Figure 4: Proposed First Floor Plan

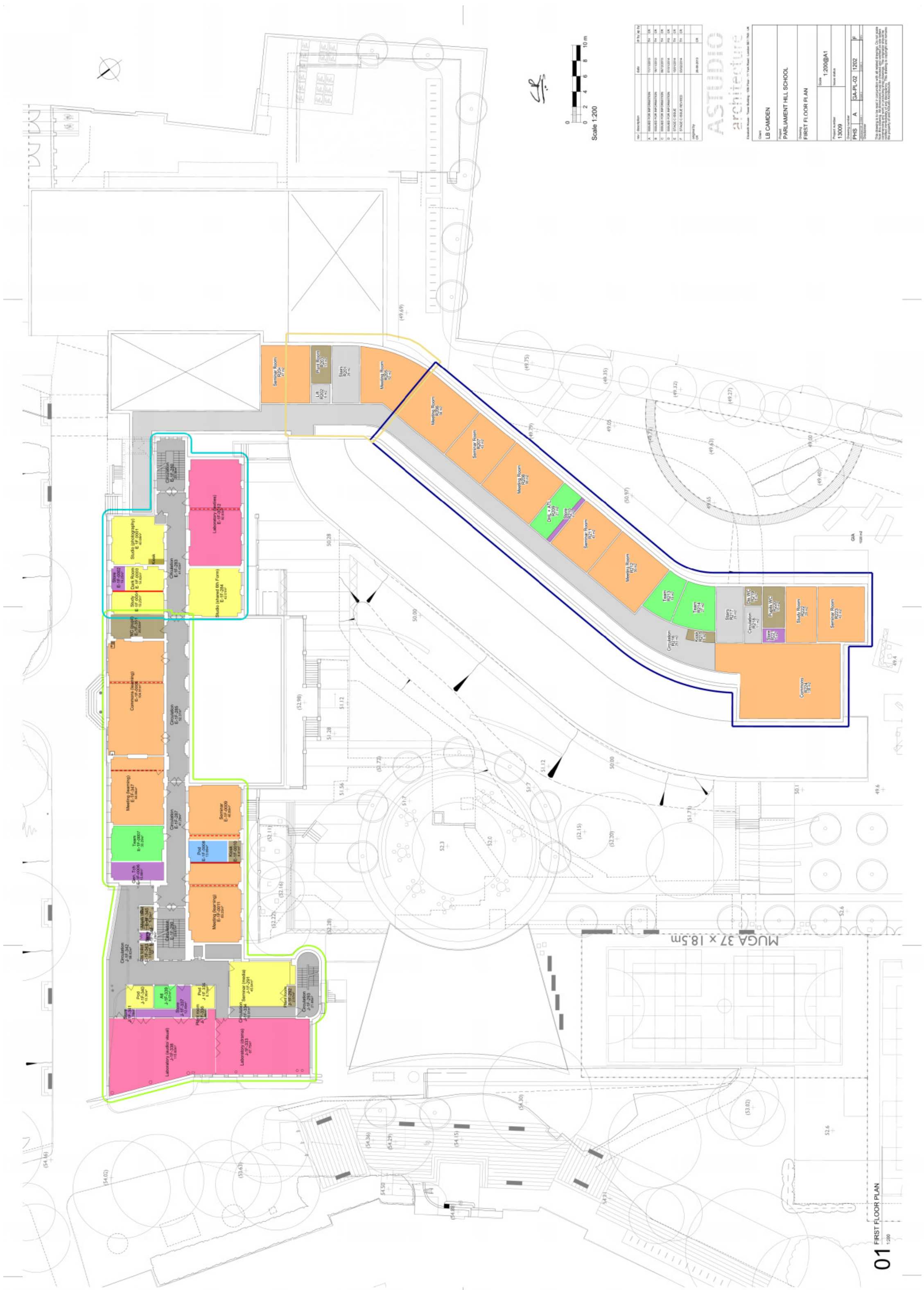


Figure 5: Proposed Second Floor Plan

