

SEDIMENT ASSESSMENT REPORT

FOR

MM PORT FZE PROJECT

Executive Summary

Sediment provides sanctuary for benthic macro invertebrates and also a sink for pollutants on any water body. Consequently, it was considered a critical aspect of MM Port FZE Project ESIA study in order to establish the baseline condition of the sediment within the project area. The sediment assessment study revealed pH ranged between 6.40 - 7.30 with pH average of 6.94 within the project influence area while pH value of 6.40 and 6.90 was recorded at the two control stations indicating that sediment with the project area is slight acidic to moderately alkaline.

Ammonia ranged between 0,70 - 0.96mg/kg within the project influence zone, while the control stations recorded 0.73 and 0.88mg/kg at control station 1 and 2. Total Nitrogen ranged between 0.108 - 0.210mg/kg within the project area, while the control station recorded 0.216 and 0.233mg/kg for control station 1 and 2. THC ranged between 7.81 - 15.10mg/kg with 10.73mg/kg average within the project influence zone while the control stations recorded 7.50 and 6.31mg/kg for control station 1 and 2 respectively. The least concentration of THC was observed at station 1 and 2 while highest was observed within the project influence zone specifically at station 7 (SED7).

Heavy metals were generally <0.001 except for Iron (Fe), Zinc (Zn) and Cobalt (Co) which were detected with iron recording the highest concentration of average of 3605.0mg/kg, Zinc 13.03mg/kg and cobalt 2.76mg/kg within the project site. Notably this is not in significant variation with the control stations' results. Microbial count revealed THB has the highest microbial count with 2.22 cfu/g x 10⁶ average, followed by THF with average count of 1.06 cfu/g x 10⁶, followed by HUB with average count

of 0.62cfu/g x 10³ and HUF with 0.46cfu/gx10³ average count within the project influence zone.

Leachate test for sampled sediments revealed parameters tested for leachability were generally low and below detection limit for most parameters. While sediment sources were majorly washing from exposed soil and waste material including sewage within and around the study area.

Introduction

Sediments are the loose sand, silt and other soil particles that settle at the bottom of a waterbody. Sediment strata serve as an important habitat for the benthic macro invertebrates whose metabolic activities contribute to aquatic productivity (Abowei *et al* 2005). Sediment is a major site for organic matter decomposition which is largely carried out by bacteria. Important macro-nutrients such as nitrogen and phosphorous are continuously being interchanged between sediment and overlying water (Abowei *et al* 2005). Consequently, the sediment was considered a critical aspect of the environmental impact assessment of the proposed project. As such sediment samples were collected at twelve (12) stations, ten (10) within the project influence zone and two (2) as control stations. Table 2 presents the sediment quality results.

Scope of study

The scope of the study is to establish existing sediment condition within the through field observation during sampling and laboratory analysis of sediment samples collected from the waterbody closest to the project site. Furthermore, to analyze possible impacts that may occur to sediment component in all phases (Pre-construction, Construction and Operation) of the project life cycle.

Field Approach

The study adopted both onsite and offsite approach in executing the study. The onsite is majorly for sediment sample collection in the field and submission of samples to laboratory, while the offsite includes laboratory analysis of samples and report writing.

Methodology

The study adopted standard international best practice in all aspects of the study execution ranging from field data gathering and laboratory analysis. Specifically, sediment samples were collected using Eckman grab which is launched down the water sediment to retrieve sediments. Samples were collected into plastic bags after being wrapped in aluminum foil and packed into containers made of high UV (Ultraviolet) resistant material. Sample labeling was done at the point of sampling with the correct Station ID. A total of twelve (12) sediment samples were collected, ten (10) were located with the project influence zone and two (2) controls away from the proposed project influence zone, which is the same for surface water and aquatic biodiversity stations.

The sediments sampling station coordinates, depth and approximate distance from the riverbank are shown in table 1.

