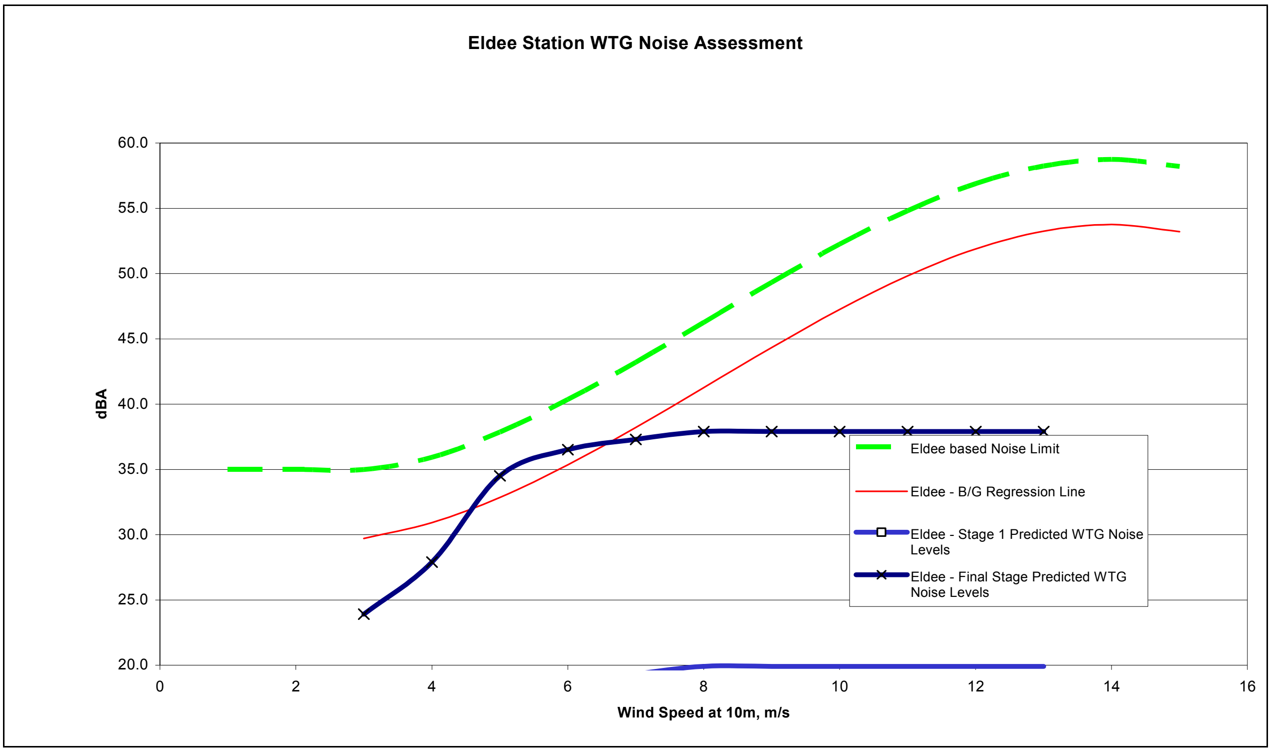
WTG NOISE ASSESSMENT CURVES


Eldee Station WTG Noise Assessment
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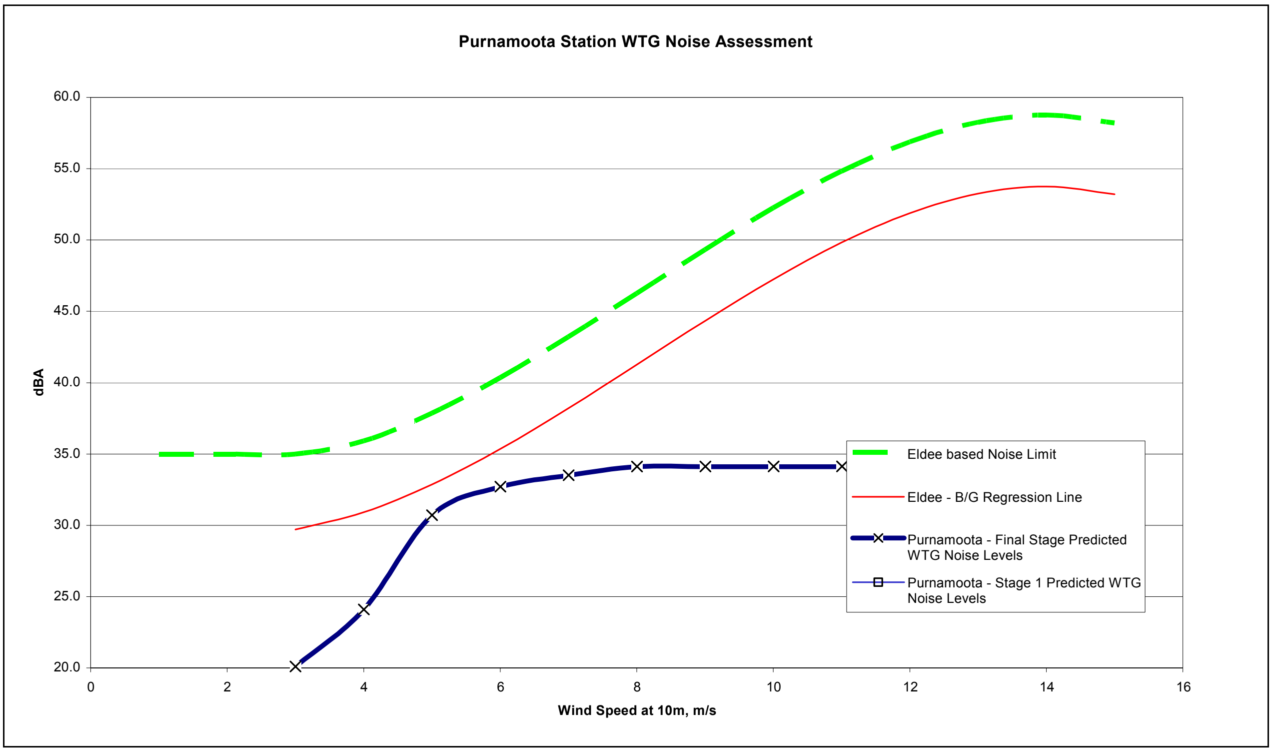
55.0
50.0
45.0
40.0
35.0
30.0
25.0
20.0
dBA
0
2
4
6
8
10
12
14
16
Wind Speed at 10m, m/s
Eldee based Noise Limit
Eldee - B/G Regression Line
Eldee - Stage 1 Predicted WTG Noise Levels
Eldee - Final Stage Predicted WTG Noise Levels


Purnamoota Station WTG Noise Assessment
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50.0
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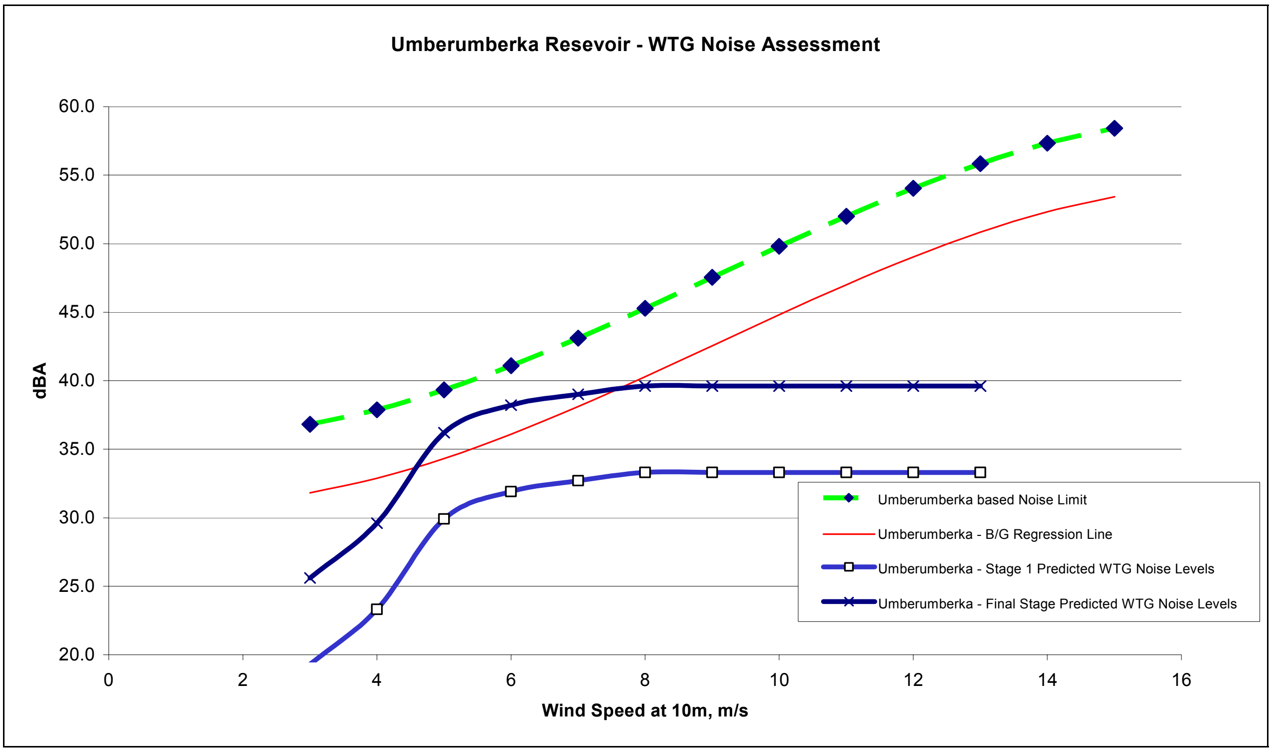
25.0
20.0
dBA
0
2
4
6
8
10
12
14
16
Wind Speed at 10m, m/s
Eldee based Noise Limit
Eldee - B/G Regression Line
Purnamoota - Final Stage Predicted WTG Noise Levels
Purnamoota - Stage 1 Predicted WTG Noise Levels


Umberumberka Resevoir - WTG Noise Assessment
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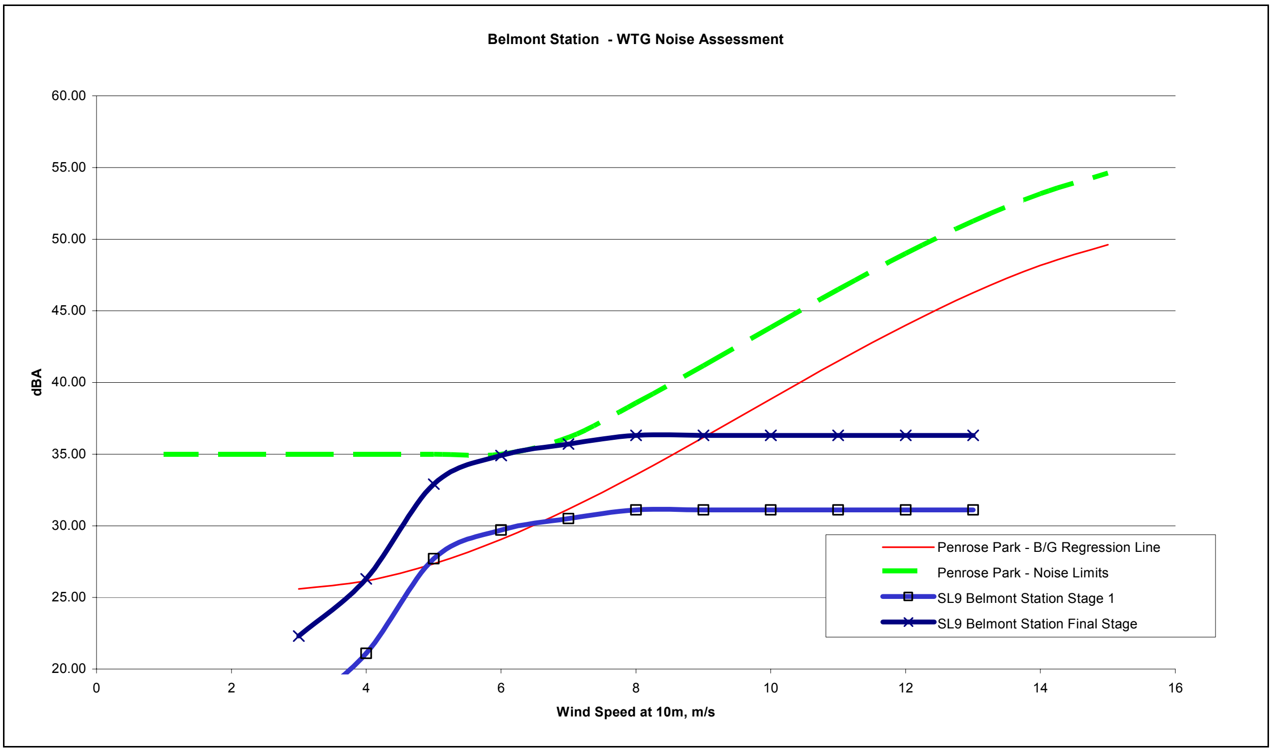
25.0
20.0
dBA
0
2
4
6
8
10
12
14
16
Wind Speed at 10m, m/s
Umberumberka based Noise Limit
Umberumberka - B/G Regression Line
Umberumberka - Stage 1 Predicted WTG Noise Levels
Umberumberka - Final Stage Predicted WTG Noise Levels


Belmont Station - WTG Noise Assessment
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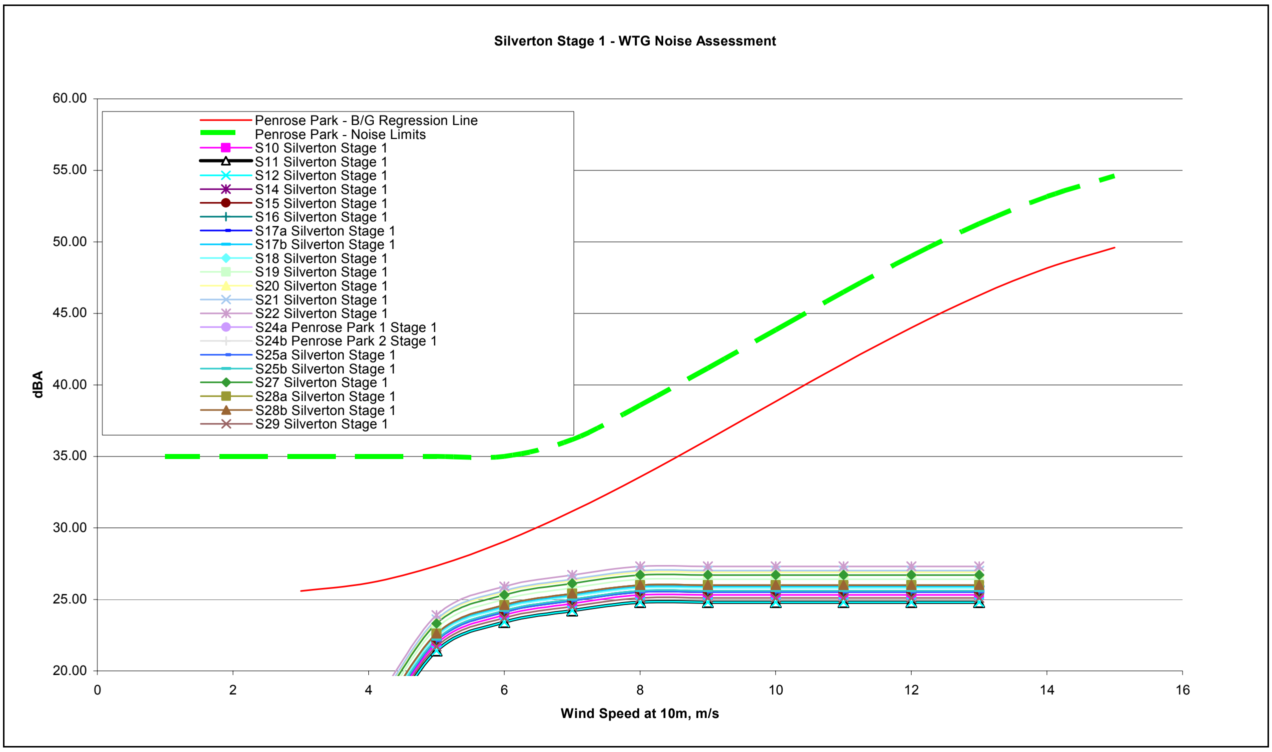
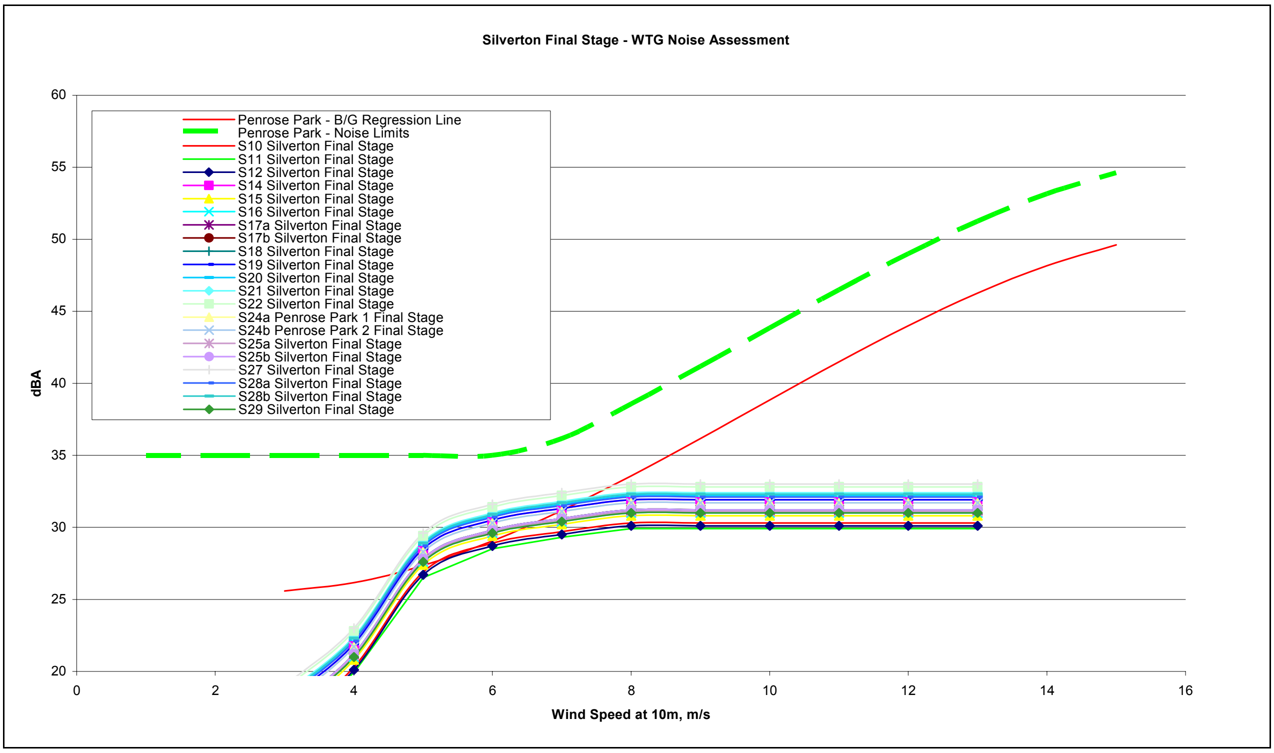
55.00
50.00
45.00
40.00
35.00
30.00
25.00
20.00
dBA
0
2
4
6
8
10
12
14
16
Wind Speed at 10m, m/s
Penrose Park - B/G Regression Line
Penrose Park - Noise Limits
SL9 Belmont Station Stage 1
SL9 Belmont Station Final Stage


