Appendix O – Noise Impact Assessment

Dubai Waste to Energy

Noise Impact Assessment

Prepared for: GHD

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Acronyms

UAE	United Arab Emirates
ISO	International Organisation for Standardisation
NSR	Noise Sensitive Receptor
IoA	Institute of Acoustics
IEMA	Institute of Environmental Management and Assessment

1 Introduction

WKC Environment Consultancy (WKC) have been contracted by GHD to undertake a noise impact assessment for the proposed Dubai Waste to Energy development. This report presents the findings of a noise modelling study for operational noise emissions associated with the proposed development.

1.1 Project Site

The proposed project site is located in Dubai, United Arab Emirates (UAE). The site location within the UAE is illustrated in Figure 1-1. Figure 1-2 presents the project in a local context.

Figure 1-1 - Project Location within the UAE

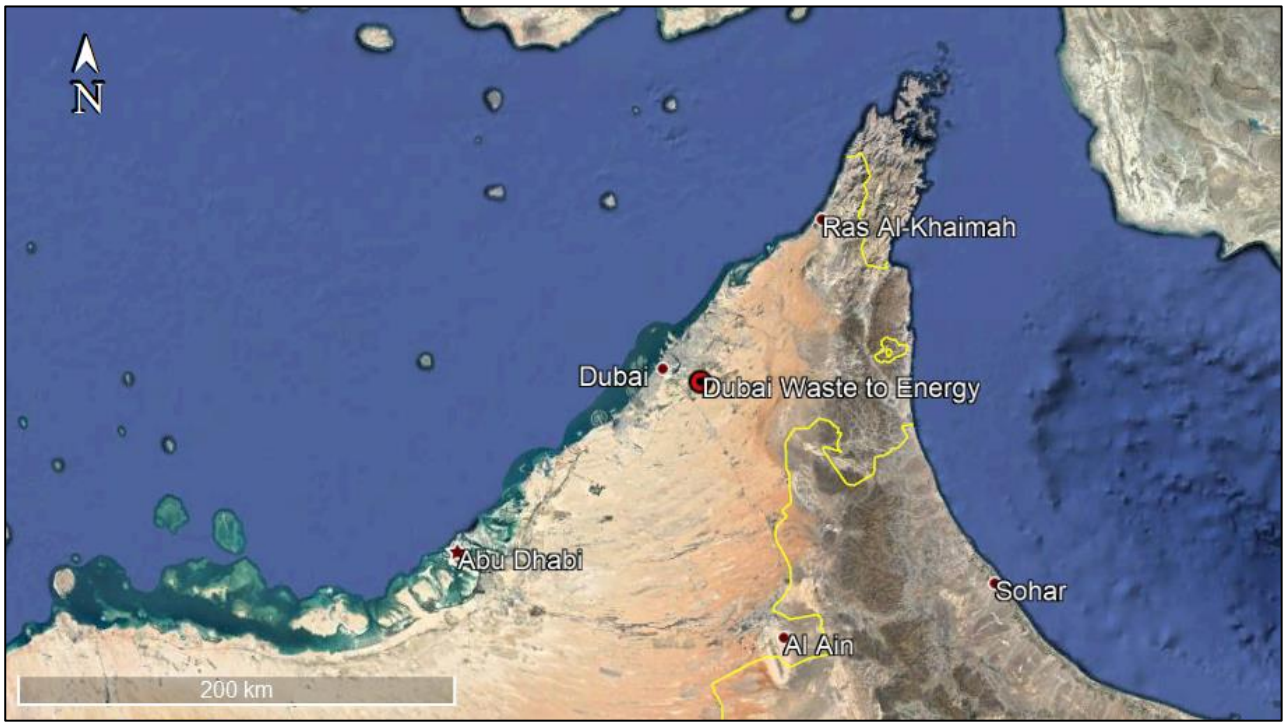


Figure 1-2 - Location of Project Facilities in a Local Context

1.2 About This Report

This report presents the findings of an environmental noise modelling study for the Dubai Waste to Energy project during normal operations. Through a review of provided data, potentially noisy equipment items have been identified and modelled using SoundPlan V8.0

A series of noise contour plots have been produced detailing the overall project noise levels, with these being assessed in accordance with the environmental noise standards detailed in Section 2.

2 Noise Standards and Guidance

This section presents the national and international standards, guidance and Project specifications applicable to the assessment.

2.1 UAE Federal Environmental Noise Limit

Table 2-1 presents the UAE Federal Noise Limits for classes of receptor areas as specified by the UAE Federal Environment Agency [1].

Table 2-1 - Noise Level Limit – UAE Federal Environment Agency [1]

Receptor Areas	Allowable Noise Limits (L_{Aeq_1hour} - dB(A))	
	Daytime (7:00 am – 8:00 pm)	Night time (8:00 pm – 7:00 am)
Residential Areas with Light Traffic	40 – 50	30 – 40
Residential Areas in Downtown	45 – 55	35 – 45
Residential Areas with some Workshops & Commercial or near Highways	50 – 60	40 – 50
Commercial Areas & Downtown	55 – 65	45 – 55
Industrial Areas (Heavy Industry)	60 – 70	50 - 60

2.2 International Guidance

2.2.1 ISO 1996-1-3 'Description and Measurement of Environmental Noise'

International Organization for Standardisation (ISO) d1996-1-3 – 'Description and Measurement of Environmental Noise' [2] defines the basic quantities to be used for the description of noise in community environments and the basic procedures for the determination of these quantities. It also includes the methods for acquisition of data that enable specific noise situations to be checked for compliance with given noise limits.

2.2.2 ISO 9613-2 'Acoustics – Attenuation of Sound during Propagation Outdoors'

ISO 9613 Acoustics – 'Attenuation of Sound during Propagation Outdoors' [3] specifies an engineering method for calculating the attenuation of sound during propagation outdoors in order to predict the levels of

environmental noise at a distance from a variety of sources. The method predicts the equivalent continuous A-weighted sound pressure level (LAeq) under meteorological conditions favourable to propagation (i.e. generic downwind conditions) from sources of known sound emission.

2.2.3 Calculation of Operational Noise

ISO 9613 Acoustics – Attenuation of Sound During Propagation Outdoors' [3] specifies an engineering method for calculating the attenuation of sound during propagation outdoors in order to predict the levels of environmental noise at a distance from a variety of sources. The method predicts the equivalent continuous A-weighted sound pressure level (LAeq) under meteorological conditions favourable to propagation from sources of known sound emission.

SoundPLAN© 8 is an internationally recognised noise modelling software that adopts ISO 9613, and has been used to estimate the operational noise levels associated with the Project. This software allows for a spatially-constructed model, incorporating noise emission parameters of the Project facilities/activities, and calculates sound propagation and attenuation by recognised methods in order to predict the levels of environmental noise at a distance from the modelled sources. The method predicts the LAeq under meteorological conditions favourable to propagation from sources of known sound emission.

The criteria for the assessment of change in noise levels arising at noise sensitive receptors (NSRs) from the operation of the Project have been adapted from the joint Institute of Environmental Management and Assessment (IEMA) and the Institute of Acoustics (IoA) guidelines for noise and vibration impact assessment categories and are given in Table 2-2.

Table 2-2 - Noise Impact Assessment Criteria

Impact Category	Incremental Change in Ambient Noise Level	Description of Impact
No Effect	0 dB(A)	Not discernible
Negligible	0.1 – 2.9 dB(A)	Not discernible – Marginal changes in noise levels of less than 3 dB(A) in residential areas, or outdoor recreational areas in close proximity to main roads.
Minor Negative	3 to 4.9 dB(A)	Noticeable adverse – Noise levels of 3-5 dB(A) in residential areas, or at outdoor recreational areas.
Moderate Negative	5 to <10 dB(A)	Considerable adverse – Noise levels warrant mitigation of residential properties on a widespread basis in a community, or for outdoor recreation areas close to main roads.
Major Negative	10 dB(A) or more	Major adverse – Noise increases to a level where continued residential use of individual properties is inappropriate, or where the use of a community building could be inappropriate.

3 Baseline Noise Conditions

3.1 Noise Measurement Locations

A baseline noise study was conducted from the 18th to the 19th of August 2018, in order to determine the environmental noise characteristics at a number of locations of interest around the Project area. Details of the measurement locations are summarised in Table 3-1, and the measurement locations are provided in Figure 3-1.

Table 3-1 - Noise Measurement Locations and Applicable Noise Limits

Ref.	Site Description	Site Classification	Coordinates (m E)	Coordinates (m N)	Daytime Noise Limit (dB(A))	Nigh time Noise Limit (dB(A))
NQM01	North Point	Residential Areas	343218.94	2783889.51	45 – 55	35 - 45
NQM02	West Point	Industrial Areas	342611.71	2783687.29	60 – 70	50 - 60
NQM03	South Point	Industrial Areas	342955.16	2782874.07	60 – 70	50 - 60
NQM04	East Point	Industrial Areas	343567.66	2783531.63	60 – 70	50 - 60

Figure 3-1 - Noise Measurement Locations

3.2 Survey Timing, Frequency and Duration

The measurement period for weekday and weekend measurements are summarised in Table 3-2 and Table 3-3.

Table 3-2 - Weekend Survey Timing and Schedule

Ref.	Site Description	Daytime Measurements			Night-Time Measurements		
		Date	Start Time	End Time	Date	Start Time	End Time
NQM01	North Point	18/08/2018	10:40	10:55	18/08/2018	21:15	21:30
NQM02	West Point	18/08/2018	11:20	11:35	18/08/2018	21:30	21:45
NQM03	South Point	18/08/2018	09:30	09:45	18/08/2018	20:15	20:30
NQM04	East Point	18/08/2018	10:20	10:45	18/08/2018	20:50	21:10

Table 3-3 - Weekday Survey Timing and Schedule

Ref.	Site Description	Daytime Measurements			Night-Time Measurements		
		Date	Start Time	End Time	Date	Start Time	End Time
NQM01	North Point	19/08/2018	11:15	11:30	19/08/2018	20:45	21:00
NQM02	West Point	19/08/2018	11:40	11:55	19/08/2018	21:15	21:30
NQM03	South Point	19/08/2018	10:25	10:40	19/08/2018	20:00	20:15
NQM04	East Point	19/08/2018	11:05	11:20	19/08/2018	21:35	21:50

3.2.1 Noise Survey Results

The ambient noise measurements recorded at the identified locations are summarised below in Table 3-4 and Table 3-5.

Table 3-4 - Ambient Noise Survey Results: Daytime Noise Levels

Site ID	Site Description	Noise Limit dB(A)	Weekend		Weekday	
			Leq dB(A)	L90 dB(A)	Leq dB(A)	L90 dB(A)
NQM01	North Point	45 - 55	55	48	50	46
NQM02	West Point	60 – 70	53	47	59	42
NQM03	South Point	60 – 70	53	39	52	45
NQM04	East Point	60 – 70	55	47	60	45

Table 3-5 - Ambient Noise Survey Results: Night-time Noise Levels

Site ID	Site Description	Noise Limit dB(A)	Weekend		Weekday	
			Leq dB(A)	L90 dB(A)	Leq dB(A)	L90 dB(A)
NQM01	North Point	35 - 45	49	46	48	45
NQM02	West Point	50 - 60	49	42	56	48
NQM03	South Point	50 - 60	42	40	49	47
NQM04	East Point	50 - 60	45	40	61	48

As can be seen from the results presented above the day time measurements for locations NQM02, NQM03 and NQM04 on weekdays and weekends were below the relevant limits. Night time measurements for NQM02, NQM03 and NQM04 were below the relevant limits except for exceedances of the lower end of the standard at NQM02 and the upper limit at NQM04 during the weekday measurements. NQM01 noise levels were above the lower daytime residential limits for both the weekend and weekday measurements. The night-time upper limit at NQM01 was exceeded for both weekend and weekday measurements.

An average daytime noise level of 54.5 dB(A) and a night-time level of 50 dB(A) has been calculated from all measurements to give a representative average noise level for the area.

4 Operational Noise Impact Assessment

The following section details the assessment of the operations phase of the Project including the project noise sources considered, the assessment methodology followed and the impact assessment results.

4.1 Project Noise Sources

The Project noise sources to be included in the noise modelling assessment were provided by GHD [4]. The modelled noisy equipment item categories include:

- Waste Bunker;
- Flue Treatment Hall;
- Boiler Hall;
- Steam Turbine Hall;
- IBA;
- Stacks;
- Air Cooled Condenser;
- Transformer; and,
- Conveyor.

Full details of all noise generating equipment items considered in the operations phase impact assessment are shown in Appendix B.

4.1.1 Equipment Noise Levels

For this Project, all equipment noise level data was provided by GHD in the form of a Noise Impact Assessment conducted by Pro-Acoustics [4] as well as additional information detailed in document “50057151-0.4: Noise Impact Assessment - Dubai Waste to Energy BOT GS003” prepared by Hitachi Zosen Inova Besix [5]. The complete noise log including all equipment noise levels, frequency noise spectra and noise level sources is included in Appendix B.

4.2 Noise Model

In order to estimate the operational noise levels, the internationally recognised noise modelling software SoundPLAN© 8 has been utilised.

The propagation methodology adopted within the SoundPLAN© model was the International Organisation for Standardization (ISO) 9613 'Acoustics – Attenuation of Sound during Propagation Outdoors' (ISO, 1996) [3]. This document can be referred to for an in-depth description of the methodology SoundPLAN© utilises for attenuation of sound and propagation outdoors.

ISO 9613 specifies an engineering method for calculating the attenuation of sound during propagation outdoors in order to predict the levels of environmental noise at a distance from a variety of sources. The method predicts the LAeq under meteorological conditions favourable to propagation from sources of known sound emission. The source/s may be moving or stationary and takes account of the following physical effects:

- Geometrical divergence;
- Atmospheric absorption;
- Ground effect;
- Reflection from surfaces; and
- Screening by obstacles.

This method is applicable in practice to a great variety of noise sources and environments. It is applicable, directly or indirectly, to most situations concerning: industrial noise sources, road, construction activities, and many other ground-based noise sources.

4.3 Propagation of Sound

The variables which affect sound propagation over ground away from a source have been the subject of much detailed investigation over the years. The principal factors influencing sound attenuation with distance from the source are:

- Geometrical spreading (this is the standard spherical wave divergence term which gives 6 dB reduction in noise level for each doubling of distance from point source e.g. small motor, 3 dB for a line source e.g. piping)
- Source directivity;
- Atmospheric (molecular) absorption;
- Ground effects (different for hard/soft ground, and type of ground cover);
- Atmospheric wind temperature gradients (refraction);
- Source height;
- Atmospheric turbulence; and,
- Barrier effects (diffraction).

The total attenuation due to all these factors except geometrical spreading and directivity is generally referred to as 'excess attenuation' and will vary with frequency. Because of these effects, a significant noise source may not be significant at, and beyond, the boundary and vice-versa. For example, a noise source dominated by low frequency noise (with a long wave length) is likely to travel a greater distance under the same excess attenuation factors to that of a noise source dominated with high frequency noise (with a shorter wavelength).

4.4 Meteorological and Ground Conditions

The most influential environmental condition on noise propagation is distance, the greater the distance between the noise source and the receiver the greater the noise reduction achieved. Typically for stationary sources, a reduction of 6 dB(A) per doubling of distance is considered the norm.

The type of ground cover also influences noise propagation. Soft ground such as sand or agricultural land absorbs sound energy shortening the propagation path whereas hard ground such as compact soil or tarmac reflects the sound energy and thereby noise travels further. It has been conservatively assumed for this assessment that the ground cover will be hard with an associated absorption coefficient of 0.

For noise propagation over short distances climatic conditions do not have a significant effect, however over longer distance over 50 m wind becomes more influential. Downwind the level may increase by a few dB, depending on wind speed whereas on the upwind or side-wind the level can drop by 10 dB.

Temperature gradients create effects similar to those of wind gradients, except that they are uniform in all directions from the source. On a sunny day with no wind, temperature decreases with altitude, giving a noise shadow (the result is the noise is taken up and away from the source and the ground). On a clear night temperature may increase with altitude (temperature inversion) focusing sound towards the ground surface.

4.5 Modelling Assumptions

The following assumptions have been made for the modelling assessment, and wherever possible, a conservative approach has been taken:

- Only normal operations have been modelled;
- In the absence of a detailed equipment list, all noise sources have been based on data provided by GHD [4];
- Equipment has been modelled at heights based on provided data where possible, where not identifiable heights have been assumed;
- All equipment has been modelled as either point, area, line or block sources;
- Due to the absence of a detailed equipment list and associated plot plan, some equipment locations were estimated based on the general areas provided;
- The model does not incorporate features which might provide partial screening (e.g., columns, pipe racks, structural steelwork, and small equipment);
- Ground absorption has been modelled as a mixture of hard and soft ground (having an absorption coefficient of 0.6) to maintain a conservative assessment;
- Reasonable worst-case meteorological conditions have been applied, i.e. steady wind conditions blowing in each direction.

4.6 Site Boundary Contributions

For the purposes of assessment, point receptors were set up on the boundary fence of the site. A Boundary Limit of 70 dB(A) has been applied at the boundary as per the UAE Federal Environment Agency's Industrial limit [1]. The boundary noise contributions from the plant is detailed below.

Figure 4-1 below details the locations of the modelled point receptors at the power plant's boundary used to carry out the boundary noise assessment.

Figure 4-1 - Power Plant Boundary Point Receiver Locations

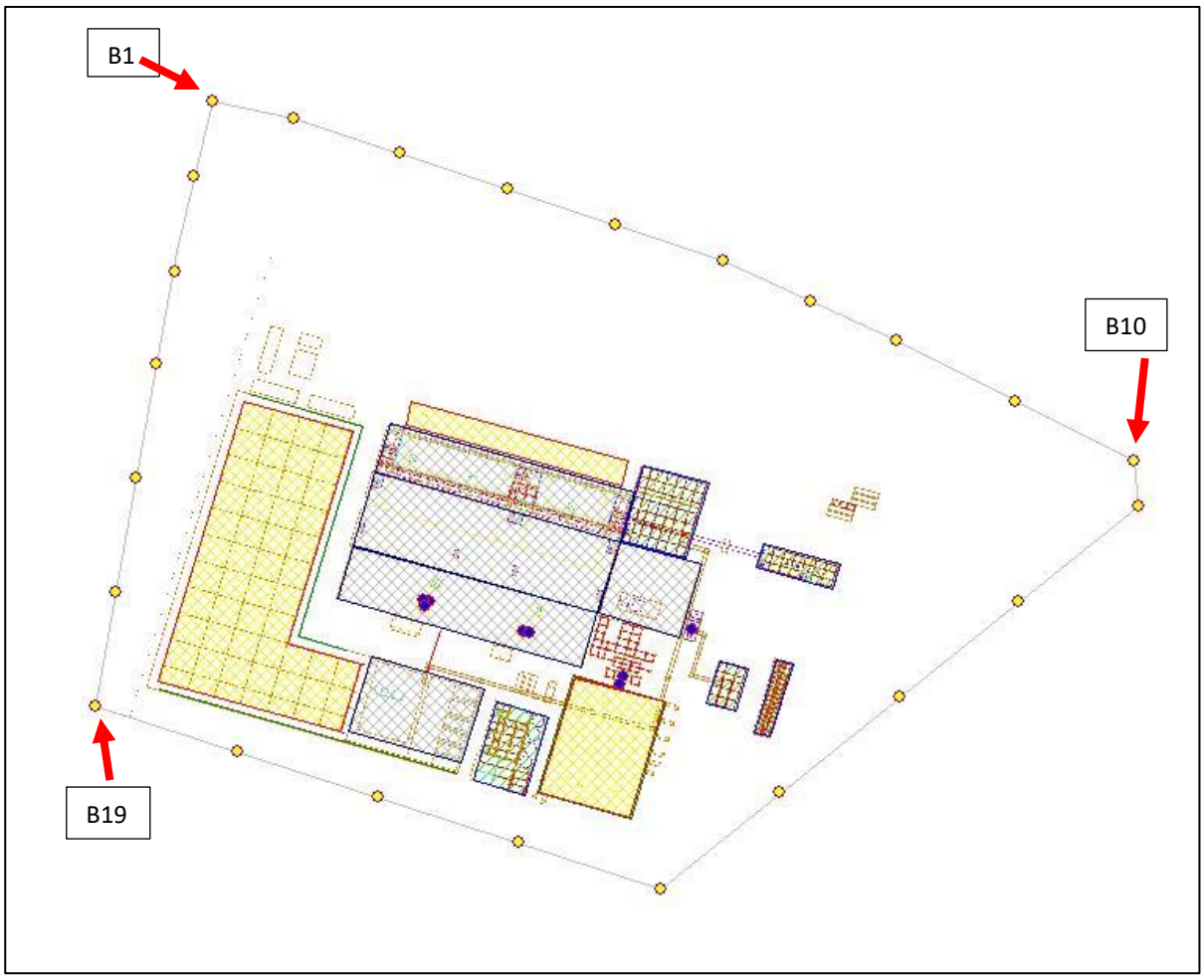


Table 4-1 details the modelled noise contribution of the project equipment at the point receptors on the boundary of the site. The average baseline noise level recorded at the closest measurement location, NM4, has been applied along the power plant site boundary to determine the potential operational cumulative noise levels.

Table 4-1 - Boundary Contribution from Project Noisy Equipment

Receiver Reference	Boundary Noise Contribution dB(A)	Receiver Reference	Boundary Noise Contribution dB(A)
B1	55.8	B13	56.0
B2	57.4	B14	60.3
B3	60.3	B15	61.7
B4	61.9	B16	64.2
B5	62.3	B17	59.7
B6	61.3	B18	56.9

Receiver Reference	Boundary Noise Contribution dB(A)	Receiver Reference	Boundary Noise Contribution dB(A)
B7	60.0	B19	57.1
B8	57.2	B20	60.3
B9	53.6	B21	58.9
B10	52.8	B22	59.0
B11	53.0	B23	59.3
B12	54.6	B24	56.9

Based on the point receiver noise levels along the site boundary, the Project is not anticipated to exceed the boundary noise limit. The highest value achieved was 64.2 dB(A) on the southern boundary, this value is significantly below the limit of 70 dB(A).

4.7 Operational Noise Model Assessment

A series of noise contour maps have been produced to depict predicted noise levels within the Project study area. Calculations have been carried out under normal operating conditions to determine level of compliance to environmental standards.

4.7.1 Noise Contour Maps

The following contour maps have been generated:

- Figure A1: Overall Daytime Contour
- Figure A2: Overall Night-time Contour
- Figure A3: Overall Daytime Contour with Baseline
- Figure A4: Overall Night-time Contour with Baseline
- Figure A5: Daytime with Receptors
- Figure A6: Night-time with Receptors

4.7.2 Environmental Noise Assessment (Project Contribution in Isolation)

The environmental noise assessment takes into account all provided noise sources within the Project scope. The guidelines state that the noise levels in Residential areas should not exceed 55 dB(A) during the day and 45 dB(A) at night time. The noise contributions at the Measurement locations are shown in Table 4-2 below.

Table 4-2 - Contributed Noise Levels at Selected Sensitive Receptors

ID.	Description	UAE Federal Environment Agency Noise Limits (dB(A))		Daytime Modelled Results (dB(A))	Night-time Modelled Results (dB(A))
		Day	Night		
SR1	Northern Residences	55	45	51.6	41.8

As can be seen from the above table the predicted noise level contributions at the measured locations are below both the night time and daytime noise limits.

4.7.3 Cumulative Impact Assessment

An impact assessment was performed in order to determine the severity of the impact of the project at the nearest sensitive receptor locations. These locations are presented in Figure 4-2 below:

Figure 4-2 - Noise Measurement Locations

The results of the Project noise contribution and resulting impact at SR1 is presented in Table 4-3 for day-time and night-time operations respectively. NQM01 has been used as representative of the baseline noise level at SR1 due to the proximity of the location.

Table 4-3 - Operational Impact Assessment

ID.	Description	Project Noise Contribution (dB(A))	Baseline Noise Level (dB(A))	Cumulative Noise Level (dB(A))	Maximum Change in Noise Level at Receptor (dB(A))	Impact Severity
Day Time Operational Impact Assessment						
SR1	North Residences	51.6	55	56.6	1.6	Negligible
Night Time Operational Impact Assessment						
SR1	North Residences	41.8	49	49.8	0.8	Negligible

Based on the operational noise impact assessment results at sensitive receptors identified there are predicted to be negligible impacts.

5 Conclusions

An environmental noise assessment has been conducted for the Dubai Waste to Energy Project. The project is located in the in Dubai, UAE.

The aim of the noise assessment was to establish project compliance with environmental noise standards. This report presents the findings of an environmental noise modelling analysis of high noise-emitting equipment associated with the Project.

Potentially noisy items of plant were modelled using the internationally recognised SoundPLAN model and a series of noise contour maps produced (Appendix A).

A site boundary noise assessment was undertaken, and the levels at the Project boundary ranged from 52.8 dB(A) to 64.2 dB(A) with the highest noise level occurring on the southern boundary. The boundary limit of 70 dB(A) was thus predicted not to be exceeded at any point along the property fence line boundary.

An assessment was conducted at nearby identified sensitive receptors. There are predicted to be negligible impacts due to the operation of the plant for both daytime and night-time periods.

6 References

[1] Ministry of Environment and Water, *UAE Federal Law No. (24) of 1999 for the Protection and Development of the Environment,* Abu Dhabi, United Arab Emirates: Ministry of Environment and Water, 1999.

[2] International Organisation for Standardisation (ISO), *ISO1996-1-3 'Description and Measurement of Environmental Noise',* 2003.

