EAME
Earth & Marine Environmental Consultants

Chapter 5 - Air

Contents

5 Air

5.1 Introduction

This Chapter presents the summary of the assessment of air quality and noise conditions in the project area and considers the likely significant effects of the proposed Terminal in terms of noise, air quality and climate. Noise and Air Quality are described separately below.

5.2 Noise

5.2.1 Introduction

A noise assessment was undertaken that involved the measurement of background noise levels on the site to determine the ambient acoustic environment around the site. These are the baseline noise conditions against which the project impacts will be assessed.

In the context of this assessment, noise in terms of environmental impact is defined as unwanted or undesirable sound derived from sources that interfere with normal activities.

This chapter addresses:

- methodology adopted for this assessment;
- identification of receptors;
- the baseline conditions currently existing at the site;
- the likely significant environmental effect during the construction and operational phases of the proposed Terminal;
- the proposed mitigation measures (if required) which will prevent, reduce or offset any significant adverse effects; and
- likely residual effects after the mitigation measures have been implemented.

5.2.2 Basic Acoustic Terminology

Sound is produced by mechanical vibration of a surface, which sets up rapid pressure fluctuations in the surrounding air. Between the quietest audible sound and the loudest tolerable sound there is a million to one ratio in sound pressure level. It is because of this wide range that a logarithmic noise level scale is used in noise measurement studies. This is the decibel scale. Audibility of sound covers a range of about 0 to 140 decibels (dB) corresponding to the intensity of the sound pressure level. The ability to recognise a particular sound is dependent on the pitch or frequencies present in the source. Sound pressure measurements taken with a microphone cannot differentiate in the same way as the ear, consequently a correction is applied by the noise measuring instrument in order to correspond more closely to the frequency response of the ear which responds to sounds from 20 Hz to 20,000 Hz. This is known as 'A weighting' and written as dB(A). The use of this unit is internationally accepted and correlates well with subjective annoyance to noise.

The logarithmic basis of noise measurements means that when considering more than one noise source their addition must be undertaken in terms of logarithmic arithmetic. Thus, two noise sources each of 40 dB(A) acting together would not give rise to 40 + 40 = 80 dB(A) but rather 40 + 40 = 43 dB(A). This 3 dB(A) increase represents a doubling in sound energy but would be only just perceptible to a human ear. *Figure 5.1* gives typical noise levels in terms of dB(A) for common situations.

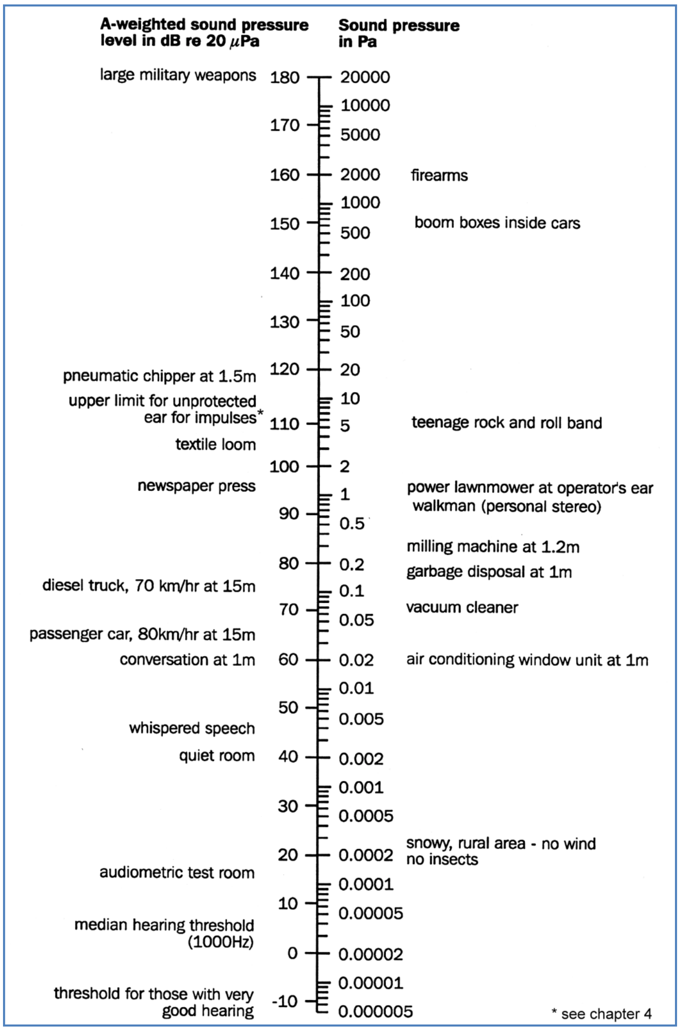

Figure 5.1: *Sound levels from typical noise sources*[1]

Table 5.1 summarises the subjective perception of noise level changes and shows that a reduction in sound energy of 50% results in a reduction of 3 dB and is just perceptible to the normal ear.

Table 5.1: Subjective Effect of Changes in Sound Pressure Level[1]			
Change in sound level (dB)	**Change in Power (decrease)**	**Change in Power (increase)**	**Change in apparent loudness**
3	1/2	2	Just perceptible

[1] Occupational exposure to noise: evaluation, prevention and control, Chapter 1: Fundamentals of Acoustics, World Health Organization, p33, http://www.who.int/occupational_health/publications/occupnoise/en/index.html

Table 5.1: Subjective Effect of Changes in Sound Pressure Level[1]

Change in sound level (dB)	Change in Power (decrease)	Change in Power (increase)	Change in apparent loudness
5	1/3	3	Clearly noticeable
10	1/10	10	Half or twice as loud
20	1/100	100	Much quieter or louder

Noise levels can vary with time according to source activity and indices have been developed in order to be able to assign a value to represent a period of noise level variations and to correspond with subjective response.

The definition, in layman's terms, is given below for terminology used in the measurement and results obtained during the survey work.

- **Ambient noise:** The totally encompassing sound in a given situation at a given time usually composed of sound from many sources near and far.
- **Attenuation:** Noise reduction.
- **Background noise:** The general quiet periods of ambient noise when the noise source under investigation is not there.
- **Decibel (dB):** The unit of measurement for sound based on a logarithmic scale. 0dB is the threshold of normal hearing; 140dB is the threshold of pain. A change of 1dB is only detectable under controlled laboratory conditions.
- **dB(A) [decibel A weighted]:** Decibels measured on a sound level meter incorporating a frequency weighting (A weighting) serves to distinguish sounds of different frequency (or pitch) in a similar way to how the human ear responds. Measurements in dB(A) broadly agrees with an individual's assessment of loudness. A change of 3dB(A) is the minimum perceptible under normal everyday conditions, and a change of 10dB(A) corresponds roughly to doubling or halving the loudness of sound.
- **dB(C): [decibel C weighted]:** Frequency weighting which does not alter low frequency octave band levels by very much compared to `A' weighting. Similar to linear reading (i.e. linear does not alter frequency spectra at all).
- **Frequency (Hz):** The number of sound waves to pass a point in one second.

- **$L_{Aeq,T}$:** This is a noise index used to describe the "average" level of a noise that varies with time (T). It allows for the different sensitivities of the human ear to different frequencies (pitch), and averages fluctuating noise levels in a manner, which correlates well with human perceptions of loudness.

- **$L_{A10,T}$:** This noise index gives an indication of the upper limit or peak levels of the fluctuating noise. It is the "A-weighted" noise level exceeded for 10 per cent of the specified measurement period (T) *e.g.* if the measurement period was over 10 hours and the L_{A10} reading was say 60 dB, then this means that for 1 hour out of 10 the level went above 60 dB.

- **$L_{A90,T}$:** This noise index gives an indication of the lower limit or levels of the fluctuating noise. It is the "A-weighted" noise level exceeded for 90 per cent of the specified measurement period (T) *e.g.* if the measurement period was over 10 hours and the L_{A90} reading was say 50 dB, then this means that for 9 hours out of 10 the level went above 50 dB.

