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Environmental monitoring plan for marine ports, case study Shuwaikh Port, Kuwait

Ahmed Al Rashed [1], Hossam Mostgab [1*], Ahmed Gad [1]

[1] Kuwait University, KUWAIT
*Corresponding author: Hossam.mostagab@gmmai.com

Abstract

Shuwaikh port is considered the main commercial port in Kuwait. It is located in west Kuwait. The total area of the port is about 4.4 million squares meters. It was established in 1961 after the independence from England. The port is considered the major one in the country. Rapid growth in population urbanization and life style has led to enlargement of infra structures of the port. This paper provides comprehensive environmental monitoring assessment issues associated with the port operations, terminal consideration and construction and aeration and its effect on the port and the surrounding area.

Keywords: Shuwaikh, port, assessment, environment

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INTRODUCTION

The state of Kuwait is part of the Arabian Gulf located in the Arabian Peninsula. Occupying the north side of it. The area of Kuwait 17,830 km2 (Figure 1) the history of Kuwait goes back to about three hundred years when it established in 1775 as a small town over cooking the Arabian Gulf. The country grows rapidly after then. The geographic location on the coast of the Arabian Gulf provides the mean source of income limpet and export of goods from and to Kuwait. The expansion in the urban and industrial areas led to the organization of commerce by the government. Accomplice port with well-developed infra-structure was built in three kilometers from Kuwait City the name Shuwaikh was given to this port. Shuwaikh is located very close to the main consumption areas of Kuwait. The close distance makes transport to the final customer cheap. Shuwaikh acts as a local gateway for Kuwaiti cargo. It has a strong position in this segment. Compared to Shuaiba (another port in Kuwait), security is less strict and therefore shippers and consignees prefer the use of Shuwaikh. The Marine Services Department is very well organized. The pilots of Shuwaikh port are very experienced and marine operations are very efficient. **Fig. 1** shows satellite image for Shuwaikh Port.

PORT ENVIRONMENTAL IMPACTS OF ON HUMAN HEALTH

Impacts on human health can be broadly categorized as:

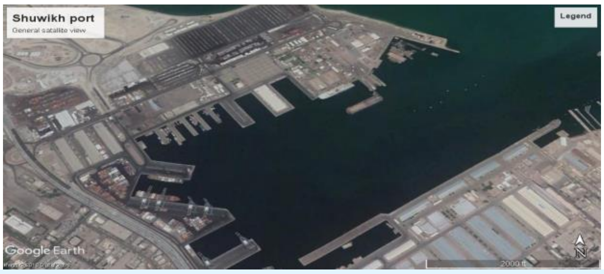

Fig. 1. Satellite image for Shuwaikh Port

1. Hazards/accidents both onshore and offshore from handling of hazardous materials such as flammables, explosives and toxics from vessel collisions.
2. Noise from construction equipment/activity, vehicles, cargo handling equipment and ship and port public address systems/sirens
3. Respiratory illness from escaping dust and particulates. Most health impacts (except communicable diseases) will generally be confined to the immediate port vicinity/ work environment. Occupational health programmes should be established and provisions should be made for adequate medical emergency services

Guidelines for Environmental Management Plan in Ports

The adequacy of equipments for handling oil and related liquid bulk spills and other emergencies should

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be assessed in the light of increased traffic since the facility was opened.

- The review of dredging practices, the toxicity of the dredged material and the disposal location.
- Improving the handling facilities for dry bulk cargoes, especially for coal and iron ore. This is potentially a costly exercise and will inevitably be constrained by financial considerations.
- Providing facilities for collection and disposal of waste oil and solid waste (garbage) in accordance with the marine pollution convention. Collection facilities need to be conveniently located for ships, open at hours to suit ship movements.
- Hazardous waste materials should be separately collected and disposed off at the designated site.
- Health related monitoring should be performed on the workers who are working in bulk storage area and handling chemicals.
- Facilities need to be brought to the attention of shippers to encourage their use.
- The location of the treatment or disposal facilities needs to be carefully planned so as not to give rise to negative environmental impacts elsewhere, particularly in the case of garbage disposal.
- Adopting mitigation techniques for reducing the pollutant concentration like green belt/plantation, conservation of water and energy etc. Various other considerations to control air and water quality in the port and harbour region are discussed below.