[3] International Organisation for Standardisation (ISO), *ISO9613-2 'Acoustics – Attenuation of Sound During Propagation Outdoors',* 1996.

[4] Pro-Acoustics GmbH, *"Noise impact assessment" for Dubai Waste to Energy BOT GS003,* Rev0.4 ed., 2018.

[5] Hitachi Zosen Inova Besix, *50057151-0.4: Noise Impact Assessment - Dubai Waste to Energy BOT GS003,* 2018.

7 Glossary

LAeq T: This is the continuous equivalent sound level. It is a widely used noise parameter that calculates a constant level of noise with the same energy content as the varying acoustic noise signal being measured. The letter “A” denotes that the A-weighting has been included and “eq” indicates that an equivalent level has been calculated. Hence, L_{Aeq} is the A-weighted equivalent continuous noise level. A-weighting is a filter incorporated into a sound level meter which when measuring noise replicates the sensitivity of human hearing.

LASN, T percentile levels: The level of A-weighted noise exceeded for N% of the measurement time. L_{AS90}, T is often used as a measure of background noise in many standards and guidelines. The L_{AS90}, T parameter would therefore represent the level exceeded for 90% of the measurement period, T. Likewise the L_{AS10}, T would indicate the level exceeded for 10% of the measurement period, T indicating the higher noise levels measured.

Octave Band Analysis: To identify frequency components of a sound, there is octave band analysis in which frequencies are segmented into proportionate widths (octave bands) and analysed. The sound pressure level of a single octave band is called the "octave band level", while that analysed for $^1/_3$ of the octave band is called a "$^1/_3$ octave band level". The frequency band in the octave band and $^1/_3$ octave band is expressed as the centre frequency of that band. Using f_1 and f_2 as the upper and lower end frequencies of the band.

Sound Pressure Level (Lp): An acoustic measurement for the ratios of sound energy. Rated in decibels.

Sound Power Level (Lw): The Lw is a measure of the total airborne acoustic power generated by a noise source, expressed on a decibel scale referenced to a common standard (10^{-12} watts).

Decibel (dB): dB is a logarithmic unit of measurement that expresses the magnitude of a physical quantity (usually power or intensity) relative to a specified or implied reference level. Since it expresses a ratio of two quantities with the same unit, it is a dimensionless unit.

dB(A): The ‘A’ weighting network is very similar to the way in which the human ear responds to variations in sound pressure level as it places higher attenuation on the lower frequencies than on the mid to upper frequencies. It is applied to the decibel scale in order to account for how the human ear responds to changes in sound levels.

Appendix A: Noise Contour Maps

Figure A1 – Overall Daytime Contour

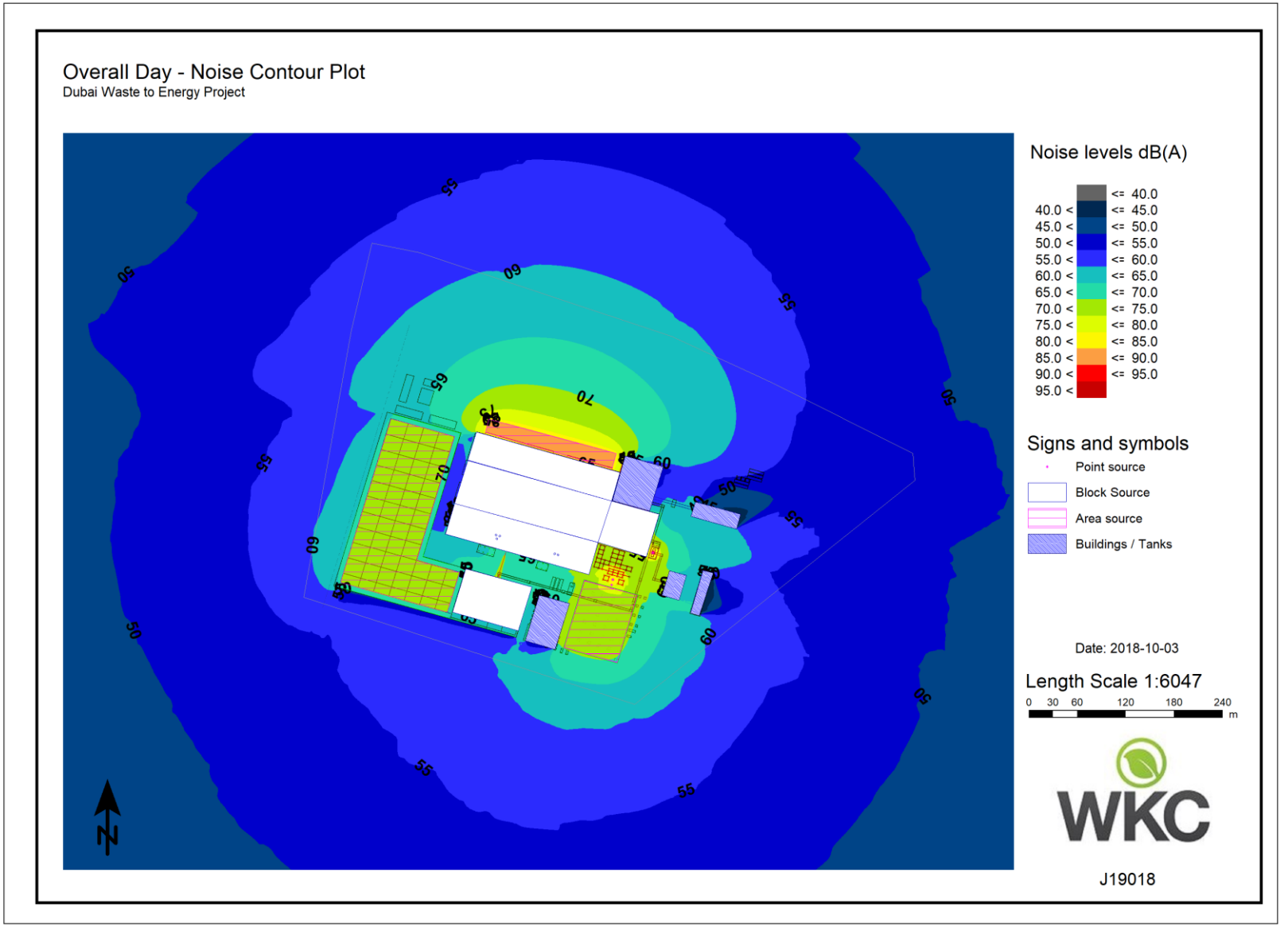


Figure A2 – Overall Night-time Contour

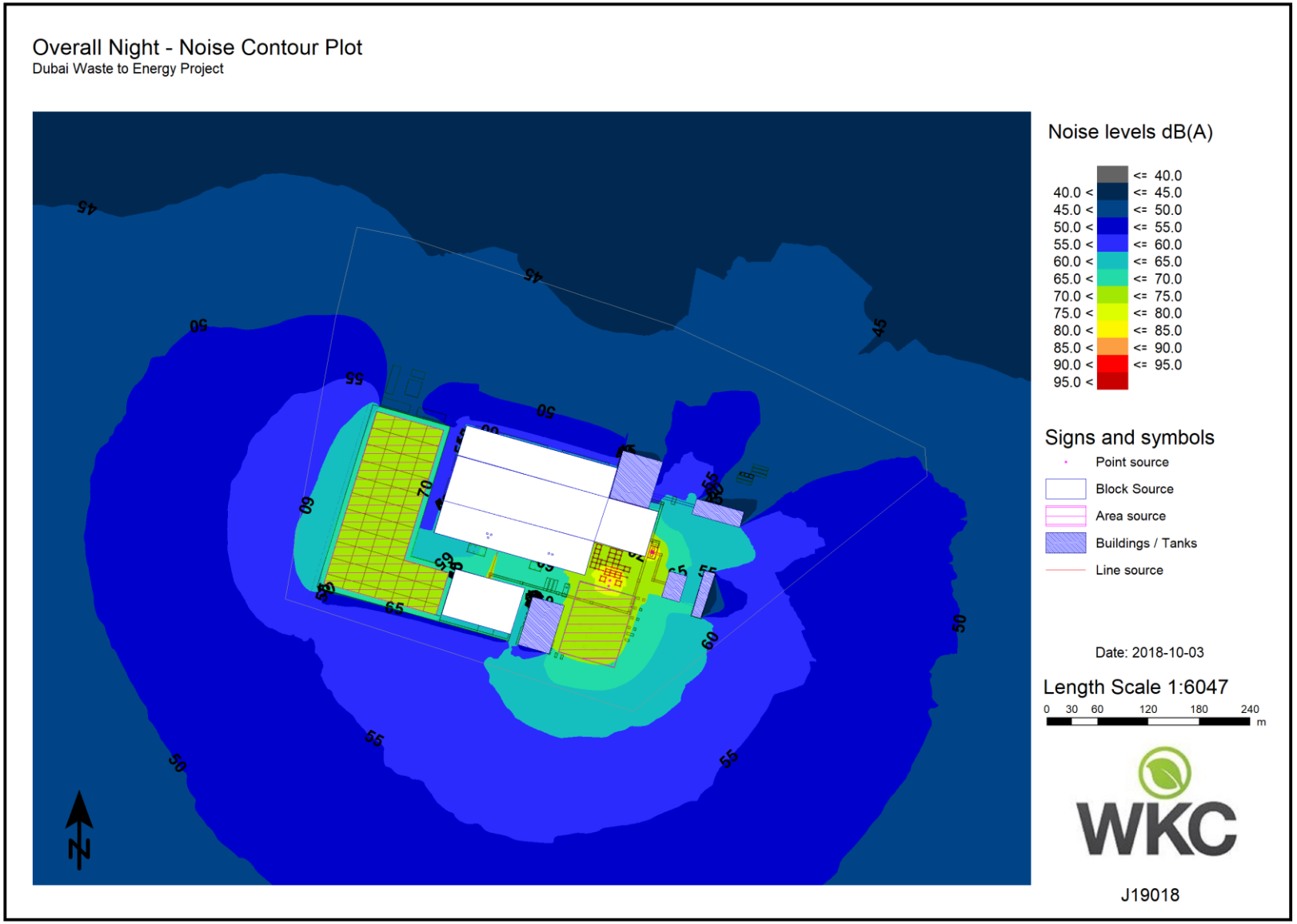


Figure A3 – Overall Daytime Contour with Baseline

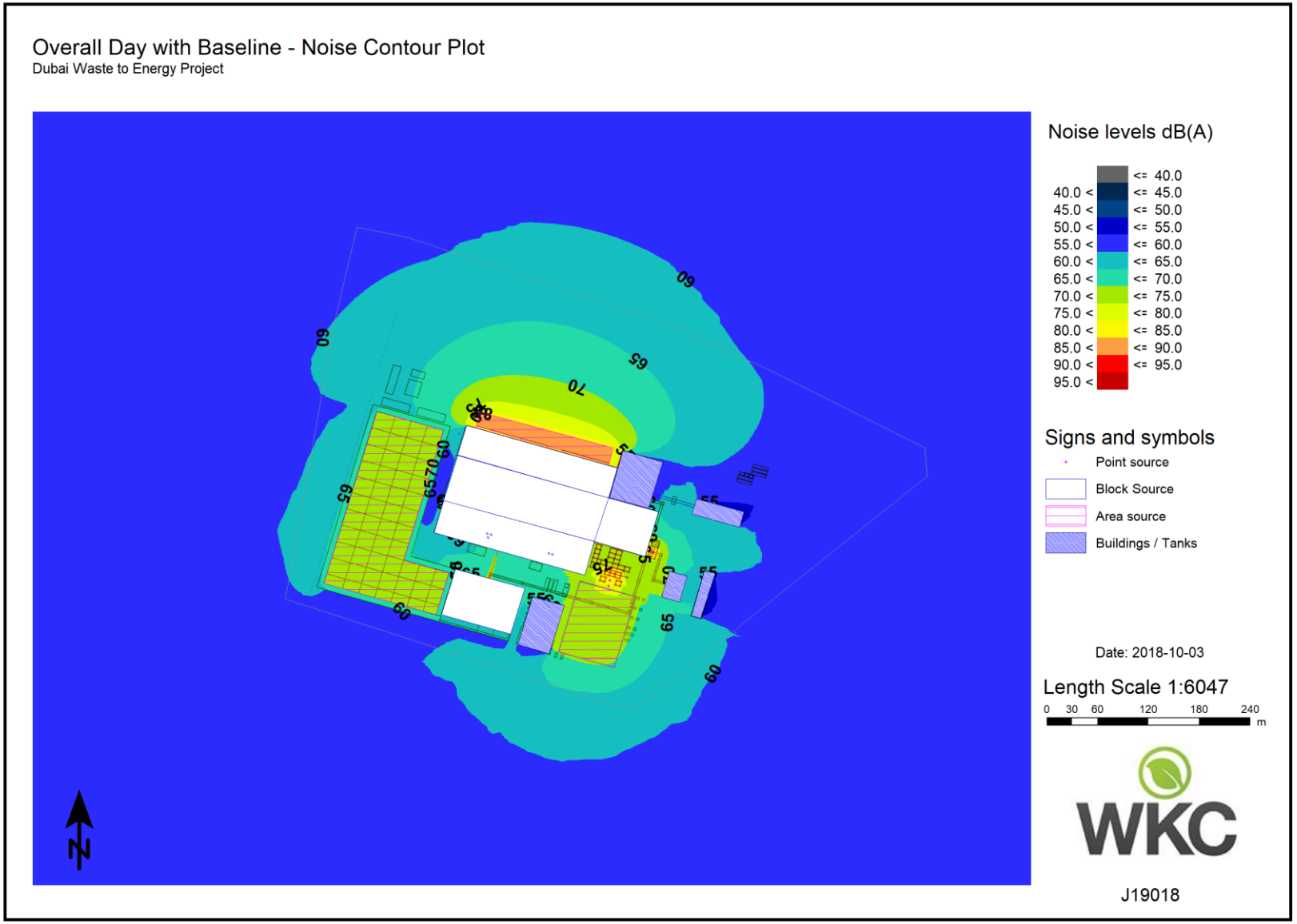


Figure A4 – Overall Night-time Contour with Baseline

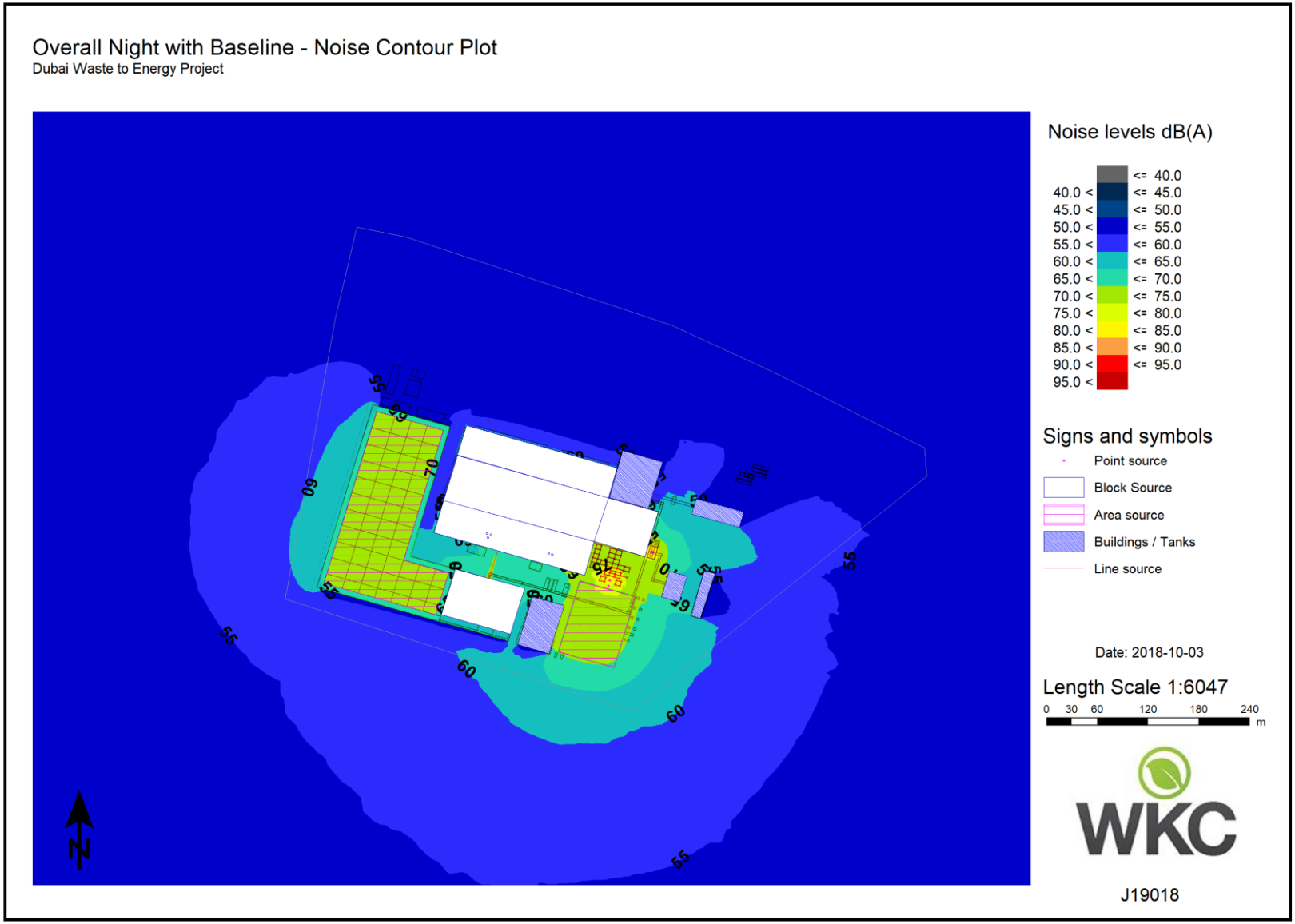


Figure A5 – Daytime Contour with Receptors

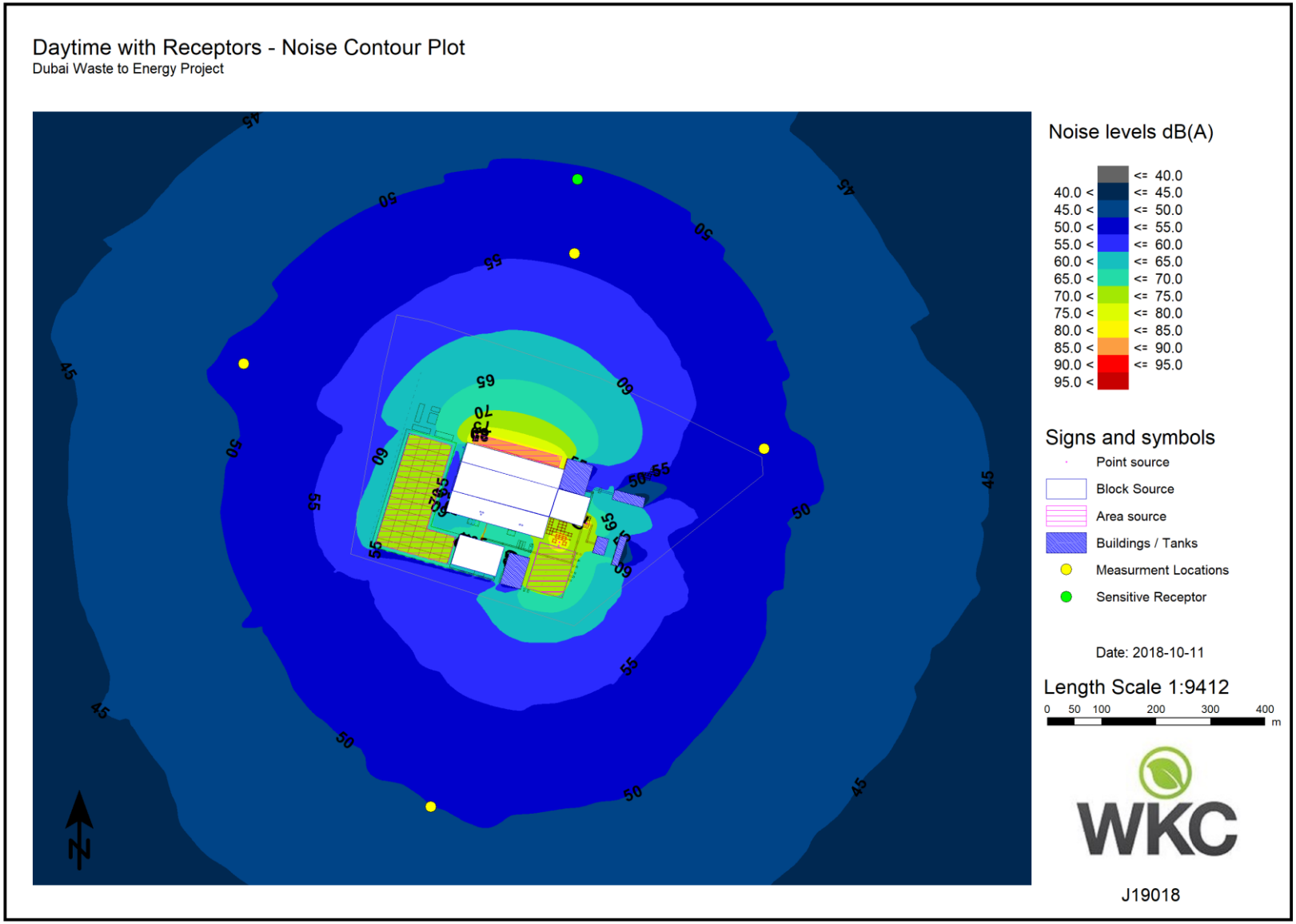
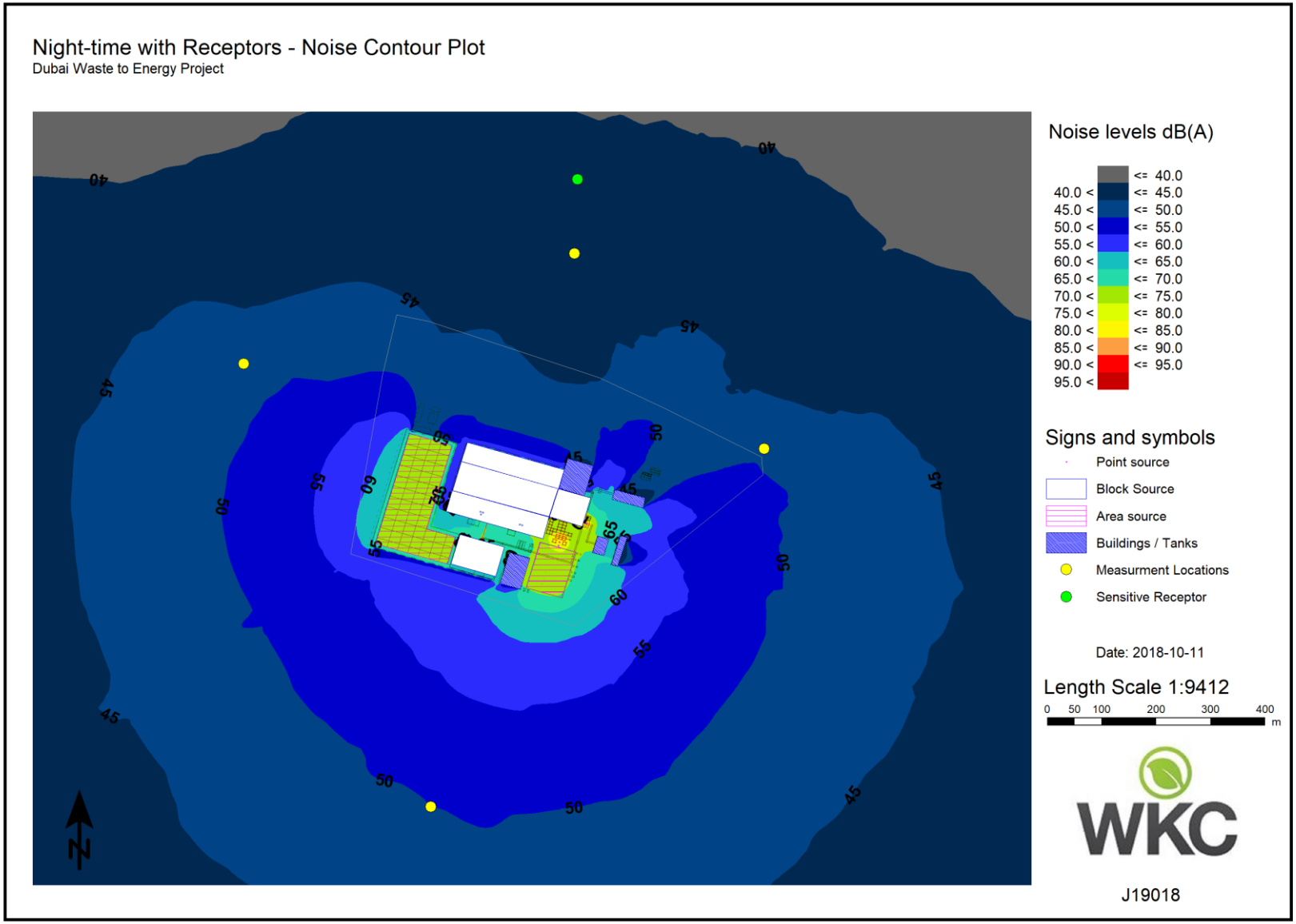


Figure A6 – Night-time Contour with Receptors



Appendix B: Noise Log

Table B1: Noise Log (Model Inputs)

