RDK-KEEEN

REPORT OF TECHNOLOGY DEMONSTRATION FOR REMEDIATION OF HYDROCARBON IMPACTED SOIL

USING

ELECTROKINETIC OXIDATION ENHANCED BIOREMEDIATION

AT

KWAWA, KHANA LOCAL GOVERNMENT AREA OF RIVERS STATE. NIGERIA

BY

RDK ENVIRONMENTAL ECO SOLUTIONS LIMITED

AS PART OF ONGOING REMEDIATION OF IMPACTED SOIL IN OGONI AREA OF RIVERS STATE, UNDER THE HYDROCARBON POLLUTION REMEDIATION PROJECT (HYPREP)

FROM

27TH APRIL, 2017 – 12TH MAY, 2017

RDK ENVIRONMMENTÁL ECO SOLUTIONS LTD

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RDK-KEEEN

ELECTROKINETIC OXIDATION ENHANCED BIOREMEDIATION OF CRUDE OIL IMPACTED SITE AT KWAWA, KHANA LOCAL GOVERNMENT AREA OF RIVERS STATE. NIGERIA.

INTRODUCTION

Technology for soil remediation presented to The Hydrocarbon Pollution Remediation Project (HYPREP) by RDK Environmental Eco Solutions Limited was demonstrated in Kwawa between April 27 and May 12, 2017. The procedure adopted involved baseline investigation of the level of Total Petroleum Hydrocarbon (TPH) in the impacted area, excavation of soil for mixing with nutrient (ORS-Sorb) for microbial uptake, addition of hydrocarbon utilizing microbes (KEEEN Oil Spill Control), and installation of electrodes (EKOGRID^{TM}) to provide required electrons transfer.

In the course of demonstration and monitoring; soil, sediment, and water samples were collected by both RDK and HYPREP for parallel analysis, however this report is based on analysis conducted by RDK. Baseline samples were analysed for TPH only, but monitoring samples were analysed for more parameters; PAH, BTEX, and microbial counting.

After 80 days of demobilizing from site, the baseline top soil (0 – 0.5 m) average TPH of 14,660 mg/kg was reduced to 4,300 mg/kg, while appreciable change was not observed at 1.0 m (baseline; 5256 mg/kg, monitoring; 6480 mg/kg). All surface water samples recorded TPH (720 µg/L) above national intervention limit of 600 µg/L.

Other analysedparameters could not be compared since these were absent in baseline study. However all Polycyclic Aromatic Hydrocarbon (PAH) were below national intervention limit of 40 mg/kg, while Benzene, Toluene, Ethylbenzene, and Xylene were below detection limit of 0.001 mg/kg. In addition, 85% of the soil and sediment bacteria wereHydrocarbon Utilizing Bacteria (HUB).

Further monitoring and sampling have been scheduled to follow up on performance of the technology.However, from the results obtained so far, the demonstrated technology has shown capability of remediating crude oil impacted site.

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LOCATION AND SITE DESCRIPTION

The Bioremediation Technology Demonstration site is located in Kwawa community, Khanna Local Government Area of Rivers State. The site is a Shell Petroleum Development Company (SPDC) disused manifold area in Yorla Oil Field. The site is about 80 m northwest from the disused manifold and covers an area of 1050 m^2. The site was dominated by grasses, shrubs and trees that are adapted to saturated soil due to adjoining seasonal swamp. There was an adjoining forest area about 15 m north and west of the site made up of palm trees and other shrubs.

A tarred road leading to the community was located about 50 m southeast of the site. Topography of the site is relatively flat and slopes gradually northwest into a seasonally waterlogged area. Trenches were dug round the designated site area to act as water-break and redirect runoff from entering into the treatment area. Figure 1 – 3 provide an overview of the site.

Figure 1. HYPREP Project Coordinator and representative of RDK during initial site visit