Table 1: Sampling stations

S/No	Station Code	Depth (meters)	Distance from bank (meters)	WGS 84	
				LATITUDE (N)	LONGITUDE (E)
1	SED1	4.8	150	4°39'39.2"N	7°08'50.5"E
2	SED2	4.3	140	4°39'55.9"N	7°08'24.5"E
3	SED3	6.5	170	4°40'02.8"N	7°08'10.1"E
4	SED4	4.0	130	4°40'07.0"N	7°07'47.2"E
5	SED5	3.5	110	4°40'14.6"N	7°07'28.8"E
6	SED6	6.0	200	4°39'59.6"N	7°09'14.7"E
7	SED7	8.7	210	4°40'29.6"N	7°09'22.3"E
8	SED8	4.9	140	4°40'28.9"N	7°07'00.7"E
9	SED9	5.2	150	4°40'24.7"N	7°06'45.7"E
10	SED10	6.5	600	4°39'30.0"N	7°08'03.6"E
11	SEDC1	9.2	600	4°36'38.0"N	7°10'35.3"E
12	SEDC2	7.9	900	4°42'44.4"N	7°05'39.9"E



Grab Sampling for sediment and Benthos



Sampling for Sediments

Results and Discussion

Results

Summary results of sediment properties within and around proposed project site is presented in table 1, while the comprehensive results is presented in appendix 1. Table 2 presents the leachate test results from TCLP analysis carried out on the sediment samples, while the comprehensive results attached as appendix 2.

Table 1: Present summary results of sediment properties

S/N	Parameter(s)	Min	Max	Ave	SED C1	SED C2
1	Sand (%)	78.25	81.99	80.18	80.48	80.41
2	Silt (%)	4.45	6.33	5.34	4.87	5.84
3	Clay (%)	12.65	17.25	14.47	14.65	13.75
4	Texture	~	~	~	LS	LS
5	Porosity	0.37	0.40	0.38	0.38	0.38
6	Colour	~	~	~	Black	Black
7	Permeability (cm/sec)×10	0.17	0.2	0.18	0.18	0.20
8	Bulk Density (g/cm ³)	1.27	1.53	1.39	1.36	1.47
	pH	6.40	7.30	6.94	6.40	6.90
9	Phosphate, PO ₄ ³⁻ (mg/kg)	1.10	1.93	1.47	1.26	1.30
10	Sulphide, S ₂ (mg/kg)	<0.01	<0.01	<0.01	<0.01	<0.01
11	Sulphate, SO ₄ ²⁻ (mg/kg)	490	710	625.00	510	610
12	Nitrate, NO ₃ ⁻ (mg/kg)	2.4	3.4	2.9	2.5	3.0
14	TOC (%)	1.25	2.43	1.62	2.50	2.69
15	THC (mg/kg)	7.81	15.10	10.73	7.50	6.31
16	Ammonia (mg/kg)	0.70	0.96	0.84	0.73	0.88
18	Total Nitrogen (%)	0.108	0.210	0.140	0.216	0.233
19	Cobalt, Co (mg/kg)	1.39	4.14	2.76	1.97	2.94
21	Manganese, Mn (mg/kg)	25.39	122.5	64.57	56.50	38.10
22	Iron, Fe (mg/kg)	2617.7	4333.2	3605.0	4,301.4	3,685.1
23	Zinc, Zn (mg/kg)	11.32	15.74	13.03	16.02	14.23
	Silver, Ag (mg/kg)	<0.001	<0.001	<0.001	<0.001	<0.001
24	Vanadium, V (mg/kg)	<0.001	0.29	0.16	<0.001	<0.001
25	Nickel, Ni (mg/kg)	<0.001	6.13	0.29	<0.001	<0.001
26	Chromium, Cr (mg/kg)	<0.001	<0.001	<0.001	<0.001	<0.001
27	Lead, Pb (mg/kg)	3.05	3.05	3.05	<0.001	<0.001
28	Copper, Cu (mg/kg)	<0.001	0.98	0.08	<0.001	0.83
29	Mercury, Hg (mg/kg)	<0.001	<0.001	<0.001	<0.001	<0.001
30	Arsenic, As (mg/kg)	<0.001	<0.001	<0.001	<0.001	<0.001
31	THB (CFU/g) x 10 ⁶	1.2	3.2	2.22	1.1	2.2

S/N	Parameter(s)	Min	Max	Ave	SED C1	SED C2
32	THF (CFU/g) x 10 ⁶	0.5	1.7	1.06	0.7	1.1
33	HUB (CFU/g) x 10 ³	0.3	1.3	0.62	0.5	0.8
34	HUF (CFU/g) x 10 ³	0.2	1.0	0.46	0.3	0.6

