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CONNAH'S QUAY POWER STATION: ENVIRONMENTAL NOISE SURVEYS, NOVEMBER AND DECEMBER 2013

prepared for
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SUMMARY

Environmental noise surveys have been completed at key residential receptors around Connah's Quay Power Station. The surveys took place on the 26 November 2013 and 2/3 December 2013 and included measurements during evening and night time periods. The operation of the plant during the surveys was broadly typical of the current operational pattern for the site. On each occasion the generating units shutdown mid to late evening and then recommenced generation early/mid-morning; the Gas Treatment Plant was processing gas at a variable rate throughout the period.

The community noise climate is dominated by traffic noise and the noise contribution from the site is only consistently apparent at the nearest residential receptors (Woodfield 'Railway' Cottages and Kelsterton Farm). At more distant residential receptors, it is only overnight when the number of vehicles using the road network decreases considerably that noise from the site becomes discernible. Due to the prevailing generation pattern for the plant, no units were on-load during the overnight periods, however the Gas Treatment Plant and some cooling towers (cooling water pumps, cooling water and Purge Pond Cooling Tower) were operational throughout the periods.

The noise signature from the site is made up of contributions from a wide variety of plant items and their relative dominance varies between each residential receptor. During lulls in traffic noise, the Purge Pond Cooling Tower is the most identifiable source at the Woodfield 'Railway' Cottages whilst at Kelsterton Farm, the main cooling towers are the power station noise source that is most prominent.

Overall, it is estimated that the specific plant levels from site were similar or less than the whole-site predicted noise levels for the EA approved modifications to the Unit 1 and 2 cooling towers. A BS 4142 assessment of the site noise at Rockcliffe Cottages is broadly consistent with preceding studies; however the prominence of the Purge Pond Cooling Tower contribution at Woodfield 'Railway' Cottages also makes the BS 4142 rating level similarly high as the previous assessment. It is understood that operational restrictions at the time prevented the Purge Pond Cooling Tower fan from being taken out of service. If it has not occurred already, it is recommended that further remedial work to the fan's gearbox/motor takes place as soon as possible to mitigate this item of plant's contribution to the environmental noise climate and minimise the potential for future degradation.

An assessment of noise levels and spectra measured at nine on-site monitoring locations has also been undertaken. There was no overnight generation at the time of the surveys so the measurements had to be taken during early evening periods prior to plant shutdown. Undesirable contributions from traffic noise sources have compromised the overall noise levels and spectral data at the key positions (3, 4 and 5), and has meant that the assessment has been inconclusive.

It is recommended that contemporaneous notes about relative dominance of noise sources are made in the future to assist in future data trend assessments.

Prepared by

Master report signed by K Brown & T A Hill, 11 August 2014

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CONTENTS

1 INTRODUCTION

At the request of Connah's Quay Power Station, E.ON Technologies (Ratcliffe) Ltd have undertaken a series of environmental noise measurements to characterise and quantify the current noise impact of the plant's operation upon the community. The survey was completed during a period of typical plant operation on two separate occasions in November and December 2013.

2 SITUATION

Details of the residential receptors considered in this survey are given in Table 1 and shown in Figure 1. Typically, the highest steady noise levels will be generated when all four generating units are at full load and the Gas Treatment Plant (GTP) is processing and exporting gas. However, due to the prevailing electricity demand and market, these circumstances did not occur at the time of the surveys. Although all four units were available for generation during the survey periods, none were on-load between 22:00 and 06:00. For operational and plant integrity reasons the Purge Pond Cooling Tower (PPCT) and main cooling tower pumps (circulating water and causing broad band waterfall noise from the wet-stages of the towers) typically continue to run even though the units are shutdown.

This pattern of plant operation means that the higher noise emissions from site during on-load operation coincide with periods of the day and evening when residual ambient noise levels from traffic are also elevated. Furthermore, any step changes in site noise emissions that occur for the shutdowns and start-ups occur at the time that traffic flows are subsiding or rising respectively. Consequently, although the measurements cannot be considered to be representative of the noisiest plant state and greatest impact (4 units on overnight) they are typical of current winter operation.

During the 26 November 2013 survey the winds were between 2-3 m/s from a W/NW direction during the evening. The wind strengthened overnight and into the next morning – which prevented any meaningful measurement of noise levels during early morning start-up of the plant. During the 2/3 December 2013 survey the wind speed was considerably lower and calm/light SW conditions prevailed from evening through into morning, and weather did not compromised this particular exercise.

3 MEASUREMENTS

Precision sound level meters were used meeting the requirements of BS EN 60651 and 60804 Type 1 or BS EN 61672 Class 1. All measurement apparatus used are maintained in calibration by regular certification, with an accredited laboratory, to BS 7580-1. Each set of measurements was preceded and followed by a calibration check using the sound level meter's acoustic calibrator. No significant drift in meter response was detected during the exercise. Calibration certificates for the equipment used in the survey are given in Figure 2.

The primary measurements were undertaken at the nearest residential locations. These positions are known to be strongly affected by traffic noise, so unattended continuous measurements were also taken at two on-site locations where residual ambient noise levels are less. For security reasons the continuous noise monitoring equipment was deployed within the site boundary. One of the positions was chosen to be close to Woodfield 'Railway' Cottages and the other was at the southern edge of the site, in the direction of Kelsterton Road.

The continuous unattended sound level meters were configured to measure overall L_{Aeq}, L_{A10} and L_{A90} levels. The meter used for the off-site survey was configured to measure 1/3rd octave band L_{Aeq}, L_{A10}, L_{A90} and L_{A99} levels. Narrow band Fast Fourier Transform (FFT) measurements were also made to support the subjective noise signature observations. The survey consisted of performing 5 minute duration samples at each of the residential receptor locations during the day, evening and night periods. (Note: strictly speaking BS 4142 requires day and evening measurements to be of 1 hour duration but to allow measurements to be undertaken at several receptors in turn, shorter 5 minute measurements were taken; these shorter sampling measurements are still considered to be broadly representative of the noise climate).

4 RESULTS AND ASSESSMENT

The ambient noise climate is dominated by traffic noise and so the L_{Aeq} level is often not a reliable measure of the plant noise level contribution at off-site locations. The majority of on-load measurements were made during evening and early morning periods when there were significant noise contributions from near and distant traffic flows. This meant that any lulls in the traffic noise during which the noise climate might be attributable to the power station operation were relatively infrequent. Ordinarily (under variable residual ambient noise circumstances) an estimate of the specific noise from the steady operation of an industrial plant can be derived from the L_{A90} index.

Typically it is only when the traffic subsides overnight that the L_{A90} becomes truly indicative of the plant noise contribution, therefore it is informative to also consider the L_{A99} value in an attempt to identify the plant noise contribution within short lulls in the day and evening traffic noise. The overall L_{A10}, L_{A90}, L_{A99} and L_{Aeq} measured during the survey on the 26 November 2013 are shown in Tables 2 and for 2-3 December 2013 in Table 3.

Due to the 26 November survey being affected by weather, these results shall not be considered any further in this assessment. The values from the 2-3 December survey are highlighted in bold (italics if off-load or underlined if on-load) are considered to represent the best estimate of the specific noise level from the plant at various receptors. Where no value is highlighted in bold-italics it is considered that none of the level metrics were representative of the specific noise level of the plant. The results from the continuous monitoring that took place at on-site locations 'Near railway' (relevant to Woodfield 'Railway' Cottages) and South edge of site corner are shown in Figure 3. In November the ambient background noise level is noticeably raised during the overnight off-load compared to the equivalent period in December, demonstrating the effect of additional wind induced noise and confirming that the data was atypical and not worthy of further analysis.

The noise levels at the two locations in December show a strong correlation, especially the L_{A90}, and suggest that when contributions from other ambient noise sources subside (00:00 to 04:00) and the plant activities become the dominant steady noise source, levels are around 43dBA L_{A90} at the 'Near Railway' and 44dBA L_{A90} at the southerly edge of the site. At the continuous monitoring positions there are periods when the difference between the L_{Aeq} and L_{A90} are as low as 1dB. This level of difference between the two metrics shows that the plant noise emissions are predominantly steady and further suggests that the specific L_{Aeq} from the plant experienced off-site can be estimated from the measured off-site L_{A90} level (i.e. $L_{Aeq} = L_{A90} + 1dB$). The most reliable L_{A90} results to use as the basis for specific noise estimates are highlighted in Table 3.

Note: The timing of the unit shutdowns and start-ups relative to the diurnal ambient level pattern is unfortunate because at face value the ambient L_{A90} noise level appears to be strongly affected by the station's operations. In fact it is the late evening decrease and early morning

increase in traffic flow that is primarily responsible for the noise level changes at most of the residential locations. This sensitivity is particularly apparent in the significant changes in L_{A90} levels at Rockcliffe cottages and Kelsterton Farm between 21:30-22:30 and 04:30-05:30 where the plant was off-load. See Figure 4 which shows the time history of on- and off-site L_{A90} levels.

The power station plant has operational noise limits within its consent conditions, however revised levels were suggested within the modelling assessment which accompanied the permit variation for modification to the cooling towers (PT/07/LC1202/R, March 2008). Although there was no overnight generation during the survey, it remains appropriate to compare the night time measurements with the revised values in the 2008 permit variation (see Table 4). During the survey the specific L_{Aeq} noise levels arising from site operational activities were similar or less than the model predictions at all locations.

Observations of the noise climate during the 2-3 December survey are given in Table 3, and comprehensive details of the discernibility and character of the noise from the site are given in Table 4. When site noise is discernible during lulls in the traffic, this is considered to be predominantly attributable to noise from the PPCT. Narrow band Fast Fourier Transform (FFT) spectra measured at selected receptors during the evening and night periods are shown in Figure 5. Where possible these measurements were taken during breaks in the traffic noise and therefore represent a robust characterisation of the site signature. The FFT spectra presented in Figure 5 have been analysed for tonal prominence in broad accordance with the requirements of ISO 1996-2 Appendix B. The data was analysed for the known cooling tower tones at 370Hz and PPCT tones (253Hz, 506Hz and tone 709-759Hz).

None of the on-load data during evening/early morning periods are assessed as having tones that should attract a penalty (which would range from 0 to 6dB). When the plant was off-load overnight but with some of the cooling tower plant still running, the tones are not so readily masked by lower overnight background noise. At Woodfield Railway Cottage the spectra measured at 04:31 is assessed as having tones which attract penalties (1dB penalty for tone around 370Hz and 5dB penalty for tones clustered around 730Hz). At Kelsterton Farm at 04:43 the 370Hz tone from the main cooling towers is assessed as being sufficiently audible relative to other broadband noise that it attracts a 3dB penalty according to ISO 1996.

The spectra measured suggest that the noise climate has a tonal signature at the Woodfield 'Railway' Cottages and Kelsterton Farm locations and should be attracting a 5dB 'penalty' according to BS 4142. At Kelsterton Farm the off-load spectrum is deemed to be tonal during quiet overnight periods. It is presumed that the dominance of the cooling towers would also prevail and render the site tonal at this location in the event of on-load operation overnight. At other locations the historic character of the plant and relative dominance of certain plant sources suggests that the plant would not be prominently tonal at these locations during on-load operation.