Equipment Description	LW (dB(A))	Octave Band Central Frequency Spectrum Noise (dB)								Comment / Reference
		63Hz	125Hz	250Hz	500Hz	1kHz	2khz	4khz	8khz	
Waste Bunker	69.5	88.0	77.0	78.0	69.0	70.0	46.0	38.0	30.0	Reference document: “PA-18034 Additional input for noise prediction calculations_HZI”, Transmission losses accounted for.
Flue Treatment Hall	69.1	90.0	83.0	78.0	70.0	61.0	58.0	48.0	39.0	Reference document: “PA-18034 Additional input for noise prediction calculations_HZI”, Transmission losses accounted for.
Boiler Hall	65.1	90.0	82.0	73.0	62.0	63.0	47.0	35.0	25.0	Reference document: “PA-18034 Additional input for noise prediction calculations_HZI”, Transmission losses accounted for.
Steam Turbine Hall	75.5	88.0	88.0	76.0	71.0	67.0	66.0	62.0	58.0	Reference document: “PA-18034 Additional input for noise prediction calculations_HZI”, Transmission losses accounted for.
IBA	70.0	90.0	82.0	75.0	70.0	63.0	62.0	49.0	43.0	Reference document: “PA-18034 Additional input for noise prediction calculations_HZI”, Transmission losses accounted for.
Tipping Area	118.0	123.0	118.0	113.0	108.0	111.0	111.0	111.0	108.0	Reference document: “PA-18034 Additional input for noise prediction calculations_HZI”
Stack Body	97.0	101.0	100.0	104.0	93.0	72.0	70.0	70.0	70.0	Reference document: “50057151-0.4: Noise Impact Assessment”
Stack Opening	100.0	116.0	112.0	106.0	88.0	70.0	68.0	68.0	68.0	Reference document: “50057151-0.4: Noise Impact Assessment”
ACC inlet	112.0	119.0	117.0	112.0	109.0	108.0	99.0	95.0	91.0	Reference document: “50057151-0.4: Noise Impact Assessment”
ACC Outlet	108.0	116.0	114.0	109.0	106.0	104.0	96.0	90.0	85.0	Reference document: “50057151-0.4: Noise Impact Assessment”
ACC Steam Duct	108.0	104.0	104.0	98.0	97.0	98.0	105.0	95.0	92.0	Reference document: “50057151-0.4: Noise Impact Assessment”
ACC Recoolers	106.0	106.0	109.0	106.0	105.0	100.0	96.0	90.0	87.0	Reference document: “50057151-0.4: Noise Impact Assessment”
Transformer	104.0	107.0	107.0	104.0	104.0	98.0	93.0	88.0	81.0	Reference document: “50057151-0.4: Noise Impact Assessment”
IBA Conveyor	95.0	97.0	95.0	93.0	92.0	91.0	87.0	84.0	83.0	Reference document: “50057151-0.4: Noise Impact Assessment”
IBA outdoor handling	110.0	112.0	115.0	110.0	105.0	103.0	102.0	100.0	95.0	Reference document: “50057151-0.4: Noise Impact Assessment”

Appendix O – Noise Impact Assessment

Dubai Waste to Energy

Noise Impact Assessment

Prepared for: GHD

Ref.: J19018-01

Date: 26-10-2018

Report Approval & Revision Record

Project:	Dubai Waste to Energy			
Document Title:	Noise Impact Assessment			
Client:	GHD			
Report Number:	J19018-01			
Rev	**Date**	**Prepared**	**Reviewed**	**Approved**
01	11-10-2018	Ian Goble Environmental Engineer	Ashley Meyer Environmental Engineer	Richard Palmer Partner
02	15-10-2018	Ian Goble Environmental Engineer	Ashley Meyer Environmental Engineer	Richard Palmer Partner
03	26-10-2018	Ian Goble Environmental Engineer	Ashley Meyer Environmental Engineer	Richard Palmer Partner

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Acronyms

UAE	United Arab Emirates
ISO	International Organisation for Standardisation
NSR	Noise Sensitive Receptor
IoA	Institute of Acoustics
IEMA	Institute of Environmental Management and Assessment

1 Introduction

WKC Environment Consultancy (WKC) have been contracted by GHD to undertake a noise impact assessment for the proposed Dubai Waste to Energy development. This report presents the findings of a noise modelling study for operational noise emissions associated with the proposed development.

1.1 Project Site

The proposed project site is located in Dubai, United Arab Emirates (UAE). The site location within the UAE is illustrated in Figure 1-1. Figure 1-2 presents the project in a local context.

Figure 1-1 - Project Location within the UAE

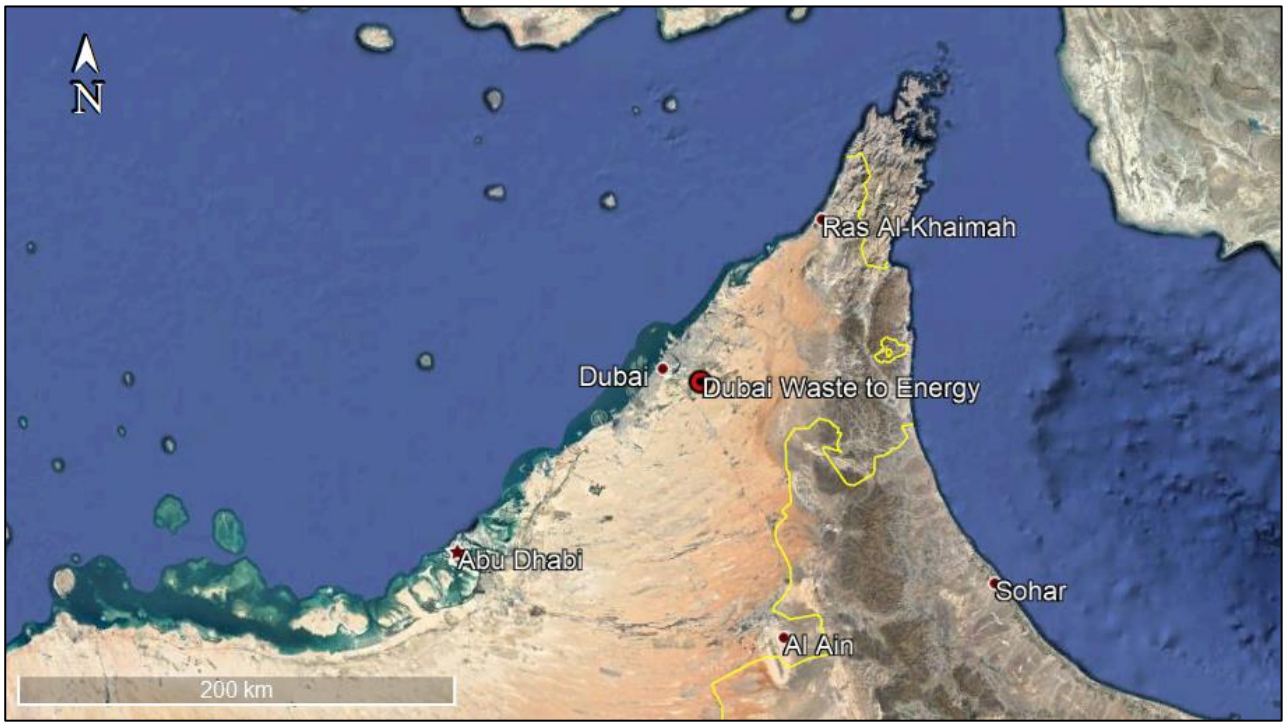


Figure 1-2 - Location of Project Facilities in a Local Context

1.2 About This Report

This report presents the findings of an environmental noise modelling study for the Dubai Waste to Energy project during normal operations. Through a review of provided data, potentially noisy equipment items have been identified and modelled using SoundPlan V8.0

A series of noise contour plots have been produced detailing the overall project noise levels, with these being assessed in accordance with the environmental noise standards detailed in Section 2.

2 Noise Standards and Guidance

This section presents the national and international standards, guidance and Project specifications applicable to the assessment.

2.1 UAE Federal Environmental Noise Limit

Table 2-1 presents the UAE Federal Noise Limits for classes of receptor areas as specified by the UAE Federal Environment Agency [1].

Table 2-1 - Noise Level Limit – UAE Federal Environment Agency [1]

Receptor Areas	Allowable Noise Limits (L_{Aeq_1hour} - dB(A))	
	Daytime (7:00 am – 8:00 pm)	Night time (8:00 pm – 7:00 am)
Residential Areas with Light Traffic	40 – 50	30 – 40
Residential Areas in Downtown	45 – 55	35 – 45
Residential Areas with some Workshops & Commercial or near Highways	50 – 60	40 – 50
Commercial Areas & Downtown	55 – 65	45 – 55
Industrial Areas (Heavy Industry)	60 – 70	50 - 60

2.2 International Guidance

2.2.1 ISO 1996-1-3 'Description and Measurement of Environmental Noise'

International Organization for Standardisation (ISO) d1996-1-3 – 'Description and Measurement of Environmental Noise' [2] defines the basic quantities to be used for the description of noise in community environments and the basic procedures for the determination of these quantities. It also includes the methods for acquisition of data that enable specific noise situations to be checked for compliance with given noise limits.

2.2.2 ISO 9613-2 'Acoustics – Attenuation of Sound during Propagation Outdoors'

ISO 9613 Acoustics – 'Attenuation of Sound during Propagation Outdoors' [3] specifies an engineering method for calculating the attenuation of sound during propagation outdoors in order to predict the levels of

environmental noise at a distance from a variety of sources. The method predicts the equivalent continuous A-weighted sound pressure level (LAeq) under meteorological conditions favourable to propagation (i.e. generic downwind conditions) from sources of known sound emission.

2.2.3 Calculation of Operational Noise

ISO 9613 Acoustics – Attenuation of Sound During Propagation Outdoors' [3] specifies an engineering method for calculating the attenuation of sound during propagation outdoors in order to predict the levels of environmental noise at a distance from a variety of sources. The method predicts the equivalent continuous A-weighted sound pressure level (LAeq) under meteorological conditions favourable to propagation from sources of known sound emission.

SoundPLAN© 8 is an internationally recognised noise modelling software that adopts ISO 9613, and has been used to estimate the operational noise levels associated with the Project. This software allows for a spatially-constructed model, incorporating noise emission parameters of the Project facilities/activities, and calculates sound propagation and attenuation by recognised methods in order to predict the levels of environmental noise at a distance from the modelled sources. The method predicts the LAeq under meteorological conditions favourable to propagation from sources of known sound emission.

The criteria for the assessment of change in noise levels arising at noise sensitive receptors (NSRs) from the operation of the Project have been adapted from the joint Institute of Environmental Management and Assessment (IEMA) and the Institute of Acoustics (IoA) guidelines for noise and vibration impact assessment categories and are given in Table 2-2.

Table 2-2 - Noise Impact Assessment Criteria

Impact Category	Incremental Change in Ambient Noise Level	Description of Impact
No Effect	0 dB(A)	Not discernible
Negligible	0.1 – 2.9 dB(A)	Not discernible – Marginal changes in noise levels of less than 3 dB(A) in residential areas, or outdoor recreational areas in close proximity to main roads.
Minor Negative	3 to 4.9 dB(A)	Noticeable adverse – Noise levels of 3-5 dB(A) in residential areas, or at outdoor recreational areas.
Moderate Negative	5 to <10 dB(A)	Considerable adverse – Noise levels warrant mitigation of residential properties on a widespread basis in a community, or for outdoor recreation areas close to main roads.
Major Negative	10 dB(A) or more	Major adverse – Noise increases to a level where continued residential use of individual properties is inappropriate, or where the use of a community building could be inappropriate.

3 Baseline Noise Conditions

3.1 Noise Measurement Locations

A baseline noise study was conducted from the 18th to the 19th of August 2018, in order to determine the environmental noise characteristics at a number of locations of interest around the Project area. Details of the measurement locations are summarised in Table 3-1, and the measurement locations are provided in Figure 3-1.

Table 3-1 - Noise Measurement Locations and Applicable Noise Limits

Ref.	Site Description	Site Classification	Coordinates (m E)	Coordinates (m N)	Daytime Noise Limit (dB(A))	Nigh time Noise Limit (dB(A))
NQM01	North Point	Residential Areas	343218.94	2783889.51	45 – 55	35 - 45
NQM02	West Point	Industrial Areas	342611.71	2783687.29	60 – 70	50 - 60
NQM03	South Point	Industrial Areas	342955.16	2782874.07	60 – 70	50 - 60
NQM04	East Point	Industrial Areas	343567.66	2783531.63	60 – 70	50 - 60

Figure 3-1 - Noise Measurement Locations

3.2 Survey Timing, Frequency and Duration

The measurement period for weekday and weekend measurements are summarised in Table 3-2 and Table 3-3.

Table 3-2 - Weekend Survey Timing and Schedule

Ref.	Site Description	Daytime Measurements			Night-Time Measurements		
		Date	Start Time	End Time	Date	Start Time	End Time
NQM01	North Point	18/08/2018	10:40	10:55	18/08/2018	21:15	21:30
NQM02	West Point	18/08/2018	11:20	11:35	18/08/2018	21:30	21:45
NQM03	South Point	18/08/2018	09:30	09:45	18/08/2018	20:15	20:30
NQM04	East Point	18/08/2018	10:20	10:45	18/08/2018	20:50	21:10

Table 3-3 - Weekday Survey Timing and Schedule

Ref.	Site Description	Daytime Measurements			Night-Time Measurements		
		Date	Start Time	End Time	Date	Start Time	End Time
NQM01	North Point	19/08/2018	11:15	11:30	19/08/2018	20:45	21:00
NQM02	West Point	19/08/2018	11:40	11:55	19/08/2018	21:15	21:30
NQM03	South Point	19/08/2018	10:25	10:40	19/08/2018	20:00	20:15
NQM04	East Point	19/08/2018	11:05	11:20	19/08/2018	21:35	21:50

3.2.1 Noise Survey Results

The ambient noise measurements recorded at the identified locations are summarised below in Table 3-4 and Table 3-5.

Table 3-4 - Ambient Noise Survey Results: Daytime Noise Levels

Site ID	Site Description	Noise Limit dB(A)	Weekend		Weekday	
			Leq dB(A)	L90 dB(A)	Leq dB(A)	L90 dB(A)
NQM01	North Point	45 - 55	55	48	50	46
NQM02	West Point	60 – 70	53	47	59	42
NQM03	South Point	60 – 70	53	39	52	45
NQM04	East Point	60 – 70	55	47	60	45

Table 3-5 - Ambient Noise Survey Results: Night-time Noise Levels

Site ID	Site Description	Noise Limit dB(A)	Weekend		Weekday	
			Leq dB(A)	L90 dB(A)	Leq dB(A)	L90 dB(A)
NQM01	North Point	35 - 45	49	46	48	45
NQM02	West Point	50 - 60	49	42	56	48
NQM03	South Point	50 - 60	42	40	49	47
NQM04	East Point	50 - 60	45	40	61	48

As can be seen from the results presented above the day time measurements for locations NQM02, NQM03 and NQM04 on weekdays and weekends were below the relevant limits. Night time measurements for NQM02, NQM03 and NQM04 were below the relevant limits except for exceedances of the lower end of the standard at NQM02 and the upper limit at NQM04 during the weekday measurements. NQM01 noise levels were above the lower daytime residential limits for both the weekend and weekday measurements. The night-time upper limit at NQM01 was exceeded for both weekend and weekday measurements.

An average daytime noise level of 54.5 dB(A) and a night-time level of 50 dB(A) has been calculated from all measurements to give a representative average noise level for the area.

4 Operational Noise Impact Assessment

The following section details the assessment of the operations phase of the Project including the project noise sources considered, the assessment methodology followed and the impact assessment results.

4.1 Project Noise Sources

The Project noise sources to be included in the noise modelling assessment were provided by GHD [4]. The modelled noisy equipment item categories include:

- Waste Bunker;
- Flue Treatment Hall;
- Boiler Hall;
- Steam Turbine Hall;
- IBA;
- Stacks;
- Air Cooled Condenser;
- Transformer; and,
- Conveyor.

Full details of all noise generating equipment items considered in the operations phase impact assessment are shown in Appendix B.

4.1.1 Equipment Noise Levels

For this Project, all equipment noise level data was provided by GHD in the form of a Noise Impact Assessment conducted by Pro-Acoustics [4] as well as additional information detailed in document “50057151-0.4: Noise Impact Assessment - Dubai Waste to Energy BOT GS003” prepared by Hitachi Zosen Inova Besix [5]. The complete noise log including all equipment noise levels, frequency noise spectra and noise level sources is included in Appendix B.

4.2 Noise Model

In order to estimate the operational noise levels, the internationally recognised noise modelling software SoundPLAN© 8 has been utilised.

The propagation methodology adopted within the SoundPLAN© model was the International Organisation for Standardization (ISO) 9613 'Acoustics – Attenuation of Sound during Propagation Outdoors' (ISO, 1996) [3]. This document can be referred to for an in-depth description of the methodology SoundPLAN© utilises for attenuation of sound and propagation outdoors.

ISO 9613 specifies an engineering method for calculating the attenuation of sound during propagation outdoors in order to predict the levels of environmental noise at a distance from a variety of sources. The method predicts the LAeq under meteorological conditions favourable to propagation from sources of known sound emission. The source/s may be moving or stationary and takes account of the following physical effects:

- Geometrical divergence;
- Atmospheric absorption;
- Ground effect;
- Reflection from surfaces; and
- Screening by obstacles.

This method is applicable in practice to a great variety of noise sources and environments. It is applicable, directly or indirectly, to most situations concerning: industrial noise sources, road, construction activities, and many other ground-based noise sources.

4.3 Propagation of Sound

The variables which affect sound propagation over ground away from a source have been the subject of much detailed investigation over the years. The principal factors influencing sound attenuation with distance from the source are:

- Geometrical spreading (this is the standard spherical wave divergence term which gives 6 dB reduction in noise level for each doubling of distance from point source e.g. small motor, 3 dB for a line source e.g. piping)
- Source directivity;
- Atmospheric (molecular) absorption;
- Ground effects (different for hard/soft ground, and type of ground cover);
- Atmospheric wind temperature gradients (refraction);
- Source height;
- Atmospheric turbulence; and,
- Barrier effects (diffraction).

The total attenuation due to all these factors except geometrical spreading and directivity is generally referred to as 'excess attenuation' and will vary with frequency. Because of these effects, a significant noise source may not be significant at, and beyond, the boundary and vice-versa. For example, a noise source dominated by low frequency noise (with a long wave length) is likely to travel a greater distance under the same excess attenuation factors to that of a noise source dominated with high frequency noise (with a shorter wavelength).

4.4 Meteorological and Ground Conditions

The most influential environmental condition on noise propagation is distance, the greater the distance between the noise source and the receiver the greater the noise reduction achieved. Typically for stationary sources, a reduction of 6 dB(A) per doubling of distance is considered the norm.

The type of ground cover also influences noise propagation. Soft ground such as sand or agricultural land absorbs sound energy shortening the propagation path whereas hard ground such as compact soil or tarmac reflects the sound energy and thereby noise travels further. It has been conservatively assumed for this assessment that the ground cover will be hard with an associated absorption coefficient of 0.

For noise propagation over short distances climatic conditions do not have a significant effect, however over longer distance over 50 m wind becomes more influential. Downwind the level may increase by a few dB, depending on wind speed whereas on the upwind or side-wind the level can drop by 10 dB.

Temperature gradients create effects similar to those of wind gradients, except that they are uniform in all directions from the source. On a sunny day with no wind, temperature decreases with altitude, giving a noise shadow (the result is the noise is taken up and away from the source and the ground). On a clear night temperature may increase with altitude (temperature inversion) focusing sound towards the ground surface.

4.5 Modelling Assumptions

The following assumptions have been made for the modelling assessment, and wherever possible, a conservative approach has been taken:

- Only normal operations have been modelled;
- In the absence of a detailed equipment list, all noise sources have been based on data provided by GHD [4];
- Equipment has been modelled at heights based on provided data where possible, where not identifiable heights have been assumed;
- All equipment has been modelled as either point, area, line or block sources;
- Due to the absence of a detailed equipment list and associated plot plan, some equipment locations were estimated based on the general areas provided;
- The model does not incorporate features which might provide partial screening (e.g., columns, pipe racks, structural steelwork, and small equipment);
- Ground absorption has been modelled as a mixture of hard and soft ground (having an absorption coefficient of 0.6) to maintain a conservative assessment;
- Reasonable worst-case meteorological conditions have been applied, i.e. steady wind conditions blowing in each direction.

4.6 Site Boundary Contributions

For the purposes of assessment, point receptors were set up on the boundary fence of the site. A Boundary Limit of 70 dB(A) has been applied at the boundary as per the UAE Federal Environment Agency's Industrial limit [1]. The boundary noise contributions from the plant is detailed below.

Figure 4-1 below details the locations of the modelled point receptors at the power plant's boundary used to carry out the boundary noise assessment.

Figure 4-1 - Power Plant Boundary Point Receiver Locations

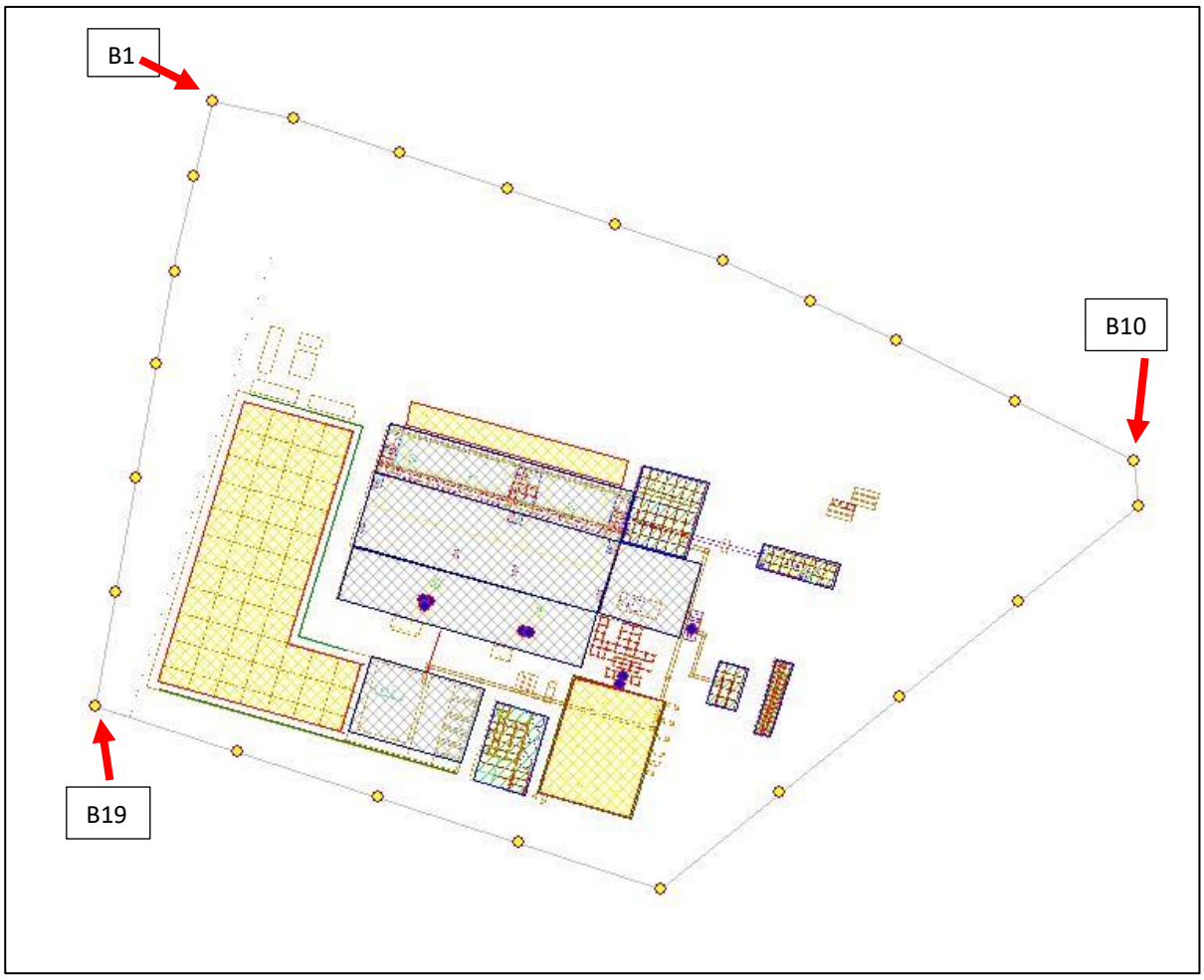


Table 4-1 details the modelled noise contribution of the project equipment at the point receptors on the boundary of the site. The average baseline noise level recorded at the closest measurement location, NM4, has been applied along the power plant site boundary to determine the potential operational cumulative noise levels.

Table 4-1 - Boundary Contribution from Project Noisy Equipment

Receiver Reference	Boundary Noise Contribution dB(A)	Receiver Reference	Boundary Noise Contribution dB(A)
B1	55.8	B13	56.0
B2	57.4	B14	60.3
B3	60.3	B15	61.7
B4	61.9	B16	64.2
B5	62.3	B17	59.7
B6	61.3	B18	56.9

Receiver Reference	Boundary Noise Contribution dB(A)	Receiver Reference	Boundary Noise Contribution dB(A)
B7	60.0	B19	57.1
B8	57.2	B20	60.3
B9	53.6	B21	58.9
B10	52.8	B22	59.0
B11	53.0	B23	59.3
B12	54.6	B24	56.9

Based on the point receiver noise levels along the site boundary, the Project is not anticipated to exceed the boundary noise limit. The highest value achieved was 64.2 dB(A) on the southern boundary, this value is significantly below the limit of 70 dB(A).

