CLIENT: LONDON UNDERGROUND LIMITED

CONTRACT REF: TLL 7917

NORTHERN LINE EXTENSION

MAIN WORKS CONTRACT

Kennington Underground Station Attended Construction Noise Monitoring

Prepared by	Checked by	Approved by	Date	Rev
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CONTENTS

1 INTRODUCTION

Ferrovial Laing O'Rourke (FLO) is currently undertaking works at Kennington Underground Station as part of the London Underground Extension of the Northern Line (NLE) running from Kennington to Battersea (Charing Cross branch).

Temple has been appointed to undertake an attended noise survey of works taking place at Kennington Underground Station. A compressor, concrete pump, containerised diesel generator and hybrid generator are positioned externally serving internal works taking place in the Kennington cross passages.

This report details the noise levels measured during the attended noise survey undertaken between Tuesday 10th July and Wednesday 11th July 2018.

Noise levels associated with the works were predicted at the noise sensitive receptors based on the engineering team's information and presented in the current Section 61. The measured levels are assessed against these predictions and the pre-existing ambient noise level in accordance to the Northern Line Extension Construction Noise and Vibration Mitigation Scheme.

2 THE SITE AND ITS SURROUNDINGS

The main works are taking place at the cross passages of Kennington Underground Station. Four containerised static plant items are located at ground level on Braganza Street. The plant items are located approximately 20 metres away from the Kennington Station entrance.

The plant on site are all housed within storage containers and are shown below;

- Compressor;
- Diesel generator;
- Hybrid Generator; and
- A concrete pump.

The noise sensitive receptors that have been identified are as follows:

- 1 Braganza Street - Residential property over three floors to the east of the worksite, approximately 5m away from the nearest worksite boundary; and
- 87a Kennington Park Road - Residential property over two levels to the south of the site, approximately 5m away from the nearest worksite boundary.

Please see **Appendix I** indicating the location of the worksite and the layout of the containers.

3 NORTHERN LINE EXTENSION: CONSTRUCTION NOISE AND VIBRATION MITIGATION SCHEME

The NLE: Construction Noise and Vibration Mitigation Scheme (CNVMS) assessment methodology states that:

A dwelling will be eligible for noise insulation where the total noise level due to construction of the railway (pre-existing ambient plus airborne NLE construction noise), measured or predicted at a point one metre in front of the most exposed of any windows and doors in any façade of a building which is an eligible dwelling, exceeds whichever is the higher of either: a) any of the following criteria in ***Table 1****.*

Table 1 Noise insulation trigger levels.

NOISE INSULATION TRIGGER LEVEL TABLE			
Time	**Relevant Time Period**	**Noise level ($L_{Aeq,\ 10h}$) dB**	**Noise Insulation Trigger Level ($L_{Aeq,\ T}$) dB**
Monday to Friday	07:00 – 08:00	1 hr	70
	08:00 – 18: 00	10 hr	75
	18:00 – 19:00	1 hr	70
	19:00 – 22:00	3 hr	65
	22:00 – 07:00	1 hr	55
Saturday	07:00 – 08:00	1 hr	70
	08:00 – 13:00	5 hr	75
	13:00 – 14:00	1 hr	70
	14:00 – 22:00	3 hr	65
	22:00 – 07:00	1 hr	55
Sunday and Public Holidays	07:00 – 22:00	1 hr	65
	22:00 – 07:00	1 hr	55

Or
(b) 5 dB above the pre-existing airborne noise level for the corresponding times of day (i.e. the Relevant Time Periods presented in column 2 of ***Table 1****);*
And
for a period of 10 or more days of working in any 15 consecutive days or for a period of 3 or more nights (22:00-07:00) of working in any 7 consecutive nights or for a total of days exceeding 40 in any six consecutive months.

4 MEASUREMENT METHODOLOGY

The key objective of this noise survey was to undertake measurements at the nearest receptors to the worksite and compare predicted and measured construction noise levels.

