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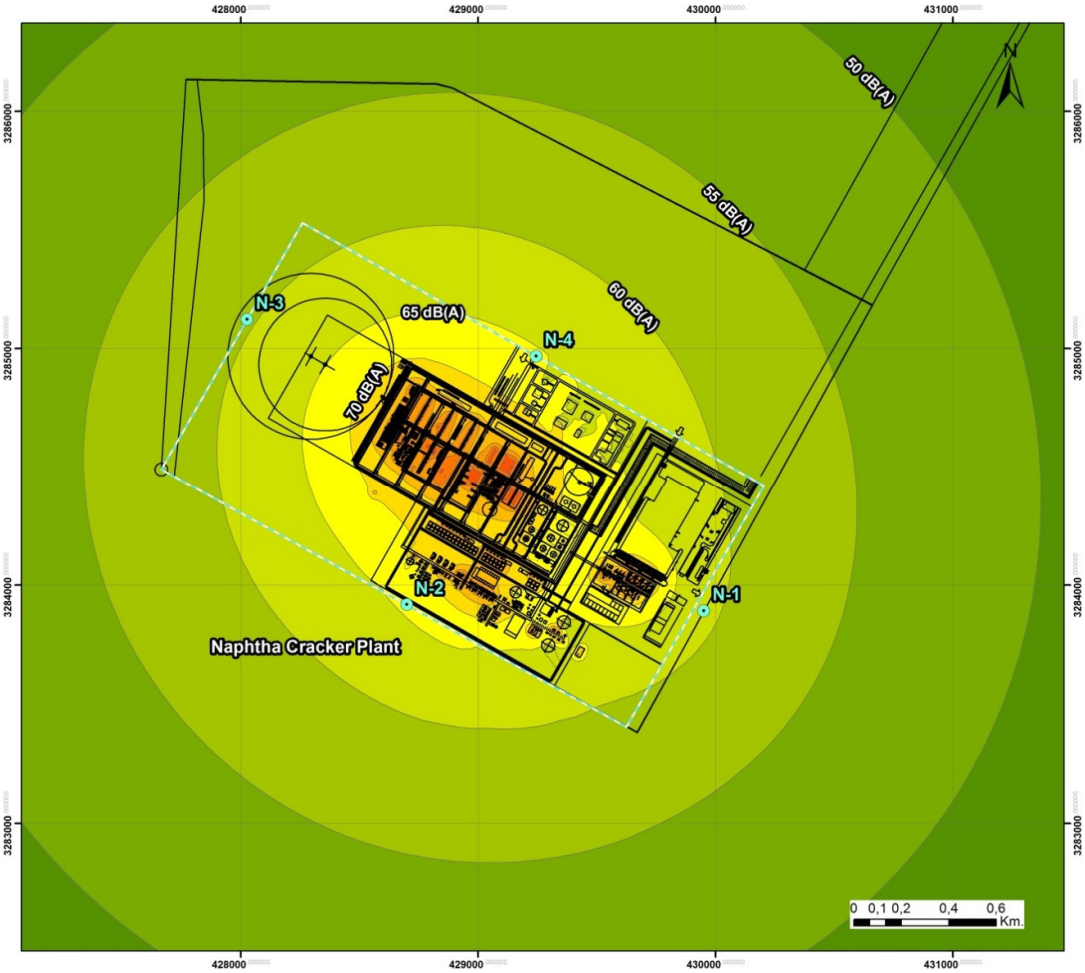
TAHRIR PETROCHEMICALS

Noise Model

Tahrir Petrochemicals Complex, Economic Zone in Ain Sokhna, Egypt



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Infrastructure & Environment

69 90th Street, 1st Sector, 5th Settlement, New Cairo,

Cairo,

Egypt

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PROJECT 455-EJ6195-00-EN-REP- - NOISE MODEL

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Appendix 1 - Noise Maps

1. EXECUTIVE SUMMARY

WorleyParsons was retained by Tahrir Petrochemicals to complete a noise modelling assessment to predict the Sound Pressure Levels (SPLs) expected during the operational phase of the project and to estimate the noise contribution from the facility to the current baseline conditions. The SPLs that would be generated during facility operation were predicted using the SoundPLAN software tool, which is an industry standard.

The baseline noise conditions (background noise) were determined in the project area based on the results of two monitoring campaigns that were conducted in 2014 and on historical sound measurements recorded in 2009 at the port area.

The SPLs that are predicted to be generated by the proposed complex and the cumulative noise levels with the background SPLs were discussed and compared with the Maximum Permissible Limits for Noise Intensity defined by Egyptian regulation (Law 4/1994) and the IFC Guidelines. This assessment focused on evaluating the compliance of the noise contributions from the project in the sensitive receptors and industrial areas with national and international ambient noise standards.

Based on the Noise Model results, the proposed Tahrir Petrochemicals is complying with the national & International limits presented in the report with applying the required mitigation, however should the model input parameters change in the detailed engineering phase, a model rerun would be required to assure the as built design compliance before commissioning & start-up.

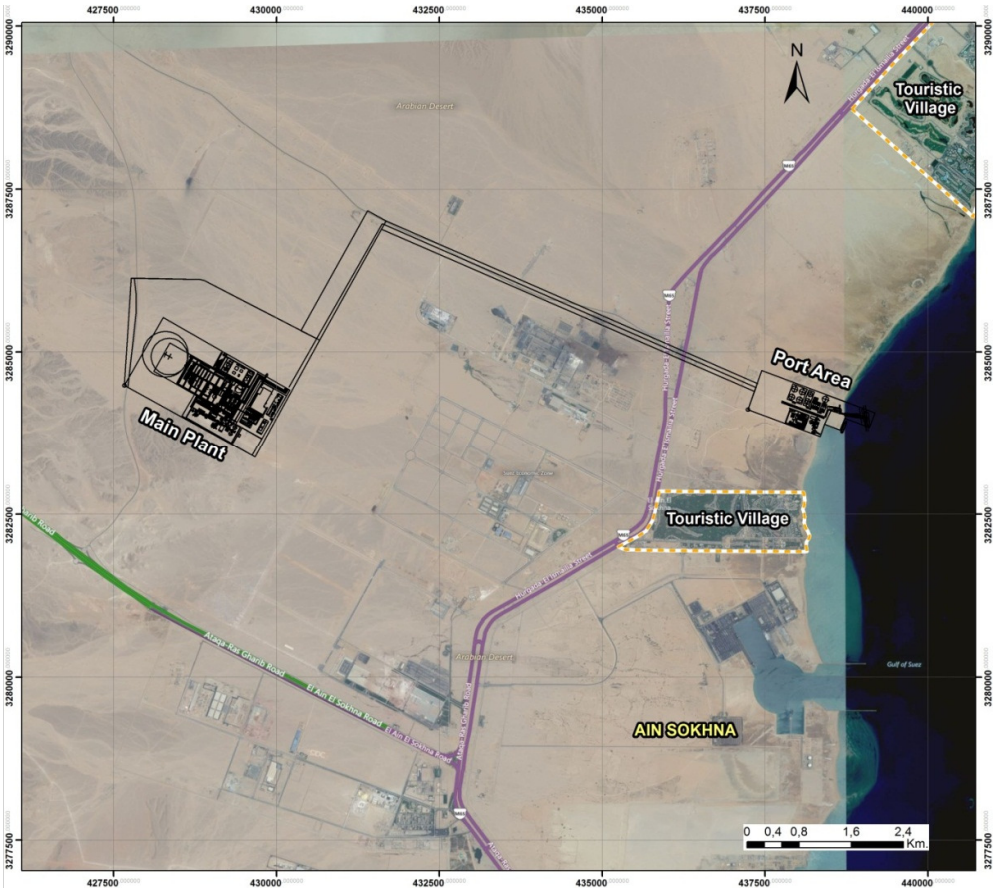
2. INTRODUCTION

2.1 Project Overview

Tahrir Petrochemicals Complex will include Naphtha Cracker facility to produce Ethylene and various derivative units along with a Polyethylene Plant and utilities (Main Plant area), and a dedicated storage area and jetty at the Sokhna 1(McDermott) Port (Port Area). A distance of 7.5 km separates the Main Plant from the Port Area.

The project is proposed in the Economic Zone in Ain Sokhna (Suez), as shown in Figure 2-1 . The nearest sensitive receptors are two (2) tourist villages that are located on the coast: 0.9 km south of the Port Area, and 3.6 km northeast of the Port Area. The locations of these receptors were primarily identified using Google Earth and verified during WorleyParsons team field visit to the proposed Complex area in August 2014.

Figure 2-1 Tahrir Petrochemicals Complex Location



2.2 Objective and Scope of Work

WorleyParsons was retained by Tahrir Petrochemicals to complete a noise modelling assessment to predict the Sound Pressure Levels (SPLs) expected during the operational phase of the project and to estimate the noise contribution from the facility to the current baseline conditions.

The SPLs that would be generated during facility operation were predicted using the SoundPLAN software tool, which is an industry standard. This software incorporates the modelling of point, line and area noise sources with screening effects of barriers and buildings and ground absorption effects to construct an acoustic model. The results are presented in the form of an acoustic map with contour lines of equal noise levels (isophones) at 5 decibel dB(A) intervals.

The baseline noise conditions (background noise) were determined in the project area based on the results of two monitoring campaigns that were conducted in 2014 and on historical sound measurements recorded in 2009 at the port area.

The SPLs that are predicted to be generated by the proposed complex and the cumulative noise levels with the background SPLs were discussed and compared with the Maximum Permissible Limits for Noise Intensity defined by Egyptian regulation (Law 4/1994) and the IFC Guidelines. This assessment focused on evaluating the compliance of the noise contributions from the project in the sensitive receptors and industrial areas with national and international standards.

This Noise Model report is intended to be used as input to the Environmental and Social Impact Assessment (ESIA) of the project. This noise model is considered a screening approach to evaluate potential environmental noise impacts from the proposed Complex. This model was run based on Pre- Front End Engineering Design (Pre-FEED) data, which is a common practice at such early stage of the project. In a later stage after construction and before operation, it is highly recommended to rerun the model should there are any deviations in the current model inputs.

3. REGULATIONS

The following applicable national and international standards have been considered to evaluate the compliance of the project with ambient noise standards. This section presents both the Egyptian limits and IFC Guidelines for ambient noise. As for the European Union relevant guidelines, Directive 2002/49/EC of the European Parliament and of the Council of 25 June 2002 relating to the assessment and management of environmental noise, establishes that the concrete figures of any limit values are to be determined by the Member States. Consequently, there are no reference values on ambient noise set by European legislation to be presented in this section.

3.1 Egyptian Legislation

Law No. 4 is the main Environmental Law in Egypt concerning the environment. The Egyptian Environmental Affairs Agency (EEAA) has the power to set criteria and conditions, monitor compliance and take action against violators of these criteria and conditions.

Maximum noise levels generated by an industrial facility are discussed in Egyptian Environmental Law 4/1994, its executive regulations (D338, A44) modified by decree 1095/2011 and 710/2012, and its annexes (Annex 7, Table 3). The allowable noise limits, listed in Table 3-1, are determined by zone types and vary with the time of day.

Table 3-1 Maximum Permissible Limits for Noise Intensity (dB(A)), Egyptian Law 4/1994

Type of Area	LAeq (dB(A))	
	Daytime (7am–10pm)	Night-time (10pm-7am)
Areas sensitive to exposure noise	50	40
Residential suburbs with limited movement and service activities	55	45
Residential areas in towns with commercial activities	60	50
Residential areas located on roads narrower than 12 metres with workshops, commercial and administrative activities, and recreational activities or amusement parks	65	55
Areas located on roads 12-metres wide or wider, or in industrial zones with light industry and other activities	70	60
Industrial zone with heavy industries	70	70

Areas sensitive to exposure to noise are: schools, hospitals, libraries, public gardens, tourist villages, resorts and rural areas.