Silverton Stage 1 - WTG Noise Assessment
dBA
Wind Speed at 10m, m/s
Penrose Park - B/G Regression Line
Penrose Park - Noise Limits
S10 Silverton Stage 1
S11 Silverton Stage 1
S12 Silverton Stage 1
S14 Silverton Stage 1
S15 Silverton Stage 1
S16 Silverton Stage 1
S17a Silverton Stage 1
S17b Silverton Stage 1
S18 Silverton Stage 1
S19 Silverton Stage 1
S20 Silverton Stage 1
S21 Silverton Stage 1
S22 Silverton Stage 1
S24a Penrose Park 1 Stage 1
S24b Penrose Park 2 Stage 1
S25a Silverton Stage 1
S25b Silverton Stage 1
S27 Silverton Stage 1
S28a Silverton Stage 1
S28b Silverton Stage 1
S29 Silverton Stage 1


Silverton Final Stage - WTG Noise Assessment
dBA
Wind Speed at 10m, m/s
Penrose Park - B/G Regression Line
Penrose Park - Noise Limits
S10 Silverton Final Stage
S11 Silverton Final Stage
S12 Silverton Final Stage
S14 Silverton Final Stage
S15 Silverton Final Stage
S16 Silverton Final Stage
S17a Silverton Final Stage
S17b Silverton Final Stage
S18 Silverton Final Stage
S19 Silverton Final Stage
S20 Silverton Final Stage
S21 Silverton Final Stage
S22 Silverton Final Stage
S24a Penrose Park 1 Final Stage
S24b Penrose Park 2 Final Stage
S25a Silverton Final Stage
S25b Silverton Final Stage
S27 Silverton Final Stage
S28a Silverton Final Stage
S28b Silverton Final Stage
S29 Silverton Final Stage

MANUFACTURER PROVIDED SOUND POWER LEVEL DOCUMENTATION IEC 61400-11

Sound Power Level

MM92 Evolution

1 Sound Power Level MM92 Evolution

1.1 Sound Power Level according to IEC for different Hub Heights

HH	V_{10}[1] [m/s]	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0
68,5m	L_{WA}[2] [dB(A)]	101.4	103.4	104.3	105.0	105.0	105.0	105.0	105.0
78,5m	L_{WA}[2] [dB(A)]	101.6	103.5	104.4	105.0	105.0	105.0	105.0	105.0
80m	L_{WA}[2] [dB(A)]	101.6	103.6	104.4	105.0	105:0	105.0	105.0	105.0
100m	L_{WA}[2] [dB(A)]	102.2	103.8	104.5	105.0	105.0	105.0	105.0	105.0

All sound power levels above are based on wind speeds of V_{10} at 10 m height. The data of the noise level are based on the requirements of the IEC 61400-11: Wind turbine generator systems – part 11.
The calculation of the wind speed in 10m height is based on a roughness length of 0.05m, equivalent to a vertical wind shear coefficient of 0.14.

1.2 Sound Power Level according to FGW Guideline at 95% of rated power

The sound power level measured according to the Technical Guideline "Fördergesellschaft Windenergie e.V. (FGW)" at 95% of the rated power is independent of the hub height:

$$\mathbf{L_{WA,\,95\%} = 105.0\ dB(A)}$$

[1] Wind speed in 10 meters height

[2] Sound power level of the turbine in hub height

WINDTEST
Grevenbroich GmbH

Excerpt from the acoustic test report SE06010B2 about the wind turbine type REpower MM92 at St. Michaelisdonn / Germany

25.05.2007

SE06010B2A1

REpower Dokumenten-Nummer	Rev.
D-2.9-VM.SM.03-D	A -GB
Freigabe	**Datum**
Sk	25.05.2007

Durch das DAP Deutsches Akkreditierungssystem Prüfwesen GmbH akkreditiertes Prüflaboratorium.

Die Akkreditierung gilt für die in der Urkunde aufgeführten Prüfverfahren.

Deutscher Akkreditierungs Rat
DAR
DPT-P-03.175-00-97-00

WINDTEST Grevenbroich GmbH, Frimmersdorfer Straße 73, 41517 Grevenbroich, Telefon 0 21 81 / 22 78-0, Telefax 0 21 81 / 22 78-11, info@windtest-nrw.de

WINDTEST
Grevenbroich GmbH

Excerpt from the acoustic test report SE06010B2 about the wind turbine type REpower MM92 at St. Michaelisdonn / Germany

Abridged report SE06010B2A1

Location:	St. Michaelisdonn / Germany, Ser.-No. 90001

Customer:	REpower Systems AG Rödemis Hallig D-25813 Husum

Supplier:	WINDTEST Grevenbroich GmbH Frimmersdorfer Str. 73 D-41517 Grevenbroich

Date of Order:	12.06.06		**Order Number:**	06 0058 06

Editor: Dipl.-Met. Klaus Hanswillemenke

Auditor: Dipl.-Ing. Thomas Fischer

Grevenbroich, 25.05.2007

REpower Dokumenten-Nummer	Rev.
D-2.9-VM.SM.03-D	A
Freigabe	**Datum**
SK	25.05.2007

-GB

This report may only be copied in excerpts with written consent of WINDTEST Grevenbroich GmbH: It consists of a total of 3 pages including the appendix.

Excerpt from the acoustic test report SE06010B2

Summary of results from the acoustic noise measurement at the wind turbine type REpower MM92 according to

IEC 61400-11:2002: Wind turbine generator systems – Part 11: Acoustic noise measurement techniques.

General information		**Technical data (manufacturers specifications)**	
Manufacturer:	**REpower Systems AG** **Rödemis Hallig** **D-25813 Husum**	**Rated power (generator):** **Rotor diameter:** **Hub height above ground:**	**2000 kW** **92,5 m** **80 m**
Serial No.:	**90001**	**Tower design:**	**Steel tube**
Location:	**RW: 3505388 HW: 5983725**	**Power control**	**Pitch**
Supplementary data about the rotor (manufacturers specifications		**Supplementary data about gearbox and generator (manufacturers specifications)**	
Rotor blade manufacturer:	**LM or similar**	**Gearbox manufacturer:**	**Eickhoff or similar**
Blade type:	**LM 45.3_P**	**Gearbox type:**	**CPNHZ-224**
Blade pitch setting:	**---°**	**Generator manufacturer:**	**VEM or similar**
Number of blades	**3**	**Generator type:**	**DASAA5025-4UA**
Rotor speed range:	**7,8 – 15,0 rpm**	**Generator speed range:**	**1000 – 1800 rpm**

Test report for the power curve: REpower document No. D-2.9-VM.LK.01-A Rev B-GB

	Reference point		**Noise emission-parameter**	**Comments**
	Standardized wind speed at 10 m height	Electrical active power		
Sound power level $L_{WA,P}$	6 ms^{-1} 7 ms^{-1} 8 ms^{-1} 9 ms^{-1} 10 ms^{-1}	1088 kW 1640 kW 1980 kW 2025 kW ---	101,6 dB 102,9 dB 103,0 dB 102,1 dB ---	95 % rated power at 7,6 m/s > 95 % rated power ---
Tonality for the vicinity of the wind turbine $\Delta L_{a,k}$	6 ms^{-1} 7 ms^{-1} 8 ms^{-1} 9 ms^{-1} 10 ms^{-1}	1088 kW 1640 kW 1980 kW 2025 kW ---	0 dB 6 ms^{-1} 0 dB 7 ms^{-1} 0 dB 8 ms^{-1} 0 dB 9 ms^{-1} --- 10 ms^{-1}	95 % rated power at 7,6 m/s > 95 % rated power ---
Impulsivity for the vicinity of the wind turbine	6 ms^{-1} 7 ms^{-1} 8 ms^{-1} 9 ms^{-1} 10 ms^{-1}	1088 kW 1640 kW 1980 kW 2025 kW ---	0 dB 0 dB 0 dB 0 dB ---	95 % rated power at 7,6 m/s > 95 % rated power ---

Third octave sound power level at v_{10} = 7,6 ms^{-1} in dB

Frequency	50	63	80	100	125	160	200	250	315	400	500	630
$L_{WA,P}$	74,44	78,59	82,1	84,5	86,49	88,8	89,83	92,86	94,05	93,33	94,18	93,76
Frequency	800	1000	1250	1600	2000	2500	3150	4000	5000	6300	8000	10000
$L_{WA,P}$	93,15	91,59	89,74	88,14	85,61	83,43	81,54	78,98	76,84	77,37	76,84	74,76

Octave sound power level at v_{10} = 7,6 ms^{-1} in dB

Frequency	63	125	250	500	1000	2000	4000	8000
$L_{WA,P}$	83,15	91,41	97,03	98,7	96,73	91,01	84,3	81,09

These specifications do not substitute the above mentioned full test report (particularly for noise immission prognosis).

Comments:

Measured by: WINDTEST Grevenbroich GmbH
Frimmersdorfer Str.73
D-41517 Grevenbroich

