Blacktown Hospital, Main Campus

Noise Impact Assessment

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1 INTRODUCTION

This report presents our assessment the potential noise impact associated with demolition, construction, operation and operation noise generated by the proposed Blacktown Hospital, Main Campus development.

We note that a detailed construction program for the demolition, excavation and construction of the development is not available at present (this is not typically undertaken prior to project approval) and as such, a detailed construction noise assessment cannot be undertaken at this stage.

We recommend that a detailed assessment of noise emissions from construction activities be undertaken at Construction Certificate Stage, once a construction programme has been determined. As such, only an indicative analysis is possible, as outlined below.

2 SITE DESCRIPTION / POTENTIALLY AFFECTED PROPERTIES

The project includes the construction of a multi-storey hospital building as part of the Main Campus. The nearest affect receivers are residential properties located on Panorama Avenue, and residential properties to the east of the site. Proposed works, noise sensitive properties and noise monitoring locations are outlined below.

Potentially affected residential receivers

Unattended noise monitors

Figure 1 – Stage One Site Map

Figure 1 – Blacktown Hospital

3 NOISE DESCRIPTORS

Environmental noise constantly varies. Accordingly, it is not possible to accurately determine prevailing environmental noise conditions by measuring a single, instantaneous noise level.

To accurately determine the environmental noise a 15-20 minute measurement interval is utilised. Over this period, noise levels are monitored on a continuous basis and statistical and integrating techniques are used to determine noise description parameters.

In analysing environmental noise, three-principle measurement parameters are used, namely L_{10}, L_{90} and L_{eq}.

The L_{10} and L_{90} measurement parameters are statistical levels that represent the average maximum and average minimum noise levels respectively, over the measurement intervals.

The L_{10} parameter is commonly used to measure noise produced by a particular intrusive noise source since it represents the average of the loudest noise levels produced by the source.

Conversely, the L_{90} level (which is commonly referred to as the background noise level) represents the noise level heard in the quieter periods during a measurement interval. The L_{90} parameter is used to set the allowable noise level for new, potentially intrusive noise sources since the disturbance caused by the new source will depend on how audible it is above the pre-existing noise environment, particularly during quiet periods, as represented by the L_{90} level.

The L_{eq} parameter represents the average noise energy during a measurement period. This parameter is derived by integrating the noise levels measured over the 15 minute period. L_{eq} is important in the assessment of traffic noise impact as it closely corresponds with human perception of a changing noise environment; such is the character of environmental noise.

4 BACKGROUND NOISE MONITORING

Unattended background noise monitoring was undertaken by this office from the 26 May to 1 June 2011, using Acoustic Research Laboratories noise monitors. The monitors were located in the positions detailed in Figures 1 and 2. The monitor was programmed to store 15-minute A-weighted statistical noise levels throughout the monitoring period. The monitor was calibrated at the beginning and end of the measurement period using a RION NC-73 sound level calibrator with no significant drift detected. All noise measurements were taken on A-weighted fast response mode. Noise logger data is provided in Appendix 1.

Table 1 summarises the background noise levels determined at the monitoring location.

Table 1 – Measured Background Noise Levels

Location	Background noise level dB(A)$L_{90(15minutes)}$		
	Daytime (7am-6pm)	Evening (6pm-10pm)	Night (10pm-7am)
Monitor Location 1	42	42	41
Monitor Location 2	48	46	42

5 CONSTRUCTION NOISE AND VIBRATION ASSESSMENT

This section of report addresses noise impact associated with the proposed demolition, excavation and construction of the Stages of the project.

5.1 HOURS OF WORK

Table 1 in section 2.2 of the Office of Environment and Heritage (OEH) Interim Construction Noise Guideline lists the recommended standard hours of construction and section 2.3 outlines the situations, where construction work may need to be undertaken outside these hours.

Table 2 – Recommended Standard Hours for Construction Work

Work Type	Recommended Standard Hours of Work
Normal Construction	Monday to Friday 7am to 6pm Saturday 8am to 1pm No work on Sundays or public holidays
Blasting	Monday to Friday 9am to 5pm Saturday 9am to 1pm No work on Sundays or public holidays

Situations, where construction work may need to be undertaken outside these hours are:

- the delivery of oversized plant or structures that police or other authorities determine require special arrangements to transport along public roads;
- emergency work to avoid the loss of life or damage to property, or to prevent environmental harm;
- maintenance and repair of public infrastructure where disruption to essential services and/or considerations of worker safety do not allow work within standard hours;
- public infrastructure works that shorten the length of the project and are supported by the affected community; and
- works where a proponent demonstrates and justifies a need to operate outside the recommended standard hours.

5.2 CONSTRUCTION NOISE AND VIBRATION CRITERIA

5.2.1 Construction Noise

Relevant guidelines are:

- The OEH Interim Construction Noise Guidelines and
- Australian Standard 2436.

5.2.1.1 OEH Interim Construction Noise Guideline

This guideline nominates acceptable external and internal management levels for noise emissions from construction activities, based on the existing background noise level in the area and type of receiver. For projects within the recommended standard hours, the guideline recommends a noise level of 10 dB(A) above the background – this level is referred to as the "noise effected level", for residential receivers. The noise emission goals for the nearby affected receivers are presented below:

Table 3 – Noise Emission Goal – Residential Properties

LOCATION	TIME OF DAY	MEASURED BACKGROUND LEVELS – dB(A)L_{90}	NOISE EFFECTED LEVEL BACKGROUND + 10dB(A)$L_{eq(15min)}$
Western Properties	Recommended standard hours: Monday to Friday 7am to 6pm Saturday 8am to 1pm No work on Sundays or public holidays	42	52
Eastern Properties		48	58

Table 4 – Noise Emission Goal – Hospital

TIME OF DAY	Space	Noise Emission Goal dB(A)$L_{eq(15min)}$
When in Use	Hospital Wards and Operating Theatres	45 (internal noise level)*
	Offices	70 (external most – affected point of the premises)

Assuming standard façade construction, and external noise level of 65 – 70 dB(A) will result in an internal noise level of 45dB(A).

Where noise from the construction works is above the "noise affected level", the proponent should apply any feasible and reasonable work practices to minimise noise.

If noise emissions are likely to exceed 75 dB(A)$L_{eq(15min)}$, the receiver is deemed to be "highly noise affected". Introduction of management controls such as scheduling of noisy periods, or respite periods is recommended.

5.2.1.2 Australian Standard 2436-1981 "Guide to Noise Control on Construction Maintenance and Demolition Site".

Where compliance with OEHW cannot be achieved, noise emissions are to be managed in accordance with principles in AS2436:

- That reasonable suitable noise criterion is established (i.e. – adopt Council guidelines).
- That all practicable measures be taken on the building site to regulate noise emissions, including the siting of noisy static processes on parts of the site where they can be shielded, selecting less noisy processes, and if required regulating construction hours.
- The undertaking of noise monitoring where non-compliance occurs to assist in the management and control of noise emission from the building site.

5.2.2 Construction Vibration

Vibration caused by construction should be limited to:

- For structural damage vibration, German Standard DIN 4150-3 *Structural Vibration: Effects of Vibration on Structures; and*
- For human exposure to vibration (amenity), the evaluation criteria presented in the British Standard BS 6472:1992 *Guide to Evaluate Human Exposure to Vibration in Buildings (1Hz to 80Hz)* for low probability of adverse comment

The criteria and the application of this standard are discussed in separate sections below.

5.2.2.1 Structure Borne Vibrations

German Standard DIN 4150-3 (1999-02) provides vibration velocity guideline levels for use in evaluating the effects of vibration on structures. The criteria outlined in DIN 4150-3 (1999-02) are presented in Table 5.

It is noted that the peak velocity is the absolute value of the maximum of any of the three orthogonal component particle velocities as measured at the foundation, and the maximum levels measured in the x- and y-horizontal directions in the plane of the floor of the uppermost storey.

Table 5 – DIN 4150-3 (1999-02) Safe Limits for Building Vibration

TYPE OF STRUCTURE		PEAK PARTICLE VELOCITY (mms^{-1})			
		At Foundation at a Frequency of			**Plane of Floor of Uppermost Storey**
		< 10Hz	**10Hz to 50Hz**	**50Hz to 100Hz**	**All Frequencies**
1	Buildings used in commercial purposes, industrial buildings and buildings of similar design	20	20 to 40	40 to 50	40
2	Dwellings and buildings of similar design and/or use	5	5 to 15	15 to 20	15
3	Structures that because of their particular sensitivity to vibration, do not correspond to those listed in Lines 1 or 2 and have intrinsic value (e.g. buildings that are under a preservation order)	3	3 to 8	8 to 10	8

5.2.2.2 Assessing Amenity

The OEHW's "Assessing Vibration: A Technical Guideline" (Feb 2006) is based on the guidelines contained in BS 6472:1992. This guideline provides procedures for assessing tactile vibration and regenerated noise within potentially affected buildings.

The recommendations of this guideline should be adopted to assess and regulate vibration within the construction site.

Table 6 – OEHW Recommended Vibration Criteria

		RMS acceleration (m/s^2)		**RMS velocity (mm/s)**		**Peak velocity (mm/s)**	
Place	Time	Preferred	Maximum	Preferred	Maximum	Preferred	Maximum
Continuous Vibration							
Critical working areas (e.g. hospital operating theatres, precision laboratories)	Day or Night-time	0.005	0.01	0.1	0.2	0.14	0.28
Offices	Day or Night-time	0.02	0.04	0.4	0.8	0.56	1.1
Residences	Daytime	0.01	0.02	0.2	0.4	0.28	0.56
Impulsive Vibration							
Critical working areas (e.g. hospital operating theatres, precision laboratories)	Day or Night-time	0.005	0.01	0.1	0.2	0.14	0.28
Offices	Day or Night-time	0.64	1.28	13.0	26.0	18.0	36.0
Residences	Daytime	0.3	0.6	6.0	12.0	8.6	17.0

5.3 COMMENT / ASSESSMENT

Potential noise and vibration impacts are reviewed below.