- **$L_{Amax,T}$:** This is the highest A-weighted noise level recorded during a noise measurement period (T).

5.2.3 Assessment Methodology

Baseline Noise Assessment

The noise assessment took place at five locations, determined after the initial site reconnaissance, in order to assess the representative baseline conditions. Each location was monitored for four 30 minute periods over two days. Although in general there was no anthropogenic noise source on the site (and no activity likely to give rise to any), there were occasional noises from passing ships and the nearby port operations. It was thus important to monitor the noise levels at different times of the day to try and capture some of these variations.

All noise measurements were undertaken in accordance with the principles of BS7445: 1991: Parts 1-3, *Description and Measurement of Environmental Noise* and following the guidance given in BS4142. The noise parameters of $L_{Aeq,T}$, $L_{A90,T}$ $L_{A10,T}$ and L_{AFmax} were recorded during the measurement period at each position.

All measurements were undertaken approximately 1.5m above local ground level, well away from any existing buildings, scrap debris or walls that could provide some form of shielding or attenuation or reflection of ambient noise (so called free-field conditions).

Photograph 5.1: *Noise monitoring at AN05*

All acoustic measurement equipment used during the noise surveys conformed to Type 1 specification of British Standard 61672: 2003: *Electroacoustics. Sound level meters*. Part 1 *Specifications.*

All meters were calibrated before and after the measurements period and no signal drift was found to have occurred during any of the monitoring periods. All equipment holds current manufacturers calibration certificates and conforms to relevant parts of IEC: 651:1979 (equivalent to BS5969:1981) for the requirements of Type 1 acoustic accuracy. Additionally the equipment conforms to specification contained within IEC 804:1985 (equivalent to BS6698:1986) for integrating Sound Level Meters. Fast meter response and free field settings were used for all measurements carried out during the survey.

Measurements were generally made in accordance with BS7445:1991 '*Description and measurement of environmental noise*' Part 2: 'acquisition of data pertinent to land use'. Environmental windshields were used at all times throughout the survey.

5.2.4 Noise Assessment Criteria

The criteria to be used to assess the noise environment considered the following requirements:

- Iraqi National Standards, Instructions No. 2, 1993;
- World Health Organisation (WHO) Guidelines for Community Noise, WHO, 1999; and
- International Finance Corporation (IFC) Noise Management Standard (April 2007).

A comparison of the standards is outlined below.

Iraqi National Standards, Instructions No. 2, 1993

The stated construction and operation noise level guidelines within residential locations is 55 dBA (daytime) and 45dBA (night-time) respectively (*Table 5.2*). It should be noted, however, that there are no residential locations in close proximity to the site. These quoted noise levels correlate with the Guidelines values stated by the Guidelines for Community Noise, WHO, 1999.

Table 5.2: Iraqi Noise Standard One Hour L_{Aeq}		
Zone	**Level L_{Aeq}(day time)**	**Level L_{Aeq} (night time)**
Industrial	70	70
Commercial	70	70
Residential	55	45

WHO Guidelines for Community Noise

The WHO guideline values in *Table 5.3* are organized according to specific environments. When multiple adverse health effects are identified for a given environment, the guideline values are set at the level of the lowest adverse health effect (the critical health effect). An adverse health effect of noise refers to any temporary or long-term deterioration in physical, psychological or social functioning that is associated with noise exposure. The guideline values represent the sound pressure levels that affect the most exposed receiver in the listed environment.

The time base for L_{Aeq} for "daytime" and "night-time" is 16 hour and 8 hour, respectively. No separate time base is given for evenings alone, but typically, guideline value should be 5 –10 dB lower than for a 12 hour daytime period.

Table 5.3: WHO Guideline Values for Community Noise in Specific Environments

Specific Environment	Critical health effect(s)	L_{Aeq} (dB)	Time base (Hours)	L_{Amax}, fast (dB)
Outdoor living area	Serious annoyance, daytime and evening	55	16	-
Outdoor living area	Moderate annoyance, daytime and evening	50	16	-
Dwelling, indoors	Speech intelligibility and moderate annoyance, daytime and evening	35	16	-
Dwelling, indoors, inside bedrooms	Sleep disturbance, night-time	30	8	45
Industrial, commercial, shopping and traffic areas, indoors and outdoors	Hearing impairment	70	24	110

IFC Noise Management Standard

Under the requirements of the IFC standards '*Noise prevention and mitigation measures should be applied where predicted or measured noise impacts from a project facility or operations exceed the applicable noise level guideline at the most sensitive point of reception*'.

Table 5.4: IFC Noise Level Guidelines (One Hour L_{Aeq})		
Receptor	**Day time (07:00 – 22:00)**	**Night time (22:00 – 07:00)**
Residential, institutional and educational	55	45
Industrial and commercial	70	70

The IFC guidelines are in-line with the Guidelines for Community Noise, World Health Organization (WHO), 1999.

In addition, to comply with requirements routinely applied elsewhere in the world, an appreciation of the background noise conditions is required, against which to determine the impact of the proposed development at the nearby receptors. This is the basis for assessment under the British Standard BS4142:1997 *'Method for Rating Industrial Noise Affecting Mixed Residential and Industrial Areas'*.

5.2.5 Baseline Conditions

Receptor Identification

The site is irregular in shape and covers a total area of approximately 1km^2. The northern elevation of the site comprises KAZ Jetty No. 1 and areas of unsurfaced land with areas utilised for the storage of scrap metal, much of which appears to be marine-derived (wreck salvage). However, the majority of the site, approximately 95%, is undeveloped and there is no discernible difference between the site and surrounding land, which stretches for many kilometres with little change in relief or features. Other than a narrow strip of intertidal vegetation that is exposed at low tide (approximately 20m wide) and patches of Sabhka vegetation, the site is featureless and characterised by dry, silty sand with salt encrustation. There is evidence of disturbance of some of the soils by heavy plant and some accumulations of earth mounds from earthworks activities. Also there is an earth bank road running along the site parallel to the shoreline with two smaller earth bank roads extending to the water line.

The site surrounds are as follows:

- **North:** Khor Al-Zubair Port (KZP). Constructed between 1975 and 1980, the Port was designed to handle general cargo and specialised bulk materials such as fertilizer, phosphate, petrochemical and iron (scrap) exports together with iron ore imports. The Port's facilities extend beyond the quay side to include cranes and warehouses. The

Port covers an approximate area of 400 hectares (ha) and includes 12 berths giving approximately 3km of quay;

- **East:** Khor Al-Zubair River;
- **South:** Undeveloped land beyond which is the effluent channel from the fertiliser plant;
- **West:** Undeveloped land beyond which is Highway 26, approximately 5.5km distant at its closest point to the site; and
- **North-west**: KZP Freezone including the SKA Terminal which comprises tanked storage facilities, offices and worker accommodation.

Due to the very limited development of the site, the noise levels currently generated from the site itself are negligible. Although the northern boundary of the site is adjacent to KZP, the noise levels there are also minimal. No sensitive receptors have been identified in close proximity to the site. The nearest housing is located adjacent to the Highway 26, at least 5.5km distant. Consequently, the site is not in itself a significant contributor to the ambient noise levels and is similarly not subjected to significant noise from adjacent sources. The Freezone and the port are not especially busy in terms of plant and machinery operations, so there is little noise generated from these areas. The other larger industrial plants like the fertilizer plant and steelworks are some considerable distance from the project site so even strong noise sources on these sites would not be discernible at the project site.