3.2 International Finance Corporation (IFC) Ambient Noise Guidelines

The International Finance Corporation (IFC) has established guidelines for maximum permissible noise levels generated by a facility. The IFC Environmental, Health, and Safety (EHS) Guidelines for Noise Management (April 2007) refer to guidelines for industrial sectors.

Noise impacts should not exceed the levels listed in Table 3-2.

Table 3-2 IFC Maximum Allowable Noise Levels (Leq 1-hour, dB(A))

Type of Area	LAeq (dB(A))	
	Daytime (7am–10pm)	Night-time (10pm-7am)
Residential, Institutional, Educational	55	45
Industrial	70	70

Source: IFC, 2007; Environmental, Health, and Safety General Guidelines

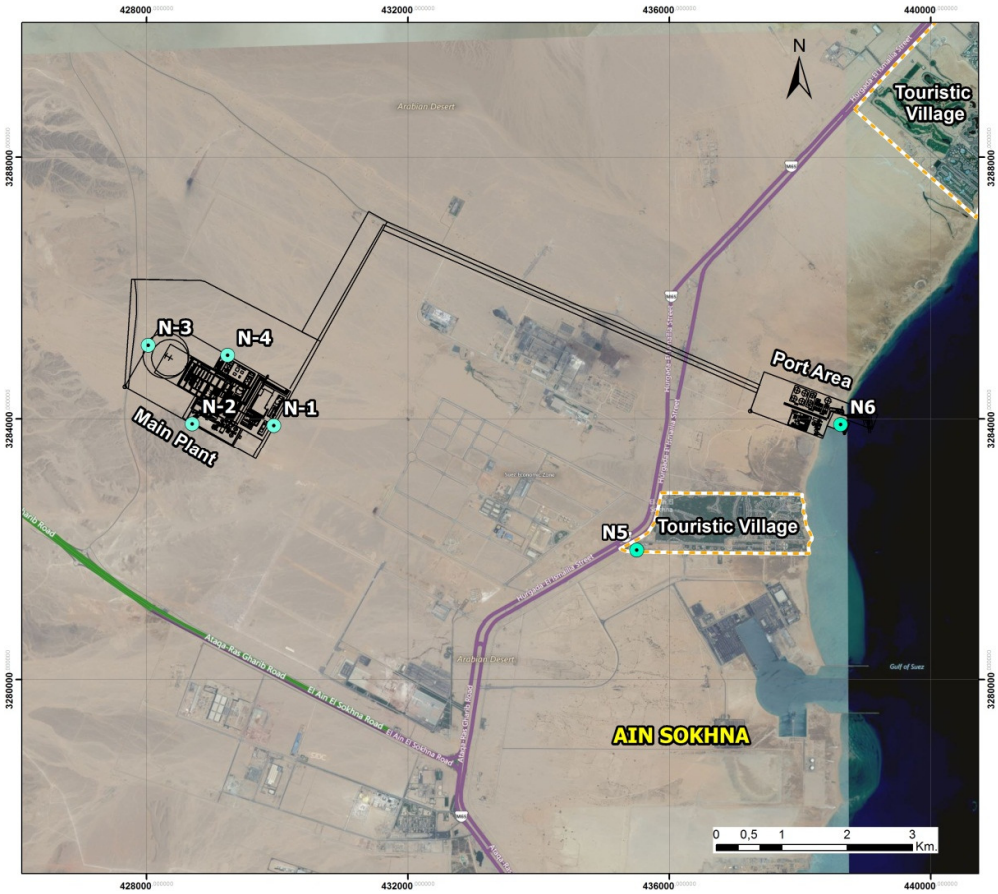
4. BASELINE NOISE CONDITIONS

The background noise levels measured in the project area were used to determine the baseline noise conditions. These noise levels were used in combination with the predicted noise levels to be contributed from the proposed project based on the model to determine the expected cumulative noise levels.

For the purpose of this assessment, two sources of data were available:

- Results of two monitoring campaigns: A monitoring survey was conducted in August 2014 at four locations (N1-N4) along the Main Plant boundary and an additional measurement was conducted in November 2014 at one location (N5) southwest of the Port Area.
- Noise data recorded on March 2009 at one location (N6) in the Port Area.

Figure 4-1 Location of Noise Monitoring Measurements



Background Noise Monitoring Campaign (August and November 2014)

Measurements were continuously recorded at the N1-N5 locations during a 24-hour period that covered two intervals, 'Day' and 'Night', as per Egyptian Law 9/2009, Decree 1095/2011 and Decree 710/2012.

Measurement locations were chosen to be as relevant as possible to the project design and the locations of predicted noise sources. The N1-N4 locations are representative of the existing sound levels at points along the Main Plant boundaries, while the N5 location is in the proximity of a tourist village that is southwest of the port and affected by traffic noise. It was anticipated that these locations would remain the same for the purpose of construction monitoring, performance guarantee tests, and operation monitoring.

The 24-hour ambient noise measurements were conducted using a Type I (precision grade) sound level meter, and 1/3 octave band logging was employed. The parameters measured at each location included, but were not limited to, the equivalent continuous sound pressure level (LAeq) and the LN percentile parameters (10, 50, 90 and 95).

Monitoring equipment included the following devices:

- B & K 2238 Mediator, Integrating Sound Level Meter, compliant with IEC 1672 Class 1 standard
- B & K 4231 Sound Level Calibrator, compliant with IEC 942 Class 1 standard
- B & K 4198 Outdoor Weatherproof Microphone Kit
- GPS unit (Garmin eTrex)
- Digital Camera

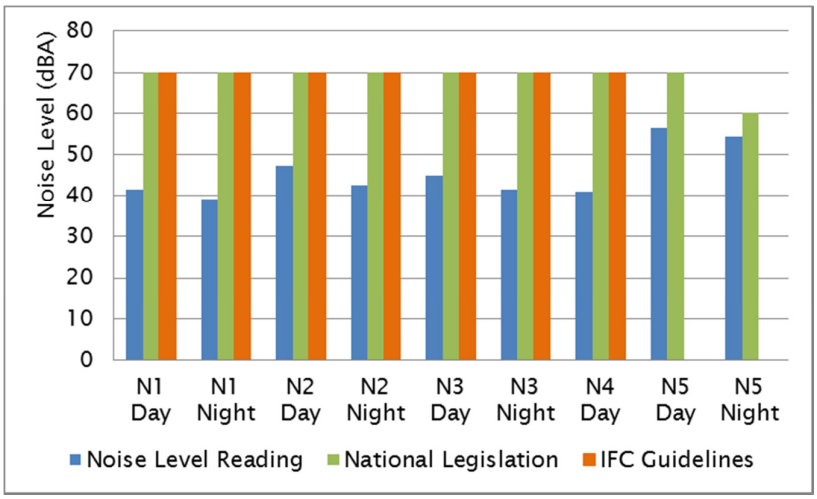
The background noise measurements, including the weighted sound level parameters LAeq, L10, L50, L90 and L95 for the five monitoring locations, are presented in Table 4-1. Night measurements taken at the N4 location were not recorded due to error in the device readings.

Table 4-1 Ambient Noise Level Readings (24-hr measurements) - 2014

Location	Coordinates	Period	SPLs: A-weighted Equivalent and Percentiles, dB(A)				
			LAeq	L10	L50	L90	L95
N1	29°41'1.90"N 32°17'1.60"E	Day	41.6	42.6	37.9	33.8	32.7
		Night	39.1	41.1	36.6	32.4	31.3
N2	29°41'3.25"N 32°16'15.50"E	Day	47.2	49.8	33.1	25.6	24.8
		Night	42.5	35.7	30.3	26.2	25.2
N3	29°41'41.50"N 32°15'50.80"E	Day	45.0	49.6	33.8	25.9	25.0
		Night	41.5	37.3	30.8	26.9	26.0
N4	29°41'37.10"N 32°16'36.60"E	Day	40.9	43.8	35.7	31.5	30.6
N5	29°39'58.07"N 32°20'0.75"E	Day	56.5	58.2	54.7	53.3	53.0
		Night	54.3	55.4	53.6	52.6	52.3

The results were compared to Egyptian Law 9/2009 and Executive Regulation (Decree 710 for 2012) and IFC general guidelines for 'Day' and 'Night' intervals, as shown in Figure 4-2 , for the corresponding type of area. National and international standards for "industrial areas" would apply to locations N1-N4, and standards for an "area located on roads 12-metres wide or wider" would apply to the N5 location (Egyptian Law 9/2009). All of the measurements of the ambient noise levels were found to be below these standards.

Figure 4-2 Ambient Noise Level Readings and Legal Standards



Historical Background Noise Monitoring (2009) at the Port Area

WorleyParsons conducted a background noise monitoring campaign on March 2009 as part of other environmental studies in the Port Area. The 24-hour LAeq sound level that was recorded at one location (N6) was found at that time to be in compliance with the applicable industrial noise standards (70dB).

Table 4-2 Ambient Noise Level Readings (24-hr measurements) at Port Area – 2009

Location	Coordinates	Date	Period	SPLs: A-weighted Equivalent and Percentiles, dB(A)	
				LAeq	L90
N6	29°41'1.40"N 32°21'56.40"E	March 2009	24 hours	50.3	--

5. METHODOLOGY

5.1 Modelling Software

The SoundPLAN software (written by SoundPLAN LLC, Braunstein + Berndt GmbH) was used to predict noise levels that will result from the proposed facility. SoundPLAN is a modelling and presentation tool that helps optimizing the noise control measures and visualizing the effects of noise propagation throughout complex systems, such as the proposed facilities.

SoundPLAN is industry-standard noise prediction software used to calculate sound pressure levels and generate noise maps. The maps are a graphical representation of the calculated sound pressure levels, considering reflections and diffractions of sound, and taking into account the geometry of buildings at the site and topography. The pressure level calculated or interpolated for each point within the modelling domain are shown as a grid of sound pressure, from which a contour map is generated showing isophones (lines of equal sound pressure). SoundPLAN generates industrial noise maps using the calculation methods given by standards ISO 8913 for noise emissions and ISO 9613 for noise propagation.

5.2 Modelling Approach

The program includes a database module that prompts for all input data required for the calculations made by the noise model, including geometrical data (layout, building shape and height) of all objects relevant to the investigation. All data entered into the database can be further edited by adding attributes, such as x, y, z coordinates, noise emission levels, noise absorption and reflective properties. The calculation area is also defined.

The noise sources can be of four different types: point sources, line sources, area sources and industrial buildings. The two latter sources can be defined by their total acoustic power or by the acoustic power density of the source. Every source is described in terms of its acoustic power, which allows the noise propagation calculation to be based on any of the standards that are included in the software.

The calculation module generates a grid of receptors over the calculation area defined in the database. The main calculation module provides the necessary data to calculate or interpolate the noise pressure in the middle of each grid cell from the receptors around it. Grid spacing is chosen to accommodate the model resolution requirements.

Additional corrections, such as reflection and absorption coefficients of walls and ground material, can be made. Impulse and tonal sources can be defined; and the sources can be associated with a radiation pattern. The library module of the software program is used to provide industrial standard noise for each source in the absence of vendor data. The library defines each noise source in terms of central frequency or in terms of frequency spectrum. If spectral data are unknown and the project has an industrial nature, as in this case, the

noise pressure in each cell can be calculated using a default central frequency of 500 Hz (typical industrial standard) or a different value, if the choice is supported.

5.3 Cumulative Effects

Accumulated levels of sound pressure are calculated combining the sound contribution generated during the operation phase and the conditions of existing background noise.