4.7 Operational Noise Model Assessment

A series of noise contour maps have been produced to depict predicted noise levels within the Project study area. Calculations have been carried out under normal operating conditions to determine level of compliance to environmental standards.

4.7.1 Noise Contour Maps

The following contour maps have been generated:

- Figure A1: Overall Daytime Contour
- Figure A2: Overall Night-time Contour
- Figure A3: Overall Daytime Contour with Baseline
- Figure A4: Overall Night-time Contour with Baseline
- Figure A5: Daytime with Receptors
- Figure A6: Night-time with Receptors

4.7.2 Environmental Noise Assessment (Project Contribution in Isolation)

The environmental noise assessment takes into account all provided noise sources within the Project scope. The guidelines state that the noise levels in Residential areas should not exceed 55 dB(A) during the day and 45 dB(A) at night time. The noise contributions at the Measurement locations are shown in Table 4-2 below.

Table 4-2 - Contributed Noise Levels at Selected Sensitive Receptors

ID.	Description	UAE Federal Environment Agency Noise Limits (dB(A))		Daytime Modelled Results (dB(A))	Night-time Modelled Results (dB(A))
		Day	Night		
SR1	Northern Residences	55	45	51.6	41.8

As can be seen from the above table the predicted noise level contributions at the measured locations are below both the night time and daytime noise limits.

4.7.3 Cumulative Impact Assessment

An impact assessment was performed in order to determine the severity of the impact of the project at the nearest sensitive receptor locations. These locations are presented in Figure 4-2 below:

Figure 4-2 - Noise Measurement Locations

The results of the Project noise contribution and resulting impact at SR1 is presented in Table 4-3 for day-time and night-time operations respectively. NQM01 has been used as representative of the baseline noise level at SR1 due to the proximity of the location.

Table 4-3 - Operational Impact Assessment

ID.	Description	Project Noise Contribution (dB(A))	Baseline Noise Level (dB(A))	Cumulative Noise Level (dB(A))	Maximum Change in Noise Level at Receptor (dB(A))	Impact Severity
Day Time Operational Impact Assessment						
SR1	North Residences	51.6	55	56.6	1.6	Negligible
Night Time Operational Impact Assessment						
SR1	North Residences	41.8	49	49.8	0.8	Negligible

Based on the operational noise impact assessment results at sensitive receptors identified there are predicted to be negligible impacts.

5 Conclusions

An environmental noise assessment has been conducted for the Dubai Waste to Energy Project. The project is located in the in Dubai, UAE.

The aim of the noise assessment was to establish project compliance with environmental noise standards. This report presents the findings of an environmental noise modelling analysis of high noise-emitting equipment associated with the Project.

Potentially noisy items of plant were modelled using the internationally recognised SoundPLAN model and a series of noise contour maps produced (Appendix A).

A site boundary noise assessment was undertaken, and the levels at the Project boundary ranged from 52.8 dB(A) to 64.2 dB(A) with the highest noise level occurring on the southern boundary. The boundary limit of 70 dB(A) was thus predicted not to be exceeded at any point along the property fence line boundary.

An assessment was conducted at nearby identified sensitive receptors. There are predicted to be negligible impacts due to the operation of the plant for both daytime and night-time periods.

6 References

[1] Ministry of Environment and Water, *UAE Federal Law No. (24) of 1999 for the Protection and Development of the Environment,* Abu Dhabi, United Arab Emirates: Ministry of Environment and Water, 1999.

[2] International Organisation for Standardisation (ISO), *ISO1996-1-3 'Description and Measurement of Environmental Noise',* 2003.

[3] International Organisation for Standardisation (ISO), *ISO9613-2 'Acoustics – Attenuation of Sound During Propagation Outdoors',* 1996.

[4] Pro-Acoustics GmbH, *"Noise impact assessment" for Dubai Waste to Energy BOT GS003,* Rev0.4 ed., 2018.

[5] Hitachi Zosen Inova Besix, *50057151-0.4: Noise Impact Assessment - Dubai Waste to Energy BOT GS003,* 2018.

7 Glossary

LAeq T: This is the continuous equivalent sound level. It is a widely used noise parameter that calculates a constant level of noise with the same energy content as the varying acoustic noise signal being measured. The letter “A” denotes that the A-weighting has been included and “eq” indicates that an equivalent level has been calculated. Hence, L_{Aeq} is the A-weighted equivalent continuous noise level. A-weighting is a filter incorporated into a sound level meter which when measuring noise replicates the sensitivity of human hearing.

LASN, T percentile levels: The level of A-weighted noise exceeded for N% of the measurement time. L_{AS90}, T is often used as a measure of background noise in many standards and guidelines. The L_{AS90}, T parameter would therefore represent the level exceeded for 90% of the measurement period, T. Likewise the L_{AS10}, T would indicate the level exceeded for 10% of the measurement period, T indicating the higher noise levels measured.

Octave Band Analysis: To identify frequency components of a sound, there is octave band analysis in which frequencies are segmented into proportionate widths (octave bands) and analysed. The sound pressure level of a single octave band is called the "octave band level", while that analysed for $^1/_3$ of the octave band is called a "$^1/_3$ octave band level". The frequency band in the octave band and $^1/_3$ octave band is expressed as the centre frequency of that band. Using f_1 and f_2 as the upper and lower end frequencies of the band.

Sound Pressure Level (Lp): An acoustic measurement for the ratios of sound energy. Rated in decibels.

Sound Power Level (Lw): The Lw is a measure of the total airborne acoustic power generated by a noise source, expressed on a decibel scale referenced to a common standard (10^{-12} watts).

Decibel (dB): dB is a logarithmic unit of measurement that expresses the magnitude of a physical quantity (usually power or intensity) relative to a specified or implied reference level. Since it expresses a ratio of two quantities with the same unit, it is a dimensionless unit.

dB(A): The ‘A’ weighting network is very similar to the way in which the human ear responds to variations in sound pressure level as it places higher attenuation on the lower frequencies than on the mid to upper frequencies. It is applied to the decibel scale in order to account for how the human ear responds to changes in sound levels.

Appendix A: Noise Contour Maps

Figure A1 – Overall Daytime Contour

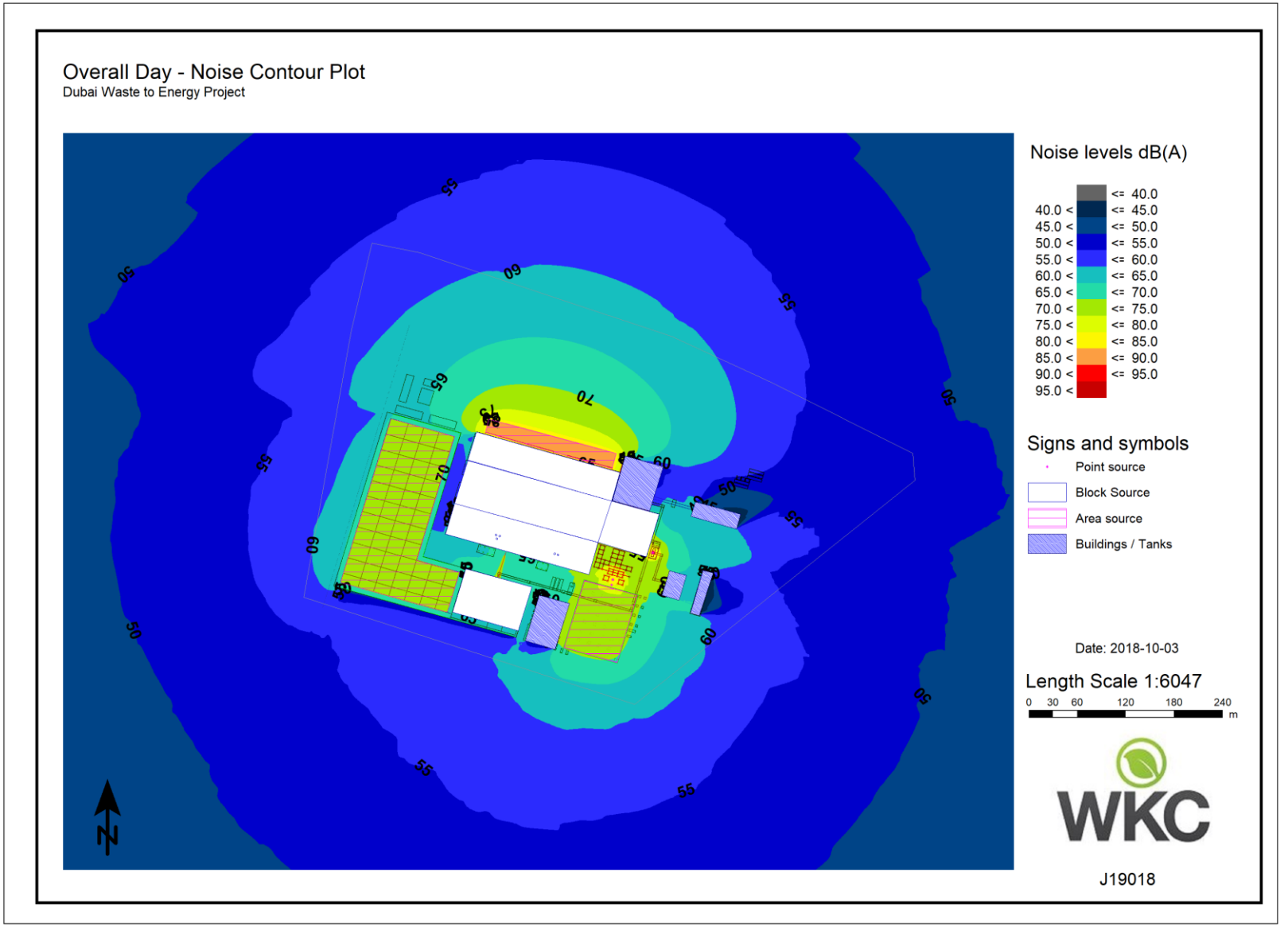


Figure A2 – Overall Night-time Contour

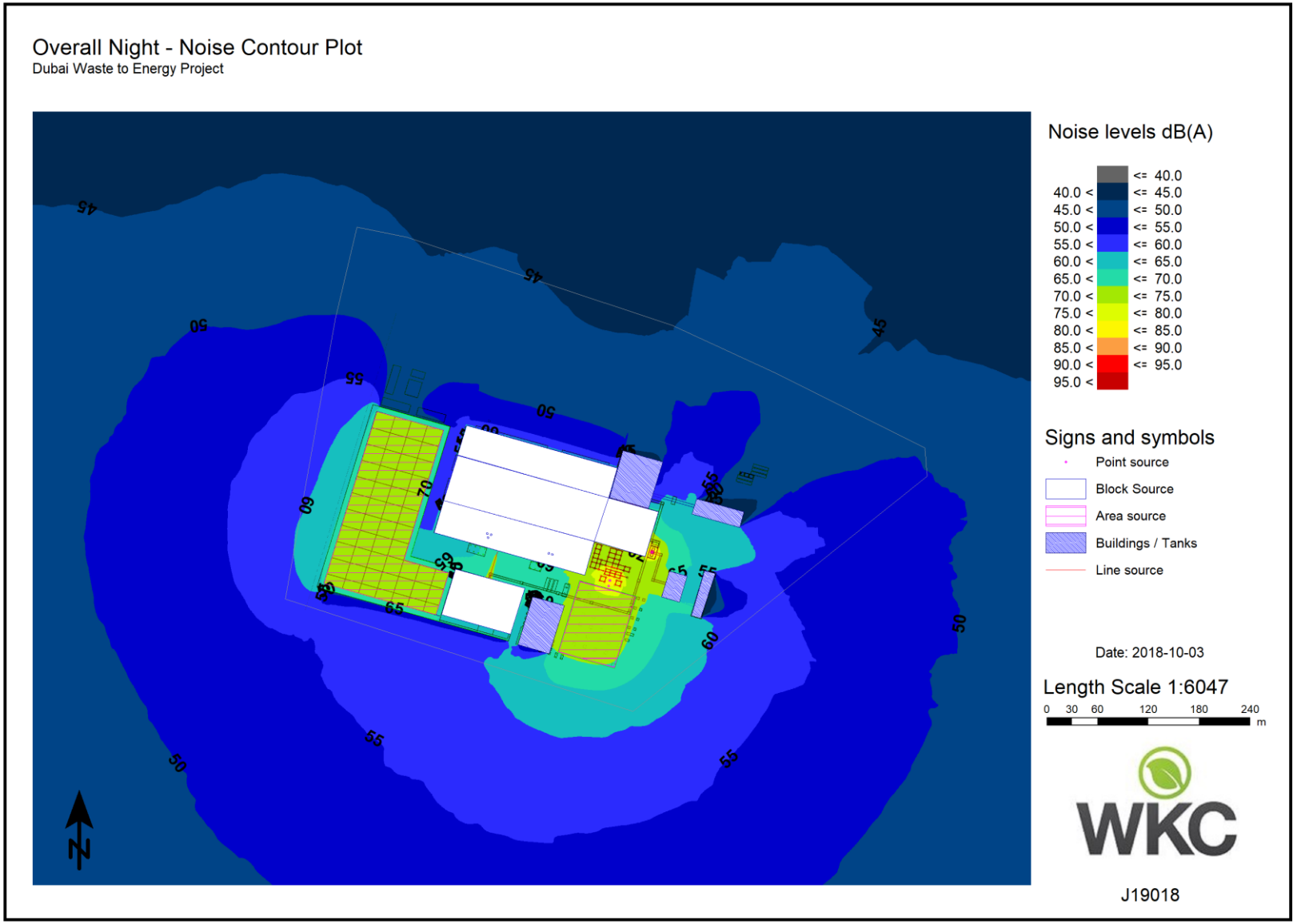


Figure A3 – Overall Daytime Contour with Baseline

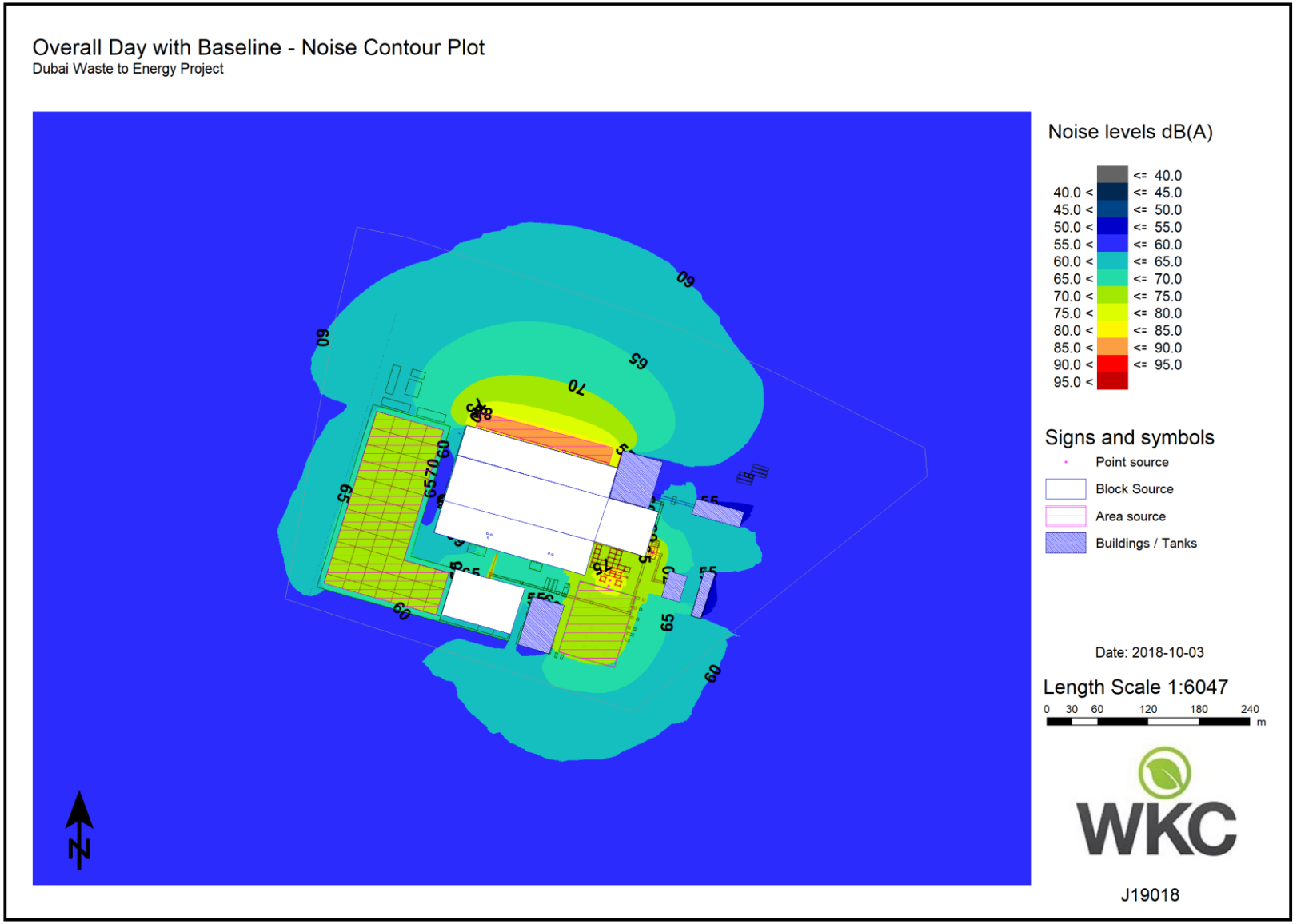


Figure A4 – Overall Night-time Contour with Baseline

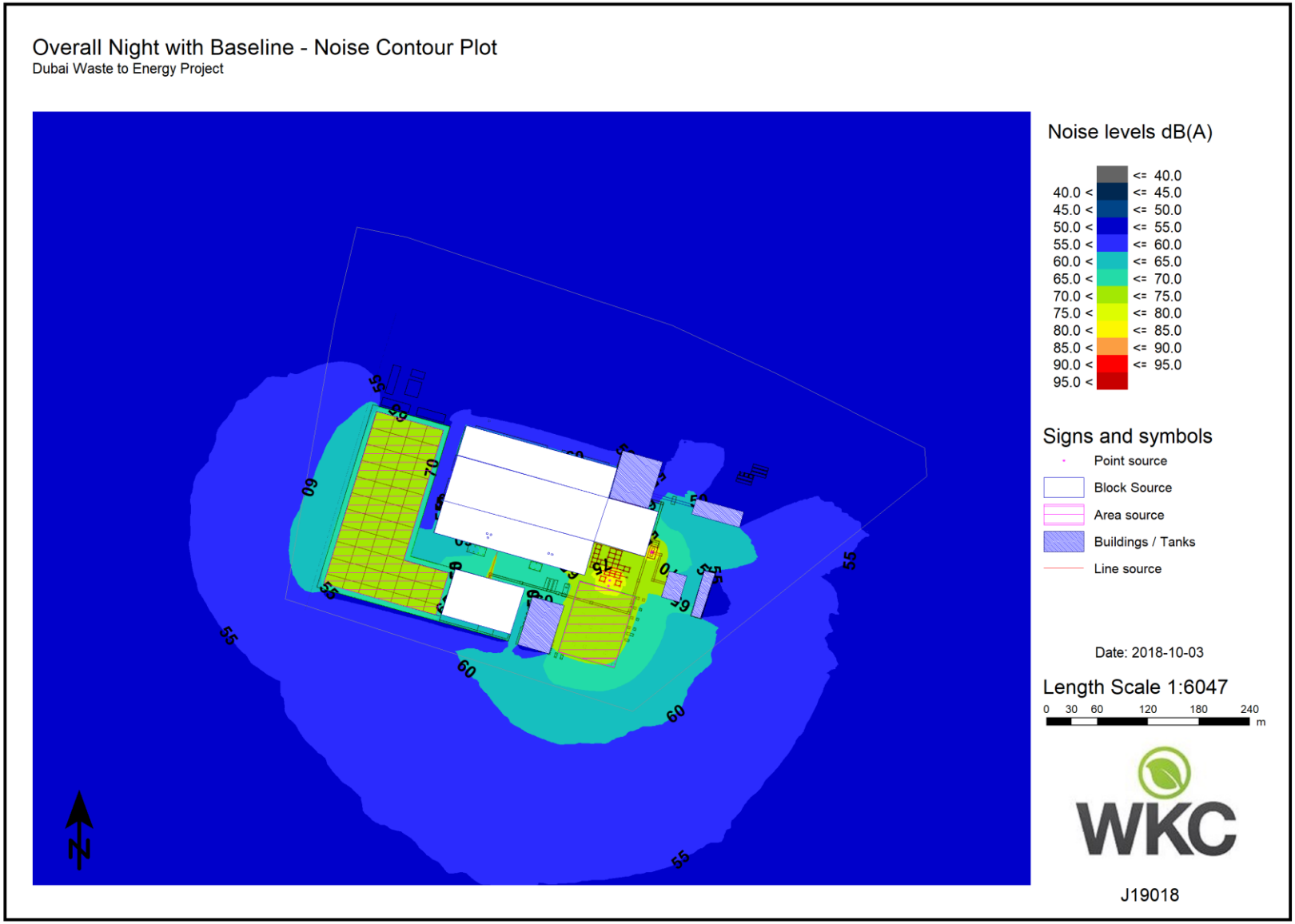


Figure A5 – Daytime Contour with Receptors

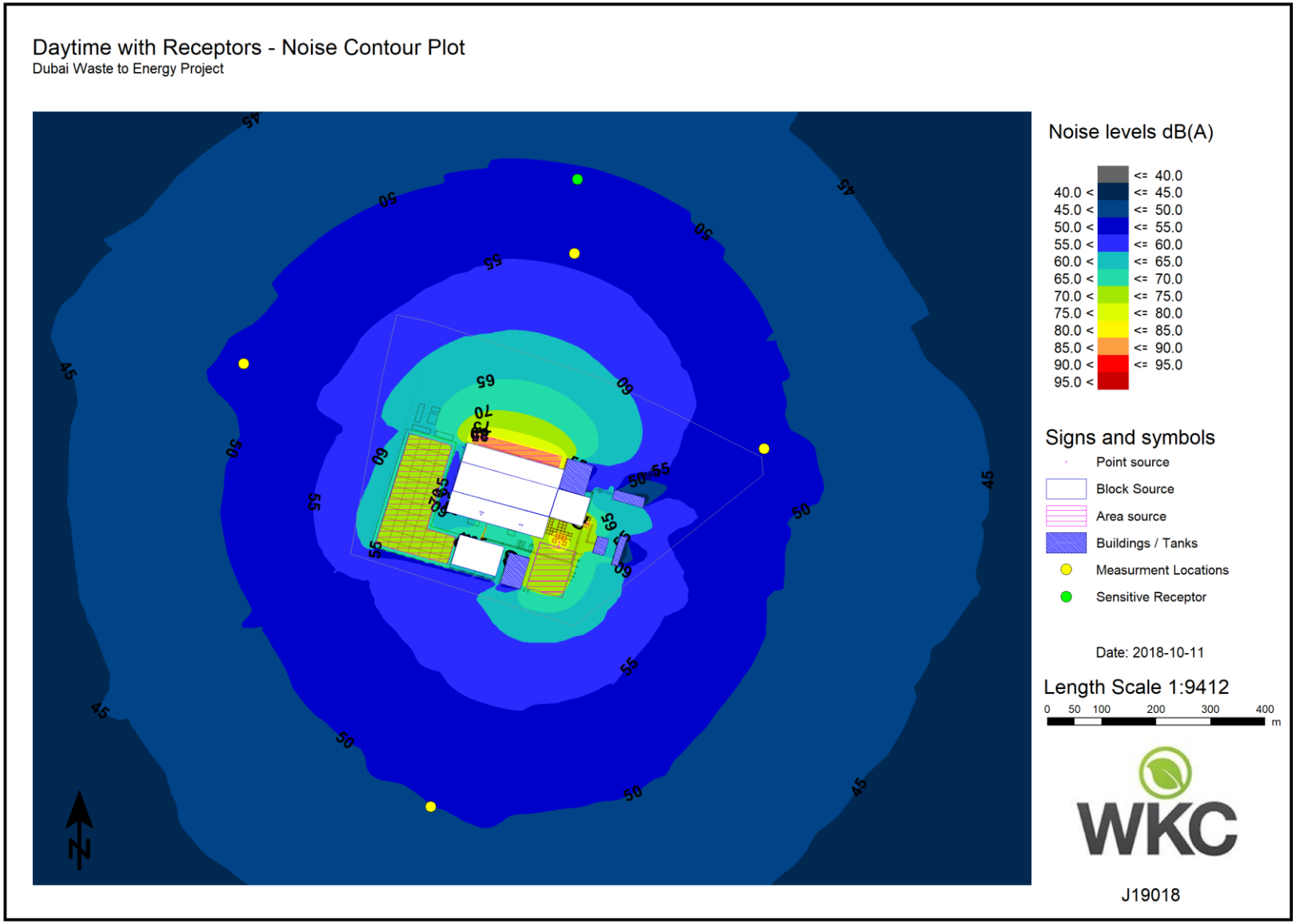
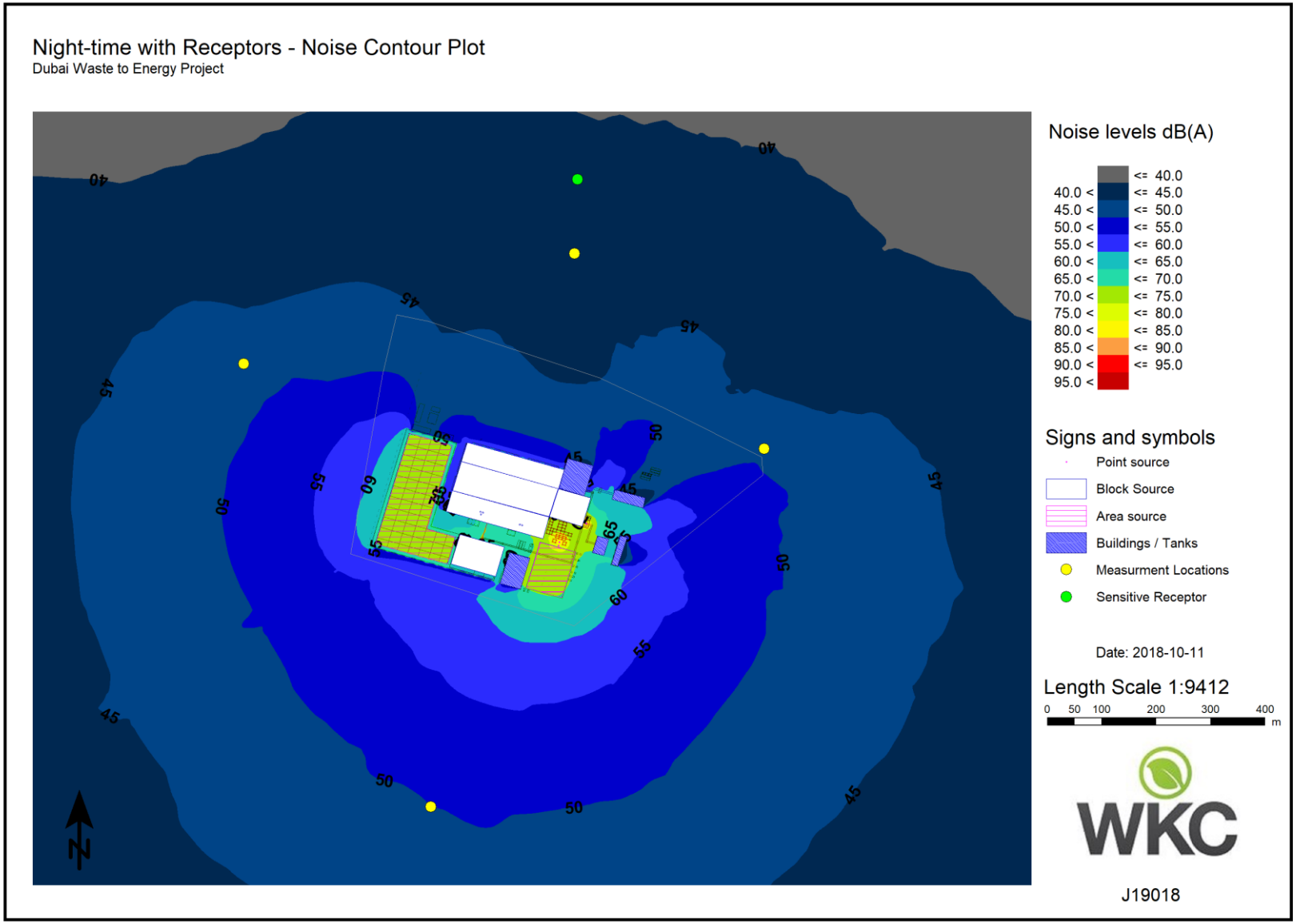