The PPCT is the prominent noise source affecting the Woodfield 'Railway' Cottages area. This was identified in the previous year's survey, hence it is informative to compare the current spectrum (both in terms of character and magnitude) with the equivalent spectrum from 2012. This is shown in Figure 6. Despite remedial work having taken place in 2013, the current signature is very similar to that measured in the previous survey. It is understood that even when the main plant is off-load the PPCT is kept running for cooling purposes and also because its gearbox is prone to being damaged during restart. It is recommended that further investigations are undertaken to mitigate the noise emissions from the tower and possibly improve the robustness of the plant to allow it to be safely shutdown when not required.

4.1 BS 4142 Assessment

In general, the steady and intermittent noise climate at residential locations is dominated by traffic on the nearby roads. It is typically only when traffic flows subside to a minimum between 01:00 and 04:00 that the steady noise contribution from the site becomes more noticeable. Although there was no generation activity overnight, there was sufficient auxiliary plant operation for the noise from the plant to be discernible at three of the residential locations. Specific and rating levels from the plant are compared to overnight background noise levels in Table 6, to allow a BS 4142 assessment. The table shows specific and rating levels from the plant compared to overnight background noise levels. According to BS 4142 the difference between the rating level, L_{Ar}, and the background, L_{A90}, is an indication of the likelihood of public complaint. The Table 6 results show the likelihood of complaint ranges from *'marginal significance'* at Rockcliffe Cottages to *'likely'* at Woodfield 'Railway' Cottages and Kelsterton Farm.

5 ON-SITE ROUTINE MONITORING

The power station's environmental monitoring programme advises that periodic monitoring of the plant's noise 'footprint' should take place. Measurements at the nine on-site locations were made during 2013 and the results have been compared to previous spectra to determine whether any new noise features/degradations have occurred; see Appendix A.

The operational pattern of the power station meant that in order to survey whilst the plant was generating the exercise had to take place during early evening periods. At this time ambient contributions from ambient noise sources affects the robustness of the results.

6 CONCLUSIONS

At more distant residential receptors, it is only during the night time period when the number of vehicles using the road network decreases considerably that noise from the site becomes discernible. Due to the prevailing generation pattern for the plant, no units were on-load during the overnight survey, however the Gas Treatment Plant and some cooling towers (Unit 4 and Purge Pond Cooling Towers) were operational throughout.

The noise signature from the site is made up of contributions from a wide variety of plant items and the relative dominance of contribution varies between each residential receptor. During lulls in traffic noise, the PPCT is the most identifiable and distinctive site noise source at the Woodfield 'Railway' Cottages and the gearboxes on the main cooling tower are discernable at Kelsterton Farm.

Overall, the specific plant levels from site were similar to or less than the predicted noise levels for the EA approved modifications to the Unit 1 and 2 cooling towers. When the character of the noise is taken into account in a BS 4142 assessment the prominence of the PPCT contribution at Woodfield 'Railway' Cottages and Kelsterton Farm makes the BS 4142 rating similar to 2012 levels and a positive indication that complaints are likely.

The on-site surveys yielded a wider variety of results than previous years which were partially attributable to the prevailing plant operation at the time. There were some unexplainable deviations from historic trends, however any increase in spectrum component was not consistently apparent in subsequent surveys.

7 RECOMMENDATION

It is recommended that further remedial work to the PPCT fan's gearbox/motor takes place to mitigate this item's contribution to the environmental noise climate.

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BS 4142 :1997. Method for rating industrial noise affecting mixed residential and industrial areas.

GLOSSARY

dB	Decibel. Used here to represent the sound pressure level, P, expressed as twenty times the logarithm of the ratio of this pressure to a reference pressure, P_0, 20×10^{-6} N/m^2. Thus dB = $20 \times \text{Log}_{10}(P/P_0)$.
dBA	As above except that the measured sound is first subject to a frequency weighting, known as the 'A' weighting, which is designed to compensate for the varying sensitivity of the human ear to sounds of different frequency.
$L_{A90,T}$	The A-weighted sound level exceeded for 90% of the measurement period of duration T.
$L_{Aeq,T}$	The equivalent steady dBA sound level containing the same acoustic energy as the actual, measured, fluctuating level.
$L_{A.r}$	The specific equivalent continuous dBA sound pressure level, rated upwards by 5dB if tonal or intermittent in character.
$L_{C90,T}$	The 'C'-weighted sound level exceeded for 90% of the measurement period of duration T.
$L_{Ceq,T}$	The equivalent steady 'C'-weighted sound level containing the same acoustic energy as the actual, measured, fluctuating level.
1/3rd octave bands	An octave is a doubling or halving of frequency. One-third octave bands are even finer sub-divisions of the frequency range that are centred at specific frequencies, i.e. 125,160, 200, 250, 315,400, 500Hz etc.
FFT	Fast Fourier Transform – narrow band analysis to reveal tonal components with a measurement spectrum.

BS 4142 (1997) provides a procedure which can be used to assess the likelihood of public complaint based on the difference between the rated $L_{A,r}$ noise level from the installation and the background L_{A90} noise level, as follows:

$L_{A,r} - L_{A90} <$ -10 dB, then complaints are very unlikely
$L_{A,r} - L_{A90} >$ +10 dB, then complaints are very likely
$L_{A,r} - L_{A90} \approx$ +5 dB, then the likelihood of complaints is of 'marginal significance'

If there is a tonal, intermittent or percussive feature in the source noise then an additional 5 dB is to be added to the L_{Aeq} specific noise source level in recognition that it is more likely to attract attention.

Within this report, some additional terms have also been used to describe those situations where the level difference lies in between the three criteria described above.

PLANT ABBREVIATIONS

BHP AGI	BHP Above Ground Installation compound
PPCT	Purge Pond Cooling Tower
GTP	Gas Treatment Plant

Table 1: Details of monitoring positions

Position	Grid Reference Easting: Northings	Distance to Power Station centre/m (Approx)
102 Kelsterton Road	327960, 370700	380
Rockcliffe Cottages	327150, 371265	830
Kelsterton Farm	327565, 370800	480
Woodfield 'Railway' Cottages	327415, 371110	540
Kelsterton Gatehouse#	327905, 370720	360

Note Kelsterton Hostel Gatehouse was stated within the Power Station's original Operational Noise Programme. However due to it and other properties on Kelsterton Road being screened by the A548 carriageway, surveys have historically concentrated on quantifying the nearby noise climate with measurements based at 102 Kelsterton Road only.

Supplementary noise monitoring was also undertaken near the Sheiling/Wenlo properties (see Figure 1) however subsequent assessments have concentrated on the key residential properties stated in the Operational Noise Programme where historic data exists.

Table 2: Off-site survey results 26 November 2013

Location	Time	L_{Aeq}	L_{A10}	L_{A90}	L_{A99}	Comment
102 Kelsterton Road	17:55	62.0	64.6	57.3	55.5	Traffic noise from B5129 and A548 dominant L_{Aeq} and L_{A90} source. Power station noise indiscernible.
	19:43	57.9	61.7	48.9	45	
Kelsterton Farm	17:44	57.6	60.0	54.1	49.4	Traffic on B5129 and A548 is the dominant L_{Aeq} and L_{A90} Power station noise only discernible during lulls.
	18:38	56.0	58.7	51.2	48.3	
	19:31	54.3	57.4	49.4	46.7	
	20:33	54.0	57.6	46.5	44.1	
Rockcliffe Cottages	17:15	61.2	62.8	56.7	54.9	Traffic A548 is the dominant L_{Aeq} and L_{A90}. Power station noise indiscernible.
	18:08	60.9	63.9	55.5	51.1	
	18:59	57.7	59.5	52.2	47.1	
	19:56	56.2	59.7	49.5	46.5	
Sheiling/ Wenlo	17:23	57.8	58.3	52.7	51.0	Traffic on A548 is the dominant L_{Aeq} and L_{A90}. Power station noise discernible during lulls in later evening.
	18:16	57.9	59.7	51.2	47.9	
	19:06	54.8	57.7	48.7	45.5	
	20:04	51.5	53.3	47.1	45.4	
Woodfield Railway Cottages	17:34	63.0	65.9	57.6	53.8	Traffic on B5129 and A548 is the dominant L_{Aeq} and L_{A90} Power station noise discernible during lulls. Foliage/Wind noise.
	18:26	61.2	63.9	54.8	52.4	
	19:16	58.3	61.7	49.8	45.5	
	20:15	55.6	59.8	48.0	45.9	
Plant Conditions	Unit 1, 3 and 4 on load initially. No measurements made at night due to plant being shut-down and breezy wind conditions.					
Meteorological Conditions	2-3 m/s wind from N/NW, 100% cloud cover. 8-9°C & 80-90% RH					

