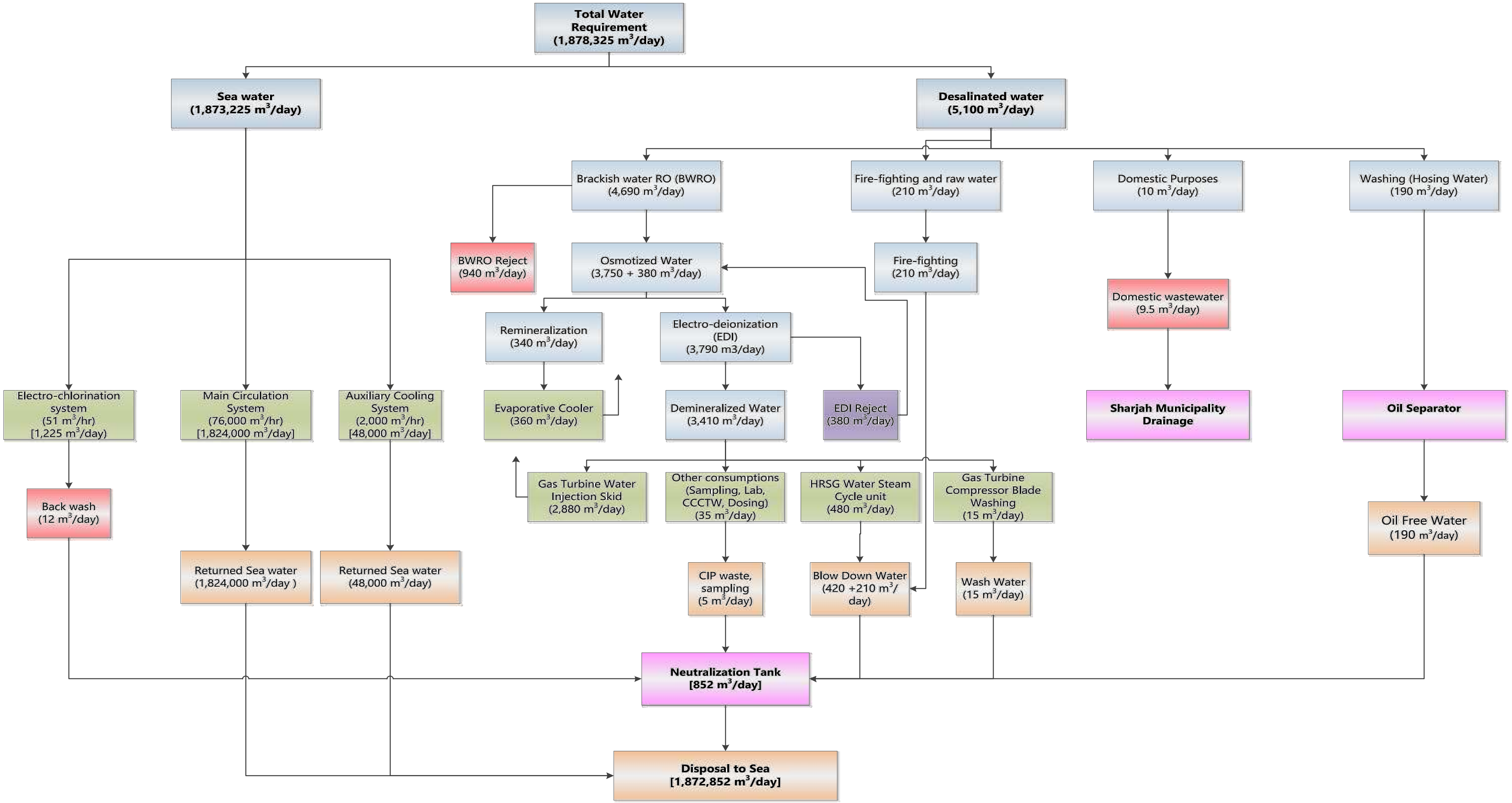


Figure 6 – Water Balance Diagram

Table 36 – Details of the Intake System

S. No.	Description	Details	
		Details of the Intake System	
1	Details of the intake system	Seawater intake pumping station with screens, chlorination system and pumps	
2	Maximum intake quantity	1,873,225m³/day	
3	Intake seawater quality	**Parameter**	**Value**
		Total Suspended Solids (TSS)	5 – 20 mg/l
		Total Dissolved Solids (TDS)	38,000 – 45,000 mg/l
		Temperature (Min. – Average – Max.)	18 – 28 – 35 °C

5.5.4. FUELS, CONSUMABLES

The raw materials, consumables used during the normal operation of the plant are given in **Table 37**.

Table 37 – Details of fuels/consumables to be used for the proposed project

S. No.	Name of the Chemical	Nature	Quantity to be required	Purpose of usage	Storage
1	Natural Gas	Gas	189.4 Ton/hr	Fuel	Existing Distribution system
2	Light Fuel Oil	Liquid	160 m³/hr	Fuel	Tanks

5.5.4.1. Specifications of Fuel Gas

Fuel Gas to be utilized for the proposed project shall comply with the following quality specifications:

- Gross Heating Value of fuel gas shall not be less than 950 BTU/SCF and not more than 1100 BTU/SCF;
- Water dew point shall be below 32°F at the Delivery Pressure;
- Hydrocarbon dew point shall be below 50°F at the Delivery Pressure;
- Hydrogen sulphide shall not be more than 1.0 grain or more than 10 grains of total sulphur, per 100 SCF

- Carbon dioxide shall not be more than 3.5% carbon dioxide, on a molar basis and Nitrogen shall not be more than 6.0% nitrogen, on a molar basis;
- Net Heating Value shall not be less than 89% of the GHV;
- Specific gravity shall not be less than 0.5 and not more than 0.7. Reference to determine specific gravity is air, and air shall be deemed to have a specific gravity of 1;
- Wobbe Index value shall not be less than 1090BTU/SCF and not more than 1210 BTU/SCF;
- Temperature shall not be greater than 130 degrees Fahrenheit; provided, however, that during summer time when extreme ambient air temperatures prevail the temperature shall not exceed 140 degrees Fahrenheit.

5.6. WASTE STREAMS

5.6.1. AIR EMISSIONS

The primary pollutants from gas turbine engines are nitrogen oxides (NOx), Carbon Monoxide (CO), and to a lesser extent, volatile organic compounds (VOC). Particulate matter (PM) is also a primary pollutant for gas turbines using liquid fuels. Nitrogen oxide formation is strongly dependent on the high temperatures developed in the combustor. Carbon monoxide, VOC, hazardous air pollutants (HAP), and PM are primarily the result of incomplete combustion. Trace to low amounts of HAP and sulfur dioxide (SO_2) are emitted from gas turbines. Ash and metallic additives in the fuel may also contribute to PM in the exhaust. Oxides of sulfur (SO_X) will only appear in a significant quantity if heavy oils are fired in the turbine. Emissions of sulfur compounds, mainly SO_2, are directly related to the sulfur content of the fuel *(US EPA, 2009)*.

The following main control mechanisms will be installed to reduce the emissions generated from the gas turbine system.

- Hot exhaust gas discharged from the gas turbine is channeled through an HRSG in order to heat incoming feed water and subsequently generate saturated and superheated steam. The exhaust gas exits the HRSG through an exhaust stack via damper and silencer located in HRSG stack.
- Gas turbine system will be equipped with Dry Low NOx (DLN) burner system which controls nitrogen oxide emissions.

Hot exhaust gas discharged from the gas turbine is channeled through bypass stack and HRSG system. The exhaust gas exits the HRSG through HRSG (main) stack. During normal operation, the plant will be operated in combined cycle mode, and the main HRSG stack will be in operation. Bypass stack may be operated in single cycle mode during maintenance of HRSG. The main HRSG stack (2 Nos. – each one per HRSG) and the bypass stack (2 Nos. – each one per GT) will not be operating concurrently at any time. The details of main HRSG stack and bypass stack are presented in **Table 38**.

Table 38 – Details of Emissions from HRSG main stack and bypass stack

S. No.	Parameters	Unit	HRSG Main Stack		Bypass Stack	
1	Operation Mode	--	CC - Fuel Gas	CC - Fuel Oil	SC - Fuel Gas	SC - Fuel Oil
2	Internal Diameter of stack	m	6.9		6.4	
3	Flue gas temperature	°C	87	171	639	464
4	Flue gas exit velocity	m/s	21.8	28.0	64.1	54.0
5	Flue gas exit pressure	bar	1.013	1.013	1.013	1.013
6	**Flue gas Pollutant Emission Rates (Maximum)**					
(i)	Particulate matter	mg/Nm^3	<30	<30	<30	<30
		g/s	3.32	3.6	3.32	3.6
(ii)	Oxides of nitrogen (NO_x)	mg/Nm^3	<70	<150	<70	<150
		g/s	8.2	11.88	8.2	11.88
(iii)	Sulphur di-oxide	mg/Nm^3	<500	<500	<500	<500
		g/s	41.6	37.2	41.6	37.2
(vi)	Carbon mono-oxide (CO)	mg/Nm^3	<500	<500	<500	<500
		g/s	15.96	13.78	15.96	13.78

Green House Gases - Carbon dioxide (CO_2) and nitrous oxide (N_2O) emissions are produced during natural gas and distillate oil combustion in gas turbines. Nearly all of the fuel carbon is converted to CO_2 during the combustion process. Methane (CH_4) is also present in the exhaust gas and is thought to be unburned fuel in the case of natural gas or a product of combustion in the case of distillate fuel oil. Although the formation of CO acts to reduce CO_2 emissions, the amount of CO produced is insignificant compared to the amount of CO_2 produced. The majority of the fuel carbon not converted to CO_2 is due to incomplete combustion. A complex series of reactions govern the Formation of N_2O during the combustion process, and its formation is dependent upon many factors. However, the formation of N_2O is minimized when combustion temperatures are kept high (above 1475°F), and excess air is kept to a minimum (less than 1 %) *(US EPA, 2009)*.

Besides, the air quality of the surrounding area will be influenced by fugitive dust emissions generated from vehicular movement on unpaved roads, exhaust emissions from vehicular traffic and fuel-fired equipment/machinery used for the proposed project.

5.6.2. NOISE EMISSIONS

The sources of noise pollution in the proposed facility will be the operation of pumps, turbines, compressors, generators, movement of vehicles and other routine activities in the facility. Noise can be reduced through planning, plant and equipment design & selection, processing equipment within buildings and acoustic enclosures to comply with the norms of noise exposure guidelines as per Occupational Safety and Health Administration (OSHA). The followings are the noise emission levels generated by equipment/machinery to be utilized during the operation of the facility.

Table 39 – Assumed Noise Emission Levels of Equipment/Machinery

Name of Equipment/Machinery/ Building	Noise Emission Level - dB (A)
Gas Turbine and Enclosure	85.0
Steam Turbine	85.0
HRSG Enclosure	80.0
Fuel Gas Heater	75.0
Cooling Air Cooler	80.0
Purge Air Compressor	85.0
GT Casing Cooling Fan	85.0
Plant Air Compressor	90.0
GT Generator	95.0
HRSG Recirculation pump	95.0
ST Oil Cooler	85.0
Condenser	85.0
Condenser Vacuum Pump	95.0
Condensate Extraction Pump	95.0
HP Feed Water Pump	95.0
LP Feed Water Pump	95.0
Outfall Chamber	90.0
Intake water pumping station	95.0

5.6.3. LIQUID WASTE GENERATION AND MANAGEMENT

The sources of water pollution in the proposed project will be domestic wastewater, industrial wastewater generated from the power generation process and used/waste oil generation. The estimated quantity of domestic wastewater generation is in the range of

12.0 – 14.5 m^3/day. The generated domestic wastewater (sewage) will be collected in the underground septic tank and discharge to existing Sharjah Municipality drainage system**.** Sources and quantity of industrial wastewater generated from the process are presented in **Figure 6**. The industrial wastewater to be generated from the proposed project will be neutralized, and neutralized wastewater will be discharged to the sea through the outfall discharge system. The expected characteristics of outfall effluent are hereunder presented.

