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***Information and providing advice on improving the quality of environment in Slovakia**.*
The project is cofinanced by Cohesion Fund of the EU under Operational programme Quality of Environment.

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Vermiremediation strategy for remediation of Kuwaiti oil contaminated soil

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The activity has been implemented within the framework of national project
***Information and providing advice on improving the quality of environment in Slovakia**.*
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Introduction

The State of Kuwait sustained significant and widespread environmental damage resulting from the Iraqi invasion in August 1990 and the 1991 Gulf War. The occupation of Kuwait by the Iraqi army caused substantial damage to Kuwait's environment.

Case Study

- GULF WAR IN 1991

- 700 wells destroyed during the war

Lakes were formed at more than 500 different locations, covering a total area initially estimated at 49 km²

The surrounding environment is exposed to the oil lakes with all the contaminants left on the surfaces

22.7 million m³ of contaminated soil remains,

THREATENING POLLUTION OF PRECIOUS GROUNDWATER RESOURCES IF NOT TREATED

Side Effects from oil Contamination Sand

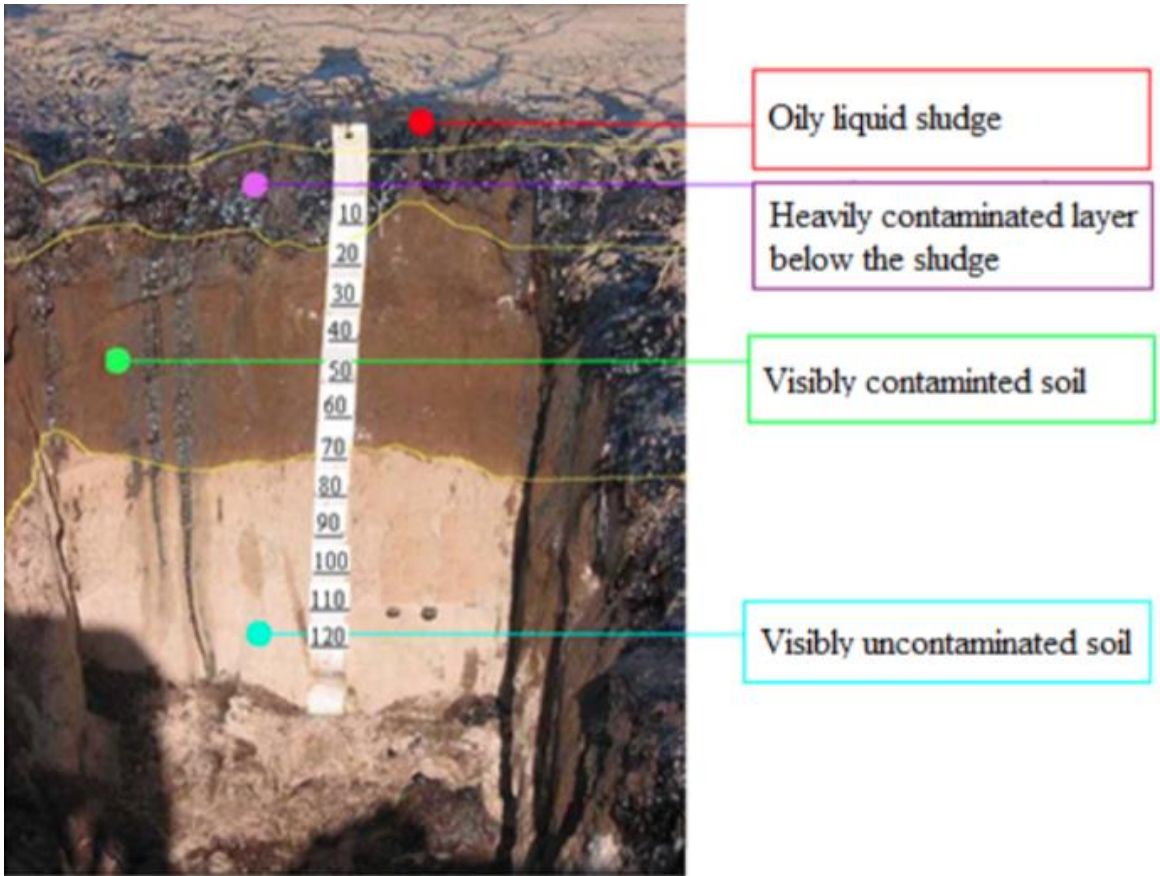
Studies conducted by and Gevao, et al. (2006) & Al-Awadi, et al. (2009) showed that: If the oil contaminated sand remain untreated, its considered as a PAHs reservoir that will maintain feeding the atmosphere and groundwater.

