- E 88 - Al Dhaid Road connecting the Emirate of Fujairah.
- E 102 - Sharjah - Kalbah Road - Connecting Fujairah and Kalba.
- S 12 - Maliha Road

The project site is well connected by road network. The road S101 (Al Meena Street) leading from project site connects the road S108 (Al Khan Street) and it connects the Emirate road E11 at a distance of around 4.5 km (road distance) on ESE. The E11 emirate road connects the important cities of all emirates. The level of service of the adjacent roads is moderate during peak hours and good during non-peak hours.

The project site is well accessible by air and sea route. Sharjah Khalid Port is located adjacent to the project site. The Sharjah International Airport is located at the distance of about 12.5 km on East direction.

6.7.2. WASTE AND ITS MANAGEMENT

Sharjah set up a municipal waste management company Bee'ah (the Arabic word for environment) in 2007 in the form of a public private partnership. In 2011, the emirate announced an ambitious plan for "Zero Waste to Landfill" in line with the vision of His Highness Dr. Sheikh Sultan bin Mohammed Al Qasimi, Member of the Federal Supreme Council and Ruler of Sharjah, to be the leading environmental city in the Middle East. To attain this goal, Bee'ah developed a state-of-the-art Waste Management Centre, one of the world's largest waste management plants to process and recycle different materials including construction waste, medical waste, used vehicles, used tires, metal waste, e-waste and organic waste. Since 2012, the company has been introducing recyclable waste collection systems, along with a new tipping fee structure set in cooperation with the Sharjah City Municipality to incentivize waste reduction and to closely regulate landfill contents. It has established more than 1,700 three-stream recycling bins for residents to encourage the community to separate between paper, plastics and cans, and general waste. Tandeef, a waste collection division of Bee'ah, has distributed blue recycling bins and totes among over 4,500 offices, and introduced a range of unique services. The "You Call, We Haul" free service comes to pick up bulky waste such as furniture and appliances. Bee'ah also provides services for safely destroying and recycling confidential data and documents. The recovery rate or the diversion rate of waste in Sharjah has steadily risen from around 53% in 2012 to 70% in 2015, as waste has been recycled or recovered. The emirate is set to become the first Arab city to divert 100% of its waste from landfill within the next few years. *[Source: UAE - State of Green Economy report, 2016]*.

The wastes (domestic waste, non-hazardous & hazardous industrial wastes) generated in the emirate of Sharjah are being collected by Bee'ah for better waste management to achieve zero waste to landfill.

7. ASSESSMENT OF ENVIRONMENTAL AND SOCIAL IMPACTS

7.1. GENERAL METHODOLOGY

Impact assessment describes identification and appraisal of various impacts due to the proposed project. "Environmental and Social Impact" can be defined as any alteration of environmental conditions and society or creation of a new set of environmental and social conditions, adverse or beneficial, caused or induced by the action or set of actions under consideration. Generally, the environmental and social impacts can be categorized as either primary or secondary:

- Primary impacts are those, which are attributed directly by the project
- Secondary impacts are those, which are indirectly induced and typically include the associated investment and changed patterns of social and economic activities by the proposed action

The impact of the proposed project has been assessed by using Environment and Social Impact Assessment Matrix. The environmental and social impact assessment matrix considers the three basic elements:

- A listing of the effects on the environment and society which would be caused by the proposed development, and an estimate of the *magnitude* of each.
- An evaluation of the relative *importance* of the potential (sensitive) receptors.
- Effect – Significance of the impact - combining of *magnitude* and *importance* estimates in terms of a summary evaluation.

Generic criteria for the definition of magnitude and sensitivity are presented in **Section 3.4.3** of the report**.** In addition to the general criteria for determining magnitude of impact, additional criteria are determined for specific environmental components in the report.

Sensitive receptors – It 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/Valuable Ecosystem components are already identified in **Section 6.2**)

Significance of the effect - Likely impacts are assessed taking into account the interaction between the magnitude and sensitivity criteria to determine the significance of any effect, which may be adverse or beneficial, as presented in **Table 14.** Major or moderate effects are considered as significant.

7.2. ENVIRONMENTAL IMPACTS WITH EMBEDDED MITIGATIONS

Embedded mitigation measures considered while evaluating the impact. 'Embedded mitigation' describes the features of the design that avoid or reduce adverse environmental impacts. It is taken into account in the assessment of impacts. Wherever possible, mitigation for potential impacts has been identified and incorporated into the design and construction programme by SEWA and EPCC.

7.3. AIR ENVIRONMENT

The impacts of the proposed project during the construction and operation phases have been identified and evaluated using impact assessment methods. The process of air quality impact assessment hereunder described.

7.3.1. ASSESSMENT METHODS

The significance of air quality impacts are determined by the consideration of the following components:

- Regulatory requirement;
- The baseline conditions of the area – The baseline of ambient air quality is characterized based on air quality monitoring data collected in the project site;
- The sensitivity of receptors; and
- Criteria for assessment.

7.3.1.1. Regulatory requirement

In accordance with Equator principles, **United Arab Emirates (UAE)** is a non-designated country, and as such, the assessment process for the project must evaluate compliance with the applicable IFC regulations/guidelines.

The IFC General EHS Guidelines recommend that emissions of the proposed project do not result in pollutant concentrations that reach or exceed relevant ambient quality guidelines and standards by applying national legislated standards, or in their absence, the current WHO Air Quality Guidelines, or other internationally recognized sources. As UAE has its own nationally legislated standards (presented in **Table 20**), these have been used to determine the significance of potential ambient impacts. As described above the nationally legislated standards are considered to include suitable averaging periods for the key pollutants emitted from the project and therefore have not be supplemented with additional standards from international sources. In addition to compliance to ambient air quality standard, as a general rule, emissions should not contribute more than 25% of the relevant air quality standards to allow additional, future sustainable development in the same airshed.

7.3.1.2. Summary of air quality baseline conditions

Ambient air quality survey was conducted at 4 locations in the project site continuously for 24 hours. 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 µg/Nm^3 which comply with maximum allowable limit (230 µg/Nm^3) prescribed by UAE - MoCCaE. Levels of PM_{10} ranged from 83 to 115 µg/Nm^3 which comply with maximum allowable limit (150 µg/Nm^3). 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). Other pollutants in the ambient air are less or not detectable and are well within maximum allowable limits prescribed by UAE-MoCCaE.

Perusal on last 5 years data, most prevalent wind flowing directions in Sharjah region is North-western directions, East, West & South-eastern and average wind speed is 7.5 miles per hour (breeze – constantly moving air).

7.3.1.3. Sensitivity of the receptors

Sensitive receptors in relation to air quality are presented in **Table 66**.

Table 66 – Details of sensitive receptors in relation to air quality

Receptor Type	Sensitivity	Name of the receptor	Aspects
Construction phase			
High density residential block	High (Type 1 area)	Al Layyah suburb Al Marijah suburb Al Khaleidia suburb	Residents have the potential to be exposed by particulate matter (TSP & PM_{10}) as well as deposited dust as a result of construction activities.
School premises	High (Type 1 area)	American School of Creative Science Manar Al Sabeel Quran Center Canadian Montessori Nursery	School residents have the potential to be exposed by particulate matter (TSP & PM_{10}) as well as deposited dust as a result of construction activities.

Receptor Type	Sensitivity	Name of the receptor	Aspects
		Arabian Gulf School	
		British Islamic Nursery	
		Al Khan School	
Commercial buildings and other public areas	Moderate (Type 2 area)	Golden Beach Motel	Visitors/guests have the potential to be exposed by particulate matter (TSP & PM_{10}) as well as deposited dust as a result of construction activities.
		Sahara Beach Resort	
		Marhaba Resort	
Industry	Marginal (Type 4 area)	Onsite workers/ personnel	Exposure to dust/particulate matter generated by construction activities can cause health implications
			Combustion emissions generated by the operation of fuel fired construction equipment/machinery
Operation phase			
High density residential block	High (Type 1 area)	Al Layyah suburb	Residents have the potential to be exposed by emissions generated by operation of gas turbines.
		Al Marijah suburb	
		Al Khaleidia suburb	
		Al Majaz	
		Al Majaz 1	
School premises	High (Type 1 area)	American School of Creative Science	School residents have the potential to be exposed by to be exposed by emissions generated by operation of gas turbines.
		Manar Al Sabeel Quran Center	
		Canadian Montessori Nursery	
		Arabian Gulf School	
		British Islamic Nursery	
		Al Khan School	
Hospital premises	High (Type 1 area)	Al Zahra Hospital	Exposure of emissions generated by power plant can worsen the heath conditions of patients.
		Zuleka Hospital	
Heritage Area	Moderate (Type 2)	Sharjah Heritage Area	Prolonged exposure to particulates and combustion emissions produced by the power plant can deteriorate the heritage materials
		Sharjah Art Museum	
		Wasit Natural Reserve	Prolonged exposure to particulates and combustion emissions produced by the power plant can deteriorate the natural

Receptor Type	Sensitivity	Name of the receptor	Aspects
			reserve.
		Golden Beach Motel Sahara Beach Resort Marhaba Resort	Visitors/guests have the potential to be exposed by emissions generated by operation of gas turbines.

7.3.1.4. Assessment methodology and criteria

7.3.1.4.1. Construction phase air quality impacts

Air quality impacts for the project during construction phase are assessed in a qualitative manner following WBG-IFC EHS guidelines and guidance document of Institute of Air Quality Management, London -UK[26]. Dust emission impact is assessed based on the following steps in accordance with IAQM:

STEP 1 (Screening) is to screen the requirement for a more detailed assessment. No further assessment is required if there are no receptors within a certain distance of the works. Construction impacts will be located in close proximity to the project site and will not extend beyond 500m from any construction or decommissioning activity as construction activities lead to the generation of large particles that are unable to travel large distances and therefore usually deposit with 100-250m. This assessment has assumed that particles have the potential to deposit as far as 500 m from the site boundary of access road to take account of dry conditions and to provide a conservative assessment. An assessment will normally be required where there is a 'human receptor' within 350 m of the boundary of the site; or- 50 m of the route(s) used by construction vehicles on the public highway, up to 500 m from the site entrance(s) and an 'ecological receptor' within 50 m of the boundary of the site; or 50 m of the route(s) used by construction vehicles on the public highway, up to 500 m from the site entrance(s).

STEP 2 (Dust risk assessment) is to assess the risk of dust impacts. This is done separately for each of the four activities (demolition; earthworks; construction; and track out) and takes account of the scale and nature of the works, which determines the potential dust emission magnitude, and the sensitivity of the area.

The risk of dust arising in sufficient quantities to cause annoyance and/or health and/or ecological impacts should be determined using four risk categories: negligible, minor, moderate and major risk. A site is allocated to a risk category based on the scale and nature of the works, which determines the potential dust emission magnitude as low, moderate or major, and the sensitivity of the area to dust impacts. These two factors are combined in to determine the risk of dust impacts.

[26] *Holman et al., 2014. Guidance on assessment of dust from demolition and construction. Institute of Air Quality Management, London (www.iaqm.wp-content/uploads/guidance/dust_assessment.pdf)*

7.3.1.4.2. Operation phase air quality impacts

In accordance with best practice, potential impacts of emissions from operation of the plant on ambient air quality have been assessed within 10 km of the project by atmospheric dispersion modeling system. The contributions of stack emissions from the project during operation phase have been quantitatively assessed using an air dispersion model, Lakes Environmental – AERMOD.

7.3.1.4.2.1. Green House Gas Emission Estimation

For Scope 1, GHG emissions calculation is based on the international guidelines. The main document used is Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories, 2006 (2006 IPCC Guidelines).

7.3.1.4.3. Assessment criteria

Based on the assessment, criteria for determining the air quality impact is defined, and described in **Table 67**.