Table 2 Summary results of TCLP Analysis on Sediment samples

S/No	Parameters	Min	Max	Ave	SED C1	SED C2
1	Iron, Fe (mg/l)	2.107	8.145	5.8111	7.346	4.154
2	Manganese, Mn (mg/l)	0.258	1.434	0.7337	1.451	0.636
3	Zinc, Zn (mg/l)	0.816	2.651	1.7566	2.816	1.751
4	Vanadium, V (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001
5	Nickel, Ni (mg/l)	<0.001	0.246	0.0246	<0.001	<0.001
6	Chromium, Cr (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001
7	Lead, Pb (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001
8	Copper, Cu (mg/l)	<0.001	0.076	0.0076	<0.001	0.065
9	Mercury, Hg (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001
10	Arsenic, As (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001
11	Cobalt, Co (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001

Discussion

pH

Figure 1 Below presents the pH concentration of sediment within the project environment, the figure reveals pH concentration ranged between 6.40 – 7.30 with pH average of 6.94 within the project influence area while pH value of 6.40 and 6.90 was recorded at the two control stations indicating that sediment with the project area is slight acidic to alkaline.

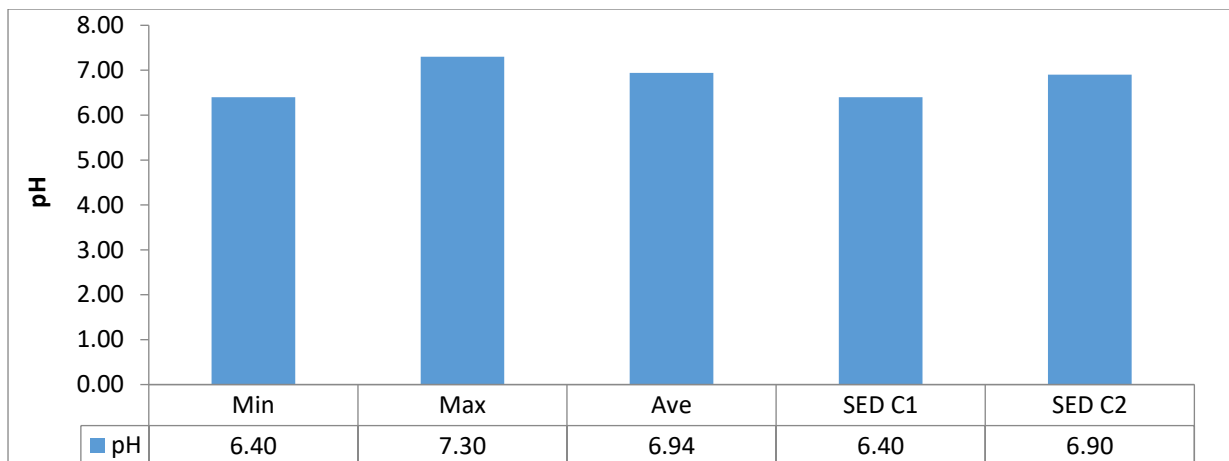


Figure 1: pH concentration of sediment within the project environment.

Ammonia and Total Nitrogen

Figure 2 presents the concentration of Ammonia and Total Nitrogen of sediment within the project area. The figure revealed ammonia ranged between 0,70 – 0.96mg/kg within the project influence zone, while the control stations recorded 0.73 and 0.88mg/kg at control station 1 and 2. Total Nitrogen ranged between 0.108 – 0.210mg/kg within the project area, while the control station recorded 0.216 and 0.233mg/kg for control station and 2. The control stations recorded the highest level of total nitrogen which is not in significant variation with the results recorded within the project influence zone.