Table 40 – Characteristic of outfall effluent

S. No.	Parameters	Units	*Concentration Levels (Maximum)*
1)	pH	--	6 - 9
2)	Turbidity	NTU	75
3)	Chlorine (Residual)	mg/L	0.2
4)	Nitrogen - Ammonia	mg/L	5.0
5)	Total Suspended Solids (TSS)	mg/L	30
6)	Biochemical Oxygen Demand (BOD)	mg/L	30
7)	Chemical Oxygen Demand (BOD)	mg/L	150
8)	Oil and Grease	mg/L	10
9)	Phenols	mg/L	0.5
10)	*Total Coliforms*	CFU/100 ml	100
11)	Arsenic (As)	mg/L	0.05
12)	Cadmium (Cd)	mg/L	0.05
13)	Chromium (Cr)	mg/L	0.5
14)	Cobalt (Co)	mg/L	0.5
15)	Copper (Cu)	mg/L	0.5
16)	Iron (Fe)	mg/L	2.0
17)	Lead (Pb)	mg/L	0.1
18)	Zinc (Zn)	mg/L	0.1
19)	Nickel (Ni)	mg/L	0.1
20)	Mercury (Hg)	mg/L	0.001

The used/waste oil will be disposed to the authorized waste oil recyclers/re-processors. The estimated quantity of used/waste oil generation from the facility will be 10,000 – 15,000 litres/Annum.

5.6.3.1. Outfall Discharge System

Layyah Power Station has existing outfall channel for discharging the effluent generated from existing desalination plant and power plant in the premises. The estimated quantity of discharge through the existing outfall channel is around 125,500 m^3/hr (Max.).

Presently, two (2) options are proposed for outfall discharge systems. The considered options are the following:

Option 1: Outfall discharge to be conveyed through a pipeline to a multiport diffuser located offshore; multiport diffuser to be located north side from the existing intake head structures;

Option 2: Outfall discharge to be conveyed through a pipeline to a multiport diffuser located offshore; multiport diffuser to be located south side from the existing intake head structures;

The suitable option will be finalized based on hydro-dynamic modeling & re-circulation study. The estimated outfall discharge by the proposed project will be approximately 1,872,852 m^3/day (78,035 m^3/hr). The tentative locations considered are represented in Google image (**Figure 3**) and layout **(ANNEXURE 3)**.

5.6.4. SOLID WASTE GENERATION AND MANAGEMENT

The details of the solid waste generation are given in **Table 41.**

Table 41 – Solid waste generation and management

S. No.	Type of Waste	Quantity	Management
1	Domestic solid waste	1.0 – 2.0 Tons/month	Disposed to SM authorized service providers
2	Paper, packing materials, wood scraps	2.0 – 4.0 Tons/Annum	Disposed to SM authorized service providers
3	RO membranes and catridges	5 – 10 Tons/Annum	Disposed to authorized recyclers/re-processors
4	Hazardous waste (Waste chemicals/Paints/ Oil sludge/ oil soaked cotton, rags etc.,)	2.0 – 4.0 Tons/ Annum	Disposed to SM authorized service providers

5.7. PROJECT STATUS AND SCHEDULE

The present status of the project is in design finalization and getting necessary approval/permit from concerned regulatory authorities. Site photos of the project site are presented in **ANNEXURE 4.** The construction phase is planned for around 39 months. The proposed project will be expected to start the operation in July 2021. The tentative project implementation schedule with major milestone is enclosed as **ANNEXURE 6.**

5.8. CONSTRUCTION PHASE

It is proposed to construct a built-up area of 23,000m^2 for the proposed power project and its support facilities. The duration of the construction phase is planned to be around 34 months with a requirement of man power of 750-1250 numbers of people. During the construction, it is approximated that there will be a total water requirement of 140 – 265 m^3/day which will be supplied by SEWA or private water supplier. The required power will be met through DG sets or SEWA according to the availability. The waste generated will be disposed through Sharjah Municipality approved disposal mechanisms. The main activities to be carried out during construction are detailed in **Table 42**.

Table 42 – Main activities to be carried out during construction phase

Construction Activity	Details
Site Clearance	This will include clearance of materials and dismantling of existing structures at the expansion site. Since there is no major vegetation at the site, vegetation clearance will not be required. This will allow for excavation, compaction and grading of the expansion site.
Excavation works	Excavation works including compaction and grading will be undertaken to prepare the site for the fill required to raise the site as required. Excavation works will also be required to establish foundations.
Site enabling works	Vehicle access to the site will be required for the frequent delivery of soil and other materials during construction. To allow this, access roads and tracks must be of sufficient quality, and so the main access route on the approach to the proposed site must be appropriately developed.
Foundation construction	Once the site is suitably prepared. Bar cage reinforcement and shuttering will be installed prior to concrete pouring. Concrete raft, piled foundations, or a combination of both will be used.
Erection of mechanical and electrical equipment	This stage mainly involves construction of the major power plant components including gas turbines, steam turbine and condenser. Concrete and steel will be the primary construction materials for this stage.
Construction of transmission line	Towers will be erected and transmission line will be strung, connecting the GIS substation to the substation for wider distribution throughout Sharjah.
Construction of offshore intake and out fall pipelines	The main execution and installation activities are as follows: • Assemble and prepare HDPE pipe strings. • Onshore works; o Removing revetment o Sheet piling o Excavation o Re-instatement

Construction Activity	Details

	• Marine trenching and backfilling.
	• Pipeline installation.
	• Finalizing installation works;
	  o Intake structures (Marine)
	  o Diffuser structures (Marine)
	The supplier will fabricate individual pipeline sections and transported to the site. The pipe sections will be welded together into long strings. Above stringing and manholes installation activities will be either done from a quay-side or on a marine crane-barge after which process the pipe strings will be floating. All pipe string ends being closed by blind flanges. Concrete collars around HDPE pipe strings will be installed. Concrete collar installation will be done from either a crane barge or quay-side. The HDPE pipe strings will remain floating during this process and could be lifted partly out of the water for easy collar installation. Appendages on each pipe string end for the flooding process will be installed.
	Onshore works - Onshore works will be supported by regular earth moving equipment and carnage. Due to the depth of the onshore trench 6 m below reference level and consequently in the order of 8m below surface level, temporary sheet piling will be installed to assure a stable trench and limit the top-width of the onshore trench. The trenches will be kept wet so no groundwater extraction will be required. After installation of the different pipe strings the trench will be backfilled with trenched materials after which sheet piling will be removed. The revetment will be re-instated using the original materials.
	Marine trenching - Marine trenching works are based on Backhoe dredger supported by split hopper barges for the disposal of dredged materials.
	Pipeline installation - The pipeline installation process can be summarized in the following typical working steps;
	• A prepared pipe string will be collected from the assembled location. Due to the length, this towage operation will involve multiple work vessels.
	• After arrival on site the pipe string is maneuvered on its future center axis by support of multiple work vessels.
	• At shore a flooding hose is connected to the appendages on the pipe string end.
	• At offshore end of the pipe string, the marine construction barge will hold the pipe end in place and

Construction Activity	Details
	some tension is introduced to the system to assist alignment on the center axis. • During the flooding operation air will be released at offshore end of the string. • The flooded section of the HDPE pipeline will sink to the seabed and an S-shaped transition section will arise between flooded and non-flooded section. • When the first pipe string is almost flooded to the offshore end the next pipe string is delivered and coupled to the pipe string already installed. • This is a repetitive installation process up to installation of the overall pipe length. **Marine backfilling** - Backfilling operations will be carried out in two different spreads of equipment; 1. The first step is backfilling with sand around the installed pipelines with a top level just above the concrete collars. 2. Step 2 is the placement of rock on top of the sand layer. Backfilling with sand will be done with a small Trailing Suction Hopper Dredger (TSHD). Due to the limited water depth, a discharge pipeline will be used during backfilling is connected to the bow coupling of the TSHD and ending on a spray-pontoon on the other end. The mooring pontoon could be either the marine construction barge or other similar anchored pontoon. Rock is delivered by rock transport barges which will be moored alongside the main mooring barge. Rock placement is done by wheel loader(s) and/or excavators operating from the rock transport barges. During shift to the next rock cargo barge, the earth moving equipment will be parked on the main mooring barge. **Various installation works -** Installation works of both Intake structure and Diffuser will be done by the marine construction barge. The marine construction barge will be equipped with a typically 250mT crawler crane. Consequently, it is assumed that the ultimate weight of both Intake and Diffuser structures (could be modular will be within lifting capabilities of such a crane. After positioning on the seabed the structures will be flanged to the HDPE pipelines by divers.

The salient features of construction Phase is detailed **Table 43**

Table 43 – Salient features of the construction phase of the project

S. No.	Description	Details	
1	Duration of the construction phase	Around 34 Months	
2	Maximum manpower to be deployed at peak construction	750 - 1250	
3	Proposed built-up area of construction	23,000 m^2 (Approx.)	
4	Water supply and requirement		
	Water Supply	SEWA Water supply/Private water suppliers	
	Water requirement	Domestic purposes	40 – 65 m^3/day
		Construction purposes	100 – 200 m^3/day
		Total	140 – 265 m^3/day
5	Power supply	SEWA /DG sets	
6	Waste generation and management		
	Type of waste	**Quantity of Generation (Approx.)**	**Management**
a	Domestic solid waste	25 – 35 CBM/month	Disposed to SM authorized service providers
b	Construction & demolition waste	15 – 25 Tons/month	
c	Hazardous waste (paint drums, construction chemicals, oil-soaked rags, cotton etc.,)	0.5 – 1 Tons/month	Disposed to SM authorized hazardous waste service providers after obtaining NOC
d	Domestic wastewater (sewage)	35 – 60 m^3/day	Collected in the septic tank and discharged to SM drainage system
e	Dredged waste from dredging activity	25,000m^3	Disposed to SM authorized service providers

6. DESCRIPTION OF ENVIRONMENT

6.1. GENERAL METHODOLOGY

In order to carry out environmental and social impact assessment study, it is first necessary to delineate and define the existing environmental and social factors in and around the project site on the existing environmental and social scenario which will include various environs like ecology, socioeconomic profiles and environmental quality in respect of air, water, noise & soil etc. This section incorporates the description of the existing environmental and socioeconomic settings around the project site. A description focused on the aspects of the environment and society likely to be significantly affected by the project.

The baseline environmental survey (terrestrial and marine environment) conducted during **July 2018** and **August, 2018.** The sampling was done under supervision of ESC and analysis of terrestrial environmental components was carried out by **RAK Lab LLC, Ras Al Khaimah**. The sampling was done by marine ecology team led by Dr. Shahid Mustafa and analysis of marine environmental components was carried out by **Lonestar Technical Services, Dubai.** The secondary data for baseline environmental and social components are collected from web sources, articles and books. Secondary data on meteorology were collected from monitoring stations of National Center of Meteorology & Seismology (NCMS) (Sharjah International Airport station and Dubai International Airport Station). The summaries of sources used for data collection of environmental components are presented in **Table 44**.