Table 3: Off-site survey results 2-3 December 2013

	Time	L_{Aeq}	L_{A10}	L_{A90}	L_{A99}	Comment
102 Kelsterton Road	15:57	64.3	66.7	57.9	55.8	Traffic noise from B5129 and A548 dominant L_{Aeq}, L_{A90} and L_{A99} source. Power station noise indiscernible even during lulls in traffic.
	18:53	59.3	62.7	52.4	45	
	20:51	57.5	61.1	45.6	42.6	
	21:45	55.0	59.9	40.3	36.1	
	04:47	52.2	54.8	35.3	34.0	
	05:47	57.2	61.4	48.6	42.8	
	06:34	58.2	62.2	50.8	49.0	
Kelsterton Farm	15:48	59.5	61.9	55.2	52.7	Traffic noise from B5129 and A548 dominant L_{Aeq} and L_{A90} source during afternoon and early morning period. Power station noise discernible during lulls in traffic. (Hum from main cooling tower area). Late evening and very early morning measurements – Power station auxiliary plant (Main Cooling tower and PPCT audible).
	16:39	60.2	62.3	57.0	55.2	
	18:38	56.3	58.9	51.4	49.2	
	19:42	53.5	56.8	46.6	43.3	
	20:29	52.6	56.0	44.7	**41.7**	
	20:35	51.8	55.5	44.5	**42.7**	
	20:44	50.4	54.3	43.0	**41.8**	
	21:34	49.9	53.6	42.6	40.7	
	22:24	47.6	52.0	34.7	33.7	
	04:36	43.1	47.0	***35.0***	***33.8***	
	05:36	51.3	55.0	41.4	39.6	
	06:24	53.1	56.3	45.5	43.2	
Kelsterton Hostel	04:58	61.5	63.6	45.3	***36.2***	L_{Aeq} and L_{A90} levels mainly reflect traffic noise. L_{A99} is best estimate of plant noise (Cooling towers and pumps) at this location.
Rockcliffe Cottages	15:17	57.6	59.1	52.9	50.4	A548 traffic dominates L_{Aeq} and L_{A90} levels. Site noise (cooling towers and GTP) very minor and only discernible during lulls in traffic after 8pm. Additional intermittent noise from trains and wildlife.
	16:08	60.2	61.8	54.7	52.7	
	18:05	57.8	60.1	54.5	51.9	
	19:06	57.3	59.3	50.7	48.4	
	19:54	54.0	57.3	46.8	44.7	
	21:04	57.6	61.4	47.9	45.5	
	21:55	53.1	56.9	38.2	37.2	
	04:18	41.3	44.5	***36.2***	***35.4***	
	05:16	55.4	57.8	45.4	40.0	
	05:59	54.9	58.3	48.9	45.9	
Sheiling/ Wenlo	15:24	54.0	55.7	49.9	48.6	A548 traffic dominates L_{Aeq} and L_{A90} levels. Site noise (cooling towers and GTP) slightly more prominent than at Rockcliffe Cottages. Discernible during lulls in traffic throughout the period. Additional intermittent noise from trains and wildlife.
	16:16	57.3	57.1	52.7	51.2	
	18:12	53.6	55.6	49.9	47.9	
	19:17	50.5	52.9	45.6	42.6	
	20:04	51.0	53.2	46.2	44.4	
	21:14	49.1	52.0	**41.6**	**40.2**	
	22:02	51.1	53.7	46.7	44.3	
	05:09	52.3	55.1	45.5	***41.6***	
	06:05	52.9	55.6	47.8	45.6	
Woodfield Railway Cottages	15:37	59.9	63.2	52.3	49.6	A548 traffic dominates L_{Aeq} levels. GTP noise is discernible but PPCT is the main plant component. Drone/whine is discernible during traffic lulls throughout the period – but only becoming the principal contributor to the L_{A90} level for mid-evening onwards. Additional intermittent noise from trains and wildlife. Interestingly one of the residents of Woodfield 'Railway' Cottages was present for a short time during the late evening – but made no mention of site noise.
	16:27	60.9	64.3	54.5	51.4	
	18:23	60.6	63.7	54.6	52.3	
	19:31	57.2	61.5	45.7	**44.6**	
	20:14	57.7	61.5	50.9	48.5	
	20:22	58.0	61.9	50.9	49.3	
	21:24	56.9	60.0	49.0	46.6	
	22:13	55.4	58.9	45.4	43.7	
	04:27	52.8	57.5	***42.8***	***41.8***	
	05:26	59.9	63.4	49.2	46.5	
	06:15	58.6	62.1	51.7	49.0	
Plant Conditions	Units 2, 3 and 4 on load initially. Units coming off load 19:00-21:45. Unit 4 back on load 06:00 approx.					
Meteorological Conditions	Initially calm then light (1 m/s) from SW later, 100% cloud cover. 7-8°C & 70-80% RH					
Key	**nn.n** denotes the best estimate of site's noise contribution during on-load operation ***nn.n*** denotes the best estimate of site's noise contribution during no load operation.					

Table 4: Estimate of Specific Noise Level from Operations on the Site

Position	Representative L_{A90} or L_{A99} Nov/Dec 2013		Specific Noise Level from Site L_{Aeq} Nov/Dec 2013@		Predicted Specific Noise Level from Site following Cooling Tower Modifications#
	On Load	Off Load	On Load	Off Load	On Load (All Units)
102 Kelsterton Road	N/A	<34	N/A	<34	41.4
Rockcliffe Cottages	N/A	36	N/A	37	43.7
Kelsterton Farm	42	35	43	36	41.4
Woodfield 'Railway' Cottages	45	42	46	43	45.8

@ Specific noise level from site activities is estimated on the basis of the lowest measured L_{A90} (or L_{A99}) + 1 dB correction. The correction originates from the on-site continuous monitoring which is less susceptible to ambient noise contributions. i.e. at both on-site locations the L_{Aeq} was typically only 1 dB greater than the L_{A90} during quiet periods. See Figure 3.

Predicted post-modification noise levels, PT/07/LC1202/R, April 2008

Table 5: Subjective discernibility and character of noise from the Site

Location	Time Period		
	Late Afternoon	Evening	Overnight/Early Morning
102 Kelsterton Road	PS indiscernible due to traffic noise	PS indiscernible due to traffic noise	PS indiscernible
Kelsterton Farm	PS discernible but only during lulls in traffic	PS discernible but only during lulls in traffic	Main Cooling Towers are the main discernible steady noise source.
	[General industrial signature – low/mid frequency range from Cooling Towers]		
Rockcliffe Cottages	PS indiscernible due to traffic noise	PS only discernible during lulls in traffic	PPCTs are the main steady noise source. Minor contribution from GTP.
			[Low-Mid frequency drone/whine from PPCT. High frequency mixed industrial noise from GTP]
Woodfield 'Railway' Cottages	PS discernible during breaks in traffic.	PS discernible during breaks in traffic.	PPCT is the main steady noise source, Minor contribution from GTP.
	[Low/mid frequency signature from PPCT]		

Table 6: Specific, Background and Rating levels for BS 4142 Assessment

Position	Night time Background		Estimated Specific L_{Aeq} dB Noise Level from Site [Note 1]		Rating Level $L_{A,r}$ dB [Note 2]		Rating Level $L_{A,r}$ minus Background L_{A90} dB		Night-time BS 4142 Likelihood of Complaint	
	Aug'07 Mean L_{A90}	July'12 Mean L_{A90}	Plant On-load	Plant Off-load	Plant On-load	Plant Off-load	Plant On-load	Plant Off-load	Plant On-load	Plant Off-load
102 Kelsterton Road	33.2	33.3	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Kelsterton Farm	36.2	34.5	43	36	48	41	12-13	5-6	Likely	Marginal Significance
Rockcliffe Cottages	36.2	33.8	N/A	37	N/A	37	N/A	1-3	N/A	Marginal Significance
Woodfield 'Railway' Cottages	34.5	35.3	46	43	51	48	16	13	Likely	Likely

Note 1 Based on subjective observations and the noise signature from the plant is only considered to have a tonal character at the Woodfield 'Railway' Cottage and Kelsterton Farm positions during an on- and off-load operation. Therefore the Rating Level at these locations is 5 dB greater than the specific noise level. No penalty has been applied to the other locations.

Note 2 The specific level is for the following operation: Gas Treatment Plant, BHP Above Ground Installation, PPCT and Unit 4 Cooling Towers – no units were generating overnight.

Table 7: Comparison of Dec 2009/Dec 2010/Dec 2011, Nov2012 and Dec2013 BS 4142 Differences

Position	Period	Rating Level $L_{A,r}$ minus Background L_{A90}					
		December 2009	December 2010	December 2011	November 2012	Nov/Dec 2013	
						Off-Load	On-Load
102 Kelsterton Road	Night	+6	+6	+4	N/A	N/A	N/A
	Evening	+2	+2	0	N/A	N/A	N/A
	Day	-12	-12	-14	N/A	N/A	N/A
Kelsterton Farm	Night	+7	+12	+6	+5	+5	+12
	Evening	-2	+3	-3	N/A	-4	+3
	Day	-12	-7	-12	N/A	-14	-7
Rockcliffe Cottages	Night	+7	+7	+2	+5	+2	N/A
	Evening	-2	-2	-7	N/A	-7	N/A
	Day	-4	-5	-9	N/A	-9	N/A
Woodfield 'Railway' Cottages	Night	+10	+10	+7	+15	+13	+16
	Evening	+2	+2	0	N/A	+5	+8
	Day	-5	-5	-7	N/A	-2	+1

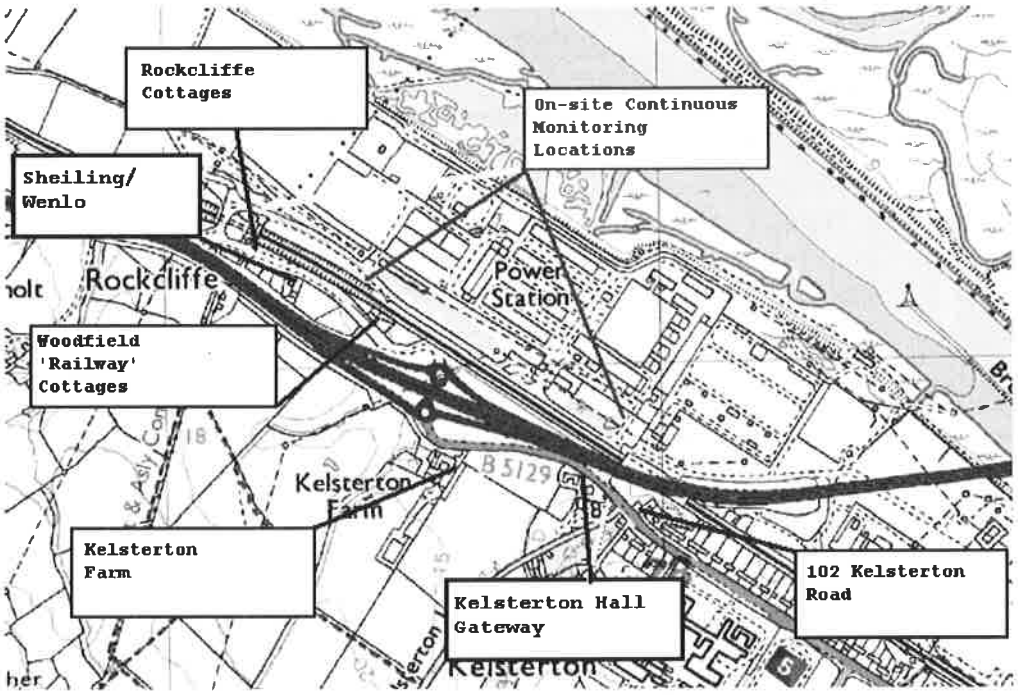
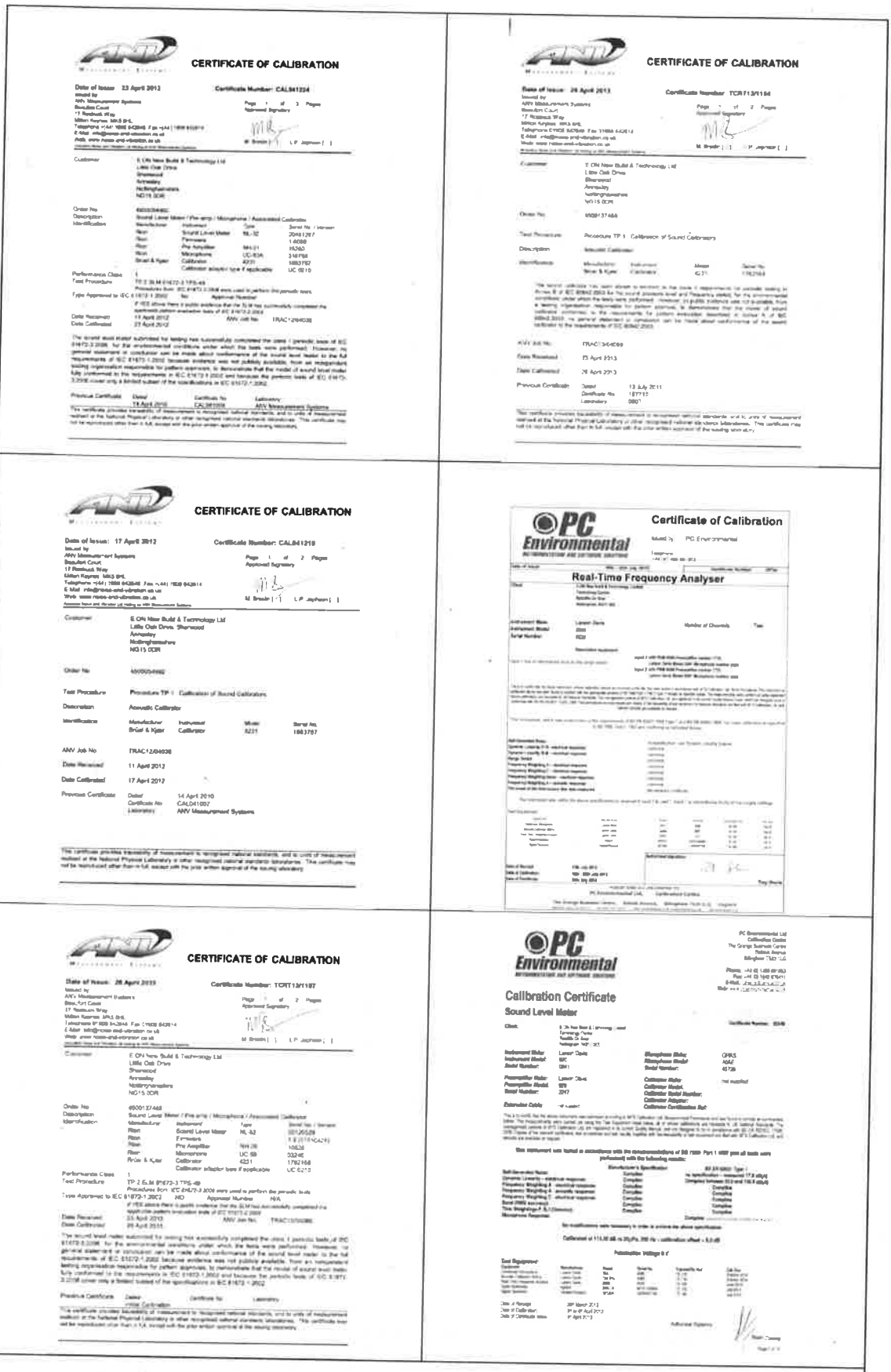