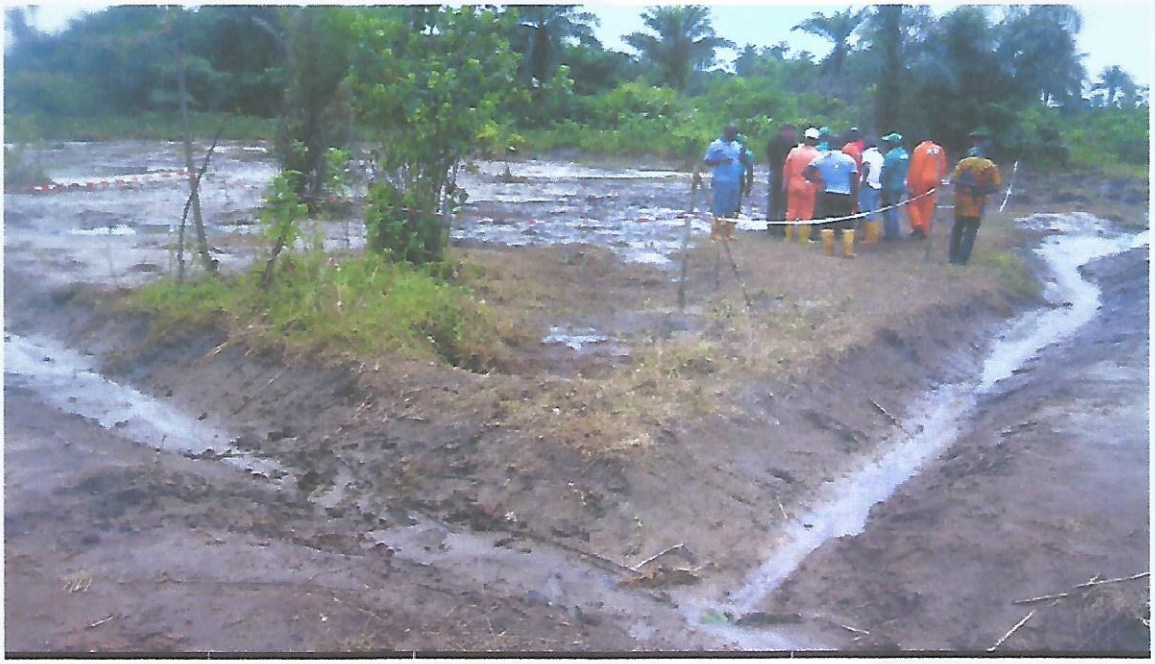
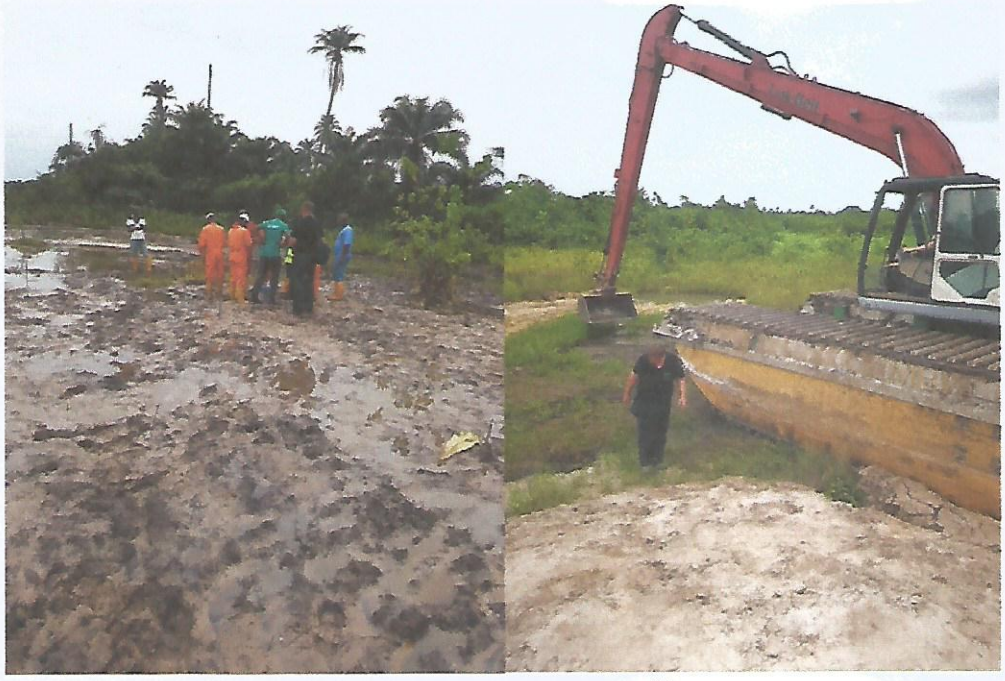


Figure 2. Cleared and demarcated site with trenches for diverting run-off



(a) (b)

Figure 3. Ongoing work at the site (a) Sampling (b) Soil excavation

SITE MONITORING

Post-demonstration site monitoring was conducted on 31st July, 2017 by RDK to appraise the level of remediation occurring within the worked area. About 80% of the site has been colonized by indigenous macrophytes with deep green leave colour and overgrown than

adjoining grasses where treatment did not take place. Also the open stagnant water was clear without any floating oil sheen. However, some pockets of sediment disturbances resulted into release of light oil sheen on water. The ambient air around the site was free of hydrocarbon odour, but, soil and sediment samples showed varying hydrocarbon odour from medium to faint.