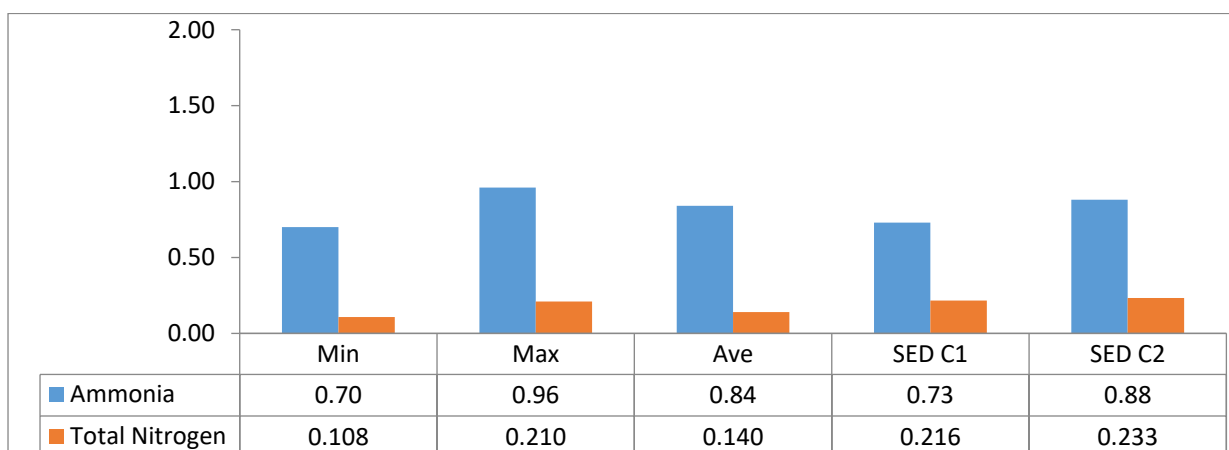


Figure 2: Concentration of Ammonia and Total Nitrogen

Phosphate, Nitrate and TOC

Figure 3 Below presents the concentration of Phosphate, Nitrate and Total Organic Carbon as observed during the EIA study. The figure revealed Phosphate ranged between 1.10 to 1.93mg/kg with 1.47mg/kg average within the project influence zone, similar concentration was also recorded at the two controls stations; while Nitrate ranged between 2.4 - 3.4mg/kg with 2.9mg/kg average with similar results been recorded at the control stations. Total organic carbon ranged between 1.25-2.43mg/kg within the project possible influence zone, while the control stations recorded 2.50 and 2.69mg/kg for control 1 and control 2 respectively. Observed phosphate is low compared to 5.5 - 15.5mg/kg observed by Adesuyi et al (2016) on Nwaja creek and 13.43mg/kg mean recorded by Daka and Moslen in Azuabie River sediment. Moreso, observed nitrate results is in agreement with the range (2.60 - 4.10 mg/kg) recorded by Ezekiel et al (2011) within the study area.



Figure 3: Concentration Phosphate and Nitrate and TOC

Total Hydrocarbon

Figure 4 presents the concentration of Total Hydrocarbon recorded during the field survey. The figure revealed THC ranged between 7.81 - 15.10mg/kg with 10.73mg/kg average within the project influence zone while the control stations recorded 7.50 and 6.31mg/kg for control station 1 and 2 respectively. The least concentration of THC

was observed at station 1 and 2 while highest was observed within the project influence zone specifically at station 7 (SED7).