Table 67 – Assessment criteria to determine magnitude for air quality

Magnitude	Criteria and Increase of pollutants as % of standard
Major	Environmental effects are noticeable and are sufficient to destabilize the resource. Regional/national/international change/effect. The contribution by the proposed project to sensitive receptors may increase the pollutant level more than 50% of the limit prescribed by MoCCAE.
Moderate	Environmental effects are sufficient to noticeably alter important attributes of the resource but not to destabilize them. Change/Effect to local condition and or to areas immediately outside. The contribution by the proposed project to sensitive receptors may increase the pollutant level more than 25 - 50% of the limit prescribed by MoCCaE.
Minor	Environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource. Change/effect only within the project site. The contribution by the proposed project to sensitive receptors may increase the pollutant level more than 5 - 25% of the limit prescribed by MoCCaE.
Negligible	Results in an impact on feature but of insufficient magnitude to affect the use or integrity of the element. The effect would

Magnitude	Criteria and Increase of pollutants as % of standard
	lead to no observable change in the component. The contribution by the proposed project to sensitive receptors may increase the pollutant level of less than 5% of the limit prescribed by MoCCaE.

7.3.2. IMPACT ON AIR ENVIRONMENT DURING CONSTRUCTION PHASE

7.3.2.1. Identification of air quality impacts

The various activities during construction phase include site preparation, construction of approach roads, excavation, drilling, foundation, deployment of machinery, erection, transportation, dumping, and nature of site condition may generate dust and gaseous emissions. These emissions are expected to result in the change in baseline air quality, primarily in the working area and cause an immediate effect on the construction workers. Dust and other emissions are not likely to spread on the broader region, which would affect the site itself. The primary emissions during construction activities will be the following:

- Combustion emissions from vehicles and heavy equipment;
- Combustion emissions from generators;
- Dust emissions from vehicular movement and heavy equipment activities;
- Dust emissions from mechanical activities and material handling

7.3.2.2. Evaluation of air quality impacts

7.3.2.2.1. Combustion from Vehicles and Heavy Equipment

Mobile sources of emissions in the construction phase include vehicles and heavy equipment such as moving cranes, excavators, compressors etc. Vehicles for the transport of workers, materials and other resources will also contribute emissions. Emissions from these mobile sources depend on various factors such as chemical composition of fuel (e.g. sulfur), vehicle load, engine maintenance condition and travel speed.

7.3.2.2.2. Combustion Emissions from Generators

For construction activities, generators are mainly used to supply the power requirements of construction equipment (e.g. drill, welding machine). During its operation, the generator will release combustion emissions due to the consumption of diesel fuel. Expected emissions include NOx, CO, SOx and other hydrocarbons. This generator should the need be required, will be equipped with a suitable spark arrestor. If a 250-kVA generator will be used for the construction works, the expected emissions will be as follows (Ref: Caterpillar Technical Data for 250 kVA generator):

- NOx will be 25-50 mg/Nm^3;
- CO will be 90-100 mg/Nm^3; and
- SOx emissions will depend on the percentage of sulphur in the fuel used.

The construction activities are temporary in nature. In addition, mixing of the combustion emissions with the ambient air facilitates dispersion; thus, impact on air environment is considered as localized, reversible and short duration of time.

7.3.2.2.3. Dust Emissions

Dust will be generated from excavation and backfilling activities which are dust-intensive operations. The airborne dust may contain crystalline silica that can pose health hazards to construction workers exposed to these particles. Dust from vehicle and machine movements is deemed significant since paved and unpaved road network in the project study area will be utilized for the transportation of construction materials to and from the site.

Fugitive dust emissions sources include the transfer of sand and aggregate, truck loading, mixer loading, wind erosion from sand & aggregate storage piles and mechanical activities such as mixing, cutting, grinding and sawing. The amount of fugitive dust emissions generated during the transfer of sand and aggregate depends primarily on the surface moisture content of these materials. The airborne dust may contain crystalline silica that can pose health hazards to construction workers exposed to these particles. Dust emissions from truck movement on unpaved roads have been found to vary directly with the fraction of silt in the road surface materials. According to US-EPA emission factors (Chapter 13.2.2 – Unpaved roads), the estimated fugitive dust emission generated from truck movement unpaved road will be 2.5 kg of TSP/vehicle kilometer travelled (VKT) and 0.84 kg of PM_{10}/VKT (Silt content is considered as 20% in average and weight of truck is considered as 15 Ton in average).

The impact magnitude of construction activities is conservatively described as ‘major’ for the whole construction period in accordance with activities. However, not all construction activities have a high dust raising potential and therefore it can be considered that potential dust episodes may only occur over short periods, and not throughout the whole construction phase. **Figure 40** presents the project area with associated dust buffers.

Figure 40 – Construction dust buffers for main construction site

As shown in **Figure 40**, there are no high or moderate receptors within 250m of the dust buffer area. Golden beach hotel is situated in the 500m dust buffer zone. The expected impact on Golden beach hotel will assessed as moderate.

Construction traffic will use the local road network and therefore has the potential to generate dust in residential areas and communities.

7.3.2.3. Embedded mitigation measures during construction phase

The following dust suppression measures and good site practices are recommended for the construction phase and taken into account when assessing the significance of potential impacts:

- Erection of minimum 2m high site hoardings around the site boundary;
- Water spraying of or covering all exposed areas and stockpiles;
- Specifying transport networks and locating stockpiles as far away from the site boundary which is close to the air sensitive receptors, as practicable to minimize the impact of air pollutants and dust;
- Minimizing the size of exposed areas and material stockpiles and the periods of their existence;
- Temporary stockpiles of dusty materials will be either covered entirely by impervious sheets or sprayed with water to maintain the entire surface wet all the time;

- Covering the construction materials transported by trucks or vehicles entirely to prevent dust emissions;
- Controlling the height of unloading the fill materials during filling as far as possible. Where possible, this should be well below the height of the hoardings along the Project site boundary;
- Watering the main haul road regularly to suppress dust emissions during truck movement;
- Prohibiting the burning of waste or vegetation on site;
- Compacting the reclaimed land immediately to avoid fugitive dust emissions;
- Maintaining and checking the construction equipment regularly;
- Switching off engines when idling; and
- Using commercial available low sulphur diesel for trucks and diesel-fuelled construction equipment.

Table 68 – Summary of environmental aspects and probable impacts on air quality during construction phase

Environmental Aspects	Probable Environmental Impacts	Impacted Receptor	Magnitude of Impact	Sensitivity of Receptor	Effect (Magnitude × Sensitivity)
Generation of fugitive dust emissions due to truck transport of debris on unpaved roads; truck unloading of debris; Earthworks operations: and windblown dust from stockpiles	Dust deposition and air pollution	Project Site/ Onsite workers	Moderate	Moderate	Moderate
Exhaust emissions of combustion gases due to operation of fuel fired equipment/machinery	Air pollution - Increase in NO_X, SO_2, CO, VOCs in ambient air due to combustion emissions	Project Site/ Onsite workers	Minor	Moderate	Minor
Generation of fugitive dust emissions due to truck transport of debris on unpaved roads; truck unloading of debris; Earthworks operations: and windblown dust from stockpiles	Dust deposition and air pollution	Residential areas	Minor	High	Minor
		School premises	Minor	High	Minor
		Hospitals	Minor	High	Minor
		Heritage areas	Minor	Moderate	Minor
		Commercial Destination – Golden Beach Resort	Moderate	Moderate	Moderate

7.3.3. IMPACT ON AIR ENVIRONMENT DURING OPERATION PHASE

7.3.3.1. Identification of operation phase air quality impacts

The identified environmental aspects for causing air environment during operation phase are mainly stack emissions from gas turbines. The main air pollutant of concern for a fuel gas/fuel oil-fired combined cycle power plant are nitrogen dioxide (NO_2), sulphur dioxide (SO_2), particulate matters (PM) and Green House Gases (GHGs)

The proposed project consists of two sets of gas turbine & generating unit, two sets of heat recovery steam generator (HRSG) and one steam turbine generating unit with associated auxiliary equipment. The project will be designed to operate continuously throughout the year in either simple cycle or combine cycle mode. Each gas turbine is equipped with one bypass stack for simple cycle mode and one main HRSG stack for combined cycle mode. During normal operation of the proposed project, the plant will be operated in combined cycle mode and the main HRSG stack will be in operation. Bypass stack may be operated in simple 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.

7.3.3.2. Evaluation of operation phase air quality impacts

The operation phase impact due to emission from stack is evaluated by air quality dispersion modeling to determine the dispersion of emissions from a stack by the emission characteristics of the source, particularly their temperature and velocity when they exit the stack.

7.3.3.2.1. Stack Height Determination

For proper dispersion to occur, it is necessary for the emissions to be released well above the top of nearby structures. In accordance with WBG-IFC requirement, stack heights shall be generally designed according to Good International Industry Practice (GIIP) formula to avoid excessive ground level concentrations and minimize impacts, including acid deposition. In line with requirement of WBG-IFC GIIP formula, a minimum height required for the stack will be **65m** considering steam turbine building which has 28m height and 24.2m lesser dimension.

7.3.3.2.2. Impact of stack emissions

Air quality dispersion modeling was performed for the dispersion of pollutants in the ambient air. The emission details of main HRSG stack and bypass stack (modeling input data) are presented in **Table 38**.

Modeling has been undertaken assuming the determined stack height for the future operational scenarios. The following scenarios have been considered for the assessment:

Scenario 1 – Combined cycle operation with fuel gas combustion – HRSG stacks are in operation and bypass stacks are on stand-by;

Scenario 2 - Combined cycle operation with fuel oil combustion – HRSG stacks are in operation and bypass stacks are on stand-by;

Scenario 3 - Simple cycle operation with fuel gas combustion – Bypass stacks are in operation and HRSG stacks are on stand-by; and

Scenario 4 - Simple cycle operation with fuel oil combustion – Bypass stacks are in operation and HRSG stacks are on stand-by.

In the present case, model simulations have been carried out for the whole year. For the short-term simulations, the concentrations have been estimated for receptors to obtain an optimum description of variations in concentrations over the site in 10-km radius covering 16 directions. Perusal on air quality modeling results reveal that the maximum incremental short-term 24 hourly ground level concentrations for particulate matter, SO_2 NOx and CO likely to be encountered in the operation of the proposed project are given in **Table 69**.

In addition to that maximum ground level concentrations, project contributions to the sensitive receptors are also analyzed for confirming the requirement of World Bank Group – IFC EHS guidelines. It suggested that emissions from a single project should not contribute more than 25% of the applicable ambient air quality standards to allow additional, future sustainable development in the same air shed.

According to the modeled results, the maximum GLC is found occurring at a distance of about 0.49-km in the SE direction which is in project site boundary. The perusal of the modeled results, stack emissions from the proposed project contributes more SO_2 to ambient air than other pollutants. The contribution levels of pollutants to the ambient are in the order of SO_2>CO>NO_2>PM. Based on the predicted maximum increase of pollutant level within project boundary and baseline air quality, the resultant AAQ levels after implementation of the proposed project will remain within the permissible limits. The expected impact will be minor effect. The identified impact on air environment at project site will be localized, minor magnitude, long-term and reversible.

The incremental short-term 24 hourly ground level concentrations for particulate Matter, SO_2 NO_2 and CO in the nearby sensitive receptors are given in **Table 70**. It is estimated that impact due to the increase of pollutant level in the sensitive receptors will be negligible to minor (16.5% increase of SO_2 as of the standard in Layyah and Marijah residential area). It clearly indicates that there is minor impact due to the proposed project in the nearby sensitive receptor. The project contributions to sensitive receptors comply with the recommended norms of World Bank Group – IFC EHS guidelines that emissions from a single project should not contribute more than 25% of the applicable ambient air quality standards to allow additional, future sustainable development in the same airshed. Hence, identified impact on air environment at nearby sensitive receptors will be insignificant, minor magnitude, long-term and reversible.