These oil lakes including the contaminated ground can possibly cause danger to the environment if not treated, and amongst others, they are:

- Threat to human and animal, health.
- Contamination of the surrounding soil.
- Contamination of the aquifers.

The Situation of the Oil Lake

- The oil lakes containing crude oil and partially combusted oil with soot,
- Most of the oil lakes are now “dry,” i.e., the contamination now comprises a black, moderately hard, tar-like dry surface layer.
- Even at 70 cm below ground, the contamination can be seen



Evaluation of oil lakes in Kuwait desert

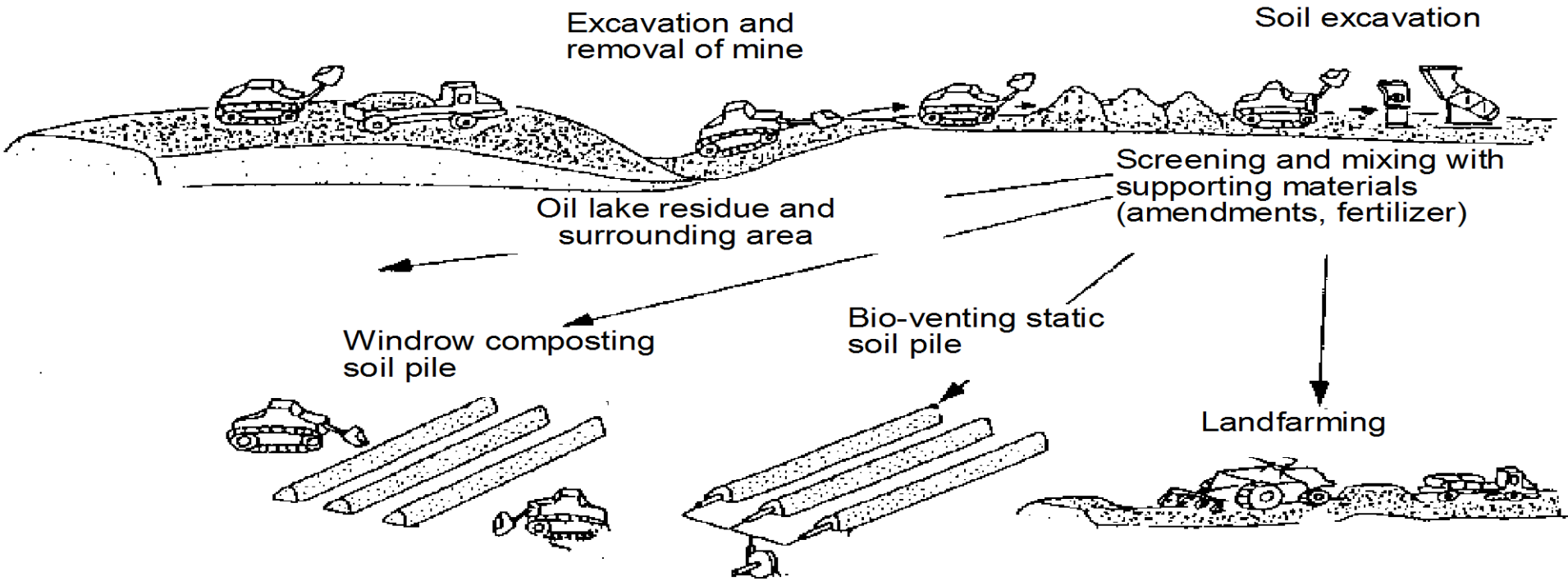
Area	Number of oil lakes	Description
Fresh groundwater	172	Lakes in north oil field
Residential areas and operational areas	69	Lakes within 1 km from residential areas, i.e., Ahmadi & the Ja'aidan garden and within 1 km of operational areas
Road, wells and pipelines	71	All lakes within 0.5 km paved road and in which wells lie and over which pipelines cross
Burgan oil field	123	Lakes in the Burgan oil field
Unclassified	79	Lakes in southern fields

Remediation of hydrocarbon contamination

- Remediation of hydrocarbon-contaminated land can occur by removing the source of the pollution or by breaking the pathways to the receptors.
- Pollution can be removed physically by the removal of contaminated soils; installation of physical barriers; vapour extraction; soil washing and thermal treatment.
- Bioremediation involves engineering measures to intensify and enhance the natural degradation processes in the soil. This can be achieved by adding microbial seeds, mechanical aeration pumps to increase the oxygen levels and by the addition of fertilisers.