5.3.1 Noise impacts

Noise impacts from the construction of the multi-storey Main Campus development on nearby development will be dependant on the type of construction activities and the relative location of the works on site. Excavation and piling works tend to be the loudest typical activity. Work close to the eastern and western boundaries will have greatest impact on the surrounding residences while work along the northern and southern boundaries will have greatest impact on Hospital buildings.

Initial analysis indicates:

- Excavation/soil retention phase - Primary noise emissions occur during excavation and earth retention (piling), with equipment items typically having sound power levels of approximately 115dB(A)$L_{eq(15min)}$. Excavators (dozers with bucket, saws or hammers) and piling works are typically the loudest activity during construction. Noise levels of between 55-65dB(A) within the hospital and 60-75dB(A) at the nearest residents (at the boundary) will potentially be generated, indicating that OEH acoustic criteria (refer to tables 3 and 4) may be exceeded from time to time, with higher noise levels generated when working near the eastern and western boundaries of the site.

- During erection of structures, it is cranes and the use of hand tools (angle grinders etc) and concrete pumps which are the loudest typical activity (sound power levels of approximately 105dB(A)$L_{eq(15min)}$). Noise levels of between 45-60dB(A) within the hospital and 55-65dB(A) at the nearest residents will potentially be generated, indicating that the OEH acoustic criteria (refer to tables 3 and 4) may be exceeded from time to time, with higher noise levels generated when working near the eastern and western boundaries of the site.

- Once construction of the building shell is complete, noise from hand tools will be relatively low, as the new building façade will provide considerable noise attenuation. Once the building shell is largely complete, use of hand tools in internal areas is unlikely to exceed OEH recommended levels.

Noise impacts can be minimised using the following:

- Selection of equipment and process.

- Location of static plant (particularly concrete pumps and cranes).

- Use of screens or enclosures (typically only feasible for static plant).

- Scheduling of noisy activities and provision of respite periods.

Detailed construction noise planning is typically undertaken after engagement of a builder and a construction program is prepared (i.e. – after DA stage) and therefore, detailed planning is not possible at this stage.

In light of the above, we recommend:

- During preparation of the construction program (CC stage), consult with Blacktown Hospital to determine what areas of the hospital are particularly noise sensitive, and at what time (ward rooms, operating theatres etc).

- On completion of the construction program, acoustic review of proposed construction activities and plant/methods should be undertaken to identify work items likely to exceed OEH guidelines.

- For those noise intensive activities, the analysis should identify where on the construction site are the areas likely to result in high noise levels. This will then assist in determining the likely time period for which high noise levels will occur at nearby properties.

- Identify feasible acoustic controls or management techniques (use of screens, scheduling of noisy works, notification of adjoining land users, respite periods) when excessive levels may occur.

- For activities where acoustic controls and management techniques still cannot guarantee compliant noise levels, implement a notification process whereby nearby development is made aware of the time and duration of noise intensive construction processes.

Through adoption of the above, noise impacts on nearby development can be suitably managed to prevent excessive impact.

5.3.2 Vibration Impacts

Excavation and earth retention works (piling) are the primary vibration generating activities.

Due to its proximity, vibration impacts on the residential properties to the east and west are unlikely to be higher than the levels of vibration to be generated at the boundary of the adjacent hospital buildings, especially the exiting hospital development in the northern portion of the site. In particular, if excavating in rock or installing driven piles in close proximity to the façade of the hospital buildings. We recommend:

- Consultation with Blacktown Hospital prior to excavation/construction to determine if there is any particularly vibration sensitive equipment items on site boundaries (MRI, microscopes etc) in order to determine appropriate vibration criteria.

- Where practicable, excavation in rock should be done using rock saws as opposed to pneumatic hammers.

- If piling is required, use of augured or vibro-piling should be used rather than impact piling.

- For the initial stages of excavation and piling, vibration monitoring within areas of the hospital housing sensitive equipment should be conducted to ensure excessive levels of vibration are not achieved. Any monitoring system should allow for rapid feedback to the contractor (for example, SMS notification) in the event that excessive levels are reached.

Adoption of the above will provide a framework to ensure that appropriate systems for monitoring and management of vibration can be implemented.

6 OPERATIONAL NOISE ASSESSMENT

6.1 NOISE EMISSION LIMITS – NOISE GENERATED ON THE SITE

The Office of Environmental and Heritage (OEH), the old DECCW, Industrial Noise Policy provides guidelines for assessing noise impacts from development sites. The recommended assessment objectives vary depending on the potentially affected receivers, the time of day, and the type of noise source. The OEH's Industrial Noise Policy has two requirements which both have to be complied with, namely an amenity criterion and an intrusiveness criterion. In addition, the OEH in its Environmental Noise Control Manual states that noise controls should be applied with the general intent to protect residences from sleep arousal.

For land use developments with the potential to create additional traffic on local roads the development should comply with the requirements detailed in the Environmental Criteria for Road Traffic Noise (ECRTN).

6.1.1 OEH Intrusiveness Criterion

The OEH guideline is intended to limit the audibility of noise emissions at residential receivers and requires that noise emissions measured using the L_{eq} descriptor not exceed the background noise level by more than 5 dB(A). Where applicable, the intrusive noise level should be penalised (increased) to account for any annoying characteristics such as tonality.

6.1.2 OEH Amenity Criterion

The OEH guideline is intended to limit the absolute noise level from all industrial noise sources to a level that is consistent with the general environment.

The OEH's Industrial noise policy sets out acceptable noise levels for various localities. Table 2.1 on page 16 of the policy indicates 4 categories to distinguish different residential areas. They are rural, suburban, urban and urban/industrial interface.

Table 5 of the INP provides the recommended ambient noise levels for the suburban residential receivers for the day, evening and night periods. For the purposes of this condition:

- Day is defined as the period from 7am to 6pm Monday to Saturday and 8am to 6pm Sundays and Public Holidays;
- Evening is defined as the period from 6pm to 10pm; and
- Night is defined as the period from 10pm to 7am Monday to Saturday and 10pm to 8am Sundays and Public Holidays.

Table 7 – EPA Recommended Amenity Industrial Noise Levels

Type of Receiver	Time of day	Recommended Acceptable Noise Level dB(A) L_{eq}
Residential	Day	55
	Evening	45
	Night	40

6.1.3 Sleep arousal

To minimise the potential for sleep arousal the $L_{1\ (1\ minute)}$ noise level of any specific noise source does not exceed the background noise level (L_{90}) by more than 15 dB(A) outside a resident's bedroom window between the hours of 10pm and 7am. The L_1 noise level is the level exceeded for 1 per cent of the time and approximates the typical maximum noise level from a particular source. Where the typical repeatable existing L_1 levels exceed the above requirement then the existing L_1 levels form the basis for, sleep disturbance criteria.

6.1.4 Summary of Assessment Criteria

The OEH INP intrusiveness, amenity and sleep arousal criteria for this project have been determined using these guidelines and the noise monitoring results. These are summarised below. We note that the formulation of the assessment criteria has been based on the lowest ambient levels determined from all monitoring data.

6.1.4.1 Day Time Period

The following table sets out the measured L_{90} background noise levels, and the assessment criteria based on the suburban criteria. The day period applies between 7am and 6pm Monday to Saturday; and 8am to 6pm Sundays and public holidays.

Table 8 - Measured L_{90} Noise Levels and Criteria - Daytime

Location	Measured L_{90} Noise Level dB(A)	Amenity Criterion dB(A) L_{eq}	Intrusiveness Criterion dB(A) L_{eq}
Location 1 – Western Residences	42	55	47
Location 2 – Eastern Residences	48	55	53

6.1.4.2 Evening Period

The following table sets out the measured L_{90} background noise levels, and the assessment criteria based on the suburban criteria. The evening period applies between 6pm and 10pm.

Table 9 - Measured L_{90} Noise Levels and Criteria - Evening

Location	Measured L_{90} Noise Level dB(A)	Amenity Criterion dB(A) L_{eq}	Intrusiveness Criterion dB(A) L_{eq}
Location 1 – Western Residences	42	45	47
Location 2 – Eastern Residences	46	45	51

6.1.4.3 Night Time Period

The night period (that is, between 10pm and 7am) is the period where noise emissions can have the most significant effect on residential amenity. In addition to the quasi-steady state criteria the L_1 noise emission level should not exceed the background noise level by more than 15 dB(A) to prevent sleep arousal from intermittent events. The night time period applies between 10pm and 7am.

Table 10 – Measured L_{90} Noise Levels and Criteria - Night Time Period

Location	Measured L_{90} Noise Level dB(A)	Amenity Criterion dB(A) L_{eq}	Intrusiveness Criterion dB(A) L_{eq}	Night time Sleep Disturbance dB(A) $_{L1\ (1\ Min)}$
Location 1 – Western Residences	41	40	46	56
Location 2 – Eastern Residences	42	40	47	57

6.2 MECHANICAL NOISE EMISSIONS

Mechanical plant items are not typically selected at selected at a DA Application stage.

Detailed review of all external mechanical plant should be undertaken at construction certificate stage (once plant selections and locations are finalised). Acoustic treatments should be determined in order to control plant noise emissions to the levels set out in section 8 of this report.

