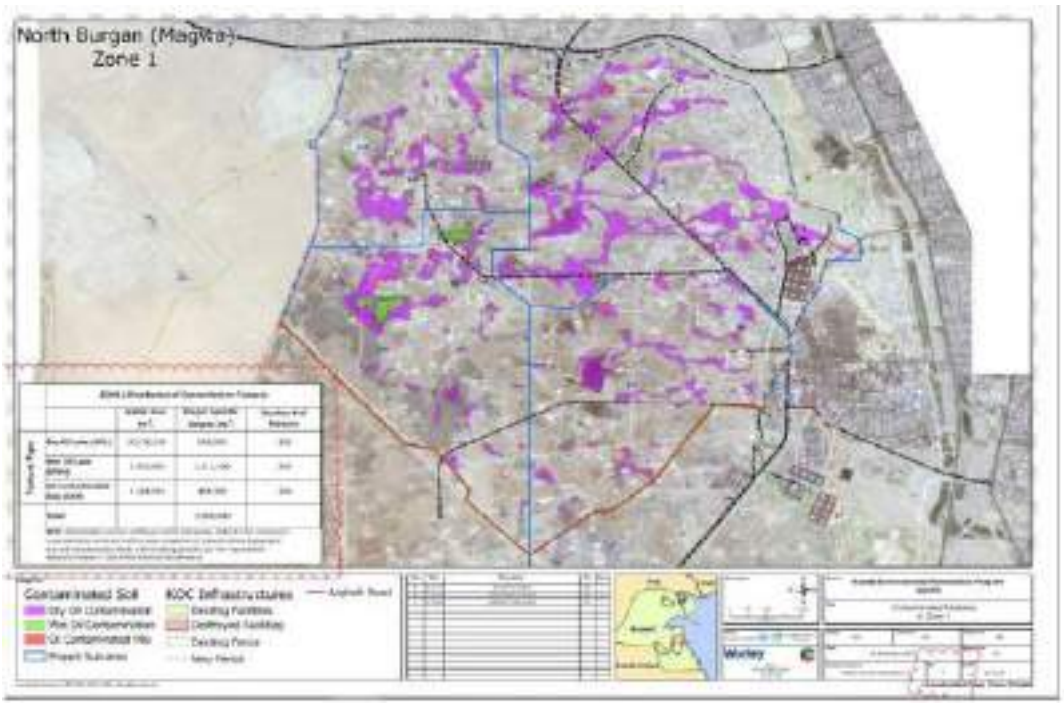


Figure 6.8 South Kuwait Projects, SKETR Zone 1

As for the Oil Contaminated Piles (OCP), there are 651 features covering an area of 304,520 m^2 and a volume of 1,440,000 m^3.

C.2.2 SK ZONE 2:

Zone 2 has a total of 1963 features with a total area of 12,868,941 m^2 and a total volume of 4,858,000 m^3 of contaminated soil 200 of those features are Dry Oil Lakes (DOL) with an area of 9,967,851 m^2 and a volume of 2,100,000 m^3 of contaminated soil As for the Wet Oil Lakes (WOL), there are 695 features with an area of 2,545,737 m^2 and a volume 1,629,000 m^3 of contaminated soil As for the Oil Contaminated Piles (OCP), there are 1,068 features covering an area of 355,353 m^2 and a volume of 1,129,000 m^3.

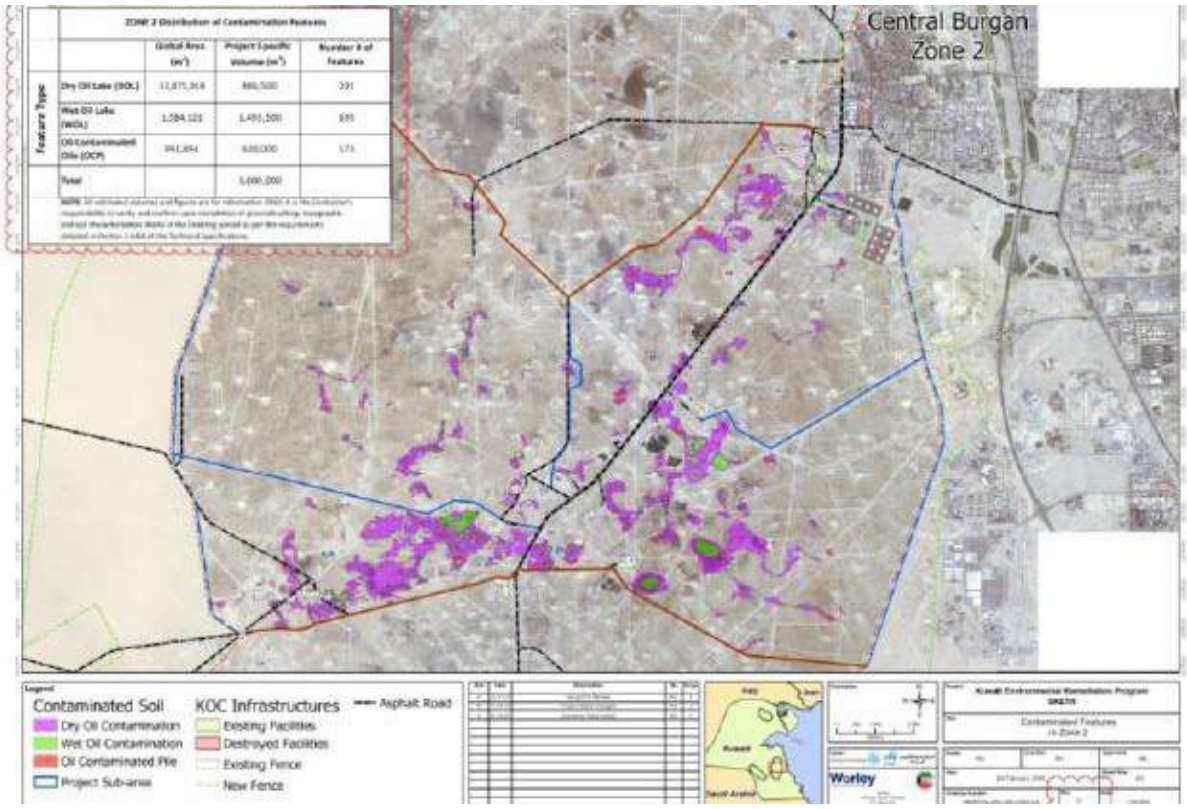


Figure 6.9 South Kuwait Projects, SKETR Zone 2

C 2.3 SK ZONE 3:

Zone 3 has a total of 2407 features with a total area of 27,714,860 m^2 and a total volume of 9,877,000 m^3 of contaminated soil 380 of those features are Dry Oil Lakes (DOL) with an area of 24,337,725 m^2 and a volume of 5,100,000 m^3 of contaminated soil As for the Wet Oil Lakes (WOL), there are 1,591 features with an area of 2,301,092 m^2 and a volume 1,473,000 m^3 of contaminated soil. As for the Oil Contaminated Piles (OCP), there are 436 features covering an area of 1,076,043 m^2 and a volume of 3,304,000 m^3 However, only part of the OCPs in Zone 3 are included in the contract The remaining OCPs are to be treated within the scope of SKETR II.

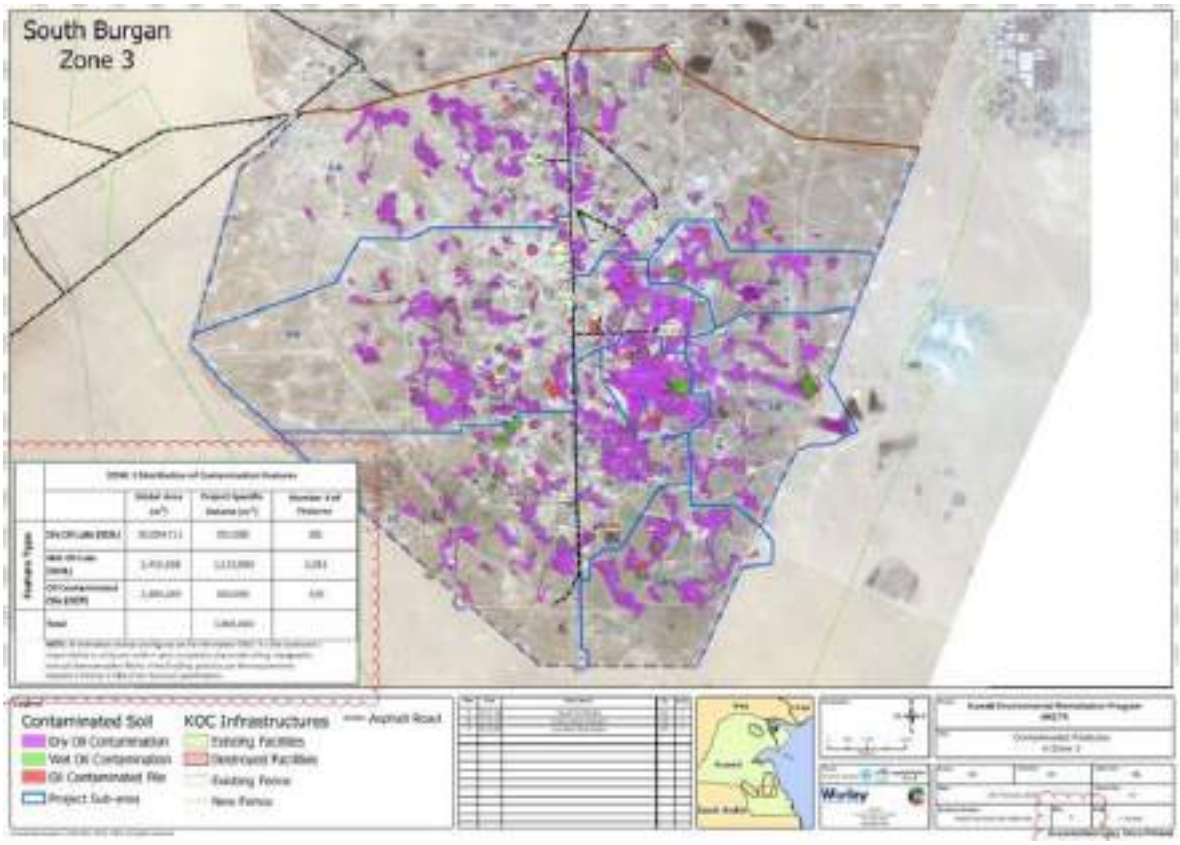
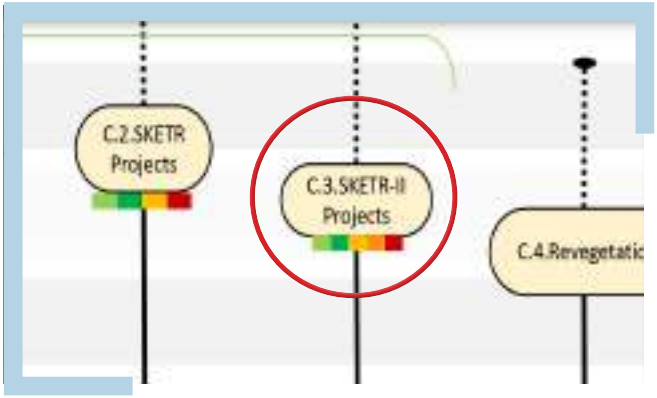


Figure 6.10 South Kuwait Projects, SKETR Zone 3

Figure 6.11 KOC & PMC members during different site activities at the Mega project sites

C.3 SKETR II

South Kuwait Excavation, Transportation and Remediation Project (SKETR II) is divided into three separate zones Zone A, B & C as shown in Figure 6.11 SKETR II project is currently in the pre-bid phase; as a result, the contracts are yet to be granted to contractors In addition to the responsibilities of contractor of Zone 3, they are also responsible for the works in **Wadi Al-Batin Area.**



The scope of Works of SKETR II Zone A, B & C includes, but is not limited to, all Works to be executed and services and/or materials to be provided by the Contractor including but not limited to the engineering design, procurement of materials, conducting studies, expediting, shipping, project management, UXO clearance, soil characterization, bench scale laboratory and field remediation trials tests, optimization studies reports, construction support, excavation, transportation, remediation, landfill facility design and construction, inspection, site restoration, testing and verification and all the associated works including but not limited to utilities and services, necessary coordination, temporary Works and facilities, the provision of manpower and resources, and all works and services which could be reasonably deemed necessary to complete the works.

It is estimated that the quantities of contaminated soil in SKETR II is around 8,040,000 m^3 including the remaining features of SKETR I. The main difference between SKETR I and SKETR II is that latter has both an active and enhanced passive bioremediation approaches to treating the contaminated soil.

ENHANCED NATURAL ATTENUATION (ENA)

Enhanced Natural Attenuation (ENA) for soil with TPH > 1% to ≤2% (Phase 1) is the primary remediation method for this range of low oil impacted KERP soil. The large volumes of contaminated soil in South Kuwait (SK), especially those remaining after the SK E&T and SEKTR projects, will require efficient approaches to handle the remaining considerable volume of contaminated soils The Enhanced Natural Attenuation process is a slow natural process where endemic soil microorganisms naturally present in the soil structure biodegrades (intake) hydrocarbon contamination. The ENA will be applied on the marginally contaminated soils (i.e 1% < TPH < 2%) and will be only applicable in SKETR II project. This natural process is typically very slow, however it can be accelerated by adding nutrients/amendments and increasing the water content to biodegrade the total petroleum constituents to the remediation target concentration (RTC). This approach can be used for improving biodegradation rates to optimize RTC endpoint and provide a permanent solution to open gatch pits in the entire oil field(s). This this approach also facilitates a low cost and well-established solution that is in line with the TRS and UNCC Plans and has gained preliminary approvals from KOC and KEPA (via the approval of scoping report) for approximately 1.6 – 2.4 Mm^3 The ENA represent a stand-alone portion of the SKETR II tender package for the anticipated works.

In addition, the scope of SKETR II also includes the construction of oil storage pits as well as the design, construction, and management of a temporary oil sludge extraction system to recover crude oil for enhancement. Furthermore, the contractors must also design, construct and handover to the company two integrated oil recovery systems after passing all testing phases successfully. The final difference between the two scopes is that SKETR II has a focus enhanced natural attenuation (ENA) which is considered a passive bioremediation method The project is expected to commence in February 2023 with an estimated duration of four years.

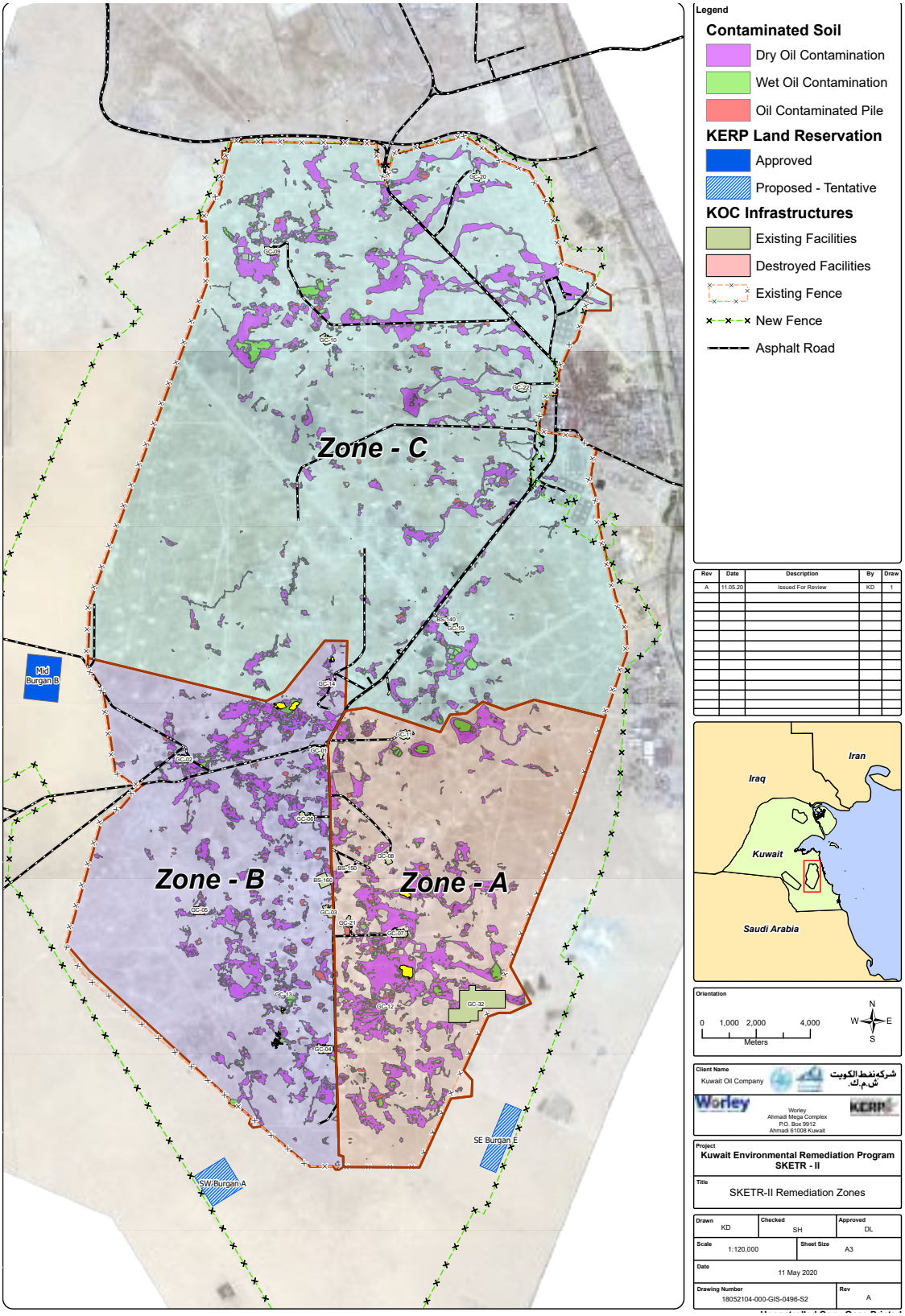


Figure 6.12 South Kuwait Projects, SKETR II

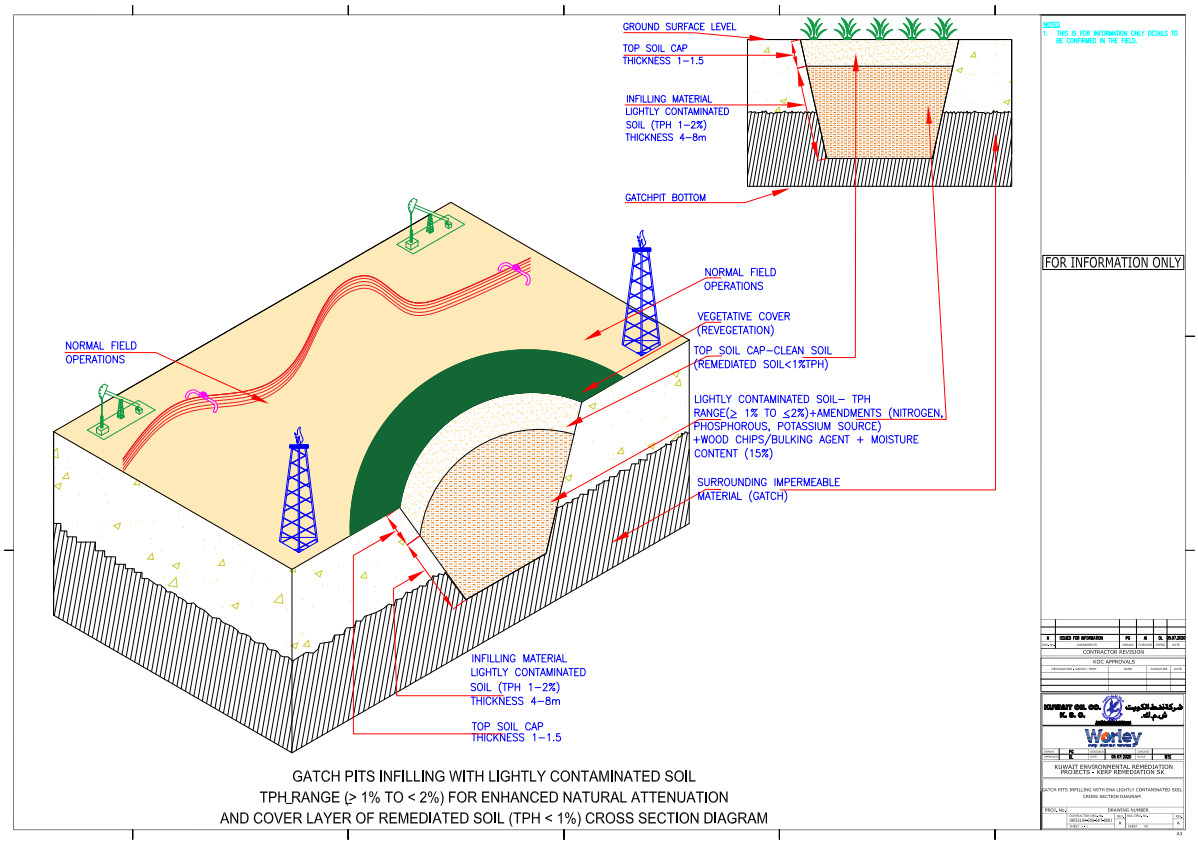


Figure 6.13 3D Model, and profile view - Filling Gatch Pits with Marginally Contaminated Soil

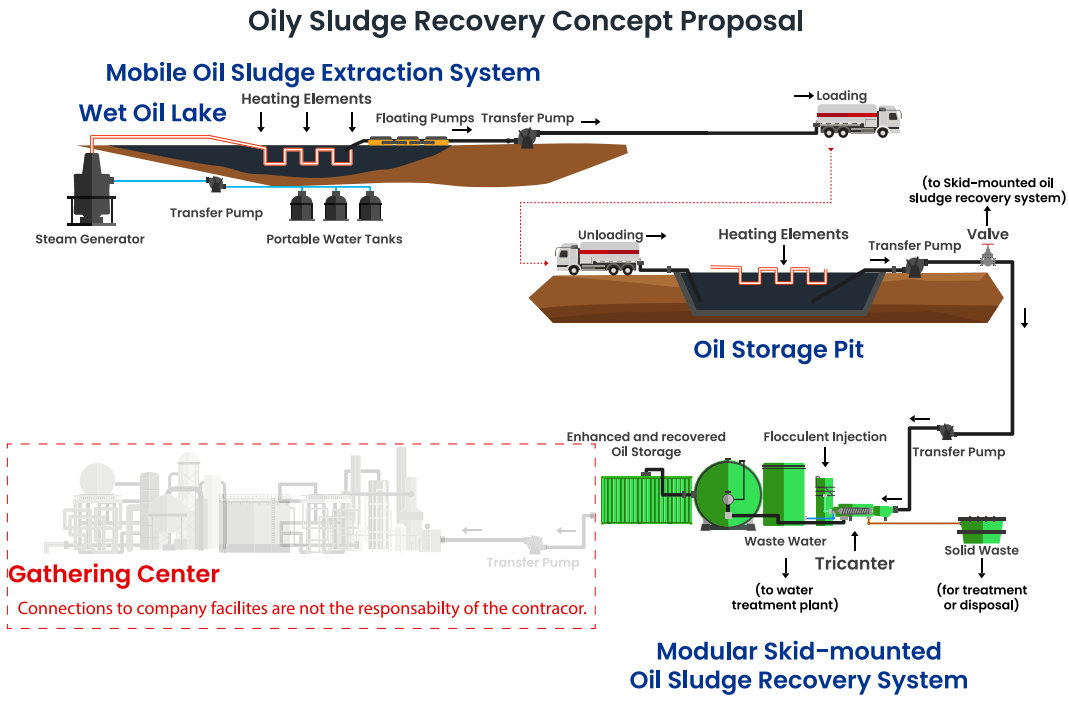


Figure 6.14 Example of Oil Recovery Process

TYPES OF SOIL CONTAMINATION FEATURES UNDER NKETR, SKETR AND SKETR II

DRY OIL LAKES (DOL)

Dry oil lakes are areas covered with thin and moderately hard dry black tar layer. Dry oil lakes are generally found in shallow depressions and/or flat areas, often forming fringe areas around wet oil lakes. Dry contamination areas cover more areas of the desert than wet ones, with an average mean depth of approximately 0.27 m below surface grades. The surface tar material in areas of dry soil contamination is found to contain mean TPH concentrations of about 7.3%. Underlying contaminated soil is found to contain a mean TPH concentration of 2.5%. The deeper layer had mean TPH concentrations in the range of 0.07% Aliphatic hydrocarbon profile data suggests petroleum hydrocarbons are dominated by hydrocarbons with chain lengths between C20 and C34.

Figure 6.15 Example of Dry Oil Lakes

WET OIL LAKES (WOL)

Wet oil lakes are areas covered with black liquid (highly weathered oil) and semi-solid oil saturated material resulting from oil flow damaged oil wells. Wet oil Lakes occur in areas where liquid oil accumulated because of local topography and micro relief. Soil investigations revealed that the average depth of oil contamination in the wet contaminated areas is approximately 0.65 m below surface grades. Sludge material has been found to contain mean TPH concentrations more than 19%. The underlying contaminated soil is found to contain a mean TPH concentration of 3.4% Aliphatic hydrocarbon profile data suggests petroleum hydrocarbons are dominated by hydrocarbons with chain lengths between C20 and C34.

Figure 6.16 Example of Wet Oil Lakes

TYPES OF WET OIL LAKES

Type 1: Hardened crust

The hardened crust is typically very thin, <0.05m, and often brittle occasionally free product is entrained within. These lakes have typically formed where shallow wet oil lakes have dried out, leaving a crust. The crust is variable in nature but can include vesicle-like free product In terms of KERP Consortium of International Consultants (CIC) definition, the Type 1 lakes are more akin to dry oil lakes and are, on the whole, traversable by foot.

Figure 6.17 Example of Wet Oil Lakes – Type 1

Type 2: Soft to hard bituminous skin / layer

The thin (generally 0.05m or less) bituminous skin / layer can often, though not always, retain water beneath. These lakes show seasonal variability. During winter, many though not all, of the Type 2 lakes can be readily traversed. During the summer months, the lakes can become more challenging to traverse as the Layer 1 material becomes less viscous.

Figure 6.18 Example of Wet Oil Lakes – Type 2

Type 3: Thin brittle crust overlying a wet oily slurry / Sludge

The thin crust can be readily broken and does not support the weight of a perso. Water is present immediately beneath the crust there is water present. The water can either be a discrete layer of its own or form part of an oily emulsion, sediment slurry or jelly-like material. The thickness of Layer 1 can be in excess of 0.15m. This can make traversing these lakes more challenging, requiring additional works and/or equipment to readily access.

Figure 6.19 Example of Wet Oil Lakes – Type 3

Type 4: Oily Sediments

These are found in the lowest lying lakes which act as natural drainage areas and have resultant sedimentation. Frequently wet with either standing water (winter) or perched shallow groundwater presence. These lakes, during hotter periods, often evidence ground heave, sometimes with salt precipitation, and localized discrete free product presence. These lakes can also exhibit jellification. As such, these lakes are frequently requiring additional support measures especially where shallow groundwater presence is likely. Thicknesses are highly variable and can range from very thin, <0.05m, to greater than 0.15m.

Figure 6.20 Example of Wet Oil Lakes – Type 4

Type 5: Tar like weathered crude oil

These lakes are black in appearance and in the height of summer some lakes have an oil component that can be almost water-like. During cooler periods, the oil component can vary significantly from a hardened viscous mass to a thick paint consistency. After rainfall events, water ponding readily occurs Type 5 lakes are believed to have some of the greater thicknesses of oil materials, typically >0.15m and have been estimated as being > 0.5m deep in larger lake features, though further characterization work is required to confirm. Access across these features is challenging, especially during the hotter summer periods.

Figure 6.21 Example of Wet Oil Lakes – Type 5

OIL CONTAMINATED PILES (OCP)

Oil Contaminated piles consolidate oil-contaminated soil and/or liquid oil into mounds. Oil-contaminated pile surface materials are found to contain mean TPH concentrations of about 4.0%. The underlying contaminated soil is found to contain a mean TPH concentration of 4.6%. These piles were made in an effort to stop the spread of oil flows caused by the destruction of oil wells or to clear areas of heavy oil contamination as necessary to facilitate fire-fighting. The deeper layer had mean TPH concentrations in the range of 4.4% Aliphatic hydrocarbon profile data suggests petroleum hydrocarbons are dominated by hydrocarbons with chain lengths between C20 and C34.

TYPES OF OIL CONTAMINATED PILES

There are a number of considerations regarding characterization and remediation of OCPs that are primarily related to the physicality of the OCPs and their contamination profile. As noted earlier, the internal composition of the piles cannot be determined, unless there are pre-formed excavations into or through piles. The various types of piles as observed at surface are summarized as follows:

Figure 6.22 Example of an Oil Contaminated Pile

TYPE A

Type A piles are visually clean or have a tarcrete-like covering with visually clean soils within. This is suggestive that either the area in which the pile exists did not have significant oilfield infrastructure damage or that the pile may have been present prior to the damage and destruction of oilfield infrastructure and was simply masked with a tarcrete-like covering.

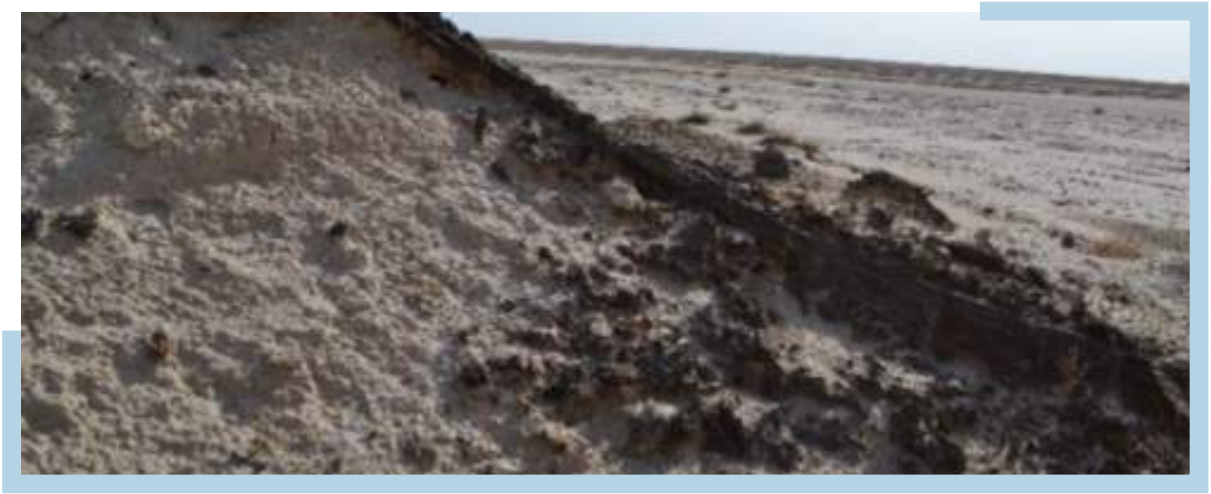


Figure 6.23 Example of OCP – Type A

TYPE B

Type B piles appear to have low to moderate contamination levels evidenced by a light brown discoloration to the soil profile and, pile dependent, a broken crust like material. These OCPs, particularly on the extremities of the oilfield and where present as low-lying piles, have a wind-blown sand covering. Although not exclusively the case, where low-lying piles are present, these may be expedited for UXO clearance, or as a minimum UXO anomaly avoidance, to allow trial pitting and sampling from within the piles.

Figure 6.24 Example of OCP – Type B

TYPE C

Type C piles appear to have moderate levels of contamination as evidenced by the medium brown discoloration to the surface soils. These piles have an absence of an outer crust or a broken-up crust though the surface soils are frequently cemente. These piles can have an increased presence of detritus, including damaged and broken flowlines and other metallic debris In the areas of former Gathering Centers, metallic debris is more common. This debris is a consideration with respect to UXO anomaly avoidance and clearance activities.

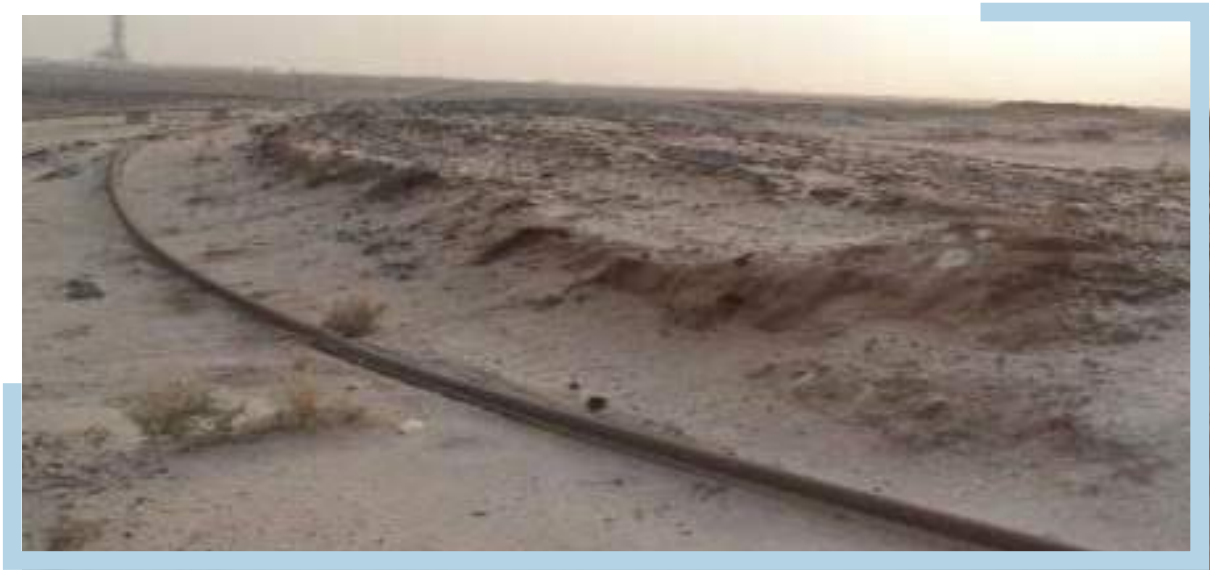


Figure 6.25 Example of OCP – Type C

TYPE D

Type D piles are moderate to highly contaminated, evidenced by medium to dark brown soils. These piles frequently contain black coarse gravels and cobbles of consolidated and often burnt/fused crust material at surface. These generally larger piles are typically either domed or have been pushed into a raised flattened ramp profile. There can be metal debris embedded within these piles which needs to be considered during UXO clearance activities.