Figure A6 – Night-time Contour with Receptors



Appendix B: Noise Log

Table B1: Noise Log (Model Inputs)

Equipment Description	LW (dB(A))	Octave Band Central Frequency Spectrum Noise (dB)								Comment / Reference
		63Hz	125Hz	250Hz	500Hz	1kHz	2khz	4khz	8khz	
Waste Bunker	69.5	88.0	77.0	78.0	69.0	70.0	46.0	38.0	30.0	Reference document: “PA-18034 Additional input for noise prediction calculations_HZI”, Transmission losses accounted for.
Flue Treatment Hall	69.1	90.0	83.0	78.0	70.0	61.0	58.0	48.0	39.0	Reference document: “PA-18034 Additional input for noise prediction calculations_HZI”, Transmission losses accounted for.
Boiler Hall	65.1	90.0	82.0	73.0	62.0	63.0	47.0	35.0	25.0	Reference document: “PA-18034 Additional input for noise prediction calculations_HZI”, Transmission losses accounted for.
Steam Turbine Hall	75.5	88.0	88.0	76.0	71.0	67.0	66.0	62.0	58.0	Reference document: “PA-18034 Additional input for noise prediction calculations_HZI”, Transmission losses accounted for.
IBA	70.0	90.0	82.0	75.0	70.0	63.0	62.0	49.0	43.0	Reference document: “PA-18034 Additional input for noise prediction calculations_HZI”, Transmission losses accounted for.
Tipping Area	118.0	123.0	118.0	113.0	108.0	111.0	111.0	111.0	108.0	Reference document: “PA-18034 Additional input for noise prediction calculations_HZI”
Stack Body	97.0	101.0	100.0	104.0	93.0	72.0	70.0	70.0	70.0	Reference document: “50057151-0.4: Noise Impact Assessment”
Stack Opening	100.0	116.0	112.0	106.0	88.0	70.0	68.0	68.0	68.0	Reference document: “50057151-0.4: Noise Impact Assessment”
ACC inlet	112.0	119.0	117.0	112.0	109.0	108.0	99.0	95.0	91.0	Reference document: “50057151-0.4: Noise Impact Assessment”
ACC Outlet	108.0	116.0	114.0	109.0	106.0	104.0	96.0	90.0	85.0	Reference document: “50057151-0.4: Noise Impact Assessment”
ACC Steam Duct	108.0	104.0	104.0	98.0	97.0	98.0	105.0	95.0	92.0	Reference document: “50057151-0.4: Noise Impact Assessment”
ACC Recoolers	106.0	106.0	109.0	106.0	105.0	100.0	96.0	90.0	87.0	Reference document: “50057151-0.4: Noise Impact Assessment”
Transformer	104.0	107.0	107.0	104.0	104.0	98.0	93.0	88.0	81.0	Reference document: “50057151-0.4: Noise Impact Assessment”
IBA Conveyor	95.0	97.0	95.0	93.0	92.0	91.0	87.0	84.0	83.0	Reference document: “50057151-0.4: Noise Impact Assessment”
IBA outdoor handling	110.0	112.0	115.0	110.0	105.0	103.0	102.0	100.0	95.0	Reference document: “50057151-0.4: Noise Impact Assessment”

Appendix P – Terrestrial Ecology Survey Report

Dubai Municipality Solid Waste to Energy Plant Facility Project

Terrestrial Ecology Survey

Prepared for: GHD

Ref.: J19018

Date: 29-09-2018

Report Approval & Revision Record

Project:	Dubai Municipality Solid Waste to Energy Plant Facility Project
Document Title:	Terrestrial Ecology Survey
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Rev	Date	Prepared	Reviewed	Approved
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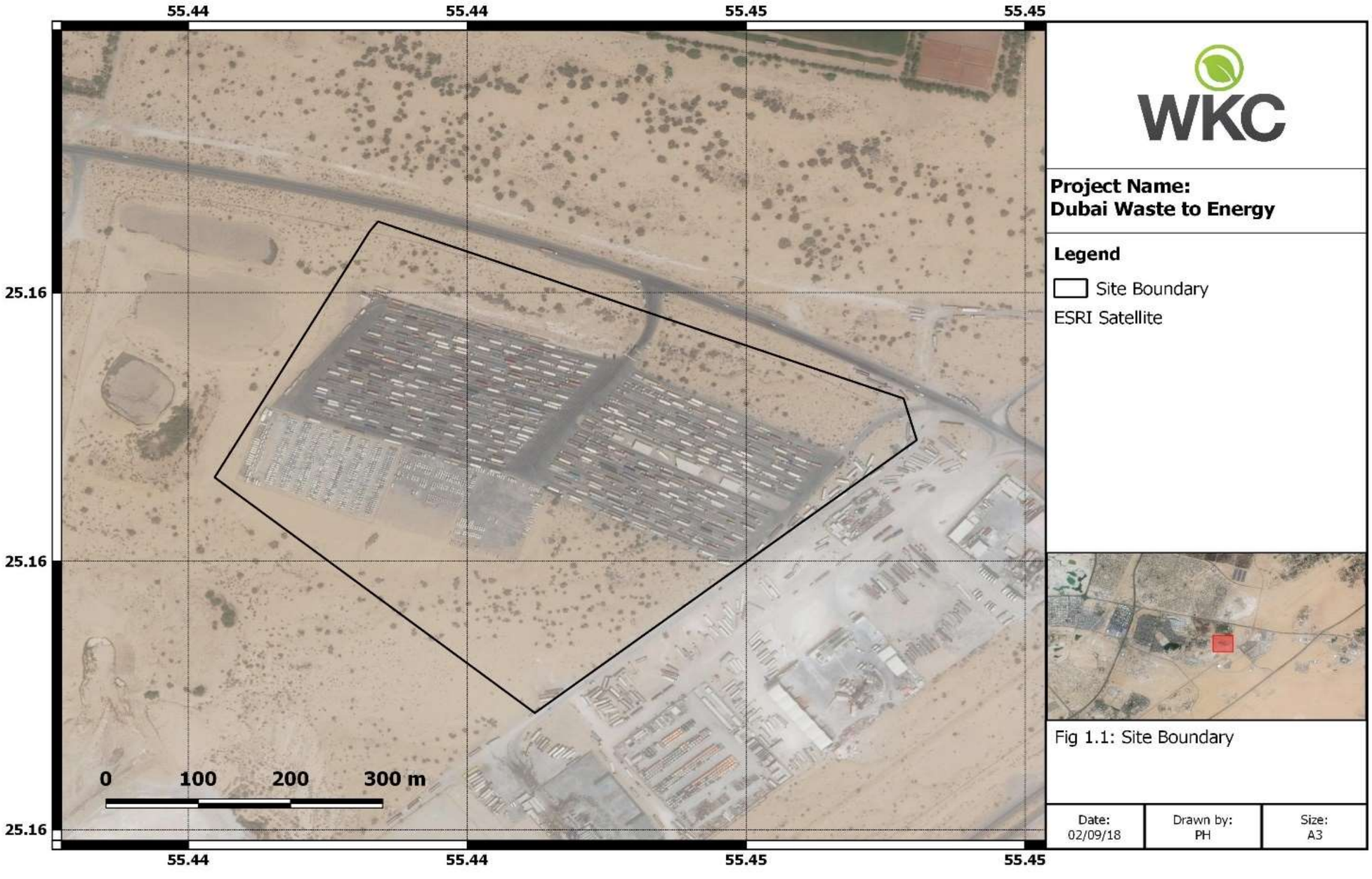
1 Introduction

GHD Global PTY. LTD. (GHD) have commissioned WKC Environment Consultancy (WKC) to undertake a terrestrial ecology survey at the proposed Dubai Municipality Solid Waste to Energy Plant facility. The facility will be built in an approximately 15 hectares of land situated Al Warsan 2 area of Dubai, UAE. The plot is close to the existing sanitary landfill for Municipal Solid Waste and to Al Awir Sewage Treatment Plant. The location of the proposed facility is presented in Figure 1-1.

Figure 1-1 – Project Location



1.1 Purpose of the Study

The purpose of the study was to conduct a terrestrial ecology survey at the proposed new Dubai Municipality Solid Waste to Energy Plant facility. The objectives of the terrestrial ecology survey are as follows:

- Survey for fauna and flora species present onsite;
- Determine the species richness, composition and conservation value;
- Identification of environmentally sensitive terrestrial areas and critical habitats within the study area; and
- Identification and mapping of terrestrial habitat types present.

2 Survey methodology

The terrestrial ecology survey was conducted from 19th to 20th of August 2018 (two days and one night) to determine the species richness and composition of flora and fauna in the study area. A combination of transect counts, quadrat sampling, trapping and general observations were employed to assess the flora and fauna in the study area. Furthermore, an assessment of current satellite imagery of the study area was undertaken prior to mobilisation to identify hotspots for targeted surveys. The following methodologies were employed during the survey.

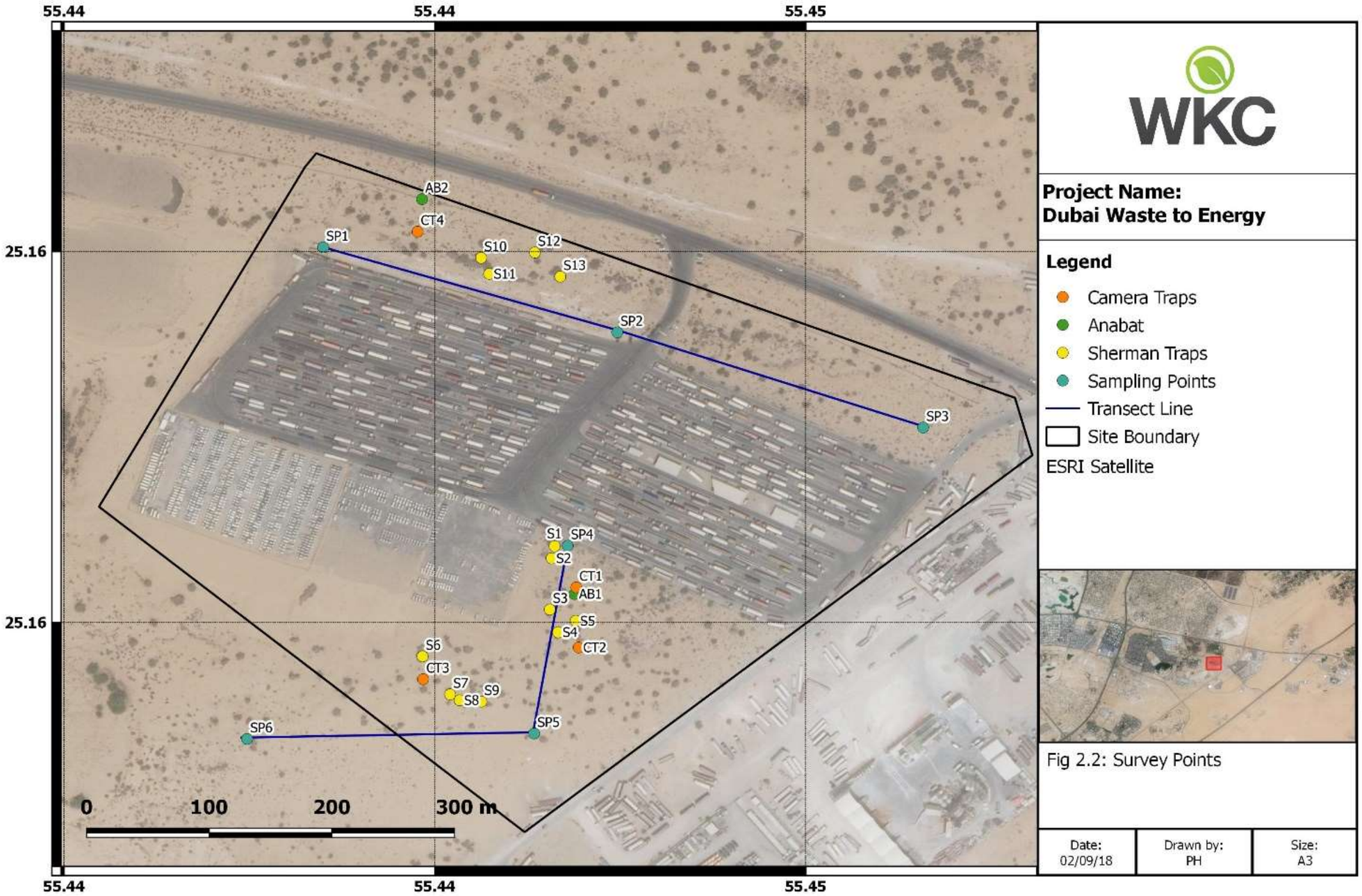
2.1 Habitat and Flora

The vegetation of the study area was assessed by identifying the main habitat types and associated plant communities. The project site was surveyed using six (6) quadrats of approximately 10m x 10m in size. The locations of the quadrats are presented in Figure 2-1. Brown and Boer (2004) was utilised for the habitat classification onsite [1]. The quadrats surveyed aimed to record all plant species and assess the floristic communities using the DAFOR (Dominant, Abundant, Frequent, Occasional and Rare) scale.

2.2 Birds

Sites identified as providing suitable habitats for birds were monitored using two (2) 500 m transect lines. The locations of the transect lines and sampling points are presented in Figure 2-1. Each transect line was divided into three (3) sampling points in which a 15-minute observation period were undertaken to record all bird species. Furthermore, bird activities, namely foraging, calling, singing, nesting and flight were also noted.

Figure 2-1 – Survey Area



2.3 Mammals

Mammalian surveys were undertaken using a combination of transects survey and trappings. Mammals were recorded by visual sightings as well as signs, inclusive of tracks, burrows, scats, and other signs, if identifiable. Nocturnal torchlight surveys for mammals were also undertaken to determine the presence of any mammalian species such as rodents, bats and foxes. In areas where activities of small mammals are noted, thirteen (13) Sherman small mammal traps were placed in transect formation, see Figure 2-1. Traps were baited with rolled oats and deployed prior to sunset, with all traps collected within 1 hour of sunrise the following day.

Figure 2-2 – HD Infrared Camera Trap at Habitat B (left) and Anabat Express Bat Detector at Habitat A (right)

In addition, four (4) remote infra-red camera traps were deployed for one (1) night at suitable locations to assist in the identification of species, see Figure 2-2. Furthermore, two (2) Anabat Express Bat Detectors were also deployed for a 24-hour period to determine the presence or absence of volant mammals (bat) species onsite, see Figure 2-2. Both locations were chosen for their suitability to support bats either hunting or travelling to/from their roost sites. The locations of the Camera traps and Anabat Units are presented in Figure 2-1.

2.4 Reptiles

Reptile surveys were undertaken during the transects survey and quadrats sampling across the study area. Where discarded plywood sheets and other anthropogenic debris was noted, the material was lifted to identify any species taking refuge. Nocturnal torch surveys were completed in conjunction with the mammal survey to identify species of gecko and snake.

The track logs of diurnal and nocturnal surveys as well as the GPS way points are provided in Appendix 1.

2.5 Limitation of the Survey

This survey was undertaken during Summer period and only provides information relevant to the species richness, composition and habitat use at the point of the survey. In an event that Dubai Municipality requests a seasonal variation, additional surveys will be required during Winter period. Furthermore, this survey focused on major vertebrate groups (birds, mammals, and reptiles) which are commonly used for rapid site assessments (RSA) of habitat quality. Invertebrates which are complex and poorly understand group, are not included in this survey as it is very difficult to provide a reliable assessment due to the time and resource limitations.

3 Survey Results

The terrestrial ecology survey records a total of twelve (12) species of plants, seventeen (17) species of birds, five (5) mammal and five (5) reptile species. The species richness, distribution, relative abundance, and flora and fauna habitat association within the study area are discussed in the following sections.

3.1 Flora

3.1.1 Species Richness

The study area is sparsely vegetated with a low diversity of species of about twelve (12) species (less than 2 % of the total species present in the UAE). The main vegetation consists of scattered large and small shrubs, and perennial grasses. The majority of the species are present in the northern and southern sections of the study area. Furthermore, several species of plants such as Broom Brush (*Leptodinia pyrotechnica*), Sodom's Apple (*Calatropis procera*), *alqa* (*Dipterygium glaucum*), Rusty Indigo (*Indigofera colutea*), and Devil's thorn (*Tribulus terrestris*) were observed to be on the flowering and/or fruiting stages, see Figure 3-1.

Figure 3-1 – Flowering Sodom's Apple (*Calatropis procera*) and Devil's Thorn (*Tribulus terrestris*)

All plants recorded during the survey are native species and are well adapted to desert environment. In addition, except for *Tamarix cf. nilotica* which is classified as a Least Concern species, the population status of the remaining plants species is currently unknown as the IUCN Red List of Threatened Species has not yet assessed their respective populations [2] . However, all recorded plant species in the study area are commonly found in the desert environment of the Emirate of Dubai [3]. The species list which includes the local distribution, population status, and habitat observed during the survey is provided in Table 3-1.

Table 3-1: Recorded Plant Species Onsite

Common Name	Latin Name	Local Distribution [3]	IUCN Red List	Habitat
Family Poaceae				
Turgid panic grass	*Panicum turgidum*	Common and widespread	Not Yet Assessed	A, B
Desert grass	*Stipagrostis plumosa*	Common and widespread	Not Yet Assessed	A, B
Family Cyperaceae				
Cyperus	*Cyperus conglomeratus*	Common and widespread	Not Yet Assessed	A, B, C
Family Asclepiadaceae				
Broom Brush	*Leptodinia pyrotechnica*	Common and widespread in Northern Emirates	Not Yet Assessed	A, B, C
Sodom's Apple	*Calatropis procera*	Common and widespread in Northern part of the country	Not Yet Assessed	A, B
Family Boraginacae				
Turnsole	*Heliotropium kotschyi*	Common and widespread	Not Yet Assessed	A, B
Family Capparaceae				
Alqa	*Dipterygium glaucum*	Common and widespread	Not Yet Assessed	A, B, C
Family Cucurbitaceae				
Desert squash	*Citrullus colocynthis*	Common and widespread	Not Yet Assessed	A
Family Fabaceae				
Rusty Indigo	*Indigofera colutea*	Locally common	Not Yet Assessed	A
Family Tamaricaceae				
Tarfa	*Tamarix cf. nilotica*	Common along the Arabian Gulf coast and sandy desert area	Least Concern	A
Family Zygophyllaceae				
Devil's thorn	*Tribulus terrestris*	Not common but widespread in urban areas	Not Yet Assessed	A, B, C
Bean Caper	*Zygophyllum qatarense*	Common and widespread along the Arabian Gulf coast	Not Yet Assessed	A, B

Note: Definition of Habitat Types are provided in Section 3.5.

3.1.2 Vegetation Type and Species Dominance

Based on species dominance, the vegetation of the area can be broadly classified as Zygophyllum-Heliotropium Vegetation Type and Leptodinia-Calatropis Vegetation Type, which are typical of the dune deserts. The floristic association of these vegetation types are as follows:

1. The Zygophyllum-Heliotropium Type is found mainly in the northern part of the area. The plant density in this area is relatively high and species richness consists of twelve (12) species, with unpalatable species the most common. The dominant species are Bean Caper *(Zygophyllum qatarense)* and Turnsole (*Heliotropium kotschyi*) whilst Broom Brush (*Leptodinia pyrotechnica*) and Sodom's Apple

(*Calatropis procera*) are also abundant. In addition, scattered individuals of Alqa (*Dipterygium glaucum*), Rusty Indigo (Indigofera colutea), and Devil's thorn (*Tribulus terrestris*) were noted in this vegetation. Three species of grass were found to be common in this vegetation type.

2. Leptodinia-Calatropis Vegetation Type is found in the southern part of the area. The plant density and species richness (10 species) in this vegetation type is lower when compared with Zygophyllum-Heliotropium type. The dominant species are Broom Brush (*L. pyrotechnica)* and Sodom's Apple (*C. procera*). Scattered individuals of Bean Caper *(Z. qatarense)*, Turnsole (*H. kotschyi*), Alqa (*D. glaucum*), and Devil's thorn (*T. terrestris*) area were also noted in this vegetation type. Cyperus (*Cyperus conglomeratus*) is the only representative of the grass group in this area during the survey

The over-all species Relative Abundance (R.A.) values of all plant species recorded in the study area are provided in Table B-1 of Appendix B.

Figure 3-2 – Dominant Plant Species *Leptadenia pyrotechnica* (left) and *H bacciferum* (right)

3.2 Birds

3.2.1 Species Richness

Bird species diversity onsite is low. A total of 17 (seventeen) species of birds representing 7 avian families were recorded onsite which is approximately 4 % of the total number (445) of bird species recorded in the UAE. The avifauna in the study area is composed of 12 (71 %) breeding resident, 3 (18%) introduced species with stable breeding population, and 2 (12%) species that have resident and migrant populations [4, 5]. Furthermore, the majority of recorded birds onsite are common and well adapted to desert environment specifically on dune with dwarf shrubs habitat. In addition, several species of birds such as Rock Dove (*Columba livia*), Rose-ringed Parakeet (*Psittacula krameri*), Common Myna (*Acridotheres tristis*), and House Sparrow (*Passer domesticus*) are well known to be associated with human influenced landscapes such as parks and farmland.

All species recorded during the survey period are classified as Least Concern species in IUCN Red List of Threatened Species [2].

Figure 3-3 – *Psittacula krameria* Onsite

The species list which includes the local distribution, national and global population status, number of individuals observed, and habitat observed during the survey period is provided in Table 3-2.