Table 69 – Resultant Concentrations due to Maximum Incremental GLC's for combined cycle fuel gas combustion

Pollutants	Scenarios	24 hour Incremental GLC Concentration (Max.) (μg/m³)	Location, Distance (km) and Direction from source	% of increase as of standard	Baseline Concentration (μg/m³) - Max	Resultant Concentration (μg/m³)	UAE-MoCCAE Prescribed Limit (μg/m³)
Particulate Matter (PM)	Combined Cycle – Fuel Gas (CC-FG)	3.58	Project Site Boundary 0.49 (SE)	1.56	223.0	226.58	**230**
	Combined Cycle – Fuel Oil (CC-FO)	3.07		1.33		226.07	
	Simple Cycle - Fuel Gas (SC-FG)	1.16	1.28 (SE)	0.50		224.16	
	Simple Cycle - Fuel Oil (SC-FO)	1.66	0.93 (SE)	0.72		224.66	
SO_2	CC-FG	44.83	0.49 (SE)	29.89	26.2	74.72	**150**
	CC-FO	31.76		21.17		57.96	
	SC-FG	14.59	1.28 (SE)	9.73		40.79	
	SC-FO	17.16	0.93 (SE)	11.44		43.36	
NO_2	CC-FG	8.78	0.49 (SE)	5.85	18.8	27.58	**150**
	CC-FO	7.88		5.25		26.68	
	SC-FG	2.88	1.28 (SE)	1.92		21.68	
	SC-FO	5.48	0.93 (SE)	3.65		24.28	

Pollutants	Scenarios	24 hour Incremental GLC Concentration (Max.) (μg/m^3)	Location, Distance (km) and Direction from source	% of increase as of standard	Baseline Concentration (μg/m^3) - Max	Resultant Concentration (μg/m^3)	UAE-MoCCAE Prescribed Limit (μg/m^3)
CO	CC-FG	17.20	0.49 (SE)	0.17	1,000	1,017.20	**10,000**
	CC-FO	9.14		0.09		1007.14	
	SC-FG	5.60	1.28 (SE)	0.05		1005.60	
	SC-FO	6.36	0.93 (SE)	0.06		1006.36	

Table 70 – Resultant Concentrations due to Incremental GLC's in the Sensitive Receptors (Combined cycle – Fuel gas combustion)

Name of the Receptor	Pollutant	Project Contribution (PC) – 24hour (μg/m^3) [Max.]	% of AAQ Standard	Impact Magnitude	Receptor Sensitivity	Effect
Al Layyah suburb	TSP	2.0	0.86	Minor	High	Minor
	SO_2	20.8	16.5			
	NO_2	4.9	3.3			
	CO	9.5	0.10			
Al Marijah suburb	TSP	2.0	0.86	Minor	High	Minor
	SO_2	23.2	16.5			
	NO_2	4.9	3.3			
	CO	9.5	0.10			
Al Khaleidia suburb	TSP	1.2	0.53	Minor	High	Minor
	SO_2	14.1	10.2			
	NO_2	3.0	2.0			
	CO	5.9	0.06			
Al Majaz	TSP	0.4	0.18	Negligible	High	Neutral

Name of the Receptor	Pollutant	Project Contribution (PC) – 24hour (μg/m³) [Max.]	% of AAQ Standard	Impact Magnitude	Receptor Sensitivity	Effect
	SO_2	4.7	3.4			
	NO_2	1.0	0.7			
	CO	1.9	0.02			
Al Majaz 1	TSP	1.0	0.45	Minor	High	Minor
	SO_2	11.9	8.6			
	NO_2	2.5	1.7			
	CO	4.9	0.05			
American School of Creative Science	TSP	1.6	0.72	Minor	High	Minor
	SO_2	18.6	13.8			
	NO_2	4.1	2.7			
	CO	7.9	0.08			
Manar Al Sabeel Quran Center	TSP	1.2	0.52	Minor	High	Minor
	SO_2	14.1	9.9			
	NO_2	2.9	2.0			
	CO	5.7	0.06			
Canadian Montessori Nursery	TSP	0.9	0.39	Minor	High	Minor
	SO_2	10.6	7.5			
	NO_2	2.2	1.5			
	CO	4.3	0.04			
Arabian Gulf School	TSP	1.3	0.56	Minor	High	Minor
	SO_2	14.9	10.7			
	NO_2	3.2	2.1			
	CO	6.1	0.06			
British Islamic Nursery	TSP	0.8	0.37	Minor	High	Minor
	SO_2	10.2	7.0			

Name of the Receptor	Pollutant	Project Contribution (PC) – 24hour (µg/m^3) [Max.]	% of AAQ Standard	Impact Magnitude	Receptor Sensitivity	Effect
	NO_2	2.1	1.4			
	CO	4.1	0.04			
Al Khan School	TSP	0.8	0.35	Minor	High	Minor
	SO_2	9.8	6.7			
	NO_2	2.0	1.3			
	CO	3.9	0.04			
Al Zahra Hospital	TSP	0.7	0.29	Minor	High	Minor
	SO_2	7.9	5.5			
	NO_2	1.6	1.1			
	CO	3.2	0.03			
Zuleka Hospital	TSP	0.2	0.10	Negligible	High	Neutral
	SO_2	2.7	1.9			
	NO_2	0.6	0.4			
	CO	1.1	0.01			
Sharjah Heritage Area	TSP	1.7	0.74	Minor	Moderate	Minor
	SO_2	19.3	14.2			
	NO_2	4.2	2.8			
	CO	8.1	0.08			
Sharjah Art Museum	TSP	0.5	0.20	Negligible	Moderate	Neutral
	SO_2	5.5	3.8			
	NO_2	1.1	0.8			
	CO	2.2	0.02			
Wasit Natural Reserve	TSP	0.1	0.06	Negligible	High	Neutral
	SO_2	1.6	1.1			
	NO_2	0.3	0.2			

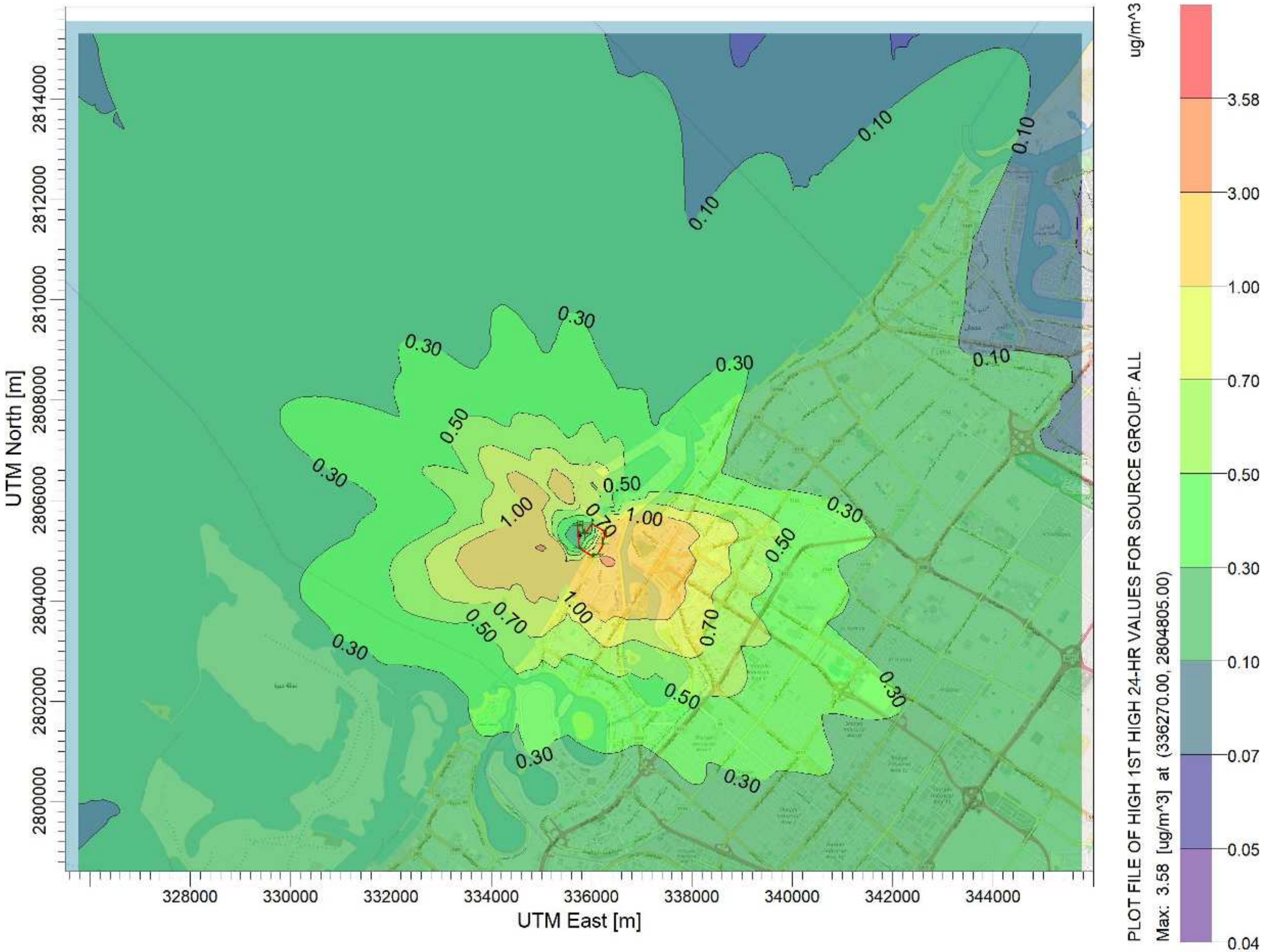
Name of the Receptor	Pollutant	Project Contribution (PC) – 24hour (µg/m^3) [Max.]	% of AAQ Standard	Impact Magnitude	Receptor Sensitivity	Effect
	CO	0.6	0.01			
Golden Beach Motel	TSP	2.3	1.00	Minor	Moderate	Minor
	SO_2	28.6	19.1			
	NO_2	5.7	3.8			
	CO	11.0	0.11			
Sahara Beach Resort	TSP	2.1	0.91	Minor	Moderate	Minor
	SO_2	26.3	17.5			
	NO_2	5.2	3.5			
	CO	10.1	0.10			
Marhaba Resort	TSP	1.8	0.80	Minor	Moderate	Minor
	SO_2	23.1	15.4			
	NO_2	4.6	3.0			
	CO	8.9	0.09			

Figure 41 – Short Term 24 Hourly Incremental GLC's of Particulate Matter (μg/m^3)

(Combined cycle – Fuel gas combustion)

PROJECT TITLE:

SEWA-Combined Cycle Power Project
Dispersion of Particulate matter



COMMENTS:

SOURCES:

2

RECEPTORS:

6595

OUTPUT TYPE:

Concentration

MAX:

3.58 ug/m^3

COMPANY NAME:

Environmental Solutions and Consultancy

SCALE: 1:120,392

0 4 km

PROJECT NO.:

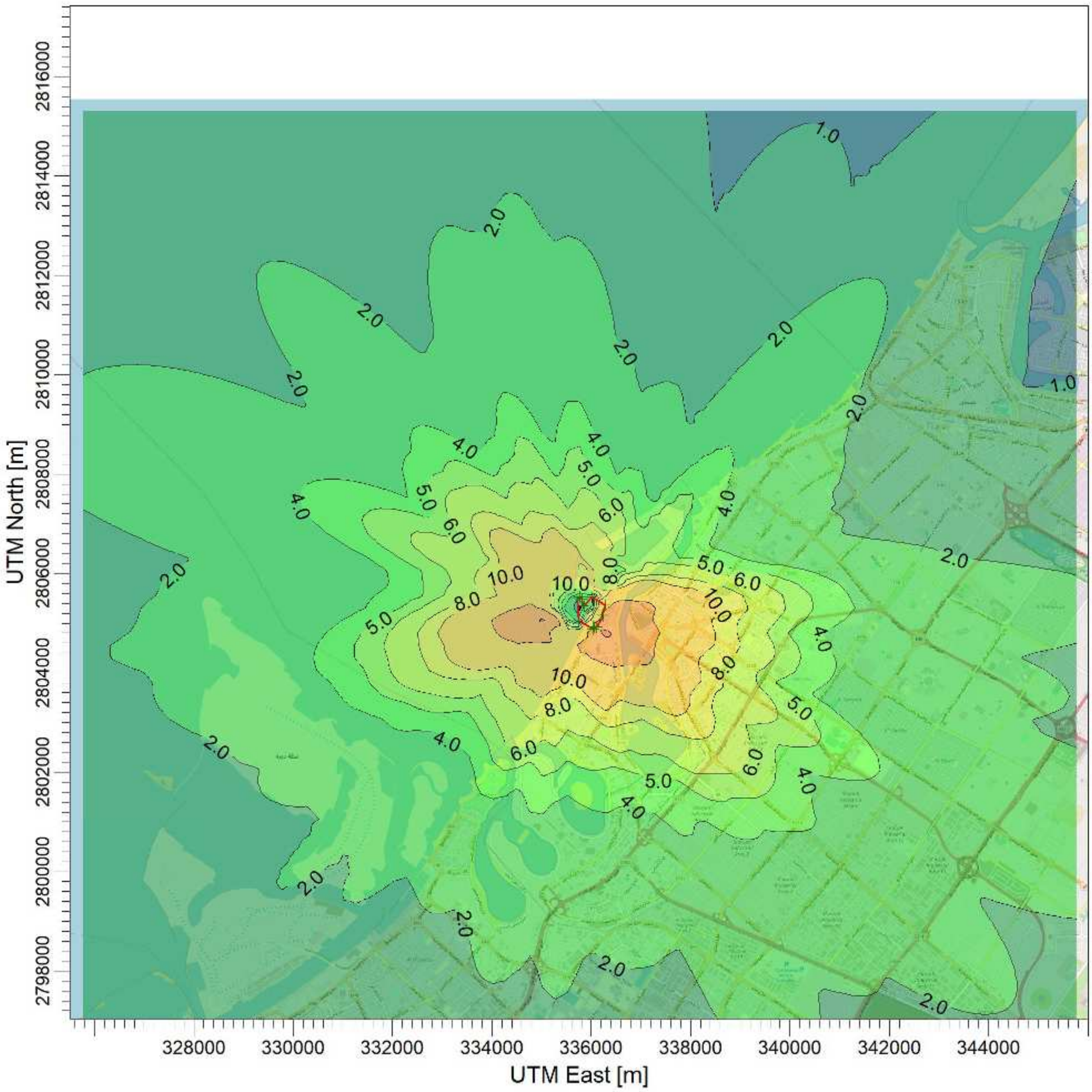
AERMOD View - Lakes Environmental Software

Figure 42 – Short Term 24 Hourly Incremental GLC's of SO_2 ($\mu g/m^3$)

(Combined cycle – Fuel gas combustion)

PROJECT TITLE:

SEWA-Combined Cycle Power Project
Dispersion of Sulphur dioxide



PLOT FILE OF HIGH 1ST HIGH 24-HR VALUES FOR SOURCE GROUP: ALL ug/m^3

Max: 44.8 [ug/m^3] at (336270.00, 2804805.00)

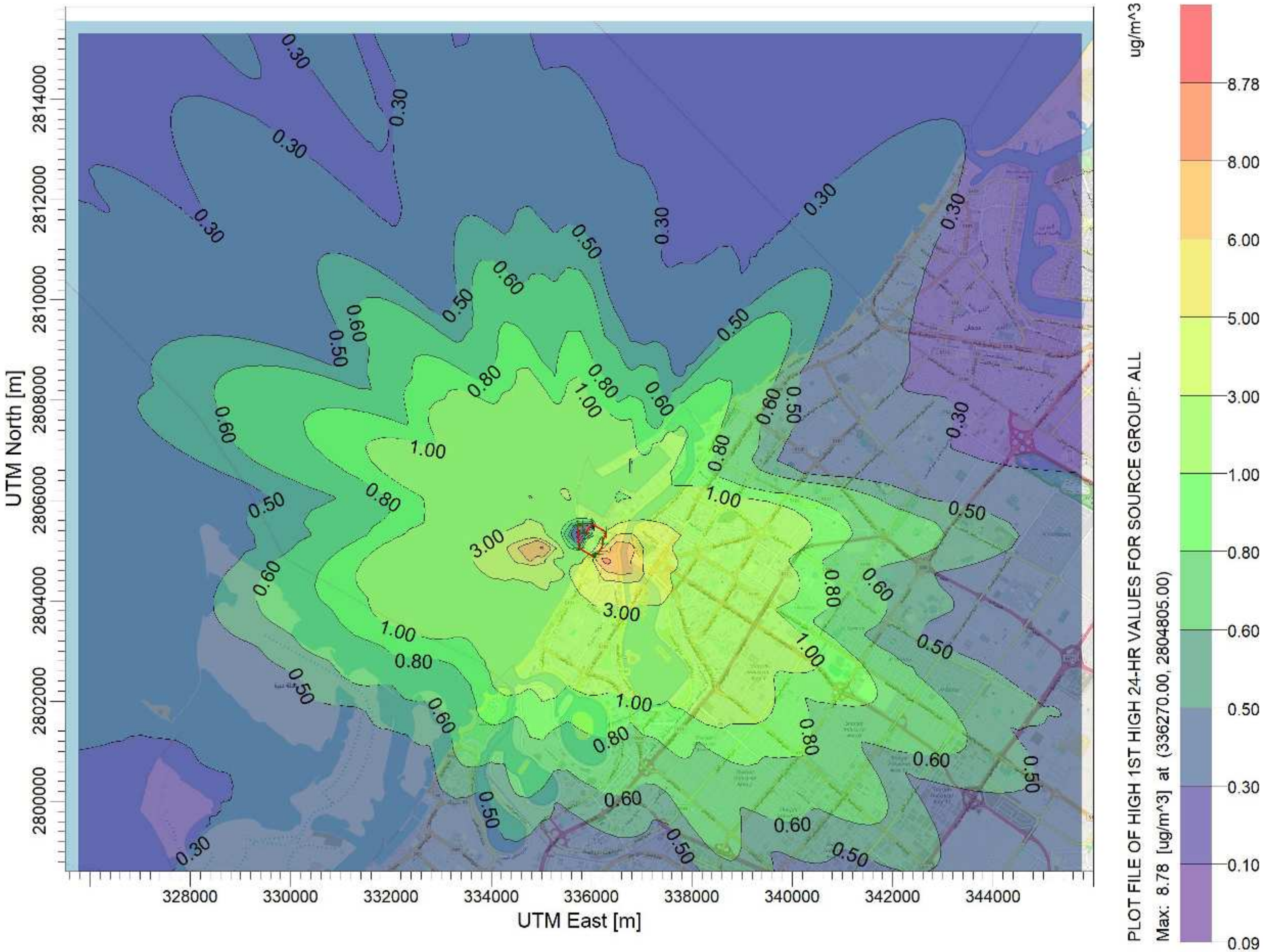
0.4 0.5 0.6 0.8 1.0 2.0 4.0 5.0 6.0 8.0 10.0 20.0 40.0 44.8

COMMENTS:	SOURCES:	COMPANY NAME:	
	2	Environmental Solutions and Consultancy	
	RECEPTORS:		
	6595		
	OUTPUT TYPE:	SCALE: 1:132,377	
	Concentration	0 — 5 km	
	MAX:		PROJECT NO.:
	44.8 ug/m^3		

Figure 43 – Short Term 24 Hourly Incremental GLC's of NOx ($\mu g/m^3$)
(Combined cycle – Fuel gas combustion)

PROJECT TITLE:

SEWA-Combined Cycle Power Project
Dispersion of Nitrogen dioxide



COMMENTS:

SOURCES:

2

RECEPTORS:

6595

OUTPUT TYPE:

Concentration

MAX:

8.78 ug/m^3

COMPANY NAME:

Environmental Solutions and Consultancy

SCALE: 1:120,392

0 4 km

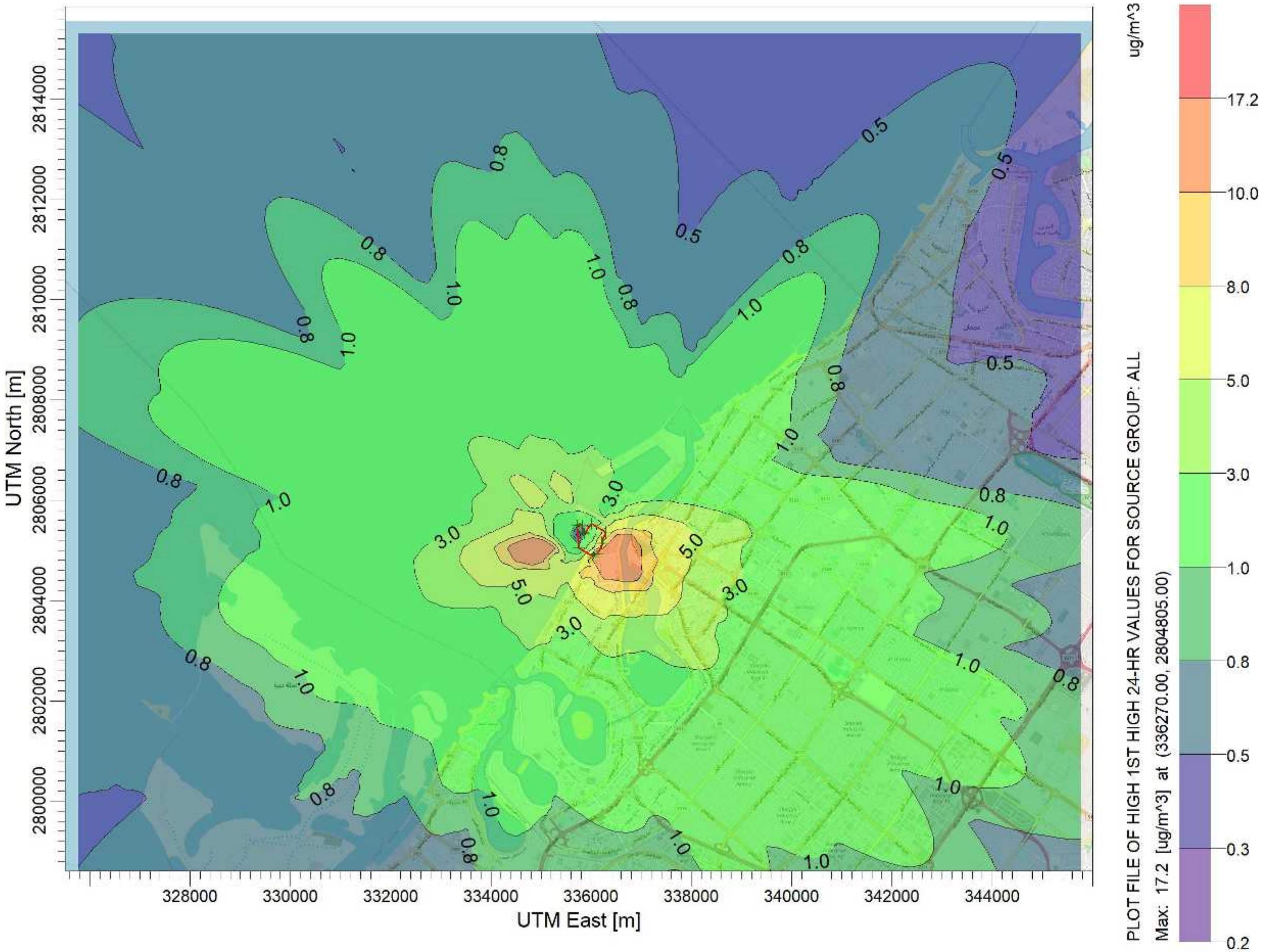
PROJECT NO.:

AERMOD View - Lakes Environmental Software

Figure 44 – Short Term 24 Hourly Incremental GLC's of CO (μg/m^3)
(Combined cycle – Fuel gas combustion)

PROJECT TITLE:

SEWA-Combined Cycle Power Project
Dispersion of Carbon dioxide



COMMENTS:

SOURCES:

2

RECEPTORS:

6595

OUTPUT TYPE:

Concentration

MAX:

17.2 ug/m^3

COMPANY NAME:

Environmental Solutions and Consultancy

SCALE: 1:120,392

0 4 km

Environmental Solutions and Consultancy

PROJECT NO.:

AERMOD View - Lakes Environmental Software

7.3.3.2.3. Green House Gas Emissions

During operation phase, electricity for the power plant will be supplied by the Plant itself, so there would be no Scope 2 emissions to consider. Scope 1 emissions of GHG from the plant operation will mainly come from fuel gas/fuel oil-fired gas turbine generators. The gas turbine will use natural gas as the primary fuel and fuel oil as supplementary fuel. The details of fuel consumption for the operation of power plant are provided in **Table 71**.