Table 44 – Summary on baseline environmental and social components data collection

S. No.	Environmental Components	Parameters & Source	Details on Primary Survey		Source of Secondary Data
			Method of Sampling	Frequency & No. of Samples	
Terrestrial Environmental Components					
1	Climatology & Meteorology	Wind Speed, Wind direction, Relative humidity, dew point and Temperature – Primary & Secondary data	Micro-controller based automatic weather station with data logger was used	Project Site	Secondary data on meteorology were collected from National Center of Meteorology & Seismology (NCMS) for the years, 2007 to 2017. Wind data sourced from Lowa Environmental Mesonet Site. (http://mesonet.agron.iastate.edu)
2	Air Environment	Air Quality – TSP, PM_{10}, SO_2, NOx, CO, O_3, Pb, TVOC – Primary data	High flow-rate respirable dust sampler (Model AAS 217 BL) was used along with calibrated multi-gases sensors (electro-chemical, infra-red, photo ionization detectors)	24 hours continuous – 4 locations at project site.	
3	Noise levels	Noise levels in dB (A) - Min, Max and Average – Primary data	Calibrated integrating sound level meter was used	13 hours for day time & 11 hours for night time – 4 locations at project site	
4	Water Environment	Primary data - Groundwater quality – pH, Temp, Turbidity, Colour, EC, Alkalinity, TDS, TSS, O&G, BOD,	Sampling & Analysis as per standard methods given in APHA, AWWA-2012	One time sampling – 2 groundwater samples at project site	

S. No.	Environmental Components	Parameters & Source	Details on Primary Survey		Source of Secondary Data
			Method of Sampling	Frequency & No. of Samples	
		COD, Chlorides, Sulphates, Fluorides, Hardness, Ca and Mg Hardness, Na, K, Total Nitrogen, Phosphorus, Fe, Cu, Zn, Pb, Cd, Mn, Cr, Ni, Phenols			
		Water Resources – Secondary data	--	--	**Zein, S.R. and Abdulrahman, S.A.** 2003. Water resources in the UAE. In: Water Resources Perspectives: Evaluation, Management and Policy. Edited by A.S. Alsharhan and W.W. Wood. Published by Elsevier Science, Amsterdam, The Netherlands, p. 245-264.
5	Ecology	Existing terrestrial flora and fauna within the study area – Primary & Secondary data	Field Observations	Project site	IUCN – Red Data Book on Red listed species. Federal Law 24 of 1999 Chapter VI Natural Resources Article 64. Tribulus – Journal of Emirates Natural History Group.
6	Geology & Soil	Primary data - Soil samples analyzed for physical and chemical parameters - pH, Moisture content,	Sampling and Analysis as per British Standard (BS 1377:1990)	Composite soil sampling - 4 Locations at project site	--

S. No.	Environmental Components	Parameters & Source	Details on Primary Survey		Source of Secondary Data
			Method of Sampling	**Frequency & No. of Samples**	
		Chlorides, Nitrogen, Phosphorus, Potassium, Alkalinity, Electrical Conductivity and Heavy Metals (As, Ba, Cd, Cr, Cu, Fe, Hg, Mn, Ni, Pb, Se, Zn) and Total Petroleum Hydrocarbon			
		Geological Resources – Secondary data	--	--	Holocene coastal carbonates and evaporites of the southern Arabian Gulf and their ancient analogues by Alsharhan and Kendall (2003).
Marine Environmental Components					
1	Oceanography	Hydrographic survey - Bathymetry, tide levels and current	Single beam Echo sounder integrated with differential GPS is used for bathymetry survey. Acoustic Doppler Current Profiler (ADCP) and tide gauge is used for current and tide levels measurement.	Project Study area – 7 × 3 km 1 location at Arabian Gulf.	--
2	Marine water (Sea)	**In-situ parameters** - pH, Temperature,	In-situ water quality profiling measurements was carried out in using calibrated	One time sampling & 12 sea water samples at marine	--

S. No.	Environmental Components	Parameters & Source	Details on Primary Survey		Source of Secondary Data
			Method of Sampling	**Frequency & No. of Samples**	
		Turbidity, Dissolved Oxygen (DO), Salinity **Ex-situ parameters -** Total Dissolved Solids (TDS), Total Suspended Solids (TSS), Calcium, Magnesium, Sodium, Potassium, Carbonates, Chloride, Sulphate, Fluoride, Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total residual chlorine, Total Nitrogen, Nitrate Nitrogen, Ammonia Nitrogen, Nitrite Nitrogen, Boron, Bromide, Heavy Metals (Al, As, Cd, Cr, Cu, Fe, Hg, Zn), Surfactants,	probes. For ex-situ parameters, water samples were collected in middle depth in the water column using Niskin water sampler. Sampling and Analysis as per APHA, 2017 – Sharjah Municipality recognized Laboratory	impact area and 2 samples from existing outfall channel	

S. No.	Environmental Components	Parameters & Source	Details on Primary Survey		Source of Secondary Data
			Method of Sampling	Frequency & No. of Samples	
		Total Petroleum Hydrocarbons, Chlorophyll, and *E. coli*.			
3	Marine Sediment	Particle size analysis, Total Organic Carbon,, Total Nitrogen, Nitrate Nitrogen, Ammonia Nitrogen, Phosphate, Sulphate Heavy Metals (Al, As, Cd, Cr, Cu, Fe, Hg, Zn), Total Petroleum Hydrocarbons	Stainless steel Van Veen grab sampler was used for the collection of bottom sediments. Sampling and Analysis as per APHA, 2017 – Sharjah Municipality recognized Laboratory	One time sampling & 10 samples at marine impact area	
4	Marine Ecology (Flora, Fauna, epi-benthic and in-fauna communities)	Species identification, Taxonomic classification, Abiotic characteristics including substrate type and any other notable features, Relative abundance, diversity index	Marine Ecology study was carried out underwater, by qualified divers (marine ecologist) in the study area. The observations are also documented using media tools such as videography and photographs.	One time sampling & 10 samples at marine impact area	

S. No.	Environmental Components	Parameters & Source	Details on Primary Survey		Source of Secondary Data
			Method of Sampling	**Frequency & No. of Samples**	
Socio-Economic Components					
1	Socio-economic Aspects	Socio-Economic Components of the study area – Secondary data • Labour and working conditions • Community health, safety and security • Land acquisition and involuntary resettlement • Indigenous peoples • Cultural Heritage	--	--	Data collected from Federal Competitiveness and Statistics Authority (FCSA) and Department of statistics and community development of Sharjah

6.2. STUDY AREA – PROBABLE IMPACT AREA

Prior to the collection of baseline data, the impact areas have been delineated. Establishing the coverage of the impact areas can be difficult. There are a lot of factors to be considered such as physical attributes of the project site, prevailing meteorological conditions, Valued Ecosystem Components (VECs), adjacent facilities and distance of the nearest community, among others. The primary impact areas cover the existing sites and areas at least a 2 kilometer within its radius. The secondary impact areas are a radius of about 5 kilometer from the project site. Initially, the coverage of the impact areas is limited to ensure accuracy in the identification of impacts. The coverage may be expanded once the impact assessment shows that the project will have impact to a much larger area as initially delineated. The map showing the primary and secondary impacts areas are represented in **Figure 7** and **Figure 8**.

6.2.1. ENVIRONMENTAL SENSITIVITY OF THE STUDY AREA

Sensitive receptors (Valuable ecosystem components) in the primary impact and secondary impact areas are identified. Sensitive receptors can be described as features that are notable in some way, whether due to their local or national importance or if they are especially sensitive to changes. Typically, sensitive receptors relate to ecological or human receptors (habitats, species, population centres) as well as geographical phenomenon or structures. Sensitive receptors are the specially protected resources and those vulnerable people in a given area at the receiving end of the discharges, emissions and pollutions from a project or activity. VECs normally require the most attention for protection against the harmful effects of project implementation. The details of receptors and its sensitivity are described in **Table 45**.

Table 45 - Details of sensitive receptors in and around the project site

S. No.	Name of the Receptor	Sensitivity*	Distance from Project Site (km)	Direction from Project site
1.	Al Layyah suburb – Residential area	High	0.45	S
2.	Al Marijah suburb – Residential area	High	0.70	E
3.	Al Khaleidia suburb – Residential area	High	1.0	S
4.	American School of Creative Science - School premises	High	0.60	S
5.	Manar Al Sabeel Quran Center –	High	0.90	S

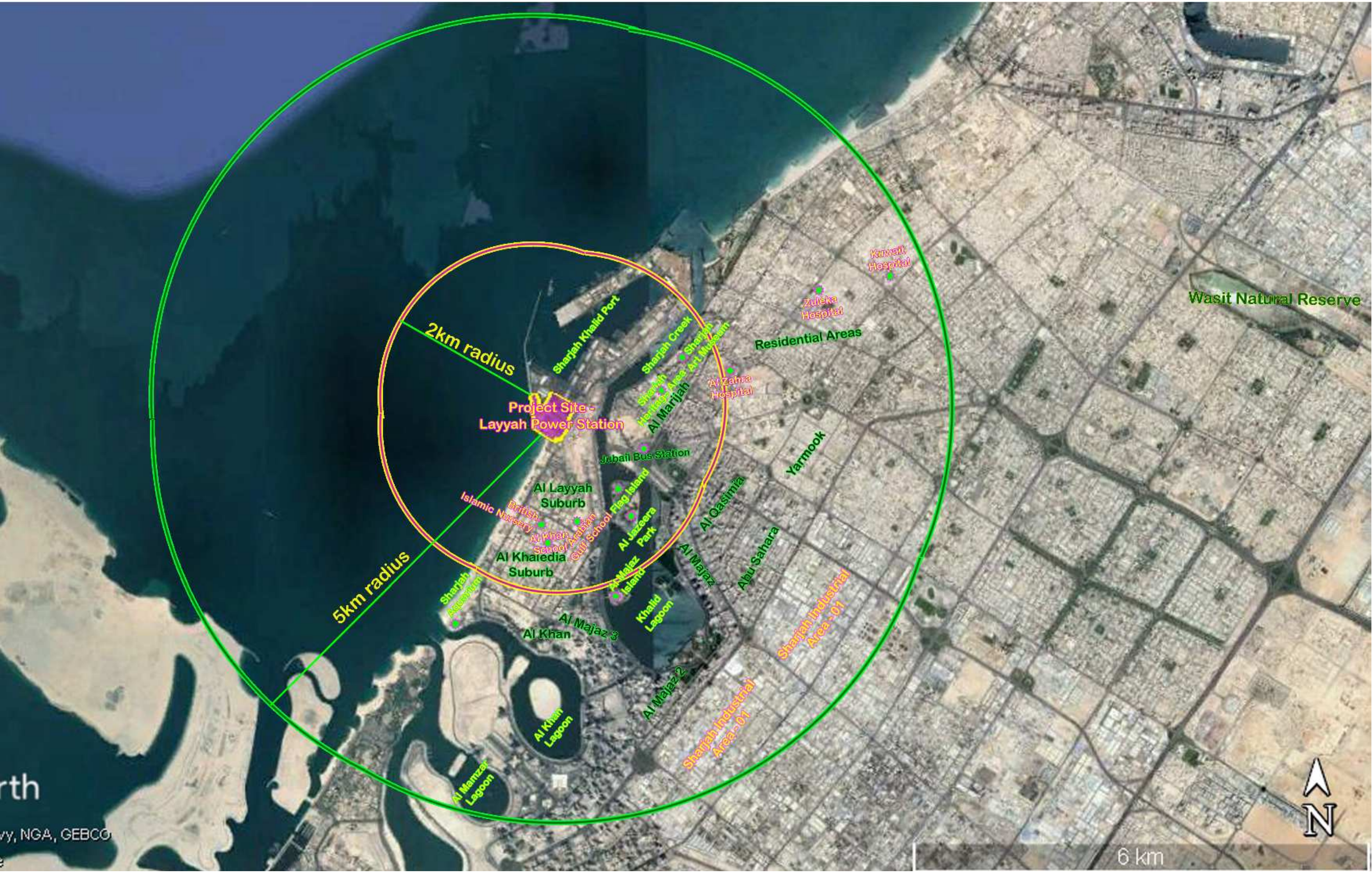
S. No.	Name of the Receptor	Sensitivity*	Distance from Project Site (km)	Direction from Project site
	School premises			
6.	Canadian Montessari Nursery – School premises	High	1.00	SSW
7.	Arabian Gulf School - School Premises	High	1.10	SSE
8.	British Islamic Nursery - School Premises	High	1.15	S
9.	Al Khan School – School Premises	High	1.20	S
10.	Al Zahra Hospital	High	2.00	ENW
11.	Zuleka Hospital	High	3.25	ENW
12.	Sharjah Creek	Moderate	0.40	E
13.	Arabian Gulf (Sea)	Moderate	Adjacent	--
14.	Sharjah Khalid Port	Moderate	Adjacent	--
15.	Khalid Lagoon	Moderate	1.50	SSE
16.	Al Khan Lagoon	Moderate	2.60	S
17.	Sharjah Heritage Area	Moderate	0.90	E
18.	Sharjah Art Museum	Moderate	1.40	ENW
20.	Wasit Natural Reserve	High	8.5	E
21.	Golden Beach Motel – Other public place	Moderate	0.20	S
22.	Sahara Beach Resort - Other public place	Moderate	0.40	SSW
23.	Marhaba Resort - Other public place	Moderate	0.50	S

