ACOUSTICS AND AIR

CBD AND SOUTH EAST LIGHT RAIL (CSELR)
EIS NOISE & VIBRATION ASSESSEMENT
INDEPENDENT ADEQUACY REVIEW & GAP ANALYSIS

REPORT NO. 14055
VERSION A

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PREPARED FOR

DEAPARTMENT OF PLANNING
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GLOSSARY OF ACOUSTIC TERMS

Most environments are affected by environmental noise which continuously varies, largely as a result of road traffic. To describe the overall noise environment, a number of noise descriptors have been developed and these involve statistical and other analysis of the varying noise over sampling periods, typically taken as 15 minutes. These descriptors, which are demonstrated in the graph below, are here defined.

Maximum Noise Level (L_{Amax}) – The maximum noise level over a sample period is the maximum level, measured on fast response, during the sample period.

L_{A1} – The L_{A1} level is the noise level which is exceeded for 1% of the sample period. During the sample period, the noise level is below the L_{A1} level for 99% of the time.

L_{A10} – The L_{A10} level is the noise level which is exceeded for 10% of the sample period. During the sample period, the noise level is below the L_{A10} level for 90% of the time. The L_{A10} is a common noise descriptor for environmental noise and road traffic noise.

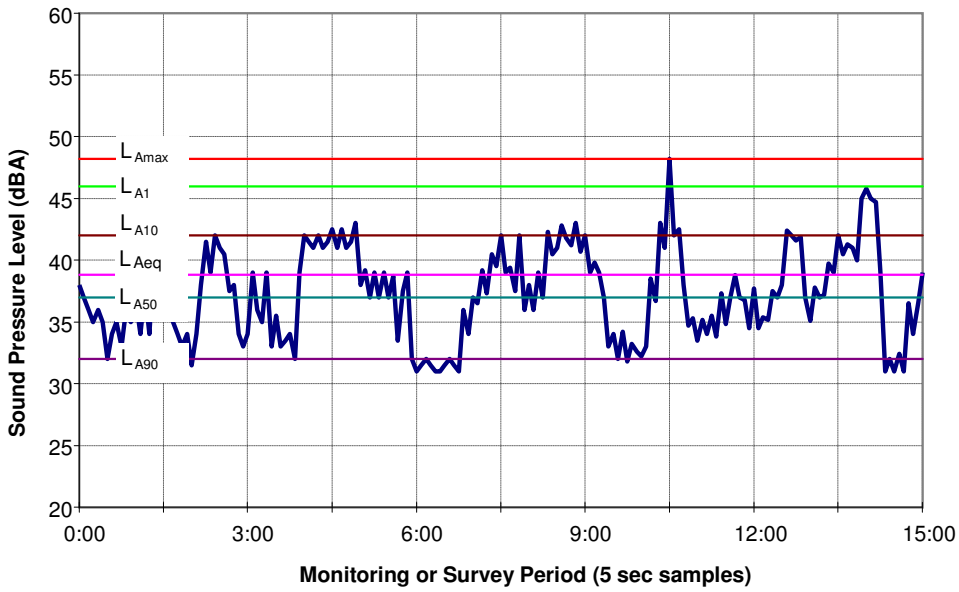
L_{A90} – The L_{A90} level is the noise level which is exceeded for 90% of the sample period. During the sample period, the noise level is below the L_{A90} level for 10% of the time. This measure is commonly referred to as the background noise level.

L_{Aeq} – The equivalent continuous sound level (L_{Aeq}) is the energy average of the varying noise over the sample period and is equivalent to the level of a constant noise which contains the same energy as the varying noise environment. This measure is also a common measure of environmental noise and road traffic noise.

ABL – The Assessment Background Level is the single figure background level representing each assessment period (daytime, evening and night time) for each day. It is determined by calculating the 10^{th} percentile (lowest 10^{th} percent) background level (L_{A90}) for each period.

RBL – The Rating Background Level for each period is the median value of the ABL values for the period over all of the days measured. There is therefore an RBL value for each period – daytime, evening and night time.

Typical Graph of Sound Pressure Level vs Time



1 INTRODUCTION

Transport for NSW (TfNSW) proposes to construct and operate the CBD and South East Light Rail Project (CSELR) comprising a new light rail service in Sydney, including approximately 12 kilometres of new light rail track from Circular Quay to Central, Kingsford and Randwick via Surry Hills and Moore Park.

On behalf of TfNSW, Parsons Brinkerhoff has prepared an Environmental Impact Statement (EIS) for the Project. The EIS includes a Noise and Vibration Impact Assessment (NVIA) prepared by SLR (EIS Volume 6, Technical Paper 11).

In accordance with the requirements of Part 5.1 of the EP&A Act, the EIS was placed on public exhibition for a minimum 30-day period during which a number of written submissions from government agencies, interested groups and the community were received by the Department of Planning and Infrastructure (DP&I).

Following the conclusion of the public exhibition period, TfNSW prepared a Submissions Report (incorporating a Preferred Infrastructure Report) to address the issues raised in community and stakeholder submissions, and to document a number of proposed design changes and additional investigations undertaken since exhibition of the EIS.

Wilkinson Murray (WM) has been commissioned by the DP&I in a peer review role capacity to:

1. undertake a technical review of the CSELR noise and vibration assessment, provide comment on its adequacy and where necessary identify any errors or omissions;

2. undertake review of the submissions received by government agencies, interested groups and the community; and

3. undertake a review of and provide comment on the Submissions Report to ensure that responses to the submissions relevant to noise and vibration are appropriately addressed.

Wilkinson Murray's initial adequacy review and gap analysis of the NVIA identified several points for clarification and further explanation. This review has been documented in the Wilkinson Murray Report dated 21 February 2014 (Ref:*14055Ltr140214JW*), which is included as an attachment to this report in Appendix A.

Responses to the points highlighted by Wilkinson Murray have been subsequently provided by SLR, as set out in the SLR memo dated 25 March 2014 (Ref:*610.12515 Response to Planning 20140325*). The SLR memo is included as an attachment to this report in Appendix B.

This report provides:

- a review of the EIS NVIA, with consideration to the responses set out in Appendix B;
- a review of the relevant parts of the Submissions Report; and
- recommended Conditions of Consent.

Wilkinson Murray has reviewed the project EIS, NVIA, submissions and Submissions Report inclusively, however the reporting is generally focused only on the points of concern. Following is a summary of each area of concern and subsequent recommendations. Where particular issues have not been identified, Wilkinson Murray considers that these have been appropriately dealt with in the project documents and/or could be managed through appropriate conditions of approval.

2 OVERVIEW OF EIS NOISE & VIBRATION IMPACT ASSESSMENT

2.1 Director-General Requirements

Consistent with the approval process for a State Significant Infrastructure (SSI) proposal, the environmental assessment requirements are set out within the NSW Director-General Requirements (DGRs).

The DGRs are summarised comprehensively in Volume 1C of the EIS and those relevant to noise and vibration are reproduced in Table 1 of the SLR report (with reference to the section of the report where each of the relevant DGRs have been addressed).

This review has deemed the assessment to have satisfactorily addressed the relevant DGRs as set out in Table 2-1.

Table 2-1 Director-General Requirements

Director-General Requirements	Where Assessed in the Assessment prepared by SLR (EIS Volume 6, Technical Paper 11)
Key issues Noise and Vibration & including but not limited to:	
Assessment of the noise and vibration impacts from construction activities and sources on and off site.	Section 12 Construction Airborne Noise Assessment Section 13 Construction Road Traffic Noise Assessment Section 14 Construction Groundborne Noise Assessment Section 15 Construction Vibration Assessment
The nature, sensitivity and impact to potentially affected receivers and structures (including heritage items).	Section 4.2 Identification of Noise and Vibration Sensitive Receptors
A strategy for managing construction noise and vibration and out-of-hours activities, with a particular focus placed on those activities identified as having the greatest potential for adverse noise or vibration impacts, and a broader, more generic approach developed for lower-risk activities.	Section 12.6 Construction Noise Mitigation Strategy Section 14.4 Groundborne Noise Mitigation Section 15.5 Vibration Mitigation
Noise and vibration impacts along the corridor associated with light rail operations, including specific consideration of impacts on sensitive receivers (such as educational facilities and hospitals), the use of public address systems and the operation of stabling and maintenance activities.	Section 5 Airborne Operational Noise Section 6 Operational Vibration Assessment Section 7 Groundborne Noise Section 8 Stabling Yard and Maintenance Depot Noise Assessment Section 9 Noise from Operation of Substations Section 10 Operational Noise at Stops Section 11 Changes in Operational Road Traffic Noise

Director-General Requirements	Where Assessed in the Assessment prepared by SLR (EIS Volume 6, Technical Paper 11)
Reasonable and feasible mitigation measures to reduce impacts during construction and operation.	Section 12.6 Construction Noise Mitigation Strategy Section 14.4 Groundborne Noise Mitigation Section 15.5 Vibration Mitigation
Taking into account the Interim Construction Noise Guideline (DECC, 2009), Rail Infrastructure Noise Guideline (DEC, 2006) for construction and operation of the proposal and the Industrial Noise Policy (and associated application notes) for proposed stabling and maintenance facilities. Noise from new or upgraded railways should be assessed using the Rail Infrastructure Noise Guideline (EPA, 2013).	Section 5 to Section 11 inclusive
If blasting is required for any reason during the construction or operational phase, impacts from blasting should be demonstrated to be capable of complying with the guideline contained in Australian and New Zealand Environment Council – Technical basis for guidelines to minimise annoyance due to blasting overpressure and ground vibration (ANZEC, 1990).	Blasting is not anticipated to be required for the Proposal

2.2 Scope of Assessment

SLR's construction and operational noise and vibration assessment for the CSELR has included:

- ambient noise surveys to determine the existing noise environment within the surrounding environment of the proposal;
- identification of receptors along the alignment potentially sensitive to noise and vibration;
- prediction of noise and vibration from the construction and operation of the light rail line, including stabling yard and maintenance depot, stops and ancillary infrastructure;
- assessment of potential noise and vibration impacts in accordance with relevant legislation and guidelines;
- identification of potential improvement to existing noise environments as a result of the proposal; and
- the recommendation of management and mitigation measures to reduce and control potential impacts where noise and vibration levels are predicted to be above the assessment criteria.

The assessment divides the corridor into five main precinct areas reflecting the changing land uses adjacent to the proposal and further divides the five precincts into Noise Catchment Areas (NCAs). The location of the various precincts and NCAs, as shown in Figures 2-4 of the report, are considered suitable.

Ambient noise survey locations, as detailed in Table 4 of the assessment (and shown in Figures 2-4) are considered to have been appropriately selected for the purpose of providing a broad characterisation of the acoustic environments along the alignment.

The noise monitoring methodology has seemingly been undertaken in accordance with standard practice and the instrumentation used complies with the relevant Australian Standard.

Analysis of the measured noise levels has been carried out in accordance with the procedures contained in the NSW *Industrial Noise Policy (INP).*

The noise monitoring results set out in Tables 5 and 6 of the assessment are broadly consistent with WM's experience of ambient noise levels measured throughout Sydney.

2.3 Assessment Guidelines

The assessment has adopted the appropriate NSW Environment Protection Authority (EPA) guidelines, as required by the DGRs, as follows:

- Noise from the operation of the light rail line has been appropriately assessed in accordance with guidance provided by the EPA in the *Rail Infrastructure Noise Guideline (RING)*, NSW EPA, 2013.
- Noise from stabling yard and maintenance depot sites, stops and electrical substations has been appropriately assessed in accordance with the NSW *Industrial Noise Policy (INP)*, NSW EPA, 2000, with guidance on sleep disturbance criteria taken from the online Application Notes to the *INP*.
- Construction noise has been appropriately assessed in accordance with the *Interim Construction Noise Guideline (ICNG)*, DECC, 2009.
- Construction road traffic noise has been appropriately assessed in accordance with the NSW *Road Noise Policy (RNP)*, NSW EPA, 2011.
- Vibration from operation and construction has been assessed in accordance with *Assessing Vibration: A Technical Guideline*, DEC, 2006.

2.4 General Review Comments

In general terms, WM considers the SLR noise and vibration assessment to have been undertaken adequately and proficiently, consistent with the relevant Director-General Requirements as set out in Volume 1C of the EIS.

Wilkinson Murray generally concurs with the methodologies applied to the technical assessments, which appear to have been undertaken appropriately and in-line with best practice. The calculated/modelled results are broadly consistent with WM experience on other similar projects.

It is considered that the SLR assessment is sufficiently thorough with consideration to this early planning stage of the project. Notwithstanding this, some aspects are open ended; i.e. there are identified potential impacts that the consultant (or proponent) believe can be resolved, but details of the actual mitigation measures have generally been deferred until the detailed design phase.

If the project is approved it is recommended that the Approval includes conditions requiring that these currently unresolved issues are adequately addressed in an Operational Noise and Vibration Review (ONVR) to confirm the exact noise and vibration control measures to be implemented and the efficacy of these measures.

Further detailed review on the EIS NVIA is provided in the following sections.

3 DETAILED REVIEW OF OPERATIONAL NOISE ASSESSMENT

3.1 Operational Noise Criteria for Light Rail

For new light rail developments such as the CSELR, the RING recommends that the airborne noise levels identified in Table 3-1 are not exceeded, as assessed external to residential land uses. Where these 'trigger levels' are predicted to be exceeded, the *RING* recommends that feasible and reasonable mitigation measures are considered to reduce noise levels from the rail infrastructure project.

Table 3-1 *RING* Noise Assessment Criteria

Receiver	Daytime (7.00am to 10.00pm)	Night Time (10.00pm to 7.00am)
Residential	$L_{Aeq,15hr}$ 60 dBA	$L_{Aeq,9hr}$ 50 dBA
	L_{Amax} 80 dBA	L_{Amax} 80 dBA

L_{Amax} refers to the maximum noise level not exceeded for 95% of rail passby events and is measured using 'fast' response setting on a sound level meter. These noise trigger levels are external levels.

The assessment appropriately identifies the relevant criteria (trigger levels). The *RING* requires noise to be assessed against the criteria at the project opening year and at a future design year (typically ten years after opening). For this proposal, the two timeframes which have been assessed are 2021 (the proposed year of opening) and 2036 (the future design year).

3.2 Predicted Operational Noise Impacts

The EIS identified predicted exceedances of the *RING* criteria in several areas as indicated in Table 3-2.

Table 3-2 CSELR Predicted Operational Noise Levels

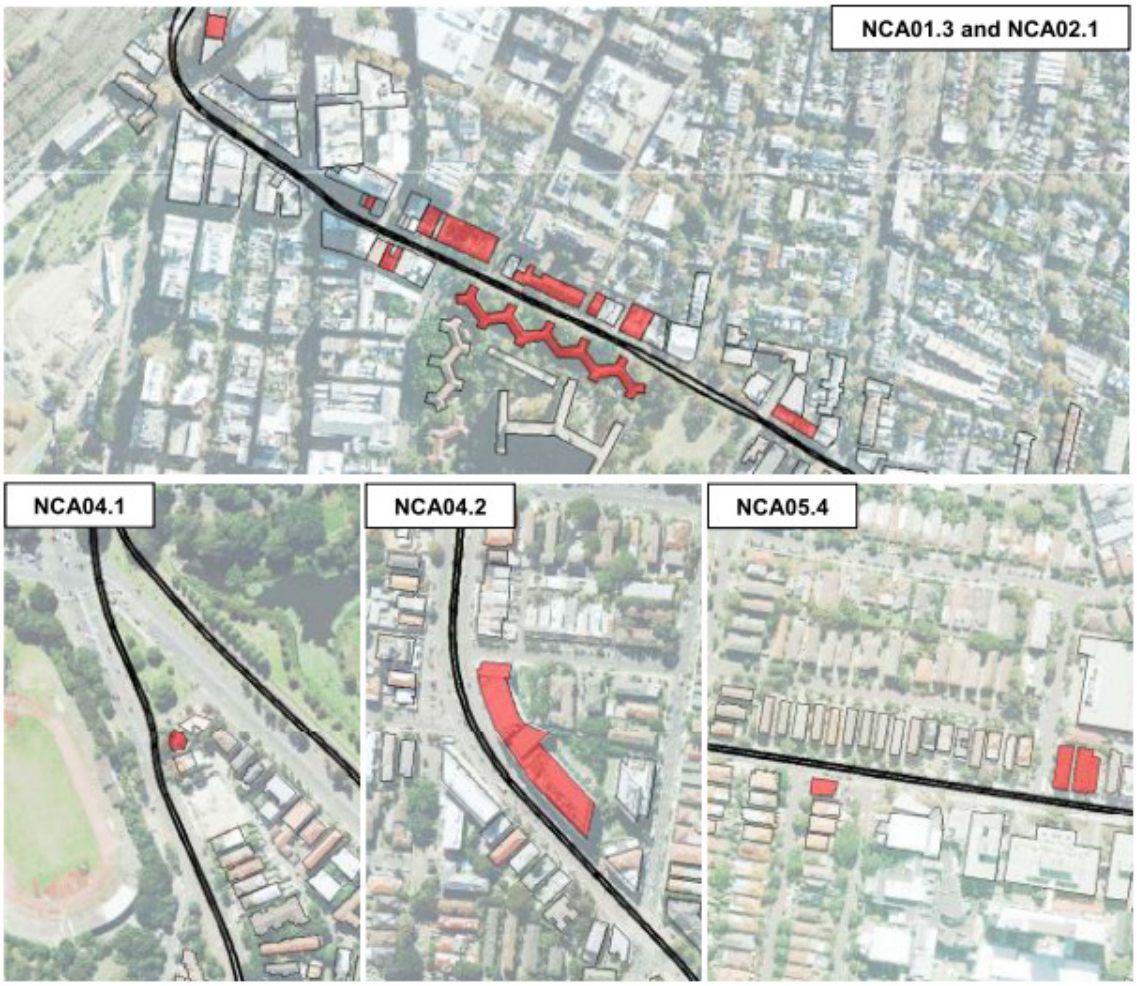
Precinct	NCA	Worst-Case Predicted Level (dBA)					
		2021 Opening Scenario			2036 Future Scenario		
		Daytime $L_{Aeq,15hr}$	Night Time $L_{Aeq,9hr}$	L_{Amax}	Daytime $L_{Aeq,15hr}$	Night Time $L_{Aeq,9hr}$	L_{Amax}
Noise Criteria (dBA)		60	50	80	60	50	80
City Centre	NCA01.1	49	42	70	49	42	70
	NCA01.2	55	48	72	55	48	72
	NCA01.3	59	52	77	60	52	77
Surry Hills	NCA02.1	62	55	83	62	55	83
Moore Park	NCA03.1	52	45	68	52	45	68
Kensington / Kingsford	NCA04.1	58	51	82	59	51	82
	NCA04.2	57	51	79	68	51	79
	NCA04.3	55	48	75	55	48	75

Precinct	NCA	Worst-Case Predicted Level (dBA)					
		2021 Opening Scenario			2036 Future Scenario		
		Daytime $L_{Aeq,15hr}$	Night Time $L_{Aeq,9hr}$	L_{Amax}	Daytime $L_{Aeq,15hr}$	Night Time $L_{Aeq,9hr}$	L_{Amax}
Randwick	NCA05.1	53	46	75	54	46	75
	NCA05.2	49	43	70	50	43	70
	NCA05.3	55	49	77	56	49	77
	NCA05.4	58	52	83	59	52	83

Note: The levels shown in red exceed the *RING* trigger levels.

Figure 3-1 identifies the locations of the trigger level exceedances.

Figure 3-1 Residential Exceedance Locations



As shown in Table 3-2, the greatest potential impacts appear to be within the Surry Hills Precinct. In this area, the daytime $L_{Aeq,15hr}$ trigger level is predicted to be exceeded by up to 2 dB and the night time $L_{Aeq,9hr}$ trigger level is predicted to be exceeded by up to 5 dB. Additionally the L_{Amax} trigger level is predicted to be exceeded by up to 3 dB.

The other main area of concern is Randwick where High Street has three apartment buildings with 2 dB exceedance of the $L_{Aeq,9hr}$ trigger.

The EIS NVIA suggests that apart from on Devonshire Street, Surry Hills, the trigger level exceedances are predicted only in areas with relatively high existing road traffic noise and therefore in these areas it is unlikely there would be a noise impact.

Based on further review of the details provided by SLR (Appendix B), WM concurs with the recommendation put forward by the NVIA that in locations where road traffic noise dominates and is unlikely to decrease, exceedances of the noise trigger levels by up to 2 dB would be acceptable.

WM considers that reasonable technical justification for the proposed project specific noise trigger levels has been provided and concurs with SLRs conclusions based on the additional night time attended noise measurements in each precinct, as follows:

- *Acceptance of light rail noise impacts above the RING trigger levels for L_{Amax} or L_{Aeq} in the CBD Precinct would be considered reasonable in light of the existing high L_{Amax} and L_{Aeq} road traffic noise impacts, as mitigating light rail noise would not reduce the overall future road traffic noise levels.*
- *In Surry Hills, consideration of reasonable and feasible mitigation of light rail noise is required at all locations where the RING trigger levels are exceeded.*
- *In Moore Park, consideration of reasonable and feasible mitigation of light rail noise would be required at any locations where the RING trigger levels are exceeded, noting that no exceedances are anticipated at this location.*
- *In Randwick, acceptance of the predicted light rail noise levels of 2 dB to 3 dB above the RING trigger levels along High Street is considered reasonable with consideration to the existing road traffic noise impacts.*

  Along Wansey Road, consideration of mitigation of light rail noise would be required at any locations where the RING trigger levels are exceeded, noting that no exceedances are anticipated at this location.
- *In Kensington and Kingsford, acceptance of light rail noise levels above the RING trigger levels along Anzac Parade is considered reasonable in light of the existing high road traffic noise impacts, as mitigating light rail noise would not reduce the overall future road traffic noise levels.*

3.3 Treatment of Residual Operational Noise Impacts

The SLR memo identifies potential mitigation options including optimisation of the route alignment, specification of low noise LRVs, absorptive track treatments and speed limits in residential streets for the control of LRV noise to within the *RING* trigger levels where these measures are feasible and reasonable to implement.

WM considers that in the case of the Surry Hills precinct, where such measures would be most beneficial for the reduction of any potential noise impacts, they would unlikely be practicable. Therefore, appreciable residual exceedances of the *RING* trigger levels would be likely to remain after all feasible and reasonable 'at-source' mitigation measures have been exhausted.

