Forth Replacement Crossing

Employer's Delivery Team
Construction Noise Monitoring Report

FIFE ITS Contract
(April 2012)

TRANSPORT SCOTLAND

An agency of The Scottish Government

FORTH REPLACEMENT CROSSING

FORTH REPLACEMENT CROSSING

EMPLOYER'S DELIVERY TEAM
CONSTRUCTION NOISE MONITORING REPORT

FIFE ITS CONTRACT (APRIL 2012)

Revision Status

Revision	Date	Description	Author	Approved for Use
0	June 2011	Original	DGC	AMM

FORTH REPLACEMENT CROSSING

EMPLOYER'S DELIVERY TEAM
CONSTRUCTION NOISE MONITORING REPORT

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1. INTRODUCTION

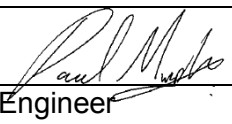
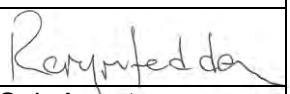
1.1 This report sets out the results of the construction noise monitoring undertaken on the Fife ITS Contract during April 2012 as part of the Forth Replacement Crossing project.

APPENDIX A - CONSTRUCTION NOISE MONITORING REPORT

FORTH REPLACEMENT CROSSING – FIFE ITS

FRC/FITS/JG/PCNV/CP/0013

NOISE COMPLIANCE MONITORING REPORT FOR SOUTHBOUND CARRIAGEWAY RESURFACING (APRIL)

Completed by:	Paul Murphy	**Reviewed by:**	Rory McFadden
Signed:		**Signed:**	
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Revision Record

Revision	*Date*	*By*	*Summary of Changes*	*Checked*	*Approved*

Fife ITS Scheme

Southbound Re-surfacing Noise Compliance Report

June 2012

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Fife ITS Scheme

Southbound Re-surfacing Noise Compliance Report

Client Name: Graham Construction
Document Reference: EED12317-100-R-11.1.3-MM
Project Number: EED12317

Quality Assurance – Approval Status

This document has been prepared and checked in accordance with
Waterman Group's IMS (BS EN ISO 9001: 2008 and BS EN ISO 14001: 2004)

Issue	Date	Prepared by	Checked by	Approved by
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Our Markets


Property & Buildings


Transport & Infrastructure


Energy & Utilities


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Executive Summary

E12748-100-R-2.1.1-JL

1. Introduction

Waterman Energy, Environment & Design Limited (hereafter 'Waterman') was instructed by John Graham (Dromore) Limited to undertake compliance noise monitoring during resurfacing of the south bound carriageway of the M90. Noise monitoring was completed in line with the guidance provided in the Forth Replacement Crossing Code of Construction Practice (the CoCP) and Appendix 1/9 of the Employers Requirements (hereafter 'the Employers Requirements').

A Plan for the Control of Noise and Vibration was submitted and approved for the works to be undertaken during the resurfacing works (FRC-FITS-JG-PCNV0010) which assessed the potential noise impacts associated with the resurfacing works.

In order to ensure compliance with Best Practicable Means (BPM) the approved PCNV, CoCP and the Employers Requirements noise monitoring was undertaken at four locations representative of the closest sensitive receptors to the works. This document sets out the findings of the compliance monitoring exercise.

2. Site Description and Development Proposals

2.1 Works Description

The works undertaken included the resurfacing of the southbound carriageway of the M90 between Chainage 9090 and Chainage 13050. The sequence of works for the resurfacing process is set out below:

- Set up of traffic management schemes on the southbound carriageway;
- Plane off existing surfaces on the southbound carriageway; and
- Total closure of the southbound carriageway of the M90, 3 surface paving machines lay surfacing in tandem over three lanes. Surfacing took place over three consecutive weekend closures of the M90 southbound.

2.2 Noise Sensitive Receptors

The closest noise sensitive receptors to the resurfacing works were identified following a site walkover. The noise sensitive receptors are described in Table 1.

Table 1 Noise Sensitive Receptors

Noise Sensitive Receptor	Name	Description	Approximate Grid Reference	Distance from Works
NSR A	Craig Street	Two story residential dwellings	312355,683622	60m
NSR B	Park Lea	Two story residential dwellings	312410,683958	60m
NSR C	Properties off Masterson Road	Two story residential dwellings	313011,684754	50m
NSR D	Gatehouse of Duloch	Static Caravan	313296,685133	50m

3. Noise Assessment Criteria

Section A2 of Appendix 1/9 of the Employers Requirements and The Forth Replacement Crossing Code of Construction Practice (CoCP) require that noise levels generated during the construction of any phase of works should not exceed the residual effects set out in the Forth Replacement Crossing Environmental Statement ("the ES"). This document sets out the ABC Threshold Level assessment methodology presented in Appendix E of BS5228-1:2009 as being the appropriate assessment methodology for the works.

This method defines category threshold values which are determined by the time of day and existing monitored ambient noise levels. The noise level generated by construction activities is then compared with the 'threshold value'. If the total noise level exceeds the 'threshold value', a significant effect is deemed to occur. The construction noise impact criteria are set out in Table 2.

Table 2 Construction Noise Impact Criteria

Period	Assessment Category					
	A		B		C	
	$L_{Aeq,T}$	L_{Amax}	$L_{Aeq,T}$	L_{Amax}	$L_{Aeq,T}$	L_{Amax}
Night	45	60	50	65	55	65
Evening	55	70	60	75	65	80
Day	65	80	70	85	75	90
Saturday	65	80	70	85	75	90

Note:

- Category A: are threshold values to use when ambient levels rounded to the nearest 5dB) are less than these values;
- Category B: are values to use when ambient noise levels (rounded to the nearest 5dB) are the same as the Category A values; and
- Category C: are values to use when ambient noise levels (rounded to the nearest 5dB) are greater than Category A values.

Consideration is also required to $L_{Amax,fast}$ noise levels in line with Section 5.4 of the CoCP. The Employers Requirements require the execution of the works to be limited to maximum noise levels that are 5dB lower than those defined in the CoCP and summarised in Table 2.

A baseline noise monitoring exercise was undertaken at locations representative of the closest sensitive receptors to the Fife ITS study corridor. The monitoring data is provided in full as report FRC-FTIS-JG-NVMP-BMR-0001. Following completion of the baseline monitoring exercise noise assessment category levels were set in line with the guidance provided within the CoCP and the Employers Requirements (see Table 2). The assessment category levels in terms of $L_{Aeq,T}$ and L_{Amax} are presented as Table 3.

Table 3: Summary of Noise Threshold Levels

Monitoring Location	Period	L_{Aeq} Assessment Category Level	L_{Amax} Threshold level
NSR A -Craig Street	Daytime	70	85
	Evening	65	80
	Night-time	55	65
NSR B - Park Lea	Daytime	75	90
	Evening	65	80
	Night-time	55	65
NSR C - Masterson Road	Daytime	75	90
	Evening	65	80
	Night-time	55	65
NSR D – Gatehouse of Duloch	Daytime	75	90
	Evening	65	80
	Night-time	55	65

4. Noise Monitoring Methodology

Noise monitoring was undertaken at selected locations throughout resurfacing works on the southbound carriageway of the M90. Monitoring locations were selected so as to be representative of the closest sensitive receptors to the works. The monitoring locations are described in full in Table 4.

Table 4: Noise Monitoring Locations

Location	Description	Notes
ML1	**Craig Street**	Noise climate dominated by road traffic on the M90. Some noise associated with local traffic was also noted.
ML2	**Park Lea**	Noise climate dominated by road traffic on the M90. Some noise associated with local traffic was also noted.
ML3	**Properties off Masterson Road**	Noise climate dominated by distant road traffic on the M90. Some noise associated with local traffic on Masterson Road was also noted.
ML4	**Gatehouse of Duloch**	Noise climate dominated by distant road traffic on the M90. Some noise associated with local traffic on Aberdour Road was also noted.

Noise monitoring was undertaken by Jon Lee who holds corporate membership to the Institute of Acoustics and is fully competent and trained in the use of the noise monitoring equipment.

The parameters logged throughout the survey period were L_{Aeq}, L_{Amax}, L_{Amin}, L_{A90} and L_{A10}. These parameters are described in Appendix A. The L_{Aeq} level is the equivalent continuous sound pressure level over the measurement period; L_{Amax} is an indicator of the highest sound level during the measurement period; the L_{Amin} is the lowest level during the measurement period; L_{A90} is used as a descriptor of background noise levels and L_{A10} is the noise level which is achieved for 10% of the monitoring period and is often used to describe road traffic noise.

The monitoring equipment used during the survey period is described in Table 5. The sound level meter was calibrated both before and after each monitoring period; no significant drift from the reference level of 94 dB was recorded. The monitoring equipment used during the survey period is described in Table 5. The sound level meter was calibrated both before and after each monitoring period; no significant drift from the reference level of 94dB was recorded.

All measurements were unattended and undertaken under free-field conditions. However, during night-time works a member of Waterman's Noise and Vibration Team was on site at all times A wind shield was fitted to the monitoring equipment at all times. Weather conditions experienced throughout the survey period are set out as Appendix B.