Pervious Remediation Practices

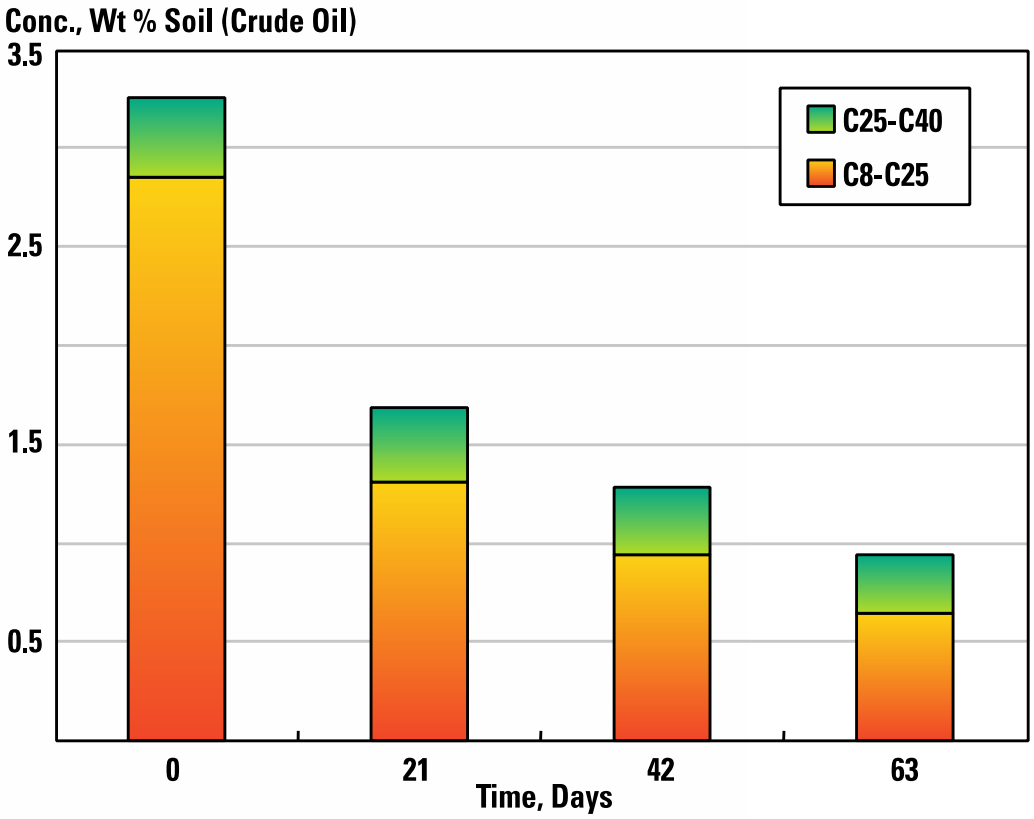
•In 1993, Japan Petroleum Energy Center (PEC) with the Kuwait Institute for Scientific Research (KISR) has been researching for the remediation of oil-contaminated soil.



- The previous methods are efficient at a concentration of TPH in soil below 20,000 mg/kg.

- As the age of an oil spill increases, there will be more opportunity for the oil to weather and for its constituents to attenuate in the environment. In general, ***the more weathering that has occurred, the less biodegradation that can occur***.

- At higher hydrocarbons concentrations, the ***bacteria population decreases*** and the soil ***bioremediation does not occur***.



This research suggested that a higher efficiency of oil reduction can be achieved by the introduction of earthworms into contaminated soil, i.e. by

Vermiremediation method

•Earthworms facilitate the removal of contaminants from soil and change the physical and chemical properties of soil by mixing it with organic substance and improving soil aeration, thus making contaminants accessible to microorganisms

Vermi-remediation Vs Oil Contamination

Vermi-remediation

This process is not always succeeded to destroy or remove of residual, heavy and hydrocarbons in contaminated soil. But, there is some evidence that this remediation is also able to degrade oil.

Vermi-remediation:

- Ex situ
- Relatively inexpensive
- Uses natural earthworm processes aeration, soil mixing, increased microbial activity, increased bioavailability of contaminants instead of intensive management to enhance physical and chemical properties

Toxicity Testing: Heavy Crude

EXP 1:

•Earth-worms (100) were added to 0.5 kg of soil and moisture was maintained at a level of 25 % for 5, 10, 20 and 30 days.