Environmental Legal Framework and Relevant Quality Standard

The Kuwait Environment Public Authority (KEPA) is the lead government agency in the State of Kuwait. According to KEPA, wherever standards are not available in KEPA we follow Kuwait Oil Company (KOC) Health, Safety & Environmental Standards (HSEMS Guide 2009). It requires that “local regulatory and other requirements shall be met or exceeded”. Where these are absent or inadequate, the highest accepted industry standards shall be applied to protect people and the environment. As such, Best Available Technique (BAT) shall be applied to minimize any significant environmental impacts as identified during the impact identification process. This entire paper guidance manual for Port and Harbor projects accordingly addresses the related environmental concerns duly taking into consideration the requirements of all the Environmental, Health, and Safety (EHS) Guidelines according to KEPA regulations and international standards (IFC) in management of the ports and harbors. The entire guidelines include general and industry-specific examples of Good International Industry Practice (GIIP).

Aim of the Study

To carry out Environmental Monitoring study for Shuwaikh marine port in the state of Kuwait. The study presents the results of environmental monitoring activities undertaken at Onshore (marine) facilities for the period of January 2019 to April 2019.

Following monitoring activities were carried out;

- Noise Monitoring at various locations
- Air quality monitoring (Total Suspended particles (TSP)) and SO_2, NO_2 & BTEX)
- Ambient air quality monitoring.

The baseline status take under consideration biological environment for marine and coastal habitat surface water quality in and around the harbor area, sewage, bilge waste, ships waste (Solid – leakage – harmful material), and finally air and water pollution of oil and gases released from ships in the port and around it.

Key Environmental Issues for Port Development and Operations

Port activities can cause deterioration of air and marine water quality in the surrounding areas due to multifarious activities. Hence, for the determination of levels of pollution, identification of pollution sources, control and disposal of waste from various point and non-point sources and for prediction of pollution levels for future, regular monitoring and assessment are required during the entire construction and operation phase of a major port. It is extremely essential that port and harbour projects should have an environmental management plan (EMP), which also incorporates monitoring of air and marine water quality along with the collection of online meteorological data throughout the life of the project.

The Pollution Problems Usually Caused by Port and Harbour Activities can be Categorized as Follows

- Coastal habitats may be destroyed and navigational channels silted due to causeway construction and land reclamation.
- Unregulated Mari culture activities in the port and harbor areas may threaten navigation safety.
- Deterioration of surface water quality may occur during both the construction and operation phases.
- Harbour operations may produce sewage, bilge wastes, solid waste and leakage of harmful materials both from shore and ships.
- Human and fish health may be affected by contamination of coastal water due to urban effluent discharge.
- Oil pollution is one of the major environmental hazards resulting from port/harbour and shipping operations.

- This includes bilge oil released from commercial ships handling non-oil cargo as well as the more common threat from oil tankers.
- Air pollutant emissions due to ship emissions, loading and unloading activities, construction emission and emissions due to vehicular movement.

Environmental Issues in Port and Terminal Construction and Operation Primarily Include the Following

- Terrestrial and aquatic habitat alteration and biodiversity
- Climate change resilience
- Water quality
- Air emissions
- Waste management
- Hazardous materials and oil management
- Noise and vibration (including underwater)

Costal Habitats

Marine and coastal ecology includes aquatic fauna and flora composed of large number species of bacteria, phytoplankton, zoo plankton, benthonic organisms, coral, seaweed, fish and other aquatic biota, divisorial flora such as mangroves wetlands. Loss of bottom habitat and fishery resource is also significant problems include in this category. The location of a port affect aquatic fauna and flora through changes of water quality, coastal hydrology and bottom contamination. The pelagic community is composed of organisms living in the water column above sea flora and below the surface. Planktons which are microscopic organisms live in the water and didn't left with sea current is probably the most significant group of pelagic community. The benthic community is a group of organisms living in and on the bottom of the ocean floor which habitats host large variety of species, destruction or modification by harbor activities and lead to signification loss in overall biodiversity of these habitats. To distinguish natural flections of the benthic community and construction effect of the mind farm, and analysis of long – term monitoring data must be made.

Methodology

NOISE Quality Monitoring

Overview

Noise quality monitoring was carried out at the site to identify the noise levels generated at the study area. The noise levels are monitored for the following scenarios.

- Noise level measurement for 48 hours at construction site.
- Noise level measurement for 48 hours at random, sensitive locations.
- Personal Exposure Noise levels at site by using Personal Dosimeters.

Fig. 2. Sound level meter

Noise monitoring locations were selected based on the noise- sensitive receptors. Noise measurements were carried out continuously at each location. During the monitoring event, observations were made on the weather as well as the surrounding noise sources.