Table 5: Noise Monitoring Equipment

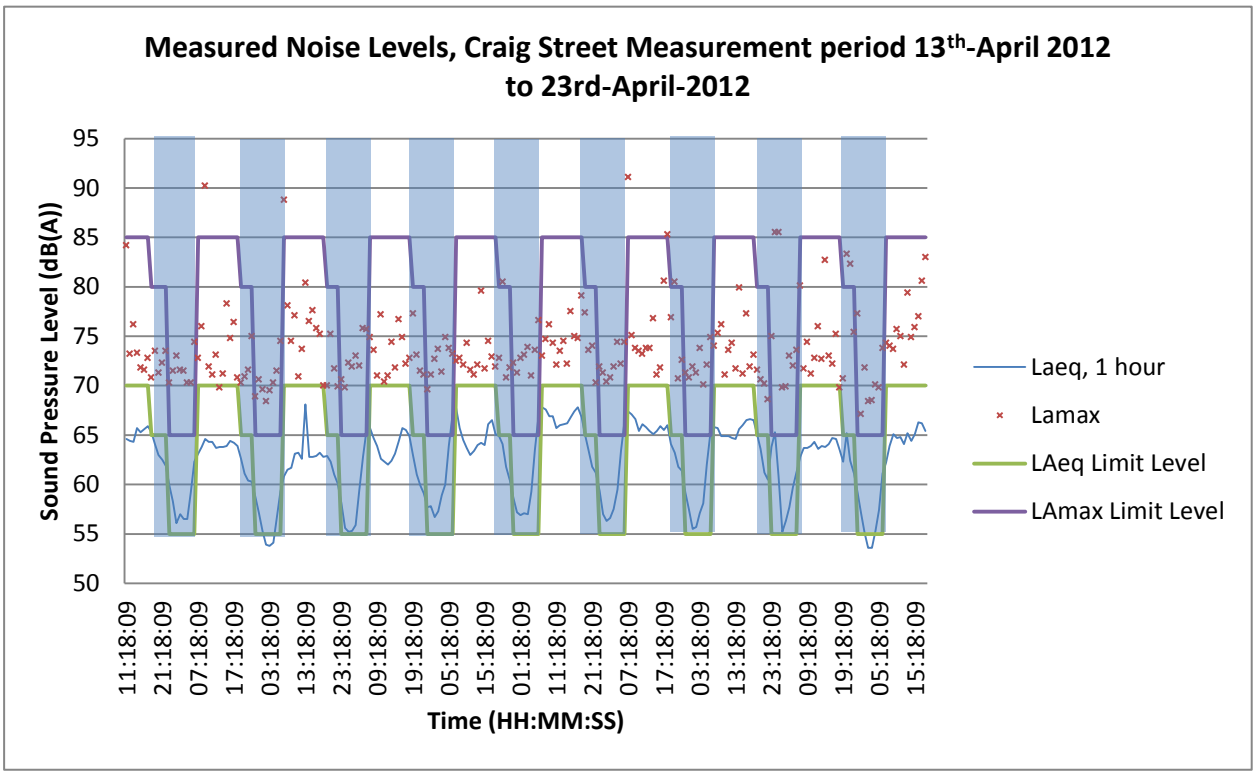
Sound Level Meter	ML1	ML2	ML3	ML4
Meter Model	Rion NL-32	Rion NL-31	Rion NL-52	Rion NL-52
Serial Number	00482656	00562436	012568	012642
Calibrator				
Calibrator Model	Rion NC-74	Rion NC-74	Rion NC-74	Rion NC-74
Serial Number	35173533	35173533	35173533	35173533
Calibration Level at 1000 Hz	94dB	94dB	94dB	94dB
Microphone				
Microphone Type	UC-53A	UC-53A	UC-53A	UC-53A

5. Noise and Monitoring Results

5.1 ML1 Craig Street

Noise monitoring at Craig Street commenced at 11:18 on the 13th April 2012 and continued until 18:18 on the 22nd April 2012. The monitoring result are presented in full as Graph 1, the daytime, evening and night-time monitoring results are presented in the Noise Liaison Groups agreed format as Graph 2,3 and 4.

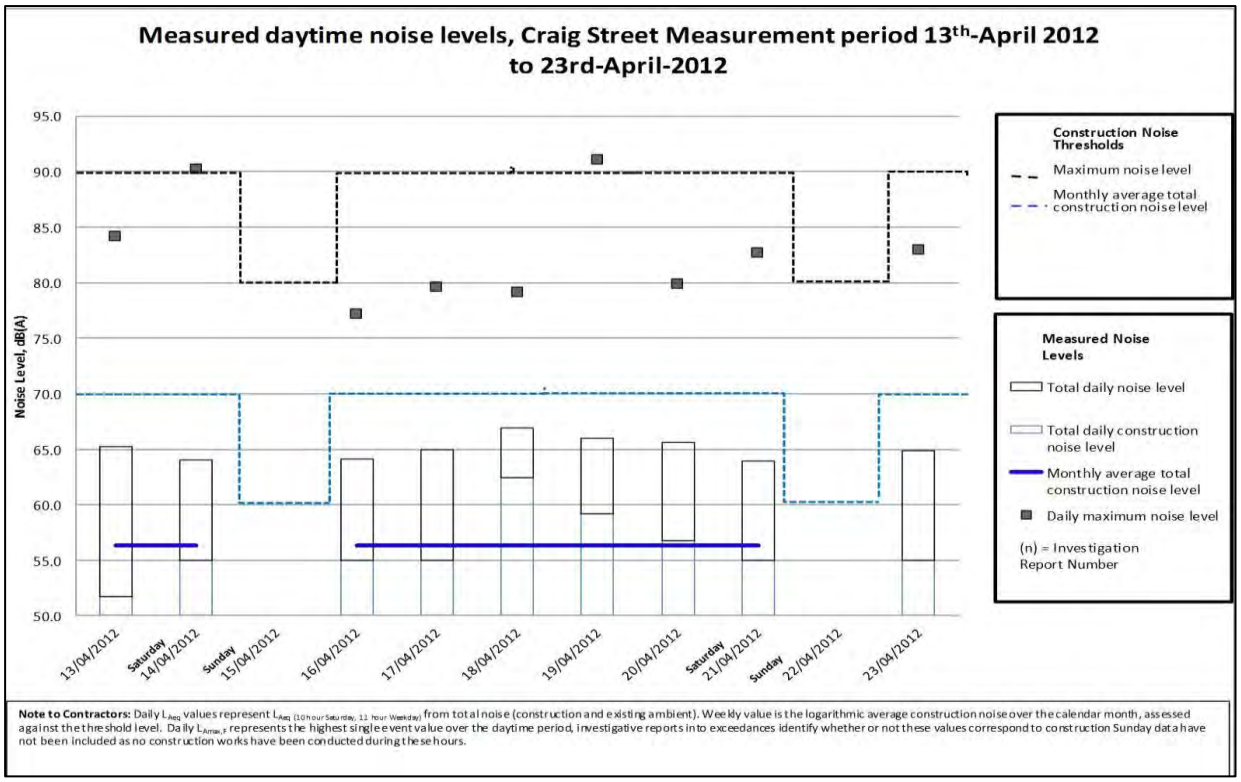
Graph 1 – Monitored Noise Levels Craig Street



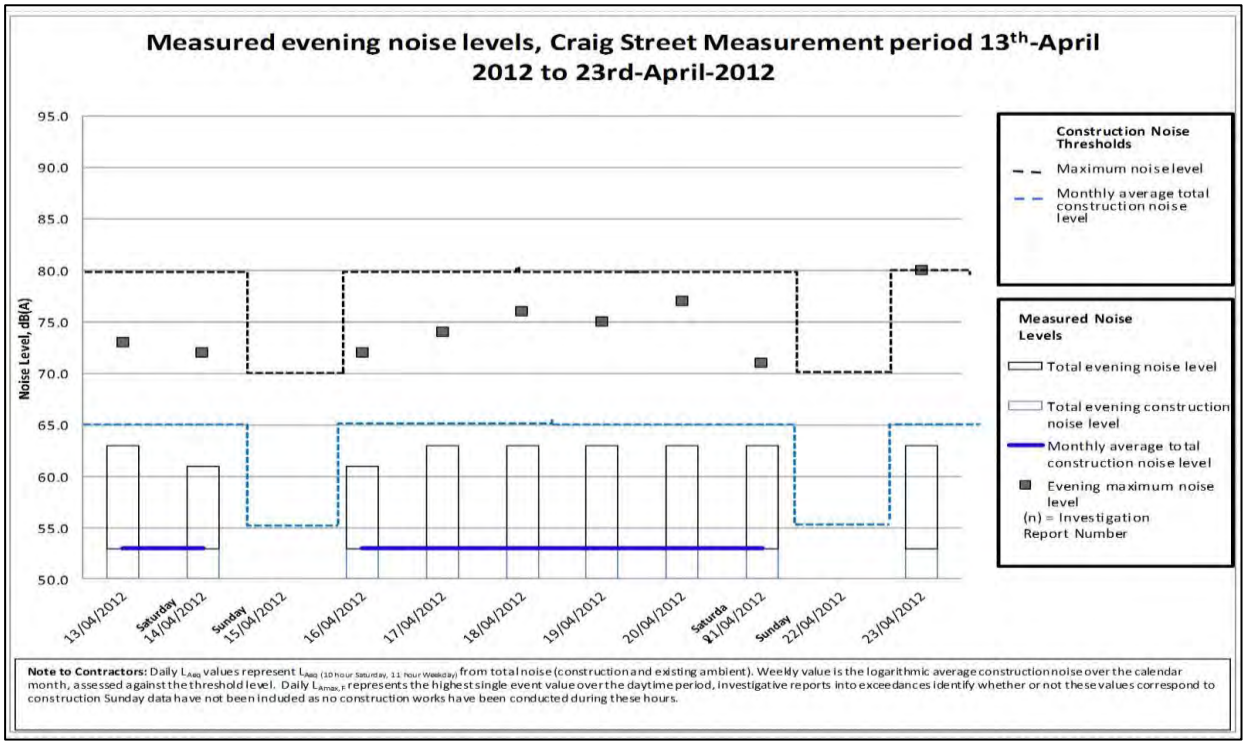
The monitored noise levels presented as Graph 1 indicate that during the daytime and evening periods monitored noise levels for the most part fell below the adopted category threshold levels. However, during the night-time period the adopted threshold level of 55dB $L_{Aeq,1hour}$ was consistently exceeded. Further examination of the monitoring data indicates that exceedences occurred both inside and outside of periods of work associated with the resurfacing works. As such, it is considered that the noted exceedences where not as a direct result of the works and as such impacts associated with the works were negligible.

Further to the above the assessment criteria in terms of L_{Amax} was consistently exceeded during the evening and night-time periods. Following a number of site visits and review of all available data it was determined that the recorded exceedences arose as a result of HGV pass-bys along the M90 and not as a direct result of the resurfacing works.