** Sensitivity based on Dubai Municipality technical guidelines no. 2 - EIA Requirements for Land Development, Infrastructure, and Utility Projects – Aug., 2017 and importance of the receptor in the particular context.*

Figure 7 – Map showing the surrounding features of project site covering 1 km radius

Sharjah Khalid Port
Sharjah Court
Sharjah Creek
Sharjah Heritage Area
Al Marijah
500 m radius
Project Site - Layyah Power Station
1 km radius
Golden Beach Motel
Sahara Beach Resort
American School of Creative Science
Sharjah Museum Authority
Sharjah Government Buildings
Jubail Bus station
Flag Island
Al Layyah Suburb
Manar Al Sabeel Quran Center
Canadian Montessari Nursery

Figure 8 – Map showing the surrounding features of project site covering 5 km radius


Kuwait Hospital
Zuleka Hospital
Wasit Natural Reserve
Residential Areas
Sharjah Khalid Port
Sharjah Creek
Sharjah Art Museum
Al Zahra Hospital
2km radius
Sharjah Heritage Area
Al Marijah
Project Site - Layyah Power Station
Jubail Bus Station
Yarmook
Al Layyah Suburb
Islamic Nursery
British
Al Khan School
Arabian Gulf School
Flag Island
Al Jazeera Park
Al Qasimia
Abu Sahara
Al Majaz
Al Khaledia Suburb
5km radius
Sharjah Aquarium
Al Majaz Island
Khalid Lagoon
Al Majaz 3
Al Khan
Sharjah Industrial Area - 01
Al Majaz 2
Sharjah Industrial Area - 01
Al Khan Lagoon
Al Mamzar Lagoon
N
6 km

6.3. GEOGRAPHY AND TOPOGRAPHY OF THE STUDY AREA

The United Arab Emirates is a Sovereign federal monarchy (Wikipedia, accessed in 30th October,2018)) , constituting of seven emirates (states) namely : Abu Dhabi, Dubai, Al Sharjah, Ras Al Khaimah, Al Fujairah, Umm al Qaiwain, and Ajman. It has geographic boundary of Arabian Gulf in West and North, The south has the sandy plains of Saudi Arabia with oasis of Al Liwa. UAE is mostly arid, characterized with sand dunes, oasis, rock mountains, valleys, marshes and mangroves and salt plain. The salt plan, called sebkha is in the west, and Hajar mountains on the east, bordering the country with Oman.

Sharjah is in between the co-ordinates 25° 26′ 0″ N, 55° 23′ 0″ E, with access to west coast and East coast and has islands as well. It is the third largest emirate, with flat plain lands in between the both coast (www.nationsencyclopedia.com, 2018), typically of 3 main ecosystem- desert ecosystem, mountain ecosystem and coastal and marine ecosystem. The Khor fakkan- kalba region in the western coast is identified with rich biodiversity and fertile areas suitable for cultivation (www.government.ae, 2018)

6.3.1. TOPOGRAPHY OF PROJECT SITE

The proposed land area for the project is already reclaimed during the time of LPS previous developments. The proposed land is sandy without any vegetation and currently left barren which is used for temporary storage.

Topographic survey was carried out in the project site of Layyah Power Station. The survey area consists of buildings, desalination plant, substation, Tank, and Existing Roads. The following features are surveyed at site during the Topographic Survey:

- Linear features for substation, gates, sheds in the work area, kerbs, bollards, walls, tanks, buildings and fence.
- Street furniture such as road signs, traffic lights and street lights.
- The location & cover levels of all the Existing Utility Details are recorded to represent in the Survey Drawing.
- Spot heights observed @ 5m grid

Perusal on topographical survey data, ground level at the proposed project region is in between +3 to +4 m MSL. Topographic survey map are presented in **Annexure 7.**

6.4. BASELINE TERRESTRIAL ENVIRONMENTAL SURVEY

The baseline survey on terrestrial environment was conducted during the month of **May, 2018** by RAK Lab LLC, Ras Al Khaimah. The details of baseline terrestrial environmental survey (ambient air quality, ambient noise quality, ground water quality and soil quality) are presented in **Table 46.**

Table 46 – Details of Environmental Monitoring/Sampling Locations

Location Code	GPS Coordinates		Period of Survey
	Latitude	Longitude	
Ambient Air Quality & Ambient Noise Quality			
AAQ 1 & ANQ 1	25° 21' 21" N	55°22' 03"E	24 hours (05th July, 2018 @11.45 am to 06th July, 2018 @11.45 am)
AAQ 2 & ANQ2	25° 21' 12" N	55° 22' 06" E	24 hours (05th July, 2018 @11.00 am to 06th July, 2018 @11.00 am)
AAQ 3 & ANQ 3	25° 21' 10" N	55° 22' 18" E	24 hours (06th July, 2018 @12.00 am to 07th July, 2018 @12.00 am)
AAQ 4 & ANQ 4	25° 21' 18" N	55° 22' 21"E	24 hours (06th July, 2018 @11.30 am to 07th July, 2018 @11.30 am)
Groundwater Quality			
GWQ 1	25° 21' 16" N	55° 22' 03" E	05th July, 2018
GWQ 2	25° 21' 15" N	55° 22' 08" E	09th July, 2018
Soil Quality			
SQ 1	25°21'18.93"N	55°22'3.73"E	05th July, 2018
SQ 2	25°21'16.53"N	55°22'3.94"E	05th July, 2018
SQ 3	25°21'19.45"N	55°22'5.59"E	05th July, 2018
SQ 4	25°21'16.96"N	55°22'6.21"E	05th July, 2018
SQ 5	25°21'15.23"N	55°22'8.10"E	05th July, 2018
SQ 6	25°21'17.52"N	55°22'8.44"E	05th July, 2018

Baseline terrestrial environmental survey locations are represented in Figure 9 – Google image showing the locations of ambient air and ambient noise quality monitoring at project site Figure 9 and Figure 10**.**

Figure 9 – Google image showing the locations of ambient air and ambient noise quality monitoring at project site

Figure 10 – Google image showing ground water (borehole) and soil sampling locations at project site

6.4.1. CLIMATE AND METEOROLOGY OF THE STUDY AREA

UAE is generally warm and dry in the winter, however during summer months coastal weather brings in humidity along with very high temperatures. Due to the presence of the Al Hajar al Gharbi Mountains in the proximity, high altitudes lead to generally cooler weather conditions. UAE climate can be broadly classified as two main seasons' summer and winter. Summers are between April to September with very dry weather conditions. Where in the temperature rise to about 48 degrees Centigrade in coastal cities – with accompanying humidity levels reaching as high as 90%. In the southern desert regions, temperatures can increase to as high as 50° Centigrade. Major part of the country is subject to violent dust storms with rainfall being infrequent and irregular. The description of regional climate data of UAE is presented in **ANNEXURE 8.**

This section describes the weather of project study region based on primary data collected at the project site, and secondary data collected at the **Sharjah International Airport** (Sharjah, United Arab Emirates) weather station (which is located 12.5 km away from project site on Eastern direction. The results of weather data collected at the project site are presented in **Table 47.**

Table 47 – Micrometeorology data at the project site

Parameters		Units	Micrometeorology	
			05th July @ 11 am – 06th July, 2018 @ 11am	06th July @ 11 am – 07th July, 2018 @ 11am
Ambient Temperature	Min	°C	33.00	34.52
	Mean		38.53	39.10
	Max		44.28	45.16
Relative Humidity	Min	%	23.52	26.45
	Mean		51.57	50.21
	Max		79.15	69.11
Wind Speed		m/s	1.20	1.30
Wind Direction		(°)	1.44	199
Solar Radiation		w/m^2	455	447

6.4.1.1. Temperature

The Arabian Gulf has substantial impact to the climate and temperature at the project site due to the proximity to the coast. Data on Sharjah International Airport is presented in **ANNEXURE 8.**

The perusal of the Sharjah International Airport (SIA) data indicates that lowest minimum absolute temperature (Min.) observed in a specific month during 2013 – 2017 was 5.2°C in January, 2013 and highest maximum absolute temperature (Max.) was 48.8°C in July, 2013. The lowest average temperature (Mean) observed in a specific month during 2013 – 2017 was 18.4°C in January, 2014 and highest average temperature was 37.7°C in July, 2017.

The perusal of the primary data collected at the project site during the survey indicates that lowest minimum temperature observed was 33°C, and highest maximum temperature was 45.16°C. The average temperature (Mean) observed was around 39°C.

6.4.1.2. Relative humidity

The perusal on Sharjah International Airport (SIA) data on relative humidity indicates that lowest minimum absolute relative humidity (Min.) observed in a specific month during 2013 – 2017 was 4% in October, 2014 and highest maximum absolute relative humidity (Max.) was 99% in the months of January to April, 2013 and March, 2016. The lowest value of mean minimum relative humidity (Mean Min.) observed in a specific month during 2013 – 2017 was 15% in May, 2015 and highest value of mean maximum relative humidity (Mean Max.) was 89% in February, 2013.

The perusal of the primary data collected at the project site during the survey indicates that lowest minimum relative humidity observed was 23.52%, and highest maximum relative humidity was 79.15%. The average relative humidity (Mean) observed was around 51%.