The decibels have a logarithmic value. In order to calculate the contribution of several sound sources, it is necessary to use the following formula:

$$L_{P_t} = 10\log\left(\sum_{i=1}^{n} 10^{L_{Pi}/10}\right)$$

Where:

L_{Pt} = Total sound pressure

L_{Pi} = Partial sound pressure

n = Number of sources of sound

An example that illustrates the cumulative effect of adding one sound source B to another sound source A is provided in Table 5-1. Based on the calculation above, the effective contribution of a second sound source is dependent on its value relative to the original sound source.

Table 5-1 Cumulative Effect of Adding Two Sound Sources

Source A dB(A)	Source B dB(A)	Contribution from Source B dB(A)	Cumulative Effect dB(A)
60	60	3	60 + 3 = 63
61	60	2.5	61 + 2.5 = 63.5
66	60	1	66 + 1 = 67
75	60	0.1 (negligible)	75 + 0.1 ≈ 75

The addition of two sound sources of equal sound power produces an increase of 3 dB(A) in the sound pressure generated on the receptor. If the difference between two sound sources is 1 dB(A), an increase of approximately 2.5 dB(A) is produced. If the difference between two sound sources is 6 dB(A), an increase of approximately 1 dB(A) is produced. When there is a difference of more than 15 dB(A) between the two sources, a cumulative effect is negligible, with the result being equivalent to the sound pressure (SPL) of the greater of the two.

6. NOISE MODEL

This section includes the model inputs provided by Tahrir Petrochemicals, the assumptions considered, and the details of the applied modelling options.

6.1 Model Inputs

The noise model presented in this report is considered a screening approach to evaluate potential environmental noise impacts from the proposed Complex. Due to the early stage of the project, the data available are based on Pre-Front End Engineering Design (Pre-FEED) provided by the project contractors. Accordingly, should the as built information deviates from the current information used to run this model, it is highly recommended to rerun the model with the as built information before the plant start-up.

To generate the noise maps in SoundPLAN, the data presented in the below sections were utilized.

Topography and Terrain

The study area was assumed to be flat, which most closely approximates the actual topography. Obstacles to noise propagation, e.g., vegetation and infrastructure, located outside of the Tahrir Petrochemicals Complex were not considered. For the purpose of the model, the ground absorption factor (G) was determined for evaluating ground effects on sound propagation. The model domain includes two types of areas:

G=0	Hard terrain, corresponding to asphalt and industrial sites, was assumed below the projected facilities.
G=0.6	Intermediate ground absorption, typical of a desert field, was assumed across the remaining modelling domain.

Facility Layout

The following project drawings were used for the facilities layout of the noise model:

- GENERAL PLOT PLAN (OPTION “C” McDERMOTT): 3816-XX-DG-200-02 (Revision 02)
- GENERAL PLOT PLAN OF MAIN PLANT (CRACKING-PE-U&O) (OPTION “C” McDERMOTT): 3816-XX-DG-201-01 (Revision 01)
- GENERAL PLOT PLAN OF PORT AREA (STORAGE-DESAL-JETTY) (OPTION “C” McMcDERMOTT): 3816-XX-DG-202-01 (Revision 01)

Building Attributes

The main buildings and tanks that are to be constructed were introduced into the model as building elements, which will act as noise barriers by shielding receptors from the source. Each element and its corresponding height are listed in Table 6-1. Small elements, such as structures, pipes and racks, were not included as noise sources or sound barriers in this

assessment. Furthermore, obstacles to noise propagation outside the proposed complex were not considered.

Table 6-1 Buildings and Tanks to be Constructed and their Heights

Item	Buildings / Tanks	Height (m)
1_1 and 1_2	Administration Building	7.0
3	Maintenance Workshop & Offices	12.0
4_1	Security Guardhouse	3.6
4_2	Main Security Guardhouse	3.6
5	Mosque	10.0
6	Main Administration Building	3.6
7	Training Centre	10.0
8	Medical and First Aid Centre	3.6
9	Fire Station	3.6
10	Vehicle Maintenance Workshop	8.0
11	Material Warehouse and Offices	5.0 (1)
12	Staff Canteen	3.6
24-D31	Naphtha Feed Buffer Tank	8.0 (1)
59-D31	Mixed C4 Tank	8.0 (1)
66-D31	Mixed C6 Tank	18.5
71-D31	Ethylene Tank	29.5
71-D33	Ethane Tank	8.0 (1)
72-D31	Raw Pygas Tank	30.6
73-D31	Butene-1 Tank	8.0 (1)
74-D31	Iso-Pentane Tank	8.0 (1)
75-D31	Hexene-1 Tank	19.6
76-D31	n-Hexane Tank	7.3
77-D31	PGO/PFO Tank	11.2
D-1004	Fuel Oil #2 Daily Tank	11.6
D-1005	Slop Oil Storage Tank	10.2
D-1008 A/B	Fire & Fresh Water Combined Storage Tanks	18.2

Item	Buildings / Tanks	Height (m)
D-1010	Demineralised Water Storage Tank	14.8
D-1013	Clean Condensate Storage Tank	12.7
D-1014	Suspect Condensate Storage Tank	8.8
D-1024	OSBL Desalted Water	15.9
D-1028	Off Spec Fuel Oil #2 Tank	8.2
D-5003 A/B/C/D	Naphtha Storage Tanks	22.0
D-5006	Propylene Storage Tank	16.0
D-5014	Ethylene Tank	14.0
D-5007 A/B	Butadiene Tanks	15.0
D-5008 A/B	Benzene Tanks	14.0
D-5009 A/B	Fuel Oil #2 Tank Import	20.0
D-5010	Hexene-1 Tank	16.0
D-5011	Tank Farm Fresh Water & Fire Water	18.0
D-7002	Desalinated Water Storage Tanks	12.0
--	UF Permeate Tank	8.0 (1)
--	SWRO Permeate Tank	8.0 (1)
--	BWRO Reject Tank	8.0 (1)

Note: Information provided by the EPC Contractors (References A and B in Section 8).

(1) Data not available at this stage. A reasonable assumption was made based on best practice and similar cases.

Noise Emission Sources

The identification and characterization (height and acoustic power emission data, Lw) of noise sources at the following project components were provided by the proposed Complex contractors (Linde, SK E&C, Maire Tecnimont and Archirodon):

- Main Plant: Ethylene Plant (Table 6-2); Polyethylene Plant (Table 6-3); Hexene-1 Unit (Table 6-4); and U&O Main Plant Site (Table 6-5).
- Port Area: Tank Farm (Table 6-6); Sea Water Intake (Table 6-7); Sea Water Desalination System (Table 6-8) and Jetty (Table 6-9).

Limited project-specific noise data are currently available due to the relatively early phase of project development. In the absence of accurate or complete information, the following assumptions were made:

- The main emission sources were assumed to be point or linear sources based on their nature. Sound waves from point sources travel in all directions (spherical propagation), and the sound energy decreases more rapidly under free field conditions than for linear or area sources.
- Small elements, such as structures, pipes and racks, were not included as noise sources or sound barriers.
- All sources were assumed to generate a mean frequency of 500 Hz. If spectral data are unknown or unavailable, industrial applications are most often calculated using a mean frequency of 500 Hz as an accepted practice.
- Configuration of some packages (see tables below) is unknown at present. In the absence of the equipment distribution layout and acoustic characteristics, a combination of point and linear noise sources were incorporated and sound power levels were adjusted to generate SPLs at the package area imaginary perimeter below 85 dB(A).
- All noise sources were assumed to be operating continuously throughout the daytime and night-time periods, including discontinuous noise sources, which corresponds to a conservative approach (higher acoustic impact). Stand-by units were not considered in the model as noise sources.

Table 6-2 Ethylene Plant Noise Emission Sources

Unit ID	Description	Height (m)	Lw (dB(A))	No.	Type
01-F01 – 09-F01	Cracking Furnaces	21.0	107.0	9	Point
15-D31 A/B	Decoking Cyclones	48.0	102.0	1	Point
31-C01	Cracked Gas Compressor	15.0	114.5	1	Linear
31-E11-15 31-D-31-34	Intercoolers & Suction Drums Cracked Gas Compressor	1.0	114.0	2	Point
--	Lube Oil System Cracked Gas Compressor	1.0	108.0	1	Point
31-X01	Cracked Gas Compressor Turbine	15.0	118.0	1	Point
31-Y03	Cracked Gas Compressor Turbine Condenser	8.5	115.0	1	Point
44-C01	Ethylene Compressor	15.0	111.5	1	Point
44-X02	Ethylene Compressor Turbine	15.0	113.0	1	Point
46-C01	Propylene Compressor	15.0	114.5	1	Point
46-X02	Propylene Compressor Turbine	15.0	113.0	1	Point
44-Y03	Refrigerant Compressor Turbine Condenser	8.5	116.0	1	Point
44-E13-14, 46-E11, 46-D31-34	Intercoolers & Suction Drums Ethylene / Propylene Compressor	10.5	115.0	2	Point
--	Lube Oil System Refrigerant Compressor	1.0	108.0	1	Point
64-C01 A/S	GH II Make-up and Recycle Compressor	1.0	112.0	1	Point

Unit ID	Description	Height (m)	Lw (dB(A))	No.	Type
28-P71 A-C/S	Quench Water Pumps	1.0	107.0	3	Point
28-X01	Quench Water Pump Turbine	1.0	108.0	1	Point
28-PM71 B/S	Quench Water Pump E-Motor	1.0	101.0	1	Point
27-P72 A/S	Pyrolysis Gas Oil Pump	1.0	104.0	1	Point
27-P71 A-D/S	Pyrolysis Fuel Oil Pump I	1.0	108.0	4	Point
27-X01	Quench Oil Pump Turbine	1.0	108.0	1	Point
27-PM71 B/C/S	Pyrolysis Fuel Oil Pump I E-Motor	1.0	102.0	2	Point
38-P71 A/S	De-ethanizer Reflux Pump + E-Motor	1.0	103.5	1	Point
51-P71 A/S	De-propanizer Reflux Pump + E-Motor	1.0	104.5	1	Point
55-P71 A/S	Propylene Pump + E-Motor	1.0	106.0	1	Point
83-P71 A/B/S	HHP BFW Pumps	1.0	111.0	2	Point
83-X01	BFW Pump Turbine	1.0	103.0	1	Point
83-PM71 B/S	HHP BFW Pump E-Motor	1.0	110.0	1	Point
83-P72 A/B/S	HP BFW Pumps	1.0	102.0	2	Point
48-Y01	PSA Unit	1.0	108.0	1	Point
48-Y02	Hydrogen Product Booster	2.0	108.0	1	Point
90-F02	Sour Gas Flare	50.0	112.0	1	Point
--	Piping (1)	4.0	120.0	8	Linear
58-Y01	Butadiene Extraction Unit	See Note (2)			
67-Y01	Benzene Toluene Extraction Unit				
68-Y01	Hydrodealkylation Unit				
79-Y01	Butene-1 Unit				

Note: Information provided by the EPC Contractors (Reference C in Section 8).

(1) "Piping" source was defined by the client on "List of Main Noise Sources Ethylene Cracker" document (Reference C in Section 8). Unit ID is not shown on project layouts.

(2) Configuration of these packages is unknown at present. In the absence of the equipment distribution layout and acoustic characteristics, a combination of point and linear noise sources were incorporated and sound power levels were adjusted to generate SPLs at the package area imaginary perimeter below 85 dB(A).