Table 71 – Details of Fuel Consumption

S. No.	Name of Fuel	Nature	Quantity to be required
1	Natural Gas – Primary fuel	Gas	189.4 Ton/hr
2	Light Fuel Oil – Supplementary fuel	Liquid	160 m^3/hr

Greenhouse gas emissions are estimated based on the following equation:

$$\textbf{Emissions}_{\textbf{GHG, fuel}} = \textit{Fuel Consumption}_{fuel} \times \textit{Emission Factor}_{GHG,\ fuel}$$

Where:

Emissions $_{\text{GHG, fuel}}$ = emissions of a given GHG by type of fuel (kg GHG);

Fuel Consumption $_{\text{fuel}}$ = amount of fuel combusted (TJ)

Emission Factor $_{\text{GHG, fuel}}$ = default emission factor of a given GHG by type of fuel (kg gas/TJ). For CO_2, it includes the carbon oxidation factor, assumed to be 1.

Fuel Consumption $_{\text{fuel}}$ rate is calculated based on the following equation

$$\textbf{Fuel Consumption}_{\textbf{fuel}} = \textit{Fuel Consumption}_{(Gg)} \times \textit{Net Calorific Value}_{(TJ/Gg)}$$

Where:

Fuel Consumption $_{(Gg)}$ = amount of fuel combusted in Gigagram ($\times 10^6$ kg);

Net Calorific Value $_{(TJ/Gg)}$ = Net Calorific Value of fuel (TJ/Gg)

The result of GHG emissions calculations are shown in **Table 72**.

Table 72 – Estimated GHG emissions

S. No.	Source	Fuel Type	Fuel Consumed (TJ/hr)	GHG Emissions (kg CO_2e/hr)			
				CO_2	CH_4	N_2O	Total
Global warming potential for 100-year time horizon				**1**	**28**	**265**	
Default emission factor (kg of GHG/TJ)			**Fuel Gas**	**56,100**	**1**	**0.1**	
			Fuel Oil	**74,100**	**1**	**0.6**	
1	Turbine	Primary fuel	9.10	510,510	9.10	0.91	510,520

S. No.	Source	Fuel Type	Fuel Consumed (TJ/hr)	GHG Emissions (kg CO_2e/hr)			
				CO_2	CH_4	N_2O	Total
		– Fuel Gas					
2		Primary fuel – Fuel Oil	7.60	563,160	7.60	4.56	563,172
GHG emission (tonnes CO_2e/hr)				Fuel gas combustion			**510**
				Fuel oil combustion			**563**
GHG emission (tonnes CO_2e/day)				Fuel gas combustion			**12,252**
				Fuel oil combustion			**13,605**
GHG emission (tonnes CO_2e/year)				Fuel gas combustion			**4,472,155**
				Fuel oil combustion			**4,965,781**

It is anticipated that the daily emission of GHG is estimated to be 12,252 tonnes of CO_2 by fuel gas combustion and 13,605 tonnes of CO_2 by fuel oil combustion. An annual emission of GHG is estimated to be 4,472,155 tonnes of CO_2 by fuel gas combustion and 4,965,781 tonnes of CO_2 by fuel oil combustion.

The estimated GHG emission per kilo watt hour (kWh) electricity generation is 464g CO_2 for fuel gas combustion and 512 g CO_2 for fuel oil combustion. According to UAE state of green economy report 2017, the intensity of electricity generation recorded was 643 gCO_2/kWh in 2014 as reported by International Energy Agency (IEA).

The estimated GHG emissions from the proposed project during operation will exceed the threshold that defines significant emitters of GHGs and EP III (100,000 tonnes CO_2e per year) and IFC PS3 (25,000 tonnes CO_2e per year). Therefore, the project is required to implement measures for GHG reduction, and report annual GHG emissions as per the applicable reference framework.

Table 73 – Summary of environmental aspects and probable impacts on air quality during operation phase

Environmental Aspects	Probable Environmental Impacts	Impacted Receptor	Magnitude of Impact	Sensitivity of Receptor	Effect (Magnitude × Sensitivity)
Generation of fugitive dust emissions due to truck transport of debris on unpaved roads	Dust deposition and air pollution	Project Site/ Onsite workers	Minor	Moderate	Minor
Exhaust emissions of combustion gases due to operation of fuel fired equipment/machinery	Air pollution - Increase in NO_X, SO_2, CO, VOCs in ambient air due to combustion emissions	Project Site/ Onsite workers	Moderate	Moderate	Moderate
Exhaust emissions of combustion gases due to power generation process	Air pollution - Increase in NO_X, SO_2, CO, VOCs in ambient air due to combustion emissions	Project Site/ Onsite workers	Minor	Moderate	Minor
		Residential areas	Minor	High	Minor
		School premises	Minor	High	Minor
		Hospitals	Minor	High	Minor
		Heritage areas	Minor	Moderate	Minor
		Commercial Destination – Golden Beach Resort	Minor	Moderate	Minor

7.4. NOISE ENVIRONMENT

Impacts are considered during construction and operation of the proposed project, in particular:

- Predicted noise and vibration levels from any construction works;
- Noise from the proposed project during operation; and
- An increase in noise associated with traffic attributed to the project.

7.4.1. ASSESSMENT METHOD

The significance of noise quality impacts are determined by the consideration of the following components:

- Regulatory requirement;
- The baseline conditions of the area – The baseline of ambient air level is characterized based on noise level monitoring data collected in the project site;
- The sensitivity of receptors – sensitive receptors are identified and described in **Table 45**; and
- Assessment criteria

7.4.1.1. Regulatory requirement

UAE-MoCCaE air pollution regulation suggested that noise levels should not exceed the maximum allowable levels and maximum span for exposure as mentioned in **Table 17.**

IFC-EHS Guidelines suggested that noise impacts within the specific environments should not exceed the levels presented in **Table 29** or result in a maximum increase in background levels of 3 dB at the nearest sensitive receptors.

7.4.1.2. Summary of baseline noise level at project site

Ambient noise level survey was conducted at 4 locations in the project site continuously for 24 hours. 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 and those levels are higher than maximum allowable limits prescribed by UAE-MoCCAE except day time noise level recorded at ANQ1 & ANQ 3 monitoring location.

7.4.1.3. Assessment methodology and criteria

The proposed project's contribution to surrounding environment was assessed by sound propagation modeling. Any industrial complex in general consists of several sources of noise in clusters or single. These clusters/single sources may be housed in buildings of different dimensions made of different materials or installed in open or under sheds. In order to predict ambient noise levels due to the cumulative impact of the proposed project, the propagative modeling has been done. For computing the noise levels at various distances with respect to the project, noise levels are predicted using a user friendly model the details of which are elaborated below.

7.4.1.3.1. Sound Propagation Modeling

For an approximate estimation of dispersion of noise in the ambient from the point sources, a standard mathematical model for sound wave propagation is used. The sound pressure level generated by noise source is decreasing with increasing distance from the source due to wave divergence. An additional decrease in sound pressure level with distance from the source is expected due to atmospheric effect or its interaction with objects in the transmission path. Environmental noise propagation is estimated according to ISO 9613-2:1996 - Attenuation of sound during propagation outdoors Part 2: General method of calculation. For hemispherical sound wave propagation through homogenous loss free medium, one can estimate noise levels at various locations, due to different sources using model based on first principles, as per the following equation:

$$Lp_2 = Lp_1 - 20 \text{ Log } (r_2/r_1) \quad \text{.......... (1)}$$

Where,

Lp_2 and Lp_1 are Sound Pressure Levels (SPLs) at points located at distances r_2 and r_1 from the source. The combined effect of all the sources then can be determined at various locations by the following equation.

$$L\rho_{(total)} = 10 \text{ Log } (10^{(Lp1/10)} + 10^{(Lp2/10)} + 10^{(Lp3/10)} .....) \quad \text{.......... (2)}$$

Where,

L_{p1}, L_{p2}, L_{p3} are noise pressure levels at a point due to different sources.

Based on the above equations, a user-friendly model has been developed. The details of the model are as follows:

* Maximum number of sources is limited to 200;
* Noise levels can be predicted at any distance specified from the source;
* Model is designed to take topography or flat terrain;
* Coordinates of the sources in meters;
* Maximum and Minimum levels are calculated by the model;

* Output of the model in the form of isopleths; and
* Environmental attenuation factors and machine corrections have not been incorporated in the model but corrections are made for the measured L_{eq} levels.

The magnitude of the impact on noise environment will be determined by the criteria mentioned in **Table 74**.

Table 74 – Assessment Criteria to determine magnitude for noise quality

Magnitude	Criteria – Change in noise level [dB(A)] as % of standard
Major	The contribution by the proposed project may increase noise level more than 10% of limit prescribed by MoCCAE
Moderate	Increase level 5 - 10%
Minor	Increase level 2 - 5%
Negligible	Increase level 1 - 2%
Insignificant	Increase level <1%

7.4.2. IMPACT ON NOISE AND VIBRATION LEVEL DURING CONSTRUCTION PHASE

The identified sources of noise emissions during construction phase are mainly from the cranes, drilling equipment, compressors, generators, pneumatic tools and traffic & transportation. It is planned to deploy the equipment/machinery with inbuilt acoustic enclosure to conform the norms of noise exposure guidelines as per Occupational Safety and Health Administration (OSHA) which is considered as embedded mitigation measure. The noise levels generated by major equipment/machinery to be utilized during the construction phase are presented in **Table 75**.