6.4.1.3. Wind speed and wind direction

The wind speed and wind direction for Sharjah International Airport is represented by wind rose diagram which is given in Figure 11**.** The wind rose diagram indicates that North-western directions, East, West & South-eastern are the most prevalent wind flowing directions. The average wind speed for the last 5 years is 7.5 miles per hour at Sharjah International Airport.

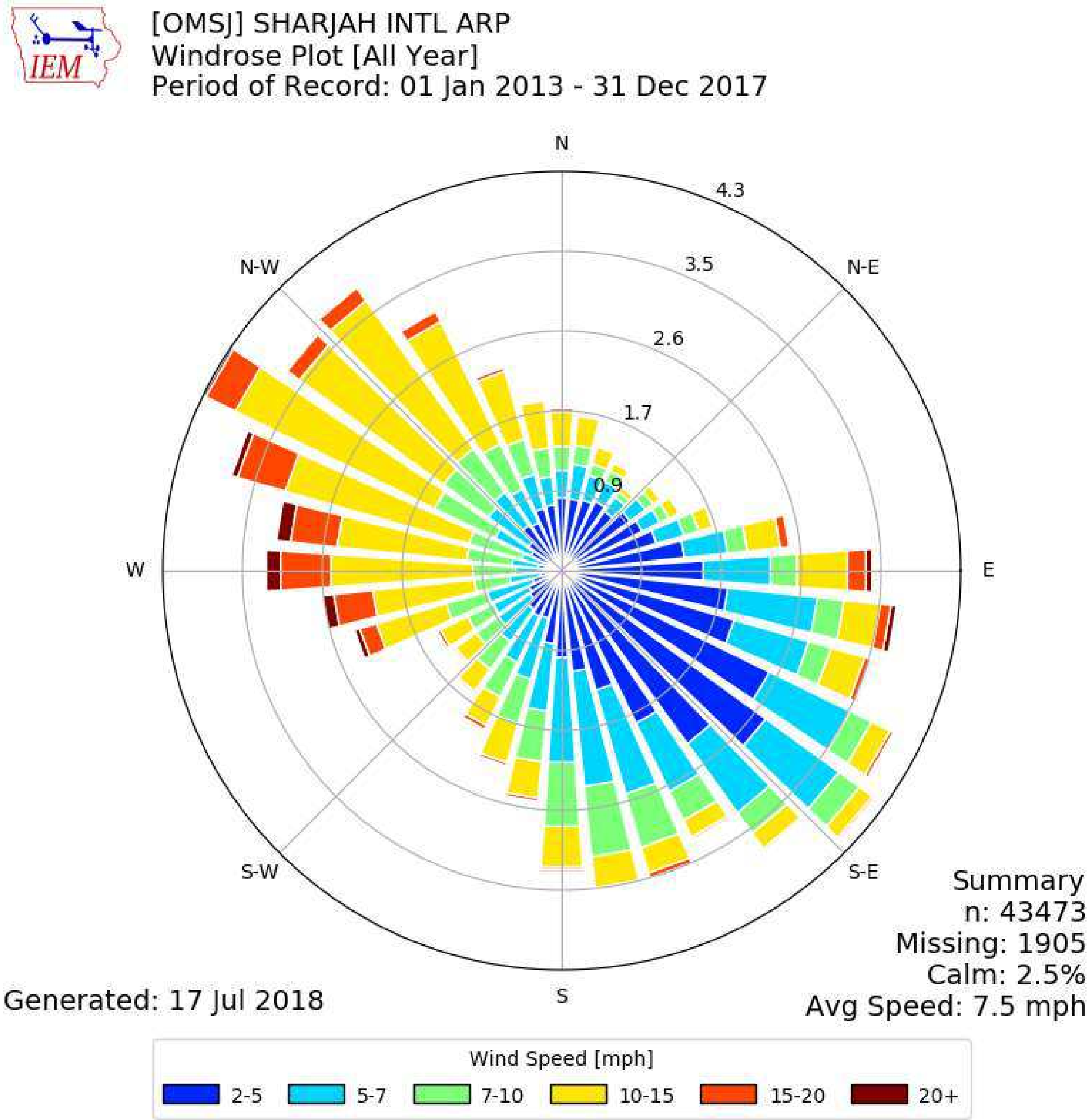


Figure 11 - Wind rose diagram of Sharjah International Airport for 2013 – 2017

(Source: Iowa Environmental Mesonet Web - http://mesonet.agron.iastate.edu/)

6.4.1.4. Rainfall

The rainfall in the UAE is known in its fluctuation during 2007-2017 and there is variation in the average of rainfall from one area to another also. The higher level of rainfall received in Sharjah was 135.5mm during 2009 when compared with last 11 years data (2007 – 2017). The average rainfall received in Sharjah during 2007 – 2017 was 63.4mm and number of rainy days was 22.6. Rainfall received in Sharjah during 2017 was 61.7mm and number of rainy days for the year was 31. Rainfall is not recorded during the survey.

6.4.1.5. Solar radiation

The perusal of the UAE data recorded in 2017 showed that the mean of sunshine hours, in almost all the months of the year to be more than 8 sunshine hours and in average of 10 hours daily. The highest value of average daily solar radiation was in June, (8420 wh/m^2) and the lowest was in February (3191 wh/m^2). There is no available data for Sharjah emirate from NCMS.

6.4.2. AMBIENT AIR QUALITY

Baseline ambient air quality in the project site was determined by establishing four (4) monitoring stations at the project site. The locations of ambient air quality monitoring locations are represented in Google image which is given in Figure 9**.** The measured ambient air quality parameters are Total Suspended Particulates (TSP), Respirable Suspended Particulate Matter less than 10 microns (PM_{10}), Sulfur Dioxide (SO_2), Carbon Monoxide (CO), Ozone (O_3), Carbon Dioxide (CO_2) Nitrogen Dioxide (NO_2) and Total Volatile Organic Compounds (TVOC). The monitoring was conducted for twenty-four (24) hours on-site.

6.4.2.1. Monitoring and Test Method for AAQ

Air quality was monitored using a calibrated high flow-rate respirable dust sampler (Model AAS 217 BL). The volumetric flow rates of the sampling were maintained at 0.9 - 1.4 m^3/min for TSP and PM_{10} parameters. The sampling and analysis of air quality parameters were carried out by the procedures described in the relevant parts of US EPA–eCFR, the United States Environment Protection Agency-electronic Code of Federal Regulations: Title 40: Part 50 and 53.

Meteorological data of the day was collected using an Automatic Weather Station which is a micro-controller based weather station. All sensors (wind speed, direction, temperature, humidity, dew point and solar radiation) are attached with the data logger for the collection of real-time data automatically.

Gas pollutants were monitored using calibrated multi gases sensors (electrochemical, infrared, photoionisation detector) attached gas detectors (model-dragger Xam7000 and dagger Xam5000). The sensors detect the gases in different concentration. The sampling and analysis of gaseous pollutants were carried out following the procedures described in the relevant parts of BSEN 60079-29-2; 2007, BSEN 45544-1; 2000 and BSEN 50271; 2010.

6.4.2.2. Results and observation of AAQ

The results of ambient air quality monitoring are given in Table 48**.** The obtained results are compared with ambient air quality limits prescribed by UAE-MoCCaE and WHO air quality guidelines[5].

Table 48 - Ambient Air Quality Monitoring results at project site

Parameters	Units	AAQ Results				UAE MoCCaE AAQ limits	WHO AQGs
		AAQ 1	AAQ 2	AAQ 3	AAQ 4		
Total Suspended Particulates (TSP)	$\mu g/Nm^3$	217	204	223	196	**230**	**--**
Respirable Particle Matter (PM_{10})	$\mu g/Nm^3$	83	98	115	89	**150**	**150*** **50#**
Sulphur dioxide (SO_2)	$\mu g/Nm^3$	<0.1	<0.1	26.2	<0.1	**150**	**--**
Nitrogen dioxide (NO_2)	$\mu g/Nm^3$	18.8	<0.1	18.8	<0.1	**150**	**125*** **20#**
Carbon monoxide (CO)	mg/Nm^3	<1	<1	<1	<1	**10**	**--**
Ozone (O_3)	$\mu g/Nm^3$	58.9	78.5	78.5	58.9	**120**	**160*** **100#**
Total Volatile Organic Compounds	ppm	0.05	<0.01	0.03	<0.01	--	--
Lead (Pb)	ppm	<0.01	<0.01	<0.01	<0.01	--	--

**Interim target 1; #Guideline value (Interim targets are provided in recognition of the need for a staged approach to achieving the recommended guidelines)*

The results of the ambient air quality survey indicate that levels of particulate matter (TSP and PM_{10}) and ozone are found to be significant in the ambient air. Levels of TSP in ambient air of project site ranged from 196 to 223 $\mu g/Nm^3$ which comply with maximum allowable limit (230 $\mu g/Nm^3$) prescribed by UAE - MoCCaE while those values are in near borderline of the maximum allowable limits. Levels of PM_{10} ranged from 83 to 115 $\mu g/Nm^3$ which comply with maximum allowable limit (150 $\mu g/Nm^3$). Higher levels of particulate matter in the ambient air may be contributed by wind-blown dust, fugitive dust emissions by vehicular movement in paved/unpaved roads in the project site/adjacent roads.

Ozone levels in ambient air ranged from 58.9 to 78.5 mg/Nm^3 which are also in compliance with maximum allowable limit (150 mg/Nm^3). Higher levels of O_3 may be

[5] *WHO Air quality guidelines for particulate matter, ozone, nitrogen dioxide and sulfur dioxide - Global update 2005 - Summary of risk assessment, World Health Organization*

associated with high sunny periods where the pollutants are indirectly formed by the action of sunlight on nitrogen dioxide. Other pollutants in the ambient air are less or not detectable and comply with maximum allowable limits prescribed by UAE-MoCCaE.

6.4.3. AMBIENT NOISE LEVEL

The baseline status of noise environment is accessed through noise level monitoring programme. The existing noise level in the project site was determined by establishing four (4) ambient noise level monitoring stations. The locations of ambient noise level monitoring locations are represented in Google image which is given in Figure 9**.** The monitoring was conducted for twenty four (24) hours on-site. Equivalent Continuous Sound Level was measured at site in A-weighting using calibrated integrating noise data logger sound level meters. The measurement was according to the standard ISO 1996-2: 2007. Sinus Tago (Class 1) sound level meter and Casella 63 (Class 1) sound level meter are used for ambient noise quality monitoring along with acoustic calibrator (Class 1).

6.4.3.1. Results and Observations

The results of ambient noise level monitoring are given in Table 49 The results of ambient noise quality are compared with the limits of UAE-MoCCAE and World Health Organization (WHO) guideline values for community noise.