•Four trials were conducted to determine the survivability of earthworms such as *Eisenia fetida and Lumbricus terrestris* in the presence of crude- oil-contaminated soil after several days.

Conditions

- Water-content was adjusted to 25% on a soil dry weight. It was maintained during incubation by making additions as determined from reweighing containers.
- The jars were kept in an incubator at 20 ◦C
- TPH 1.0, 2.0, 2.5, 3.0 and 4.0%.
- The experimental units were plastic containers, the length, width and height of which are 0.49 m, 0.30 m and 0.35 m, respectively.

Result

The casts of the earthworms were collected to determine if the digestive systems of the earthworms were being exposed to oil.

Day	*Eisenia fetida*				*Lumbricus terrestris*				
	Survival of earthworms				Survival of earthworms				
	1.0%	2.0%	2.5%	3. 0%	1.0%	2.0%	2.5%	3.0%	4.0%
5	100	100	100	80	100	100	100	80	40
10	100	90	40	40	100	100	20	20	20
20	100	80	20	0	100	60	0	0	0
30	90	70	10	0	40	40	0	0	0

It has been found that the"

If the contamination " Weathered Oil Contamination" in soil > 2.00 % oil may not allow for survival of earthworms.

Toxicity Testing: Heavy Crude

EXP 2:

Earth-worms E. fetida (around 200) were added to 1 kg of soil and moisture was maintained at a level of 25 % for 150 days. The main aim of this experiment to evaluate if the earthworms are capable to remove or reduce the contamination of hydrocarbon from soil.

Conditions

- Water-content was adjusted to 25% on a soil dry weight. It was maintained during incubation by making additions as determined from reweighing containers.
- The jars were kept in an incubator at 20 ◦C

Result

Hydrocarbon	Soil with earth worm		Soil without earth worm
	Amount decrease	% Removal	% Removal
TPH	2- Fold	42	11
SVOC	1.3- Fold	52	9
VOC	Complete	100	62

- Results indicate that earthworms do play significant role, both, directly (through ingestion and enzymatic degradation) and indirectly (by stimulating microbial action) in removal of contamination of hydrocarbon from soil.

The results of these experiments show that earthworms, particularly E. fetida, can be used to enhance bioremediation and accelerate crude oil TPH degradation.

Result

- Degradation of 42% or more of crude oil within 150 days is realistic even with TPH concentrations exceeding 30,000 mg/kg. This level of TPH degradation in a native soil from a remediation site is strong evidence that vermiremediation is a potentially viable treatment technology for crude oil contaminated soils.

- This experiment found that the TPH concentration decreased significantly in samples with *E. fetida* within 150 days compared to the treatments without worms.

Will vermi-remediation be a viable alternative to reduce or remove of TPH from crude oil contaminated sites?

This experiment suggested that earthworms could be applied in the later stages of the bioremediation of even highly contaminated sites, when TPH concentrations and potential toxicity have been decreased to a moderate level.

- **IS the combination process required**

Soil washing is a treatment technology that uses water and a mechanical process to remove hazardous contaminants from soil.

US 20170138135A1

(19) **United States**

(12) **Patent Application Publication** (10) **Pub. No.: US 2017/0138135 A1**

ALMUTAIRI (43) **Pub. Date: May 18, 2017**

(54) **SYSTEM AND METHOD FOR REMEDIATION OF OIL-CONTAMINATED SAND**

(71) Applicant: **MESHARI ALMUTAIRI**, SAFAT (KW)

(72) Inventor: **MESHARI ALMUTAIRI**, SAFAT (KW)

(21) Appl. No.: **14/945,358**

(22) Filed: **Nov. 18, 2015**

Publication Classification

(51) **Int. Cl.**

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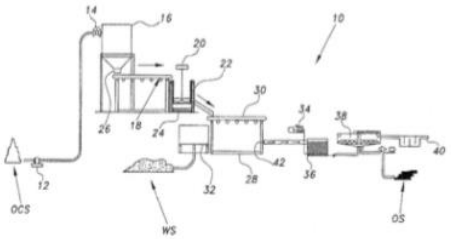
B08B 3/14	(2006.01)
C02F 1/52	(2006.01)
B08B 3/10	(2006.01)
B08B 3/12	(2006.01)
C02F 1/74	(2006.01)