With levels of $L_{Aeq,9Hr}$ 55 dBA predicted during regular service and $L_{Aeq,9Hr}$ 57-58 dBA predicted on nights of special events, residual exceedances of the trigger levels by 5 dB every night and 7-8 dB on special event nights may be expected to arise.

It would appear that 'at-receiver' mitigation in the form of architectural treatments applied to the most exposed residential building facades would be the most practicable mitigation for the Devonshire Street receivers to ensure that satisfactory internal levels are maintained within these dwellings.

Whilst further investigation would be necessary to determine the extent of any façade upgrades, it is likely that the measures would principally comprise the upgrade to glazing standards, doors and wall vents. It would be recommended that if these measures are to be provided that they are implemented prior to construction of the project infrastructure in the local vicinity. This would provide the additional benefit of limiting construction noise impacts on the receivers (see Section 4).

With respect to internal noise levels, WM notes that the assessment makes reasonable assumptions for the level of inherent attenuation that would be achieved though external facades of existing buildings, i.e. 20 dB for CBD receptors and 10 dB for receptors outside of the CBD.

WM recommends the protection of residential amenity in existing quiet areas be managed through the adoption of Specific Operational Noise Impact Statements as discussed Section 6.

3.4 Noise Source Level Assumptions and Model Validation

Operational airborne noise has been modelled using the SoundPLAN (Version 7.1) environmental noise modelling software, applying the Nordic Rail Traffic Noise Prediction Method (Kilde 1984). The factors considered in the noise modelling, as described in Sections 5.4.1 to 5.4.8 of the report are in-line with standard practice.

The calculation factors the speed and length of the LRV to determine the maximum potential noise levels at a receptor during a passby event.

The LRV source noise emissions for the proposal were determined by SLR from a review of measured LRV noise levels from yearly compliance measurements of the existing Sydney light rail system between 2004 and 2013, as well as a review of data available from light rail systems in Europe. The source noise levels adopted for the assessment for the LRV referenced at 7.5 m from the track centreline and 1.2 m above ground are:

- L_{Amax} 82 dBA (45 m in length, travelling at 60 km/h); and
- L_{AE} 83 dBA (45 m in length, travelling at 60 km/h).

WM has reviewed the attended LRV passby measurements of the existing Sydney Light Rail undertaken by SLR. Based on the noise compliance measurement details provided in addition to the reasoned assumptions and corrections applied, WM considers the source level applied by the EIS (L_{AE} 83 dBA) appears to be reasonable, though would note that without the adoption of an uncertainty factor is not considered particularly conservative.

SLR notes that in the detailed design stage, the ONVMR would be required (by the tender specifications) to provide evidence that the noise and vibration prediction model has been validated via measurement and prediction on other rail systems. WM agrees that this would provide further confidence in the modelling results and therefore propose that this is conditioned, as set out in Section 6.

3.5 Operational Noise Uncertainty Factor

Given the uncertainty in the noise predictions in the absence of details of the track form, rolling stock and operating speeds, SLR has considered the effect on the number of properties that would be considered for mitigation, if the source level was increased by 2 dB or 5 dB.

The memo notes that as exceedances of the RING noise goals are controlled by the night time L_{Aeq} levels, the increased impacts with increased source levels should be viewed in light of the existing night time road traffic noise environment.

WM considers the following conclusions drawn for the various precincts to be reasonable:

- *In the City Centre, increasing the light rail source levels by up to 5 dB would not increase the impacts above the existing road traffic levels. No additional mitigation would be expected to be required.*
- *In Surry Hills, the close proximity of the residences on Devonshire Street means these properties are already triggered for consideration of mitigation. Addition of 2 dB to the source levels would trigger only two additional buildings. Addition of 5 dB to the source levels would extend the requirement to consider mitigation throughout the Surry Hills Precinct.*
- *In Moore Park, no properties would be triggered for consideration of mitigation even with a factor added to the noise source levels.*
- *In Kensington and Kingsford, while more properties would be triggered the light rail levels would remain well below the existing road traffic L_{Aeq} levels. No additional mitigation would be expected to be required.*
- *In Randwick, the addition of 2 dB to the source levels would trigger consideration of mitigation at 5 buildings on Wansey Road. However, it is noted that design changes in this area mean the light rail tracks are now proposed to be dropped to below road height, with a retaining wall having potential to shield the affected receivers. These changes have not been assessed in detail as they are expected to reduce the noise impacts. At this location, source and path control measures may be effective if required. Increasing the L_{Aeq} source levels along High Street would trigger a large number of properties for consideration of mitigation; however, the light rail L_{Aeq} levels would remain below the existing traffic L_{Aeq} levels. Recognising that the number of high noise events is not likely to increase, with a reduction in bus services to be replaced by LRVs, mitigation of noise on High Street may not be considered reasonable*.

3.6 Rolling Stock Noise Emissions

WM notes that consultation with rolling stock providers will take place throughout the tender process. It is considered that the draft specifications for the light rail system include a reasonable limit for the LRV noise emissions. It is recommended that the LRV noise emissions are controlled by an appropriate Condition, such as discussed in Section 7.

3.7 LRV Service Frequency and Special Events

The assessment notes that during periods of high demand, such as sporting events and concerts, a special event service would operate between Central Station and the Moore Park stop. This service would comprise additional services running in combination with regular services with a resulting service frequency of an LRV every 2.5 minutes.

The assessment notes that when special event services extend into the night time period the increase in $L_{Aeq,9hr}$ noise levels above normal operations would be up to 2 dB with 45 m LRVs, and up to 3 dB for those events which require 90 m LRVs to clear crowds.

With respect to special events SLR has noted:

While it is noted that special events are expected to occur around once a week, special events requiring 90 m LRVs to clear crowds during the night time period would be less frequent. Of the total special events, around one in ten would have crowds >30,000 and may require 90 m LRVs. Around one in four events would have crowds in the 20,000 to 30,000 range with the remainder of events having crowds less than 20,000. It is estimated that 90 m special event services would be required for approximately 20 events per year. RING suggests that the assessment should reflect the reasonable maximum use, or the 'worst-case' typical day rather than average use. At this stage in the project, it is not known how many of these events would require special event services after 10:00 pm. Final operating service frequencies and hours of operation would be confirmed during detailed design once the PPP contractor is engaged.

In the event that the frequency of regular services is increased in future, the predicted exceedances of the LAeq noise goals would increase. The increase would depend on the time of day of the increased service frequency. In the event that the number of services in the CBD, Surry Hills and Moore Park would increase by 50% up to predicted capacity the resulting increase in night time L_{Aeq} noise levels would be 1.8 dB.

As stated in Section 3.2 of this report with levels of $L_{Aeq,9Hr}$ 55 dBA predicted during regular service and $L_{Aeq,9Hr}$ 57-58 dBA predicted on nights of special events, residual exceedances of the trigger levels by 5 dB every night and 7-8 dB on special event nights may be expected to arise. As such it would appear that 'at-receiver' mitigation in the form of architectural treatments applied to the most exposed residential building facades would be the most practicable mitigation for the Devonshire Street receivers to ensure that satisfactory internal levels are maintained within these dwellings.

3.8 Road Traffic Noise Impacts

The report considers the resulting changes in noise as a result of the project in Section 11 and indicates twenty locations where existing road traffic noise levels have potential to increase by more than 2 dB in either the morning or afternoon peak.

WM has reviewed the further night time attended monitoring results provided by SLR (Appendix B, Table 8) which confirm relatively high existing night time road traffic noise levels on the arterial routes of Chalmers Street, Elizabeth Street and Randle Street.

Based on these results, WM considers that the night time external noise goals for local roads defined in the NSW Road Noise Policy may not be appropriate, however understand that there is a need to comply with government policy. SLR states that appropriate internal noise goals would be developed for these receivers in the detailed design stage with reference to AS 2107, and following measurement of the existing internal noise levels and the attenuation provided across the facade.

SLR additionally notes that mitigation of road traffic noise impacts due to the diversion and additional traffic on Elizabeth Street (and other affected arterial roads in the CBD) may not be considered reasonable in light of the existing road traffic noise environment but will need to be confirmed. It is recommended that surveys of the residential dwellings in those streets potentially exposed to these increased road traffic noise levels be conducted and mitigation provided as relevant.

3.9 Stabling and Maintenance Facilities

The stabling yard proposed on the corner of Doncaster Avenue and Alison Road presents the highest risk with regard to noise impacts from this proposal. The stabling yard would be a 24-hour operation with various noise generating activities conducted throughout the night time.

The NVIA identifies noise as a significant concern and discusses the use of mitigation in the form of barriers, partial roofs or a complete shed to manage noise emissions from the site, without including any plans or elevations showing the extent of these building areas.

WM's initial adequacy review requested the provision of further details to demonstrate how noise would be mitigated/managed and achieve INP criteria. In response to this SLR has noted that at this stage of the project it is difficult to confirm details of mitigation measures.

Therefore the approach taken has been to identify whether it is possible for a stabling facility at the Randwick location to be designed to comply with the INP goals. The assessment indicates it is possible for the facility to comply with the noise goals at all locations in all time periods, with the exception of 5 receiver points located in two buildings adjacent to the site exit road. The source of the exceedance at this location is staff cars (light vehicles) leaving the site, for example drivers leaving at the end of a shift.

WM considers that based on the current information provided a complete shed for the site would appear to be the most reliable solution. As a minimum, an enclosed shed area would be considered necessary where the LRVs are tested.

With the inclusion of an acoustic shed, SLR reports compliance with the noise criteria at all receptors during the daytime and evening periods with exceedances at up to five receptors during the night time period.

The NVIA does not consider the combination of a reasonable height noise wall, of for instance approximately 4 metres, with residual impacts treated with architectural treatments. WM recommends this should be considered as an option to mitigate the noise and possibly provide a barrier and any architectural treatments (if required) at the beginning of the project so that construction noise could be mitigated.

3.10 Additional Night Time Noise Measurements at Randwick Stabling Yard Site

Further attended night time noise measurements conducted by SLR at the southern and northern extents of the proposed Randwick Stabling facility site indicate that the background noise level determined by the EIS may be representative of the lowest existing background noise level for the site and therefore the existing logger location may be considered acceptable for assessment purposes. Notwithstanding this, given the potential for impacts from the stabling yard it is recommended that long-term logging be undertaken at the extremities of the site to confirm RBLs in accordance with the procedure described by the *INP*.

Assuming the measured long-term background noise level of 38 dBA is found to be representative, the controlling operational criterion may be considered to be $L_{Aeq,15min}$ 43 dBA.

Subject to further confirmation, WM would recommend that this limit be included as a Condition of Approval. Further assessment at detailed design stage should be undertaken to demonstrate compliance once the site layout is confirmed. There may some provision for exceedance of the identified limit external to the two buildings adjacent to the site exit road on the basis that satisfactory internal noise levels, in accordance with the provisions of AS/NZ 2107 are confirmed within all habitable rooms.

3.11 Randwick Stabling Yard and Rozelle Maintenance Facility Predictions

SLR has provided site layouts (SoundPLAN output) of the Randwick Stabling Yard and Rozelle Maintenance Facility which identify the horizontal spatial relationships between tracks and the closest receivers. Noise contours/façade plots to indicate where the noise impacts are (for each scenario) have not, however, been provided. WM recommends that these are included in the subsequent ONMR.

3.12 Substation Noise

WM notes the proposed changes to the locations of three substations situated in Haymarket, Chalmers Street and Surry Hills. Operational noise limits for the substations, consistent with the submissions report are set out in Section 7.4. WM recommends that these are included in the subsequent ONMR.

4 DETAILED REVIEW OF CONSTRUCTION NOISE & VIBRATION ASSESSMENT

4.1 Construction Airborne Noise Assessment

It is evident from the construction noise assessment in the report that there are significant noise impacts as a result of the light rail construction works. As the light rail tracks would be constructed through busy urban areas, works have the potential to disrupt traffic at many intersections throughout the proposal area. To minimise disruption, it is likely that works will be required outside of standard construction hours. The approach taken in the assessment has been to identify noise impacts of representative construction activities and their likely individual duration. However, as the project is inherently linear in nature at most locations, the duration of the noisiest activities would be relatively short.

The SLR construction noise assessment appears to be quite comprehensive with all the assumptions being reasonable. However, due to the limited currently available detail concerning the construction scheduling, the duration of the noise impact at locations along the construction of the light rail system remains unclear.

Indicative construction noise profiles for each precinct have been provided (Appendix B, Figures 5-9). It is recommended that these for the basis of further construction noise assessment during detailed design and are revised and included in construction noise management plans, subject to the project being approved.

Due to the close vicinity of the proposed works to residents in Surry Hills, this precinct would appear to be the most potentially impacted area. The predicted noise levels within Surry Hills reported by the EIS indicate high exceedances of the NMLs by up to 41 dB during standard construction hours and 51 dB during Out of Hours Works (OOHWs) at nearest residences.

4.2 Construction Hours

For the City Centre precinct the EIS states that it is anticipated that allowing 24-hour works in George Street will reduce the duration of services/relocations by more than six months, and reduce the duration of installation of track slab by more than two months. Similar benefits are envisaged across all construction activities.

For the other precincts working from 7.00am to 11.00pm along the remainder of the alignment would reduce the duration of services relocations by more than three months.

It would appear reason to increase standard working ours for this project to reduce the project duration. WM considers the following standard working hours reason:

- CBD Area – 6am to 10pm Monday to Friday and 8am to 5pm Saturday and Sunday; and
- Other Areas - 6am to 6pm Monday to Friday and 8am to 5pm Saturday and Sunday

4.3 Construction Noise Mitigation

The EIS states that the reasonableness of a number of feasible mitigation measures would be considered. These are summarised in **T**able 4-1 below, along with WM comments.

Table 4-1 Summary of Feasible Construction Noise Mitigation Measures

Mitigation Measure	WM Comment
For construction concentrated in a single area, such as at the stops, worksites, substation construction sites, bridge sites and stabling / maintenance facility locations, temporary acoustic fencing/barriers around the site perimeter should be considered where feasible and reasonable to mitigate off site noise levels. Noise walls are effective for receptors at or near ground level and not effective for receptors overlooking the sites.	WM agrees that these measures appear to be reasonable and notes that such measures have been successfully used on other similar projects.
Given the potentially high noise levels at residential receptors, adherence to daytime construction hours is recommended for excavation, demolition or rock breaking activities, and for activities concentrated in a single area (ie activities that do not move along the alignment, and do not require out of hours activities for safety reasons or to minimise disruption to road networks).	WM agrees that these activities should be restricted to within standard daytime construction hours. Additionally it is noted that TfNSW should provide a protocol for night time construction management.
Night works should be programmed to minimise the number of consecutive nights work impacting the same receptors.	This would appear to be reasonable. WM would recommend a restriction of two consecutive nights.
When working adjacent to schools, particularly noisy activities should be scheduled outside normal school hours, where possible.	All these mitigation methods would appear to be reasonable.
Avoiding the coincidence of noisy plant working simultaneously close together and adjacent to sensitive receptors would result in reduced noise emissions.	
Equipment which is used intermittently is to be shut down when not in use.	
Where possible, the offset distance between noisy plant items and nearby noise sensitive receptors should be as great as possible.	
Where possible, equipment with directional noise emissions should be oriented away from sensitive receptors.	
Regular compliance checks on the noise emissions of all plant and machinery used for the proposal would indicate whether noise emissions from plant items were higher than predicted. This also identifies defective silencing equipment on the items of plant.	
Ongoing noise monitoring during construction at sensitive receptors during critical periods to identify and assist in managing high risk noise events.	

Mitigation Measure	WM Comment
Where possible heavy vehicle movements should be limited to daytime hours.	
Reversing of equipment should be minimised so as to prevent nuisance caused by reversing alarms.	
Loading and unloading should be carried out away from sensitive receptors, where practicable.	

The additional mitigation measures described in the TfNSW Construction Noise Strategy are summarised below:

- Periodic Notifications;
- Website;
- Project Info-line and Construction Response Line;
- Email Distribution List;
- Signage;
- Specific Notifications (SN);
- Phone Calls (PC);
- Individual Briefings (IB);
- Monitoring (M);
- Project Specific Respite Offer (RO); and
- Alternative Accommodation (AA).

The EIS states offers of alternative accommodation to residents are unlikely to be reasonable and feasible in the City Centre precinct. This is partly due to the impracticability of providing alternative accommodation to large numbers of people during the proposed 24-hour works, but also reflects the fact that the existing night time noise environment in the City Centre precinct means that facades of residential buildings would generally provide a high level of noise attenuation.

WM considers this to be a reasonable generalisation; however, alternative accommodation should not be ruled out totally as their may be instances where alternative mitigation is reasonable.

WM would not recommend that 24-hour construction should be allowed outright. Experience has shown that night works are frequently more effectively managed by developing a respite procedure, allowing out of hours construction to occur, for instance, for 2 consecutive nights followed by 2 nights' respite. Such a procedure is often found to be more acceptable to impacted communities.

The EIS states in other precincts, offers of alternative accommodation would be considered in the event that more than two consecutive nights of highly intrusive works are required in any particular location. WM agrees that this would appear to be a reasonable management strategy.

With consideration to the details set out above, for the effective management of construction noise and vibration impacts WM recommends that a Construction Noise and Vibration Management Sub Plan be prepared for the project, with specific management of local areas and out-of-hours works to be managed by Specific Construction Noise Impact Statements.

WM has prepared draft Conditions of Approval which include the requirements for these management controls/documents. These are set out in Section 6.

5 REVIEW OF SUBMISSIONS & SUBMISSION RESPONSES

Wilkinson Murray has reviewed the submissions relevant to noise and vibration provided, including those submissions made by:

- Government agencies including the NSW Environment Protection Authority (EPA); City of Sydney Council; Randwick City Council; Leichhardt Council; NSW Department of Education & Communities; NSW Department of Health (Sydney Local Health District – SLHD); NSW Department of Health Infrastructure; and NSW Small Business Commissioner;
- Action groups/private sector stakeholders including Inner Sydney Regional Council for Social Development; City Plan Services on behalf of Wansey Road Action Group; Australian Turf Club; Sydney Boys High School; JBA on behalf of Anson City Developments; Wai Ngor Pak (Director of Anson City Developments); TMM Consulting Pty Ltd t/a Soundmatters; EGMA; JBA Urban Planning consultants on behalf of University of NSW; and
- Members of the local communities and general public.

The noise and vibration submissions and subsequent responses are summarised in Sections 5.10.2 to 5.10.11 of the Submissions Report. WM review has found the responses to the submissions to be sufficiently thorough and conclusive, with consideration to the stage of the project. WM's further minor comments, where considered relevant, are included in Appendix C.

6 RECOMMENDED CONDITIONS OF APPROVAL FOR CONSTRUCTION

Following detailed review of the EIS and Submissions documentation, WM would propose the following Conditions of Approval for the effective management of construction noise and vibration impacts.

6.1 Construction Noise and Vibration Management Sub Plan

A detailed Construction Noise and Vibration Management Sub Plan shall be prepared as part of the Construction Framework EMP to the satisfaction of the Director-General and following consultation with the EPA and Council(s). The Sub Plan shall provide details of noise and vibration control measures to be undertaken during the construction stages. The Sub Plan shall include/document, but not be limited to:

- identification of sensitive receivers particularly residents and sensitive equipment.
- outline of construction working hours and detailed procedure for out of hours work activities identification of all noise and vibration generating tasks, duration and predicted airborne noise and vibration levels;
- construction noise criteria according to the EPA's Interim Construction Noise Guideline (ICNG);
- impacts from site compounds/construction depots;
- location, type and timing of erection of temporary and permanent noise barriers and/or other noise and vibration mitigation measures;
- specific physical and managerial measures for controlling noise and vibration demonstrating how activities would be managed so that relevant EPA guidelines and the conditions of approval are complied with;
- identification of all noise and vibration generating tasks, duration, and predicted air-borne noise levels and vibration levels;
- the requirement for respite periods;
- internal compliance audits of all plant and equipment;
- construction timetabling, in particular works outside standard hours, to minimise noise impacts;
- details of community consultation processes to be implemented during construction;
- procedures for notifying residents of construction activities likely to affect their noise and/or vibration amenity;
- contingency plans to be implemented in the event of non-compliances and/or noise complaints; and
- monitoring methods and programme.

6.2 Construction Noise Impact Statements

Specific Construction Noise Impact Statements shall be prepared in consultation with relevant government agencies, relevant Councils, Community Liaison Groups (CLGs) for specific stages of construction consistent with the Construction Noise and Vibration Management Sub Plan and shall specifically address each of the major construction sites.

The statements shall include:

- a description of the proposed processes and activities;
- predicted noise levels;
- examination of alternative methods that would potentially reduce noise if the potential noise exceeds the relevant criteria;
- description and commitment to work practices which limit noise;
- description of specific noise mitigation treatments and time restrictions, including respite periods, duration, and frequency (where possible programming of night works over consecutive nights in the same locality shall be avoided);
- justification for any activities outside the normal hours specified in Condition of Approval Section 6.4;
- internal noise audit systems including recording of daily hours of construction, progressive impact assessments as work proceeds, conducting informal checks by the Environmental Management Representative (EMR), providing active and continuous communication links to relevant Councils, residents etc.;
- assessment of potential noise from the proposed construction methods including noise from construction vehicles and noise impacts from required traffic diversions;
- community consultation and notification;
- all feasible measures including adopting the least noisy available construction methods, systems and equipment;
- assessment and examination of potential feasible offsite mitigation; and,
- additional noise mitigation measures as negotiated with affected residents and other sensitive receptors.

6.3 Construction Noise Criteria

The Proponent shall ensure that noise from construction activities is limited such that the construction noise level does not exceed the criteria in the *ICNG* at any residence or other sensitive receiver unless specified in the Construction Noise Impact Statement prepared in accordance with the construction noise impact statements.

6.4 Construction Hours

With the exception of the CBD precinct, the Proponent shall only undertake construction works associated with the project during the following hours:

- 6.00am to 6.00pm, Mondays to Fridays inclusive;
- 8.00am to 5.00pm on Saturdays; and
- at no time on Sundays or public holidays.

Within the CBD precinct, the Proponent shall only undertake construction works associated with the project during the following hours:

- 6.00am to 10.00pm, Mondays to Fridays inclusive;
- 8.00am to 5.00pm on Saturdays; and
- at no time on Sundays or public holidays.