Figure 6: Time History of Unattended Measurements at Position L1

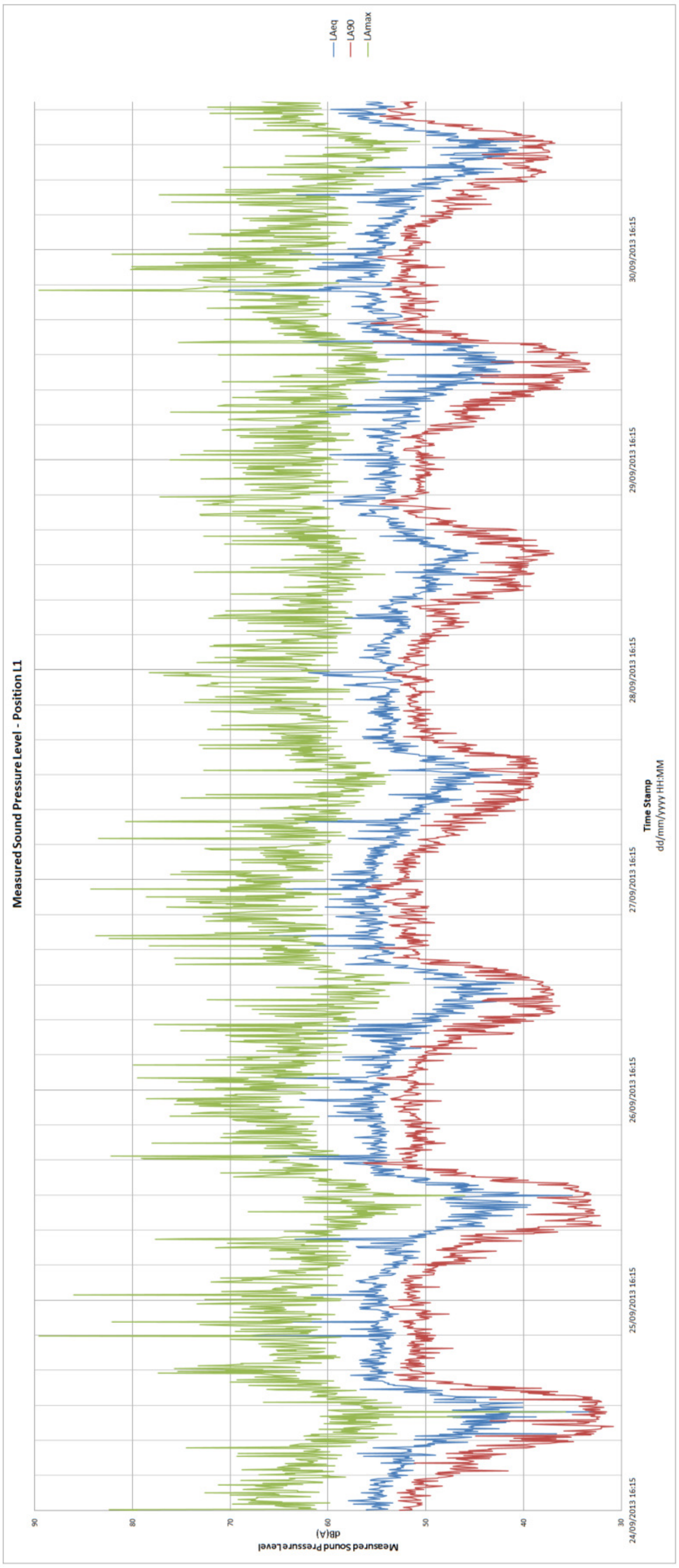
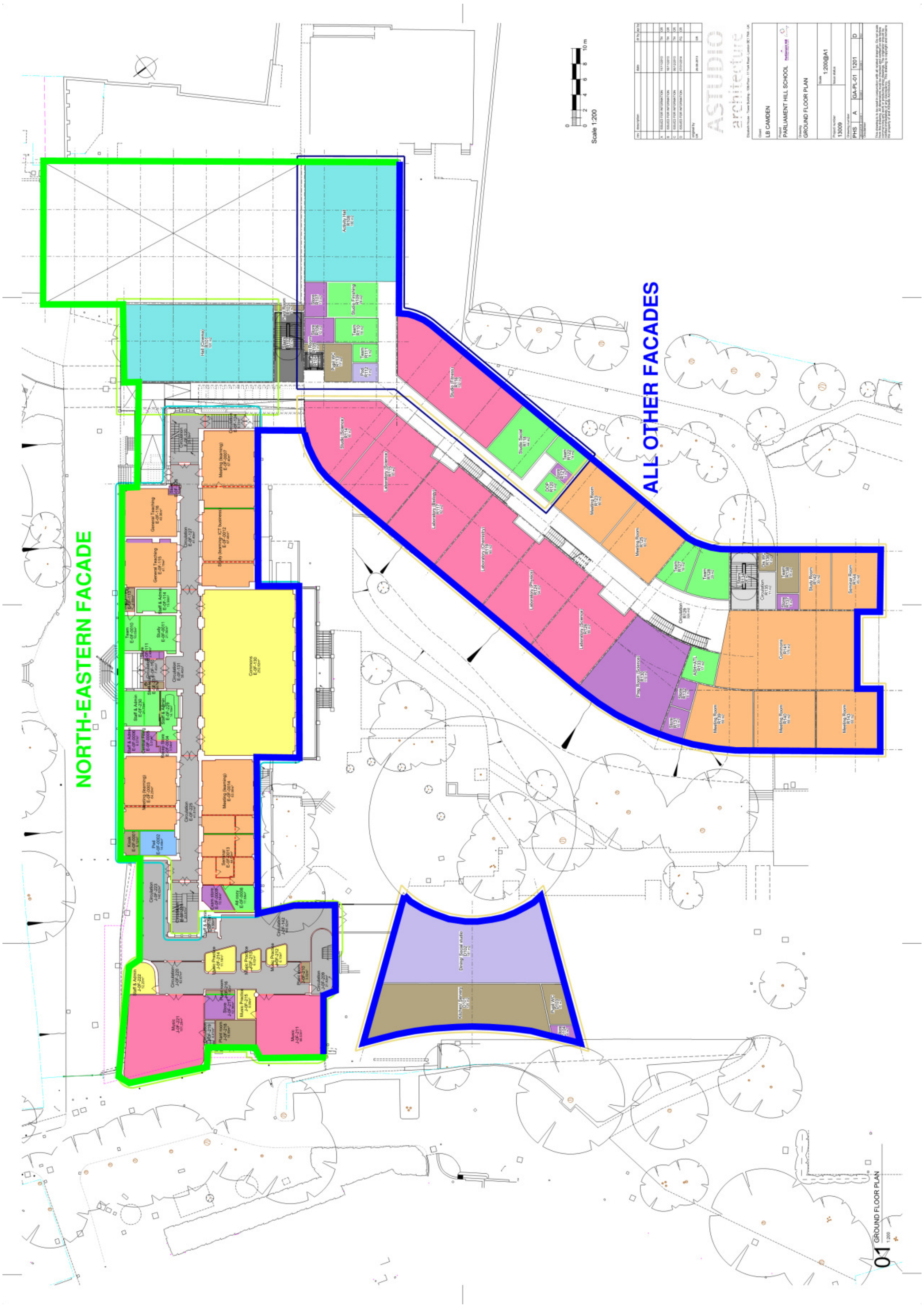