Table 6-3 Polyethylene Plant Noise Emission Sources

Unit ID		Description	Height (m) [1]	Lw (dB(A))	No.	Type
MR No	Item No					
MF140-01	G-9103/ 9104	ANSI Type Pumps (OH1)	1.5	96.0	2	Point
MF110-01	G-1002/ 1003/ 1014	Overhung Pumps (OH2)	1.5	96.0	3	Point
MF110-01	G-1412/ 1413	Overhung Pumps (OH2)	1.5	96.0	2	Point
MF110-01	G-4004/4204/4404/ 4005/4205/4405	Overhung Pumps (OH2)	1.5	99.0	6	Point
MF110-01	G-5212/5512/5812/ 5213/5513/5813	Overhung Pumps (OH2)	1.5	96.0	6	Point
MF110-01	G-5215/5515/5815/ 5216/5516/5816	Overhung Pumps (OH2)	1.5	96.0	6	Point
MF110-01	G-5225/5525/5825/ 5228/5528/5828	Overhung Pumps (OH2)	1.5	96.0	6	Point
MF240-01	G-9701	Sump Pump (VS4)	1.5	96.0	1	Point
MF240-01	G-9702	Sump Pump (VS4)	1.5	96.0	1	Point
MF310-01	G-4051/ 4251	Rotary Pumps	1.5	94.0	2	Point
MF310-01	G-4476	Rotary Pump	1.5	94.0	1	Point
MF310-01	G-6214/ 6314	Rotary Pumps	1.5	94.0	2	Point
MF410-01	G-1503/ 1504/ 1507	Diaphragm Pumps (Motor)	1.5	94.0	3	Point
MF410-01	G-4053/ 4253	Diaphragm Pumps (Motor)	1.5	94.0	2	Point
MF410-01	G-4054/ 4254	Diaphragm Pumps (Motor)	1.5	94.0	2	Point
MF410-01	G-4058/ 4258	Diaphragm Pumps (Motor)	1.5	94.0	2	Point
MF410-01	G-4480	Diaphragm Pump (Motor)	1.5	94.0	1	Point
MG110-01	K-4003/K-4203/K-4403	Centrifugal Compressors	2.0	99.0	3	Point
MG200-01	K-1102/ K-1103	Reciprocating Compressors	2.0	112.5	2	Point
MG200-02	K-5206/K-5506/K-5806	Refrigeration System	2.0	102.5	3	Point
MG200-02	V-5214/V-5514/V-5814	Refrigeration System	3.0	102.5	3	Point
MH310-01	Y-7001/Y-7301/Y-7501	Pelleting Unit (Continuous Mixer)	3.0	107.5	3	Point
MH310-01	Y-7004/Y-7304/Y-7504	Pelleting Unit (Melt Pumps)	3.0	107.5	3	Point
MH310-01	Y-7007/Y-7307/Y-7507	Pelleting Unit (Pelletizer)	3.0	102.5	3	Point
MH310-01	G-7012/G-7312/G-7512	Pelleting Unit (PCW Pumps)	1.5	102.5	3	Point
MK500-01	K-8104/K-8304/K-8504	MHU (Production Pellet Blower)	2.0	102.5	3	Point

Unit ID		Description	Height (m) (1)	Lw (dB(A))	No.	Type
MR No	Item No					
MK500-01	K-8105/K-8305/K-8505	MHU (Production Pellet Blower)	2.0	102.5	3	Point
MK500-01	K-8124/K-8324/K-8524	MHU (Pellet Blending Blower)	2.0	102.5	3	Point
MK500-01	K-8127/K-8327/K-8527	MHU (Pellet Blending Blower)	2.0	102.5	3	Point
MK500-01	K-8130/K-8330/K-8530	MHU (Pellet Blending Blower)	2.0	102.5	3	Point
MK500-01	K-8133/K-8333/K-8533	MHU (Packaging Transfer Blower)	2.0	102.5	3	Point

Note: Information provided by the EPC contractors (References D and E in Section 8).

(1) Data not available at this stage. A reasonable assumption was taken based on best practice and similar cases.

Table 6-4 Hexene-1 Unit Noise Emission Source

Unit ID	Description	Height (m))	Lw (dB(A))	No.	Type
--	Hexene-1 Unit	See Note (1)			

Note: Based on information provided by the EPC contractors.

(1) Configuration of this package is unknown at present. In the absence of the equipment distribution layout and acoustic characteristics, a combination of point and linear noise sources were incorporated and sound power levels were adjusted to generate SPLs at the package area imaginary perimeter below 85 dB(A).

Table 6-5 U&O Main Plant Site Noise Emission Sources

Unit ID	Description	Height (m) (1)	Lw (dB(A))	No.	Type
P-1001 A/B	Natural Gas Compressor Package	2.0	105.0	1	Point
P-1003 A/B/C	Instrument Air / Plant Air Compressor	2.0	103.0	2	Point
F-1004 A/B/C	Plant Air Compressor Dryer	3.0	100.0	2	Point
Y-1002	Waste Wastewater Treatment Package	3.0	100.0	1	Point
Y-1003	Sanitary Wastewater Treatment Package	3.0	95.0	1	Point
P-1004 A/B/C/D	Gas Turbine Generators and Ancillary Equip & Systems	4.0	112.0	4	Point
P-1005 A/B	Steam Turbine Generators and Ancillary Equipment & Systems	4.0	111.0	2	Point
B-1001 A/B/C/D	Heat Recovery Steam Generators	8.0	109.0	4	Point
	Main Stacks	50.0	105.0	4	Point
B-1002 A/B/C/D	HP Steam Boilers	17.0	85.0	3	Point
G-1001 A/B/C	Condensate Extraction Pumps from Steam Turbine Condenser	1.5	103.0	2	Point

Unit ID	Description	Height (m) [1]	Lw (dB(A))	No.	Type
G-1002 A/B/C	Condensate Extraction Pumps from Steam Turbine Condenser	1.5	103.0	2	Point
G-1003 A/B/C	Condensate Extraction Pumps from Excess Steam Condensers	1.5	103.0	2	Point
Y-1004	Demineralised Water Package (EDI System)	3.0	95.0	1	Point
Y-1005	EDR System	3.0	95.0	1	Point
Y-1006	Potable Water Package	3.0	90.0	1	Point
G-1004 A/B/C	Safety Shower Water Pumps [2]	1.5	85.0	2	Point
Y-1008	Boiler Feed Water Chemical Dosing Package (Phosphate for Boilers)	3.0	95.0	1	Point
Y-1009	Boiler Feed Water Chemical Dosing Package (Deox)	3.0	90.0	1	Point
Y-1010	Boiler Feed Water Chemical Dosing Package (Ammine)	3.0	90.0	1	Point
Y-1011 A/B/C	Condensate Polishing Package	3.0	95.0	3	Point
G-1005 A/B/C	Fuel Oil #2 GTs Pumps	1.5	90.0	2	Point
G-1006 A/B/C/D	Fuel Oil #2 Boilers Pumps	1.5	95.0	3	Point
G-1007 A/B	EDI Brine Pumps	1.5	85.0	1	Point
G-1008 A/B	EDR Brine Pumps	1.5	85.0	1	Point
G-1009 A/B	Clean Condensate Pumps	1.5	102.0	1	Point
G-1015	Slops Oil Tank Pump to Truck	1.5	85.0	1	Point
G-1016	Slop Tank Waste Water Pump to WWT	1.5	85.0	1	Point
G-1020 A/B/C	Fresh Water Pumps	1.5	97.0	2	Point
G-1021 A/B/C	Cooling Water Make Up Pumps	1.5	103.0	2	Point
G-1028 A/B	Potable Water Pumps	1.5	85.0	1	Point
G-1029 A/B/C	Demineralised Water Pumps	1.5	95.0	2	Point
G-1032 A/B/C	MP Boiler Feed Water Pumps	1.5	100.0	2	Point
G-1033 A/B	HP Boiler Feed Water Pumps	1.5	105.0	2	Point
G-1034 A/B/C	Suspect Condensate Pumps	1.5	100.0	2	Point
G-1048 A/B	PE/PP Condensate Flash Drum Pumps	1.5	90.0	1	Point
E-1005	Suspect Condensate Coalescent Cooler	3.0	95.0	1	Point
G-1049 A/B/C/D	OSBL Cooling Tower Pumps	1.5	105.0	3	Point
E-1009	Cooling Towers (OSBL) [3]	16.0	114.0 (per cell)	6	Point
Y-1013	OSBL CT Scaling Dosing Package	3.0	90.0	1	Point

Unit ID	Description	Height (m) (1)	Lw (dB(A))	No.	Type
Y-1014	OSBL CT Corrosion inhibitor Dosing Package	3.0	90.0	1	Point
Y-1015	OSBL CT Biocide Dosing Package	3.0	90.0	1	Point
Y-1016 A/B	Steam Turbine Condensers Vacuum System	3.0	100.0	2	Point
Y-1021	Fuel Treatment Package	3.0	95.0	1	Point
G-1053 A/B/C	Desalinated Water Pumps	1.5	97.0	2	Point
Y-1022	Re-mineralization Package	3.0	90.0	1	Point
G-1055 A/B	Boilers Blow Down Flash Drum Pumps	1.5	90.0	1	Point
G-1058 A/B	Off Spec Fuel Oil #2 Pumps	1.5	85.0	1	Point
G-1009 C	Clean Condensate Pump ST Driven	1.5	103.0	1	Point
G-1033 C/D	HP Boiler Feed Water Pumps ST Driven	1.5	105.0	1	Point
G-1049 E	OSBL Cooling tower Pump ST Driven	1.5	105.0	1	Point
E-1109	Cooling Towers (ET) (3)	16.0	105.0 (per cell)	14	Point
E-1209	Cooling Towers (PE) (3)	16.0	106.0 (per cell)	3	Point
Y-1113	ET CT Scaling Dosing Package	3.0	90.0	1	Point
Y-1114	ET CT Corrosion Inhibitor Dosing Package	3.0	90.0	1	Point
Y-1115	ET CT Biocide Dosing Package	3.0	90.0	1	Point
Y-1213	PE CT Scaling Dosing Package	3.0	90.0	1	Point
Y-1214	PE CT Corrosion Inhibitor Dosing Package	3.0	90.0	1	Point
Y-1215	PE CT Biocide Dosing Package	3.0	90.0	1	Point
G-1249 A/B/C	PE Cooling Tower Pumps	1.5	105.0	2	Point
G-1250	PE Cooling Tower Pump (Steam Driven)	1.5	105.0	1	Point
G-1149 A/B/C/D/E/F	ET Cooling Tower Pumps	1.5	105.0	5	Point
G-1150 G/H	ET Cooling Tower Pumps (Steam Driven)	1.5	105.0	2	Point

Note: Information provided by the EPC contractors (Reference A in Section 8). Equipment that operates only under emergency situations was not included.

(1) Data not available at this stage. A reasonable assumption was made based on best practice and similar cases.

(2) Discontinuous noise source.

(3) Effect of sound directivity was incorporated into the noise propagation from the cooling towers.