As per KEPA standards, employees must not be exposed to an average of noise levels greater than 85 dB during an 8-hour workday. In order to determine if exposures are at or above this level, it is necessary to measure or monitor the actual noise levels in the workplace on a periodic basis.

Sound level meters and dosimeters were generally deployed for noise monitoring. Sound level meter is generally necessary to take a number of measurements at different times during the day to estimate noise exposure over a workday.

Ambient Noise Monitoring for this study was done by using Type 1 Sound Level Meter (Cirrus Instrument Model G066204, CR: 172A and Cirrus Model CR:152A Model G079619, the instrument can measure up to 140 dB (A) and 143 dB(C) Peak with the standard Microphone Preamplifier.

Air Quality Monitoring Study Methodology

The object of monitoring air quality in the port area and around it, is to identify the existing ambient air quality and compliance evolution in line with environmental protection of Kuwait and the international environmental agencies. Air quality in a port area can be affected by dust and particulates from traffic (re suspension of road dust), site clearing, rock excavation and construction activity, and emissions from vehicles bringing materials to the site and from ships and construction equipments Ship emissions are the main source of SO2 in port and harbour areas.

To identify the quality of air at the study area the following monitoring activities were carried out:

1) Ambient air quality monitoring
2) Air Quality monitoring (Total Suspended Particles (TSP))
3) Air Quality Monitoring using Diffusion Tubes (NO2, SO2 & BTEX)

Ambient air quality monitoring was carried out by deploying the ambient air quality monitoring laboratory at the site location. During this monitoring activity the pollutants include PM10, $PM_{2.5}$, SO_2, NO, NO_2, O_3, CO,

Fig. 3. AAQM lab deployed at site

Fig. 4. Area Dust Monitor Model: ADR1500 equipment

NMHC, NH3, H2S, Benzene simultaneously with wind speed, wind direction, temperature, relative humidity was monitored. Monitoring was carried out at the site on a continuous basis, for the determination of pollutant concentrations and to compare the concentration of pollutants with the KEPA Air Quality Standards.

Air Quality monitoring (Total Suspended Particles (TSP))

Air quality - TSP monitoring was carried out at the present study to know the Dust Emissions i.e. Total Suspended particles (TSP) generated at the construction site; measurements were carried out continuously for 24 hours at each on 3 selected locations. Air quality monitoring - TSP locations were selected based on the sensitive receptors.

As per Kuwait Environmental Public Authority EPA rules and regulations for dust emissions and particulate matters (PM-10) mentioned within KEPA ambient air quality standards are the main applicable rules for this dust control plan 350 mg/cubic meters is the average daily mean for suspended particulate matter PM-10 which should not occur more than once during the year.

Area Dust Monitor Model: ADR1500 equipment (**Fig. 4**) was deployed for Dust monitoring i.e. Total Suspended particles. Area dust monitor has measured the TSP at different times in a day to estimate dust emissions over a workday.

Air Quality Monitoring using Diffusion Tubes (NO2, SO2, & BTEX)

Air quality monitoring – Diffusion Tubes were deployed at the site to identify the NO_2, SO_2 and BTEX emissions generated at the area. Diffusion tubes were installed at 3 locations on the site permanently for 3 to 4 weeks in a month. After the monitoring, the tubes were collected and sent to the Laboratory for analysis. Diffusion Tubes locations were selected based on the sensitive receptors.