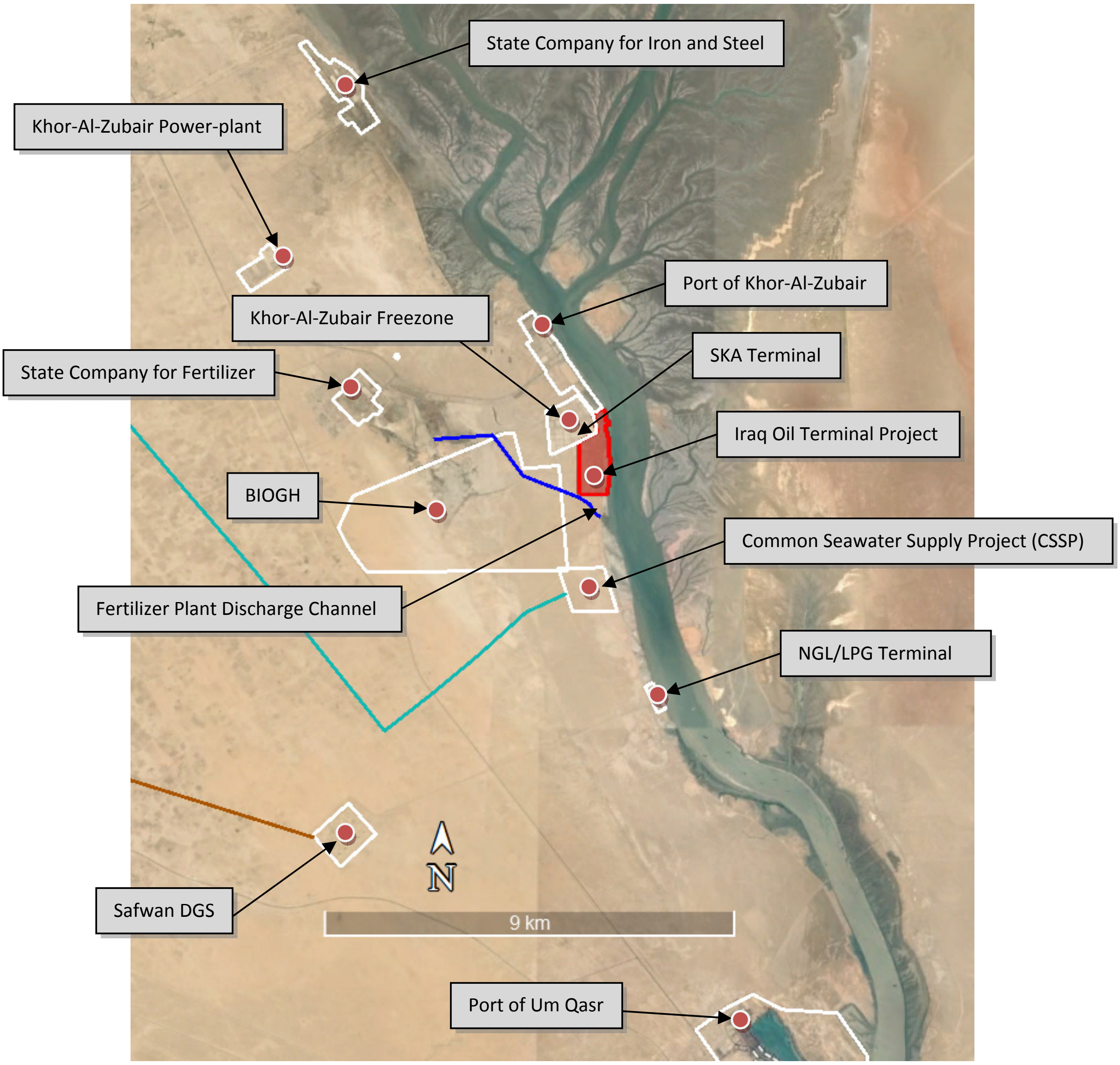

Figure 5.2: *Site and surrounding features*

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Baseline Noise Measurements

A series of baseline environmental noise measurements were carried out at the site on 29th – 30th August 2014 in order to determine the prevailing noise levels at the proposed terminal. EAME deployed a Casella CEL-633 Class 1 noise meter at five locations for four 30 minutes periods over the two day campaign. The locations were determined following the site reconnaissance and are intended to provide spatial coverage of the baseline noise conditions at the site.

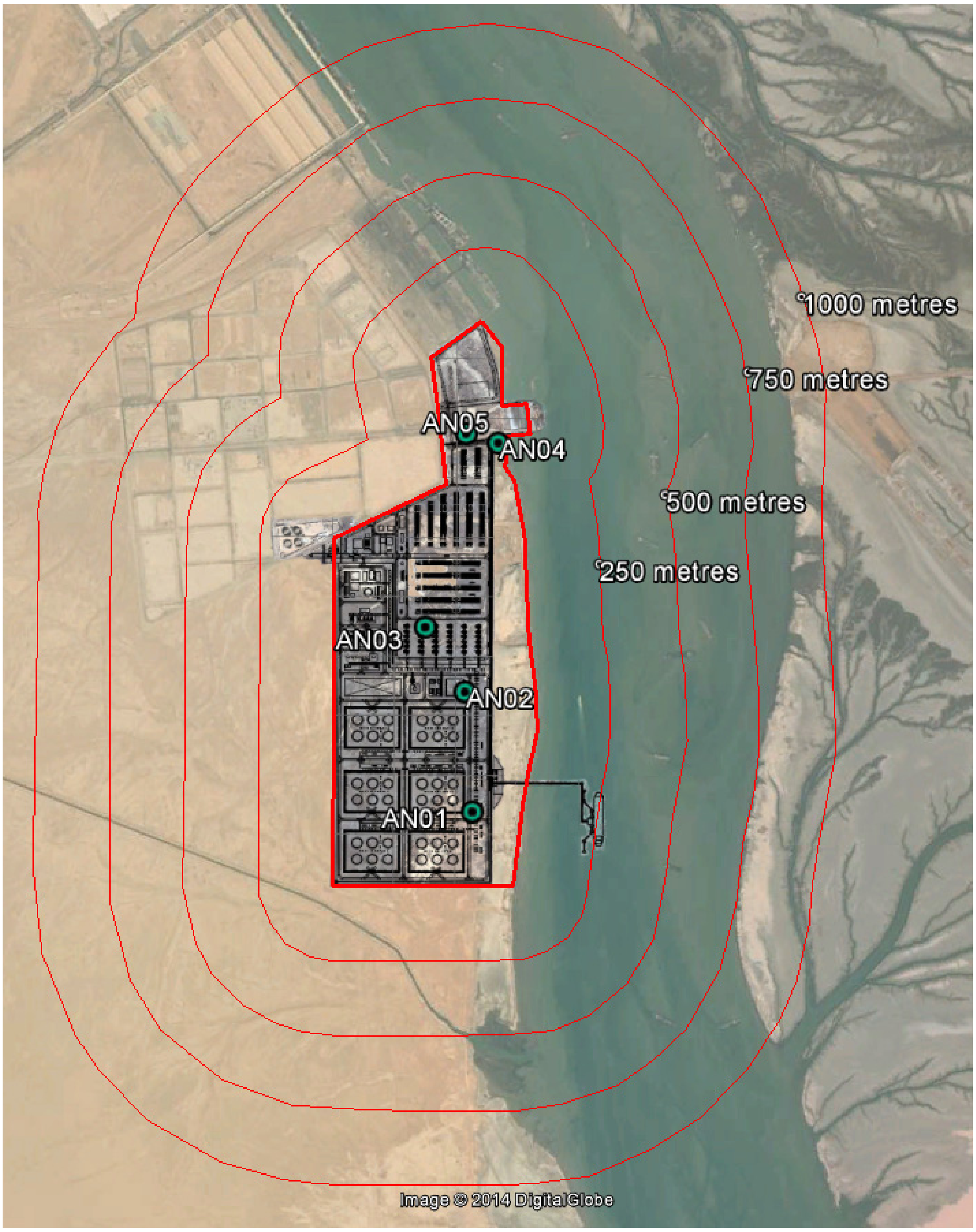

Figure 5.3: *Five noise measurement locations AN01 – AN05*

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Table 5.5: Noise Monitoring Locations	
Location	**Latitude, Longitude**
AN01	30°10'10.00"N, 47°53'31.00"E
AN02	30°10'23.00"N, 47°53'30.00"E
AN03	30°10'30.00"N, 47°53'25.00"E
AN04	30°10'50.00"N, 47°53'34.00"E
AN05	30°10'51.00"N, 47°53'30.00"E

The weather during the surveys was generally conducive to noise measurement with dry conditions, however, due to the exposed location of the site and the presence of the summer *Shamal*, the site was windy on occasion with periodic strong gusts. As such, in the instances where high wind fluctuations occurred during monitoring non-typical high background level (L_{A90}) readings may have been recorded.