Figure 7: Nearest Noise Sensitive Receptor

Figure 8: Façade Locations



APPENDICES

Appendix A: List of Measurement Equipment

Sound Level Meter (Position L1 - Unattended)

- Rion NL-31 Sound Level Meter (Serial Number 00841830)
- Rion NH-21 Pre-Amplifier (Serial Number 12962)
- Brüel and Kjær 4231 Sound Calibrator (Serial Number 2445715)
- Rion UC-53A Microphone (Serial Number 307209)

Noise Spectral Analyser (Octave Band Measurements at all Positions - Attended)

- Rion NA-28 Sound Level Meter (Serial Number 01260201)
- Rion NH-23 Pre-Amplifier (Serial Number 60104)
- Rion NC-74 Sound Calibrator (Serial Number 35173534)
- Rion UC-59 Microphone (Serial Number 00281)

Sound level meters were field calibrated before and after noise survey and no discernible variations occurred.

Appendix B: Acoustic Terminology

Sound

Sound is produced by mechanical vibration of a surface, which sets up rapid pressure fluctuations in the surrounding air.

The Sound Pressure

The Sound Pressure is the force (N) of sound on a surface area (m^2) perpendicular to the direction of the sound. The SI-units for the Sound Pressure are Nm^{-2} or Pa (Pascal).

Sound is measured with microphones responding proportionally to the sound pressure – *p*. The power is proportional to the square of the sound pressure.

The Sound Pressure Level

The human ear has an approximately logarithmic response to sound pressure over a very large dynamic range. The lowest audible sound pressure approximately 2 x 10^{-5} Pa (2 ten billionths of an atmosphere) and the highest is approximately 100 Pa.

