APPENDIX L

Noise and Vibration Assessment

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Phase 2/3 Works - Noise and Vibration Impact Assessment

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DOCUMENT CONTROL REGISTER

Project Number	20110844.3
Project Name	Wagga Wagga Base Hospital Redevelopment
Document Title	Phase 2/3 Works - Noise and Vibration Impact Assessment
Document Reference	20110844.3/1112A/R1/YK
Issue Type	Email
Attention To	NSW Health Infrastructure (ABN 89 600 377 397) Mr Jeremy Oakes

Revision	Date	Document Reference	Prepared By	Checked By	Approved By
0	3/12/2012	20110844.3/0312A/R0/YK	YK		BW
1	11/12/2012	20110844.3/1112A/R1/YK	YK		BW

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1 EXECUTIVE SUMMARY

Acoustic Logic Consultancy (ALC) has undertaken a review of the potential noise impacts associated with the development of the new Acute Hospital building (Phase 2/3) as part of the proposed redevelopment of the Wagga Wagga Base Hospital.

Construction Noise and Vibration Assessment:

- A preliminary review of construction noise and vibration has been undertaken. Based on relevant guidelines of the NSW Environment Protection Authority (EPA) and a survey of existing ambient noise levels on site, noise and vibration emission goals have been determined.

- Exceedance of noise emission goals are predicted at the boundary of the existing residential properties to the east and south, from typical plant/processes used during excavation and demolition stages. A detailed noise and vibration assessment and management plan is recommended when the construction program and plant is finalised.

- Where compliance with EPA guidelines is not strictly achievable for noise emissions resulting from any construction plant/processes, noise management in accordance with AS 2436 is recommended.

- The nearest external (not associated with the hospital) noise sensitive receivers are the residential properties located approximately 50m and 70m to the south and east of the subject development. No vibration impacts are predicted at these receivers from standard demolition, construction or excavation activities.

Helipad Noise and Vibration Assessment:

- Noise and Vibration impacts associated with the use of the proposed new rooftop Acute building helipad was also undertaken.

- As the proposed helipad is to be used for emergency flights only, typically adopted standard for aircraft noise AS2021-2000 is not appropriate for the design of noise from emergency vehicles. Noise emissions associated with emergency flight movements will be assessed with reference to the Air Services Australia's principle of a recommended external goal of 95dB(A)L_{Max} at any affected external receiver.

- Predicted noise emissions from the WNW and ESE emergency flight paths, comply with the relevant noise goal.

- No vibration impacts are predicted at any external (not associated with the hospital) receivers from emergency helipad operations.

Operational Noise and Vibration Assessment:

- An assessment of noise and vibration likely to be generated from the operation of site (new Acute Hospital building and phase 3 carpark) has also been undertaken. Operational noise (services noise, vehicle noise and traffic generation) have been assessed with reference to relevant planning controls (EPA's Industrial Noise Policy and Road Noise Policy).

- A survey of surrounding development has been undertaken, including an acoustic survey of existing ambient noise levels to determine noise emission goals.

- Based on the measured levels and modelling of predicted operational noise, compliance with noise emission goals will be achievable. Recommendations include:

    - Detailed acoustic design of all external mechanical plant and equipment (during the detailed design process) to ensure all plant items have appropriate acoustic treatment.

2 INTRODUCTION

This report presents an assessment of the operational noise impacts associated with the phase 2/3 works, proposed as part of the Wagga Wagga Base Hospital Redevelopment project. The works associated with this portion is proposed to be divided into two phases;

- Phase 2 – Construction of new Acute Hospital building; and
- Phase 3 – Construction of a canopy, forecourt and outdoor carparking space for the new Acute Hospital building.

In this report we will:

- Identify relevant Council and EPA noise emission criteria applicable to the development.
- Identify nearby noise sensitive receivers and operational noise sources with the potential to adversely impact nearby development.
- Predict operational noise emissions and assess them against acoustic criteria.
- If necessary, determine building and/or management controls necessary to ensure ongoing compliance with noise emission goals.
- Identify relevant EPA and Australian Standard criteria applicable to potential noise and vibration impacts on nearby developments, arising from the demolition and construction activities associated with the proposed phase of works.
- If necessary, determine building and/or management controls necessary to ensure compliance with noise and vibration goals for the construction phase.

3 SITE DESCRIPTION AND PROPOSED WORKS

Wagga Wagga Base Hospital is located on the southern site of Edward Street/Stuart Highway, at the intersection of Edward Street and Docker Street. The entire hospital boundary is bounded by Edward Street to the north, Docker Street to the west, Rawson Lane to the south and Murray Street to the east.

This report investigates the potential noise impacts associated with the development of a new Acute Hospital building as part of the development works proposed to the existing hospital. This potion of works encompasses the site immediately to the west of Lewis Drive, which includes the existing multi-storey ward building, mortuary building and Gissing House. Refer to figure 1 below for the subject phase 2/3 site boundary.

This portion of works is proposed to be divided into two phases;

- **Phase 2**
    - Clearing site; and
    - Construction of a new eight storey Acute Hospital Building on site with rooftop helipad.
- **Phase 3**
    - Demolition of existing multi-storey ward building on site; and
    - Construction of new canopy, forecourt and carp parking space (60 parking spots).

The proposed Acute building will serve as the main wing of the hospital, and will operate 24 hours a day.

Development in the vicinity of the subject phase of works consists of:

- Residential properties located along Doris Roy Lane, adjacent to the exsiting carpark to the north-east;
- Residential properties located along Yabtree Street, adjacent to the existing carpark to the east;
- Residential properties located along Yathong Lane and Street, adjacent to the Phase 1 Mental Health Facility; and
- Residential properties located along Rawson Lane, to the south of subject site.

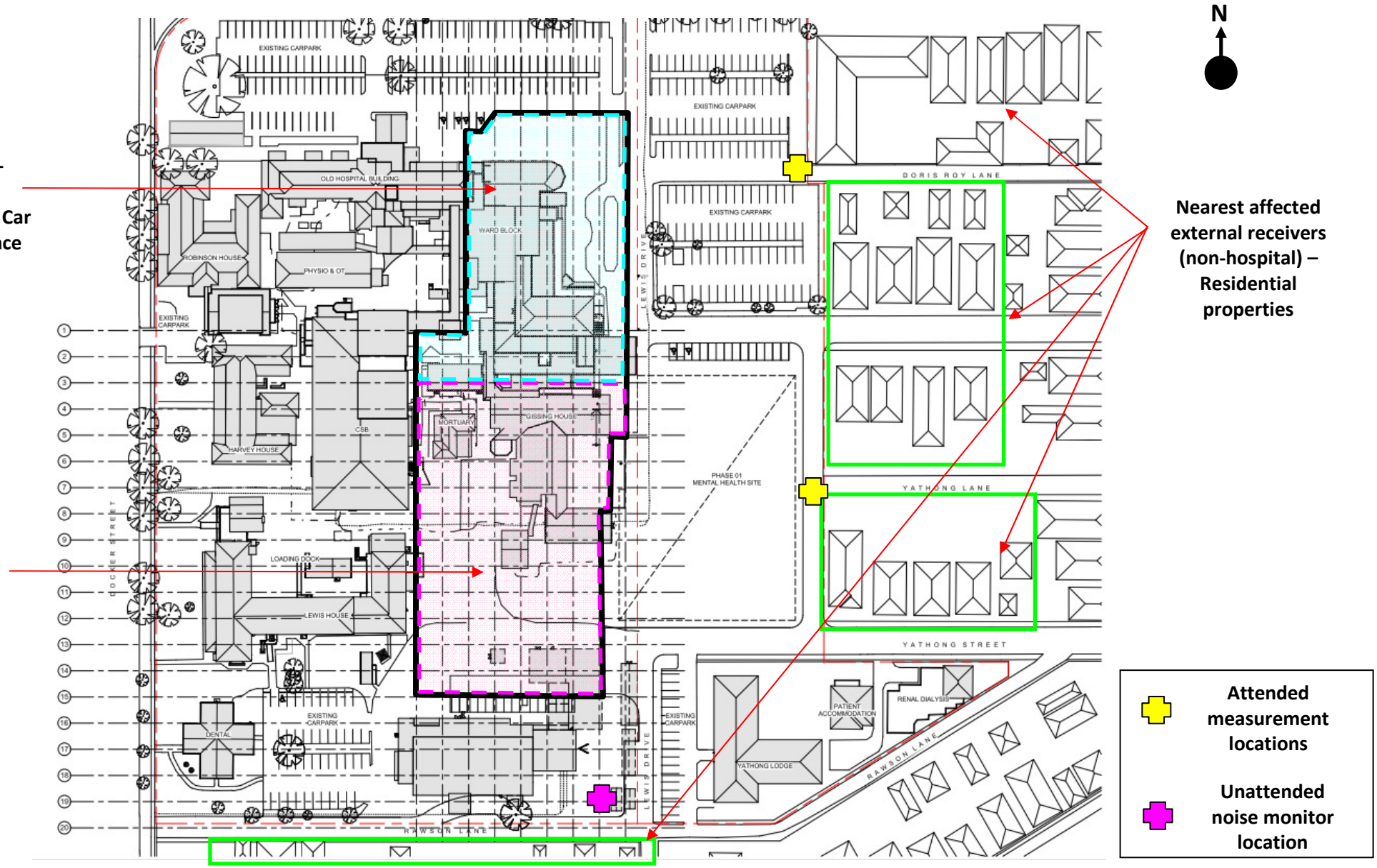


Figure 1 – Site Map

4 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.

L_1 levels represent is the loudest 1% noise event during a measurement period.

5 SURVEY OF AMBIENT NOISE

A survey of existing ambient noise at the site was conducted using both, long term unattended monitoring and short term attended hand held measurements.

Long term unattended noise monitoring was conducted using a noise monitor installed at the rear of the last work shed (on the corner of Lewis Drive and Russell Avenue), to the east of the engineering building (refer figure 1).

Unattended background noise monitoring was conducted from the 29th September to 12th October 2011 using an Acoustic Research Laboratories noise monitor. The monitor was programmed to store 15-minute 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.

Attended short term measurements were also conducted by this office (refer to Figure 1 above for measurement locations) to supplement the long unattended noise monitoring data.

Table 1 summarises the background noise levels determined based on unattended and attended noise measurements. The background noise levels detailed below are representative of the ambient noise levels at all the identified surrounding receivers.

Table 1 – Measured Background Noise Levels

Location	Background noise level dB(A)$_{L90}$*		
	Daytime (7am – 6pm)	Evening (6pm – 10pm)	Night (10pm – 7am)
Wagga Wagga Base Hospitals	37	37	32

*** Measured background noise levels corrected for façade reflection, -2.5 dB(A) as directed by the Australian Standards.**

6 ASSESSMENT CRITERIA

Noise emissions from the site should be assessed to ensure that the amenity of nearby land users is not adversely affected.

Noise sources associated with the subject phase of works, with the potential to impact on the amenity of nearby existing land users are;

- Demolition and Construction noise and vibration;
- Noise emissions associated with the operation of the proposed helipad on the roof of the new Acute Hospital building;
- Noise emissions generated by additional traffic in the area as a result of the proposed development; and
- Noise emissions from the regular operation of any external mechanical plant and equipment servicing the proposed development.

The nearest potentially affected external (not associated with the hospital) receivers have been identified in section 2 of this report, and are illustrated in Figure 1.

6.1 DEMOLITION AND CONSTRUCTION NOISE AND VIBRATION

6.1.1 Assessment Criteria

There are no specific acoustic controls outlined in the Wagga Wagga City council DCP with regards to construction noise and vibration impacts. In the absence of this, the following noise and vibration controls will be adopted.