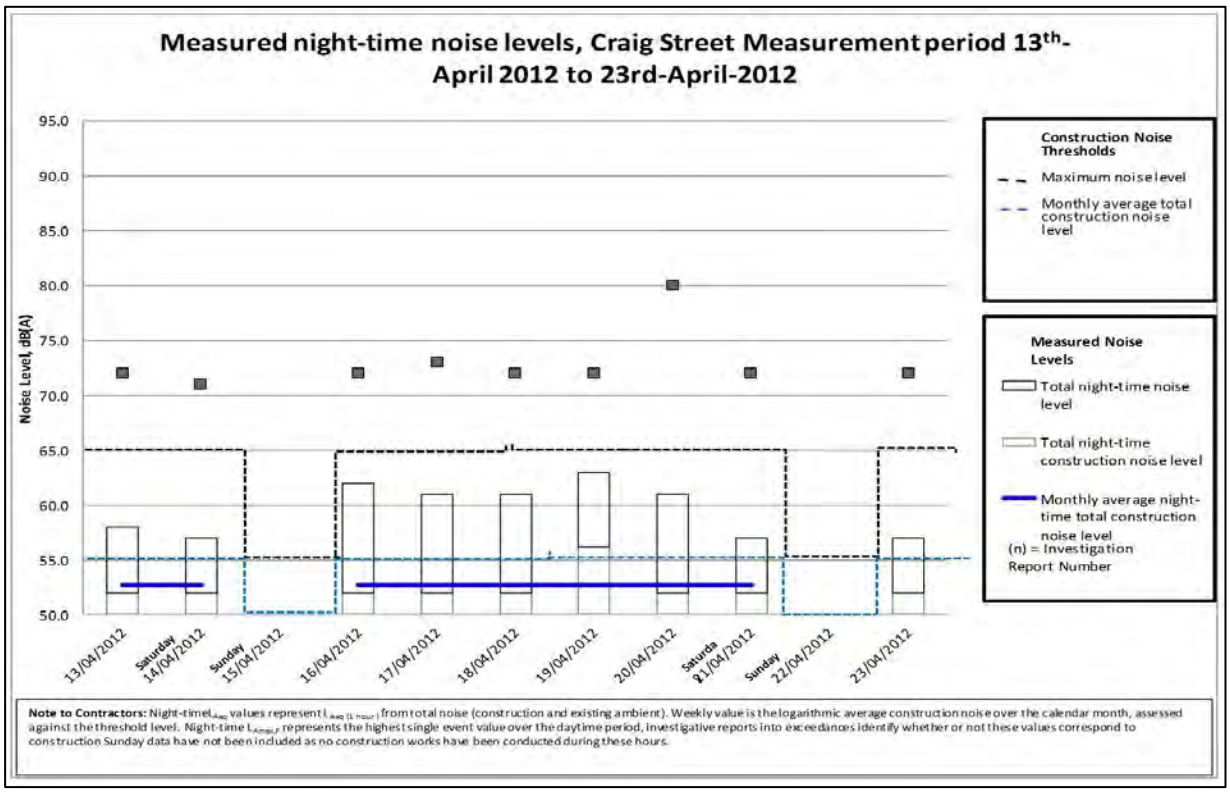
Graph 2 – Monitored Daytime Noise Levels Craig Street



Graph 3 – Monitored Evening Noise Levels Craig Street



Graph 4 – Monitored Night-time Noise Levels Craig Street



Monitored noise levels presented as Graph 2 indicate that both the weekly average total construction noise levels and monthly average construction noise levels fell significantly below the category threshold level throughout the survey period.

Monitored noise levels in terms of L_{Amax} were also noted to fall below the threshold level with the exception of on the 19th April were a single exceedence was recorded. Further investigation has indicated that the monitored noise levels in terms of L_{Amax} occurred as a result of body slap on a HGV travelling along the M90 and not as a direct result of surfacing works.

During the evening period (Graph 3) both the weekly average evening construction noise levels and the monthly average evening construction noise levels fell below both the category threshold level and existing background noise level throughout the survey period.

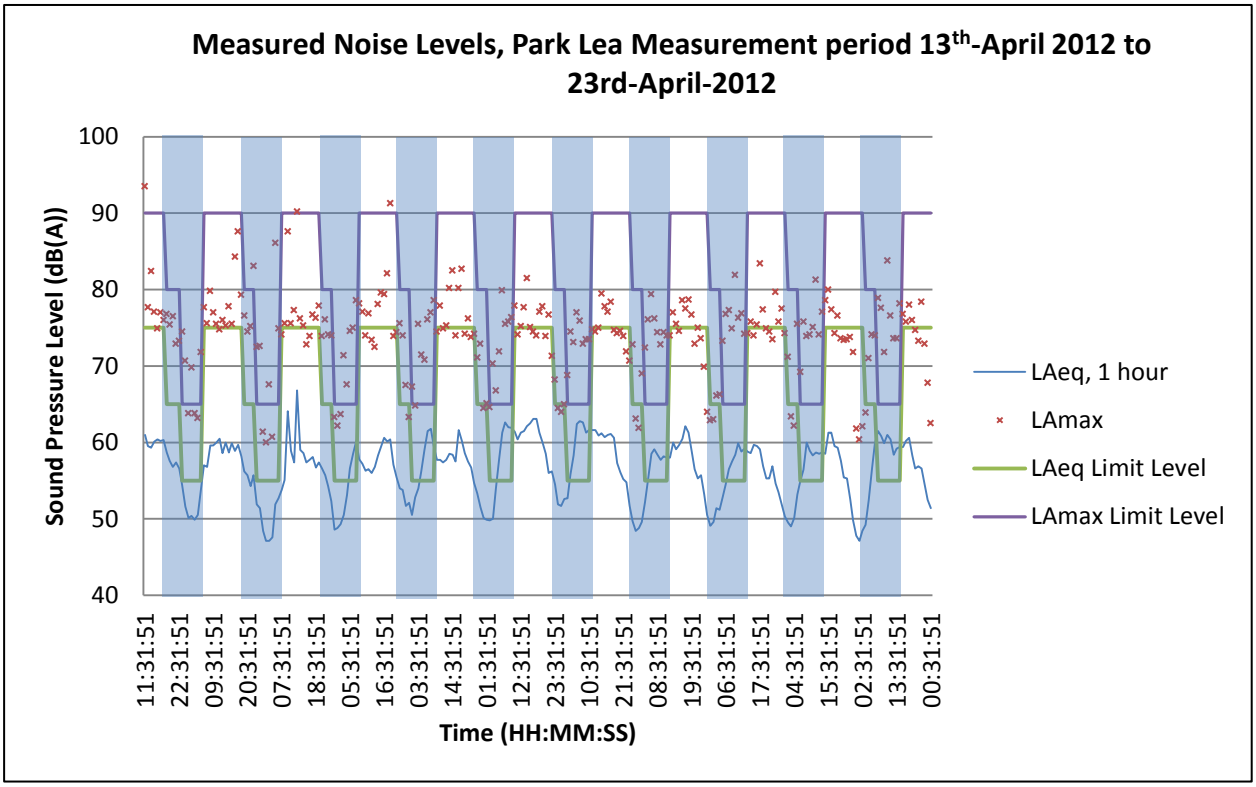
During the night-time period monitored noise levels were consistently above both the L_{Aeq} and L_{Amax} threshold levels. However, following detailed review of the monitoring data and the works record for the site it was determined that all exceedences occurred as a result of normal traffic flows and not as a direct result of works on site.

Further to the above it should be noted that no complaints were received from residents of Craig Street as a result of the works.

5.2 ML2 Park Lea

Noise monitoring at Park Lea commenced at 11:31 on the 13th April 2012 and continued until 00:31 on the 24th April 2012. The monitoring result are presented in full as Graph 5, the daytime monitoring results are presented in the Noise Liaison Groups agreed format as Graph 7, 8 and 9.

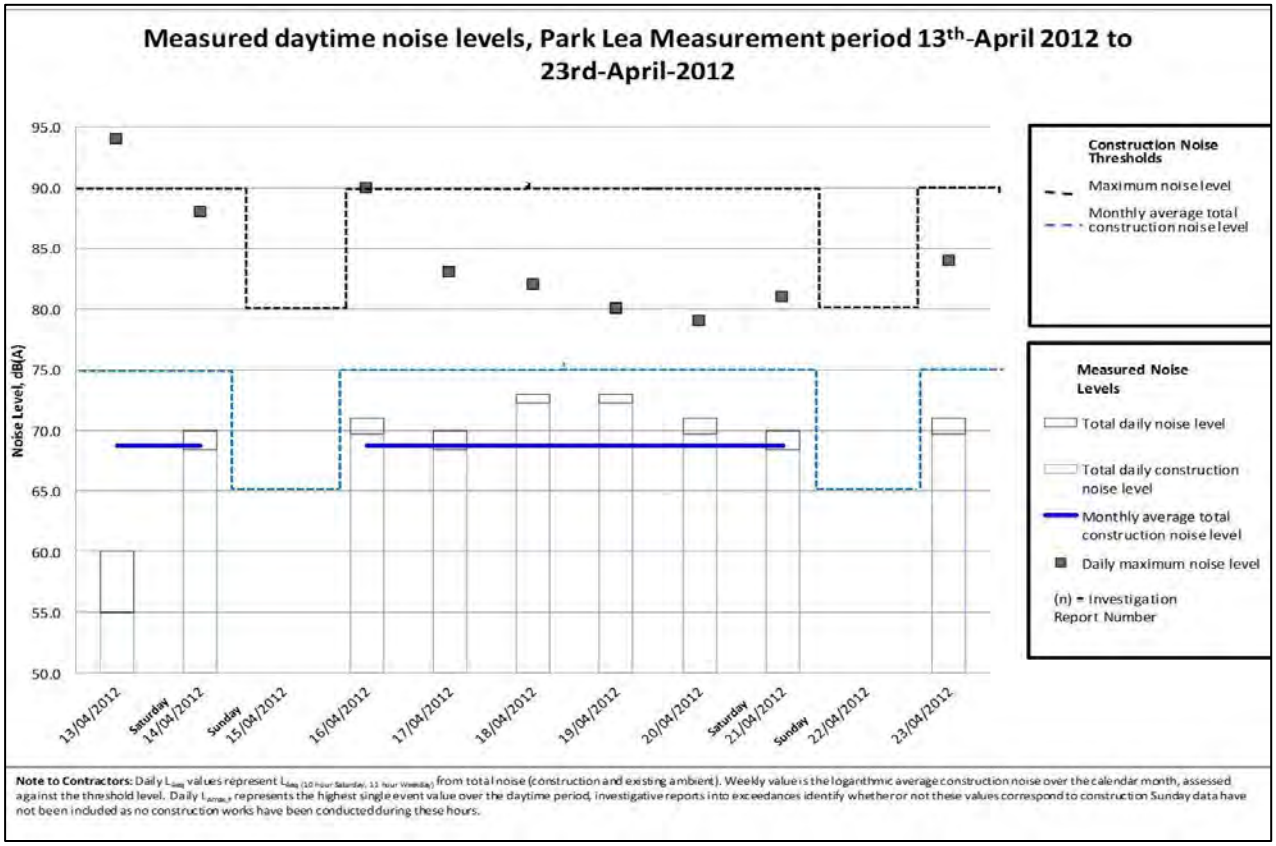
Graph 5 – Monitored Noise Levels Park Lea