Table 49 – Results of Ambient Noise Quality in the project site

Locations	Day Time (7 am – 8 pm)			Night time (8 pm – 7 am)		
	Noise levels (dB (A))					
	LMin.	Leq. (Avg.)	LMax.	LMin.	Leq. (Avg.)	LMax.
ANQ 1	56.4	**69.7**	89.5	52.9	**65.4**	75.8
ANQ 2	58.7	**72.7**	96.6	54.5	**69.6**	92.3
ANQ 3	50.2	**64.3**	93.8	48.3	**61.6**	91.2
ANQ 4	58.5	**80.9**	96.1	54.7	**76.4**	93.7
UAE-MoCCAE Limit*	--	**6 0 - 70**	--	--	**50 - 60**	--
WBG-IFC Guideline	--	**70**	--	--	**70**	--
WHO Guideline value#	Leq value = 70 dB (A) for 24 hours at Industrial, commercial, shopping and traffic areas. LMax = 110 dB(A)					

**MoCCAE, UAE - Allowable Limits for Noise Level (dBA) in Industrial Areas*
#Table 4.1 – Guideline values for community noise in specific environment

The recorded daytime noise level (Leq) at the project site ranged from 64.3 to 80.9 dB(A), and nighttime noise level (Leq) ranged from 61.6 to 76.4 dB(A). As apparent from the results, noise levels at the project site are significantly higher than maximum allowable limits prescribed by UAE-MoCCAE except day time noise level recorded at ANQ1 & ANQ 3 monitoring location. However, measured noise levels in the project areas are less than guideline value of WHO [Lmax – 110 dB(A)] for community noise specified for industrial environment. The higher noise levels during day and night times in the project area are contributed by adjacent activities of ongoing industrial activity, port and vehicular traffic.

6.4.4. WATER ENVIRONMENT

The common water sources of United Arab Emirates (UAE), are ground water, falajs, springs and seasonal floods. Ground water is being used for cultivation as well. However Desalination water is the main source of potable water.

6.4.4.1. Groundwater resources

The distribution of aquifer types in UAE is categorized as following (*Brook, M. and Dawoud, M.A., 2005*) which is represented in **Figure 12.**

- Coastal Sabkha
- Eastern Gravel aquifer
- Western Gravel Aquifer
- Ophiolite aquifer
- Northern Limestone aquifer

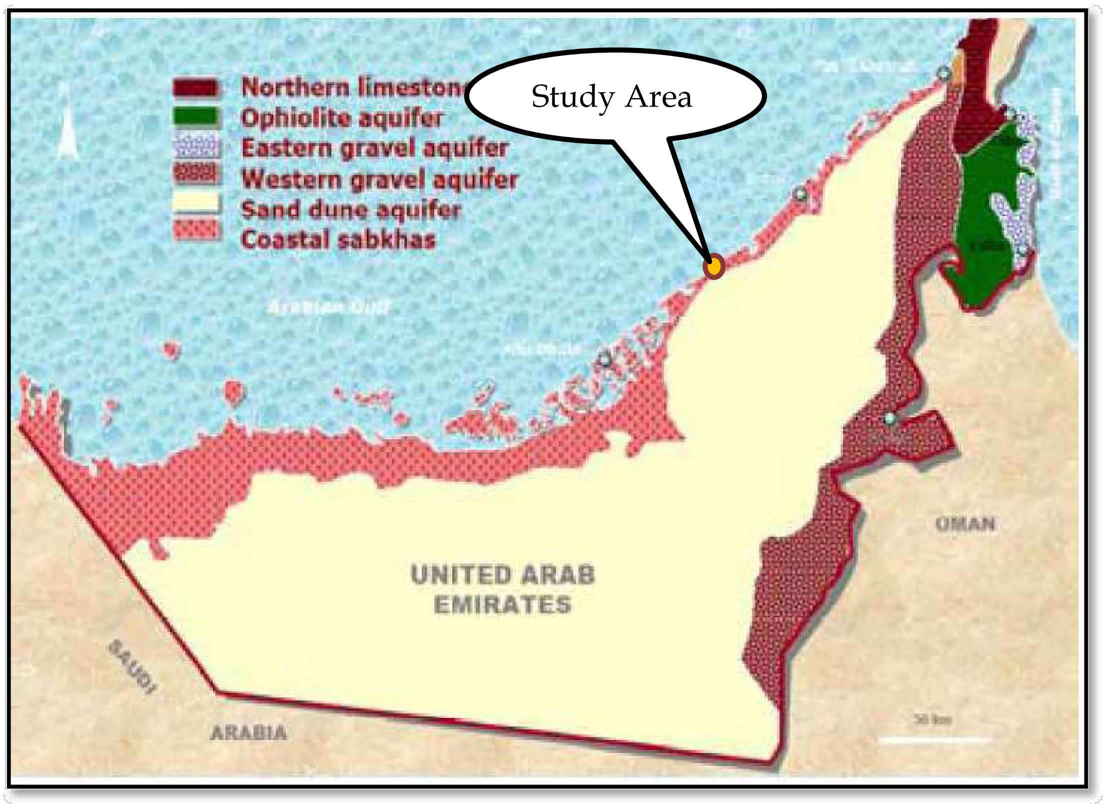


Figure 12 - Aquifer Types of United Arab Emirates (Source: Brook, M. and Dawoud, M.A., 2005)

6.4.4.2. Groundwater Quality

The borehole was made for ground water quality monitoring. Two boreholes were drilled and samples were collected. Groundwater level encountered in the boreholes was at a depth of between 1.80 to 2.20 m below existing ground level (i.e. between level +2.20m SMD (Sharjah Municipality Datum) and +1.80m SMD below Average Borehole Level of +4.00m SMD).

6.4.4.2.1. Results and observations

The results obtained for ground water quality analysis are summarized in Table 50**.**

Table 50 - Results of Ground water quality

S. No.	Parameters	Units	Results		*Dutch Intervention Values**
			GW1	GW2	
1)	Temperature	°C	29.2	28.0	
2)	Colour	Co/pt	Normal	Normal	--
3)	Turbidity	NTU	7.75	1.64	
4)	pH at 25^0 C	-	7.82	7.38	--
5)	Conductivity at 25^0C	µS/cm	5270	1242	--
6)	Total Suspended Solids (TSS)	mg/L	26	<5	--
7)	Total Dissolved Solids (TDS) at 180^0 C	mg/L	2820	602	--
8)	Chemical Oxygen Demand (COD)	mg/L	128	24	--
9)	Biochemical Oxygen Demand (BOD)	mg/L	38	11	--
10)	Oil & Grease	mg/L	<5	<5	--
11)	Chloride (Cl)	mg/L	1524	305	--
12)	Sulphate (SO_4^{2})	mg/L	95	34	--
13)	Calcium (Ca)	mg/L	58	60	--
14)	Magnesium (Mg)	mg/L	53.5	14.6	--
15)	Total Alkalinity	mg/L	80	38	--
16)	Total Hardness as $CaCO_3$	mg/L	365	210	--
17)	Phosphorous	mg/L	0.30	0.01	--
18)	Fluoride(F^-)	mg/L	0.59	0.79	--
19)	Phenols	mg/L	<0.02	<0.02	**2.0**
20)	Total Nitrogen	mg/L	8	3	--
21)	Sodium (Na)	mg/L	996	146	--
22)	Potassium (K)	mg/L	24.01	7.51	--
23)	Iron (Fe)	mg/L	0.05	0.07	--
24)	Manganese (Mn)	mg/L	0.01	0.09	--
25)	Chromium (Cr)	mg/L	<0.001	<0.001	**0.006**

S. No.	Parameters	Units	Results		*Dutch Intervention Values**
			GW1	GW2	
26)	Copper (Cu)	mg/L	0.01	0.01	**0.075**
27)	Lead (Pb)	mg/L	<0.01	<0.01	**0.075**
28)	Zinc (Zn)	mg/L	0.41	0.18	**0.8**
29)	Nickel	mg/L	<0.01	<0.01	**0.075**
30)	Cadmium (Cd)	mg/L	<0.001	<0.001	**0.006**

**Dutch Target and Intervention Values, 2000 - Circular on target values and intervention values for soil remediation*

The results were compared with Dutch Intervention values, levels of toxic contaminants (heavy metals) in the collected ground water samples are below the limits or not detected.

6.4.5. SOIL ENVIRONMENT

Geo-technical investigation was carried out in the project site. The investigation results are suggestive of that, the general site stratigraphy of the area and the area in general is consistent. The classification and description of soil samples has been carried out in accordance with BS 5930:1999. Based on the investigation results and interpretations, a general site stratigraphy relevant to different structure locations were developed and is given in **Table 51.**

Table 51 – General site stratigraphy of project site

Depth (m) [below existing ground level]	Description
0.0m to 0.50m	Light Brown, slightly silty to silty, gravelly, fine to medium **SAND.** (MAN MADE-FILL)
0.50m to 1.50m	Medium dense, light brownish grey, slightly silty to silty, very shelly, slightly gravelly, fine to medium **SAND** with frequent shell and shell fragments (MAN MADE-FILL).
1.50m to 5.00m	Loose to medium dense, light brownish grey, slightly silty to silty, gravelly, fine to medium **SAND** with occasional cemented sand pieces (MAN MADE-FILL).
5.0m to 12.00m	Medium dense to dense becoming very dense, light grey, very shelly, gravelly, fine to medium, fine to medium **SAND** with occasional cemented sand pieces
12.0m to 12.2/13.32m	Very dense, light grey, very shelly, gravelly, fine to medium, fine to medium **SAND** with occasional cemented sand pieces

Depth (m) [below existing ground level]	Description
12.2/13.32m to 15.4m	Very weak to weak, light grey, medium bedded, fine to coarse grained **CALCARENITE**, slightly weathered, medium spaced, sub-horizontal to inclined fracture.
15.4 to 30.0m	Very weak, light grey, locally light brown, thinly bedded and laminated, locally fragmented, fine to medium grained calcareous **SANDSTONE**, with animal burrows and boring at places, slightly to moderately weathered, closely spaced, sub-horizontal to inclined fracturing.

6.4.5.1. Soil Quality

The soil samples were collected in the four (4) locations in the proposed project area and testing was performed. The following test methods were adopted: BS 1377-3:1990, APHA 21st:2005, EPA 8015.

6.4.5.1.1. Result and Observations

Table 52 - Results of soil analysis at project site

S. No.	Parameters	Units	Soil Quality Results						DM Limit*
			SQ1	SQ2	SQ3	SQ4	SQ5	SQ6	
1.	Moisture	%by weight	0.56	0.63	0.34	0.46	0.56	0.88	--
2.	pH @ 25°C	-	7.54	7.46	7.70	7.63	7.42	7.07	--
3.	Conductivity	µS/cm	21600	10200	2380	8610	12450	41250	--
4.	Chloride	mg/kg	6736	3120	425	2623	3758	1347	--
5.	Total Alkalinity	mg/kg	28	36	32	32	24	28	--
6.	Total Nitrogen	mg/kg	55	22	23	33	30	250	--
7.	Phosphate	mg/kg	0.5	1.0	0.5	0.6	0.9	0.9	--
8.	Potassium	mg/kg	156.5	88.73	17.49	69.27	80.79	97.84	--
9.	Nickel	mg/kg	<0.01	0.03	<0.01	<0.01	<0.01	<0.01	--
10.	Arsenic	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	**50**
11.	Copper	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	**100**
12.	Iron	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	--
13.	Zinc	mg/kg	<0.01	<0.01	<0.01	<0.01	0.02	<0.01	**500**
14.	Manganese	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	**700**

S. No.	Parameters	Units	Soil Quality Results						DM Limit*
			SQ1	SQ2	SQ3	SQ4	SQ5	SQ6	
15.	Mercury	mg/kg	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	**2**
16.	Lead	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	**200**
17.	Cadmium	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	**5**
18.	Chromium	mg/kg	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	**250**
19.	Selenium	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	**2**
20.	Barium	mg/kg	0.09	0.07	0.05	0.04	0.08	0.24	**--**
21.	Total Petroleum Hydrocarbon (TPH)	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	**1000**

**Land Contamination Indicator Levels – Dubai Municipality (DM) Environmental standards and allowable limits of pollutants on land, water, and air environment - May, 2003.*

The results of soil analysis in the project site clearly indicate that the nature of the soil is non-saline to saline. It is also observed that toxic contaminants (heavy metals and petroleum hydrocarbon) levels in the project region are well within the maximum allowable limits of Dubai Municipality. It indicates that there is no contamination in the soil samples collected in the project region.