Table 3-2: Recorded Bird Species Onsite

Common Name	Latin Name	OSME [5]	IUCN Red List [2]	Habitat
Family Phasianidae				
Grey Francolin	*Francolinus pondicerianus*	Very common and widely distributed	Least Concern	B
Family Charadriidae				
Red-wattled Lapwing	*Vanellus indicus*	Very common resident, passage migrant and winter visitor	Least Concern	A, B
Family Columbidae				
Laughing Dove	*Spilopelia senegalensis*	Abundant and widespread resident.	Least Concern	A, B, C
Eurasian Collared-dove	*Streptopelia decaocto*	Locally abundant	Least Concern	A, B, C
Rock Dove	*Columba livia*	Very common	Least Concern	A, B, C
Family Psittacidae				
Rose-ringed Parakeet	*Psittacula krameri*	Common resident	Least Concern	A, B
Family Meropidae				
Green Bee-eater	*Merops orientalis*	Common to very common resident	Least Concern	A, B
Family Alaudidae				
Crested Lark	*Galerida cristata*	Very common to abundant resident	Least Concern	A, B
Family Cisticolidae				

Common Name	Latin Name	OSME [5]	IUCN Red List [2]	Habitat
Graceful Prinia	*Prinia gracilis*	Very common breeding resident	Least Concern	A
Family Leiotrichidae				
Arabian Babbler	*Turdoides squamiceps*	Common breeding resident.	Least Concern	A, B
Family Laniidae				
Lesser Grey Shrike	*Lanius minor*	Fairly common migrant, April to May, uncommon late August to mid-November	Least Concern	A, C
Family Pycnonotidae				
White-eared Bulbul	*Pycnonotus leucotis*	Common and widespread	Least Concern	A, B
Red-vented Bulbul	*Pycnonotus cafer*	Common and range expanding.	Least Concern	A, B
Family Sturnidae				
Common Myna	*Acridotheres tristis*	Very common, introduced	Least Concern	A, B, C
Family Nectariniidae				
Purple Sunbird	*Cinnyris asiaticus*	Common breeding resident	Least Concern	A, B
Family Estrildidae				
Indian Silverbill	*Euodice malabarica*	Very common resident	Least Concern	A, B
Family Passeridae				
House Sparrow	*Passer domesticus*	An abundant resident	Least Concern	A, B, C

Note: Definition of Habitat Types are provided in Section 3.5.

3.2.2 Species Relative Abundance and Feeding Guild

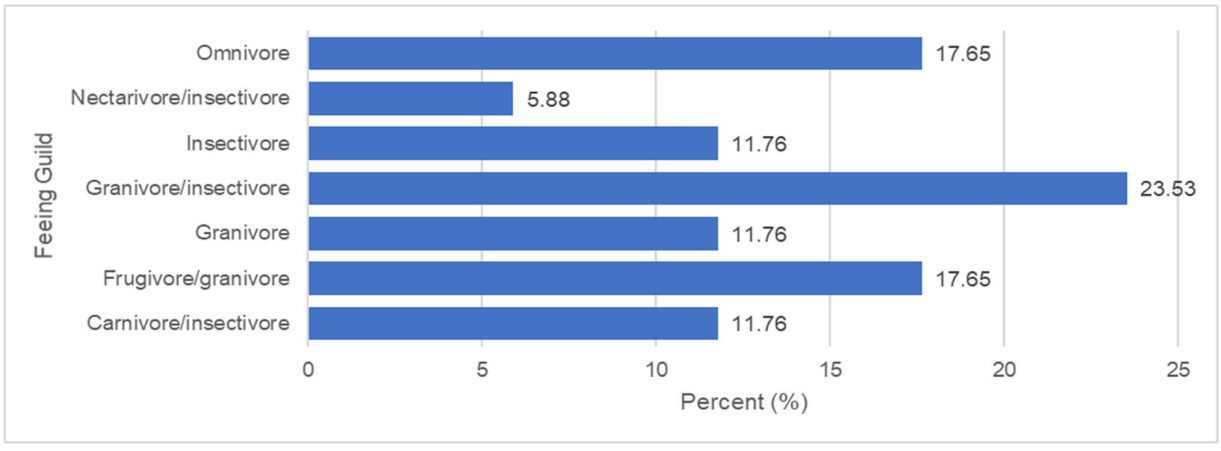
The analysis of species R.A. values indicates that House sparrow (*P. dometicus*) (R.A. ,16%), Indian Silverbill (*E. malabarica*) (R.A.,13%), and Laughing Dove (*Spilopelia senegalensis*) (R.A., 10%) were the three most abundant species in the study area. These species are commonly observed in large feeding flocks onsite. The Lesser Grey Shrike (*Lanius minor*) with R.A. value of 1% is considered as rare or uncommon species onsite as only one individual was observed during the survey period. The remaining bird species onsite such as Eurasian Collared-dove (*Streptopelia decaocto*), Purple Sunbird (*Cinnyris asiaticus*), and Common Myna (*Acridotheres tristis*) are considered common species. The R.A. values of avifauna onsite are provided in Table B-2 of Appendix B.

Figure 3-4 – *Passer Domesticus* (left) and *Euodice malabarica* (right)

Furthermore, small mixed flocks or feeding units normally composed at least 2 to 5 individuals of Rose-ringed Parakeet (*Psittacula krameria)*, Arabian Babbler (*Turdoides squamiceps*), White-eared Bulbul (*Pycnonotus leucotis*), Purple Sunbird (*C. asiaticus*), Indian Silverbill (*E. malabarica*), and House sparrow (*P. dometicus*) were observed onsite. These small feeding units were usually observed feeding in areas with flowering and/or fruiting individuals of Sodom's Apple (*C. procera*) and Broom Brush (*L. pyrotechnica*).

The foraging behaviours of bird species onsite were grouped into seven feeding guilds to determine the feeding behaviours of different bird species and the food resources of the study area, Figure 3-5. The assessment of feeding guild indicates that granivore/insectivore (23.53 %), omnivore (17.65%), and frugivore/granivore (17.65%) were the three most abundant feeding guilds onsite. The granivore/insectivore guild is comprised of species from Family Columbidae (doves) and Crested Lark (*Galerida cristata*) whilst Omnivores are represented by Grey Francolin (*Francolinus pondicerianus*), Arabian Babbler (*T. squamiceps*), and Common Myna (*A. tristis*). Nectivore/insectivore (5.88%), which is comprised of Purple Sunbird (*C. asiaticus*) is considered as the rarest feeding guild in the study area during the survey period. The analysis of the feeding guilds suggests insects and grains/seed producing plants are the main food resources onsite.

Figure 3-5 – Feeding Guilds of Avifauna Onsite



3.3 Mammals

3.3.1 Species Richness and Population Status

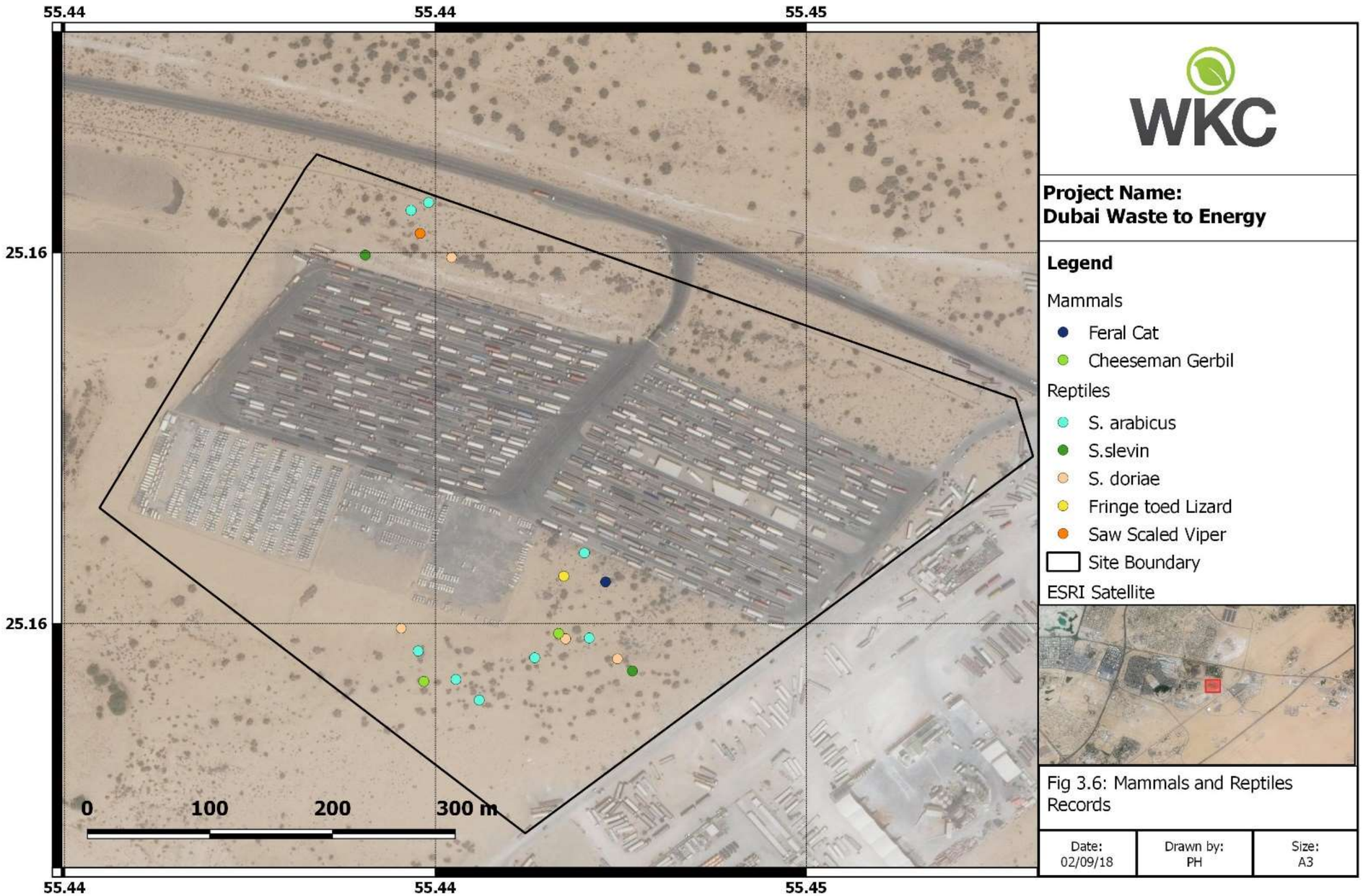
The mammalian species diversity onsite is also low with a total of five (5) species recorded during the survey period. The majority of the species onsite are listed as data deficient (DD) or additional data are required to assess the local population in the UAE [6]. However, except for the Feral cat (*Felis cattus*), the remaining mammalian species in Table 3-3 are classified as Least Concern species in the IUCN Red List of Threatened Species [2]. The species list which includes the local distribution and population status of recorded mammals during the survey are provided in Table 3-3. The survey points where different species of mammals were recorded onsite are presented in Figure 3-6.

Table 3-3: Recorded Mammalian Species Onsite

Common Name	**Latin Name**	**EAD Red List** [6]	**IUCN Red List** [2]	**Habitat**
Family Muridae				
Cheesman's Gerbil	*Gerbillus cheesmani*	Least Concern	Least Concern	B
Family Felidae				
Feral Cat	*Felis cattus*	Not Listed	Not Listed	B
Family Vespertilionidae				
Kuhl's Pipistrelle	*Pipistrellus kuhli*	Data Deficient	Least Concern	A, B
Common Pipistrelle	*Pipistrellus pipistrellus*	Data Deficient	Least Concern	A, B
Muscat Mouse-tailed Bat	*Rhinopama muscalletum*	Data Deficient	Least Concern	A

Note: Definition of Habitat Types are provided in Section 3.5.

Figure 3-6 – Mammals and Reptiles Records Onsite



Non-Volant (Small Mammal)

Two (2) species of small non-volant mammals representing two (2) mammalian families were recorded onsite. Three (3) individuals of Cheesman's Gerbril (*Gerbillus cheesmani*) were caught via Sherman traps in Habitat B. These individuals were immediately released after proper species identification, see Figure 3-7. This nocturnal and solitary rodent species is well adapted in arid areas and commonly found on sandy soils and mud flats in eastern deserts [2]. Furthermore, this species is considered as common in the Arabian Peninsula [2].

Although Cheesman's Gerbril (*G. cheesmani*) was only recorded in Habitat B it is highly likely that it is also present in Habitat A. This assumption is due to the fact that Habitat A and Habitat B is generally classified Habitat 4310 (Sand sheets and dunes with dwarf shrub cover) which is a known habitat of the species. In addition, potential burrows of this species were also observed in Habitat A.

Figure 3-7 – Cheesman's Gerbil during Released

In addition, a juvenile feral cat (*Felis cattus*) was recorded at Habitat B during night survey. The population of feral cat in the UAE is growing exponentially, and impacts associated with feral cat predation on native species is well documented throughout the world. In the UAE, a further impact is the cross breeding of wild-domestic felines with Gordon's Wild Cat (*Felis silvestris gordoni*).

Volant Mammals (Bats)

The volant mammal survey using Anabat Express bat detectors recorded three (3) species of volant mammals representing two (2) mammalian families onsite. The detailed species accounts and their respective distributions are discussed below.

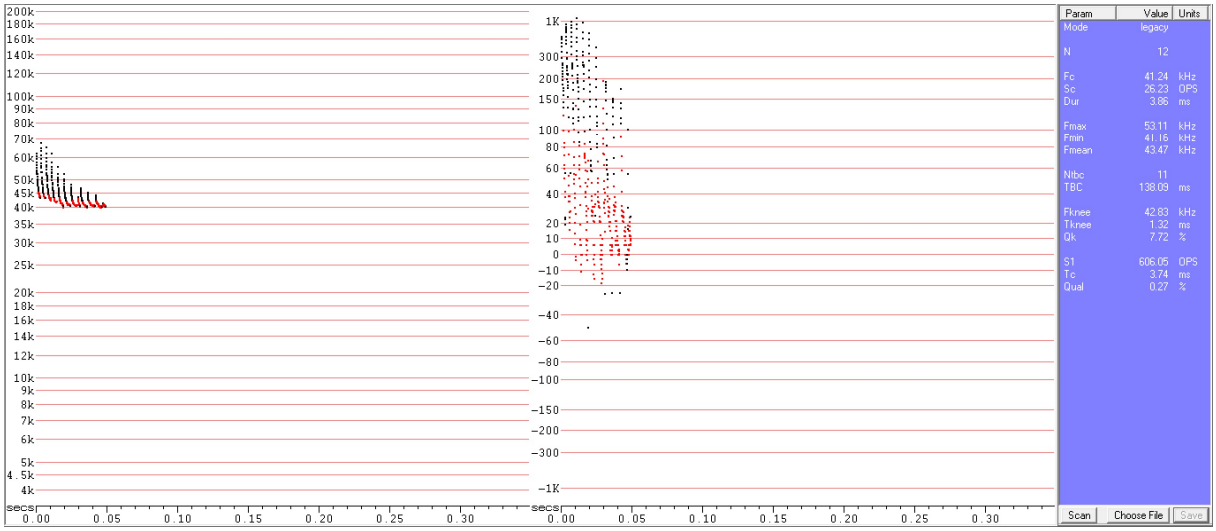
Kuhl's Pipistrelle (*Pipistrellus kuhli*)

This species is recognised as one of the most common bat species in the Middle East. Kuhl's Pipistrelle (*P. kuhli*) is a common and widespread species, that can be found from Europe to the Middle-east and North Africa. This is an opportunistic species that contrary to many other species, benefits from human development, utilising buildings, houses and plantations to establish their roost. Despite the important lack of information on the status of species in the UAE and Middle East, this species is presumably the most abundant bat species found within urban environments. Pipistrelle bat species have been recorded utilising a variety of habitats,

inclusive of urban and agricultural areas where they predate on insects. It has been reported that urbanisation, particularly in Dubai, has benefitted this species with the provision of favourable roost sites and an increase in prey items due to changes in habitat composition.

Throughout the Project site, a total of 60 registrations identified as Kuhl's Pipistrelle were recorded during the single evening of monitoring. Highlighted within Figure 3-8, is a registration assigned to Kuhl's Pipistrelle. Note that the Fknee (knee frequency) in the call is registered at 42.83khz whilst the Fmin (minimum frequency) and Fmax (maximum frequency) are 41.16khz and 53.11khz respectively. These registrations are all within the assigned call frequency for Kuhl's Pipistrelle in the Middle East.

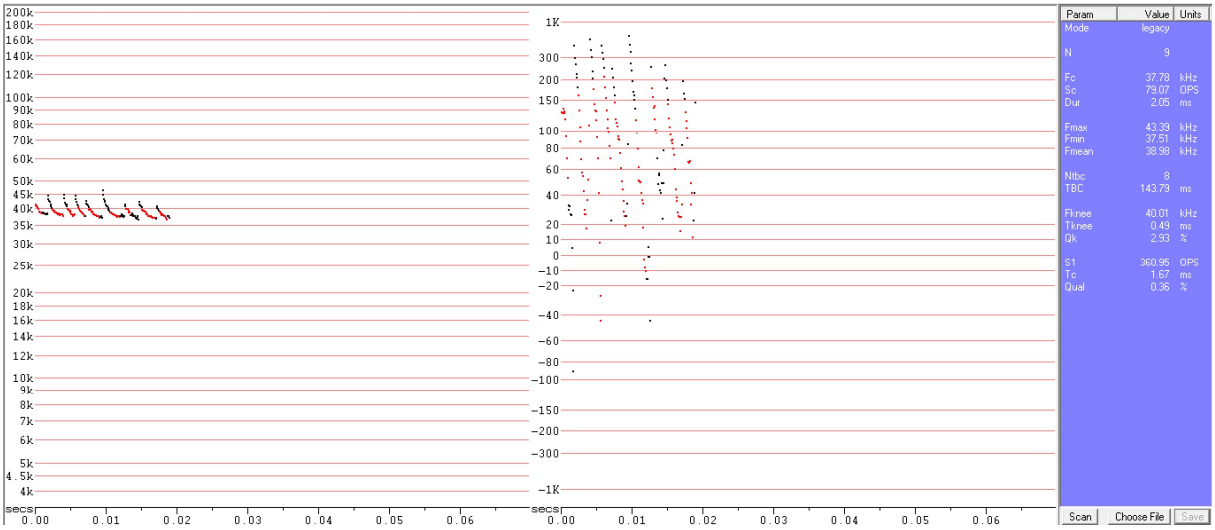
Figure 3-8 –Kuhl's Pipistrelle Bat echolocation



Common Pipistrelle (*Pipistrellus pipistrellus*)

Whilst the species is considered common and widespread throughout Europe, is yet to be confirmed in the Middle East. In the instance of detailed bat studies conducted throughout the Middle East to date, there is an increase in data suggesting that this species may occur from western KSA to the UAE. As highlighted in Figure 3-9, the call range comprises of a Fmax at 50.56khz whilst the Fmin is 40.04khz. Of importance however is the Fknee, that dictates the differentiation between Kuhl's Pipistrelle (*P. kuhli*) and possible Common Pipistrelle (*P. pipistrellus*) with in this instance, the echolocation registering a Fknee of 41.97khz.

Figure 3-9 – Possible Common Pipistrelle echolocation



There is however limited data available on the distribution of Common Pipistrelle (*P. pipistrellus*) in the Middle East, with confirmed records obtained in Jordan and more recently, western KSA. In both instances, the calls recorded are of similar frequency to those obtained on the Project site. However, detailed assessment of call frequency variation associated with the pipistrelle family is yet to be conducted in the Middle East, and whilst the species has provisionally been identified as Common Pipistrelle, there is the possibility that it may be Arabian Pipistrelle (*Pipistrellus arabicus*), a species with a similar call range.

Common Pipistrelle will forage in a variety of habitats, including open woodland and woodland edges, semi-desert, farmland, rural gardens and urban areas. Predating on primarily small moths and flies, this species as with all bats are biological controls for mosquito populations. Roosts, as with Kuhl's Pipistrelle (*P. pipistrellus*), are commonly found throughout buildings and trees. Owing to large scale development and creation of landscaped facilities, this species is likely to have benefitted from urbanisation in the Middle East.

Muscat Mouse-tailed Bat (*Rhinopama muscalletum*)

A solitary registration assigned to the species Muscat Mouse-tailed Bat (*R. muscalletum*) was recorded at location AB01 (Figure 3-10). This species is considered common throughout the UAE, however it is primarily associated with mountain and rocky areas, where suitable roost locations are available. Within the middle east, this species is at present restricted to the UAE and Oman, with populations recorded throughout southern Iran (Figure 3-11).

Figure 3-10 – Muscat Mouse-tailed Bat echolocation

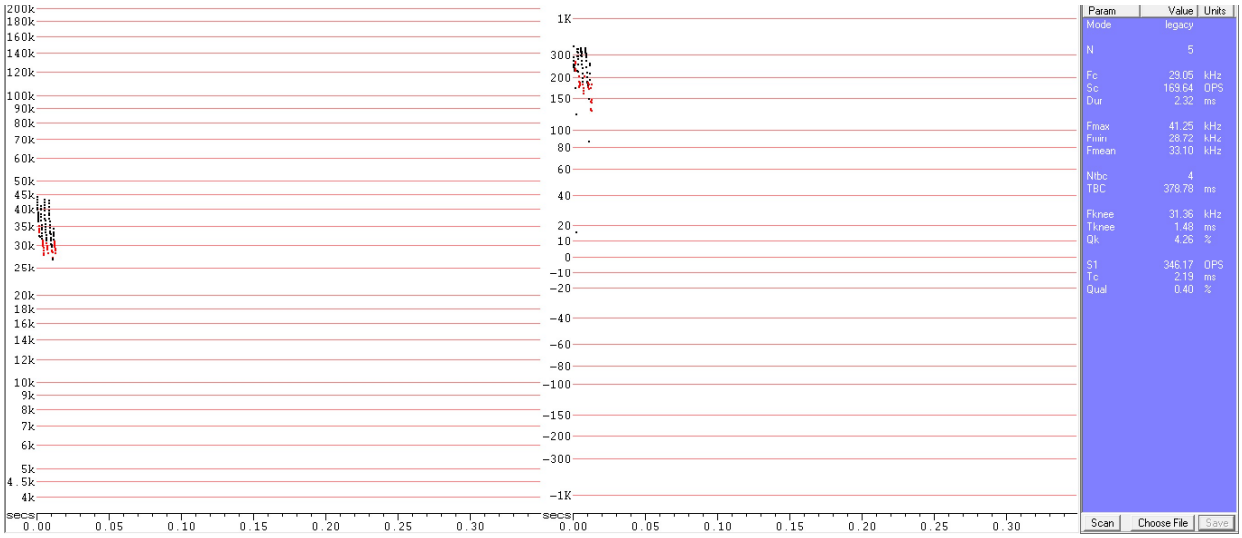
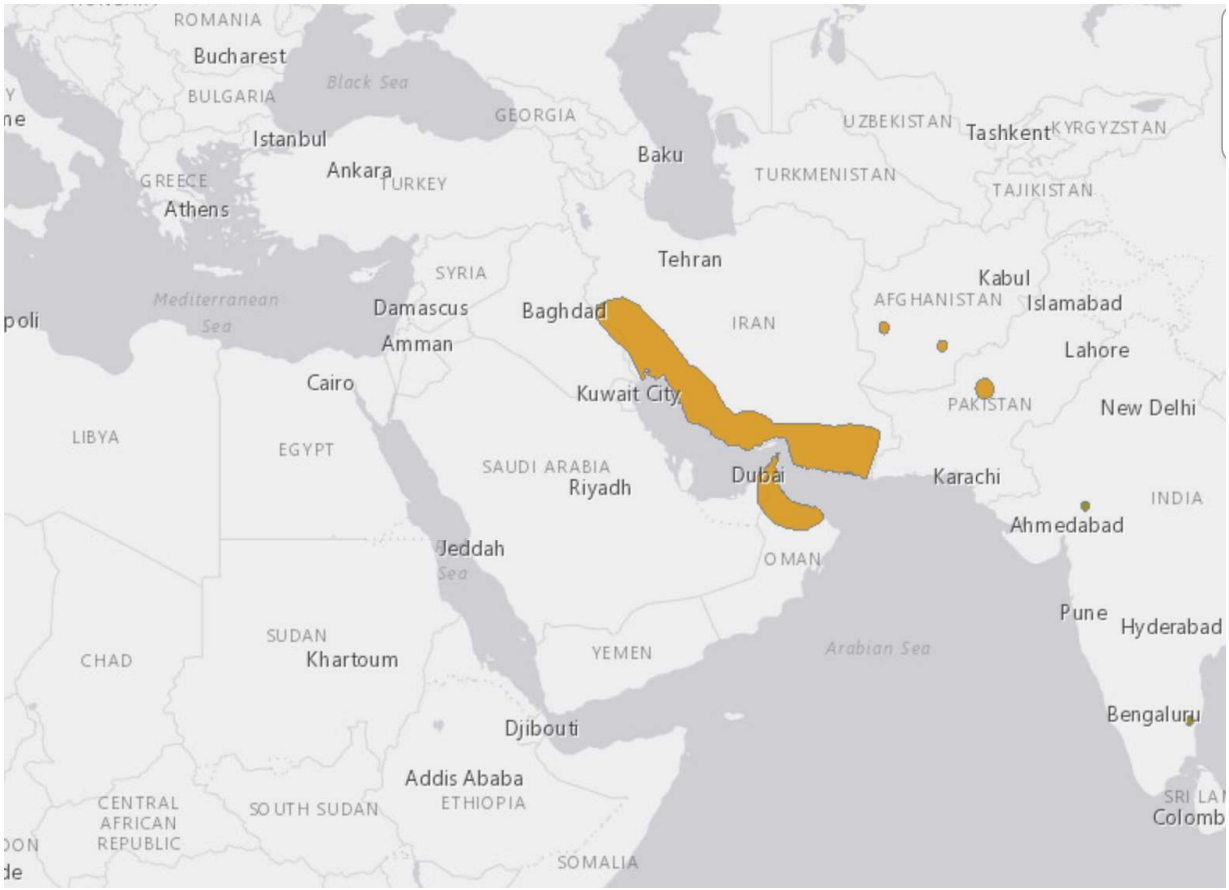


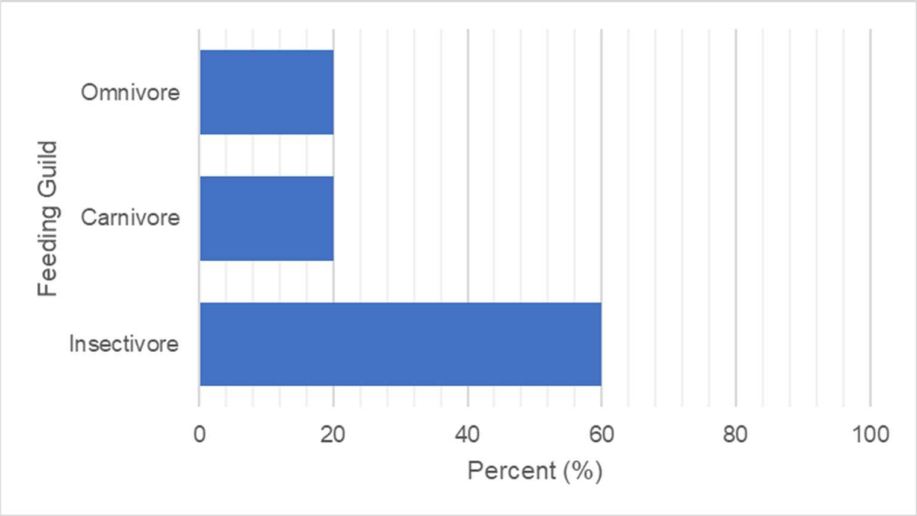
Figure 3-11 – Muscat Mouse-tailed Bat Global Distribution [2]



3.3.2 Species Relative Abundance and Feeding Guild

Species relative abundance for this group was not assessed as the Anabat data do not provide the actual number of individuals recorded onsite. The assessment of feeding guild of mammalian fauna onsite indicates that insectivorous mammals (all bats) are the dominant feeding trophic onsite. It suggests that insects are stable food resource onsite. The feeding guilds of the mammalian fauna onsite are presented in Figure 3-12.