Figure 1: Map showing monitoring locations



CERTIFICATE OF CALIBRATION

CERTIFICATE OF CALIBRATION

CERTIFICATE OF CALIBRATION

Certificate of Calibration

Real-Time Frequency Analyser

CERTIFICATE OF CALIBRATION

Calibration Certificate

Sound Level Meter

Figure 2: Calibration certificates for equipment used in survey

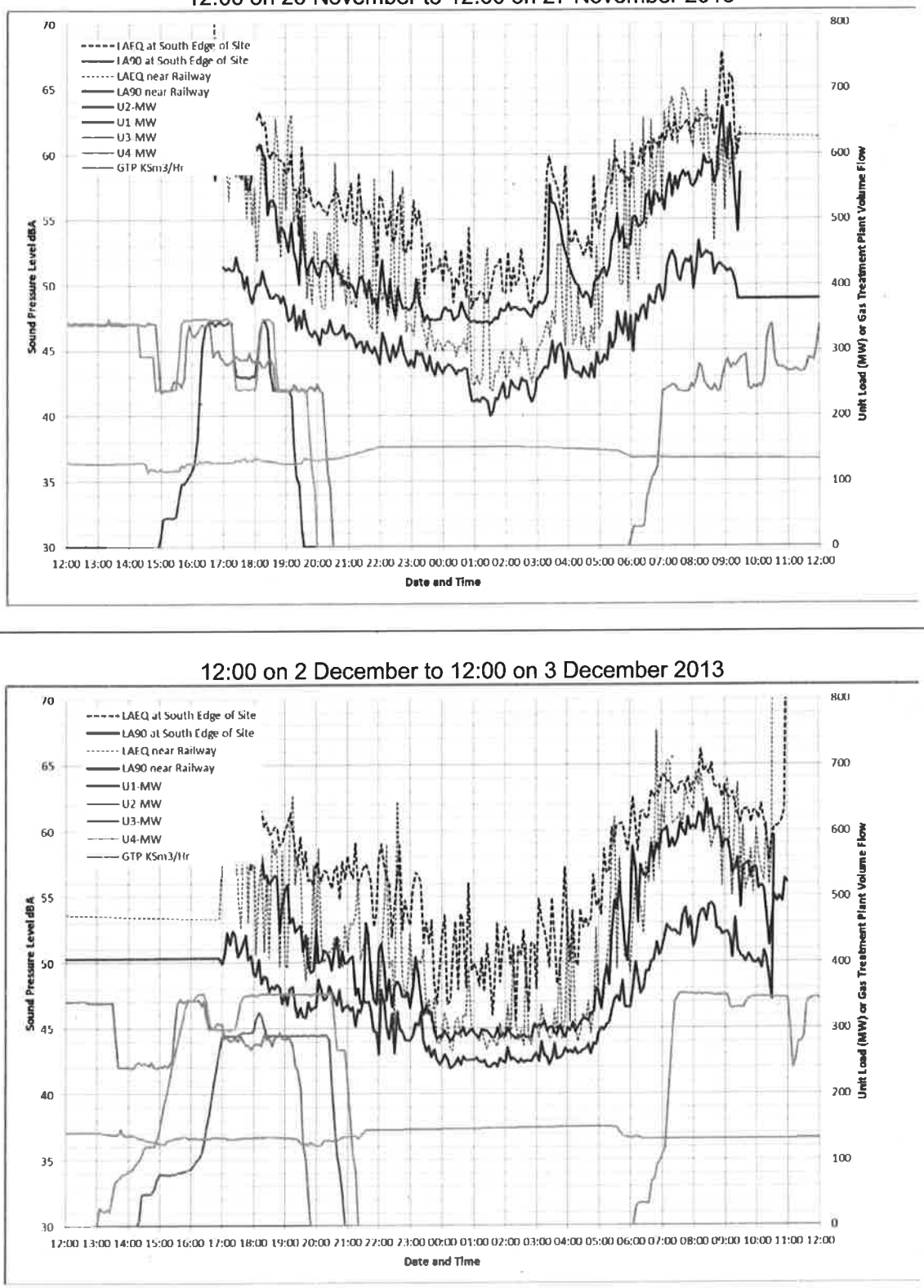


Figure 3: Time History of on-site continuous monitoring location at Near Railway position (near to Woodfield 'Railway' Cottages) and Site South Corner