Sediment and water samples were collected at three locations within submerged area, while soil samples at 0.5 m and 1.0 m depth were collected at a point in uplandtreated area. Please see the certificate of analysis for the results.

Table 1: Sampling schedule for monitoring remediation work

S/N	Stage of sampling	Sampling date	No of samples collected		
			Soil	Sediment	Surface water
1	Before demonstration	22/03/207	4	-	-
2	Post demonstrationmonitoring	31/07/2017	2	3	3
Total number of samples collected			**6**	**3**	**3**

Figure 4.Post demonstration monitoring and sampling

Figure 5. Grass appearance within and outside worked area

Figure 6. Clear water within worked area

Figure 7. Inhabitant macrophytes

SAMPLING PROCEDURE

Soil, sediment, and surface water samples were collected in different phases during the remediation demonstration. The GPS coordinates are indicated in the attached laboratory analysis reports.

Soil samples were collected with the aid of stainless steel hand auger at intervals of 0.5m and 1.0m in all the soil sampling locations. The auger holes were backfilled to avoid soil fragmentation in the soil structure. During the baseline sampling, a total of four (4) soil samples were collected within the demarcated area, while two(2) was collected during post-demonstration monitoring in addition to 3 sediment, and 3 water samples. The samples were stored in coolers boxes fitted with ice packs.

Baseline samples were analysed for TPH only, but post-demonstration monitoring samples were analysed for more parameters (PAH, BTEX, and microbial count) in addition to TPH.

Figure 8.Baseline sampling exercise.

Figure 9. Sediment sampling during post-demonstration monitoring

RESULTS AND INTERPRETATION

The TPH result is shown in Table 2. The result at 0.5 m shows significant decrease from 14,662 mg/kg before treatment to 4,302 mg/kg after treatment but there was no appreciable change at 1.0 m depth. It is to be noted that two time sampling and analysis might not be enough to fully analyse the performance of the treatment technology neither will the trend of parameter change identified. Above all, the current results hover around the national intervention limit (5,000 mg/kg) ahead of further sampling and analysis.

The TPH result of water samples is shown in Table 3. All the results are above national intervention limit (600 µg/L). This could be possibly due to sampling procedure of collecting water samples after sediment sampling. The results however corroborated the emergence of oil sheen when sediment was disturbed.

For other parameters, PAHs were below national intervention limit (40 mg/kg for soil & sediment, and 70 µg/L for water), while BTEX were below detection limit (<0.001 mg/kg and <0.001 µg/L). For the microbial analysis however (Table 4), bacteria dominated the total heterotrophic microbes in the samples, and about 85% of the bacteria in soil and sediment were composed of hydrocarbon utilizing bacteria species. Future analysis will be used to identify correlation of HUB and TPH in all samples.

Table 2.TPH in Soil and Sediment Samples (mg/kg)

	Before treatment		**Post-treatment monitoring**	
DATE	**22/03/2017**		**31/07/2017**	
SAMPLE ID	**0.5m**	**1.0m**	**0.5m**	**1.0m**
KW - SS1	16607.7	6102.9		
KW -SS2	12717	4410.9		
KW-SS1			4511	6480
KW-SED1			3890	
KW-SED2			3390	
KW-SED3			5419	
AVERAGE	**14662.35**	**5256.9**	**4302.5**	**6480**

The values in red are higher than national intervention limit (5000 mg/kg)

Table 3. TPH in surface water samples (µg/L)

SAMPLE ID	TPH
KW-W1	690.75
KW-W2	670.63
KW-W3	800.67
AVERAGE	**720.68**

Table 4.Microbial analysis of soil, sediment and water samples.

SAMPLE ID	Soil (cfu/g)	Sediment (cfu/g)	Water (cfu/L)
Total heterotrophic bacteria	23.15×10^5	20.87×10^5	8.83×10^5
Hydrocarbon utilizing bacteria	19.00×10^5	18.02×10^5	2.26×10^5
Total heterotrophic fungi	11.00×10^5	9.45×10^5	0.71×10^5
Hydrocarbon utilizing fungi	7.00×10^5	5.74×10^5	0.33×10^5

CONCLUSION

Electrokinetic enhanced bioremediation technology was demonstrated by RDK Environmental Eco Solutions Limited in crude oil impacted site at Kwawa, Local Government Area of Rivers State. The technology involved biostimulation and bioaugmentation, which were complemented by electrokinetic oxidation. In the post-demonstration site monitoring, the site is currently colonized by indigenous grasses and appeared to overgrow than grasses outside treated area.