4.1 Noise Measurements

Attended noise measurements were undertaken at two locations, 15 minutes per location over four consecutive hours between 21:00 and 01:00. The first measurement position (**MP1**) was located outside the facade of 87a Kennington Park Road on Braganza Street and located around 6 meters away from the nearest edge of the containers. The second position (**MP2**) was located on the footpath outside 1 Braganza Street and located around 4 meters away from the nearest edge of the containers. The sound level meter was set to measure A-weighted L_{eq}, L_{Fmax}, L_{10}, and L_{90} sound pressure levels over 15-minute intervals during the survey. The microphone was positioned at 1.5m height above the local ground level at both positions and all measurements were measured approximately 1m from the nearest façade.

An unattended measurement (**KPST1**) was installed prior to the survey. The measurement position is located on top of a small container which is approximately 5 metres in width. Either side of this container, the larger storage containers with the plant are located. The storage containers are stacked in two and reach an approximate height of 5.5 metres. This meter has been set to measure A-weighted L_{eq} and L_{Fmax} sound pressure levels over 15-minute intervals and was measuring continuously during the attended survey. The microphone was positioned at 3.5m height above local ground level and considered to be a façade measurement.

A site plan with the locations of the measurement positions and the location of the plant can be found in **Appendix I.**

The survey observations and results are shown in **Section 5** of this report.

4.2 Equipment

The equipment used is detailed in **Table 2**. The RION sound level meter used for the attended measurements was checked for calibration before and after the measurements and no drift was observed. Calibration certificates showing periodic validation of the equipment to national and international standards are available upon request

Table 2 Survey Equipment

SURVEY EQUIPMENT				
Manufacturer	Item	Type	Serial Number	Calibration Date
Attended Monitoring				
RION	Calibrator	NC-74	35173548	29/08/2017
RION	Sound Level Meter	NL-32	00982876	21/12/2017
Unattended Monitoring				
Sigicom	Sound Level Meter	S50	7375	17/06/2017
Sigicom	Weather Station	X20WXT	9565	n/a

4.3 Weather Conditions

Table 3 shows the mean wind speed and total rain fall measured by the sonic anemometer operating on the main Battersea site (**BW3**).

Table 3 - Survey weather conditions

SURVEY WEATHER CONDITIONS		
Period	Total Rainfall (mm)	Mean wind speed (m/s)
01/11/2016 21:00 – 02/11/2016 01:00	0.0	0.6

5 SURVEY RESULTS

5.1 Survey Observations

Measurement Position 1 (MP1)

MP1 was positioned on Braganza Street and located south of the containers. The acoustic environment consisted of road traffic noise, high flying aircraft noise and pedestrian noise. The road traffic flow gradually reduced through the night from 22:00. The construction noise consisted of the containerised diesel generator (which was in operation until 22:05), a compressor enclosed in a storage container and a hybrid generator (which was in operation from 22:05). There was also sound of materials being moved as well as the doors of the containers being opened/closed occasionally

Measurement Position 2 (MP2)

MP2 was positioned outside 1 Braganza Street and east of the containers. Measurements in this position could only be undertaken after 23:30 due to pedestrian traffic from the tube station. The acoustic environment consisted of road traffic noise and pedestrian noise. The construction noise had contributions from the hybrid generator and to a lesser extent from the compressor.

5.1 Noise Measurement Results

Presented within **Table 4, Table 5** and **Table 6** are the measured noise levels. The measured levels presented are all facade levels.