Table 6-6 Tank Farm Noise Emission Sources

Unit ID	Description	Height (m) (1)	Lw (dB(A))	No.	Type
G-5001 A/B	Safety Shower Water Pumps (2)	1.5	85.0	1	Point
Y-5001	Potable Water Package	3.0	85.0	1	Point
G-5002 A/B	Potable Water Pumps	1.5	85.0	1	Point
G/5003 A/B/C/D	Naphtha Transfer Pumps and Pipeline to MPS	1.5	100.0	2	Point
P-5001 A/B/C	Instrument Air / Plant Air Compressor	2.0	100.0	2	Point
F-5001 A/B/C	Plant Air Dryer for Tank Farm	2.0	95.0	2	Point
G-5004 A/B	Tank Farm Fresh Water Pumps	1.5	90.0	1	Point
Y-5003	Propylene Butadiene Boil Off Gas Collection and Refrigeration Package	3.0	100.0	1	Point
G-5006 A/B	Propylene Pumps	1.5	103.0	1	Point
G-5008 A/B	Butadiene Pumps	1.5	97.0	1	Point
G-5009 A/B	Benzene Pumps	1.5	97.0	1	Point
G-5010 A/B	Hexene-1 Pumps to Plant	1.5	100.0	1	Point
G-5011 A/B/C	Fuel Oil #2 Pumps	1.5	100.0	2	Point
Y-5006	Nitrogen Storage and Vaporization Package	3.0	105.0	1	Point
Y-5007	Re-mineralization Package	3.0	90.0	1	Point
E-5005	Tank Farm Air Cooling Water Heat Exchangers (3)	16.0	95.0 (per fan)	62	Point
G-5017 A/B/C	Tank Farm Closed Circuit Circulating Pumps	1.5	103.0	2	Point
Y-5008	Tank Farm CCCW Chemical Injection Package	3.0	90.0	1	Point
G-5018 A/B	Hexene-1 Pumps to Jetty	1.5	97.0	1	Point
G-5023 A/B	Ethylene Pumps to Jetty	1.5	100.0	1	Point

Note: Information provided by the EPC Contractors (Reference A in Section 8). Equipment that operates only under emergency situations was not included.

(1) Data not available at this stage. A reasonable assumption was made based on best practice and similar cases.

(2) Discontinuous noise source.

(3) Effect of sound directivity was incorporated into the noise propagation from fans.

Table 6-7 Sea Water Intake Noise Emission Sources

Unit ID	Description	Height (m) (1)	Lw (dB(A))	No.	Type
G-7002A/B/C/D/E/F	Sea Water Pumps	1.5	106.0	4	Point
Y-7004	Ultra Filtration System - Seawater Reverse Osmosis System	3.0	103.0	1	Point
G-7003 A/B/C/D/E	Desalinated Water Pumps	1.5	103.0	4	Point

Unit ID	Description	Height (m) (1)	Lw (dB(A))	No.	Type
Y-7007	Electrochlorination Package	3.0	100.0	1	Point
G-7005 A/B/C/D/E	Backpulse Waste Pumps	1.5	100.0	5	Point
G-7007	Sodium Hydroxide Tank Filling Pump	1.5	85.0	1	Point
G-7008	Sodium Bisulfite Tank Filling Pump	1.5	85.0	1	Point
G-7009	Hydrochloric Acid Tank Filling Pump	1.5	85.0	1	Point
G-7010	Citric Acid Tank Filling Pump	1.5	85.0	1	Point
G-7011	Sodium Hypochlorite Tank Filling Pump	1.5	85.0	1	Point
G-7012	Ferric Chlorite Tank Filling Pump	1.5	85.0	1	Point
G-7013	MDC150 (Antiscalant) Filling Pump	1.5	85.0	1	Point
G-7014	MCT404 (RO CIP) Filling Pump	1.5	85.0	1	Point
G-7015	MCT411 (RO CIP) Filling Pump	1.5	85.0	1	Point

Note: Information provided by the EPC Contractors (Reference A in Section 8).

(1) Data not available at this stage. A reasonable assumption was made based on best practice and similar cases.

Table 6-8 Sea Water Desalination System Noise Emission Sources

Unit ID	Description	Height (m) (1)	Lw (dB(A))	No.	Type
1	SWRO HP Feed Pumps	1.5	91	11	Point
2	ERD Boost Pumps	1.5	78	11	Point
3	14 ERD PX-Q300 Units	1.5	79	11	Point
4	BWRO LP Feed Pumps	1.5	85	4	Point
5	BWRO Stage 1 Feed Pumps	1.5	90	6	Point
6	BWRO Stage 2 Feed Pumps	1.5	73	6	Point
7	UF Permeate Pumps	1.5	85	20	Point
8	UF Backpulse Pumps	1.5	85	3	Point
9	Recirculation/Neutralization Pumps	1.5	85	3	Point
10	PIAB Ejectors	2.0	67	20	Point
11	Air Compressors	2.0	66	3	Point
12	Roots Blowers (1 operating, 2 in stand-by)	2.0	74	1	Point
15	SWRO LP Feed Pumps	1.5	86	6	Point

Note: Information provided by the EPC Contractors (Reference F in Section 8).

(1) Data not available at this stage. A reasonable assumption was made based on best practice and similar cases.

Table 6-9 Jetty Noise Emission Sources

Unit ID	Description	Height (m)(1)	Lw (dB(A))	No.	Type
K-2001	Naphtha Metering Skid(2)	2.0	90.0	1	Point
K-6001	Ethylene Metering Skid(2)	2.0	90.0	1	Point
K-6002	Propylene Metering Skid(2)	2.0	90.0	1	Point
K-6003	Benzene Metering Skid(2)	2.0	90.0	1	Point
K-6004	Butadiene Metering Skid(2)	2.0	90.0	1	Point
K-6005	Hexene-1 Metering Skid(2)	2.0	90.0	1	Point
K-6006	Isopentane Metering Skid(2)	2.0	90.0	1	Point
T-6003	Ship Loading System - Benzene (2)	2.0	100.0	1	Point
T-6007	Ship Loading/Unloading Hexene-1 System (2)	2.0	100.0	1	Point
T-6011	Ship Unloading Isopentane/Unloading Butene-1 System (2)	2.0	100.0	1	Point
K-6007	Fuel Oil #2 Metering Skid (2)	2.0	100.0	1	Point
T-6012	Ship Unloading System Fuel Oil #2 Import (2)	2.0	100.0	1	Point
T-6013	Gangway	2.0	100.0	1	Point
Y-6001	Ship Vapour Recovery (VCU) (2)	2.0	102.5	1	Point
G-6014 A/B	Onshore Slops Forwarding Pumps (2)	1.5	90.0	2	Point
G-6015 A/B	Loading Platform Slops Forwarding Pumps (2)	1.5	90.0	2	Point
T-6020	Ship Loading System Propylene/Ethylene Liquid (2)	3.0	90.0	1	Point

Note: Information provided by the EPC Contractors (Reference A in Section 8).

(1) Data not available at this stage. A reasonable assumption was made based on best practice and similar cases.

(2) Discontinuous noise source.

6.2 Model Options

The input data used for the noise model are listed in Table 6-10.

Table 6-10 General Modelling Options

Run Description	**Situation Modelled**
Calculation	Grid Noise Map
Run Parameters	
Reflection order	2
Maximal reflection distance to receiver	200 m
Maximal reflection distance to source	50 m
Search radius	20 000 m
Weighting	dB(A)
Tolerance	0.010 dB
Calculation with side screening. Source side reflection pre-calculation enabled	
Standards	
Industry	ISO 9613-2 : 1996
Air Absorption	ISO 9613
Limitation of Screening Loss: single/multiple	20 dB / 25 dB
Ground height of sources above buildings set to roof top	
Environment (1)	
Air Pressure	1013.3 mbar
Humidity	70%
Temperature	10.0 °C
VDI-Parameters for diffraction	C_1=3; C_2=20
Dissection Parameters	
Distance to diameter factor	8
Minimum Distance [m]	1 m
Max. Difference GND + Diffraction	1 dB(A)
Max. Number of Iterations	4
Assessment	Leq

Map	
Grid Spacing	10 m
Grid Interpolation	
Field Size	9 x 9
Min/Max	10 dB(A)
Difference	0.1 dB(A)
Geometric Constraints	Geometry Data; Topography; Building Geometry; Calculation Area Geometry; Main Noise Sources Geometry

(1) For the purposes of this assessment, ISO 9613-2:1996 method default values were selected for meteorological conditions, which correspond to soft wind blowing in all directions at the same speed and an average temperature of 10 °C. These conditions generate minimum attenuation over the modelling domain, which corresponds to a conservative approach.

7. MODEL RESULTS AND DISCUSSION

The results of the model are presented on noise contour maps that were generated from a colour-coded noise level distribution grid. The colour scale was chosen so that cool colours (green) represent low values of sound pressure and warm colours (red) represent elevated values of sound pressure. Contour lines (isophones) are representative of noise pressure intervals of 5 dB(A).

The noise contour maps only represent the SPLs predicted in each area as a result of the operation of the Tahrir Petrochemicals Complex. For this reason, the background SPLs measured at four locations (N1-N4) along the Main Plant boundary and at one location (N5) southwest of the Port Area, as described in Section 4, were added to the SPLs predicted from the proposed facilities at these locations to calculate the cumulative noise levels using the formula described in Section 5.3. In addition, historical background noise data recorded on March 2009 in the Port Area were used to provide a general overview of the background acoustic conditions at this location.

The predicted SPLs generated by the proposed complex and the cumulative noise levels were discussed and compared with the Maximum Permissible Limits for Noise Intensity defined by Egyptian regulation (Law 4/1994) and the IFC Guidelines. This assessment focused on evaluating compliance of the noise contributions from the project in the sensitive receptors and industrial areas with national and international standards.

As previously mentioned in Section 6, the information used for running the model and presented in this report is from Pre-FEED design data provided by the project contractors. Accordingly, should the as built information deviates from the current information used to run this model, it is highly recommended to rerun the model with the as built information before the plant start-up.

7.1 Project Contribution – Before Mitigation

The model predictions beyond the property boundaries, based on the provided facility details and the assumptions made (see Section 6) are summarized below:

Plant Boundaries

- **Main Plant:** Predicted SPLs at points along the facility boundary are below the noise limits for industrial areas defined by Egyptian regulation and the IFC Guidelines (70 dB(A), national and international standards).
- **Port Area:** Based on the results obtained using SoundPLAN, the maximum noise level generated at the Port Area boundary will be 74 dB(A), which is above the national and international standards for industrial areas. This potential non-compliance is predicted in the proximity of the sea water pumps. SPLs at other locations along the Port Area fence line are predicted to be below 70 dB(A).

The model predictions of the noise levels (before mitigation) along the boundaries of the Tahrir Petrochemicals Complex Main Plant and the Port Area are shown in Figure 7-1 and Figure 7-2, respectively.