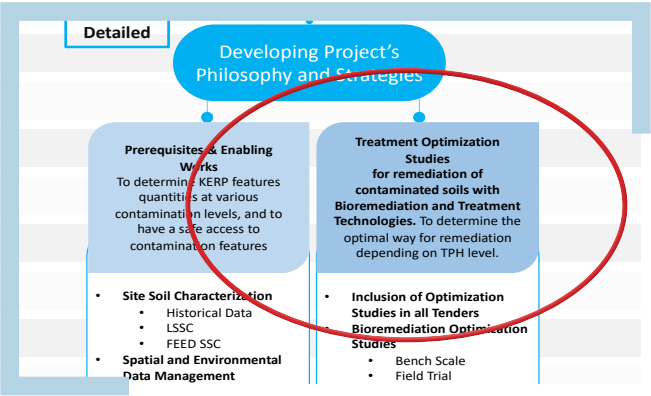
Figure 6.26 Example of OCP – Type D

TYPE E

Type E piles are highly contaminated and have dark brown to black colored sand with ponding and/or drainage of free product from within the pile during seasonal temperature variations. Frequently there are cobbles and/or boulders of fused soils present. These piles can be in areas with wet oil lakes present nearby. The pile shapes can vary significantly but are frequently either angular pyramidal or flattened with contamination ponding. These piles often have a large footprint.

Figure 6.27 Example of OCP – Type E

B.3.2 SOIL REMEDIATION METHODS & TECHNOLOGIES:



The treatment methods mostly used to remove the contaminant in the soil. Eliminating the contaminants may remove the risk posed by contaminants if the by-products are not toxic. Treatments can be in situ (in place) or ex situ (after excavation of the soil or pumping of the ground water from the aquifer).

In some cases, the best option may be to physically remove the contaminated soil and move it to a designated Treatment, Storage and Disposal Facility (TSDF). This is especially true with soils that are contaminated with both chemicals and radioactive agents In other cases, it is possible to remove the contaminant from the soil using such technologies as surfactant washing, soil washing or thermal desorption.

The structure of the soil is stratified. The upper layer is the unsaturated zone (or infiltrating zone), below which is the saturated zone. There are many characteristics of the soil that influence the transport of contaminants, such as: density, porosity, humidity and permeability. This phenomenon is also influenced by some properties of the contaminants, such as vapor pressure and chemical nature. After identifying the type of soil and the nature of the contaminants, a suitable remediation technique must be chosen, and the effectiveness of the decontamination process evaluated.

The existing methods for soil decontamination may be divided into: "in situ" techniques, "ex situ" techniques, and the confining/isolation of the contaminated area, which is a temporary solution These methods can be further divided into biological and non-biological methods. The non-biological methods are subdivided into physical-chemical methods, thermal methods and other methods (e.g., supercritical extraction and electro-kinetic).

BIOREMEDIATION

Bioremediation is the process of exploiting the ability of certain micro-organisms (e.g., indigenous, cultivated or commercially available strains), to degrade petroleum hydrocarbon constituents and requires a sustained source of nutrients, water, and electron acceptors (e.g., oxygen) to degrade petroleum hydrocarbons.

Types of bioremediation processes include, but are not limited to:

- Biopiles
- Windrows
- Land farming
- Bioreactors

Benefits of bioremediation:

- Natural process
- Aids in the elimination of contaminants
- Less expensive

BIOPILES

Biopiles treatment is a full-scale technology in which excavated soils are mixed with soil amendments and placed in a treatment area that includes leachate collection systems and some form of aeration. It is used to reduce concentrations of petroleum constituents in excavated soils through the use of biodegradation Moisture, heat, nutrients, oxygen, and pH can be controlled to enhance biodegradation.

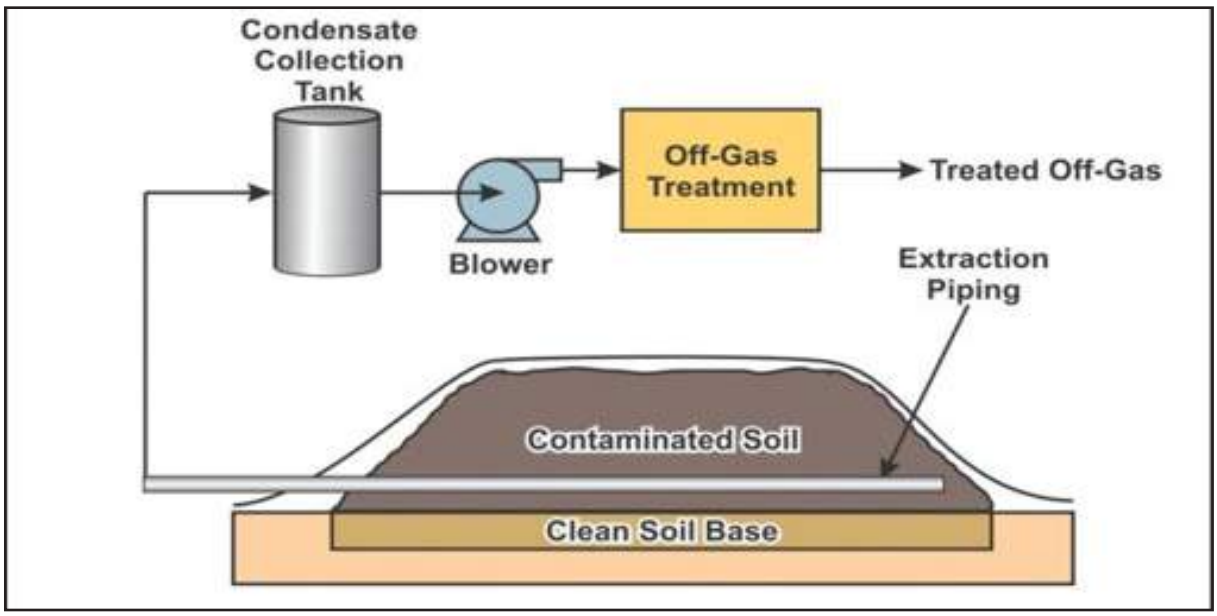


Figure 6.28.1 Biopile Process diagram

Figure 6.28.2 Biopile Process Profile

LANDFARMING:

Landfarming is an ex-situ waste treatment process that is performed in the upper soil zone or in bio treatment cells contaminated soils, sediments, or sludge are transported to the land farming site, incorporated into the soil surface, and periodically turned over (tilled) to aerate the mixture. This technique has been used for years in the management and disposal of drill cuttings, oily sludge, and other petroleum refinery wastes.

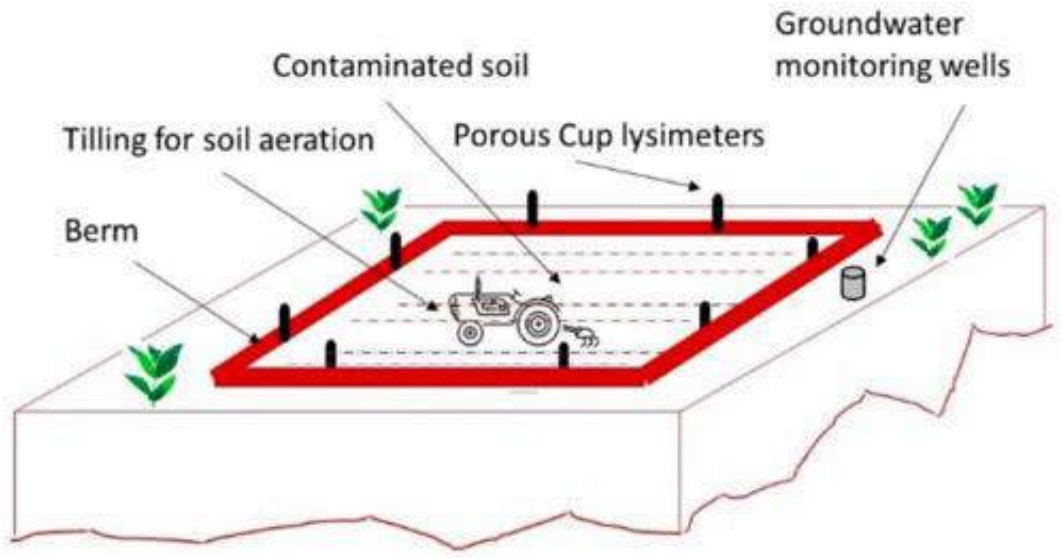


Figure 6.29.1 Landfarming Process Profile

Figure 6.29.2 Landfarming Process demonstration

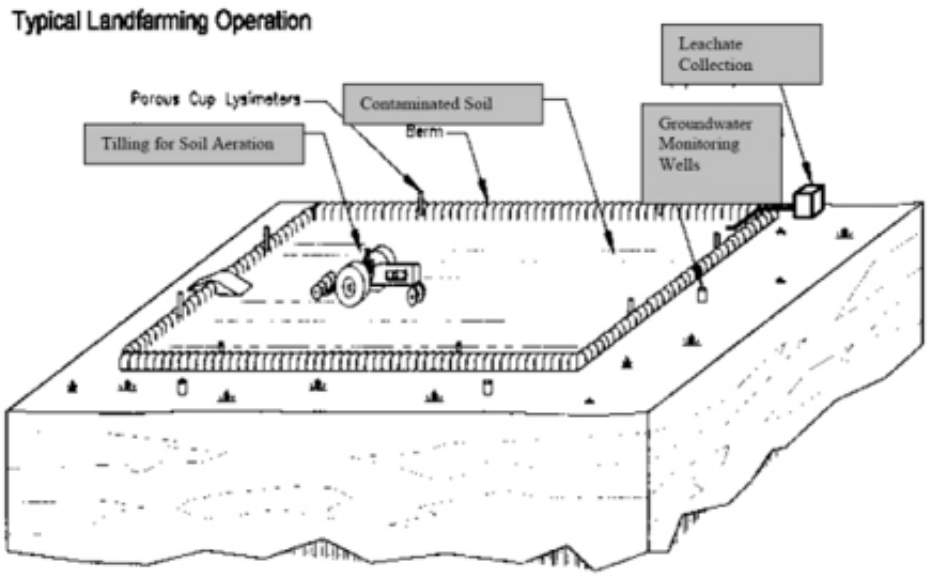


Figure 6.30 Landfarming Process demonstration

BIO COMPOSTING:

The process involves mixing the contaminated soil with organic materials, which will enhance and support the microbial growth present Static pile, mechanically agitated in-vessel composting, and windrow composting are examples of composting Composting oil-contaminated soils under field conditions with the simultaneous optimization of their physicochemical and agrochemical parameters revealed the high efficiency of the soil purification.

Figure 6.31 Example of Bio Composting

BIO REACTOR:

Bioreactor is a vessel that carries out a biological reaction and is used to culture aerobic cells for conducting cellular or enzymatic immobilization Bioreactors degrade contaminants in soil/water with microorganisms through attached or suspended biological systems In suspended growth systems, such as activated sludge, fluidized beds, or sequencing batch reactors.

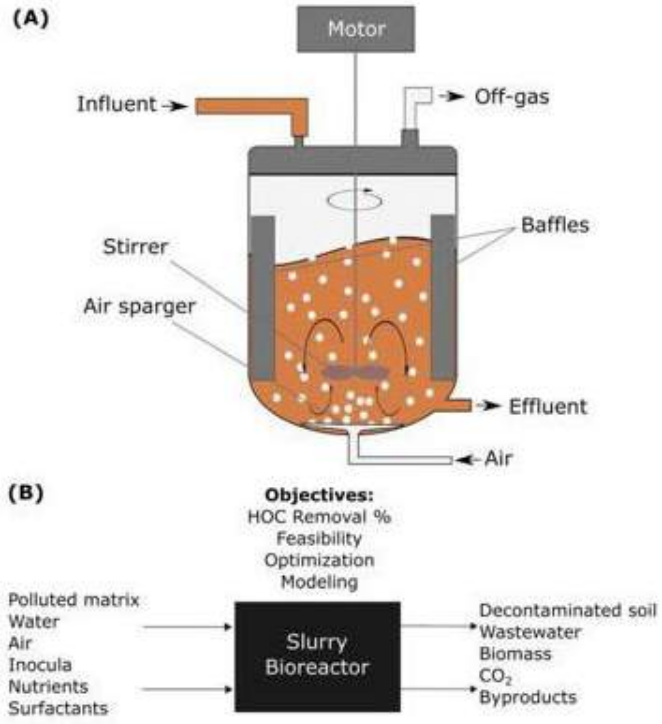


Figure 6.32 Bioreactor Process Description

Figure 6.33 Bioreactor

SLURRY-PHASE BIOREMEDIATION:

Slurry-Phase bioremediation, also known as bioreactors, is a controlled treatment that involves the excavation of the contaminated soil, mixing it with water and placing it in a bioreactor. Fig.6.34 shows a typical bioreactor system. As shown in the figure, the process requires the processing of the soil to provide a low viscosity. This processing involves the separation of stones and rubbles from the contaminated soil. Next, the soil is mixed with a predetermined water amount to form the slurry. The concentration of water added depends on the concentration of pollutants, the rate of biodegradation, and the physical nature of the soil. When this process is done the soil is removed and dried up using pressure filters, vacuum filters or centrifuges. The next procedure is the disposition of the soil and further treatment of the resulting fluids.

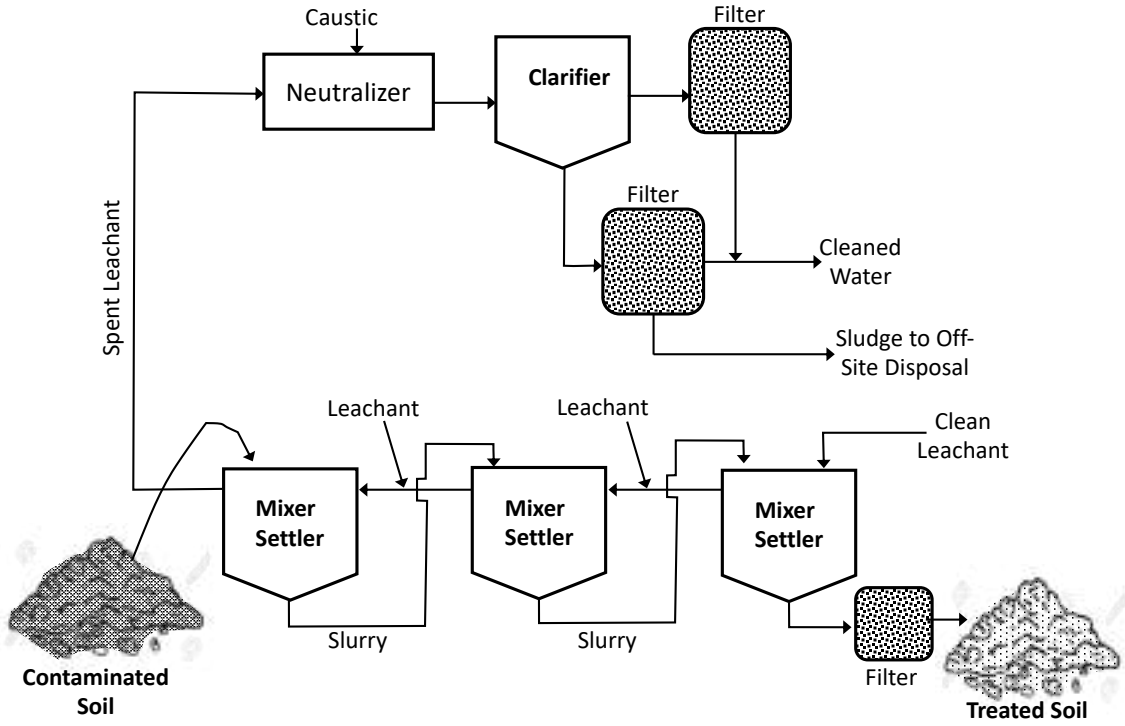


Figure 6.34 Slurry Phase Bioremediation Description

FACTORS AFFECTING BIODEGRADATION

a Soil water :

Water present in soil affects not only the moisture available to microorganisms, but also the soil aeration status, the nature and amount of soluble, osmotic pressure and the pH. Water activity in the soil is measured in terms of potential (matrix and osmotic). Matrix potential is the capability of water to adsorb to solid surfaces. This potential is usually negative because it reduces the free energy of water. Osmotic potential in the other hand is related to solubility. Since water is a universal solvent, the presence of solute in the soil tend to also reduce the free energy of water and create another negative potential.

The sum of osmotic and matrix potentials describe the water availability, and as a result will define how much energy must a microorganism spend to obtain water. Microbial activity is known to have maximum reaction rates at water potentials of - 0.01Mpa (megapascals); however, these rates tend to decrease if the soil becomes either waterlogged (near zero Mpa) or drier, at negative water potentials.

b Redox Potential :

Bacteria obtain their energy from oxidation and reduction of compounds present in the soil by removing electrons from these compounds in order to obtain the energy available during the oxidation process. This process depends largely on a compound that can accept electrons. When talking about aerobic degradation the final electron acceptor is oxygen.

c Soil pH

Soil pH values are somewhat related to the size of the organisms present and the multiplicity of enzymes at the microbial level. Bacteria tend to have optimum pH between 6.5 and 7.5, which equals the intracellular pH. The biodegradation of a compound is dependent on specific enzymes, which are secreted by the organisms. These enzymes are largely pH dependent .

d Soil temperature

Temperature is one of the major factors affecting the biodegradation of a toxic compound. It not only affects the rates of biochemical reactions in the organisms, but also the soil moisture, and redox potential. All microbial activities are dependent upon the laws of thermodynamics. At too high temperatures there is a denaturizing of the proteins and the cell membrane permeability. It is generally known that metabolism tends to slow down at low temperatures; however, psychrophiles, bacteria which grow in cold temperatures, are capable of degrading contaminants due to osmotic regulations and cytoplasmic constituents that prevent the bacteria's cell interior from freezing.

Table 6.2 shows the advantages and disadvantages of some of the existing bioremediation techniques.

TECHNOLOGY	ADVANTAGES	DISADVANTAGES
Landfarming	-Relative simple design and implementation; -Short treatment times (six months to two years under optimal conditions).	-Reductions of concentration greater than 95% and concentrations lower than 0.1 ppm are difficult to achieve; -The required area is high; -Dust and vapor generation during landfarming aeration may cause some air quality problems.
Bioventing	-Uses readily available equipment, easy to install; - Creates minimal disturbance to the treatment site; -May not require costly off gas treatment; -Easily combinable with other technologies (e.g., air sparging, groundwater extraction).	-The high concentrations may be toxic for microorganisms; -Not applicable for certain site conditions (e.g., low soil permeability); -Sometimes requires nutrients and air injection wells; -Only treats unsaturated zones of soils, and needs other methods to treat saturated zones of soils and groundwater.
Natural attenuation	-The generation of less remediation waste, and less impact on the environment; -Ease to use when combined with other technologies; -No equipment down time.	-The public may not perceive the effectiveness of the process correctly; -Site characterization can be more costly and complex; - Due to monitoring, active remediation may be more economical; -The potential exists for continued migration.
Phytoremediation	-Is much less expensive than conventional options.	-Is a technology that is seasonal; - Only applicable to low profundity.
Bio sparging	-Readily available equipment; -Cost competitive; -Requires no removal, treatment, storage or discharge of groundwater.	-Some interactions among complex chemical, and physical and biological processes are not well understood; -Potential for inducing migration of constituents.
Bio-Rehabilitation in-situ	-Degradation of material dissolved in infiltrated and saturated zone; -Equipment easily available.	-The hole can be obstructed by biomass or precipitation; -Continuous monitoring and maintenance.

Table 6.2 Advantages and disadvantages of some biological technologies used in soil remediation

NON-BIOLOGICAL TREATMENT TECHNOLOGIES

Treatment Technologies is the process of soil remediation using a single or treatment train of technologies to achieve the established RTC.

Types that treatment technologies may comprise of but are not limited to:

- Ex situ soil washing systems.
- Ex situ chemical oxidation systems.
- Ex situ treatment co-processing or multiple treatment systems.
- Ex situ mechanical segregation and solvent extraction systems,
- Ex situ train of the above treatment technologies including bioremediation.

In accordance with the findings of Report and Recommendations Made By The Panel of Commissioners Concerning Part Two of The Fourth Installment of "F4" Claims, Clause 89, 91, 100, the F4 Panel considers High Temperature Thermal Desorption (HTTD) treatment would result in soil that is sterile and devoid of biogenic structures, microorganisms, and other organic materials, and this would make it more difficult to successfully revegetate the damaged areas. The Panel considers that bioremediation is a suitable alternative for the less contaminated materials It should be noted that thermal treatment (thermal desorption indirect or direct, incinerator, etc.) is disregarded and not allowed under the KERP program.

However; ex-situ bioremediation involves the excavation and the treatment of the contaminated soil somewhere else, which makes it less cost-effective.

Ex-situ treatment technology is further divided into slurry-phase bioremediation and solid-phase bioremediation.

EX-SITU PHYSICAL/CHEMICAL TREATMENT:

Available ex-situ physical/chemical treatment technologies include:

- chemical reduction/oxidation
- dehalogenation
- soil washing
- fluid vapor extraction
- stabilization/solidification
- solvent extraction

CHEMICAL REDUCTION/OXIDATION :

Reduction/oxidation (Redox) reactions chemically convert hazardous contaminants to non-hazardous or less toxic compounds that are more stable, less mobile, and/or inert. Redox reactions involve the transfer of electrons from one compound to another specifically, one reactant is oxidized (loses electrons) and one is reduced (gains electrons).

Chemical oxidation reactions involve the transfer of electrons and the breaking of chemical bonds. Oxidants are generally non-specific and will react with the targeted contaminants and with the soil organic content. The oxidizing agents most commonly used for treatment of hazardous contaminants are ozone, hydrogen peroxide, hypo-chlorites, chlorine, and chlorine dioxide. Chemical redox is a full-scale, well-established technology used for disinfection of drinking water and wastewater, and it is a common treatment for cyanide wastes (Fig 6.35). Enhanced systems are now being used more frequently to treat contaminants in soils (EPA, 1991).

The target contaminant group for chemical redox is inorganics. The technology can be used but may be less effective against non-halogenated VOCs and SVOCs, fuel hydrocarbons, and pesticides.

Factors that may limit the applicability and effectiveness of the process include:

- Incomplete oxidation or formation of intermediate contaminants may occur depending upon the contaminants and oxidizing agents used.
- The process is not cost-effective for high contaminant concentrations because of the large amounts of oxidizing agent required.
- Oil and grease in the media should be minimized to optimize process efficiency.

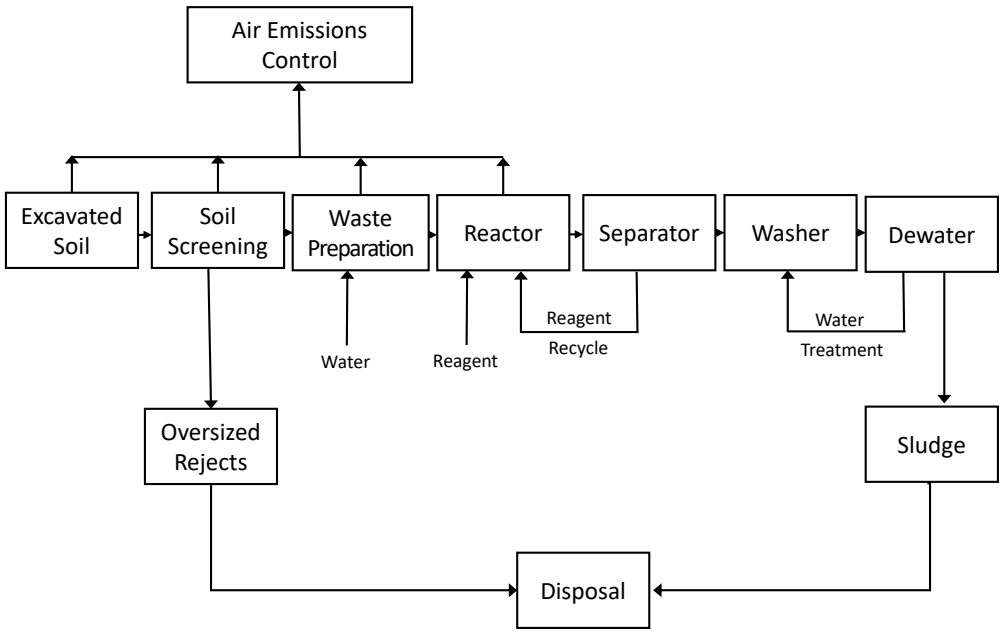


Figure 6.35 Schematic representation of Chemical Reduction/oxidation process

DEHALOGENATION:

Dehalogenation is a full-scale technology in which an alkaline polyethylene glycol (APEG) reagent is used to dehalogenase halogenated aromatic compounds in a batch reactor. Potassium polyethylene glycol (KPEG) is the most common APEG reagent contaminated soils and the reagent are mixed and heated in a treatment vessel In the APEG process, the reaction causes the polyethylene glycol to replace halogen molecules and render the compound non-hazardous or less toxic. For example, the reaction between chlorinated organics and KPEG causes replacement of a chlorine molecule and results in a reduction in toxicity. Dehalogenation (APEG/KPEG) is generally considered a standalone technology; however, it can be used in combination with other technologies.

Treatment of the wastewater generated by the process may include chemical oxidation, biodegradation, carbon adsorption, or precipitation. The metal hydroxide that has been most widely used for this reagent preparation is potassium hydroxide (KOH) in conjunction with polyethylene glycol (PEG) (typically, average molecular weight of 400) to form a polymeric alkoxide referred to as KPEG. A variation of this reagent is the use of potassium hydroxide or sodium hydroxide/tetra ethylene glycol, referred to as ATEG, that is more effective on halogenated aliphatic compounds. In some KPEG reagent formulations, dimethyl sulfoxide (DMSO) is added to enhance reaction rate kinetics, presumably by improving rates of extraction of the haloaromatic contaminants.

The reagent (APEG) dehalogenases the pollutant to form a glycol ether and/or a hydroxylated compound and an alkali metal salt, which are water soluble by-products. The target contaminant groups for glycolate dehalogenation are halogenated SVOCs and pesticides. The technology can be used but may be less effective against selected halogenated VOCs APEG dehalogenation is one of the few processes available other than incineration that has been successfully field tested in treating PCBs.

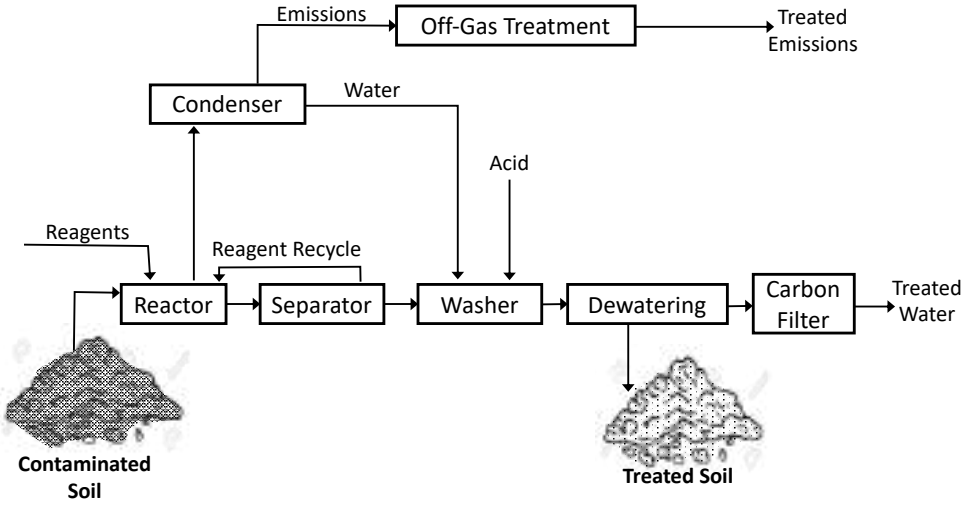


Figure 6.36 Schematic representation of Dehalogenation (Glycolate process)

The process has successfully destroyed PCDDs and PCDFs contained in contaminated pentachlorophenol oil. For a contaminated activated carbon matrix, direct treatment was less effective, and the reduction of PCDDs/PCDFs to concentrations less than 1 ppb was better achieved by first extracting the carbon matrix with a solvent and then treating the extract.

It should be noted that thermal treatment (thermal desorption, incinerator, etc.) is disregarded and not allowed under KERP program because of concerns that the process would result in soils that are hydrophobic and/or devoid of biogenic structures, microorganisms and other organic materials and which will hinder natural soil conditions and soil revegetation without further soil enhancement.

SOIL WASHING

Soil washing is a water-based process for scrubbing soils ex situ to remove contaminants. The process, Figure 8, removes contaminants from soils in one of two ways:

- By dissolving or suspending them in the wash solution (which is later treated by conventional wastewater treatment methods).
- By concentrating them into a smaller volume of soil through particle size separation, gravity separation, and attrition scrubbing (similar to those techniques used in sand and gravel operations).

Soil washing systems incorporating most of the removal techniques offer the greatest promise for application to soils contaminated with a wide variety of heavy metal, radionuclides, and organic contaminants. The concept of reducing soil contamination through the use of particle size separation is based on the finding that most organic and inorganic contaminants tend to bind, either chemically or physically, to clay, silt, and organic soil particles. The silt and clay, in turn, are attached to sand and gravel particles by physical processes, primarily compaction and adhesion.

Washing processes that separate the fine (small) clay and silt particles from the coarser sand and gravel soil particles, effectively separate and concentrate the contaminants into a smaller volume of soil that can be further treated or disposed off. Gravity separation is effective for removing high or low specific gravity particles such as heavy metal containing compounds (lead, radium oxide, etc.). Attrition scrubbing removes adherent contaminant films from coarser particles. The clean, larger fraction can be returned to the site for continued use.

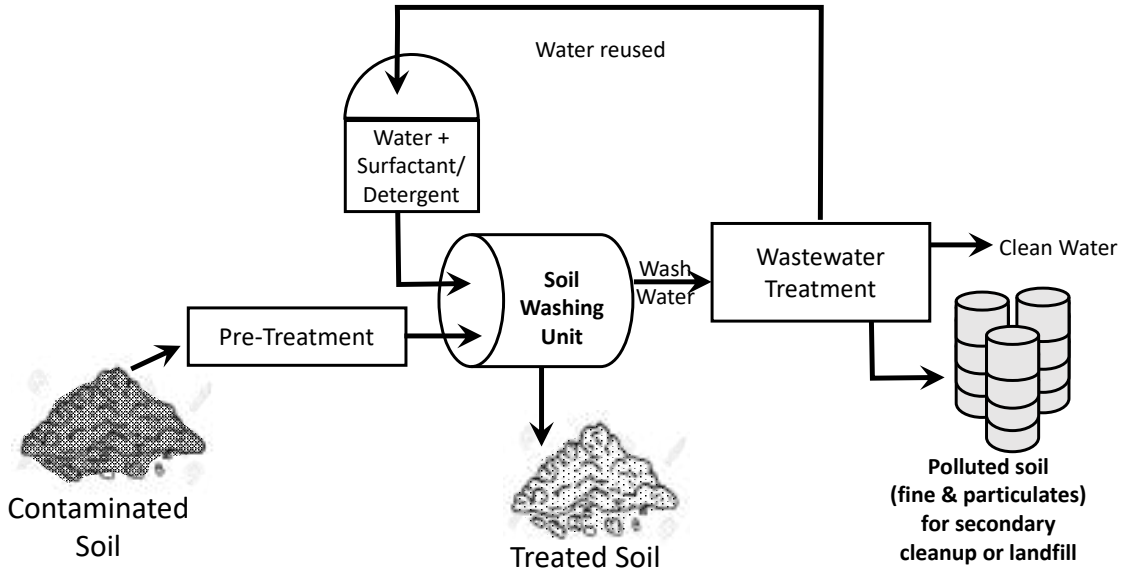


Figure 6.37 Schematic representation of Soil Washing Process

Figure 6.37.1 Soil Washing

Figure 6.37.2 Soil Washing

The target contaminant groups for soil washing are SVOCs, fuels, and inorganics. The technology can be used on selected VOCs and pesticides. The technology offers the potential for recovery of metals and can clean a wide range of organic and inorganic contaminants from coarse grained soils. Factors that may limit the applicability and effectiveness of the process include;

- Fine soil particles (e.g. silt, clays) may require the addition of a polymer to remove them from the washing fluid.
- Complex waste mixtures (e.g. metals with organics) make formulating washing fluid difficult.
- High humic content in soil may require pre-treatment.
- The aqueous stream will require treatment. Soil washing is most commonly used in combination with the following technologies: bioremediation, incineration, and solidification/stabilization. Depending on the process used, the washing agent and soil fines are residuals that require further treatment. When contaminated fines have been separated, coarse-grain soil can usually be returned clean to the site.