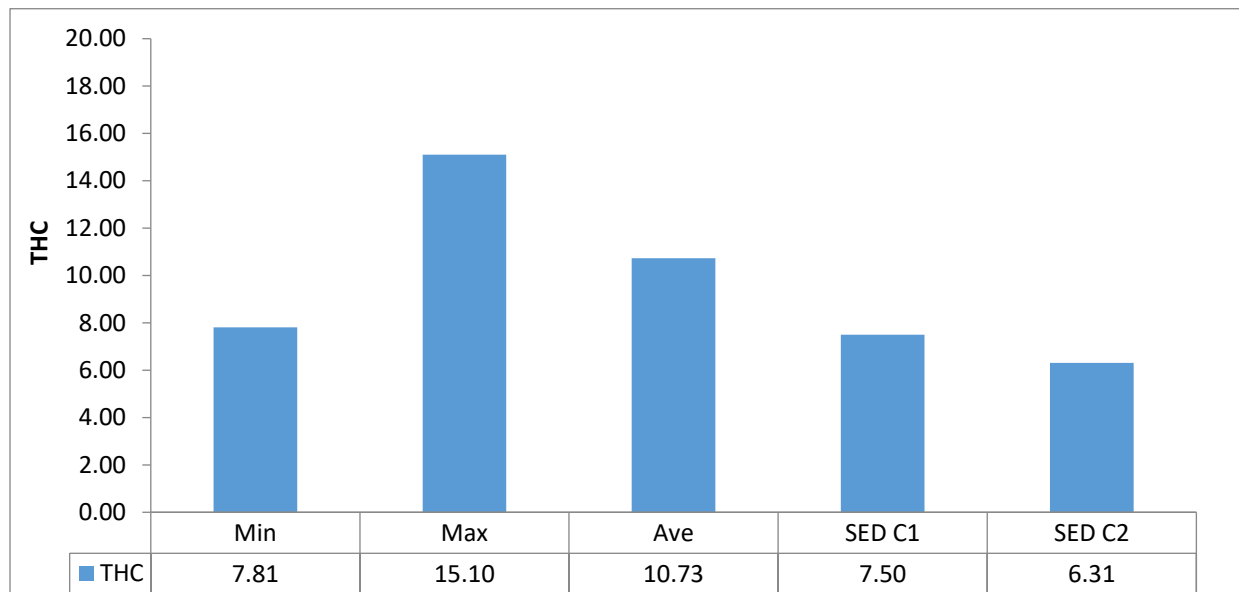


Figure 4: Concentration of Total Hydrocarbon and Oil/Grease

Heavy Metal

Heavy metal parameters analyzed for the EIA study includes Fe, Zn, Co, Ag, V, Ni, Cr, Pb, Cu and As, among the metals analyzed Fe recorded the highest concentration which ranged between 2617.7 - 4333.2mg/kg with 3605.0mg/kg average within the project influence zone, which is similar to concentration of 4301.4 and 3685.1mg/kg observed at the control stations 1 and 2 respectively. This is typical of the Niger Delta Environment. Zn ranged between 11.32 -15.74mg/kg; Cobalt ranged between 1.39 - 4.14mg/kg which are not in significant concentration with results from the control stations. Generally, Ag, V, Ni, Cr, Pb, Cu and As were <0.001mg/kg Average concentration of 0.09>0.35>1.00>3.05mg/kg was recorded for Barium, Aluminum, Lead and Copper respectively within the project influence zone. Similar results were also recorded at control stations for these parameters.

Microbiology

Figure 5 presents the microbial count of sediment microbes observed during the EIA study. The figure revealed THB has the highest microbial count with 2.22 cfu/g x 10⁶

average, followed by THF with average count of $1.06 \text{ cfu/g} \times 10^6$, followed by HUB with average count of $0.62 \text{ cfu/g} \times 10^3$ and HUF with $0.46 \text{ cfu/g} \times 10^3$ average count within the project influence zone. The microbial count recorded at the control stations are within the range observed at the project influence zone. The low concentration of HUB and HUF corroborate the low concentration of Total Hydrocarbon as observed in this study as this microbe (HUB and HUF) are attracted by the presence of hydrocarbon.