Figure 7-1 Tahrir Petrochemicals Complex Noise Map – Main Plant

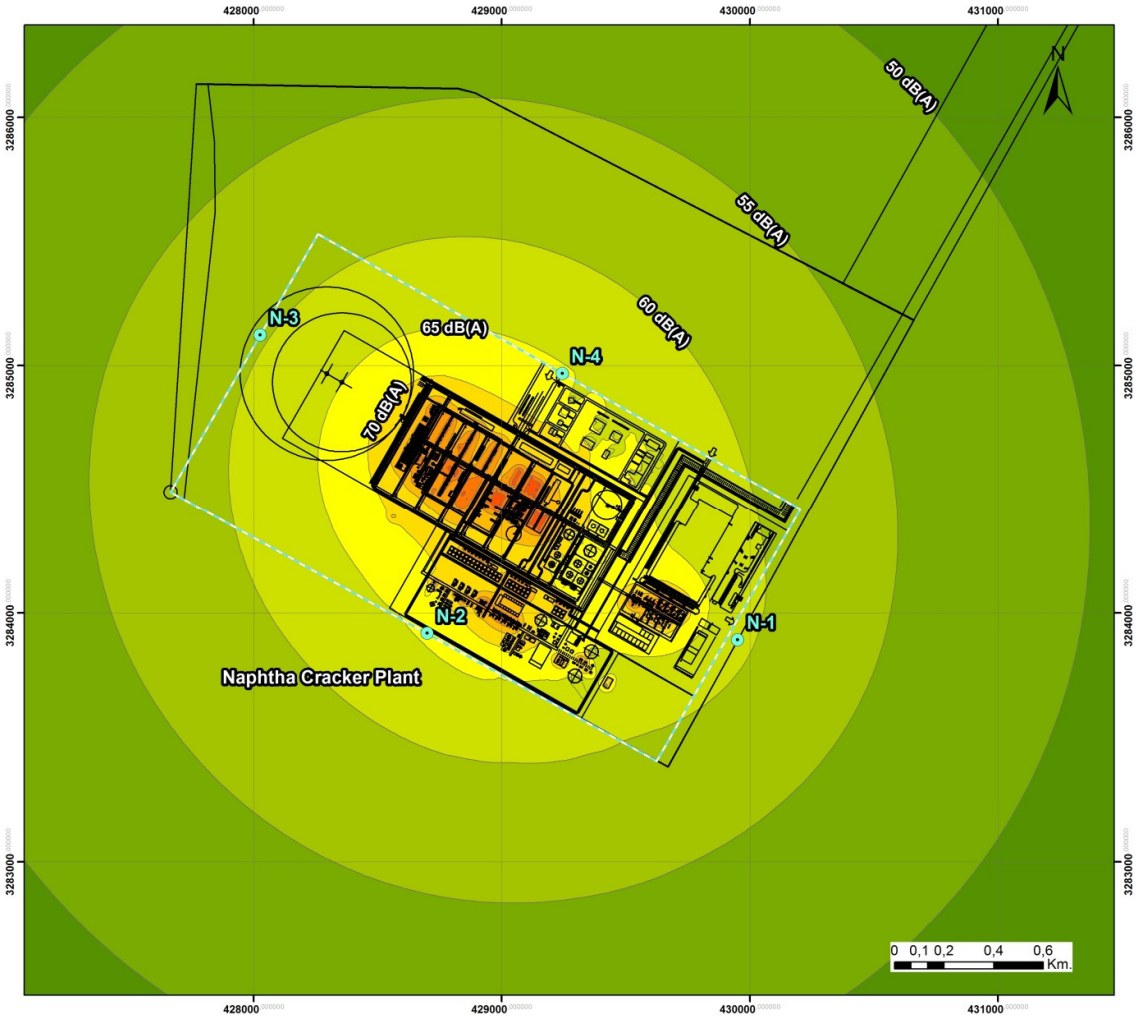


Figure 7-2 Tahrir Petrochemicals Complex Noise Map – Port Area

Nearest Receptors

The SPLs from the operation of the Main Plant and the Port Area components that are predicted by the model across the area of influence, which includes two tourist villages located on the coast, are shown in the noise map provided at the end of this report (Figure 1). Noise sources in the Port Area are the main contributors that could impact the tourist villages. The maximum SPLs predicted at the two receptors are as follows:

- 43 dB(A) at the tourist village located 0.9 km south of the Port Area
- 27 dB(A) at the tourist village located 3.6 km northeast of the Port Area

These noise levels are below the IFC ambient noise limits for "residential, institutional, educational" areas, which are 55 dB(A) during daytime and 45 dB(A) during night-time.

At the recreational area located south of the Tahrir Petrochemicals Complex Port Area, the predicted SPLs exceed the Maximum Permissible Limit for Noise Intensity in "Areas sensitive to exposure noise" during the night-time, which is 40 dB(A) based on Egyptian regulation (Law 4/1994).

The results of a preliminary mitigation measures assessment are provided in Section 7.2.

7.2 Mitigation Measures

This section describes mitigation measures that are proposed to reduce the SPLs that are predicted at the southern boundary of the Port Area and the noise contributions from the project at the tourist village located 0.9 km south of the port.

Mitigation measures might include one or more of the following:

- Selection of equipment with lower guaranteed emission levels: Could be accomplished through the technical specifications for equipment acquisition, in which the maximum allowed noise emission levels per equipment are stated.
- Acoustic insulation: In cases for which stringent technical specifications cannot be met, the unit could be appropriately insulated to adequately mitigate the sound pressure levels that are generated.
- Noise barriers: Installing barriers that could effectively reduce noise levels between the equipment that generates noise and the receptors.

The mitigation measures that were assessed as part of this study are: 1) the attenuation of the noise levels produced by equipment (through the selection of equipment with lower guaranteed emission levels or by acoustic insulation); and 2) the installation of a perimeter wall at the Port Area boundary. Mitigation measures based on the localized installation of noise barriers shall be assessed at the detailed engineering phase.

7.2.1 Noise Attenuation at the Main Sources

The most efficient strategy to mitigate the potential impact was defined by identifying those noise sources in the Tahrir Petrochemical Complex that would result in higher noise level contributions at the receptors. SoundPLAN was used to evaluate the attenuation that would be required to mitigate the sound levels produced by these sources.

The predicted SPLs above the standards at the Port Area boundary are due to the operation of the sea water pumps, which are located close to the fence line. These units would require an acoustic power emission attenuation of 4 dB(A) (Lw after mitigation would be 102 dB(A)), to reduce the noise levels at the southern facilities boundary to below 70 dB(A).

Further mitigation at the sea water pumps and other equipment in the Port Area would be required to mitigate the model predictions at the tourist village located 0.9 km south of the port to below the limit set by Egyptian Law 4/1994 for "Areas sensitive to exposure noise" (40 dB(A) during night-time). This study found that applying the attenuation indicated in

Table 7-1 (as given in acoustic power emission data, Lw) at sources that will contribute higher noise levels at the receptor would reduce the noise levels to 40 dB(A). Model predictions at facility fence line and at nearest receptors are as follows:

- 63 dB(A) at the Port Area boundary (maximum predicted SPL), complying with the national and international standards for industrial areas,
- 40 dB(A) at the tourist village located 0.9 km south of the Port Area and 25 dB(A) at the tourist village located 3.6 km northeast of the Port Area. These SPLs comply with the IFC ambient noise limits for "residential, institutional, educational" areas (55 dB(A) during daytime and 45 dB(A) during night-time) and the Egyptian Maximum Permissible Limit for Noise Intensity in "Areas sensitive to exposure noise" (50 dB(A) during daytime and 40 dB(A) during night-time).

The results of the model assuming the implementation of adequate mitigation are represented in Figure 2 at the end of this report.

Table 7-1 Noise Levels from Selected Equipment Before/After Attenuation

Sources		Sound Pressure Level, SPL (dB(A))		
		Contribution	Lw (initial)	Lw (mitigated)
G-7002 A/B/C/D/E/F	Sea Water Pumps	31.8 – 32.0	106.0	95.0
Y-5006	Nitrogen Storage and Vaporization Package	29.7	105.0	97.0
G-5017 A/B/C	Tank Farm Closed Circuit Circulating Pumps	26.8	103.0	98.0
G-7003 A/B/C/D/E	Desalinated Water Pumps	26.5	103.0	98.0
Y-7004	Ultra Filtration System - Seawater Reverse Osmosis System	26.0	103.0	98.0
G-5006 A/B	Propylene Pumps	25.4	103.0	99.0
Y-7007	Electrochlorination Package	25.4	100.0	96.0
P-5001 A/B/C	Instrument Air / Plant Air Compressor	24.3	100.0	97.0
Y-6001	Ship Vapour recovery (VCU)	24.2	102.5	100.0
G-7005 A/B/C/D/E	Backpulse Waste Pumps	24.2 – 24.1	100.0	97.0
G-5011 A/B/C	Fuel Oil #2 Pumps	22.7 – 2.8	100	99.0

Sources		Sound Pressure Level, SPL (dB(A))		
		Contribution	Lw (initial)	Lw (mitigated)
G-5010 A/B	Hexene-1 Pumps to Plant	22.5	100	99.0

7.2.2 Perimeter Wall

The effectiveness of installing a noise barrier along the south boundary of the Port Area was assessed using SoundPLAN to determine if the predicted SPLs would be sufficiently reduced at the areas of potential non-compliance. The modelled perimeter wall was 3 metres high and constructed of brick with the following absorption coefficients:

Frequency	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz
Absorption Coefficient	0.020	0.030	0.030	0.030	0.040	0.050	0.060	0.070

Source: SoundPLAN database

Incorporating a perimeter wall into the SoundPLAN model (without any other mitigation measure) found that the attenuation would be limited to the immediate proximity of the noise barrier. SPLs at the facilities boundary would be reduced to below 70 dB(A) limit, but sound levels at the tourist village located south of the port would not be mitigated with maximum predicted SPLs being:

- 43 dB(A) at the tourist village located 0.9 km south of the Port Area
- 27 dB(A) at the tourist village located 3.6 km northeast of the Port Area

Model results after mitigation are represented in Figure 7-3 and on the noise map at the end of this report in Figure 3.

Since the effectiveness of this measure does not verify the total project compliance with ambient noise standards, this mitigation has been discarded.

Figure 7-3 Tahrir Petrochemicals Complex Noise Map with a Perimeter Wall – Port Area

7.3 Cumulative Effects (model + background noise)

Background Noise Monitoring Campaign (August – November 2014)

Using the noise level values predicted by the model and the formula described in Section 5.3, the cumulative effects of the proposed facility predicted at the background noise measurement locations (N1 – N5) are listed in Table 7-2. This assessment considers model results after the attenuation at selected equipment proposed above (see Section 7.2.1). As mentioned in Section 7.2.2, incorporating a perimeter wall into Port Area fence-line will attenuate the acoustic impact in the immediate proximity of the noise barrier, but sound levels at the tourist villages will not be significantly mitigated, therefore this mitigation has been discarded.

Table 7-2 Cumulative Noise Levels (N1-N5 Monitoring Locations)

Loc.	Period	Background LAeq, dB(A)	Predicted SPL from Project, dB(A)	Cumulative SPL, dB(A)	Noise Limit, dB(A)	
					Egyptian Law 4/1994	IFC Guidelines
N1	Day	41.6	61.1	61.1	70	70
	Night	39.1		61.1	70	70
N2	Day	47.2	65.7	65.8	70	70
	Night	42.5		65.7	70	70
N3	Day	45.0	59.6	59.8	70	70
	Night	41.5		59.7	70	70
N4	Day	40.9	65.5	63.5	70	70
N5	Day	56.5	33.1	56.5	70	--
	Night	54.3		54.3	60	--

The calculated cumulative effects indicate that the noise levels at N1-N4 monitoring locations will be below the Egyptian Maximum Permissible Limits for Noise Intensity in industrial areas (70 dB(A)). The calculated SPLs will also comply with the IFC limit (70 dB(A)) in industrial areas).

Cumulative SPLs measured at the N5 location in the proximity of a tourist village, which is located southwest of the port and is affected by traffic noise, will comply with national standards for "areas located on roads 12-metres wide or wider". The calculated contribution from the project above the background levels is predicted to be negligible.

Historical Background Noise Monitoring (2009) at the Port Area

The cumulative effect of the proposed facility, after the attenuation at selected equipment proposed in Section 7.2.1, was calculated at the Port Area fence-line where maximum SPLs were predicted. It was assumed that background noise measurement conducted at N6 is representative of the acoustic conditions at the port.

As shown in Table 7-3, result is below the national and international standard for industrial areas (70 dB(A)).

Table 7-3 Cumulative Noise Levels (Port Area fence-line)

Loc.	Period	Background LAeq, dB(A)	Predicted SPL from Project, dB(A)	Cumulative SPL, dB(A)	Noise Limit, dB(A)	
					Egyptian Law 4/1994	IFC Guidelines
N6	24h	50.3	63.4	63.6	70	70

8. CONCLUSIONS AND RECOMMENDATIONS

1) This noise model is considered a screening approach to evaluate potential environmental noise impacts from the proposed facility. The information used for running the model and presented in this report is from Pre-FEED design data provided by the project contractors. Accordingly, should the as built information deviates from the current Pre-FEED information used to run this model, we recommend rerunning the model with the as built information before the plant start-up.