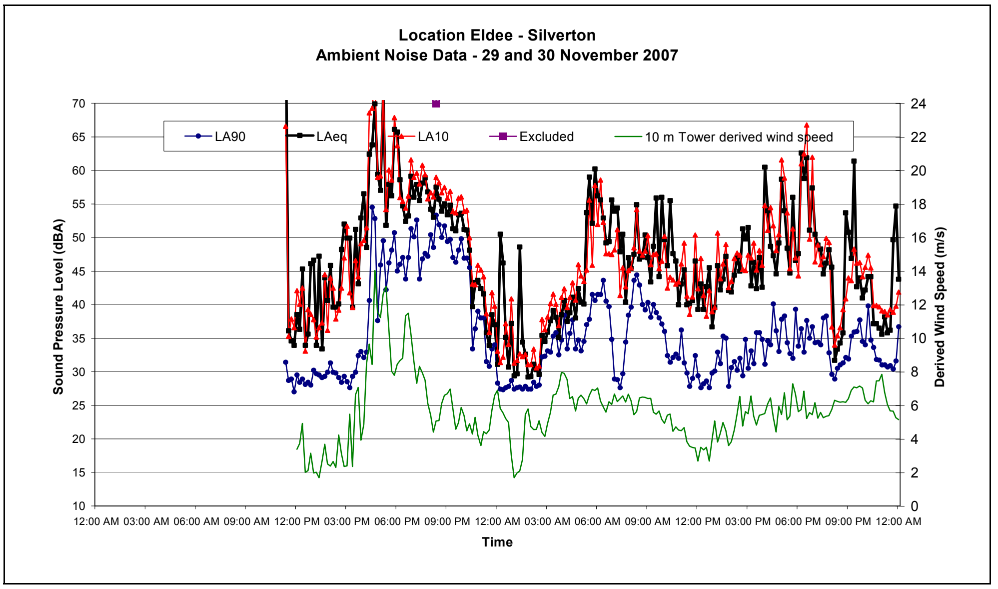
Date: 25.05.2007

Dipl.-Met. Klaus Hanswillemenke   Dipl.-Ing. Thomas Fischer

Schallemission FGW 2007 Konformitätssiegel

REpower Dokumenten-Nummer	Rev.
D-2.9-VM.SM.03-D	A -GB
Freigabe	Datum
	25.05.2007

BACKGROUND NOISE MONITORING DATA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Ambient Noise Data - 29 and 30 November 2007
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LA10
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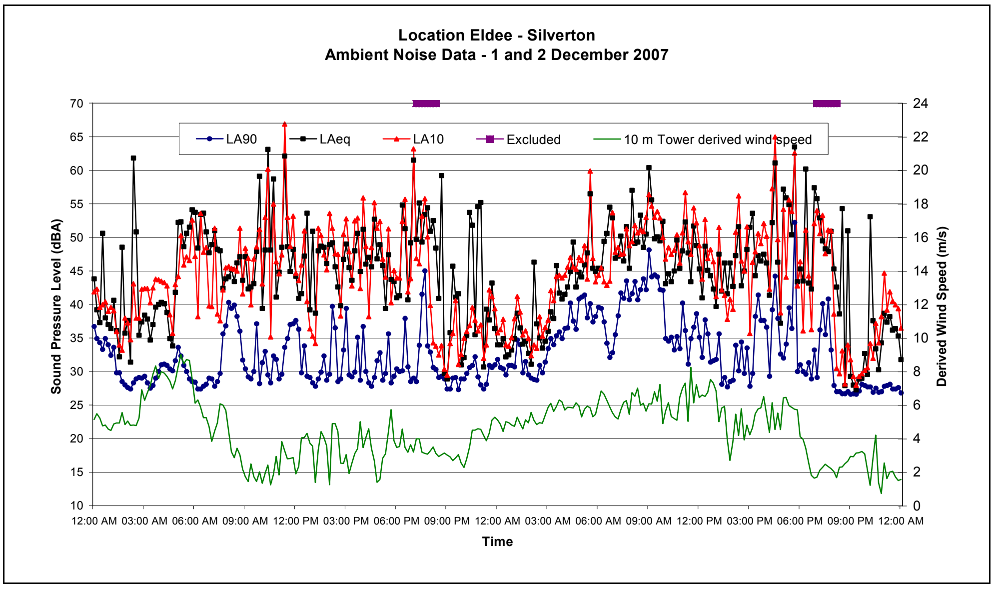
Sound Pressure Level (dBA)
Derived Wind Speed (m/s)
Time
12:00 AM 03:00 AM 06:00 AM 09:00 AM 12:00 PM 03:00 PM 06:00 PM 09:00 PM 12:00 AM 03:00 AM 06:00 AM 09:00 AM 12:00 PM 03:00 PM 06:00 PM 09:00 PM 12:00 AM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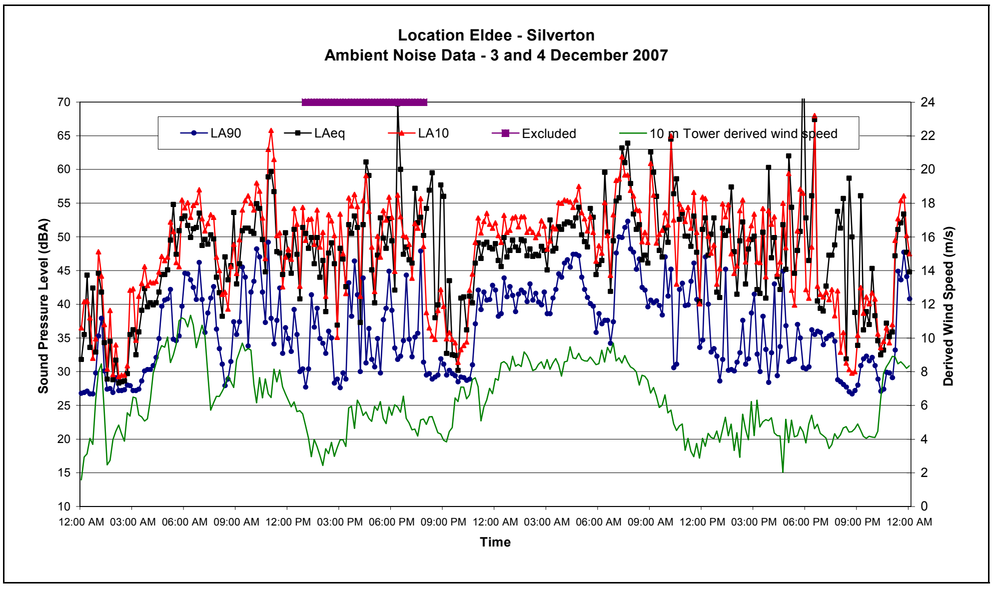
Sound Pressure Level (dBA)
Derived Wind Speed (m/s)
Time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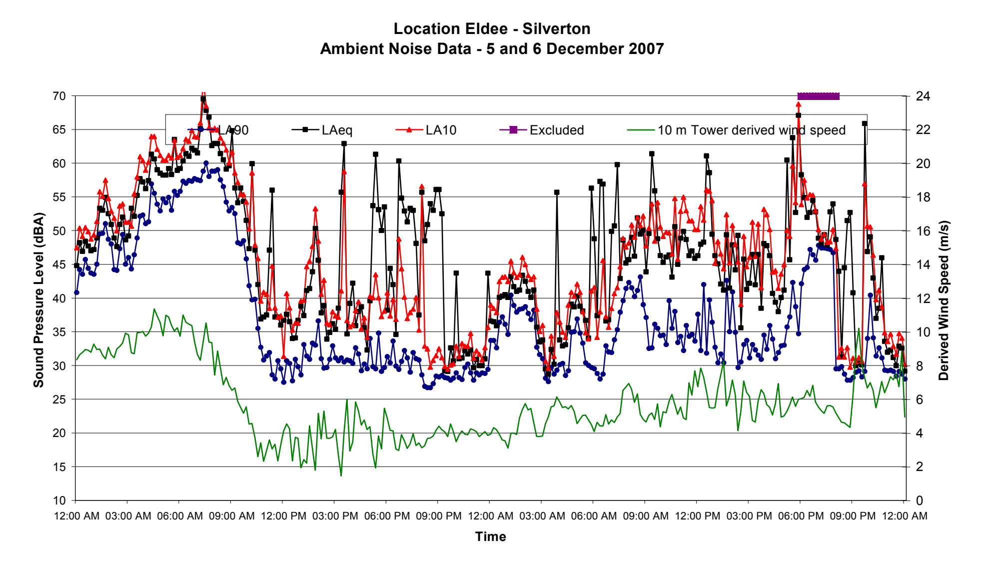
Sound Pressure Level (dBA)
Derived Wind Speed (m/s)
Time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Sound Pressure Level (dBA)
Derived Wind Speed (m/s)
Time
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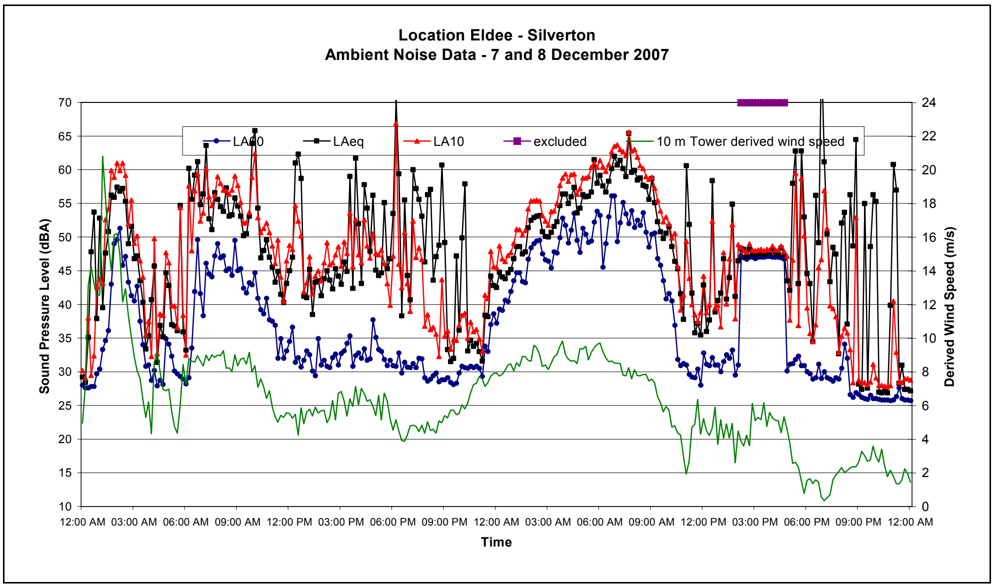
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Derived Wind Speed (m/s)
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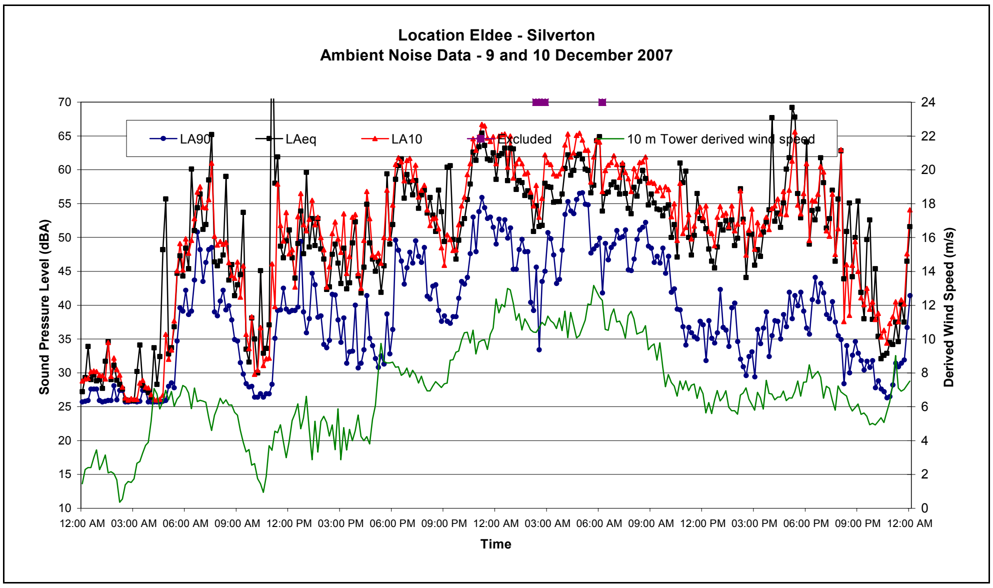
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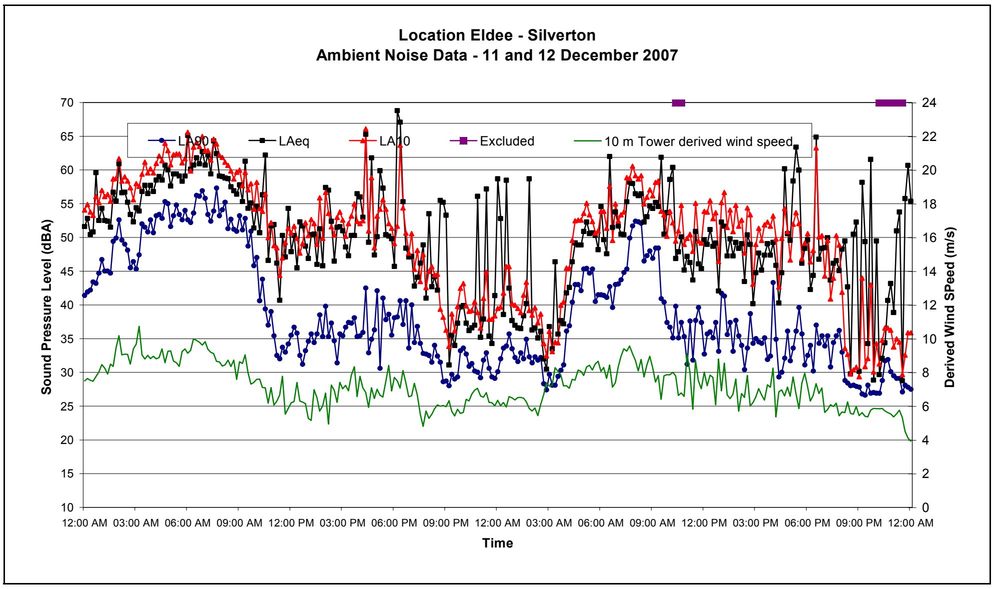
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Sound Pressure Level (dBA)
Derived Wind SPeed (m/s)
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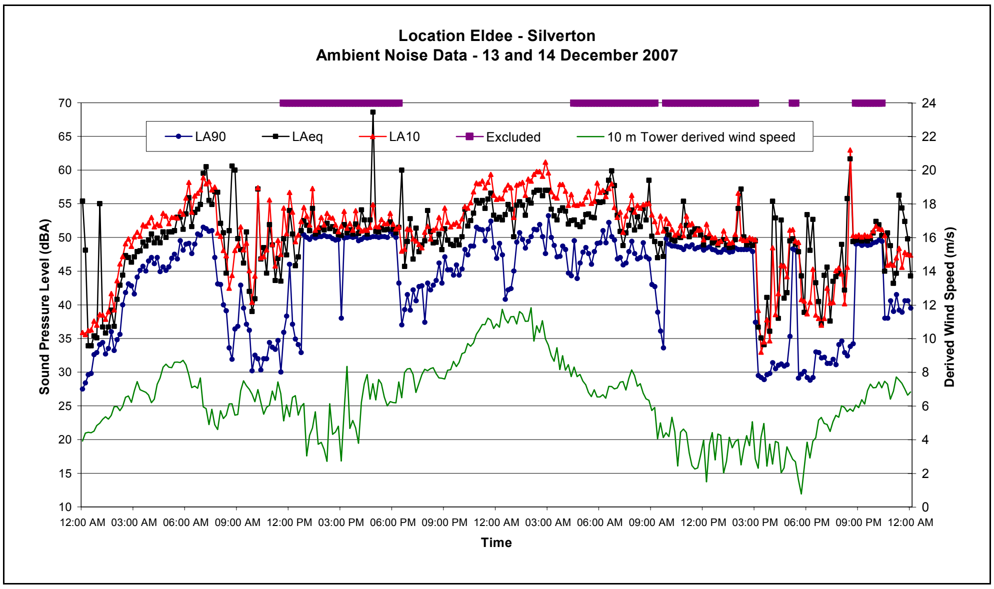
Time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Sound Pressure Level (dBA)
Derived Wind Speed (m/s)
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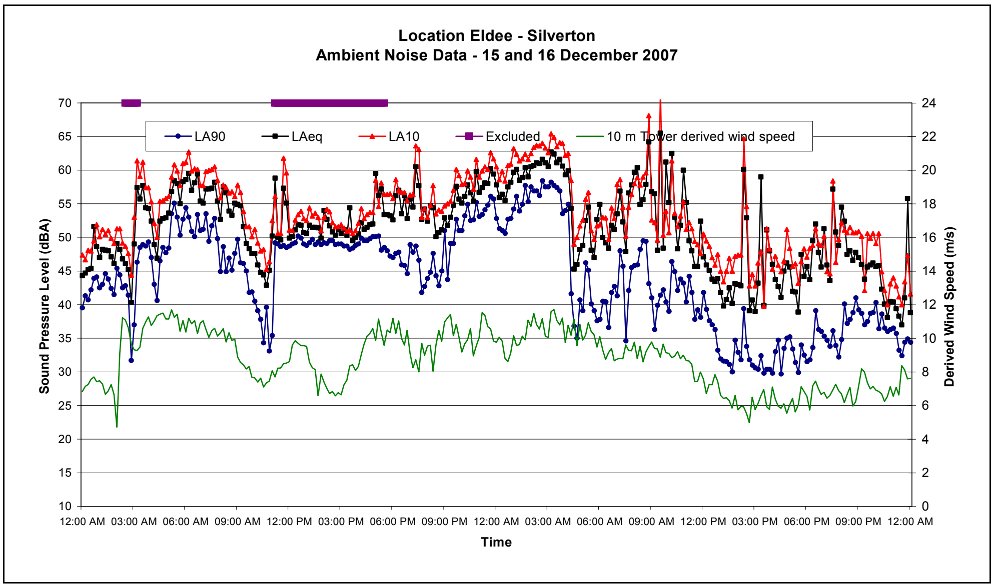
Time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Sound Pressure Level (dBA)
Derived Wind Speed (m/s)
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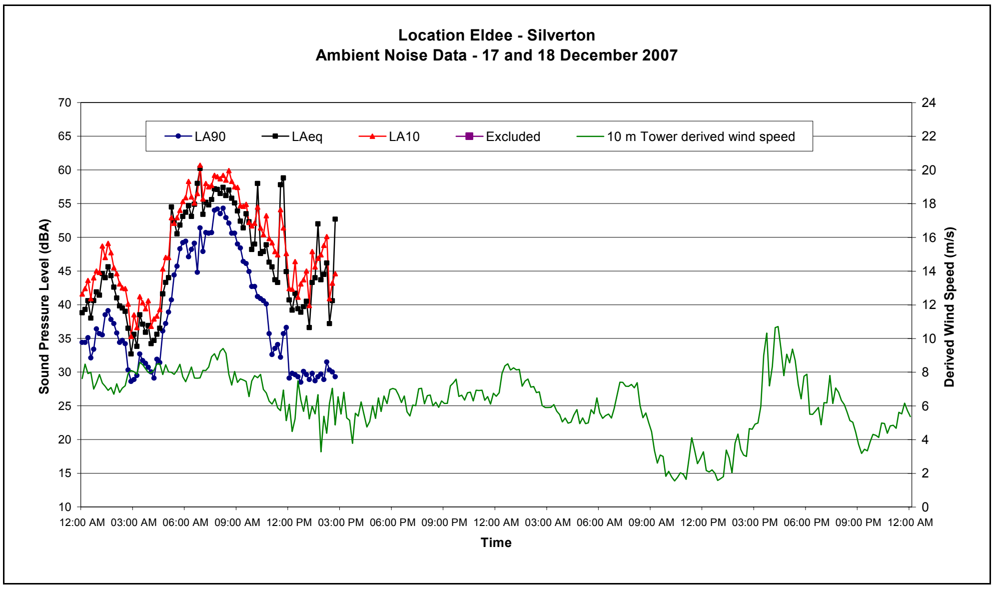
Time


Location Eldee - Silverton
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LAeq
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Excluded
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Sound Pressure Level (dBA)
Derived Wind Speed (m/s)
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70
65
60
55
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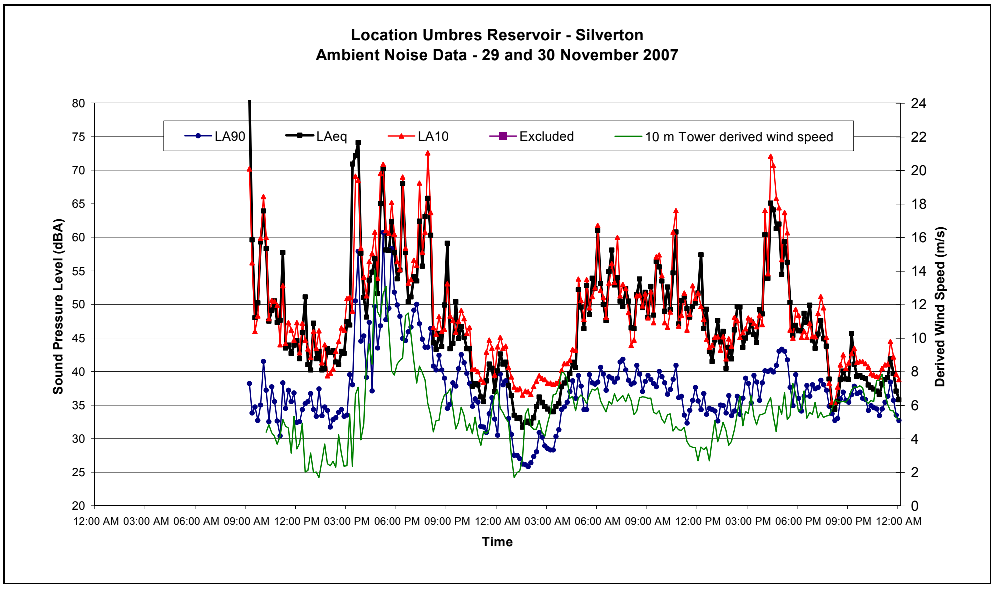

Location Umbres Reservoir - Silverton
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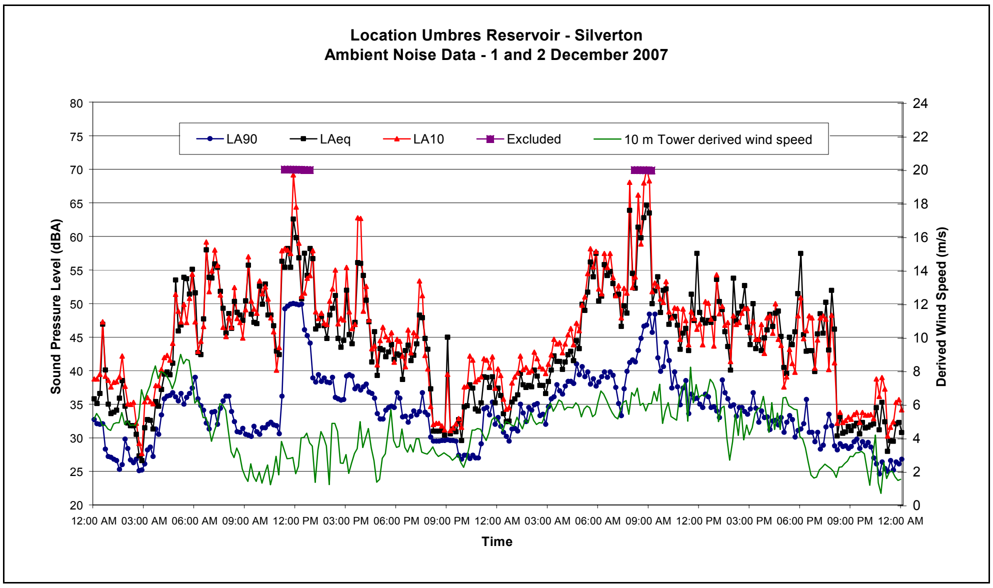
Sound Pressure Level (dBA)
Derived Wind Speed (m/s)
Time



Location Umbres Reservoir - Silverton
Ambient Noise Data - 1 and 2 December 2007
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LAeq
LA10
Excluded
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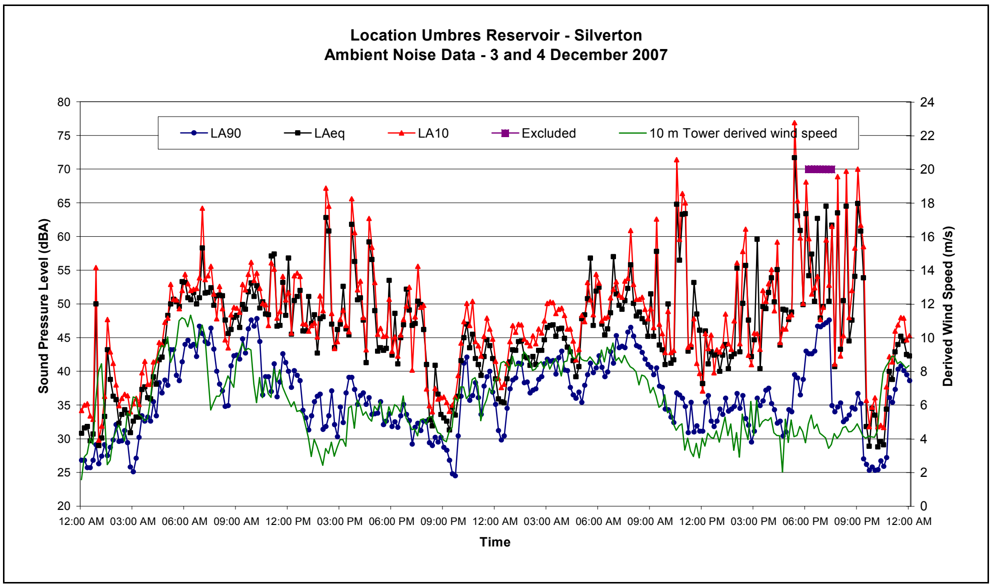
Sound Pressure Level (dBA)
Derived Wind Speed (m/s)
Time



Location Umbres Reservoir - Silverton
Ambient Noise Data - 3 and 4 December 2007
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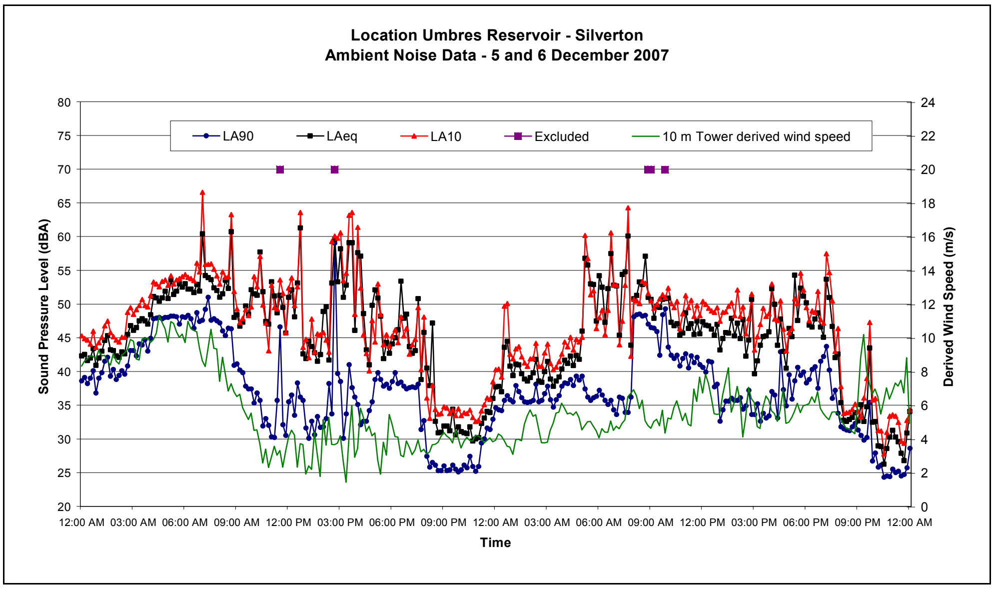
Sound Pressure Level (dBA)
Derived Wind Speed (m/s)
Time


Location Umbres Reservoir - Silverton
Ambient Noise Data - 5 and 6 December 2007
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LAeq
LA10
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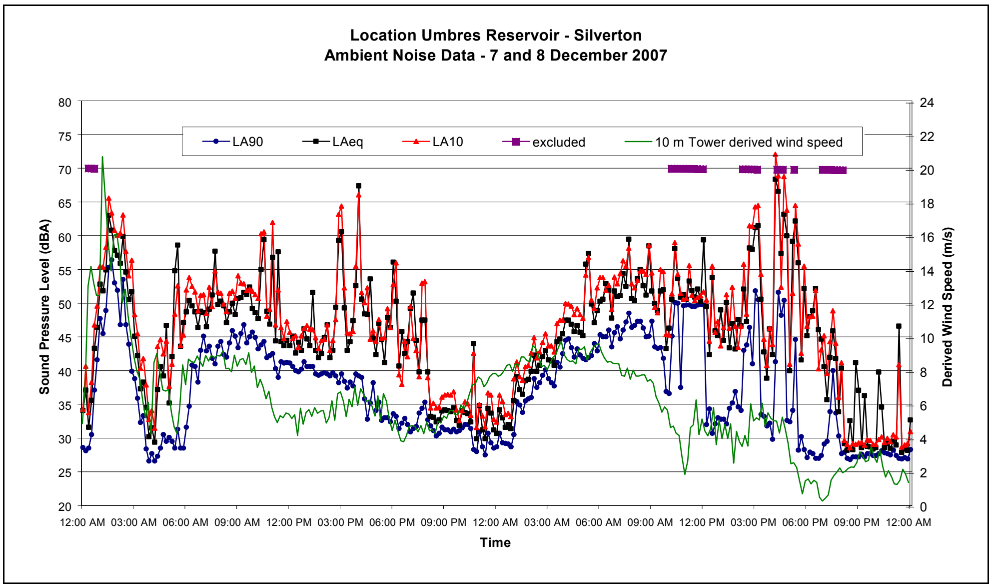
Sound Pressure Level (dBA)
Derived Wind Speed (m/s)
Time
12:00 AM 03:00 AM 06:00 AM 09:00 AM 12:00 PM 03:00 PM 06:00 PM 09:00 PM 12:00 AM 03:00 AM 06:00 AM 09:00 AM 12:00 PM 03:00 PM 06:00 PM 09:00 PM 12:00 AM