Given the lack of receptors and a dominant noise climate in the immediate and wider environs of the site, the baseline noise measurements were undertaken on-site in order to derive a set of background noise statistics representative of the site. The results of the baseline environmental noise measurements at each of the locations are summarised in *Table 5.6* and presented in full in *Appendix F1*:

Table 5.6: Baseline Environmental Noise Measurements					
Position	**Period**	**Noise Level, dB**			
		L_{Aeq}	L_{A90}	L_{A10}	L_{AFmax}
AN01	Maximum	56.5	48	56.5	78.6
	Mean	40.4	35.2	43.3	48.4
	Minimum	33.9	29.5	36.5	42.3
AN02	Maximum	53.0	48	56.5	61.1
	Mean	46.1	42.1	48.5	51.7
	Minimum	38.8	35.5	41.0	33.2

Table 5.6: Baseline Environmental Noise Measurements					
Position	Period	Noise Level, dB			
		L_{Aeq}	L_{A90}	L_{A10}	L_{AFmax}
AN03	Maximum	63.7	53.5	64.5	76.1
	Mean	45.1	40.6	47.4	53.5
	Minimum	34.2	30.0	35.0	37.7
AN04	Maximum	61.7	49.5	57.0	80.4
	Mean	42.3	39.0	44.0	48.5
	Minimum	34.4	32.5	36.0	38.7
AN05	Maximum	61.2	53.0	60.5	61.2
	Mean	43.5	39.5	45.7	43.5
	Minimum	38.4	36.5	38.5	38.8

During the monitoring period, the general noise levels were considered low with no discernible obtrusive tonal or noise impacts being observed. No significant differences were noted between the monitoring locations.

Using 1993 Iraqi Noise Standards, none of the maximum values or calculated means were found to be elevated above the 70 dB standard for industrial and commercial properties and overall the site can be considered to be a quiet low noise environment at present. The most dominant noise source on the site is the wind and occasional bird song from wading birds on the foreshore.

The observed noise levels and related guidance criteria are presented below.

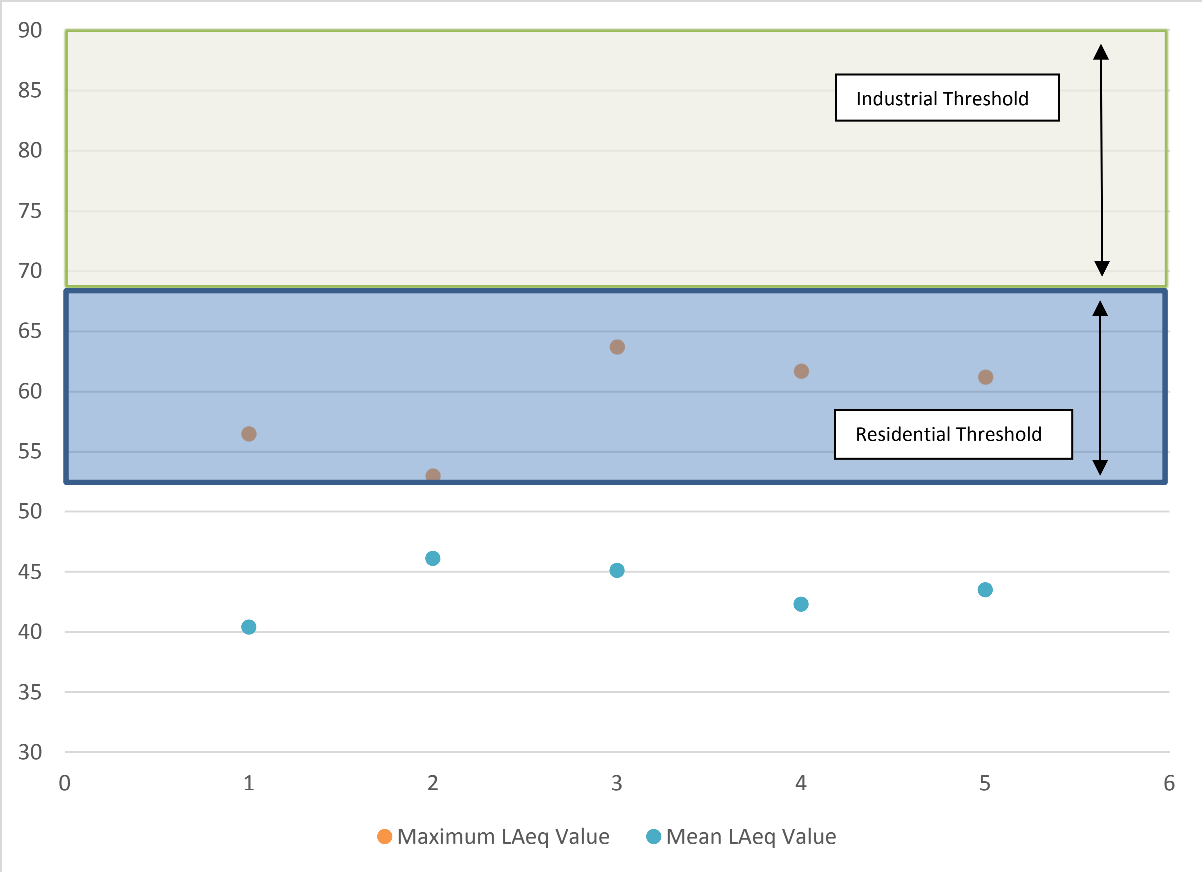

Figure 5.4: *Summarised noise monitoring vs reference criteria*

It can be seen from the figure above that none of the observed baseline noise levels exceed the threshold criteria for industrial environments (grey shaded area) and none of the mean values exceed the residential criteria (blue shaded area), but the peak levels for all locations (other than AN02) do exceed the residential criteria. As previously stated, however, the nearest residential property is over 5km away and this threshold is not directly applicable to the site environment.

5.2.6 Impact Assessment

Construction Impacts

It is inevitable with any major development that there will be some noise, particularly during the site clearance and construction phase when heavy plant and machinery is engaged. Typically, however, noise disruption due to construction is a localised phenomenon, temporary in nature by definition and only people living or working within a few hundred metres of the site boundary are likely to be impacted by construction noise. The table below illustrates the typical noise output levels that could be associated with construction plant and equipment.

Table 5.7: Typical Sound Power Levels Associated With Construction Activities		
Plant Type	**Possible Areas of Use**	**Activity Sound Power Levels, L_W (dB)**
Hand-held hammer	Demolition, general site activities	112
Pneumatic breaker	Demolition, site preparation, concreting operations	109
Tracked crane	Demolition, concreting operations	121
Compressor	Site preparation, concreting operations, general site activities	100
Dozer	Site preparation	113
Dump truck	Site preparation, general site activities	110
Grader	Site preparation	111
Lorry	Site preparation, general site activities	115
Tracked Excavator	Site preparation, concreting operations	102
Tractor	Site preparation	116
Trenching machine	Site preparation	105
Vibratory roller	Site preparation	106
Wheeled loader	Site preparation, concreting operations	108
Air hammer pile driver	Pilling	126
Auger crane mounted	Pilling	116
Drop hammer pile driver	Pilling	116
Pneumatic chipping hammer	Pilling	116
Tripod winch	Pilling	112
Batching plant	Concreting operations	106
Concrete mixer	Concreting operations	104

Table 5.7: Typical Sound Power Levels Associated With Construction Activities

Plant Type	Possible Areas of Use	Activity Sound Power Levels, L_W (dB)
Generator	Concreting operations, general site activities	122
Poker vibrator	Concreting operations	122
Truck mixer	Concreting operations	108
Circular saw	General site activities	110
Pneumatic circular saw	General site activities	103

In the case of the proposed development, all of the most noise-sensitive receptors (residential properties) are over 5km from the site. They are therefore, highly unlikely to experience any, let alone significant impacts, as a result of the proposed construction works on the site. There are thus no anticipated noise impacts on residential receptors from construction activities.