Table 75 – Assumed Noise Emission Levels of Construction Equipment/Machinery

Name of Equipment/Machinery/ Building	Noise Emission Level – Lmax dB (A) @ 50 feet
Tracked cranes (cranes, elevators, hoists, etc.)	85.0
Air compressors	85.0
Bulldozers/Excavators	85.0
Scrapers/Graders/Dump Truck	85.0
Impact Pile Driver/Vibratory Pile Driver	95.0
Concrete mix truck/pump truck	90.0
Diesel generators	85.0
Welding equipment and generators/Pneumatic tools	85.0
Grader (includes motor grader)	85.0

Name of Equipment/Machinery/ Building	Noise Emission Level – Lmax dB (A) @ 50 feet
Wheeled excavators	85.0
Jack Hammer/Man Lift	90.0
Rock Drill/Auger Drill Rig	90.0
Blasting	95.0

7.4.2.1. Presentation of Noise Model – Construction phase

The model results are discussed below and are represented through contours in **Figure 46.** The predicted model results at plant boundary are tabulated in **Table 76.**

Table 76 – Predicted Noise Levels at Receptors from the proposed project during construction phase

S. No.	Name of the Receptor	Maximum Incremental Noise Level [dB (A)]	Base Line Noise Level [dB (A)]		Resultant Noise Level - dB (A)	
			Day Time	Night Time	Day Time	Night Time
1	Plant Boundary – N	61.0	69.7	65.4	**70.2**	**66.7**
2	Plant Boundary – NE	52.9	69.7	65.4	**69.8**	**65.6**
3	Plant Boundary – E	51.3	80.9	76.4	**80.9**	**76.4**
4	Plant Boundary – SE	51.0	64.3	61.6	**64.5**	**62.0**
5	Plant Boundary – S	56.3	64.3	61.6	**64.9**	**62.7**
6	Plant Boundary – SW	62.4	72.7	69.6	**73.1**	**70.4**
7	Plant Boundary – W	66.8	72.7	69.6	**73.7**	**71.4**
8	Plant Boundary – NW	64.4	69.7	65.4	**70.8**	**67.9**
9	Al Mirjah Suburb	44.6	55.0*	45.0*	**55.2**	**46.9**
10	SHJ Heritage sites	42.5			**55.2**	**46.5**
11	SHJ Art Museum	37.2			**55.1**	**45.6**
12	Al Layyah Sub-urb	36.9	60.0#	50.0#	**60.1**	**51.1**
13	Al Al Khaleidia suburb	41.4			**60.1**	**50.6**
14	American School of Creative Science	44.4			**60.1**	**51.0**
15	Manar Al Sabeel Quran Center	42.0			**60.1**	**50.6**

S. No.	Name of the Receptor	Maximum Incremental Noise Level [dB (A)]	Base Line Noise Level [dB (A)]		Resultant Noise Level - dB (A)	
			Day Time	Night Time	Day Time	Night Time
16	Canadian Montessari Nursery	41.6			**60.1**	**50.6**
17	Golden Beach Motel	49.3			**60.4**	**52.7**
18	Sahara Beach Resort	46.6			**60.2**	**51.6**
19	Marhaba Resort	45.5			**60.2**	**51.3**

*Assumption based on UAE-MoCCAE Maximum limits for residential areas in down town

#Assumption based on UAE-MoCCAE Maximum limits for Residential Areas which include some workshops & Commercial, Business or Residential Areas near the Highways

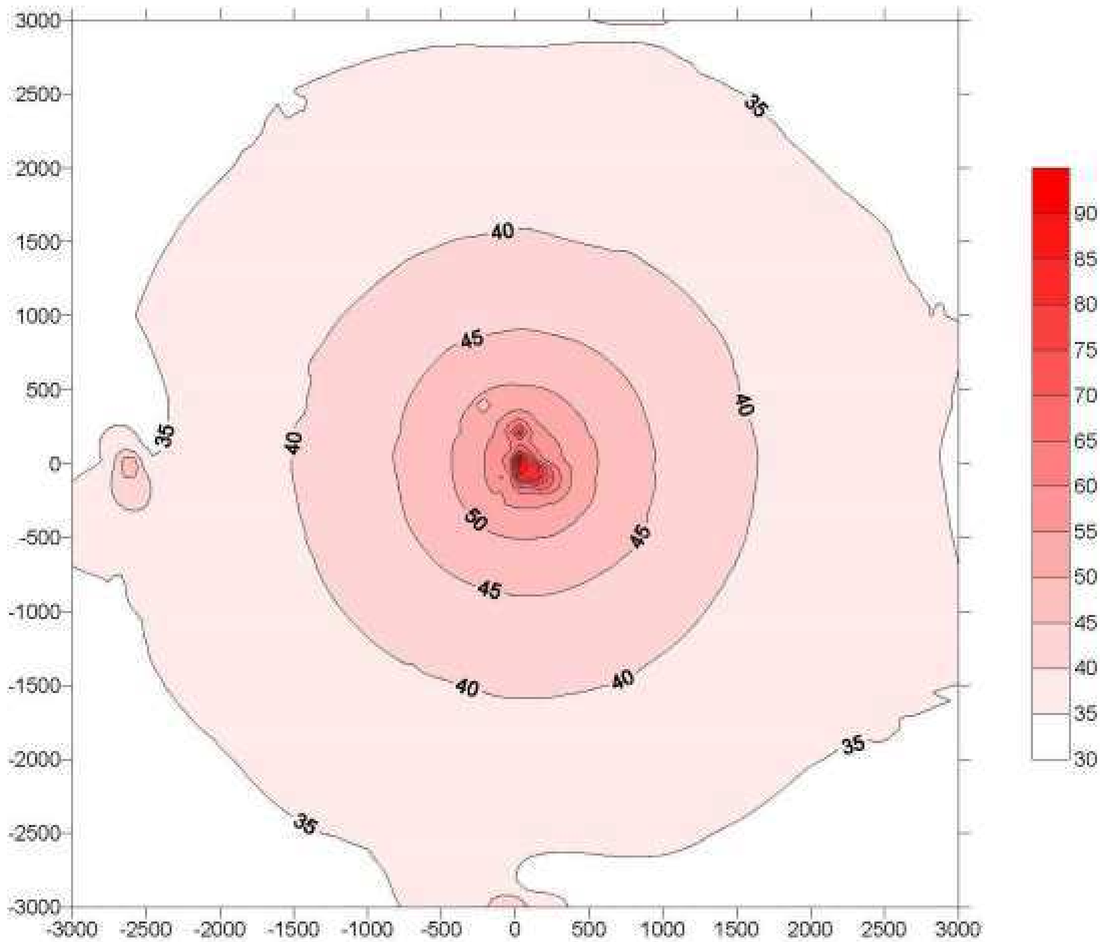


Figure 45 – Predicted Noise Dispersion Contours – dB(A) during construction phase

The predicted noise modeling results in the project boundary and sensitive receptors are presented in **Table 76.** It was observed from the modeling results within project site boundary area that predicted maximum incremental noise levels in the boundary areas of the project site are observed in between 51.0 dB (A) to 66.8 dB (A) and resultant noise level based on the baseline ambient noise level at the project site will be 64.5dB (A) to 80.9 dB (A) during day time and 62.0 dB (A) to 76.4 dB (A) which is higher than limits prescribed by UAE-MoCCAE and WHO guideline value. The noise level increase (above baseline) will be in the range 0.0 to 1.1 dB (A) during day time and 0.0 to 2.5 dB (A) during night time within the project boundary and it is estimated that impact due to the increase of ambient noise level within project boundary will be minor (1.6% as of the standard during day time and 3.6% during night time). The identified impact on noise level at project site will be localized, minor magnitude, short-term and reversible.

Continuous exposure of workers to high sound levels may result in annoyance, fatigue etc. The acceptable limit for each shift being of 8-hour duration, the equivalent noise level exposure during the shift is 90 dB(A) as per OSHA standards. Hence noise generation due to excavation may affect workers, if equivalent 8 hours exposure is more than the safety limit. The workers in general are likely to be exposed to an equipment noise level of 80-90 dB (A) in an 8 hour shift for which all statutory precautions as per laws will be taken into consideration.

The increase of resultant noise level in the nearest sensitive receptors based on the assumed standard will be 0.1 to 0.4 dB (A) during day time and 0.6 to 2.7 dB(A) during night time. It is estimated that impact due to the increase of ambient noise level in the sensitive receptor will be negligible to minor (0.7% as of the standard during day time and 5.4% during night time). It comply with the recommended norms of World Bank Group – IFC EHS noise guidelines that maximum increase of resultant noise level at the nearest receptor location off-site shall be less than 3 dB (A).

Construction vibrations may be harmful to adjacent and remote structures, sensitive instruments and people. Construction vibration sources have a wide range of energy, displacement, velocity and acceleration transmitted on the ground. Implementation of construction projects involves various sources of construction vibrations such as pile driving, dynamic compaction and operating heavy equipment. Vibrating, impacting, rotating, and rolling construction equipment is used for soil excavation, modification and improvement. Machinery with dynamic loads and blasting are sources of construction vibrations. The most prevalent powerful sources of construction vibrations are pile driving and dynamic compaction. The identified negative impact will be localized, moderate magnitude, short-term and reversible.

7.4.3. IMPACT ON NOISE LEVEL DURING OPERATION PHASE

The identified sources of noise emissions during operation phase are mainly from the operation of turbines, compressors, pumps, condensers, coolers, generators and traffic & transportation. It is planned to procure the equipment/machinery with inbuilt acoustic enclosure to conform the norms of noise exposure guidelines as per Occupational Safety and Health Administration (OSHA) which is considered as embedded mitigation measure. The noise levels generated by equipment/machinery to be utilized during the operation of the facility are presented in **Table 77**.

7.4.3.1. Presentation of Noise Model – Operation phase

The model results are discussed below and are represented through contours in **Figure 46.** The predicted model results at plant boundary are tabulated in **Table 77.**

Table 77 – Predicted Noise Levels at Receptors from the proposed project during operation phase

S. No.	Name of the Receptor	Maximum Incremental Noise Level [dB (A)]	Base Line Noise Level [dB (A)]		Resultant Noise Level - dB (A)	
			Day Time	Night Time	Day Time	Night Time
1	Plant Boundary – N	60.7	69.7	65.4	**70.2**	**66.7**
2	Plant Boundary – NE	53.0	69.7	65.4	**69.8**	**65.6**
3	Plant Boundary – E	51.9	80.9	76.4	**80.9**	**76.4**
4	Plant Boundary – SE	51.9	64.3	61.6	**64.5**	**62.0**
5	Plant Boundary – S	57.6	64.3	61.6	**65.1**	**63.1**
6	Plant Boundary – SW	64.6	72.7	69.6	**73.3**	**70.8**
7	Plant Boundary – W	66.7	72.7	69.6	**73.7**	**71.4**
8	Plant Boundary – NW	69.2	69.7	65.4	**72.5**	**70.7**
9	Al Mirjah Suburb	42.9	55.0*	45.0*	**55.3**	**47.1**
10	SHJ Heritage sites	41.4			**55.2**	**46.6**
11	SHJ Heritage Museum	37.7			**55.1**	**45.7**
12	SHJ Art Museum	37.3			**55.1**	**45.7**
13	Al Layyah Sub-urb	45.4	60.0#	50.0#	**60.1**	**51.3**
14	Al Al Khaleidia suburb	42.1			**60.1**	**50.7**
15	American School of Creative Science	45.1			**60.1**	**51.2**
16	Manar Al Sabeel Quran Center	42.7			**60.1**	**50.7**
17	Canadian Montessari	42.3			**60.1**	**50.7**

S. No.	Name of the Receptor	Maximum Incremental Noise Level [dB (A)]	Base Line Noise Level [dB (A)]		Resultant Noise Level - dB (A)	
			Day Time	Night Time	Day Time	Night Time
	Nursery					
18	Golden Beach Motel	50.2			**60.4**	**53.1**
19	Sahara Beach Resort	47.5			**60.2**	**51.9**
20	Marhaba Resort	46.3			**60.2**	**51.5**

*Assumption based on UAE-MoCCAE Maximum limits for residential areas in down town

#Assumption based on UAE-MoCCAE Maximum limits for Residential Areas which include some workshops & Commercial, Business or Residential Areas near the Highways