Location Umbres Reservoir - Silverton
Ambient Noise Data - 7 and 8 December 2007
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LAeq
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excluded
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Sound Pressure Level (dBA)
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Time
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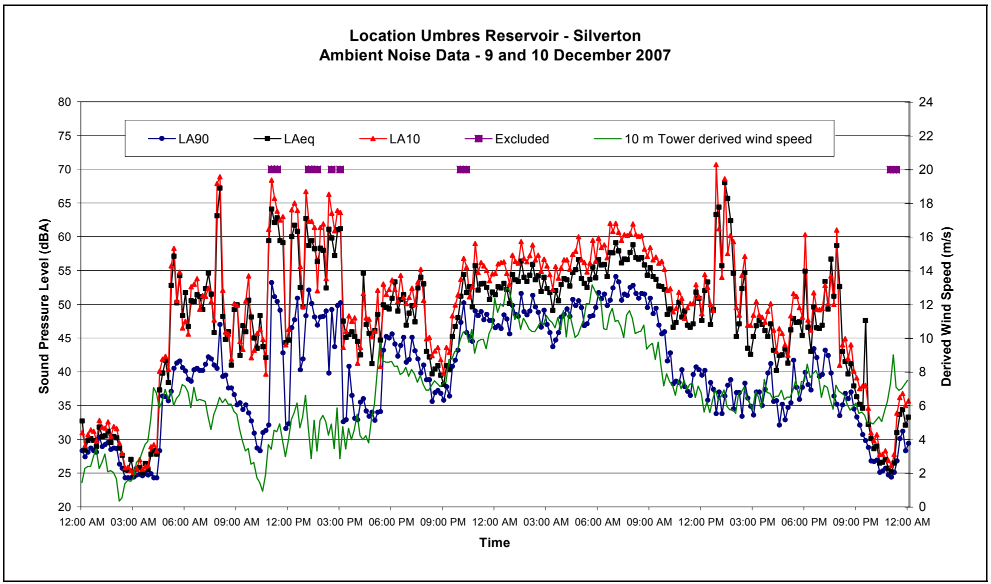
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Sound Pressure Level (dBA)
Derived Wind Speed (m/s)
Time
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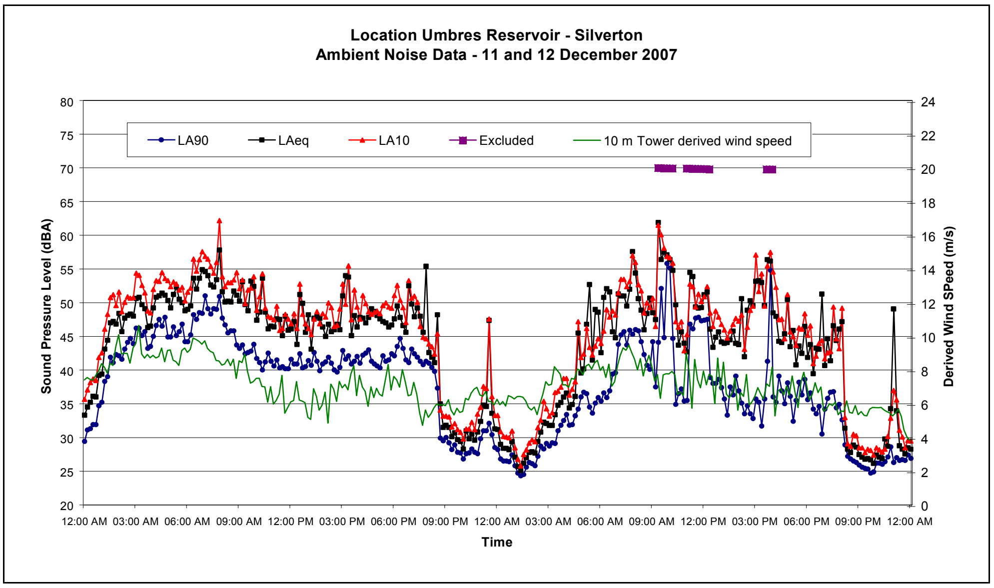
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LAeq
LA10
Excluded
10 m Tower derived wind speed
Sound Pressure Level (dBA)
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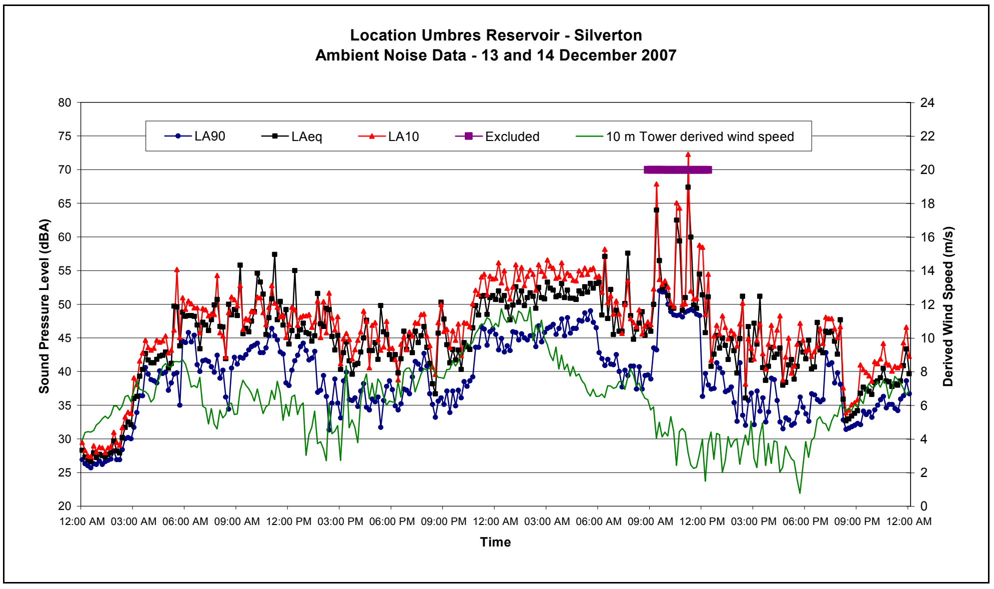
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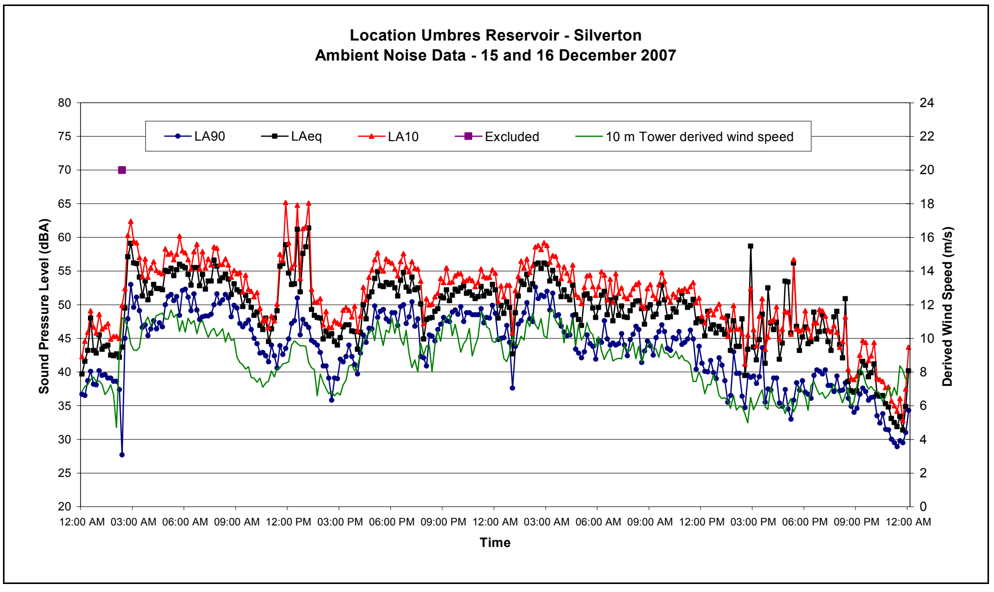
Derived Wind Speed (m/s)
Time


Location Umbres Reservoir - Silverton
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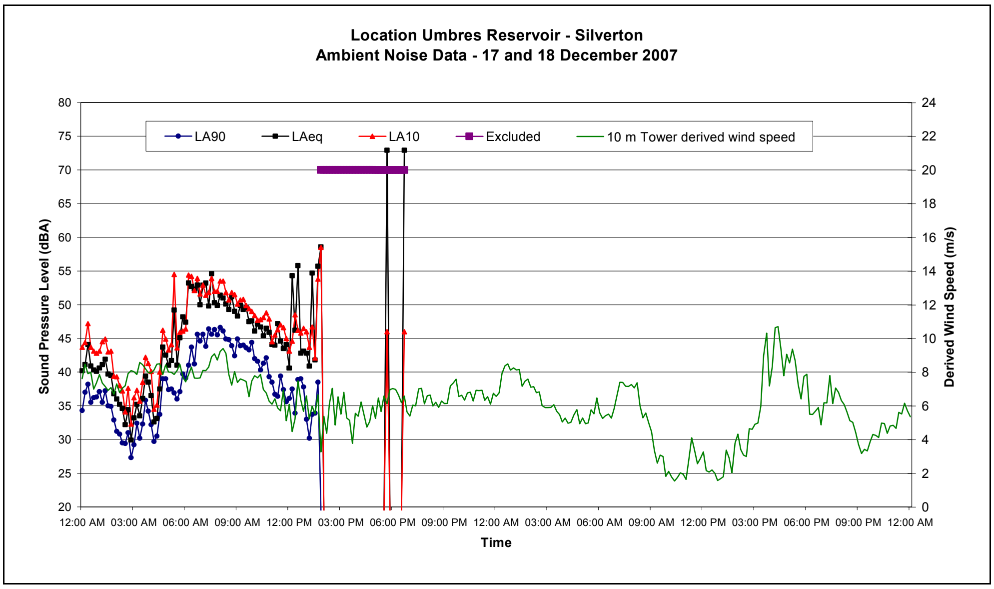
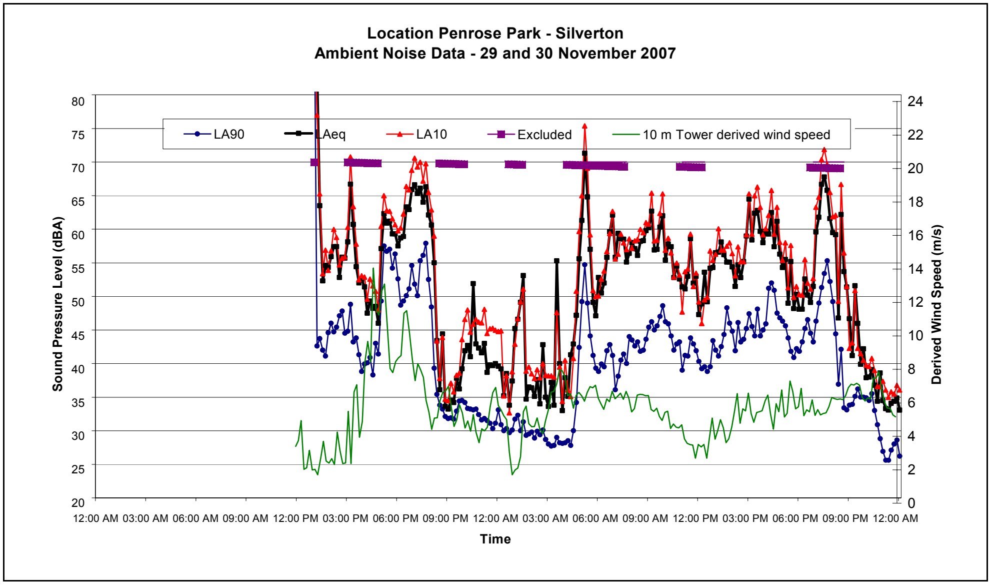
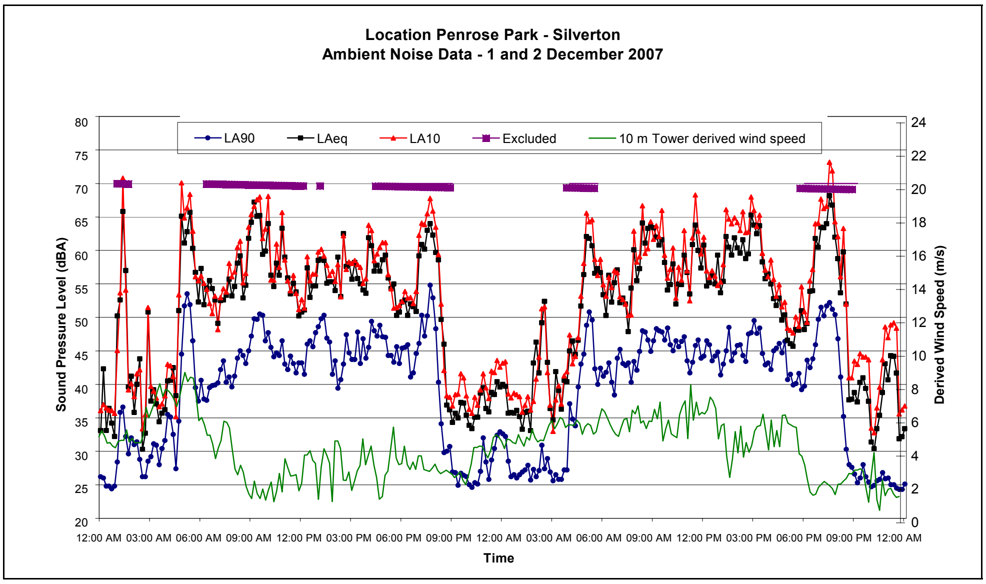
LAeq
LA10
Excluded
10 m Tower derived wind speed
Sound Pressure Level (dBA)
Derived Wind Speed (m/s)
Time


Location Umbres Reservoir - Silverton
Ambient Noise Data - 17 and 18 December 2007
LA90
LAeq
LA10
Excluded
10 m Tower derived wind speed
Sound Pressure Level (dBA)
Derived Wind Speed (m/s)
Time
12:00 AM
03:00 AM
06:00 AM
09:00 AM
12:00 PM
03:00 PM
06:00 PM
09:00 PM


Location Penrose Park - Silverton
Ambient Noise Data - 29 and 30 November 2007
LA90
LAeq
LA10
Excluded
10 m Tower derived wind speed
Sound Pressure Level (dBA)
Derived Wind Speed (m/s)
Time
12:00 AM 03:00 AM 06:00 AM 09:00 AM 12:00 PM 03:00 PM 06:00 PM 09:00 PM 12:00 AM 03:00 AM 06:00 AM 09:00 AM 12:00 PM 03:00 PM 06:00 PM 09:00 PM 12:00 AM


Location Penrose Park - Silverton
Ambient Noise Data - 1 and 2 December 2007
LA90
LAeq
LA10
Excluded
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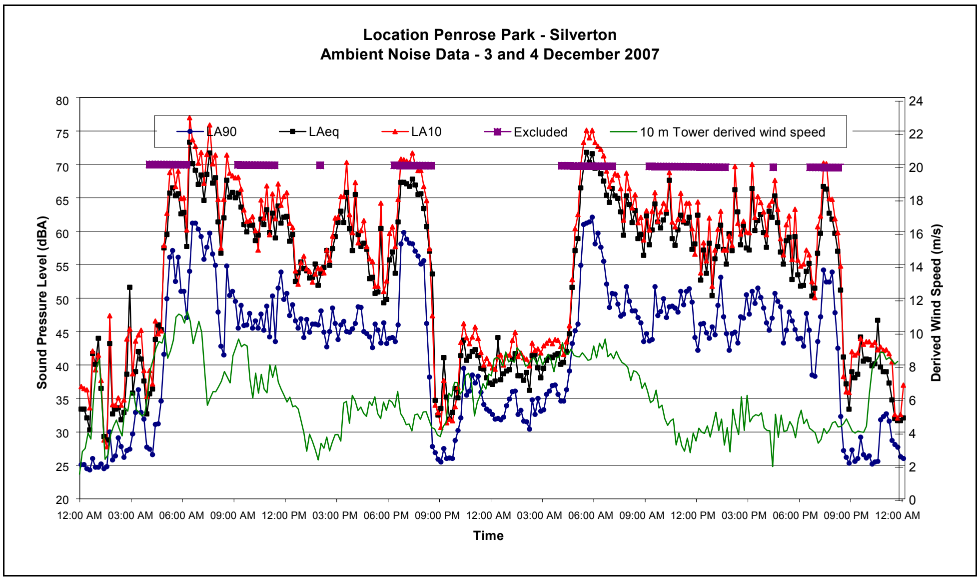
Sound Pressure Level (dBA)
Derived Wind Speed (m/s)
Time
12:00 AM 03:00 AM 06:00 AM 09:00 AM 12:00 PM 03:00 PM 06:00 PM 09:00 PM 12:00 AM 03:00 AM 06:00 AM 09:00 AM 12:00 PM 03:00 PM 06:00 PM 09:00 PM 12:00 AM


Location Penrose Park - Silverton
Ambient Noise Data - 3 and 4 December 2007
LA90
LAeq
LA10
Excluded
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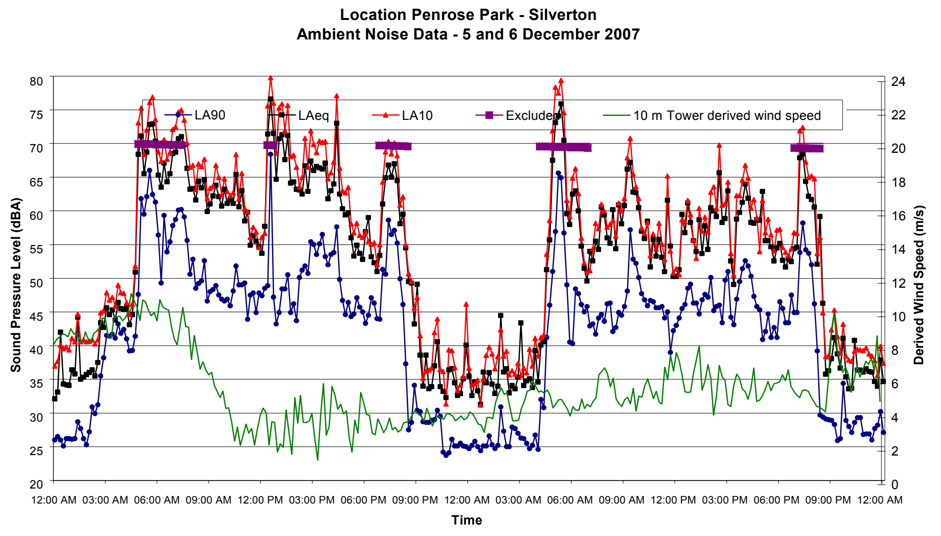
Sound Pressure Level (dBA)
Derived Wind Speed (m/s)
Time
12:00 AM 03:00 AM 06:00 AM 09:00 AM 12:00 PM 03:00 PM 06:00 PM 09:00 PM 12:00 AM 03:00 AM 06:00 AM 09:00 AM 12:00 PM 03:00 PM 06:00 PM 09:00 PM 12:00 AM


