Finley Hospital

Noise and Vibration Impact Assessment

Health Infrastructure (NSW Government Health Infrastructure)

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→ **The Power of Commitment**

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[Compliance statement]

Glossary of acoustic terms and abbreviations

Table 1.1 Glossary of acoustic terms and abbreviations

Abbreviation	Definition
Background noise	The underlying level of noise present in the ambient noise, excluding the noise source under investigation, when extraneous noise is removed. This is described using the L_{A90} descriptor.
dB	Decibel is the logarithmic unit used for expressing the sound pressure level (SPL) or power level (SWL) in acoustics.
dBA	Frequency weighting filter used to measure 'A-weighted' sound pressure levels, which conforms approximately to the human ear response, as our hearing is less sensitive at very low and very high frequencies.
$L_{Aeq(period)}$	Equivalent sound pressure level: the steady sound level that, over a specified period of time, would produce the same energy equivalence as the fluctuating sound level actually occurring.
$L_{A90(period)}$	The sound pressure level exceeded for 90% of the measurement period.
L_{Amax}	The maximum A-weighted sound level recorded during the measurement period.
L_{Cmax}	The maximum C-weighted sound level recorded during the measurement period.
$L_{Aeq(15hr)}$	The L_{Aeq} noise level for the period 7 am to 10 pm.
$L_{Aeq(9hr)}$	The L_{Aeq} noise level for the period 10 pm to 7 am.
$L_{Aeq(1hr)}$	The highest hourly L_{Aeq} noise level during the day and night periods.
Noise sensitive receiver	An area or place potentially affected by noise including residential dwellings, schools, child care centres, places of worship, health care institutions and active or passive recreational areas.
Rating background level (RBL)	The overall single-figure background level representing each assessment period over the whole monitoring period.
RNP	Road Noise Policy (DECWW, 2011)
SEARs	Secretary's Environmental Assessment Requirements

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1. Introduction

1.1 Overview

The NSW Government has committed $25 million to the Finley Hospital redevelopment, which will enhance the current services and facilities, in order to meet the healthcare needs of the community and outlying areas, now and into the future.

GHD has prepared a noise and vibration impact assessment (NVIA) for the Finley Hospital redevelopment ("the Project"). This NVIA was prepared in support of an Review of Environmental Factors (REF) for the project.

The objective of this acoustic assessment is to assess construction and operational noise emission from the redevelopment, and if required, recommend acoustic measures to ensure acceptable amenity.

1.2 Scope and limitations

GHD has undertaken the following works as part of this NVIA:

– Identification of surrounding sensitive receivers potentially impacted by construction noise
– Determination of the noise criteria for the Project based on the *Interim Construction Noise* Guideline (DECCW, 2009) (ICNG) and *Noise Policy for Industry* (EPA, 2017) (NPI)
– A quantitative assessment of construction noise and vibration
– Reviewing the potential noise impacts due to construction traffic generation
– An assessment of operational noise impacts
– Providing construction noise and vibration mitigation measures to minimise impacts on the community
– Prepare a noise and vibration impact assessment outlining results of the acoustic assessment and, where required, mitigation recommendations. The Acoustic Report will form part of the EIS and address the Secretary's Environmental Assessment Requirements (SEARs) key issues in relation to noise

This report has been prepared with consideration to the following documents:

– *Interim Construction Noise* Guideline (DECCW, 2009) (ICNG)
– *Road Noise Policy* (DECCW, 2011) (RNP)
– *Assessing Vibration: a technical guideline* (EPA, 2006) (AVTG)
– *Noise Policy for Industry* (EPA, 2017) (NPI)

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2. Existing environment

2.1 Project description

Finley Hospital is a small community hospital that occupies 19,740m2 (1.974ha) located on the corner of Dawe Avenue and Donaldson Street in the rural NSW town of Finley. The site contains the main hospital, a staff accommodation building, and a community building. The single-storey hospital was built in 1962, with the staff and community buildings added in the 1980s. In 2018, the emergency department and inpatient beds were refurbished. Though the site has been updated and modernized over the years, it is aged and in poor condition with building services that are at the end of life.

The site benefits from extensive, well-maintained gardens and largely flat topography. Located between the hospital and Hamilton Street is the Finely Regional Care centre. Directly south of the site, on the opposite side of Scoullar Street, a retirement community is currently under construction. Parking at the hospital is on-grade.

Figure 2.1 Project location

The masterplan for this redevelopment is focused on providing upgrades and extension to priority spaces within the limitations of the budget. The scope of work consists of:

- New Front of House (FOH) which consists of a small extension to the existing building footprint.
- Replan of triage and staff station to achieve suitable flows between Emergency Department (ED)/ Inpatient Unit (IPU) and FOH.

– New isolation bay added to ED.
– New Medical Imaging
– Extension to IPU to provide 6 new beds.
– Light upgrade to staff room and central corridor.
– Upgraded and expanded comms room.
– New roof sheeting and sarking to the main hospital roof.
– Essential services upgrades

2.2 Sensitive receivers

Noise sensitive receivers are defined based on the type of occupancy and the activities performed in the land use and could include:

– residential dwellings
– educational institutes, libraries or childcare centres
– hospitals, surgery or other medical institutions
– places of worship
– passive and active recreational areas such as parks, sporting fields or golf courses
– community centres
– commercial or industrial premises

The following sensitive receivers and land uses have been identified for this assessment.

– Finley High School (north-east of the Project)
– Finley Preschool Kindergarten & OOSH (east of the Project)
– Residential receivers located along:
    - Dawe Avenue (north of the Project)
    - Donaldson Street (east of the Project)
    - Tocumwal Road (east of the Project)
    - Scoullar Street (south of the Project)
    - McNamara Street (south of the Project)
    - Hamilton Street (west of the Project)
– Community facilities located along:
    - Pinnuck Street (north of the Project)
    - Dawe Avenue (west of the Project)
– Commercial premises located along:
    - Dawe Avenue (north of the Project)
    - Tocumwal Street (east of the Project)
    - Hamilton Street (west of the Project)
– Industrial premises located along:
    - McNamara Street (south of the Project)
    - Hamilton Street (west of the Project)

Representative sensitive receivers included for modelling and assessment purposes are detailed in Table 2.1. The location of the site, including nearby sensitive receivers considered for the assessment, is shown in Figure 2.2.