Notwithstanding the conditions above, construction works associated with the project may be undertaken outside the hours specified under that condition in the following circumstances:

- Construction that causes $L_{Aeq(15minute)}$ noise levels that are:
  - no more than 5 dB above rating background level at any residence in accordance with the Interim Construction Noise Guideline (DECC, 2009); and
  - no more than the noise management levels specified in Table 3 of the Interim Construction Noise Guideline (DECC, 2009) at other sensitive land uses; or
- For the delivery of materials required by the police or other authorities for safety reasons; or
- Where it is required in an emergency to avoid the loss of lives, property and/or to prevent environmental harm; or
- Works approved through an out-of-hours work protocol prepared as part of the Construction Noise Management Plan, provided local residents are informed of the timing and duration at least 48 hours prior to the commencement of the work; or
- Works approved through an Environment Protection Licence for the Moore Park Tunnel, including for works identified in an out of hours works protocol.

6.5 Mitigation Prior to Construction

Where practicable, operation noise mitigation measures shall be implemented to the satisfaction of the Director General at the start of construction (or at other times during construction) to minimise construction noise impacts.

6.6 Respite Periods

The Proponent shall ensure that rock breaking, rock hammering, sheet piling, pile driving and

any other activities which result in impulsive or tonal noise generation are only scheduled between the following hours unless approved by the Director General:

- 8.00am to 12.00pm, Monday to Friday;
- 2.00pm to 5.00pm Monday to Friday; and
- 8.00am to 12.00pm Saturday.

Where these activities are undertaken for a continuous three (3) hour period and exceed construction noise criteria at noise sensitive receptors, a minimum respite per of at least one (1) hour shall be scheduled before activities recommence.

6.7 Noisy Works before Midnight

The Proponent shall ensure that the noisiest activities associated with night time works are scheduled wherever possible to be completed before midnight.

6.8 Vibration Criteria

The Proponent shall ensure that vibration from construction of the Project is limited to:

- for structural damage, the vibration limits set out in the German Standard DIN 4150-3: *Structural Vibration – effects of vibration on structures*; and
- for human exposure, the acceptable vibration values set out in the Environmental Noise Management Manual *Assessing Vibration: A Technical Guideline* (Department of Environment and Conservation, 2006).

Where there is an inconsistency between these standards, the more stringent criteria shall apply.

6.9 Sensitive Facilities

Prior to commencement of construction activities likely to result in high vibration levels, the Proponent shall identify potential highly sensitive facilities, including scientific equipment, measuring equipment and the like, where the criteria above may not be adequate. Should such cases arise, the Proponent shall consult with the potentially affected owners and develop appropriate mitigation measures to ensure impacts are acceptable.

6.10 Pre-Vibration Construction

Prior to construction the Proponent shall undertake pre-operational vibration monitoring, in consultation with sensitive facilities, such as Health Infrastructure and UNSW, to establish existing vibration and magnetic field levels at vibration sensitive facilities such as the NSW Health Cancer Treatment Centre at High Street, Randwick and the Lowy Cancer Research Centre at UNSW High Street, Randwick. Results from these studies shall be documented in the Construction Noise and Vibration Management Plan or Construction Noise Impact Statement.

6.11 Noise and Vibration Monitoring

Construction noise levels shall be monitored to verify compliance with the Construction Noise and Vibration Management Sub Plan and Construction Noise Impact Statements.

Should monitoring indicate exceedances of the criteria stated in the Construction Noise Impact Statements, the Proponent shall consult with the Director General and implement all reasonable and feasible mitigation measures to the satisfaction of the EMR and/or the Director General.

7 RECOMMENDED CONDITIONS OF APPROVAL FOR OPERATION

Following detailed review of the EIS and Submissions documentation, WM would propose the following Conditions of Approval for the effective management of operational noise and vibration impacts.

7.1 Guideline Criteria

The CBD and South East Light Rail Project shall be designed and operated with the objective of not exceeding the airborne and groundborne noise trigger levels as defined in the *Rail Infrastructure Noise Guideline* (EPA 2012) and the vibration levels defined in the *Assessing Vibration: A Technical Guideline* (DEC,2006).

7.2 Operational Noise Management Sub Plan

A detailed Operational Noise Management Sub Plan shall be prepared as part of the Operational EMP, to the satisfaction of the Director-General.

The Sub Plan shall provide details of noise and vibration control measures to be implemented during operations which are sufficient to address the requirements of the NSW Government's *Rail Infrastructure Noise Guideline*, NSW Government's *Road Noise Policy*, the NSW Government's *Industrial Noise Policy* and the RTA's *Environmental Noise Management Manual*. The Sub Plan shall include, but not be limited to:

- identification of the appropriate operational noise criteria;
- predicted noise levels at all affected residential, recreational, commercial and industrial land uses;
- location, type and timing of erection of permanent noise barriers and/or other noise mitigation measures demonstrating all reasonable and feasible noise mitigation;
- specific physical and managerial measures for controlling noise;
- noise monitoring; and
- reporting and response procedures including the monitoring on surrounding roads which experience significantly increased traffic volumes as a result of the Project.

7.3 Operational Noise Impact Assessment

Specific Operational Noise Impact Statements shall be prepared in consultation with relevant government agencies, relevant Councils, CLGs for specific stages of operation/ sites consistent with the Operational Noise and Vibration Management Sub Plan and shall specifically address each of the major operational stages/sites.

The statements shall include:

- a description of the proposed processes and activities;
- assessment of potential noise from the proposed activity including rail, road traffic, stationary site noise;
- examination of alternative methods that would potentially reduce noise if the potential noise exceeds the relevant criteria;
- description of specific noise mitigation treatments, architectural treatments, respite periods, duration, and frequency;
- community consultation and notification;
- assessment and examination of potential feasible offsite mitigation measures for traffic noise consistent with criteria in the AS 2107 and Infrastructure SEPP; and,
- additional noise mitigation measures as negotiated with affected residents and other sensitive receptors.

7.4 Stationary Sources Operational Noise Limits

The Proponent shall ensure that noise emanating from stationary noise sources do not exceed the noise limits at the nearest sensitive receptor in accordance with the EPA's *Industrial Noise Policy* or at a minimum as specified in Table 7-1 and Table 7-2.

Table 7-1 Operational Noise Limits for Stabling Yard and Maintenance Facility at Sensitive Receivers

Location	Day $L_{Aeq,15min}$	Evening $L_{Aeq,15min}$	Night $L_{Aeq,15min}$	Night $L_{A1,1min}$
Randwick Stabling Yards	49 dBA	49 dBA	43 dBA	53 dBA
Lilyfield Maintenance Facility	61 dBA	60 dBA	52 dBA	62 dBA

Note: Limits can only be modified with the approval of the Director-General following a detailed noise assessment during the detailed design phase.

Table 7-2 Operational Noise Limits for Substations at Sensitive Receivers

Location of Substations	$L_{Aeq,15min}$ (All Times of Day)	Receiver
Circular Quay	55 dBA	Residential
Martin Place	65 dBA	Commercial
Hay Market (Parker Street)	65 dBA	Library
Chalmers Street	60 dBA	Residential
	65 dBA	Commercial
Surry Hills	37 dBA	Residential
	50 dBA	Passive Recreation
Kensington/ Moore Park	55 dBA	Active Recreation

Location of Substations	$L_{Aeq,15min}$ (All Times of Day)	Receiver
Royal Randwick Racecourse	44 dBA	Residential
Randwick Stop	48 dBA	Residential
High Street (Anzac Parade)	51 dBA	Residential
Kingsford	51 dBA	Residential

Note: Limits can only be modified with the approval of the Director-General following a detailed noise assessment during the detailed design phase.

7.5 Groundborne Noise Limits

Groundborne noise from rail traffic shall not exceed the following criteria as measured at the nearest residential receptors (Internally):

- L_{ASmax} 40 dB(A) between the hours of 6.00pm and 10.00pm; and
- L_{ASmax} 35 dB(A) between the hours of 10.00pm and 7.00am.

7.6 LRV Operational Noise Limits

For the LRV running at speeds up to 60km/hr under all operating conditions, with all systems operating and the doors closed, the LpAeq,Tp noise level during a passby measured at a point 7.5 metres from the centreline of the track and 1.2 above rail level shall be no greater than 78 dBA.

7.7 Operational Noise Monitoring

Monitoring of operational noise shall be undertaken in accordance with the Operational Noise Management Sub Plan. The Proponent shall, to the satisfaction of the Director-General and in consultation with the EPA, assess the adequacy of the rail, traffic and stationary noise mitigation measures after one (1) year from opening of the Project and having regard to the criteria specified in the Operational Noise Management Sub Plan. Should assessment indicate a clear trend that rail, traffic and stationary noise in levels exceed the Operational Noise Management Sub Plan defined noise design goals prepared in accordance with the relevant guidelines, the Proponent shall implement further reasonable and feasible mitigation measures in consultation with affected landowners and/or occupiers.

7.8 Post-Vibration Monitoring

Prior to Operation of the Project the Proponent shall prepare and implement a detailed Vibration Management Plan in consultation with EPA and Health Infrastructure and UNSW, to the satisfaction of the Director-General. The Plan shall identify how post-operational vibration levels shall be maintained throughout the life of the project.

APPENDIX A

INITIAL ADEQUACY REVIEW AND GAP ANALYSIS OF EIS NOISE AND VIBRATION IMPACT ASSESSMENT

WILKINSON MURRAY

21 February 2014

WM Project Number: 14055
Our Ref: 14055Ltr140214JW

Ingrid Ilias
Department of Planning and Infrastructure
Bridge Street
SYDNEY NSW 2000

Dear Ingrid

Re: Noise/Vibration Assessment - CBD and South East Light Rail Project - Independent Review

Wilkinson Murray Pty Ltd has been commissioned to conduct an independent review of the CBD and South East Light Rail Project Environmental Impact Assessment (the project), particularly the Technical Paper 11: Noise and Vibration Assessment (the report), prepared by SLR Consulting Australia Pty Ltd (the consultant).

This letter presents an initial adequacy review of the report. It identifies noted gaps in the assessment and recommends additional information required for the final review.

The review focussed on operational and construction noise and vibration; and was conducted with reference to the following NSW Government Guidelines:

- Industrial Noise Policy (INP);
- Interim Construction Noise Guidelines (ICNG);
- Assessing vibration: a technical guideline (AVTG);
- Rail Infrastructure Noise Guideline (RING); and,
- Road Noise Policy (RNP).

Wilkinson Murray has reviewed the project EIS and Technical Paper inclusively, however the reporting is focused only on the points of concern. Following is a summary of each area of concern and subsequent recommendations. If issues are not identified below, Wilkinson Murray considers that the issue has been appropriately dealt with in the project documents and/or could be managed through appropriate conditions of approval.

OPERATIONAL NOISE

For this early planning stage of the project the report it is quite thorough, although some aspects are open ended; i.e. there are identified potential impacts that the consultant (or proponent) believe can be resolved, but details of the actual mitigation measures have generally been deferred until the detailed design phase.

For this review it is assumed that all the assumptions in the report about Light Rail Vehicle (LRV) type, numbers, speeds, frequency, identification of receivers and distances etc are correct.

On the basis, in terms of light rail operational noise, the report concludes that there are some exceedances of the airborne light rail noise triggers predicted, particularly in Surry Hills, Kensington and Randwick. The report appears to suggest that apart from on Devonshire Street, Surry Hills, these exceedances are in areas with higher road traffic noise and therefore it is unlikely there would be a noise impact.

Page 51 of the report states *"While not a mitigation measure, acceptance of higher rail noise levels is a reasonable option in locations where existing noise levels from other sources (for example road traffic noise) are higher than the predicted rail noise impacts, and are accepted as being unlikely to decrease in future. In this situation, the provision of rail noise mitigation is unlikely to provide an appreciable benefit."*

Page 52 of the report states *"Acceptance of the exceedances of the noise trigger levels of 2 dB or less at locations where road traffic noise dominates and is unlikely to decrease is recommended."*

Query/ **Recommendation:** An exceedance of the noise trigger levels by 2 dB or less at locations where traffic noise dominates may be intuitively appropriate; however the consultant should provide additional technical justification. The information should include, but not be limited to, actual background noise (L_{A90}) measurements in the areas affected (eg Kensington and Randwick), show the emergence of the LRV over the background level (L_{A90}) rather than a comparison of L_{Aeq} levels, the frequency of LRV events, the frequency of traffic passby events (particularly buses), consideration that the LRV is a new noise source, dose response relationships, cumulative noise levels, etc.

The rail noise modelling in the report was conducted by using SoundPLAN V7.1 noise propagation software using the Nordic Rail Traffic Noise Prediction Method. Specific corrections have been included in the model for speed, surface discontinuities, bridge noise, curving and flanging (Section 5.4 of the report).

Query/ **Recommendation:** A number of models are available for predicting airborne noise levels at receptors as a result of railway operations. They include the Nordic Rail Prediction Method, Schall 03 (German), OAL30 (Austrian) and Calculation of Railway Traffic Noise (CoRN – United Kingdom). All models can calculate the L_{Aeq} level. The Nordic model calculates L_{Amax} in addition to L_{Aeq} and may be advantageous to use for this project. However, as this is a unique use of the Nordic model to predict light rail noise in an urban environment it is recommended that the model is validated for this project. This could be done, for example, by modelling some parts of the existing Sydney light rail network in an urban environment and comparing the results with measured noise levels.

Page 33 of the report presents the source noise levels for the LRV, referenced at 7.5 m from the track centreline and 1.2 m above ground, adopted for this assessment. The source levels are:

- L_{Amax} 82 dBA (45 m in length, travelling at 60 km/h)
- L_{AE} 83 dBA (45 m in length, travelling at 60 km/h)

It is stated that the LRV source noise emissions for the proposal where determined by SLR from a review of measured LRV noise levels from yearly compliance measurements of the existing Sydney light rail system between 2004 and 2013, as well as a review of data available from light rail systems in Europe as reported by the SILENCE Project.

Query/ Recommendation: Please provide reference material, namely:

- *http://www.silence&ip.org/site/index.php?id=197; and*
- Compliance measurements of the existing Sydney light rail system between 2004 and 2013

Additionally provide all assumptions which were used in the calculation of the L_{AE} and L_{Amax} 95% levels from the reference levels, for example LRV passby duration, etc.

Query/ Recommendation: The Operational Vibration assessment in section 6.3 has included a 5 dB safety factor for the purpose of determining frequency-dependent vibration impacts, to account for potential differences in the spectrum measured on the existing Sydney Light Rail and the CSELR (with different trackform and rolling stock). Should a safety factor be included in the operational noise predictions to ensure that noise predictions are not exceeded or are the current noise predictions essentially conservative?

The report states on page 51 that it may be reasonable and feasible mitigation strategy to specify *"more stringent noise levels during the procurement process. The modelled levels are based on a combination of measurements of the existing light rail system and understanding of best practice in Europe, but it may be possible to target lower levels, possibly by up to 2 dB particularly in L_{Amax}. However, the L_{Amax} criterion is a 95th percentile criterion, meaning 19 out of 20 LRV passbys are required to be quieter than the criterion in any case. This approach would introduce a risk that the rolling stock options available may be restricted, or that some aspects of the rolling stock may need to be customised, possibly increasing cost or requiring compromise in other areas of performance. This approach would only be recommended following consultation with rolling stock providers to establish whether more stringent noise specifications could feasibly be achieved."*

Query/ Recommendation: Having the lowest possible Light Rail Vehicle specification would be sensible to mitigate any possible noise impacts from the operation of the Light Rail. Please provide any consultation with rolling stock providers on possible low noise specifications.

The report in Section 5.4.4 (Table 10 and 11) presents typical LRV Service frequencies in minutes and numbers on which the operational noise predictions are based for 2021 (at opening) and 2036 (future). Section 5.5.6 presents Service frequencies in minutes and numbers for special events for the Moore Park and Surry Hills area. The EIS states in Section 5.4.2 that the proposals design capacity would allow for a service frequency with two minute intervals between LRVs when required.

Query/ Recommendation: Table 10 of the report is inconsistent with Table 5.5 of the EIS main body (Volume 1A). Are the minimum intervals for the LRV in 2036 2.7 or 2.5 minutes? Does this have any consequence with the noise predictions?

A service interval of 2 minutes would allow an increase in frequency of LRVs. Will the network ever work at the design capacity? Should noise predictions be conducted under this design capacity scenario?

PA SYSTEMS AND WARNING BELLS

The report presents a detailed assessment of PA systems for stops and warning bells. It is stated in the report that noise from LRV warning bells would not be expected to result in any significant impacts given that they would only be required in emergency situations or where the driver considers there to be a danger to public safety. Additionally for PA systems the report states at stops the proposed PA systems are only to be used for verbal emergency announcements and to augment the functionality of the Passenger Information Display systems (i.e. in the event of significant delays or disruptions).

Query/ Recommendation: PA systems and warning bells are a constant source of community complaint. Please confirm that warning bells would not be routinely used upon entry to stops by drivers, unless of course there is an emergency situation?

Overseas experience would suggest that light rail systems typically do not have PA systems on road stops and rely on information display systems. Please justify the use of PA systems for the proposed project?

ROAD TRAFFIC NOISE IMPACTS

Operational traffic noise for the project is assessed in Section 11 of the report. The report considers the resulting changes in noise as a result of the project. The assessment indicates that 104 road sections would have a noticeable change in road traffic noise with twenty locations where there is the potential increase in road traffic noise levels greater than 2 dB in either the morning of afternoon peak. Six locations are identified in the CBD where there would be noticeable decreases in traffic noise, primarily George Street.

The report states *"In the absence of any practicable mitigation measures, acceptance of the identified potential road traffic noise impacts is proposed".*

Query/ Recommendation: It is understood that potential traffic noise impacts as part of the project are difficult to manage and potentially there is little opportunity to mitigate the traffic noise levels. Based on review of the reported changes in road traffic noise levels, road traffic noise impacts appear to be quite significant, however they are in streets predominately commercial.

To understand the potential traffic noise impacts more closely, it is recommended that the existing noise levels in the road sections where increases in traffic noise have been identified to be greater than 2 dB be estimated and a survey of residential dwellings in those streets be conducted.

STABLING AND MAINTENANCE FACILITYIES

The stabling yard proposed on the corner of Doncaster Avenue and Alison Road presents the highest risk with regard to noise impacts from this proposal. The stabling yard would be a 24-hour operation with all sorts of activities at night time. There is no commentary in the Technical paper regarding the reasoning behind the proposed layout to determine that it has been optimised in respect of noise.

The Report states that without noise mitigation between 75 and 78 properties exceed the night time noise criteria. With a 6 m noise barrier between 21 and 33 properties exceed the night time noise criteria and with an acoustic shed this reduces to less than 5 properties exceeding the night time noise criteria. As such, the report has identified noise as a significant concern and raised the issue of barriers / partial roofs or a complete shed, without including any plans or elevations showing the extent of these building areas. The report correctly raises visual and overshadowing and cost as possible reasons not to build a large shed.

The report concludes *"During the detailed design stage, it is anticipated that alternative noise mitigation options to a full enclosure would be investigated for feasibility before determining the final solution to meet the INP noise criteria"*.

From the current information provided a complete shed for the site would appear to be the most reliable solution. As a minimum an enclosed shed area would be necessary where the LRVs are tested.

Additional issues associated with the assessment of stabling yard noise assessment are as follows:

- The background measurement location at rear of 24 Doncaster Avenue is possibly too close to Alison Road. The background noise level Ascot Street may be lower. Suggest a need to be further south. Need attended measurements at night to characterise sources of noise (only daytime conducted).

- Given the main source of noise is indicated as the air-conditioning and power converter units on top of LRVs, it is surprising that the highest noise levels are at ground floor (Table 33). It is not clear where the calculation locations are i.e. Ground floor (within rear garden); first and second floor (at the façade). It is assumed the assessment ignores any garden fences, though this is not clear. Further it is not clear why the the maximum levels vary so much between the receiver heights.

- The report states noise from cleaning is minor but is not described in more detail. Have voices from cleaners been considered? Will doors be open when vacuum cleaners are being used? Which way do the doors face? If the LRV has the a/c on for cleaning is this intermittent noise? i.e. a 5dB penalty may need to be applied at night time.

- Roof top mechanical plant (if there is any) from the facilities building needs to be included. Its source level needs to be set well below the criteria to allow enough headroom for the other operations on site.

- Whilst the report talks about increased risk of rail noise on tight radius curves very close to residences, these have been introduced into the stabling yard with regular night time use.

Query/ Recommendation: The report confirms that noise is a significant concern with this site and raised the issue of barriers / partial roofs or a complete shed, without including any plans or elevations showing the extent of these building areas. With the extent of the impacts and non-compliance of the night time noise criteria presented in the report it is recommended that the noise assessment be revised in detail to show how noise will be mitigated/managed and achieve INP criteria. The assessment needs to address the issues highlighted above, present plans, cross sections and elevations showing the extent of mitigation, show noise contour or façade plots to indicate where the noise impacts are for each scenario, exact source locations for each scenario, etc.

Query/ Recommendation: Please review Table 36 in the Report which presents predicted noise levels from the Rozelle Maintenance Facility. Given the location of the noise sources, it is surprising that the highest noise levels are on the ground floor. It is unclear where the receiver locations are. The assessment needs to present noise contour or façade plots or a plan showing receiver locations to indicate where the noise impacts are for each noise scenario.

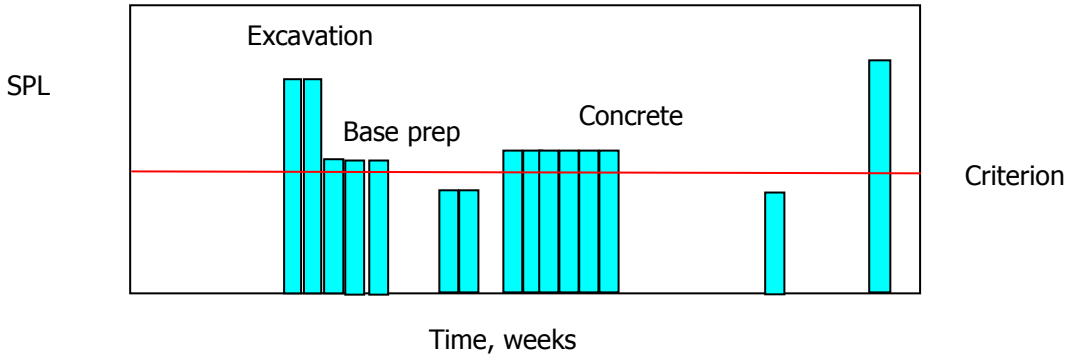
CONSTRUCTION NOISE

It is evident from the construction noise assessment in the report that there are significant noise impacts as a result of the light rail construction works. As the light rail tracks would be constructed through busy urban areas, works have the potential to disrupt traffic at many intersections throughout the proposal area. To minimise disruption, it is likely that works will be required outside of standard construction hours. The approach taken in the assessment has been to identify noise impacts of representative construction activities and their likely individual duration. However, as the project is inherently linear in nature at most locations, the duration of the noisiest activities would be relatively short.