6.1.1.1 Noise

Noise emission resulting from any demolition/construction activities on site will be assessed against the criteria stipulated in the following guidelines;

- EPA Interim Construction Noise Guideline; and
- Australian Standard 2436:1981 "*Guide to Noise Control on Construction Maintenance and Demolition Site*". In particular, the requirements stipulated in Section 3 of the standard will be followed.

6.1.1.1.1 EPA Interim Construction Noise Guideline (ICNG)

6.1.1.1.1.1 Airborne Noise – Residential Receivers

This guideline nominates acceptable levels of noise emissions above the background noise level. The table below sets out management levels for noise at residences and how they are applied. The rating background level or RBL is the overall single-figure background noise levels measured in each relevant assessment period (during or outside the recommended standard hours).

Typically the difference between the internal and external noise levels is about 10 dB with windows open at the residences for ventilation.

Table 2 – Noise Management Levels for Residential Receivers

Time of Day	Management Level dB(A)$L_{eq(15minutes)}$	How to apply
Monday to Friday – 7am to 6pm Saturday – 8am to 1pm No work on Sundays or public holidays	Noise affected RBL + 10 dB = 47	The noise affected level represents the point above which there may be some community reaction to noise.
	Highly noise affected 75 dB(A)	The highly noise affected level represents the point above which there may be **strong** community reaction to noise.
Outside the recommended standard hours	Noise affected RBL + 5 dB = 42	A strong justification would typically be required for works outside the recommended standard hours.

6.1.1.1.2 Airborne Noise – Commercial and Industrial Premises

For the commercial / industrial receivers surrounding the subject site, the ICNG outlines the following maximum external noise levels at the most – affected point of these premises:

- Commercial Premises – Offices, retail outlets – 70 dB(A)$L_{eq(15min)}$
- Industrial Premises – 75dB(A)$L_{eq(15min)}$

6.1.1.1.3 Ground-borne Noise

The ground – borne noise criteria outlined by the ICNG in section 4.2 only applies for evening and night – time periods, as the objective protects the amenity and sleep of receivers within any affected surrounding residential receiver.

All demolition and construction activities are only proposed to occur during the recommended standard hours and hence this criterion is not applicable for this assessment.

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

Where compliance with project consent requirements (above) cannot be achieved, noise emissions to be managed in accordance with principles in AS 2436:

- That reasonable suitable noise criterion is established.
- 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.

Based on these the following procedure will be used to assess noise emissions:

- Predict noise levels produced by typical construction activities at the sensitive receivers.

- If noise levels exceed "background + 10 dB(A)" noise goal at sensitive receiver locations, investigate and implement all practical and cost effective techniques to limit noise emissions. A background + 10 dB(A) criterion has been applied because, due to the size of the whole site, impacts at any one sensitive receiver are unlikely to occur for a greater period than 6 months.

- If the noise goal is still exceeded after applying all practical engineering controls to limit noise emissions investigate management and other techniques to mitigate noise emissions.

6.1.1.3 Vibration

Vibration caused by any demolition/construction activities on site must comply with the controls outlined in the following guidelines:

- For structural damage vibration, German Standard DIN 4150-3 *Structural Vibration: Effects of Vibration on Structures; and*

- For human exposure to vibration, 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

6.1.1.3.1 Structure Borne Vibrations (Building Damage)

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

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 3 – 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

6.1.1.3.2 Assessing Amenity (Human Comfort)

The EPA *"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 excavation/construction site.

Table 4 – EPA 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							
Residences	Daytime	0.01	0.02	0.2	0.4	0.28	0.56
Offices		0.02	0.04	0.4	0.8	0.56	1.1
Workshops		0.04	0.08	0.8	1.6	1.1	2.2
Impulsive Vibration							
Residences	Daytime	0.3	0.6	6.0	12.0	8.6	17.0
Offices		0.64	1.28	13.0	26.0	18.0	36.0
Workshops		0.64	1.28	13.0	26.0	18.0	36.0

6.2 HELIPAD OPERATION – NOISE AND VIBRATION

6.2.1 Noise

The proposed helipad is to be used for emergency flights only (predicted total of 6 – 7 helicopter transfers per month – Refer *Helicopter Noise Assessment* report prepared by Wilkinson Murray; report no. 09257 – A, Version A).

Typically applied aircraft noise impact guideline AS 2021 – 2000 *"Acoustics – Aircraft noise intrusion – Building siting and construction"* and noise emission guidelines such as the EPA *Industrial Noise Policy*, are not applicable for the assessment of emergency vehicle noise.

Additionally, even guidelines such as the EPA's *Managing Vehicle Noise* document is not applicable, as noise associated with the use of emergency vehicles is expressly excluded from compliance with acoustic controls.

Hence, we note that noise emissions associated with the operation of the helipad will be assessed with reference to the Air Services Australia document *Environmental Principles and Procedures for Minimising the Impact of Aircraft Noise.* Relevant principle outlined in this document is as follows:

> *Principle 7 – There should be a current agreed aircraft noise exposure level above which no person should be exposed, and agreement that this level should be progressively reduced. The goal should be 95dB(A).*

Where practicable, compliance with this principle should be achieved.

6.2.2 Vibration

No vibration impacts are expected from the helipad operations to surrounding existing residential receivers.

6.3 TRAFFIC MOVEMENTS – NOISE AND VIBRATION

6.3.1 Noise – EPA Road Noise Policy

Noise from traffic movements as a result of the new Acute hospital development will have to comply with the provisions of EPA Road Noise Policy. These are detailed below;

6.3.1.1 Noise from Increased Traffic Generation on Public Streets

For land use developments with the potential to create additional traffic on the surrounding road network, the development should comply with the requirements for new developments detailed in section 2.3 of EPA's Road Noise Policy.

Based on Mott Macdonald's Transport and Accessibility Study, revision B dated 30 November 2011, the existing road networks are classified as follows;

- Edward Street (Stuart Hightway) – Arterial Road
- Docket Street – Collector Road
- Lewis Drive – Local Road

Noise levels generated by traffic should not exceed the noise levels set out in the table below when measured at the boundary of the nearest affected properties.

Table 5 – Road traffic noise criteria for Residential Land Use Developments

Type of Development	Time of day	External Criteria for Acceptable Traffic Noise Level
Land use developments with potential to create additional traffic on arterial/sub-arterial roads	Day (7am – 10pm)	60 dB(A) $L_{Aeq(9hr)}$
	Night (10pm – 7am)	55 dB(A) $L_{Aeq(15hr)}$
Land use developments with potential to create additional traffic on local roads	Day (7am – 10pm)	55dB(A) $L_{Aeq(1hr)}$
	Night (10pm – 7am)	50dB(A) $L_{Aeq(1hr)}$

However, if existing noise levels exceed those in the table below, all reasonable steps should be undertaken to minimise noise impacts. Section 3.4 of the Policy states that an increase in the existing noise level of 2dB(A) would be considered a barely perceptible increase to the average person.

6.3.1.2 Sleep Arousal Assessment – Impact from Vehicles accessing Phase 3 carpark

Sleep arousal is a function of both the noise level and the duration of the noise.

To assess potential sleep arousal impacts, a two stage test is carried out:

- Step 1 – An "emergence" test is first carried out. That is, the $L_{1(1min)}$ noise level of any specific noise source should not exceed the background noise level (L_{90}) by more than 15dB(A) outside a resident's bedroom window between the hours of 10pm and 7am. If the noise events are within this, then sleep arousal impacts are unlikely and no further analysis is needed. This is consistent with the Noise Guide for Local Government. The guideline level is set out below.

Table 6 – Sleep Arousal Emergence Criteria

Location	Sleep Disturbance Emergence Level dB(A) $L_{1(1min)}$
	Night (10pm – 7am)
Outside bedroom window of worst-affected residential receiver	BG + 15 dB(A) = 47

- Step 2 – If there are noise events that could exceed the emergence level, then an assessment of sleep arousal impact is required to be carried out taking into account the level and frequency of noise events during the night, existing noise sources, etc. This test takes into account the noise level and number occurrences of each event with the potential to create a noise disturbance. As is recommended in the explanatory notes of the EPA Industrial Noise Policy, this more detailed sleep arousal test is conducted using the guidelines in section 5 of EPA's Road Noise Policy.

  Section 5.4 (Sleep Disturbance) of this policy concludes from the research into sleep disturbance to date;

  - *maximum internal noise levels below 50–55 dB(A) are unlikely to awaken people from sleep*
  - *one or two noise events per night, with maximum internal noise levels of 65–70 dB(A), are not likely to affect health and wellbeing significantly.*

6.3.2 Vibration

No vibration impacts are expected from the helipad operations to surrounding existing residential receivers.

6.4 MECHANICAL PLANT AND EQUIPMENT – NOISE

In the absence of any relevant noise control outlined in the Wagga Wagga City Council DCP, noise emissions from all external plant and equipment servicing the proposed phase 2 development, will be assessed against the controls of the EPA NSW Industrial Noise Policy (INP).

6.4.1 EPA Industrial Noise Policy

The INP has two requirements which both have to be complied with, namely an amenity criterion and an intrusiveness criterion. In addition, the EPA in its Environmental Noise Control Manual states that noise controls should be applied with the general intent to protect residences from sleep arousal.

6.4.1.1 Intrusiveness Criterion

The 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.

Allowable noise level is as follows:

Table 7 – Allowable Intrusive Noise Levels

Location	Intrusiveness Noise Goals dB(A) $L_{eq(15\ minutes)}$		
	Day (7am-6pm)	Evening (6pm-10pm)	Night (10pm-7am)
Boundary of any affected residential receiver	42	42	37

6.4.1.2 Amenity Criterion

The INP sets out acceptable noise levels for various localities to maintain the general amenity of that area. 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 8 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 8 – EPA Recommended Amenity Noise Levels

Type of Receiver	Time of day	Recommended Acceptable Noise Level dB(A) $L_{eq(period)}$
Residential – Suburban	Day (7am-6pm)	55
	Evening (6pm-10pm)	45
	Night (10pm-7am)	40
Commercial premises	When in use	65

6.5 SLEEP AROUSAL ASSESSMENT

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.

Table 9 – External Mechanical Plant Sleep Arousal Noise Goal

Location	Sleep Disturbance Noise Goal dB(A) $L_{1(1min)}$
	Night (10pm – 7am)
Outside bedroom window of worst-affected residential receiver	BG + 15 dB(A) = 47

7 NOISE AND VIBRATION IMPACT ASSESSMENT

7.1 DEMOLITION AND CONSTRUCTION ACTIVITIES

We have been asked to provide comment on potential noise and vibration impacts to nearby existing developments, arising from the proposed phase 2/3 works.

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.

7.1.1 Noise Impacts

Noise impacts on nearby developments will be dependant on the activity and where on the site the activity is undertaken. Excavation and piling works tend to be the loudest typical activity. Based on the location of the proposed phase 2/3 works (refer Figure 1), the nearest affected external (non hospital) receivers are located to the east and south of the of the subject site (refer Figure 1 and description in section 2). Hence work close to the eastern and southern boundaries will have greatest impact on these residents. As the proposed works (associated with the new Acute Hospital building) are to be divided into two phases, they will be discussed separately below.