EX-SITU SOIL VAPOR EXTRACTION (SVE) :

Ex situ soil vapor extraction (SVE), Fig 6.38 is a full-scale technology in which soil is excavated and placed over a network of aboveground piping to which a vacuum is applied to encourage volatilization of organics. The process includes a system for handling off-gases.

Advantages over its in-situ counterpart include that the excavation process forms an increased number of passageways, shallow groundwater no longer limits the process, leachate collection is possible, and treatment is more uniform and easily monitored (EPA, 1990).

The target contaminant group for ex situ SVE is VOCs. The following factors may limit the applicability and effectiveness of the process;

- air emissions may occur during excavation and materials handling, possibly requiring treatment.
- high humic content or compact soil inhibits volatilization.
- as a result of air emission treatment, SVE may require treating residual liquid and spent activated carbon, increasing the project cost.
- a large amount of space is required.

An advantage of the technology over its in-situ counterpart is the increased number of passageways formed by the excavation process; however, as an ex-situ remedy, the excavation associated with SVE poses a potential health and safety risk to site workers through skin contact and air emissions. Personal protective equipment, at a level commensurate with the contaminants involved, is normally required during excavation operations. The time required to remediate a site using ex situ SVE is highly dependent upon the specific soil and chemical properties of the contaminated media.

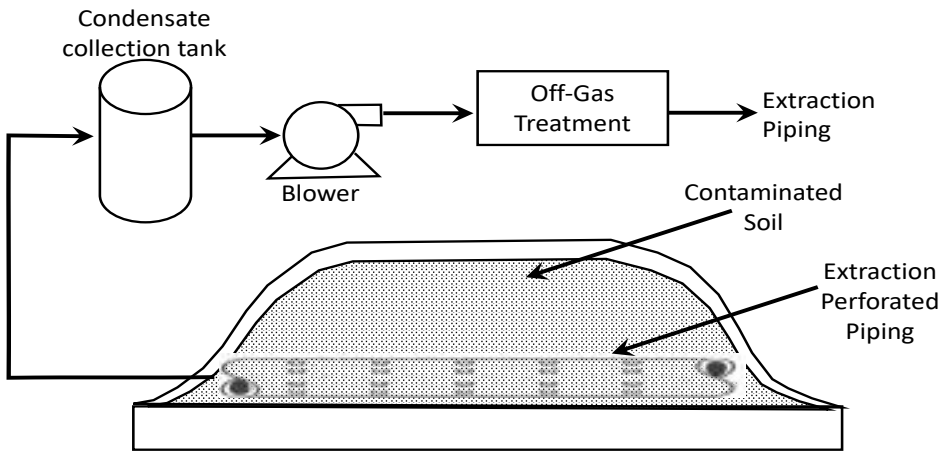


Figure 6.38 Schematic representation of soil vapor extraction Process

SOLIDIFICATION/STABILIZATION:

As for in-situ solidification/stabilization (S/S), ex-situ S/S contaminants are physically bound or enclosed within a stabilized mass (solidification), or chemical reactions are induced between the stabilizing agent and contaminants to reduce their mobility (stabilization). Ex-situ S/S, however, typically requires disposal of the resultant materials

The target contaminant group for ex situ S/S is inorganics, including radionuclides. The technology has limited effectiveness against SVOCs and pesticides; however, systems designed to be more effective against organic contaminants are being developed and tested.

Factors that may limit the applicability and effectiveness of the process include :

- Environmental conditions may affect the long-term immobilization of contaminants.
- Some processes result in a significant increase in volume (up to double the original volume).
- Certain wastes are incompatible with different processes Treatability studies are generally required.
- VOCs are generally not immobilized
- Long-term effectiveness has not been demonstrated for many contaminant/process combinations.

Depending upon the original contaminants and the chemical reactions that take place in the ex-situ S/S process, the resultant stabilized mass may have to be handled as a hazardous waste. For certain types of radioactive waste, the stabilized product must be capable of meeting stringent waste form requirements for disposal (e.g. Class B or Class C low level materials.

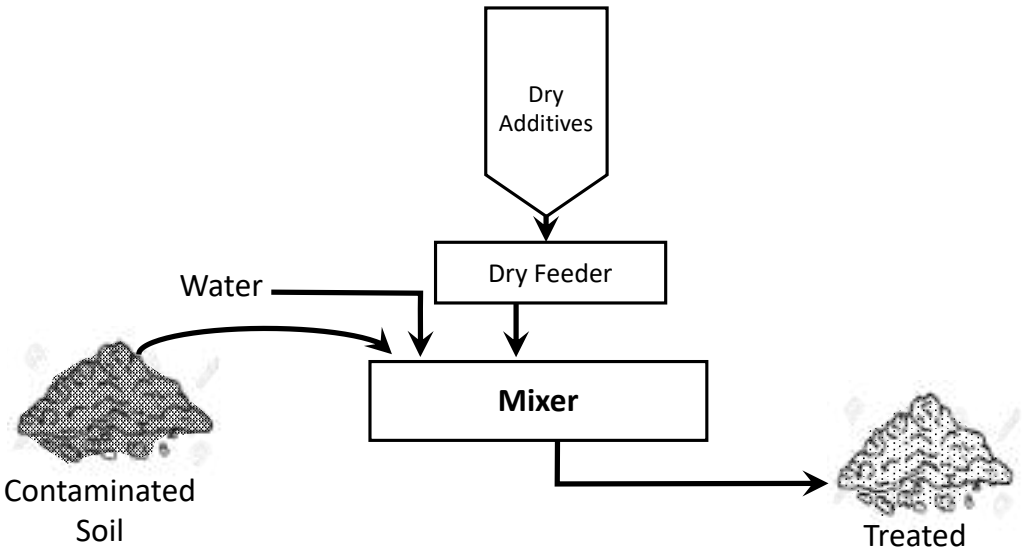


Figure 6.39 Schematic representation of Ex-situ solidification/stabilization Process

SOLVENT EXTRACTION

Solvent extraction does not destroy wastes but is a means of separating hazardous contaminants from soils, sludge and sediments, thereby reducing the volume of the hazardous waste that must be treated. The technology uses an organic chemical as a solvent and differs from soil washing, which generally uses water or water with wash improving additives. Commercial scale units are in operation; they vary regarding the solvent employed, type of equipment used, and mode of operation.

Solvent extraction is commonly used in combination with other technologies, such as solidification/stabilization, incineration, or soil washing, depending upon site-specific conditions. It also can be used as a standalone technology in some instances. Organically bound metals can be extracted along with the target organic contaminants, thereby creating residuals with special handling requirements. Traces of solvent may remain within the treated soil matrix, so the toxicity of the solvent is an important consideration. The treated media are usually returned to the site after having met Best Demonstrated Available Technology (BDAT) and other standards.

Solvent extraction has been shown to be effective in treating sediments, sludge and soils containing primarily organic contaminants such as PCBs, VOCs, halogenated solvents, and petroleum wastes. The process has been shown to be applicable for the separation of the organic contaminants in paint wastes, synthetic rubber process wastes, coal tar wastes, drilling muds, wood – treating wastes, separation sludge, pesticide/insecticide wastes, and petroleum refinery oily wastes.

- Factors that may limit the applicability and effectiveness of the process include :
- Organically bound metals can be extracted along with the target organic pollutants, which restrict handling of the residuals.
- The presence of detergents and emulsifiers can unfavorably influence the extraction performance.
- Traces of solvent may remain in the treated solids; the toxicity of the solvent is an important consideration.
- Solvent extraction is generally least effective on very high molecular weight organic and very hydrophilic substances.
- Some soil types and moisture content levels will adversely impact process performance.

Table 6.3 shows the advantages and disadvantages of some of the existing decontamination techniques.

TECHNOLOGY	ADVANTAGES	DISADVANTAGES
Vitrification (Thermal)	-Ex situ vitrification is a well-developed technology; -The mobility of contaminants is reduced/eliminated; -The vitrified mass resists leaching for geologic periods of time.	-The process requires intensive energy and high temperatures up to near 2000 K; -Water in soil affects operation and increases the total costs of the process; -Off gases must be collected and treated before release; -In situ vitrification is in pilot scale development.
Incineration (Thermal)	-Contaminant toxicity, as well as volume reduction is addressed by this technology This is specially true for organic contaminants; -Widely used and available commercially.	-Metals are not destroyed and end up in the flue gases or in the ashes; -Community resistance to incineration is often present; -Certain types of soils such as clay soils or soils containing rocks may need screening.
Soil Washing (Physical-Chemical)	-Reduces the volume of contaminant, therefore, further treatment or disposal is less problematic; -Commercially available.	-Contaminant toxicity is unchanged, although volume is reduced; -Less effective when soil contains a high percentage of silt and clay; -Costs associated with the disposal of the subsequent waste streams must be considered.
Soil Vapour Extraction (physical chemical)	- Proven performance, readily available equipment, easy to install; - Minimal disturbance to site operations; -Short treatment times (6-48 months)	-Concentration reductions greater than 90% are difficult to achieve; -Effectiveness decreases when applied to sites with low permeability; -Only treats the unsaturated zone; -May require costly treatment for atmospheric discharge of the extracted vapor.
Electrokinetic (others)	In situ technology that has small impact on environment (soil removal is not required). -Metals are actually removed from soil unlike stabilization, which leaves the metals in the soil.	-Alkaline soils reduce the effectiveness of the process; -Requires soil moisture.

Table 6.3 Advantages and disadvantages of some non-biological Treatment Technologies used in soil remediation

CONTAMINATED SOIL CATEGORIZATION IN NEW KERP MEGA PROJECTS:

As part of Kuwait Environmental Remediation Program (KERP), North Kuwait Excavation Transportation and Remediation (NKETR), and South Kuwait Excavation Transportation and Remediation Contracts and Projects address oil contaminated soil based in the Raudhatain/Sabriya and Burgan oilfields respectively.

These contracts have been developed in such a way that contaminated soils were quantified based on their TPH range. These TPH ranges are TPH >1% to ≤5%, >5% to ≤7%, >7% to ≤10%, >10% to ≤15% and > 15%.

NKETR projects will only handle the first three TPH ranges due to the removal of most of the WOLs in the previous NK Excavation & Transportation project, while SKETR projects will have the full range of TPHs within the scope of works.

SOIL WITH TPH >1 % TO ≤ 5 % | (APPLICABLE TO NKETR/SKETR PROJECTS)

Bioremediation shall be performed by the Contractor as the primary treatment method for the majority of KERP soil features (OCPs and DOLs) with TPH (HEM) concentrations >1% to ≤ 5%.

A minimum of 90% of the actual treatment soil quantity (mass) shall be bioremediated to meet the RTC The remaining 10% of the actual treatment soil quantity (mass) may be treated by the Contractor using best approaches or processes to meet the RTC as directed and approved by the Company.

SOIL WITH TPH >5 % TO ≤ 7% | (APPLICABLE TO NKETR/SKETR PROJECTS)

The Contractor segregated contaminated soil with >5% to ≤7% TPH (HEM) shall be stockpiled until the results of the decision regarding bioremediation and/or treatment with technologies is sought and agreed for such materials. A minimum of 80% of the actual treatment soil quantity (mass) shall be bioremediated and/or remediated with treatment technologies to meet the RTC with the remainder either treated using best approaches and processes to meet the RTC, or (if untreatable – subject to results of Treatment Optimization Studies and Contractor revising their treatment approach) may be disposed of at the landfill by Contractor

SOIL WITH TPH >7 % | (APPLICABLE TO NKETR PROJECTS)

SOILS WITH TPH >7%

The Contractor shall use his proposed treatment technology(ies) for this TPH concentration range to treat the soil and achieve the RTC. The treatment design shall be based on the results of the Treatment Optimization Study.

A minimum of 70% of the actual treatment soil quantity (mass) shall be treated with the remainder (if untreatable) disposed of as waste by Contractor. The waste material will be segregated from the treatment stream and addressed. In the case the Treatment Optimization Study indicates that the proposed treatment method will not achieve the RTC for at least 70% of the actual treatment soil quantity (mass) within the project duration, the Contractor shall revise.

SOILS WITH TPH > 7% TO ≤ 10 % TPH | (APPLICABLE TO SKETR PROJECTS)

The Contractor shall use its treatment technology(ies) for this TPH range to treat the soil and achieve the RTC within the project duration. The treatment design shall be based on the results of the Treatment Optimization Study.

Where the Contractor selects remediation of TPH > 5% to ≤ 7% contaminated soils via treatment technologies, a minimum of 80% of the Actual Treatment Soil Quantity (mass) shall be remediated with the remainder (untreatable) disposed as waste by Contractor at a KERP SK Landfill. The waste material will be segregated from the treatment stream and addressed.

In case the Treatment Optimization Study indicates that the proposed treatment method will not achieve the RTC for at least 80% of the soil within the project duration, the Contractor shall revise their treatment approach and test the revised approach.

A minimum of 70% of the TPH > 7% to ≤ 10% Actual Treatment Soil Quantity (mass) shall be remediated with the remainder (untreatable) disposed as waste by Contractor at a KERP SK Landfill In the case the Treatment Optimization Study indicates that the proposed treatment method will not achieve the RTC for at least 70% of the soil within the project duration, the Contractor shall revise their treatment approach and test the revised approach.

SOILS WITH TPH > 10% TO ≤ 15% AND > 15% (OPTIONAL) | (APPLICABLE TO SKETR PROJECTS)

Materials with hydrocarbon concentrations TPH >10% to ≤15%, and >15% shall undergo remediation only upon successful completion of Treatment Optimization Studies, as approved by Company. The Contractor shall use its treatment technology(ies) for this TPH range to treat the soil and achieve the RTC within the project duration. The treatment design shall be based on the results of the Treatment Optimization Study. In the case the Treatment Optimization Study indicates that the proposed treatment method will not achieve the RTC and/or within the project duration, the Contractor shall, upon Company approval, dispose the material to landfill.

NKETR PROJECTS - PROPOSED TREATMENT TECHNOLOGIES

CONTRACTOR / JV NAME	TPH RANGE 5-7 %	TPH RANGE 1-5 %	TPH RANGE >7%
NKETR Zone 1 JV/C of Khalid Ali Al Kharafi & Bros Construction, Contracting Co K.S.C.C with Lamor Corporation AB	Bid Strategy:		
	Bioremediation via covered windrows and biopiles.		Soil Washing enhanced by Solvent Extraction
	Optimization Study Strategy:		
	Contractor will conduct Bench Scale Studies and Field trial to examine different initial conditions effects.		in Preparation
	Optimization Study Early Results (At the time of issuance of this E-Book):		
	Currently, the bench scale studies are in progress		
NKETR Zone 2 The Kuwait Company for Process Plant Construction & Contracting (KPSC) with Environmental Technology Management Company	Bid Strategy:		
	Bioremediation via landfarming and windrows.		Bioremediation and/ or Soil Washing technique
	Optimization Study Strategy:		
	Contractor will conduct Bench Scale Studies to examine different initial conditions effects.		
	Optimization Study Early Results (At the time of issuance of this E-Book):		
	Early Results indicate achieving 45% TPH reduction in a span of 60 days		

Table 6.4 NKETR Projects - Proposed Treatment Technologies

C.1.1 NKETR ZONE 1 – PROGRESS WITH OPTIMIZATION STUDIES

NKETR Zone 1 Contractor as at the end of 2022 is executing Treatment Optimization Studies (TOS) through Bench Scale Setups. In the approved TOS plan, 24 trials for each TPH range, each tray 10kg contaminated soil (72 trials in total). These trays are targeting contaminated soil with TPH ranges (<1%-5%) & (>5%-7%) & mixture (>1%-7%). Currently, preparatory studies including identification of indigenous bacterial species, toxicity, leachability studies are undergoing in preparation for starting the Bench scale experiments.

C.1.2 NKETR ZONE 2 – PROGRESS WITH OPTIMIZATION STUDIES

NKETR Zone 2 Contractor as at the end of 2022 is progressing Treatment Optimization Studies (TOS) through Bench Scale Setups In the approved TOS plan, 18 trays for each TPH range, each tray 10kg contaminated soil (54 tray total). These trays are targeting contaminated soil with TPH ranges (<1%-5%) & (>5%-7%) & mixture (>1%-7%).

Figure 6.40 Bench Scale Treatment Trials and Bioremediation Early Results for NKETR Zone 2

C2 SKETR PROJECTS - PROPOSED TREATMENT TECHNOLOGIES

CONTRACTOR / JV NAME	TPH RANGE 1-5 %	TPH RANGE 5-7 %	TPH RANGE 7-10%	TPH RANGE 10-15% & >15%
SKETR Zone 1- JV/C of Khalid Ali Al Kharafi & Bros Construction, Contracting Co K.S.C.C with Lamor Corporation AB	Bid Strategy:			
	Bioremediation via covered windrows and bio piles.			Soil Washing enhanced by Solvent Extraction
	Optimization Study Strategy:			
	Contractor will conduct Bench Scale Studies and Field trial to examine different initial conditions effects.			in Preparation
	Optimization Study Early Results (At the time of issuance of this E-Book):			
	Currently, the bench scale studies are in progress			
SKETR Zone 2- JV/C of Heavy Engineering Industries & Shipbuilding Co KSC, with Hangzhou Zaopin St Co Ltd	Bid Strategy:			
	Bioremediation via landfarming and windrows.			Soil Washing enhanced with Hot water
	Optimization Study Strategy:			
	in Preparation			Contractor will conduct Field Trial for Soil washing
	Optimization Study Early Results (At the time of issuance of this E-Book):			
				Contractor successfully commissioned a SW modular plant for conducting field trials, currently optimizing operating conditions
SKETR Zone 3 JV/C of Enshaat Al-Sayer General Trading & Contracting Co WLL with Water & Soil Remediation S.R.L	Bid Strategy:			
	Bioremediation via deep landfarming and windrows		Hot water Desorption and Solvent extraction	
	Optimization Study Strategy:			
	Contractor will conduct Bench Scale Studies to examine different initial conditions effects.		in Preparation	
	Optimization Study Early Results:			
	Did not start yet		Did not start yet	

Table 6.5 SKETR Projects - Proposed Treatment Technologies

C2 1 SKETR ZONE 1 – PROGRESS WITH OPTIMIZATION STUDIES

SKETR Zone 1 Contractor as at the end of 2022 is executing Treatment Optimization Studies (TOS) through Bench Scale Setups. In the approved TOS plan, 24 trials for each TPH range, each tray 10kg contaminated soil (72 trials in total). These trays are targeting contaminated soil with TPH ranges (<1%-5%) & (>5%-7%). Currently, preparatory studies including identification of indigenous bacterial species, toxicity, leachability studies are undergoing in preparation for starting the Bench scale experiments.

Figure 6.41 Preparatory works for Bench Scale Studies for SKETR Zone 1

C2 2 SKETR ZONE 2 – PROGRESS WITH OPTIMIZATION STUDIES

SKETR Zone 2 Contractor as at the end of 2022 is executing Treatment Optimization Studies (TOS) through Field Trials for Portion 4 Materials. The purpose of this study is to demonstrate and validate soil washing as a cost-effective treatment technology that can be applied to treat highly contaminated soils at Zone 2 Ex-situ soil washing will be demonstrated at a field scale by conducting trial runs at HEISCO Yard in Kuwait. The trials aim to optimize the use of proprietary surfactants and a set of operational parameters for equipment manufactured by Zaopin to separate the coarse sediments from the oil-laden fine particles.

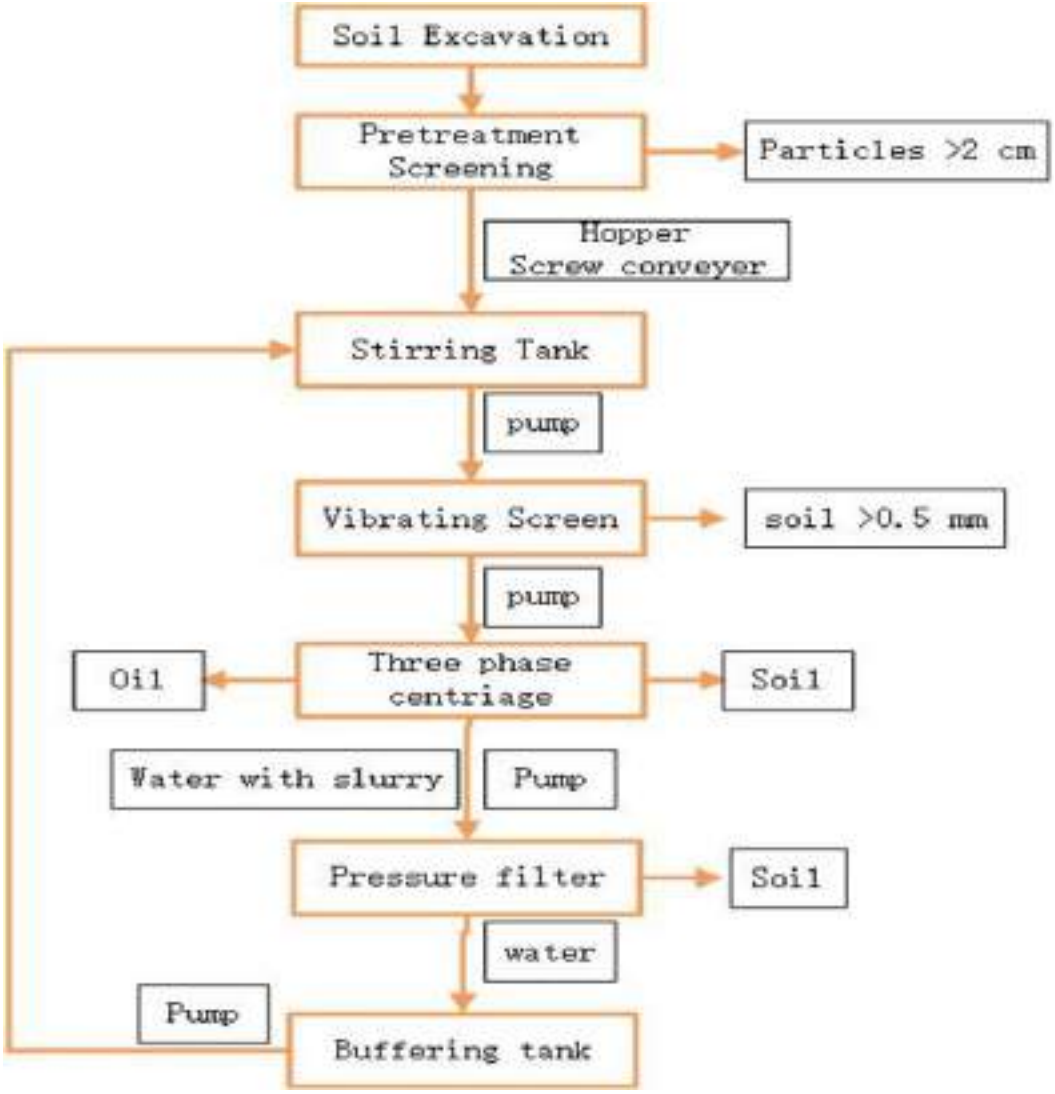
Figure 6.42 Field Trials works for portion 4 utilizing Soil Washing Treatment for SKETR Zone 2

C2 2 SKETR ZONE 2 – PROGRESS

The main process flow diagram activities in soil washing include:

- Pre-screening of excavated contaminated soils
- Addition of water to soil, surfactant, and mixing in Stirring Tank
- Solid/liquid separation-Vibrating Screen
- Oil/water separation- 3 Phase Centrifuge
- Process water/fines separation- at Filter Press
- Filter cake management-Filter cake stockpile or disposal

The preliminary results of the soil washing optimization studies are shown below:



Group 3B & 4A contaminated soils were sourced from Dry oil Lake (DOL) from feature 663,6B. Representative soil samples were collected and analyzed at the field screening/sampling cabin at Heisco Trial Yard. The same laboratory method, USEPA 9071B, TPH (HEM) was performed to check the TPH level in the soil. The results indicated the TPH was 6.71 % for Portion 3B & 9.96 % for Portion 4A.

The contaminated soils were transported in covered trucks using signed loading notes and brought to the yard. Here the materials were segregated and stockpiled accordingly.The soils were then screened using an Allu bucket to less than 2 cm before treatment.

C3 SKETR II ZONE A, B & C

As part of Kuwait Environmental Remediation Program (KERP), the South Kuwait Excavation Transportation and Remediation – II (SKETR-II) Project addresses oil-contaminated soil and sludges located within the Greater Burgan oilfield of South Kuwait (SK) and Wadi Al-Batin (WAB) area/site.

SOIL WITH TPH >1 % TO ≤ 2 % | (APPLICABLE TO SKETR-II PROJECTS)

Enhanced natural attenuation shall be performed by the Contractor as the primary remediation method for the majority of KERP features (Oil Contaminated Piles (OCPs) and Oil Lakes) with TPH concentrations >1 % to ≤2% with nutrients amendments and water and placed in gatch pit(s) or designated areas for long term degradation

SOIL WITH TPH >2 % TO ≤ 5 % | (APPLICABLE TO SKETR-II PROJECTS)

Bioremediation shall be performed by the Contractor as the primary remediation method for the majority of KERP features (Oil Contaminated Piles (OCPs) and Oil Lakes) with TPH concentrations.

SOIL WITH TPH >2 % TO ≤ 5 % | (APPLICABLE TO SKETR-II PROJECTS)

Where the Contractor selects to undertake bioremediation of contaminated soils with TPH >5% to ≤7%, minimum of 80% of the Actual Treatment Soil Quantity (mass) shall be treated with the remainder (if deemed untreatable) disposed as waste at SK landfill by Contractor.

SOIL WITH TPH >5 % TO ≤ 7 % | (APPLICABLE TO SKETR-II PROJECTS)

The Contractor shall use its treatment technology(ies) for this TPH range to treat the soil and achieve the RTC within the project duration.

The treatment design shall be based on the applicability and performance for Kuwait oil-contaminated soils (with same TPH range) during prior KERP remediation projects and shall refer to lessons learned from those projects, involving relevant treatment technologies.

Where the Contractor selects remediation of TPH > 5% to ≤ 7% contaminated soils via treatment technologies, a minimum of 80% of the Actual Treatment Soil Quantity (mass) shall be remediated with the remainder (untreatable) disposed as waste by Contractor at a KERP SK Landfill.

WADI AL BATIN

This oil spill occurred near the Kuwaiti-Iraqi border in the Wadi Al Batin, which is approximately 5 kilometres West of the Tawen border police station. The oil spill occurred in 1994 when a buried 42-inch pipeline emplaced by the Iraqis was broken while a border trench was being constructed between Iraq and Kuwait as part of the border security system. The existence of the 42-inch pipeline in this location was not known because the pipeline was buried.

The number of contaminated soil layers and their properties varies based on geology and the extent of oil contamination. Due to the overflowing of the trenches with oil and multiple damaged pipelines, the WAB area was exposed to multiple oil spills which resulted in soil contamination. These spills are similar to the oil spills resulting from the damaged oil wells or pipelines and follow the topologies (Layering) for Wet Oil Lakes (WOLs) and Dry Oil Lakes (DOLs).

According to CIC report the oil spills closer to Wadi Al Batin are mostly present within the secondary channels of the wadi. These spills have been reported to have an average depth of 1.5 m (Omar et al., 2000). The CIC field survey delineated 40,534 m^2, including four spills in the wadi when multiplied by 1.5 m as an average depth, this results in a volume estimate of 60,801 cubic meters of contaminated soil.

Figure 6.43.1 Section of Wadi Al Batin Trench Early 1991-92.

Figure 6.43.2 WAB in 2005 (Courtesy of KISR/KNFP)

A network of oil trenches was constructed by the Iraqi troops as part of the defense system in Wadi Al-Batin. Oil trenches were fed by pipelines and filled with crude oil during the Gulf War. The construction of these trenches caused deformation of the natural terrain and contamination of underlying soil with oil. The filling and settlement of the oil trenches over a long period allowed deep penetration of the crude oil to the soil, primarily in deep sandy soils.

The thickness of the contaminated layer varied considerably according to the soil type and its physical properties. Typically, up to four oil-contaminated layers in the oil trenches have been recognized. The upper layer consisted of a hardened tar layer with varied thickness. It formed as a result of drying of the crude oil during hot and dry summertime. This upper layer was underlain by a sandy and/or gravelly oily soil layer, followed by a calcrete and/or gypcrete rich oily soil layer and then a highly fractured oil-contaminated bedrock layer. As per CIC report, the total length of trenches are 99,981 meters, the average trench width is 5.72 meters, and the average thickness of the contaminated bedrock/gatch is 5.99 meters. KERP Scope as per UNCC claim is only limited to 7 Kilometres including Wadi Al Batin Main Channel, and parts of Umm Gudair-Wadi Al Batin (Shiqaya) trench.

Wadi al Batin channel has the dimensions of 4,152 meters length (segmented trenches), 5.2-meter average width, and 8.52-meter average thickness. Umm Gudair-Wadi Al Batin (Shiqaya) trench dimensions are 99,981 meters long (segmented trenches), 5.72-meter average width, 1.46-meter average thickness.

Area of interest in Trenches to be handled under KERP program is divided into 5 segments of alternating trenches which has a length range of 800m-1250m respectively. A volume estimate of 240,000 cubic meters of contaminated soil is expected from Trenches

KERP Scope of Work is limited to a total Volume of 300,000m^3 from both the Trenches and Oil Spills.

Figure 6.43.3 Contaminated Soil in Oil Spill in Wadi Al Batin 2019

Figure 6.43.4 Oil trench finishing near border of Iraq in Wadi Al Batin 2019

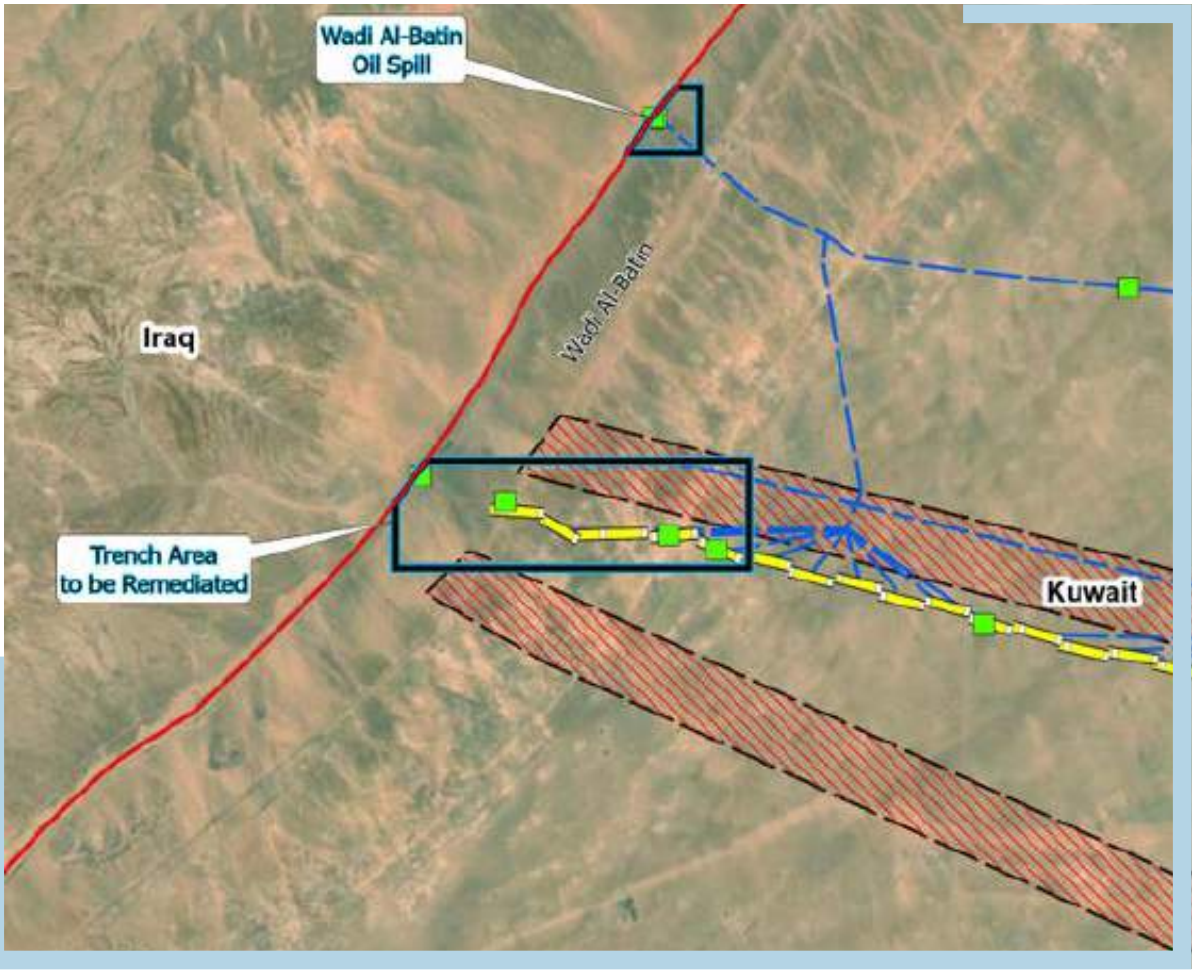
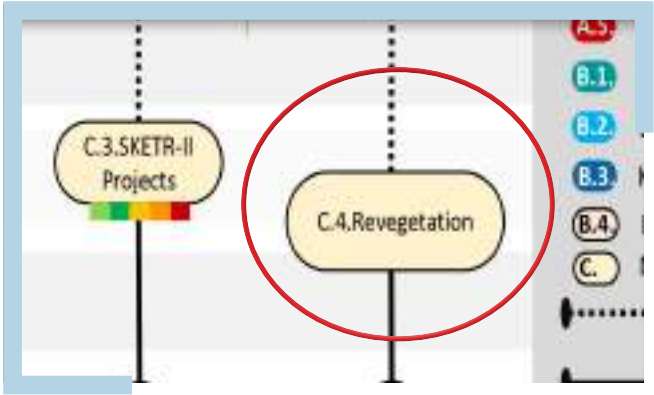


Figure 6.43.5 Area of Interest near border of Iraq in Wadi Al Batin – Northwest of Al-Salmi Land Port

C.4 REVEGETATION PROJECTS



The revegetation projects are part of the overall scope of Claim 5000454-2 "Revegetation of areas damaged by Oil lakes, Oil-contaminated piles, Oil trenches and Oil spills" of Kuwait Environmental Remediation Program (KERP) funded by UNCC. The objective of the revegetation project is to safely revegetate the identified areas within NK & SK, to restore the ecological function of these areas and maximize sustainable ecological restoration.