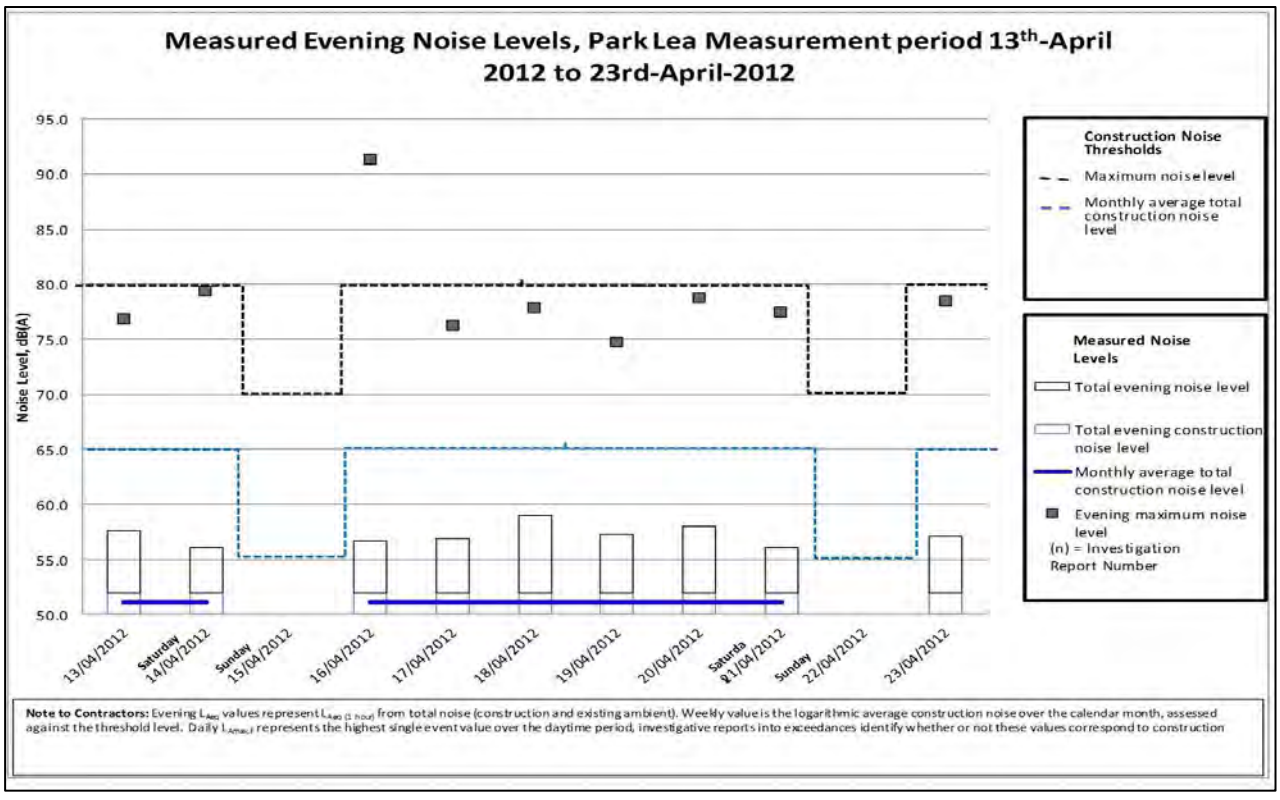
The monitored noise levels presented as Graph 5 indicate that during the daytime and evening periods monitored noise levels for the most part fell below the adopted category threshold levels. However, during the night-time period the adopted threshold level of 55dB $L_{Aeq,1hour}$ was consistently exceeded. Further examination of the data indicates that exceedences occurred both inside and outside of periods of resurfacing works. As such, it is considered that the noted exceedences where not as a direct result of the works and as such impacts associated with the works were negligible.

Further to the above the assessment criteria in terms of L_{Amax} was consistently exceeded during the evening and night-time periods. Following a number of site visits and review of all available data it was determined that the recorded exceedences arose as a result of HGV pass-bys along the M90 and not as a direct result of the resurfacing works.

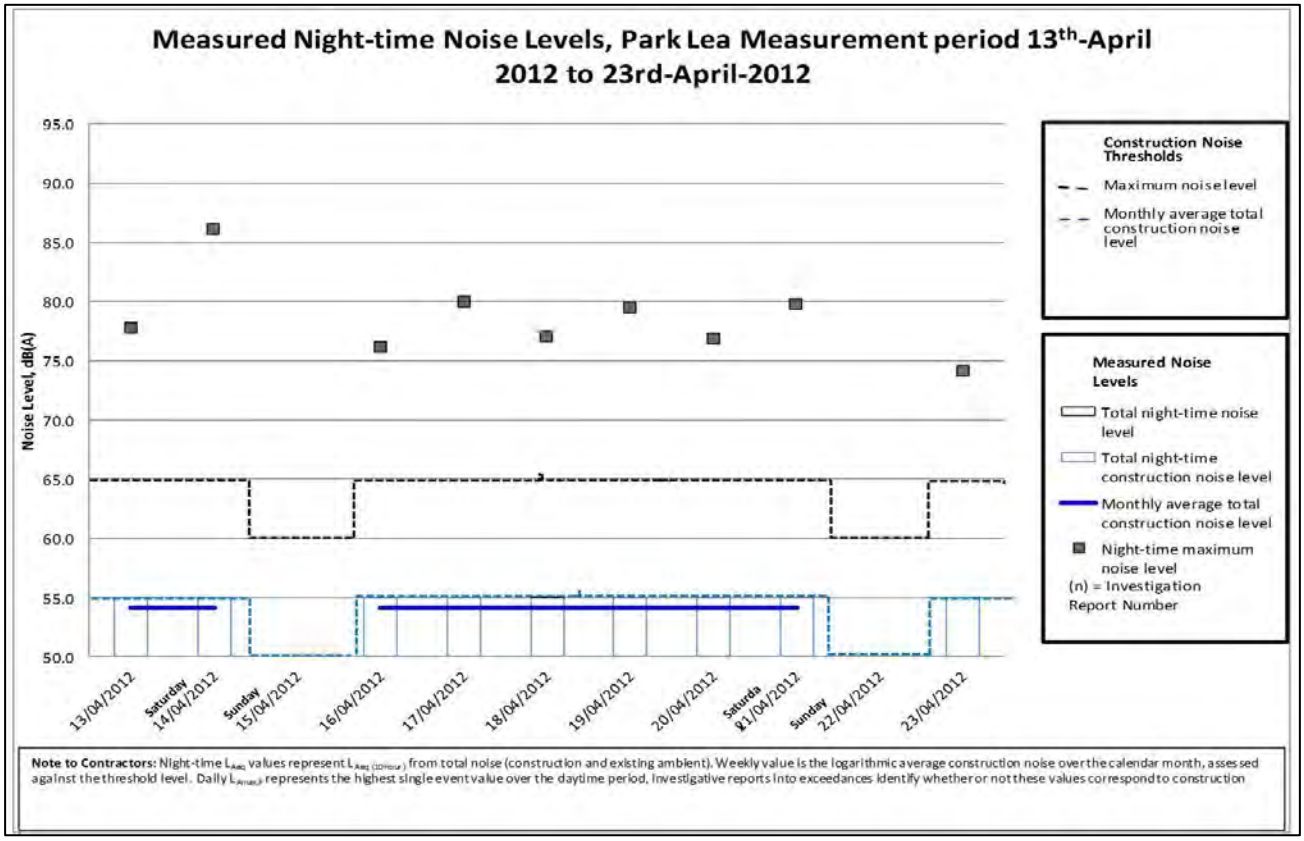
Graph 6 – Monitored Daytime Noise Levels Park Lea



Graph 7 – Monitored Evening Noise Levels Park Lea



Graph 8 – Monitored Night-time Noise Levels Park Lea



Monitored noise levels presented as Graph 6 indicate that both the weekly average total construction noise levels and monthly average construction noise levels fell significantly below the category threshold level throughout the survey period.

Monitored noise levels in terms of L_{Amax} were also noted to fall below the threshold level with the exception of on the 11th April were a single exceedence was recorded. Further investigation has indicated that the monitored noise levels in terms of L_{Amax} occurred as a result of HGVs travelling at speed along the M90 and not as a direct result of surfacing works.

During the evening period (Graph 7) monitored noise levels in terms of both L_{Aeq} and L_{Amax} were found to fall below the adopted threshold levels with the exception of on the 16th April where a single exceedance of the L_{Amax} limit level was recorded. Further investigation of the monitoring data indicates that no works where taking place adjacent to properties on Park Lea during this period as such, it is likely that this single exceedence arose as a result of HGV movements along the M90 and not as a direct result of surfacing works.

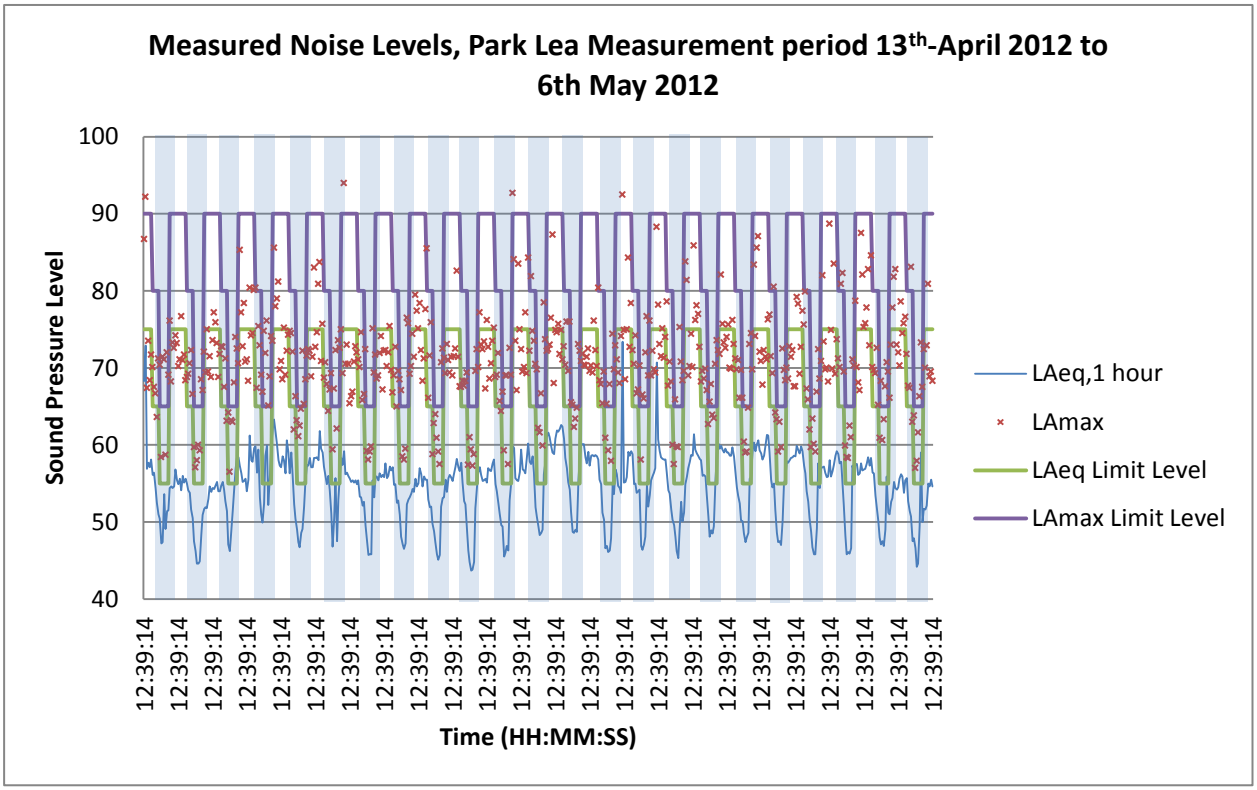
During the night-time period (Graph 8) noise levels generated by the construction works when monitored in terms of L_{Aeq} were noted to fall below both the adopted threshold level and the existing monitored ambient noise level. However, monitored noise levels in terms of L_{Amax} were noted to exceed the L_{Amax} criteria on all days. However, further analysis of the monitoring data indicated that noise levels in terms of L_{Amax} were consistent throughout the daytime, evening and night-time periods suggesting road traffic noise was the dominant source of the identified exceedences.