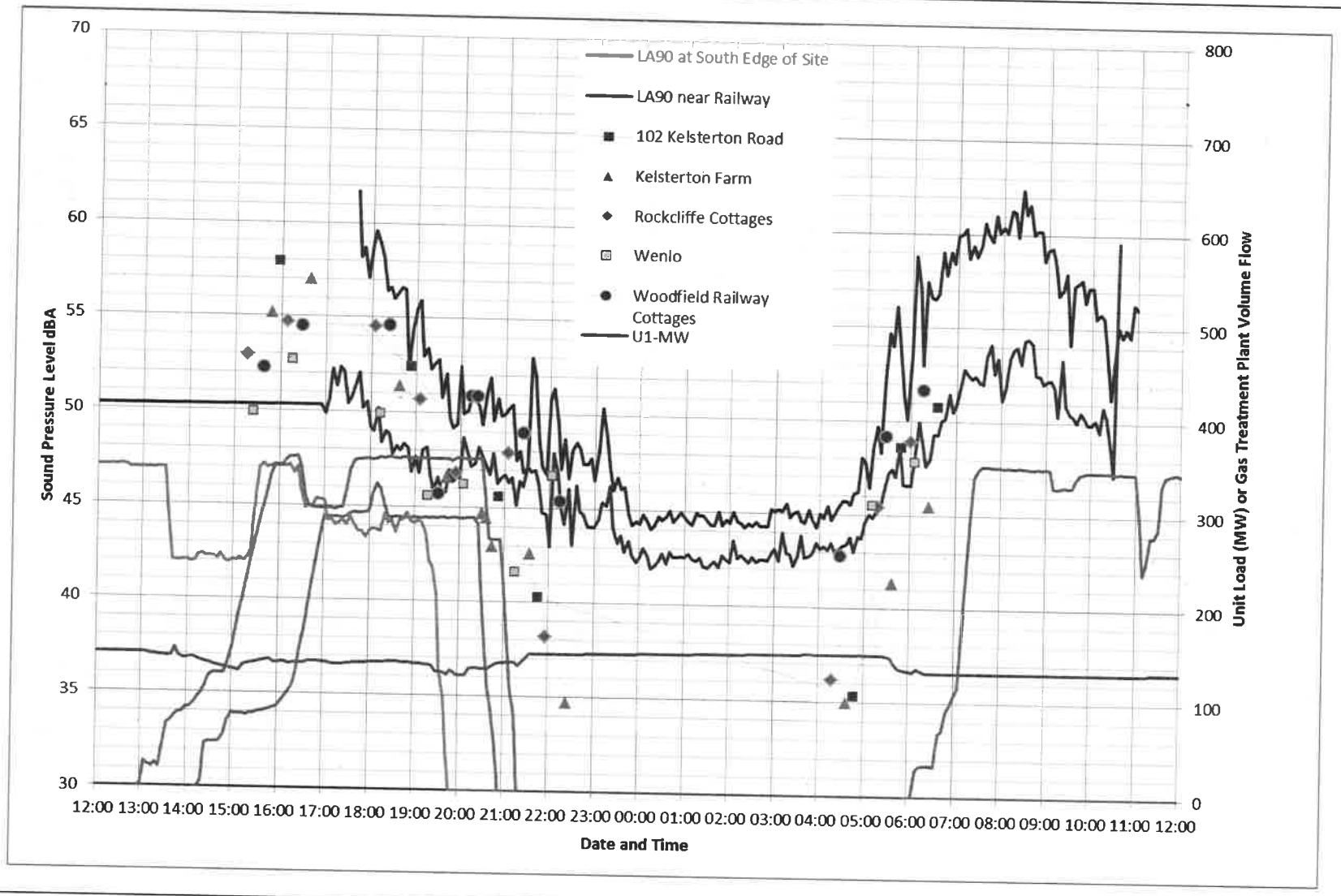
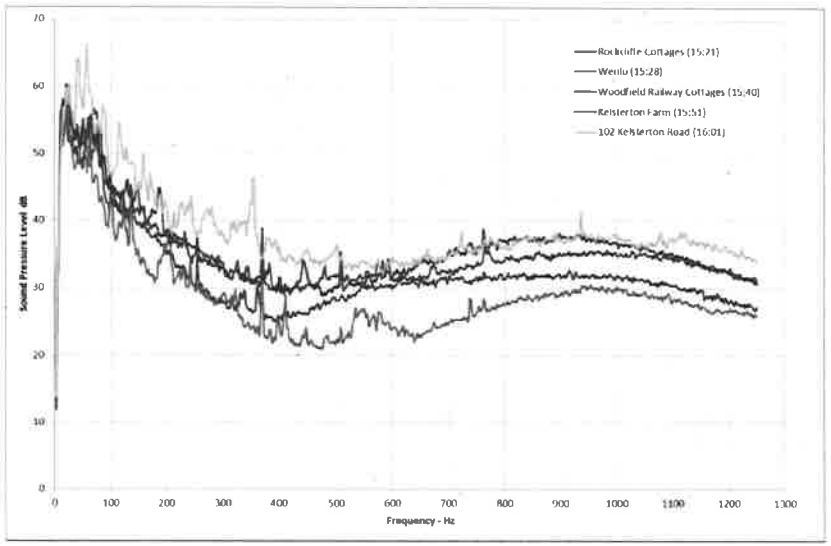
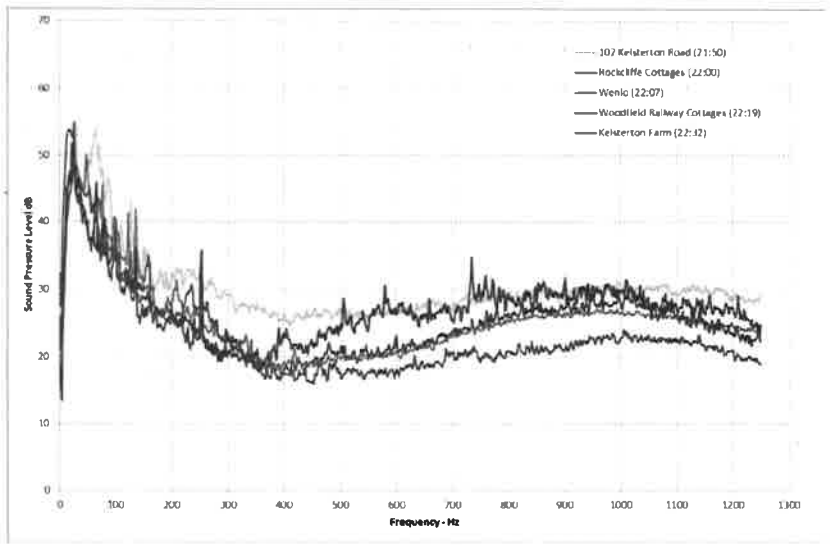
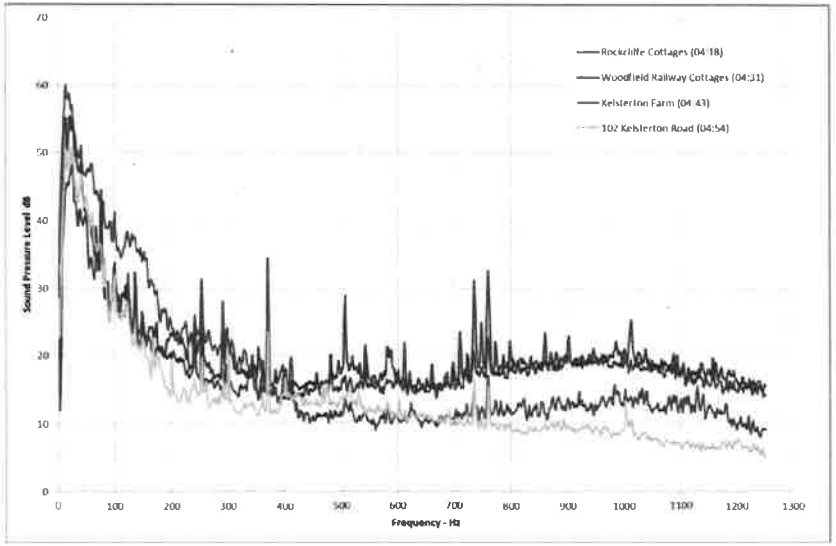


Figure 4: Time History of on-site and off-site monitoring 2-3 December 2013







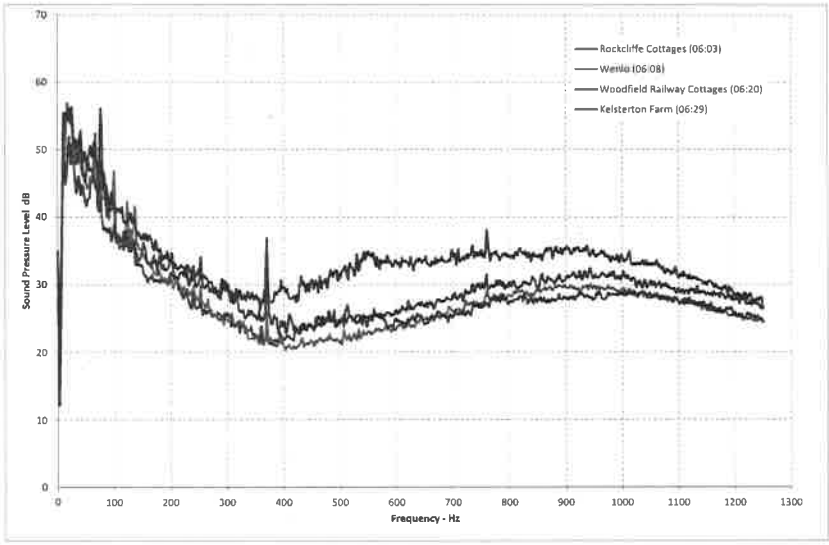
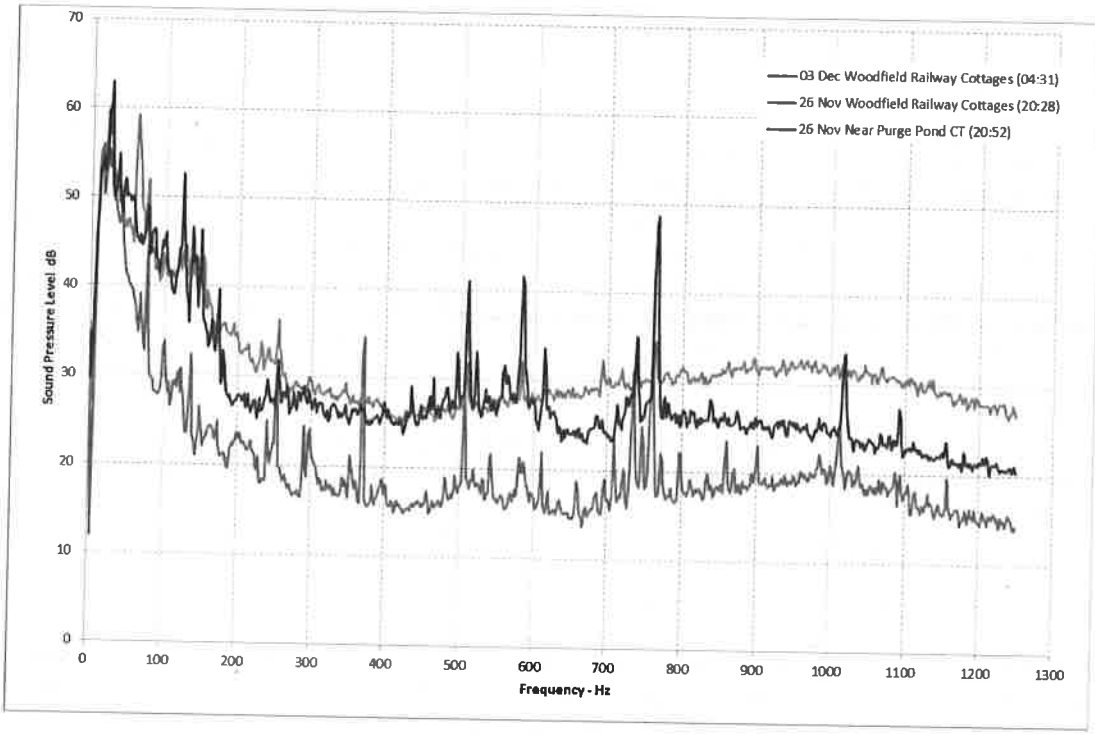


Figure 5: Narrow band FFT spectra at key receptors during afternoon, early evening, overnight and early morning periods



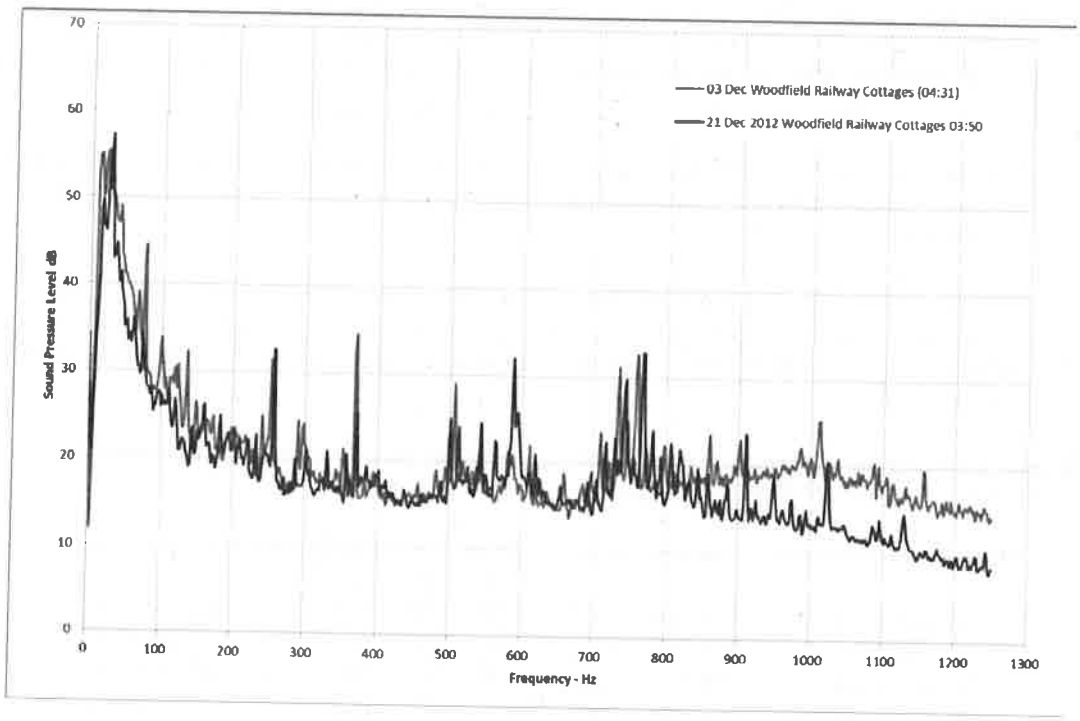


Figure 6: Narrow band FFT spectra showing prominence of PPCT noise during no-load operation at the site

APPENDIX A

On-site Monitoring Results Review

A1 Introduction

Connah's Quay Power Station's PPC environmental noise management plan requires that noise measurements are routinely undertaken around nine monitoring positions that are close to key operational areas. The monitoring positions were originally selected on the basis that the plant noise level would be relatively prominent and readily quantifiable. In addition the monitoring positions were specifically chosen to be remote from any individual plant item so that the resultant noise level would comprise of contributions from multiple sources. Any significant upward drift in plant noise level at the monitoring position could be interpreted as a change that might potentially elevate plant noise levels at off-site residential locations.