Several million native plant species including grasses, shrubs and trees will be planted over areas selected in North and South of Kuwait for revegetation projects. Plants will be irrigated initially to assist their establishment and survivorship at early growth stage. Kuwait Institute for Scientific Research (KISR) will be responsible for long-term ecological monitoring of physical and biological parameters of the revegetation areas to determine the restoration of ecological functioning.

Besides increasing the vegetation cover, the revegetation projects will support and enhance the wildlife fauna. Perennial shrubs such as Haloxylon salicronicum are effective in trapping aeolian sand along with organic matter to form nebkha (dunes) around their bases. These nebkhas would provide microhabitats that supports wildlife activities and natural germination of native species Currently, Soil Remediation Group is preparing the tender for revegetation projects.

The revegetation projects involve the following key stages: Selection of suitable sites, UXO clearance, and development of revegetation design; Implementation of revegetation works, which includes installation of irrigation systems, undertaking initial and replacement planting, and growth monitoring; and implementation of ecological monitoring program.

Figure 6.44 Area of Interest: - Revegetated area from a previous SEED project

Figure 6.45.1 KOC & PMC Land Reservation Site visits for Revegetation project.

SELECTION OF SUITABLE SITES

In accordance with the requirements of UNCC, selection of KERP features and/or areas that were physically disturbed as a result of war related activities during invasion including the construction and backfilling of oil trenches and pipelines are mandatory for the implementation of Revegetation Projects.

Several meetings were held between KOC and KNFP to discuss and select the sites for revegetation projects. In a meeting held on 9th July 2020, KNFP was informed that the areas within KERP claims are limited in space and not contiguous due to the conflicts or concerns for future project developments. In response, KNFP highlighted that number of small areas or sparse islands are to be avoided for reasons such as problems associated with execution and monitoring etc. KNFP further recommended that larger areas or contiguous areas of re-vegetation existing within KOC fenced areas, for example Abdaliya preserve area, landfill areas and treatment pad areas etc. are to be considered without breaking the vegetation areas into smaller pieces/islands.

The Soil Remediation Group (SRG) identified the following alternative areas for the revegetation projects: in SEK and NK outside features and/or areas to be used for treated soil for storages or soil treatment pads used during the KERP remediation; West Kuwait; KOC Oasis Expansions or Abdaliya Preserve Areas; Gatch Pits outside features to be released from SKETR and SKETR II projects.

Since future KOC operational plans require to use of large KERP areas, it was considered necessary to evaluate the location of these concentrated revegetation areas to ensure the longevity of project success. Hence, consideration has been given to the long-term operational land requirements of KOC to prevent conflict with the revegetation program. Therefore, most revegetation works will be undertaken outside of main KERP areas to avoid this conflict.

The following are some of the important factors that were considered for site selection:

- Areas that will be permanently under revegetation with no restriction for any future Company development plans.
- Minimal/No aboveground and underground utilities in the vicinity of the site.
- Minimal number of road crossing and cuttings the revegetation areas.
- Soil types of the proposed areas to ensure no high salinity and/or areas with low topography for rain/run off water harvesting that can enhance seeding establishment for revegetation success.
- Selected belt areas to mitigate sand movement or encroachment by plant establishment.
- Use of limited bioremediated or treated KERP soils with readily available nutrients and amendments to achieve ecological recovery within the revegetated areas

- Areas close to available water sources; and
- Easy access from the existing roads and company developments.

Figure 6.45.2 KOC & PMC Land Reservation Site visits for Revegetation project.

IMPLEMENTATION OF REVEGETATION WORKS.

It is proposed to have four (4) contracts – two each in NK (Zones 1 and 2) and SK (Zones 3 and 4) See Figures 6.48 and 6.49.

S#	Plants	Arabic name	Arabic name	Type	Species Category
1	Rhanterium epapposum	العرفج	Al-Afraj	Shrub	Primary species
2	Panicum turgidum	الثمام	Al-Thamam	Grass	Primary species
3	Pennisetum divisum	السباط	Al-Sabat	Grass	Primary species
4	Calligonum comosum	الارطي	Al-Arta'a	Shrub	Primary species
5	Farsetia aegyptia	اللبانه	Al-Labbana	Shrub	Primary species
6	Haloxyon salicornicum	الرمث	Al-Rimth	Shrub	Primary species
7	Nitraria retusa *	الغردق	Al-Ghardaq	Shrub	Secondary species
8	Acacia pachyceras*	الطلحه	Al-Talha	Tree	Secondary species
9	Ziziphus spina-Christi*	السدر	Al-Sider	Tree	Secondary species
10	Lycium shawii	العوسج	Al-Ousag	Shrub	Secondary species
11	Helianthemum lippii	الرقروق	Al-Raqrouq	Shrub	Secondary species
12	Ochradenus baccatus	القرظي	Al-Qardi	Shrub	Secondary species

Table 6.6 List of Plant species as Finalized in Consultation with KEPA, KNFP, KISR and PAAF.

SPECIES SELECTION

The UNCC recommended the use of the following keystone native plant species for the revegetation projects.

For Burgan and Southern areas (Rhanterium community) Rhanterium epapposum, Calligonum comosum, Farsetia aegyptia (all shrubs), and Panicum turgidum & Pennisetum divisum (grasses) For Rawdatain, Sabriya and northern areas (Haloxylon community) Haloxylon salicornicum (shrub) and Panicum turgidum and Pennisetum divisum (grasses).

Subsequently, following comprehensive consultations with KISR, KEPA and PAAF 12 species were selected for revegetation in North and South Kuwait areas. The names of the12 species and some basic information are summarized in the Table 6.6.

Since local agricultural nurseries prequalified by PAAF were expected to produce all the seedlings required for revegetation projects, a "Market Survey" was conducted in May-June 2021 to assess the availability of the above native plants in the local nurseries and their ability to propagate the plants in required numbers for the revegetation projects. Based on the outcomes of the market survey and in consultation with all stakeholders, the final list of plants for the revegetation projects will be prepared.

NR.	PLANTS	PICTURES
1	Rhanterium epapposum	
2	Panicum turgidum	
3	Pennisetum divisum	

NR.	PLANTS	PICTURES
4	Calligonum comosum	
5	Farsetia aegyptia	
6	Haloxylon salicornicum	

NR.	PLANTS	PICTURES
7	Nitraria retusa	
8	Acacia pachyceras	
9	Ziziphus spina-christi	

NR.	PLANTS	PICTURES
10	Lycium shawii	
11	Helianthumum lippii	
12	Ochradenus baccatus	

IRRIGATION SYSTEM

The F4 Panel of UNCC recommended the use of a portable irrigation system that consists of mains, lateral tubing, and fittings (polyvinyl chloride - PVC and/ or high-density polyethylene - HDPE); 'Y' strainers/filters; and drip emitters). This irrigation system will have a number of injection points where the driver of the water tanker will inject the water into the mains for a specified duration to deliver a predetermined volume of water to each plant before moving to the next injection point. The above ground parts were proposed to be reused after the discontinuation of the supplemental irrigation.

Besides drip irrigation, there are several other types of irrigation systems, depending on how water is distributed in the field Some common types include:

- **Surface irrigation:** This refers to systems that deliver water to plants using a gravity-fed, overland flow of water Surface irrigation systems can be classified into three major types: basin, border, and furrow systems. Considering the huge number of plants that will be planted in the revegetation projects, and high wastage of water in surface irrigation, this method will not be viable for the revegetation projects.
- **Localized irrigation:** A method of applying water that results in wetting only a small area of the soil surface and sometimes only part of the root zone. Water is applied near the base of the plant so that the application is concentrated in the root zone. Water is generally applied at a low flow rate, in small amounts, and frequently. The application devices may be small tubes, orifices, nozzles, or perforated pipes The water may either be applied above or below the soil surface.
- **Sprinkler irrigation:** A method of applying water that is similar to natural rainfall. Water is distributed through a system of pipes usually by pumping. It is then sprayed into the air through sprinklers so that it breaks up into small water drops which fall to the ground. The pump supply system, sprinklers and operating conditions must be designed to enable a uniform application of water. Water is distributed by overhead high-pressure sprinklers or guns from a central location in the field or sprinklers on moving platforms.
- **Tractor driven pulling type boom spray system:** This system consists of a tractor, and a boom spray with a water tank. When the tractor moves along the field, the driver stops at each row and with the press of a button makes the spray nozzles attached to the boom deliver a fine mist of required volume of water to each plant (Figure 6.46).
- **Manual irrigation:** Water is distributed across the field area through manual labor and watering cans This system is very labor-intensive.

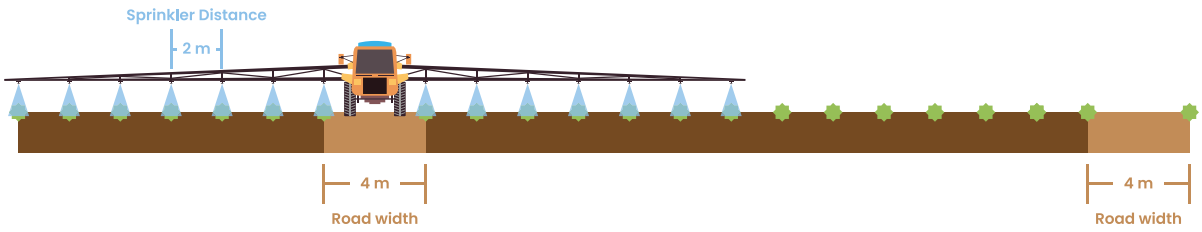


Figure 6.46 Tractor driven pulling type boom spray system

The revegetation contractor shall propose an irrigation system for their projects.

TYPE OF IRRIGATION WATER

It is expected that the revegetation contractors will source tertiary treated water from the Ministry of Public Works (MPW) for irrigating the plants. Irrespective of the source, the water used for irrigation will be required to comply with the standards specified in "Guidelines for Water Used for Irrigation" (KEPA Decision 12- 2017, Law 42 for 2014 – Environment Protection).

Figure 6.47 Representation of Drip Irrigation System

PREPARATION OF PITS AND PLANTING:

This activity involves marking and preparing suitable sized pits, transporting the seedlings to the site, holding them under proper conditions until they are planted, and application of soil amendments.

The revegetation contractors will be allowed to plant only within the permitted planting period of Kuwait. As is customary in all revegetation / restoration projects, the plants will be required to be true to type, healthy, and free of pests and diseases at the time of planting. The contractors will be permitted to add any chemical or microbiological soil amendments to enhance the survival and growth of the plants.

Plant survivorship surveys will be conducted at periodic intervals and the revegetation contractors will be permitted to replace / replant dead plants as required to maintain required plant densities.

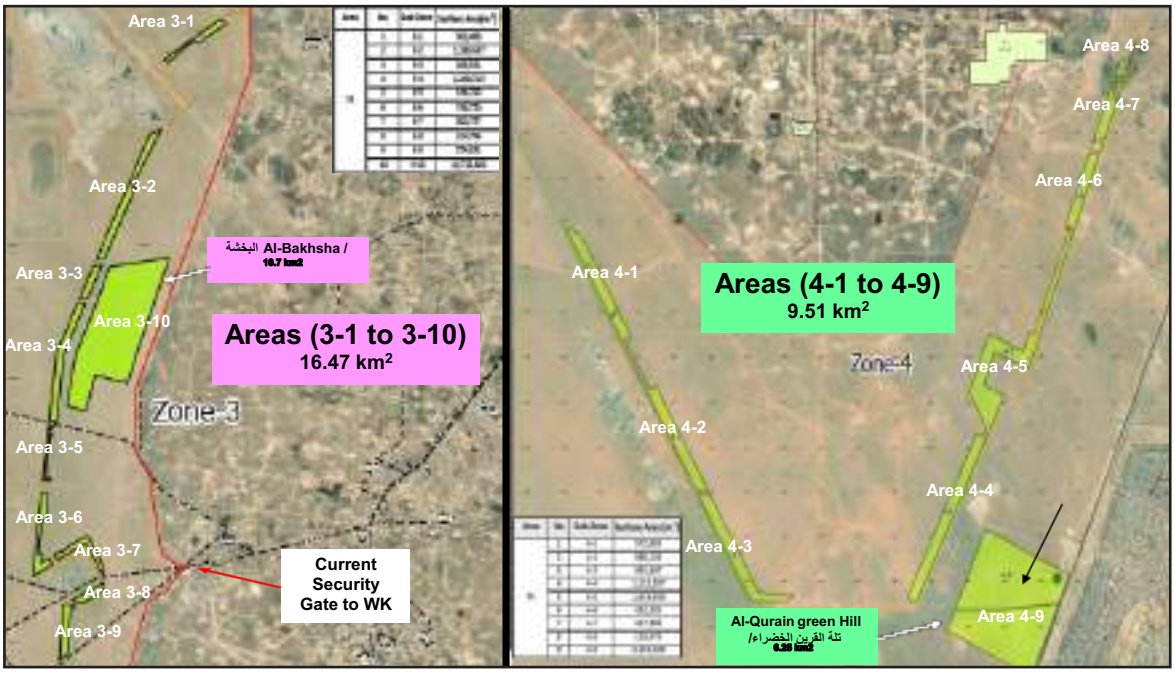


Figure 6.48 Proposed Areas for Re-Vegetation in North Kuwait

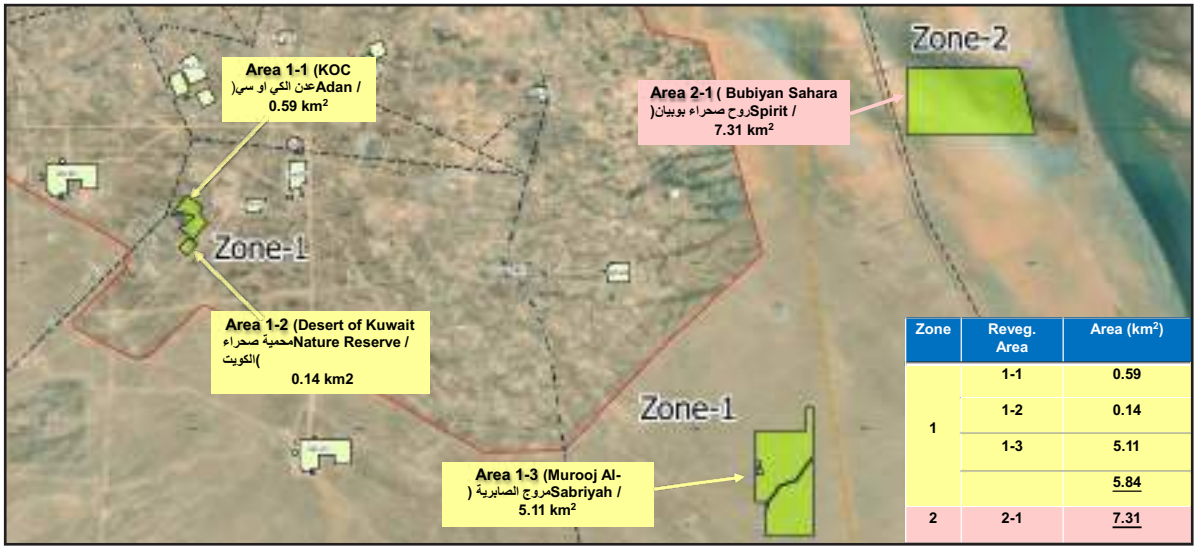


Figure 6.49 Proposed Areas for Re-Vegetation in South Kuwait

Figure 6.50 KOC & PMC Site Visit to Abdullia Reserve

SECURITY FENCING AND SAND DRIFT FENCING

Following the site set up, a permanent low security fence will be constructed along the perimeter of all planting areas situated outside of KOC security premises. The permanent security fence will be a chain-link fence, minimum 1.8 m high and consisting of galvanized steel pipes and wire meshes per KOC standards.

The sand drift fence will consist of minimum 1.5 m tall, slatted fence and shall consist of galvanized carbon steel pipes with coated metal or wooden slats and tension wires. It will be constructed along the windward portion of the re-vegetation area. The main purpose of this fence is to reduce the velocity of the wind and trap the mobile sand. The trapped sand will be monitored regularly during the aftercare and maintenance program.

Figure 6.51 Representation of Fencing surrounding Revegetation in SEED Project

ENVIRONMENTAL MONITORING

Environmental monitoring refers to the tools and techniques designed to observe an environment, characterize its quality, and establish environmental parameters, for the purpose of accurately quantifying the impact an activity has on an environment. Results are gathered, analyzed statistically, and then published in a report Environmental monitoring has two components: Compliance Monitoring and Ecological Monitoring

a. **Compliance Monitoring will be performed by the Revegetation Contractor(s) during the execution of the of revegetation projects.**

   The most important parameter to be recorded under Compliance Monitoring will be plant survivorship / mortality in accordance with the requirements of the. Contract In addition, the Revegetation Contractors will be required to record baseline data on groundwater and surface water (if present) quality, soil quality, air, aust and noise quality and monitor all these parameters at periodic intervals during the execution of the project.

b. **Ecological Monitoring will be performed by the Kuwait Institute for Scientific Research (KISR).**

   The objective of Ecological Monitoring is to determine the success or otherwise of the revegetation activities and assess the resumption of ecological functioning in the revegetated areas. Ecological monitoring of physical and biological parameters is required to reveal whether the ecological functioning has been restored and if so, to what extent, and whether the ecological trajectory of the restored sites is moving towards the selected end goals

For ecological monitoring, KISR, will select monitoring plots, i.e., reference, control, and revegetation monitoring plots, and obtain baseline data on soil physical and chemical characteristics, microbes, existing vegetation, climate, hydrology, wildlife, and sand movement; conduct site-specific ecotoxicological evaluation from representative remediated areas for the valued ecological receptors and derive a site-specific assessment standard, obtain long-term ecological function monitoring data from study sites during and after revegetation to evaluate them based on reference conditions; record and observe changes over time in structural and functional components of the restoration and revegetation study sites, particularly any changes that are related to the natural variation in the recorded baselines and control components, document changes in ecological functionality to determine whether the ecological trajectory of the restored sites is moving towards the selected end goals, and establish a database and periodically update it with new data/information.

The conceptual model that will be used to generate data from the three types of monitoring plots as given in Figure 6.52.

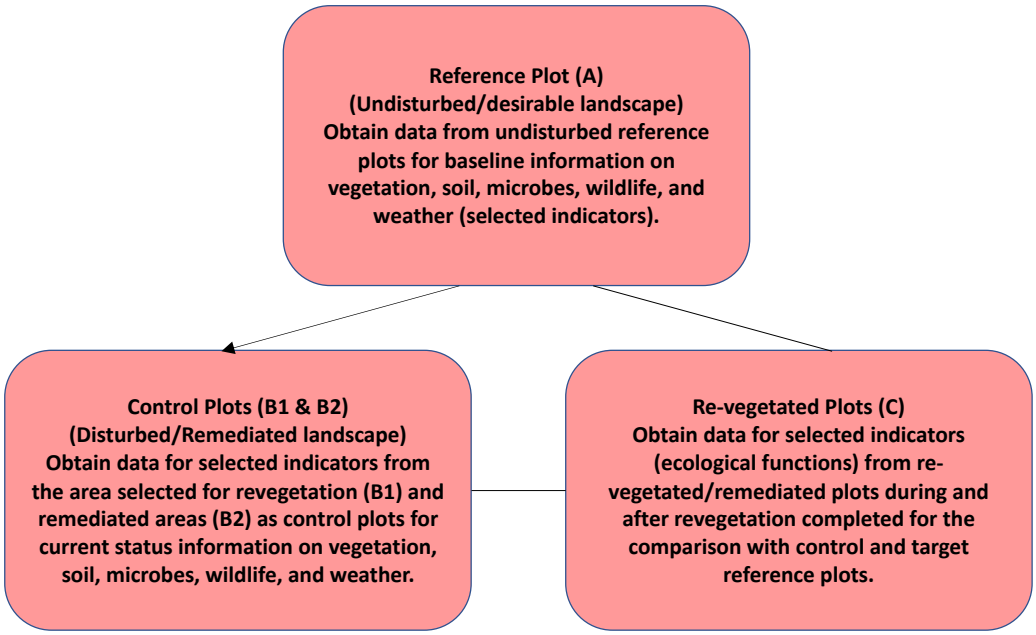


Figure 6.52 Generalized monitoring concept for all sites

The list of selected measurable Vital Ecosystem Attributes (VEAs) related to Ecosystem Structure include Perennial species richness, Annual species richness, total plant cover, soil-borne seed bank, Plant biomass, Microbial biomass and diversity of soil biota, Wildlife fauna species composition and size of population, and faunal biodiversity index VEAs related to Ecosystem Function include biomass productivity, soil organic matter (SOM), soil moisture, total nitrogen, cation exchange capacity (CEC), soil aggregation/surface condition, and nutrient cycling indices.

In the first year KISR will collect baseline and ecological risk assessment data and conduct subsequent ecological/ surveillance monitoring for four years from the date of completion of active revegetation activities at specified locations across North Kuwait and South Kuwait Revegetation Areas. The monitoring activities will be repeated on monthly, quarterly, semi-annual, and annual basis depending on the nature of indicators.

A revegetation project will be considered successful when the measured values of the investigated attributes in the revegetated areas are similar to those in the naturally regenerating sites (reference sites) in terms of structure, function and resilience. The goal of restoration is to emulate a healthy, natural, self-regulating system that is integrated into the surrounding natural landscape.

PREVIOUS REVEGETATION / REHABILITATION WORKS AT KOC

Revegetation projects to rehabilitate gatch pits, sludge pits and effluent pits have been completed in the recent past at KOC field areas under SEED projects. The results have been encouraging in terms of establishment and survival of native shrubs and grasses planted at the rehabilitating pits as shown in the below.

Figure 6.53 Gatch Pits rehabilitated under SEED project

Figure 6.54 Sludge Pits rehabilitated under SEED project

Chapter - 7

Restoration Gains & Remediation Improvement

RESTORATION GAINS & REMEDIATION IMPROVEMENT

It is said that "The past is where you learned the lesson and the future is where you apply it." The KOC KERP journey till December 2022, was not a lesser trail, as there where multiple hurdles which could slow and delay the journey or its phase at several junctures. Despite all these, the KERP team has embraced every challenge as an opportunity to learn more, improve on experience, sharpening the mission and focus while striding towards a cleaner and sustainable Kuwait. This chapter discusses those lessons learnt during the journey so far.

The uncertain scale, extent & magnitude of contamination, burnt oil, high viscosity of the waste, high salt content, the arid environment, harsh temperatures in Summer, presence of ashphaltenes, water unavailability and the remote location of many of the contaminated sites, were among the key challenges in KERP journey along with other the unexpected hindrances such as the strike of global pandemic.

LESSONS LEARNT FROM PREVIOUS EXECUTED PROJECTS

SEED PROJECT

SEED PROJECT | SOIL WASHING TECHNOLOGY- Sustainable Environmental Economic Development (SEED):-

Back ground :- The Project's scope of work was to repair damage done to the natural landscape as a result of oil operations over many decades and:

- To rehabilitate a selection of contaminated features to ecologically functioning areas that are able once again to support a typical range of native plant species.
- To Adapt Health & Safety protocols and Explosive Ordnance Detection (EOD) appropriate to the associated risks noted with the features.
- To recover oil contained within the features, where applicable.
- To apply a risk based methodology of remediation concurrent with recognized international protocols adapted to the prevailing environmental conditions in Kuwait.
- To initiate soil remediation techniques associated with the nature of the oil contamination existing within the features.
- To monitor and compare the effectiveness of various remediation approaches using the established native plant species as performance indicators.

	COMPOUND	MALFUNCTION	OCCURRENCE	MALFUNCTION REASON	IMPACT
General	Main Generator	break down	very frequent	overheating	no production up to 5 days
	Internal Conveyors	screws, belts and bearings damaged	frequent	wear and tear	no production at least for 1-2 days
	Internal Valves	leakages, blockages	frequent	abrasion, weariness, sediment overload	production stop for several hours
	Internal Pumps	blockages	very frequent	sediment overload	no production at least for 1-2 days
	Internal Piping	blockages	very frequent	sediment & contaminant overload	no production up to 1 day
Pre-Screening	Feed Hopper	conveyor belt & bearings damaged	frequent	wear and tear	no production at least for 1 day
	Grizzly	no problems reported			
	Attritioner	blockages; damages	frequent	concrete blocks; abrasion	production stop for several hours
Solid-Solid Separation	Vibrating Screen	motor and/ or transmission damaged	frequent	weariness	no production at least for 1 day
	Heating	no problems reported			
	Attritioner	blockages; damages	less frequent	sediment overload, abrasion	production stop for several hours
	Blade Mill	motor break down, blockages	frequent	overload, concrete and stones	no production at least for 1-2 days
	Hydrocyclone	leakages, blockages	frequent	abrasion, weariness, sediment overload	no production at least for 1 day
	Decanter Centrifuge	leakages, blockages	frequent	overload, concrete and stones	no production at least for 1-2 days
Liquid-Solid Separation	Centrifuge	leakages, blockages	frequent	abrasion, weariness, sediment overload	no production at least for 1 day
	Hydrocyclone	leakages, blockages	frequent	sediment overload, plastic particles	no production up to 1 day
	Microcyclone	leakages, blockages	frequent	sediment overload	production stop for several hours
	Air Compressor	break down	frequent	overheating	production stop for several hours
	Band Filter Press	motor, band, roller bearings damages	very frequent	abrasion, weariness	no production at least for 1-2 days
	Frame Filter Press	motor & filter canvas damages	frequent	too high portion of fines	no production at least for 1 day
	Lamella Clarifier	piping, lamellas & discharge blocked	frequent	fine sediment overload	no production up to 5 days
Liquid-Liquid Separation	Centrifuge	leakages, blockages	frequent	abrasion, weariness, sediment overload	no production at least for 1 day
	Floatation Cell	blockages	less frequent	fine sediment overload	production stop for several hours
	Oil/Water Separator	blockages	less frequent	fine sediment overload	production stop for several hours

Table 7.1 Malfunctions and Impacts on Productivity

SOIL WASHING SYSTEMS AND CONFIGURATION

There were five (5) different soil washing plants deployed within SEED Phase 1 consisting of the following four general components:

- Pre-screening: feed hopper, fixed bar screen (grizzly) to mechanically segregate oversized and non-natural materials (metal, concrete blocks etc.), attritionary to disaggregate agglomerated materials;
- Solid-solid separation: fixed or vibrating screens (wet or dry), hydrocyclones, density/gravity separators (e.g., settling tank), shaking table to mechanically segregate different grain size fractions;
- Liquid-Solid separation: clarifier, settling tank, lamella clarifier, flotation cell and solids dewatering using screen, centrifuge, band or frame filter press;
- Liquid-Liquid separation: water recycling using flotation cell, oil/water gravity separator.

The five (5) plants were different, regarding the sequence, the cut size of the physical particle separation steps and the residence time in the particular treatment units.

ANALYSIS OF SOIL WASHING PLANTS' MALFUNCTIONS

During SEED 1 daily logs were kept for the soil washing plants in which all malfunctions and breakdowns were documented. Based on this information the plant usages were evaluated. In the table 7.1. malfunctioning or broken-down elements are outlined including the reasons and impact on productivity of the plants.

LESSONS LEARNT CONCLUSIONS & RECOMMENDATIONS

Based on the information the lessons learnt exercise for SEED, the following conclusions are made.

PRE-SCREENING PROCESS

Due to the natural conditions of the soils to be treated, feeding the Feed Hopper should be conducted using robust materials. Belt conveyors were found very susceptible to malfunction, in particular moving parts (belt, ball and roller bearings). As an alternative, loader and excavator were used.

Fixed-bar screens (grizzlies) were largely unsusceptible to external influence factors such as heat and abrasion and hence, were an indispensable component of the pre-screening process.

To replace attritions which are found susceptible to malfunction, trommels are recommended as blockages were not expected to occur due to the design. In addition, trommels can also be used for dis-aggregation and size reduction of clumping materials. Using this technology, separation ranges from 5cm down to less than 5mm are feasible.

SOLID-SOLID SEPARATION

Due to the high content of "soft" minerals in the oil field sands (such as carbonates), crushing, coarse/fine grinding of the feed material should be avoided. During operation of the different soil washing plant types it was noted that applying strong physical forces (e.g., high-pressure water jet, collision chamber) produces additional fine grained material. These additional fines together with high viscous oil present in the contaminated soils are responsible for clogging of pipes, pumps, cyclones, and filters. Where crushing and grinding was minimal, less blockages and higher throughput rates were achieved.

Fixed mechanical or vibrating screens (dry or wet) are the tools of choice to classify the particle sizes of the sediments and may be used at more than one point within the treatment process. The smallest screening size practically should be between 0.5mm and 1.0mm. Below that size the use of screens is not feasible. For the screens woven wire or perforated plates are recommended.

The undersize material from the screens can be treated by hydrocyclones which are separating the slurry by specific gravity. Feasible particle size cuts are 0.005mm to 0.25mm. The overflow contains the undersize transported with the water through the vortex finder at the top of the cone. The underflow consisting of the oversize is discharged at the bottom of the cyclone through an apex. To avoid blockages, the maximum size of particles entering the cyclone should be half of the apex diameter.

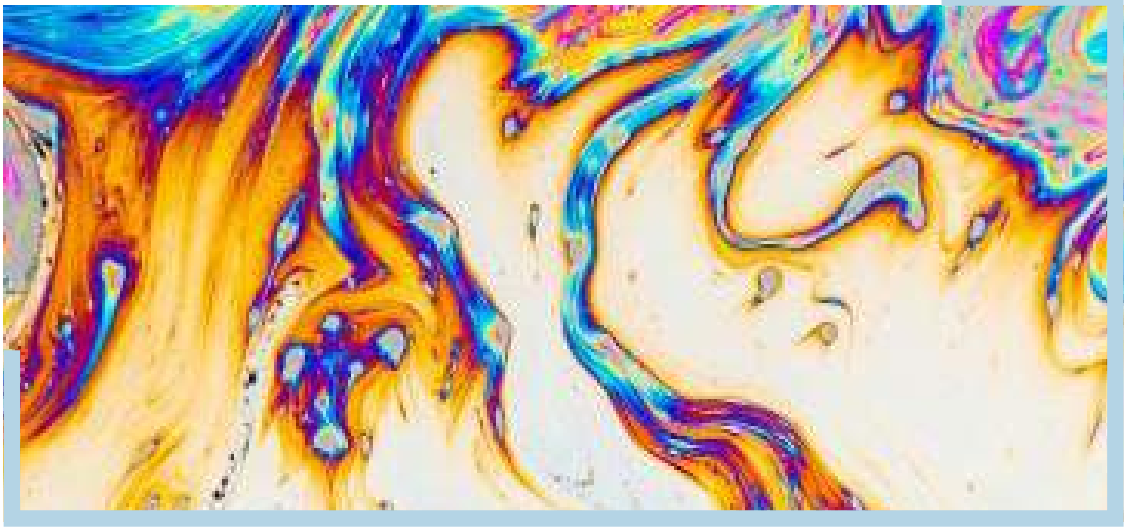
Attritioners are used for disaggregation of lumps and provision of "homogenized" slurry and may be used at more points within the treatment process. They were found susceptible to malfunction when used for treatment of sediments with a wide range of particle sizes. As they may produce additional fines by grinding the minerals, their application should be specifically for the provision of homogenized slurry. Additional fines were causing blockages and fines overload within downstream treatment processes. Application of heat using steam or boilers is highly recommended to support the disaggregation and separation of oil and particles.

SOLID-LIQUID SEPARATION

To separate fine solids from the slurry stream different technologies were used such as lamella clarifier, centrifuge, hydrocyclone, floatation cells, dewatering screens and dewatering bags Except for the screens and bags all other technologies were found susceptible to malfunc- tion mainly due to overload with fine sediments and material weariness The high fines' content in the slurries induced blockages in pumps and the piping system.

Tested technologies are regarded as feasible as long as the maximum solids content in the fine slurry is kept below the application limits of each module The portion of fines <0.005mm is to be (kept) low, because the dewatering costs for slurries are exponentially increasing with rising portion of this fraction in the sediments to be treated, hence, the coarse/fines cut should be at 0.063mm.

Application of heat using steam or boilers is highly recommended to support separation of oil and particles.



LIQUID-LIQUID SEPARATION

It is mandatory for a substantial oil-water separation, so that more or less all solids were removed from the liquid to be treated. All operated systems (centrifuge, floatation cells, oil/water separator) were struggling with excess solid residuals in the liquid.

In Lot B project soil washing plants, fine particles of the silt-clay fraction produced by high physical forces (e.g., grinding) were insufficiently removed by the solid-liquid separation (coarse/fines cut too high) resulting in overload, blockages and finally a non-operational system. In consequence, oil was not separated, and the washing water was not recycled but replaced with fresh water at high costs Oil, water and fines were discharged.