Further to the above it should be noted that no complaints were received from residents of Park Lea as a result of the works.

5.3 ML3 Masterson Road

Noise monitoring at Masterson Road commenced at 11:31 on the 13th April 2012 and continued until 00:31 on the 24th April 2012. The monitoring result are presented in full as Graph 9, the daytime monitoring results are presented in the Noise Liaison Groups agreed format as Graphs 10, 11 and 12.

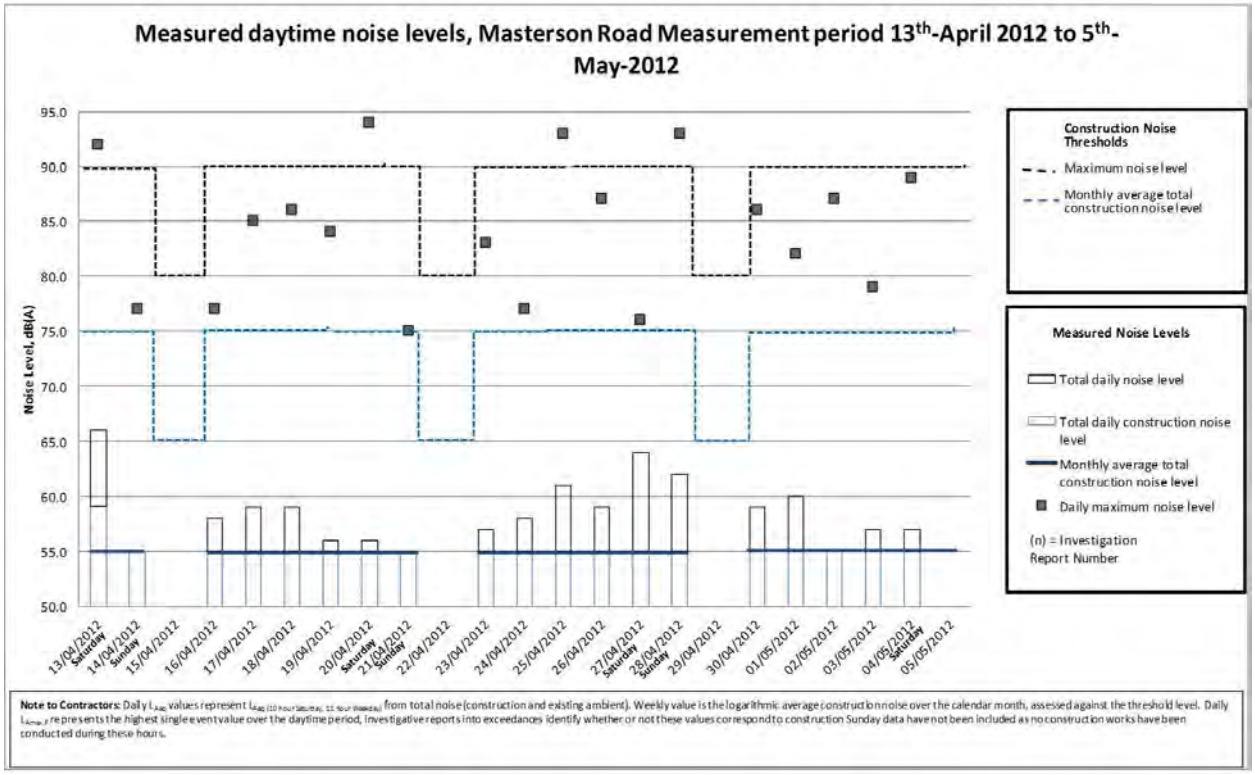
Graph 9 – Monitored Noise Levels Masterson Road



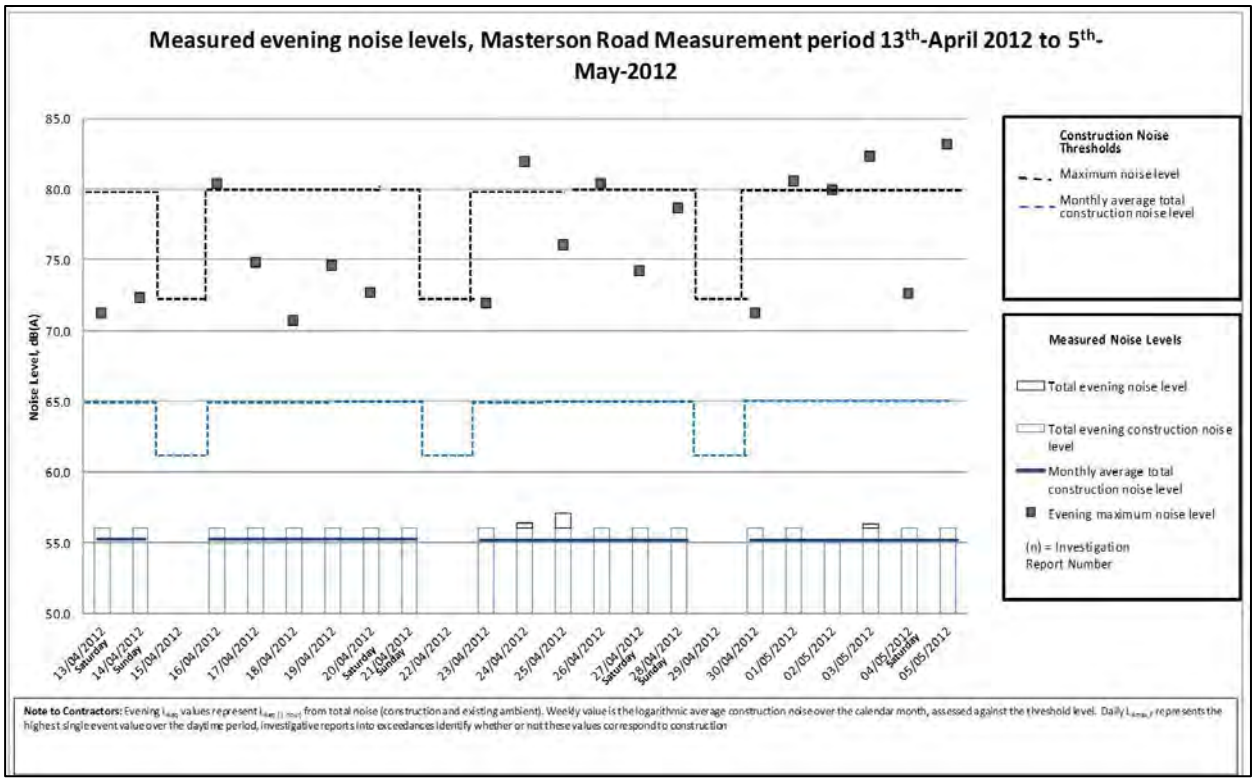
The monitored noise levels presented as Graph 9 indicate that during the daytime and evening periods monitored noise levels for the most part fell below the adopted category threshold levels throughout the survey period.

However, the assessment criteria in terms of L_{Amax} were consistently exceeded during the evening and night-time periods. Following a number of site visits and review of all available data it was determined that the recorded exceedences arose as a result of HGV pass-bys along the M90 and not as a direct result of the resurfacing works.

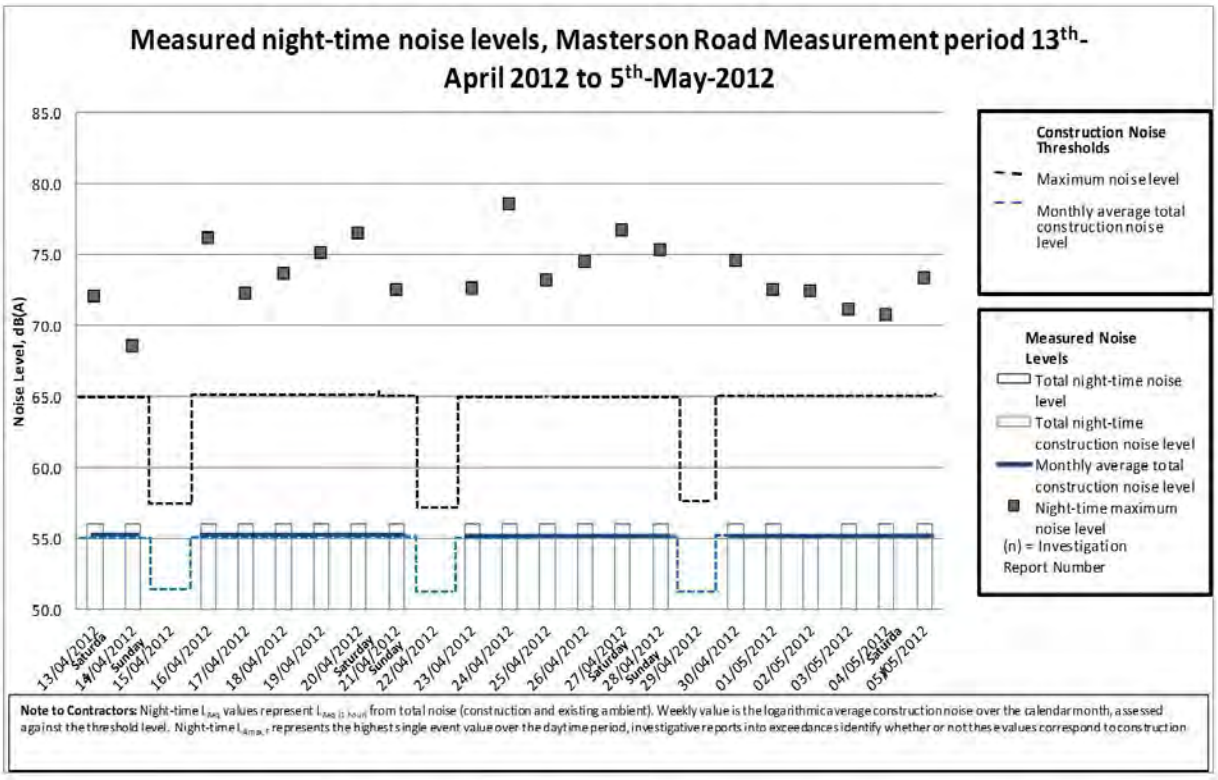
Graph 10 – Monitored Daytime Noise Levels Masterson Road



Graph 11 – Monitored Evening Noise Levels Masterson Road



Graph 12 – Monitored Night-time Noise Levels Masterson Road



Monitored noise levels presented as Graph 10 indicate that both the weekly average total construction noise levels and monthly average construction noise levels fell significantly below the category threshold level throughout the daytime survey period.