Location Penrose Park - Silverton
Ambient Noise Data - 5 and 6 December 2007
LA90
LAeq
LA10
Excluded
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Sound Pressure Level (dBA)
Derived Wind Speed (m/s)
Time
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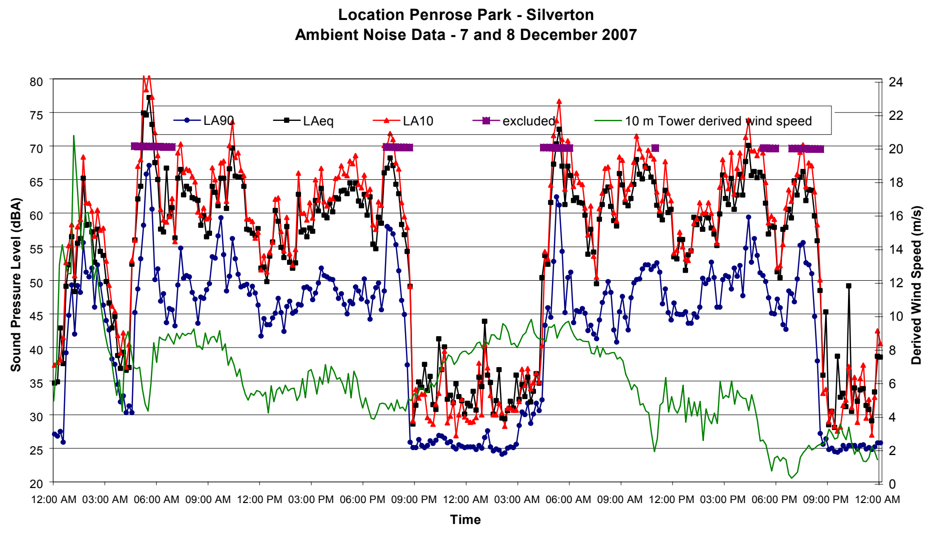
Location Penrose Park - Silverton
Ambient Noise Data - 7 and 8 December 2007
LA90
LAeq
LA10
excluded
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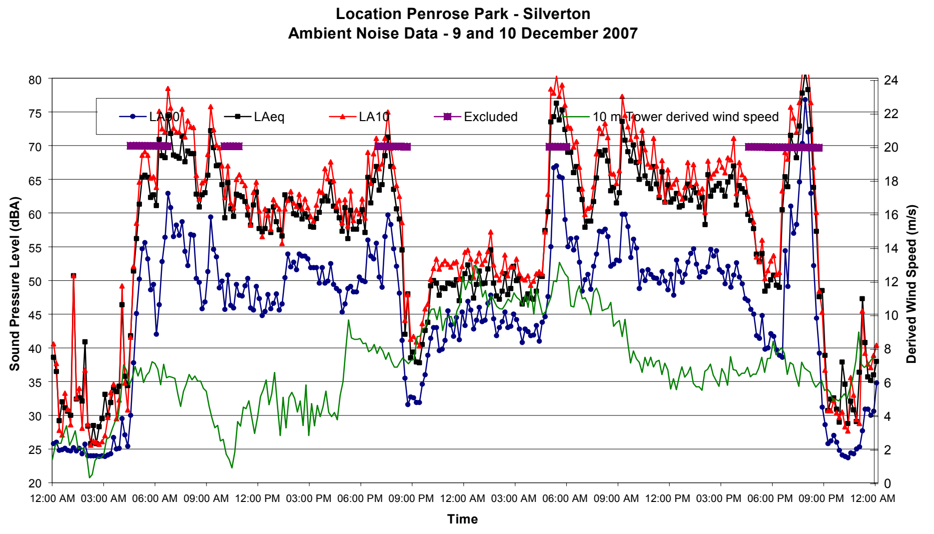
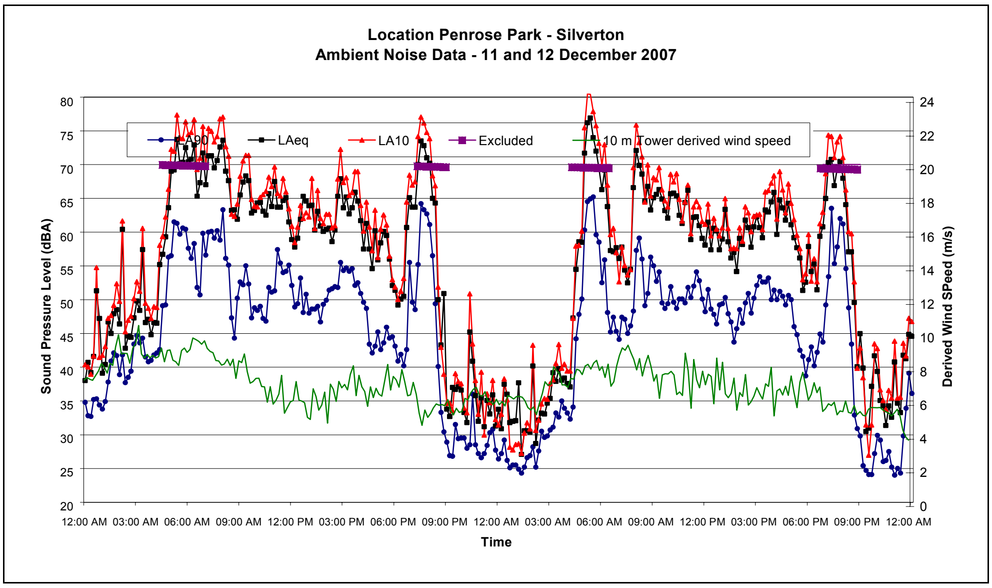
Sound Pressure Level (dBA)
Derived Wind Speed (m/s)
Time
12:00 AM 03:00 AM 06:00 AM 09:00 AM 12:00 PM 03:00 PM 06:00 PM 09:00 PM 12:00 AM 03:00 AM 06:00 AM 09:00 AM 12:00 PM 03:00 PM 06:00 PM 09:00 PM 12:00 AM


Location Penrose Park - Silverton
Ambient Noise Data - 9 and 10 December 2007
LA90
LAeq
LA10
Excluded
10 m Tower derived wind speed
Sound Pressure Level (dBA)
Derived Wind Speed (m/s)
Time
12:00 AM 03:00 AM 06:00 AM 09:00 AM 12:00 PM 03:00 PM 06:00 PM 09:00 PM 12:00 AM 03:00 AM 06:00 AM 09:00 AM 12:00 PM 03:00 PM 06:00 PM 09:00 PM 12:00 AM



Location Penrose Park - Silverton
Ambient Noise Data - 11 and 12 December 2007
LA90
LAeq
LA10
Excluded
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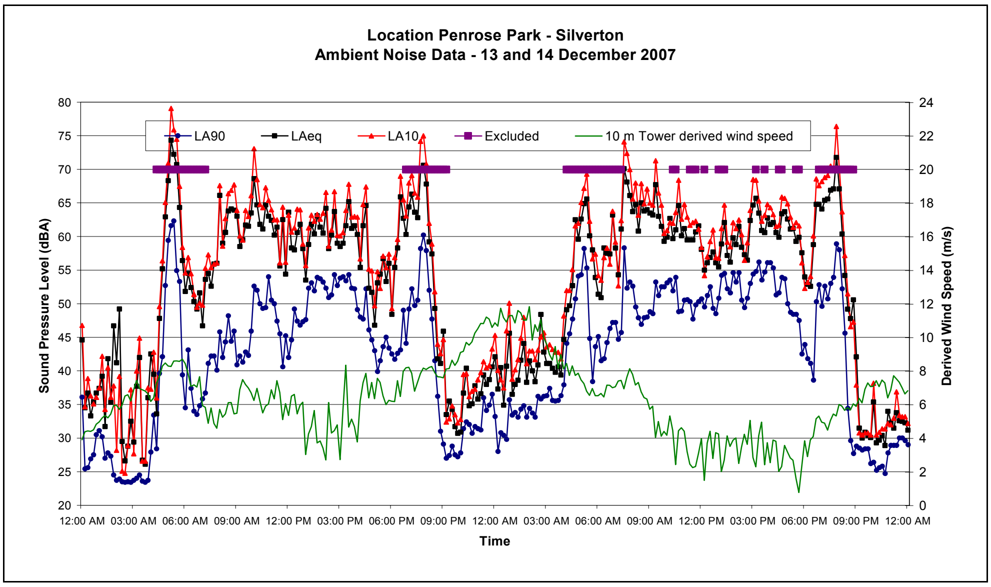
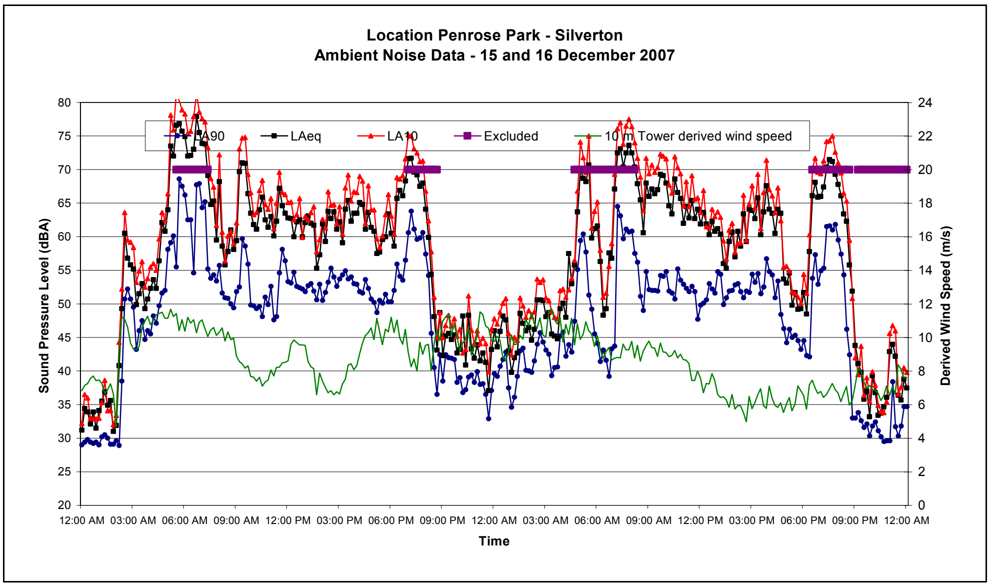
Sound Pressure Level (dBA)
Derived Wind SPeed (m/s)
Time



Location Penrose Park - Silverton
Ambient Noise Data - 13 and 14 December 2007
LA90
LAeq
LA10
Excluded
10 m Tower derived wind speed
Sound Pressure Level (dBA)
Derived Wind Speed (m/s)
Time



Location Penrose Park - Silverton
Ambient Noise Data - 15 and 16 December 2007
LA90
LAeq
LA10
Excluded
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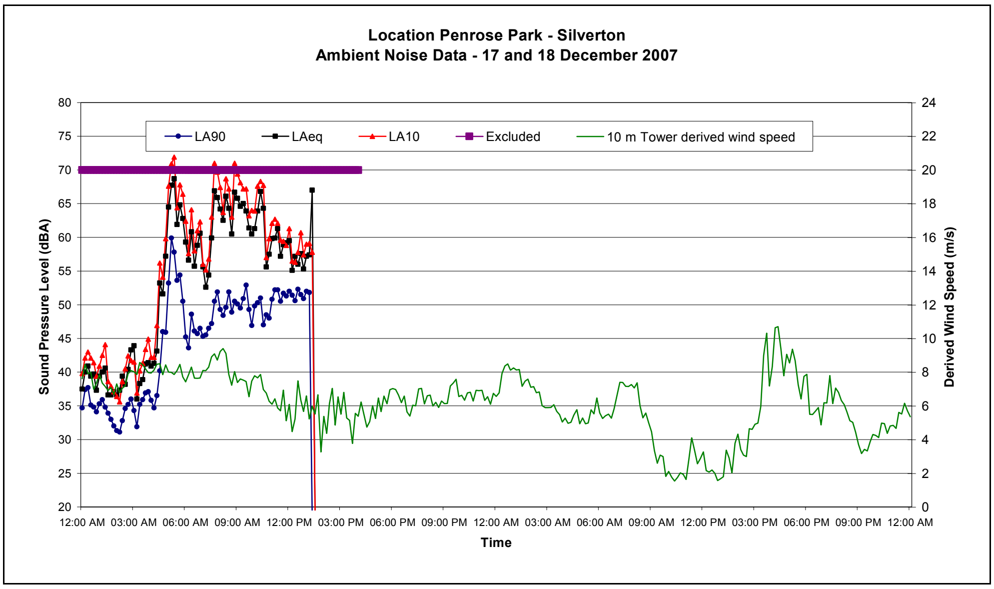
Sound Pressure Level (dBA)
Derived Wind Speed (m/s)
Time


Location Penrose Park - Silverton
Ambient Noise Data - 17 and 18 December 2007
Sound Pressure Level (dBA)
Derived Wind Speed (m/s)
LA90
LAeq
LA10
Excluded
10 m Tower derived wind speed
Time
12:00 AM 03:00 AM 06:00 AM 09:00 AM 12:00 PM 03:00 PM 06:00 PM 09:00 PM 12:00 AM 03:00 AM 06:00 AM 09:00 AM 12:00 PM 03:00 PM 06:00 PM 09:00 PM 12:00 AM

ACOUSTIC TERMINOLOGY

1 Sound Level or Noise Level

The terms "sound" and "noise" are almost interchangeable, except that in common usage "noise" is often used to refer to unwanted sound.

Sound (or noise) consists of minute fluctuations in atmospheric pressure capable of evoking the sense of hearing. The human ear responds to changes in sound pressure over a very wide range. The loudest sound pressure to which the human ear responds is ten million times greater than the softest. The decibel (abbreviated as dB) scale reduces this ratio to a more manageable size by the use of logarithms.

The symbols SPL, L or L_P are commonly used to represent Sound Pressure Level. The symbol L_A represents A-weighted Sound Pressure Level. The standard reference unit for Sound Pressure Levels expressed in decibels is 2E-5 Pa.

2 "A" Weighted Sound Pressure Level

The overall level of a sound is usually expressed in terms of dBA, which is measured using a sound level meter with an "A-weighting" filter. This is an electronic filter having a frequency response corresponding approximately to that of human hearing.

People's hearing is most sensitive to sounds at mid frequencies (500 Hz to 4000 Hz), and less sensitive at lower and higher frequencies. Thus, the level of a sound in dBA is a good measure of the loudness of that sound. Different sources having the same dBA level generally sound about equally loud.

A change of 1 dBA or 2 dBA in the level of a sound is difficult for most people to detect, whilst a 3 dBA to 5 dBA change corresponds to a small but noticeable change in loudness. A 10 dBA change corresponds to an approximate doubling or halving in loudness. The table below lists examples of typical noise levels

Sound Pressure Level (dBA)	Typical Source	Subjective Evaluation
130	Threshold of pain	Intolerable
120 110	Heavy rock concert Grinding on steel	Extremely noisy
100 90	Loud car horn at 3 m Construction site with pneumatic hammering	Very noisy
80 70	Kerbside of busy street Loud radio or television	Loud
60 50	Department store General Office	Moderate to quiet
40 30	Inside private office Inside bedroom	Quiet to very quiet
20	Unoccupied recording studio	Almost silent

Other weightings (eg B, C and D) are less commonly used than A-weighting. Sound Levels measured without any weighting are referred to as "linear", and the units are expressed as dB(lin) or dB.

3 Sound Power Level

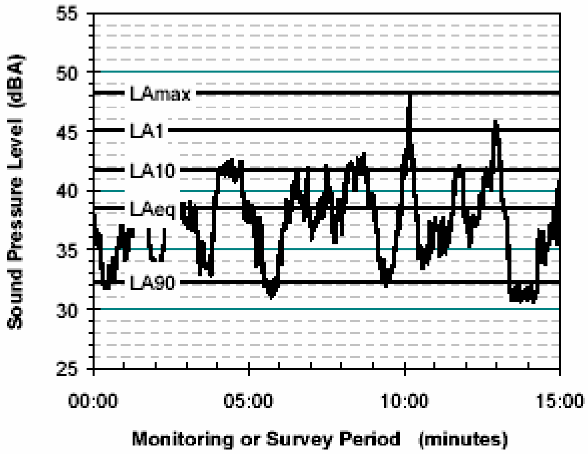
The Sound Power of a source is the rate at which it emits acoustic energy. As with Sound Pressure Levels, Sound Power Levels are expressed in decibel units (dB or dBA), but may be identified by the symbols SWL or Lw, or by the reference unit 1E-12 W.

The relationship between Sound Power and Sound Pressure may be likened to an electric radiator, which is characterised by a power rating, but has an effect on the surrounding environment that can be measured in terms of a different parameter, temperature.

4 Statistical Noise Levels

Sounds that vary in level over time, such as road traffic noise and most community noise, are commonly described in terms of the statistical exceedance levels L_{AN}, where L_{AN} is the A-weighted sound pressure level exceeded for N% of a given measurement period. For example, the L_{A1} is the noise level exceeded for 1% of the time, L_{A10} the noise exceeded for 10% of the time, and so on.

The following figure presents a hypothetical 15 minute noise survey, illustrating various common statistical indices of interest.



Of particular relevance, are:

L_{A1} The noise level exceeded for 1% of the 15 minute interval.

L_{A10} The noise level exceed for 10% of the 15 minute interval. This is commonly referred to as the average maximum noise level.

L_{A90} The noise level exceeded for 90% of the sample period. This noise level is described as the average minimum background sound level (in the absence of the source under consideration), or simply the background level.

L_{Aeq} The A-weighted equivalent noise level (basically the average noise level). It is defined as the steady sound level that contains the same amount of acoustical energy as the corresponding time-varying sound.

When dealing with numerous days of statistical noise data, it is sometimes necessary to define the typical noise levels at a given monitoring location for a particular time of day. A standardised method is available for determining these representative levels.

This method produces a level representing the "repeatable minimum" L_{A90} noise level over the daytime and night-time measurement periods, as required by the EPA. In addition the method produces mean or "average" levels representative of the other descriptors (L_{Aeq}, L_{A10}, etc).

5 Tonality

Tonal noise contains one or more prominent tones (ie distinct frequency components), and is normally regarded as more offensive than "broad band" noise.

6 Impulsiveness

An impulsive noise is characterised by one or more short sharp peaks in the time domain, such as occurs during hammering.