2) The baseline noise conditions (background noise) were determined in the project area based on the results of two monitoring campaigns that were conducted in 2014 and on historical sound measurements recorded in 2009 at the port area.

3) Preliminary mitigation measures to reduce the predicted SPLs at the southern boundary of the Port Area and the noise contributions from the project at the tourist village located south of the port were assessed. Attenuation of SPLs produced by selected equipment would be effective; and the installation of a perimeter wall along the southern boundary of the Port Area would mitigate SPLs at the facilities boundary, but not at the tourist village. Mitigation measures based on the localized installation of noise barriers should be assessed at the detailed engineering phase.

4) Results of the noise modelling assessment of the proposed Tahrir Petrochemicals Complex Project operation after attenuation at selected equipment indicated in this report, are as follows:

   Project Contribution

   a) **Main Plant:** Predicted SPLs at points along the facility boundary are below the noise limits for industrial areas defined by Egyptian regulation and the IFC Guidelines (70 dB(A), national and international standards).

   b) **Port Area:** The maximum noise level predicted at the Port Area boundary is 63 dB(A), complying with the national and international standards for industrial areas.

   c) **Nearest Receptors:** Predicted SPLs are 40 dB(A) at the tourist village located 0.9 km south of the Port Area and 25 dB(A) at the tourist village located 3.6 km northeast of the Port Area. These SPLs comply with the IFC ambient noise limits for “residential, institutional, educational” areas (55 dB(A) during daytime and 45 dB(A) during night-time) and the Egyptian Maximum Permissible Limit for Noise Intensity in “Areas sensitive to exposure noise” (50 dB(A) during daytime and 40 dB(A) during night-time).

Cumulative Effects (model + background noise)

a) **Main Plant:** The calculated cumulative noise levels at the monitoring locations along the site boundary (N1-N4) will be below the Egyptian Maximum Permissible Limits for Noise Intensity and the IFC limit in industrial areas.

b) **Port Area:** The cumulative effect was calculated at the Port Area fence-line where maximum SPLs were predicted; assuming that background noise measurement conducted at N6 is representative of the acoustic conditions at the port. Result is below the Egyptian Maximum Permissible Limits for Noise Intensity and the IFC limit in industrial areas.

c) **Nearest Receptors:** The calculated cumulative noise levels at the N5 monitoring location, in the proximity of a tourist village southwest of the port that is affected by traffic noise, will comply with national standards for "areas located on roads 12-metres wide or wider". The calculated contribution of the project above the background levels is predicted to be negligible.

3) Historical background noise data were used to provide a general overview of the acoustic conditions at the Port Area. It is recommended that a monitoring campaign be conducted at the Port Area and at the tourist village located south of the port before project construction and operation.

4) Monitoring should be conducted during the initial stages of operation to validate the model results and to determine the necessity for further mitigation.

Based on the Noise Model results, the proposed Tahrir Petrochemicals are complying with the national & International limits presented in the report with applying the required mitigation, however should the model input parameters change in the detailed engineering phase, a model rerun would be required to assure the as built design compliance before commissioning & start-up.

9. REFERENCES

External References

Law 4 of 1994, Environment Law and its Executive Regulations, Egypt

ISO 9613-2: 1996. Acoustics -- Attenuation of sound during propagation outdoors

SoundPLAN Manual, 2008, Braunstein + Berndt GmbH / SoundPLAN LLC

US Department of Transportation (December 2011); Highway Traffic Noise: Analysis and Abatement Guidance

IFC, 2007; Environmental, Health and Safety General Guidelines

Documents provided by the Contractors

A. "Noise and Air Model Input Updated_Nov 2014_Cairo - TPC 10-11-2014"

B. "TPC_RFQ_BuildingDescription_27042014"

C. "&AA S-LX 1501 List of Main Noise Sources Rev.1_Jan 2013" (and subsequent clarifications)

D. PE_Noise Data (PWL)_Dec 2012

E. PE_Noise Emission PLOT_PLAN_04.08.2013

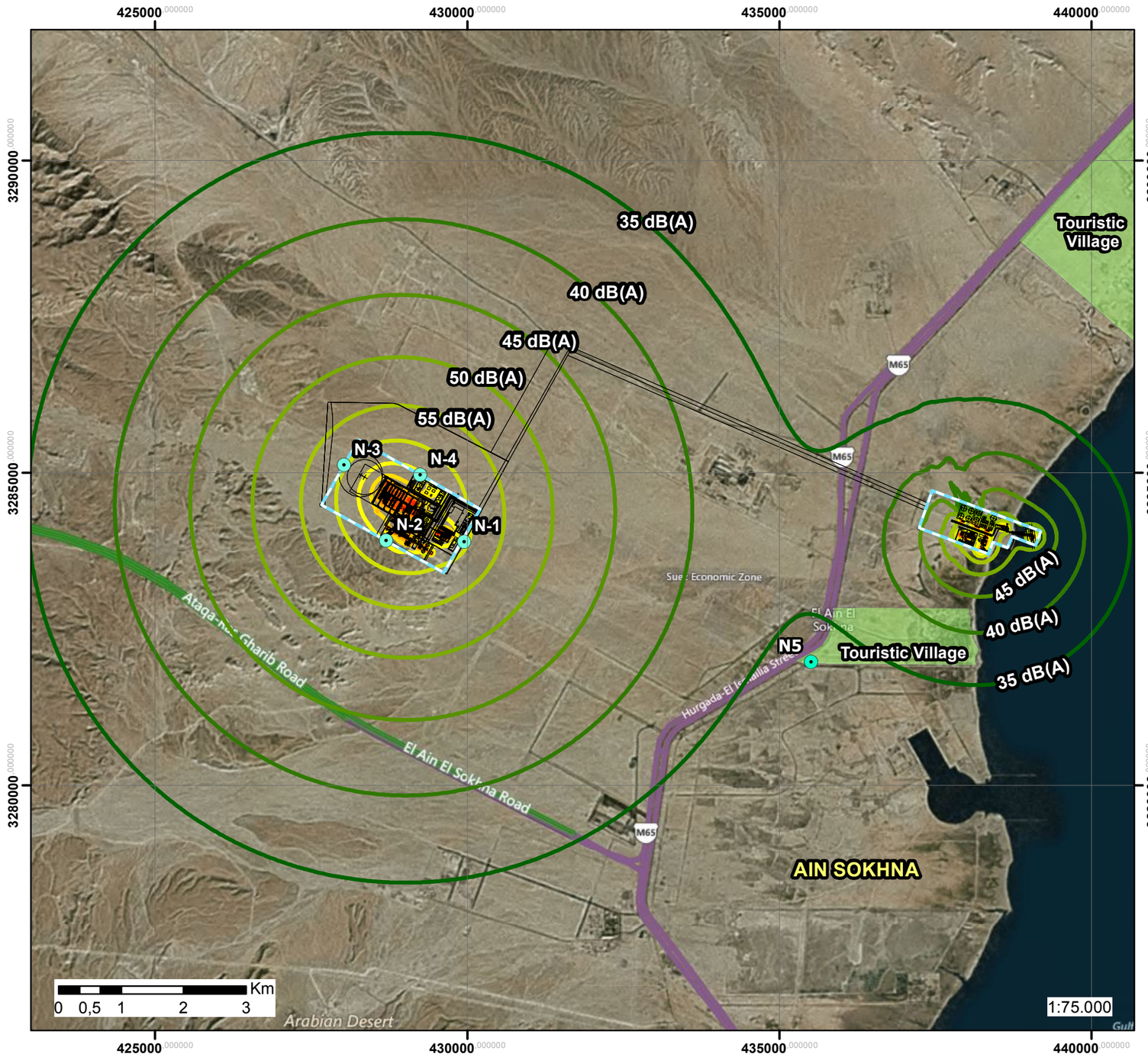
F. Sound Survey Seawater Desalination System at Port

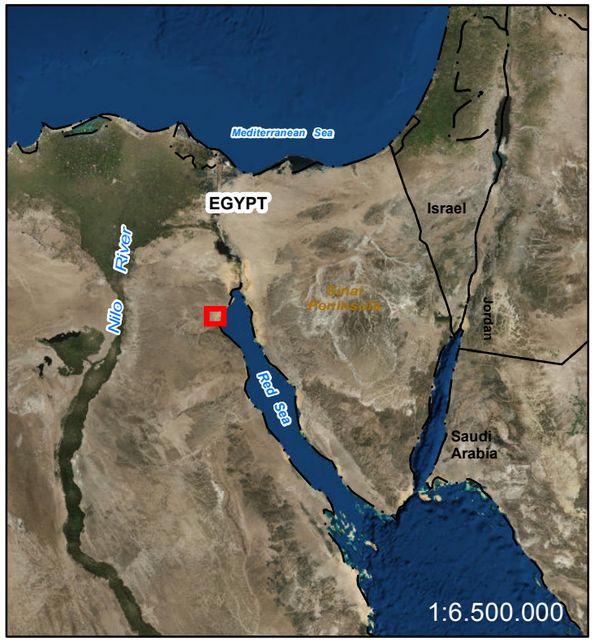
G. GENERAL PLOT PLAN (OPTION "C" McDERMOTT): 3816-XX-DG-200-02 (Revision 02)

H. GENERAL PLOT PLAN OF MAIN PLANT (CRACKING-PE-U&O) (OPTION "C" McDERMOTT): 3816-XX-DG-201-01 (Revision 01)

I. GENERAL PLOT PLAN OF PORT AREA (STORAGE-DESAL-JETTY) (OPTION "C" McMcDERMOTT): 3816-XX-DG-202-01 (Revision 01)

Appendix 1 - Noise Maps





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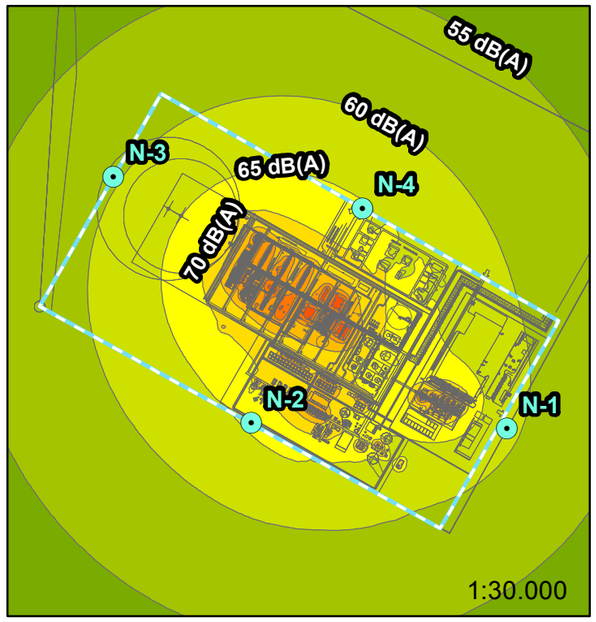

Legend

- Monitoring Locations
- 35 dB(A)
- 40 dB(A)
- 45 dB(A)
- 50 dB(A)
- 55 dB(A)
- 60 dB(A)
- 65 dB(A)
- 70 dB(A)
- 75 dB(A)
- 80 dB(A)
- 85 dB(A)
- 90 dB(A)
- 95 dB(A)