Monitored noise levels in terms of L_{Amax} were also noted to fall below the threshold level with the exception of four separate exceedences on the 13th, 21st, 25th and 28th April 2012. Further investigation has indicated that the monitored noise levels in terms of L_{Amax} occurred as a result of HGVs travelling along the M90 and not as a direct result of surfacing works.

During the evening period (Graph 11) monitored noise levels in terms of $L_{Aeq,1\ hour}$ fell below the adopted threshold level throughout the survey period. However the L_{Amax} threshold was exceeded on several occasions during this period. Further analysis of the monitoring data indicated that noise levels in terms of L_{Amax} were consistent throughout the daytime, evening and night-time periods suggesting road traffic noise was the source of the identified exceedences.

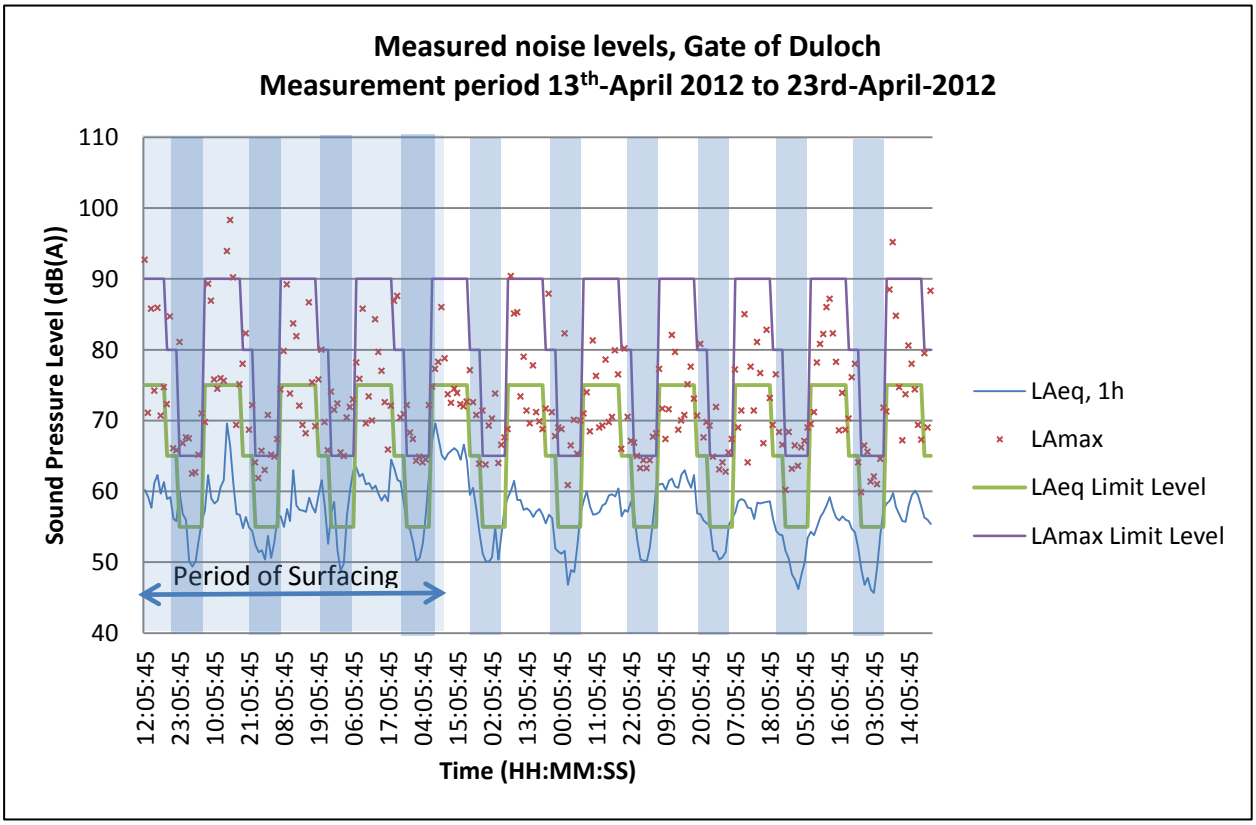
During the night-time period (Graph 12) monitored noise levels in terms of both L_{Aeq} and L_{Amax} were in excess of the adopted threshold levels. However, following further analysis of the data it was determined that exceedences occurred both during and outside of work periods. Furthermore noise levels were typical of those recorded during the baseline period. As such, it can be seen that the identified exceedences did not arise as a direct result of the works.

Further to the above it should be noted that no complaints were received from residents of Masterson Road as a result of the works.

5.4 ML4 – Gate of Duloch

Noise monitoring at Gate of Duloch commenced at 12:05 on the 13th April 2012 and continued until 21:05 on the 24th April 2012. Resurfacing works at the site commenced on the evening of the 13th April 2012 and continued through until the early hours of 17th April 2012. The monitoring result are presented in full as Graph 13, the monitoring results are presented in the Noise Liaison Groups agreed format as Graph 14,15 and 16.

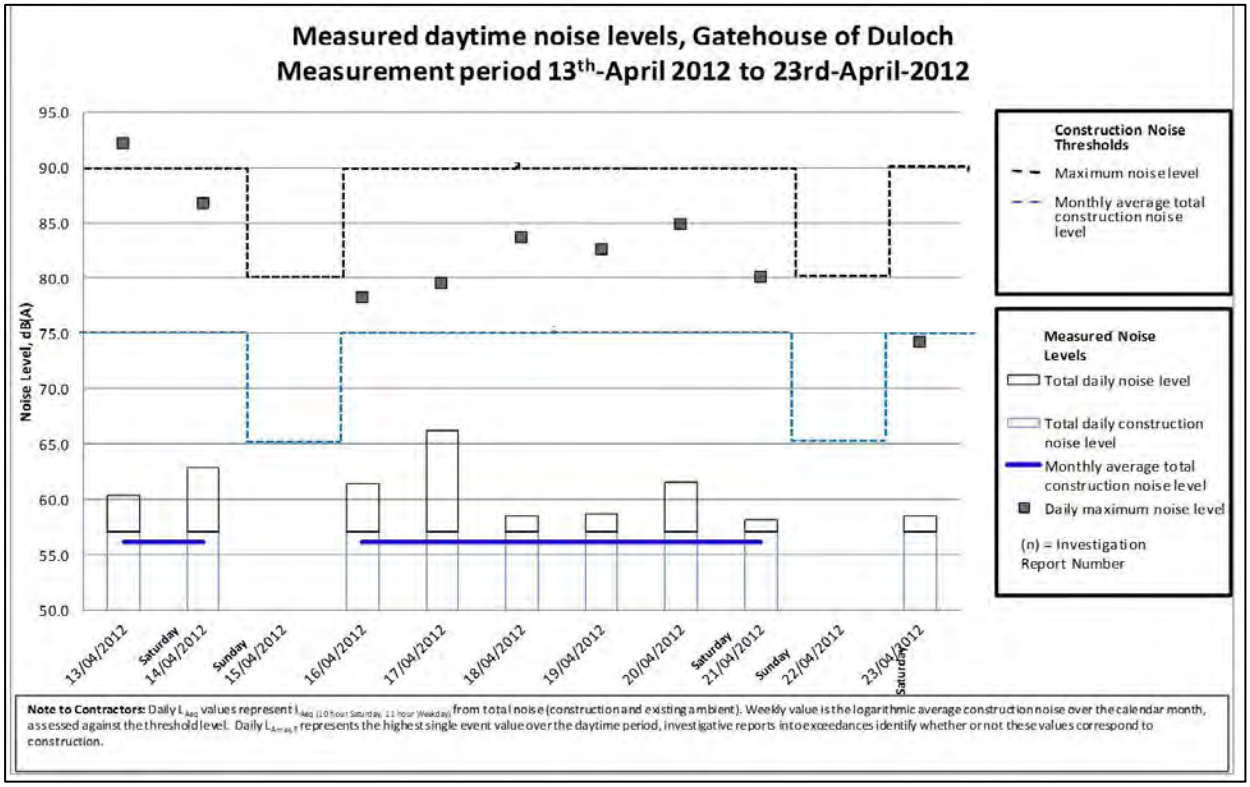
Graph 13 – Monitored Noise Levels Gatehouse of Duloch