6.4.6. ECOLOGY

The United Arab Emirates (UAE) is characterized by a wide variety of habitats (i.e., mountainous, coastal lowlands, desert and alluvial plains) that support unique diversity of plant genetic resources. Despite the UAE is regarded as floristically poor, it harbors unique plants with remarkable morphological, physiological and anatomical adaptations strategies that enable them tolerating the very harsh climatic conditions prevailing in the country (*Tourenq and Launay, 2008*[6]).

Sharjah is the third largest emirate in the United Arab Emirates, covering an area of 2,590 km^2. In addition to the area to the east and south of Sharjah city, the emirate includes four enclaves on the east coast of the UAE (Nahwa, Kalba, Dibba Al-Hisn and Khor Fakkan). As a result, a wide range of Arabian Peninsula habitats may be found within Sharjah. At the east and west coasts are salt flats, sand, gravel plains and, at Khor Kalba, a mangrove. Inland, much of the land area of Sharjah is sand desert, though the enclaves to the east extend up into the igneous Hajar Mountains, with their associated wadis.

Tourenq, C. and Launay, F., 2008. Challenges facing biodiversity in the United Arab Emirates. Management of Environmental Quality An International Journal, 19(3):283-304.

Analysis of the accounts of the UAE flora by *Karim and Fawzi (2007)* [7], suggests that some 400-450 species of plant are to be found within Sharjah, just over half the UAE's total flora. The coastline of mainland UAE including Sharjah extends for about 650 km, and comprises the Arabian Gulf coast in the north, and the Gulf of Oman coast to the east. Due to the harsh climatic conditions, soils are generally extremely poor in organic matter, and biological activity is low. The properties of the little-altered parent material (sand, silt, gravels, bedrock) therefore exert a dominant influence on species composition of the vegetation, and in turn, on the fauna in most parts of the country. Soil fertility is therefore extremely low. The severe climatic conditions, though, mean that vegetation cover is generally sparse, particularly in areas with exceptionally low rainfall, and has been further reduced by severe overgrazing. The limited number of plant species involved, the relatively broad ecological tolerances of many key perennials and the fact that some potentially suitable species do not appear for years under unfavorable rainfall conditions are factors that serve to complicate vegetation classification in many desert habitats.

The proposed project will be established in the existing site of Layyah Power Station of SEWA. The study area of project site is already developed and the project site does not have significant flora and fauna.

6.5. BASELINE MARINE ENVIRONMENTAL SURVEY

The Arabian Gulf is a semi-enclosed, shallow (average 30 m in depth), subtropical sea surrounded by a large, arid land mass. It is connected to the Gulf of Oman by the Strait of Hormuz, which restricts water exchange between these two water bodies. Due to this unusual physical environment, the Arabian Gulf experiences marked temperature extremes a typical of seas at similar latitude, with hot, dry, tropical conditions during the summer and temperate conditions during the winter. In addition to extreme variations in temperature, the Arabian Gulf also experiences substantial fluctuations in salinity levels, which can exceed 70 PSU (Practical Salinity Unit) in some embayments. High salinity levels are driven by strong evaporation, which exceeds combined rainfall and freshwater inputs by over a factor of ten *(Sheppard, 1993*[8]*)*. Circulation in the Gulf is in an anti-clockwise motion, driven primarily by density gradients, creating a reverse estuarine flow similar to the circulation of the Mediterranean Sea *(Reynolds, 1993*[9]*)*. Water enters the Gulf through the Strait of Hormuz, moves northwards along the Iranian coast, while a secondary coastal current flows southerly along the northern Iranian coast, against the

---

Karim, F.M. and Fawzi, N.M., 2007. Flora of the United Arab Emirates. Vol. 1. United Arab Emirates University, Al Ain, UAE.

Sheppard, C.R.C. 1993. Physical-environment of the Gulf relevant to marine pollutionan overview. Mar. Pollut. Bull. 27: 3–8.

Reynolds, R. M. 1993. Physical Oceanography of the Gulf, Strait of Hormuz, and the Gulf of Oman: Results from the Mt Mitchell Expedition. Marine Pollution Bulletin 27: 35–59.

inflow water in the Strait of Hormuz, driven by density differences from river runoff in the northern Gulf. A southward coastal flow moves along the south-western coastline of the Arabian Gulf, where stagnation and evaporation in the southern embayments increases salinities to 40 PSU. This denser water sinks and flows towards the entrance of the Gulf, where it lies beneath the incoming water.

The baseline marine oceanography and environmental survey (bathymetry, water current, tides, sea water quality and marine sediment quality) was conducted during the month of **July, 2018**. The details of baseline marine oceanography and environmental survey (bathymetry, water current, tides, sea water quality and marine sediment quality) are presented in Table 53**.**

Table 53 – Details of Marine Environmental Survey

Location Code	GPS Coordinates		Date of Sampling/ Survey
	Latitude	Longitude	
Sea Water Quality			
SW – 01 (Harbour)	25°21'45.10"N	55°22'7.28"E	19th July, 2018
SW – 02 (Arabian Gulf)	25°22'8.76"N	55°22'19.09"E	19th July, 2018
SW – 03 (Arabian Gulf)	25°22'52.47"N	55°22'54.10"E	19th July, 2018
SW – 04 (Sharjah Creek Entry)	25°22'33.29"N	55°23'19.76"E	19th July, 2018
SW – 05 (Arabian Gulf)	25°22'58.43"N	55°22'4.79"E	19th July, 2018
SW – 06 (Arabian Gulf)	25°22'8.68"N	55°21'42.81"E	19th July, 2018
SW – 07 (Arabian Gulf)	25°21'27.02"N	55°21'48.96"E	19th July, 2018
SW – 08 (Arabian Gulf)	25°21'32.58"N	55°20'53.47"E	19th July, 2018
SW – 09 (Arabian Gulf)	25°20'34.70"N	55°21'17.83"E	19th July, 2018
SW – 10 (Al Khan Lagoon)	25°19'42.01"N	55°21'49.19"E	19th July, 2018
SW – 11 (Sharjah Creek)	25°21'40.02"N	55°22'59.22"E	19th July, 2018
SW – 12 (Khalid Lagoon)	25°20'3.09"N	55°22'52.60"E	19th July, 2018
SW – 13 (Outfall Channel)	25°21'18.17"N	55°22'11.65"E	23rd July, 2018
SW – 14 (Outfall Channel)	25°21'26.06"N	55°22'4.74"E	23rd July, 2018

Location Code	GPS Coordinates		Date of Sampling/ Survey
	Latitude	Longitude	
Marine Sediment Quality			
MS – 01 (Arabian Gulf)	25°22'17.09"N	55°22'22.80"E	19th July, 2018
MS – 02 (Arabian Gulf)	25°22'53.57"N	55°22'53.55"E	19th July, 2018
MS – 03 (Khalid Lagoon)	25°20'14.04"N	55°22'51.09"E	19th July, 2018
MS – 04 (Sharjah Creek Entry)	25°22'30.88"N	55°23'19.32"E	19th July, 2018
MS – 05 (Arabian Gulf)	25°23'5.17"N	55°22'2.70"E	19th July, 2018
MS – 06 (Arabian Gulf)	25°22'9.08"N	55°21'43.17"E	19th July, 2018
MS – 07 (Arabian Gulf)	25°21'27.65"N	55°21'49.66"E	19th July, 2018
MS – 08 (Arabian Gulf)	25°21'32.65"N	55°20'54.40"E	19th July, 2018
MS – 09 (Arabian Gulf)	25°20'34.54"N	55°21'18.08"E	19th July, 2018
MS – 10 (Al Khan Lagoon)	25°19'29.02"N	55°22'4.24"E	19th July, 2018
Marine Ecology Survey			
ME – 01 (Arabian Gulf)	25°22'17.09"N	55°22'22.80"E	19th July, 2018
ME – 02 (Arabian Gulf)	25°22'53.57"N	55°22'53.55"E	19th July, 2018
ME – 03 (Khalid Lagoon)	25°20'14.04"N	55°22'51.09"E	19th July, 2018
ME – 04 (Sharjah Creek Entry)	25°22'30.88"N	55°23'19.32"E	19th July, 2018
ME – 05 (Arabian Gulf)	25°23'5.17"N	55°22'2.70"E	19th July, 2018
ME – 06 (Arabian Gulf)	25°22'9.08"N	55°21'43.17"E	19th July, 2018
ME – 07 (Arabian Gulf)	25°21'27.65"N	55°21'49.66"E	19th July, 2018
ME – 08 (Arabian Gulf)	25°21'32.65"N	55°20'54.40"E	19th July, 2018
ME – 09 (Arabian Gulf)	25°20'34.54"N	55°21'18.08"E	19th July, 2018
ME – 10 (Al Khan Lagoon)	25°19'29.02"N	55°22'4.24"E	19th July, 2018

Table 54 – Details of Marine Oceanographic Survey

Location	GPS Coordinates		Duration of Survey
	Latitude	Longitude	
Water Current			
Arabian Gulf at Sharjah	25°21'27.74"N	55°21'37.61"E	22nd July, 2018 – 20th August, 2018
Tide (Water Level)			
Arabian Gulf at Sharjah	25°22'24.91"N	55°23'29.39"E	2nd July, 2018 – 20th August, 2018

Baseline marine environmental survey locations (sea water quality, marine sediment quality and marine ecology survey) are represented in **Figure 13, Figure 14** and **Figure 15.** Bathymetry survey in the project study area covering than 7km (long-shore) by 3km (cross-shore) which is represented in **Figure 16.** Water current and tide (water level) data was collected at one location each in the study area.