Table 2.1 Sensitive receivers

Receiver ID	Receiver address	Receiver type
COMME 01	63-67 Tocumwal St, Finley NSW 2713	Commercial Building
COMME 02	75/85 Hamilton St, Finley NSW 2713	Commercial Building
COMMU 01	117 Pinnuck St, Finley NSW 2713	Active Recreation Area
COMMU 02	Tocumwal St, Finley NSW 2713	Educational Building
COMMU 03	Tocumwal St, Finley NSW 2713	Educational Building
COMMU 04	Tocumwal St, Finley NSW 2713	Educational Building
IND 01	McNamara St, Finley NSW 2713	Industrial Building
IND 02	37 Hamilton St, Finley NSW 2713	Industrial Building
R01	25 Dawe Ave, Finley NSW 2713	Residential
R02	25 Dawe Ave, Finley NSW 2713	Residential
R03	67 Ulupna St, Finley NSW 2713	Residential
R04	18 Dawe Ave, Finley NSW 2713	Residential
R05	6 Donaldson St, Finley NSW 2713	Residential
R06	8 Donaldson St, Finley NSW 2713	Residential
R07	10 Donaldson St, Finley NSW 2713	Residential
R08	66 Osborne St, Finley NSW 2713	Residential
R09	84 Tocumwal St, Finley NSW 2713	Residential
R10	88 Tocumwal St, Finley NSW 2713	Residential
R11	79-97 Tocumwal St, Finley NSW 2713	Residential
R12	96 Tocumwal St, Finley NSW 2713	Residential
R13	25 McNamara St, Finley NSW 2713	Residential
R14	40 McNamara St, Finley NSW 2713	Residential
R15	7 Quirk St, Finley NSW 2713	Residential
R16	13 Burke St, Finley NSW 2713	Residential
R17	143-155 Hamilton St, Finley NSW 2713	Residential
R18	125 Hamilton St, Finley NSW 2713	Residential
R19	64 Broockmanns Rd, Finley NSW 2713	Residential
R20	Maculata, 75-85 Hamilton St, Finley NSW 2713	Residential
R21	69 Hamilton St, Finley NSW 2713	Residential
R22	1173 Hamilton St, Finley NSW 2713	Residential
R23	49 Hamilton St, Finley NSW 2713	Residential
24	36 Hamilton St, Finley NSW 2713	Residential
R25	10 Norman Lee Ct, Finley NSW 2713	Residential
R26	8 Norman Lee Ct, Finley NSW 2713	Residential
R27	73 Pinnuck St, Finley NSW 2713	Residential
R28	60 Scoullar St, Finley NSW 2713	Residential
R29	60 Scoullar St, Finley NSW 2713	Residential
R30	26 Dawe Ave, Finley NSW 2713	Aged care facility (assumed residential)

Figure 2.2 ***Site Location and identified sensitive receivers***

3. Criteria

3.1 Noise Policy for Industry

The NPI provides noise levels for assessing the potential impact of noise from industry and includes a framework for considering feasible and reasonable mitigation measures. This enables the EPA to regulate noise emissions from scheduled premises under the POEO Act.

The objectives of Project Noise Trigger Levels (PNTL) for industry are to balance the need for industrial activity with the community's desire to minimise intrusive noise.

It should be noted that the audibility of a noise source does not necessarily equate to disturbance at an assessment location. To ensure these objectives are met, the EPA provides two separate noise trigger levels: intrusiveness and amenity. The intrusiveness noise levels apply over 15 minutes in any period (day, evening or night) and aim to control the relative audibility of operational noise compared to the background level at residential receivers.

The amenity noise level limits the total level of extraneous noise for all receiver types and is assessed over the entire assessment period (day, evening or night). Both the intrusiveness and amenity noise levels are calculated and the lower of the two in each time period is set as the PNTL. For the purposes of assessment to standardise the approach the NPI recommends that the $L_{Aeq(15min)} = L_{Aeq(period)} + 3$ dBA unless an alternative approach can be justified.

3.1.1 Intrusiveness noise level

The intrusiveness noise level is determined by a 5 dB addition to the RBL with a minimum intrusiveness noise level of 35 dBA for the evening and night period and 40 dBA for the day period. The NPI recommends that the intrusiveness noise level for the evening and day period should not exceed the daytime period. The intrusiveness noise levels are only applicable to residential receivers.

3.1.2 Project amenity noise level

The recommended amenity noise level applies to all industrial noise in the area which when combined should remain below the recommended amenity noise level. The recommended amenity noise level represents the total industrial noise at a receiver location and a Project Amenity Noise Level is set at 5 dBA below the recommended amenity noise level.

Residential receiver areas are characterised into 'urban', 'suburban', 'rural' or other categories based on land uses and the existing level of noise from industry and road traffic. With consideration to the NPI 'noise amenity area' classification, the residential receivers identified are classified as 'Rural Residential' as per the NPI.

3.1.3 Summary of project noise trigger levels

Based on the NPI, a summary of the PNTLs for residential land uses are presented in Table 3.1. All identified residential receivers have been classified as 'rural residential'. Compliance with the residential PNTLs ensure compliance with the less-stringent non-residential PNTLs.

For a residence, the project noise trigger level and maximum noise levels are to be assessed at the reasonably most-affected point on or within the residential property boundary or, if that is more than 30 metres from the residence, at the reasonably most affected point within 30 m of the residence, but not closer than 3 m to a reflective surface and at a height of between 1.2–1.5 m above ground level.

In assessing amenity noise levels at commercial or industrial premises, the noise level is to be assessed at the reasonably most-affected point on or within the property boundary.

Given the location of the site, background noise monitoring has not been undertaken for this project. The minimum assumed background noise levels from the EPA's Noise Policy for Industry have conservatively been used for this assessment.

Table 3.1 Project noise trigger levels for rural residential receivers

Receiver	Assessment period	Rating Background Level (RBL), $L_{90,T}$- dBA	Intrusive noise level, $L_{Aeq(15min)}$	Project amenity noise level[1] $L_{Aeq(15min)}$	Project noise trigger level, $L_{Aeq(15min)}$) dBA
Residential	Day	35	40	48	40
	Evening	30	35	43	35
	Night	30	35	38	35

Notes:

1. Project amenity noise level (ANL) is rural ANL (Table 2.1) minus 5 plus 3 dB(A) to convert from a period level to a 15-minute level.