7.4.3.2. Findings of Noise Model – Operation phase

It could be seen from Figure 46 that in the facility premises most of the machinery/equipment generate noise levels around 85-95 dB (A). The personnel working within the facility, however, have to be provided with protective measures. According to the Occupational Safety and Health Administration (OSHA) Standards, the allowable noise level for the workers is 90 dB(A) for 8 hours exposure a day. Therefore, adequate protective measures in the form of ear muffs/ear plugs to the workers working in high noise areas need to be provided. In addition, reduction in noise levels in the high noise machinery areas could be achieved by adoption of suitable preventive measures such as suitable building layout in which the equipment are to be located, adding sound barriers, use of enclosures with suitable absorption material, *etc.*

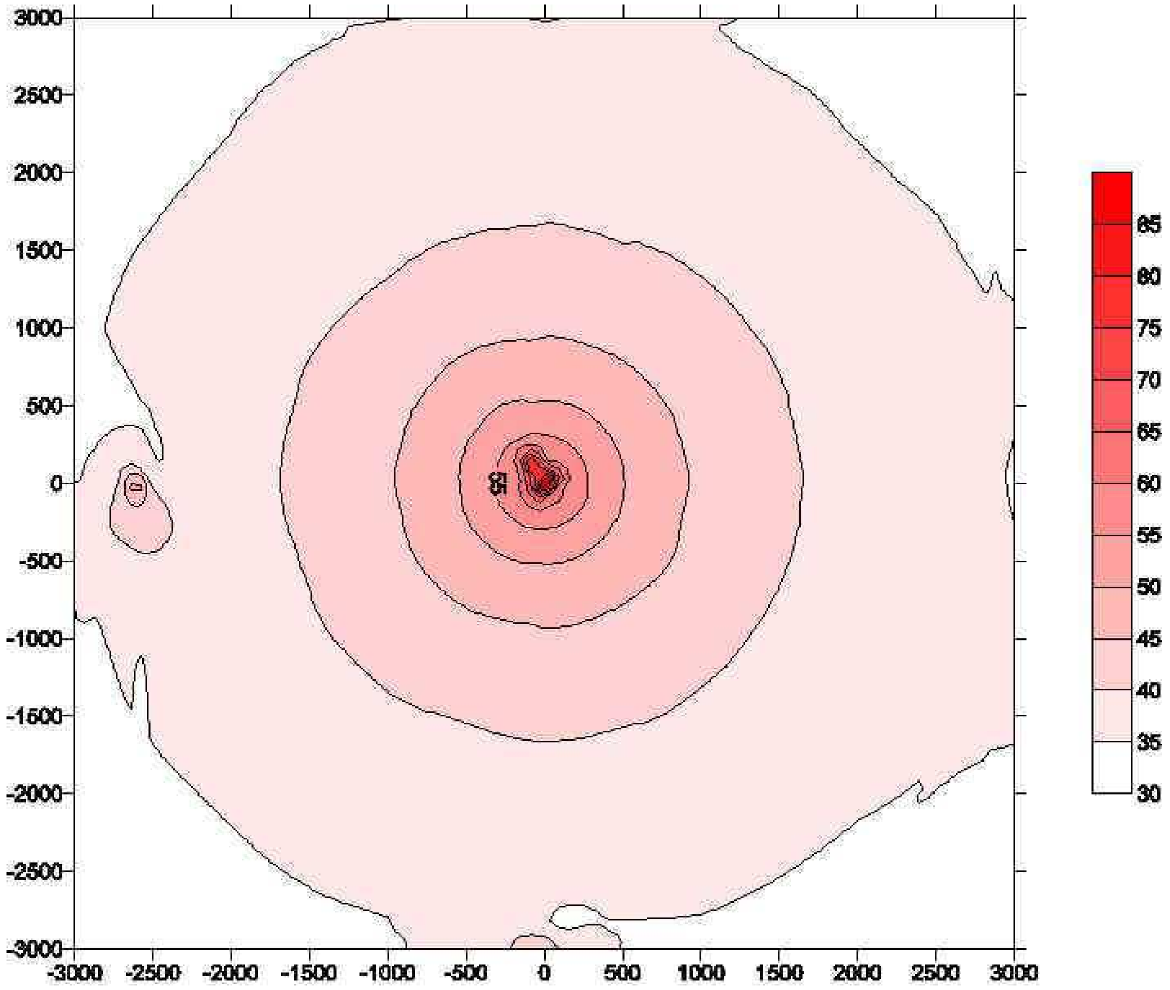


Figure 46 – Predicted Noise Dispersion Contours – dB(A) during operation phase

The predicted noise modeling results in the project boundary and sensitive receptors are presented in **Table 77.** It was observed from the modeling results within project site boundary area that predicted maximum incremental noise levels in the boundary areas of the project site are observed in between 51.9 dB (A) to 69.2 dB (A) and resultant noise level based on the baseline ambient noise level at the project site will be 64.5dB (A) to 80.9 dB (A) during day time and 62.0 dB (A) to 76.4 dB (A) which is higher than limits prescribed by UAE-MoCCAE and WHO guideline value. The noise level increase (above baseline) will be in the range 0.0 to 2.8 dB (A) during day time and 0.0 to 5.3 dB (A) within the project boundary and it is estimated that impact due to the increase of ambient noise level within project boundary will be minor to moderate (4.0% as of the standard during day time and 8.8% during night time). The identified impact on noise level at project site will be localized, moderate magnitude, long-term and reversible.

The increase of resultant noise level in the nearest sensitive receptors based on the assumed standard will be 0.1 to 0.4 dB(A) during day time and 0.7 to 2.9 dB(A) during night time. It comply with the recommended norms of World Bank Group – IFC EHS noise guidelines that maximum increase of resultant noise level at the nearest receptor location off-site shall be less than 3 dB (A). It is estimated that impact due to the increase of ambient noise level in the sensitive receptor will be negligible to minor (0.7% as of the standard during day time and 5.8% during night time). It clearly indicates that there is minor impact due to the proposed project in the nearby sensitive receptor.

7.5. WATER ENVIRONMENT

The impacts of the proposed project on water environment during the construction and operation phases have been identified and evaluated using impact assessment methods. The assessment process of impact on water environment hereunder described.

7.5.1. IMPACT ASSESSMENT METHODS

The significance of water environment (terrestrial and marine environment) impacts is determined by the consideration of the following parameters:

- Regulatory requirement
- The baseline conditions of the water resources – The baseline of terrestrial and marine environment is characterized based on ground water quality, sea water quality and marine sediment quality data collected in the study area
- The sensitivity of receptors – general sensitive receptors are identified and described in **Table 45** and specific to water environment is identified in **Table 78**.
- Criteria for assessment

7.5.1.1. Regulatory requirement

In line with the requirement of WBG-IFC, discharge of outfall effluent to Arabian Gulf should not result in contaminant concentrations more than local ambient water quality criteria or, in the absence of local criteria, other sources of ambient water quality. As UAE emirates has its own nationally legislated standards, Sharjah Municipality discharge limits and Dubai Municipality (DM) marine water quality objectives have been used to determine the significance of potential impacts. Additional considerations that should be included in the setting of project-specific performance levels for wastewater effluents include:

- The temperature of wastewater before discharge does not increase greater than 3°C of ambient temperature at the edge of a scientifically established mixing zone which takes into account ambient water quality, receiving water use and assimilative capacity among other considerations;

- In line with requirement of DM Local order 61 of 1991, the following criteria shall be met:
  - The discharge end of any effluent discharge pipe must be sited a minimum of 1m below the lowest tide level at the proposed discharge site;
  - A 300 m radius from the point of effluent discharge is set as the initial zone of dilution.
- Outfall effluent shall comply the maximum allowable limits of Sharjah Municipality for discharging to sea, and Dubai Municipality marine water quality objective shall be complied for ambient seawater quality; and
- Sharjah municipality discharge limits for sewerage treatment works shall be complied for the discharge of domestic wastewater into drainage system.

7.5.1.2. Summary of baseline conditions

7.5.1.2.1. Seawater quality

Totally 12 sea water samples from Arabian Gulf and lagoon area were collected and analyzed for quality analysis. Owing to the sampling being carried out during the peak summer months, the surface temperature of the seawater ranged from 34.0 – 38.34 °C. In general, the turbidity was low (<1 NTU) at most of the locations except at SW12 (Khalid lagoon) which is recorded as 4.36 NTU. The salinity was invariably high ranging from 41.0 – 43.6 ppt. Dissolved oxygen concentration ranged between 4.84 and 5.71 mg/L. The pH values ranged from 8.14 to 8.26.

7.5.1.2.2. Marine Sediment quality

Out of 10 identified sampling stations performed for sediment collection, 6 sediment samples were only collected from Arabian Gulf and Lagoon. Owing to the hard substrate, sediment samples using a grab sampler could not be collected at four sampling stations. The results of sediment analysis are compared with Canadian marine sediment quality guidelines. The perusal of the results, toxic contaminants in the sediment samples are well within the Canadian marine sediment quality guidelines.

7.5.1.3. Sensitivity of the receptors

Sensitive receptors in relation to water environment are presented in **Table 66**.

Table 78 – Details of sensitive receptors in relation to water environment

Receptor Type	Sensitivity	No.	Name of the receptor	Aspects
Groundwater	Moderate (Type 2 area)	WER-01	Project area	The components of the groundwater in the project region are subject to potential contamination. Various potentially hazardous materials are likely to be used on site during construction and operation of the project, which could potentially impact the groundwater quality, if not managed responsibly.
Sea	Moderate (Type 2)	WER-02	Arabian Gulf – Project region	The intake of sea water can also affect marine resources by altering natural currents in the area of the intake structure. The discharge of outfall effluent may deteriorate the seawater quality
Port	Moderate (Type 2)	WER-03	Sharjah Khalid Port	The discharge of outfall effluent may deteriorate the seawater quality
Creek and Lagoons	Moderate (Type 2)	WER-04	Sharjah Creek	The discharge of outfall effluent may deteriorate the seawater quality
		WER-05	Khalid Lagoon	
		WER-06	Al Khan Lagoon	

7.5.1.4. Assessment methodology and criteria

The potential impact of outfall effluent discharge from the proposed project is predicted through hydro-dynamic modeling and recirculation study.

7.5.1.4.1. Hydro-dynamic modeling and Re-circulation Study

The objectives of the study are the following:

- Evaluate the hydrodynamic environment at the project study area

- Simulate the dispersion of the effluent from the outfall;
- Quantify the extent of the temperature, salinity and suspended sediment plume, and;
- Investigate the potential recirculation risk between the outfall and intake systems

Hydro-dynamic modeling and re-circulation study is hereby summarized.

An outfall design screening assessment was used to asses multiple discharge designs and locations in order to ensure the selection of an optimal design based on environmental benefits. This screening assessment was carried out using the model MIKE 21 AD.

7.5.1.4.1.1. Numerical Modeling Software – MIKE 21

Typically, dispersion and mixing of pollutant concentrations on receiving waters is dependent on the ambient conditions of the receiving environment and discharge characteristics of the effluent. The ambient conditions are defined by the water body's geometry, currents, as well as its dynamic characteristics. The discharge conditions are a function of outfall geometry (diameter, height above bed, orientation) and flux characteristics (discharge rate, density, momentum and buoyancy). For the present study Danish Hydraulic Institute's MIKE 21 is considered to be best suited. Hence it is proposed to use the USEPA and FEMA approved MIKE 21 AD (Advection-Dispersion) flow model.

MIKE 21 Flow Model is a modeling system for 2D free-surface flows based on flexible mesh approach, which uses dynamically-coupled transport equations for water level, velocity and temperature simulations in water bodies under the influence of major forcing (eg. Wind, river inputs etc.). MIKE 21 Flow Model is applicable to the simulation of hydraulic and environmental phenomena in lakes, estuaries, bays, coastal areas and seas. It may be applied wherever stratification can be neglected.