It is therefore convenient to express the sound pressure as a logarithmic decibel scale related to this lowest human audible sound, where:

$$L_p = 10\ log\left(\frac{p^2}{{p_{ref}}^2}\right) = 10\ log\left(\frac{p}{p_{ref}}\right)^2 = 20\ log\left(\frac{p}{p_{ref}}\right)$$

Where: *L_p = sound pressure level (dB)*

p = sound pressure (Pa)

p_{ref} = 2 x 10^{-5} – reference sound pressure (Pa)

In accordance with the logarithmic scale, doubling the sound pressure level gives an increase of 6 dB.

Decibel (dB)

The decibel is the unit used to quantify sound pressure levels as well as sound intensity and power levels.

In accordance with the logarithmic scale, an increase of 10 dB in sound pressure level is equivalent to an increase by a factor of 10 in the sound pressure level (measured in Pa). Subjectively, this increase would correspond to a doubling of the perceived loudness of the sound.

Sound Pressure Level of Some Common Sources

An indication of the range of sound levels commonly found in the environment is given in the following Table.

Source	**Sound Pressure Level** dB
Threshold of Hearing	0
Rustling Leaves	20
Quiet Whisper	30
Home	40
Quiet Street	50
Conversation	60
Inside a Car	70
Loud Singing	80
Motorcycle (10m)	90
Lawn Mower (1m)	100
Diesel Truck (1m)	110
Amplified Music (1m)	120
Jet Plane (1m)	130

Frequency

The rate at which the pressure fluctuations occur determines the pitch or *frequency* of the sound. The frequency is expressed in Hertz (Hz) or cycles per second.

Octave and Third Octave Bands

An octave is the interval between two points where the frequency at the second point is twice the frequency of the first.

There are many methods of describing the frequency content of a noise. The most common methods split the frequency range into defined bands, in which the mid-frequency is used as the band descriptor and in the case of octave bands is double that of the band lower. For example, two adjacent octave bands are 250 Hz and 500 Hz.

Third octave bands provided a fine resolution by dividing each octave band into three bands. For examples, third octave bands would be 160 Hz, 250 Hz and 315 Hz for the same 250 Hz octave band.

The human ear is sensitive to sound over a range of frequencies between approximately 20 Hz to 20 kHz and is generally more sensitive to medium and high frequency than to low frequencies within the range. This is the basis of the A-weighting.

A-Weighting

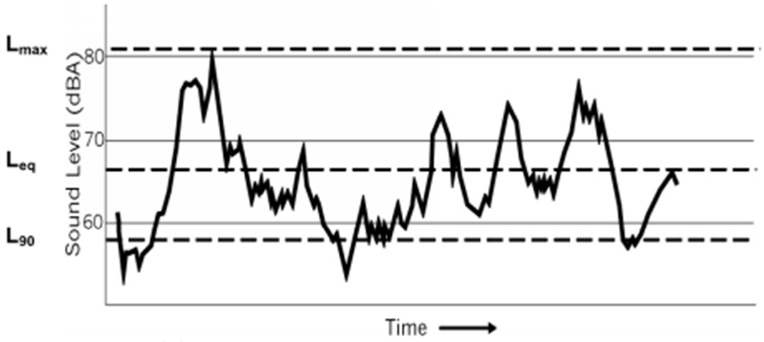
The A-weighting is a correction term applied to the frequency range in order to mimic the sensitivity of the human ear to noise. It is generally used to obtain an overall noise level from octave or third octave band frequencies.

An A weighted value would be written as dB(A), or including A within the parameter term.

Noise Units

In order to assess environmental noise, measurements are carried out by sampling over specific periods of time, such as five minutes, the statistically determined results being used to quantify various aspects of the noise.

The figure below shows an example of sound level varying with time. Because of this time variation the same period of noise can be described by several different levels. The most common of these are described below.



$L_{eq,T}$

The $L_{eq,T}$ is a parameter defined as the equivalent continuous sound pressure level over a defined time period 'T'. It is the sound pressure level equivalent to the acoustic energy of the fluctuating sound signal.

The $L_{eq,T}$ can be thought of as an 'average' sound pressure level over a given time period (although it is not an arithmetic average). Typically the $L_{eq,T}$ will be an A-weighted noise level in dB(A) and is commonly used to describe all types of environmental noise sources.

$L_{01,T}$

The $L_{01,T}$ is a parameter defined as the sound pressure level exceeded for 1% of the measurement period 'T'.

It is a statistical parameter and cannot be directly combined to other acoustic parameter.