Query/ Recommendation: It is unclear the level and duration of the noise impact at locations along the construction of the light rail system. To understand the construction noise impacts along the construction of the track it is requested that a noise profile be constructed for a typical (worst) receiver (day, evening and night) and show in graphical terms the duration of construction in each of the areas, namely:

- City Centre Precinct ;
- Surry Hills Precinct;
- Moore Park Precinct;
- Kensington / Kingsford Precinct;
- Randwick Precinct;
- Randwick stabling yard; and
- Rozelle maintenance facility.

The profile should be similar to: eg xx Devonshire Street (Day) (typically x metres from the Receiver)



CONCLUSION

A review of the CBD and South East Light Rail Project Environmental Impact Assessment was conducted by Wilkinson Murray. The general methodology for the noise and vibration assessment was appropriate. However, some gaps in the assessment have been identified and recommendations for additional information have been presented above.

If you have any question or require clarification please do not hesitate to contact me.

Yours faithfully
WILKINSON MURRAY

John Wassermann
Director

APPENDIX B

RESPONSES TO INITIAL ADEQUACY REVIEW AND GAP ANALYSIS RE: EIS NOISE AND VIBRATION IMPACT ASSESSMENT

MEMORANDUM

610.12515 Response to Planning 20140325.docx

Tim.Green@transport.nsw.gov.au	Tim Green Transport for NSW	DATE: NO OF PAGES: TO BE MAILED:	25 March 2014 23 No

Dear Tim

CBD and South East Light Rail Project
Independent Review of Noise/Vibration Assessment
Response to Issues Raised

Wilkinson Murray Pty Ltd has reviewed the CBD and South East Light Rail Project Environmental Impact Assessment, in particular the Noise and Vibration Technical Paper, at the request of the NSW Government Planning and Infrastructure Agency (Planning & Infrastructure). Their letter Ref 14055Ltr140214JW dated 21 February 2014 raises a number of issues and requests for clarification. The issues and responses are summarised below.

1 Operational Noise

> ***Query/* Recommendation:** An exceedance of the noise trigger levels by 2 dB or less at locations where traffic noise dominates may be intuitively appropriate; however the consultant should provide additional technical justification. The information should include, but not be limited to, actual background noise (L_{A90}) measurements in the areas affected (eg Kensington and Randwick), show the emergence of the LRV over the background level (L_{A90}) rather than a comparison of L_{Aeq} levels, the frequency of LRV events, the frequency of traffic passby events (particularly buses), consideration that the LRV is a new noise source, dose response relationships, cumulative noise levels, etc.

This response focuses on the night-time noise impacts, in recognition that the light rail noise goals for the night-time period control the noise mitigation requirements.

Additional night-time attended measurements and road traffic observations have been undertaken throughout the proposal area at representative locations in each Precinct. These measurements were undertaken mid-week, during the period from 10:00 pm to 12:00 am, and repeated in the early morning period from 5:00 am to 7:00 am. Measurements were undertaken on the public footpath at each location with the distance to the centre of the nearest traffic lane and to the nearest facade shown in in **Table 1**. In the discussion that follows, it is assumed that the footpath levels are approximately equivalent to facade levels.

The aim of these measurements and observations was to characterise the existing road traffic during the expected times of night-time operation of the CSELR. The measured L_{Amax} noise levels for different road vehicles are summarised in **Table 1** along with the number of each type of vehicle observed in a 15 minute period, and the background and ambient noise levels (L_{A90} and L_{Aeq}).

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During these times, the anticipated service frequency under normal operations (excluding special events) is one LRV every 10 minutes (each way) in the CBD, Surry Hills and Moore Park Precincts, and one LRV each way every 20 minutes in the Kensington/Kingsford and Randwick Precincts.

Table 1 15 Minute Attended Measurements – Existing Traffic Noise

Location	Date	Start Time	Overall Noise Levels (dBA)		Events		Noise Levels (dBA)
			L_{Aeq}	L_{A90}	Type	No.	L_{Amax}
485 George St, Sydney 2 m from centre of nearest traffic lane 3 m from nearest facade	11/03/2014	21:59	74	65	Buses	10	75, 75, 75, 85, 79, 84, 84, 87, 79, 81
					Cars	139	$L_{Amax,50\%}$ 75, $L_{Amax,95\%}$ 81
					Trucks	1	81
					Motorbikes	2	81, 75
	12/03/2014	04:50	73	60	Buses	6	74, 84, 90, 84, 88, 89
					Cars	30	$L_{Amax,50\%}$ 74, $L_{Amax,95\%}$ 82
					Trucks	14	75, 83, 72, 76, 89, 86, 82, 78, 83, 77
					Motorbikes	2	77, 77
129 Devonshire St, Surry Hills 3 m from centre of nearest traffic lane 2 m from nearest facade	11/03/2014	23:56	61	46	Buses	0	n/a
					Cars	24	$L_{Amax,50\%}$ 71, $L_{Amax,95\%}$ 75
					Trucks	1	82
					Motorbikes	0	n/a
	12/03/2014	06:30	70	50	Buses	0	n/a
					Cars	37	$L_{Amax,50\%}$ 73, $L_{Amax,95\%}$ 77
					Trucks	4	80, 88, 69, 93
					Motorbikes	1	89
256 Devonshire St, Surry Hills 3 m from centre of nearest traffic lane 2 m from nearest facade	11/03/2014	23:34	66	48	Buses	0	n/a
					Cars	40	$L_{Amax,50\%}$ 72, $L_{Amax,95\%}$ 77
					Trucks	0	n/a
					Motorbikes	1	85
	12/03/2014	06:06	65	47	Buses	0	n/a
					Cars	26	$L_{Amax,50\%}$ 72, $L_{Amax,95\%}$ 77
					Trucks	4	80, 79, 78, 79, 78
					Motorbikes	1	78
Corner Devonshire St and Edgley St, Surry Hills 5 m from centre of nearest traffic lane 5.5 m from nearest facade	11/03/2014	23:08	55	43	Buses	0	n/a
					Cars	17	$L_{Amax,50\%}$ 65, $L_{Amax,95\%}$ 69
					Trucks	0	n/a
					Motorbikes	0	n/a
	12/03/2014	05:45	58	44	Buses	1	70
					Cars	7	$L_{Amax,50\%}$ 69, $L_{Amax,95\%}$ 75
					Trucks	1	76
					Motorbikes	1	75

Location	Date	Start Time	Overall Noise Levels (dBA)		Events		Noise Levels (dBA)
			L_{Aeq}	L_{A90}	Type	No.	L_{Amax}
625 South Dowling St, Surry Hills 4 m from centre of nearest traffic lane 5 m from nearest facade	11/03/2014	22:43	70	56	Buses	0	n/a
					Cars	239	$L_{Amax,50\%}$ 73, $L_{Amax,95\%}$ 79
					Trucks	3	85, 84, 76
					Motorbikes	0	n/a
	12/03/2014	05:22	71	60	Buses	0	n/a
					Cars	168	$L_{Amax,50\%}$ 78, $L_{Amax,95\%}$ 81
					Trucks	5	74, 78, 70, 87, 85
					Motorbikes	5	75, 82, 80, 85, 85
58 Martin Rd, Centennial Park 21 m from centre of nearest bus lane 3 m from nearest facade	11/03/2014	22:20	56	50	Buses	12	54, 66, 61, 65, 54, 58, 59, 63, 60, 56, 58, 58
					Cars	18	$L_{Amax,50\%}$ 57, $L_{Amax,95\%}$ 60
					Trucks	2	58, 60
					Motorbikes	3	68, 62, 59
	12/03/2014	05:00	54	47	Buses	4	64, 54
					Cars	40	$L_{Amax,50\%}$ 53, $L_{Amax,95\%}$ 62
					Trucks	17	53, 63, 58, 56, 58, 52, 50
					Motorbikes	0	n/a
19 Wansey Rd, Randwick 3 m from centre of nearest traffic lane 3 m from nearest facade	11/03/2014	23:58	49	40	Buses	1	42 (distant road)
					Cars	2	$L_{Amax,50\%}$ 72, $L_{Amax,95\%}$ 73
					Trucks	1	53, 51 (distant road)
					Motorbikes	3	57, 50, 54 (distant road)
	12/03/2014	06:32	63	47	Buses	0	n/a
					Cars	39	$L_{Amax,50\%}$ 71, $L_{Amax,95\%}$ 75
					Trucks	1	73
					Motorbikes	1	76
56 High St, Randwick 2 m from centre of nearest traffic lane 4 m from nearest facade	12/03/2014	22:10	59	42	Buses	1	60
					Cars	33	$L_{Amax,50\%}$ 65, $L_{Amax,95\%}$ 73
					Trucks	1	79
					Motorbikes	2	75, 74
	12/03/2014	06:59	66	50	Buses	7	69, 83, 69, 72, 73, 78, 74
					Cars	26	$L_{Amax,50\%}$ 68, $L_{Amax,95\%}$ 72
					Trucks	4	68, 75, 80, 76
					Motorbikes	0	n/a
6 Anzac Parade, Kensington 2 m from centre of nearest traffic lane 4 m from nearest facade	11/03/2014	22:47	66	51	Buses	6	71, 85, 78, 65, 82, 82
					Cars	60	$L_{Amax,50\%}$ 70, $L_{Amax,95\%}$ 75
					Trucks	1	66
					Motorbikes	2	78, 73
	12/03/2014	05:23	63	49	Buses	3	65, 68, 83
					Cars	56	$L_{Amax,50\%}$ 67, $L_{Amax,95\%}$ 73
					Trucks	3	72, 68, 72
					Motorbikes	1	77

Location	Date	Start Time	Overall Noise Levels (dBA)		Events		Noise Levels (dBA)
			L_{Aeq}	L_{A90}	Type	No.	L_{Amax}
244 Anzac Pde, Kensington 5 m from centre of nearest traffic lane 5 m from nearest facade	11/03/2014	23:09	68	52	Buses	2	76, 91
					Cars	55	$L_{Amax,50\%}$ 69, $L_{Amax,95\%}$ 75
					Trucks	2	79, 75
					Motorbikes	2	69, 62
	12/03/2014	05:44	70	54	Buses	7	82, 84, 78, 78, 89, 69, 70
					Cars	56	$L_{Amax,50\%}$ 73, $L_{Amax,95\%}$ 79
					Trucks	7	78, 71, 71, 84, 78, 79
					Motorbikes	3	80, 85, 78
301-303 Anzac Pde, Kingsford 4 m from centre of nearest traffic lane 7 m from nearest facade	11/03/2014	23:33	64	52	Buses	5	72, 78, 75, 67
					Cars	43	$L_{Amax,50\%}$ 67, $L_{Amax,95\%}$ 73
					Trucks	2	77, 69
					Motorbikes	1	71
	12/03/2014	06:06	70	58	Buses	8	80, 68, 85, 80, 76, 77, 81, 70
					Cars	70	$L_{Amax,50\%}$ 71, $L_{Amax,95\%}$ 76
					Trucks	6	76, 72, 75, 73, 78, 68
					Motorbikes	5	71, 78, 72, 81

The impact of introducing light rail in each area is discussed in **Table 2**.

Table 2 Light Rail Impacts vs the Observed Existing Traffic Environment (Night-time)

Precinct	Proposed Light Rail Night-time Passbys per Hour[1]	Existing Hourly Number of Events L_{Amax} > 80dBA[2]	Discussion
City Centre	12 (10 minutes each way)	34 (excluding cars)	The number of observed traffic events above the light rail $L_{Amax,95\%}$ goal of 80 dBA is almost three times greater than the proposed number of light rail events. The $L_{Amax,95\%}$ level due to cars was also above 80 dBA at the measurement location. The existing background noise level is 10-15 dB above the light rail L_{Aeq} noise goal. Existing L_{Aeq} noise levels up to 24 dB above the light rail noise goals were observed during the night-time period. For this reason, mitigation of light rail noise impacts would have minimal impact on the overall noise environment. Acceptance of light rail noise impacts above the RING trigger levels for L_{Amax} or L_{Aeq} in the CBD Precinct would be considered reasonable in light of the existing high road traffic noise impacts.
Surry Hills	12 (10 minutes each way)	0-8 (Devonshire Street) 14 (South Dowling Street)	The introduction of the light rail to Devonshire Street will introduce a new noise source to an area that experiences low existing road traffic noise. Existing background noise levels are also generally below the light rail L_{Aeq} noise goals. Locations fronting South Dowling Street experience more existing traffic noise than other residential areas in the Surry Hills Precinct. Consideration of reasonable and feasible mitigation of light rail noise is required at all locations where the RING trigger levels are exceeded.

Precinct	Proposed Light Rail Night-time Passbys per Hour[1]	Existing Hourly Number of Events L_{Amax} > 80dBA[2]	Discussion
Moore Park	12 (10 minutes each way)	0	While a high number of heavy vehicles were observed on Anzac Parade, the set back to the residences in this area means the existing maximum noise levels due to road traffic are well below 80 dBA. Existing background noise levels are generally below the light rail L_{Aeq} noise goals, while existing L_{Aeq} levels are around 5 dB above the light rail L_{Aeq} trigger level. Consideration of reasonable and feasible mitigation of light rail noise is required at all locations where the RING trigger levels are exceeded.
Randwick	6 (20 minutes each way)	0 (Wansey Road) 2 (High Street)	The number of heavy vehicles observed on High Street was 26 per hour across the measurement periods. One bus was observed to generate noise above the light rail $L_{Amax,95\%}$ goal with a level of 83 dBA. The bus timetable indicates that 3-4 buses per hour are scheduled along High Street during the period 10:00 pm to midnight, and around 12 buses per hour are scheduled between 5:00 am and 7:00 am (both directions combined). Some of these bus services (but probably not all) would be replaced by light rail services. The maximum noise levels from buses on High Street are expected to be similar to maximum noise levels from light rail. The number of light rail services relative to existing bus numbers is unlikely to result in an increase in the number of high noise night-time events along High Street. While the background noise level on High Street was observed to be as low as 42 dBA, the existing L_{Aeq} noise levels are around 9 dB higher than the light rail L_{Aeq} noise goals. Acceptance of light rail noise impacts 2 dB to 3 dB above the RING trigger levels for L_{Amax} or L_{Aeq} along High Street in Randwick is considered reasonable in light of the existing road traffic L_{Aeq} and L_{Amax} noise impacts. Along Wansey Road, there is a low incidence of existing road traffic and consideration of reasonable and feasible mitigation of light rail noise is required at all locations where the RING trigger levels are exceeded.
Kensington / Kingsford	6 (20 minutes each way)	6-12	The number of observed traffic events above the light rail $L_{Amax,95\%}$ goal is up to two times greater than the proposed number of light rail events. The number of bus passbys observed was 18-26 per hour. Maximum noise levels up to 91 dBA due to buses were observed at 244 Anzac Parade, which is one of the closest locations to the both the road and the light rail alignment (identified with a marginal exceedance of the light rail noise goals in the EIS). At this location, existing L_{Aeq} noise levels up to 20 dB above the light rail noise goals were observed during the night-time period. Acceptance of light rail noise impacts above the RING trigger levels for L_{Amax} or L_{Aeq} along Anzac Parade in Kensington and Kingsford is considered reasonable in light of the existing high road traffic noise impacts.

Note 1: Based on EIS night-time service frequency, including both directions.

Note 2: The number of road traffic passby events observed in the two 15 minute measurements with maximum levels above the Light Rail 95th percentile LAmax goal, scaled to estimate the hourly number of events.

The following points summarise the conclusions from the additional night-time attended noise measurements in each precinct:

- In the City Centre, the existing road traffic noise environment gives rise to many more high noise events during the night-time than would be introduced by the light rail. Acceptance of light rail noise impacts above the RING trigger levels for L_{Amax} or L_{Aeq} in the CBD Precinct would be considered reasonable in light of the existing high L_{Amax} and L_{Aeq} road traffic noise impacts, as mitigating light rail noise would not reduce the overall future road traffic noise levels.
- In Surry Hills, Devonshire Street has low numbers of heavy vehicles during the night-time. Consideration of reasonable and feasible mitigation of light rail noise is required at all locations where the RING trigger levels are exceeded.
- In Moore Park, the nearest residences are set back from the bus lanes and Anzac Parade, and existing maximum noise levels due to traffic are below the RING noise goals. Consideration of reasonable and feasible mitigation of light rail noise would be required at any locations where the RING trigger levels are exceeded, noting that no exceedances are anticipated at this location.
- In Randwick, the maximum noise levels from buses on High Street are expected to be similar to maximum noise levels from light rail. While the existing background noise level on High Street is low, the existing L_{Aeq} noise levels are around 9 dB higher than the light rail L_{Aeq} noise goals. The number of light rail services relative to existing bus numbers is unlikely to result in an increase in the number of higher night-time noise events along High Street. Acceptance of the predicted light rail noise impacts of 2 dB to 3 dB above the RING trigger levels along High Street in Randwick is considered reasonable in light of the existing road traffic noise impacts.

  Along Wansey Road, there is a low incidence of existing road traffic noise and consideration of mitigation of light rail noise would be required at any locations where the RING trigger levels are exceeded, noting that no exceedances are anticipated at this location.
- In Kensington and Kingsford acceptance of light rail noise impacts above the RING trigger levels along Anzac Parade is considered reasonable in light of the existing high road traffic noise impacts, as mitigating light rail noise would not reduce the overall future road traffic noise levels.

2 Treatment of Residual Operational Noise Impacts

It is noted that the detailed design of the project will need to balance airborne noise impacts with ground-borne noise and vibration impacts. In general, track designs that minimise ground-borne noise and vibration result in higher airborne noise levels, while track designs that minimise airborne noise levels can give rise to higher vibration and ground-borne noise levels. The RING specifies external noise goals, as well as internal ground-borne noise goals. The internal ground-borne noise goals are relevant only where they are higher than the airborne noise. This means that ground-borne noise levels above the RING goals are considered acceptable if the airborne noise masks the ground-borne noise.

At locations where the route is in close proximity to residential facades, balancing the ground-borne and airborne noise impacts may require acceptance of external noise levels above the RING goals and above the EIS airborne noise predictions in order to facilitate the minimisation of internal ground-borne noise.

Where the light rail trigger levels are exceeded, RING requires an assessment of feasible and reasonable mitigation measures that would be required to reduce noise levels down to the trigger levels. If it is reasonable to achieve these levels, the proponents should do so. In this case, mitigation options include optimisation of the route alignment, specification of low noise LRVs, absorptive track treatments, speed limits in residential streets, etc. Barriers are not feasible in most areas.

Where the trigger levels can't be met using feasible and reasonable mitigation measures (as is the case in some areas of the project), then the noise assessment should provide justification as to why they cannot be met and project-specific noise levels should be identified. An assessment of the acceptability of residual impacts should also be provided in the event of noise impacts above the RING trigger levels after source mitigation.

At the meeting between TfNSW, SLR Consulting, Wilkinson Murray and Planning & Infrastructure on 5 March 2014 the possibility of defining a Condition of Approval to clarifying the approach to be taken to residual impacts was discussed. The objective of this Condition would be to protect residential amenity in existing quiet areas. The following points are made with regard to the acceptability of residual impacts.

2.1 Acceptability of Residual Impacts

It is noted that the RING night-time L_{Aeq} noise trigger levels are relatively stringent. According the RING (Appendix 5 Figure 2), an external $L_{Aeq(9hour)}$ level of 50 dBA would correspond to less than 5% of people being highly annoyed, while a level of 55 dBA would correspond to less than 10% of people being highly annoyed.

The impact would also depend on the existing noise environment. An increase in overall road traffic noise of 2 dB is described in the NSW Road Noise Policy as being an appropriate limit on the increase in total traffic noise due to a development. This provides some justification for applying a 2 dB increase limit to overall traffic noise (road plus light rail).

Further justification for an approach including both a light rail overall noise level of 55 dBA and an increase in total noise exposure can be found in the US Federal Transit Administration guideline *Transit Noise and Vibration Impact Assessment* (FTA-WA-90-1003-06, May 2006). The FTA guideline provides information on transit noise impacts in relation to existing noise exposure. It discusses impacts in terms of the L_{DN} parameter – in the following discussion, this is replaced with the equivalent night-time $L_{Aeq(9hour)}$ value, being the L_{DN} minus 10 dB.

It is noted that the FTA existing noise exposure includes both noise from roads and transit sources, and also ambient noise (for example due to population density). In the FTA Guideline, the following points are made:

- A change in noise level from an existing external night-time ambient $L_{Aeq(9hour)}$ of 40 dBA to 45 dBA is a minimal impact. It takes a 5 dB increase in noise to cause a 2% increase in highly annoyed people if the existing noise level is 40 dBA.
- A change in noise level from an existing external night-time ambient $L_{Aeq(9hour)}$ of 50 dBA to a cumulative level of 55 dBA with a project represents a change from an acceptable noise environment to the threshold of an unacceptable noise environment.
- A moderate impact on residences is considered to occur when the transit noise level in isolation equals or exceeds 55 dBA $L_{Aeq(9hour)}$. A severe impact is considered to occur whenever the transit noise level equals or exceeds 65 dBA $L_{Aeq(9hour)}$.

At the RING trigger levels, the CSELR would have a low to moderate impact in existing quiet locations, but minimal impact in areas with existing higher ambient noise levels. At 5 dB above the RING trigger levels, the impact in existing quiet areas (for example Devonshire Street or Wansey Road) would be on the threshold of an unacceptable residual impact. In areas with some existing traffic noise such as High Street, a light rail noise level of 55 dBA $L_{Aeq(9hour)}$ would represent a moderate impact. The impact of this level in high noise areas such as the CBD and Anzac Parade would remain low.