7 Frequency Analysis

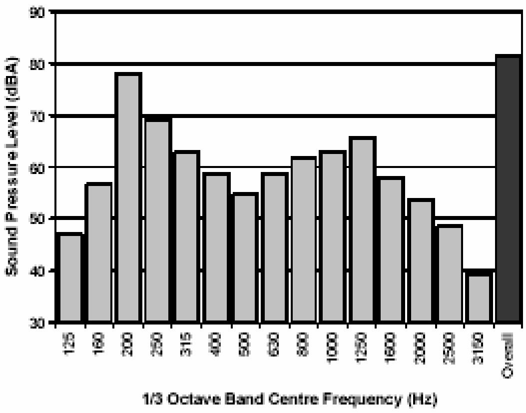
Frequency analysis is the process used to examine the tones (or frequency components) which make up the overall noise or vibration signal. This analysis was traditionally carried out using analogue electronic filters, but is now normally carried out using Fast Fourier Transform (FFT) analysers.

The units for frequency are Hertz (Hz), which represent the number of cycles per second.

Frequency analysis can be in:

- Octave bands (where the centre frequency and width of each band is double the previous band)
- 1/3 octave bands (3 bands in each octave band)
- Narrow band (where the spectrum is divided into 400 or more bands of equal width)

The following figure shows a 1/3 octave band frequency analysis where the noise is dominated by the 200 Hz band. Note that the indicated level of each individual band is less than the overall level, which is the logarithmic sum of the bands.



8 Vibration

Vibration may be defined as cyclic or transient motion. This motion can be measured in terms of its displacement, velocity or acceleration. Most assessments of human response to vibration or the risk of damage to buildings use measurements of vibration velocity. These may be expressed in terms of "peak" velocity or "rms" velocity.

The former is the maximum instantaneous velocity, without any averaging, and is sometimes referred to as "peak particle velocity", or PPV. The latter incorporates "root mean squared" averaging over some defined time period.

Vibration measurements may be carried out in a single axis or alternatively as triaxial measurements. Where triaxial measurements are used, the axes are commonly designated vertical, longitudinal (aligned toward the source) and transverse.

The common units for velocity are millimetres per second (mm/s). As with noise, decibel units can also be used, in which case the reference level should always be stated. A vibration level V, expressed in mm/s can be converted to decibels by the formula 20 log (V/V_o), where V_o is the reference level (1E-6 mm/s). Care is required in this regard, as other reference levels are used by some organizations.

9 Human Perception of Vibration

People are able to "feel" vibration at levels lower than those required to cause even superficial damage to the most susceptible classes of building (even though they may not be disturbed by the motion). An individual's perception of motion or response to vibration depends very strongly on previous experience and expectations, and on other connotations associated with the perceived source of the vibration. For example, the vibration that a person responds to as "normal" in a car, bus or train is considerably higher than what is perceived as "normal" in a shop, office or dwelling.

10 Over-Pressure

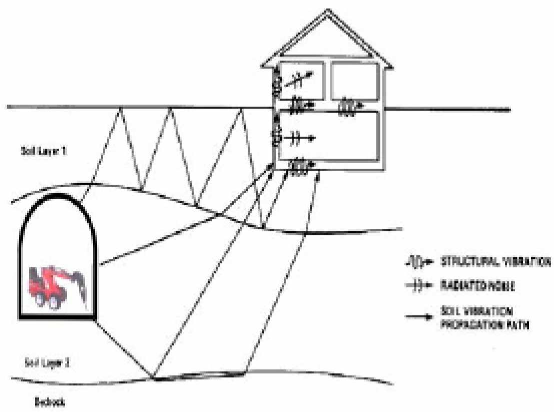
The term "over-pressure" is used to describe the air pressure pulse emitted during blasting or similar events. The peak level of an event is normally measured using a microphone in the same manner as linear noise (ie unweighted), at frequencies both in and below the audible range.

11 Regenerated Noise

Noise that propagates through a structure as vibration and is radiated by vibrating wall and floor surfaces is termed "regenerated noise", "structure-borne noise", or sometimes "ground-borne noise". Regenerated noise originates as vibration and propagates between the source and receiver through the ground and/or building structural elements, rather than through the air.

Typical sources of regenerated noise include tunnelling works, underground railways, excavation plant (eg rockbreakers), and building services plant (eg fans, compressors and generators).

The following figure presents the various paths by which vibration and regenerated noise may be transmitted between a source and receiver for construction activities occurring within a tunnel.



The term "regenerated noise" is also used to describe other types of noise that are emitted from the primary source as a different form of energy. One example would be a fan with a silencer, where the fan is the energy source and primary noise source. The silencer may effectively reduce the fan noise, but some additional noise may be created by the aerodynamic effect of the silencer in the airstream. This "secondary" noise may be referred to as regenerated noise.

PROPOSED WTG COORDINATES

Code	Easting	Northing	Location	Code	Easting	Northing	Location
A1	521202	6484997	Stage 1 - Belmont	A53	523888	6483006	Stage 1 - 9 Mile
A2	521451	6485194	Stage 1 - Belmont	A54	523902	6485206	Stage 1 - 9 Mile
A3	521626	6485700	Stage 1 - Belmont	A55	523902	6481750	Stage 1 - 9 Mile
A4	521748	6485275	Stage 1 - Belmont	A56	523949	6482597	Stage 1 - Belmont
A5	521944	6484148	Stage 1 - 9 Mile	A57	523950	6478612	Stage 1 - Belmont
A6	521948	6485702	Stage 1 - Belmont	A58	524000	6483687	Stage 1 - Belmont
A7	521950	6486096	Stage 1 - 9 Mile	A59	524041	6484723	Stage 1 - Belmont
A8	522061	6484852	Stage 1 - Belmont	A60	524041	6480149	Stage 1 - Belmont
A9	522246	6487313	Stage 1 - 9 Mile	A61	524101	6485449	Stage 1 - Belmont
A10	522252	6479250	Stage 1 - Belmont	A62	524150	6480523	Stage 1 - Belmont
A11	522259	6485064	Stage 1 - 9 Mile	A63	524200	6483902	Stage 1 - Belmont
A12	522296	6483936	Stage 1 - Belmont	A64	524366	6480099	Stage 1 - Belmont
A13	522300	6477700	Stage 1 - 9 Mile	A65	524542	6478395	Stage 1 - Belmont
A14	522326	6485809	Stage 1 - Belmont	A66	526200	6483100	Stage 1 - Belmont
A15	522337	6484306	Stage 1 - Belmont	A67	526600	6482799	Stage 1 - Belmont
A16	522497	6478082	Stage 1 - 9 Mile	A68	526832	6485800	Stage 1 - Belmont
A17	522501	6486951	Stage 1 - Belmont	A69	526999	6483449	Stage 1 - Belmont
A18	522505	6487368	Stage 1 - Belmont	A70	527000	6485247	Stage 1 - Belmont
A19	522522	6488153	Stage 1 - 9 Mile	A71	527053	6482153	Stage 1 - Belmont
A20	522529	6486452	Stage 1 - Belmont	A72	527147	6482483	Stage 1 - Belmont
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A27	522800	6480150	Stage 1 - 9 Mile	A79	528001	6482353	Stage 1 - Belmont
A28	522840	6487673	Stage 1 - Belmont	A80	528020	6484202	Stage 1 - Belmont
A29	522880	6483469	Stage 1 - Belmont	A81	528131	6483084	Stage 1 - Belmont
A30	522910	6484211	Stage 1 - Belmont	A82	528347	6484148	Stage 1 - Belmont
A31	522959	6479400	Stage 1 - Belmont	A83	528438	6486593	Stage 1 - Belmont
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A34	523099	6481299	Stage 1 - Belmont	A86	528748	6484699	Stage 1 - Belmont
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A37	523158	6484397	Stage 1 - 9 Mile	A89	529104	6485451	Stage 1 - Belmont
A38	523190	6483332	Stage 1 - Belmont	A90	529444	6485547	Stage 1 - Belmont
A39	523209	6480558	Stage 1 - 9 Mile	A91	529499	6486400	Stage 1 - Belmont
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A44	523500	6479619	Stage 1 - Belmont	A96	524805	6479151	Stage 1 - Belmont
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A50	523705	6480803	Stage 1 - 9 Mile	A102	525351	6480097	Stage 1 - Belmont
A51	523741	6481218	Stage 1 - 9 Mile	A103	525694	6481400	Stage 1 - Belmont
A52	523751	6477950	Stage 1 - 9 Mile	A104	525700	6479452	Stage 1 - Belmont

Code	Easting	Northing	Location	Code	Easting	Northing	Location
A105	525966	6481012	Stage 1 - Belmont	B37	524649	6487247	Stage 2 - Belmont
A106	526150	6481802	Stage 1 - Belmont	B38	524650	6489000	Stage 2 - Belmont
A107	526294	6480951	Stage 1 - Belmont	B39	524865	6474351	Stage 2 - Belmont
A108	526684	6480801	Stage 1 - Belmont	B40	524901	6485044	Stage 2 - Belmont
A109	526799	6481405	Stage 1 - Belmont	B41	524952	6486250	Stage 2 - Belmont
A110	526802	6480301	Stage 1 - Belmont	B42	524992	6475298	Stage 2 - Belmont
A111	526951	6480907	Stage 1 - Belmont	B43	525027	6488851	Stage 2 - Belmont
A112	527141	6481253	Stage 1 - Belmont	B44	525043	6473850	Stage 2 - Belmont
A113	527750	6481600	Stage 1 - Belmont	B45	525142	6489503	Stage 2 - Belmont
A114	528466	6482991	Stage 1 - Belmont	B46	525182	6474353	Stage 2 - Belmont
A115	528707	6483144	Stage 1 - Belmont	B47	525225	6489070	Stage 2 - Belmont
A116	528855	6483562	Stage 1 - Belmont	B48	525268	6484750	Stage 2 - Belmont
A117	529094	6483730	Stage 1 - Belmont	B49	525393	6475656	Stage 2 - Belmont
A118	529312	6484147	Stage 1 - Belmont	B50	525454	6486251	Stage 2 - Belmont
A119	529461	6484431	Stage 1 - Belmont	B51	525477	6474399	Stage 2 - Belmont
A120	529650	6484801	Stage 1 - Belmont	B52	525498	6489335	Stage 2 - Belmont
B1	519601	6481851	Stage 2 - Belmont	B53	525600	6476102	Stage 2 - Belmont
B2	519773	6482400	Stage 2 - Belmont	B54	525738	6474547	Stage 2 - Belmont
B3	519854	6482829	Stage 2 - Belmont	B55	525751	6477549	Stage 2 - Belmont
B4	520108	6482000	Stage 2 - Belmont	B56	525822	6475250	Stage 2 - Belmont
B5	520192	6482731	Stage 2 - Belmont	B57	525853	6476498	Stage 2 - Belmont
B6	520388	6482299	Stage 2 - Belmont	B58	525950	6477002	Stage 2 - Belmont
B7	520483	6483596	Stage 2 - Belmont	B59	525950	6475550	Stage 2 - Belmont
B8	520608	6483900	Stage 2 - Belmont	B60	525953	6485600	Stage 2 - Belmont
B9	520650	6481296	Stage 2 - Belmont	B61	526048	6474601	Stage 2 - Belmont
B10	520702	6482304	Stage 2 - Belmont	B62	526049	6488098	Stage 2 - Belmont
B11	520703	6484300	Stage 2 - Belmont	B63	526185	6474996	Stage 2 - Belmont
B12	520949	6483703	Stage 2 - Belmont	B64	526250	6488891	Stage 2 - Belmont
B13	520996	6480951	Stage 2 - Belmont	B65	526297	6485410	Stage 2 - Belmont
B14	521098	6482194	Stage 2 - Belmont	B66	526394	6488146	Stage 2 - Belmont
B15	521301	6480351	Stage 2 - Belmont	B67	526519	6474906	Stage 2 - Belmont
B16	521349	6483500	Stage 2 - Belmont	B68	527600	6487344	Stage 2 - Belmont
B17	521371	6480702	Stage 2 - Belmont	B69	527850	6475443	Stage 2 - Belmont
B18	521401	6481249	Stage 2 - Belmont	B70	527935	6487262	Stage 2 - Belmont
B19	521421	6482156	Stage 2 - Belmont	B71	527950	6487847	Stage 2 - Belmont
B20	521551	6483043	Stage 2 - Belmont	B72	528047	6474708	Stage 2 - Belmont
B21	521691	6479443	Stage 2 - Belmont	B73	528097	6486826	Stage 2 - Belmont
B22	521805	6481201	Stage 2 - Belmont	B74	528598	6475781	Stage 2 - Belmont
B23	521807	6480803	Stage 2 - Belmont	B75	528613	6488646	Stage 2 - Belmont
B24	521951	6481497	Stage 2 - Belmont	B76	528750	6487501	Stage 2 - Belmont
B25	522051	6482504	Stage 2 - Belmont	B77	528803	6489050	Stage 2 - Belmont
B26	522154	6483096	Stage 2 - Belmont	B78	528879	6478116	Stage 2 - Belmont
B27	522194	6481751	Stage 2 - Belmont	B79	528900	6476148	Stage 2 - Belmont
B28	522910	6476803	Stage 2 - Belmont	B80	528971	6476897	Stage 2 - Belmont
B29	523150	6476958	Stage 2 - Belmont	B81	528997	6488551	Stage 2 - Belmont
B30	523201	6477390	Stage 2 - Belmont	B82	529001	6475704	Stage 2 - Belmont
B31	523402	6477700	Stage 2 - Belmont	B83	529050	6477247	Stage 2 - Belmont
B32	524001	6487849	Stage 2 - Belmont	B84	529092	6487350	Stage 2 - Belmont
B33	524096	6475799	Stage 2 - Belmont	B85	529117	6487949	Stage 2 - Belmont
B34	524098	6486999	Stage 2 - Belmont	B86	529295	6476098	Stage 2 - Belmont
B35	524103	6475356	Stage 2 - Belmont	B87	529415	6476996	Stage 2 - Belmont
B36	524506	6475297	Stage 2 - Belmont	B88	529501	6476320	Stage 2 - Belmont

Code	Easting	Northing	Location	Code	Easting	Northing	Location
B89	529546	6478151	Stage 2 - Belmont	N47	532750	6484204	Stage 2 - 9 Mile
B90	529693	6476600	Stage 2 - Belmont	N48	532752	6483698	Stage 2 - 9 Mile
B91	529902	6476803	Stage 2 - Belmont	N49	532787	6480720	Stage 2 - 9 Mile
B92	530044	6477150	Stage 2 - Belmont	N50	533053	6484951	Stage 2 - 9 Mile
B93	530240	6478052	Stage 2 - Belmont	N51	533059	6483248	Stage 2 - 9 Mile
B94	530575	6478003	Stage 2 - Belmont	N52	533061	6481043	Stage 2 - 9 Mile
N1	527752	6479050	Stage 2 - 9 Mile	N53	533078	6483901	Stage 2 - 9 Mile
N2	528201	6478207	Stage 2 - 9 Mile	N54	533099	6482146	Stage 2 - 9 Mile
N3	528292	6480054	Stage 2 - 9 Mile	N55	533120	6485450	Stage 2 - 9 Mile
N4	528540	6478241	Stage 2 - 9 Mile	N56	533198	6481338	Stage 2 - 9 Mile
N5	528600	6478606	Stage 2 - 9 Mile	N57	533288	6483447	Stage 2 - 9 Mile
N6	528851	6481114	Stage 2 - 9 Mile	N58	533320	6484054	Stage 2 - 9 Mile
N7	529008	6478905	Stage 2 - 9 Mile	N59	533350	6484432	Stage 2 - 9 Mile
N8	529097	6481266	Stage 2 - 9 Mile	N60	533399	6483012	Stage 2 - 9 Mile
N9	529150	6480510	Stage 2 - 9 Mile	N61	533416	6484787	Stage 2 - 9 Mile
N10	529155	6479194	Stage 2 - 9 Mile	N62	533491	6485203	Stage 2 - 9 Mile
N11	529250	6480074	Stage 2 - 9 Mile	N63	533601	6485900	Stage 2 - 9 Mile
N12	529300	6479479	Stage 2 - 9 Mile	N64	533701	6485404	Stage 2 - 9 Mile
N13	529422	6480955	Stage 2 - 9 Mile	N65	533706	6483348	Stage 2 - 9 Mile
N14	529643	6481149	Stage 2 - 9 Mile	N66	533796	6482898	Stage 2 - 9 Mile
N15	529851	6481352	Stage 2 - 9 Mile	N67	534052	6483103	Stage 2 - 9 Mile
N16	530002	6482270	Stage 2 - 9 Mile	N68	534113	6486798	Stage 2 - 9 Mile
N17	530147	6480555	Stage 2 - 9 Mile	N69	534508	6482971	Stage 2 - 9 Mile
N18	530249	6481606	Stage 2 - 9 Mile	N70	534550	6484147	Stage 2 - 9 Mile
N19	530256	6482400	Stage 2 - 9 Mile	N71	534552	6485485	Stage 2 - 9 Mile
N20	530395	6478554	Stage 2 - 9 Mile	N72	534603	6483672	Stage 2 - 9 Mile
N21	530405	6479655	Stage 2 - 9 Mile	N73	534646	6484950	Stage 2 - 9 Mile
N22	530447	6481003	Stage 2 - 9 Mile	N74	534650	6483256	Stage 2 - 9 Mile
N23	530703	6482804	Stage 2 - 9 Mile	N75	534694	6486504	Stage 2 - 9 Mile
N24	530746	6486651	Stage 2 - 9 Mile	N76	534701	6485764	Stage 2 - 9 Mile
N25	530999	6479198	Stage 2 - 9 Mile	N77	534922	6483352	Stage 2 - 9 Mile
N26	531028	6486754	Stage 2 - 9 Mile	N78	534947	6483892	Stage 2 - 9 Mile
N27	531274	6486898	Stage 2 - 9 Mile	N79	534954	6486697	Stage 2 - 9 Mile
N28	531299	6483504	Stage 2 - 9 Mile	N80	535034	6486270	Stage 2 - 9 Mile
N29	531330	6482903	Stage 2 - 9 Mile	N81	535065	6485857	Stage 2 - 9 Mile
N30	531448	6483847	Stage 2 - 9 Mile	N82	535218	6486896	Stage 2 - 9 Mile
N31	531453	6482467	Stage 2 - 9 Mile	N83	535229	6483497	Stage 2 - 9 Mile
N32	531545	6483098	Stage 2 - 9 Mile	N84	535352	6486270	Stage 2 - 9 Mile
N33	531630	6484132	Stage 2 - 9 Mile	N85	535396	6485852	Stage 2 - 9 Mile
N34	531733	6484454	Stage 2 - 9 Mile	N86	535449	6484798	Stage 2 - 9 Mile
N35	531749	6480097	Stage 2 - 9 Mile	N87	535589	6486756	Stage 2 - 9 Mile
N36	531905	6480389	Stage 2 - 9 Mile	N88	535646	6485043	Stage 2 - 9 Mile
N37	532051	6483998	Stage 2 - 9 Mile	N89	535649	6485446	Stage 2 - 9 Mile
N38	532202	6480850	Stage 2 - 9 Mile	N90	535903	6486747	Stage 2 - 9 Mile
N39	532207	6480418	Stage 2 - 9 Mile	N91	535916	6485551	Stage 2 - 9 Mile
N40	532292	6481184	Stage 2 - 9 Mile	N92	535999	6485101	Stage 2 - 9 Mile
N41	532429	6481864	Stage 2 - 9 Mile	N93	536447	6485102	Stage 2 - 9 Mile
N42	532535	6480577	Stage 2 - 9 Mile	P1	536232	6485599	Stage 2 - Purnamoota
N43	532598	6482522	Stage 2 - 9 Mile	P2	536908	6485846	Stage 2 - Purnamoota
N44	532701	6481152	Stage 2 - 9 Mile	P3	536563	6485992	Stage 2 - Purnamoota
N45	532713	6482871	Stage 2 - 9 Mile	P4	538106	6486245	Stage 2 - Purnamoota
N46	532745	6483251	Stage 2 - 9 Mile	P5	537676	6486250	Stage 2 - Purnamoota