Table 4 – Measured Noise Levels at MP1

MEASURED NOISE LEVELS AT MP1							
Date	Start Time	Plant Operational	$L_{Aeq,15mins}$ (dB)	$L_{Amax,15mins}$ (dB)	$L_{Amin,15mins}$ (dB)	$L_{A10,15mins}$ (dB)	$L_{A90,15mins}$ (dB)
10/07/18	21:14	Compressor, diesel generator	66.0	81.9	61.6	67.8	62.6
	21:46		66.2	86.8	61.6	68.0	62.6
	22:18	Compressor, hybrid generator	65.4	84.5	60.4	68.5	61.8
	23:35		65.5	85.1	59.7	67.3	61.9
11/07/18	00:15		63.7	84.1	60.8	64.2	62.1

Table 5 – Measured Noise Levels at MP2

MEASURED NOISE LEVELS AT MP2							
Date	Start Time	Plant	$L_{Aeq,15mins}$ (dB)	$L_{Amax,15mins}$ (dB)	$L_{Amin,15mins}$ (dB)	$L_{A10,15mins}$ (dB)	$L_{A90,15mins}$ (dB)
10/07/18	23:52	Compressor & hybrid generator	54.8	68.7	49.9	56.5	51.5
11/07/18	00:30		56.5	77.7	49.5	58.4	51.5

Table 6 – Measured Noise Levels at KPST1

MEASURED NOISE LEVELS AT KPST1				
Date	Start Time	Plant Operational	$L_{Aeq,15mins}$ (dB)	$L_{Amax,15mins}$ (dB)
10/07/18	21:15	Compressor & diesel generator	67.7	79.9
	21:30		67.6	77.3
	21:45		67.6	74.6
	22:00	Compressor & hybrid generator	67.6	84.4
	22:15		67.6	77.4
	22:30		67.3	84.9
	22:45		67.9	89.7
	23:00		66.7	75.6
	23:15		66.5	72.1
	23:30		66.6	74.1
	23:45		66.6	74.4
11/07/18	00:00		66.7	75.9
	00:15		66.5	71
	00:30		66.4	71.8
	00:45		66.7	77.3
	01:00		66.9	82.2

6 ASSESSMENT

6.1 Survey Assessment

At MP1, the compressor and diesel generator were audible during the extended period along with contributions from road traffic. Once the diesel generator was turned off at 22:05 and the hybrid compressor was switched on, the construction related activities contributed less to the ambient noise, but the road traffic stayed at a similar level.

At MP2, the contributions from the compressor were less noticeable when compared to MP1 due to the onsite screening provided by the containers. The hybrid generator was audible at this location.

The table below summarises the typical measured baseline levels compared against the range of measured noise levels when the plant was operational.

Table 7 - Survey assessment

SURVEY ASSESSMENT			
Representative receptor	Assessment Period	Typical measured baseline, $L_{Aeq,15mins}$ (dB)	Range of measured noise levels, $L_{Aeq,15mins}$ (dB)
87 Kennington Park Road (MP1)	Extended (19:00-22:00)	60.2	66.0 – 66.2
1 Braganza Street (MP2)		58.9	n/a
Unattended monitor (KPST1)		n/a	67.6 - 67.7
87 Kennington Park Road (MP1)	Night (22:00 – 07:00)	60.8	63.7 - 65.4
1 Braganza Street (MP2)		56.8	54.8 – 56.5
Unattended monitor (KPST1)		n/a	66.4 - 67.6

6.2 Predicted and Measured Noise Levels

The predicted noise levels at the receptors have been calculated in accordance with the procedures set out in British Standard 5228 Part 1 (BS 5228-1) as part of the Section 61 submitted on 03/07/2018. The model was predicted by using manufacturers' data sheets, BS 5228 data and measured levels of plant in-situ. The source term levels for the Hybrid Generator were described in the manufacturer's data sheet as "*inaudible above background*". The assessment of the predicted levels compared to the measured levels are shown in **Table 8**.