It is possible, however, that workers on the adjacent Freezone and port site would be able to receive noise impacts given their closer proximity to the works. The principal noise source will be from the engines of heavy plant and equipment during earthworks activities and the piling rigs. The noise levels will, however, be transient and will be masked to some extent by local activities within the port such as crane loading and ship engine running during berthing operations. There are no significant activities (that would involve personnel being present for prolonged periods of time) in the port and Freezone areas closest to the project site. Consequently, notwithstanding the natural attenuation of noise by buildings, the exposure time of personnel in zones likely to be affected would be very small.

A further consideration is that the local wind environment can substantially affect how far noise will travel. The ESIA work has been accompanied by a metocean study which has included 30 days of intensive meteorological monitoring on the KZP site. The wind rose for this study is presented in *Figure 5.5* overleaf.

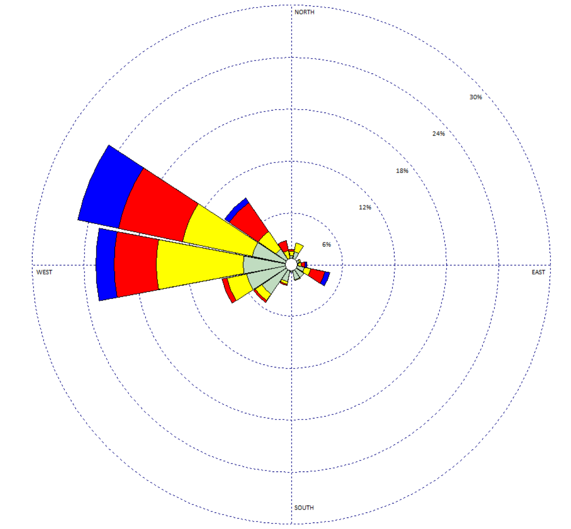

Figure 5.5: *Wind rose direction (blowing from) (hourly data points) between 10/09/14 – 10/10/14*

It can be seen that the predominant wind direction and the strongest winds are from the west and north-west. This accords with other studies in the area and is typical of the *Shamal* which blows for most of the year from the north and west. This means that on most occasions throughout the year the prevailing wind would carry noise from the project site out onto the Khor Al-Zubair and away from neighbouring land uses and residential areas.

Bearing the above discussion in mind there are not expected to be any significant noise impacts associated with the construction activities and the baseline noise conditions are not expected to change.

Operational Impacts

The other key consideration in terms of potential impacts is from the operational phase of the development. This could manifest itself in two ways in terms of the noise and air quality environment. These are the emissions and noise output associated with the fixed activities on the project site itself and those associated with marine and road traffic generated be the operations. Each of these are considered separately overleaf.

Operational Traffic Impacts - Road

The traffic impacts associated with the development proposals are discussed more fully in *Chapter 9 – Socio Economic Impacts*, however, in summary additional traffic associated with the development proposals could lead to additional traffic related impacts such as noise and air quality. The KZP site generates large amounts of Heavy Goods Vehicle (HGV) traffic primarily in the form of petrol tankers entering the port to load with petroleum products for redistribution into the local supply market. The tankers tend to queue on the main access road during the day and then load and travel through the night. The new berth will provide an alternate facility to the arrangements at KZP, so in that respect the operations will not generate new additional traffic, for these vehicles, it will provide an alternate facility. Increases in efficiency and capacity could, however, increase the numbers of vehicles (which can number several hundred per day).

The other main source of heavy traffic in the area is associated with the import of pipe for the oil and water infrastructure projects. Periodically large stock piles of pipes are built up in the Port, these are then transported to the oilfields by HGV's. There is thus the potential for additive impacts to arise if peak vehicle movements coincide.

The main impact of this in terms of noise could be HGV engines and road noise affecting residential receptors that the vehicles pass. There are, however, no noise-sensitive receptors (residential communities) along the main routes to and from the port. As such, even if HGV numbers increase substantially at times, it will not impact significantly on residential communities. Given the traffic volumes already generated within the port operations at KZP and Umm Qasr and the Safwan border crossing, noise related impacts from the additional traffic associated with the terminal are considered to be insignificant.

Operational Traffic Impacts – Marine

Marine traffic will inevitably increase as a result of the proposed terminal and the frequency of vessel transits will increase due to the increased turnaround efficiency of the new terminal. The vessels, however, will be approaching from the main channel (manoeuvred in to position by tugs), which has no sensitive land uses associated with the riparian lands and is a large open estuary. Consequently, any noise impacts associated with these vessels are likely to be insignificant.

Operational Impacts – Site Operations and Management

The main noise generating activities likely to be associated with the proposed development, (once operational) include generators, compressors, pumps, mechanical equipment (cranes, etc) and maintenance activities. Given the separation distance between the proposed operational areas and noise-sensitive receptors, it is considered that noise from the day to day site operations (and associated mechanical plant and equipment) is unlikely to be perceptible at those noise-sensitive receptor locations (such as the nearest residences which are over 5km away). It is likely that operational noise from the terminal will be audible in the Freezone and port area but the duration and level of exposure to operatives in those locations will be negligible.

It should also be borne in mind that the wind conditions are fairly consistent and predictable in Iraq with the predominant wind feature being the *Shamal* which blows from the west and north-west on most days. This would, on most occasions, carry any noise generated on the site out onto the open water of the Khor Al-Zubair, away from neighbouring land uses and distant residential properties.

It is reasonable to conclude therefore that the potential for significant noise impacts from the operational terminal is very low.

5.2.7 Mitigation

Given the lack of noise-sensitive receptors in close proximity to the site, and the low likelihood of significant noise generating activities on the site, no specific mitigation measures are considered to be necessary during the construction and operational phases. Notwithstanding that, in accordance with best practice (and to lessen potential occupational noise impacts for site workers) there should be some effort applied to reduce potential noise sources where possible. Techniques may include:

- Select low noise equipment or modes of operation that produces less noise (e.g. turn off engines rather than let them idle when not in use);
- keep stationary noisy plant such as generators and compressors, as far as possible from noise sensitive facades and sheltered by a properly built acoustic enclosures or screening;
- use noise control equipment such as jackets on pneumatic drills, and shrouds on piling rigs and cranes;
- use rotating or impacting machines on anti-vibration mountings; and
- ensure that audible warning systems, including reversing alarms, are switched to the minimum setting required to meet Health and Safety requirements. Also traffic routes that avoid reversing on site will minimise the impact.

5.2.8 Residual Impacts

Residual noise impacts are considered to be negligible and environmentally insignificant.

5.3 Air Quality

5.3.1 Introduction

The potential impacts of the proposed development on local air quality during construction, operational and decommissioning phases have been assessed. For these phases, the type, source and significance of potential impacts are identified and the measures that should be employed to minimise these impacts are described, where applicable.

5.3.2 Information from Desktop Study

The overall air quality in Basra Governorate has been deteriorating as development, population, traffic and industrial activity have increased in the region. Furthermore, the lack of state of the art controls over many of the gaseous discharges from the oil fields and open burning of domestic waste have also have had an effect on air quality. Also, given the lack of reliable power there is a growing use of diesel generators and associated emissions. There are also natural air quality issues in the form of fine dusts that are generated from the periodic and sometimes prolonged dust storms that affect the region. The population of Basra Governorate are in direct daily contact with the different gaseous pollutants that are caused by daily urban activities, mostly by increasing the use of fossil fuel combustion from electrical generators and motor vehicles, as well as exposing the population to industrial activities2.