Figure 3-12 – Feeding Guilds of Mammalian Fauna Onsite



3.4 Reptiles

3.4.1 Species Richness and Population Status

Species richness of reptiles onsite is low with a total of five (5) species which is approximately 9 % of the herpetofauna (54) of the UAE. The herpetofauna onsite is composed of three (3) geckoes, one (1) lizard and one (1) snake species representing three (3) reptilian families. Except for Sind saw-scaled viper (*Echis carinatus sochureki*) which is not yet assessed by the IUCN, the remaining species on the list are classified as Least Concern species. In addition, all reptilian species recorded during this survey are considered as common in the UAE. The survey points where different species of mammals were recorded onsite are presented in Figure 3-6.

The species list which includes the local distribution and population status of recorded reptiles during the survey are provided in Table 3-4.

Table 3-4: Recorded Reptiles Onsite

Common Name	**Latin Name**	**EAD Red List** [6]	**IUCN Red List** [2]	**Habitat**
Family Gekkonidae				
Arabian Sand Gecko	*Stenodactylus arabicus*	Not yet assessed	LC	A, B
Dune Sand Gecko	*Stenodactylus doriae*	Not yet assessed	LC	A, B

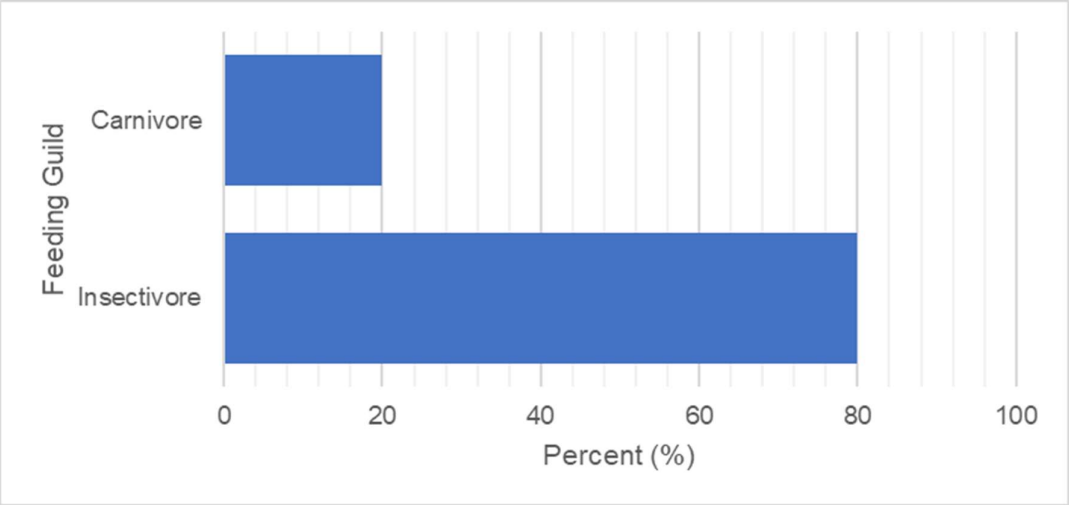
Common Name	Latin Name	EAD Red List [6]	IUCN Red List [2]	Habitat
Slevin's sand gecko	*Stenodactylus slevini*	Not yet assessed	Least Concern	A, B
Family Lacertidae				
Schmidt's Fringe-toed Lizard	*Acanthodactylus schmidtii*	Not yet assessed	Least Concern	B
Family Viperidae				
Sind saw-scaled viper	*Echis carinatus sochureki*	Not yet assessed	Not yet assessed by IUCN	A

Note: Definition of Habitat Types are provided in Section 3.5.

3.4.2 Species Relative Abundance and Feeding Guild

Species R.A. values for this group indicate that Arabian Sand Gecko (*Stenodactylus arabicus*) is the most abundant gecko in the study area with R.A. value of 50% followed by Dune sand gecko (*Stenodactylus doriae*) and Slevin's sand gecko (*Stenodactylus slevini*) with R.A. values of 25% and 12.5%, respectively. The Schmidt's fringe-toed Lizard (*Acanthodactylus schmidti*) and Sind saw-scaled viper (*Echis carinatus sochureki*) with R.A value of 6.25 % are considered as uncommon in the study area. The R.A. values of herpetofauna onsite are provided in Table B-4.

Figure 3-13 – Feeding Guilds of Herpetofauna Onsite



The assessment of feeding guilds of reptiles onsite indicates that insectivore (80%) and carnivore (20%) are the only feeding guilds in the study area. The feeding guilds of herptofauna onsite are presented in Figure 3-13. The insectivores are composed of geckos such as Arabian Sand Gecko (*S. arabicus*) and Schmidt's fringe-toed Lizard (*A. schmidti*), see Figure 3-14. The dominance of the insectivores suggest that the habitat onsite supports a healthy insect population.

Figure 3-14 – *Stenodactylus arabicus* (left) and *Acanthodactylus schmidti* (right)

The Sind saw-scaled viper (*E carinatus sochureki*) is the only carnivorous reptilian species recorded onsite, see Figure 3-15 . This nocturnal species mainly feeds on small lizards, toads, anthropods, bird eggs, and nestling. Whilst a single juvenile individual of this species was recorded during the survey, the presence of juvenile suggests that there could a healthy population of this species onsite. The presence several prey items such as geckoes, lizard, and nesting birds onsite could have dictated their presence in the area.

Figure 3-15 – *Echis carinatus* onsite

3.5 Habitat Types and Associated Flora and Fauna

Based on EAD Habitat Classification [1], Habitat 4130 (Sand sheets and dunes with dwarf shrub cover) and Habitat 9600 (Disturbed ground) are the prominent habitat types in the study area, see Figure 3-16. The descriptions of these habitats including the associated species of flora and fauna are discussed in the following sections:

Figure 3-16 – Habitat 4130A (left) and Habitat 4130B onsite(right)

3.5.1 Habitat 4130: Sand sheets and dunes with dwarf shrub cover

Habitat 4130 is the only natural habitat type present onsite. However, this habitat type can be divided into two sub-types based on dominant plant communities and these are as follows:

Habitat 4130 A – This sub-habitat type (designated as Habitat A) is located at the northern section of the survey area in which Zygophyllum-Heliotropium community is the dominant vegetation type. The plant density and species richness can be considered as relatively high when compared Habitat 4130 B and Habitat 9600. A total of twelve (12) plants, nine (9) birds, three (3) mammals, and four (4) reptiles were recorded in this habitat. The Bean Caper (*Z. qatarense*) and Turnsole (*H. kotschyi*) are the dominant plant species in this habitat type. Several flowering and fruiting individuals of Sodom's Apple (*C. procera*) have been observed in this area. Furthermore, Sind saw-scaled viper (*E. carinatus sochureki*) was only observed in this area. This area is also relatively undisturbed compared with Habitat 4130 B where human activities such as off-road driving and trekking have been noted.

Habitat 4130 B – This sub-habitat type (designated as Habitat B) is located at southern part of the survey area in which Leptodinia-Calatropis community is the dominant vegetation type. The plant density and species richness in this vegetation type is low when compared with Habitat 4130 A. Furthermore, this habitat type is dominated by Broom Brush (*L. pyrotechnica*) whilst scattered individuals of Sodom's Apple (*C. procera*) were observed. The remaining plant species are restricted in northern section of this habitat. A total of eight (8) plants, thirteen (13) birds, one (1) mammals, and four (4) reptiles were recorded in this habitat. The relatively high bird species richness in this area could be due to several flowering individuals, such as Broom Brush (*L. pyrotechnica*) and Sodom's Apple (*C. procera*), as the majority of the mixed feeding units were observed in areas where patches of these species exist.

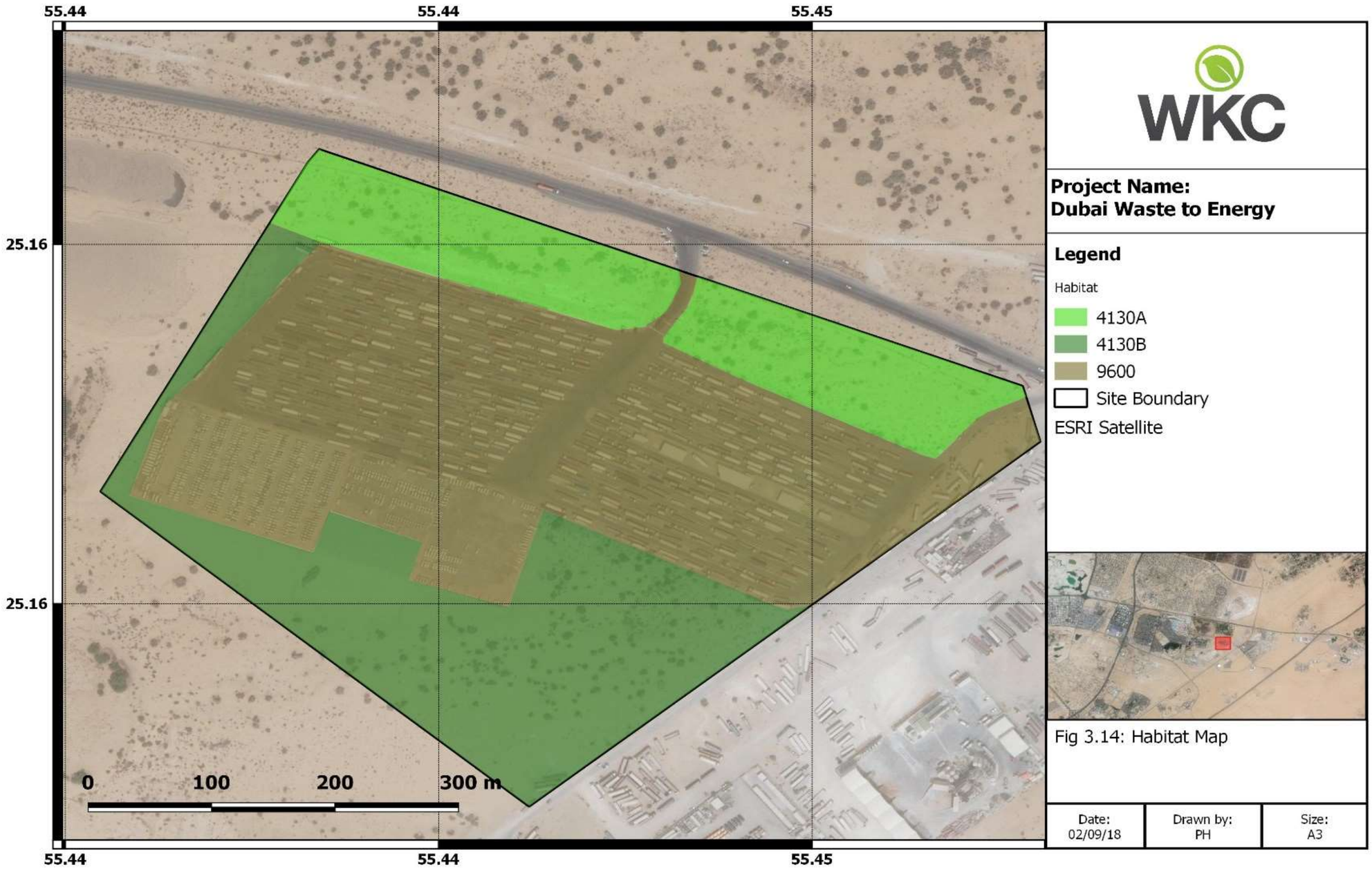
3.5.2 Habitat 9600 (Disturbed ground)

This habitat type (designated as Habitat C in this report) is located at middle and western sections of the study area and is the dominant habitat type onsite. Species richness in this area is very low when compared with Habitat 4130 A and Habitat 4130 B which could be due to complete alteration of the natural landscapes into asphalt paved parking spaces, see Figure 3-17. Only four (4) species of plants and six (6) species of birds were recorded in this habitat.

The locations of different habitat types in the study area are presented in Figure 3-18.

Figure 3-17 – Habitat 9600 (Disturbed ground) Onsite

Figure 3-18 – Locations of Different Habitat Types in the Study Area



4 Discussion

A total of 39 species of flora and fauna were recorded onsite during the survey. The over-all species richness of the study area (which is approximately 3% of the total species of flora and fauna in the UAE) can be considered as very low. The comparison of the species recorded onsite with the total number of species in the UAE is provided in Table 4-1.

Table 4-1: Comparison of Species Richness Onsite with the Total of Number of Species in the UAE

Group	Recorded Onsite	UAE
Plants	12	678 [3]
Birds	17	445 [4]
Mammals	5	45 [6]
Reptiles	5	54 [6]
Amphibian	0	2 [6]
Total	**36**	**1,224**

In addition, no species of flora and fauna is currently classified as threatened species in the IUCN 2018 Red List of Threatened species which suggests that only common and highly resilient species of flora and fauna are present in the study area. Furthermore, analysis of the overall feeding guilds on terrestrial fauna indicates that insectivores and grain (i.e. seed) feeders are that most common feeding guild onsite. This finding further supports the claim that all species of fauna onsite are common as insects and grain producing plants such as species of grasses (Family Poaceae) are also common in human influenced landscapes in the UAE.

The assessment of habitats onsite suggests that Habitat 4130 A have a relatively high species richness, especially plants, when compared with Habitat 4130 B. This is mainly due to absence of human activities such off-road driving and trekking in Habitat 4130 A. Furthermore, plant life in Habitat 4130 A is relatively dense and intact which provides more habitat to fauna. However, all habitats onsite especially Habitat 9600 have little conservation value as no threatened species or species that requires specific habitat to survive are found in the entire study area.

Bat species recorded during the survey are likely to be utilising the site for predation of insects, likely associated with the surrounding activities. The potential recording of Common Pipistrelle (*P. pipistrellus*) is noteworthy and could be a subject of further investigation. To date, the distribution and population of this species in the Middle East is known from only a handful of locations, with confirmed records being obtained from studies in KSA, Jordan and the UAE. However, detailed assessment of call frequency variation associated with the

pipistrelle family is yet to be conducted in the Middle East, and whilst the species has provisionally been identified as Common Pipistrelle, there is the possibility that it may be Arabian Pipistrelle (*P. arabicus*), a species with a similar call range.

Bats provide a key ecological function in predation of invertebrates, ensuring that natural populations of such species are balanced. Although feeding (particularly on invertebrates) is likely to occur on site, the majority of bats are likely to be passing through the area from roosts to feeding grounds elsewhere (potentially nearby landscaped areas). It is considered unlikely that the project site is used for roosting, due to lack of suitable structures and habitats.

The observation of a juvenile Sind saw-scaled viper (*E. carinatus sochureki*) suggests that area could hold a breeding population of this species. This finding might require additional survey to ascertain whether a viable population of this species are present in the study area. When necessary, translocation should be undertaken for this species prior to construction of the facility as it poses a health and safety risk to construction workers.

5 References

[1] G. a. B. B. Brown, “). Interpretation Manual of Major terrestrial natural and semi-natural Habitat types of Abu Dhabi Emirate.,” ERWDA Internal Research Report, 2004.

[2] IUCN, “The IUCN Redlist of Threatened Species,” 2018.

[3] M. Jongbloed, “The Comprehensive Guide to the Wild Flowers of the United Arab Emirates,” ERWDA, 2003.

[4] a. R. P. Aspinall S., “Birds of the United of the United Arab Emirates,” Bloomsbury Publishing, London, 2011.

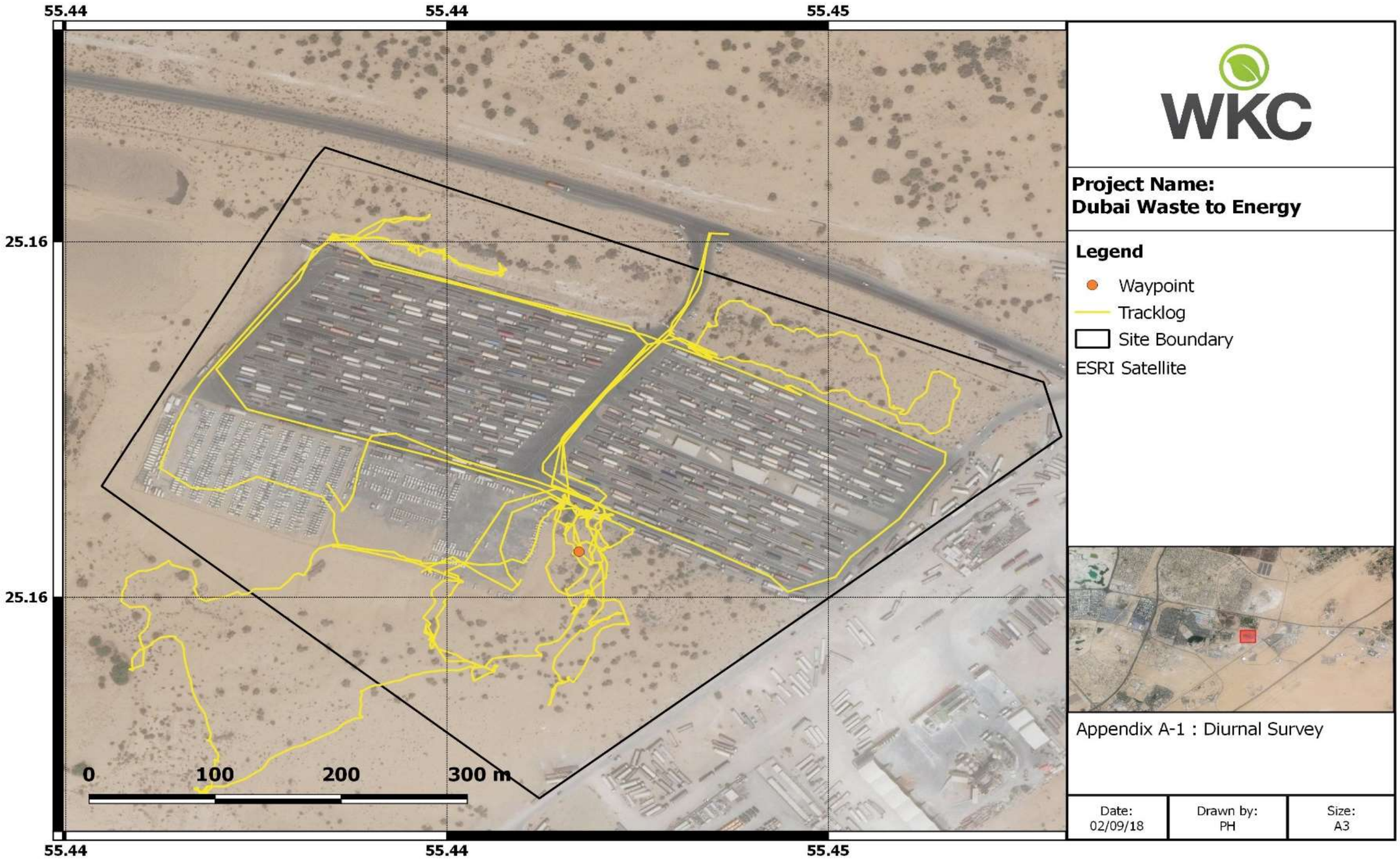
[5] U. B. C. www.uaebirding.com.

[6] C. A. D. S. B. I. a. T. C. Drew, “The Terrestrial Mammals, Reptiles and Amphibians of the UAE - Species List and Status Report,” ERWDA, 2005.

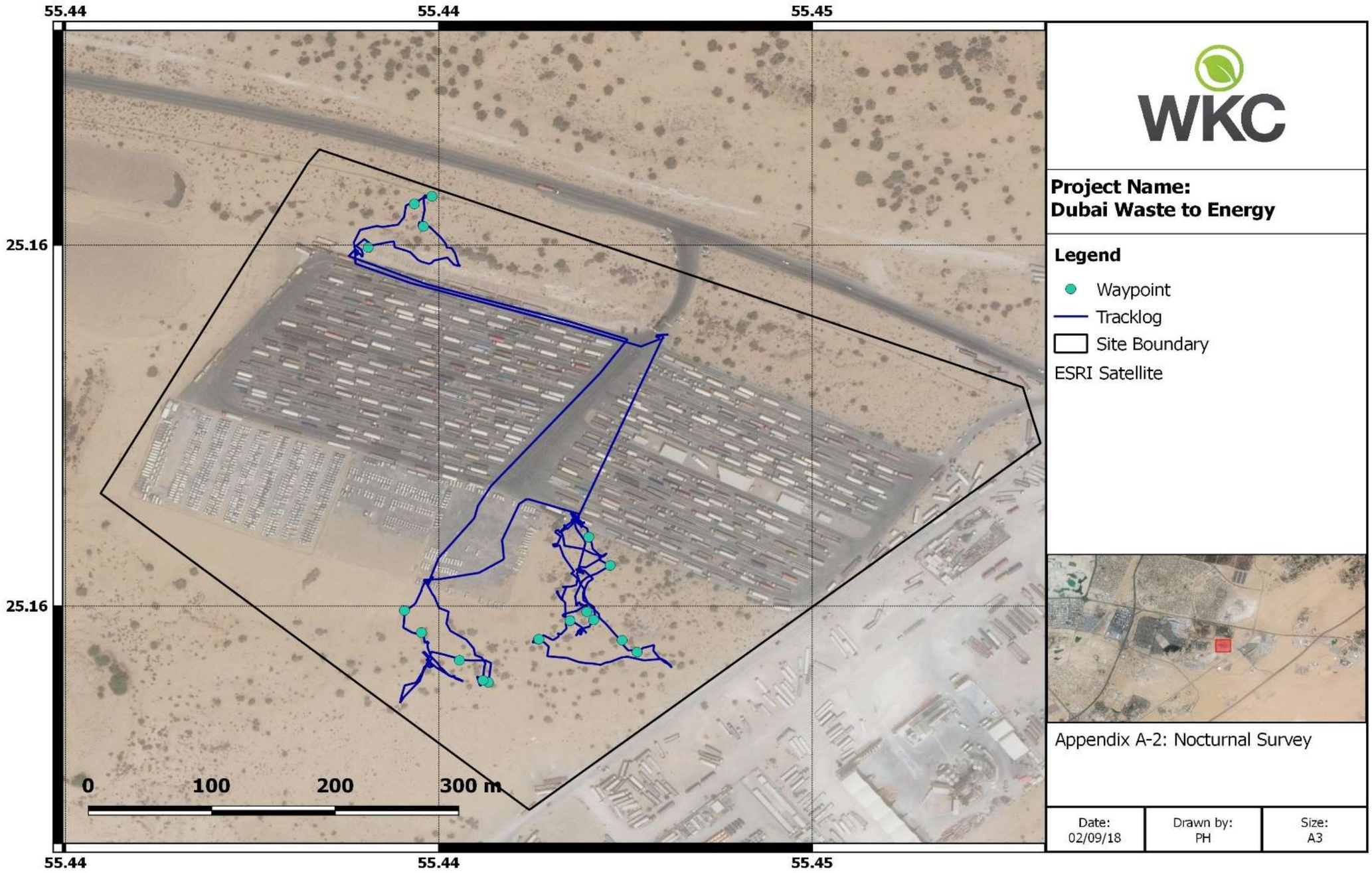
[7] R. (. Perry, Terrestrial Environment of Abu Dhabi., Environment Agency of Abu Dhabi, 2008.