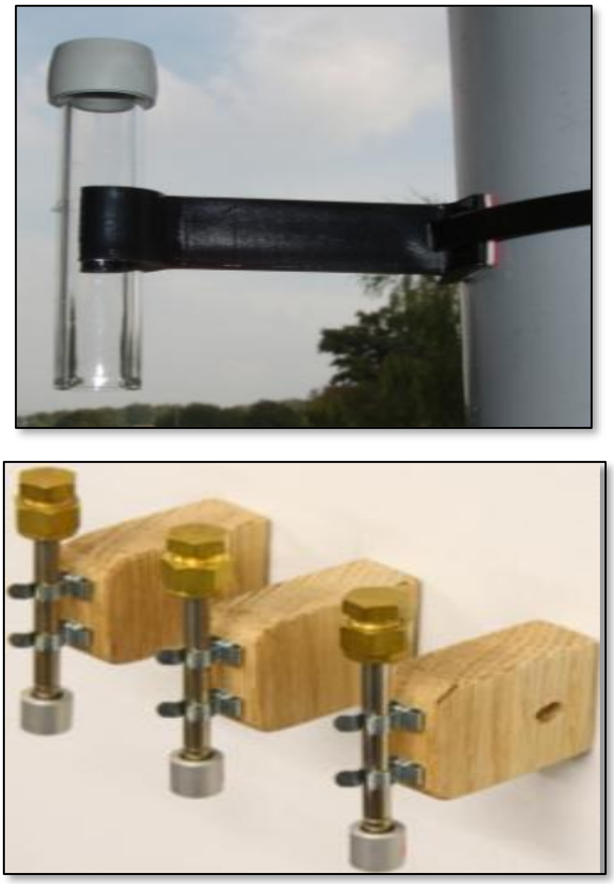

Fig. 5. NO_2 and SO_2 Diffusion Tubes

Diffusion Tubes (**Fig. 5**) were deployed for NO_2, SO_2 and BTEX monitoring. Diffusion tubes work by a process called molecular diffusion. During molecular diffusion, compounds will move from an area of high concentration to an area of low concentration. The compounds in the air are at a higher concentration than those in the tube, so the compounds diffuse into the tube and collect on the absorbent at the end of the tube. These tubes were placed in the site for minimum 2 weeks to absorb the pollutant concentration and then analyzed to get the results.

RESULTS AND DISCUSSION

Port activities can cause deterioration of air and marine water quality in the surrounding areas due to multi various activity, Hence for the determination of levels of pollution, identification of pollution sources, control and disposal of waste from various point and non point sources and for prediction of pollution levels for futures, regular monitoring and assessment are required

Sl #	Activities	Equipment	Frequency	Reporting
1	Noise Monitoring	Noise Dosimeter	1 day, 5 badges per month	Monthly
2	Noise Monitoring	Noise Level meter	4 locations for 2 days per Month	Monthly
3	Noise Monitoring (random sensitive location)	Noise Level meter	4 locations, 2days per month	Monthly
4	Ambient Air Quality Monitoring for NO_2, SO_2 & BTEX	Diffusive Passive Tubes	3 locations per month	Monthly
5	Ambient air quality Monitoring for Total Suspended particles (TSP)	Area Dust Monitor Model:ADR1500	3 locations per month	Monthly
6	Ambient air quality monitoring (Real time continuous monitoring of PM_{10}, NO, NO_2,SO_2, H_2S, NH_3, O_3, CO, CH_4, VOC (BTEX), NMHC) and Real time continuous monitoring of Meteorological Parameters such as wind speed and direction, air temperature, relative humidity, barometric pressure, dew point	Air Quality Monitoring Lab	1 location continuously for 10 days	One time
8	Waste water	Sample bottles	1 sample	One time

during the entire construction and operation phase of major port.

The pollution problems usually caused by port and harbor activities can sunrise by coastal habitats destruction, unregulated maricultural activities in the port and harbor areas, deterioration of surface water quality in the harbor, sewage produced from harbor operations and finally air pollution with oil spilling in the activities area.

Environmental monitoring was being carried out at the study area and surroundings for a continual quality assessment of air quality and noise levels for three months. The details of environmental monitoring performed during the Period are given above:

Applicable Standards for Noise measurements

Under Article 7, Decision No.8 and Decision No.5 of 2017, KEPA has developed the noise levels standards based on type of area and time periods. The most relevant noise standards applicable to this study are presented in **Table 1**.

Noise Level Measurements at the Study Area

Noise levels were measured in 4 selected locations for 48 hours each to measure the intensity of noise during port operations.

Noise Level Measurement Using Personal Dosimeters

Dosimeters were used to measure an employee's personal exposure to noise over a specified period of time at the site. 5 dosimeters were deployed to 5 workers shoulders and noise levels were measured for a period of 8 hours at site. Noise level results for July 2019 to September 2019 are reported and summarized in **Table 3**.

Air Quality Monitoring Test Method

Air monitoring was carried out using the continuous Ambient air monitoring lab equipped with OPSIS system and sophisticated analyzers; these analyzers are designed as per USEPA Automated Test Method of 40 CFR 53. The meteorological data was generated using meteorological data logging sensors mounted on the monitoring systems.