The study area has a number of industrial activities and in particular the steel works, fertiliser plant and power plants (land based and ship based), which all lie north and north west of the site and hence upwind of the project site most of the time. In the immediate vicinity of the project site, however, there are few sources of air emissions.

Previous studies have indicated high concentrations of carbon monoxide, NOx and SOx within the industrial areas of Basra[2] and given that concentrations from these emissions are expected to increase, and could become hazardous to human health in places close to these sources or in urban areas.

Dust and sandstorms occur periodically in southern Iraq and are highly influential on both regional and local air quality. The area is susceptible to these storms because of the low topographic relief, scant vegetation cover, light-textured topsoil and recurring strong and turbulent winds[3].

[2] *Gaseous Pollutants in Basra City, Iraq,* Douabal *et al*., Air, Soil and Water Research 2013:6, 2013
[3] *Wind Regime of the Arabian Gulf*, Ali Hamid Ali, The Gulf War and the Environment, edited by Farouk El-Baz and R.M. Makharita, 1994, Gordon and Breach Science Publishers

Bearing all of the above in mind there are numerous potential sources of air pollutants in the wider area and region generally, but within the immediate locality of the site there are few.

5.3.3 Assessment Methodology

Air quality assessment was undertaken at the same five locations as the noise monitoring namely AN01 – AN05 (see *Figure 5.1*). The selection of monitoring sites was based in part on providing spatial spread across the site, but was also dictated by available structures of features to fit sampling tubes to. The parameters and periods of sampling are outlined in *Table 5.7*:

Table 5.7: Air Quality Sampling Parameters

Parameter	Sampling Method	Period
Nitrogen oxides (NOx),	Passive Static Sampling (Air diffusion tubes)	4 weeks continuous
Oxides of Sulphur (SOx)	Passive Static Sampling (Air diffusion tubes)	4 weeks continuous
Carbon Monoxide (CO)	Static Sampling through use of Gresham pump set	Once
Particulates (PM_{10} and $PM_{2.5}$)	Static Sampling and Monitoring Equipment through the use of Turnkey Instruments DustMate dust monitor	4 x 30 minute sampling periods per station over 2 days
Volatile Organic Compounds (VOC) methane and ethane	Passive Static Sampling (TENAX tubes or similar)	4 weeks continuous

Passive Diffusion Tubes

Passive diffusion tubes were installed within dedicated monitoring fixed to poles or perimeter fencing around the site. The passive diffusion tubes were used for SOx, NOx and VOC sampling. During the installation process, the following conditions were considered:

- that the tubes open end was exposed to the free circulation of air;
- the immediate area around the sampler location was open, allowing free circulation of air;
- the tubes were installed at breathing height;

- no tubes were directly attached to surfaces which may act as absorbers for NO_2;
- no tubes were installed in any form of recess;
- areas of high turbulence (*i.e.* corners of buildings) were avoided;
- sites were open to the sky with no overhanging vegetation or buildings; and
- sources of localised pollution (*i.e.* heater flues, air conditioning outlets, extractor vents, underground ventilation shafts *etc.*) were avoided.

Photograph 5.2: *Passive Tube Monitoring Shelter*

Gresham Tubes

Gresham tubes are used for collecting pressurised samples of air for laboratory analysis. Using the gas sampling pump, the air at each location is pumped into a 55ml stainless steel sample cylinder which becomes pressurised with the sample. The cylinders are then despatched to the laboratory for analysis. The Gresham tubes were used for CO sampling and analysis.

Laboratory Analysis

All laboratory analytical work was undertaken by SAL Laboratories located in the United Kingdom. The laboratory is both United Kingdom Accreditation Service (UKAS) and the Environment Agency's (UK regulatory body) Monitoring Certification Scheme (MCERTS) certified. UKAS is the sole accreditation body recognised by government to assess, against internationally recognised standards, organisations that provide certification, testing, inspection and calibration services.

Particulate Monitoring

The methodology used for each of the particulate surveys was relatively simple in that a dedicated tripod mounted particulate monitor was used in the fixed sample locations and was attended by an EAME field scientist who switched the device on and downloaded the data periodically to a laptop. Sampling took place for 30 minutes at a time, on four separate occasions (spread over 2 days) at each of the sampling locations.

Photograph 5.3: *Particulate Monitoring*

All sampling and laboratory analysis was undertaken with reference to appropriate guidance and accreditation.

The air quality assessment also recorded climatic conditions and the presence of any identified or potentially significant pollutant sources that were evident at the time of sampling.

5.3.4 Air Quality Standards

World Bank and International Finance Standards

In order to try and put the findings of the air quality survey results into perspective, EAME considered the air quality standards and pollution concerns of the World Bank and International Finance Corporation (IFC), as well as Iraqi standards. According to these sources the main air emissions (continuous or non-continuous) associated with oil and gas activities include:

- combustion sources from power and heat generation, and the use of compressors, pumps, and reciprocating engines (boilers, turbines, and other engines);
- emissions resulting from flaring and venting of hydrocarbons; and
- fugitive emissions.

Principal pollutants from these sources include nitrogen oxides, sulphur oxides, carbon monoxide, and particulates. Additional pollutants can include: hydrogen sulphide (H_2S); volatile organic compounds (VOCs), methane and ethane; benzene, ethyl benzene, toluene, and xylenes (BTEX); glycols; and polycyclic aromatic hydrocarbons (PAHs).

The IFC Standard establishes limits for a number of air quality standards which in turn have been based on recommendations made by the World Health Organization (WHO)[4]. The relevant parameters of these standards are provided within *Table 5.8*.

The air quality standards are long-term benchmarks for ambient pollutant concentrations which represent negligible or zero risk to health, based on medical and scientific evidence reviewed by the WHO. These are general concentration limits, above which sensitive members of the public (*e.g.* children, the elderly and the unwell) might experience adverse health effects.

[4] IFC Environmental, Health, and Safety (EHS) Guidelines (April 30, 2007)

For some pollutants there is both a long-term (annual mean) standard and a short-term standard. In the case of NO_2, the short-term standard is for a 1-hour averaging period, whereas for PM_{10} it is for a 24-hour averaging period. These periods reflect the varying impacts on health of differing exposures to pollutants (*e.g.* temporary exposure on the pavement adjacent to a busy road, compared with the exposure of residential properties adjacent to a road).

Table 5.8: IFC Stated Ambient Air Quality Guidelines

Parameter	Averaging Period	Guideline Value in µg/m^3	Guideline Value in ppm
Sulphur dioxide (SO_2)	24-hour 10 minute	20 (guideline) 500 (guideline)	0.007 ppm 0.187 ppm
Nitrogen dioxide (NO_2)	1-year 1-hour	40 (guideline) 200 (guideline)	0.021 ppm 0.104 ppm
Particulate Matter PM_{10}	1-year 24-hour	20 (guideline) 50 (guideline)	-
Particulate Matter $PM_{2.5}$	1-year 24-hour	10 (guideline) 25 (guideline)	-

Notes:

Sulphur dioxide conversion factor 1 ppm = 2,860 µg/m^3

Nitrogen dioxide conversion factor 1 ppm = 1,880 µg/m^3

Local Regulatory Standards

Local air quality standards are defined by the Iraqi *National Clean Air Act 1979*. This act establishes long term, medium and short term ambient quality standards across a range of pollutant parameters.

Typically air quality objectives are medium-term policy based targets set by the Government which take into account economic efficiency, practicability, technical feasibility and timescale. Some objectives are equal to the agreed WHO guideline limits, whereas others involve a margin of tolerance based on local industry activity i.e. allow a limited number of permitted exceedances of the standard over a given period. No stated exceedances are provided with the Iraqi standards.

These ambient standards are provided within *Table 5.9*.