Table 3.2 Project noise trigger levels for non-residential receivers (external)

Type	Time of day	Project noise trigger level, $L_{Aeq(15min)}$) dBA
Commercial premises	When in use	63[1]
Industrial premises	When in use	68[1]
Place of worship	When in use (1 hour)	50[2]
School classroom – internal	When in use (1 hour)	45[2]
Hospital ward – internal	Noisiest 1 hour	35
Hospital ward – external	Noisiest 1 hour	50
Area specifically reserved for passive recreation	When in use	48[1]

Notes:

1. A + 3 dB correction has been applied to convert $L_{Aeq(period)}$ to $L_{Aeq(15\ min)}$
2. External noise level assumes minus 10 dBA for noise through an open window.

3.1.4 Modifying factor corrections

The NPI requires that corrections for annoying characteristics are applied if the noise sources contain tonal, intermittent or low frequency characteristics, which have the potential to increase annoyance. The modifying factor adjustments are detailed in Table 3.3. At this point in time it is assumed that no equipment operating on-site has any annoying characteristics.

Table 3.3 NPI modifying factor corrections

Factor	Assessment/ measurement	When to apply	Correction[1,2]
Tonal noise	One-third octave or narrow band analysis	Level of one-third octave band exceeds the level of the adjacent bands on both sides by: – 5 dB or more if the centre frequency of the band containing the tone is above 400 Hz – 8 dB or more if the centre frequency of the band containing the tone is 160 to 400 Hz inclusive – 15 dB or more if the centre frequency of the band containing the tone is below 160 Hz	5 dBA[2]
Low frequency noise	Measurement of C-weighted and A-weighted level	Measure/assess C and A weighted $L_{eq,T}$ levels over same time period. Correction to be applied if the difference between the two levels is 15 dB or more and: – Where any of the one-third octave noise levels in Table C2 are exceeded by up to and including 5 dB and cannot be mitigated, a 2 dBA positive adjustment to measured/predicted A-weighted levels for the evening/night period.	5 dBA[2]

Factor	Assessment/ measurement	When to apply	Correction[1,2]
		– Where any of the one-third octave noise levels in Table C2 are exceeded by more than 5 dBA and cannot be mitigated, a 5 dBA positive adjustment to measured/predicted A-weighted noise levels applies for the evening/night period and a dBA positive adjustment for the daytime period.	
Intermittent noise	Subjectively assessed	When the night-time noise level drops to that of the background noise level with a noticeable change in noise level of at least 5 dBA.	5 dBA

Notes:

1. Where two or more modifying factors are present the maximum correction is limited to 10 dBA.
2. Where a source emits a tonal and low-frequency noise, only one 5 dB correction should be applied if the tone is in the low frequency range.

3.2 Construction noise goals

As part of this project, there would be a number of elements which would fall under an assessment in accordance with the *Interim Construction Noise Guideline* (ICNG). This includes bulk earthworks phase, gravel and lining placement phase.

3.2.1 ICNG construction hours

The ICNG provides guidance for assessment and management of construction noise. The guideline recommends standard hours for project activities as follows:

– Monday to Friday: 7:00 am to 6:00 pm
– Saturday: 8:00 am to 1:00 pm
– No work on Sundays or Public Holidays.

Where practical, and subject to the final construction timetable, it is assumed that construction would be carried out during the standard construction hours only.

The ICNG acknowledges that the following activities have justification to be undertaken outside the standard construction hours assuming all feasible and reasonable mitigation measures are implemented to minimise the impacts to the surrounding sensitive land uses:

– The delivery of oversized plant, equipment and materials 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 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
– Works where a proponent demonstrates and justifies a need to operate outside the recommended standard construction hours
– Works which maintain noise levels below the noise management levels outside of the recommended standard construction hours.

Works requires outside standard construction hours would be identified during construction planning and nearby residents would be notified before works begin.

3.2.2 Noise management levels

The construction noise management levels (NMLs) represent a noise level that, if exceeded, would require management measures including:

– Reasonable and feasible work practices

– Contact with the residences to inform them of the nature or works to be carried out, the expected noise levels, and durations and contact details.

The management measures are aimed at reducing noise impacts at the residential receivers. However, it may not be reasonable and feasible to reduce noise levels to below the noise affected management level at all times. The noise affected construction NMLs are not intended as a noise limit but rather a level at which noise management is required.

Table 2 in the ICNG provides recommended NML for residential receivers, which are detailed in Table 3.4. For non-residential receivers, the recommended NML stated in the INCG have been used, as detailed in Table 3.5.

Table 3.4 Residential construction noise management levels, dBA (ICNG, 2009)

Time of day	Noise management level, $L_{Aeq(15\ min)}$	Application notes
Recommended standard hours	Noise affected: RBL + 10 dBA	The noise affected level represents the point above which there may be some community reaction to noise. Where the predicted or measured $L_{Aeq(15\ min)}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected: 75 dBA	The highly noise affected level represents the point above which there may be strong community reaction to noise. Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: – Times identified by the community when they are less sensitive to noise (such as before and after school, or mid-morning or mid-afternoon for works near residences). – If the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours	Noise affected: RBL + 5 dBA	A strong justification would typically be required for works outside the recommended standard hours. The proponent should apply all feasible and reasonable work practices to meet the noise affected level. Where all feasible and reasonable measures have been applied and noise is more than 5 dBA above the noise affected level, the proponent should negotiate with the community.

Table 3.5 Noise at sensitive land uses (other than residences), dBA(ICNG, 2009)

Land Use	Noise management level, $L_{Aeq(15\ min)}$[3]
Industrial premises	75 dB(A)[1]
Offices, retail outlets	70 dB(A)[1]
Classrooms at school and other educational institutions	45 dB(A)[2] / 55 dB(A)[4]
Hospital wards and operating theatres	45 dB(A)[2] / 55 dB(A)[4]
Places of worship	45 dB(A)[2] / 55 dB(A)[4]
Active recreation areas	65 dB(A)[1]
Passive recreation areas	60 dB(A)[1]

Notes:

1. External noise level
2. Internal noise level
3. Applies when the properties are in use
4. External noise level based on a 10 dB reduction through a partially open window

3.2.3 Sleep disturbance

No construction works are proposed during the night period (10:00 pm to 7:00 am Monday to Saturday and 10:00 pm on Saturday to 8:00 am on Sunday). If activities are required to be undertaken during these times it would be limited to activities which are not audible at the nearest sensitive receptor, or discreet events which need to be undertaken outside standard hours for safety reasons.