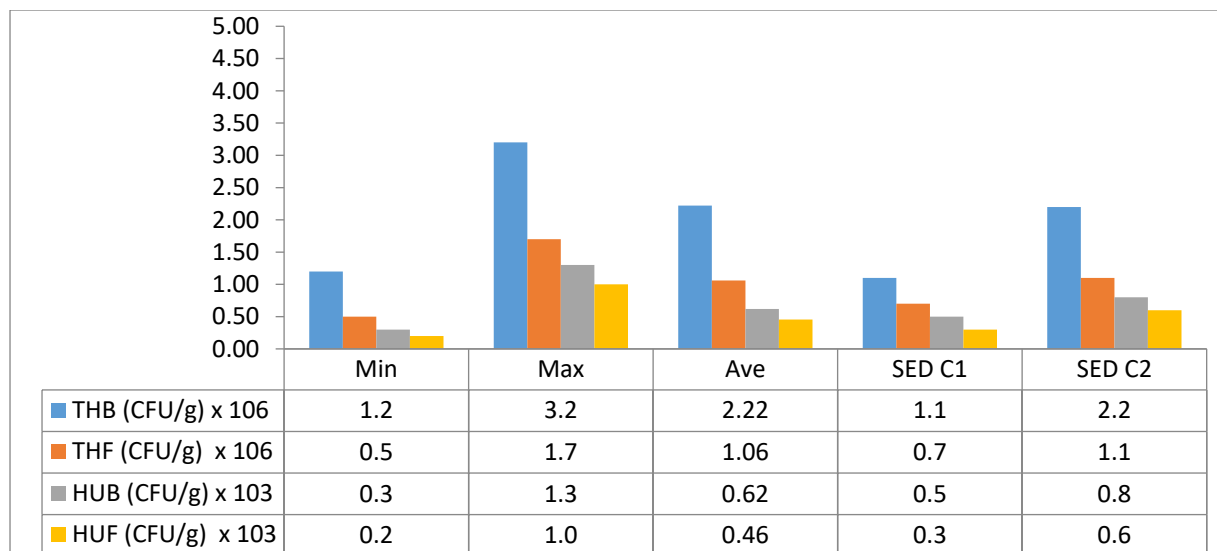


Figure 5: Microbial count of some microbes within the project environment

Toxicity Characteristic Leaching Procedure (TCLP) Test

The TCLP analysis was carried out to establish the leachability potentials of sediment from the project area. Consequently, collected sediment samples were subjected to TCLP analysis test and the results are presented in Table 2. The table revealed Iron (Fe) ranged between 2.107 – 8.145mg/l with 5.8111mg/l average; Manganese (Mn) ranged between 0.258 – 1.434mg/l with 0.7337mg/l average and Zinc (Zn) ranged between 0.816 -2.651mg/l with 1.7566mg/l average, while other metals (V, Ni, Cr, Pb, Cu, Hg, As and Co) were $<0.0001 \text{ mg/l}$. Iron present the highest concentration, followed by Zinc and Manganese the least. The results recorded within the control stations were within the range recorded within the possible project influence zone. The leachate test for sampled sediments showed that all the parameters tested for leachability were generally low and below detection limit for most parameters.

Sediment Source

Sediment sources within the study area were generally washings from exposed soil, debris/waste, and sewage into the surface waterbody. Moreso, vessel movement and fishing activities may have the possibility to re-suspend sediment.

Possible Project Impact on Sediment

Possibilities of Sediment contamination

Indiscriminate dumping of waste, oil/chemical spillage, improper treatment of sewage and other forms of liquid effluent both during construction and operation may lead to contamination of sediment.

Mitigation

Waste generated during construction and operation should be managed by accredited and experienced waste management facilities.

Handling of hazardous material by trained and experienced personnel to reduce its possibility of spillage.