All plant can be satisfactorily attenuated to levels complying with noise emission criteria through appropriate location and (if necessary) standard acoustic treatments such as noise screens, enclosures, in-duct treatments (silencers/lined ducting) or similar.

7 MECHANICAL NOISE ASSESSMENT

As detailed plant selections for the proposed multi-storey development are not available at this stage it is not possible to carry out a detailed examination of the ameliorative measures that may be required to achieve the noise targets.

Noise from the capark and energy centre will be designed such that the noise levels comply with the criteria detailed in Section 7 of this report.

Plant will be acoustically treated to prevent noise emissions from adversely impacting the surrounding properties in conjunction with the criteria detailed in this report. This may include selecting the quietest plant practicable, or treating the plant with enclosures, barriers, duct lining and silencers, etc as required to comply with the sound level recommendations.

Experience with similar projects indicates that it would be possible to achieve the requirement with appropriate treatment of the plant. General requirements for a number of potential plant items on the site are expanded on below.

Details of the acoustic treatments to the energy centre will be provided as part of the design documentation fro the project.

7.1 SUPPLY / EXHAUST FANS

Supply and exhaust fans may be located within the underground plant rooms or in rooftop plant areas. These units typically emit high noise levels and require acoustic treatment such as silencers and internal lined ductwork. Silencer requirements would be determined once fan selections have been completed.

7.2 MINOR PLANT

Other minor plant items, such as bathroom or kitchen exhaust fans, may also be required. These items typically emit relatively low noise levels and may require minimal acoustic treatment of a standard nature, such as internally lining of ductwork.

7.3 MAJOR PLANT

It is at the construction design stage that consideration should be given to the placement of equipment including intake and discharge air locations.

In addition to the location of the equipment acoustic treatments to the major plant items may include silencers, treatment to ducting, time control, operational limitations, vibration isolation and the like.

8 CONCLUSION

This report provides the results of the Noise Impact Assessment for the proposed Blacktown Hospital Main Campus development. In accordance with relevant acoustic standards for the site, noise at the site has been measured and noise goals have been set with reference to the requirements of the relevant statutory/regulatory authorities including the Office of Environment and Heritage.

The following has been also been addressed within the report:

- An assessment of noise emissions as a result of demolition and construction of the stages of the Hospital;
- Operational noise associated with the development such as mechanical plant noise.

We trust this information is satisfactory. Please contact us should you have any further queries.

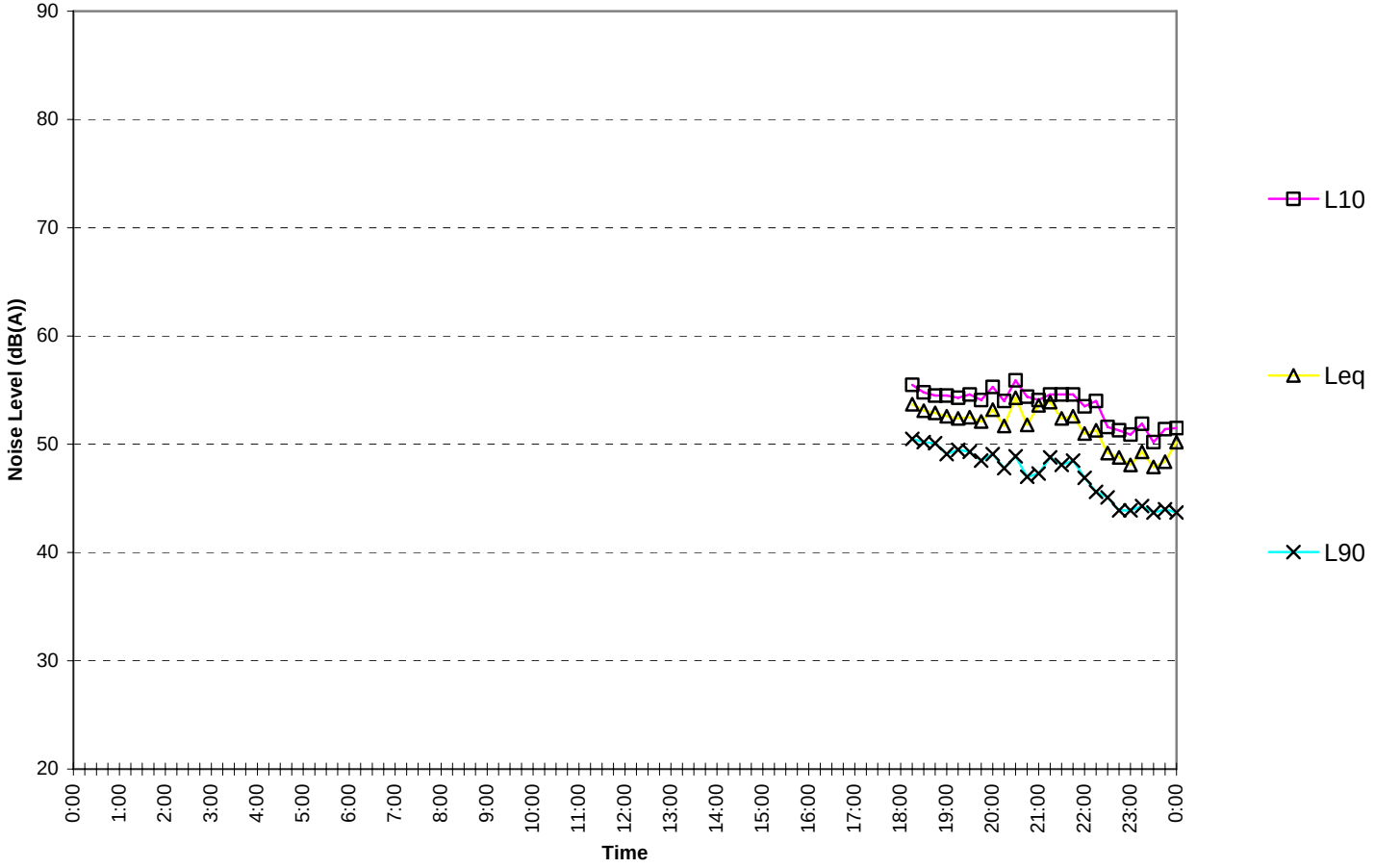
Yours faithfully,

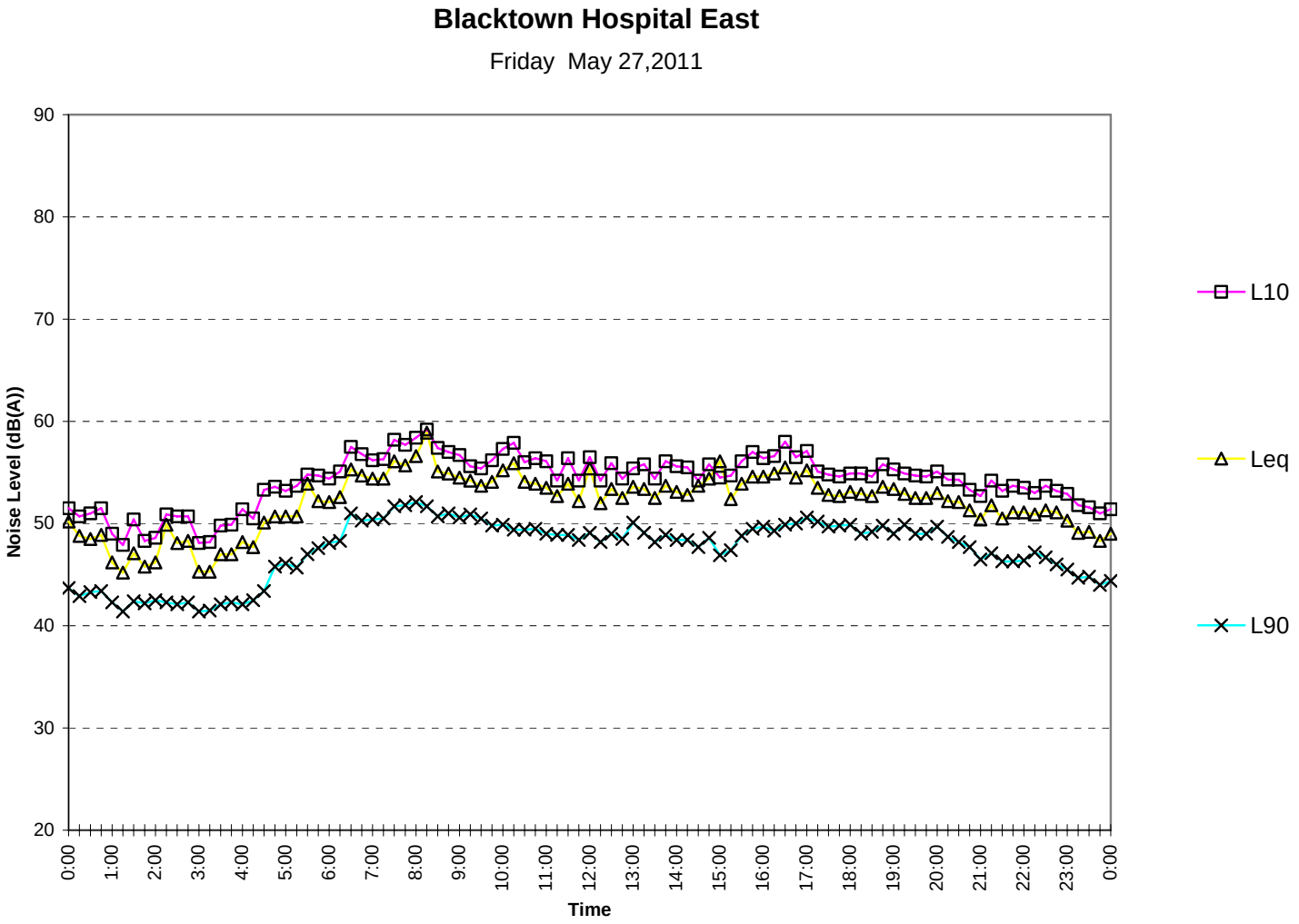
Acoustic Logic Consultancy Pty Ltd
Ben White