The advection/dispersion module simulates the spreading of dissolved substances subject to advection and dispersion processes in lakes, estuaries and coastal regions. MIKE 21 Flow Model can be used to simulate a wide range of hydraulic and related items, including:

- Tidal exchange and currents
- Storm surges
- Heat and recirculation
- Water quality

The hydrodynamic module simulates water level variations and flows in response to a variety of forcing functions in lakes, estuaries and coastal regions. The effects and facilities include:

- Bottom shear stress
- Wind shear stress
- Barometric pressure gradients
- Coriolis force
- Momentum dispersion
- Sources and sinks
- Evaporation
- Flooding and drying
- Wave radiation stresses

Typical applications include cooling water recirculation and water quality studies. In order to setup the model, the following parameters are required:

- Bathymetry of the study area and initial and boundary conditions of water level variations in the model domain and at the boundaries;
- Tides and current measurements for validation of modeling results;
- Atmospheric parameters such as wind speed, wind direction, air temperature, and humidity for estimating the heat flux; and
- Initial and boundary temperature conditions, source and sink characteristics and locations, discharge properties (quantity, flow rate and temperature), heat dissipation, decay and heat exchange.

7.5.1.4.1.2. Model Setup

Predicted tidal elevations, water levels and currents extracted at select locations such as outfall and intake points are provided as inputs to the model. Validation of the model output is carried out with currents and water levels measured from the study region.

To simulate the spatial advection and dispersion of the discharged waste water, it is necessary to predict the regional currents driven by the winds and tides. DHI's two-dimensional ocean/coastal circulation model, MIKE21 HD, was used to predict the circulation of the receiving waters. MIKE21 simulates the 2-D flows of ocean waters within a model region due to forcing of the tides, wind stress and bottom friction. Higher resolutions are used for areas with complex bathymetry and areas of interest. To simulate the ocean circulation over the area of interest, the model was provided with the measured bathymetry for the area, which defines the shape of the seafloor. Bathymetry was defined by Survey and has a horizontal resolution of 3 m.

7.5.1.4.1.3. Hydrodynamic Model Resolution

The finest grid resolution in the area of interest was set at 10 m. This very fine resolution can be assumed to accurately reproduce the key hydrodynamic processes which is driving the movement of the plume. The model predictions compared very well with the measured data. This confirms that winds and tides used as input are capable of replicating the currents in the study area. The 2-D model was used because the waters of this area are tidally driven and therefore predominantly 2-D in structure.

7.5.1.4.1.4. Advection – Dispersion Modeling

The MIKE21 AD model was used to simulate the spreading of the plume subject to currents and wind in the coastal region. The discharge rate and salinity associated with the different scenarios are used as input in the model. The simulation period was set to 28 days, which covers one neap and spring period. The model predicts the transport and dilution of the plume by ambient currents within the model domain and therefore can accurately predict the 'rate of dilution' of the far-field mixing zone where tidal and wind induced currents determine the plume's spreading characteristics.

7.5.1.4.1.5. Methodology and approach

The 2D hydrodynamic solution is used to drive the AD module. For this purpose, a coastal grid domain has been setup and validated around area of interest with measured tides and currents. In order to have a proper examination from salinity dispersion in the vicinity of the project site, a grid resolution of 10 m was used around the two proposed outfall locations.

The time step integration was set so that the maximum Courant number was 3.1. The horizontal dispersion coefficient was specified through the spatially varying Smagorinsky formulation. A Smagorinsky coefficient of 0.38m2/s was used. The bed resistance controls water surface elevation and current speed for each point and can be introduced to model through both Chezy and Manning formula. Although there are some laboratory based relationships for calculation of bed resistance for the current study a calibrated Manning coefficient of 28 was used. The format of the wind data is specified as varying in both time and space. The wind friction is specified as a constant value of 0.001255.

The contribution of the outfall location to the continuity equation is taken into account by specifying the magnitude of the source (in m3/s). The AD module sets up additional transport equations for temperature and salinity. The calculated temperature and salinity are feed-back to the hydrodynamic equations through buoyancy forcing induced by density gradients.

7.5.1.4.2. Assessment criteria

In addition to general criteria for determining magnitude, additional criteria for assessing the water quality impact are described in **Table 79**.

Table 79 – Assessment Criteria to determine magnitude for Sea Water Quality

Magnitude	**Criteria – Change in criteria pollutant concentration as % of standard – DM EPSS - Marine Water Quality Objectives***
Temperature	
Major	The contribution by the proposed project may increase the temperature level more than 7°C from ambient level
Moderate	Increase level 4 - 7°C from ambient level
Minor	Increase level 2 - 4°C from ambient level
Negligible	Increase level 0.5 - 2°C from ambient level
Insignificant	Increase level <0. 5°C from ambient level
Salinity as Total Dissolved Solids (TDS)	
Major	The contribution by the proposed project may increase the TDS level more than 10% from ambient level
Moderate	Increase level 5 – 10% from ambient level
Minor	Increase level 2 – 5% from ambient level
Negligible	Increase level 0.5 – 2% from ambient level
Insignificant	Increase level <0. 5% from ambient level

** EPSS – Dubai Municipality - Environmental Standards and Allowable Limits of Pollutants on Land, Water and Air Environment, 2003 (***Table 24***)*

7.5.2. IMPACT ON WATER ENVIRONMENT DURING CONSTRUCTION PHASE

7.5.2.1. Identification of impacts

Construction phase requires large quantities of water to be used in various processing such as material preparation etc. The entire water requirement will be met from SEWA. Hence, no adverse impact of ground water resources is envisaged.

The construction of intake and outfall structures and the laying of pipelines in the seabed may cause the following environmental impacts on marine water environment:

- Displacement or disturbance of sediments and sediment layering, or a compaction of sediments or wave refractions or changes to long shore currents may occur
- When placed above the ground, the intake and outfall structures and pipelines can act as an artificial breakwater. A breakwater may change wave and current

patterns and thereby interfere with dynamic sediment processes, such as erosion or deposition, which may cause a redistribution of sediments along the shoreline.

- Accidental spills of chemicals, oils or fuels, or the leakage of these substances from underwater construction machinery may cause localized sediment contamination.
- The disturbance of sediments may lead to a re-suspension of material into the water column and a temporarily increased turbidity in the vicinity of the construction site.

7.5.2.2. Evaluation of impacts

7.5.2.2.1. Impact on seawater quality

The supplier will fabricate individual pipeline sections and transported to the site. The pipe sections will be welded together into long strings, placed in the trenches and subsequently covered with concrete, sand and rock. Boulders and sediments will be displaced in the dredging process, and the associated biota will most likely be eliminated.

Dredging will involve the excavation of sediment from the seabed. The excavation of sediment will be undertaken mainly by the dredger. Dredging activities generate sediment plume that would result in increased suspended sediments in the water column and can remain in the water column for an extended period. The impact of the sediment plume, however, is expected to be relatively localized and of short duration (during offshore construction below seabed – approximately 2 to 3 months) within the marine construction zone. The short-term and localized increase in suspended sediments is considered unlikely to impact long-term on the broader distribution. However, a moderate short-term impact is likely.

The project construction methods incorporate the following measures to reduce potential impacts at source as embedded mitigation measures.

- All marine works will be undertaken within silt curtains;
- A site-wide CEMP and site-specific CEMPs including arrangements for turbidity monitoring will be developed including measures to limit dredging losses, trigger levels for maximum allowable suspended sediment concentrations;

Considering the embedded mitigation measures, the expected impact on seawater quality will be minor effect.

7.5.2.2.2. Impact of accidental spills on Arabian Gulf

Offshore pipeline installation would involve increased vessel traffic in the near-shore areas during marine construction period. There would thus be potential for or accidental spillage or leakage of fuel, chemicals or lubricants, litter. Any release of liquid hydrocarbons has the potential for direct, indirect and cumulative effects on the marine environment through contamination of the water and/or sediments. These effects include physical oiling and toxicity impacts to marine fauna and flora, localized mortality of plankton, eggs and fish larvae, and habitat contamination. Considering the moderate sensitivity of habitat in the marine construction area, expected impact is assessed as moderate due to accidental spill/leaks.

7.5.2.2.3. Impact of construction waste on groundwater quality

The source of groundwater contamination may be due to improper disposal of waste water generated by the workforce. Change in quality of water forms an important concern associated with the project particularly during the construction phase. It is anticipated that a proportion of construction workforce sewage will be stored in septic tank facilities and it will be disposed to existing drainage of SEWA Layyah Power Station. There is potential for degradation of groundwater quality from leaks or spills during the maintenance and use of these facilities. Impacts on water quality within groundwater are expected to be moderate. Considering the light sensitivity of receptor, expected impacts are assessed as minor.

Generation of construction waste during site preparation and construction work would include cut vegetation and typical construction waste (e.g. wasted concrete, steel, wooden scaffolding and forms, bags, waste earth materials, etc.). This waste would negatively impact the site and surrounding environment if not properly managed and disposed properly.

Following are the most susceptible locations for contamination of ground water during construction:

- Ground water resources close to construction material storage yard, concrete mixer plants and maintenance sites of construction vehicles; and may cause water pollution of ground water body.
- Accident spills may also cause water pollution and soil environment.

Impact due to poor construction waste management and accidental spills or due to bad construction practice, will be moderate in magnitude and confined to the construction period only. The effect of impact on environment will be moderate. Considering the light sensitivity of receptor, expected impacts are assessed as minor.

Any excavations below the ground water table may require dewatering. The dewatered groundwater will be discharged to storm water network. If groundwater quality is poor this has the potential to impact water quality in the designated source of discharge. The discharge may also disturb sediment increasing suspended solids and may encourage the dissolution of contaminants. Impacts on water quality are expected to be moderate and therefore the effects are assessed as moderate. Hence mitigation measures are required to avoid any contamination.

7.5.3. IMPACT ON WATER ENVIRONMENT DURING OPERATION PHASE

7.5.3.1. Identification of impacts

The following are the key issues and major potential impacts mostly associated with the operational phase of proposed project.

- The effect on seawater quality by discharge of process/treatment chemicals in the outfall effluent
- The effect of the discharged effluent potentially having a higher temperature and salinity than the receiving environment; and

7.5.3.2. Evaluation of impacts

7.5.3.2.1. Effect on seawater quality by discharging chemicals in outfall effluent

Besides high temperature and salinity, the outfall effluent contains other chemical residuals to be used for neutralization, backwash and cleaning process. A list of chemicals expected to be used in the proposed project is listed in **Table 35.**

Residuals from the above chemicals in the neutralized wastewater will be discharged along with cooling returned seawater. The volume of neutralized wastewater (852 m^3/day – 35.5m^3/hr) will be relatively small when it is compared with total outfall effluent (1,872,861m^3/day – 78,000m^3/hr) to be discharged to sea, and it will be significantly diluted with cooling returned seawater. Hence, there is no significant change in the quality of outfall effluent due to chemical residuals in the neutralized wastewater.

The quality of outfall effluent will comply with the maximum allowable limits prescribed by Sharjah Municipality and IFC effluent guidelines. The expected impact on seawater quality will be minor effect.

7.5.3.2.2. Impact on seawater quality

7.5.3.2.2.1. Hydro-dynamic modeling and plume dispersion study

The outfall effluent water discharged from the proposed project will constitute high-TDS and high temperature effluent. Although the effluent will have a higher density than the receiving water, discharge through outfall diffuser will ensure adequate dispersal throughout the water column and pooling of the effluent near the seabed, where the receiving water masses may potentially have lower temperatures than the effluent is unlikely. Insufficient mixing of the effluent with the receiving water may occur only under conditions of extreme calm. Hydro-dynamic modeling and re-circulation study was carried out to simulate the dispersion of the effluent from the outfall, quantify the extent of the temperature, salinity and suspended sediment plume and to investigate the potential recirculation risk between the outfall and intake systems. The details of the