(52) **U.S. Cl.**

CPC ***E21B 21/066*** (2013.01); ***B08B 3/12*** (2013.01); ***C02F 1/74*** (2013.01); ***C02F 1/52*** (2013.01); ***B08B 3/102*** (2013.01); ***B08B 3/14*** (2013.01); *C02F 2101/32* (2013.01)

(57) **ABSTRACT**

The system and method for remediation of oil-contaminated sand provides for washing and separation of sand from oil and oil-based contamination. The system includes a feed hopper for receiving a volume of oil-contaminated sand in communication with a cleaning tank for receiving the volume of oil-contaminated sand therefrom. A mechanical stirrer mixes the volume of oil-contaminated sand with a surfactant solution in the cleaning tank. An ultrasonicator ultrasonicates the volume of oil-contaminated sand and the surfactant solution in the cleaning tank to create a mixture of washed sand and oily wastewater. A collection tank then receives the mixture. A basal filter covers an open upper end of the collection tank, such that the mixture of washed sand and oily wastewater is filtered to separate out the washed sand, which may then be collected. The separated oily wastewater is then collected in the collection tank.



[19] *PATENT OFFICE OF THE COOPERATION COUNCIL FOR THE ARAB STATES OF THE GULF*

[19] مكتب براءات الاختراع
مجلس التعاون لدول الخليج العربية

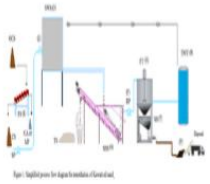
[12] Patent

[11] Patent No.:GC0006708 [45] Date of Publishing the Grant of the Patent: 30/Dec /2017 44/2017	Number of the Decision to Grant the Patent:2017/117487 Date of the Decision to Grant the Patent:14/Dec/2017
[21] Application No.:GC 2017-33018 [22] Filing Date:22/2/2017 [72] Inventor: meshari saad almutairi [73] Owner: meshari saad almutairi, block 7 street 2 5 home 50, subah alnasser, PO Box 5114. , Kuwait [74] Agent: meshari saad almutairi	[51]IPC: Int. Cl.: B08B 3/10, 3/12, 3/14; C02F 1/52, 1/74; E21B 21/06 (2006.01) [56] Cited Documents: US 5376182 (Lorne G. Everett, et al) 27 December 1994- US 6082548 (Robert John Stephenson, et al) 4 July 2000- Examiner: Eng. Sattam M.AlMutairi

[54] REMEDIATION OF OIL CONTAMINATED SAND: USING COMBINATION OF ULTRASONIC SYSTEM AND MECHANICAL STIRRER WITHIN INTEGRATED SYSTEM PROCESS

[57] Abstract: Soil remediation has traditionally been regarded as an afterthought by major oil producers. With increased global environmental standards and the proven ability to use suggested technology (Soil washing method) in the harshest environments with the Kuwait oil sand. The novelty of the concept note is that it aims to focus on problems associated with the cleanup of oil-contaminated soil in Kuwait having Oil Lakes which have demonstrated that there is a need for a new remediation technique that are feasible, having less serious side effects, quick, and low cost, which has the potential to address environmental contamination by various pollutants mixtures. The methodology is straight forward and the results have a direct positive impact on the remediation of Kuwait oil contaminated soil.

No. of claims: 13 No. of figures: 8

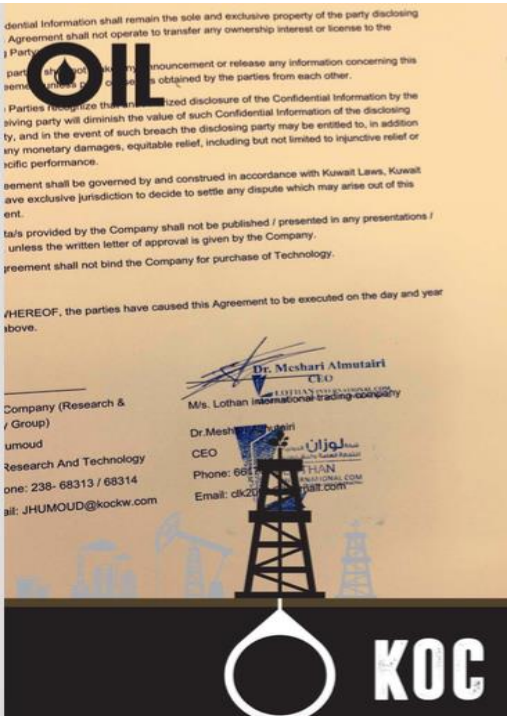


Memorandum of Understanding (MOU) with (KNPC) and (KOC)

- **Memorandum of understanding (MOU) was signed with both Kuwait National Petroleum Company (KNPC) and Kuwait Oil Company (KOC) for** the pilot project for "*Remediation of hydrocarbon contaminated soil*".