Figure A1 shows photographs taken from the monitoring positions looking towards the main local noise source. Figure A2 shows a map of the nine positions in relation to the power plant buildings.

A2 Background

The positions were originally selected to quantify the general noise level in a given plant area but there are local sensitivities and plant items which influence what can be inferred from the measurements. See general plant area annotations in Figure A2.

- Positions 1, 2 and 9 are relatively close to plant items that would be expected to be operational under normal circumstances. They are also less susceptible to interference from ambient noise sources or changes due to propagation conditions. Therefore the measurements made at these positions would not be expected to show very much natural variation between surveys.

- Positions 3, 4 and 5 are relatively remote from plant items and therefore more susceptible to contributions from other non-plant/ambient sources and variable propagation conditions.

- Positions 6, 7 & 8 are representative of the BHP Above Ground Installation (AGI) Compound and the Gas Treatment Plant (GTP) and as such the measurements are subject to contributions which vary according to the specific operational state of these plant items.

During 2013, survey of the plant noise level at the nine positions was undertaken by power station personnel on the following dates:

Date	Period	Plant Generating Status				
		U1	U2	U3	U4	GTP
15 February 2013	18:00 to 19:00	Off	Off	Off	Off	160 kSm^3/h
28 May 2013	17:30 to 18:30	**On**	**On**	**On**	Off	120 kSm^3/h
12 August 2013	18:30 to 19:30	Off	Off	Off	**On**	140 kSm^3/h
20 December 2013	18:30 to 19:30	Off	Off	**On**	Off	130 kSm^3/h

The prevailing pattern of generation has meant that units have not routinely been on-load overnight, therefore the measurements were typically taken during the late day/early evening periods when there would still be considerable traffic on local public roads. Consequently the positions which are more remote from the plant and closer to the site perimeter are likely to be subject to significant steady and intermittent contributions from non-power stations sources (primarily traffic). To be most useful the contribution from ambient sources needs to be at a minimum so that L_{Aeq} and L_{A90} levels recorded relate to the power stations sources. Due to the early evening timing of the 2013 surveys there is a high potential that the L_{Aeq} (and also L_{A90} spectra) will be elevated compared to previous late evening/overnight surveys – and that this may not be associated with the plant but with the ambient noise climate.

To minimise this uncertainty in the future it is recommended that surveys should be undertaken late in the evening/night when ambient noise contributions have subsided to lower levels, where possible for typical power station operation.

The survey on the 15 February 2013 was undertaken during a period when there was no generation taking place on site. Although this is not usual practice, for the purpose of this data review it has been retained to allow a comparison with results gathered during generation. It highlights the relative prominence or subsidiarity of the noise component from the site compared to the background/residual noise level. Note: this 'no-load' data will be excluded from future assessments to prevent it from compromising the rolling history of measurements

The measurement made at Position 9 on the 15 February 2013 was not stored within the noise meter correctly so has been removed from the dataset.

A3 Data Review and Assessment

An initial review of the measurement data reveals that there was some uncertainty associated with configuration of the meter and subsequent results collected during 28 May 2013.

The meter range was inadvertently set to 5-85 dB (Linear) which, for some of the noisier locations was too sensitive and resulted in the meter overloading during 5 of the 9 measurements. The temporal extent of the overload meant that although the L_{Aeq} levels were slightly compromised the L_{A90} levels and spectra remain unaffected and the data has been retained.

The data from the four 2013 surveys has been compared to previous reliable measurements. Figure A3 shows the trend in overall L_{Aeq} and L_{A90} noise levels measured since December 2009

Any difference between L_{Aeq} and L_{A90} levels more than 1-2 dB suggests that the sample was affected by transient noise – which is probably not associated with the power station and hence the L_{Aeq} is probably not representative of the steady noise from the plant.

Position 1, 2 & 3

Position 1 data collected during on-load operations varies considerably during 2013. The high L_{Aeq} and L_{A90} levels detected in February are probably due to operation of local plant that only operate intermittently (such as the cooling water make-up pump). At Position 2 the noise level data throughout 2013 is relatively consistent, even during the survey during non-load operation in February. The noise climate is dominated by the nearby transformers which are typically as noisy when unloaded as they are when the plant is generating electricity.

Positions 4,5 & 6

The overall L_{Aeq} and L_{A90} levels at Positions 4 and 5 fall broadly within the range of historic levels, although at Position 5 the difference between L_{Aeq} and L_{A90} suggests that the noise climate is dominated by traffic noise. The L_{Aeq} and L_{A90} data collected during February when there is no generation occurring is not significantly different to that collected during plant operation – highlighting that the residual noise is prominent at these location

Position 6 is remote from the road so is less susceptible to ambient noise and experiences a steady contribution from plant within the BHP AGI compound. The results from the last two surveys are the lowest that has been measured at this location, however it is not certain from the plant statuses why this would be the case.

Position 7,8 & 9

The small differences between the L_{Aeq} and L_{A90} levels at Positions 7 and 8 during 2013 indicates a relatively steady noise climate. These positions are near to the Gas Treatment Plant and the magnitude of the noise levels is within historic ranges.

Interestingly, all three 2013 surveys at Position 9 indicate much lower noise levels than have been measured previously. As this position is centrally located within the operational plant area and subject to contributions from a multitude of surrounding plant items such a reduction is unexpected. This is examined in more detail in the following review of 1/3rd octave band spectra.

For further detail the 1/3rd octave L_{C90} spectra have been examined and are shown in Figures A4 to A6. The following are general observations regarding how the recent spectra compare to previous ones:

All Positions:

The L_{C90} spectra measured while the units were off load provide a useful indication of auxiliary plant noise or, in the case of positions near the road, the relative magnitude of the background ambient noise. However, although the noise from the main plant activity will be reduced during non-load operation compared to when the plant is generating, other site processes will continue to operate throughout (cooling tower fans might continue to run) and in the case of some plant (i.e. GTP) may increase).

Positions 1&2

All four 2013 spectra have reduced low frequency (less than 100Hz) noise levels relative to previous surveys. In the case of Position 1 this is offset by raised mid to high components, but at Position 2 (near to the Unit 2 and 3 transformers) the 2013 data are broadly consistent with previous spectra.

Although measured whilst the units weren't generating the 15 February spectra shows that the noise climate at Position 2 remained similar to previous measurements.

Position 3

The spectra at this location also exhibit decreased levels at low frequencies compared to previous spectra. At other frequencies the on-load spectra are within the range of historic measurements and not dissimilar to the off-load spectra from February – highlighting that

position is not overly affected by break-out noise from the Turbine Hall and Boiler House during generation in the evening.

Position 4

The main noteworthy feature of the measurements made at this position is the peak in the spectra at 100Hz in February 2013. As no generation was occurring at the time, it might be expected that any transformer hum (2 x 50Hz) would become more audibly noticeable as masking from broadband noises would have been reduced. However this peak exceeds all previous values. An inspection of the L_{C01} to L_{C99} values reveals a noise level range of 64-67dBC, suggesting that the peak originated from a steady noise source rather than a transient. At other nearby locations there is a historic maximum 100Hz peak at Position 3 and a minor peak within the normal range of values at Position 5.

These spectra occurring at a cluster of positions suggests that whatever caused the raised 100Hz levels had a localised effect in this area and due to being a low frequency noise did not overly raise the overall dBA level. The origin of this measurement peak is not certain, however it was a temporary occurrence as it was absent from all three subsequent surveys.

Position 5

This position is alongside the site access road and primarily subject to contributions from the main Cooling Towers and Purge Pond Cooling Towers plus off-site traffic. The 800-1250Hz 1/3rd octave band levels are on the upper range of historic values – and this is probably attributable to early evening traffic (see narrow band spectra for afternoon periods in Figure 5); however there is also a potential that the Purge Pond Cooling Tower noise emission is contributing to the 800Hz band level. The FFTs at nearby Woodfield 'Railway' Cottages in Nov/Dec indicate that if the Purge Pond Cooling Tower noise was dominant then the 500 and 630Hz bands would also be raised. These levels are relatively consistent across the May, August and December spectra, but, due to the time the measurements were taken, it is not possible to determine whether this was due to traffic or local plant.

As this position is relatively close to the Purge Pond Cooling Tower, it is recommended that special attention be paid to making subjective observations of the levels and character of the noise at this location. Although future plant operational pattern may dictate that surveys take place at times when traffic noise is raised, the levels and subjective observations at this location are important. They are a useful indicator as to whether noise from local plant items has increased that might then impact on nearby residents when ambient noise subsides.

Position 6

There is a very wide spread in the spectra at this position. The difference is greatest at high frequencies, suggesting that perhaps the incoming gas supply control valves within the BHP AGI compound were not operating for the last two surveys.

Position 7

Although relatively close to Position 6, the spectra measured in 2013 at Position 7 have a tighter spread of values because noise from the GTP dominates at this location and was processing gas during all four

surveys. (Volume flow of 120-160 kSm^3/h). No prominent or consistent changes which would indicate a problem are apparent in the spectra.

Position 8 — This position is on eastern edge of the GTP compound. The low level spectrum measured whilst there was no electricity generation occurring on the main site (15 February 2013) is slightly unexpected since the GTP flow was relatively high at 160kSm^3/h and the noise level at the Position 7 was on the upper range of measurements. During the other three 2013 surveys the spectra were within the normal range of values encountered during previous exercises.

Position 9 — The figure shows the spectral detail behind the very considerable change in noise level noted earlier. It is understood from site engineers that there had been some changes to key plant items (Auxiliary boilers) and their operational patterns in this area over this period – which might explain the measured change.

Overall this desk-top review of 2013 measurement data reveals the following:

- At some positions the 2013 results are broadly consistent with historic L_{Aeq}/L_{A90} levels and L_{C90} 1/3rd Octave levels, however at other positions the results have been found to be significantly different than would be expected for the prevailing plant operational pattern.
- As with previous surveys, the measurements at Positions 3, 4 and 5 (which quantify the plant's noise emission in the direction of the nearest residential receptors) are subject to contributions from traffic therefore the usefulness of data is partially compromised.
- Some peaks in the spectra (100Hz at Position 3 & 4) which might have indicated an undesirable increase in plant noise emission, have not been present in subsequent measurements, suggesting that transient conditions were responsible.