Code	Easting	Northing	Location	Code	Easting	Northing	Location
P6	536154	6486337	Stage 2 - Purnamoota	P58	535806	6489946	Stage 2 - Purnamoota
P7	537327	6486400	Stage 2 - Purnamoota	P59	529451	6490102	Stage 2 - Purnamoota
P8	536391	6486504	Stage 2 - Purnamoota	P60	529750	6490397	Stage 2 - Purnamoota
P9	538057	6486663	Stage 2 - Purnamoota	P61	530050	6490799	Stage 2 - Purnamoota
P10	536601	6486707	Stage 2 - Purnamoota	P62	530248	6491041	Stage 2 - Purnamoota
P11	538400	6486799	Stage 2 - Purnamoota	P63	529600	6491352	Stage 2 - Purnamoota
P12	537047	6486992	Stage 2 - Purnamoota	P64	530202	6491845	Stage 2 - Purnamoota
P13	537356	6486997	Stage 2 - Purnamoota	P65	529304	6494197	Stage 2 - Purnamoota
P14	537596	6487152	Stage 2 - Purnamoota	P66	529650	6494211	Stage 2 - Purnamoota
P15	536403	6487172	Stage 2 - Purnamoota	P67	529933	6494290	Stage 2 - Purnamoota
P16	531310	6487272	Stage 2 - Purnamoota	P68	530130	6494515	Stage 2 - Purnamoota
P17	533551	6487306	Stage 2 - Purnamoota	P69	528304	6494852	Stage 2 - Purnamoota
P18	534950	6487342	Stage 2 - Purnamoota	P70	530505	6494999	Stage 2 - Purnamoota
P19	536549	6487454	Stage 2 - Purnamoota	P71	531806	6495491	Stage 2 - Purnamoota
P20	530198	6487515	Stage 2 - Purnamoota	P72	528500	6495544	Stage 2 - Purnamoota
P21	537649	6487550	Stage 2 - Purnamoota	P73	529090	6495607	Stage 2 - Purnamoota
P22	538353	6487588	Stage 2 - Purnamoota	P74	529800	6495701	Stage 2 - Purnamoota
P23	536203	6487600	Stage 2 - Purnamoota	P75	528748	6495707	Stage 2 - Purnamoota
P24	530897	6487745	Stage 2 - Purnamoota	P76	529299	6495815	Stage 2 - Purnamoota
P25	537299	6487801	Stage 2 - Purnamoota	P77	528147	6495853	Stage 2 - Purnamoota
P26	530348	6487806	Stage 2 - Purnamoota	P78	531976	6495897	Stage 2 - Purnamoota
P27	537949	6487806	Stage 2 - Purnamoota	P79	532863	6495915	Stage 2 - Purnamoota
P28	536650	6487848	Stage 2 - Purnamoota	P80	532262	6495962	Stage 2 - Purnamoota
P29	531101	6487950	Stage 2 - Purnamoota	P81	532520	6496094	Stage 2 - Purnamoota
P30	533918	6487953	Stage 2 - Purnamoota	P82	529859	6496250	Stage 2 - Purnamoota
P31	538158	6488017	Stage 2 - Purnamoota	P83	530450	6496348	Stage 2 - Purnamoota
P32	534190	6488050	Stage 2 - Purnamoota	P84	529522	6496352	Stage 2 - Purnamoota
P33	536198	6488050	Stage 2 - Purnamoota	P85	531985	6496357	Stage 2 - Purnamoota
P34	538462	6488051	Stage 2 - Purnamoota	P86	530074	6496451	Stage 2 - Purnamoota
P35	531350	6488081	Stage 2 - Purnamoota	P87	532498	6496662	Stage 2 - Purnamoota
P36	529353	6488113	Stage 2 - Purnamoota	P88	531652	6496664	Stage 2 - Purnamoota
P37	538714	6488185	Stage 2 - Purnamoota	P89	528515	6496709	Stage 2 - Purnamoota
P38	535752	6488290	Stage 2 - Purnamoota	P90	532724	6496851	Stage 2 - Purnamoota
P39	530352	6488391	Stage 2 - Purnamoota	P91	528752	6496868	Stage 2 - Purnamoota
P40	533945	6488480	Stage 2 - Purnamoota	P92	528164	6496895	Stage 2 - Purnamoota
P41	538812	6488526	Stage 2 - Purnamoota	P93	530052	6496956	Stage 2 - Purnamoota
P42	535195	6488548	Stage 2 - Purnamoota	P94	529051	6496963	Stage 2 - Purnamoota
P43	538001	6488597	Stage 2 - Purnamoota	P95	530964	6496970	Stage 2 - Purnamoota
P44	535856	6488615	Stage 2 - Purnamoota	P96	529347	6497021	Stage 2 - Purnamoota
P45	535404	6488751	Stage 2 - Purnamoota	P97	531223	6497097	Stage 2 - Purnamoota
P46	538250	6488755	Stage 2 - Purnamoota	P98	531531	6497112	Stage 2 - Purnamoota
P47	530154	6488900	Stage 2 - Purnamoota	P99	530402	6497127	Stage 2 - Purnamoota
P48	534797	6488903	Stage 2 - Purnamoota	P100	532889	6497139	Stage 2 - Purnamoota
P49	535555	6489027	Stage 2 - Purnamoota	P101	529717	6497232	Stage 2 - Purnamoota
P50	529701	6489049	Stage 2 - Purnamoota	P102	531798	6497236	Stage 2 - Purnamoota
P51	537950	6489153	Stage 2 - Purnamoota	P103	530643	6497280	Stage 2 - Purnamoota
P52	530753	6489205	Stage 2 - Purnamoota	P104	530056	6497356	Stage 2 - Purnamoota
P53	534397	6489351	Stage 2 - Purnamoota	P105	530897	6497638	Stage 2 - Purnamoota
P54	535851	6489352	Stage 2 - Purnamoota	P106	531206	6497638	Stage 2 - Purnamoota
P55	530102	6489602	Stage 2 - Purnamoota	P107	532002	6497642	Stage 2 - Purnamoota
P56	530349	6489749	Stage 2 - Purnamoota	P108	529506	6497657	Stage 2 - Purnamoota
P57	530958	6489900	Stage 2 - Purnamoota	P109	528321	6497658	Stage 2 - Purnamoota

Code	Easting	Northing	Location	Code	Easting	Northing	Location
P110	529178	6497659	Stage 2 - Purnamoota	P162	529601	6500558	Stage 2 - Purnamoota
P111	530557	6497799	Stage 2 - Purnamoota	P163	531700	6500598	Stage 2 - Purnamoota
P112	528835	6497807	Stage 2 - Purnamoota	P164	533991	6500656	Stage 2 - Purnamoota
P113	528500	6497895	Stage 2 - Purnamoota	P165	534243	6500792	Stage 2 - Purnamoota
P114	534248	6497919	Stage 2 - Purnamoota	P166	530860	6500794	Stage 2 - Purnamoota
P115	530119	6497946	Stage 2 - Purnamoota	P167	534649	6500983	Stage 2 - Purnamoota
P116	529791	6498002	Stage 2 - Purnamoota	P168	529466	6500999	Stage 2 - Purnamoota
P117	530715	6498077	Stage 2 - Purnamoota	P169	532517	6501111	Stage 2 - Purnamoota
P118	531914	6498144	Stage 2 - Purnamoota	P170	531547	6501133	Stage 2 - Purnamoota
P119	533350	6498156	Stage 2 - Purnamoota	P171	530362	6501248	Stage 2 - Purnamoota
P120	528598	6498225	Stage 2 - Purnamoota	P172	531187	6501269	Stage 2 - Purnamoota
P121	533780	6498228	Stage 2 - Purnamoota	P173	531752	6501347	Stage 2 - Purnamoota
P122	531297	6498244	Stage 2 - Purnamoota	P174	532864	6501395	Stage 2 - Purnamoota
P123	529199	6498273	Stage 2 - Purnamoota	P175	534808	6501440	Stage 2 - Purnamoota
P124	532560	6498379	Stage 2 - Purnamoota	P176	530829	6501498	Stage 2 - Purnamoota
P125	530047	6498390	Stage 2 - Purnamoota	P177	531397	6501565	Stage 2 - Purnamoota
P126	532942	6498441	Stage 2 - Purnamoota	P178	533094	6501566	Stage 2 - Purnamoota
P127	529430	6498442	Stage 2 - Purnamoota	P179	530044	6501571	Stage 2 - Purnamoota
P128	533950	6498482	Stage 2 - Purnamoota	P180	532525	6501696	Stage 2 - Purnamoota
P129	533450	6498515	Stage 2 - Purnamoota	P181	531039	6501703	Stage 2 - Purnamoota
P130	534193	6498680	Stage 2 - Purnamoota	P182	532764	6501864	Stage 2 - Purnamoota
P131	530240	6498698	Stage 2 - Purnamoota	P183	530544	6501985	Stage 2 - Purnamoota
P132	532243	6498700	Stage 2 - Purnamoota	P184	532171	6502051	Stage 2 - Purnamoota
P133	528649	6498751	Stage 2 - Purnamoota	P185	533350	6502068	Stage 2 - Purnamoota
P134	532459	6498893	Stage 2 - Purnamoota	P186	532938	6502119	Stage 2 - Purnamoota
P135	531864	6499030	Stage 2 - Purnamoota	P187	530750	6502201	Stage 2 - Purnamoota
P136	528797	6499155	Stage 2 - Purnamoota	P188	531832	6502300	Stage 2 - Purnamoota
P137	532122	6499160	Stage 2 - Purnamoota	P189	533005	6502475	Stage 2 - Purnamoota
P138	529788	6499197	Stage 2 - Purnamoota	P190	538418	6502550	Stage 2 - Purnamoota
P139	532688	6499248	Stage 2 - Purnamoota	P191	532643	6502601	Stage 2 - Purnamoota
P140	534548	6499275	Stage 2 - Purnamoota	P192	537609	6502694	Stage 2 - Purnamoota
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P146	534140	6499591	Stage 2 - Purnamoota	P198	533634	6503093	Stage 2 - Purnamoota
P147	528610	6499602	Stage 2 - Purnamoota	P199	537514	6503130	Stage 2 - Purnamoota
P148	532009	6499627	Stage 2 - Purnamoota	P200	537951	6503162	Stage 2 - Purnamoota
P149	532487	6499676	Stage 2 - Purnamoota	P201	531101	6503199	Stage 2 - Purnamoota
P150	529652	6499736	Stage 2 - Purnamoota	P202	536588	6503214	Stage 2 - Purnamoota
P151	530548	6499779	Stage 2 - Purnamoota	P203	533894	6503354	Stage 2 - Purnamoota
P152	532981	6499856	Stage 2 - Purnamoota	P204	536236	6503446	Stage 2 - Purnamoota
P153	532156	6500015	Stage 2 - Purnamoota	P205	536893	6503448	Stage 2 - Purnamoota
P154	532435	6500098	Stage 2 - Purnamoota	P206	533074	6503451	Stage 2 - Purnamoota
P155	529648	6500140	Stage 2 - Purnamoota	P207	537606	6503463	Stage 2 - Purnamoota
P156	528545	6500148	Stage 2 - Purnamoota	P208	538084	6503466	Stage 2 - Purnamoota
P157	533101	6500206	Stage 2 - Purnamoota	P209	534694	6503500	Stage 2 - Purnamoota
P158	531141	6500301	Stage 2 - Purnamoota	P210	533368	6503501	Stage 2 - Purnamoota
P159	528849	6500346	Stage 2 - Purnamoota	P211	536546	6503637	Stage 2 - Purnamoota
P160	533319	6500401	Stage 2 - Purnamoota	P212	537753	6503746	Stage 2 - Purnamoota
P161	533600	6500498	Stage 2 - Purnamoota	P213	533499	6503803	Stage 2 - Purnamoota

Code	Easting	Northing	Location	Code	Easting	Northing	Location
P214	536734	6503891	Stage 2 - Purnamoota	E41	525596	6492601	Stage 2 - Eldee
P215	534166	6504000	Stage 2 - Purnamoota	E42	526588	6492748	Stage 2 - Eldee
P216	538086	6504013	Stage 2 - Purnamoota	E43	525901	6493026	Stage 2 - Eldee
P217	536267	6504017	Stage 2 - Purnamoota	E44	526877	6493248	Stage 2 - Eldee
P218	535939	6504061	Stage 2 - Purnamoota	E45	525850	6493479	Stage 2 - Eldee
P219	534494	6504122	Stage 2 - Purnamoota	E46	527003	6493549	Stage 2 - Eldee
P220	533795	6504301	Stage 2 - Purnamoota	E47	526503	6493551	Stage 2 - Eldee
P221	535400	6504442	Stage 2 - Purnamoota	E48	526604	6494784	Stage 2 - Eldee
P222	538304	6504449	Stage 2 - Purnamoota	E49	527653	6494849	Stage 2 - Eldee
P223	537984	6504473	Stage 2 - Purnamoota	E50	527967	6494854	Stage 2 - Eldee
P224	535639	6504598	Stage 2 - Purnamoota	E51	526560	6495202	Stage 2 - Eldee
P225	534146	6504678	Stage 2 - Purnamoota	E52	526832	6495300	Stage 2 - Eldee
E1	526956	6489350	Stage 2 - Eldee	E53	527066	6495466	Stage 2 - Eldee
E2	527349	6489536	Stage 2 - Eldee	E54	527282	6495659	Stage 2 - Eldee
E3	526638	6489749	Stage 2 - Eldee	E55	526586	6495798	Stage 2 - Eldee
E4	525459	6489750	Stage 2 - Eldee	E56	527525	6495811	Stage 2 - Eldee
E5	525749	6489806	Stage 2 - Eldee	E57	527801	6495899	Stage 2 - Eldee
E6	526900	6489871	Stage 2 - Eldee	E58	526946	6496501	Stage 2 - Eldee
E7	528297	6489913	Stage 2 - Eldee	E59	527809	6496950	Stage 2 - Eldee
E8	527002	6490196	Stage 2 - Eldee	E60	527199	6497444	Stage 2 - Eldee
E9	529110	6490244	Stage 2 - Eldee	E61	527850	6497907	Stage 2 - Eldee
E10	526605	6490250	Stage 2 - Eldee	E62	527451	6497989	Stage 2 - Eldee
E11	525126	6490251	Stage 2 - Eldee	E63	528086	6498068	Stage 2 - Eldee
E12	525844	6490350	Stage 2 - Eldee	E64	527756	6498353	Stage 2 - Eldee
E13	525400	6490351	Stage 2 - Eldee	WB1	521105	6479206	Stage 2 - Water Board
E14	523910	6490392	Stage 2 - Eldee	WB2	521447	6479295	Stage 2 - Water Board
E15	526140	6490399	Stage 2 - Eldee				
E16	528740	6490399	Stage 2 - Eldee				
E17	527388	6490400	Stage 2 - Eldee				
E18	523351	6490417	Stage 2 - Eldee				
E19	527683	6490448	Stage 2 - Eldee				
E20	528350	6490527	Stage 2 - Eldee				
E21	525523	6490658	Stage 2 - Eldee				
E22	526650	6490688	Stage 2 - Eldee				
E23	523850	6490815	Stage 2 - Eldee				
E24	528150	6490956	Stage 2 - Eldee				
E25	525601	6491003	Stage 2 - Eldee				
E26	526604	6491106	Stage 2 - Eldee				
E27	523888	6491202	Stage 2 - Eldee				
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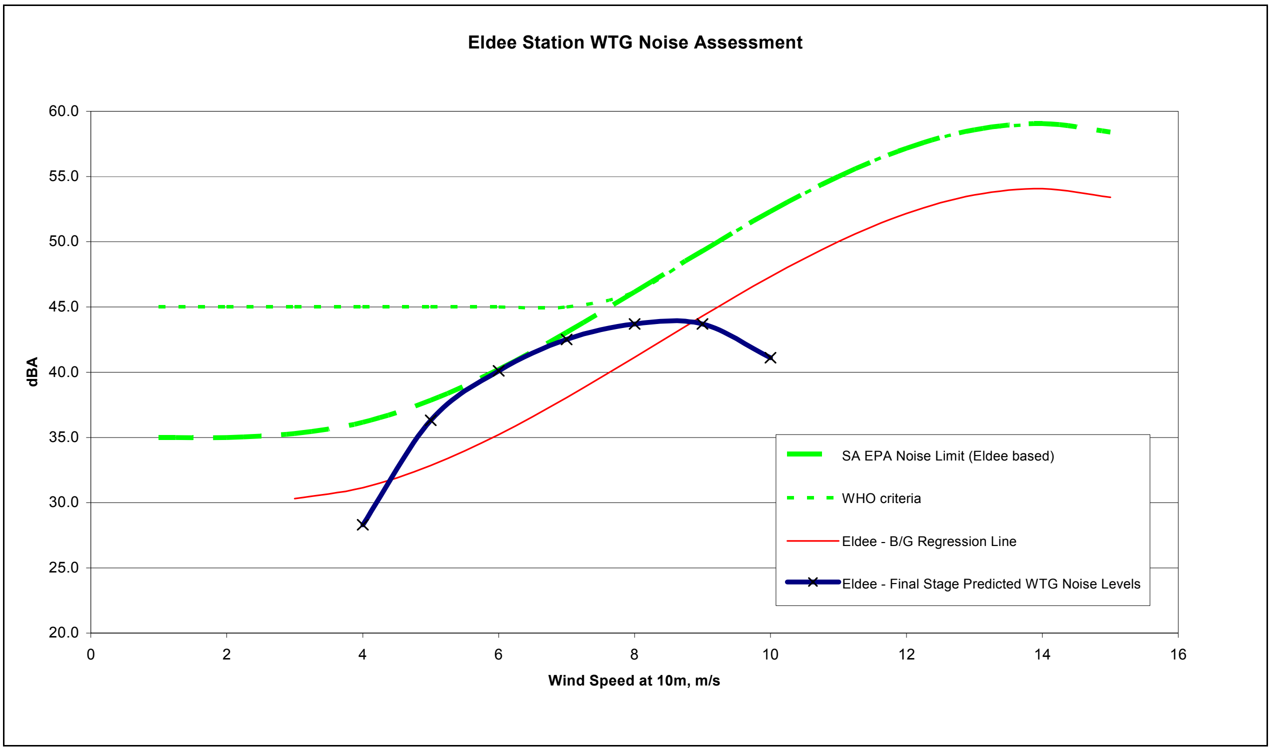
E29	523998	6491517	Stage 2 - Eldee				
E30	524594	6491597	Stage 2 - Eldee				
E31	525614	6491649	Stage 2 - Eldee				
E32	525279	6491737	Stage 2 - Eldee				
E33	525951	6491801	Stage 2 - Eldee				
E34	524946	6491848	Stage 2 - Eldee				
E35	528321	6491939	Stage 2 - Eldee				
E36	527899	6492100	Stage 2 - Eldee				
E37	525208	6492158	Stage 2 - Eldee				
E38	526143	6492383	Stage 2 - Eldee				
E39	526375	6492551	Stage 2 - Eldee				
E40	525251	6492556	Stage 2 - Eldee				