Figure 1 has been reproduced from the FTA Guideline, with the indicative impacts at key locations along the CSELR alignment. It indicates that in existing quiet areas such as Devonshire Street or Wansey Road, an increase in overall ambient noise levels of 2 dB to 3 dB would be acceptable. A 2 dB increase would also be acceptable in High Street, Randwick. In existing high-noise areas, the acceptable increase due to a transit project is almost zero. However, it is noted that in these areas the light rail noise would not be expected to contribute significantly to the overall $L_{Aeq(9hour)}$ noise levels.

Table 3 demonstrates which situations would result in residual impacts above an acceptable level in the event that light rail night-time noise levels exceed 55 dBA and the increase in total road traffic noise is 2 dB or more. In the event that source control measures cannot reduce the noise impact, residual impacts above this unacceptable level would require consideration of property treatments.

Figure 1 FTA Guideline Allowable Increase in Cumulative Noise Levels

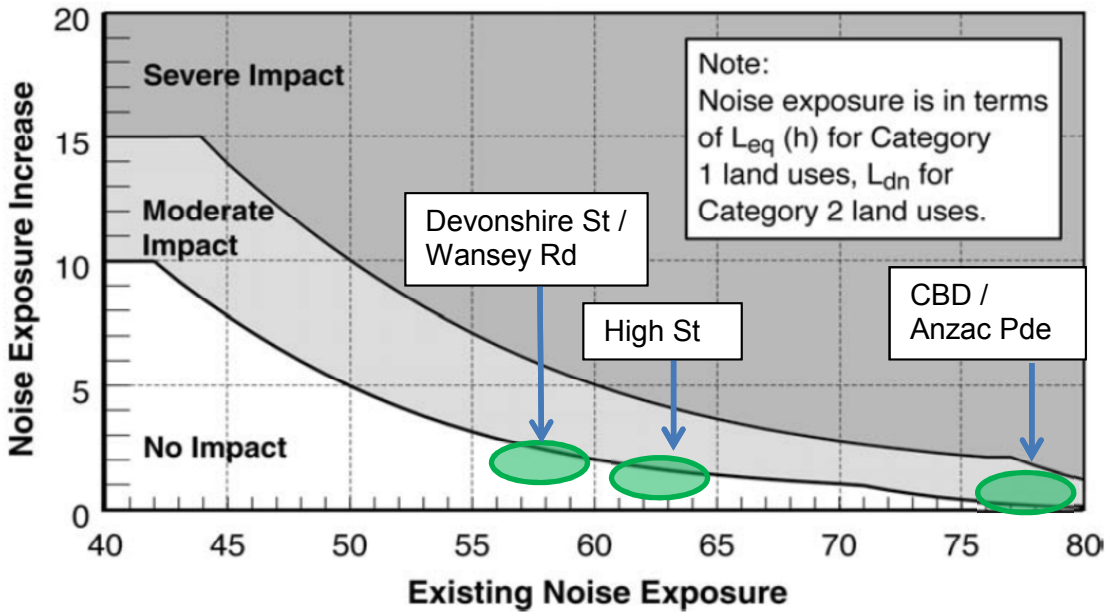


Figure 3-2. Increase in Cumulative Noise Levels Allowed by Criteria (Land Use Cat. 1 &2)

Note: FTA Guideline Figure 3-2 uses the L_{DN} parameter to describe existing noise exposure. This is approximately equivalent to LAeq(9hour) plus 10 dB.

Table 3 Example of When Property Treatments Would be Considered

Existing Road Traffic Noise LAeq(9hour) (dBA)	Light Rail Noise Level LAeq(9hour) (dBA)	Combined Overall LAeq(9hour) (dBA)	Increase in Total Road Traffic Noise (dB)
<45	**>55**	**56**	**>10.9**
45	**>55**	**56**	**10.9**
50	**>55**	**57**	**6.6**
55	**>55**	**58**	**3.3**
56	**>55**	**59**	**2.8**
57	**>55**	**59**	**2.3**
58	>55	60	1.9
59	>55	61	1.6
60	>55	61	1.3
>60	>55	62	<1.3

Note: Shaded bold values indicate situations that would require consideration of property treatments, with light rail LAeq(9hour) noise levels above 55 dBA and an increase in total road traffic noise of 2 dB or more

3 Noise Model Validation

***Query/* Recommendation:** A number of models are available for predicting airborne noise levels at receptors as a result of railway operations. They include the Nordic Rail Prediction Method, Schall 03 (German), OAL30 (Austrian) and Calculation of Railway Traffic Noise (CoRN – United Kingdom). All models can calculate the L_{Aeq} level. The Nordic model calculates L_{Amax} in addition to L_{Aeq} and may be advantageous to use for this project. However, as this is a unique use of the Nordic model to predict light rail noise in an urban environment it is recommended that the model is validated for this project. This could be done, for example, by modelling some parts of the existing Sydney light rail network in an urban environment and comparing the results with measured noise levels.

In response to this query, SLR Consulting have undertaken attended passby measurements of the existing Sydney Light Rail near Paddy's Markets, for the purpose of comparison of the results with modelled noise levels at the measurement location using the Nordic algorithm. Measurements were undertaken on 12 March 2014 in the early morning period to minimise noise from other sources.

A total of 13 passbys were captured. Audible track defects were observed throughout the embedded track section on both the Up and Down tracks between Darling Drive and Central. The influence of these defects on both tracks affected the measured noise levels and resulted in a clunking characteristic as the LRVs progressed along the tracks. The defects take the form of shallow depressions around 50 mm across. They appear to be remnants left after grinding (undertaken recently to remove more serious defects).

All measurements were taken in the free field at a distance of 7.5 m from the relevant track centre (different measurement locations were used for passbys on each track). Speeds were determined from the known 29 m length of the vehicle and the passby time. The measurement results are summarised in **Table 4.**

Table 4 Measured Noise Levels – Existing Light Rail at 7.5 m near Paddy's Market

Ref	Direction	Measurement Duration (s)	Passby Time (s)	Speed (km/h)	L_{AE} (dBA)	L_{Amax} (dBA)
0004.S3B	Dn	17	5.4	19	81	75
0006.S3B	Dn	18	5.2	19	81	75
0008.S3B	Dn	20	5.9	17	79	73
0011.S3B	Dn	13	5.4	19	80	76
0012.S3B	Dn	26	6.0	17	79	71
0015.S3B	Dn	14	5.6	18	80	74
0002.S3B	Up	10	-	-	79	76
0005.S3B	Up	16	6.2	16	78	71
0007.S3B	Up	14	4.8	21	79	75
0009.S3B	Up	14	5.2	19	81	77
0010.S3B	Up	23	5.1	20	80	77
0013.S3B	Up	16	5.9	17	77	73
0014.S3B	Up	13	5.8	17	79	76
					Average speed: 18 km/h	
					Logarithmic Average L_{AE}: 80 dBA	
					95th Percentile L_{Amax}: 77 dBA	

The presence of audible track defects means the measured noise levels cannot be directly compared with the EIS noise predictions. Notwithstanding, the measured situation has been replicated in SoundPLAN using the Nordic algorithm with input source levels adjusted to account for the measured noise levels. The comparison between modelled and measured levels is summarised in **Table 5**.

Table 5 Modelled vs Measured Noise Levels – Existing Light Rail at 7.5m near Paddy's Market

	LAeq(24hour) Assuming 100 passbys	**LAmax (dBA)**
Measurements at 7.5m	50 dBA	77
Modelled	52 dBA	76
Difference	+1.8 dB	-1.0 dB

The agreement between the measured and modelled levels is within +/- 2.0 dB for both L_{Aeq} and L_{Amax}. This variation is considered to be the usual range of modelling accuracy and is considered acceptable.

In the detailed design stage, the ONVR would be required (by the tender specifications) to provide evidence that the noise and vibration prediction model has been validated via measurement and prediction on other rail systems.

4 Noise Source Level Assumptions

Query/ Recommendation: Please provide reference material, namely:

- *http://www.silence&ip.org/site/index.php?id=197; and*
- Compliance measurements of the existing Sydney light rail system between 2004 and 2013

Additionally provide all assumptions which were used in the calculation of the L_{AE} and L_{Amax} 95% levels from the reference levels, for example LRV passby duration, etc.

The link to the SILENCE website should include a dash "-" in place of the ampersand "&":

http://www.silence-ip.org/site/index.php?id=197

See also http://www.silence-ip.org/site/index.php?id=201 for information specific to low noise rolling stock including links to recommendations for exterior noise limits (*VDV 154:2011 Noise from Mass Transit Rail Vehicles Acc. To Bostrab* (published by Verband Deutscher Verkehrsunternehmen, the association of German Transport Companies). These limits are reproduced in **Figure 2**.

Figure 2 Recommendations for Exterior Noise Limit Values

Recommendations for exterior noise limit values issued by VDV	
Standstill (1.2 m/ 3.5 m mic height)	60/63 dB
Passby (60 km/h)	79 dB
Starting	75 dB
Exterior microphone distance 7.5m; L_{pAeq} for all cases except "starting" (L_{pAmax})	

The recommendations shown in **Figure 2** do not specify maximum noise levels, but it is anticipated that on a well maintained system they would typically be only 1 dB to 2 dB above the L_{pAeq} noise level, and therefore assuming an L_{Amax} 95th percentile of 82 dBA (3 dB above the L_{Aeq}) is appropriate.

For a 45 m LRV, a passby L_{pAeq} noise limit of 79 dBA is equivalent to an L_{AE} of 83 dBA considering only the passby time itself. It is acknowledged that the time either side of the passby itself should also be included, but this was omitted in the EIS. The effect of the rise and fall on the L_{AE} depends on the track form (track decay rate) and would vary with different track forms and at different speeds. It is estimated that this could increase the source levels and hence noise predictions by 1 dB to 2 dB above the EIS predictions, depending on the speed and trackform. Further discussion of the sensitivity of the model predictions to this change in source level follows in **Section 5**.

Compliance measurements on the existing light rail have been taken at six locations between 2003 and 2013. The locations for compliance measurements include locations with crossovers, and locations near stops with passbys at relatively low speeds (with residential receivers in close proximity). One location, in Federal Park, has been measured with typical speeds near the reference speed of 60 km/h. Measurements were undertaken at a distance of 7.5 m from one track, with the results from the other track corrected for distance to correspond to the reference distance. The measured levels at this location are summarised in **Table 6**. It is noted that the maximum noise level observed in Federal Park often includes flanging noise due to the curve.

Table 6 Federal Park Compliance Measurements Corrected to 7.5 m and 60 km/h

Year	Number of Passbys	Logarithmic Average L_{AE} (dBA)	Average L_{Amax} (dBA)	Maximum L_{Amax} (dBA)
2003	11	82	76	83
2004	10	81	77	81
2005	10	78	76	79
2006	9	82	78	82
2007	9	82	79	85
2009	10	81	75	84
2010	10	81	78	83
2012	11	80	79	82
Overall	**80**	**81**	**83 (95th Percentile)**	

Note: Measurements from 2011 have been excluded due to high squeal levels (attributed to a lubrication system failure). Corrections for distance are based on a 20 log relationship for LAmax and a 10 log relationship for LAE. Corrections for speed are based on a 30 log relationship for LAmax and a 20 log relationship for LAE.

The above measurements on the existing system give a logarithmic average of 81 dBA for L_{AE} (with an LRV length of 29 m) and a 95th percentile L_{Amax} of 83 dBA (including flanging events). Extending the LRV length to 45 m would increase the L_{AE} to 83 dBA, which is the source level assumed in the EIS assessment.

5 Operational Noise Uncertainty Factor

Query/ Recommendation: The Operational Vibration assessment in section 6.3 has included a 5 dB safety factor for the purpose of determining frequency-dependent vibration impacts, to account for potential differences in the spectrum measured on the existing Sydney Light Rail and the CSELR (with different trackform and rolling stock). Should a safety factor be included in the operational noise predictions to ensure that noise predictions are not exceeded or are the current noise predictions essentially conservative?

It is recognised that there is uncertainty in the noise predictions in the absence of details of the track form and rolling stock, and the necessary assumptions around operating speeds. The current predictions are not considered to be conservative, unless LRV's travel at lower speeds than assumed. The predictions are considered to be representative of the noise emissions of a modern, well maintained system, with track form selected to minimise airborne operational noise levels.

The impact of operational source noise levels 2 dB and 5 dB above the assumed source levels has been tested in terms of the number of locations triggered for consideration of noise mitigation. The results are summarised in **Table 7** in terms of the Noise Catchment Areas (NCA's) defined in the EIS.

Table 7 RING Trigger Locations – Sensitivity to Increased Source Levels

Precinct	NCA	Residential Buildings Above RING Trigger Levels		
		EIS Source Levels	EIS +2 dBA	EIS +5 dBA
City Centre	NCA01.1	0	0	0
	NCA01.2	0	0	Two apartment buildings on George Street
	NCA01.3	One apartment building facing Chalmers Street	As in EIS	As in EIS
Surry Hills	NCA02.1	All residential buildings between Elizabeth Street and Crown Street	As in EIS, plus two additional residences: at the corner of Nickson Road and Devonshire Street, and on Bourke Street (north of Wimbo Park)	Effectively all residential properties immediately adjacent to the tracks, including properties with facades on Devonshire Street, houses on Nobbs Street and Parkham Street, and houses on Bourke Street either side of Wimbo Park
Moore Park	NCA03.1	0	0	0
Kensington / Kingsford	NCA04.1	One apartment building facing Anzac Parade, on corner of Abbotford Street	As in EIS, plus three additional apartment buildings fronting Anzac Parade	19 buildings fronting Anzac Parade, being a mix of apartment buildings and houses
	NCA04.2	Apartments above shops on Anzac Parade between Darling Street and Doncaster Avenue	As in EIS, plus four additional apartment buildings fronting Anzac Parade	23 buildings fronting Anzac Parade, being a mix of apartment buildings and houses
	NCA04.3	0	0	3 buildings fronting Anzac Parade
Randwick	NCA05.1	0	0	One building fronting Alison Road
	NCA05.2	0	0	0
	NCA05.3	0	Five buildings on Wansey Road	29 Buildings on Alison Road, Wansey Road and High Street
	NCA05.4	Two apartment buildings and one house on High Street.	19 buildings on High Street	23 buildings on High Street

As exceedances of the RING noise goals are controlled by the night-time L_{Aeq} levels, the increased impacts with increased source levels should be viewed in light of the existing night-time road traffic noise environment.

- In the City Centre, increasing the light rail source levels by up to 5 dB would not increase the impacts above the existing road traffic levels. No additional mitigation would be expected to be required.

- In Surry Hills, the close proximity of the residences on Devonshire Street means these properties are already triggered for consideration of mitigation. Addition of 2 dB to the source levels would trigger only two additional buildings. Addition of 5 dB to the source levels would extend the requirement to consider mitigation throughout the Surry Hills Precinct.
- In Moore Park, no properties would be triggered for consideration of mitigation even with a factor added to the noise source levels.
- In Kensington and Kingsford, while more properties would be triggered the light rail levels would remain well below the existing road traffic L_{Aeq} levels. No additional mitigation would be expected to be required.
- In Randwick, the addition of 2 dB to the source levels would trigger consideration of mitigation at 5 buildings on Wansey Road. However, it is noted that design changes in this area mean the light rail tracks are now proposed to be dropped to below road height, with a retaining wall having potential to shield the affected receivers. These changes have not been assessed in detail as they are expected to reduce the noise impacts. At this location, source and path control measures may be effective if required. Increasing the L_{Aeq} source levels along High Street would trigger a large number of properties for consideration of mitigation, however the light rail L_{Aeq} levels would remain below the existing traffic L_{Aeq} levels. Recognising that the number of high noise events is not likely to increase, with a reduction in bus services to be replaced by LRVs, mitigation of noise on High Street may not be considered reasonable.

6 Rolling Stock Noise Emissions

Query/ Recommendation: Having the lowest possible Light Rail Vehicle specification would be sensible to mitigate any possible noise impacts from the operation of the Light Rail. Please provide any consultation with rolling stock providers on possible low noise specifications.

The draft specifications for the light rail system include a requirement for the LRV noise emissions as follows:

> *"For an LRV running at speeds up to 60 km/h under all operating conditions, with all systems operating and the doors closed, the $L_{pAeq,Tp}$ noise level during a passby measured at a point 7.5m from the centreline of track and 1.2m above rail level must be no greater than 78 dBA."*

This target noise level is to be maintained throughout the life of the system. The target is considered to be representative of best practice noise emissions. Consultation with rolling stock providers will take place throughout the tender process.

7 LRV Service Frequency and Special Events

Query/ Recommendation: Table 10 of the report is inconsistent with Table 5.5 of the EIS main body (Volume 1A). Are the minimum intervals for the LRV in 2036 2.7 or 2.5 minutes? Does this have any consequence with the noise predictions?

A service interval of 2 minutes would allow an increase in frequency of LRVs. Will the network ever work at the design capacity? Should noise predictions be conducted under this design capacity scenario?

The service frequencies in Table 10 of the Noise Technical Paper are consistent with the hourly maximum number of services shown in Table 5.6 of the EIS Volume 1A. The 2.5 minute service frequency is considered in the Noise Technical Paper Section 5.5.6 for special events. Operating the special event frequency during the daytime gives rise to a relatively small increase in the noise predictions, but operating the special event frequency at night for one hour with 90 m LRVs increases the night-time L_{Aeq} predictions by 3 dB.

While it is noted that special events are expected to occur around once a week, special events requiring 90 m LRVs to clear crowds during the night-time period would be less frequent. Of the total special events, around one in ten would have crowds >30,000 and may require 90 m LRVs. Around one in four events would have crowds in the 20,000 to 30,000 range with the remainder of events having crowds less than 20,000. It is estimated that 90 m special event services would be required for approximately 20 events per year. RING suggests that the assessment should reflect the reasonable maximum use, or the 'worst-case' typical day rather than average use. At this stage in the project, it is not known how many of these events would require special event services after 10:00 pm. Final operating service frequencies and hours of operation would be confirmed during detailed design once the PPP contractor is engaged.

In the event that the frequency of regular services is increased in future, the predicted exceedances of the L_{Aeq} noise goals would increase. The increase would depend on the time of day of the increased service frequency. In the event that the number of services in the CBD, Surry Hills and Moore Park would increase by 50% up to predicted capacity the resulting increase in night-time L_{Aeq} noise levels would be 1.8 dB.

8 PA Systems and Warning Bells

Query/ Recommendation: PA systems and warning bells are a constant source of community complaint. Please confirm that warning bells would not be routinely used upon entry to stops by drivers, unless of course there is an emergency situation?

Overseas experience would suggest that light rail systems typically do not have PA systems on road stops and rely on information display systems. Please justify the use of PA systems for the proposed project?

With regard to warning bells, while these would not be required on approach to a stop, at locations with high pedestrian activity, bells would be used to alert pedestrians of the presence of an LRV. There are a number of different bell sounds that might be used.

With regard to PA systems, the EIS identifies the potential for annoyance due to PA systems at stops in residential areas. It is agreed that regular PA announcements at all stops are not necessary. The existing Sydney Light Rail stops are fitted with PA systems, but these are not used on a regular basis.

9 Road Traffic Noise Impacts

Query/ Recommendation: It is understood that potential traffic noise impacts as part of the project are difficult to manage and potentially there is little opportunity to mitigate the traffic noise levels. Based on review of the reported changes in road traffic noise levels, road traffic noise impacts appear to be quite significant, however they are in streets predominately commercial.

To understand the potential traffic noise impacts more closely, it is recommended that the existing noise levels in the road sections where increases in traffic noise have been identified to be greater than 2 dB be estimated and a survey of residential dwellings in those streets be conducted.

The estimate of increase in traffic noise is conservative in that it assumes that an increase in traffic numbers corresponds directly to an increase in noise. While this would be the case in free flowing traffic, in congested city traffic the change in noise would be less (where engine noise dominates over wheel/road noise).

This comment is considered particularly applicable to road traffic noise impacts on Randle Street following diversion of existing traffic from Chalmers Street. Additional night-time attended measurements have been taken on Chalmers Street, Randle Street and Elizabeth Street to characterise the existing night-time noise environment as described in **Table 8**.

Table 8 Attended Noise Monitoring Results – Randle Street, Surry Hills

Location	Date	Time	Noise Levels (dBA)					Description and Typical L_{Amax} Levels (dBA)
			L_{Amax}	L_{A1}	L_{A10}	L_{Aeq}	L_{A90}	
372 Elizabeth St, Surry Hills 5 m from centre of nearest traffic lane 3 m from nearest facade	12/03/2014	00:16	89	78	73	69	54	Buses 81-87 Cars 68-80 Trucks 68-89
30 Chalmers St, Surry Hills 4.5 m from centre of nearest traffic lane 4 m from nearest facade	12/03/2014	00:37	79	75	68	64	51	Cars 64-78 Pedestrians 60
15 Randle St, Surry Hills 4 m from centre of nearest traffic lane 2.5 m from nearest facade	12/03/2014	00:55	83	71	59	60	50	Cars 69-70 Trucks 65-83 Pedestrians 54 Waste truck 58
1-5 Randle St, Surry Hills 6 m from centre of nearest traffic lane 4 m from nearest facade	12/03/2014	01:12	83	72	68	64	52	Cars 61-75 Trucks 68-83

Table 8 confirms that existing night-time road traffic noise impacts on the arterial routes of Chalmers Street and Elizabeth Street are relatively high. At residential apartments on Randle Street, the noise impacts vary with distance from the existing arterial routes. 1-5 Randle Street is located on the corner of Elizabeth Street, with existing night-time L_{Aeq} levels around 64 dBA. At the rear of apartments with a façade on Randle Lane, near 15 Randle Street, existing night-time L_{Aeq} noise levels are around 60 dBA.

With these existing noise levels on Randle Street, it is clear that the night-time external noise goals for local roads defined in the NSW Road Noise Policy are not appropriate. Appropriate internal noise goals would be developed for these receivers in the detailed design stage with reference to AS2107, and following measurement of the existing internal noise levels and the attenuation provided across the facade.

Mitigation of road traffic noise impacts due to the diversion and additional traffic on Elizabeth Street (and other affected arterial roads in the CBD) is not considered reasonable in light of the existing road traffic noise environment.

10 Stabling and Maintenance Facilities

Query/ Recommendation: The report confirms that noise is a significant concern with this site and raised the issue of barriers / partial roofs or a complete shed, without including any plans or elevations showing the extent of these building areas. With the extent of the impacts and non-compliance of the night time noise criteria presented in the report it is recommended that the noise assessment be revised in detail to show how noise will be mitigated/managed and achieve INP criteria. The assessment needs to address the issues highlighted above, present plans, cross sections and elevations showing the extent of mitigation, show noise contour or façade plots to indicate where the noise impacts are for each scenario, exact source locations for each scenario, etc.