Appendix One -
Unattended Monitoring Results

Blacktown Hospital East

Thursday May 26,2011

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6:00
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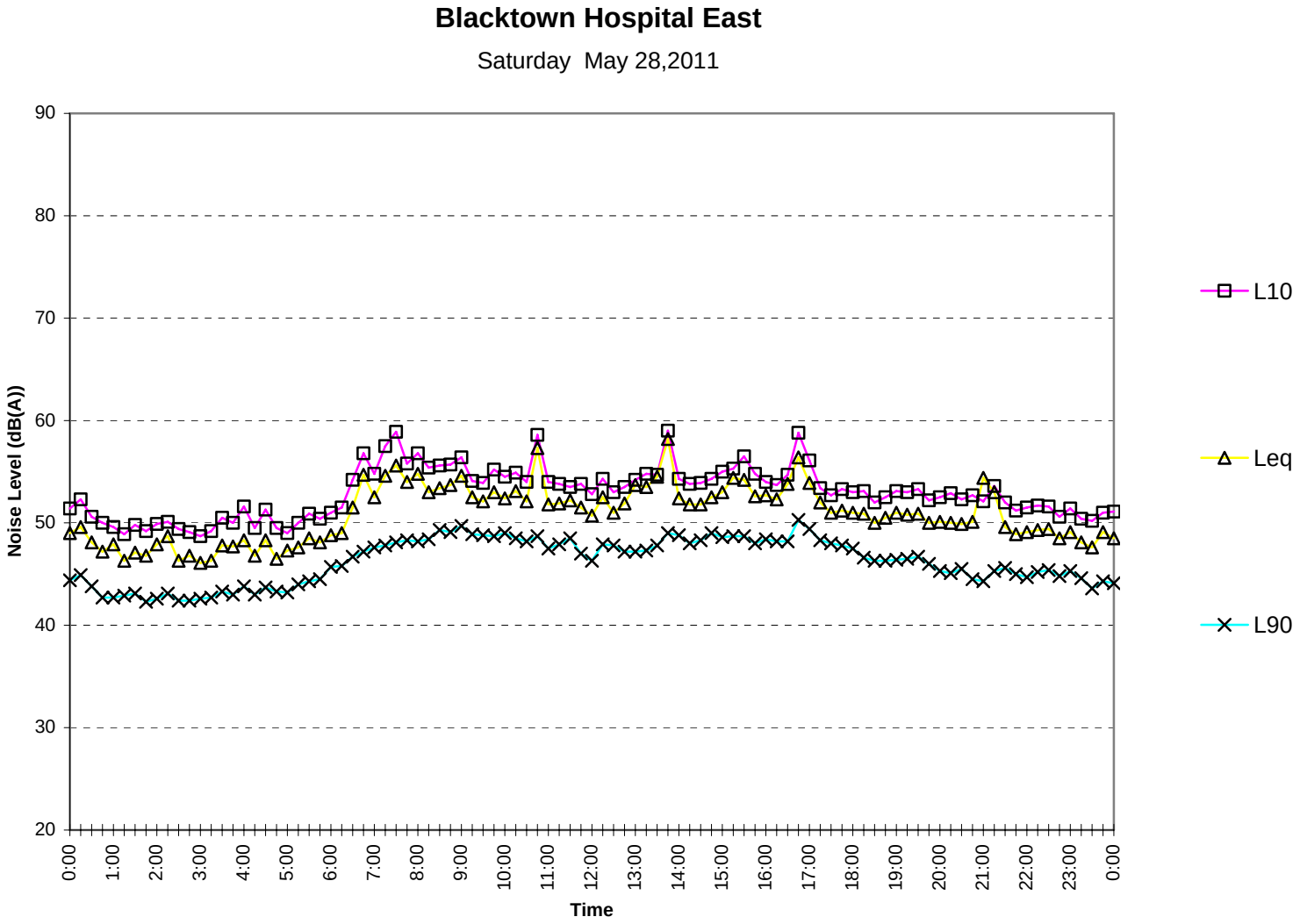
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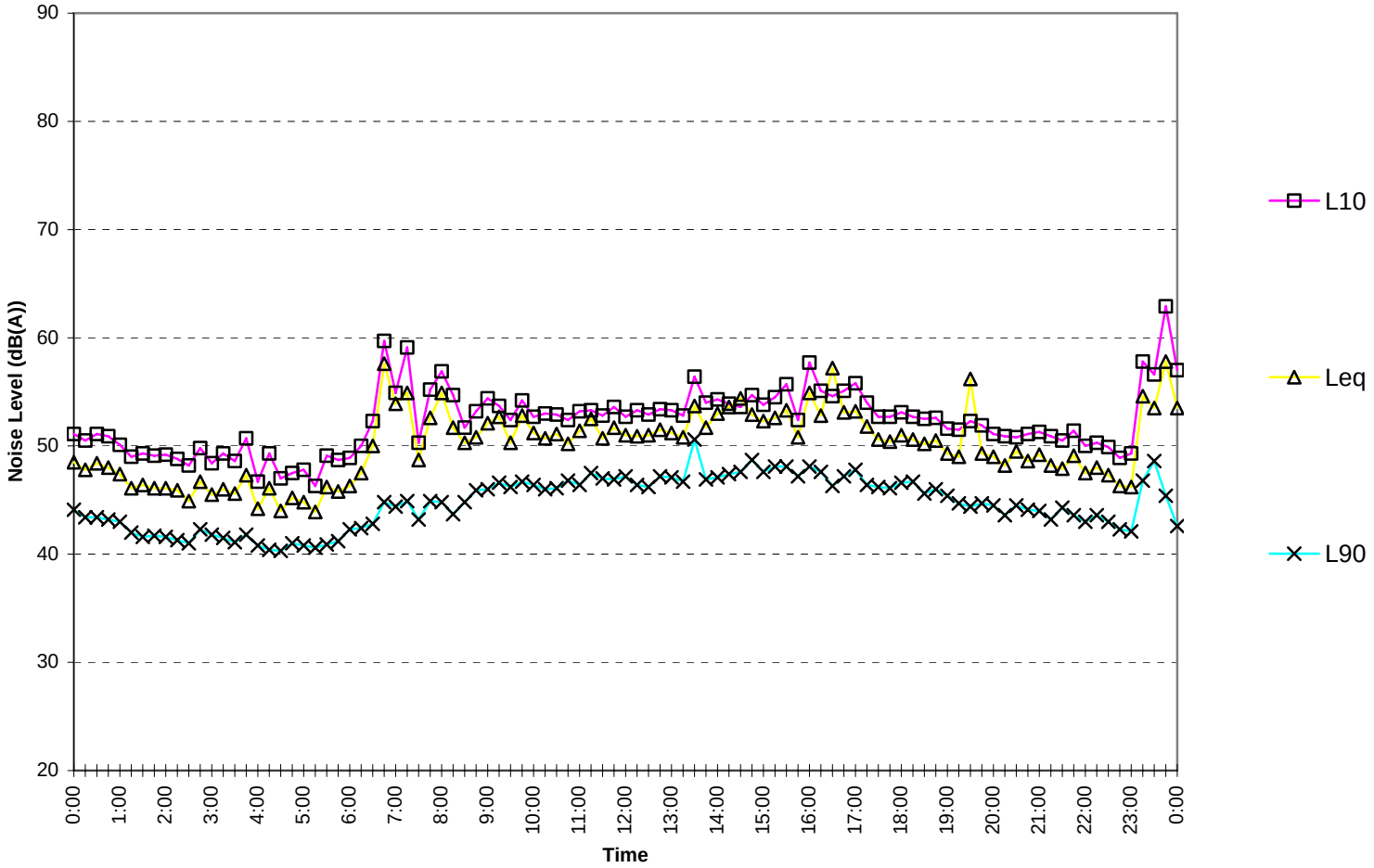
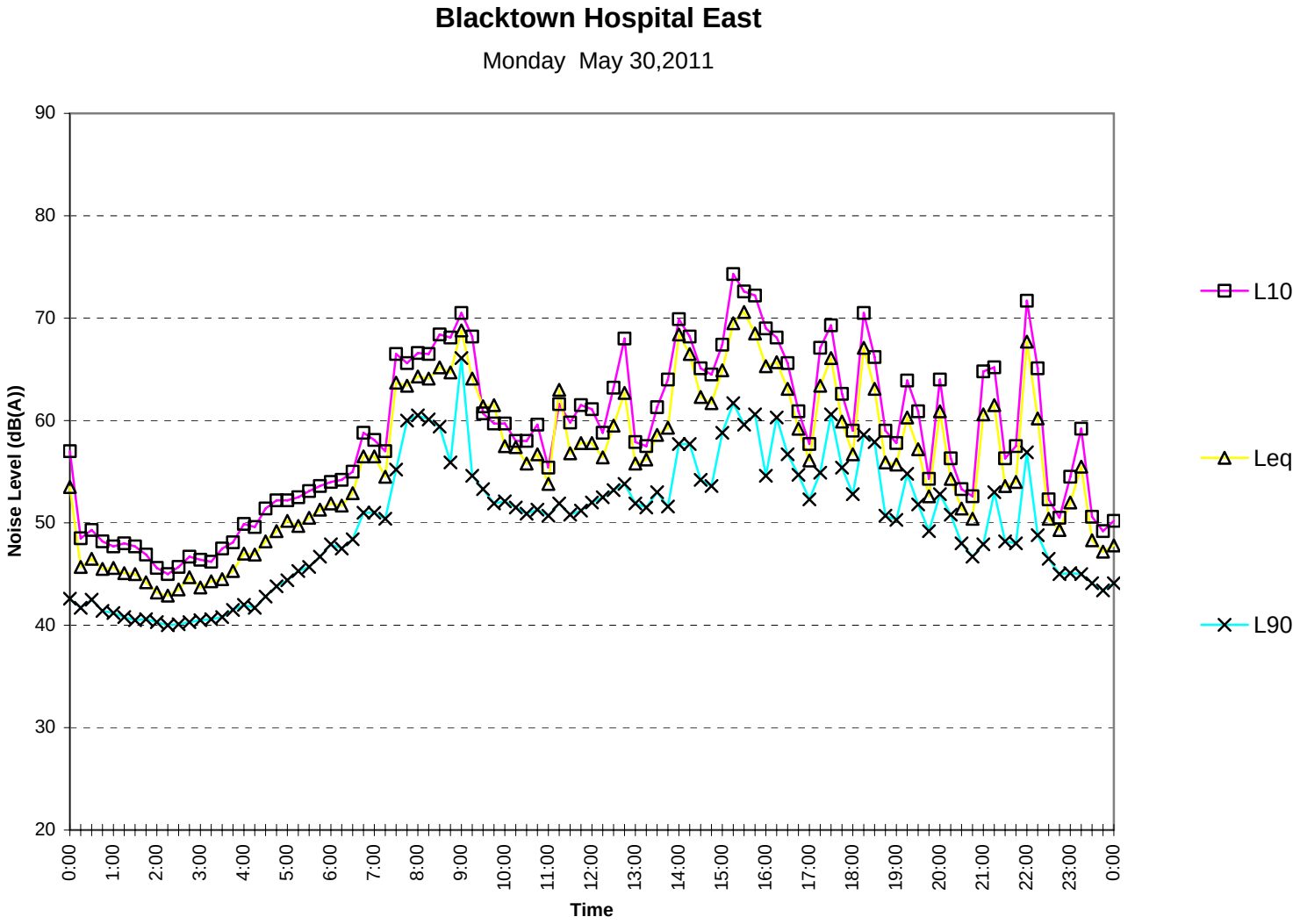
Blacktown Hospital East