As such, no sleep disturbance impacts are anticipated during the construction phases of the project.

3.2.4 Noise management levels

The noise management levels (NMLs) at sensitive receivers in the study area are summarised in Table 3.6, and have been based on the RBLs presented in Table 3.4 and NMLs presented in Table 3.5.

Table 3.6 Project specific noise management levels

Sensitive receptor type	Construction Noise Management Levels, $L_{Aeq(15min)}$	
	Standard construction hours	
	Noise affected	Highly noise affected
Residential	45 dB(A)	75 dB(A)
Industrial premises	75 dB(A)	N/A
Offices, retail outlets	70 dB(A)	N/A
Classrooms at school and other educational institutions	55 dB(A)	N/A
Hospital wards and operating theatres	55 dB(A)	N/A
Active recreation areas	65 dB(A)	N/A

3.3 Traffic noise

The RNP provides traffic noise target levels for residential receivers in the vicinity of existing roads and are applied to road upgrades. For this assessment, these levels are also applied to traffic associated with construction works to identify potential construction traffic impacts and the potential for reasonable and feasible mitigation measures. The RNP road types are based on the functional roles shown in Table 3.7.

Table 3.7 Road Categories from RNP

Road category	Functional role	Public roads used by project
Local roads	Provide vehicular access to abutting property and surrounding streets. Provide a network of the movement of pedestrians and cyclists and enable social interaction in a neighbourhood. Should connect, where practicable, only to sub-arterial roads.	– Dawe Avenue and Scoullar Street

The application notes for the RNP state that "*for existing residences and other sensitive land uses affected by additional traffic on existing roads generated by land use developments, any increase in the total traffic noise level as a result of the development should be limited to 2 dB above that of the noise level without the development. This limit applies wherever the noise level without the development is within 2 dB of, or exceeds, the relevant day or night noise assessment criterion*."

If the road traffic noise increase from the project is within 2 dB of current levels, then the objectives of the RNP are met and no specific mitigation measures are required. Mitigation should be applied when road traffic noise levels increase by 2 dB *and* the controlling noise criterion in Table 3.8 are exceeded at the façade of the residence.

Table 3.8 Road traffic noise criteria, dBA

Development type	Applicability to assessment	Day 7:00 am to 10:00 pm	Night 10:00 pm to 7:00 am
Existing residence affected by additional traffic on local roads generated by land use developments	– Dawe Avenue and Scoullar Street	55 $L_{eq(1hr)}$	50 $L_{eq(1hr)}$

3.4 Construction vibration

3.4.1 Human comfort

Guidance in relation to acceptable vibration levels for human comfort are provided in EPA's *Assessing Vibration: a technical guideline* (AVTG) (2006). The document is based on the guidelines contained in British Standard *BS 6472-1:1992 Evaluation of human exposure to vibration in buildings (1–80 Hz)*.

Typically, construction works generate ground vibration of an intermittent nature. In accordance with BS 6472-1:1992, intermittent vibration is assessed using the Vibration Dose Value (VDV). Acceptable VDVs, as outlined in *Assessing Vibration: A Technical Guideline*, are listed in Table 3.9.

There is a low probability of adverse comment or disturbance to building occupants at vibration values below the preferred values. Adverse comment or complaints may be expected if vibration values approach the maximum values. Activities should be designed to meet the preferred values where an area is not already exposed to vibration. Where all feasible and reasonable measures have been applied, values up to the maximum range may be used if can be justified. For values beyond the maximum value, the proponent should negotiate with the affected community.

Table 3.9 Acceptable vibration dose values for intermittent vibration

Location	Daytime [1] ($m/s^{1.75}$)		Night-time [1] ($m/s^{1.75}$)	
	Preferred value	Maximum value	Preferred value	Maximum value
Critical areas [2]	0.10	0.20	0.10	0.20
Residences	0.20	0.40	0.13	0.26
Offices, schools, educational institutions, and places of worship	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60

Notes:

1. Daytime is 7 am to 10 pm and night-time is 10 pm to 7 am.
2. Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. These criteria are only indicative, and there may be a need to assess intermittent values against the continuous or impulsive criteria for critical areas.

While the assessment of response to vibration in BS 6472-1:1992 is based on VDV and weighted acceleration, for construction-related vibration, it is considered more appropriate to provide guidance in terms of Peak Particle Velocity (PPV), since this parameter is more likely to be routinely measured based on the more usual concern over potential building damage.

Humans are capable of detecting vibration at levels well below those that risk causing damage to a building. The degrees of perception for humans are suggested by the vibration level categories given in British Standard *BS 5228-2:2009 Code of practice for noise and vibration on construction and open sites – Part 2: Vibration* as listed in Table 3.10.

Table 3.10 Guidance on the effects of vibration levels

Approximate vibration level	Degree of perception
0.14 mm/s	Vibration might be just perceptible in the most sensitive situations for most vibration frequencies associated with construction. At lower frequencies, people are less sensitive to vibration.
0.30 mm/s	Vibration might be just perceptible in residential environments.
1.00 mm/s	It is likely that vibration of this level in residential environments would cause complaint but can be tolerated if prior warning and explanation has been given to residents.
10.00 mm/s	Vibration is likely to be intolerable for any more than a very brief exposure to this level.

3.4.2 Structural damage to standard and heritage structures

Vibrations as a result of construction work relating to the project are considered as a short-term vibration impact and criteria have been established accordingly.

The minimum working distances for structural (cosmetic) damage used for this assessment have been based on *DIN 4150-3 Structural Vibration – effects of vibration on structures* (German Standards, 2016) levels from ground borne vibration which enables the likelihood of building damage from ground vibration to be assessed. Experience has shown that if these values are complied with, damage that reduces the serviceability of the building would not occur. If damage nevertheless occurs, it is to be assumed that other causes are responsible. Measured values exceeding those listed in Table 3.11 do not necessarily lead to damage; should they be significantly exceeded; however, further investigations may be necessary.