7.1.1.1 Phase 2 – Acute Hospital Building

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 activities during this phase. Noise levels of between 67-71 dB(A) and 66-68 dB(A) are predicted at the boundary of the nearest residents to the south and east respectively. The higher end of predicted noise levels will only occur for short periods, when working close to the southern and eastern boundaries (within 20m of these boundaries). Typical noise levels are likely to be closer to 65-66 dB(A), with a majority of the plant items used during this stage being transitory (excavators, dozers etc.) and intermittent in nature (pilling, hammering), and are not predicted to exceed the highly noise affected management level of 75 dB(A).

- During erection of structure, it is the use of hand tools (angle grinders, hammers etc.) and concrete pumps which are the loudest typical activity (sound power levels of approximately 105 dB(A)$L_{eq(15min)}$). Noise levels of between 57-60 dB(A) and 55-57 dB(A) are predicted at the boundary of the nearest residents to the south and east respectively. Obviously, 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.

7.1.1.2 Phase 3 – Canopy, Forecourt and Carpark

Initial analysis indicates:

- Demolition Works – Primary noise emissions will occur during the demolition of the existing multi-storey ward building. Noisy plant will typically include bulldozers, excavators and hand tools (hammers, angle grinders etc.), with sound power levels of approximately 105 dB(A)$L_{eq(15min)}$. The phase 2 Acute hospital building will act as a barrier, screening the residential receivers to the south (along Rawson Lane). Noise levels of between 55-57 dB(A) are predicted at the boundary of the residential properties to the east (along Doris Roy Lane and Yabtree Street), who will be the worst affected receivers. The EPA criteria (refer to Table 2) may be exceeded from time to time, particularly when working within 20m of the eastern and northern site boundaries. However, this stage is predicted to extend over a short duration, with activities being largely intermittent and are unlikely to exceed the highly noise affected management level of 75dB(A).

- Construction of the new canopy, forecourt and carparking space will primary comprise of hand tools and some excavators (for fill). Intermittent exceedances of the EPA noise goals are predicted at the boundary of the residential properties to the east, however this phase of works will only occur for a very short duration of the entire construction programme and will be masked by the ambient noise of the area (which will potentially rise as a result of the proposed hospital redevelopment).

7.1.2 Vibration impacts

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

As the nearest external (not associated with the hospital) receivers i.e. the residential properties to the south and east (refer Figure 1 above) are located approximately 50m and 70m from the site boundary, no vibration impacts are predicted at these receivers.

7.1.3 Recommended Construction Noise and Vibration Controls

Noise impacts can be minimised using the following:

- Selection of equipment and process.

- Location of static plant (particularly concrete pumps).

- 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:

- 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 EPA guidelines.

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

- 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.

7.2 OPERATION OF NEW HELIPAD

7.2.1 Brief Summary

A helipad is proposed to be constructed on level 7 of the new Acute hospital building, above the level 6 plant rooms. Figure 1 below illustrates the locations of the proposed helipad.

The following information was outlined in the preliminary Helicopter Noise Assessment report prepared by Wilkinson Murray (report no. 09257 – A, Version A) which details the proposed operation of the helipad (both current and future);

Currently

- Helicopters transferring patients to and from the Wagga Wagga hospital use the Duke of Ken Park in South Parade, which is located approximately 1 km to the north – west of the hospital.

- A total of 47 flight transfers per year (helicopters and fixed wing aircrafts).

Proposed (if landing site moves to new helipad)

- All flight transfers to the hospital will occur via the new helipad.
- An increase in total flight transfers per year from 47 to 78 (all helicopters). Approximately 45% of the helicopter transfers will occur between 8am to 6pm, with 25% occurring between 6pm to midnight and the remainder 25% between Midnight to 8am.
- This will result in a total of 6 – 7 helicopter transfers per month. **Helicopter movements after 6pm and during the midnight – 8m period will be emergency flights, with no more than two per month predicted.**

7.2.2 Helicopter Services and Flight Paths

The Wilkinson Murray report (report no. 09257 – A, Version A) identifies the following helicopter types currently being used at the Duke of Kent Park landing site and will be similar to the proposed future use of the Wagga Wagga based hospital helipad;

- Bell 412
- Augusta Westland 139
- EC 145
- BK117
- AS365 N-N Dauphin

Section 2.4 of the Wilkinson Murray report outlines WNW and ESE flight paths from the new helipad, as shown in figure 2 below.

Proposed range of flight path – landing/take-off can occur in both directions

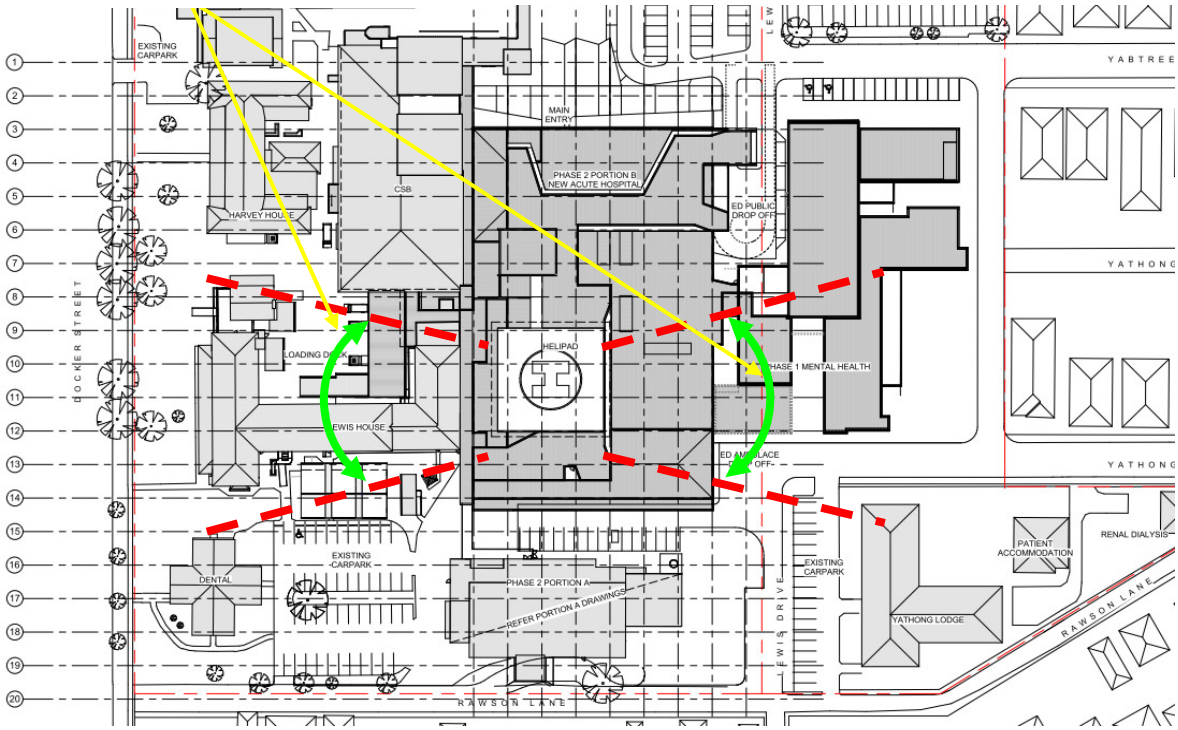


Figure 2 – Helipad Location and Proposed Flight Paths

7.2.3 Noise Impacts

7.2.3.1 Assessment Methodology

- Noise level data for all the helicopters which will potentially use the helipad are not available. This assessment has been based on noise level measurements of an AW 139 helicopter, which was previously undertaken by this office. The measured noise level of an AW 139 helicopter landing on a helipad of a medical centre was measured as a sound power level (SWL) of 139 dB(A).

- For the purposes of our assessment we have assumed an angled approach and take-off for all helicopter movements, as indicated in the figure below;

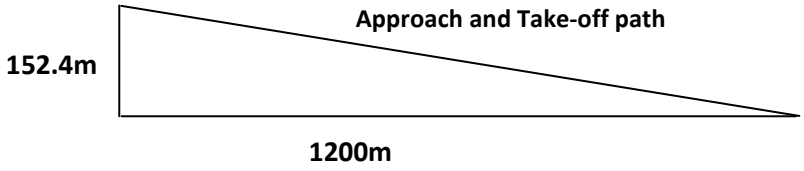


Figure 3 – Indicative Approach and Take-off Path

7.2.3.2 Predicted Noise Levels

Maximum predicted noise level at nearby residential properties will occur in the event that helicopter take-off or landing movements occur in an easterly direction, directly over one of the residential properties along Yathong Street. Based on the assumed approach gradient, the likely distance between the helicopter and the single storey properties can be determined, and a resultant noise level determined. Predicted noise levels are presented below:

Table 10– Helicopter Noise – Worst Affected Residences

Receiver Location	Air Services Australia Guideline	Predicted Noise Level - Based on AW139 Helicopter at Acute Building
Residential Properties along Yathong Street (single storey houses)	95dB(A)L_{max}	90dB(A)L_{max}

Maximum predicted noise level (worst-case assumption of helicopter flying directly above existing residential properties) complies with the Air Services Australia noise guideline. Hence no additional treatments or alternate flight paths required.

7.2.4 Vibration Impacts

As the nearest affected external receivers (not associated with the hospital), in the proposed flight path of the emergency helicopter are located approximately 100m to the east, no vibration impacts are expected from the emergency flight movements associated with this helipad.

7.3 TRAFFIC MOVEMENTS

7.3.1 Noise

Noise impacts associated with traffic movements as a result of the phase 2/3 works will be assessed in two separate parts;

- Noise generated by traffic movements associated with the phase 2 Acute Hospital building (additional vehicle movements and use of public drop off area) and phase 3 new carparking space; and

- Noise generated by additional traffic on existing road network.

7.3.1.1 Noise Generated By Use of Phase 2/3 Works

7.3.1.1.1 Normal Operation

Main access to the existing hospital is via the Edward Street/ Lewis Drive access. Some vehicle movements also occur via Doris Roy Lane, Yabtree Street, Yathone Lane and Yathong Street, especially vehicles accessing the exiting car park adjoining Doris Roy Lane to the west.

Based on Mott Macdonald's Transport and Accessibility Study, revision B dated 30 November 2011, a worst hour prediction of 70 vehicle movements are estimated as a result of the phase 2/3 redevelopment. This will result in an insignificant increase to the existing vehicle movements accessing the hospital i.e. approximately 1 vehicle per minute additional, spread across a number of access roads.

Assuming an absolute worse case assumption of 70 vehicle movements per hour occurring continuously over a 24 hour period; this will result in a total of 1680 vehicle movements during a day, resulting in only a 1 dB increase to the existing noise levels on site. Hence no increase to the existing noise levels at the boundary of the worst affected external receivers (not associated with the hospital) is predicted from the proposed precinct B works.

7.3.1.1.2 Peak Noise Events (Sleep Arousal)

As the Acute Hospital building is operational 24 hours a day, 7 days a week, noise emissions from night-time (10pm to 7am) use of the phase 3 carpark and phase 2 public drop off has been included in this assessment for completeness.

Note: Existing ward block is also operational 24 hours a day, 7 days a week, with vehicles currently using the existing carpark to the north-west (adjoins Doris Day Lane)

A sleep arousal assessment of peak noise events from the phase 3 car park will be conducted.

The peak noise assessment will be assessed is based on the following assumptions:

- The loudest typical peak noise event from the use of the car park will be from a car door closing or a car starting, both with an approximate sound power level of approximately 95dB(A)$L_{1(1min)}$.

- The noise event examined is that from the closing/starting of a car door at the easternmost carparking spot in the new phase 3 carpark space.

The prediction takes into account the relative position of noise source and receiver, and noise attenuation over distance.