All provided technologies are regarded as feasible as long as the maximum solid content in the liquid from solid liquid separation is kept below the application limits of the respective liquid-liquid separation technology.

SEED PROJECT | BIOREMEDIATION LESSONS LEARNT

- Low production because predicted degradation failed to materialize Less moisture content, less aeration (tilling); deviation from method description.
- Predicted degradation far exceeded because initial PHC con- centration overstated, removal of oily lumps during treatment.
- Highly contaminated residuals, remaining oily lumps treatable only using different technology Sieving of contaminated material generating oily lumps so siev- ing to be replaced by homogenizing (e.g. using AL- LU-bucket).
- Sustainability - high freshwater consumption because of loss of moisture due to evaporation and infiltration Loss of water to be minimized by suitable measures such as windrow technology, covering of soils and consolidated tight treatment area.
- Rebound effect- PHC concentrations rebound even after achieving remediation standards Degradation not completed Start-
- ing degradation of complex non-HEM long-chain PHC after completion of short-chain PHC degradation Degradation monitoring to be conducted in-
- cluding rebound effect Contract to define achievement of remediation standards considering rebound effect.

SEED PROJECT I| SITE CHARACTERIZATION LESSONS LEARNT

- Method of characterization could only provide indicative volumes due to limited access. Volume calculations to be carried by modelling based on developed soil charaterisation.
- Lag times in analytical results and delays in agreeing volumes resulted in delays in follow on excavation works. Material will be screened in field utilizing RemScan type equipment to speed classification process and expedite excavation works.
- Inconsistency between sample results and reporting formats from differing labs across the different contrac- tors 3rd party laboratory to be used by Company for QA/QC audits.
- Contractor has provided site sample characterization data which was initially improperly formatted and contained errors. Required multiple timeconsuming iterations and revisions Implementation of an Environmental Data Quality System such as EQuIS would aid in standardizing data entry and laboratory results. This would additionally minimize errors, automate reports and provides geospatial analysis (GIS) capabilities.

SEED PROJECT I | SITE RE-VEGETATION LESSONS LEARNT

- Bio-remediated soils showed lowest survivorship rates of all treatment methods. Survivorship in bio-remediated soils lower with amendments (17%) than without (23%). Amendments added to fertilizers used in bio-remediation result in over-fertilization and in this case fertilizer rate during remediation shall be tailored to soil types.
- Insignificant discrepancy in survivorship rates in soils remediated to Primary vs Alternate RS (53% : 45%). Different TPH levels below 10,000 mg/kg do not have significant effects on plant survivorship and/or growth.
- In Lot B survivorship rates in remediated soils higher than in reference area and that can be be- cause plants set into remediated soils were pre- grown in nurseries for more than 10 -12 months and thus, have higher chances to survive. When planting in rehabilitated areas then plants pre-grown in nurseries at least for one year.
- Remediated soils were naturally re-colonized by local plants. Seeds accept remediated soils for germination. No re-planting required for remediated soils enabling asset to reuse land if required.

SEED PROJECT I| OIL RECOVERY LESSONS LEARNT

- Oil viscosity seasonal variations due to temperature caused extraction issues.
- In the Summer - oil is pumpable and, in the Winter – low viscosity required mechanical excavation or heating. Ensure this factor is included within future site works and also is taken into consideration in planning.
- Oil Quality Criteria & Market, Recoverable oil to be extracted from pits where viable and stored in temporary holding pits. Long Term – Requirement to undertake technical and economic review considering State Wealth concerns to determine viable reuse options.

KERP UXO PHASE I PROJECT | EOD/UXO LESSONS LEARNED

- Turnaround time between Digital Geophysical Mapping (DGM) survey and Intrusive investigations need to be reduced. Contractor must expedite data processing and the production of future Dig.
- Packages, they must utilize more manpower in order to conduct Intrusive Investigations of recently produced dig Packages concurrently with reducing the backlog of Target Investigation Dig Packages already processed and pending.
- To ensure that the Schonstedt metal detector can detect metallic anomalies at the contractual depth the Schonstedt metal detector setting have now all been adjusted to setting “H” during daily functionality tests and EOD operations, this ensures that metallic anomalies can be detected down to contractual depth in accordance with the specified ISOs.

- Introduce control measures (cones) placed at each corner of the laydown areas for plant operators to maintain a uniform depth of 50cm when laying soil plot.
- VSOR Teams should remove all obstacles that will lead to DGM gaps being generated.
- Contractor QC Specialist must conduct site inspections, record and report to Company any items greater than 45Kgs prior to removal from the grid.
- Must look to process more DGM data in house to enable more effective planning and maintain overall control of which dig packages are being produced.
- Contractor must have sufficient resources to enable teams to work independently when dig packages are sporadic. Must look to process more DGM data in house to enable more effective planning and maintain overall control of dig packages.
- Must utilize other resources such as a REMU bucket (Mixing buckets attached to heavy machinery for segregating, mixing and crushing) to expedite these heavy metallic contaminated areas. Additionally, Contractor should look to up armor a JCB to be more versatile & effective during VSOR & Intrusive Investigations activities.
- When situations like this are identified during Target Reacquisition & Intrusive Investigations so that site visits can be conducted with PMC and these areas can be excluded from the clearance.
- Contractor to conduct in house training with all EOD personnel in the correct use and maintenance of equipment and methodology to be used during each EOD.
- Interviews of key personnel before assuming positions.
- Contractor should have adequate spares supply to keep equipment operating and needs more resources to complete required documentation.

UXO PHASE I PROJECT | CONSTRUCTION ACTIVITIES LESSONS LEARNED

- All areas requiring land reservations are to be identified within initial studies at the beginning of the project.
- Field Development must actively visit site with all involved parties at each stage of defining rig pad boundaries and revised rig pad boundaries while discussing access routes and obstacles final decisions must be communicated formally.
- Ensure utility maps for work areas are available from the beginning of the project.
- It is more efficient to involve site-based contractor and PMC staff in identifying suitable stockpile locations before developing maps for official review.

- Ensure tolerances for over-excavation are specified in contract.
- Ensure that enough IVS's are constructed in the field and that they are evenly distributed and maintained to minimize travel distance and time from any worksite to the nearest IVS.
- Ensure in subsequent projects that resources for generating dig packages are available within Contractor's organization, co-located with Contractor or based in-country.
- Ensure stockpile location is ready for use before commencing OCP activities in a new sub-area.
- Appropriate incentive schemes, when correctly applied, can boost workers' productivity when it is most needed.
- Proper management and streamlining of rest and lunch breaks can lead to significant increase in daily production.
- Adequate manpower supported by logistics leads to enhanced productivity.
- Clustering site activities within the same geographical area can reduce the pressure on logistics and welfare facilities and increase the level of supervision.
- Ensure stockpile locations that are closest to OCP location are ready prior to commencing OCP activities.
- Ensure that suitable mechanical equipment is selected for the type of soil being cleared.
- Prior to commencing work on any OCP, contractor should scan the perimeter of the OCP with a cable locator to identify any buried cable passing beneath the OCP. Also coordinate with appropriate Company Operations personnel to positively identify underground cables / utilities in the area.
- Provide proper supervision, sufficient separation between screened and unscreened soil pile and also provide adequate signage to eliminate the potential for loading and moving uncleared soil to stockpile locations.

- Ensure that buffer zones around flow lines and utilities are properly defined in advance to avoid unnecessary BAC work in areas where future excavation work cannot be carried out due to safety restrictions on mechanical excavation close to flow lines.
- Should use all available methods (scanning, slit trenching etc.) to positively confirm there are no underground utilities in an area prior to excavating with mechanical equipment and must proceed with caution when excavating.
- On future projects, WSS at the OCP location is to ensure that a red flag is attached to trucks that carry heavily contaminated soil and a white flag to trucks that carry lightly contaminated soil. Both flagman and driver will then be able to decide easily where the material is dumped at the stockpile location. This will ensure proper segregation at the stockpile location.

UXO PHASE I PROJECT | PLANNING & SCHEDULING LESSONS LEARNED

- It was observed that contractor was not updating the schedule properly nor reporting realistic forecast dates resulting in misleading information for understanding the actual status of project.
- While achieving progress at site they reported more progress based on the approved Physical PMS. However, they were slow in preparing and submitting documents (Intrusive Certificates, RFI etc). Due to this there was always a big difference in physical progress reporting and invoice reporting. It will be recommended to the future execution contractors to assign reasonable weights for documentation parts also, so that they will concentrate to achieve all the steps. This will help to diminish the difference between physical and invoice PMS percentage.
- Contractor's planning team need to be advised to spend/interact enough time with all the necessary persons before finalizing the Baseline schedule. That helps in deciding the right duration, sequence and proper resource requirements.

NK & SK LANDFILL PROJECTS | CONSTRUCTION ACTIVITIES LESSONS LEARNED

- Construction of landfill into cell(s) with clear berms/demarcations walls is not practicable from engineering standards and created havoc for E&T project. No clear demarcation or dividing wall of cell 1 & 2 has created havoc to fill the landfill in safe and practical manner Eliminate the need to construct cells but one large cell or facility to fill with multiple (minimum 2) access ramps to minimize congestion and traffic accidents.
- NK & SK Landfill Projects | Quality Assurance/Quality Control Lessons Learned
- Advise Construction team to avoid receiving materials with incomplete docs at Site to encourage Contractor to submit docs on time.
- ITP's to be developed to control the quality for all items / activities included in the contract.
- Contractor shall submit the scope of Third-Party Inspections in order to ensure that all the required tests are being carried out as per the requirement for the material / equipment.
- ITPs of manufacture where third party inspections are to be carried out at vendors place shall be submitted by the contractor for Company review and approval.
- Absence of standard forms at Site during the first few months result- ing in delay in invoice verification Advise HSEQ to ensure EC QAQC Plan contains a complete set of standard forms to be used at Site.
- CPR to be verified and countersigned by Company before attaching to the Monthly Report so a copy of the same could be attached to the Invoice.
- Advise construction team not to proceed with installation and construction works until materials have passed the required Compliance Test Reports.

LESSON LEARNT SHAPING THE FUTURE PROJECTS

Project lessons learned are tangible result of an executed "project review", taking the project experience, in whole or part, and breaking it down into actionable conclusions about what went right, what went wrong, and what could be done better. Every project experience has "lessons" to offer. These lessons are discovered through the project review process, providing the means by which the project experience can be examined and evaluated to find underlying lessons. The overall goal of this process is "continuous improvement" to utilize the experience gained from one project to benefit future projects and improve project management capabilities and, this is all realized through the "lesson learned".

Project lessons exist at two levels - performance lessons and results lessons. Performance lessons encompass the procedures and practices used to plan, manage and execute approved projects. Results lessons encompass the "project" itself and the work effort performed to produce planned results. The project review is best executed as a standardized management process, providing the basis for how projects are reviewed and how the review results are used and incorporated.

To ensure that all goals can be fully met, standardized review practices should incorporate the following parameters:

- Project review timing and triggers (what types of events will lead to review initiation?).
- Review input requirements (what types of events and circumstances will be reviewed considering project plans, deliverables, activities, tasks, decisions, and related variables?).
- Data collection methodologies (how will review inputs be identified, gathered, and organized for review purposes?).
- Review benchmarks and analysis criteria (forming the basis for "lessons" identification).
- Lessons learned reporting methodologies (how will identified lessons be produced, documented and incorporated into the "institutional body of knowledge"?).

The key to project review success is the timely application of identified lessons learned to future projects, practices and related services. This is achieved when key lessons are documented as part of the "institutional body of knowledge" (record of the collective "organizational" project experience), available for reference as time passes and organizational changes occur. This step provides the required continuity that is a key element of continuous improvement.

It is important to remember that "project lessons" can present themselves at any point in the project lifecycle and not just as part of formal reviews. You may be in the middle of any task, activity, event or decision and suddenly realize that something, could have been done better or anything that should have to be kept in mind for the next project. You can also learn something from observing projects managed by others Whatever the source, these "spur of the moment" lessons should be immediately noted and documented to be addressed as part of the larger (and more formal) project review process.

Chapter - 8

KERP
Building Capacity & Future Perspective.

The KERP program has managed to introduce Kuwaiti researchers, specialists and engineers in KOC and local contractors to the remediation/rehabilitation industry and has created the chance for specialized capacity building across the managerial, senior engineers, engineers, and Under Development (UDs) levels.

KUWAIT OIL COMPANY- SOIL REMEDIATION GROUP

Since the establishment of Kuwait National Focal Point, and the Soil Remediation Group (SRG) within KOC, SRG and the different teams within, it, including SRS, SRP I, and SRP II have and still are exerting huge and incessant efforts to align the organization with the international best practices in remediation, rehabilitation and restoration. Many team members are actively participating to various workshops, conferences, scientific symposiums within the country and internationally where related topics and new trends or innovations in the remediation field are discussed.

Moreover, several steps of work preparation in executing the KERP program have been taken Working with international PMC's and intenational remediation contractors has led to the transfer of these experiences to KOC specialists and engineers.

SRG for the past 10 years has been working in collaboration with internationally and well recognized PMCs to plan, and successfully remediate/rehabilitate contaminated land within KOC restricted area. The programs and projects were designed and carried out with international reputable remediation companies which aimed to treat soil using different established technologies and succeed in achieving the remediation standards as per the contracts.

Figure 8.1 Ms. Aisha Al Baroud Presenting during SKETR Forum 2019

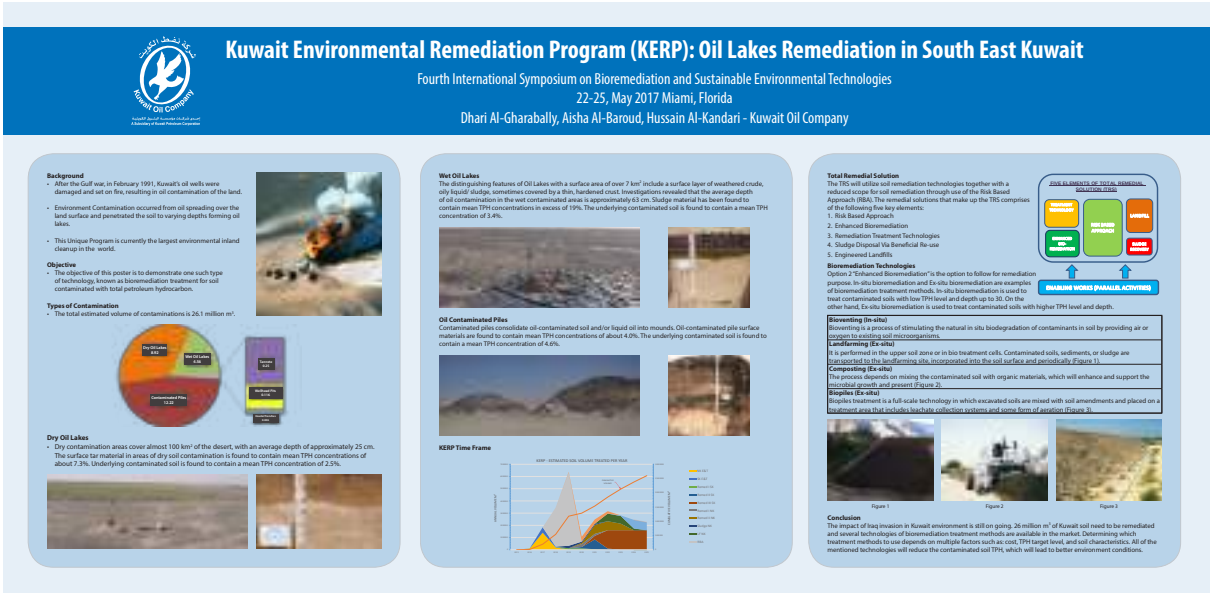


Figure 8.2 Poster Participation in International Bioremediation Symposium in Florida 2015

Figure 8.3 Some of the Scientific Papers Published in International Journals

The different stages of preparation from setting objectives, strategies, timeframes, budget analysis, KOC Stage Gate FEED (developing & preparing the project technical requirements), tender preparations, bidder's evaluation, projects' execution have all happened with the vital and crucial participation of different concerned KOC teams and specifically the different SRG teams.

KOC has managed to establish and maintain a highly qualified and specialized team of engineers and specialists that can develop, monitor and track Remediation projects Several scientific publications and related research projects are the best verdict for this Some of these published technical papers have given in the appendix section of this book for reference. Working closely and on day-today basis with the PMC team of specialists and experts helped to raise the technical capabilities and skills of the KOC teams.

OTHER KOC TEAMS

During the preparation stages for the different KOC-KERP projects, other KOC teams (H&E, QHSE) have always been proactive to update KOC's environmental related standard procedures to reflect the latest technologies and development in this industry. In addition, while preparing for the new projects, a series of technical workshops, market surveys and vendors question sessions have been conducted to take into consideration the latest developments in the industry. These were initiated to ensure that the best practices are well captured in future tenders and projects.

KOC awarded contracts for SEED phase I and KERP to international specialized contractors and the hands-on experience gained from that were applied during projects' preparation phase, thereby ensuring smooth daily field activities follow-up and progress.

Figure 8.4 KOC SRG Team

Figure 8.5.1.,8.5.2.&8.5.3 KOC SRG Team members during several outreach programs

UNIVERSITIES AND RESEARCH INSTITUTIONS

KOC has conducted several forums and has made several presentations to institutions and universities to educate and collaborate on research projects in environmental and remediation aspects of the Kuwait contaminated soils and creating new prototypes of techniques and remediation approaches to deal with the existing soil contamination and building capacity in this research field on various types of soil.

Figure 8.6 - Audience attending KERP Forum 2019

Figure 8.7.1.,8.7.2.&8.7.3 KOC SRG Team members during several outreach programs

STAKEHOLDERS (KEPA; KNFP, KISR, PAAF)

KOC has educated key stakeholders (including KNFP, KEPA) on international tools such as Environmental Risk Assessment used to support the Risk Based Approach (RBA) for remediation projects. This tool is utilized by experts on the environment to define quantitatively and qualitatively risks to public health, environment and ecology on international standards to minimize the risks and redefines the volumes and remediation criteria for KERP, and potentially save soil volumes from unnecessary remedial intervention. This forum established frameworks and criteria to be utilized in KERP and future environmental/remediation projects.

Figure 8.8 Technical panel discussion KERP Forum 2019

Figure 8.9 KNFP UNCC IRS Technical meeting costa del sol January 17, 2013

Figure 8.10 KNFP UNCC IRS Technical meeting costa del sol January 17, 2013

Figure 8.11.1 & 8.11.2 8.11.3 Pictures from SEK Landfill Portion 1 Completion Ceremony - March 2015

Figure 8.12 Completion and Capping of the landfill

Figure 8.13 KOC KNFP Meeting Project Execution Progress 2017

Figure 8.14 KERP Forum Invitations to Local Contractors, Research Institutes and Media Agencies

LOCAL CIVIL AND REMEDIATION CONTRACTORS

KOC has successfully completed five (5) specialized projects, and currently five (5) more projects are being executed and in progress and another three (3) in the pipeline with remediation aspects. All these contracts/projects were or are developed in such a way that the main civil contractor should be a Kuwaiti contractor in Joint Venture (JV) with an International firm in the remediation and environmental field. This has allowed local Kuwaiti civil contractors to gain experience in working with contaminated soil, better understand the concepts of projects management and handling starting from delineation, characterization, executing and managing remediation works.

Working closely with international JV remediation partners has allowed local Kuwaiti civil contractors to get exposed to, capture, and indigenize this specific type of experience, namely restoration, rehabilitation, and remediation.

SPREADING THE WORD AROUND

Apart from being eloquent and spreading the message on the importance of soil remediation and the work done by KERP in bringing back a greener Kuwait across the social arena KOC SRG have been featured and applauded for their ceaseless proactivity, in different publications in house, and local. The following pages will display few of those samples of those accolades and laurels received.

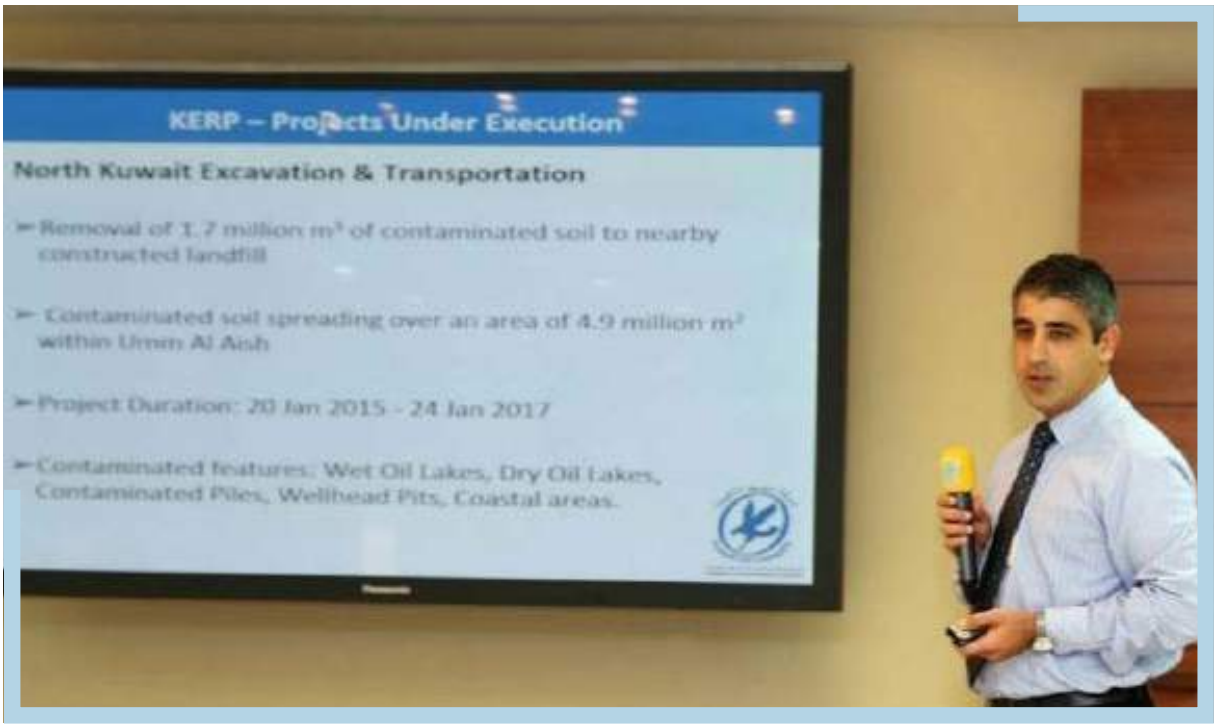


Figure 8.15 KOC Technical Presentation Kick-off meeting 2015

Soil Remediation Group Meeting

Al-Fodari: We appreciate efficiency

In the presence of Group Manager Mohammed Al-Fodari, the Soil Remediation Group held a meeting in the presence of Team Leaders Faris Al-Mansouri, Dhari Al-Gharabally and Mansour Al-Khariji. During the meeting, the Group Manager listened to a detailed explanation of the current and future projects undertaken by the group.

The most important projects being implemented by the group which were discussed included the Kuwait Environmental Remediation Program (KERP) which is meant for the remediation of contaminated soil since the Iraqi invasion of Kuwait in 1990, and the Sustainable Environmental Economic Development (SEED) Project for remediation of soil affected by KOC operations. The latter project covers 25 sites and continues for a period of two years.

They also discussed the group's expansion strategy in the coming years in order to serve the Company's operations and achieve sustainable development of the environment in Kuwait.

Several discussions took place during the meeting, which witnessed presentations by members of the group on the current projects. The Group Director urged teams to complete projects on time with the required efficiency, stressing that the group shoulders great responsibility of remediation of soil in order to preserve the environment and address the environmental impacts of the production processes.

ENERGY - 28th April 2013

Land Remediation Group Visits KGOC-Saudi Chevron Zone

Visit aims to educate staff on soil remediation efforts

The Land Remediation Group recently conducted a field visit to the KGOC-Saudi Chevron Joint Operations Zone in Wafra in order to become familiar with efforts geared toward remediating the soil damaged by oil operations.

Kuwait Gulf Oil Company officials made a visual presentation which detailed the actions and projects carried out in order to remediate the damaged soil. This was followed by a tour of the affected areas.

Toward the end of the visit, Team Leader Land Remediation (II) Fares Al-Mansouri expressed gratitude to Joint Operations Manager Shabeeb Al-Ajmi, Team Leader for Main Gathering Center Salam Al-Mufti, Team Leader for Major Projects in Wafra Ali Al-Abdullah, as well as Chevron and Joint Operations employees for their cooperation and hospitality.

ENERGY - 1st September 2013

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Honoring

Export Operations Group Honors Employees

5

Sports

KOC Soccer Team Resumes Activities

7

Campaign

KOC Launches 2nd Environmental Campaign

8

KOC Signs Contract with Combined Group Contracting Co.

Construction of Landfill Facilities for Contaminated Soil in NK

KOC recently signed a contract with Combined Group Contracting Co. for the Construction of Landfill Facilities for Hydrocarbon Contaminated Soils in North Kuwait (Group B).

The contract was signed by CEO Hashem S. Hashem on behalf of KOC and Combined Group Contracting CEO Sulaiman Abdul Rahman Al-Marouf signed on behalf of his company.

Representatives and top officials from KOC, Kuwait National Focal Point (KNFP), Kuwait Institute for Scientific Research (KISR), Soil Remediation Group, and AMEC were in attendance for this significant ceremony.

The Kuwait Environmental Remediation Program (KERP) is a large-scale Environmental Remediation and Restoration Project with high visibility and importance on both a local and international level. It is under the direction of the KOC Soil Remediation Group.

2014 WORLD ENVIRONMENT DAY

KOC SRG invites other KOC officials, group contractors and other stakeholders to com- memorate world Environment Day 2014 The even got covered by KOC Energy news.

KOC Starts Soil Remediation

Biggest project of its kind in Middle East

Coinciding with World Environment Day, Soil Remediation Group invited a number of representatives from consulting offices, and a group of contractors and representatives from EPA and Kuwait National Focal Point, to visit the landfill site, which was established within the Directorate south and east of Kuwait to contain soil treatment.

Attendees included Team Leader Soil Remediation Projects 2, Mohsen Al-Shammari, and a number of officials, in addition to about 10 engineers from various disciplines with the company.

The first phase of the project, which is the largest of its kind in the Middle East, includes opening a pit area ranging between 500-700 square meters, and transferring the treated soil that had been contaminated by oil lakes, through excavators.

The pit will be established within oblique walls of 60-degree angles, and a depth to be determined after the preview, but will range between 10, 12 and 20 meters, before transferring 250 cubic meters of treated soil to fill the hole, covering it and cultivating the surface layer after that.

The remaining contaminated soil will follow another program that may include pulling oil, washing, thermal processing, or removing bacteria.

The oil lakes formed after burning wells during the invasion. There were 790 wells spilling oil to the neighboring areas of northern, southern and eastern Kuwait, and the lakes widened due to erosion and sand encroachment.

ENERGY - 24th August 2014

LANDFILL SITE VISIT

The UNCC and KNFP visited one of the two land fill sites for KERP to evaluate the construction Progress This event was covered by KOC Energy News.

Soil Remediation Group Hosts Visiting Delegation

Site visit to landfill construction site and Guest House

The Soil Remediation Group recently organized a meeting at the Guest House and a site visit to a landfill construction site in South Kuwait for United Nations Advisory Panel members and Kuwait National Focal Point (KNFP) personnel. KNFP is the governing body of the Kuwait Environmental Remediation Program (KERP) and the purpose of the visit was to assess the progress of the program.

DCEO Ismail Abdullah and Team Leader Soil Remediation Projects II Mohsen Al-Shammari, along with other Group members, attended the opening meeting. A discussion regarding the progress of KERP was held, followed by a presentation about the landfill from Eng. Reem Al-Othman from Soil Remediation Projects II.

The meeting at the Guest House was followed by a site visit to the landfill construction site, where TL Al-Shammari explained the design concept and ongoing construction activities. The delegation was then returned to the Guest House and was given a presentation about "Total Remedial Solution (TRS) Strategy," which was followed by discussions about KERP.

ENERGY - 26th October 2014

KERP WORKSHOP BY SRG

A three-day workshop was organized by Soil Remediation Group of KOC which was attended by international companies discussing on latest soil remediation technologies in preparation for their upcoming soil remediation projects. The event was attended by more than 200 persons from 70 companies this event was covered by KOC Energy newsletter.

Soil Remediation Group Organizes KERP Workshop

More than 200 individuals participate

The Soil Remediation Group recently organized a three-day workshop attended by international companies specialized in soil remediation in order to exchange information in preparation for the application of soil treatment technologies.

More than 200 individuals from 70 companies participated in the workshop, and representatives were briefed on the details of the Kuwait Environment Remediation Program (KERP), which is one of the largest projects of its kind in the world. Attendants received samples of the soil to study in their laboratories in preparation for a meeting before submitting the bids for the related tenders.

During the workshop, Manager Soil Remediation, Waleed Al-Shuaib, presented an overview of the KERP Project with the participation of Acting Secretary General of the Kuwait National Focal Point, Naheel Al-Abdulrazzak. Individual meetings were held on the sidelines of the workshop between contractors and eight committees comprised of relevant staff from the Company, particularly from the Soil Remediation Support Team headed by Dhari Al-Gharabally, as well as from the Project Management Consultant (PMC).




ENERGY - 22nd February 2015

SIGNING OF MOU FOR NK LANDFILL

The Landfill Construction and disposal of Oil contamination in North Kuwait was contracted to Al-Ghanim International and the MOU regarding this was signed. The event was featured in KOC energy newsletter 2015 February issue.

KOC Signs MoU with Al-Ghanim International

Agreement falls under framework of KOC's environmental efforts

KOC recently signed a Memorandum (MoU) of Understanding with Al-Ghanim International General Trading and Contracting Company for the transport and burial of oil-polluted materials to landfills in North Kuwait. The memo also maintains that Al-Ghanim will conduct geophysical seismic studies to identify and remove unexploded ordinance from oil lakes, trenches and coastal sites.

KOC's Chief Executive Officer Hashem Hashem and Al-Ghanim's International Chairman of the Board of Directors, Tareq Issa, signed the MoU in an event attended by Deputy Chief Executives and officials from both companies.

The project comes within the framework of efforts aimed at meeting the demands of the United Nations' Compensations Committee to rehabilitate the environment in Kuwait and from the repercussions of Iraq's 1990/91 invasion, all while avoiding any impact on KOC's oil fields. It also aims at having a sustained program to develop and improve the Company's facilities through best practices.


ENERGY - 22nd February 2015

CELEBRATION OF FIRST PHASE OF SEK LANDFILL CONSTRUCTION IN 2015

KOC Soil Remediation Group celebrated the completion of the first phase of SEK landfill to contain oil contaminated soil under the KERP Program. This event was reported in KOC Energy newsletter.

Soil Remediation Group Celebrates Completion of Construction

Of first phase of contaminated soil landfill

As part of its effort to protect Kuwait's environment, the Soil Remediation Group recently celebrated the completion of the first phase of construction for a landfill devoted to contaminated soil. The project, located in Kuwait's southeast, falls under the Kuwaiti rehabilitation program for affected environments of the 1990 invasion that saw the damage and burning of hundreds of oil wells.

DCEO (WK) Hassan Bunain, General Manager of Kuwait EPA Sheikh Abdulla Ahmad Al-Homoud Al-Sabah and his deputies, delegates from UNCC, members of KNFP and a number of Managers, Team Leaders, staff, employees and contractors attended the celebration.

DCEO Corporate Services Ismail Abdulla and his guests visited the site, where he thanked those involved for their efforts in completing the project on time, which is the biggest of its kind in the Middle East.

ENERGY - 19th April 2015

A MEETING FOR IN-HOUSE ENLIGHTENMENT

KOC Soil Remediation Group conducted a meeting for other KOC Teams to enlighten them on the magnitude and relevance of work handled by the group. This event was covered by KOC Newsletter Energy in November 2015.

Soil Remediation Group Organizes Meeting

Group provided overview of the work it conducts

The Soil Remediation Group recently organized a meeting for all departments that are involved with the Company's soil remediation efforts. The aim of the meeting was to explain the nature of the Group's role and inform the audience of the projects that are currently being implemented. The meeting also highlighted the achievements that have already been accomplished and what other Teams throughout the Company can do to cooperate on ongoing or future efforts.

Group Manager Waleed Al-Shuaib spoke at the event. In addition, Team Leader Soil Remediation Support Dhari Al-Gharabally, Team Leader Soil Remediation Projects – I Mansour Al-Khareji, and Team Leader Soil Remediation Projects – II Muthanna Al-Mumin also spoke during the meeting.

Attendees were informed that the Group had completed the planning phase for its projects and began the implementation phase, where it currently has three projects underway. The Group was founded in 2012 and tasked with remediating contaminated soil from the 1990 invasion, in addition to soil affected by Company operations.

During the event, Al-Shuaib upheld the determination of his Group to cooperate with the various departments of the Company. The Group is currently working on restoring Kuwait's soil in cooperation with the Kuwait National Focal Point. So far, the Group has established two landfills that will contain the contaminated soil in a safe and efficient manner.

ENERGY - 8th November 2015

AN ARTICLE ON BIO REMEDIATION FROM SRG

Many articles by talented engineers from KOC Soil Remediation Group were published in several publications both local and international. An example of such an article about bioremediation was featured in Al- Kuwaiti magazine in 2017.