The vibration levels in this standard are adopted as building damage criteria and are presented Table 3.11 for industrial premises, domestic premises, and heritage structures.

No heritage structures have been identified within 250 metres of the project footprint. At this distance no vibration impacts to heritage structures are anticipated.

Table 3.11 DIN 4150-3:2016 guideline values for short term vibration velocity

Line	Type of building	Guideline values for velocity, (mm/s)		
		Vibration at the foundation at a frequency of		
		1 Hz to 10 Hz	10 Hz to 50 Hz	50 Hz to 100 Hz[3]
1	Offices and industrial premises	20	20-40	40-50
2	Domestic houses and similar construction	5	5-15	15-20
3	Structures that, because of their particular sensitivity to vibration, cannot be classified under lines 1 and 2 and are of great intrinsic value (e.g. listed buildings under preservation order)	3	3 to 8	8 to 10

Notes:

1. Values referred to are at the base of the building.
2. At frequencies below 4 Hz, a maximum displacement of 0.6 mm (zero to peak) should not be exceeded.
3. At frequencies above 100 Hz the values given in this column may be used as minimum values.

3.5 Sensitive scientific and medical equipment

Some scientific equipment (e.g. electron microscopes and microelectronics manufacturing equipment) can require more stringent objectives than those applicable to human comfort. While the acceptable vibration levels for such equipment are recommended to be obtained from the instrument manufacturers, generic vibration criterion (VC) curves as published in *Generic Vibration Criteria for Vibration Sensitive Equipment* (C.Gordon 1999) may be adopted as vibration objectives.

The max level criteria for frequencies greater than 8 Hz (in μm/sec, rms) for each generic VC curve are presented in Table 3.12.

Table 3.12 Application and interpretation of the generic VC curves

Criterion Curve	Max Level (μm/sec), rms)	Detail size (microns)	Description of use
Operating Theatre	100	25	Vibration not perceptible. Suitable in most instances for surgical suites, microscopes to 100X and for other equipment of low sensitivity
VC-A	50	8	Adequate in most instances for optical microscopes to 400X, microbalances, optical balances, proximity and projection aligners, etc.
VC-B	25	3	Appropriate for inspection and lithography (including steppers) to 3 μm line widths.
VC-C	12.5	1-3	Appropriate standard for optical microscopes to 1000X, inspection and lithography inspection equipment (including moderately sensitive electron microscopes) to 1 μm detail size, TFT-LCD stepper/scanner processes.
VC-D	6	0.1 – 0.3	Suitable in most instances for the most demanding equipment including electron microscopes (TEMs and SEMs) and E-Beam systems.
VC-E	3	< 0.1	A challenging criterion to achieve. Assumed to be adequate for the most demanding of sensitive systems including long path, laser-based, small target systems, E-Beam lithography systems working at nanometer scales, and other systems requiring extraordinary dynamic stability.

4. Noise and vibration impacts

4.1 Operational noise impacts

4.1.1 Mechanical services

The following information was taken from the Finley Hospital Schematic Design Report, prepared by HDR on behalf of NSW Health Infrastructure (HI) (February 2024), regarding mechanical services.

> *There is an existing VRF system serving the ED ward of the hospital that was installed as part of the 2018 works. It is proposed to retain this system and reconfigure the indoor units to suit any room changes in the area. Where additional indoor units are required to supplement the refurbishment and expansion, investigations will be undertaken to ascertain if the existing system has capacity for additional indoor unit connections.*
>
> *The new IPU expansion will require a new VRF system to provide heating and cooling to the new patient rooms. External heat pump units are proposed to be located adjacent to the existing units serving the ED ward. Fresh air shall be provided by roof cowls and ducted to the various indoor units to provide fresh air to the spaces in accordance with the relevant standards and codes.*
>
> *The medical imaging department shall have its own standalone heat pump air conditioning system, due to the differing operational hours of this department compared to ED and IPU. It is proposed to utilize ducted concealed indoor units connected to reverse cycle outdoor units, located in the area where the existing ED outdoor units are installed.*

Based on the above, it is not expected that additional noise impacts would occur. However, these should be assessed as the design progresses and the exact details of the model and location of the mechanical equipment is determined.

4.1.2 Car parking

The following information was also taken from the Finley Hospital Schematic Design Report.

> *No changes to existing car parking are proposed as part of the works. Existing parking arrangement consists of visitor parking accessed from Dawe Ave on the north of the site including on-street parking, Community Centre parking accessed from Dawe Ave located at the west of the site and staff parking in an informal arrangement at the south of the site accessed from Scoullar St.*

As such, no noise assessment is required to determine noise impacts from the car park, as these are not proposed to be changed.

5. Construction noise assessment

5.1 Construction works program

The plant and equipment likely to be required throughout each proposed stage of construction have been used to predict the noise levels that would be expected during construction works. The predicted noise levels were assessed against the construction noise management levels identified in Section 3.2.

Construction scenarios have been created based on construction equipment operating simultaneously at any given time. All works are located within or adjacent to the Project site. It is unlikely that construction machinery would be operating at the same time (as the modelling assumes) but analysing the 'worse-case' scenario helps to identify where noise impacts could be a concern and assists in the formulation of mitigation areas.

5.1.1 Construction activities

The construction hours for the Project are assumed to be standard hours as per the ICNG, being:

– Monday to Friday: 7:00 am to 6:00 pm
– Saturday: 8:00 am to 1:00 pm
– No work on Sundays or Public Holidays.

The Project is anticipated to be undertaken in one stage and follow the general work methodology and staging provided in Table 5.1. These construction scenarios have been modelled to determine the potential construction noise impacts on the environment.

Table 5.1 Construction staging

Construction scenario	Construction phase	Construction hours
CS01	Demolition of temporary Site establishment Investigation works Services diversions and relocations	Standard hours
CS02	Excavation and earthworks	Standard hours
CS03	Piling and footing works	Standard hours
CS04	Structure works	Standard hours
CS05	Fit-out	Standard hours
CS06	Landscaping and civil works	Standard hours

5.1.2 Noise generating equipment

Plant and equipment needed for the Project would be determined during the construction planning phase. Typical equipment for the proposed activities has been assumed for this assessment. Other equipment may be used, however, it is anticipated that they would produce similar net noise emissions when used concurrently with the equipment listed.