The modelling of noise impacts for the Randwick Stabling facility refers to measurements and observations of the existing Light Rail Depot at Pyrmont. TfNSW have advised that there may be scope to change pre-start practices to minimise noise impacts. Furthermore, the layout of the facility may change as tenderer's propose alternatives. It may also be possible to enclose only some areas of the site.

At this stage it is difficult to confirm details of mitigation measures. The approach taken has been to identify whether it is possible for a stabling facility at the Randwick location to be designed to comply with the INP goals. The assessment indicates it is possible for the facility to comply with the noise goals at all locations in all time periods, with the exception of 5 receiver points located in two buildings adjacent to the site exit road. The source of the exceedance at this location is staff cars (light vehicles) leaving the site, for example drivers leaving at the end of a shift.

Following discussion with Wilkinson Murray and Planning & Infrastructure, it is noted that the concerns with the Randwick Stabling area also relate to concerns around residential amenity in general.

The applicability of the noise logger position BG07 at 24 Doncaster Avenue to the site extremities was also discussed in the meeting with Wilkinson Murray and Planning & Infrastructure. Additional night-time attended measurements at the northern and southern ends have been undertaken and are shown in **Table 9**.

Table 9 Attended Noise Monitoring Results – Randwick Stabling Extremities

Location	Date	Time	Noise Levels (dBA)					Description and Typical L_{Amax} Levels (dBA)
			L_{Amax}	L_{A1}	L_{A10}	L_{Aeq}	L_{A90}	
7 Doncaster Ave, Randwick (Northern end of proposed stabling facility)	12/03/2014	00:32	77	67	61	58	43	Buses 56-67 Cars 48-67 Trucks 61-77 Motorbike 62
66 Doncaster Ave, Randwick (Southern end of proposed stabling facility)	12/03/2014	00:58	56	47	45	42	39	Buses 42-43 Cars 43-46 Motorbike 46-56

The BG07 logger recorded a night-time background noise level of 38 dBA, and a night-time L_{Aeq} noise level of 46 dBA. The additional attended measurements confirm that the ambient and background levels are higher near Alison Road (at 7 Doncaster Avenue) than at the southern end of the site. However, the assessment of noise impacts at this site is controlled by the background level. The attended night-time measurements of the background level confirm that the logger is representative of the receivers with the lowest existing background noise levels.

The receivers and source locations considered in the assessment are shown in **Figure 3**.

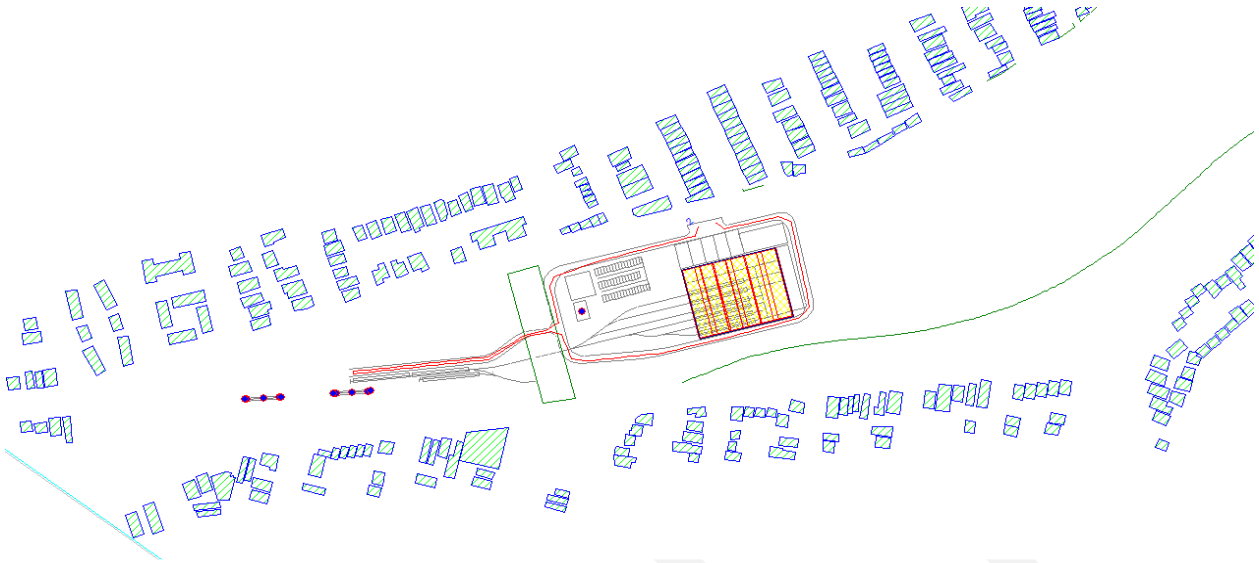
> ***Query/ Recommendation:*** Please review Table 36 in the Report which presents predicted noise levels from the Rozelle Maintenance Facility. Given the location of the noise sources, it is surprising that the highest noise levels are on the ground floor. It is unclear where the receiver locations are. The assessment needs to present noise contour or façade plots or a plan showing receiver locations to indicate where the noise impacts are for each noise scenario.

The maximum levels impacting on different building stories reported in Table 36 are not necessarily incident on the same building (some buildings have only one storey).

The receivers and source locations considered in the assessment are shown in **Figure 4**.

Figure 3 Randwick Stabling Model and Receivers

Figure 4 Rozelle Maintenance Facility Model and Receivers

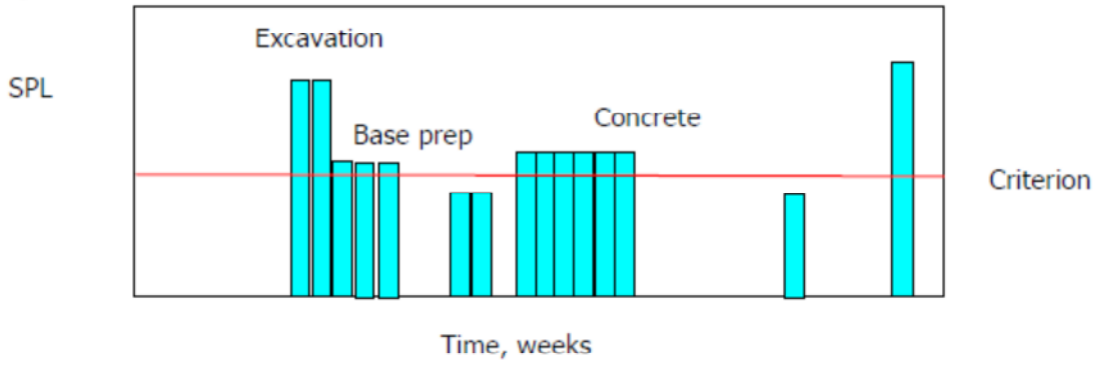


11 Construction Noise

Query/ Recommendation: It is unclear the level and duration of the noise impact at locations along the construction of the light rail system. To understand the construction noise impacts along the construction of the track it is requested that a noise profile be constructed for a typical (worst) receiver (day, evening and night) and show in graphical terms the duration of construction in each of the areas, namely:

- City Centre Precinct ;
- Surry Hills Precinct;
- Moore Park Precinct;
- Kensington / Kingsford Precinct;
- Randwick Precinct;
- Randwick stabling yard; and
- Rozelle maintenance facility.

The profile should be similar to: eg xx Devonshire Street (Day) (typically x metres from the Receiver)



At this stage, details of the schedule for the works are not available. There are a number of different approaches that could be taken to construction that would give an entirely different noise profile (for example, whether Appitrack or Slipforming machines are used).

An indicative graph of the mainline track construction work stages is shown for the most affected residential location in each Precinct in the following figures. The schedule is based on a number of assumptions as follows:

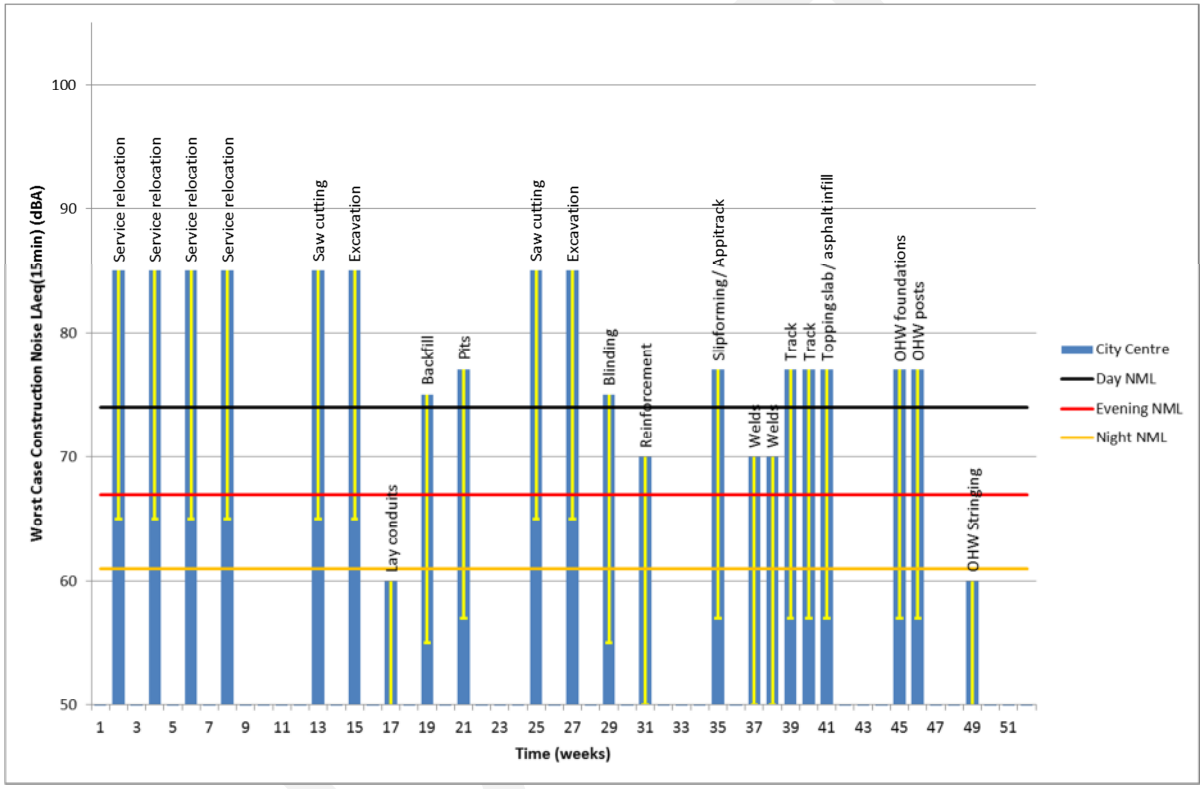
- Works shown are occurring mid-block – works at intersections would occur during road closures and the schedule would be different.
- The overall duration of mid-block works is anticipated to be approximately 12 months.
- Around two months of this would be required for service relocations.

The majority of other activities would occur in “waves” along the alignment. For a 200 m long section of track mid-block, most individual activities would be completed in 3-8 shifts, that is, over approximately three to eight days. Each week of activity is assumed to be followed by a week with minimal activities (at each individual receiver location), while work is taking place further along the alignment and before the next “wave” comes through.

Even with works in the same block, the noise impacts on any single receiver would be less for the proportion of that time that works are not occurring immediately adjacent. As the source moves away from the receiver, the noise level would reduce. An indicative reduction would be around 20 dB where the source is around 100m further along the alignment than the nearest point, for a receiver around 10m from the track. The noise levels corresponding to this reduction from the worst case situation is shown in the following figures in the form of a 20 dB range (shown as a yellow bar) below the predicted worst case level.

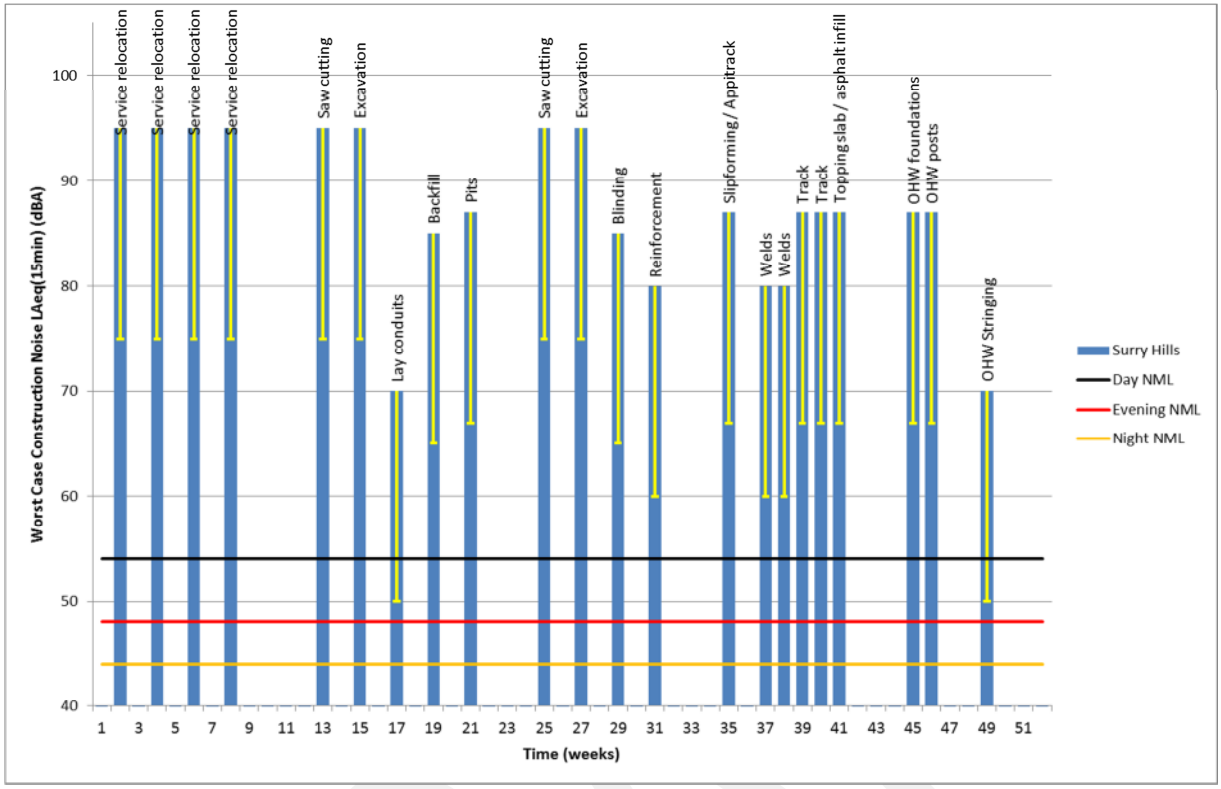
It is noted that the Roads and Maritime Traffic Management Centre (TMC) require work outside of standard hours for intersections as well as for some mid-block works. For example, mid-block works along Anzac Parade will be required during the night-time, as these works will require closure of the traffic lanes adjacent to the works (which would not be permitted during the daytime). The following figures show the relevant Noise Management Levels (NMLs) in each time period.

Figure 5 Indicative Construction Impacts on Residential Receivers – City Centre



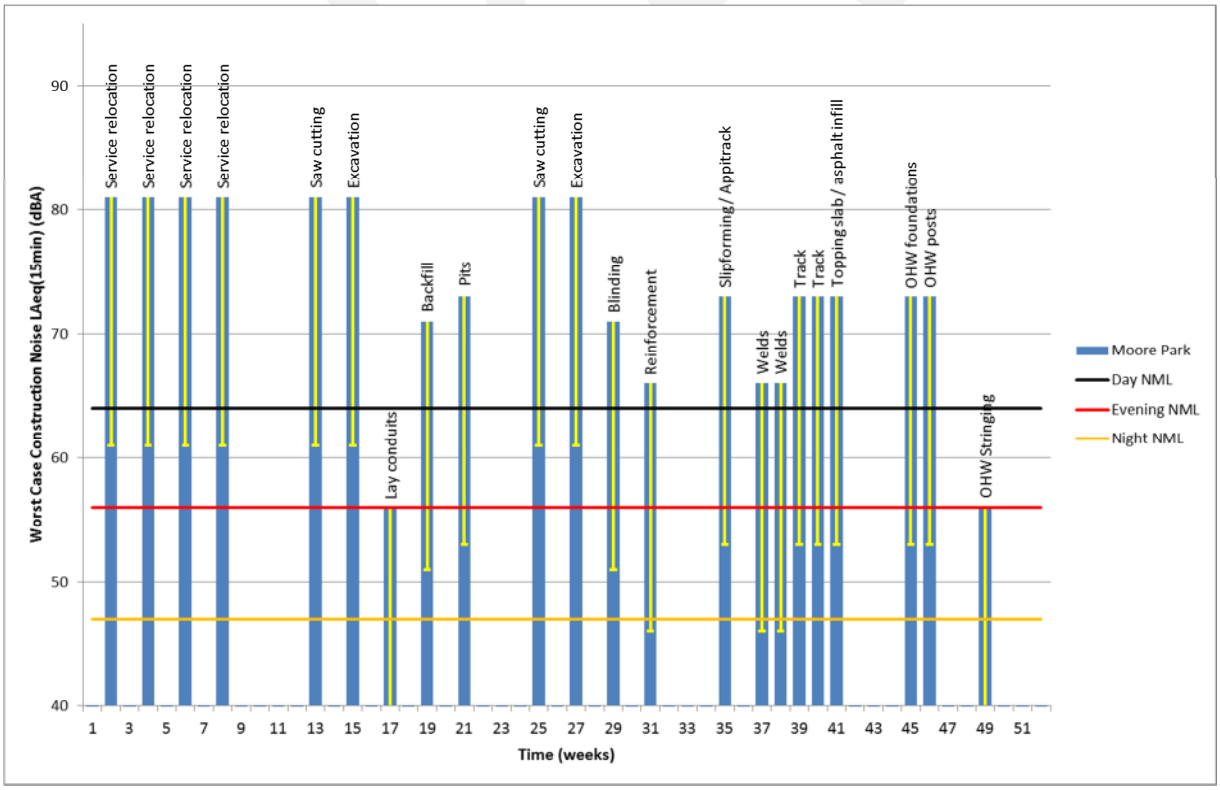
Note: Yellow bars indicate 20 dB range for approximate noise levels where the source is within 100 m of an individual receiver.

Figure 6 Indicative Construction Impacts on Residential Receivers – Surry Hills



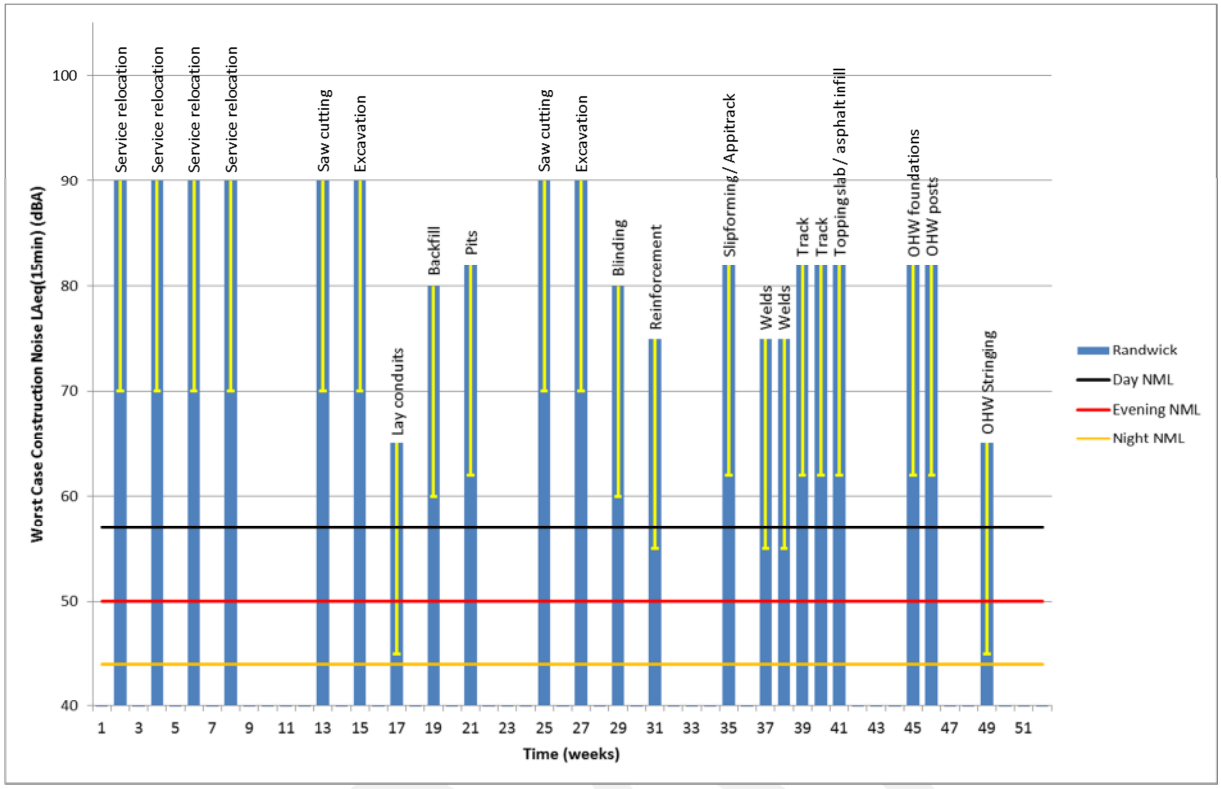
Note: Yellow bars indicate 20 dB range for approximate noise levels where the source is within 100 m of an individual receiver.