Table 5.9: Iraqi Air Quality Standards			
Pollutant	**Period**	**Ambient Air Standard (ppm)**	**Ambient Air Standard (µg/m^3)**
Sulphur Dioxide	1 hour 24 hours 1 year	0.1 0.04 0.018	None Stated
Carbon Monoxide	8 hrs 1 hr	10 35	None Stated
Nitrogen Dioxide	1 hr 24 hrs	0.05 0.04	None Stated
PM_{10}	24 hours	None Stated	150
$PM_{2.5}$	24 hours 1 year	None Stated	65 15
Total Suspended Particulate	24 hours 1 year	None Stated	350 150
Benzene	1 year	None Stated	0.003 (mg/m^3)

The composition of individual substances within the VOC group may differ considerably where characterisation of VOCs has not been undertaken. In this case it is best to adopt a precautionary approach and assume that the composition is 100% benzene.

5.3.5 Baseline Data

Passive air tubes were installed and the Gresham Tubes were filled on the 11th August 2014 and the particulate monitoring was undertaken on between the 29th and 30th August 2014. The passive air tubes installed on the 11th August 2014 and collected in on the 18th September, an exposure of 31 days.

All laboratory analytical certificates are presented in *Appendix F2.* For the purposes of discussion, the results are summarized in *Table 5.10* overleaf.

Carbon Monoxide

Table 5.10: Carbon Monoxide Analytical Results		
Location	**Iraqi National Standard**	**Observed Concentration (ppm)**
ANO1	8 hrs 10 ppm 1hr 35 ppm	0.31
ANO2		3.1
ANO3		5.3
ANO4		0.25
ANO5		5.3

The main man-made source of carbon monoxide is petrol vehicles which are not fitted with a catalytic converter, however, small amounts are also released from the burning of fossil fuels in power stations and waste incinerators where combustion is incomplete.

The levels of CO within the ambient air at all monitoring sites were below the Iraqi standards for CO over an 8 hour (10 ppm, 11.45 mg/m^3) and a 1 hour (35 ppm, 40.08 mg/m^3) averaging periods. As such, all monitored levels are below the stated environmental benchmark and significant pollution by this contaminant has not been observed.

NO_2

Table 5.11: Nitrogen Dioxide Analytical Results					
Location	**Iraqi National Standard**	**IFC Standard**	**Observed Concentration**		
			µg	**ppm**	**µg/m^3**
ANO1	1 hr 0.05 ppm 24 hrs 0.04 ppm	1 hr 0.104 ppm 1 yr 0.021 ppm	0.27	0.027	5.1
ANO2			1.4	0.014	27
ANO3			1.3	0.013	25
ANO4			1.6	0.016	31
ANO5			1.5	0.015	28

The current WHO guideline value of 0.021 ppm (40 µg/m^3 (annual mean)) is set to protect the public from the health effects of gaseous NO_2. The WHO identifies that, as an air pollutant, NO_2 has several correlated activities. At short-term concentrations exceeding 200 µg/m^3, it is a toxic gas which causes significant inflammation of the airways. NO_2 is also the main source of nitrate aerosols, which form an important fraction of $PM_{2.5}$ and, in the presence of ultraviolet light, of ozone. The major sources of anthropogenic emissions of NO_2 are combustion processes (*i.e.* heating, power generation, and internal combustion engines in cars).

None of the NO_2 concentrations were found to be above the Iraqi air quality or the IFC standards. As such, all monitored levels are below the stated environmental benchmarks and environmentally insignificant.

Table 5.12: Nitrogen Oxide Analytical Results

Location	Observed Concentration		
	µg	ppb	µg/m^3
ANO1	0.06	0.64	1.2
ANO2	<0.03	ND	ND
ANO3	<0.03	ND	ND
ANO4	<0.03	ND	ND
ANO5	<0.03	ND	ND

There are no Nitrogen Oxide guideline values, however, this parameter was not detected in four of the five samples and present in low concentrations in sample AN01.

The ambient levels of NO in the project area are not considered to be representative of poor air quality.

Sulphur Dioxide

Table 5.13: Sulphur Dioxide Analytical Results					
Location	Iraqi National Standard	IFC Standard	Observed Concentration		
			µg	ppm	µg/m³
ANO1	1 hr 0.1 ppm 24 hrs 0.04 ppm 1 yr 0.018 ppm	24 hrs 0.007 ppm 10 mins 0.187 ppm	1.1	0.021	56
ANO2			3.6	0.068	180
ANO3			0.99	0.019	50
ANO4			0.6	0.011	30
ANO5			0.98	0.018	49

The current WHO guideline value of 0.187 ppm (500 µg/m^3) should not be exceeded over average periods of 10 minutes duration. Studies indicate that a proportion of people with asthma experience changes in pulmonary function and respiratory symptoms after periods of exposure to SO_2 as short as 10 minutes. SO_2 is a colourless gas with a sharp odour. It is produced from the burning of fossil fuels (coal and oil) and the smelting of mineral ores that contain sulphur. The main anthropogenic source of SO_2 is the burning of sulphur-containing fossil fuels for domestic heating, power generation and motor vehicles.

All of the samples were found to be below both the IFC 10 minute and Iraqi 1 hour air quality standards and do not indicate poor air quality on the project site.

Total Volatile Organic Compounds

Table 5.14: VOCs Analytical Results			
Location	Observed Concentration		
	µg	ppb	µg/m³
ANO1	1.1	21	56
ANO2	3.6	68	180
ANO3	0.99	19	50
ANO4	0.6	11	30
ANO5	0.98	18	49

The term VOCs covers a range of chemical classes, including aliphatic, aromatic and chlorinated hydrocarbons; aldehydes; ketones; esters; ethers; acids; and alcohols. The compounds contribute directly or indirectly to a number of important environmental issues and concerns, but the nature and extent of their contributions depend on the chemical structure of each individual compound. The source of VOCs includes solvent use, road vehicles, equipment emissions, industrial processes, fires, waste disposal *etc.* The main issues of concern are:

- harmful effects on human health and on natural ecosystems through toxicity,
- carcinogenicity and other adverse physiological effects;
- damage to materials;
- tropospheric photochemical oxidant formation;
- stratospheric ozone depletion;
- global climate change; and
- odour.

There are currently no Iraqi or IFC standards for VOCs. The UK Environment Agency states that the composition of individual substances within the VOC group may differ considerably where characterisation of VOCs has not been undertaken[5]. In this case it is best to adopt a precautionary approach and assume that the composition is 100% benzene (a particularly pernicious VOC in terms of potential health impacts). As a result the monitoring results have been compared to the EC Air Quality Framework Directive & Daughter Directives[6] where Benzene has an annual mean threshold value of 5 $\mu g/m^3$.

All five samples were found to have VOC levels considerably in excess of the EU Benzene air quality limit (annual mean). It is important to note, however, that that the EU standard relates to an annual mean and the project samples are based on a one month average and the VOCs observed on site will be a range of chemical compounds of which benzene is likely to be a small component. So whilst the results do not necessarily indicate that the air is polluted to the extent that it is harmful to health it does indicate that there is a notable presence of VOC’s in the ambient air. In theory, in clean air, there should be no discernible VOC’s present, so the results indicate that anthropogenic activities are having an impact on air quality.

[5] http://publications.environment-agency.gov.uk/PDF/GEHO0410BSIL-E-E.pdf
[6] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32008L0050:EN:NOT

Particulates

The monitoring programme measured Total Particulate (*i.e.* Total Suspended Particulates (TSP)), PM_{10} (*i.e.* inhalable coarse particles which have an aerodynamic smaller than 10 micrometers and larger than 2.5 micrometers), $PM_{2.5}$ (*i.e.* fine particles 2.5 micrometers in diameter and smaller) and PM_1 (*i.e.* ultra-fine particulate matter with diameter less than 1 micrometers) at all monitoring locations.

Particulates are released into the air from combustion processes like burning of hydrocarbons, vehicle engines, waste incineration and other industrial processes and by natural phenomena such as forest fires, volcanoes and dust storms.