Table 1. Allowable Noise Exposure Limits at Work Environment (KEPA and IFC Standards)

Exposure level L,(dBA)	Time(T) Hours	Minutes	Seconds	Exposure level L,(dBA)	Time(T) Hours	Minutes	Seconds
80	25	24	-	106	-	3	45
81	20	10	-	107	-	2	59
82	16	-	-	108	-	2	22
83	12	42	-	109	-	1	53
84	10	5	-	110	-	1	29
85	8	-	-	111	-	1	11
86	6	21	-	112	-	-	56
87	5	2	-	113	-	-	45
88	4	-	-	114	-	-	35
89	3	10	-	115	-	-	28
90	2	31	-	116	-	-	22
91	2	-	-	117	-	-	18
92	1	35	-	118	-	-	14
93	1	16	-	119	-	-	11
94	1	-	-	120	-	-	9
95	-	47	37	121	-	-	7
96	-	37	48	122	-	-	6
97	-	30	-	123	-	-	4
98	-	23	49	124	-	-	3
99	-	18	59	125	-	-	3
100	-	15	-	126	-	-	2
101	-	11	54	127	-	-	1
102	-	9	27	128	-	-	1
103	-	7	30	129	-	-	1
104	-	5	57	130-140	-	-	<1
105	-	4	43		-	-	-

Table 2. Noise levels at study area (July, August, and September,2018)

Month	Location	Day/Date	Day time Leq dB (Avg) (7:00 to 14:00)	Evening Time Leq dB (Avg) (14:00 to 22:00)	Night Time Leq dB (Avg) (22:00 to 7:00)
July	NL-1	Day 1 (01 July 2018)	50.9	53.69	55.68
		Day 2 (02 July 2018)	55.26	56.84	57.8
	NL-2	Day 1 (03 July 2018)	59.52	61.06	64.51
		Day 2 (04 July 2018)	61.67	61.31	63.68
	NL-3	Day 1 (08 July 2018)	55.73	55.94	61.84
		Day 2 (09 July 2018)	60.89	60.94	61.98
	NL-4	Day 1 (18 July 2018)	59.96	59.02	60.81
		Day 2 (19 July 2018)	57.24	57.66	59.36
August	NL-1	Day 1 (04 Aug 2018)	58.54	55.07	76.58
		Day 2 (05 Aug 2018)	59.56	55.68	75.79
	NL-2	Day 1 (04 Aug 2018)	45.95	49.6	63.59
		Day 2 (05 Aug 2018)	48.65	56.84	64.04
	NL-3	Day 1 (06 Aug 2018)	58.24	60.49	62.42
		Day 2 (07 Aug 2018)	61.79	62.04	62.92
	NL-4	Day 1 (06 Aug 2018)	49.5	49.82	59.62
		Day 2 (07 Aug 2018)	50.26	49.53	61.66
September	NL-1	Day 1 (01Sep 2018)	63.67	59.5	64.28
		Day 2 (02Sep 2018)	63.63	57.2	63.44
	NL-2	Day 1 (01Sep 2018)	53.45	54.85	70.35
		Day 2 (02Sep 2018)	54.82	54.1	66.12
	NL-3	Day 1 (03Sep 2018)	53.37	57.98	63.8
		Day 2 (04Sep 2018)	68.18	61.2	64.18
	NL-4	Day 1 (03Sep 2018)	53.87	50.6	59.52
		Day 2 (04Sep 2018)	51.76	49.82	60
KEPA Standard Table 5, Decision No.8. of 2017 (Industrial and commercial areas)			70	70	65
IFC Standard Table 1.7.1 Noise Level guidelines			70	-	70

Table 3. Summary of Noise levels measured during the three months

Month	Location	Date	Leq dB (Avg)
July	DM-1	31/07/2018	77.79
	DM-2	31/07/2018	77.04
	DM-3	31/07/2018	76.96
	DM-4	31/07/2018	69.96
	DM-5	31/07/2018	75.96
August	DM-1	15/08/2018	79.22
	DM-2	15/08/2018	78.22
	DM-3	15/08/2018	77.7
	DM-4	15/08/2018	79.39
	DM-5	15/08/2018	76.91
September	DM-1	13/09/2018	74.62
	DM-2	13/09/2018	77.52
	DM-3	13/09/2018	73.97
	DM-4	13/09/2018	74.31
	DM-5	13/09/2018	73.62

Table 4. Ambient Air Quality Standards

S. No	Pollutant	Average time	Limits
1	SO_2	Hourly	75 ppb
		24- hour	19 ppb
2	NO_2	Hourly	100 ppb
		Annual	21 ppb
3	CO	Hourly	35 ppb
4	O_3	8 hour	70 ppb
5	PM_{10}	24- hour	350 µg/m^3
6	$PM_{2.5}$	24- hour	75 µg/m^3
7	NH_3	Hourly	800 ppb
		24- hour	144 ppb
8	H_2S	Hourly	100 ppb
		24- hour	20 ppb
9	NMHC	Hourly	0.24 ppb

KEPA Air Quality Standards

Standards for the protection of ambient air from pollution have been developed by the Kuwait Environmental Public Authority (KEPA) (Environmental Public Authority, Kuwait 2001). Impacts to air quality was assessed for compliance against the relevant KEPA ambient air quality standards as per Decree No.8/2017 issued under Article 48 of Law no.42/2014. KEPA Air quality standards are given in **Table 4**.