Eldee Station WTG Noise Assessment
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50.0
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40.0
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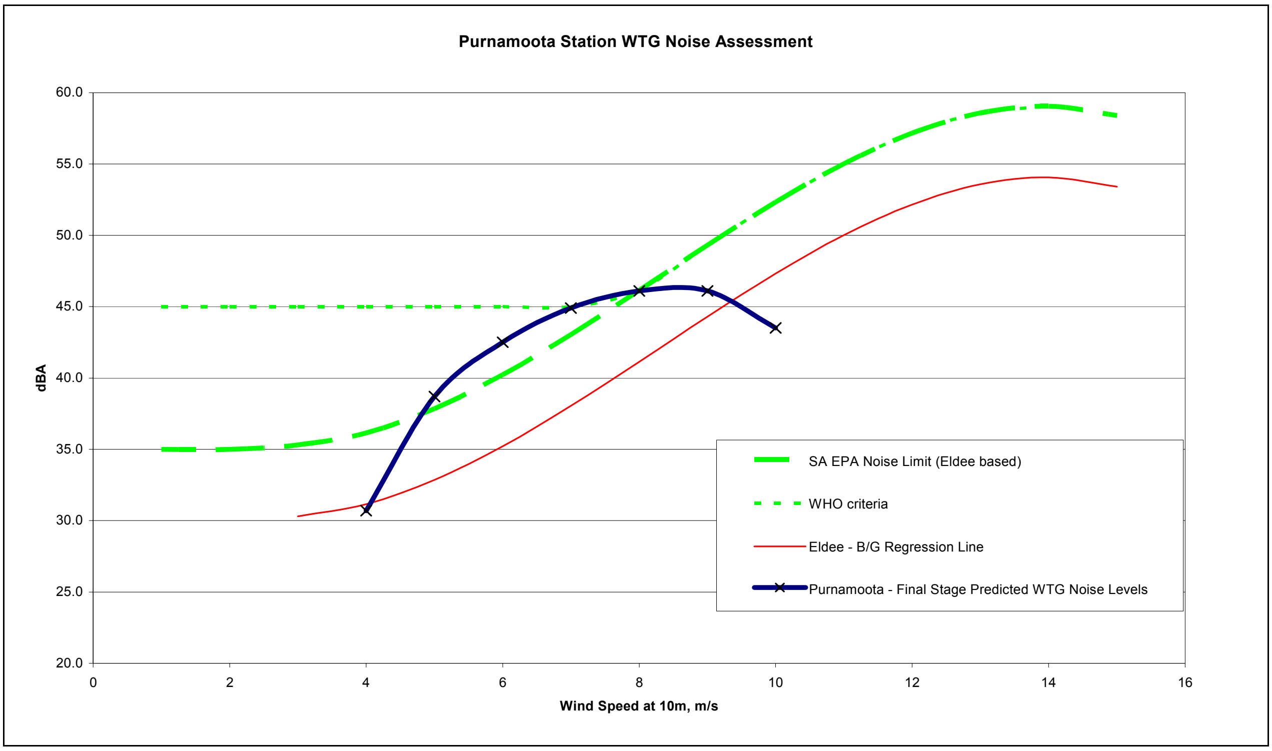
30.0
25.0
20.0
0
2
4
6
8
10
12
14
16
Wind Speed at 10m, m/s
SA EPA Noise Limit (Eldee based)
WHO criteria
Eldee - B/G Regression Line
Eldee - Final Stage Predicted WTG Noise Levels


Purnamoota Station WTG Noise Assessment
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50.0
45.0
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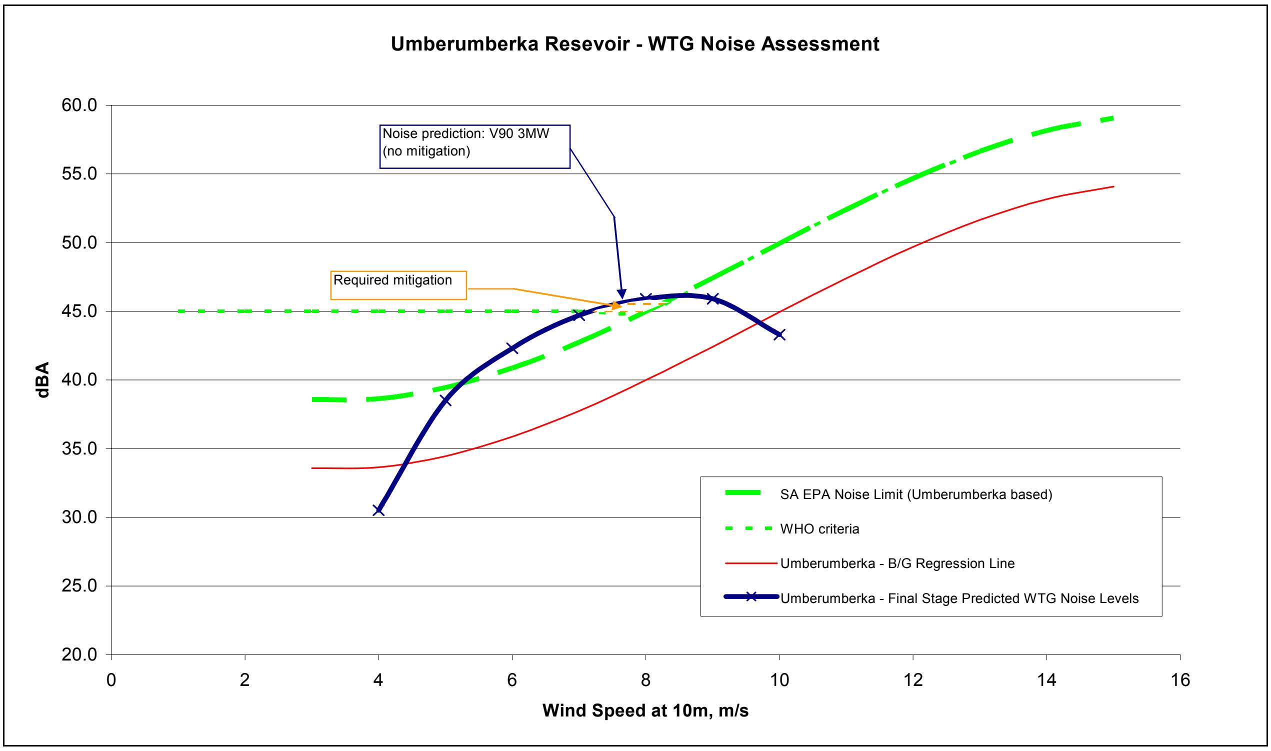
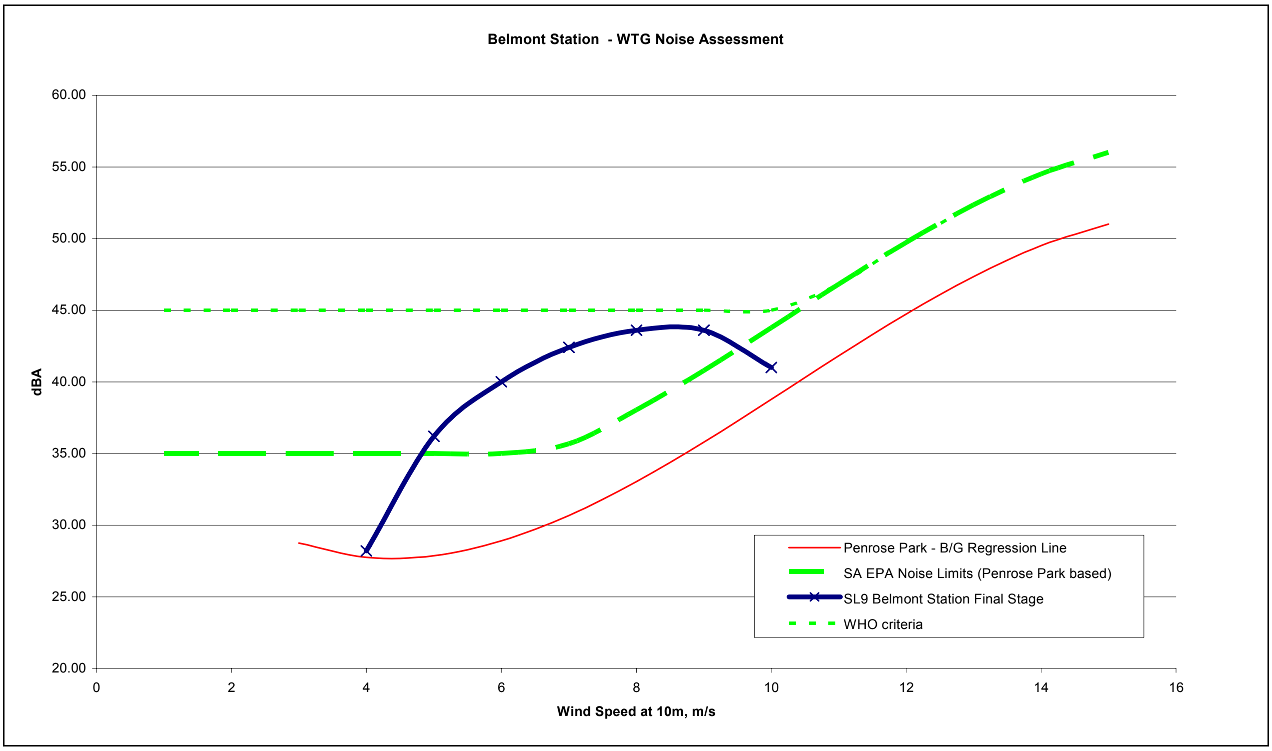
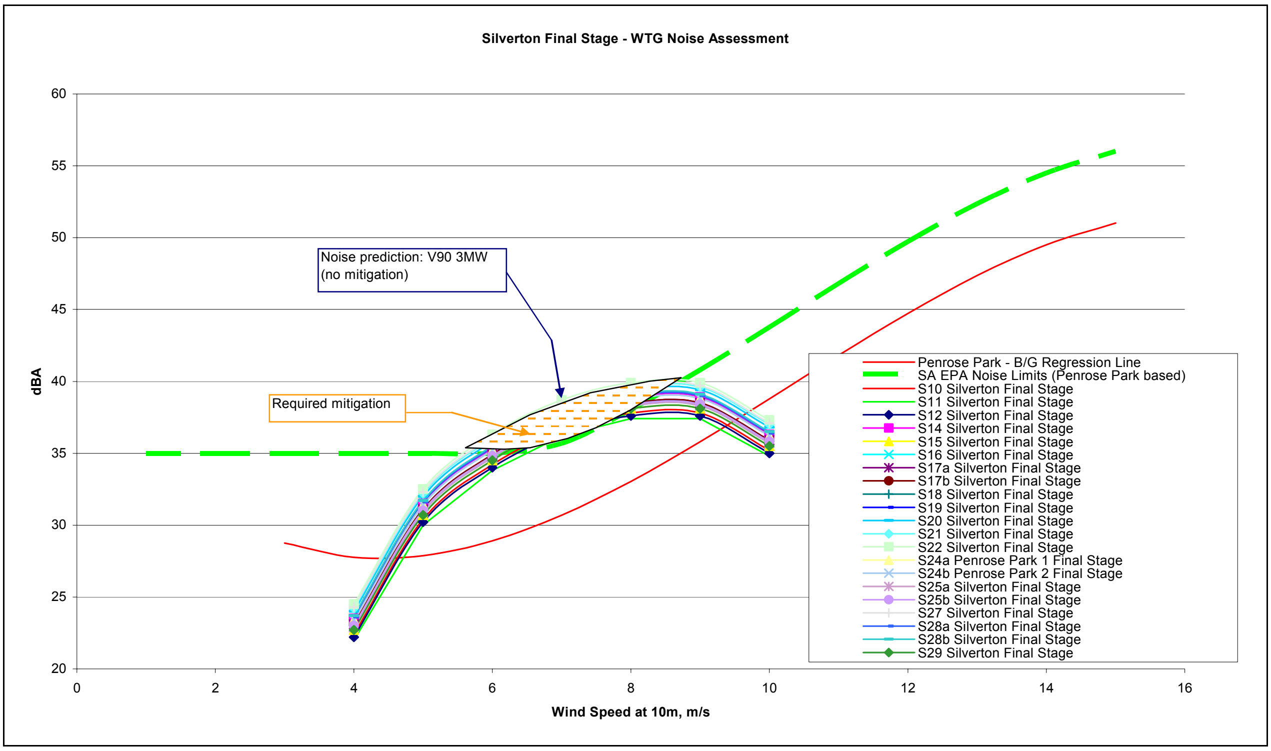
30.0
25.0
20.0
0
2
4
6
8
10
12
14
16
Wind Speed at 10m, m/s
SA EPA Noise Limit (Eldee based)
WHO criteria
Eldee - B/G Regression Line
Purnamoota - Final Stage Predicted WTG Noise Levels


Umberumberka Resevoir - WTG Noise Assessment
Noise prediction: V90 3MW (no mitigation)
Required mitigation
dBA
60.0
55.0
50.0
45.0
40.0
35.0
30.0
25.0
20.0
0
2
4
6
8
10
12
14
16
Wind Speed at 10m, m/s
SA EPA Noise Limit (Umberumberka based)
WHO criteria
Umberumberka - B/G Regression Line
Umberumberka - Final Stage Predicted WTG Noise Levels


Belmont Station - WTG Noise Assessment
dBA
60.00
55.00
50.00
45.00
40.00
35.00
30.00
25.00
20.00
0
2
4
6
8
10
12
14
16
Wind Speed at 10m, m/s
Penrose Park - B/G Regression Line
SA EPA Noise Limits (Penrose Park based)
SL9 Belmont Station Final Stage
WHO criteria


Silverton Final Stage - WTG Noise Assessment
60
55
50
45
40
35
30
25
20
dBA
0
2
4
6
8
10
12
14
16
Wind Speed at 10m, m/s
Noise prediction: V90 3MW
(no mitigation)
Required mitigation
Penrose Park - B/G Regression Line
SA EPA Noise Limits (Penrose Park based)
S10 Silverton Final Stage
S11 Silverton Final Stage
S12 Silverton Final Stage
S14 Silverton Final Stage
S15 Silverton Final Stage
S16 Silverton Final Stage
S17a Silverton Final Stage
S17b Silverton Final Stage
S18 Silverton Final Stage
S19 Silverton Final Stage
S20 Silverton Final Stage
S21 Silverton Final Stage
S22 Silverton Final Stage
S24a Penrose Park 1 Final Stage
S24b Penrose Park 2 Final Stage
S25a Silverton Final Stage
S25b Silverton Final Stage
S27 Silverton Final Stage
S28a Silverton Final Stage
S28b Silverton Final Stage
S29 Silverton Final Stage

This discussion regarding ISO9613-2 noise prediction algorithms follows some preliminary comments received from DECC, namely;

> It is noted that SoundPlan has been used to model the noise impacts using the ISO9613 package (noise algorithms). It is correctly acknowledged in the NIA that ISO9613 is a downwind model, that is the predicted levels consider downwind propagation. However, ISO9613 states that it considers wind speeds between 1 to 5 m/s. Noise from wind farms can propagate up to cut out speed which is significantly greater than 5 m/s. Validation, calibration and verification from the proponent that the constructed model can accurately predict wind farm noise based on published or recognised studies should be included in the EA.
>
> It is noted that the study; 'Development of a Wind Farm Noise Prediction Model, CEC Joule Project Report JOR3-CT95-0051,2000' recommends several modifications to the ISO9613 model to increase its accuracy under certain conditions. The modification came from empirical testing of the model. The EA should indicate whether the recommended modifications to the prediction modeling are applicable to this project and whether they have been applied.

It is worth noting that wind enhanced noise propagation is not caused directly by the wind (or wind speed) but rather by the vertical wind gradient (shear profile), the greater the wind gradient the greater the extent of refraction or bending of sound waves. Furthermore, the vertical wind gradient is generally always greatest at and close to the ground level, and hence ground level based noise sources are those most affected by wind enhanced propagation effects.

Most noise prediction algorithms are empirically derived from measurement of noise from ‘close to ground’ based noise sources, where these effects are greatest. Wind shear at higher altitudes where WTG’s operate (80-100m) is not as pronounced as at ground level, which results in wind enhanced noise propagation not being as significant an effect compared to ground based noise sources.

A study by Bass, Bullmore and Sloth[1] conducted comprehensive noise propagation measurements from an elevated noise source to varying distances over various terrain types. Noise levels at all of the monitoring locations around all of the sites were calculated using various selected calculation procedures including IEA, ISO9613-2, ENM and CONCAWE. The study found that for flat, rolling and complex terrain sites ISO9613 had impressive accuracy, predicting noise levels to within 1.5 dBA of levels measured under conditions of an 8 m/s positive wind vector. Furthermore, they noted that the output of ISO9613 was not unduly sensitive to meteorological input parameters when compared to ENM.

Some exceptions to the prediction accuracy were discussed with recommendations for modifications to improve possible shortcomings. These include the case of marginal or partial screening, with a maximum barrier effect limit of 3 dBA. In the case of elevated WTG noise sources no acoustic shielding is provided by topography to the nearest dominant turbines and therefore this exception will not have a significant effect on predicted noise levels and no additional correction is therefore justified.

The second exception was where the ground falls away significantly between the source and the receiver, such that the mean propagation height is at least 1.5x that over flat ground and particularly where the ground falls away from the receiver. In this circumstance a 3 dBA correction should be applied. Receivers surrounding the Silverton Wind Farm Project are generally on very flat terrain, and the ratio of mean propagation height between Silverton and the nearest elevated WTG is only 1.1 compared to flat ground. No additional correction is therefore justified.

A further study conducted by Plovsing and Kragh[2] of Delta Acoustics in Denmark for the EU Commission, developed heuristic noise prediction algorithms that would more specifically model noise propagation from wind farms. The developed model, WiTuProp, was comprehensively tested against measured levels for a range of conditions and showed excellent agreement, particularly under downwind conditions. The algorithms of WiTuProp were later adopted in a more advanced prediction model, Nord 2000.

A conference paper presented at Auswind 2004 by Sloth[3] presented some comparisons for WiTuProp/Nord2000 and ISO9613-2. One summary given was that if Nord2000 were not able to be used then the best alternative model was ISO9613-2 with a hard ground assumption.

A conference paper presented at Acoustics 2004 by Tickell, Ellis and Bastasch[4] compared the predicted noise levels from a variety of models including WiTuProp, CONCAWE (ENM), CadnaA (ISO9613-2), NPL and DR04173. The results of the comparison show ISO9613-2 to be more conservative than WiTuProp for all distances and all ground hardness assumptions.

On the basis of the above presentations, comparisons and verifications the implementation of ISO9613-2, with 100% hard ground assumption has been chosen as an appropriate and conservative approach for noise prediction for WTG's in this project.

[1] JH Bass, AJ Bullmore and E Sloth, "Development of a wind farm noise propagation model" Contract JOR3-CT95-0051 Jan 96 - May 98

[2] Birger Plovsing and Jorgen Kragh, *"Wind Turbine Noise Propagation Model" Contract JOR3-CT95-0065 - 6 March 1998*

[3] Erik Sloth, "*Problems related to the use of the existing noise measurement standards when predicting noise from wind turbines and wind farms" AUSWIND 2004, Launceston*

[4] Tickell, Ellis and Bastasch, *"Wind Turbine Generator Noise Prediction - Comparison of Computer Models" ACOUSTICS 2004, Gold Coast*