Predicted level is as follows:

Table 11 – Sleep Arousal Assessment

Receiver Location	Noise Source	Predicted Noise Level	Emergence Test Level	Complies
Residential Properties to the East (Refer Figure 1)	Door Close/Car Starting	51dB(A)$L_{1(1min)}$	47dB(A)$L_{1(1min)}$	Exceeds preliminary emergence test, further investigation required

Initial assessment requires that noise emissions from car door closing will exceed 47 dB(A)L_1 (15dB(A) above the background noise level). Therefore more detailed assessment is recommended by the INP explanatory notes.

In the event that the "background+15" test is not satisfied, the INP explanatory notes recommend assessment taking into account exact noise levels, and the number of noise events. The explanatory notes recommend assessment using the guidelines in the EPA's Environmental Criteria for Road Traffic noise (Appendix B), now superseded by the EPA's Road Noise Policy.

Based on section 5.4 of the Road Noise Policy, maximum *internal* noise levels below 50-55dB(A)L_1 are "unlikely to awaken people from sleep".

Assuming that the window of a bedroom facing the car park is left open, there is typically a 10dB(A) noise reduction as noise travels from outside to inside the room. On applying this reduction, an internal noise level of approximately 41dB(A)L_1 is predicted. This is within the range of the 50-55dB(A) level specified in the guidelines, and therefore unlikely to cause sleep arousal.

In addition, given that these parking spots are located further away from the external (non hospital) residential properties to the east, than the existing carpark to the north – west, noise impacts from the use of this carpark will be considerably lower than present conditions.

7.3.1.2 Increased Traffic on Public Streets

Based on Mott Macdonald's Transport and Accessibility Study, revision B dated 30 November 2011, a worst hour prediction of 70 vehicle movements are estimated as a result of the phase 2/3 redevelopment (refer section 2.3 and 2.4). This will result in an insignificant increase to the existing traffic volumes on adjacent streets, i.e. approximately 1 vehicle per minute additional, spread across a number of access roads. Hence no increase to the existing noise levels at the boundary of the worst affected external receivers (not associated with the hospital) is predicted from the proposed precinct B works.

7.3.2 Vibration

No adverse vibration impacts are predicted from vehicle movements associated with the subject phase of works.

7.4 MECHANICAL SERVICES

The following table provides a summary of the noise objectives applicable for any external mechanical plant and equipment associated with the proposed phase 2/3 works.

Table 12 – Noise Objectives for Surrounding Residential Receivers

Time of day	Measured Background Noise Level dB(A) $L_{90(15minutes)}$	Amenity Criteria dB(A) $L_{eq(period)}$	Intrusiveness Criteria Background + 5 dB(A) $L_{eq(15minutes)}$	EPA Criteria for Sleep Disturbance dB (A) $L_{1(1minute)}$
Day	37	55	42	N/A
Evening	37	45	42	N/A
Night	32	40	37	47

Detailed acoustic assessment of mechanical plant is not typically undertaken at DA stage as plant selections and locations are not finalised.

We recommend that a detailed review of plant items be undertaken at Construction Certificate stage, once mechanical plant selections have been undertaken. In particular, external roof top plant (cooling towers, condensers etc.) should be assessed to ensure that satisfactory noise levels will be achieved. Indicatively, we assume that all cooling towers will require variable speed drives (to allow for reduced fan speeds during evening and night time periods, and that noise screens capable of providing line of sight screening between the roof top plant and the nearest residences will be required.

In our opinion, all plant items will be capable of complying with EPA's INP acoustic guidelines.

8 CONCLUSION

Noise and vibration impacts associated with the proposed phase2/3 redevelopment works at the Wagga Wagga Base have been assessed with reference to relevant Council, Australian Standards and EPA guidelines.

No adverse operational noise or vibration impacts are predicted from the subject phase of works (helipad and traffic). A detailed assessment of construction noise and vibrations is recommended when the construction programme is finalised (generally after DA), to develop a noise and vibration management plan for the proposed phase of works. Additionally a review of all external mechanical plant and equipment is also required to be undertaken when equipment selections are finalised, to ensure noise emissions from all plant comply with the relevant EPA controls.

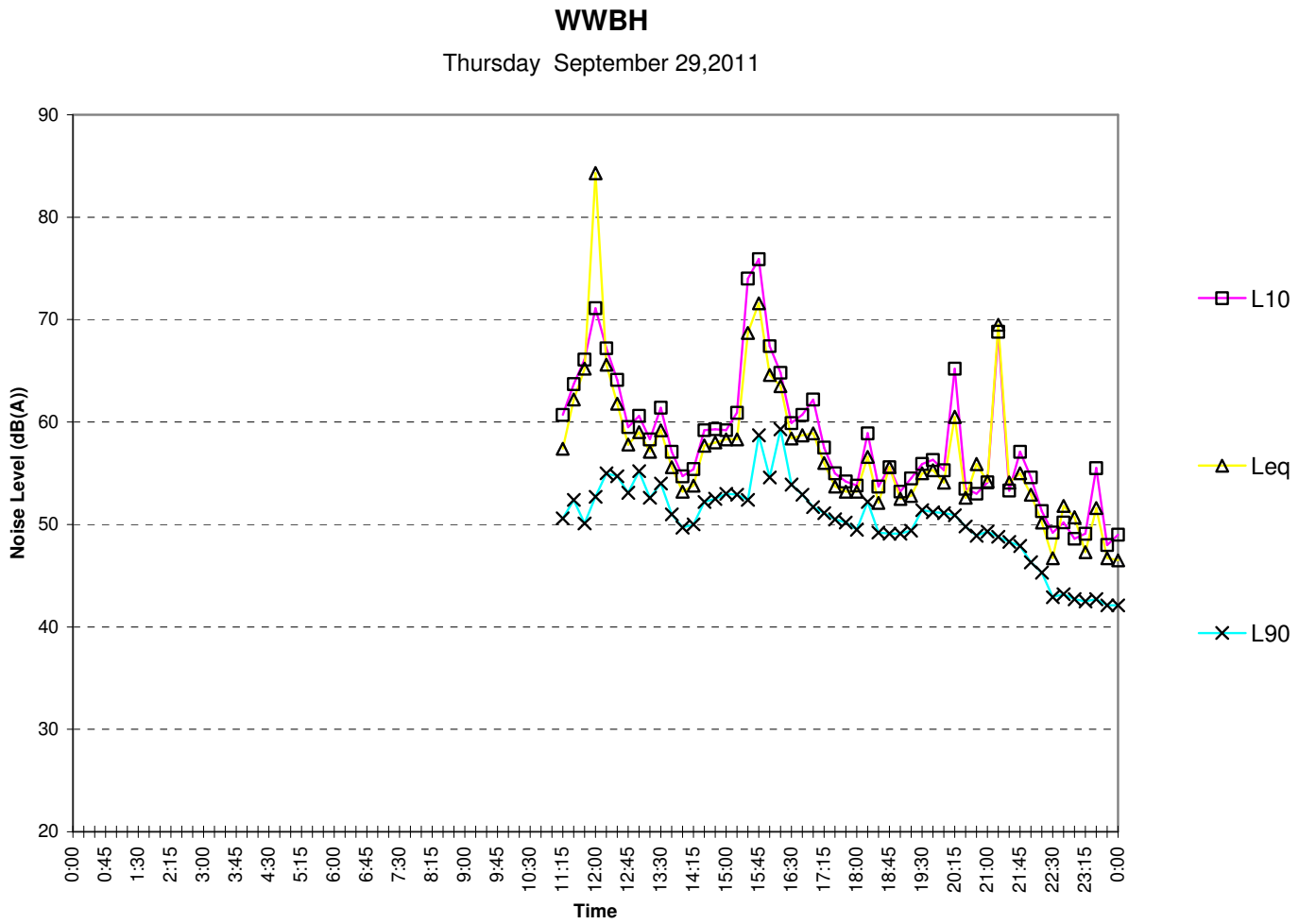
We trust this information is satisfactory. Please contact us should you have any further queries.