Result of sample analysis indicates significant reduction of TPH at 0.5 m depth though the values hover around national intervention limits, but no significant change was recorded at 1.0 m. Further sampling and analysis will be required for holistic performance review.

16/8/17

Golding Manns Ekow
Managing Director

KEMNOULLI NIGERIA LIMITED
INDEPENDENT MARINE INSPECTIONS, ENGINEERING AND QUALITY CONTROL SERVICES.
PLOT 10 SABBATH ROAD, ELELENWO, PORT HARCOURT. PHONE: 084 771798
PHONE: 080 33427 302, 081 60162 397
Email: kemnoulli@yahoo.com

DATE: 23-03-2017

RDK ENVIRONMENTAL ECO SOLUTIONS LIMITED
PORT HARCOURT
RIVERS STATE
NIGERIA
ATTENTION: MANAGING DIRECTOR

REPORT / CERTIFICATE OF ANALYSIS

DATE:	**MARCH 23, 2017**
JOB:	**ENVIRONMENTAL ASSESSMENT (SAMPLING AND ANALYSIS OF SOIL SAMPLE).**
REPORT NO:	**KNL/LAB.001/03/2017/PH**
SAMPLED BY:	**RDK**
SITE NAME:	**KWAWA**
DATE SAMPLED:	**22 - 03 – 2017**
DATE RECEIVED:	**22 - 03 – 2017**
DATE OF ANALYSIS:	**23 - 03 – 2017**

This certificate of analysis may only be used in its entirety.
Additional information concerning this certificate of analysis can be found in the analytic document 'Specification of method of Analysis'. Copies are available in our office.

A total number of Four (4) samples were collected on 22nd of March, 2017 from two (2) different sampling points at KWAWA with different depths of 0.5m and 1.0m.The soil samples were documented, preserved and transported to the laboratory in ice packed coolers to preserve the sample integrity. The soil samples were analysed for TPH

We trust that we have performed the order in accordance with your expectations. If you have any question concerning this certificate of analysis, please do not hesitate to contact the above number on the letter heading.

Approved By:

For: KNL

Engr. Martin Okoye
Managing Director/CEO

SAMPLING/ANALYSIS PLAN AND STORAGE

S/N	NAME OF SITE/LOCATION	SAMPLE ID	DEPTH	SAMPLE TYPE	PARAMETER	SAMPLE CONTAINER TYPE	
						AMBER GLASS BOTTLE	GLASS BOTTLE
1	KWAWA	KW-SS1	0.50m	SOIL	TPH	X	
2			1.00m			X	
3		KW – SS2	0.50m			X	
4			1.00m			X	

LABORATORY ANALYTICAL REPORT

REPORT NO.:	KNL/LAB.001/03/2017/PH	**INCIDENT :**	N/A
CLIENT:	RDK ENVIRONMENTAL ECO SOLUTIONS LTD	**SAMPLED BY:**	RDK
TYPE OF SAMPLE:	SOIL SAMPLE	**DATE SAMPLED:**	22 – 03 – 2017
SAMPLE ORIGIN:	KWAWA	**DATE RECEIVED:**	22 – 03 – 2017
SAMPLE SOURCE:	N/A	**DATE OF REPORTING:**	23 – 03 – 2017