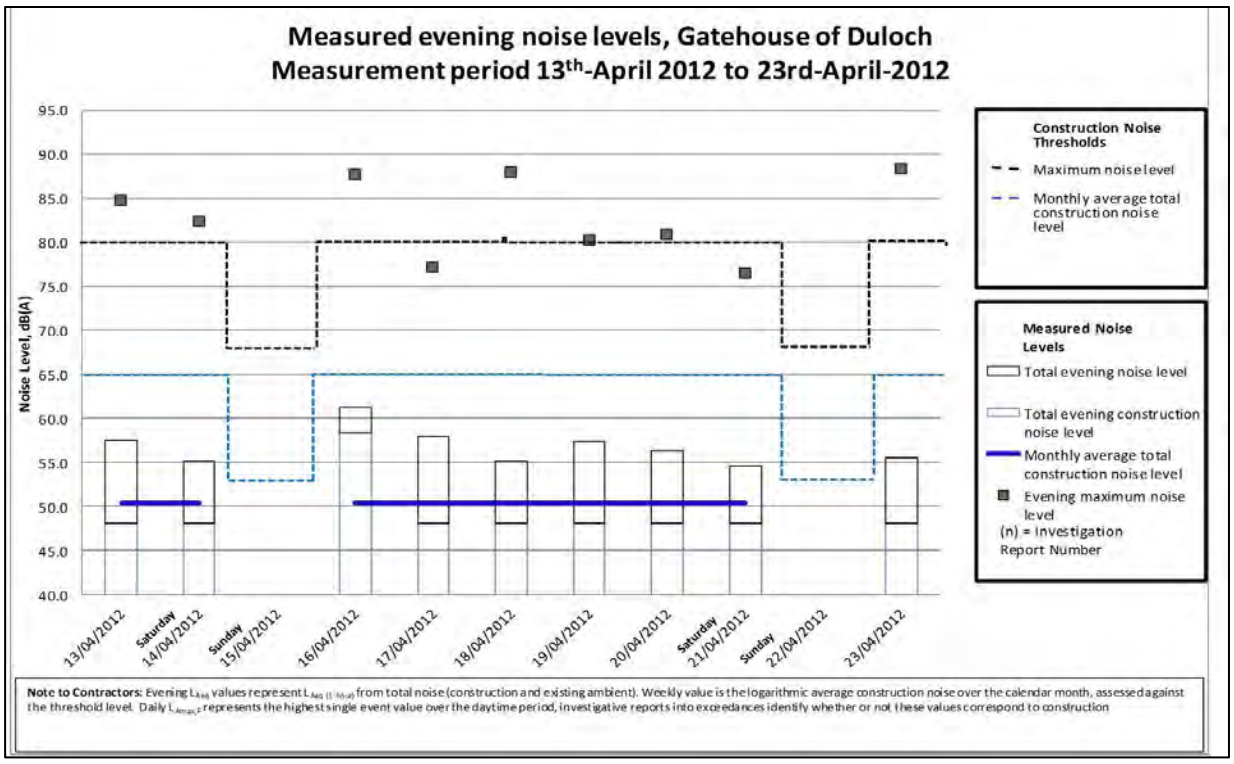
The monitored noise levels presented as Graph 7 indicate that for the most part monitored noise level below the category threshold levels although a number of exceedences of both the L_{Aeq} and L_{Amax} criteria were noted.

With regards to the exceedences of the L_{Aeq} criteria it is noted that minor exceedences occur during the night-time shoulder hours. However, given that exceedences arise both during the works and when works were not taking place adjacent to the Gate of Duloch it is considered that the recorded exceedences did not arise as a direct result of the works.

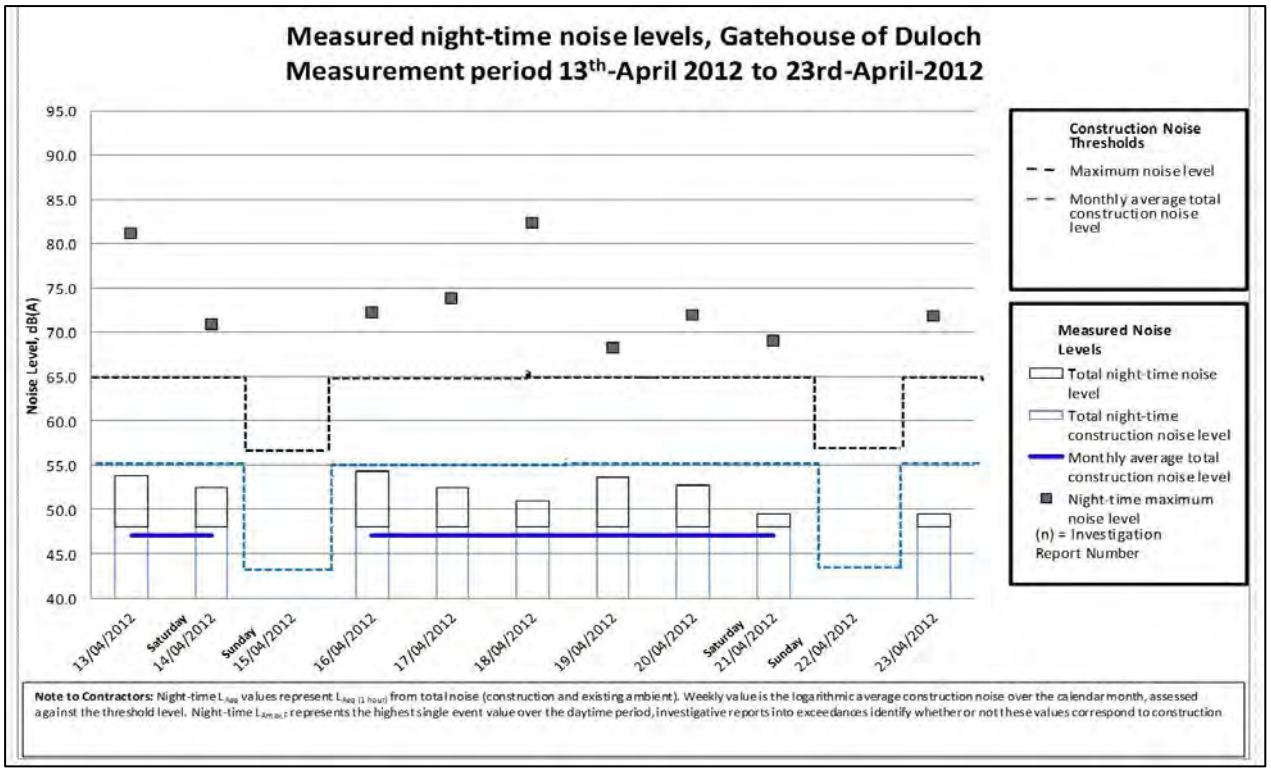
Graph 14 – Monitored Daytime Noise Levels Gatehouse of Duloch



Graph 15 – Monitored Evening Noise Levels Gatehouse of Duloch



Graph 16 – Monitored Night-time Noise Levels Gatehouse of Duloch



Monitored noise levels presented as Graph 14 indicate that both the weekly average total construction noise levels and monthly average construction noise levels fell significantly below the category threshold level throughout the survey period. Monitored noise levels in terms of L_{Amax} were also noted to fall below the threshold level with the exception of on the 13th April when a single exceedence was recorded. Further investigation has indicated that the monitored noise levels in terms of L_{Amax} occurred as a result of body slap on a HGV travelling along Aberdour Road and not as a direct result of surfacing works.

During the evening period (Graph 15) monitored noise levels in terms of $L_{Aeq,1\ hour}$ fell below the adopted threshold level throughout the survey period. However the L_{Amax} threshold was exceeded on several occasions during this period. Further analysis of the monitoring data indicated that noise levels in terms of L_{Amax} were consistent throughout the daytime, evening and night-time periods indicating that road traffic noise was the source of the identified exceedences.

During the night-time period (Graph 16) monitored noise levels in terms of both L_{Aeq} and L_{Amax} were in excess of the adopted threshold levels. However, following further analysis of the data it was determined that exceedences occurred both during and outside of work periods. Furthermore noise levels were typical of those recorded during the baseline period. As such, it can be seen that the identified exceedences did not arise as a direct result of the works.

Notwithstanding the above a complaint was received by the resident of the Gate of Duloch on Monday 16th March 2012 in relation to night-time surfacing activities. Following receipt of the complaint a member of Waterman's Noise and Vibration Team attended site so as to further explore the cause of the complaint and provide further advice with regards to noise control. In order to further reduce noise levels as a result of the works temporary acoustic barriers were installed along the boundary of the Gate of Duloch and the M90 and the number of plant utilised on site were reduced. With these measures in place there was a

notable reduction in noise levels (see Graph 13). Furthermore an e-mail was received from the resident stating noise conditions on site were much improved with these measures in place.

APPENDICES

Appendix A Acoustic Terminology

Ambient sound	The totally encompassing sound in a given situation at a given time, usually composed of sound from all sources near and far.
Assessment period	The period in a day over which assessments are made.
A-weighting	A frequency weighting applied to measured or predicted sounds levels in order to compensate for the non-linearity of human hearing.
Background noise	Background noise is the term used to describe the noise measured in the absence of the noise under investigation. It is described as the average of the minimum noise levels measured on a sound level meter and is measured statistically as the A-weighted noise level exceeded for ninety percent of a sample period. This is represented as the L_{90} noise level (see below).
Broadband	Containing the full range of frequencies.
Decibel [dB]	The level of noise is measured objectively using a Sound Level Meter. This instrument has been specifically developed to mimic the operation of the human ear. The human ear responds to minute pressure variations in the air. These pressure variations can be likened to the ripples on the surface of water but of course cannot be seen. The pressure variations in the air cause the eardrum to vibrate and this is heard as sound in the brain. The stronger the pressure variations, the louder the sound that is heard. The range of pressure variations associated with everyday living may span over a range of a million to one. On the top range may be the sound of a jet engine and on the bottom of the range may be the sound of a pin dropping. Instead of expressing pressure in units ranging from a million to one, it is found convenient to condense this range to a scale 0 to 120 and give it the units of decibels. The following are examples of the decibel readings of every day sounds; Four engine jet aircraft at 100m 120 dB Riveting of steel plate at 10m 105 dB Pneumatic drill at 10m 90 dB Circular wood saw at 10m 80 dB Heavy road traffic at 10m 5 dB Telephone bell at 10m 65 dB Male speech, average at 10m 50 dB Whisper at 10m 25 dB Threshold of hearing, 1000 Hz 0 dB
dB(A): **A-weighted decibels**	The ear is not as effective in hearing low frequency sounds as it is hearing high frequency sounds. That is, low frequency sounds of the same dB level are not heard as loud as high frequency sounds. The sound level meter replicates the human response of the ear by using an electronic filter which is called the 'A' filter. A sound level measured with this filter switched on is denoted as dB(A). Practically all noise is measured using the A filter. The sound pressure level in dB(A) gives a close indication of the subjective loudness of the noise.
Do-Minimum	Describes a scenario under which the road scheme that is under consideration does not proceed.
Façade Noise Level	A noise level measured or predicted at the façade of a building, typically at a distance of 1m, containing a contribution made up of reflections from the façade itself (+3dB).
L_{Amax} noise level	This is the maximum noise level recorded over the measurement period.
L_{Amin} noise level	This is the lowest level during the measurement period.