Aim

To evaluate the performance of the system and method for oil contaminated sand Technology developed by Dr. M. Al-Mutairi



Scope of the Pilot

- To give general overview of the technology (soil washing) that I have develop
- To share with you the result of the field pilot which was conducted in which KNPC and KOC witness
- Derive the operational indices as an indicative parameter for the design of commercial plant for the combination process of physical remediation and bioremdiation

Procedure of the pilot:

1. **Pre-treatment:** Wet screens to remove oversize materials (> 25 mm “mass particles)

2. **Soil washing system (SWS):** Contaminated soil is washed without chemical agents for 2 h

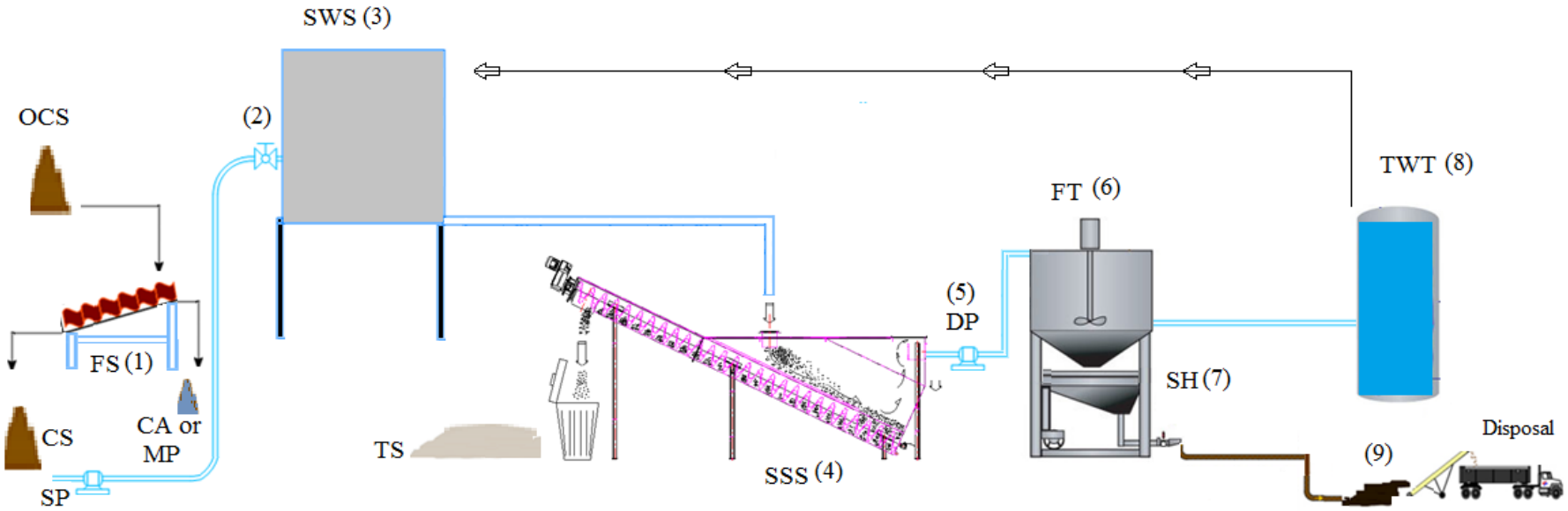
3. **Sand separator:** Sand separator is used to separate treated sand from oily wastewater

4. **water Treatment:** Wastewater is treated using flocculation tank ****Treated Water is recycled***

5.Oil residue generated: “Zero Waste Discharge” send it to cement factory /road construction.