Sunday May 29,2011

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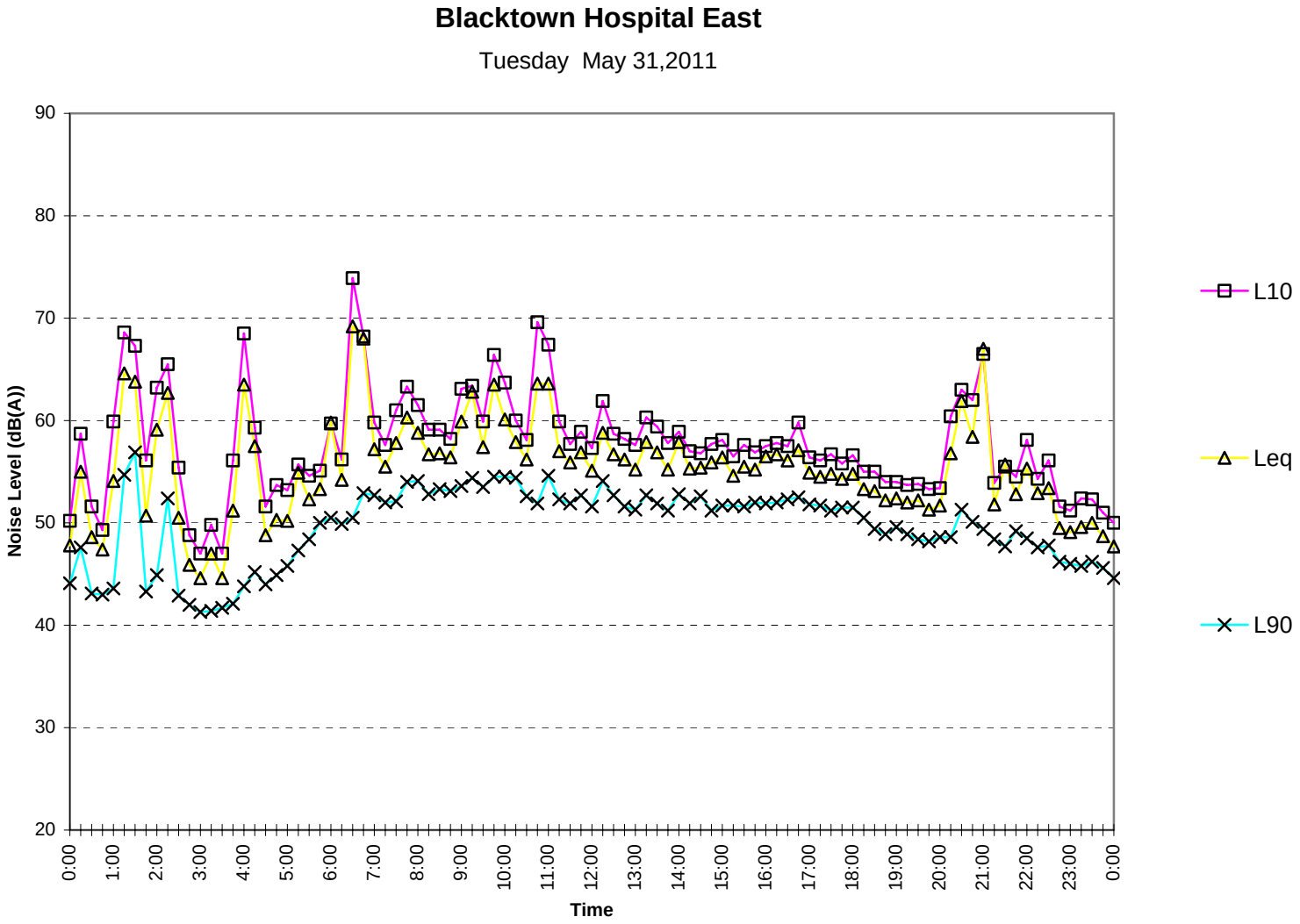
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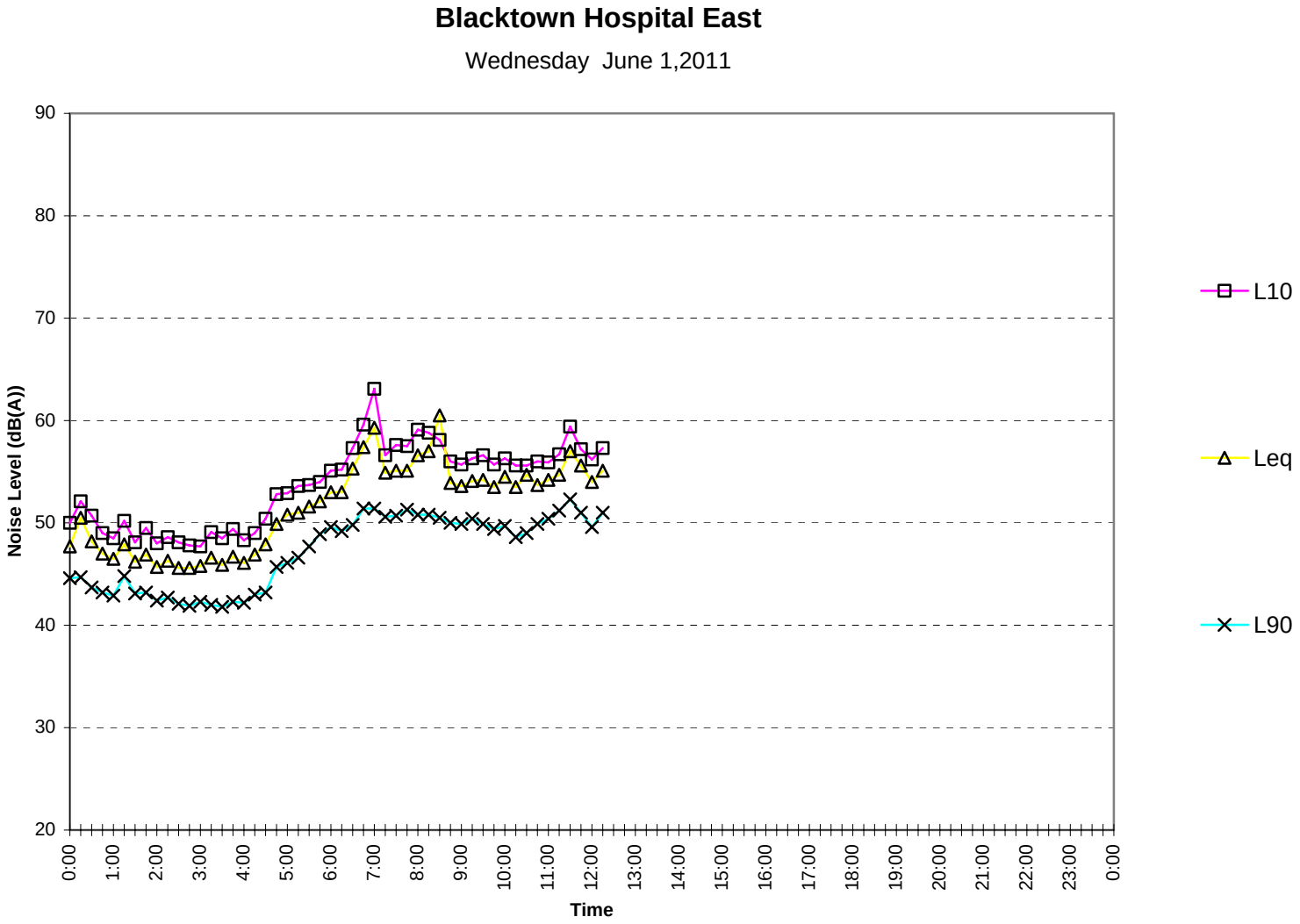
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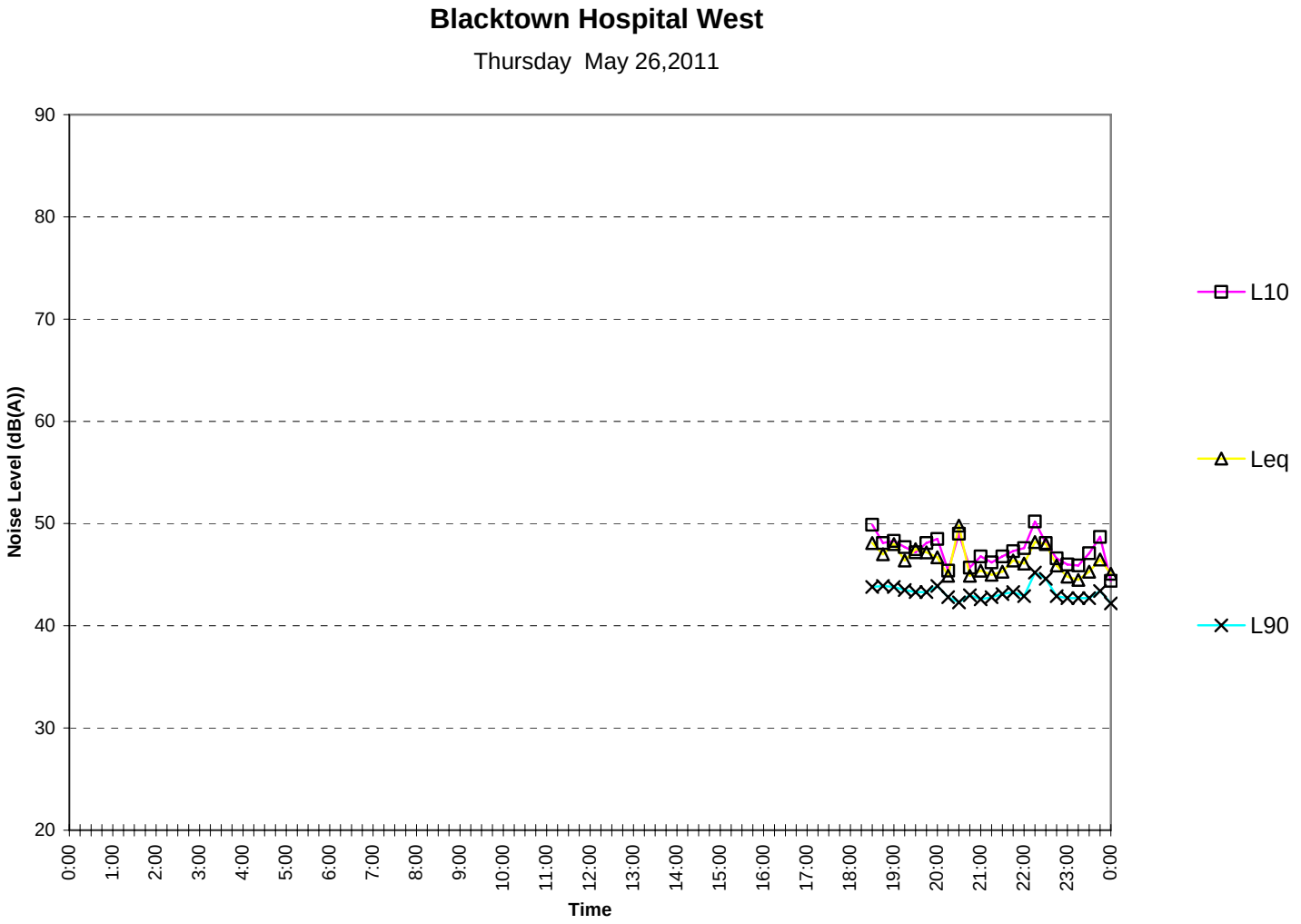