Table 8 – Predicted noise levels associated with site activity compared to measured levels

PREDICTED NOISE LEVELS				
Assessment Period	Predicted Noise Level at Receptor + Baseline $L_{Aeq,T}$ (dB)		Range of Variance compared to predictions (dB)	
	87 Kennington Park Road (MP1)	1 Braganza Street (MP2)	87 Kennington Park Road (MP1)	1 Braganza Street (MP2)
Extended (19:00 – 22:00)	60.3	58.9	+5.7 to +5.9	-
Night (22:00 – 07:00)	60.9	56.8	+2.8 to +4.5	- 2.0 to -0.3

The measured noise levels at 87 Kennington Park Road were above the predicted noise levels within the Section 61 during the extended (+5.7 to +5.9 dB) and night-time (+2.8 to +4.5 dB) periods. The measured levels at KPST1 only vary by 1 dB throughout the same survey period. As the monitor is

closest to the compressor, which is a constant throughout the survey, it is considered that this is the dominant source and main contribution of these levels at the monitor. At the time when the diesel generator was turned off, the unattended monitors showed no difference in measured levels (67.6 dB). In contrast, the levels at MP1 reduced from 66.2 dB at 21:46, to 65.5 dB by 23:35 and down to 63.7 dB at 00:15. The L_{A90} at MP1 varies only by 0.8 dB during the survey which suggests the compressor forms the main component of the background noise levels at this location. The measured levels are above the NI trigger level by 0.8 dB during the extended period but below the NI trigger level during the night period. The variance from the measured and predicted levels in the model are potentially due to insufficient spectral data for the sound sources, sound from the containers not radiating uniformly and measurements taking place within near-field conditions whereby the inverse square law[1] may not apply whereas the noise model would calculate sound propagation based in the far field.

The measured noise levels at 1 Braganza Street are below that predicted for this location. The measured noise levels are below the noise insulation trigger level of 61.8 dB (+5 dB over pre-existing ambient noise level) as per the CNVMS.

[1] Inverse square law: for every doubling of the distance from the sound source in a free-field situation, the sound intensity will diminish by 6 dec bels (based on point source propagation)

7 CONCLUSION

Ferrovial Laing O'Rourke (FLO) is currently undertaking works at Kennington Underground Station as part of the London Underground Extension of the Northern Line (NLE) running from Kennington to Battersea (Charing Cross branch).

Temple has undertaken an attended noise survey of works taking place at Kennington Station. The activities assessed at the site were a compressor, concrete pump, containerised diesel generator and a hybrid generator which were positioned externally serving internal works taking place in the Kennington cross passages.

Noise levels associated with the works were predicted at the noise sensitive receptors based on the engineering team's information and presented in the current Section 61. The measured levels were assessed against these predictions and the pre-existing ambient noise level in accordance to the Northern Line Extension Construction Noise and Vibration Mitigation Scheme.

At 87a Kennington Park, the compressor and diesel generator were audible during the extended period along with contributions from road traffic. Once the diesel generator was turned off at 22:05 and the hybrid compressor was switched on, the construction related activities contributed less to the ambient noise. The measured noise levels were above the predicted noise levels within the Section 61 during the extended (+5.7-5.9 dB) and night-time (+2.8 to +4.5 dB). The L_{A90} varies by 0.8 dB during the survey which suggests the compressor was the main component. The measured levels are above the NI trigger level by 0.8 dB during the extended period but below the NI trigger level during the night period.

At 1 Braganza Street, the contributions from the compressor were less compared to that at 87a Kennington Park Road due to the onsite screening provided by the containers. The hybrid generator was audible at this location. The measured noise levels at 1 Braganza Street were similar to that of the predicted noise levels. The measured noise levels were below the noise insulation trigger level of 61.8 dB (+5 dB over pre-existing ambient noise level) as per the CNVMS.