Procedure of the Pilot:

(1) FS: Feed sieve:***OCS**: Oil Contaminated Sand
(2) SP: Solid pump. ***CA**: Coarse aggregate& **MP**: Mass particle
(3) SWS: Soil Washing System: ***TS**: Treated Sand
(4) SSS: Sand Separated System
(5) DS: Dewatering Pump
(6) FT : Flocculation Tank
(7) SH : Sludge Hopper
(8) TWT: Treated Water Tank



Pilot Project: Initial Remedial Design

Three different samples of oil contaminated sand had been given by (KNPC) and (KOC) within three weeks, whereby:

- Light contaminated oily sand has been given in the 1st week

  The concentration of light contaminated sample = **8,645.0 mg/kg**

- Heavy contaminated oily sand has been given in the 2nd week

  The concentration of heavy contaminated sample = **18,640.0 mg/kg**

- Medium contaminated of oily sand has been given in the 3rd week

  The concentration of medium contaminated sample = **11,548.7 mg/kg**

شركة البترول الوطنية الكويتية

KNPC

Date: 02nd August 2016 Ref. No.: MAB-MRT(A)-16-0287

Dr. Meshari Al-Mutairi
Lothan International Company

Dear Dr. Al-Mutairi,

Subject: **Technology for Remediation of Hydrocarbon Contaminated Soil – Pilot Plant Testing**

Reference is made to the above subject and the MOU signed between KNPC & M/s LOTHAN to utilize Dr. Meshari's patented technology on contaminated soil treatment.

KNPC hereby confirms that the pilot plant conducted by M/s LOTHAN has been successfully completed and the results for Total Petroleum Hydrocarbon (TPH) of the treated soil is meeting K-EPA's Regulations.

Summary of the results carried out by M/s NAPESCO lab using testing method EPA 9071B is as follows:

Sample	Before (mg/Kg)	After (mg/Kg)	Percent reduction (%)
1st batch (Light Contaminated)	8645	980	88.66
2nd batch (Heavy Contaminated)	18640	3527.5	81.07
3rd batch(Medium Contaminated)	11548.7	948.8	91.78

We at KNPC would like to take this opportunity to appreciate your patented technology and we wish you all the success in your future projects.

Dr. Suad Al-Radwan
Manager R&T

Date: 8 - MAR 2017
Ref: ER21-L-17-03-023

Dr. Meshari Al-Mutairi
M/s. Lothan International Company
Kuwait

Mobile: +965 66177017
Email : clk2001@hotmail.com

Proposal for Cleaning System

Dear Dr. Meshari,

This has reference to our earlier letter dated 19th February 2017 and subsequent correspondence / discussion on the subject matter.

In this regard, please be informed that the small test conducted by you utilizing Soil Wash with Electrification concept for treatment of KOC's Contaminated Soil, during 13th-14th Dec 2016, under supervision of KOC's representative at 3B General Trading and Contracting Company W.L.L in Shuaiba, Kuwait. In this regard, we appreciate your interest to carry out this test and we are pleased to provide the summary of the Lab Test results as follows:

4 Batches each of 150 Kgs of Contaminated Soil was treated during the small test. The Total Petroleum Hydrocarbon (TPH) was observed in the range of 85,200 to 29,600 ppm in the Untreated Contaminated Soil (Before Treatment) and the Total Petroleum Hydrocarbon (TPH) was observed in the range of 8,170 to 9,620 ppm (immediately after start of Treatment) in the Treated Contaminated Soil.

A report comprises of the Treatment Method, TPH levels at different stages of the treatment, etc., on the above test conducted by you is enclosed as Attachment for your kind information and necessary reference please.

Yours Sincerely

Bader Al-Matar
Team Leader Surface Team
Research & Technology Group

Cc: TL Soil Remediation Project-I
TL Soil Remediation Support

BK/JS

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Technical Head
TEF KUWAIT

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Conclusion

- The pilot generates comprehensive information on the remediation efficiency of oil contaminated soil.
- Cost saving for operator unlike other technology
- Process works better with fines soils while the majority of contamination associated with fine particles
- All sand fractions can be treated
- Water treatment possible
- Meeting KEPA standard in the treated soil
- Zero emission of hazard material and the result residue can be utilised for other industries.

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DEGREE & P.H.D. AWARD

Dr. Meshari Almutairi has presented his thesis and ranked

4th place in Remtech 2017 Degree and P.H.D. Award.