Ambient Air Quality Monitoring Data

The observed ambient air quality monitoring data and the meteorological data during the 14 days period are provided as Attachment -IV. Each table details the Hourly average and 24-hourly averages along with day's average maximum and average minimum for individual pollutants on daily basis. The summary of observed air quality data during the 14 days monitoring period is provided in **Table 7** comparing with KEPA standards and IFC guidelines.

The monitored ambient air quality results were compared to KEPA ambient air quality standards. The ambient air quality values were well within the KEPA air quality standards except non-methane hydrocarbon (NMHC) and PM 2.5. Exceedance of PM_{10}, PM2.5 occurs when compare it with the IFC guidelines. The exceeding of non-methane hydrocarbon (NMHC) was likely due to the shift in atmospheric stability between day and night; night time is often associated with thermal inversion that restricts vertical air motion and result in high pollution levels. And $PM_{2.5}$ is due to the weather conditions and piling activities which was very close to the AQM location.

Applicable Standards for Total Suspended Particles (TSP)

As there are no KEPA standards of TSP for industrial area, measured TSP is compared to PM_{10} standards of KEPA ambient air quality standards. The standards are provided in **Table 6**.

Table 5. Summary of ambient air quality data collected at site

S.No	Pollutant	Units	Observed average values		KEPA Standards decree no.8 of 2017	IFC Regulation
			Description	Study Area		
1	SO_2	ppb	Hourly data	26.64	75 ppb	-
			24 h	26.77	19 ppb	20
2	H_2S	ppb	Hourly data	3.42	100	-
			24 h	3.41	20 ppb	-
3	NO_2	ppb	Hourly data	43.63	100 ppb	200
			24 h	43.79	-	-
4	CO	ppm	Hourly data	3.61	35 ppm	-
5	O_3	ppb	8 h average	26.28	70 ppb	100
6	NH_3	ppb	Hourly data	67.55	800 ppb	-
			24 h	67.45	144	-
7	NMHC	ppm	Hourly data	0.45	0.24 ppm	
8	PM_{10}	µg/m3	24 h	261	350 µg/m3	50
9	$PM_{2.5}$	µg/m3	24 h	174	75 µg/m3	25
10	Benzene	ppb	Hourly data	4.15	N/A	-
12	Toluene	ppb	Hourly data	3.03		-
13	Temperature	C		36.17		-
14	Wind speed	m/s		3.72		-
15	Relative humidity	%		18.22		-
16	Pressure	mbar		1058.69		-

Table 6. Ambient Air Quality Standards

S. No	Pollutant	Average time	Limits
1	PM_{10}	24- hour	350 µg/m3

Table 7. Summary of measured TSP at site

Location	Date	Average (mg/m³)
Measured TSP levels for July month		
TSP-1	15/07/2018 To 16/07/2018	145.48
TSP-2	16/07/2018 To 17/07/2018	213.20
TSP-3	17/07/2018 To 18/07/2018	225.33
Measured TSP levels for August month		
TSP-1	04/08/2018 To 05/08/2018	121.25
TSP-2	05/08/2018 To 06/08/2018	114.41
TSP-3	07/08/2018 To 08/08/2018	233.86
Measured TSP levels for September month		
TSP-1	08/09/2018 To 09/09/2018	225.50
TSP-2	10/09/2018 To 11/09/2018	286.71
TSP-3	17/09/2018 To 18/09/2018	203.69
KEPA limits for 1 day		**350 mg/m³**

Air quality (TSP) was measured at construction site at 3 selected locations for 24 hours each for every month to know the intensity of TSP at study area. Summary of measured TSP is given in **Table 9**.

Air Quality (NO_2, SO_2 & BTEX) Measurement at Construction Site

Air quality (NO2, SO2& BTEX) were measured at site at 3 selected locations continuously for minimum 3 weeks period to know the intensity of NO_2, SO_2 & BTEX at construction site. Air quality NO_2, SO_2& BTEX lab results are summarized in **Table 8**.

The air quality monitoring (for NO_2, SO_2 & BTEX) was done for a period of 3 weeks at the selected sites. The above given lab analysis results for the pollutants are average values obtained for a period of 3 weeks. As the KEPA standards are given for hourly basis it is not possible to compare the measure values with the KEPA standards.