The magnitude of off-site noise impacts associated with construction is dependent upon a number of factors:

– the intensity and location of construction activities
– the type of equipment used
– existing background noise levels
– intervening terrain and structures
– prevailing weather conditions

Construction machinery would likely move about the Project site altering the received noise for individual receivers. During any given period, the machinery items to be used would operate at maximum sound power levels for only brief stages. At other times, the machinery would produce lower sound levels while carrying out activities not requiring full power. It is highly unlikely that all construction equipment would be operating at their maximum sound power levels at any one time. Certain types of construction machinery would be present in the study area for only brief periods during construction. Therefore, noise predictions are considered conservative.

Table 5.2 below presents the number of construction equipment proposed for each construction scenario. The activity sound power level has been calculated based on the two noisiest plant to determine the worst-case noise impacts during construction. The activity noise levels have been used to predict the noise levels that would be expected during construction works.

Table 5.2 Construction scenarios sound power levels, dB(A)

Plant description	Sound power level	Construction scenario					
		CS01	CS02	CS03	CS04	CS05	CS06
Activity Sound Power Level, dB(A)		**120**	**121**	**118**	**120**	**114**	**114**
Concrete agitator truck	103		✓	✓	✓		
Concrete pump truck	108		✓	✓	✓		
Concrete saw (5 mins)[1]	119	✓	✓		✓		
Crane (mobile)	104			✓	✓		
Excavator	107	✓	✓				✓
Hand tools (electric)	111	✓	✓	✓	✓	✓	✓
Piling rig (bored)	111			✓			
Roller	112		✓	✓			
Truck (> 20 tonne)	107	✓	✓	✓	✓	✓	✓
Forklift	106	✓	✓			✓	✓
A 5 dB penalty has been added due to tonal annoyance in accordance with the NPI							

5.2 Noise modelling inputs

Noise modelling was undertaken using Cadna 2023 . Cadna is a computer program for the calculation, assessment and prognosis of noise exposure. Cadna calculates environmental noise propagation according to *ISO 9613-2 'Acoustics – Attenuation of sound during propagation outdoors'.*

The following noise modelling assumptions were made:

– Surrounding land was modelled assuming a mix of 75 per cent soft and 25 percent hard ground with a ground absorption coefficient of 0.75
– atmospheric absorption was based on an average temperature of 10°C and an average humidity of 70%
– atmospheric propagation conditions were modelled with noise enhancing wind conditions for noise propagation (downwind conditions) or an equivalently well-developed moderate ground based temperature inversions
– modelled scenarios take into account the shielding effect from surrounding buildings and structures on and adjacent to the site
– noise sources for each scenario are in some cases modelled at different locations. As such the noise modelling assesses the noise source at multiple locations and takes the maximum L_{Aeq} received noise level.

5.3 Construction noise impacts

Construction noise levels have been predicted at the sensitive receivers within the study area with consideration to the acoustic requirements of the ICNG. The predicted $L_{Aeq(15min)}$ noise levels at the most-affected sensitive receivers are presented in Table 5.3. Where the noise management level is exceeded, the predicted value has been shown in bold.

The noise modelling assumes that all pieces of equipment in the scenario are operating at maximum capacity simultaneously at the closest distance between the construction works and the receiver. As such, the predicted noise levels are often highly conservative and actual noise levels are likely to be lower than those the levels presented below for most of the time.

Predictive modelling indicates that at some receivers in the study area, predicted noise levels for all assessed scenarios are expected to be below noise management levels (NML) during worst case conditions with all equipment operating simultaneously. However, at many receivers, predicted noise levels for the construction scenarios are expected to exceed NML during the applied conditions. Due to this, the mitigation strategies outlined in Section 6.4 will be necessary to manage impacts.

At all receivers, including those where exceedances are not predicted, the application of reasonable and feasible mitigation measures at the source is considered best practice and should be implemented where reasonable and feasible.

Table 5.3 Predicted Noise Levels for Construction Scenarios

Receiver ID	Construction Scenario						Criteria – Noise affected	Criteria – Highly noise affected
	CS01.1	CS02.1	CS03.1	CS04.1	CS05.1	CS06.1	Standard Hours	Standard hours
COMME 01	45	46	47	48	42	44	70	-
COMME 02	48	49	44	45	39	41	70	-
COMMU 01 (active recreation)	44	45	41	41	35	37	65	-
COMMU 02 (school)	42	43	42	42	36	38	55	-
COMMU 03 (school)	42	43	43	43	37	39	55	-
COMMU 04 (school)	42	43	43	43	37	39	55	-
IND 01	41	41	43	42	37	38	75	
IND 02	45	45	42	42	37	38	75	
R01	**58**	**59**	**54**	**54**	**48**	**50**	45	75
R02	**49**	**49**	**48**	**48**	42	44	45	75
R03	39	40	41	41	35	37	45	75
R04	**49**	**50**	**50**	**52**	**46**	**47**	45	75
R05	**49**	**50**	**50**	**51**	**46**	**47**	45	75
R06	**49**	**50**	**50**	**51**	**46**	**47**	45	75
R07	**49**	**50**	**50**	**51**	**46**	**47**	45	75
R08	42	42	43	44	38	39	45	75
R09	42	43	44	44	39	40	45	75
R10	42	42	44	44	39	40	45	75

Receiver ID	Construction Scenario						Criteria – Noise affected	Criteria – Highly noise affected
	CS01.1	CS02.1	CS03.1	CS04.1	CS05.1	CS06.1	Standard Hours	Standard hours
R11	43	44	**45**	**46**	40	41	45	75
R12	40	41	42	42	37	38	45	75
R13	40	41	42	42	37	38	45	75
R14	43	44	44	44	39	40	45	75
R15	41	42	43	43	37	39	45	75
R16	38	39	38	39	33	35	45	75
R17	37	38	39	39	34	35	45	75
R18	40	41	42	42	37	38	45	75
R19	36	37	37	37	31	33	45	75
R20	**48**	**49**	**45**	**45**	40	41	45	75
R21	**47**	**48**	**45**	**45**	40	41	45	75
R22	40	41	39	38	33	34	45	75
R23	**46**	**46**	43	43	38	39	45	75
R24	44	**45**	40	41	35	37	45	75
R25	40	41	38	38	32	34	45	75
R26	44	**45**	40	41	36	37	45	75
R27	**49**	**50**	44	**45**	40	41	45	75
R28	**50**	**51**	**51**	**52**	**46**	**47**	45	75
R29	**47**	**48**	**49**	**50**	44	**45**	45	75
R30	**63**	**64**	**61**	**63**	**57**	**58**	45	

5.4 Sleep disturbance impacts

No night works are scheduled in the construction works program, and as such no sleep disturbance impacts have been assessed. If any night works are to be scheduled during construction a sleep disturbance impacts assessment should be carried out.