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DIPLÔME

Inventions Geneva

SALON INTERNATIONAL DES INVENTIONS

GENÈVE

Après examen, le Jury International a décidé

de remettre à: Meshari Saad Almutairi

pour l'invention: Système intégré axé sur l'assainissemen
par le pétrole

MÉDAILLE D'OR
GOLD MEDAL
GOLDMEDAILLE

Genève

Le Président du Jury: David Tol

Le Président du Salon: Jean-Luc Vincent

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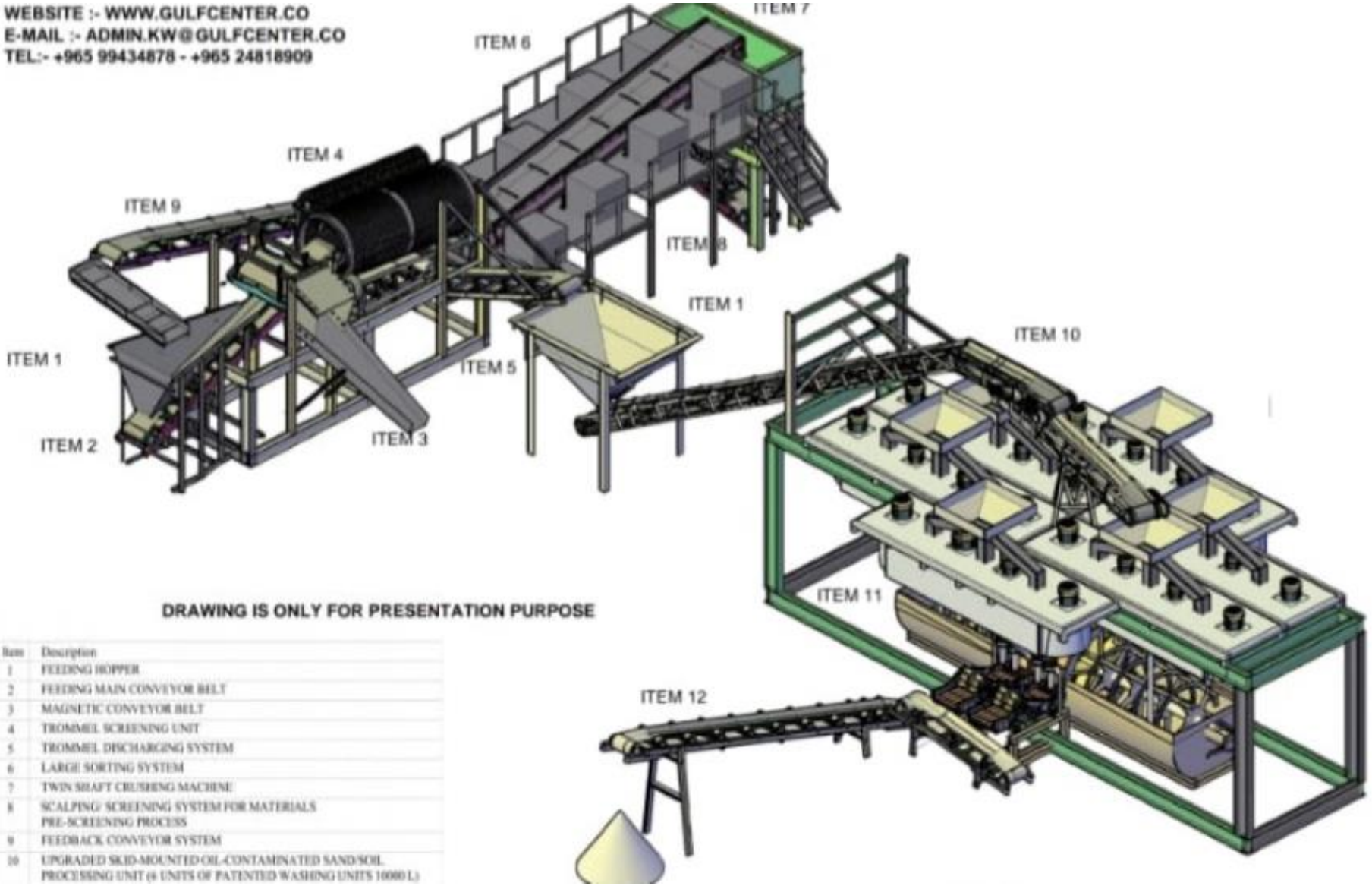

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Item	Description
1	FEEDING HOPPER
2	FEEDING MAIN CONVEYOR BELT
3	MAGNETIC CONVEYOR BELT
4	TROMMEL SCREENING UNIT
5	TROMMEL DISCHARGING SYSTEM
6	LARGE SORTING SYSTEM
7	TWIN SHAFT CRUSHING MACHINE
8	SCALPING/ SCREENING SYSTEM FOR MATERIALS PRE-SCREENING PROCESS
9	FEEDBACK CONVEYOR SYSTEM
10	UPGRADED SKID-MOUNTED OIL-CONTAMINATED SAND/SOIL PROCESSING UNIT (6 UNITS OF PATENTED WASHING UNITS 10000 L)


Thank You!