Figure 7 Indicative Construction Impacts on Residential Receivers – Moore Park



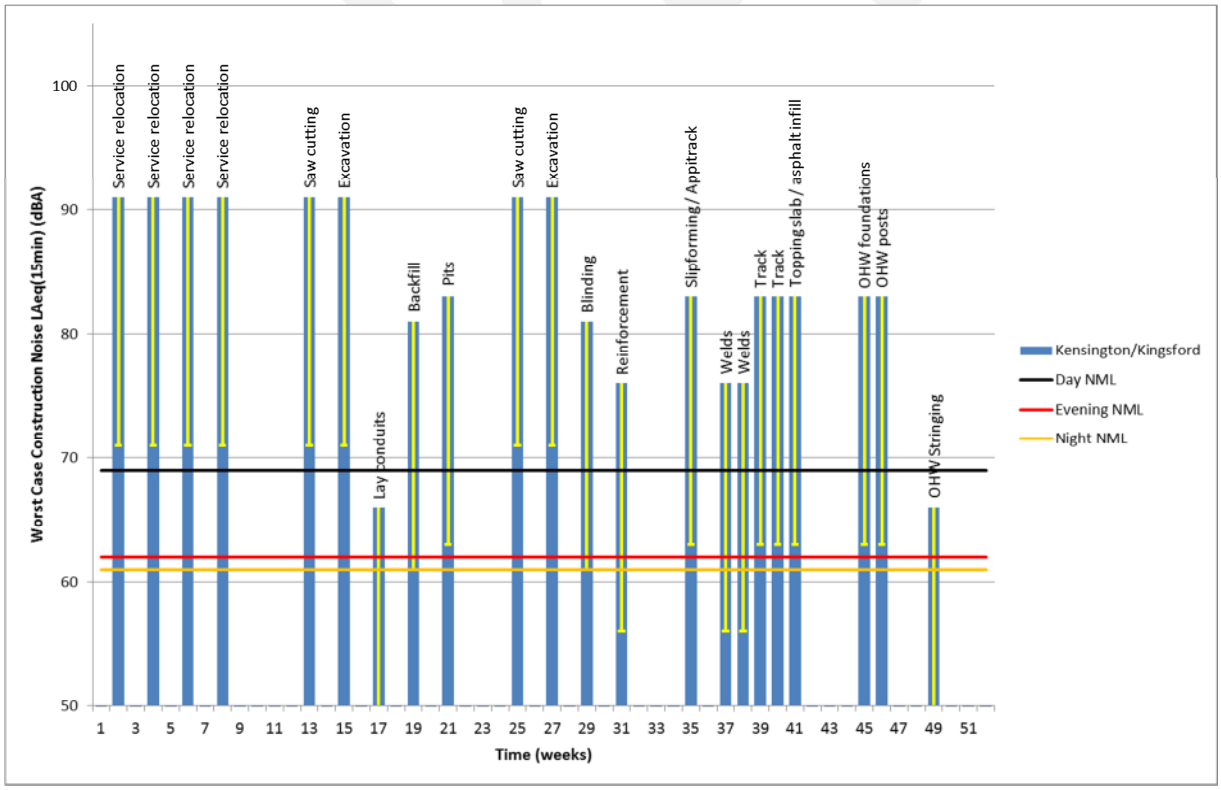
Note: Yellow bars indicate 20 dB range for approximate noise levels where the source is within 100 m of an individual receiver.

Figure 8 Indicative Construction Impacts on Residential Receivers – Randwick



Note: Yellow bars indicate 20 dB range for approximate noise levels where the source is within 100 m of an individual receiver.

Figure 9 Indicative Construction Impacts on Residential Receivers – Kensington / Kingsford



Note: Yellow bars indicate 20 dB range for approximate noise levels where the source is within 100 m of an individual receiver.

12 Concluding comment

Please contact the undersigned to discuss in the event further clarification is required.

Yours sincerely

BRIONY CROFT
Principal - Noise and Vibration

APPENDIX C

ADEQUACY REVIEW OF NOISE AND VIBRATION SUBMISSION RESPONSES

Table 5.10.2 Construction Noise and/or Vibration Impacts

Submission No.	Specific Issues Raised in Submissions	Response to Specific Issues	WM Review Comment
242, 272, 311, 320, 344, 347, 358, 399, 416, 418, 444, 446, 449, 476, 478	a) Concerned about noise and vibration during construction and how it will be mitigated.	Construction is an inherently noisy activity. It is acknowledged that construction activities in close proximity to residents and other properties would be highly intrusive at times. The impacts of construction noise on residential properties and businesses would be minimised and managed as much as is reasonable and feasible. During the detailed design phase of the proposal, the noise and vibration impacts would be re-examined with Construction Noise and Vibration Management Plan(s) (CNVMP) to be prepared for all work areas along the alignment. This plan(s) would consider all reasonable and feasible mitigation measures, and provide more detail on the level of impact at sensitive properties, and the timing and duration of works at each location. The community would be informed about upcoming works throughout the construction period, using a combination of means described in the EIS, including regular notifications, the proposal website, an email distribution list, the proposal Info-line and the Construction Response Line. These numbers provide a dedicated 24 hour contact point for any proposal enquiries and complaints regarding construction works. The documents found on the following websites provide more specific guidance on how construction noise is managed on such projects: • Transport for NSW's *Construction Noise Strategy* – http://www.transport.nsw.gov.au/sites/default/files/b2b/projects/TP_Envionmental-Services_ Strategy_April_2012.pdf. • *EPA's Interim Construction Noise Guideline* – http://www.environment.nsw.gov.au/resources/noise/09265cng. pdf. The CNVMP(s) would be prepared in line with the strategies and procedures outlined in these documents.	WM considers the response adequate.
328	b) Construction of the CSELR will produce significant levels of noise, which will affect the outdoor seating area for the Bourke Street Bakery. Noise mitigation devices must be installed around the worksite to protect the patrons and pedestrians.	The noise impacts on the Bourke Street Bakery would vary throughout the construction period and the various different construction activities. The bakery is around 60 metres from the Olivia Gardens facade. At this location the predicted worst-case external $L_{Aeq,15min}$ noise level during demolition activities is up to 70 dBA. This is an 'average' noise parameter over 15 minutes. During much of the demolition works the noise impacts would be less, depending on where the demolition equipment is operating within the Olivia Gardens site. Mitigation of the noise impacts during demolition of the upper levels of the apartments is unlikely to be feasible due to the height of the noise source. Once the buildings have been reduced to lower levels then noise barriers could become effective. The greatest noise impacts on the outdoor seating area would be during the construction of the tracks along this	WM considers the response adequate.

Submission No.	Specific Issues Raised in Submissions	Response to Specific Issues	WM Review Comment
		section of Devonshire Street. Track construction is predicted to give rise to worst case external $L_{Aeq,15min}$ noise levels of up to 80-95 dBA (which would be highly intrusive). The noise from different track construction activities would vary considerably. (Excavation is much noisier than concrete reinforcement placing, for example). The detail of the track construction methodology has not been determined at this stage, but the duration of most track construction activities would be in the order of weeks. Provision of noise barriers around the worksite during track construction would be difficult due to the nature of the works, which would move progressively along the alignment. The feasibility and effectiveness of installing temporary mobile barriers or screens would be considered during preparation of the CNVMP(s). Technical Paper 11 of the EIS (Volume 6) also identifies that noise from the construction compound in Wimbo Park would impact on this location. The compound would be used to store equipment and materials. Noise generating activity in the compound would be intermittent throughout the construction period, with worst case $L_{Aeq,15min}$ noise levels at the Bourke Street Bakery of up to 75 dBA during establishment of the compound and delivery of plant and equipment. Again, noise impacts at other times would be less. Noise barriers or solid hoardings around this construction site and the demolition site are likely to be reasonable and feasible for the duration of the works. The likely benefit of barriers would be of the order of 5 dB to 10 dB, which would provide a noticeable reduction. A CNVMP(s) would be prepared prior to construction commencing, to confirm the reasonable and feasible mitigation measures to be applied. At all times, the Bourke Street Bakery would be informed well in advance of upcoming construction activities, including the expected noise levels and hours of work.	
235, 271, 403	c) 24 hour construction activities would not be suitable in Surry Hills/residential areas. Construction activities should cease at midnight.	Due to the early construction planning undertaken to date, the noise assessment in the EIS made a conservative assumption of 24 hour works at all locations. The purpose of this was to understand the impacts and present the worst case. In Surry Hills, it is anticipated that construction works would be completed during the standard daytime construction hours where possible; that is, Monday to Friday 7.00am to 6.00pm and Saturdays 8.00am to 1.00pm. Standard working hours are likely to apply at demolition sites, construction compounds, and stop locations. However, the nature of the proposal means evening and night work would also be required at times, particularly in areas around road intersections where construction work during the daytime would result in a significant impact on traffic congestion and safety. For some construction activities such as relocation of services, working from 7.00am to 11.00pm along the alignment is an option that would reduce the overall duration of these activities (and hence the	WM considers the response adequate.

Submission No.	Specific Issues Raised in Submissions	Response to Specific Issues	WM Review Comment
		duration of impacts). 24 hour construction in Surry Hills is not proposed except in special circumstances, such as intersection works where night works are required to minimise disruption to road traffic. Additionally, working at night and out-of-hours is often required for works on major roads by road authorities (such as Councils and Roads and Maritime Services) to avoid impacts to traffic during daytime hours.	
67	d) Concerned about adverse construction noise impacts to the Sydney Girls High School. Impacts are to be fully mitigated to the greatest extent possible by the terms of the proposal and any approval. This should include scheduling of potentially disruptive work and movement out of school and travel times (preferably during holidays), frequent mandatory liaison with the school and strict measures to minimise potentially adverse effects.	For educational facilities, the Environment Protection Authority's 67 construction noise management level (NML, or noise goal) is an internal 'average' level of $L_{Aeq,15min}$ 45 dBA, during times when the school is in use. The construction noise impacts on educational receivers (including Sydney Girls High School) have been identified in the EIS, with predicted worst-case external noise levels of up to 69 dBA during some construction scenarios. The resulting internal noise level would depend on whether windows are open or closed. It is noted that the proposed CSELR alignment and location of the Moore Park stop have changed in this area. These changes and the likely expected noise impacts are discussed in section 6.8 of this Submissions Report. The Sydney Girls High School buildings are set back around 70 metres from the alignment, across Anzac Parade. As a result of the offset distance of the site, for many construction activities it is likely that existing noise from road traffic (in particularly heavy vehicles), would be of a similar level to or higher than the construction noise levels. Notwithstanding the above, the construction contractor would be required to implement all feasible and reasonable noise mitigation measures to manage impacts during the works. As identified in the EIS, when working adjacent to schools, there is a requirement for particularly noisy activities to be scheduled outside normal school hours where reasonable and feasible. Consultation and liaison with the school would be undertaken to inform the school of expected impacts, and the timing and duration of upcoming works.	WM considers the response adequate.
195	e) Concerned about the adverse noise impact that the construction of the Randwick stabling facility will have on adjacent residential properties.	The Randwick stabling facility is located adjacent to residential properties on Doncaster Avenue and consequently noise impacts during construction have the potential to be highly intrusive during some construction activities, even with all feasible and reasonable mitigation measures implemented. To minimise impacts on residences at this location, it is expected that construction works would be restricted to standard daytime construction hours of Monday to Friday 7.00am to 6.00pm, and Saturdays 8.00am to 1.00pm. Where	WM considers the response adequate. Refer to WM further comments in Section 3.9.

Submission No.	Specific Issues Raised in Submissions	Response to Specific Issues	WM Review Comment
		reasonable and feasible, a noise barrier would also be installed along the boundary of the site as soon as possible to mitigate construction noise impacts (refer mitigation measure S.1 in Chapter 8 of this Submissions Report). A CNVMP(s) would be prepared prior to construction commencing, to confirm the reasonable and feasible mitigation measures to be applied.	
237	f) Concerned about the noise impacts associated with the CSELR proposal due to the lack of details regarding construction methods and materials.	At any particular location, the potential noise impacts of construction can vary greatly depending on factors such as the relative proximity of sensitive receptors, the overall duration of the construction works, the intensity of the noise and vibration levels, the time at which the construction works are undertaken and the character of the noise or vibration emissions. There are a number of different methods and items of equipment that could potentially be used to construct the proposal. The uncertainty in methods and materials was addressed in the EIS by identifying the expected worst-case potential impacts during construction of the proposal. To give a broad indication, the noise and vibration assessment and associated noise predictions were based on indicative construction scenarios that represented key stages of the construction phase. It is also noted that the EPA's *Interim Construction Noise Guideline* states that *"As a proposal moves through the stages (from pre- approval to post-approval), more detail normally becomes available on the planned work methods, location of plant and equipment, and scheduling. The construction noise impact assessment and construction noise management plans should thus be consistent with the level of design detail available at each stage."*	WM considers the response adequate.
403	g) Demolition of Olivia Gardens will take too long, with high noise levels.	The timeframe for demolition of Olivia Gardens is not yet confirmed. The noise impact assessment assumed a timeframe of 14 months as a worst case estimate for works at this site. The actual demolition works would most likely be completed within a few months. This timeframe would be refined during detailed construction planning prior to construction. The predicted noise levels associated with demolition are predicted to be highly intrusive at times; however the noise levels would be variable throughout the period, with the noise impacts depending on the activity taking place on-site, and the movement of equipment around the site. Mitigation of the noise impacts during demolition of the upper levels of the apartments is unlikely to be feasible due to the height of the noise source. Once the buildings have been reduced to lower levels, then temporary noise barriers may be effective.	WM considers the response adequate.
354	h) Construction impacts (noise or physical) will interfere with access to activities held at the Quaker Meeting House, Surry Hills	The noise and vibration impact assessment identified the Quaker meeting house as a sensitive receiver (refer Table 3 in Technical Paper 11, Volume 6) and potential construction noise impacts are described in section 12.5.2 of that report. The greatest noise impacts on the Quaker Meeting House would be during the construction of the tracks along this section of Devonshire Street.	WM considers the response adequate.

Submission No.	Specific Issues Raised in Submissions	Response to Specific Issues	WM Review Comment
		Noise from track construction at this property would be highly intrusive at times; however, the noise from different track construction activities would vary considerably. Excavation is much noisier than concrete reinforcement placing, for example. The detail of the track construction methodology has not been determined at this stage, but the duration of most track construction activities would be in the order of weeks. Impacts on this location and reasonable and feasible mitigation measures would be considered further during the development of the detailed CNVMP(s). Regular community updates about upcoming works would be provided throughout the construction period, using a combination of the means described in section 2.4 of this Submissions Report, including regular notifications, the project website, an email distribution list, the project info-line and the construction response line. These numbers would provide a dedicated 24 hour contact point for any proposal enquiries and complaints regarding construction works.	
436	i) Comment on noise and vibration impacts has been withheld, subject to Construction Noise and Vibration Management Plan. Seeks further and ongoing consultation with accommodation providers in impacted areas, regarding noise and vibration impacts, including Four Seasons, The Westin, Mantra 2 Bond Street, Hilton, QT, Amora, Swissotel, Mercure Sydney, Capitol Square Hotel and The Marque	The level of detail on construction noise and vibration impacts provided in the EIS reflects the uncertainty around construction methods and equipment that could potentially be used to construct the proposal. To give a broad indication of impacts, the noise and vibration assessment and associated noise predictions were based on indicative construction scenarios that represented key stages of the construction phase. It is appropriate that these predictions be revised and updated in the detailed design stage and during preparation of the CNVMP(s) as more information comes available. Further and ongoing consultation with these accommodation providers is proposed as part of the proposed Community and Stakeholder Engagement Plan to be established prior to commencement of construction. Additionally, a Business Reference Group would be established, which would comprise independent representatives from the business community to advise on business concerns related to the proposal.	WM considers the response adequate.
415	j) Concern about vibrations along George Street and possible damage to QVB.	Vibration impacts during construction are discussed in the EIS (refer section 12.5.3 in Volume 1B for the City Centre). Where works are required in close proximity to existing buildings (such as the QVB), impacts would need to be carefully managed to minimise the risk of any damage. Where works are needed within the identified 'safe working distances' for vibration intensive plant, and there is no opportunity to substitute less vibratory equipment, the impacts would be managed by vibration monitoring or vibration trials to ensure that levels remain below the relevant vibration criterion.	WM considers the response adequate.

Table 5.10.3 Construction Noise and/or Vibration Mitigation

Submission No.	Specific Issues Raised in Submissions	Response to Specific Issues	WM Review Comment
347, 354	a) The following mitigation measures should be included as a minimum in the CEMP: • Excessive noise and vibration generating activities outside of the core trading hours of 8.00am to 6.00pm Monday to Sunday and after late night trading in peak trading periods. • Installation of a temporary noise wall subject to the more detailed advice of an acoustic expert. • All plant, equipment and vehicles to be shut down when not in active use. • Alternative construction methods or low impact machinery to be used where possible. • Noise not to exceed a level to be agreed with the landowner and to be stated in the CEMP. This should be 45 dBA in accordance with the recommendations in the Noise Impact Assessment in the EIS for medical and training land uses. • Vibration not to exceed a level to be agreed with the landowner and to be stated in the CEMP. • Inclusion of agreed noise and vibration KPIs and penalties in contractual arrangements. • Ongoing noise and vibration monitoring to be undertaken at the proponent's expense to ensure compliance.	Scheduling of high noise activities during standard daytime construction hours is normally required to minimise impacts on residential receivers. At some locations in the CBD, it may be possible to schedule the timing of high noise impact activities to minimise impacts on businesses, but this is subject to ongoing consultation, scheduling, and the need to manage impacts on all sensitive receivers. Restricting construction hours would extend the overall duration of disruption during the works. Provision of noise barriers around the worksites during track construction is difficult due to the nature of the works, which would move progressively along the alignment. The feasibility and effectiveness of installing temporary mobile barriers or screens would be considered during preparation of the CNVMP(s). Shutting down equipment when not in use is a requirement of both the Transport for NSW Construction Noise Strategy and the EPA's Interim Construction Noise Guideline. The same applies to the use of alternative construction methods or machinery where reasonable and feasible to do so. Construction is inherently noisy and it is common for the construction noise goals (identified in the EIS) to be exceeded on infrastructure projects, even with the application of all reasonable and feasible mitigation measures. For this reason, the noise goals are defined as 'noise management levels' (NMLs), rather than strict criteria to be met. If the NMLs are predicted to be exceeded, then the impacts would be managed and mitigated as much as possible. However, compliance with the NMLs is unlikely to be achieved for all construction activities. For commercial receivers, the NML is an external level of 70 dBA $L_{Aeq,15min}$. Stricter limits would be set for construction vibration, at levels to minimise the risk of damage to structures in accordance with the relevant Australian and International Standards. However, it is likely that vibration would be perceptible to people during some construction activities. Various community and stakeholder engagement measures are proposed during construction to regularly inform businesses and residents of upcoming works and to facilitate feedback and/or complaints (refer section 2.4 of this Submissions Report for further details). Noise and vibration monitoring is a mitigation / management measure that is regularly employed on Transport for NSW worksites, and would also be employed on the CSELR where required. Respite periods are one option for managing high noise and vibration generating activities particularly on residential receivers. The requirement for respite is dependent on the level of noise generated. The suitability of respite periods at particular locations would be considered in the preparation of the CNVMP(s).	WM considers the response adequate.

Submission No.	Specific Issues Raised in Submissions	Response to Specific Issues	WM Review Comment
	• Respite periods where no activity is undertaken to be provided during extended noise and vibration generating activities, irrespective of level.		
	• The proposal approval and the CEMP to include a mechanism for alternative dispute resolution in the event that landowners are not satisfied with the management of noise and vibration impacts and the contractor's adherence to KPIs.	The EPA's pollution response line provides an alternative dispute mechanism for noise and vibration concerns.	WM considers the response adequate.
449	b) Noise mitigation measures should protect Bourke Street Public School from construction impacts. Transport for NSW should work with the school to determine the works schedule, noting respite requirements. Recommends that a balance is struck between expediting works and providing businesses and residents with respite.	The construction contractor(s) would be required to implement all feasible and reasonable noise mitigation measures to manage impacts on the school during the works As identified in the EIS, when working adjacent to schools, there is a requirement for particularly noisy activities to be scheduled outside normal school hours where possible. Consultation and liaison with the school would be undertaken to inform the school of expected impacts, and the timing and duration of upcoming works. Provision of respite periods for sensitive receivers is one option to manage noise and is acknowledged in the EIS.	WM considers the response adequate.
347	c) Activities that would result in 108118 dB and vibration levels exceeding the threshold of human comfort should not be undertaken during trading hours.	The noise and vibration impact assessment was undertaken on the basis of a worst case scenario. Construction is an inherently noisy activity and it is acknowledged that construction activities in close proximity to businesses, residents and other properties would be highly intrusive at times. The scheduling of noisy activities requires consideration of all sensitive receiver types in the surrounding area (including residents in the CBD who are generally sensitive to noisy works at night). Similarly, construction vibration above the human comfort goals is sometimes unavoidable. Vibration impacts would be managed in accordance with *Assessing Vibration: A Technical Guideline* (DEC, February 2006). This guideline recognises that construction may sometimes result in short-term vibration levels above the human comfort goals. A Business Reference Group would be established, which would comprise independent representatives from the business community to advise on business concerns related to the proposal.	WM considers the response adequate.

Submission No.	Specific Issues Raised in Submissions	Response to Specific Issues	WM Review Comment
347	d) To manage possible construction vibration impacts, the CEMP should include: • Excessive vibration generating activities outside of the core trading hours. • Alternative construction methods or low impact machinery to be used where possible. • Vibration not to exceed a level agreed with the landowner stated in the CEMP. • Inclusion of agreed vibration KPIs and penalties in contractual arrangements. • Ongoing vibration monitoring to be undertaken at the proponent's expense to ensure compliance. • Respite periods. • Immediate cessation of activities in the event of damage to the building fabric. • No excavation works close to the building. • No plant or equipment likely to fall onto the facade of the building. • Engagement of an independent property condition survey for the building by Dymocks at the proponent's cost. • The proposal approval and CEMP to include a mechanism for alternative dispute resolution if landowners are not satisfied with the management of impacts. • Any damage caused to the building as a consequence of construction to be rectified promptly to Dymocks' satisfaction at the proponent's cost.	Please refer to the response in row a) above regarding scheduling high noise activities, which also applies to high vibration activities. The use of alternative construction methods and low impact machinery where reasonable and feasible is a requirement of both the Transport for NSW Construction Noise Strategy and the EPA's *Interim Construction Noise Guideline.* For construction vibration, criteria are applicable in accordance with the relevant Australian and International Standards, at levels to minimise the risk of damage to structures. However, it is likely that vibration would be perceptible to people during some construction activities. Vibration monitoring is a mitigation/management measure that is regularly employed on Transport for NSW worksites, and would also be employed on the CSELR where required (refer mitigation measure S.7 in Chapter 8 of this Submissions Report). Respite periods are one option for managing high vibration generating activities particularly on residential receivers. The suitability of respite periods at particular locations would be considered in the preparation of the CNVMP(s). Potential vibration impacts during construction in the City Centre are described in section 12.5.3 of the EIS (Volume 1A). Where works are required in close proximity to existing buildings, impacts would need to be carefully managed to minimise the risk of any damage. Where works are needed within the identified 'safe working distances' for vibration intensive plant, and there is no opportunity to substitute less vibratory equipment, the impacts would be managed by vibration monitoring or vibration trials to ensure that levels remain below the relevant vibration criterion. If required, vibration monitoring equipment with alarms would be employed, that could trigger a requirement to cease work. The precise locations of excavation would be determined in the detailed design stage, and the impacts would be managed through the CNVMP(s). Standard mitigation measures to manage vibration would include building condition surveys before commencement of works, and after the works (if required) to identify damage due to the works. These surveys would take place at properties in close proximity to vibration intensive construction work, where identified by a geotechnical engineer as likely to be affected. The properties to be surveyed would be identified in the detailed design stage during preparation of the CNVMP(s). Any damage caused by the proposal would be rectified at no cost to the property owner. The EPA's pollution response line provides an alternative dispute mechanism for noise and vibration concerns.	WM considers the response adequate.