Blacktown Hospital West
Thursday May 26,2011
Noise Level (dB(A))
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Time
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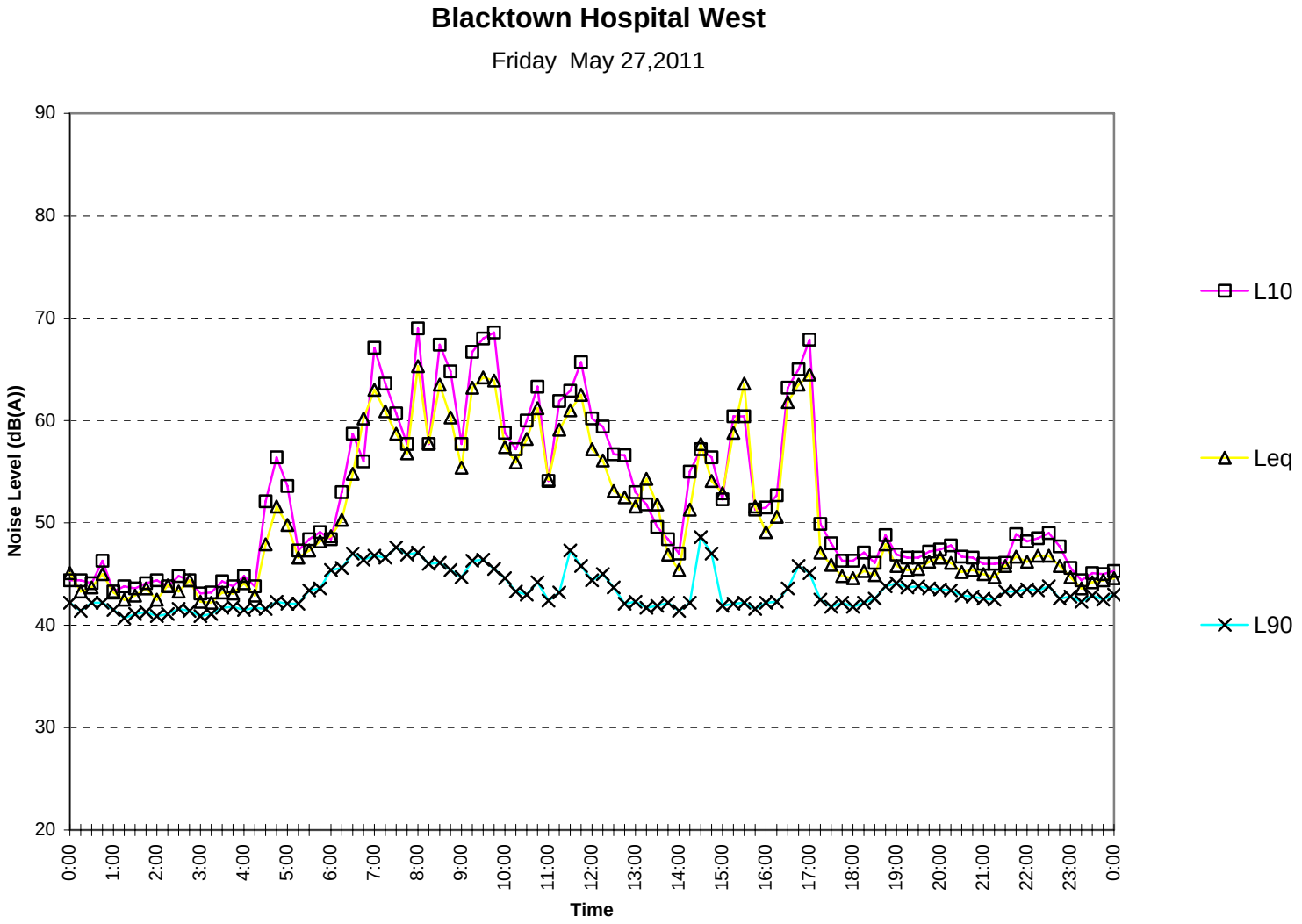
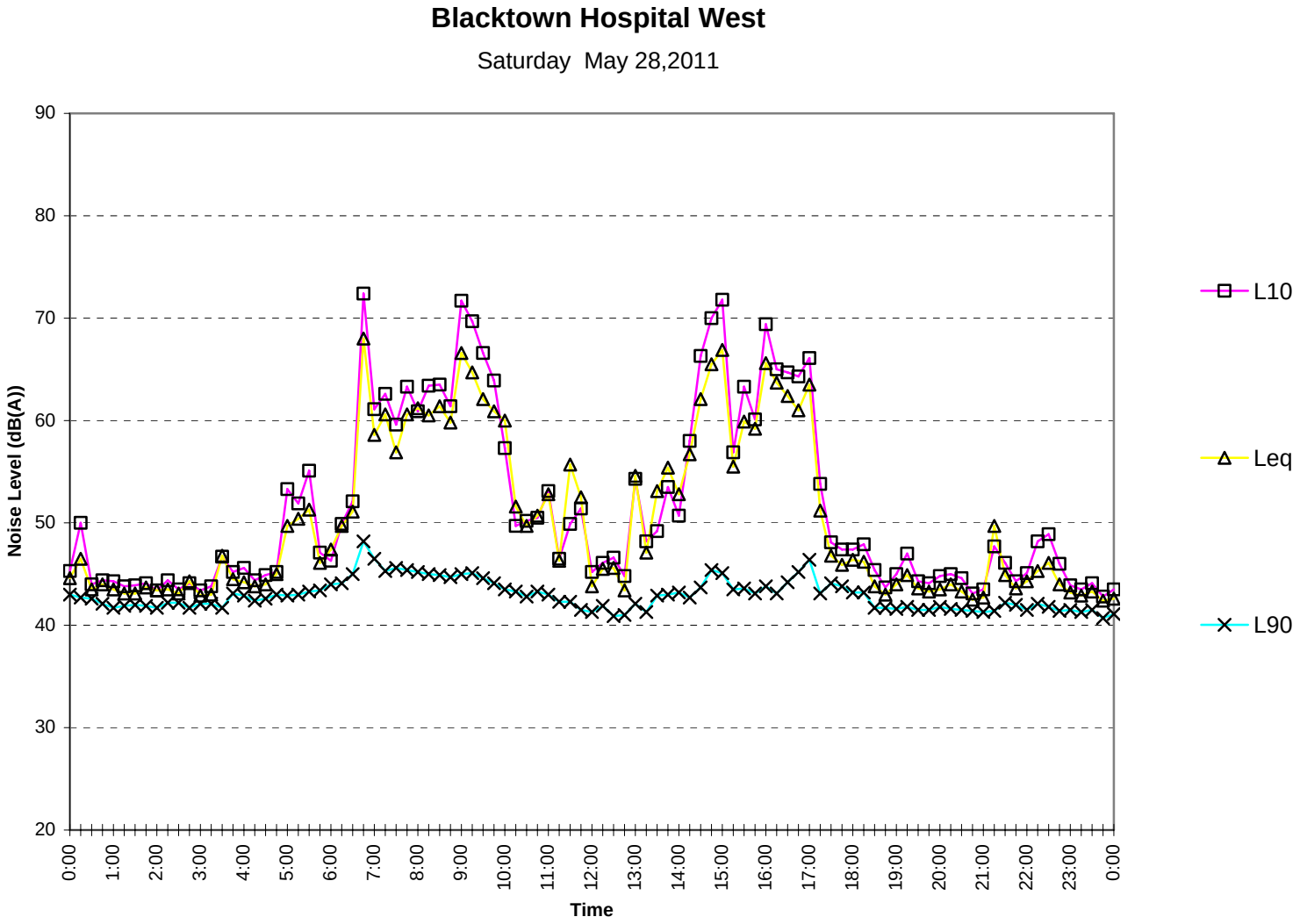
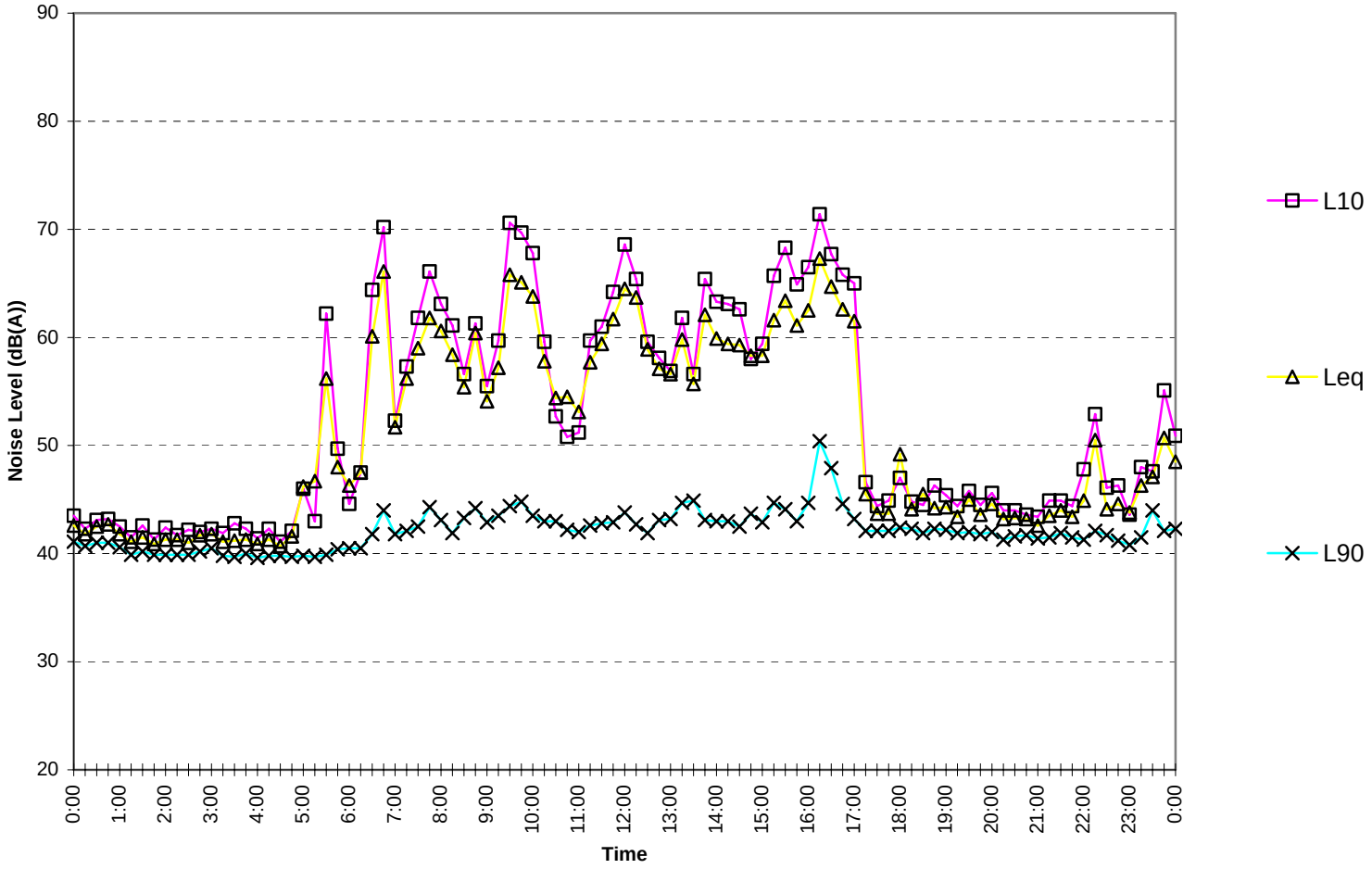
Leq
L90