Yours faithfully,

Acoustic Logic Consultancy Pty Ltd
Yogendra Kalkunte

Appendix 1

Noise Logging Data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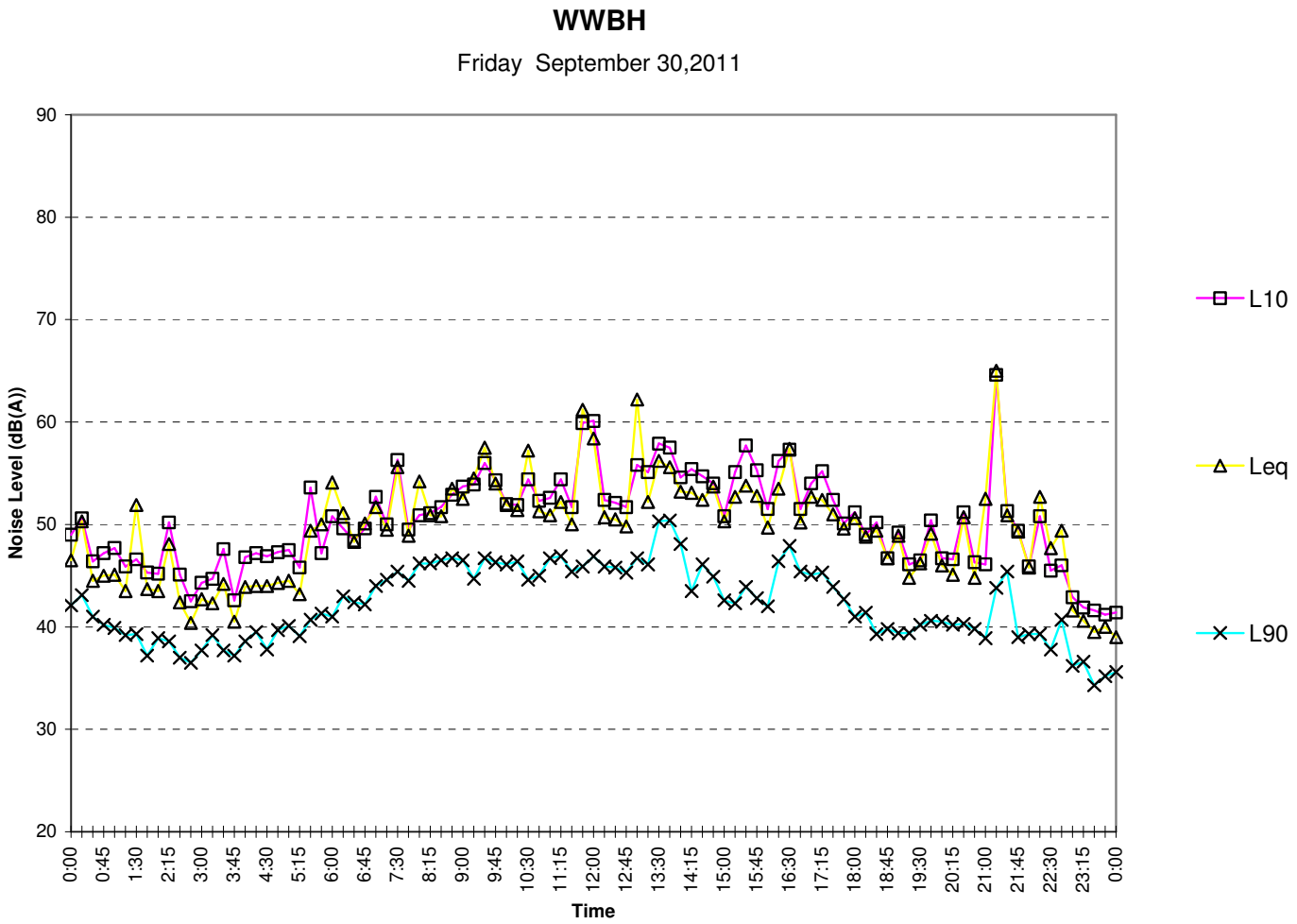
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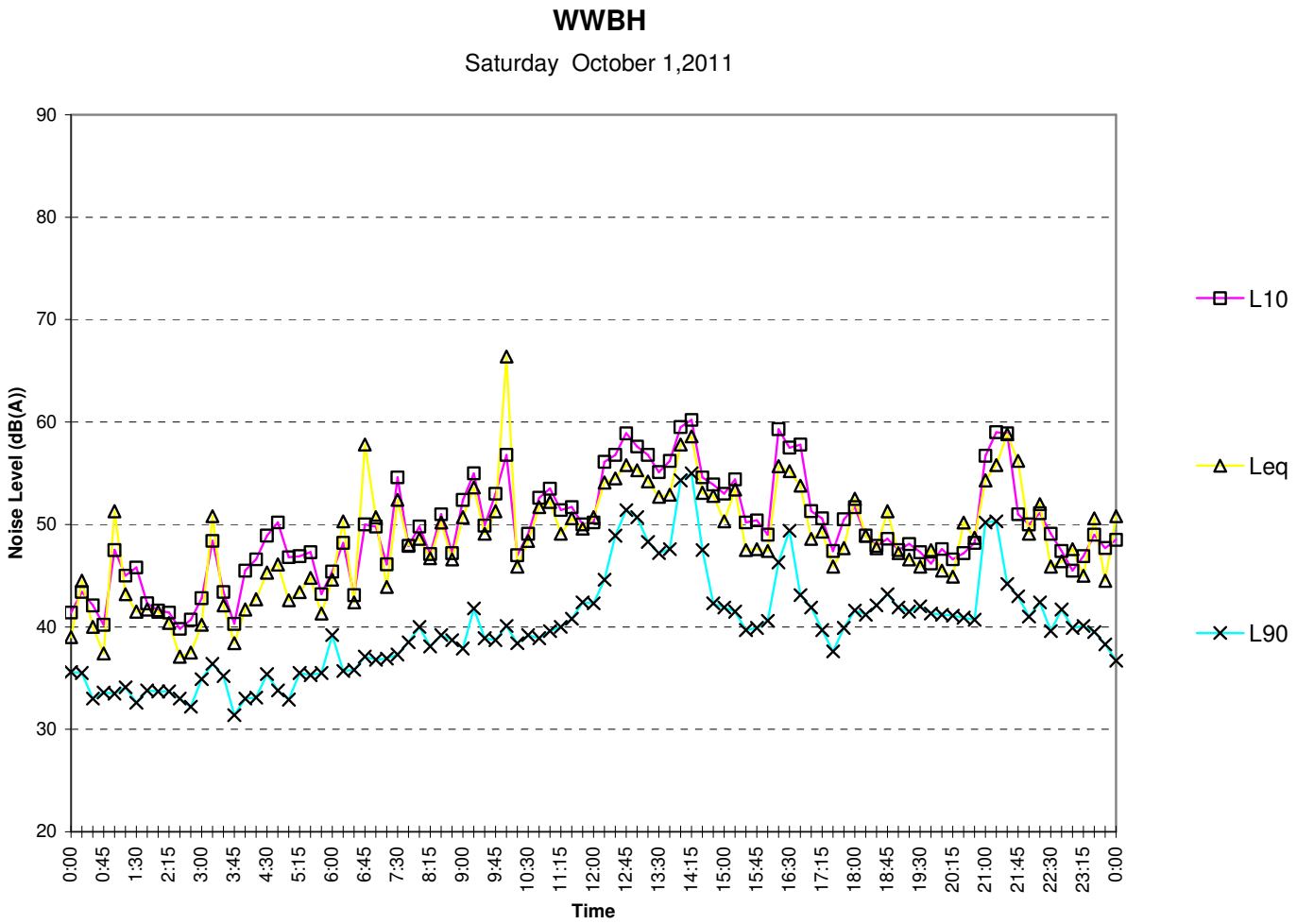
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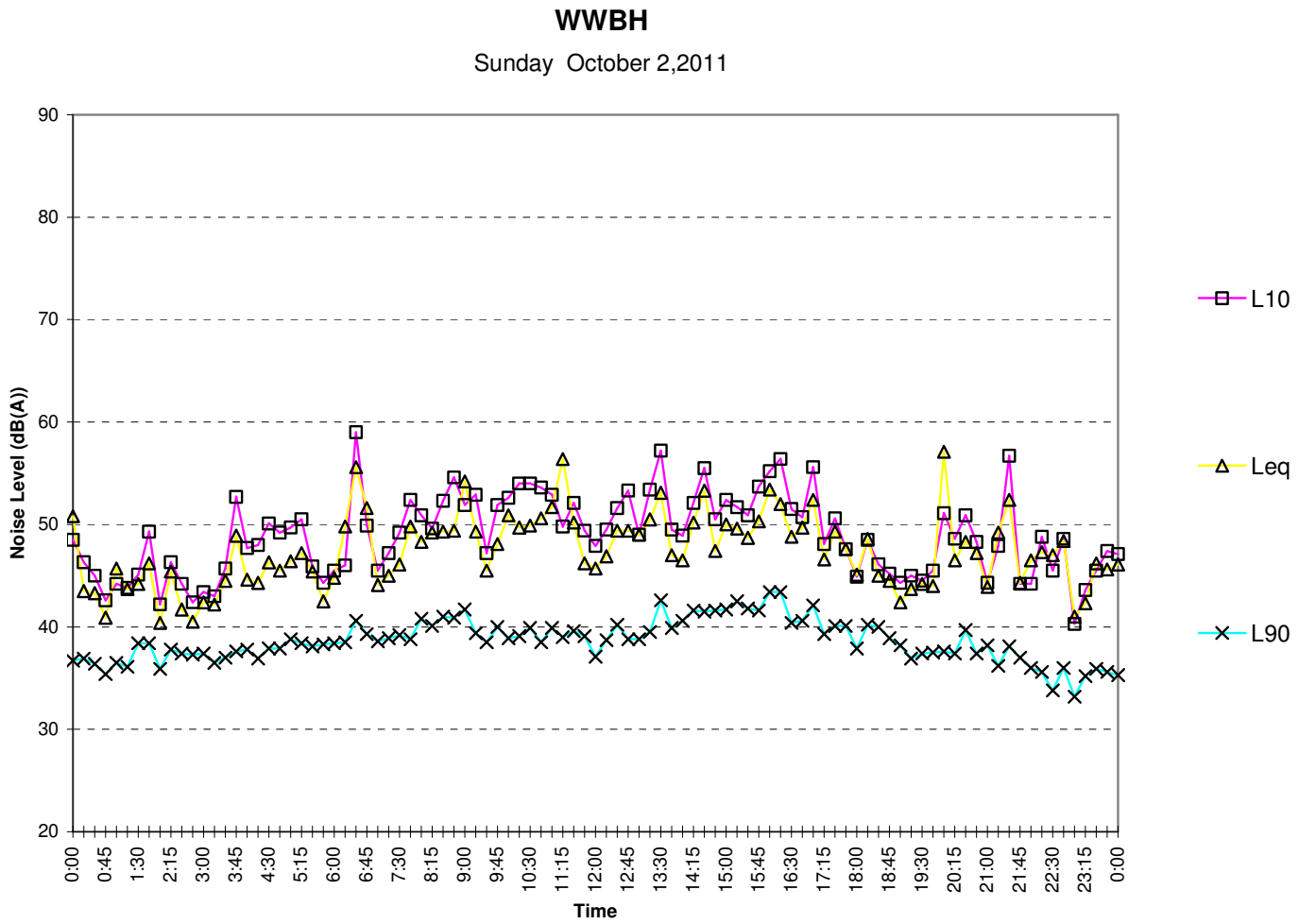