A4 Discussion

Four on-site measurement surveys were completed by power station personnel during 2013, one of which was undertaken whilst there was no generation taking place on site. This data will be excluded from the historic database used in future assessment but has served to demonstrate the magnitude of noise from auxiliary plant operation and ambient noise sources

With regard to the timing of future surveys, previous reports have recommended that surveys should *"where possible and appropriate to normal power station operation, be undertaken overnight when contributions/interference from ambient noise sources is at a minimum"*. Due to the prevailing operational pattern of the station none of the 2013 surveys were undertaken in what would be considered to be 'optimal' conditions (i.e. when ambient interference has subsided).

In the event that units only routinely operate during day/early evening periods in the future, then the measurement survey data will again be somewhat compromised. To aid future reviews of the data, it is recommended that contemporaneous notes are made about the relative contribution from site and ambient noise sources. This is particularly important at the perimeter positions (3, 4 and 5) where subjective audibility of tones from nearby plant items would be useful.

The review of the overall noise levels and spectra has shown some unexplained changes compared to historic trends. It would be useful to know from observations why the noise climate is substantially different from previous ranges. The following summary table of results collected to date may assist the engineer to put future survey results into context and proactively note reasons for possible data outliers.

Table A1: Statistical table of L_{Aeq}/L_{A90} historical results, years 2009 to 2013

Position	L_{A90} dB				L_{Aeq} dB			
	Min	Mean	Std Dev.	Max	Min	Mean	Std Dev.	Max
1	50	**56**	4	63	51	**58**	4	63
2	52	**57**	3	59	54	**58**	2	61
3	46	**50**	3	55	49	**54**	4	59
4	49	**54**	3	58	50	**56**	3	60
5	42	**50**	4	56	44	**54**	5	60
6	43	**56**	7	62	45	**56**	7	64
7	45	**54**	5	62	46	**55**	5	63
8	49	**60**	6	67	52	**61**	5	68
9	40	**55**	8	62	43	**57**	8	66

Position 1:CW make-up pump area

Position 2: Banking Compound Near transformers

Position 3 – near south corner of site

Position 4: Visitor Car Park ,Coach Parking Area

Position 5: Approach Road Railway Access

Position 6: BHP Compound Gate

Position 7: W Corner of GTP compound

Position 8: South Corner of GTP compound

Position 9: Near Auxiliary Boiler

Figure A1: Photographs of the positions for noise measurements around Connah's Quay Power Station

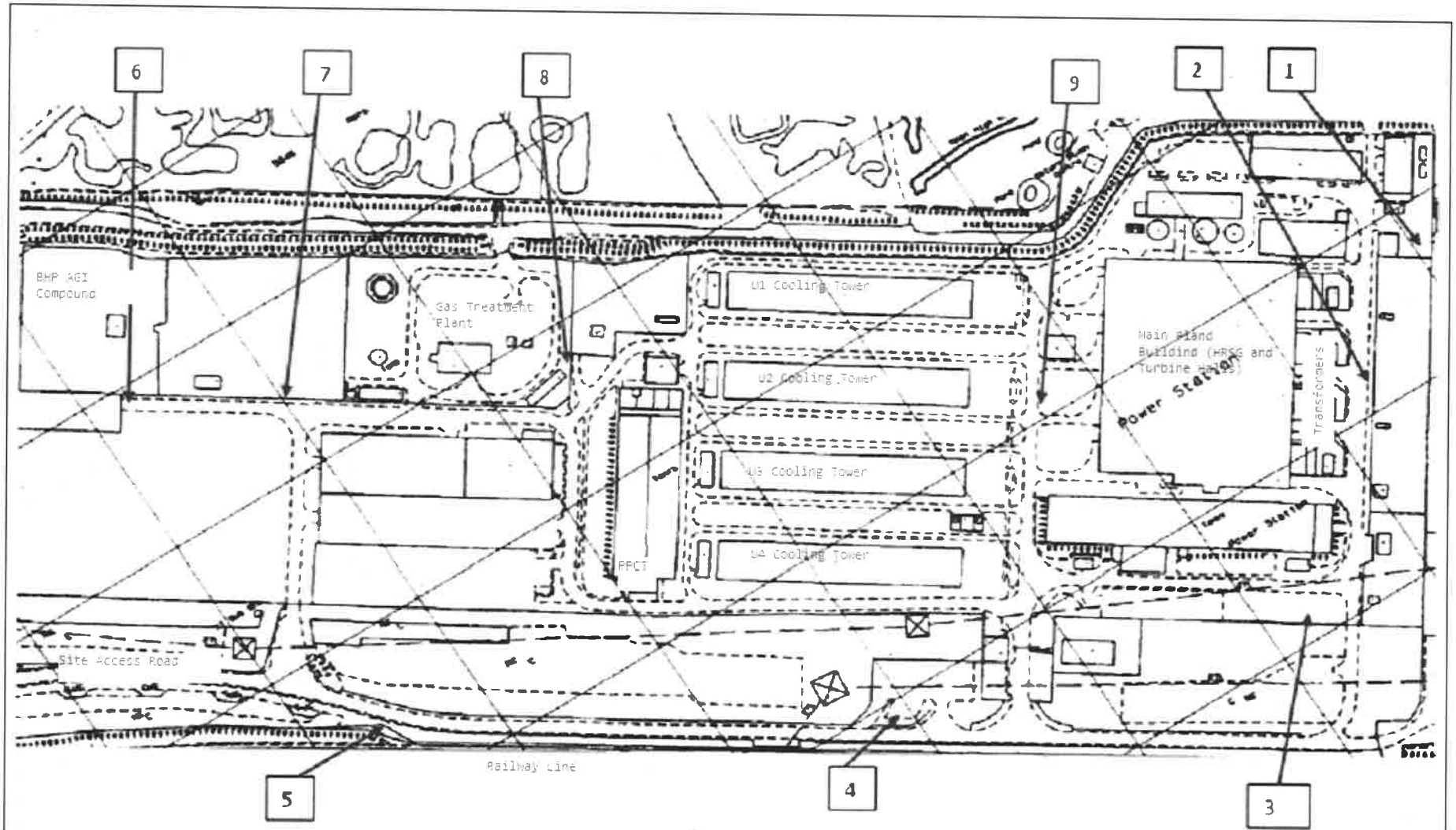


Figure A2: Map of Connah's Quay power station with the positions for noise measurements

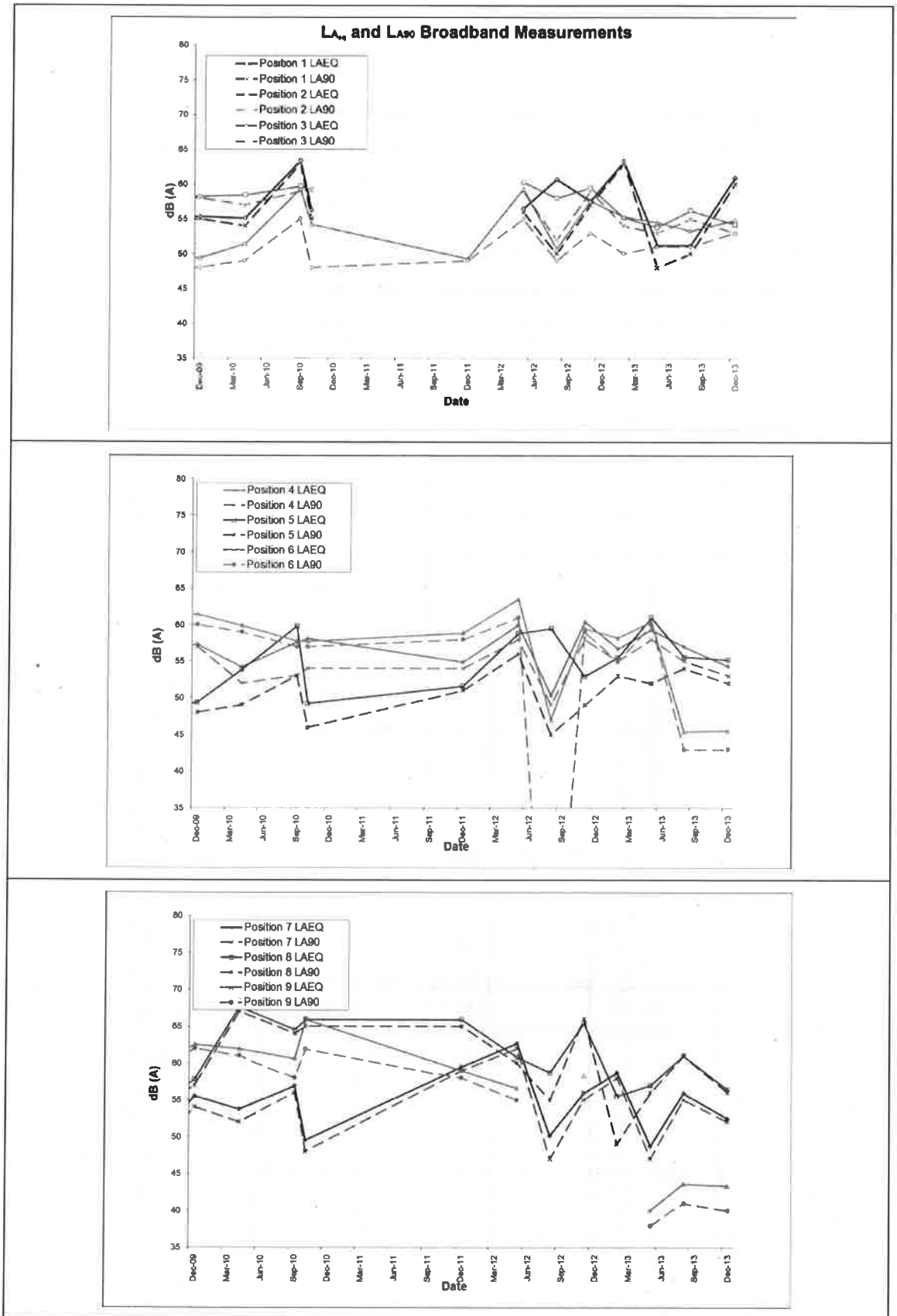


Figure A3: Time history of overall L_{Aeq} and L_{A90} levels measured at Positions 1-9, including measurements made in 2013