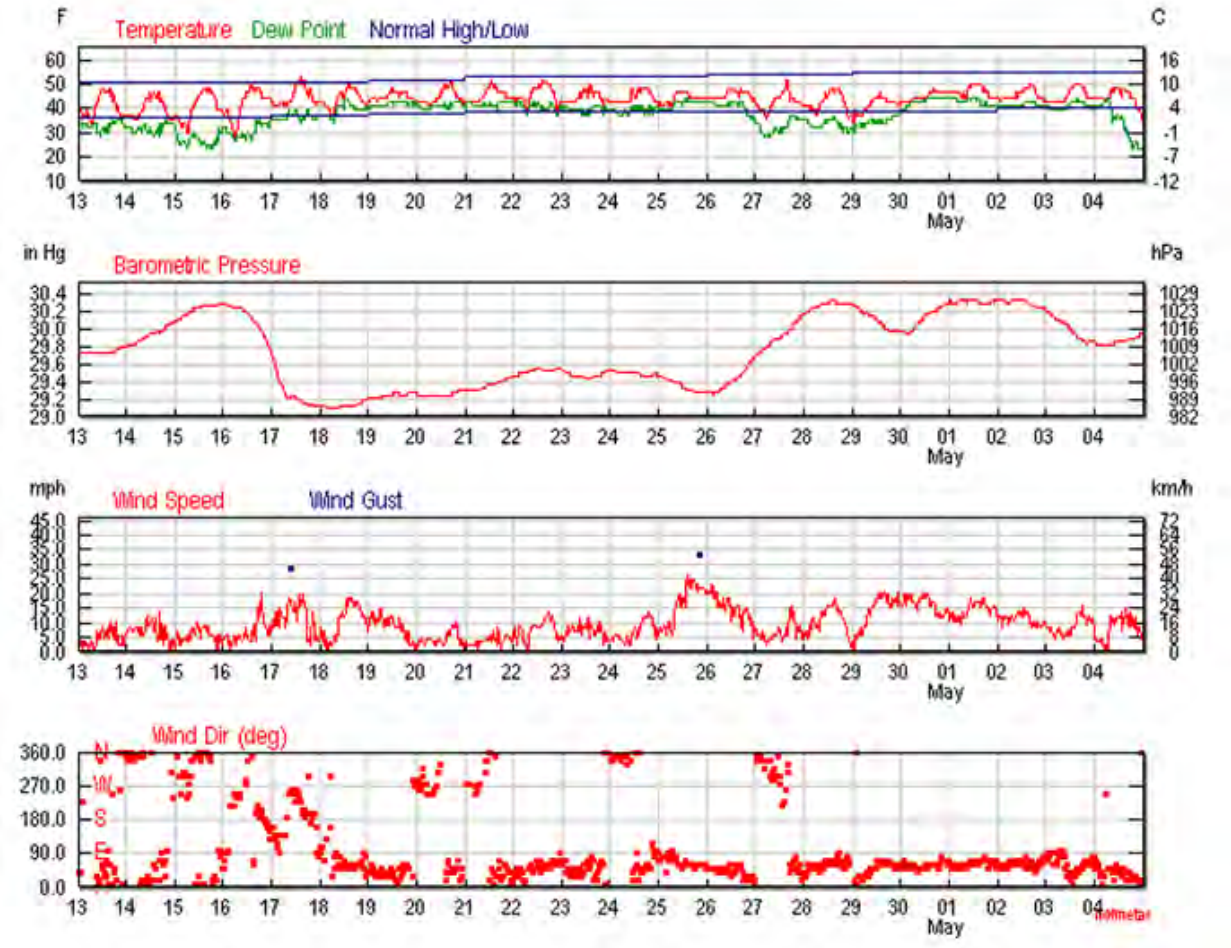
$L_{Aeq,T}$ noise level	This is the 'equivalent continuous A-weighted sound pressure level, in decibels' and is defined in British Standard 7445 as the 'value of the A-weighted sound pressure level of a continuous, steady sound that, within a specified time interval, T, has the same mean square sound pressure as a sound under consideration whose level varies with time'. It is a unit commonly used to describe construction noise, noise from industrial premises and is the most suitable unit for the description of other forms of environmental noise.
L_{A90} noise level	This is the noise level that is exceeded for 90% of the measurement period and gives an indication of the noise level during quieter periods. It is often referred to as the background noise level and is used in the assessment of disturbance from industrial noise.
L_{A10} noise level	This is the noise level which is achieved for 10% of the monitoring period and is often used to describe road traffic noise
R_w	Single number rating used to describe the **laboratory** airborne sound insulation properties of a material or building element over a range of frequencies, typically 100-3150Hz.

Appendix B Historical Weather Data

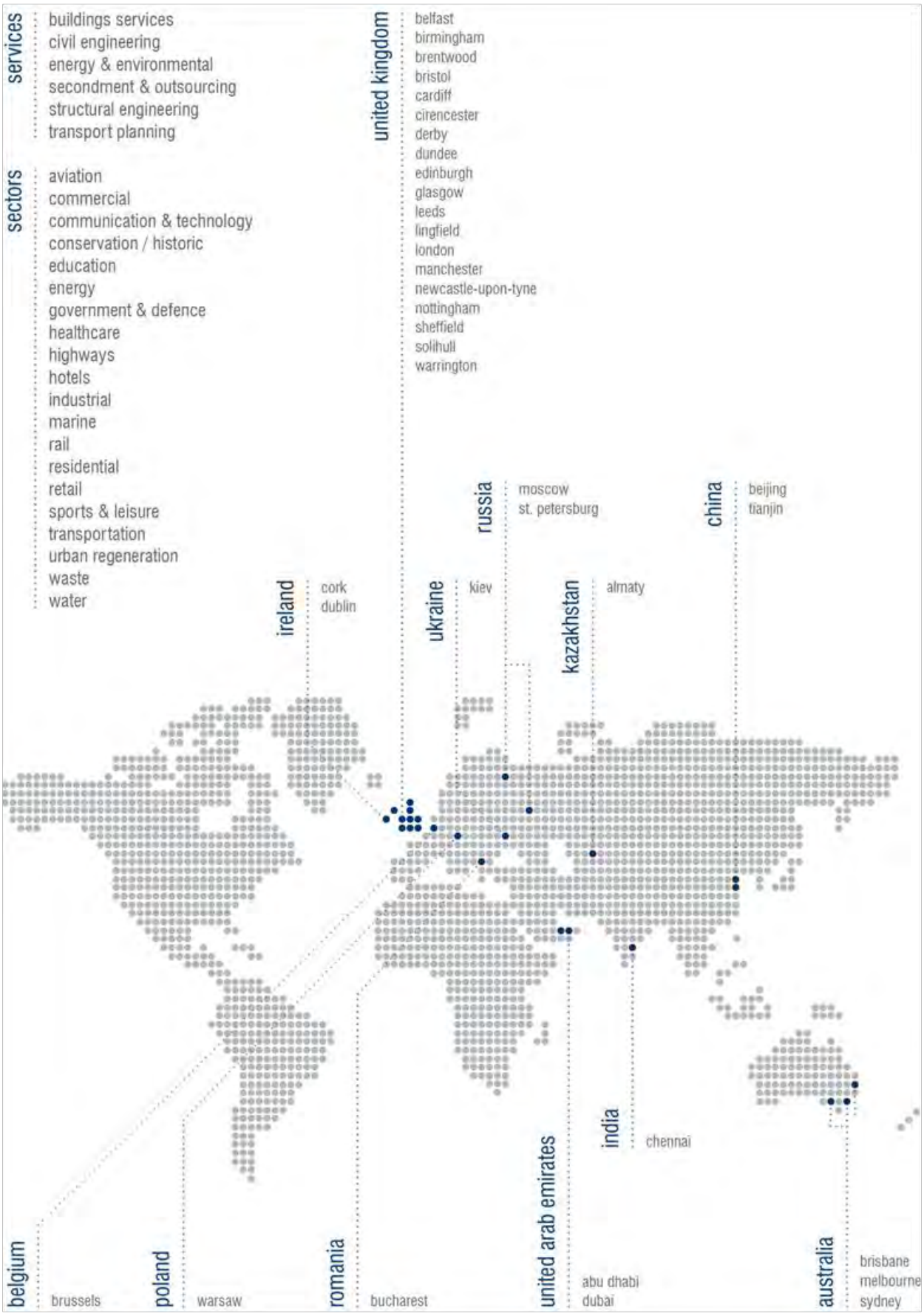
Nearest Historical Weather Station: Dundee

May 13, 2012 through May 4th, 2012

BST	Max Temp. C	Mean Temp. C	Min Temp. C	Mean Humidity	Mean Wind Speed Km/h	Precipitation mm
13/04/2012	9	4	1	74	6	0
14/04/2012	8	4	2	73	11	0
15/04/2012	9	4	-1	60	8	0
16/04/2012	10	4	-2	66	10	0
17/04/2012	12	8	5	73	18	0
18/04/2012	10	6	2	85	13	0
19/04/2012	9	7	6	88	16	0
20/04/2012	11	8	5	87	6	0
21/04/2012	11	8	5	87	6	0
22/04/2012	11	7	4	83	11	0
23/04/2012	10	8	5	82	10	0
24/04/2012	9	7	6	80	10	0
25/04/2012	8	7	5	91	21	0
26/04/2012	9	7	6	83	27	0
27/04/2012	11	6	2	69	10	0
28/04/2012	9	6	2	70	16	0
29/04/2012	8	4	1	77	18	0
30/04/2012	9	7	6	93	27	0
01/05/2012	10	8	7	86	21	0
02/05/2012	10	8	6	85	18	0
03/05/2012	10	8	6	84	13	0
04/05/2012	9	6	2	69	10	0
05/05/2012	9	4	1	74	6	0


F
Temperature
Dew Point
Normal High/Low
C
60
50
40
30
20
10
16
10
4
-1
-7
-12
13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 01 02 03 04
May
in Hg
Barometric Pressure
hPa
30.4
30.2
30.0
29.8
29.6
29.4
29.2
29.0
1029
1023
1016
1009
1002
996
989
982
13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 01 02 03 04
May
mph
Wind Speed
Wind Gust
km/h
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
72
64
56
48
40
32
24
16
8
0
13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 01 02 03 04
May
Wind Dir (deg)
360.0
270.0
180.0
90.0
0.0
N
W
S
E
13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 01 02 03 04
May

waterman


services
buildings services
civil engineering
energy & environmental
secondment & outsourcing
structural engineering
transport planning
sectors
aviation
commercial
communication & technology
conservation / historic
education
energy
government & defence
healthcare
highways
hotels
industrial
marine
rail
residential
retail
sports & leisure
transportation
urban regeneration
waste
water
united kingdom
belfast
birmingham
brentwood
bristol
cardiff
cirencester
derby
dundee
edinburgh
glasgow
leeds
lingfield
london
manchester
newcastle-upon-tyne
nottingham
sheffield
solihull
warrington
russia
moscow
st. petersburg
china
beijing
tianjin
ireland
cork
dublin
ukraine
kiev
kazakhstan
almaty
india
chennai
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bucharest
united arab emirates
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australia
brisbane
melbourne
sydney