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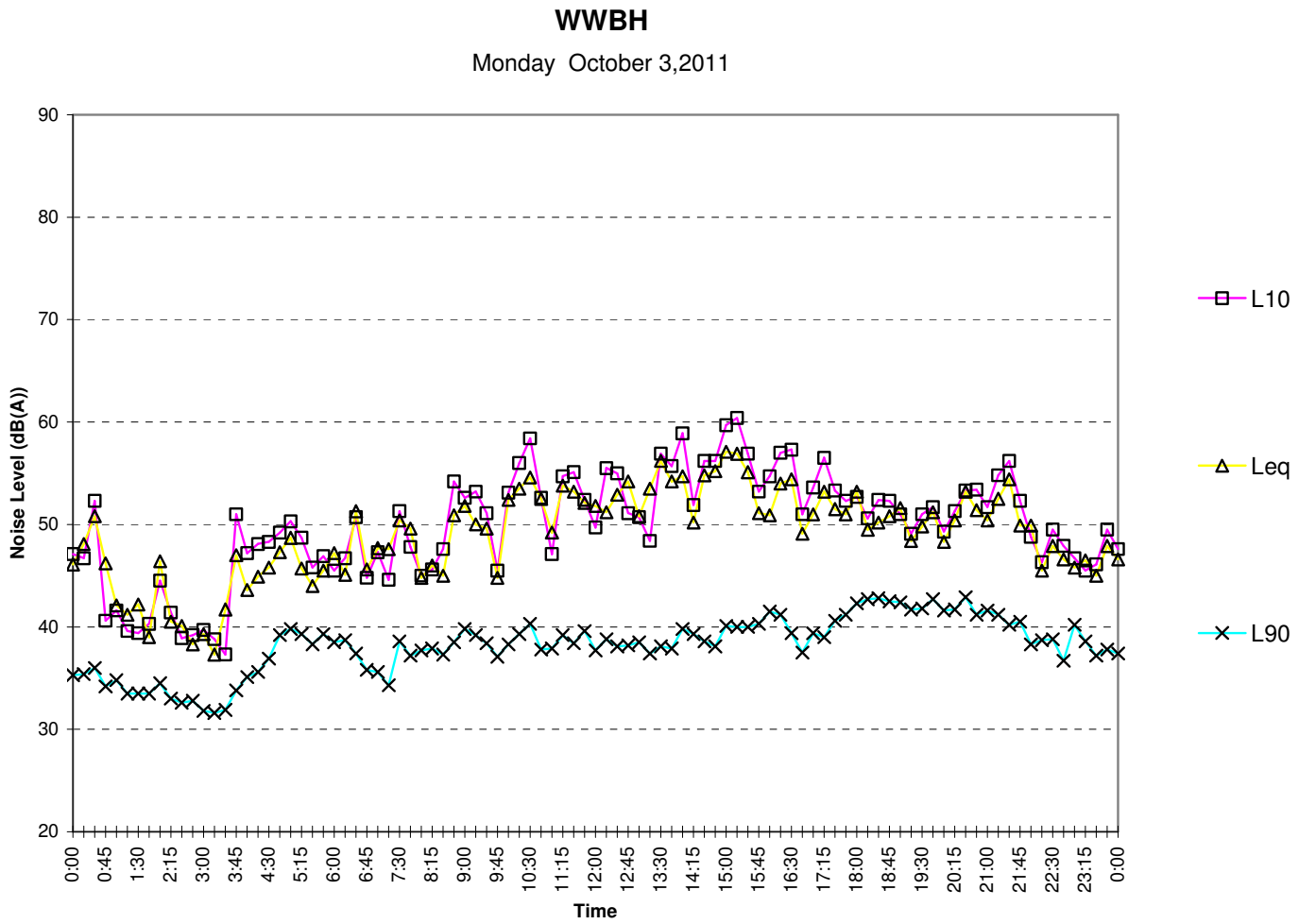
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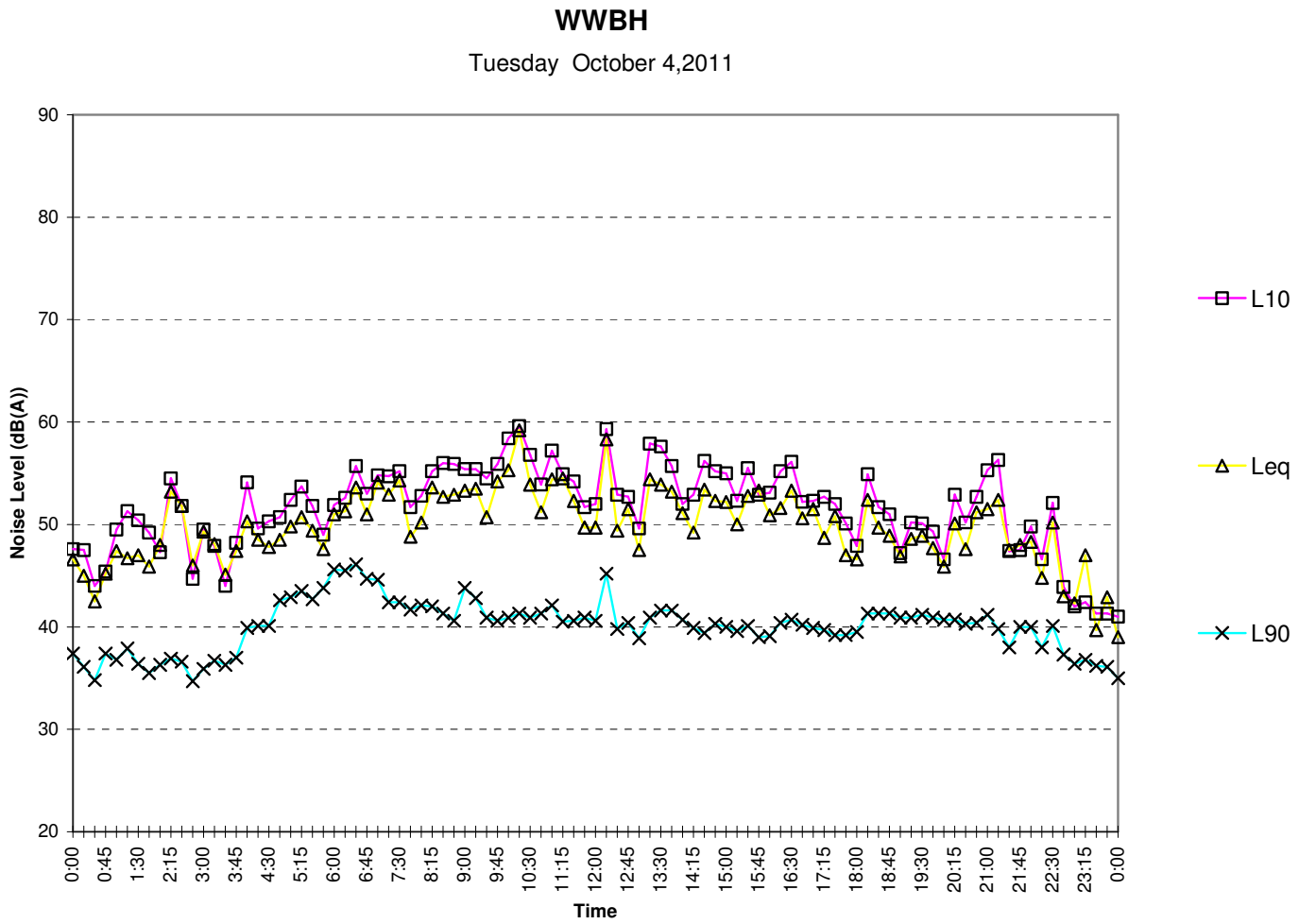
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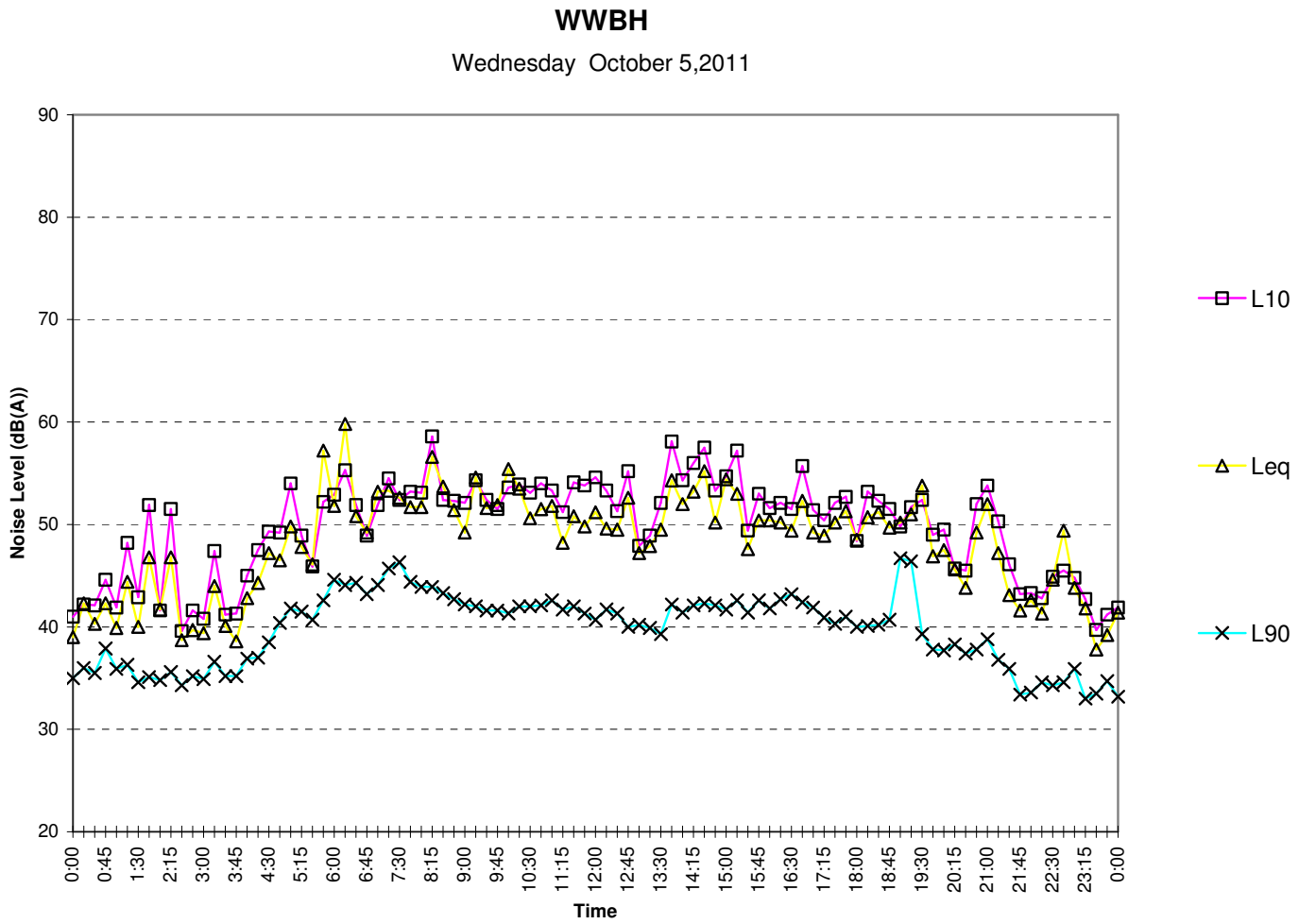