Table 8. Summary of measured NO2, SO2 and BTEX at Construction site

Location	NO2 (ppb)	SO2 (ppb)	BTEX (ppb) Benzene	Toluene	Ethyl benzene	mp-Xylene	o-Xylene
Measured SO2, NO2 & BTEX values for July month							
DTL-1	19.75	516.39	0.21	0.38	0.14	0.24	0.1
DTL-2	5.98	138.61	0.27	2.47	8.05	19.4	6.79
DTL-3	105.17	62.23	0.31	1.33	0.49	0.83	0.35
Measured SO2, NO2 &BTEX values for August month							
DTL-1	44.12	54.29	0.2	0.31	0.14	0.22	0.09
DTL-2	36	139.97	-	-	-	-	-
DTL-3	45.62	28.87	0.29	0.93	0.49	0.88	0.31
Measured SO2, NO2 &BTEX values for September month							
DTL-1	50.32	39.16	0.28	0.59	0.19	0.35	0.15
DTL-2	-	-	-	-	-	-	-
DTL-3	57.59	25.38	0.3	0.52	0.19	0.37	0.15

Waste Water Monitoring

Waste water was collected from storage tanks in the port area. The waste water generated from the ship yard. It represents human sewage removed from ships during their presence in Shuwaikh port. Since there is no treatment option for such waste disposal however, the sewage has been managed away from the port area by

Table 9. Waste water analysis results

S.NO	Parameters	Symbol	Analysis Result	Unit	KEPA limits
1	pH	pH	7.46	mg/L	6.5-8.5
2	Biological Oxygen Demand	BOD5	<2	mg/L	20
3	Chemical Oxygen Demand	COD	45	mg/L	100
4	Dissolved Oxygen	DO	7.1	mg/L	>2
5	Residual Chlorine	Cl2	<0.2	mg/L	0.5-1.0
6	Floatables	-	12	mg/L	NIL
7	Oil/grease	-	<5	mg/L	5
8	Total Suspended Solids	TSS	46	mg/L	15
9	Total Dissolved Solids	TDS	461	mg/L	1500
10	Phosphate	(PO4-P)	1.35	mg/L	30
11	Ammonia	NH3-N	3.94	mg/L	15
12	Total KJeldahl Nitrogen	TKN	6.3	mg/L	30
13	Total Nitrogen	TN	29.3	mg/L	65
14	Phenol	C6H6O	<0.05	mg/L	1
15	Fluoride	F	<0.1	mg/L	2
16	Sulfide	S	<0.1	mg/L	0.1
17	Aluminum	Al	0.12	mg/L	5
18	Arsenic	As	<0.001	mg/L	0.1
19	Barium	Ba	0.016	mg/L	2
20	Boron	B	0.06	mg/L	2
21	Cadmium	Cd	<0.0001	mg/L	0.01
22	Chromium	Cr	<0.001	mg/L	0.15
23	Nickel	Ni	0.004	mg/L	0.2
24	Mercury	Hg	<0.0001	mg/L	0.001
25	Cobalt	Co	<0.001	CFU/100mL	0.2
26	Iron	Fe	0.25	CFU/100mL	5
27	Antimony	Sb	<0.001	CFU/100mL	1
28	Copper	Cu	0.009	# viable eggs / L	0.2
29	Manganese	Mn	0.047	mg/L	0.2
30	Zinc	Zn	0.077	mg/L	2
31	Lead	Pb	<0.001	mg/L	0.5
32	Total Petroleum Hydrocarbon	TPH	<5	mg/L	5
33	Fecal Coliform Bacteria	F.C	<1	mg/L	100
34	Escherichia coli	E.coli	<1	pH Unit	50
35	Faecal Streptococci Bacteria	F.S	<1	mg/L	50
36	Egg Parasites		<1	mg/L	NIL

ministry of public work waste water management plans. (**Table 4**) provide the result of waste water analysis.

Analysis Results

One wastewater sample was collected from Waste Water Treatment Plant (WWTP). The analysis results were compared to KEPA and IFC Standards, and all are within the limits except residual Chlorine, floatables, total suspended solids.

- Regarding to residual chlorine, the dose of sodium hypochlorite shall be increased with a specific ratio in order not to lower or higher than KEPA limits.
- For floatables and suspended solids it is recommended to fix one screener or filter on the intake tank of WWTP.