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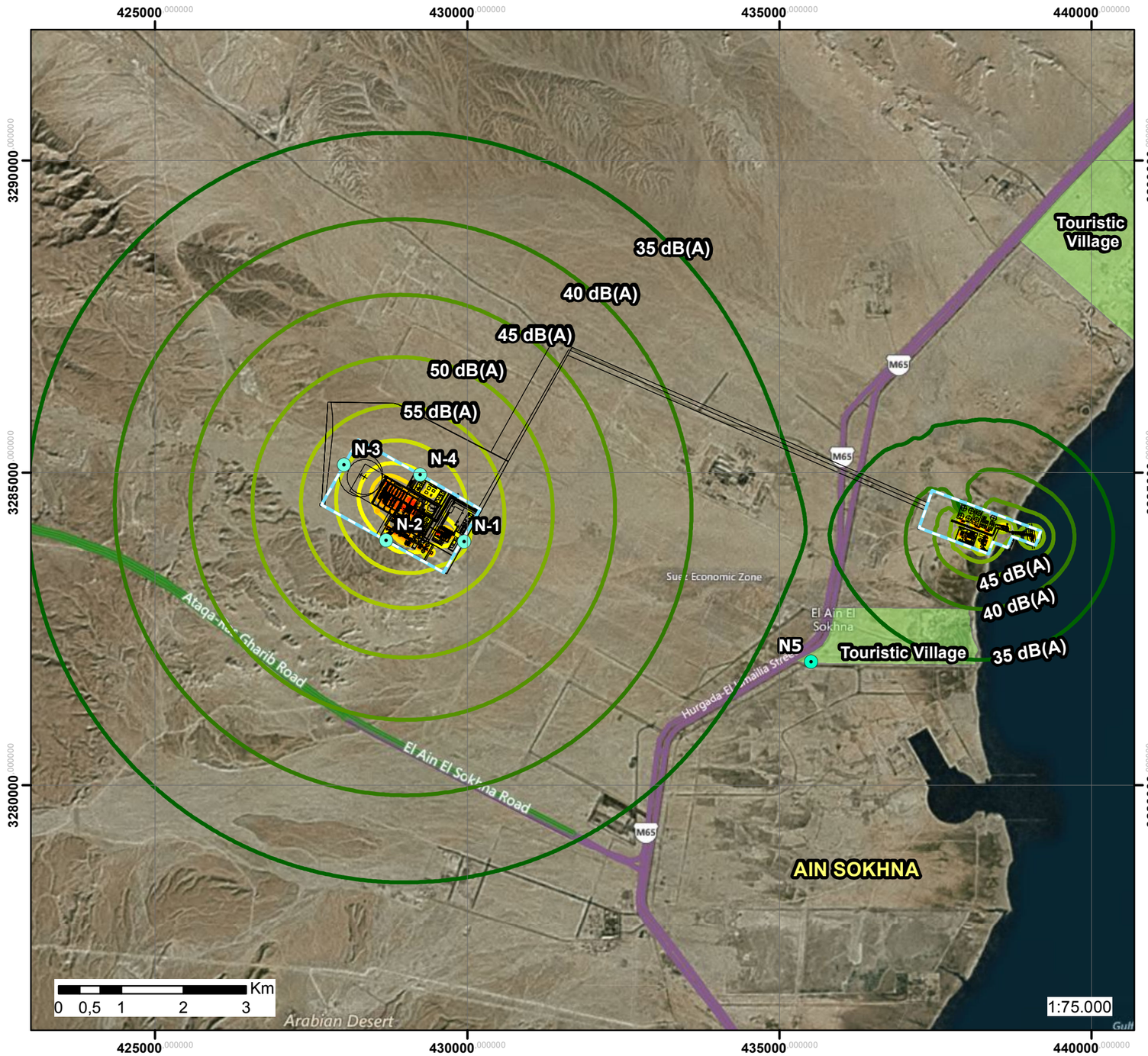
Project Nº: 60109-01
Tahrir Petrochemicals Complex Noise Model

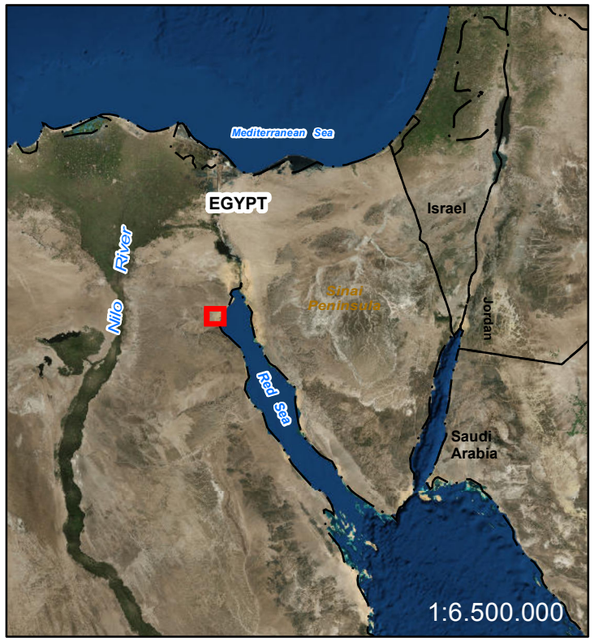
TAHRIR PETROCHEMICALS CORPORATION

NOISE MAP
BEFORE MITIGATION

WorleyParsons Consulting
Tel: +34 917 991 092 Fax: +34 913 519 296
Web: www.worleyparsons.com

DRAWN	STATUS:	APPROVED:	ORIGINAL	DATE	SCALE	OFFICE	CÓDIGO
FJPA	DRAFT	EGG	A3	12/01/2015	SHOWN	MADRID	**FIGURE 1**





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Legend

- Monitoring Locations
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- 50 dB(A)
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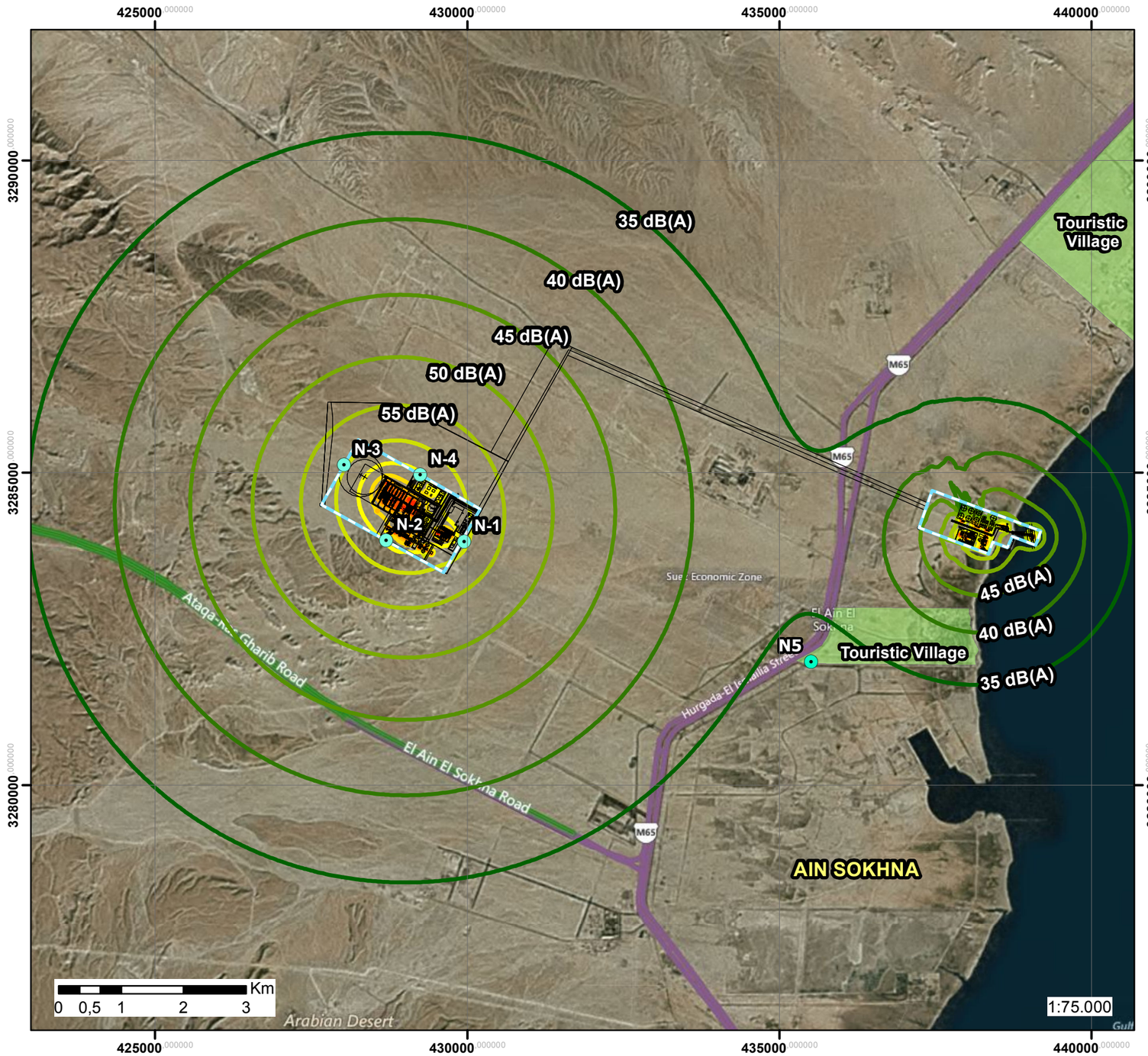
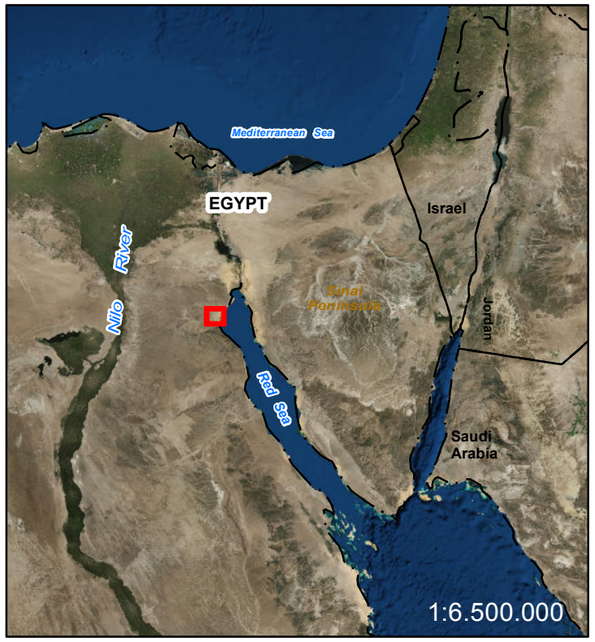
Project Nº: 60109-01 **Tahrir Petrochemicals Complex Noise Model**							**TAHRIR PETROCHEMICALS CORPORATION**	
NOISE MAP AFTER MITIGATION **NOISE ATTENUATION AT THE MAIN SOURCES**							WorleyParsons Consulting *Tel: +34 917 991 092 Fax: +34 913 519 296* *Web: www.worleyparsons.com*	
DRAWN FJPA	STATUS: DRAFT	APPROVED: EGG	ORIGINAL A3	DATE 12/01/2015	SCALE SHOWN	OFFICE MADRID	CÓDIGO	**FIGURE 2**





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Legend

- Monitoring Locations
- 35 dB(A)
- 40 dB(A)
- 45 dB(A)
- 50 dB(A)
- 55 dB(A)
- 60 dB(A)
- 65 dB(A)
- 70 dB(A)
- 75 dB(A)
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Project Nº: 60109-01
Tahrir Petrochemicals Complex Noise Model

TAHRIR PETROCHEMICALS CORPORATION

NOISE MAP AFTER MITIGATION
PERIMETER WALL

WorleyParsons Consulting
Tel: +34 917 991 092 Fax: +34 913 519 296
Web: www.worleyparsons.com

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FIGURE 3