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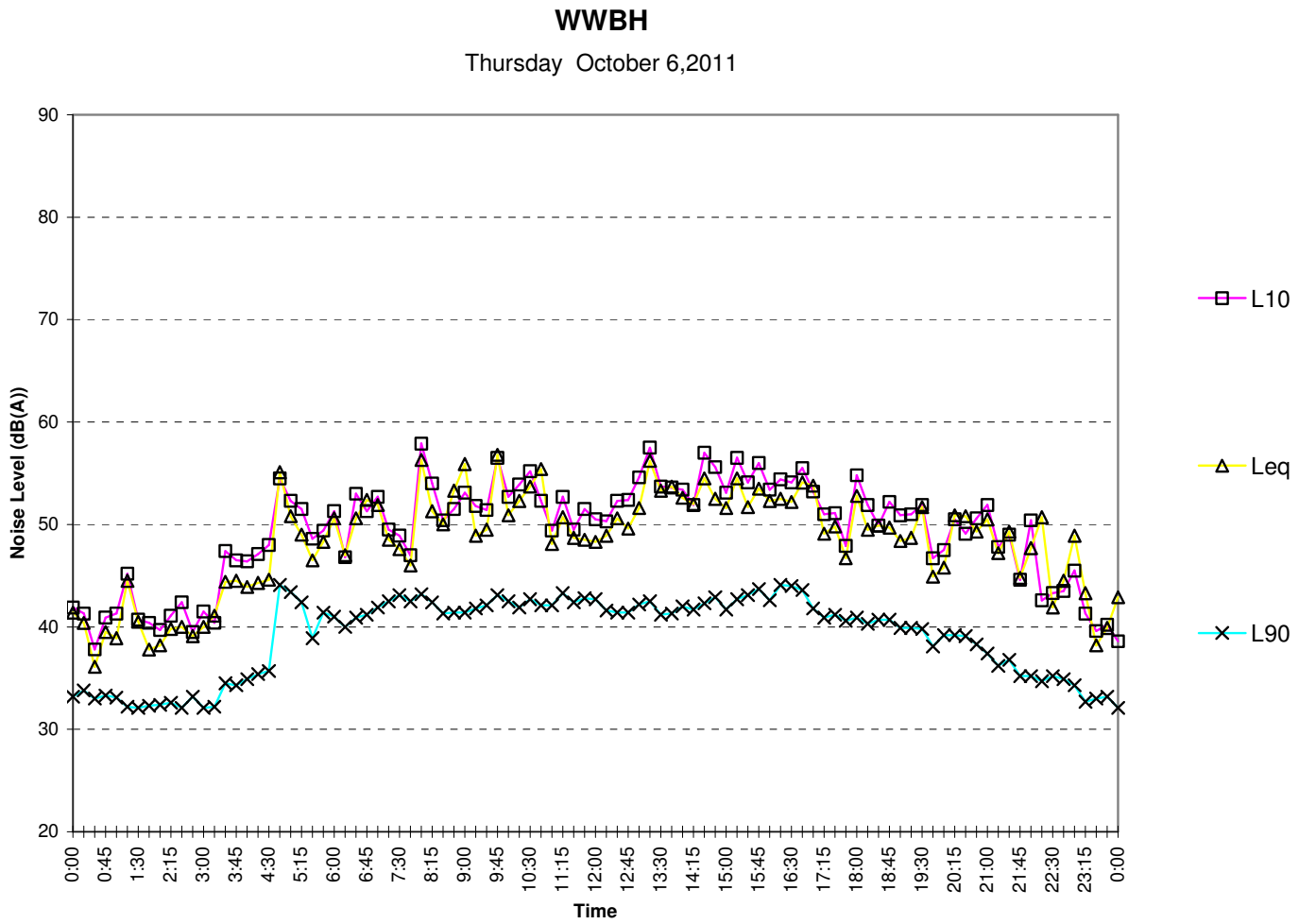
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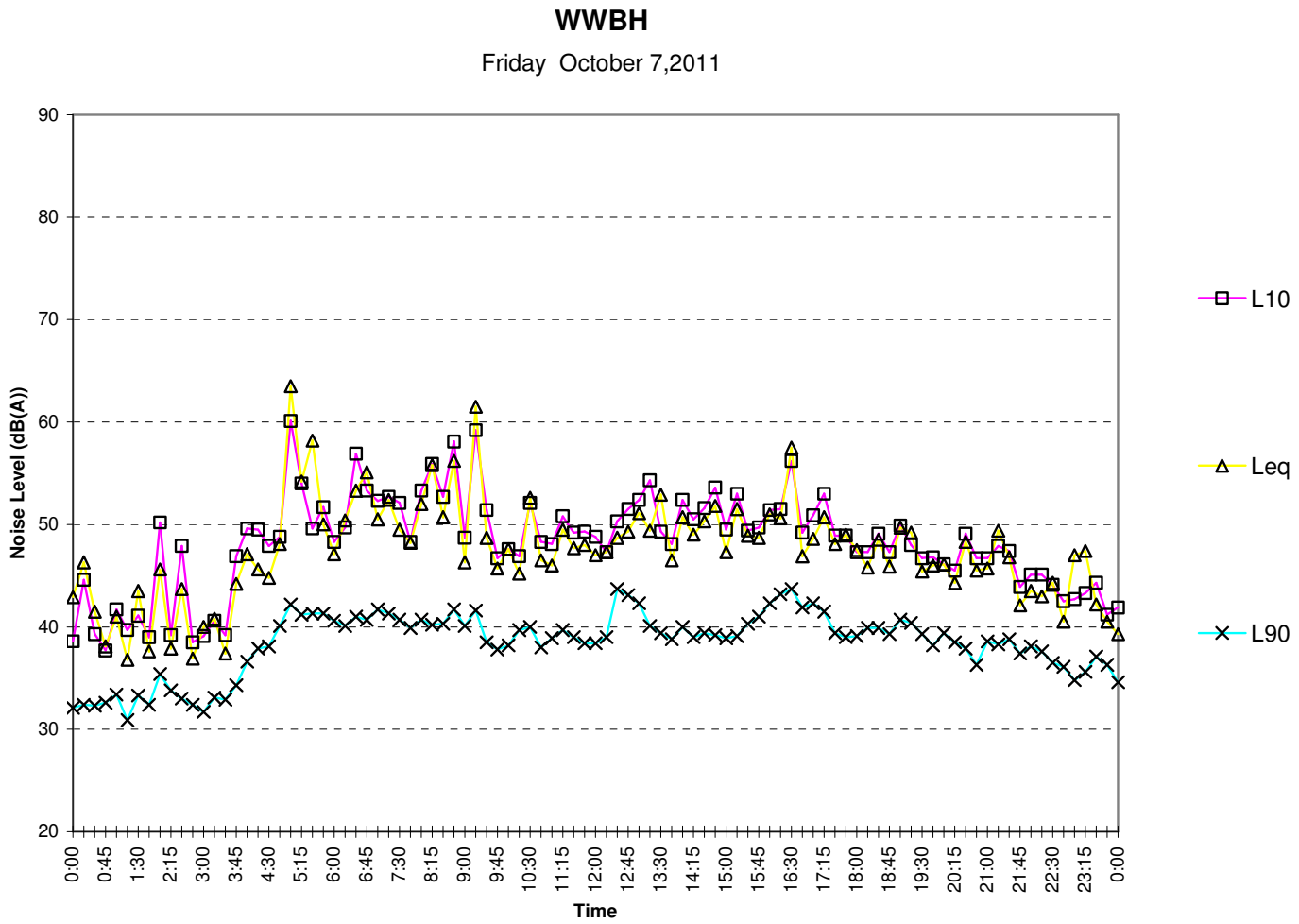
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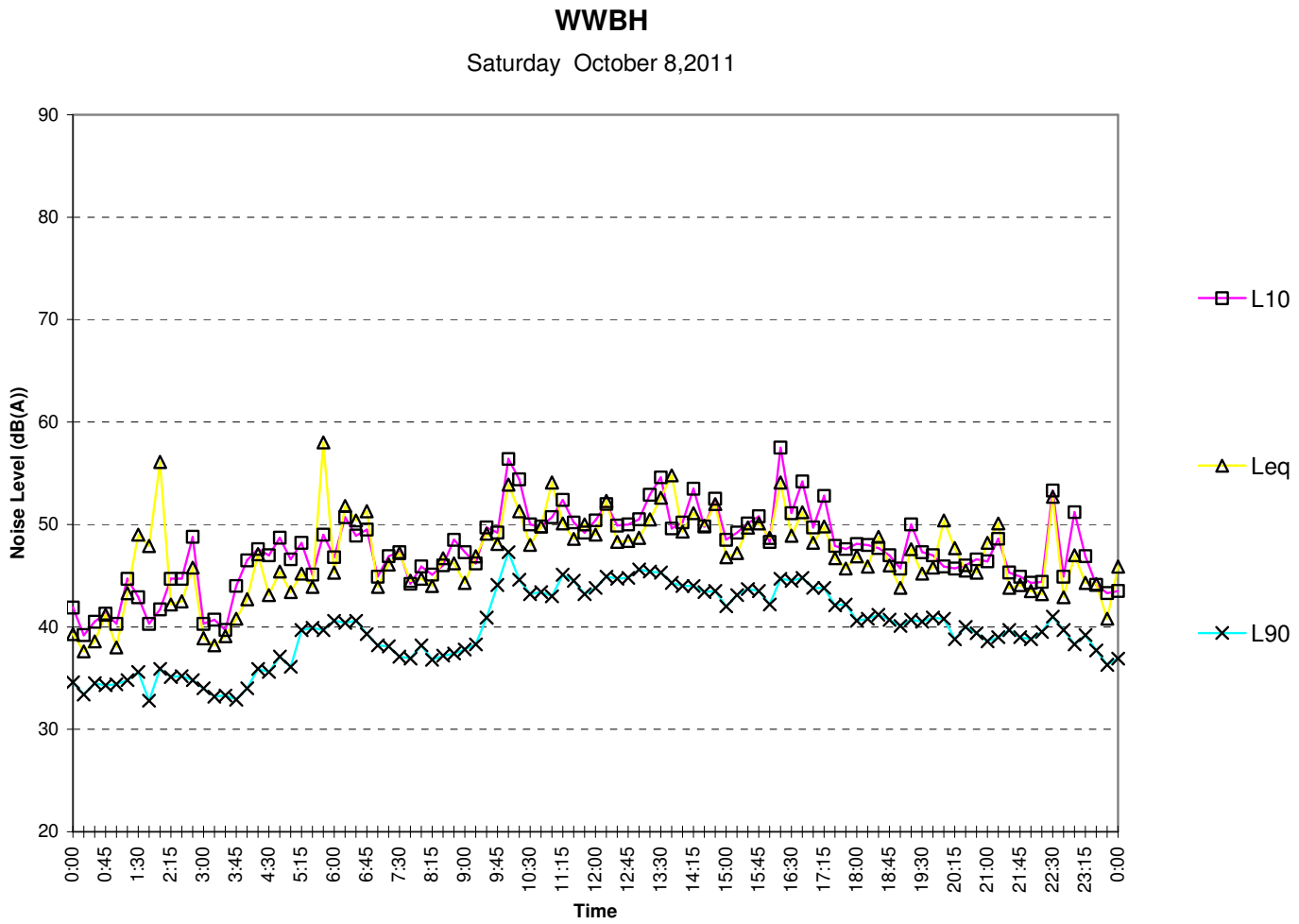
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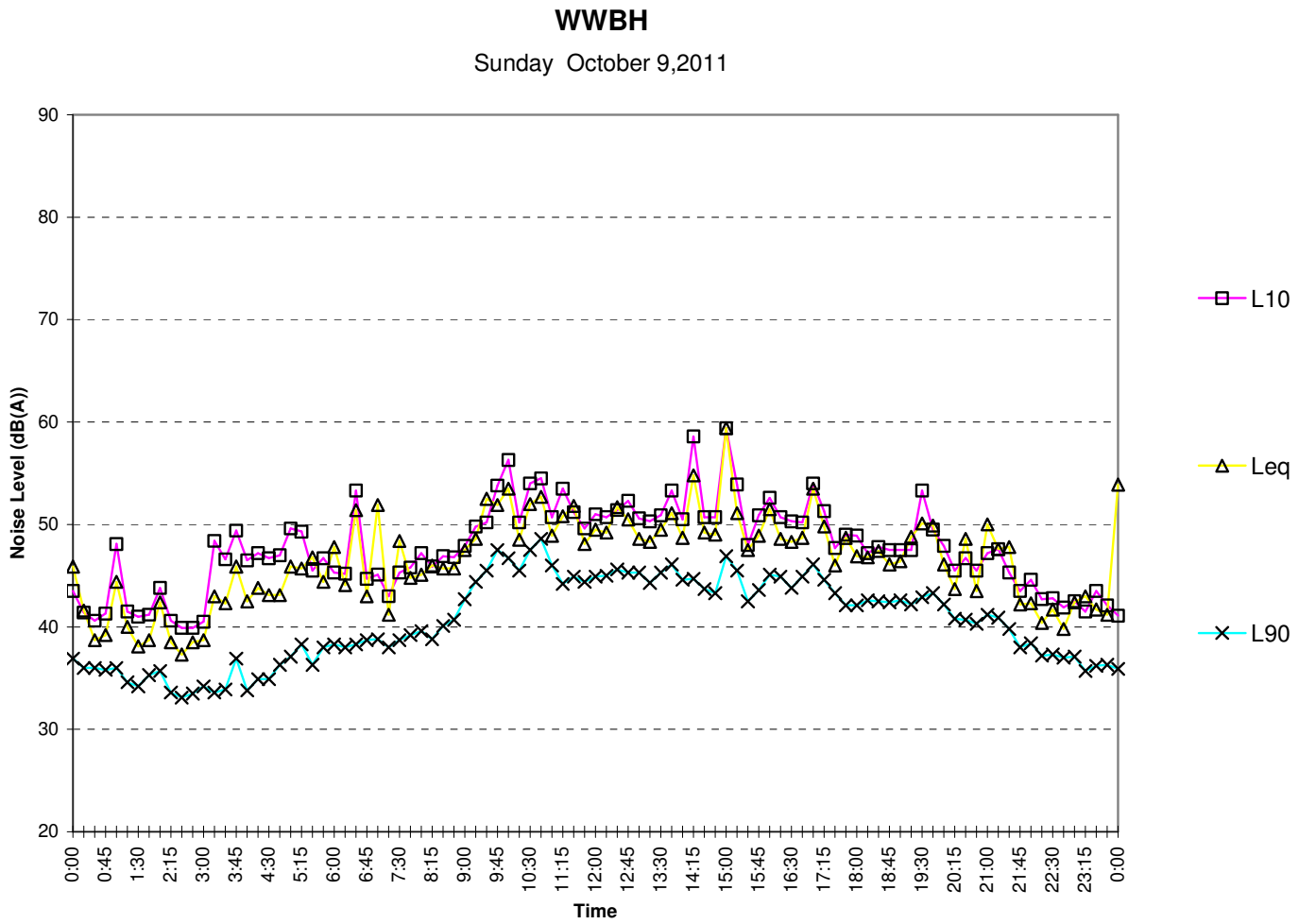