Appendix 1: Detail results of Sediment

S/N	Parameter(s)	SED 1	SED 2	SED 3	SED 4	SED 5	SED 6	SED 7	SED 8	SED 9	SED 10	SED C1	SED C2
1	Sand (%)	81.99	80.27	79.3	79.64	80.89	79.6	81.18	80.58	78.25	80.14	80.48	80.41
2	Silt (%)	5.15	6.33	4.45	4.6	5.75	4.6	6.17	5.84	4.5	6.03	4.87	5.84
3	Clay (%)	12.86	13.4	16.25	15.76	13.36	15.8	12.65	13.58	17.25	13.83	14.65	13.75
4	Texture	LS	LS	SL	SL	LS	SL	LS	LS	SL	LS	LS	LS
5	Porosity	0.40	0.38	0.38	0.38	0.39	0.38	0.40	0.39	0.37	0.38	0.38	0.38
6	Colour	Black	Black	Black	Black	Black	Black	Black	Black	Black	Black	Black	Black
7	Permeability (cm/sec)×10	0.17	0.18	0.18	0.19	0.20	0.19	0.18	0.17	0.18	0.19	0.18	0.20
8	Bulk Density (g/cm ³)	1.37	1.4	1.53	1.38	1.43	1.27	1.38	1.4	1.31	1.40	1.36	1.47
	pH	7.20	7.30	7.10	6.90	6.40	6.70	7.00	6.50	7.10	7.20	6.40	6.90
9	Phosphate, PO ₄ ³⁻ (mg/kg)	1.10	1.40	1.84	1.40	1.30	1.25	1.93	1.57	1.60	1.35	1.26	1.30
10	Sulphide, S ₂ (mg/kg)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
11	Sulphate, SO ₄ ²⁻ (mg/kg)	590	670	650	700	540	690	710	640	570	490	510	610
12	Nitrate, NO ₃ ⁻ (mg/kg)	2.8	3.1	2.4	2.5	2.8	3.0	3.3	2.6	3.0	3.4	2.5	3.0
14	TOC (%)	2.43	1.64	1.85	1.29	1.36	1.68	1.57	1.25	1.47	1.72	2.50	2.69
15	THC (mg/kg)	8.81	7.81	12.10	10.30	11.56	9.40	15.10	12.31	11.30	8.57	7.50	6.31
16	Ammonia (mg/kg)	0.81	0.90	0.70	0.72	0.82	0.88	0.95	0.75	0.87	0.96	0.73	0.88
18	Total Nitrogen (%)	0.210	0.142	0.160	0.111	0.117	0.142	0.136	0.108	0.127	0.148	0.216	0.233
19	Cobalt, Co (mg/kg)	4.14	3.24	4.1	<0.001	2.92	1.39	3.43	2.42	1.78	1.42	1.97	2.94
21	Manganese, Mn (mg/kg)	112.50	44.87	73.80	25.39	122.50	29.52	110.30	63.40	35.65	27.74	56.50	38.10
22	Iron, Fe (mg/kg)	4,047.2	3,418.2	4,256.9	2,617.7	4,206.1	3,068.8	4,333.2	3,875.7	3,126.0	3,100.6	4,301.4	3,685.1
23	Zinc, Zn (mg/kg)	13.1	11.97	15.74	11.55	13.48	11.32	14.33	12.82	13.03	12.93	16.02	14.23
	Silver, Ag (mg/kg)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
24	Vanadium, V (mg/kg)	<0.001	<0.001	<0.001	<0.001	0.29	<0.001	<0.001	0.02	<0.001	<0.001	<0.001	<0.001
25	Nickel, Ni (mg/kg)	<0.001	<0.001	<0.001	<0.001	6.13	<0.001	<0.001	0.38	<0.001	<0.001	<0.001	<0.001
26	Chromium, Cr (mg/kg)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
27	Lead, Pb (mg/kg)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	3.05	<0.001	<0.001
28	Copper, Cu (mg/kg)	<0.001	<0.001	<0.001	0.98	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.83
29	Mercury, Hg (mg/kg)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

S/N	Parameter(s)	SED 1	SED 2	SED 3	SED 4	SED 5	SED 6	SED 7	SED 8	SED 9	SED 10	SED C1	SED C2
30	Arsenic, As (mg/kg)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
31	THB (CFU/g) x 10 ⁶	2.9	2.0	1.3	2.6	1.2	2.7	3.2	1.9	2.3	2.1	1.1	2.2
32	THF (CFU/g) x 10 ⁶	1.3	1.5	0.8	0.5	0.9	1.1	1.7	0.8	1.4	0.6	0.7	1.1
33	HUB (CFU/g) x 10 ³	0.8	0.6	0.6	0.3	0.3	0.6	1.3	0.4	1	0.3	0.5	0.8
34	HUF (CFU/g) x 10 ³	0.2	0.8	0.3	0.5	NIL	0.2	1	0.3	0.6	0.2	0.3	0.6

Appendix 2: TCLP Analysis on Sediment samples

S/No	Parameter(s)	SED 1	SED 2	SED 3	SED 4	SED 5	SED 6	SED 7	SED 8	SED 9	SED 10	SED C1	SED C2
1	Iron, Fe (mg/l)	6.847	4.847	7.105	2.107	7.21	5.751	8.145	5.61	5.345	5.144	7.346	4.154
2	Manganese, Mn (mg/l)	1.253	0.415	0.258	0.545	1.215	0.415	0.625	1.434	0.754	0.423	1.451	0.636
3	Zinc, Zn (mg/l)	1.561	2.035	2.465	0.816	1.253	0.956	1.645	2.339	2.651	1.845	2.816	1.751
4	Vanadium, V (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
5	Nickel, Ni (mg/l)	<0.001	<0.001	<0.001	<0.001	0.246	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
6	Chromium, Cr (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
7	Lead, Pb (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
8	Copper, Cu (mg/l)	<0.001	<0.001	<0.001	0.076	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.065
9	Mercury, Hg (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
10	Arsenic, As (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
11	Cobalt, Co (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

Reference

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