S/N	PARAMETERS	METHODS	UNIT	DPR max. INTERVENTION LIMIT	RESULT			
					KW-SS1 (0.50m) N 4°36' 32" E 7°28' 53.50"	KW-SS1 (1.00m) N 4°36' 32" E 7°28' 53.50"	KW-SS2 (0.50m) N 4°36' 31.38" E 7°28' 53.59"	KW-SS2 (1.00m) N 4°36' 31.38" E 7°28' 53.59"
	PHYSICAL CHARACTERISTICS							
1	TEMPERATURE	-	°C	-				
2	pH	ASTM D1293B	-	-				
3	DISSOLVED OXYGEN	APHA 422B	mg/l	-				
4	ELECTRICAL CONDUCTIVITY	ASTM D1125	µS/cm	-				
5	SALINITY	APHA 2520	mg/kg	-				
6	TOTAL SUSPENDED SOLIDS	ASTM D1868	"	-				
7	TOTAL DISSOLVED SOLID	ASTM D1868	"	-				
8	TURBIDITY	APHA 2130	NTU	-				
	METALS							
1	ARSENIC	ASTM D2972	mg/kg	55				
2	BARIUM	ASTM D4382	"	625				
3	CADMIUM	ASTM D2576D	"	12				
4	COBALT	ASTM D3558A	"	240				
5	CHROMIUM	ASTM D2972	"	380				
6	COPPER	ASTM D1688D	"	190				
7	NICKEL	ASTM D1886C	"	210				
8	MERCURY	ASTM D3229	"	10				
9	LEAD	ASTM D3559	"	350				
10	ZINC	ASTM D1691 C	"	720				
1	**HYDROCARBONS**TPH	GC (FID)	mg/kg	5000	16,607.70	6,102.90	12,717.00	4,410.90
2	PAH	GC-MSD	"	40				
3	BENZENE	"	"	1				
4	TOLUENE	"	"	130				
5	ETHYLBENZENE	"	"	50				
6	XYLENE	"	"	25				
	BIOLOGICALS							
1	BOD	APHA 507	mg/l	-				
2	COD	ASTM D1252	"	-				
3	COLIFORM	MPN COUNT	MPN/ 100ml	-				
4	TOTAL HETEROTROPHIC BACTERIA	APHA 9215B	Cfu/g	-				
5	HYDROCARBON DEGRADING BAC.	"	"	-				
6	TOTAL HETEROTROPHIC FUNGI	"	"	-				
7	HYDROCARBON DEGRADING FUNGI	"	"	-				

FOR: KNL: IKENNA AYEKE
LAB.COORDINATOR

APPROVED BY: KNL: _____
MANAGING DIRECTOR

GC CONDITIONS AND METHOD

TOTAL PETROLEUM HYDROCARBON (TPH)

Samples were analyzed in line with USEPA 8015 method using Gen Tech Master GC equipped with a split/splitless injector, J and W 30 meter DB-5 column and an FID detector. The carrier gas Helium was set at 20ml/min. The injector temperature was set at 240°c and the detector temperature at 300°C. The total run time at 1µl injection volume through the capillary column with a slow ramp rate 40°c to 310°c is 45 minutes. The GC was calibrated using three working standards prepared from a stock solution of Accu standard Hydrocarbon window defining standard 500µg/ml in chloroform.

KEMNOULLI NIGERIA LIMITED
INDEPENDENT MARINE INSPECTIONS, ENGINEERING AND QUALITY CONTROL SERVICES.
PLOT 10 SABBATH ROAD, ELELENWO, PORT HARCOURT. PHONE: 084 771798
PHONE: 080 33427 302, 081 60162 397
Email: kemnoulli@yahoo.com

DATE: 04-08-2017

RDK ENVIRONMENTAL ECO SOLUTIONS LIMITED
PLOT N0. EA40, LIGHT IND. ZONE,
DEIDEI, RESIDENTIAL DESTRICT,
ABUJA, FCT,
NIGERIA.

ATTENTION: MANAGING DIRECTOR

REPORT / CERTIFICATE OF ANALYSIS

DATE:	**AUGUST 06, 2017**
JOB:	**ENVIRONMENTAL ASSESSMENT (SAMPLING AND ANALYSIS OF SOIL, SEDIMENT AND WATER SAMPLES).**
REPORT NO:	**KNL/LAB.001/07/2017/PH**
SAMPLED BY:	**NOSDRA/KNL**
SITE NAME:	**KWAWA**
DATE SAMPLED:	**31 - 07 – 2017**
DATE RECEIVED:	**31 - 07 – 2017**
DATE OF ANALYSIS:	**31/07/-05/08/ 2017**

This certificate of analysis may only be used in its entirety.
Additional information concerning this certificate of analysis can be found in the analytic document 'Specification of method of Analysis'. Copies are available in our office.

A total number of Eight (8) samples were collected on 31st of July, 2017 from different sampling points at KWAWA. Two (2) soil samples were collected from one (1) sampling point with different depths of 0.5m and 1.0m while three (3) water and three (3) sediment samples were collected from three (3) same sampling points. The soil, sediment and water samples were documented, preserved and transported to the laboratory in ice packed coolers to preserve the sample integrity. The soil and water samples were analysed for TPH

We trust that we have performed the order in accordance with your expectations. If you have any question concerning this certificate of analysis, please do not hesitate to contact the above number on the letter heading.