5.5 Construction traffic impacts

The RNP recommends that “any increase in the total traffic noise level should be limited to 2 dB above that of the corresponding ‘without construction’ scenario.” Construction of the Project would generate heavy vehicle movements associated with the transportation of construction machinery, equipment, and materials to the site. Light vehicle movements would be associated with employees and smaller deliveries. At this stage in the Project, the roads impacts by construction traffic noise have not been determined as predicted traffic volumes have not been established, however access to the construction site has been assumed to be from Dawe Avenue. The site access route road classifications are as follows:

– Dawe Avenue
– Hamilton Road

Due to the existing low traffic volumes along Dawe Avenue, construction traffic generation along these roads may lead to construction traffic noise impacts at nearby sensitive receivers. Traffic flows should be managed in a way to reduce the possible impact to residential receivers in this area. As part of the construction noise and vibration management plan (CNVMP) detailed in Section 6.4.1, an assessment of the construction traffic noise impacts should be conducted, and additional noise mitigation strategies may be required.

6. Construction vibration assessment

6.1 Assessment methodology

The method for the construction vibration assessment included:

– Identifying safe working distances to comply with the human comfort and the cosmetic damage criteria. These buffer distances have been adopted from *Construction Noise and Vibration Strategy* (CNVS) (TfNSW 2019).

– Safe working distances for vibration intensive equipment are shown in Table 6.1. The vibratory equipment associated with the Project include compactors and excavators with rock breaking attachment.

6.2 Vibration safe working distances

Safe working distances for vibratory intensive equipment has been sourced from the TfNSW CNVS and are shown in Table 6.1.

Table 6.1 Vibration safe working distances

Equipment	Human comfort (AVTG Vibration guideline)	Cosmetic damage (BS 7385)
Piling rig – Bored <800 mm	7 m	2 m (nominal)
Piling rig–Hammer (12 t down force)	50 m	15 m
Piling rig – Vibratory (sheet piles)	20 m	2 m to 20 m
Vibratory roller (>18 tonnes)	100 m	25 m
Vibratory roller (13-18 tonnes)	100 m	20 m
Vibratory roller (7-13 tonnes)	100 m	15 m
Vibratory roller (4-6 tonnes)	40 m	12 m
Vibratory roller (2-4 tonnes)	20 m	6 m
Vibratory roller (1-2 tonnes)	15 m	5 m
Small hydraulic hammer 300 kg (5-12t excavator)	7 m	2 m
Medium hydraulic hammer 900 kg (12-18t excavator)	23 m	7 m
Large hydraulic hammer 1600 kg (18-34t excavator)	73 m	22 m
Jackhammer (handheld)	Avoid contact with structure	1 m (nominal)

6.3 Construction vibration impacts

6.3.1 Human comfort

The most vibration intensive activities associated with the construction works are anticipated to be piling works. At this stage of the project, it has been assumed that a standard (non-vibratory) roller will be used, and hydraulic hammers will not be used, as such, the bored pilling rig is expected to generate the highest vibration during construction works.

The closest residential receiver is within 15 metres from construction activities, however, as this is outside of the buffer distances for bored pilling works, as detailed in , no further assessment for human comfort impacts is required. Should other activities occur, the above buffer distances should be considered and where required, measures put in place to minimise impacts.

Human comfort impacts may be experienced within the hospital itself. This should be managed by the construction contractor to minimise impacts.

As part of the construction noise and vibration management plan (CNVMP) detailed in Section 6.4.1, a detailed assessment of the vibration impacts should be conducted, and additional noise mitigation strategies may be required.

6.3.2 Structural damage

Standard structures that are a part of the existing Finley Hospital are located adjacent to the construction works. The mitigation measures that have been outlined in Section 6.4 should be applied to minimise vibrational impacts on these structures. As it has been assumed that pilling will not occur within the buffer distances detailed in Table 6.1, further mitigation measures are unlikely to be required. However, should pilling works be undertaken within these distances, or should any high vibration equipment be used, the mitigation measures provided in Section 6.4 should be considered.

The location of heritage items within the Hospital should be identified prior to construction activities. If any of the works occur within the buffer zones presented above, mitigation measures provided in Section 6.4 should be implemented.

6.3.3 Sensitive equipment

In addition to the above, any sensitive equipment within the hospital should be identified. Prior to vibratory construction works, identification of all vibration-sensitive equipment within Finley Hospital is to be undertaken with the provision of vibration monitoring.

As part of the construction noise and vibration management plan (CNVMP) detailed in Section 6.4.1, a detailed assessment of the vibration impacts should be conducted, and additional noise mitigation strategies may be required.

6.4 Construction mitigation measures

It is predicted that activities associated with the project will exceed the NMLs in accordance with the ICNG. The mitigation measures should be read in conjunction with the construction noise levels in Table 5.3 to determine which receivers these measures apply to. The measures provided in Table 6.2 are best practice and should be implemented to minimise potential noise and vibration impacts where reasonable and feasible.