The IFC guideline standard for PM_{10} is 20 µg/m^3 (annual mean) and 50 µg/m^3 (24-hour mean). In comparison the Iraqi standard is 150 µg/m^3 (24-hour mean). The IFC guideline standard for $PM_{2.5}$ is 10 µg/m^3 (annual mean) and 25 µg/m^3 (24-hour mean). In comparison the Iraqi standard is 65 µg/m^3 (24-hour mean) and 15 µg/m^3 (annual mean). The Iraqi standard for Total Suspended Particulates (TSP) is 350 µg/m^3 (24-hour mean) and 150 µg/m^3 (annual mean).

Table 5.15: Observed Particulate Data

Location	TSP	PM_{10}	$PM_{2.5}$	PM_1
AN01	311.0	181.4	27.1	4.8
AN02	318.6	187.1	26.9	5.4
AN03	413.5	233.4	34.6	9.7
AN04	357.9	212.2	31.5	6.5
ANO5	419.6	243.5	38.9	10.4

The ambient air quality of the site is affected (with regards to particulate matter) by occasional sand storms, which are a frequent phenomenon in this region. These sandstorms mobilise large volumes of fine dust into the atmosphere and can last from several hours to several days. The measured high levels of total particulate and respirable (below 10 microns) particulate matter observed during the survey period are most likely attributable to these windblown dusts and sands, rather than from industrial sources. Consequently, this will remain a dominant influence on the local air quality regardless of any construction works associated with the Project or other built development.

5.3.6 Impact Assessment

Construction Related Impacts

During the site preparation and construction phase of development, emissions to atmosphere are mainly expected to be particulate matter created by movements of construction vehicles and machinery over unsurfaced ground and the engine exhaust emissions. In particular impacts could arise from:

- coarse and fine dust from construction activities including excavation, earthmoving, materials storage and movement of construction vehicles; and
- construction plant, both mobile and stationary (e.g. cranes and generators), which emit a mixture of exhaust gases, in particular PM_{10}.

During construction of the proposed development dust emissions may arise from the following activities:

- demolition of existing structures;
- earth moving and major excavation works;
- moving and stockpiling of materials;
- movement of vehicles over unpaved or soiled surfaces causing re-suspension of dust particles;
- windblown dust emissions from stockpiles and soiled surfaces; and
- fitting out and finishing activities such as cutting and grinding of stone or bricks.

Disruption due to construction is typically a localised phenomenon and is temporary in nature. In general only people living or working within 100 metres of construction activities are likely to be impacted by nuisance dust. Dust arising from the majority of construction activities tends to be of a coarse nature and unable to travel great distances when airborne.

The ability of dust particles to remain suspended in the air depends on its shape, size and density. Coarse particles (>30µm), tend to be deposited within 100m of source[7]. Finer particles, between 10-30µm, are generally deposited within 200 to 500m of source, while very fine particles (<10µm), which remain suspended for longer, can travel up to 1km from

[7] Office of the Deputy Prime Minister (2000) MPG11: Controlling Environment Effects of Minerals Extraction, Annex 1 – The Control and Mitigation of dust at Mineral and Related Workings

source. The greatest proportion of construction dust is made up of coarse particles, thus the majority of dust emissions are deposited within 100m of source.

Only a small proportion of dust generated by construction activities would be of a fine nature (PM_{10}), but that is the proportion that can enter the human respiratory system and result in adverse health effects. The nearest residential properties are over 5km way and up-gradient of the prevailing wind and well beyond the 1km that such dusts may be expected to travel.

It should also be borne in mind that the whole area is subjected to periodic dust storms which raise the dust levels in the atmosphere across the whole area, sometimes for days.

The other potential air pollutants measured (SOx, NOx, CO) are well below concentrations that would be considered harmful to health and the temporary use of plant and machinery associated with the construction works do not have the potential to significantly alter the conditions from those observed. Localised traffic congestion caused by construction vehicles could lead to short term temporary increases in such parameters, however, the construction management programme will seek to ensure smooth traffic flows and avoid congestion as this will impact upon the programme so must be avoided. This in turn should help to minimise any short-term local effects caused by traffic congestion. The greatest potential for stationery vehicles (which is when the potential for exhaust emissions to deteriorate air quality is the highest) will be within the construction zone and working areas rather than on the approaches to the project area close to receptors. The vehicles are unlikely to travel through residential areas as there are none along the main highways leading to the site.

Operational Impacts

The following operational activities of the project have the potential to alter the baseline air quality conditions observed during this ESIA:

- Venting from tanks, (onshore and vessels);
- Emissions from vehicles visiting the site and loading/unloading; and
- Engine emissions from vessels visiting the terminal.

These activities have the potential to give rise to localised increases in the air pollutants that have been monitored for as part of the baseline activities, but the sources of these emissions will be localised and the periods of emission limited. Given this, the general absence of sensitive receptors and the predominant prevailing wind direction blowing towards the open water, the potential for significant impacts in relation to operational air emissions is considered to be very low.

5.3.7 Mitigation

Construction Activities

It is considered that with an appropriate Construction and Environmental Management Plan (CEMP) the potential for dust during construction to give rise to a nuisance will be minimal.

When preparing the Environmental Management Plan consideration will be given to inclusion of the following measures for the control of dust and emissions from construction and demolition:

- all plant and equipment to be maintained in accordance with appropriate legislation or manufacturers recommendations to ensure emissions to atmosphere are minimised;
- engines of plant and machinery and lorries to be turned off at all times when not in use;
- no burning of material to take place on site;
- ensure adequate water supply on site for damping down dust;
- wheel washing at the exits from construction areas where there is a potential for dust and mud to be carried on to the highway;
- regular visual monitoring of construction activities to identify any significant dust sources;
- water suppression in dry conditions to reduce dust emissions (use mobile bowsers or fixed sprayers as appropriate);
- appropriate speed limit applied to all construction vehicles working on the construction site;
- minimising heights for any stockpiles and tipping operations;
- avoid double handling of excavated material wherever practicable;
- seal or re-vegetate completed earthworks as soon as reasonably practicable after completion;
- sheeting of loads during transport of dusty/friable material; and
- ensure deliveries of bulk cement and other similar powder materials are in enclosed tankers and stored in suitable silos with emission control systems to prevent escape of

material and overfilling during delivery.

It is considered that with appropriate mitigation the significance of impact during construction is slight.

Operational Activities

It should be noted that the site is located in a dusty environment, however, when operational, the dust generation will reduce due to more hardstanding areas and surfaced site roads. As such, wind-blown dust originating from the site should decrease.

The road tankers which currently load and unload at KZP will utilise the proposed terminal and, as previously mentioned, the site will be operated to international industry standards, thereby, reducing the overall level of vehicle emissions.

At present, petroleum products are loaded and unloaded directly into tankers, the proposed port will utilise bulk tank storage, thereby, reducing ship discharge times and associated emissions.

Closure and Decommissioning

When the time comes to eventually close the terminal facility and decommission (and possibly demolish) it, there may again be impacts associated with this. The activities that would typically be involved in the closure and decommissioning of such a facility would be similar to those during construction, involving plant and machinery, earthworks, materials movement and management. Likewise, therefore, the impacts would be similar. It is unlikely that a site such as this would be returned to the status of the present undeveloped site. Whilst potentially polluting materials and valuable or recyclable infrastructure (tanks, pipes, scrap metal, machinery, plant, etc.) will be removed, the major structures (concrete, berths, drainage systems, walls, fences, etc.) would be unlikely to be removed. In all likelihood the site would probably be re-used for alternative uses or redeveloped. As such the extent of the works and associated traffic and construction type activities (machinery, earthworks, etc.) associated with closure of the facility, whilst similar in nature to the construction activities, are expected to be lesser in scale and duration, as would be the associated impact. It is considered therefore that the impact of closure and decommissioning activities upon the air quality environment will be negligible.

5.3.8 Residual Impacts

With appropriate measures for the control of dust during construction activities and VOC emissions during operation, it is expected that there will be no significant residual impacts on air quality associated with the project.