Approved By:

For: KNL

Engr. Martin Okoye
Managing Director/CEO

KNL
KEMNOULLI NIG. LIMITED

SAMPLING/ANALYSIS PLAN AND STORAGE

S/N	NAME OF SITE/LOCATION	SAMPLE ID	DEPTH	SAMPLE TYPE	PARAMETER	SAMPLE CONTAINER TYPE	
						AMBER GLASS BOTTLE	GLASS BOTTLE
1	KWAWA	KW-SS1	0 50m	SOIL	TPH,PAH,BTEX, MCB	X	
2			1 00m	SOIL	TPH,PAH,BTEX, MCB	X	
3		KW-SED 1	-	SEDIMENT	TPH,PAH,BTEX, MCB	X	
4		KW-SED 2	-	SEDIMENT	TPH,PAH,BTEX, MCB	X	
5		KW-SED 3	-	SEDIMENT	TPH,PAH,BTEX, MCB	X	
6		KW- W1	-	WATER	TPH,PAH,BTEX, MCB		X
7		KW- W2	-	WATER	TPH,PAH,BTEX, MCB		X
8		KW- W3	-	WATER	TPH,PAH,BTEX, MCB		X

KNL
KEMNOULLI NIG LIMITED

LABORATORY ANALYTICAL REPORT

REPORT NO.:	KNL/LAB 001/08/2017/PH	INCIDENT :	N/A
CLIENT:	RDK ENVI ECO SOLUTIONS LIMITED	SAMPLED BY:	NOSDRA KNL
TYPE OF SAMPLE:	SOIL SAMPLE	DATE SAMPLED:	31 – 07 – 2017
SAMPLE ORIGIN:	KWAWA	DATE RECEIVED:	31 – 07 – 2017
SAMPLE SOURCE:	N/A	DATE OF REPORTING:	05 – 08 – 2017

S/N	PARAMETERS	METHODS	UNIT	DPR max. INTERVENTION LIMIT	RESULT	
					KW-SS1 (0.50m)	KW-SS1 (1.00m)
	PHYSICAL CHARACTERISTICS				N04°36' 31.5" E007° 28' 53.5"	N04°36' 31.5" E007° 28' 53.5"
1	TEMPERATURE		°C	-	-	-
2	pH	ASTM D1293B	-	-	-	-
3	DISSOLVED OXYGEN	APHA 422B	mg/l	-	-	-
4	ELECTRICAL CONDUCTIVITY	ASTM D1125	µS/cm	-	-	-
	METALS				-	-
1	ARSENIC	ASTM D2972	mg/kg	55	-	-
2	BARIUM	ASTM D4382	,,	625	-	-
3	CADMIUM	ASTM D2576D	,,	12	-	-
4	COBALT	ASTM D3558A	,,	240	-	-
5	CHROMIUM	ASTM D2972	,,	380	-	-
6	COPPER	ASTM D1688D	,,	190	-	-
7	NICKEL	ASTM D1886C	,,	210	-	-
8	MERCURY	ASTM D3229	,,	10	-	-
9	LEAD	ASTM D3559	,,	350	-	-
10	ZINC	ASTM D1691 C	,,	720	-	-
1	**HYDROCARBONS**TPH	GC (FID)	mg/kg	5000	4,510.89	6,480.40
2	PAH	GC –MSD	,,	40	22.55	32.40
3	BENZENE	,,	,,	1	<0.001	<0.001
4	TOLUENE	,,	,,	130	<0.001	<0.001
5	ETHYLBENZENE	,,	,,	50	<0.001	<0.001
6	XYLENE	,,	,,	25	<0.001	<0.001
	BIOLOGICALS				-	-
1	BOD	APHA 507	mg/l	-	-	-
2	COD	ASTM D1252	,,	-	-	-
3	COLIFORM	MPN COUNT	MPN/ 100ml	-	-	-
4	TOTAL HETEROTROPHIC BACTERIA	APHA 9215B	Cfu/g	-	22.30×10^5	24.00×10^5
5	HYDROCARBON DEGRADING BAC	,,	,,	-	18.00×10^5	20.00×10^5
6	TOTAL HETEROTROPHIC FUNGI	,,	,,	-	10.00×10^5	12.00×10^5
7	HYDROCARBON DEGRADING FUNGI	,,	,,	-	7.00×10^5	7.00×10^5