Figure 13 – Google Image showing sea water sampling locations in the project study area

Figure 14 – Google Image showing marine sediment sampling locations in the project study area

Figure 15 – Google Image showing marine ecology survey locations in the project study area

Figure 16 – Google Image showing bathymetry survey region in the project study area

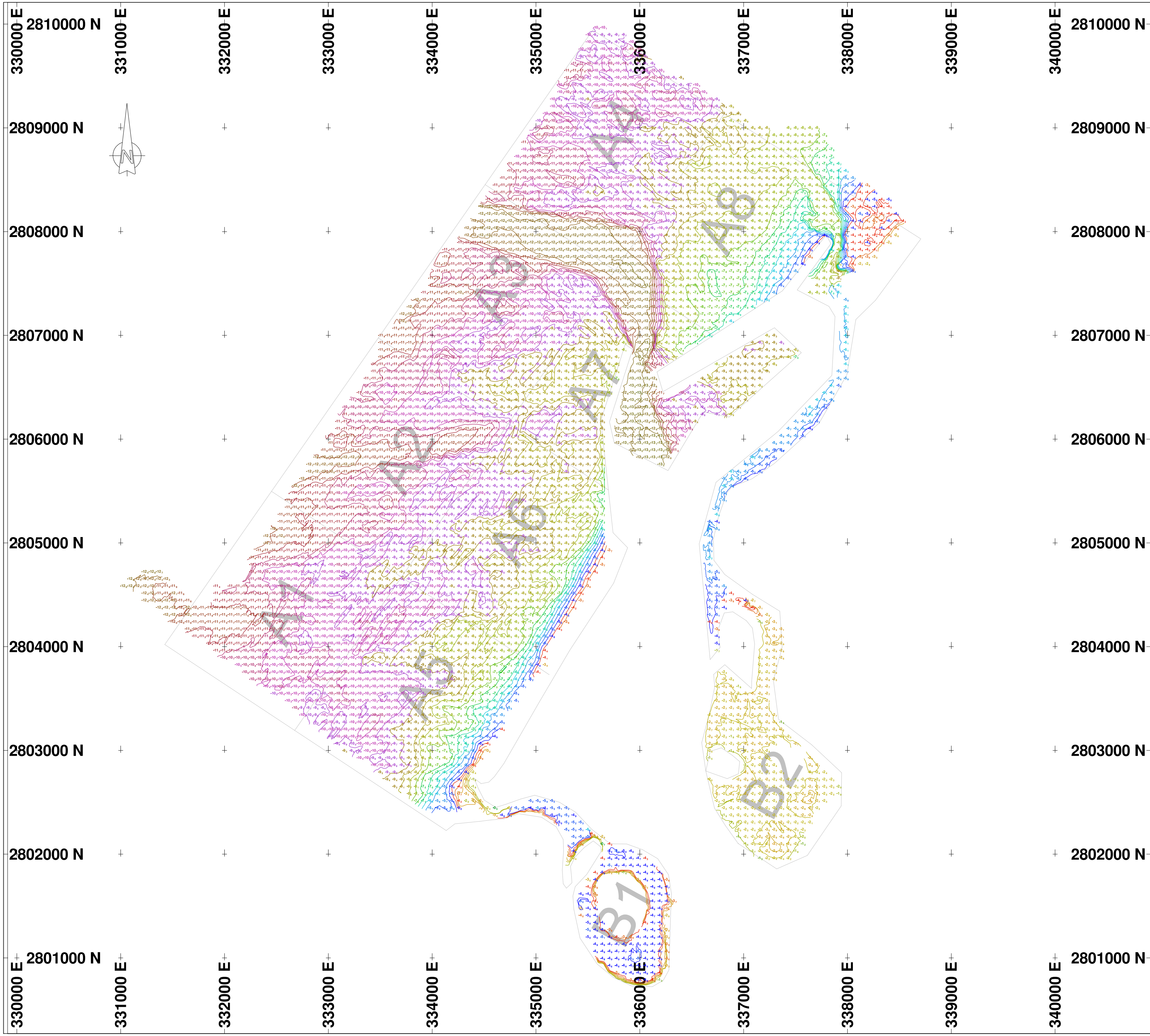
6.5.1. OCEANGRAPHIC STUDY

The Arabian Gulf, located between 24 and 30° latitude, is more than 1,000 km in length along its axis. The widest section of the Gulf spans between the coasts of UAE and Iran. Contracting the width, the peninsula of Qatar separates the northern Gulf from its central and southern part. The bathymetry is basically asymmetric along its axis with a deeper zone close to the Iranian coast and a broad, shallower shelf off the UAE coast. The southern Gulf, which is literally rocky, is characterized by marked bathymetric undulation. The contour distribution in the north becomes much smoother, probably being modified by the sediment discharges from the major rivers. Numerous islands, many of which are in the form of spikes, are dispersed all over the Gulf.

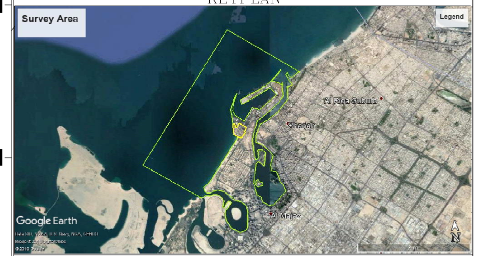
6.5.1.1. Bathymetry survey

Echo sounder integrated with DGPS (Trimble) was used during the entire surveys to record geographically referenced bathymetric data for measuring water depths. The bathymetry survey was carried out in the study region covering 7 × 3 km area. The Echo sounder system was installed and operated in accordance with the Manufacturer's instructions. Multi beam Eco sounder was used in the core region and single beam eco sounder was used in the remaining areas. Portable transducer was installed rigidly to a bracket suitable location on the survey vessel. Prior to commencing survey works, the Echo sounder was calibrated against a bar check. The procedure is to confirm accuracy of the Echo Sounder. Hypack is the real – time navigation and data acquisition software for Hydro-graphic Survey works. Hypack will receive position data from DGPS receiver and process it to provide a real time graphical navigational display for the helmsman. The data received from sensors such as Echo sounders and DGPS was displayed and logged to a file. Digital depth data was logged directly to the navigation computer along with date, time, and position for post processing and mapping.

Figure 17 – Bathymetry survey data



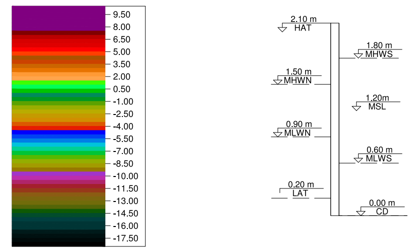
KEYPLAN



GEODETIC PARAMETERS

GEODETIC DATUM	: World Geodetic System 1984 (WGS84)
ELLIPSOID	: WGS84
Semi major axis	: 6378137
Inverse flattening	: 298.257223563
PROJECTION	: UNIVERSAL TRANSVERSE MERCATOR (UTM)
Longitude Of Central Meridian (CM)	: 57Â°00'00" East (Zone 40N)
Latitude of Origin	: 00Â°00'00" North
False Easting	: 500000 m
False Northing	: 0 m
Scale factor at CM	: 0.999600
DATUM TRANSFORMATION	: WGS84
	dX: 00.00m rX: 0.00 Scale: 0.000 ppm
	dY: 00.00m rY: 0.00
	dZ: 00.00m rZ: 00.00"
Source	: WORLD GEODATIC SYSTEM
Vertical Datum	: CHART DATUM, WHERE CD IS 1.2M BELOW MSL

LEGEND



NOTES

1. ALL DIMENSIONS AND LEVELS ARE IN METER UNLESS OTHERWISE SPECIFIED.

REV.	DATE	DESCRIPTION	DB	CHK	APD
00	05-AUG-2018	FOR REVIEW / APPROVAL	NIQ	MAK	KBG

CLIENT:-

هيئة كهرباء ومياه الشارقة
Sharjah Electricity & Water Authority

CONTRACTOR:-

ELSEWEDY ELECTRIC PSP

CONSULTANT:-

Environmental Solutions and Consultancy

KPB CONSULTANTS

SURVEY CONTRACTOR
GEOMAK SURVEY SERVICES (FZE)
PO BOX.514886, SAIF ZONE, SHARJAH. U.A.E.
TEL +971 6 7491468 EMAIL: INFO@GEOMAKSURVEY.COM
WEB: WWW.GEOMAKSURVEY.COM

PROJECT:

LAYYAH POWER PLANT EXPANSION PROJECT

TITLE:

BATHY METRIC SURVEY
COMPLETE AREA

SHEET SIZE A1	GSS DWG No.	Scale 1:17500 — 0 m 200 m 400 m 600 m 800 m 1000 m		
PROJECT No. 71/2018	DWG No.	LPP-GSS-0718-071-001	SHT.No. 01 of 15	REV. 00

6.5.1.2. Current measurements

The currents were measured via an onsite Acoustic Doppler Current Profiler (ADCP) deployed at location 27°47.088"N, 48°53.286"E at an approximate water depth of 9m from 22nd July 2018 to 23rd August 2018. The ADCP was recovered on 14th August 2018 and after downloading the data, it was re-deployed on 15th August 2018.

The maximum current observed during the period of observation from 22nd July to 23rd August 2018 is 366 mm/s (0.71 knots) at near surface. The bottom current is 229 mm/s (0.45 knots). The currents were predominantly in the north-south in direction.

The following histogram (**Figure 18**) indicates the current pattern at three levels (surface, mid and bottom):

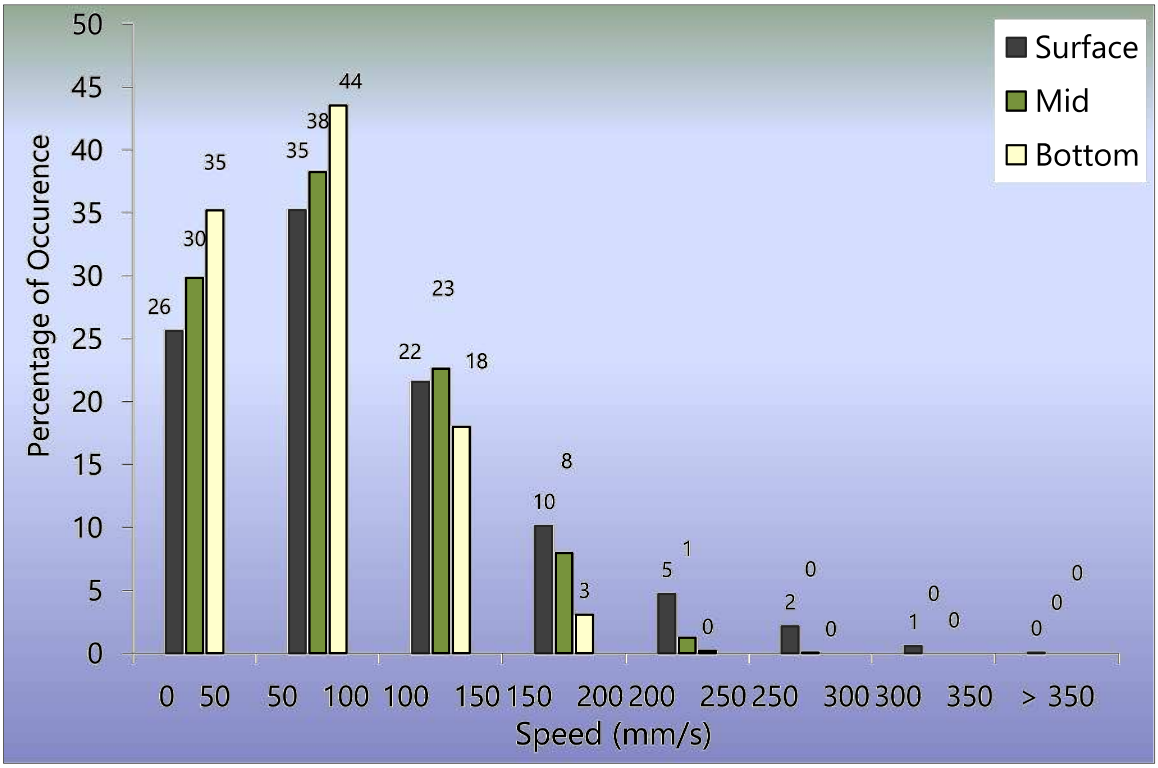


Figure 18 – Histogram of current speed (speed in mm/s)

The histogram indicates that the surface currents were less than 150mm/s about 82% of the observation. The bottom currents were less than 150mm/s (0.292 knots) about 97% of the observations, indicating less currents prevailing in the area.

Rose plots are drawn for the three levels (surface, mid and bottom), and are represented in **Figure 19, Figure 20 and Figure 21.** The rose plots indicates a northerly-southerly transport at the surface and in the subsequent layers, the currents are more to north-northeasterly and south-southwesterly.