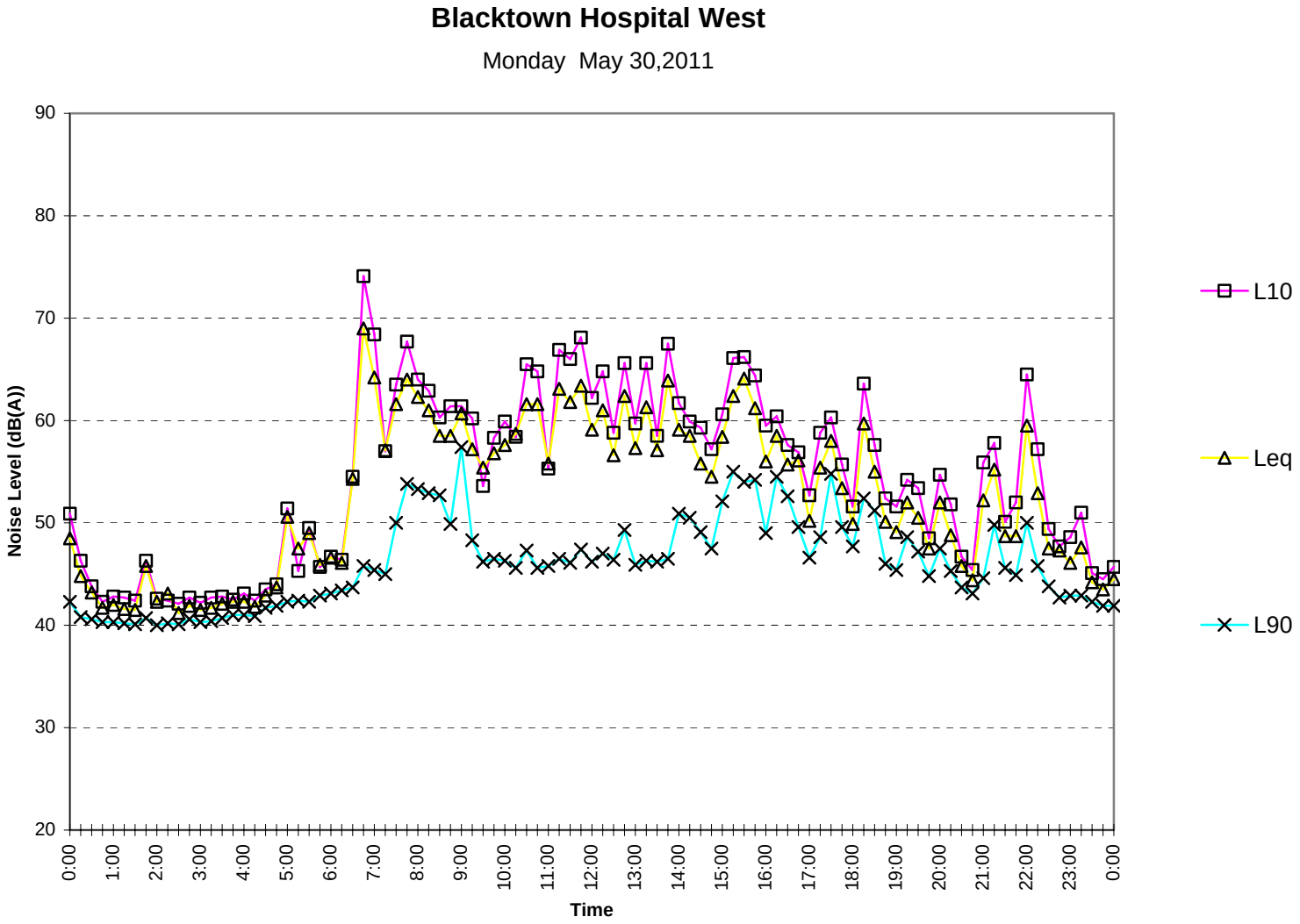

Blacktown Hospital West
Friday May 27,2011
Noise Level (dB(A))
90
80
70
60
50
40
30
20
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
0:00
Time
L10
Leq
L90