التربة تسهم بشكل كبير في الحد من انبعاثات الغازات الضارة، كما تعد مصدرا أساسيا للغذاء

أنشأت الشركة مجموعة تأهيل التربة في عام 2012 للاهتمام بالتربة والمحافظة عليها من التلوث

مجموعة متخصصة

في عام 2010، وقعت الشركة مذكرة تفاهم مع نقطة الارتباط الكويتية حول توزيع المسؤوليات في برنامج إعادة تأهيل البيئة الكويتية الذي يتم مع الأمم المتحدة، وذلك لمعالجة مسألة التربة الملوثة من مخلفات الغزو في عام 1990. وبناء على ذلك أعطت الشركة الموافقة على بدء العمل وتنفيذ الخطط الخاصة

ولتتويجاً لتلك الجهود أنشأت الشركة في عام 2012 مجموعة تأهيل التربة التي تضم عدداً من الفرق التي يدور محور عملها الأساسي والفعال حول الاهتمام بالتربة والمحافظة عليها من التلوث واستحداث النظم العلمية والعملية لتحقيق الهدف المرجو من تلك الفرق والمتمثل في وضع الآليات والطرق المثلى لمعالجتها.

وتوالت بعد ذلك الجهود البيئية الحثيثة التي تبذلها شركة نفط الكويت بهدف الحفاظ على البيئة الكويتية عبر الحملات والمبادرات البيئية المختلفة والمتنوعة التي تحرص على إقامتها سنوياً خاصة في ظل ارتباط التربة الوثيق

والهام بمجال النفط والغاز.

ويأتي هذا الاهتمام البالغ بالتربة نتيجة ما قد تحدثه في بعض الأحيان عمليات البحث والتنقيب عن النفط، حيث نجحت الشركة من خلال المجموعة باستحداث وتدشين العديد من المشاريع النوعية التي من شأنها أن تخلق التوازن البيئي عبر إعادة تأهيل التربة ومعالجتها من الملوثات والعمل على

إعادة استصلاحها وزراعتها بعد التخلص من المواد الضارة البيئة منها

مهام رئيسية

وتعتمد مهام المجموعة على محورين أو فرعين أساسين كمحدد أساسي لأعمالها، يتعلق المحور الأول بمعالجة التربة من التلوث الناجم عن الغزو العراقي للكويت، حيث وضعت

APPRECIATION FROM EPA

KOC SRG Personnel, Mr. Muthanna Al-Momin, Team Leader SRP-II and Ms. Aisha Al-Barood Senior Environment Engineer SRS was acknowledged by Environment Public Authority for their Contribution and participation in an interview International Documentary Film entitled "The Environmental Saga" in collaboration with Kuwait Environment Protection Society and Ministry of Information. This news, as published in KEPA Magazine Al- Biya is given here.

ملف العدد

تولى وكيل وزارة الاعلام السيد/ طارق المزرم مهمة تكريم «الملحمة البيئية» ممثلة اول مبادرة في الشراكة البيئية في حملة التعريف بالسادس من نوفمبر

عدد خاص

فيلم «الملحمة البيئية»

● وسام الاعلام البيئي للمخرج عبدالرضا الرامزي

عرضت الجمعية الكويتية لحماية البيئة (الملحمة البيئية) الذي وثق مراحل إحراق آبار النفط الكويتية والتعديات على كافة مرافق الدولة من قبل الاحتلال العراقي الغاشم.

وأكدت رئيسة الجمعية وجدان العقاب ان الفيلم التوثيقي (الملحمة البيئية) الذي أعده وأخرجه مركز الاعلام والتوثيق البيئي بحماية البيئة جسد كافة مراحل وتأثيرات الاحتلال العراقي الغاشم لدولة الكويت، مبينة ان فريق عمل الفيلم حرص على تناول وعرض تأثيرات الحرب على كافة مرافق الدولة من موائل بيئية وطبيعية فضلا عن إشعال آبار النفط من قبل جنود الاحتلال العراقي.

وأشارت العقاب إلى جدارة الفيلم بحصول مخرجه على وسام الاعلام البيئي في إطار الحملة السنوية التي أطلقتها الجمعية الكويتية لحماية البيئة للتعريف باليوم الدولي لمنع استخدام البيئة في الحروب والنزاعات العسكرية.

وأوضحت رئيسة جمعية حماية البيئة أن الفيلم يتناول من خلال العديد من القيادين في الدولة كل حسب مجاله واختصاصه الآثار الناجمة عن انتهاك الآليات العسكرية العراقية للبيئة في الكويت فضلا عن إشعالها لآبار النفط مخلفة وراءها واحدة من أعظم الكوارث البيئية في العالم بالاضافة إلى محطات الكهرباء والمياه والمنشآت العامة والخاصة في البلاد.

وأضافت وجدان العقاب: "فيلم الملحمة البيئية يتناول التجاوزات

● م. محمد بوشهري

● والرامزي مشملها درعا تكريمية

البيئية الصارخة على البيئة الكويتية برا وبحرا وجوا ابان التعديات العسكرية التي حدثت عام 1991 والتي بدات بزرع الالغام واشعال الابار وسكب كميات هائلة من النفط الخام في البيئة البحرية وهي تعد واحدة من اكبر الكوارث البيئية في العصر الحديث الامر الذي كان لابد من متابعته على الصعيد المحلي بجهود ابناء الكويت الاوفياء الذين لم يتوانوا في حماية هذه الارض الطيبة وتسجيل الملحمة البيئية تلك الجهود على كافة الاصعدة في دولة الكويت والتي ساهمت بشكل كبير في الصحو التنمية في هذه الدولة الصغيرة التي تقدم للعالم دروس في النهضة والكفاح" ●

● د. علي العمير

● د. محمد الأحمد

دروع لفيلم «الملحمة البيئية»

منحت الجمعية الكويتية لحماية البيئة «وسام الاعلام البيئي» لمخرج فيلم «الملحمة البيئية» عبدالرضا الرامزي، بالاضافة إلى فريق عمل الفيلم والمشاركين فيه من قيادات الدولة تم منحهم دروعا تكريمية خاصة.

القيادات المشاركة في الفيلم

1. **محمد بوشهري**
وكيل وزارة الكهرباء والماء.
2. د. علي صالح العمير
وزير النفط ورئيس المجلس الأعلى للبيئة بالإنابة سابقاً.
3- د.محمد داود الأحمد
نائب المدير العام لشئون الرقابة البيئية- الهيئة العامة للبيئة
4. م.محمد محسن العنزي
نائب المدير العام للشئون الفنية- الهيئة العامة للبيئة
5. سعد عبدالوهاب السعد
المستشار الفني للمشروع- نقطة الارتباط الكويتية لمشاريع البيئة
6. م.منى علي المؤمن
رئيس فريق مشاريع تأهيل التربة- شركة نفط الكويت
7. م.عائشة صالح البارود- كبيرة مهندسي البيئة- شركة نفط الكويت
8. وجدان العقاب- رئيس مجلس الإدارة

فريق العمل

9. محمود شهاب - توثيق الحياة الفطرية
10. عمار الجريوي- توثيق الحياة الفطرية
11. محمد خورشيد- توثيق الحياة الفطرية
12. عودة الدالي- توثيق الحياة الفطرية
13. عبدالعزيز اليوسف- توثيق الحياة الفطرية
14. حمود الشايجي- توثيق الحياة الفطرية
15. جاسم الفيلكاوي- فريق الغوص التابع للجمعية
16. جنان رضا بهزاد- الأمين العام
17. العميد/ جاسم الحساوي
مجلس الوزراء- لجنة تأهيل ومتابعة القرارات الأمنية- لجنة تأهيل مواقع ردم النفايات
18. الإعلامي/ يوسف مصطفى
19. د.سارة العتيقي
20. محمد المصري- تلفزيون الكويت
21. محمد شبكوه- تلفزيون الكويت
22. فهد العنزي- تلفزيون الكويت
23. سعيد منعه- تلفزيون الكويت
24. هاني الوزان- تعليق ●

● م. محمد العنزي

● الإعلامي يوسف مصطفى

● م. منى المؤمن

● العميد متقاعد جاسم الحساوي

● عائشة البارود

390 ALBIYA - Environment - November 2017

SRG PRESENTATION IN TEXAS

A presentation on "Comparison of site characterisation of contaminated soil in south and East oil fields" was given by KOC SRG Personnel, Ms. Aisha Al-Barood Senior Engineer SRS in the 24th International Petroleum Environmental Conference (IPEC) held in San Antonio Texas. This achievement was covered by Kuwaiti Digest Jan- March 2018 issue.

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KERP: COMPARISON OF SITE CHARACTERIZATION OF CONTAMINATED SOIL IN S&EK FIELDS

SUBMITTED BY THE SOIL REMEDIATION GROUP

The 24th International Petroleum Environmental Conference (IPEC) was held recently in San Antonio, Texas, where Aisha Al-Barrud, Senior Environment Engineer from the Soil Remediation Support Team presented an overview of the "Comparison of Site Characterization of Contaminated Soil in South and East Oil Fields" study over different decades under the Kuwait Environmental Remediation Project (KERP).

During the presentation, Al-Barood delivered information related to the Gulf War and the damage that was inflicted on oil wells and associated infrastructure in Kuwait's oil fields, which resulted in the release of large volumes of crude oil into the environment, affecting approximately 114 square kilometers of the desert terrain. The environmental damage resulted in airborne deposition of crude oil, overland flow of crude oil and the formation of medium to large wet oil lakes with variable thickness. Characteristics of oil lakes and soil piles varied in type, area, volume, and depth of oil penetration.

Wet oil lakes are areas covered with black liquid (highly weathered oil) and semi-solid oil saturated material resulting from oil flow from damaged wells. Wet oil lakes occur in areas where large liquid oil accumulated because of the local topography and micro relief. Soil investigations revealed that the average depth of oil contamination in the wet contaminated areas is approximately 65m below surface grades. Sludge material has been found to contain mean TPH concentrations in excess of 19%. The underlying contaminated soil is found to contain a mean TPH concentration of 3.4%.

Dry oil lakes are areas covered with a thin and moderately hard dry black tar layer. Dry oil lakes are generally found in shallow depressions and /or flat areas. Dry contamination areas cover more area of the desert, with an average mean depth of approximately 27m

Aisha Al-Barrud, Senior Environment Engineer

Kuwaiti Digest - January - February - March 2018

MAKING A MARK OVERSEAS

In 2018 KOC SRG could participate in in the Global Conference on Engineering and Applied Science (GCEAS) in Tokyo, Japan In which Senior Environment Engineer from SRG group, Ms. Aisha Al-Baroud Presented an over view of the remediation strategy of oil contaminated soils in North Kuwait Oil Fields under KERP This news was featured in KOC NEWS on its August 2018 issue.

KOC Takes Part in GCEAS

KOC discussed soil remediation and KERP at the event in Tokyo

KOC recently took part in the 2018 Global Conference on Engineering and Applied Science (GCEAS) in Tokyo, Japan, where Aisha Al-Baroud, Senior Environment Engineer, Soil Remediation Support Team, presented an overview of the remediation strategy of oil contaminated soils in North Kuwait oil fields under the Kuwait Environmental Remediation Project (KERP).

During the presentation, Al-Baroud delivered information related to the Gulf War and the damage inflicted on oil wells and associated infrastructure in Kuwait's oilfields, which resulted in the release of a large volume of crude oil into the environment and affected approximately 114 square kilometers of the desert terrain.

The objectives of this remediation project is to clear land for field development and treat all the oil contaminated areas through a total remediation solution plan. This will optimize the treatment processes and minimize the volume of contaminated materials to be placed into landfills by using biological, chemical and physical treatment technologies, treating approximately 4 million cubic meters of soil in the process under the UNCC directives by utilizing an environmentally sustainable approach.

KOC NEWS - 26th August 2018

CONFERENCE IN SPAIN

In 2018 August KOC SRG participated 4th World Congress on New Technologies (ICEPR 2018 NewTech'18), Senior Engineer Reem Al- Othman of SRS presented " - The Remediation of Oil Contaminated Soil in Kuwait."

Conference In Spain - 19th August 2018

PROGRESS REVIEW VISIT BY UNCC

KOC Soil remediation group's progress in its KERP Project was reviewed by UNCC and KNFP delegation. This visit and review were reported as above in 2019 May issue of KOC NEWS.

KOC Receives UNCC Delegation

Progress of the Kuwait Environment Remediation Program was reviewed

KOC, represented by the Soil Remediation Group, recently received a delegation from the United Nations Compensation Commission (UNCC). The delegation was also accompanied by members from the Kuwait National Focal Point (KNFP).

Manager Soil Remediation Mansour Al-Khareji, TL Soil Remediation Support Nada Al-Qallaf and TL Soil Remediation Projects II Muthanna Al-Momin received the delegation at the Ahmadi Guest House.

The visit aimed to follow up on the progress of the projects of the Kuwait Environmental Remediation Program (KERP), whose goal is to rehabilitate areas affected by the invasion of 1990/91. The latest progress associated with the program was reviewed, including the Unexploded Ordnance Project and the rehabilitation of oil lakes in North and South Kuwait. They also discussed future projects that will be implemented in both North and South Kuwait.

KOC NEWS - 12th May 2019

KERP FORUM

2019 July marked a major event for KERP and Soil Remediation Group A grand Forum for Kuwait Environmental remediation Program was held in Jumeirah Hotel in Kuwait Offered a chance for various organizations and individuals to learn more about the program as well as a chance for various businesses to demonstrate their environmental rehabilitation strategies and methodologies. This successful feat was covered elaborately as given here and in following pages by KOC News in July 2019.

KOC NEWS

34th Year - No. 784
14th July 2019

The KOC Newsletter

KOC News is a fortnightly newsletter published by the KOC Information Team for KOC employees • Editor-in-Chief: Qusai Naser Al-Amer • E-mail: kocinfo@kockw.com • Website: www.kockw.com

Instagram - kocofficial

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KOC Hosts Kuwait Environmental Remediation Program Forum

Event was held to share knowledge, raise awareness, and establish communication

KOC, represented by the Soil Remediation Group, recently hosted the Kuwait Environmental Remediation Program Forum at the Jumeirah Messilah Beach Hotel. The event was held under the patronage of the Minister of Oil and Minister of Electricity & Water Dr. Khaled Ali Al-Fadhel, and KOC CEO Emad Mahmoud Sultan. The event was held in cooperation with participating parties involved with KERP, which is the largest soil remediation project of its kind in the world.

The forum aimed to provide relevant information to individuals and organizations wishing to learn more about KERP. It also included the exchange of plans and strategies related to soil remediation, in addition to providing an opportunity for communication with contractors and other specialists involved with the project. It also established new communication channels, as well as developing and strengthening successful multiple-disciplinary task forces.

The event included speeches and presentations from individuals who have contributed to KERP, including a speech from KOC CEO Emad Sultan, who said that the various projects within the program demonstrated the Company's continued commitment to the environment, health, and safety.

In addition to the presentations, a video was also screened which provided an overview of this massive and pioneering project. This was followed by a panel discussion which focused on the various ways to ensure the best results were obtained in terms of soil remediation and environmental rehabilitation.

An exhibition accompanied the forum, where various companies and organizations were provided with an opportunity to present their techniques and methods used for rehabilitation efforts. KOC DCEOs, Group Managers, Team Leaders, KERP representatives, and a number of ambassadors based in Kuwait attended the forum.

KOC NEWS - 14th July 2019

منتدى برنامج الكويت لمشاريع إعادة تأهيل البيئة

KOC Hosts Kuwait Environmental Remediation Program Forum

KOC NEWS - 14th July 2019

KOC Marks 28th Anniversary of the Last Burning Oil Well

Event held in cooperation with the Kuwait Environment Protection Society

KOC recently marked the 28th anniversary of the extinguishment of the last burning oil well through two events featuring a large ceremony and exhibition.

Under the patronage of KOC CEO Emad Mahmoud Sultan, and in cooperation with the Kuwait Environment Protection Society, the Company organized the event at the Four Seasons Hotel. During the event, the CEO delivered a speech in which he highlighted the efforts of the heroes of the Kuwaiti Fire Team and their achievements in extinguishing a large number of burning wells in record time.

Team Leader Soil Remediation Projects (II) Muthanna Al-Momin delivered a presentation in which he listed the accomplishments of the Soil Remediation Group. Two short films were then screened, one of which included an interview with members from the Kuwait National Focal Point.

In addition, a book titled "Restoring the Nature of Kuwait" was launched during the ceremony. The book is the result of a collaborative partnership between KOC and the Kuwait Institute for Scientific Research. It details the enormous efforts made by the Company to remediate Kuwait's environment after the invasion.

At the closing of the ceremony, a film was screened which focused on the efforts of the late Kuwaiti Minister of Health, Dr. Abdul Rahman Al-Awadhi, in the field of environmental protection.

The second event included the establishment of a booth at the Avenues Mall which commemorated the anniversary in an innovative way. The booth included two large screens through which an interactive game was displayed for children to play. The game mimicked the efforts of the firefighters in extinguishing the oil well fires, clearing mines, and stopping oil spills. The booth also included a window in which the clothes and tools of the firefighters at the time were displayed.

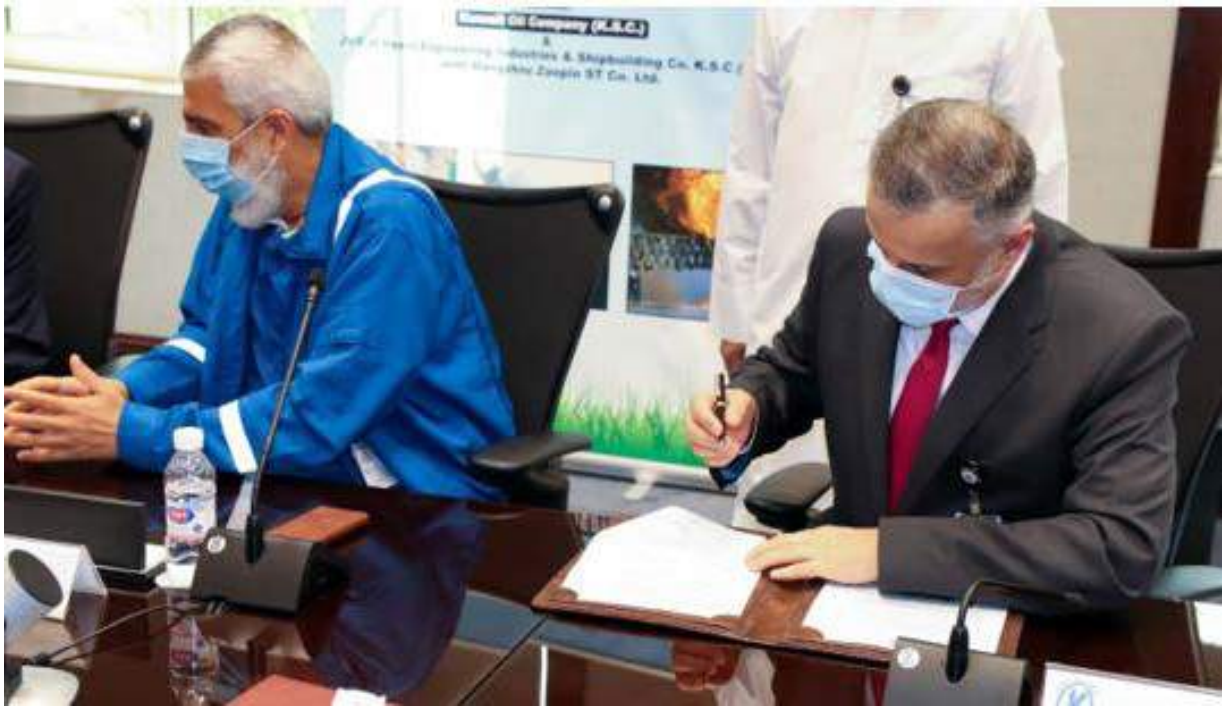
KOC NEWS - 24th November 2019

28TH ANNIVERSARY OF LAST BURNING OIL WELL

2019 November 6th KOC- SRG team participated in the event presenting about KOC-KERP Journey.
This was featured in KOC NEWS 24th November 2019 issue.

NKETR &SKETR SIGNING CEREMONY

July 2021 Marked a major milestone for Kuwait Environmental Remediation Program 5 Mega projects of KERP were signed then.



NKETR and SKETR Signing Ceremonies - July 2021

NKETR and SKETR Signing Ceremonies - July 2021

NKETR &SKETR KICK OFF MEETINGS

As Soon as the Projects were signed in July and August 2021 kick off meetings for all the 5 projects were conducted in the Auditorium of Ahmadi Mega Complex as the official start of the projects. Here are some glimpses from the event.

NKETR and SKETR Kickoff Meetings - July - August 2021

NKETR and SKETR Kickoff Meetings - July - August 2021

ARTICLE ON MP&TSD

Soil Remediation Group was featured in MP&TSD e-Bulletin for the Market Research Study done for Green House construction for Revegetation projects.

Projects Support Services Group

Industrial Services Group

HSSE Initiatives & Achievements for MP&TSD Groups with Support & cooperation of Q&HSE Team

Soil Remediation Group, HSSE Campaigns, Promotions

Local Market Study for Greenhouse Construction for Revegetation Projects in SEK & NK Fields

Kuwait Oil Company (KOC) is implementing probably the world's largest revegetation projects in Kuwait as part of Kuwait Environment Remediation Program (KERP). These projects require huge number of native plants produced under greenhouse conditions. For this purpose, KOC intends to construct selected greenhouse facilities for native plant production at its premises to propagate native plants for future revegetation in SEK & NK areas. In order to select from the greenhouse covering material to be glaze glass or polycarbonate that are capable of maintaining the climatic conditions (temperature, humidity, light and others),. Soil Remediation Group (SRG) conducted a local market survey to assess the availability of professional greenhouse construction companies that can provide greenhouse construction, operation, and maintenance services in Kuwait. The main objective of this survey to determine the availability of materials and accessories required for Glazed Glass material and/ or Polycarbonate material for greenhouse construction, aftercare and maintenance services in Kuwait market. The specific questionnaire for market survey was prepared and shared with companies prequalified by Public Agriculture and Fisher (PAAF).

MP&TSD e-Bulletin - Issues No.24 - Quarter 1 FY22/23 (April / May / June)

KOC Celebrates KERP Environment Day

Officials from KOC and HEISCO took part in the event

Under the patronage of Acting KOC CEO Khaled Al-Otaibi, the Soil Remediation Group recently organized and celebrated an Environment Day which recognized the work associated with the Kuwait Environmental Remediation Program (KERP). The event was held in cooperation with the project contractor, HEISCO.

The event, which was held at the Ahmad Al-Jaber Oil & Gas Exhibition, was attended by a number of DCEOs and officials from the Ministry of Defense, the Kuwait National Focal Point for Environmental Projects, the Environment Public Authority, and the Kuwait Institute for Scientific Research. Faculty members from Kuwait University, KOC employees, and the Chairman of the Board of Directors of HEISCO Kuwait, Marzouq Al-Kharafi, were also in attendance.

During the event, Al-Otaibi delivered a speech in which he recalled the environmental disaster associated with setting fire to more than 700 oil wells during the invasion. He maintained that KOC has made significant achievements in rehabilitating the environment and will continue to do so.

Meanwhile, HEISCO Kuwait Chairman Marzouq Al-Kharafi also delivered a speech and expressed his admiration for the exceptional efforts put forth by KOC and the Kuwait National Focal Point which aim to repair the environmental damage that resulted from the invasion.

The event included an introduction to the Kuwait Environmental Remediation Program, a presentation on bioremediation and soil washing technology, as well as other projects signed last year within the program. This includes five contracts for soil remediation within KOC's areas of operation, with two contracts in North Kuwait and three contracts in South and East Kuwait which aim to treat an estimated 13 million cubic meters of contaminated soil in the Company's fields.

KOC NEWS - 10th July 2022

WORLD ENVIRONMENT DAY

As per the 5 mega contracts, each contractor has to conduct an annual event for progress update and knowledge sharing The first among this was conducted on June 9th, 2022, at Ahmad Al- Jaber Exhibition centre by SKETR Zone 2 contractor HEISCO along with their remediation partner Hangzhou Zaopin This event was covered by different publications as portrayed here.

KOC Celebrates KERP Environment Day

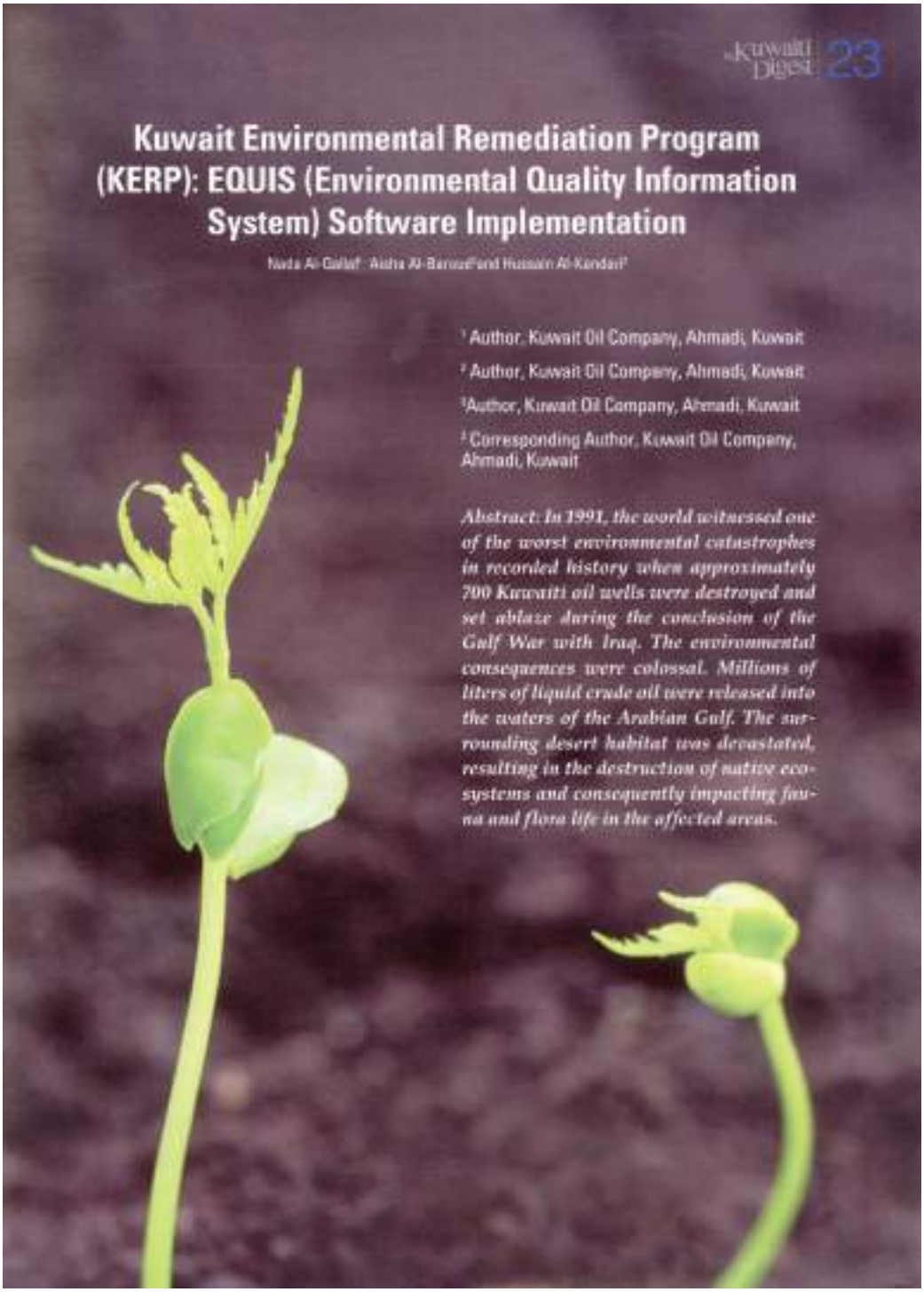
KOC NEWS - 10th July 2022

المعالجة البيولوجية وغسل التربة..
نحو بيئة نظيفة وصحية

Al-Kuwaiti – July 2022

ARTICLE ON KERP EQUIS

An Article on KERP 's Software for Environmental monitoring EQUIS was published in Kuwaiti digest magazine Jul- Sep- 2022.



Kuwaiti Digest - July - August - September 2022

UNCC DELEGATION VISIT

The UNCC delegates regularly make their quarterly visits to KOC Soil Remediation Group for the following up KERP Projects and evaluating its progress. These events are duly covered and propagandized in the KOC News bulletins. This article features the UNCC Visit conducted in August 2022.

UN Environmental Compensation Committee Delegation Visits KOC

Visiting delegation conducted a field tour to inspect progress of bioremediation efforts

The Soil Remediation Group recently organized a field inspection tour for a delegation from the advisory team of the United Nations Environmental Compensation Committee.

During the tour, team members visited one of the sites that has been designated to conduct preliminary experiments on different soil treatment methods in order to follow up on the progress of bioremediation work that is being conducted in the field.

The delegation was accompanied by Manager Soil Remediation Group Sami Al-Yaqout, TL Soil Remediation Projects Team (l) Najeeb Al-Zaid, representative of the Kuwait National Focal Point Zaki Nusseibeh, Senior Project and Environmental Engineers from the Soil Remediation Group, and representatives from the Worley consulting company.

At the end of the tour, the delegation held a meeting in the VIP Hall of the Ahmad Al-Jaber Oil & Gas Exhibition with Company officials, where they were briefed on the progress of the projects being implemented, the progress that has been made, and future projects.

KOC NEWS - 7th August 2022

KEPS HOURNERD KOC STAFF & KERP LEADERS ON NOVEMBER 6TH EVENT

Kuwait Environmental Protection Society (KEPS) honored KOC-SRG Staff for their active particiapation in remediation of contaminated soil in Kuwait. KOC SRG Manager Mr Sami Al- Yacoot, TL- SRP I Najeeb Al- Zaid, TL- SRP II Muthanna Al Mumin and senior senior Environment Engineer Aisha Al- Barood and memebers of KNFP were among the people who were honored during the function.

KOC hosts the 6th of November celebration

Organized by the Kuwait Environment Protection Society in cooperation with the Ministry of Foreign Affairs

KOC hosted the 6th of November Celebration of extinguishing the last oil well, and the International Day for Preventing the Exploitation of the Environment in War and Armed Conflict, which was organized by the Kuwait Environment Protection Society in cooperation with the Kuwaiti Ministry of Foreign Affairs under the slogan "In the wake of the oil disaster, is the rehabilitation of lands affected by oil pollution", at the Ahmed Al-Jaber Oil and Gas Exhibition in Ahmadi.

The ceremony was attended by Deputy Foreign Minister for International Organizations Affairs Counselor Abdulaziz Al-Jarallah, representative of the sponsor of the celebration, His Excellency the Minister of Foreign Affairs Sheikh Salem Abdullah Al-Jaber Al-Sabah, a number of ambassadors and diplomats to the State of Kuwait, representatives of Ministries, official bodies, and institution, UN organizations, and invited guests.

At the beginning of the celebration, Al-Jarallah gave a speech in which he stated that the adoption of the International Day by the United Nations was a Kuwaiti initiative, out of Kuwait's belief in the necessity of engraining the values of protecting the environment.

Team Leader Soil Remediation Projects-I Najeeb Al-Zaid, on behalf of Ag. CEO KOC Khalid Al-Otaibi, delivered a speech in which he thanked everyone who contributed to extinguishing the oil wells, recalling the heroism and sacrifices of the members of the teams that contributed to extinguishing the fires, and stressing the need to learn lessons from what took place.

Al-Zaid also touched on the Company's cooperation with a number of parties in the Environmental Remediation Program, and thanked them for their efforts.

This was followed by two speeches, from the Chairman of the Board of Directors of the Kuwait Environment Protection Society Dr. Wejdan Al-Uqab, and representative of the United Nations, Mazen Abul-Hassan.

Afterwards, Al-Zaid, Team Leader Soil Remediation Projects-II Muthanna Al-Mumin, Senior Environmental Engineer Aisha Al-Baroud, and Engineer Samira Al-Kandari from the Environment Public Authority, gave presentations on the rehabilitation of the environment, and the Environmental Engineers team of the Environment Authority was launched.

At the conclusion of the celebration, honorary shields were distributed to the participants, and a tour of the Ahmed Al Jaber Oil and Gas Exhibition was organized for them.