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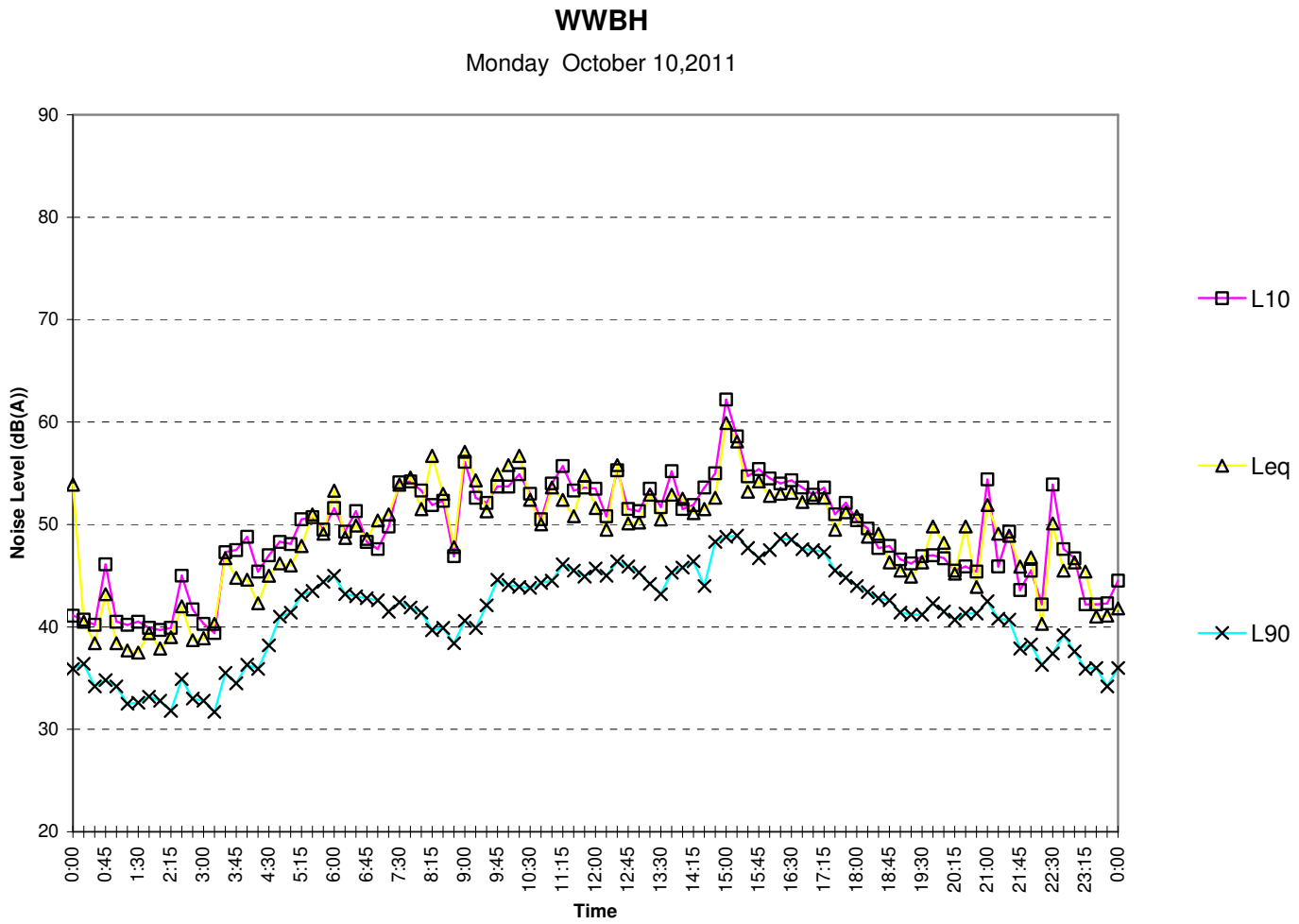
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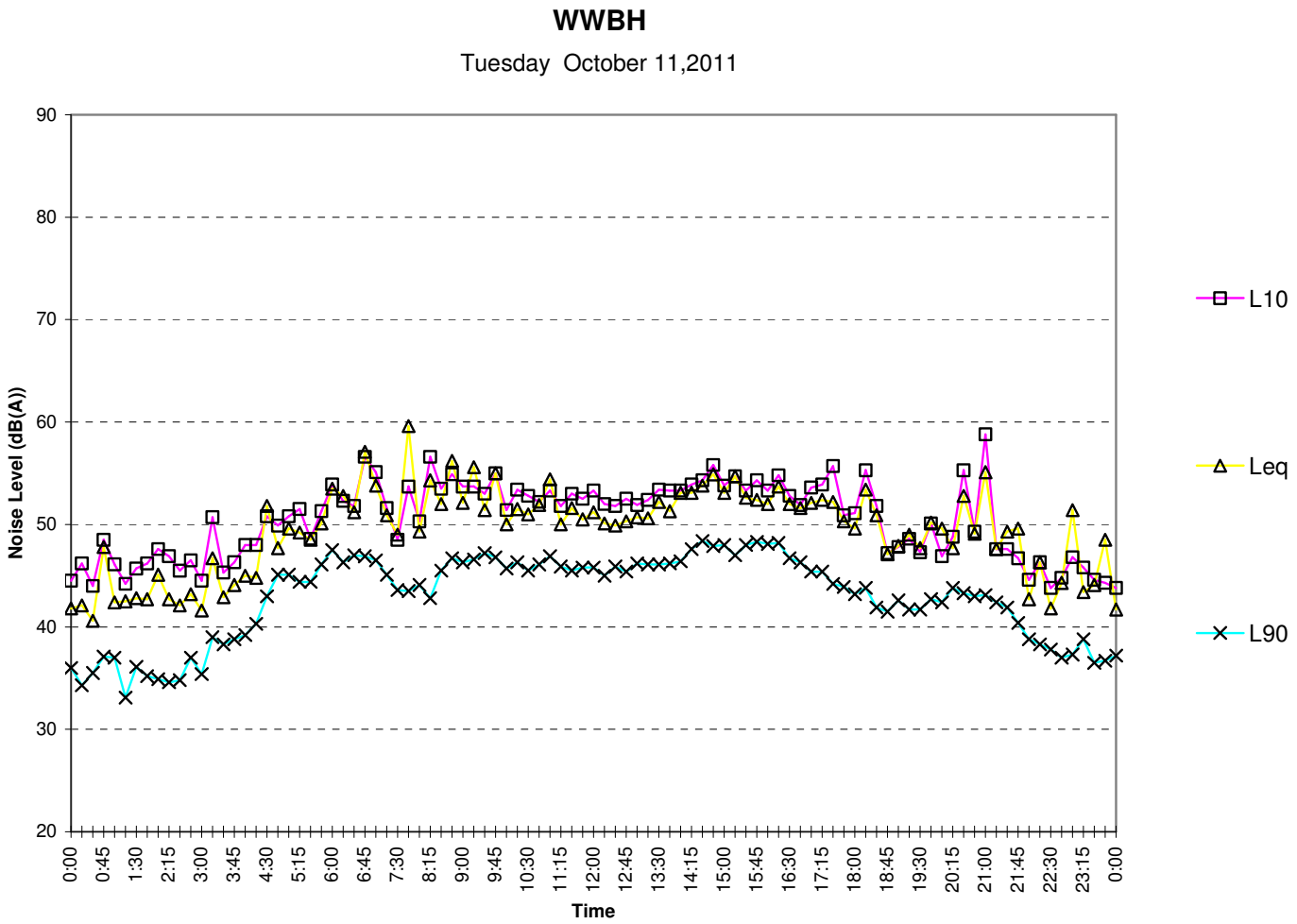
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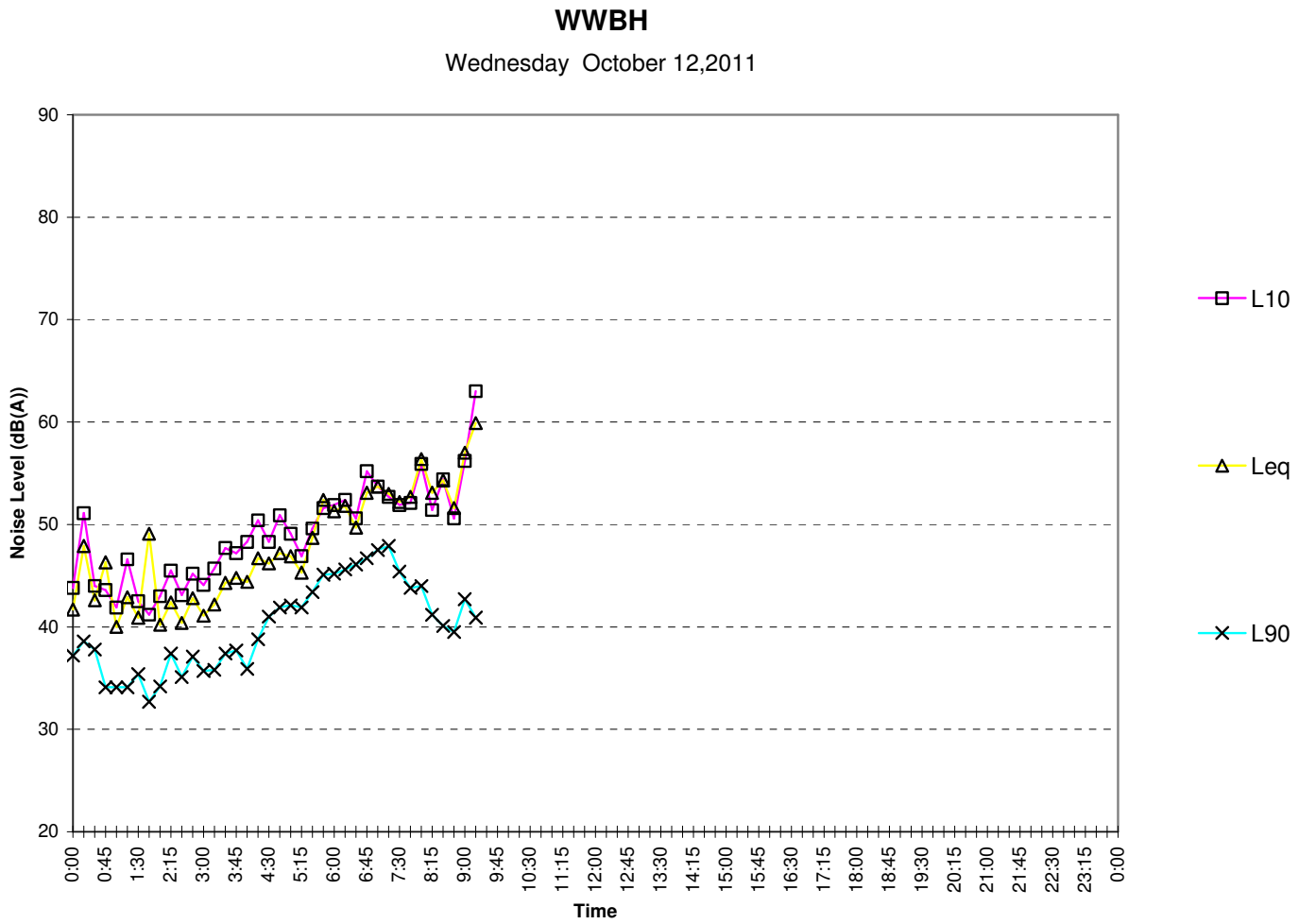
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