FOR: KNL: IKENNA AYEKE
LAB.COORDINATOR

APPROVED BY: KNL: _____
MANAGING DIRECTOR

KNL
KEMNOULLI NIG LIMITED

LABORATORY ANALYTICAL REPORT

REPORT NO.:	KNL/LAB 002/08/2017/PH	INCIDENT :	N/A
CLIENT:	RDK ENVI ECO SOLUTIONS LIMITED	SAMPLED BY:	NOSDRA/KNL
TYPE OF SAMPLE:	SEDIMENT SAMPLE	DATE SAMPLED:	31 – 07 – 2017
SAMPLE ORIGIN:	KWAWA	DATE RECEIVED:	31 – 07 – 2017
SAMPLE SOURCE:	N/A	DATE OF REPORTING:	05 – 08 – 2017

S/N	PARAMETERS	METHODS	UNIT	DPR max. INTERVENTION LIMIT	RESULT		
					KW-SED 1	KW-SED 2	KW-SED 3
	PHYSICAL CHARACTERISTICS				N04°36' 31.9" E007°28' 53.0"	N04°36' 32.3" E007°28' 53.6"	N04°36' 32.0" E007°28' 53.4"
1	TEMPERATURE	-	°C	-	-		-
2	pH	ASTM D1293B	-	-	-		-
3	DISSOLVED OXYGEN	APHA 422B	mg/l	-			-
4	ELECTRICAL CONDUCTIVITY	ASTM D1125	µS/cm	-			
	METALS						
1	ARSENIC	ASTM D2972	mg/kg	55			
2	BARRUM	ASTM D4382	,,	625	-		-
3	CADMIUM	ASTM D2576D	,,	12	-		-
4	COBALT	ASTM D3558A	,,	240	-		-
5	CHROMIUM	ASTM D2972	,,	380	-		-
6	COPPER	ASTM D1688D	,,	190	-		-
7	NICKEL	ASTM D1886C	,,	210	-		-
8	MERCURY	ASTM D3229	,,	10	-		-
9	LEAD	ASTM D3559	,,	350	-		-
10	ZINC	ASTM D1691 C	,,	720	-		-
1	**HYDROCARBONS**TPH	GC (FID)	mg/kg	5000	3,889.90	3,390.34	5,419.00
2	PAH	GC-MSD	,,	40	19.45	16.95	27.10
3	BENZENE	"	,,	1	<0.001	<0.001	<0.001
4	TOLUENE	"	,,	130	<0.001	<0.001	<0.001
5	ETHYLBENZENE	"	,,	50	<0.001	<0.001	<0.001
6	XYLENE	"	,,	25	<0.001	<0.001	<0.001
	BIOLOGICALS						
1	BOD	APHA 507	mg/l	-			-
2	COD	ASTM D1252	,,	-			-
3	COLIFORM	MPN COUNT	MPN/ 100ml	-			
4	TOTAL HETEROTROPHIC BACTERIA	APHA 9215B	Cfu/g	-	20.30×10^5	21.00×10^5	21.30×10^5
5	HYDROCARBON DEGRADING BAC	"	"	-	16.00×10^5	19.00×10^5	19.05×10^5
6	TOTAL HETEROTROPHIC FUNGI	"	"	-	8.00×10^5	10.00×10^5	10.34×10^5
7	HYDROCARBON DEGRADING FUNGI	"	"	-	5.00×10^5	5.00×10^5	7.23×10^5

FOR: KNL: IKENNA AYEKE
LAB.COORDINATOR

APPROVED BY: KNL: _____
MANAGING DIRECTOR

KEMNOULLING LIMITED

LABORATORY ANALYTICAL REPORT

REPORT NO.:	KNL/LAB 003/08/2017/PH	INCIDENT :	N/A
CLIENT:	RDK ENVI ECO SOLUTIONS LIMITED	SAMPLED BY:	NOSDRA/KNL
TYPE OF SAMPLE:	WATER SAMPLE	DATE SAMPLED:	31 07 2017
SAMPLE ORIGIN:	KWAWA	DATE RECEIVED:	31 – 07 – 2017
SAMPLE SOURCE:	N/A	DATE OF REPORTING:	05 – 08 – 2017