APPENDIX I – SITE PLAN AND PHOTOS

Figure 1 – Site layout and measurement positions

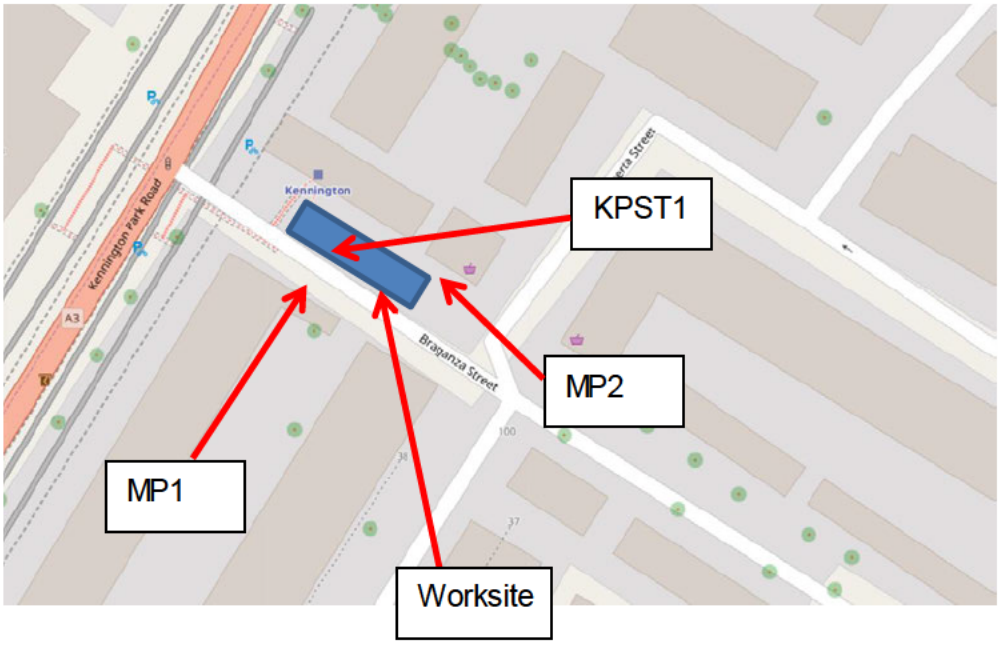
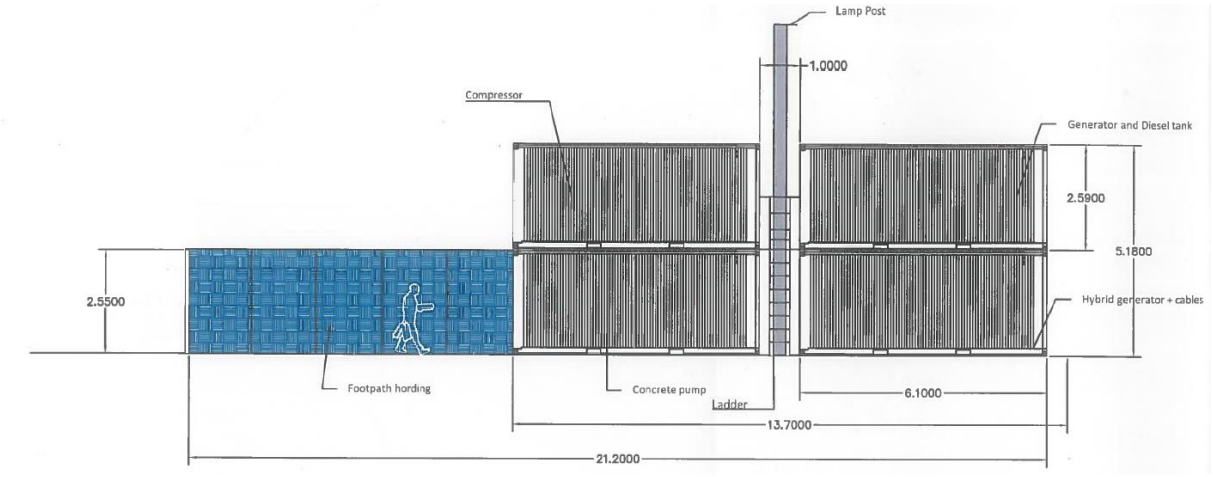


Figure 2 – Unattended Noise Monitor Location

N.B - the photo above shows the location of the unattended noise monitor. When the hybrid generator was installed the meter was located more centrally along the hand rails.

Figure 3 – Elevation of installed plant



N.B – the actual layout of the containers was revised so that the diesel generator was located at ground floor level and the hybrid generator stacked on top of this.