Al Kuwaiti News Magazaine – November 2022






YEAR	TECHNICAL PAPER PRESENTATIONS FROM KOC KERP
2022	Environmental Remediation Program (KERP): "Fresh Groundwater Risk Assessment from Tarcrete Material across the Raudhatain and Sabriyah Oil Fields, North Kuwait" Presented at Commemoration of World Environment Day under American Society of Safety Professionals- Kuwait Chapter. Kuwait Environmental Remediation Program – Overview Presented at the GPA - GCC Chapter	28th Annual Technical Conference, Exhibition & Workshops, Kuwait. Soil Remediation Trails and KERP Future Projects" Presented at Celebration of the International Day for the Prevention of the Use of the Environment in Wars and Military Conflicts, Kuwait. Kuwait Environmental Remediation Program - Revegetation Strategy and Ecological Monitoring" Presented at the Kuwait Sustainable Conference, Kuwait.
2021	Kuwait Environmental Remediation Program (KERP): Fresh Groundwater Risk Assessment from Tarcrete Material across the Raudhatain and Sabriyah Oil Fields, North Kuwait Presented at ICEPD 2021: International Conference on Environmental Planning and Development, London, United Kingdom.
2020	Kuwait Environmental Remediation Program (KERP) - Overview Presented at the 28th Annual Technical Conference of the GPA GCC Chapter, Kuwait.
2019	Southeast Kuwait Field FEED Works and Remediation Program Presented at the International Petroleum Environmental Conference (IPEC), San Antonio, Texas, USA.
2019	Kuwait Environmental Remediation Program (KERP): Roadmap to Benefits of Remediation Standard Revision Presented at the 512th International Conference on Science, Engineering & Technology (ICSET), Seoul, South Korea.
2019	KERP: Bioremediation in Southeast Kuwait Presented at the International Congress on Natural Sciences and Engineering, Fukuoka, Japan.
2018	The Remediation of Oil Contaminated Soil in Kuwait-Modern Environmental Science and Engineering, Presented in 24th World Congress on New Technologies (ICEPR 2018 NewTech'18) ,The Remediation of Oil Contaminated Soil in Kuwait" Madrid Spain.
2018	Kuwait Environmental Remediation Program (KERP) - Overview Presented at the Remediation Technologies Symposium, Alberta, Canada.
2018	KERP: Remediation Strategy of Oil Contaminated Soil in North Kuwait Presented at the Global Conference on Engineering and Applied Science (GCEAS), Tokyo, Japan.
2017	KERP: Analysis for Data in Southeast Kuwait 2003, 2014 and 2016 Presented at the 24th International Petroleum Environmental Conference, Texas, USA.
2017	Kuwait Environmental Remediation Program: Oil Lakes in Southeast Kuwait Presented at the 4th International Conference on Bioremediation and Sustainable Environmental Technologies, Florida, USA.
2016	KERP: Total Remediation Strategy (TRS) Presented at the 23rd International Petroleum Environmental Conference (IPEC), New Orleans, Louisiana, USA.
2016	Integrated Risk Management for large Soil Remediation under KERP projects 5th International Renewable Energy and Environment Conference (IREEC -2016) ,in MAdrid Spain.
2016	Overview of KERP Projects Presented at the "Enhancing Business Performance using Advanced Software Technology and Best Practices" Forum, Kuwait.

2015	An insight into KOC's Projects related to Kuwait Environment Remediation Program Presented at KPC's Hand in Hand for a Green Future Conference, Kuwait.
2014	KERP: Engineering Landfill Facilities Projects and Support Presented at the KPC Science and Technology in Society Forum, Kuwait.
2014	KERP's Unexploded Ordnance Strategy Presented at the International Conference on Computational and Experimental Science and Engineering, Antalya, Turkey.
2013	KERP: Remediation Demonstration Strategy International Conference on Engineering and Applied Sciences, Hong Kong.

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Chapter - 9

Words From State Officials & KERP Team

WORDS FROM STATE OFFICIALS & KERP TEAM

As we stand in the midst of this exciting KERP journey, we, the people behind this KERP team, are beaming with pride and satisfaction, because of the ways we have trodden. The fight we and our predecessors have fought is not small at all. This is exactly the reason why we considered it valuable and worthwhile to have few words from our KERP team members and ministry officials.

In the following pages, we have some messages from our KERP team, including current and past KOC Management, KOC Officials, KOC Senior Staff, PMC leaders, & Team Members etc. Along with this, some speeches by Ministry and KOC officials during different KERP events as published by newspapers are also included in this chapter.

"We can change our local community and work at large for the better through active cooperation towards a single goal or course."

KOC aims to continuously improve our operations and environmental initiatives through unified collaboration and teamwork. As part of this effort, the Major Projects and Technical Services directorate has been at the forefront of tapping into KOC human resources in order to motivate our employees to take charge of the effort to rehabilitate Kuwait's natural ecosystem through the Kuwait Environmental Remediation Program, KERP.

The underlying belief at the Major Projects and Technical Services directorate is that we can change our local community and work at large for the better through active cooperation towards a single goal or course.

In recent years, we have been increasingly focused on rehabilitating portions of Kuwait's natural environment which were devastated by the destruction inflicted during the invasion of 1990, to help restore our damaged environment.

I am proud to report that dedicated employees from our directorate have been instrumental in the collaborative effort with the United Nations to implement the world's largest Bioremediation project of its kind. Our employees have embodied the one team spirit which has been critical toward ensuring the Oil Lakes, Tarcrete, and other sources of contamination are properly rehabilitated and restored to their natural elements.

These efforts which are currently ongoing have proven to be resounding success, therefore I would like to commend and encourage all employees involved in this project to re-dedicate their efforts to ensure the total success of this landmark initiative for KOC and the state of Kuwait.

These efforts which are currently ongoing have proven to be resounding success.

Mr. Khalid Al-Otaibi

Ex-Deputy CEO

Major Projects &Technical Services Directorate

Kuwait Oil Company

"I am also immensely proud, thankful and consider myself fortunate to be a part of Soil Remediation Program"

When I was designated to be the manager of Soil Remediation Group, in 2020, I was so excited that I was once again becoming a part of a mission which seemed a far-fetched extension of something I was a part of in the beginning of my career.

I was the part of the team who extinguished the oil well fires long back in 1992 when I was just an enthusiastic young engineer who was new to Kuwait Oil Sector. That was such an unforgettable and enthralling experience, fighting with the horrifying and roaring fires day and night till achieving the final joy and triumph of extinguishing it. But once the fires are extinguished my country and the land looked devastated, drenched in oil smoke and soot I wondered how and when we are going to clean this mess and bring back the beauty and greenery our motherland.

Now years later, as I became a part of KOC SRG and KERP, it adds much sense and profoundness to my being, my profession and position. I am also immensely proud, thankful and consider myself fortunate to be a part of Soil Remediation Group and Kuwait Environment Remediation Program, targeting to clean the soil of Kuwait and to bring back the treasures.

I was once again becoming a part of a mission which seemed a far-fetched extension of something I was a part of in the beginning of my career.

Mr. Sami Al- Yaqout
Manager Soil Remediation Group
Kuwait Oil Company

"In life, we all strive to have purpose, to make an impression, to leave a foot print A foot print for for future generation to witness our part in the human journey, be it small or large, significant or insignificant.

Our KERP journey started with the heroes that preceded us, all the men and women that stood up and demanded to be counted. Starting with Kuwait's leadership; who due to their quick thinking and action, made decisions that ensured 1990/1991 oil fires are extinguished within record time, despite expert opinion who suggested that Kuwait will live under a black sky for 5 long years and the "Kuwait's wild well killers", Kuwait's men and women, both in the frontlines as well as those behind the scenes that would not submit to the environmental catastrophe; brave and foolhardy, entering the inferno and overpowering it; Like David against Goliath. The 'Kuwait's Wild Well Killers' dispatched an oil well fire within record time; a record which still stands and fighting the monster that is BG 160. Words do not do them justice, they entered the fray as novices, wet behind the ears surrounded by hardened veterans but left heads held high daring to stare into the abyss. The abyss that those hardened veterans dare not look when the dust settled and the smoke dissipated Kuwait was left with the largest man made Environmental disaster in living history.

Following by example, Kuwait's leadership, men and women proceeded to pick up the pieces and raised their grievances to the United Nations. After much sweat, blood and toil, in 2005 claims were awarded and United Nations Compensation Commission Governance Council Decision 258 was rolled out to create a clear and concise framework to manage the funds and to ensure its proper management.

From 2006 Kuwait National Focal Point was established to manage the Claims, to liaise with various stakeholders to ensure the proper execution of Kuwait Environmental Remediation Program from 2006 till 2012 plans were being formulated and communication channels were established to ensure proper execution of the required clean up; involving multiple stakeholders.

Kuwait Oil Company signed a memorandum of understanding in 2012 and commenced construction activities in 2013. Since 2013 and until today the Company has completed all works related to UNCC Claim 5000259 and UNCC Claim 5000450 element 2 and has recently (2021) awarded and commenced 5 of the largest if not the largest environmental remediation contracts committing more than 60% to the awarded funds towards remediation the damage caused a result of the oil well fires.

This is not the end, for we are on the cusp of obtaining offers for a final soil remediation tender which will conclude all contract awards for soil remediation related to Kuwait Environmental Remediation

I have nothing but thanks to Kuwait's Leadership, for their dedication in this great endeavor I thank Kuwait Oil Company for the opportunity to give meaning to what I do.

Program which will allow us to start Kuwait Oil Company's revegetation program in an effort to return Kuwait's ecosystem to a time before the oil fires.

Today, as I reflect on my personal journey in this great Odyssey, I can only be thankful for the opportunity to be a part of such a journey. I have nothing but thanks to Kuwait's Leadership, for their dedication in this great endeavor. I thank Kuwait Oil Company for the opportunity to give meaning to what I do, and in so doing I am availed the opportunity to give a little back to our planet in this small but not insignificant corner of the world. I thank KNFP for their trust and I thank Soil Remediation Group Staff, Project Management Consultants and Contractors for the collaboration to bring us to this present point in our journey.

I shall not list anyone's name, so as not to do injustice to those I forget to give mention to.

This is a journey we should all be very proud of and I think will stand the test of time.

When the dust settled and the smoke dissipated Kuwait was left with the largest man made environmental disaster in living history.

Mr. Muthanna Al-Momen

Team Leader

Soil Remediation Project II

Kuwait Oil Company

"The project has great international visibility too"

Kuwait Environmental Remediation Program is one of the most prestigious and vital programs as far as Kuwait's environment is concerned. The project has great international visibility too. Naturally I also felt fortunate to be a part of it when I got assigned as the Team leader of Soil Remediation Support Team under Soil Remediation Group. As I got involved with the project and learned about the challenges and hardships of the journey and it fascinated me further.

I feel that this initiative to record the KERP journey is a wonderful idea so that it serves as a record of the heroes who worked and still working for our Kuwait's soil and environment and motivating future generations of Kuwait to protect their environment, while adopting sustainable living.

Mr. Khalaf N.Hamada

Team Leader

Soil Remediation Support Team

Soil Remediation Group

Kuwait Oil Company

It serves as a record of the heroes who worked and still working for our Kuwait's soil and environment and motivating future generations of Kuwait to protect their environment, while adopting sustainable living.

"Upon completion of this phenomenal project, we hope to set a great example for future projects"

I became a part of KOC Soil Remediation Group in 2015 and initially my work area was in SEED projects. It was with great enthusiasm that I stepped into Kuwait Environmental Remediation Program (KERP) in 2021, as this project is closely linked with the history of my country and people. Now, as the Team leader of Soil Remediation project I, who oversees three zones in the current KERP Mega Projects, it has been an incredibly satisfying and exceptionally motivating experience.

Transformation from managing a Company funded project like SEED to a multi-stakeholder project like KERP that too in a leadership role throws an immense challenge of meeting the interest of various parties. We are keen on deploying sustainable & green technologies besides efficiently developing the national workforce transforming them into competent professionals who could take up further challenging projects in future. Upon completion of this phenomenal project, we hope to set a great example for future projects for the company and even for the region.

I wish that this book will serve as a record of KERP adventure and educating and inspiring the future generations of Kuwait to stand united to work forward for the sustainable progress of our motherland, Kuwait.

We are keen on deploying sustainable & green technologies besides efficiently developing the national workforce transforming them into competent professionals who could take up further challenging projects in future

Mr. Najeeb Al- Zaid

Team Leader Soil Remediation Projects I

Soil Remediation Group

Kuwait Oil Company

"There is an old Arabian proverb saying, "A tree starts with a seed" Which is very true in the case of KOC SRG" print For future generation to witness our part in the human journey, be it small or large, significant or insignificant.

When I stepped into KOC, Oil sector and Soil Remediation Group fascinated me, and I felt there was much to explore, as some of the areas seemed curious and fresh. However, I considered it more as an opportunity and motivation rather than a hindrance to move forward. What followed was a diligent journey burning midnight oil. I enthusiastically spent all my time learning, reading, researching, and being coached by experts. It was nothing but sheer luck and blessing that I could grow my potentials in an unquestionably constructive atmosphere of well-informed professionals and supportive mentors including colleagues in KOC-SRG and PMC-Worley who helped me to gain considerable knowledge and deep awareness on Environmental works. I am indeed glad and grateful for that moment when my line manager recognized me as a super star of SRG and thus becoming a key member of KERP SRG where I could manage this complex yet unique program with many unknowns and variables.

It was exciting to spearhead many significant portions of KERP Journey and to publicize the good work achieved in KERP alongside the progress of the program, in numerous international events sprawled across several countries as a proud KERP Ambassador This journey gave me opportunities to be instrumental in leading and developing environmental risk assessment and studies in multiple exercises such as RBA strategy and development, Total Remediation Strategy (TRS), UXO Strategy, Site Soil Charactization, modified remediation cleanup criteria (i.e., Total Petroleum Hydrocarbon (TPH), KERP technical specifications, Remediation Technologies, training & evaluation of vendors and tenders. Moreover, this roller coaster ride gave me great insights and lessons in networking, teaching me how to create working rapport with established external and internal stakeholders such as Kuwait Environmental Public Authority (KEPA), Kuwait Institute Scientific Research (KISR), Kuwait National Focal Point (KNFP), Public Authority Agriculture and Fisher (PAAF), Ministry of Electricity and Water (MEW), Advisory Panel (AP), Ministry of Public Works (MEP), and Volunteering Work Committee (VWC) KERP definitely bring out the best in me, as it enabled me to evolve as the SRG reference in all challenging technical issues, which required extensive reviews, evaluations, discussions, and coordination between Consultants, Contractors, the United Nations representatives and KOC employees.

I am thrilled to be a key founding member of this unique program, which is the largest environmental inland cleanup in the world and being surrounded by a team working with one spirit towards one goal as one family.

There is an old Arabian proverb saying"A tree starts with a seed" which is very true in the case of KOC SRG, as we have attained significant milestones even during the early life of Kuwait Environmental Remediation Program. The continuing work and dedication to fully restore the damaged environment across the State of Kuwait is like a seed in the ground. The work completed to date is just the beginning - though its significance and lasting impact should not be underestimated. It is crucial for the State of Kuwait as we see our injured land and environment slowly blossoming back into vitality and our untiring efforts bearing fruits.

For Kuwait Oil Company as landowner it would be tremendously relieving that these areas, which for over decades had been blighted by oil contamination and potential explosive ordnances, become once more accessible and operational. It is pivotal for Kuwait Environmental Remediation Program as it is dealing with a legacy of complex oil contamination – yet successfully achieving its goal on budget and in time. These vital milestones in KERP history will invariably be fondly remembered by the KERP team and Kuwaiti's future generation.

As the 'seed' of KERP is planted and is beginning to flourish it is with, great enthusiasm, zest, honor and interest, that I look forward to its continued growth and maturity while we all continuously strive, together, hand in hand to restore Kuwait's treasures bringing back the golden sands of Kuwait.

BIOGRAPHY

Ms. Aisha Al-Baroud has fifteen years of experience in the environmental field and started working in Kuwait Oil Company Soil Remediation Group (SRG) since 2012 when the Group was officially formed to develop Kuwait Environment Remediation Program. The keen Senior Environmentalist has earned her BSc. in Chemical Engineering and Master's in Chemical Engineering-Environment Field from Kuwait University and was bestowed with an (Honorary Doctorate Honoris Causa) in Environmental Engineering by the International Agency for Standards and Ratings. Apart from this Ms. Al-Baroud is also certified in NEBOSH (National Examination Board in Occupational Safety and Health) Environmental Management. She has published and

presented 36 technical papers in the environmental arena, which includes soil remediation, air pollution, environment software, unexploded ordnance, risk assessment & ecological monitoring, revegetation, renewable energy, and ground water pollution in several International Conferences, and Journals.

One of her outstanding initiatives, was her role as instructor in "Oil Spills Workshops" organized by Sheikh Abdullah Al-Salem Cultural Centre. These workshops have stated goal of assisting the youth learn about the KERP program and the role of KOC toward the environment.

Ms. Aisha has developed remediation training courses and mentored KU students & environment engineers in KOC, EQUATE, KIPIC, and KNPC.

Ms. Al-Baroud was also involved in several book publications and has obtained multiple awards within Kuwait Oil Company including the 1st Place in the HSSE-CV Award, Best Group award KOC, the Fast track and KAIZEN Development program for creativity and innovation in South Korea, Best HSE Performer Award and recently she received Environmental Excellence Award by Enviornmental Protection Society. She was a part of many committees and she was appointed as a member in Program Management Offices (PMO) and LEWAS - Leadership Excellence for Women committee under KPC Diversity & Inclusion (D&I) Council. She was also selected as one of KOC member for the Competition Award organized by KPC. Last but not least, Ms. Aisha has also taken part in an International documentary about KERP entitled "The Environmental Saga" in collaboration with Kuwait Environment Protection Society and Ministry of Information and participated in an interview entitled "At KOC, Environmental Protection Runs in the Family" which was published in The Kuwaiti Digest magazine.

I felt there was much to explore, as some of the areas seemed curious and fresh.

Ms. Aisha Al-Baroud

Senior Environmentalist

Soil Remediation Support Team | Soil Remediation Group

Kuwait Oil Company

"Being part of SRG added value to my career"

I started my career working in KEPA as Project Engineer from January 2005 till May 2013. It was both a pleasure and an adventure to join KOC Soil Remediation Group in May 2013 as Construction Engineer under Soil Remediation Projects II. Later, I gained vast and ample experience during the execution of Landfill Construction & Excavation and Transportation projects in NK & SEK. Being part of SRG added value to my career.

Few years later I got promoted to be Senior Engineers projects in February 2016; and was assigned as the group's focal point for external and internal audits related to KERP as well as handling the Project Management Consultancy (PMC) Contract along with all business planning tasks. I was also assigned as Member of the KNFP Management Meeting, Member of the KOC ISO 9001 Committees, Member of Focusing Team Coordination with Contract teams.

Apart from that, I am also assigned as CDU member, MP&TS coordinator for SRG Group Focal point to verify all KPI's and was selected to be among KOC innovators in 2021.

I take pride in the fact that I was able to participate in several international conferences and have presented quite a few papers related to KERP (2015, 2016 & 2018).

I am glad to be part of this journey which is a major milestone for KOC and our beloved Kuwait.

I am glad to be part of this journey which is a major milestone for my career, KOC and our beloved Kuwait.

Ms. Reem Al-Othman

Senior Engineer Project

Soil Remediation Support Team | Soil Remediation Group

Kuwait Oil Company

"I was heavily involved in managing, planning and executing KOC projects as a client representative.

With 20 years of experience in project management field working for several international companies in the hydrocarbon industry, I became an expert in managing different type of projects from the initial stage until the successful closeout.

I began my career as a site construction engineer in 2001 working for international construction companies such as, Petrofac International Ltd and Snamprogetti Eni Group. I remained in this position for three years. During that time, I was deeply involved in the execution stage of two projects constructed for Kuwait Oil Company (KOC): Construction of New BS-131 with interconnection lines through GC's & BS-130 and Capacity Upgrading of Gathering Center 23.

From 2004 to 2011, I worked for AMEC Group Limited which provided project Management consultancy services to KOC. I remained with them for 6 years in the position of Associate Project Engineer managing projects in different stages. During that time, I got heavily involved in managing, planning and executing KOC projects as a client representative.

At present, I am working directly with Kuwait Oil Company as Senior Engineer Projects under Soil Remediation Group managing environmental projects of Kuwait Environmental Remediation Program (KERP). Working under Soil Remediation Group helped me to progress in the field of project management within a serious and productive environment sharing knowledge and experience gained in various oil and gas companies.

Working under Soil Remediation Group helped me to progress in the field of project management within a serious and productive environment.

Mr. Meshari Al-Bader

Senior Engineer Projects

Soil Remediation Projects-2 | Soil Remediation Group

Kuwait Oil Company

"I am sure the KERP projects will be remembered in golden words."

I am Meshari Al Harbi and am working as a Snior Environmentalist in Soil Remediation Group.

I graduated in Chemical Engineering at year 2000 from Kuwait University and since then i have been working in the field of Environment.

From 2000 till 2006, I worked in Kuwait Environment Public Authority, then I was at Ministry of Energy till 2009. Then I joined KOC and was working in the Health and Environment team dealing with the Soil Remediation projects under KERP and other corporate environment related jobs.

Soil Remediation Group was formed in 2012 and since then, we have been exclusively working in the field of soil remediation activities under the United Nations compensation claims for the restoration of the contaminated soil inside the KOC oil fields.

Being the largest environmental remediation project in the world, it has been my pride and pleasure working on the various challenges for the treatment, restoration and recovery of the contaminated soil. thereby enhancing KOC reputation worldwide and also improving my personal knowledge and know how on the various treatment options feasible.

I am feeling grateful working under this unique project of saving the mother earth benefiting the future generation and I am sure KERP projects will be remembered in golden words.

It has been my pride and pleasure working on the various challenges for the treatment, restoration and recovery of the contaminated soil thereby enhancing KOC reputation.

Mr. Meshari Al Harbi
Senior Environmentalist
Soil Remediation Support Team | Soil Remediation Group
Kuwait Oil Company

"I am immensely happy and proud that I have been a part of this great KERP journey"

In the early days of KERP in 2013, I joined Soil Remediation Group (SRG) from Operation and Gas team initially, as Senior Engineer. I was in charge of the two active projects mainly for the construction and operation of the South and East Kuwait Landfill as first engineered landfill facility with international standards and regulations in Kuwait and KOC and the E&T Project consisting of excavation and transportation of heavily contaminated areas/features for containment into the constructed landfill as per UNCC mandate and Claims. These two projects taught me in depth environmental rules and the challenges of KERP projects are real and multi-facets obstacles and lessons learned to name a few: technical, planning and managerial, regulatory and financial to meet KERP objectives.

Later, I had the privilege to become the senior engineer in charge during the process of the Oil Sludge Recovery Concept as alternative technique for beneficial/re-use oil recovery and steered it from inception to the pilot stage with all internal KOC teams to gather and pilot test the oil recovery from a redundant wet oil lake from the Invasion war. This successful testing provided several information, engineering and design concept to the tender prior to the release stage. Other aspects of KOC Stage gate process during the planning and development of the tender specifications, which gave me new dimension in the process of project developments from strategies from the bidding/ evaluation process till the contract award of SKETR projects. That was a wonderful exercise and learning curves with an opportunity to use the insights and knowledge I gained from the earlier projects and SKETR tender into the SKETR II Tender preparation till the current stage.

Despite the pandemic and several adverse situations, we were able to conduct the first SKETR II Pre-bid Meeting completely online, with a comprehensive virtual tour of the proposed site areas and ample details, handling the queries from the bidders efficiently and promptly. This was indeed an unpreceded achievement, due to the never before situation we were facing then, and I am so proud and happy that I am part of SRG to be fortunate and to arrange that in coordination with the Contracts team and with the support of our PMC team.

During this 9th year of my journey with KOC SRG and KERP. I am immensely happy and proud that I have been a part of this great KERP journey, to restore KOC land for redevelopments and operation and to provide greener and cleaner environment to Kuwait's future generation.

Despite the pandemic and several adverse situations, we were able to conduct the first SKETR II Prebid Meeting completely online.

Mr. Ahmed Al-Maqseed
Senior Engineer Projects
Soil Remediation Project 2 | Soil Remediation Group
Kuwait Oil Company

"it was my pleasure to be part of KERP team"

I have contributed to KERP, in the preparation of Tenders for Landfill, Excavation & Transportation.

Managing PMC Contracts for KERP Projects and Managing funds for KOC-KERP projects in coordination with KNFP and KOC Finance teams. I am happy to contribute to the future generations of State of Kuwait by participating in the World's largest environmental clean up project.

BIOGRAPHY

Mr. Saravanan Kothandapani has thirty years of experience in Oil/Gas and Petrochemical Industries with expertise in Procurement, Contracts and Quality Management Systems (QMS). After his Bachelor's Degree in Mechanical Engineering, he has started working at Kuwait Oil Company (KOC) since 2011 and associated with Kuwait Environmental Remediation Program since its inception in KOC.

Managing funds for KERP projects in coordination with KNFP and KOC Finance teams.

Mr. Saravanan Kothandapani

Senior Engineer Services (HSE)

Soil Remediation Support Team | Soil Remediation Group

Kuwait Oil Company

"Sustainable Development is the pathway to the future we want for all It offers a framework to generate economic growth, achieve social justice, exercise environmental stewardship and strengthen governance."

The genesis of Soil Remediation Group (SRG) within KOC resembles this quote from Mr. Ban Ki-Moon who served as the 8th Secretary-General of United Nations from 2007 to 2016.

"Sustainable Development is the pathway to the future we want for all. It offers a framework to generate economic growth, achieve social justice, exercise environmental stewardship and strengthen governance."

Nearly two decades ago, a program titled 'SEED (Sustainable Economical & Environmental Development)' was launched in KOC to address hydrocarbon contamination caused by Company's historic operations especially addressing land restoration & rehabilitation. This humble launch grew into a massive program into the next decade that led to the formation of SRG to undertake two key soil programs of the Company viz SEED and KERP.

I was very fortunate to be part of these two wonderful programs i.e SEED which deals with the historic contamination generated due to Operations and KERP addressing the contamination caused by Gulf War.

In the SEED program, working with UK experts in initial surveys and assessment, seeking approval of senior management to address the historic soil contamination through first of environmental project tenders was a huge learning individually for me. Subsequent contract action involving a series of steps until the award ensured a huge leap of learning curve. Upon contract award, interacting with multiple disciplinary teams involving planning, project management, contract management, contractor's oversight, QA/QC & HSE turned professionals like us into experts of soil remediation. It was a proud moment indeed when the project's goals like recovery of oil, contaminated soil treatment are achieving the stipulated standards, planting native vegetation on restored soil and finally land release for future development.

The challenges faced or lessons learned of first soil remediation projects aided KERP program's remediation projects, five of which are currently in the execution stage. Implementing these remediation projects under KERP, involving massive volumes of contaminated soil which the world had not seen before gives us a sense of accomplishment and an exemplary moment to cherish.

Working under Soil Remediation Group helped me to progress in the field of project management within a serious and productive environment.

Mr. Krishna Vangala

Senior Environmentalist

Soil Remediation Project I - Soil Remediation Group

Kuwait Oil Company

I have personally accompanied KOC's efforts in Kuwait Environmental Remediation Program (KERP), and I would like to express my admiration for the tremendous work that has been done so far, and I salute all the officials and employees of the Group, and I commend the achievements made in the project. Today, as a Manager of Public Relations & Information Group, I affirm that my Team members and I are proud to spare no effort to ensure the success of the initiatives related to this pioneering program, the largest of its kind in the world, especially since every achievement made, whose activities we contribute to coordinating, is ultimately reflected in the interest of our beloved country Kuwait and benefits its environment, to offer a brighter future for our next generations.

I have personally accompanied KOC's efforts in the Kuwait Environmental Remediation Program (KERP).

Mr. Mohammad Al-Basry

Manager Public Relations & Information Group

Kuwait Oil Company

An accomplished Contracts professional, Manager of Contracts Group in Kuwait Oil Company, the 7th oil producer of the World, with over 28 years of experience in procurement and over 20 years in leadership positions regarding contracts.

Leading contracts processes for Major Projects Groups and other Groups within the KOC, managing five teams comprising of 16 multi-disciplinary specialists, senior engineers and contracts professionals, responsible for establishing the contracts strategy for 93 teams within KOC, the 50% of all KOC business, and the business of the KOC London office, ensuring the quality, timely delivery, and cost optimization of the KOC contracts in full compliance with Kuwaiti law and contracts framework, UK and international contracts law framework, following the Kuwait Petroleum Corporation strategic objectives, policies and regulations.

I have been successful in setting strategies, negotiating and concluding large and diverse types of agreements with local and international firms exceeding a total of US$ 12 billion. Expert in procurement lifecycles, risk management, and recognized ability in adapting new techniques and best practices to dramatically improve business processes to outperform the company's targets. A skilled negotiator consistently achieving remarkable cost savings in the contracts handling, by identifying opportunities for optimization and eliminating duplication.

A member of the Kuwait JTG (Joint Technical Group) overseeing the United Nations Compensation Commission pay-back Program for Awarded claims pertaining damage remediation plan for Kuwait Oil Company of the State of Kuwait (1.9 billion USD), making sure plans comply with the State's tendering regulations, and setting the optimal strategy for its implementation. Actively participated and monitored all KERP Program since 2005 for over 15 years. Involved in the KERP journey since I was Contracts Engineer until becoming Contracts Manager. Nearly, most of the KERP projects handled by KOC have been executed or under execution. KOC as well have been entrusted to handle vegetation projects, which we supposed to be handled by PAAF.

In addition, very active in the KOC CSR (Community Social Responsibility) activities, and has been leading the Contracts Group efforts in this matter since 2011.

QUALIFICATIONS

- GMP14, Harvard Business School, 2013.
- Master of Science, Civil Engineering, Construction Management, Kuwait University, Kuwait; 2000.
- Bachelor of Science, Civil Engineering, Kuwait University, Kuwait; 1992.
- Member of NCMA, IACCM, KSE, ASCE & SPE.

Ms. Aisha Al-Sulaili

Manager Contracts

Kuwait Oil Company

Actively participated and monitored all KERP Program since 2005 for over 15 years.

I have a total of 19 diversified years of working experience in Planning, Tendering Activities, and Project & Contract Management. Ever since joining Contracts Group at Kuwait Oil Company in 2012 I have been involved in enhancing multiple contracts models, reviewing contracting strategies, developing and enhancing relevant guidelines and procedures, preparing of agreements for major types of oil and gas projects, reviewing and processing various adjustment orders, in addition to participation in multiple task forces dedicated to process enhancement initiatives and was a member in various committees including claims review, dispute resolution and arbitration. I have participated in publishing and presenting a number of technical papers in the subject of contract management at different events, such as IACCM conference - Kuwait (2019), AACE International - Kuwait Section (2017), Project Management Institute - Gulf Chapter (2015).

It has been an honor to be an active participant in the KERP success journey. I have been involved in KERP from an early stage as a Contracts Engineer in preparing and executing the Landfill projects in North and South Kuwait, developing the contract management plan and strategy for execution of subsequent KERP projects in liaison with Soil Remediation Group & Kuwait National Focal Point (KNFP) which included Excavation and Transportation of Contaminated Soil (North and South Kuwait) and the mega multi-awarded contracts for Excavation, Transportation and Remediation of Contaminated Soil (North and South Kuwait) issued with Joint Venture provisions and as Open Tenders for the first time in KOC through CAPT. I have also played an active role in the preparation of the Project Management Consultancy (PMC) tender for KERP, and the market survey through the IFP mechanism soliciting different Remediation techniques from potential and specialized remediation consultants. I also supported in the preparation of a model contract that best suits the nature and size of KERP projects, to ensure effective and timely completion of the Program. As a Team Leader, I have led the processing of subsequent KERP tenders, such as Phase–II of Excavation, Transportation, and Remediation in South Kuwait (SKETR-II), the renewal of the KERP PMC contract, North and South Kuwait Revegetation, and Consultancy Services for Ecological Monitoring Services with KISR, ensuring alignment with KERP schedule and compliance with the tender law and KOC policies and regulations.

QUALIFICATIONS

- MBA – American University of the Middle East (2010).
- BSc – Industrial and Manufacturing Systems Engineering – University of Missouri Columbia, USA (2003).
- Member of Kuwait Society of Engineers.
- Contract & Commercial Management (CCM) Certified – IACCM (2017).

Ms. Nourah Osama M.Al-Tarkait

Team Leader Contracts I

Kuwait Oil Company

It has been an honor to be an active participant in the KERP success journey.

I have a total of 39 years of working and diversified experience in Contract Management, involved in developing Contracts models, planning and contracts strategies and drafting of major projects type of contracts and service agreements in oil and gas sector. My experience, also, involves other related activities such as administration and negotiation of contracts, disputes and claims resolution, creating and developing work related guidelines and manuals, training, mentoring and development of engineers (in contracts and project administration). Throughout my career I have published and presented technical papers in contract management in different events, such as IACCM conference at Kuwait - "Innovative Contract Strategy" - Nov 2019, AACE International - Kuwait Section - "Effect of Pre Contract Award Phase On Contract Management"- 2017, PMI (Project Management Institute)-Gulf Chapter on "Contracting Strategy of Construction of New Ahmadi"- 2015.

I am proud to be one of the members of Contracts Group who participated in the implementation and success of KERP program. I was involved in developing the contract management plan and strategy for execution of KERP Program in liaison with Soil Remediation Group & Kuwait National Focal Point (KNFP). Conducted market survey through the IFP mechanism seeking views on different Remediation Technologies from potential & specialized consultants / contractors in the field of remediation of hydrocarbon contaminated soil. I was involved in the preparation of a model contract that is most suitable to the nature and size of the projects of KERP that gave a flexibility to execute different activities related to / and different technologies for remediation of contaminated soil; such as soil survey, define the level of contamination, UXO detections & clearance, selection the suitable remediation technologies, handling and transportation of contaminated and remedied soil, to ensure effective and timely completion of multi contracts under KERP Program.

QUALIFICATIONS

- BSc Civil Engineering; Ain shams University, Cairo- Egypt (1983).
- Member of Engineering Egyptian Syndicate.
- Member of Kuwait Engineering Society .
- Contract & Commercial Management (CCM) Certified Advanced Practitioner (CCMAP) – IACCM (2017).

Ms. Samia Hussain

Senior Engineer Contracts

Kuwait Oil Company

I was involved in developing the contract management plan and strategy for execution of KERP Program in liaison with Soil Remediation Group & Kuwait National Focal Point (KNFP).

Having handled several tenders with Major Projects Group, I was assigned to handle Tenders for Kuwait Environmental Remediation Program (KERP) in May 2015. It was the most challenging assignment by far in my experience as we had to develop a strategy to implement projects which had several unknown factors. First I had to understand the Controlling Team's (SRP-II) requirements, the timeframe for completion and get their buy-in for successful implementation In addition to this the COVID-19 pandemic had forced everyone to work from home, hence in order to meet the KERP tight schedule, I had to work closely with the Controlling Team, and with the support of TLC-I and MCG, we managed to issue the multi-awarded Tenders for Excavation, Transportation, and Remediation in North and South Kuwait (NKETR & SKETR) simultaneously and successfully awarded Five contracts totaling appx USD 1.5 Billion Subsequently the Phase –II of Excavation, Transportation, and Remediation in South Kuwait (SKETR-II) was issued which is currently under award for three contracts appx worth Half a Billion USD.