$L_{10,T}$

The $L_{10,T}$ is a parameter defined as the sound pressure level exceeded for 10% of the measurement period 'T'.

It is a statistical parameter and cannot be directly combined to other acoustic parameter and is generally used to describe road traffic noise.

$L_{90,T}$

The $L_{90,T}$ is a parameter defined as the sound pressure level exceeded for 90% of the measurement period 'T'.

It is a statistical parameter and cannot be directly combined to other acoustic parameter and is generally used to describe the prevailing background noise level.

$L_{max,T}$

The $L_{max,T}$ is a parameter defined as the maximum noise level measured during the specified period 'T'.

Specific Noise Level, $L_{Aeq,Tr}$

This is the equivalent continuous A-weighted sound pressure level at the assessment position due to a specific noise source operating over a given time interval.

Free Field

A measurement taken in the free field is at least 3.5m from reflecting vertical surfaces and 1.2m from the ground.

Façade

A measurement is influenced by the reflection of sound from the façade of a building within 3.5m. A façade measurement is made 1m in front of the vertical building surface.

R_w

A single-number quantity which characterizes the airborne sound insulation of a material or building element in the laboratory. See BS EN ISO 717-1: 1997.

Appendix C: Octave Band Levels at Measurement Positions

Position	Measurement Period	Duration	Sound Pressure Level per Octave Band Frequency in dB								$L_{Aeq,T}$
			63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz	dB
S1	20/09/2013 10:16	02:30	70.6	59.0	54.5	56.1	51.8	51.0	45.9	41.9	58.0
	20/09/2013 10:24	05:00	64.9	56.8	55.5	54.4	52.9	49.8	46.9	39.6	57.7
S2	20/09/2013 10:02	10:00	67.8	57.8	54.8	50.4	47.7	45.9	42.0	35.8	54.0
	20/09/2013 10:30	05:00	67.8	60.2	57.6	56.1	51.7	49.9	44.4	35.7	57.9
S3	20/09/2013 09:29	10:00	55.4	51.8	48.3	43.0	38.6	38.5	32.9	28.9	46.2
	20/09/2013 10:38	05:00	60.0	53.5	54.3	49.5	45.5	44.0	36.6	29.1	52.0
S4	20/09/2013 09:42	10:00	57.2	48.4	43.7	40.6	39.7	36.8	36.3	41.3	46.4

Table 7: Ambient Levels Measured at all Positions

Position	Measurement Period	Duration	Sound Pressure Level per Octave Band Frequency in dB								$L_{A90,T}$
			63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz	dB
S1	20/09/2013 10:16	02:30	60.9	54.6	48.3	45.9	45.1	42.2	35.0	26.0	50.8
	20/09/2013 10:24	05:00	59.5	50.9	45.6	45.1	45.1	41.2	34.9	25.1	51.0
S2	20/09/2013 10:02	10:00	60.2	51.7	46.2	42.7	42.9	40.5	33.5	23.5	48.9
	20/09/2013 10:30	05:00	59.6	52.7	47.7	44.9	44.8	42.3	33.4	22.5	50.1
S3	20/09/2013 09:29	10:00	51.4	46.0	42.2	36.2	35.6	33.1	29.3	19.1	41.5
S4	20/09/2013 09:42	10:00	53.3	45.9	40.7	35.8	36.2	31.3	24.9	18.9	41.6

Table 8: Background Levels Measured at all Positions

Position	Measurement Period	Duration	Sound Pressure Level per Octave Band Frequency in dB								$L_{A01,T}$
			63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz	dB
S1	20/09/2013 10:16	02:30	79.4	66.0	62.2	65.1	61.8	63.1	59.4	56.8	68.3
	20/09/2013 10:24	05:00	72.3	64.1	66.3	64.2	64.2	60.7	56.0	49.8	66.5
S2	20/09/2013 10:02	10:00	76.7	65.8	66.3	61.5	53.1	51.4	50.3	47.5	61.6
	20/09/2013 10:30	05:00	77.1	70.8	67.6	67.0	60.0	60.8	57.4	48.6	66.1
S3	20/09/2013 09:29	10:00	61.8	61.0	58.4	52.2	44.7	45.4	40.2	41.6	53.8
S4	20/09/2013 09:42	10:00	63.7	52.9	49.9	49.3	46.5	45.9	48.0	54.6	55.1

Table 9: L_{A01} Levels Measured at all Positions