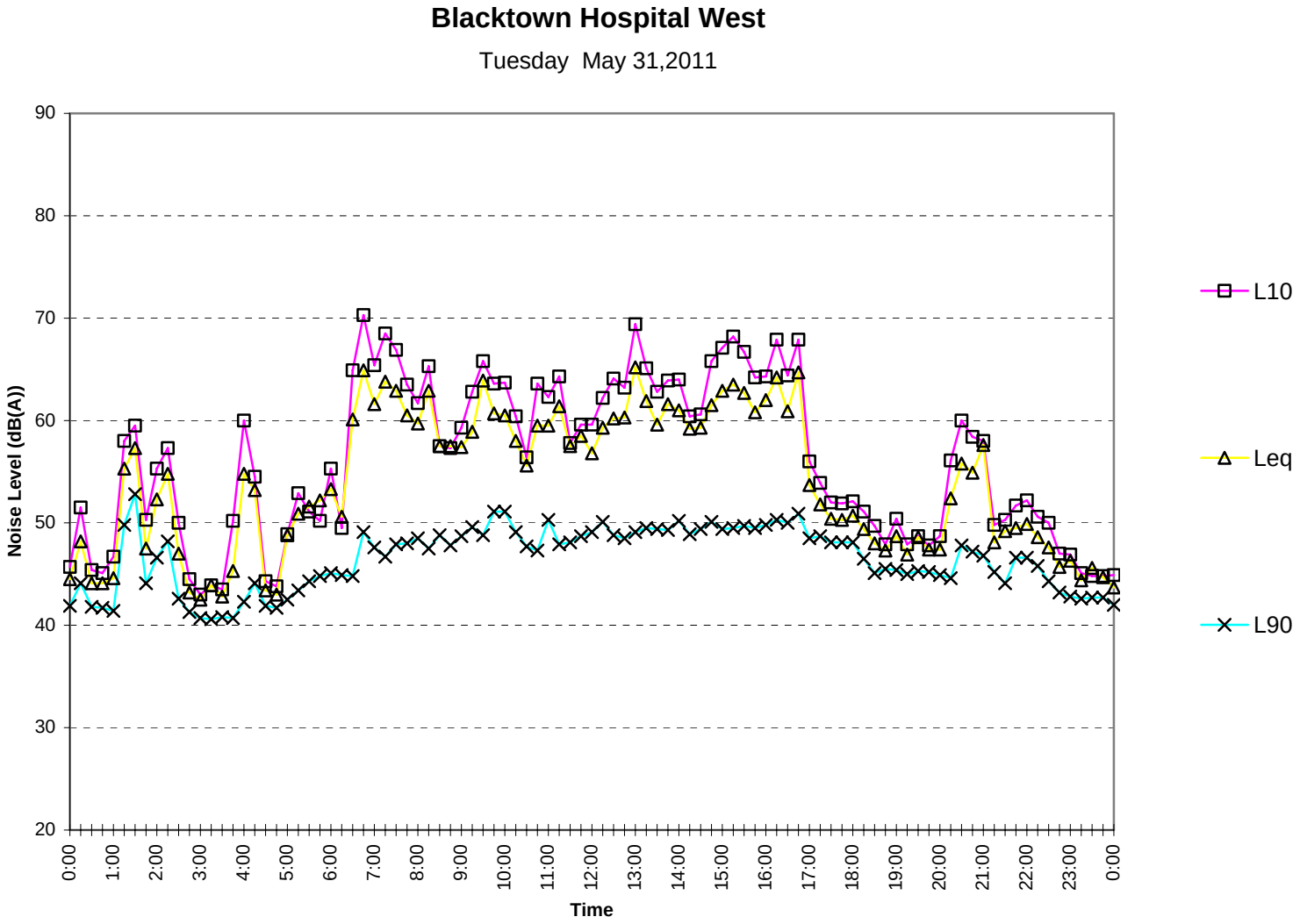

Blacktown Hospital West
Saturday May 28,2011
Noise Level (dB(A))
90
80
70
60
50
40
30
20
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
0:00
Time
L10
Leq
L90

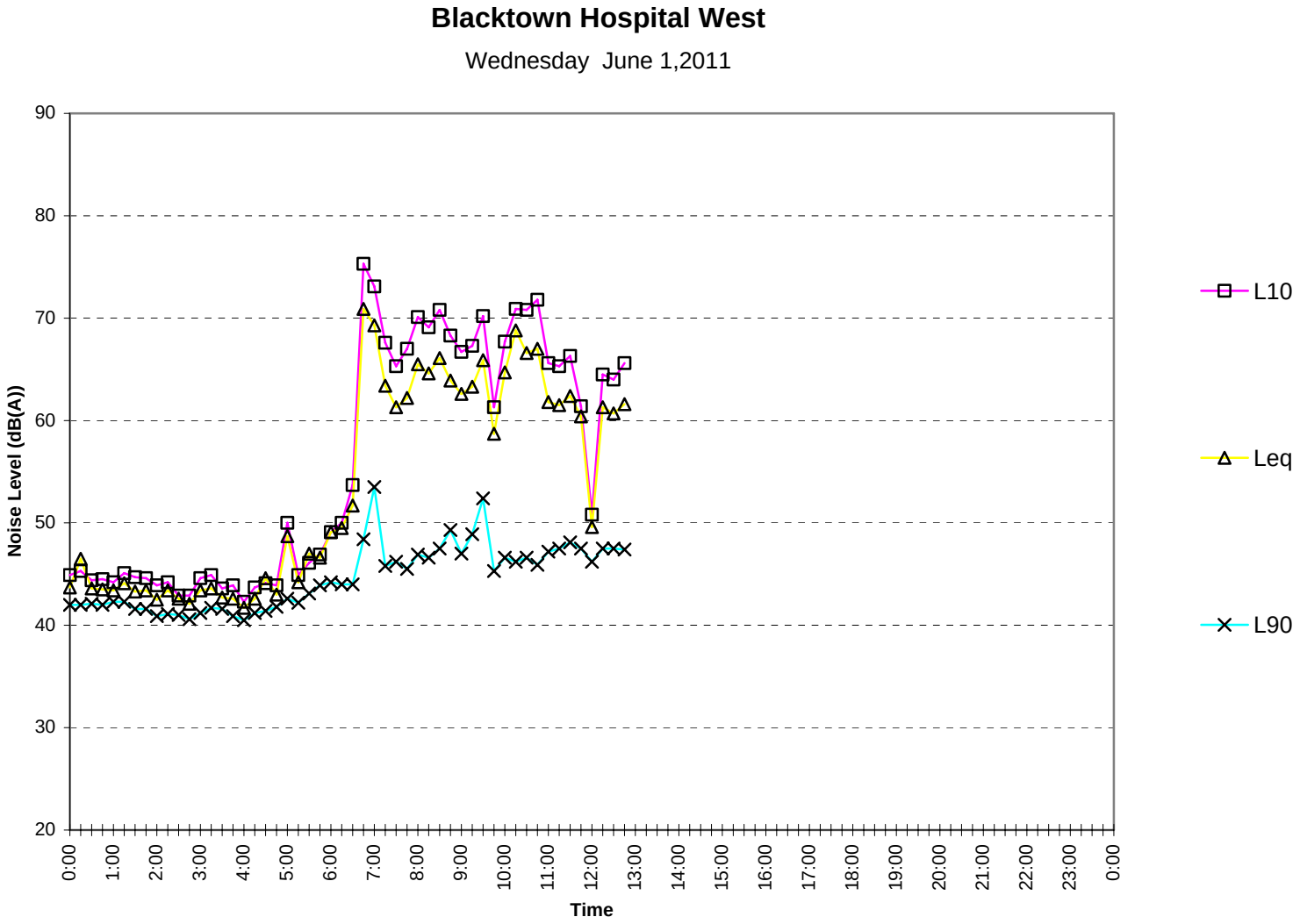
Blacktown Hospital West

Sunday May 29,2011




Blacktown Hospital West
Monday May 30,2011
Noise Level (dB(A))
90
80
70
60
50
40
30
20
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
0:00
Time
L10
Leq
L90


Blacktown Hospital West
Tuesday May 31,2011
Noise Level (dB(A))
90
80
70
60
50
40
30
20
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
0:00
Time
L10
Leq
L90


Blacktown Hospital West
Wednesday June 1,2011
Noise Level (dB(A))
90
80
70
60
50
40
30
20
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
0:00
Time
L10
Leq
L90