The above tenders were issued with special provisions including Joint venture between Local civil contractors with international Remediation contractors on a Not to Exceed Value (NTEV) basis Also these were issued as Public Tenders through CAPT which resulted in several challenges that were surmounted successfully. This experience provided a lot of Lessons that paved the way in streamlining Company's procedures for handling such Public Tenders.

As part of the above Tenders, new aspects were introduced such as Virtual Site Visit and Electronic signature of the Technical Section of Contract documents, which were welcomed by all stakeholders and proved immensely successful.

In addition to the above, I have also handled the following tenders related to KERP

1. Site Soil Characterization
2. UXO
3. Soil Remediation Project for conducting Pilot Trials etc.
4. Audio Visual Documentary

This experience provided a lot of Lessons that paved the way in streamlining Company's procedures for handling such Public Tenders.

Mr. Ramesh Babu

TPL Specialist Contracts

Kuwait Oil Company

"The KERP journey itself was a team struggle, a collective effort and we could see the passion in each new step, turn and milestone we achieved"

I joined Kuwait Environmental Remediation Program in 2015 and I was naturally quite enthusiastic as the importance of this program was immense and the value behind it was great. This was especially because as the ultimate benefactors of KERP program was the Environment of Kuwait and Kuwait's future generations. Initial phase of the program involved a lot of discussions brain storming, research, and study. A lot of people across different specialisations came together and discussed about the various options and opportunities and further discussions were made on the new objectives and findings. The KERP journey itself was a team struggle, a collective effort and we could see the passion in each new step, turn and milestone we achieved.

Raising awareness was one of the main part of this journey. There were two generations in front of us when we began: one was a generation who saw the environment before the war, who also have witnessed atrociousness of the war and resultant environmental catastrophe .Then there is this generation of youngsters for whom the war and its horridness are just a fearful story, but those who are also a part of this journey and who will eventually be the benefactors of this wonderful project. The message of this KERP e-book and the project itself is a message of endurance, rejuvenation, and gift of enlightenment from the older generation of Kuwait to its newer generation.

Being born and raised in Kuwait, it is my personal pride and privilege to be a part of this prestigious and historical project as there are a lot of memories, both personal and professional associated with it. While we are in the strive to get the damage mended, as efficiently as possible here in KERP, and passing on the light of environmental responsibility to the future generations, I would like to remember with gratitude the pioneers who tread the way before us, whose efforts can never be underestimated.

Raising awareness was one of the main part of this journey.

Mr. Hadi Diab
Project Manager Worley, KERP

I am an engineering graduate with over 41 years of experience in the Contracts Management of Heavy Engineering and process industry After graduating from in 1980 with Bachelor's degree in Mechanical Engineering. I joined as an Engineer Trainee with M/s Bharat Heavy Electricals Limited, one of the world's renowned Power and Process plant equipment's manufacturer including manufacture of On-shore Oil rigs. I worked in various capacities executing Tender formulation and Contracts management for projects of Oil, Fertilizer, and Steel Industries and Power Plants thereby developing skills and knowledge of the Contracts Terms and Conditions of the various industries, and Project Management.

In June 1994, I was recruited by Kuwait Oil Company and was initially posted in Contracts section of Projects Control Team of Engineering Group Subsequently, was transferred to Contracts Group to work on the contracts associated with Major Projects of the company handled several high value, critical, complex and strategic projects in KOC such as Gathering Centres, Booster Stations, Effluent Water Disposal plants, Technology Agreements etc and was also involved with negotiation, disputes and claims resolutions of Contracts. I am currently working as TPL Specialist I in Contracts Team I.

I proud to have been associated with the initial formulation of the tendering and contracting strategies for the tenders of Kuwait Environment Rehabilitation Program Under UN Legislation for Indemnification.

As Contracts Team representative,I had an opportunity to present the brief of KOC Policies and Regulations for Contracts to the members of KNFP (Kuwait National Focal Point), JTG (Joint Technical Group), as confidence building measures, to demonstrate the Control measures implemented by KOC in the tendering process from issuance of tender to award of Contract and subsequent changes, if any, to the Contract.

I was associated with the formulation of the tenders to award of Contract for the project of Construction of Landfill Facilities for Hydrocarbon Contaminated Soil I was also initially involved with the UXO tenders formulation.

I pray to Almighty for success of KERP projects in achieving the Environmental rehabilitation envisaged with implementation of these projects.

QUALIFICATIONS

BE (Mechanical Engineering), Osmaina University, Hyderabad, India , 1980.

Member Kuwait Society of engineers.

I proud to have been associated with the initial formulation of the tendering and contracting strategies for the tenders of Kuwait Environment Rehabilitation Program Under UN Legislation for Indemnification.

"Alone we can do so little Together we can do so much and achieve greater satisfaction".

My KERP journey commenced over ten years ago when I was offered the opportunity with my formeremployer AMEC FW/Wood Company to relocate and work in Kuwait as a technical expert/PMC to KOC soil remediation contract consisting of planning, design and execution of remediation and restoration projects in the oil field areas.

The early days and months of induction, reading and learning passed rather quickly to understand the Client team composition and stakeholders, magnitude of planning cycles, development of KERP strategy to be tailored and agreed; and the intensity of the developments and executions of the early projects as mandated by the UNCC to State of Kuwait.

Being part of PMC & KOC SRG team was and still is exciting and challenging opportunities to learn, shape, lead and dare to say. However, no remediation projects and experiences have prepared me from my first visits to the oil fields to see the destruction twenty years later of the once vibrant oilfields became a literal black flood of destruction with nearly black land and mountains of oil contaminated soil piles throughout the fields. To accomplish the vision and mission of KERP projects, genuine and incredible KOC and PMC team members and other stakeholders (KNFP & KEPA) were assembled with different background and expertise and are armed with full commitment and incredible resilience to embrace and carry out the KERP Strategy and to prepare and begin the KERP Journey by ensuring that all remaining unexploded ordnances (UXO) are cleared, and every square meter of impacted land is restored to its original condition with flourishing ecosystem.

The magnitude of KERP Journey is colossal and its challenges are significant. It will take tremendous teamwork; energy and effort to achieve its goal. But as Kuwait has risen to such challenges before, KOC SRG and PMC team involved will continue to do it again KERP team recognize that only by pooling our shared knowledges, resources and innovative endeavors, we will be able to overcome the challenges. As said, "Alone we can do so little, together we can do so much and achieve greater satisfaction".Today, I am proud to be part of this milestone projects and to my humble contributions of KERP's position and success as we continue to responsibly look for ways to carefully deliver and manage these strategically projects with emphasis of closing the KERP projects.

Dr. Djamel Lekmine Ph.D., LSRP,

Technical Service Manager | Worley | KERP

The magnitude of KERP Journey is colossal and its challenges are significant It will take tremendous teamwork; energy and effort to achieve its goal.

"It is a privilege to work in KERP where you have wide variety of people and thoughts to tackle challenges with ultimate goal of protecting the Kuwaiti environment, water soil, air and human life."

After completion of the PhD in Environmental Engineering from Northeastern University, Boston, US, I worked in several Projects related to remediation of soil and groundwater contaminated with NAPL and DNAPL contamination. In 2014, I joined KERP where Projects of North Kuwait Excavation and Transportation of Heavily Oil Contaminated Soil (NKE&T), Construction operation and capping of North Kuwait Landfill (NKLF), and UXO clearance of contaminated Soil in North and South Kuwait (UXO Phase I) were executed within time , quality and contract values. Later, I was involved in tendering process of NKETR Projects from preparation until award. Currently I am managing NKETR Zone I, II, and SKETR zone I Projects.

It is a privilege to work in KERP, where you have wide variety of people and thoughts to tackle challenges with ultimate goal of protecting the Kuwaiti environment, water soil, air and human life.

I worked in several Projects related to remediation of soil and groundwater contaminated with NAPL and DNAPL contamination.

Mr. Hussam Sarahney

Area Manager NK, Worley, KERP

"The challenges that we encounter in managing and supervising the execution of KERP projects wouldn't be solvable without the honest and knowledgeable support from the Soil Remediation Group team members, and rest of the KOC teams."

"I joined the KERP program in 2018, and I consider myself very fortunate to work in this mega remediation project Being an environmental professional, I never came across a set of projects with this diversity, scale or challenges associated.

The KERP program and all emerging projects under the KERP framework is a strong demonstration of applying environmental engineering solutions and benchmarks on an unprecedented scale. Joining the KERP in the middle of its journey allowed me to appreciate the efforts done by the various teams before and how to learn from it, build on it and maintain the momentum and driving force to achieve the successful conclusion of this program.

The challenges that we encounter in managing and supervising the execution of KERP projects wouldn't be solvable without the honest and knowledgeable support from the Soil Remediation Group team members, and rest of the KOC teams.

I am really honored and fortunate to play a role in this program, this role when collectively merged with the roles and efforts of my colleagues and all those participated in the KERP journey will always be remembered of making a difference towards the improvement of Environment in the State of Kuwait.

The KERP program and all emerging projects under the KERP framework is a strong demonstration of applying environmental engineering solutions and benchmarks on an unprecedented scale.

Mr. Ahmad Ismail

Worley, KERP

"Today's Achievements are steppingstones for the future and history for the day after".

After more than 10 years working in Kuwait oil sector, across different oil sector companies, and wading along editing, writing, multi-media, publishing, and training arenas, I was literally thrilled and excited to join KOC Soil Remediation Group and KERP project. Being, enthusiastic about environment protection and passionate about recycling, repurposing, and sustainable living, it was such a joyful and energising opportunity personally for me.

KERP is such a sublime project, rejuvenating the soil, which is the fragile skin of our earth and in which the root of our existence has spread. The fact that the project has an international distinguishability and value have also added illuminance to my fervour. It's not every time that you get a chance to work in world's greatest soil remediation initiative following a human imposed environmental disaster, etched deep down in history.

I still remember, as a child seeing those roaring oil fires of Gulf war in television and gasping how hot it would be there. Never had I imagined then, that one day I would be here be in this country involved in a project remediating that terrible loss. I moved to KERP when I joined Worley in 2019, as member of KERP Multimedia Team, and had a chance to learn a lot about soil remediation approaches techniques and best practices.

I consider it a blessing to be a part of this project and especially editing and compiling this E- book, to this form. Pulling together this wouldn't have been possible if not for my teammates, KERP family, PMC management and above all KOC SRG team. There are so many people, I should thank for this opportunity and support, and it would be ungrateful to others if I would name a few.

As it is said "The feeling of accomplishment is in the process of creative effort." I am feeling that accomplishment in the creative effort behind this E-book. Everyone leave their footprints behind; we can rejoice that ours are in the direction of bettering the future.

KERP is such a sublime project, rejuvenating the soil, which is the fragile skin of our earth and in which the root of our existence has spread.

Ms. Chinnu Babu Korah

Worley, KERP

"An extremely unique and rewarding experience."

Working on KERP has been an extremely unique and rewarding experience. I am very happy to be apart of such important projects which are ensuring a better environment for the flora and fauna of Kuwait and safer working conditions for all residents from around the world. This e-book will document the KERP journey and should be a source of enlightenment and inspiration for generations to come.

I am very happy to be apart of such important projects which are ensuring a better environment for the flora and fauna of Kuwait.

Mr. Scott Hetric

Worley, KERP

"The world is watching with great interest as Kuwait begins the next stage of this important journey"

Being part of KOC SRG was an exciting opportunity, it was very evident the amount of talent and ingenuity that we have within the team who were all up to the challenge and committed to providing a more sustainable environment for our future generation.

KERP is one-of-a-kind mass remediation projects provide significant benefits to the State of Kuwait, KOC and our wider partners, positively impacting our environment, business and economic activities in the State of Kuwait. These projects will bring together both national and global expertise in pioneering and delivering sustainable remedial solutions that will both encourage and enable the State of Kuwait to be a regional and world leader in this specialism Partnering and developing together is very important to us, as together we grow for the benefit of our country and for our future generations. The world is watching with great interest as Kuwait begins the next stage of this important journey.

I wish you all every success in undertaking and completing these unique projects, and as we always say let's all work together to restore Kuwait treasures.

These projects will bring together both national and global expertise in pioneering and delivering sustainable remedial solutions.

Ms. Nada Al-Qallaf

Ex Team Leader

Soil Remediation Support Team | Soil Remediation Group

Kuwait Oil Company

"You make Kuwait a better place"

KERP and SRG are embarking a huge and remarkable journey in handling the Iraqi aggression contamination legacy. I am happy and proud that I have been part of this journey.

To all SRG team members, thank you for a wonderful journey, you make Kuwait a better place Wishing you all the best.

BIOGRAPHY

Mr Dhari Al-Gharabally graduated from Creighton University in Omaha, Nebraska (USA) in 1997 with a double major in Environmental Science and Atmospheric Science He then returned to Kuwait and commenced his career, working for 22 years in the Oil & Gas Industry with the Kuwait Oil Company. Now he is Manager HSE in Kuwait Integrated Petroleum Industries Company (KIPIC).

Work Experience 2017-to present- KIPIC.
1997–2017 - Kuwait Oil Company (K.S.C.)

Team Leader Soil Remediation Support (August 2012 to 2017).

Working in Soil remediation Group – This group is responsible for the rehabilitation of environmentally damaged areas in KOC Oil Fields that are either due to the 1991 Gulf War or the historical legacy of the Oil & Gas Exploration & Production operations.

Team Leader Health & Environment (March 2007 to August 2012).

Working in Health, Safety and Environment Group – the corporate group responsible for developing and maintaining the HSE Management System, its procedures and guidelines for the company, managing HSE projects, conducting awareness & campaigns to enhance the company performance in HSE including preparing and conducting the HSE audits across the company as per the annual HSE audit plan.

To all SRG team members, thank you for a wonderful journey, you make Kuwait a better place.

Mr. Dhari Al-Gharaballi

KOC, Ex Team Leader,

Soil Remediation Support Team | Soil Remediation Group

Kuwait Oil Company

"I am proud and honored to have been part of Kuwait remediation and rehabilitation journey."

We have experienced one of the worst environmental disaster and it will be forever a scar on our hearts. I'm proud and honored to have been part of Kuwait remediation and rehabilitation journey.

The resilience of both the Kuwaiti people and its environment is a testimony to the world and future generations that, "We will not give up! "

BIOGRAPHY

Mrs. Hannan Al-Qanai is an Environmental Geologist by Profession where she obtained her bachelor's degree from Kuwait university (1999) and post-graduate degree from Cardiff University (UK-2010). She has over 20 years' experience in the Kuwait upstream and Downstream Oil & Gas Sectors, her core experience is in Health, Safety, Environment and Social responsibility, where she possesses international certificates in them She has participated in many conferences and has prepared 7 technical papers.

Mrs.Hannan's professional career commenced upstream at Kuwait Oil Company (KOC) in the year 2000 as Geologist in field development She then focused her career on Health, Safety and environment with an emphasis on Environment She was assigned senior in-charge (2010- 2014) of the Kuwait Environmental Remediation Program (KERP) were she played a major role in the successful release of funds (UN Claims) to the state of Kuwait from United Nations Environmental Compensation Program Mrs. Al-Qanai was a key member in establishing the Soil Remediation group in 2012 were she effectively handled the tasks and achieved an optimal outcome in the newly established SR Team/group despite the limited number of engineers available. Mrs. Al-Qanai has always been involved in the Company's' (KOC- HSE) Corporate Social responsibility During her career in KOC she was part of many committees and was part of the Fast track program. One of her outstanding initiatives was her role as a mentor in the KOC Challenge project- Nabdh "The Protégé. This project has a state goal of helping the nation's youth learn about the oil and Gas industry in the state of Kuwait.

Mrs Al-Qanais' downstream experience started as one of the founders at Kuwait Integrated Petroleum Industries Company (KIPIC) were she held several team leader positions in HSE group. Her main role is to establish the KIPIC health, environment & social management system, policies /procedures, and ensure Regulatory compliance monitoring for all three integrated Mega complexes for Refinery, petrochemicals manufacture businesses (PRIZe) and Liquefied Natural Gas Import (LNGI) facilities at Al-Zour complex She established Contractor worker welfare program through a well-documented Environment & Social Management System framework in accordance with international standards which was considered by KPC CEO as a role model among K- companies and placed as members of KPC group Environment and social requirements team for Export Credit Agency (ECA) financing she is a participating Member represented the State of Kuwait on Climate change dialogues under United Nations

The resilience of both the Kuwaiti people and its environment is a testimony to the world and future generations that, "We will not give up! "

Framework Convention (UNFCCC), and is the appointed Deputy Head of Program management Offices (PMO) under KPC Diversity & Inclusion (D&I) Council.

Mrs Hannan Al-Qanai has developed environment and social training models and mentored Environment & HSE engineers in both KOC and KIPIC, which she extremely proud of. She has also received the "Environment Excellence Award" from the Environmental Protection Society.

Ms. Hannan Al-Qanai

Ex Senior Environmental Engineer

Soil Remediation Support | Soil Remediation Group

Kuwait Oil Company

"One of the most enjoyable experiences I've had was laying the groundwork for contracting a PMC with environmental expertise to assist us in crafting sound and fair contract conditions"

Being part of KOC SRG was a wonderful chapter in my career. Soil Remediation group is undergoing a consistent process of continuous learning, while several international events were held in Kuwait to invite the most reputed environmental remediation companies in the world for them to share their experience and invite them to participate in this important project, the largest environmental remediation project in the world.

One of the most enjoyable experiences I've had was laying the groundwork for contracting a PMC with environmental expertise to assist us in crafting sound and fair contract conditions that would be attractive to local and international contractors There were lots of learnings along each stage of the project's preparations during those ten years of professional excellence at KOC and PMCs.

I believe that for all the professionals who integrate the KERP Project in KOC, KNFP, and UNCC, this project becomes a genuine passion in which all potential opportunities for the project's development have been thoroughly explored and every effort has been made to successfully complete this project for the benefit of the people of Kuwait and the world.

In the future, when other scenarios with enormous contaminations may occur around the world, the Kuwait experience of SRG in terms of science and project management will be extremely useful by a wealth of insights and new developments experience by KERP and to be shared for professionals of the environmental discipline.

Congratulations to the KOC staff, PMC, and its contractors, as well as the KNFP and UNCC for their efforts to give all the required assistance and dedication for the successful completion of this project.

Mr. Alberto De La Roche

Former Senior Consultant, 2009-2019
Soil Remediation Group
Kuwait Oil Company

In the future, when other scenarios with enormous contaminations may occur around the world, the Kuwait experience of SRG in terms of science and project management will be extremely useful by a wealth of insights and new developments experience by KERP.

"We were able to put in place appropriate plans for a world-class program"

The KERP program requires a lot of planning and monitoring by working with the United Nations Compensation Commission, which provided nearly $3 billion in project financing.

"The KERP program requires a lot of planning and monitoring by working with the United Nations Compensation Commission, which provided nearly $3 billion in project financing, and with the entities involved, and we were able to put in place appropriate plans for a world-class program."

As reported by ALANBA Daily these were the words said by Mrs. Nahil in her speech during the opening of the Kuwait Environment Rehabilitation Forum held in July 2019, which was organized by Soil Remediation Group of Kuwait Oil Company in cooperation with other stakeholders of KERP, or the parties participating in the Kuwait Program for Environmental Rehabilitation Projects.

Ms. Nahil Abdul Razzaq

Secretary General of the KNFP

Kuwait Environment Rehabilitation Forum

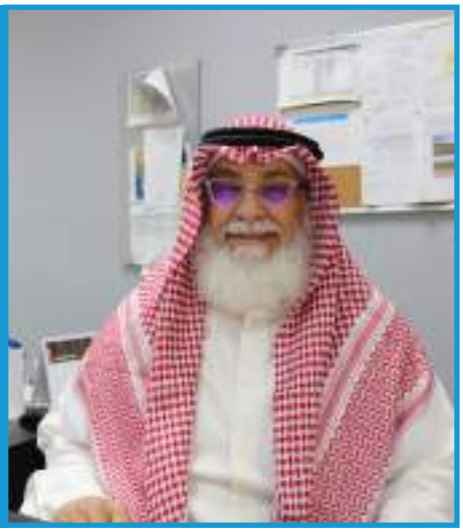
"This program, God willing, will achieve its goals soon and on time"

Kuwait Environmental Remediation Project is one of the most challenging projects handled by Kuwait Stakeholders.

It involves clearance/treatment of vast areas of contaminated soil from oil contamination as well as UXO/EOD clearance. Moreover, Revegetation of vast areas in Kuwait Desert and turning it into green areas that represent nearly 10% of Kuwait total area is another challenging task . Work is steadily progressing, achievements on the grounds are being met.

This program, God willing, will achieve its goals soon and on time.

Revegetation of Vast areas in Kuwait Desert and turning it into green areas that represent nearly 10% of Kuwait total area is another challenging task.



Mr. Saad Al- Saad

Senior Technical Consultant,

Kuwait National Focal Point

"KERP went through many phases from planning to designing and then executing the projects and each phase had its distinctive feature."

My Journey with KERP started in 2012 when I was called to participate as senior consultant at KNFP. Inspite of my background experience in managing Mega Projects in the oil sector KERP represented a new challenge in the field of environment. I have enjoyed working at KNFP for the friendly and motivating atmosphere.

The teamwork environment and the exposure to work with the United Nations delegates and various teams of the Kuwait Stakeholders also added to the flavour. KERP went through many phases from planning to designing and then executing the projects and each phase had its distinctive feature.

The effective role of KNFP Leadership, Stakeholders teams and supporting State institutions is highly appreciated in the achievement of KERP and the fulfilment of Kuwait's political assurances to the United Nations.

The teamwork environment and the exposure to work with the United Nations delegates and various teams of the Kuwait Stakeholders also added to the flavour.

Mr. Zaki Nuseibah,

Senior Technical Consultant,

Kuwait National Focal Point

Sultan said in his speech during the opening of the Kuwait Environment Rehabilitation Forum, which was organized by Kuwait Oil in cooperation with the parties participating in the Kuwait Program for Environmental Rehabilitation Projects, that "the forum provides an opportunity for a broader vision of projects within the framework of the Kuwait Environmental Rehabilitation Program, especially through the large Burgan oil field of the Kuwait Oil Company in Southern Kuwait, stressing the company's continued commitment to preserving the environment, health and safety and promoting knowledge and understanding of environmental rehabilitation."

He stated that "these projects should not be underestimated, because throughout the history of the Kuwait Oil Company, which is rich in development and innovative design, successful projects have been built on the basis of teamwork, joint experience, innovation and first-class communication with each individual who seeks with us to achieve the common goal in all safety and security, which is what applicable to the Kuwait Environmental Rehabilitation Program. He stressed that one of the main objectives of the forum is to establish open channels of communication between all participants and provide a starting point for communication as well as develop and strengthen successful and multidisciplinary work teams,as KOC realizes that we will only be able to overcome challenges through the combination of our knowledge, resources and innovative efforts."

Mr. Sultan full speech "On behalf of the Kuwait Oil Company, it is my privilege to welcome you all here today to this KERP Forum This forum provides the opportunity to understand something of the wider vision for projects under the Kuwait Environmental Remediation Program (known as KERP), particularly across Kuwait Oil Company's Great Burgan oilfield in South Kuwait. These projects, while providing an incredible opportunity to demonstrate our continuing commitment to health and safety, advancing our knowledge and understanding in environmental remediation and rehabilitation are, at the same time, not to be underestimated, and for good reason.

Throughout the Kuwait Oil Company's rich history of innovative development and design, successful projects have been built on the foundation of solid teamwork, shared expertise, innovation, and first-class communications with every member striving together to safely meet the common goal. The same is true for KERP.

Because of this, one of the main purposes of today's forum is to generate open communication amongst you all and to provide the springboard from which to connect, develop and strengthen successful multi-disciplinary teams. The Kuwait Oil Company recognizes that only by pooling our shared knowledge, resources, and innovative endeavors, we will be able to overcome the challenges. As has been said, "Alone we can do so little Together we can do so much".

Let us then strive together to make KERP not just a national or regional success, but a global one.

I wish every success as you start out on this incredible journey today."

Mr. Imad Sultan

Ex- KOC CEO, KNFP Board member

Kuwait Environment Rehabilitation Forum

KUWAIT, Jul 5 2019 (ALANBA)

He stated that "This signatory represents the completion stage of Kuwait for all its obligations in relation to the requirements of the United Nations for environmental rehabilitation program."

"The agreement also confirms Kuwait's commitment to use the funds allocated to the Environment Rehabilitation Program and approved by the United Nations to spend on projects approved by the F4 Group, as stated in a resolution the Governing Council of the United Nations Committee No 258/2005, which determined the number of projects and funds allocated to each of them and the way to deal with these projects."

He stressed that "The Kuwaiti concerned authorities took it upon themselves to implement the projects specified in the Environmental Rehabilitation Program, which are related to the rehabilitation of groundwater in the Umm Al-Aish and Al-Rawdatain areas in northern Kuwait and the rehabilitation of vast areas From the contaminated soil from the effects of burning wells during the invasion of Kuwait by the former Iraqi regime, the operations of extinguishing the oil fires and the military operations during the war to liberate Kuwait."

He said that the "United Nations Compensation Committee had taken similar measures with many countries that were affected as a result of the previous Iraqi regime's invasion of Kuwait, including Jordan, Iran and Saudi Arabia, but these countries signed. This agreement was earlier, as it was not directly affected as Kuwait was in that era."

Mr. Mustafa Al-Shamali

Ex-Deputy Prime Minister and Ex-Minister of Oil,

Ex-Chairman of the Board of directors of the KNFP

Signatory of the political assurances document

with United Nations

We Owe,those Who Guided Us...

Gratitude is a great virtue, and a catalyst for happiness. This e-book cannot be complete without remembering all those who supported us during the toughest climbs and steepest descents, those who bore the torch high for us so that we could make the way. We thank those who have supported us throughout the years and believed in our efforts. Let's remember, our other former team leaders and managers, those who have overcome obstacles and fought for the implemented methods that are used till this day and made KERP a successful reality.

MANAGERS		
NAME	YEARS IN SOIL REMEDIATION	PHOTO
Mr. Mohammed Al-Fodari	2012 to 2013	
Mr. Fakher Shabban	2013 to 2014	
Mr. Waleed Al-Shuaib	2014 to 2017	

MANAGERS		
NAME	YEARS IN SOIL REMEDIATION	PHOTO
Mr. Mansour Al-Khareji	2017 to 2020	
Mr. Bader Al-Qouad	2nd Feb 2020 – 4th July 2020	

MANAGERS		
NAME	YEARS IN SOIL REMEDIATION	PHOTO
Mr. Faries Al-Mansouri (TL.SRPII)	2012 to 2013	
Mr. Mohsen Al-Shammari (TL.SRPII)	2013 to 2015	

List of Abbreviations

BAC	Battle Area Clearance
CIC	Consortium of International Consultants
DOL	Dry Oil Lake
DRO	Diesel Range Organics
ESIA	Environmental Social Impact Assessment
EQUIS	Earthsoft EQuIS Environmental Data Management Software
GIS	Geographical Information System
GRO	Gasoline Range Organics
IMAS	International Mine Action Standard
KEPA	Kuwait Environment Public Authority
KERP	Kuwait Environmental Remediation Program
KMOD	Kuwait Ministry of Defense
KNFP	Kuwait National Focal Point
KOC	Kuwait Oil Company
LIMS	Laboratory Information Management System
LSSC	Limited Scope Soil Characterization
NK	North Kuwait
NKETR	North Kuwait Excavation, Transportation & Remediation Project
NK E&T	North Kuwait Excavation and Transportation Project
OCP	Oil Contaminated Pile
PACC	Public Authority for Compensation Commision
PAH	Poly Aromatic Hydrocarbons
PMC	Project Management & Consultant
RBA	Risk Based Analysis

List of Abbreviations

RTC	Remediation Target Criterion
SARA	Saturates, Aromatics, Resins and Asphaltines
SEED	Sustainable Environmental Economical Development, KOC Program
SEK	South & East Kuwait
SK	South Kuwait
SKETR	South Kuwait Excavation, Transportation & Remediation Project
SK E&T	South Kuwait Excavation and Transportation Project
SRG	Soil Remediation Group, KOC
SRP I	Soil Remediation Projects I Team, KOC
SRP II	Soil Remediation Projects II Team, KOC
SRS	Soil Remediation Support Team, KOC
TPH	Total Petroleum Hydrocarbons
UNCC	United Nations Compensation Commission
UXO	Unexploded Ordnance
WOL	Wet Oil Lake

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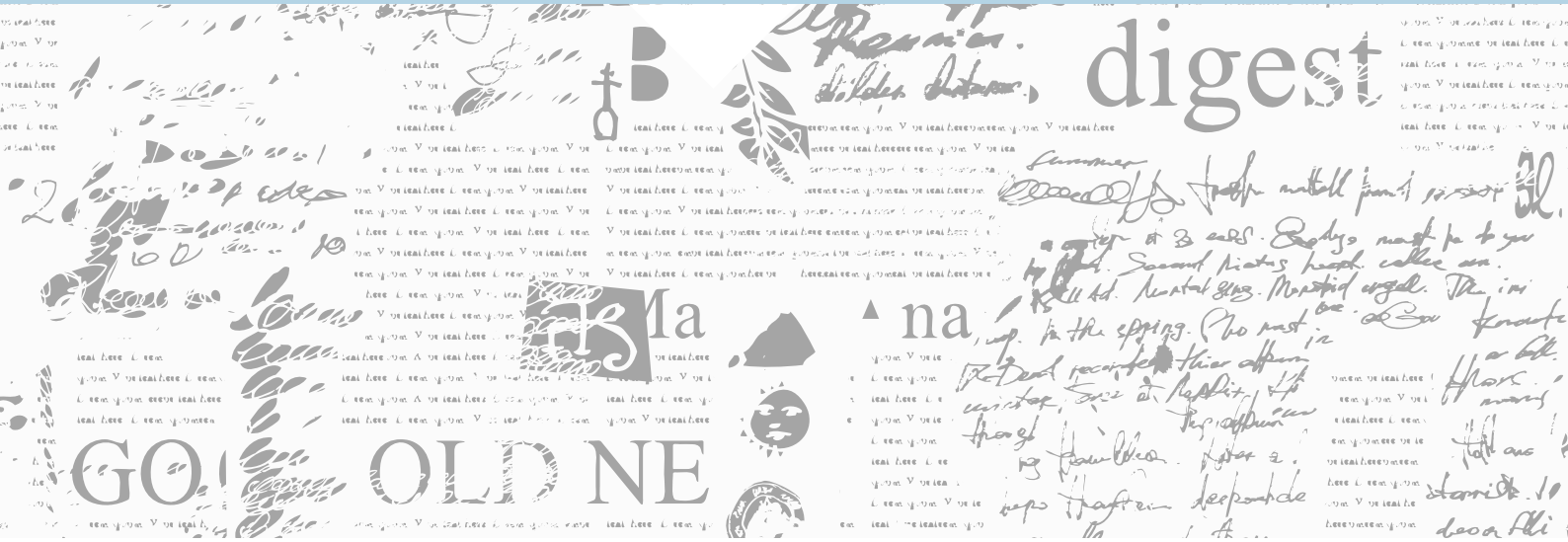
AUTHORS & CONTRIBUTORS



AUTHORS From Kuwait Oil Company - Soil Remediation Suppot Team

SE. Aisha Al-Barood	Sr Environmentalist, SRS Team
Eng. Hala Bader Al-Saleh	Planning Engineer, SRS Team
Eng. Hussain Abdulnaser Alkandari	Environmental Engineer, SRS Team
Eng. Ali Mohammad Ali Alsarraj	Environmental Engineer, SRS Team
Eng. Binu Kailas Sudhakaran	Environmental Engineer, SRS Team
Eng. Srinivasan Vedhapuri	Environmental Engineer, SRS Team

FROM PROJECT MANAGEMENT CONSULTANCY Worley

Mr. Hadi Diab	Projects Manager, Worley PMC
Dr. Djamel Lekmine	Manager Technical Services, Worley PMC
Mr. Hussam Sarahney	Area Manager, Worley PMC
Ms.Chinnu Babu Korah	Multimedia Specialist, Worley PMC
Mr. Ricardo De La Roche	Multimedia Specialist, Worley PMC
Mr. Yousef Ali Al- Haji	Project Coordinator, Worley PMC
Mr. Aliaksei Khmyl	Lead Remediation Specialist, Worley PMC
Mr. Ahmed Ismail	Lead Remediation Specialist, Worley PMC
Mr. Scott Hetrick	Lead Systems Engineer, Worley PMC
Mr. Steven Brown	Lead EOD/UXO Specialist, Worley PMC
Dr Ghulam Shabbir	Lead Ecologist Arid land Specialist, Worley PMC
Mr. Kanthimathinathan Krishnan	Agricultural Specialist, Worley PMC
Mr. Piyush Gupta	Remediation Specialist, Worley PMC
Mr. Farid Bellahdid	Remediation Specialist, Worley PMC
Mr. Arun Aravindakshan	Remediation Specialist, Worley PMC

CONTRIBUTORS Advisory Panel

Dr. Mojtaba Kazazi	President of AP
Dr. Hanns Schumacher	Member of AP
Mr. Uche Onwuamaegbu	Member of AP

Kuwait National Focal Point- KNFP

Mr. Saad Al-Saad	Senior Technical Consultant
Mr. Zaki Nuseibah	Senior Technical Consultant

Former Team Members

Mr. Alberto Dela Roche	Ex- Snr- Consultant in Soil Remediation support

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