Appendix A – Survey Track Logs

Appendix A-1 Diurnal Survey Track Logs and Way Point



Appendix A-2 Nocturnal Survey Track Logs



Appendix B – Relative Abundance & Feeding Guilds

Table B-1: Plant Species Relative Abundance Onsite

Common Name	Latin Name	Number of Individual per Species	Relative Abundance (%)	DOFAR Scale
Turgid grass	*Panicum turgidum*	4	4.82	O
Desert grass	*Stipagrostis plumosa*	5	6.02	O
Cyperus	*Cyperus conglomeratus*	10	12.05	A
Broom Brush	*Leptodinia pyrotechnica*	18	21.69	D
Sodom's Apple	*Calatropis procera*	10	12.05	A
Turnsole	*Heliotropium kotschyi*	9	10.84	F
Alqa	Dipterygium glaucum	2	2.41	O
Desert squash	*Citrullus colocynthis*	1	1.20	R
Rusty Indigo	*Indigofera colutea*	3	3.61	O
Tarfa	*Tamarix cf. nilotica*	1	1.20	R
Devil's thorn	*Tribulus terrestris*	7	8.43	F
Bean Caper	*Zygophyllum qatarense*	13	15.66	A
Total Number of Individuals		83		

Table B-2: Birds Species Relative Abundance and Feeding Guilds

Common Name	Latin Name	No. of Individual per Species		Total Number of Individuals per Species	Relative Abundance (%)
		Habitat 4130 A	Habitat 4130 B		
Grey Francolin	Omnivore	0	1	3	2
Red-wattled Lapwing	Carnivore/insectivore	1	2	3	2
Laughing Dove	Granivore/insectivore	6	8	14	10
Eurasian Collared-dove	Granivore/insectivore	5	5	10	7
Rock Dove	Granivore/insectivore	6	7	13	9
Rose-ringed Parakeet	Frugivore/granivore	2	4	6	4

Common Name	Latin Name	No. of Individual per Species		Total Number of Individuals per Species	Relative Abundance (%)
		Habitat 4130 A	Habitat 4130 B		
Green Bee-eater	Insectivore	2	4	6	4
Crested Lark	Granivore/insectivore	1	2	3	2
Graceful Prinia	Insectivore	1	2	3	2
Arabian Babbler	Omnivore	3	5	8	6
Lesser Grey Shrike	Carnivore/insectivore	1		1	1
White-eared Bulbul	Frugivore/insectivore	2	4	6	4
Red-vented Bulbul	Frugivore/insectivore	2	2	4	3
Common Myna	Omnivore	4	5	9	7
Purple Sunbird	Nectarivore/insectivore	4	4	8	6
Indian Silverbill	Granivore	7	11	18	13
House Sparrow	Granivore	9	13	22	16
Total		56	79	137	100

Table B-3: Mammals Species Relative Abundance and Feeding Guilds

Common Name	Feeding Guild	No. of Individual per Species		Total Number of Individuals per Species	Relative Abundance (%)
		Habitat 4130 A	Habitat 4130 B		
Cheesman's Gerbil	*Omnivore*	-	3	3	-
Kuhl's Pipistrelle	*Insectivore*	-	-	-	-
Common Pipistrelle	*Insectivore*	-	-	-	-
Muscat Mouse-tailed Bat	*Insectivore*	-	-	-	-
Feral Cat	*Carnivore*	-	1	1	-
Total		-	-	-	-

Note: Species relative abundance for this group was not assessed as the Anabat data do not provide the actual number of individuals recorded onsite

Table B-4: Reptiles Species Relative Abundance and Feeding Guilds

Common Name	Feeding Guild	No. of Individual per Species		Total Number of Individuals per Species	Relative Abundance (%)
		Habitat 4130 A	Habitat 4130 B		
Arabian sand gecko	Insectivore	2	6	8	50

Common Name	Feeding Guild	No. of Individual per Species		Total Number of Individuals per Species	Relative Abundance (%)
		Habitat 4130 A	Habitat 4130 B		
Dune sand gecko	Insectivore	1	3	4	25
Slevin's sand gecko	Insectivore	1	1	2	12.5
Schmidt's fringe-toed Lizard	Insectivore	-	1	1	6.25
Sind saw-scaled viper	Carnivore	1	-	1	6.25
Total		5	11	16	100

Annex 2. BASELINE SURVEY FORMAT

1. Habitat 4130 A - Northern section of the survey area in which Zygophyllum-Heliotropium community is the dominant vegetation type.

Flora (Plants)

Date and Time	Habitat (according to Brown G. and Boer B. [2004*] habitat classification)	GPS Coordinates[1]	Species	Number[2]	Activity	Method
August 19, 2018; (9 am to 1000 am)	Habitat 4130 (Sand sheets and dunes with dwarf shrub cover)	N 25° 9.613'; E 55° 26.669'	Turgid panic grass	3	N/A	Quadrat
August 19, 2018; (9 am to 1000 am)	Habitat 4130 (Sand sheets and dunes with dwarf shrub cover)	N 25° 9.613'; E 55° 26.669'	Desert grass	5	N/A	Quadrat
August 19, 2018; (9 am to 1000 am)	Habitat 4130 (Sand sheets and dunes with dwarf shrub cover)	N 25° 9.613'; E 55° 26.669'	Cyperus	8	N/A	Quadrat
August 19, 2018; (9 am to 1000 am)	Habitat 4130 (Sand sheets and dunes with dwarf shrub cover)	N 25° 9.613'; E 55° 26.669'	Broom Brush	8	N/A	Quadrat
August 19, 2018; (9 am to 1000 am)	Habitat 4130 (Sand sheets and dunes with dwarf shrub cover)	N 25° 9.613'; E 55° 26.669'	Sodom's Apple	6	N/A	Quadrat
August 19, 2018; (9 am to 1000 am))	Habitat 4130 (Sand sheets and dunes with dwarf shrub cover)	N 25° 9.613'; E 55° 26.669'	Turnsole	7	N/A	Quadrat
August 19, 2018; (9 am to 1000 am)	Habitat 4130 (Sand sheets and dunes with dwarf shrub cover)	N 25° 9.613'; E 55° 26.669'	Alqa	1	N/A	Quadrat
August 19, 2018; (9 am to 1000 am)	Habitat 4130 (Sand sheets and dunes with dwarf shrub cover)	N 25° 9.613'; E 55° 26.669'	Desert squash	1	N/A	Quadrat
August 19, 2018; (9 am to 1000 am)	Habitat 4130 (Sand sheets and dunes with dwarf shrub cover)	N 25° 9.613'; E 55° 26.669'	Rusty Indigo	3	N/A	Quadrat
August 19, 2018; (9 am to 1000 am))	Habitat 4130 (Sand sheets and dunes with dwarf shrub cover)	N 25° 9.613'; E 55° 26.669'	Tarfa	1	N/A	Quadrat

Date and Time	Habitat (according to Brown G. and Boer B. [2004*] habitat classification)	GPS Coordinates[1]	Species	Number[2]	Activity	Method
August 19, 2018; (9 am to 1000 am)	Habitat 4130 (Sand sheets and dunes with dwarf shrub cover)	N 25° 9.613'; E 55° 26.669'	Devil's thorn	6	N/A	Quadrat
August 19, 2018; (9 am to 1000 am)	Habitat 4130 (Sand sheets and dunes with dwarf shrub cover)	N 25° 9.613'; E 55° 26.669'	Bean Caper	12	N/A	Quadrat

Notes: 1) GPS Coordinates based on Sampling Point (SP) 2; 2) Cumulative number

Avifauna (Birds)

Date and Time	Habitat (according to Brown G. and Boer B. [2004*] habitat classification)	GPS Coordinates[1]	Species	Number[2]	Activity	Method
August 19 & 21, 2018; (730 am to 830 am)	Habitat 4130 (Sand sheets and dunes with dwarf shrub cover)	N 25° 9.613'; E 55° 26.669'	Red-wattled Lapwing	1	Flying	Transect Count
August 19 & 21, 2018; (730 am to 830 am)	Habitat 4130 (Sand sheets and dunes with dwarf shrub cover)	N 25° 9.613'; E 55° 26.669'	Laughing Dove	6	Flying, on perch	Transect Count
August 19 & 21, 2018; (730 am to 830 am)	Habitat 4130 (Sand sheets and dunes with dwarf shrub cover)	N 25° 9.613'; E 55° 26.669'	Eurasian Collared-dove	5	Flying, on perch	Transect Count
August 19 & 21, 2018; (730 am to 830 am)	Habitat 4130 (Sand sheets and dunes with dwarf shrub cover)	N 25° 9.613'; E 55° 26.669'	Rock Dove	6	Flying, on perch	Transect Count
August 19 & 21, 2018; (730 am to 830 am)	Habitat 4130 (Sand sheets and dunes with dwarf shrub cover)	N 25° 9.613'; E 55° 26.669'	Rose-ringed Parakeet	2	Flying	Transect Count
August 19 & 21, 2018; (730 am to 830 am)	Habitat 4130 (Sand sheets and dunes with dwarf shrub cover)	N 25° 9.613'; E 55° 26.669'	Green Bee-eater	2	Flying/Foraging	Transect Count
August 19 & 21, 2018; (730 am to 830 am)	Habitat 4130 (Sand sheets and dunes with dwarf shrub cover)	N 25° 9.613'; E 55° 26.669'	Crested Lark	1	Foraging	Transect Count
August 19 & 21, 2018; (730 am to 830 am)	Habitat 4130 (Sand sheets and dunes with dwarf shrub cover)	N 25° 9.613'; E 55° 26.669'	Graceful Prinia	1	Foraging	Transect Count

Date and Time	Habitat (according to Brown G. and Boer B. [2004*] habitat classification)	GPS Coordinates[1]	Species	Number[2]	Activity	Method
August 19 & 21, 2018; (730 am to 830 am)	Habitat 4130 (Sand sheets and dunes with dwarf shrub cover)	N 25° 9.613'; E 55° 26.669'	Arabian Babbler	3	Foraging	Transect Count
August 19 & 21, 2018; (730 am to 830 am)	Habitat 4130 (Sand sheets and dunes with dwarf shrub cover)	N 25° 9.613'; E 55° 26.669'	Lesser Grey Shrike	1	On perch	Transect Count
August 19 & 21, 2018; (730 am to 830 am)	Habitat 4130 (Sand sheets and dunes with dwarf shrub cover)	N 25° 9.613'; E 55° 26.669'	White-eared Bulbul	2	Foraging	Transect Count
August 19 & 21, 2018; (730 am to 830 am)	Habitat 4130 (Sand sheets and dunes with dwarf shrub cover)	N 25° 9.613'; E 55° 26.669'	Red-vented Bulbul	2	Foraging	Transect Count
August 19 & 21, 2018; (730 am to 830 am)	Habitat 4130 (Sand sheets and dunes with dwarf shrub cover)	N 25° 9.613'; E 55° 26.669'	Common Myna	4	Flying	Transect Count
August 19 & 21, 2018; (730 am to 830 am)	Habitat 4130 (Sand sheets and dunes with dwarf shrub cover)	N 25° 9.613'; E 55° 26.669'	Purple Sunbird	4	Foraging	Transect Count
August 19 & 21, 2018; (730 am to 830 am)	Habitat 4130 (Sand sheets and dunes with dwarf shrub cover)	N 25° 9.613'; E 55° 26.669'	Indian Silverbill	7	Foraging	Transect Count
August 19 & 21, 2018; (730 am to 830 am)	Habitat 4130 (Sand sheets and dunes with dwarf shrub cover)	N 25° 9.613'; E 55° 26.669'	House Sparrow	9	Flying, foraging	Transect Count

Notes: 1) GPS Coordinates based on Sampling Point (SP) 2; 2) Cumulative number

Small Mammals (Non-volant and Volant)

Date and Time	Habitat (according to Brown G. and Boer B. [2004*] habitat classification)	GPS Coordinates[1]	Species	Number[2]	Activity[2]	Method
August 28 to 29, 2018; 24 hours deployment	Habitat 4130 (Sand sheets and dunes with dwarf shrub cover)	N 25° 9.685'; E 55° 26.574'	Kuhl's Pipistrelle	N/A	N/A	Anabat Express
August 28 to 29, 2018; 24 hours deployment	Habitat 4130 (Sand sheets and dunes with dwarf shrub cover)	N 25° 9.685'; E 55° 26.574'	Common Pipistrelle	N/A	N/A	Anabat Express
August 28 to 29, 2018; 24 hours deployment	Habitat 4130 (Sand sheets and dunes with dwarf shrub cover)	N 25° 9.685'; E 55° 26.574'	Muscat Mouse-tailed Bat	N/A	N/A	Anabat Express

Notes: 1) GPS Coordinates based on Anabat 1 location 2) N/A - Not applicable as Anabat express only records bat calls

Herpefauna (Reptiles)

Date and Time	Habitat (according to Brown G. and Boer B. [2004*] habitat classification)	GPS Coordinates	Species	Number	Activity[1]	Method
August 19, 2018; (8 pm to 10 pm)	Habitat 4130 (Sand sheets and dunes with dwarf shrub cover)	N 25° 9.681'N; E 55° 26.568' N 25° 9.686'N; E 55° 26.570'	Arabian Sand Gecko	2	Foraging	Transect Count
August 19, 2018; (8 pm to 10 pm)	Habitat 4130 (Sand sheets and dunes with dwarf shrub cover)	N 25° 9.659'; E 55° 26.584'	Dune Sand Gecko	1	Foraging	Transect Count
August 19, 2018; (8 pm to 10 pm)	Habitat 4130 (Sand sheets and dunes with dwarf shrub cover)	N 25° 9.658'; E 55° 26.539'	Slevin's sand gecko	1	Foraging	Transect Count
August 19, 2018; (8 pm to 10 pm)	Habitat 4130 (Sand sheets and dunes with dwarf shrub cover)	N 25° 9.670'N; E 55° 26.572'	Sind saw-scaled viper	1	Foraging	General observation

Notes: Assumed to be foraging

2. Habitat 4130 B - Southern part of the survey area in which Leptodinia-Calatropis community is the dominant vegetation type.

Flora (Plants)

Date and Time	Habitat (according to Brown G. and Boer B. [2004*] habitat classification)	GPS Coordinates[1]	Species	Number[2]	Activity	Method
August 19, 2018; (7 am to 800 am)	Habitat 4130 (Sand sheets and dunes with dwarf shrub cover)	N 25° 9.426'; E 55° 26.628'	Turgid panic grass	1	N/A	Quadrat
August 19, 2018; (9 am to 1000 am)	Habitat 4130 (Sand sheets and dunes with dwarf shrub cover)	N 25° 9.426'; E 55° 26.628'	Cyperus	2	N/A	Quadrat
August 19, 2018; (9 am to 1000 am)	Habitat 4130 (Sand sheets and dunes with dwarf shrub cover)	N 25° 9.426'; E 55° 26.628'	Broom Brush	10	N/A	Quadrat
August 19, 2018; (9 am to 1000 am)	Habitat 4130 (Sand sheets and dunes with dwarf shrub cover)	N 25° 9.426'; E 55° 26.628'	Sodom's Apple	4	N/A	Quadrat

Date and Time	Habitat (according to Brown G. and Boer B. [2004*] habitat classification)	GPS Coordinates[1]	Species	Number[2]	Activity	Method
August 19, 2018; (9 am to 1000 am))	Habitat 4130 (Sand sheets and dunes with dwarf shrub cover)	N 25° 9.426'; E 55° 26.628'	Turnsole	2	N/A	Quadrat
August 19, 2018; (9 am to 1000 am)	Habitat 4130 (Sand sheets and dunes with dwarf shrub cover)	N 25° 9.426'; E 55° 26.628'	Alqa	1	N/A	Quadrat
August 19, 2018; (9 am to 1000 am)	Habitat 4130 (Sand sheets and dunes with dwarf shrub cover)	N 25° 9.426'; E 55° 26.628'	Devil's thorn	1	N/A	Quadrat
August 19, 2018; (9 am to 1000 am)	Habitat 4130 (Sand sheets and dunes with dwarf shrub cover)	N 25° 9.426'; E 55° 26.628'	Bean Caper	1	N/A	Quadrat

3. Notes: 1) GPS Coordinates based on Sampling Point (SP) 5; 2) Cumulative number

Avifauna (Birds)

Date and Time	Habitat (according to Brown G. and Boer B. [2004*] habitat classification)	GPS Coordinates[1]	Species	Number[2]	Activity	Method
August 19 & 21, 2018; (630 am to 730 am)	Habitat 4130 (Sand sheets and dunes with dwarf shrub cover)	N 25° 9.426'; E 55° 26.628'	Grey Francolin	1	Foraging	Transect Count
August 19 & 21, 2018; (630 am to 730 am)	Habitat 4130 (Sand sheets and dunes with dwarf shrub cover)	N 25° 9.426'; E 55° 26.628'	Red-wattled Lapwing	2	Flying, on perch	Transect Count
August 19 & 21, 2018; (630 am to 730 am)	Habitat 4130 (Sand sheets and dunes with dwarf shrub cover)	N 25° 9.426'; E 55° 26.628'	Laughing Dove	8	Flying, on perch	Transect Count
August 19 & 21, 2018; (630 am to 730 am)	Habitat 4130 (Sand sheets and dunes with dwarf shrub cover)	N 25° 9.426'; E 55° 26.628'	Eurasian Collared-dove	5	Flying, on perch	Transect Count
August 19 & 21, 2018; (630 am to 730 am)	Habitat 4130 (Sand sheets and dunes with dwarf shrub cover)	N 25° 9.426'; E 55° 26.628'	Rock Dove	7	Flying	Transect Count
August 19 & 21, 2018; (630 am to 730 am)	Habitat 4130 (Sand sheets and dunes with dwarf shrub cover)	N 25° 9.426'; E 55° 26.628'	Rose-ringed Parakeet	4	Flying/Foraging	Transect Count

Date and Time	Habitat (according to Brown G. and Boer B. [2004*] habitat classification)	GPS Coordinates[1]	Species	Number[2]	Activity	Method
August 19 & 21, 2018; (630 am to 730 am)	Habitat 4130 (Sand sheets and dunes with dwarf shrub cover)	N 25° 9.426'; E 55° 26.628'	Green Bee-eater	4	Foraging	Transect Count
August 19 & 21, 2018; (630 am to 730 am)	Habitat 4130 (Sand sheets and dunes with dwarf shrub cover)	N 25° 9.426'; E 55° 26.628'	Crested Lark	2	Foraging	Transect Count
August 19 & 21, 2018; (630 am to 730 am)	Habitat 4130 (Sand sheets and dunes with dwarf shrub cover)	N 25° 9.426'; E 55° 26.628'	Graceful Prinia	2	Foraging	Transect Count
August 19 & 21, 2018; (630 am to 730 am)	Habitat 4130 (Sand sheets and dunes with dwarf shrub cover)	N 25° 9.426'; E 55° 26.628'	Arabian Babbler	5	Foraging	Transect Count
August 19 & 21, 2018; (630 am to 730 am)	Habitat 4130 (Sand sheets and dunes with dwarf shrub cover)	N 25° 9.426'; E 55° 26.628'	White-eared Bulbul	4	Foraging	Transect Count
August 19 & 21, 2018; (630 am to 730 am)	Habitat 4130 (Sand sheets and dunes with dwarf shrub cover)	N 25° 9.426'; E 55° 26.628'	Red-vented Bulbul	2	Foraging	Transect Count
August 19 & 21, 2018; (630 am to 730 am)	Habitat 4130 (Sand sheets and dunes with dwarf shrub cover)	N 25° 9.426'; E 55° 26.628'	Common Myna	5	Flying, Foraging	Transect Count
August 19 & 21, 2018; (630 am to 730 am)	Habitat 4130 (Sand sheets and dunes with dwarf shrub cover)	N 25° 9.426'; E 55° 26.628'	Purple Sunbird	4	Foraging	Transect Count
August 19 & 21, 2018; (630 am to 730 am)	Habitat 4130 (Sand sheets and dunes with dwarf shrub cover)	N 25° 9.426'; E 55° 26.628'	Indian Silverbill	11	Foraging	Transect Count
August 19 & 21, 2018; (630 am to 730 am)	Habitat 4130 (Sand sheets and dunes with dwarf shrub cover)	N 25° 9.426'; E 55° 26.628'	House Sparrow	13	Flying, foraging	Transect Count

Notes: 1) GPS Coordinates based on Sampling Point (SP) 5; 2) Cumulative number

Small Mammals (Non-volant and Volant)

Date and Time	Habitat (according to Brown G. and Boer B. [2004*] habitat classification)	GPS Coordinates	Species	Number[2]	Activity[2]	Method
August 19 & 21, 2018; (10 hours deployment 630 pm to 630 am)	Habitat 4130 (Sand sheets and dunes with dwarf shrub cover)	N 25° 9.466'; E 55° 26.572' N 25° 9.452'; E 55° 26.574' N 25° 9.475': E55° 26.640'	Cheesman's Gerbil	3	N/A	Sherman Traps
August 19, 2018; 6:55 pm	Habitat 4130 (Sand sheets and dunes with dwarf shrub cover)	N 25° 9.500'; E 55° 26.663'	Feral Cat	1	Calling	General Observation
August 28 to 29, 2018; 24 hours deployment	Habitat 4130 (Sand sheets and dunes with dwarf shrub cover)	N 25° 9.497'N; E 55° 26.648'	Kuhl's Pipistrelle[1]	N/A	N/A	Anabat Express
August 28 to 29, 2018; 24 hours deployment	Habitat 4130 (Sand sheets and dunes with dwarf shrub cover)	N 25° 9.497'N; E 55° 26.648'	Common Pipistrelle[1]	N/A	N/A	Anabat Express

Notes: 1) GPS Coordinates based on Anabat 2 location 2) N/A - Not applicable as natural behaviour cannot be observed for individuals caught inside the Sherman traps whilst Anabat express only records bat calls

Herpefauna (Reptiles)

Date and Time	Habitat (according to Brown G. and Boer B. [2004*] habitat classification)	GPS Coordinates	Species	Number	Activity[1]	Method
August 19, 2018; (600 pm to 8 pm)	Habitat 4130 (Sand sheets and dunes with dwarf shrub cover)	N 25° 9.473'; E 55° 26.655' N 25° 9.463'; E 55° 26.628' N 25° 9.514'; E 55° 26.652' N 25° 9.467'; E 55° 26.572' N 25° 9.453'; E 55° 26.590' N 25° 9.443'; E 55° 26.601'	Arabian Sand Gecko	6	Foraging	Transect Count
August 19, 2018; (600 pm to 8 pm)	Habitat 4130 (Sand sheets and dunes with dwarf shrub cover)	N 25° 9.473'; E 55° 26.643' N 25° 9.463'; E55° 26.668'	Dune Sand Gecko	3	Foraging	Transect Count

Date and Time	Habitat (according to Brown G. and Boer B. [2004*] habitat classification)	GPS Coordinates	Species	Number	Activity[1]	Method
		N 25° 9.478'; E 55° 26.563'E				
August 19, 2018; (600 pm to 8 pm)	Habitat 4130 (Sand sheets and dunes with dwarf shrub cover)	N 25° 9.457'; E 55° 26.676'	Slevin's sand gecko	1	Foraging	Transect Count
August 20, 2018; (830 am)	Habitat 4130 (Sand sheets and dunes with dwarf shrub cover)	N 25° 9.503'; E 55° 26.642'	Schmidt's fringe-toed Lizard	1	Busking	General observation

Notes: Assumed to be foraging

4. Habitat 9600 (Disturbed ground) – Parking area, paved ground

Flora (Plants)

Date and Time[1]	Habitat (according to Brown G. and Boer B. [2004*] habitat classification)	GPS Coordinates[2]	Species	Number[3]	Activity[4]	Method
August 19 & 21, 2018	Habitat 9600 (Disturbed ground)	N 25° 9.583'N; E 55° 26.645'	Cyperus	N/A	N/A	General Observation
August 19 & 21, 2018	Habitat 9600 (Disturbed ground)	N 25° 9.583'N; E 55° 26.645'	Broom Brush	N/A	N/A	General Observation
August 19 & 21, 2018	Habitat 9600 (Disturbed ground)	N 25° 9.583'N; E 55° 26.645'	Alqa	N/A	N/A	General Observation
August 19 & 21, 2018	Habitat 9600 (Disturbed ground)	N 25° 9.583'N; E 55° 26.645'	Devil's thorn	N/A	N/A	General Observation

Notes: 1) No time provided as general observation was employed in this area 2) GPS Coordinates taken from middle section of this habitat 3) N/A - Not applicable as general observation was employed in this area 4) Not applicable for this group

Avifauna (Birds)

Date and Time[1]	Habitat (according to Brown G. and Boer B. [2004*] habitat classification)	GPS Coordinates[2]	Species	Number[3]	Activity	Method
August 19 & 21, 2018	Habitat 9600 (Disturbed ground)	N 25° 9.583'N; E 55° 26.645'	Laughing Dove	N/A	Flying, on perch	General Observation
August 19 & 21, 2018	Habitat 9600 (Disturbed ground)	N 25° 9.583'N; E 55° 26.645'	Eurasian Collared-dove	N/A	Flying, on perch	General Observation
August 19 & 21, 2018	Habitat 9600 (Disturbed ground)	N 25° 9.583'N; E 55° 26.645'	Rock Dove	N/A	Flying	General Observation
August 19 & 21, 2018	Habitat 9600 (Disturbed ground)	N 25° 9.583'N; E 55° 26.645'	Lesser Grey Shrike	N/A	On perch	General Observation
August 19 & 21, 2018	Habitat 9600 (Disturbed ground)	N 25° 9.583'N; E 55° 26.645'	Common Myna	N/A	Flying, Foraging	General Observation
August 19 & 21, 2018	Habitat 9600 (Disturbed ground)	N 25° 9.583'N; E 55° 26.645'	House Sparrow	N/A	Flying, foraging	General Observation

Notes: 1) No time provided as general observation was employed in this area 2) GPS Coordinates taken from middle section of this habitat 3) N/A - Not applicable as general observation was employed in this area