Table 6.2 Mitigation measures during the construction phase

Control type	ID	Measure	Timing
Community consultation			
Notification of works	NV1	Notification should be a minimum of 7 calendar days prior to the start works and should include information such as total building time, what works are expected to be noisy, their duration, what is being done to minimise noise and when respite periods will occur. If there are works outside standard hours, inform closest residents and other sensitive land use occupants within 14 days of commencement. Provide information to neighbours before and during construction through media such as letterbox drops, meetings or individual contact. In some areas, the proponent will need to provide notification in languages other than English. A website will also be established for the project to provide information.	Pre-construction
Community relations	NV2	Ensure site managers periodically check the site and nearby residences and other sensitive land uses for noise problems so that solutions can be quickly applied. Maintain good communication between the community and project staff. Consider a regular newsletter with site news, significant project events and timing of different activities. Facilitate contact with people to ensure that everyone can see that the site manager understands potential issues, that a planned	Pre-construction During construction Operation

Control type	ID	Measure	Timing
		approach is in place and that there is an ongoing commitment to minimise noise.	
Management measures			
Site inductions	NV3	All employees, contractors and subcontractors are to receive an environmental induction. The induction must at least include: – All project specific and relevant standard noise and vibration mitigation measures – Relevant licence and approval conditions – Permissible hours of work – Any limitations on high noise generating activities – Location of nearest sensitive receivers – Construction employee parking areas – Designated loading/unloading areas and procedures – Site opening/closing times (including deliveries) – Environmental incident procedures	Construction Operation
Schedule activities to minimise noise impacts	NV4	All activities on site should be confined between the hours: daytime hours of 7:00 am to 6:00 pm from Monday to Friday and 8:00 am to 1:00 pm on Saturday, with the exception of the following activities: – The delivery of oversized plant of structures – Emergency work to avoid the loss of life or damage to property, or to prevent environmental harm	Pre-construction During construction
Source mitigation measures			
Construction hours and scheduling.	NV5	Where feasible and reasonable, construction should be carried out during the standard daytime working hours. Work generating high noise and/or vibration levels should be scheduled during less sensitive time periods.	Construction
Non-tonal and ambient sensitive reversing alarms	NV6	Non-tonal reversing beepers (or an equivalent mechanism) must be fitted and used on all construction vehicles and mobile plant regularly used on site and for any out of hours work. Consider the use of ambient sensitive alarms that adjust output relative to the ambient noise level.	Construction Operation
Reduced equipment power	NV7	Use only the necessary size and power.	Construction Operation
Minimise disturbance arising from delivery of goods to construction sites.	NV8	Loading and unloading of materials/deliveries is to occur as far as possible from sensitive receivers. Select site access points and roads as far as possible away from sensitive receivers. Dedicated loading/unloading areas to be shielded if close to sensitive receivers. Delivery vehicles to be fitted with straps rather than chains for unloading, wherever possible. Avoid or minimise these out of hours movements where possible.	Construction
Engine compression brakes	NV8	Limit the use of engine compression brakes in proximity to residences.	Construction Operation
Maintain equipment	NV10	Regularly inspect and maintain equipment to ensure it is in good working order. Also check the condition of mufflers. Equipment must not be operated until it is maintained or repaired, where maintenance or repair would address the annoying character of noise identified.	Construction Operation
Construction vibration mitigation measures			
Vibration assessment –	NV11	As part of the CNVMP detailed in Section 6.4.1 below, and prior to commencement of construction works, a review of activity types and	Construction

Control type	ID	Measure	Timing
general equipment		locations should be undertaken to determine whether any vibration impacts will occur during construction works. Should this be identified, vibration monitoring should be undertaken to determine the level of impact.	
Vibration assessment – sensitive equipment	NV12	As part of the CNVMP detailed in Section 6.4.1 below, and prior to commencement of construction works, vibratory sensitive equipment within the hospital, in particular areas adjacent to the proposed works, should be identified and assessed. Should this be identified, vibration monitoring should be undertaken to determine the level of impact.	Construction

6.4.1 Construction noise and vibration management plan (CNVMP)

A construction noise and vibration management plan (CNVMP) should be developed after the construction contractor has been engaged and a detailed construction method has been developed. The CNVMP would include a review of the construction noise predictions during the environmental impact assessment phase based. The plan would be based on the construction contractor's method and include a detailed examination of feasible and reasonable work practices and noise and vibration mitigation measures to manage sensitive receivers that are predicted to be 'noise affected'. The CNVMP would also include:

- details of the construction methodology
- feasible and reasonable mitigation measures to be implemented
- updated noise predictions at sensitive receivers
- assessment of noise impacts for light and heavy vehicle movements
- a noise monitoring procedure and program for the duration of works
- a community consultation plan to liaise with the noise affected receivers, including:
  - Notification to residences a minimum of 7 calendar days prior to the start of works and should include information such as total building time, what works are expected to be noisy, their duration, what is being done to minimise noise and when respite periods will occur.
  - A procedure for complaints, including maintaining a compliant register on site
- A review of sensitive equipment within the hospital to determine whether additional mitigation measures are required.

7. Conclusion

The noise and vibration impact assessment has established the ambient and background noise and assessed the potential noise impacts associated with the construction and operational phases of the project with respect to the following guidelines:

– Operational phase - *Noise Policy for Industry* (NPI).
– Construction phase - *Interim Construction Noise Guideline* (ICNG).
– Road network - *Road Noise Policy* (RNP).
– Vibration (human comfort) – *Assessing Vibration: A Technical Guideline* (AVTG).
– Vibration (cosmetic damage) - *DIN 4150-3 (2016) Structural Vibration – effects of vibration on structures*.

Construction noise

Predicted results indicate that noise associated with the construction works is expected to have an impact on nearby sensitive receivers, however no residential receivers are predicted to experience highly intrusive noise levels. Reasonable and practical noise and vibration mitigation measures are presented in Section 6.4 and are recommended for consideration by the construction contractor to reduce potential construction noise and vibration impacts. Particular attention needs to be paid to the community consultation, notification, and complaints sections.

Construction vibration

No external sensitive receivers have been identified within the safe working distances for vibratory intensive work. As such, no adverse (structural damage or human comfort) vibration impacts are anticipated.

Works may occur within the safe working distances at the hospital building directly adjacent to where works are occurring. Mitigation measures have been provided in Section 6.4 should this occur.

Operational noise

Based on the proposed equipment to be installed on site, on-going operational noise impacts are not expected. Any additional mechanical equipment should be assessed as the design progresses to determine whether any additional mitigation measures are required, including any potential noise impacts on the hospital itself (e.g. wards).