Dredging Process

Also, long-term monitoring of the dredging process and disposal may be required. Mitigation measures recommended for reducing the release of sediments and fines into the main water body could include:

- Containment of the work area with a silt curtain to prevent excessive release of fine sediments
- Use of suction dredger instead of bucket dredger
- Dewatering of fines through sediment traps
- No dredging works during storms
- Halting dredging during the breeding seasons of economically important fish stocks or protected or rare species.
- Plan for minimizing impacts on local flora and fauna, and screen for the presence of rare, threatened or endangered species that are indigenous to the project location.
- Monitor local air quality and reduce operations if unacceptable quality arises.

Management Plan to Improve Marine Water Quality in the Port Area

1. The drains and outfall should be cleaned regularly to avoid anaerobic decomposition and also for proper flow of water/wastewater. This will also enable the characterization of wastewater and calculation of waste load
2. Domestic and canteen wastewater should be discharged only after proper treatment
3. The solid waste generated from the canteen and other diffused sources should be collected and disposed off properly
4. The discharge of oil waste into the sea from the following main sources should be controlled
   a. Discharge of oil waste from liquid chemical corridor area. This liquid waste is generated during tanker cleaning and oils spills during filling operations

   b. Oil spills at berth during unloading operations
   c. Tanker ballast discharge from ships
5. The discharge of solid waste and sewage from ships should be controlled. It should be disposed/discharged only after proper treatment
6. Bulk material should not be disposed into the sea. All drains and roads should be cleaned before the rainy season to avoid runoff from land to sea carrying a myriad of pollutants including chemicals
7. Temporary bunds should be constructed to contain surface runoff from land sites. Collected runoff should be passed through retention ponds to collect suspended solids before discharge
8. A treatment system should be provided at the construction camp. This could either be a package plant or a septic tank
9. A conventional activated sludge sewage treatment plant is not considered to be appropriate for port operations owing to fluctuations in the volume and characteristics. The following alternatives for treatment are more appropriate
   a. Either an anaerobic pond followed by facultative and polishing off ponds discharging to a near shore outfall
   b. An anaerobic pond discharging to an offshore outfall
10. Sanitary effluents should not be discharged into the harbour itself
11. Oily waste waters (from fuel storage tanks, maintenance shops, ships' bilge water, tank washings) and runoff from dirty areas of the port (vehicle marshalling, parking and fuel storage areas) should all be collected and passed through an oil water separator before discharge. Wastewater may be returned to storm water system after treatment
12. Reception facilities for oily wastes from ships should be provided and their use should be enforced by monitoring. Penalties may be imposed for oily discharges in and around the port
13. Regular monitoring of water quality should be carried out within the port and in adjacent waters during operation to identify adverse environmental changes.

CONCLUSION

Based on the environmental monitoring being carried out at the present study in Suwaikh marine port, Kuwait, no significant environmental impacts have been notified at the site during July 2018 to September 2018 months related to the port activities.

As a part of Environmental monitoring Noise level measurements and Air quality monitoring (Total Suspended particles, Pollutants such as SO2, NO2 & BTEX, and ambient air quality monitoring) were performed at different locations of the site.

NOISE MONITORING RESULTS

The measured noise levels were compared to KEPA standards, some of the noise levels at the construction site were found to be within KEPA limits except some areas were found exceeding the limit and that is because of the construction activities in some locations.

Mitigation measures for noise:

1- For construction and workshops activities :
- Workers have to be provided with ear plugs;
- Using barrier protection for noisy equipment;
- Doing regular maintenance for noisy equipment.

2- For Generators Room:
- Build a Sound Wall Around the Generator.
- Reduce Vibration in the Engine Housing.
- Adding Mufflers to generators.

AIR MONITORING RESULTS

All the measured parameters (Air Quality) are within KEPA limits except non-methane hydrocarbon (NMHC), PM2.5, PM10 and SO_2 from ambient air quality monitoring was found to be exceeding KEPA limits and IFC Standards.

- The exceedance of non-methane hydrocarbon (NMHC) is likely due to the shift in atmospheric stability between day and night; night time is often associated with thermal inversion that restricts vertical air motion and result in high pollution levels.
- For PM_{10} and $PM_{2.5}$, because of construction activities which is going on site, and unstable weather condition (Dusty conditions) for the last three month.
- For SO2 there are no major sources for SO2 in project site, but a known source of SO2 is power plants and Al-zoor thermal power plant is very near to the project location and expected to be the source of SO2 in the site.

In view of the likely increase in port development and operations, it is suggested that government in every country should consider the eventual establishment of a specialist port environmental planning unit, which could be responsible for gathering improved data on coastal environment in the vicinity of key ports, advising on environmental issues and identifying new practices, techniques and technologies.

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