S/N	PARAMETERS	METHODS	UNIT	DPR max. INTERVENTION LIMIT	RESULT		
					KW-W 1	KW-W 2	KW-W 3
	PHYSICAL CHARACTERISTICS				N04°36' 31.9' E007°28' 53.0'	N04°36' 32.3' E007°28' 53.6'	N04°36' 32.0' E007°28' 53.4'
1	TEMPERATURE	-	°C	-	-	-	-
2	pH	ASTM D1293B	-	-	-	-	-
3	DISSOLVED OXYGEN	APHA 422B	mg/l	-	-	-	-
4	ELECTRICAL CONDUCTIVITY	ASTM D1125	µS/cm	-	-	-	-
	METALS				-	-	-
1	ARSENIC	ASTM D2972	µg/l	60	-	-	-
2	BARIUM	ASTM D4382	,,	625	-	-	-
3	CADMIUM	ASTM D2576D	,,	6	-	-	-
4	COBALT	ASTM D3558A	,,	100	-	-	-
5	CHROMIUM	ASTM D2972	,,	30	-	-	-
6	COPPER	ASTM D1688D	,,	75	-	-	-
7	NICKEL	ASTM D1886C	,,	75	-	-	-
8	MERCURY	ASTM D3229	,,	0.3	-	-	-
9	LEAD	ASTM D3559	,,	75	-	-	-
10	ZINC	ASTM D1691 C	,,	800	-	-	-
1	**HYDROCARBONSTPH**	GC (FID)	µg/l	600	690 75	670.63	800.67
2	PAH	GC MS	,,	70	6.90	6.71	8.01
3	BENZENE	,,	,,	30	<0.001	<0.001	<0.001
4	TOLUENE	,,	,,	1000	<0.001	<0.001	<0.001
5	ETHYLBENZENE	,,	,,	150	<0.001	<0.001	<0.001
6	XYLENE	,,	,,	70	<0.001	<0.001	<0.001
	BIOLOGICALS				-	-	-
1	BOD	APHA 507	mg/l	-	-	-	-
2	COD	ASTM D1252	,,	-	-	-	-
3	COLIFORM	MPN COUNT	MPN/ 100ml	-	-	-	-
4	TOTAL HETEROTROPHIC BACTERIA	APHA 9215B	Cfu/ l	-	$8.30x10^5$	$7.90x10^5$	$10.30x10^5$
5	HYDROCARBON DEGRADING BAC.	,,	,,	-	$2.00x10^5$	$2.00x10^5$	$2.78x10^5$
6	TOTAL HETEROTROPHIC FUNGI	,,	,,	-	$0.68x10^5$	$0.57x10^5$	$0.89x10^5$
7	HYDROCARBON DEGRADING FUNGI	,,	,,	-	$0.34x10^5$	$0.23x10^5$	$0.43x10^5$

FOR: KNL: IKENNA AYEKE
LAB.COORDINATOR

APPROVED BY: KNL: _____
MANAGING DIRECTOR

KNL
KEMNOULLI NG LIMITED

GC CONDITIONS AND METHOD

TOTAL PETROLEUM HYDROCARBON (TPH)

Samples were analyzed in line with USEPA 8015 method using Gen Tech Master GC equipped with a split/splitless injector, J and W 30 meter DB-5 column and an FID detector. The carrier gas Helium was set at 20ml/min. The injector temperature was set at 240°c and the detector temperature at 300°C. The total run time at 1µl injection volume through the capillary column with a slow ramp rate 40°c to 310°c is 45 minutes. The GC was calibrated using three working standards prepared from a stock solution of Accu standard Hydrocarbon window defining standard 500µg/ml in chloroform.

POLYNUCLEAR AROMATIC HYDROCARBON (PAH) GC-MS

PAH analysis was carried out in line with EPA 8270 method on an Agilent 6890 GC/MSD 5973 equipped with a split/splitless injector, J and W 30 meter DB-5 column and Mass Selective Detector. The carrier gas Helium was set at 34ml/min. The total run time is 15.60minutes. The GC was calibrated using three working standards prepared from a stock solution of Accu standard for PAH of 2.0mg/ml in Dichloromethane: Benzene (1:1).

BENZENE, TOLUENE, ETHYLBENZEN, XYLENE (BTEX)

A headspace gas chromatographic mass spectrometric (GC-MS) was used for the determination of benzene, toluene, ethyl benzene and xylene (BTEX) in soil/water samples. *For water sample, measure 5ml of sample in a 20ml glass VOC vial already tuffed with 5ml* of methanol solvent, capped with screw-cap and Teflon and shake in a sonicator for extraction. For soil samples, 5mg of soil sample was placed in a 20 mL VOC vial already filled with 10 mL of methanol solvent, the mixture was shake in a sonicator for extraction. The sample was positioned in the headspace sample vial tray for BTEX analysis with the aid of GC/MS and Headspace. The GC was calibrated using three working standards prepared from a stock solution of Accu standard for BTEX of 2.0mg/ml in methanol.