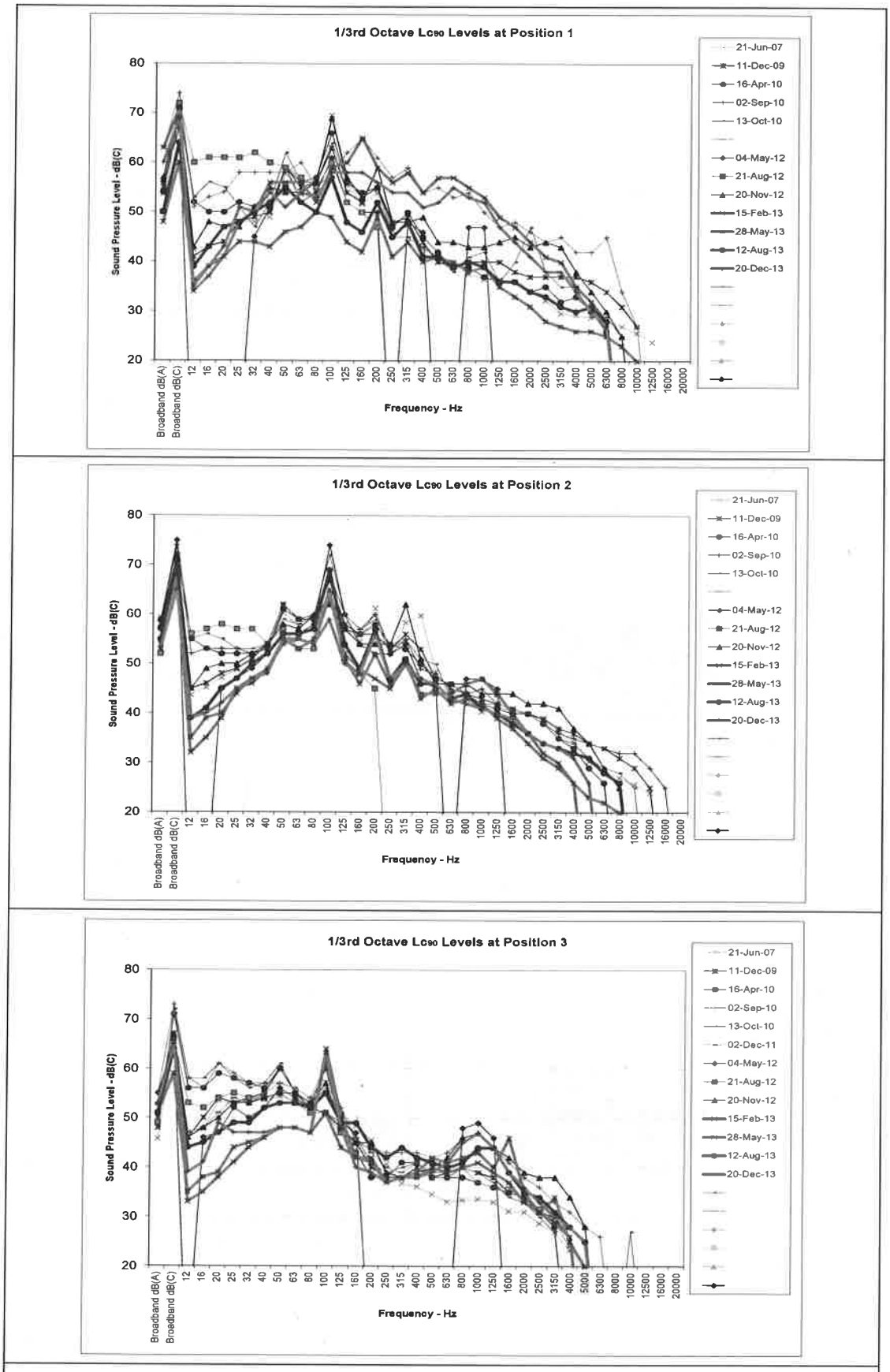


Figure A4: 1/3rd Octave Band L_{C90} spectra measured at Positions 1-3

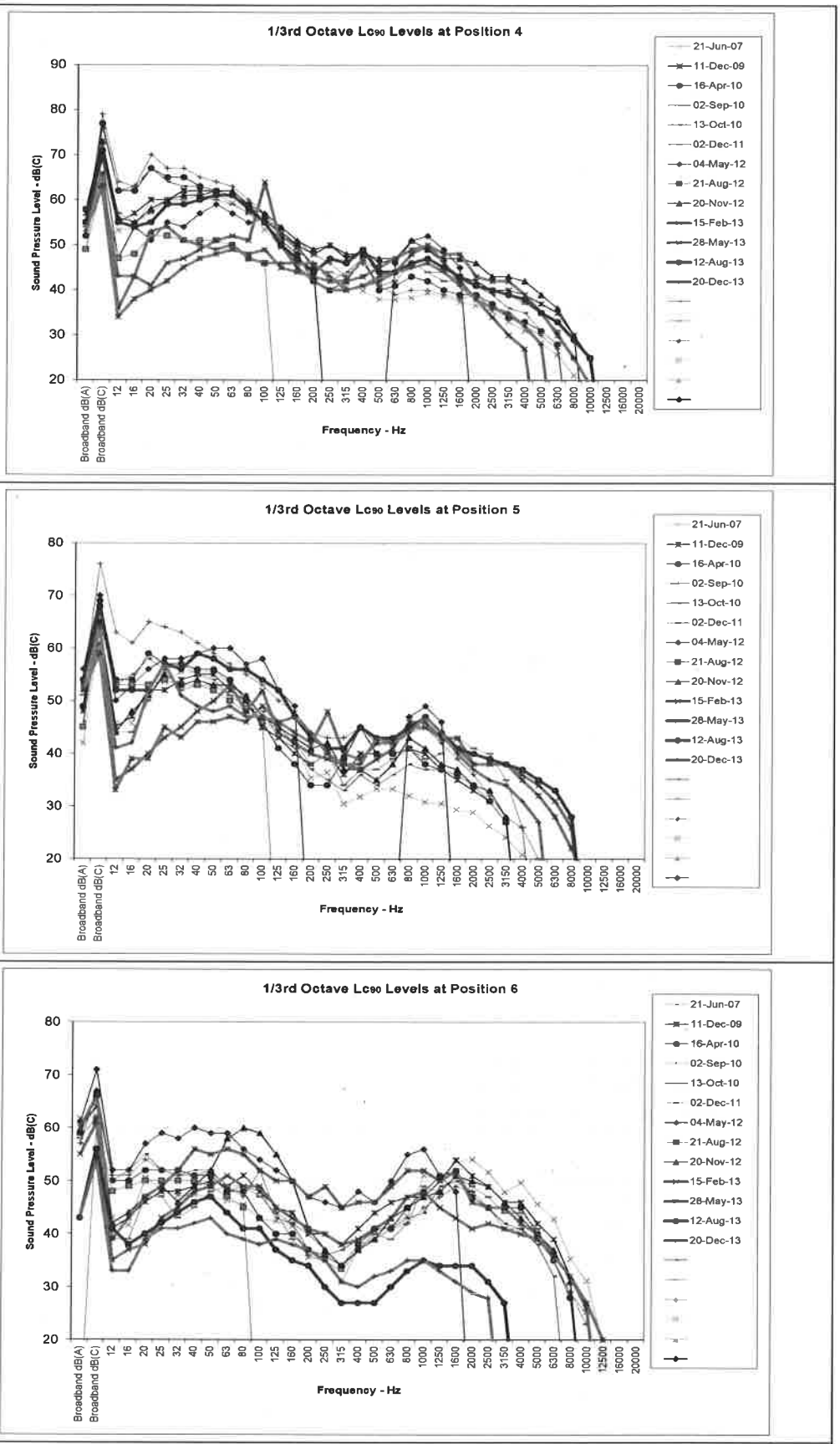


Figure A5: 1/3rd Octave Band L_{C90} spectra measured at Positions 4-6

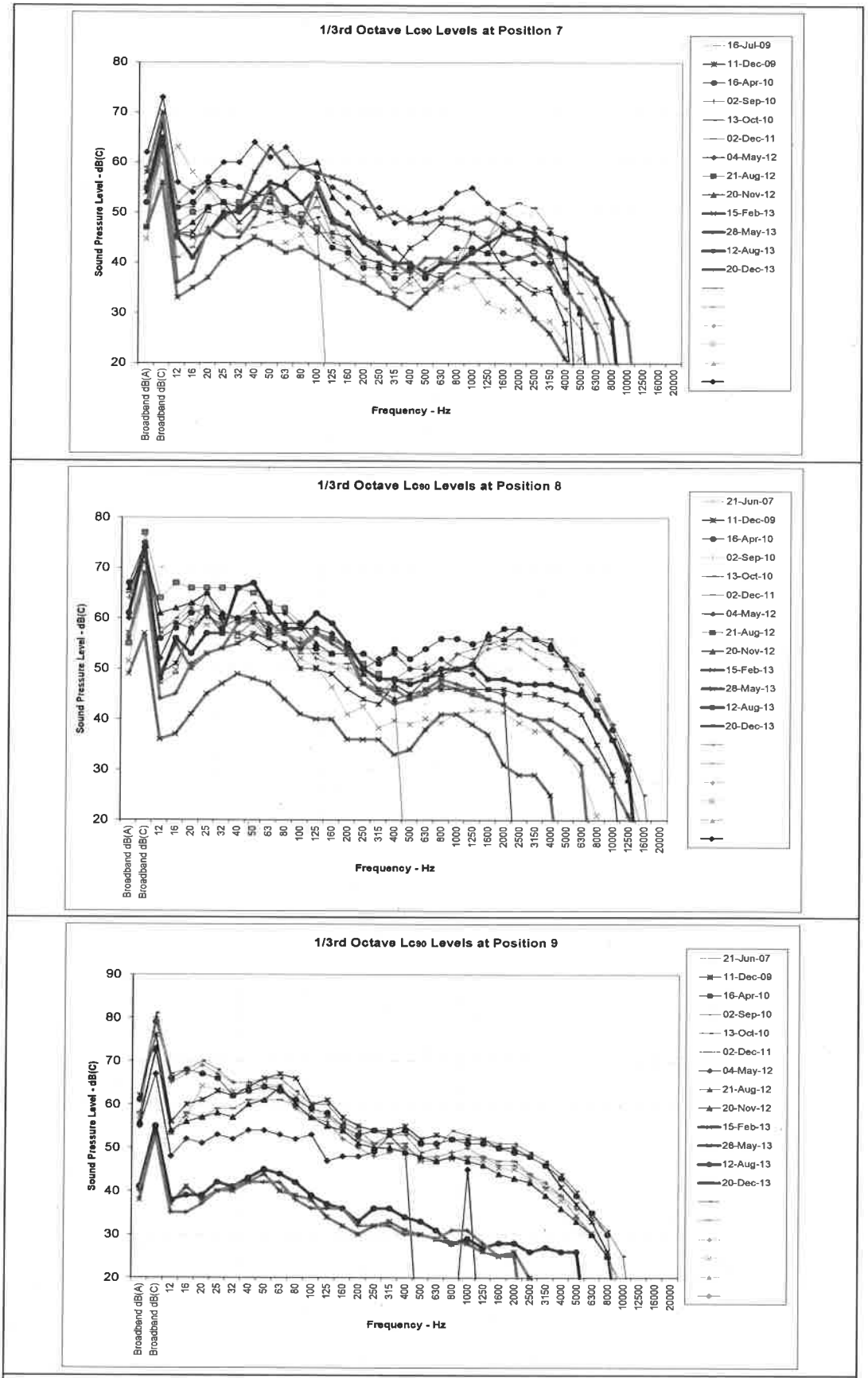


Figure A6: 1/3rd Octave Band L_{C90} spectra measured at Positions 7-9