Submission No.	Specific Issues Raised in Submissions	Response to Specific Issues	WM Review Comment
457	e) Ensure noise and vibration from the Moore Park West worksite will not impact on teaching or health at Sydney Boys High School.	It is noted that the proposed CSELR alignment and location of the Moore Park stop have changed in this area. These changes and the likely expected noise impacts are discussed in section 6.8 of this Submissions Report. The construction noise impacts on educational receivers (including Sydney Boys High School) have been identified in the EIS, with predicted worst-case external noise levels of up to 68 dBA during some construction scenarios when the construction is closest to the school. The resulting internal noise level would depend on whether windows are open or closed. The Sydney Boys High School buildings are set back around 60 metres from the alignment at the closest point, near the crossing beneath Anzac Parade. As a result of the offset distance to the site, for many construction activities it is likely that existing noise from road traffic (in particular heavy vehicles), would be of a similar level to or higher than the construction noise levels. Notwithstanding the above, all feasible and reasonable noise mitigation measures to manage impacts during the works would be implemented. As identified in the EIS, when working adjacent to schools, particularly noisy activities would be scheduled outside normal school hours where reasonable and feasible. Consultation and liaison with the school would be undertaken to inform the school of expected impacts, and the timing and duration of upcoming works. Construction noise and vibration impacts would not be at a level that would be expected to be detrimental to health.	WM considers the response adequate.
335	f) Request that the proponent comply with stringent acoustic criteria to ensure there is no adverse impact on Fox Studios activities during construction. P&I should include conditions of approval requiring the installation of noise and vibration loggers so impacts on studio activities can be monitored.	Adverse impacts on activities at Fox Studios during construction are not anticipated due to the setback distance from this site to the alignment. Notwithstanding this, the goals for management and mitigation of construction noise and vibration identified in the EIS for recording studios are applicable to Fox Studios. The details of mitigation measure and any monitoring requirements would be identified in the detailed design stage during preparation of the CNVMP(s).	WM considers the response adequate.
354	g) Recommends that for the Quaker Meeting House in Surry Hills: • Additional construction noise mitigation measures are relevant to the appropriate noise goals.	Due to the close proximity of this receiver to the alignment, there is the potential for highly intrusive noise impacts. These would be managed and minimised as much as possible through the use of all feasible and reasonable mitigation measures. Ongoing consultation with the Quaker Meeting House would be undertaken to assist in managing the impacts and to provide information on the timing and duration of the track construction works.	WM considers the response adequate.

Submission No.	Specific Issues Raised in Submissions	Response to Specific Issues	WM Review Comment
	• Feasible noise mitigation options and measures should be developed in consultation with the Quaker Meeting House. • No construction work is carried out on a Sunday morning between 9.30am and 12.30pm so that meetings based on silence will not be disrupted.	The Sunday morning period between 9.30am and 12.30pm falls outside the standard construction hours, and it is likely that this request could be accommodated, subject to any requirements from police or road authorities for out-of-hours works (e.g. for safety reasons, or to minimise disruption to road traffic).	

Table 5.10.4 Operational Noise Impacts – All Precincts/Locations

Submission No.	Specific Issues Raised in Submissions	Response to Specific Issues	WM Review Comment
237, 242, 311, 334, 361, 364, 403, 418, 444, 446	a) Concerned about operational noise from the CSELR, including: • The proposed speed limits, times of light rail operations and lack of details regarding tram line materials proposed to be used. • The hours of operation (5.00am-1.00am) which may exceed EPA's *RING*, and would compound noise and sleep disturbance impacts. • How impacts will be mitigated.	The operational noise and vibration impacts of the proposal have been assessed in the EIS in accordance with the EPA's *RING*. The majority of residential and other noise sensitive receptors would comply with the noise trigger levels within the *RING*, but some potential exceedances of the trigger levels have been identified. The proposed hours of operation of the system have been considered in the assessment, in accordance with the requirements of the *RING*. Additionally, as the proposed route is largely located on existing roads, these areas already experience some traffic noise at night. There would be a noticeable change in noise with the introduction of light rail; however this would be positive in some areas and negative in others. As described earlier in section 5.10.1, an operational noise and vibration review would be prepared in the next stage of the proposal to determine the final design of reasonable and feasible mitigation measures, and to identify any residual exceedances of the operational goals. This review would consider the possibility of changes to speeds, and alternative track designs and materials.	WM considers the response adequate.
299	b) Concerned that special event services will occur approximately 100 times a year, and may generate noise levels 2.0 dB higher than on nights when special events do not occur.	Technical Paper 11 in the EIS, Volume 6 (section 5.5.6) identifies that special event services are expected to be provided on average once a week, typically during the evening on weekends, but sometimes on weekdays. Special event services could sometimes extend into the night time period if events finish after 10pm. The increase in L_{Aeq} (average) noise level would be around 0.5 dB for daytime special events (before 10pm), and 2 dB to 3 dB for events extending special event service frequencies after 10.00pm. The noise impacts of special event services are considered acceptable in the context of the short duration of special event services. By providing more transport options, the proposal also has the potential to reduce noise impacts from pedestrians moving through Surry Hills to Central after special events, although this benefit is difficult to quantify.	Refer to WM comments in Section 3.7
271	c) Suggests a guarantee is made that 'warning bells would not form part of normal rail operations'.	The EIS (and this Submissions Report) include a mitigation measure that states: 'Warning bells on LRVs would only be used in the event of emergencies or where the driver considers there is a danger to public safety. Warning bells would not form part of normal rail operations (i.e. they would not be used by default on approach or departure from stations, or at level crossings). (refer measure A1.2 in the revised list of mitigation measures in Chapter 8 of this Submissions Report). However, in the same way that horns are required to be fitted to cars as a safety measure, there is a requirement for LRVs to be able to provide audible warning to pedestrians and other road users.	WM considers the response adequate.

Table 5.10.5 Operational Noise Impacts – City Centre

Submission No.	Specific Issues Raised in Submissions	Response to Specific Issues	WM Review Comment
290	a) Concern that tourists will not be attracted to Circular Quay because of sound pollution from light rail.	In general terms, Circular Quay is expected to experience substantial amenity benefits from the CSELR proposal, due to the proposed closure of Alfred Street to traffic between George and Loftus Street, and urban design improvements to tie the precinct into the existing pedestrianised zones around the Tank Stream Fountain and the forecourt of the Customs House. In addition, the CSELR is designed to improve the efficiency and reliability of transport to Circular Quay. Noise levels from operation of the CSELR at Circular Quay are expected to comply with the EPA's *RING* and overall should be lower than the current background noise levels generated by existing road traffic.	WM considers the response adequate.

Table 5.10.6 Operational Noise Impacts – Surry Hills

Submission No.	Specific Issues Raised in Submissions	Response to Specific Issues	WM Review Comment
36, 119, 168, 238, 271, 317, 331, 361, 364, 403, 405, 407, 410, 413, 437, 447, 478	a) General concern about operational noise in Surry Hills, including residents and businesses along Devonshire Street.	It is acknowledged that the light rail would introduce a new noise source to Surry Hills (and other locations). The noise impacts of the proposal in Surry Hills have been identified in the EIS (refer section 13.5, Volume 1B). The assessment in accordance with the EPA's *RING* indicates that operational noise mitigation measures are required to be considered for parts of Surry Hills, as a result of predicted noise impacts above the operational noise trigger levels (by up to 5 dB west of Marlborough Street). Potential mitigation measures are discussed in the EIS (section 13.5.4, Volume 1B), with further investigations required in the detailed design stage to determine which measures are feasible and reasonable at these locations. However, at these locations, even with a combination of reasonable and feasible mitigation measures, barely audible residual exceedances of the noise goals of 1 dB to 2 dB may still remain.	Refer to WM comments in Section 3.7
235, 200, 218-219, 170-174, 176, 181, 187-189, 191-194, 267, 271, 323	b) Concerned about timing (overnight) and/or frequency of light rail services and associated noise.	The EIS identifies that the expected hours of service operations would be from 5.00am until 1.00am, with the frequency of services likely to vary with demand. For example, the service may vary from every 3 minutes during peak times (7.30am to 9.30am and 5.00pm to 7.00pm) to a service every 10 minutes between 10.00pm and 7.30am. The noise impacts in Surry Hills and elsewhere would therefore be greatest during peak times (which may include evenings, particularly on weekends) and on special event days. During special events, extra services are anticipated in combination with regular services, resulting in a service frequency of every 2.5 minutes. In addition, on average, one or two LRVs would need to travel on the CSELR network each day to and from the Rozelle maintenance depot and to distribute LRVs around the network for commencement of services at 5.00am. These movements could occur at any time of the day/night.	Refer to WM comments in Section 3.7
18, 299	c) Concerned about noise impacts associated with warning bells used on LRVs. While the EIS notes that the use of bells on LRVs would be limited to emergency warnings only, this would need to be monitored. Residents should be provided with a method to report excessive noise from LRVs.	Warning bells would be a new noise source and, as such, residents would be expected to notice the change in their noise environment. As described in the EIS, warning bells would only be used when the driver considers there is a danger to public safety. It is noted that car horns are intended to serve a similar purpose. LRV warning bells are designed to be directional, with higher noise levels towards the front of the LRV (where the warning is intended to be heard) rather than to the sides. Residents and businesses would be able to report noise levels they consider to be excessive via Transport for NSW's transport info line (131 500). Noise levels from warning bells would also be measured once operations commence, to confirm the level of impact is within expectations. However it is noted that as the warning bells are audible safety devices, there are minimum requirements for their noise emissions to enable them to be heard.	WM considers the response adequate.

Submission No.	Specific Issues Raised in Submissions	Response to Specific Issues	WM Review Comment
427	d) Ward Park stop should not have a PA system, to minimise noise impacts.	Passenger announcements from public address (PA) systems at the various stops would be infrequent and limited to emergency situations or where notable disruptions in service occur. The EIS (section 13.5.2 in Volume 1B) recognises that PA noise from the Surry Hills stop at Ward Park has the potential to cause annoyance to adjacent residential receivers. This is proposed to be managed through detailed design of the PA system (which would include noise mitigation measures to comply with the NSW *Industrial Noise Policy* intrusiveness and sleep disturbance criteria).	WM considers the response adequate.
311	e) Concern about noise impacts of opening Cooper Street to Riley Street in Surry Hills on their property at 42 Adelaide Street in Surry Hills. Currently their home is protected by the park/landscaping that separates Cooper Street and Riley Street but this will be opened up to allow diverted traffic from Devonshire Street.	The noise impacts and any requirements for mitigation would be in accordance with the NSW *Road Noise Policy* which identifies operational road traffic noise goals on existing residential land uses. The *Road Noise Policy* recognises that mitigation options are generally limited for noise control on existing roads, and that strategies need to take into account what is feasible and reasonable. Given the likely level of noise impacts on these streets, consideration of mitigation may not be required. Even if consideration of mitigation is triggered under the NSW *Road Noise Policy*, mitigation (such as engineering noise controls) may not be reasonable or feasible. However, a mitigation measure has been added (refer measure B.12 in Chapter 8 of this Submissions Report) stating that further assessment of operational noise impacts on sensitive receivers associated with increased traffic due to road closures or diversions directly as a result of the proposal would be undertaken during detailed design (at which point information would become available regarding the number of vehicles forecast to use streets such as Cooper Street).	WM considers the response adequate.
361, 364	f) The eastern part of Devonshire Street and the section of Crown Street between Arthur and Devonshire Streets are currently very quiet and peaceful after about 5.00pm. The EIS underestimates the comparative noise impacts which may exceed EPA requirements.	The assessment of operational noise impacts has been undertaken in accordance with the EPA's *RING*. This guideline requires that noise from light rail traffic be identified and assessed independently of noise from other sources. The *RING* states that the acceptable operational noise levels for light rail take into account that existing roadways can be converted into light rail corridors. This approach is consistent with that generally taken for other major infrastructure projects, such as heavy rail and roads.	WM considers the response adequate.

Table 5.10.7 Operational Noise Impacts – Randwick

Submission No.	Specific Issues Raised in Submissions	Response to Specific Issues	WM Review Comment
48	a) The proposed aboveground substation at High Cross Park would have an unacceptable noise impact on the area.	The substation aboveground at High Cross Park would be designed to meet the noise criteria required by the NSW *Industrial Noise Policy* (for a copy refer to http://www.epa.nsw.gov.au/noise/industrial.htm). At High Cross Park the relevant criterion is 48 dBA L_{Aeq} which is equivalent to the predicted L_{Aeq} noise level. The main noise source at substations is the transformers. Noise from transformers can be readily mitigated by design of an appropriate acoustic enclosure. Substations are expected to be enclosed in any case, for safety and aesthetic reasons, even when enclosure is not required to meet the noise goals.	WM considers the response adequate.
80, 129, 195, 327	b) Concerned about noise impacts on adjacent residences (including Doncaster Avenue) during proposed 24-hour operation of stabling facility.	The Randwick stabling facility would be required to meet the noise criteria defined in the NSW *Industrial Noise Policy* for a copy refer to http://www.epa.nsw.gov.au/noise/industrial.htm). This Policy sets noise limits to protect the amenity of residential land uses, on the basis of the noise environment at the affected locations prior to construction of the facility. This means that noise emissions from the stabling facility would need to be carefully controlled, particularly during the night time period when existing background noise levels are low. During the detailed design stage, a review of the operational noise impacts of the facility would be prepared, which would confirm the design of noise mitigation measures. The facility would also be subject to noise compliance measurements after opening, to assess compliance with the noise goals and to determine whether any additional mitigation is required. Section 15.5.4 of the EIS (Volume 1B) identified potential mitigation measures to meet the *INP* criteria, including an acoustic shed, review of operational practices and noise barriers. With these measures in place, it is considered that the noise impacts of the facility on adjacent Doncaster Avenue residences would be controlled within acceptable limits.	WM considers the response adequate. Refer to WM further comments in Section 3.9.
242	c) Concerns that noise experienced in the area (Randwick) will increase as customers have to change services/modes.	While it is recognised that noise generated by members of the public can disturb others, there are no guidelines applicable to noise generated by people in these circumstances. Generally, noise from members of the public would not be considered to be 'offensive noise' as defined in the NSW Protection of the Environment Act 1997.	WM considers the response adequate.
231	d) Concerned about the impact of operational noise on Wansey Road residents.	Operational noise impacts on Wansey Road residents are expected to comply with the guidelines administered by the EPA for noise from light rail operations (the *RING*). It is acknowledged that the CSELR would introduce a new noise source in this area, with the impacts considered to be within acceptable levels for residential amenity. The CSELR design along Wansey Road is also proposed to be modified as explained in section 6.11 of this Submissions Report. This is expected to reduce noise impacts in Wansey Road in some cases (refer section 6.11.3), where the light rail tracks for part of Wansey Road would be lower than the road level by up to 2 metres.	WM considers the response adequate.

Table 5.10.8 Operational Vibration Impacts

Submission No.	Specific Issues Raised in Submissions	Response to Specific Issues	WM Review Comment
415	a) Concern about vibrations along George Street and possible damage to QVB.	The levels of vibration to cause damage to buildings tend to be at least an order of magnitude (10 times) greater than levels considered acceptable by people. This also applies to heritage buildings, unless they are structurally unsound. For this reason, the controlling operational vibration criterion at most locations is determined by the criteria for human responses which are more stringent than criteria for damage to building contents or structures. The CSELR system would be designed to meet the appropriate operational vibration goals to prevent damage to structures.	WM considers the response adequate.
235, 331, 271, 242, 311, 334, 418, 444, 446	b) Concern about operational vibration in Surry Hills, including Devonshire Street: • Buildings, including residences, along Devonshire Street will not be able to structurally withstand the vibration from LRVs. • LRVs moving up and down from the hill at Devonshire Street will experience stress on the motor and suspension system, generating vibration and noise.	Please refer to section 5.10.1 of this Submissions Report for discussion of the operational noise and vibration review during detailed design. The levels of vibration that can cause damage to buildings tend to be at least an order of magnitude (10 times) greater than levels considered acceptable by people. This also applies to heritage buildings, unless they are structurally unsound. For this reason, the controlling vibration criterion at most locations during operations is determined by the criteria for human responses, which are more stringent than criteria for damage to building contents or structures. Operational vibration levels would be designed to meet the human comfort criteria, and therefore the risk of damage to buildings and structures due to light rail movements is extremely low, if not negligible. No exceedances of the human comfort criteria for operational vibration are predicted for the Surry Hills Precinct or elsewhere. With regard to the concern about increased noise and vibration due to stress on the motor and suspension system up hills, the LRVs would be electric and would be designed to be compatible with the gradients along the route. Increased noise and vibration impacts due to gradient are not expected. The noise and vibration emissions would be subject to compliance measurements after opening to verify that this is the case.	WM considers the response adequate.
327	c) Concerned about vibration impacts from stabling facility on Doncaster Avenue residents.	The design of the Randwick stabling facility, including track and turnouts, would be required to meet the human comfort vibration goals at residential premises, as defined in *Assessing Vibration: A Technical Guideline* (DEC, 2006). As LRVs would be travelling very slowly into and within this facility, vibration levels are expected to easily comply with this guideline.	WM considers the response adequate.

Table 5.10.9 Management and Mitigation of Operational Noise and/or Vibration – Surry Hills

Submission No.	Specific Issues Raised in Submissions	Response to Specific Issues	WM Review Comment
92, 98, 105, 168, 170-174, 176, 181, 187-189, 191-194, 323, 334, 413, 427, 447	a) Criteria, conditions and restrictions on noise/vibration, including: • Need for stringent conditions to ensure adherence with prescribed acceptable noise and vibration limits for residential properties. • Concern that the State Government has recently changed the criteria for acceptable noise levels from light rail vehicles to match those of heavy rail operations. • General residential noise restrictions should apply as LRVs will operate during the night time. • Need for compliance with EPA guidelines.	P&I is responsible for placing conditions on the proposal for construction and operations, with the conditions requiring adherence to the relevant guidelines administered by the EPA. The relevant operational noise guideline is the EPA's *RING* (at http://www.epa.nsw.gov.au/noise/railnoisegl.htm). This guideline came into effect in May 2013. Prior to introduction of this guideline, the noise criteria applicable to light rail noise at residential receivers for day/evening/night time periods were determined on a case-by-case basis. For the existing Sydney light rail, these criteria were L_{Aeq} (average) noise levels of 60 (daytime)/55 (evening)/50 (night) dB. The criterion for L_{Amax} (maximum) noise emissions was 82 dB. The daytime period was defined as being from 7.00am to 7.00pm, the evening period from 7.00pm to 11.00pm and the night period from 11.00pm to 7.00am. The *RING* brings the day/evening/night periods in line with the day/night periods used for other road and rail projects. There has been no change in the night time L_{Aeq} (average) goal, except to make it applicable from 10.00pm to 7.00am, rather than 11.00pm to 7.00am, which is effectively more stringent than the previous Sydney light rail criterion. The daytime L_{Aeq} (average) goal is set at the same level as previously, but the daytime period now extends from 7.00am to 10.00pm rather than from 7.00am to 7.00pm. There is now no defined evening goal, which is consistent with guidelines for heavy rail and for road traffic noise. The maximum noise goal under the new guideline is 80 dBA, which is 2 dB more stringent than the previous criteria. It is noted that it is not mandatory to achieve the noise goals (trigger levels) defined in the *RING*. Where the noise trigger levels are exceeded, feasible and reasonable mitigation measures that could be implemented to reduce noise down the relevant overall trigger level must be considered. If it is reasonable to achieve these levels, the proponents should do so. The assessment should provide justification if the trigger levels cannot be met. An assessment of the acceptability of residual impacts should also be provided. Feasibility generally relates to engineering considerations and what can practically be built. While, reasonableness relates to a judgement taking into consideration factors such as noise mitigation benefits, cost, aesthetic impacts, noise levels and community views. The EIS identifies that there are locations along the alignment (in parts of Surry Hills), where the operational noise trigger levels are predicted to be exceeded. Potential mitigation measures are discussed in the EIS, but the feasibility of all these options requires further investigation, including realistic rolling stock noise goals, operational impacts of speed restrictions, durability and maintenance requirements for absorptive trackforms and confirmation of the effectiveness of absorptive trackforms.	WM considers the response adequate.

Submission No.	Specific Issues Raised in Submissions	Response to Specific Issues	WM Review Comment
		Even with a combination of mitigation measures, the EIS identifies that residual exceedances of the noise goals are likely to remain at some locations.	
18, 160, 168, 170-174, 176, 181, 187-189, 191-194, 238, 312, 323, 366 403, 407, 413, 418, 447	b) Trackform or trackbed issues, including: • Consider low noise/vibration tracks along the entire length of Devonshire Street. • Use continuous rails along Devonshire Street to reduce noise emissions at expansion joints. • Use maximum noise reducing beds below the tracks. • Construct the track base to limit vibration impacts. • Use materials, structures and technologies that reduce noise and vibration impacts - especially for the construction of rail base and rails. • Set track in insulation in grass lawn between Central and Moore Park. • Use high attenuation track forms near residential buildings and sensitive receivers. • Include cost of including noise reducing beds beneath light rail tracks included in cost/benefit analysis.	Based on the EPA's *RING*, mitigation of operational noise is only required to be considered where the trigger levels identified in the guideline are exceeded. In this instance, residential properties west of Marlborough Street, within the Surry Hills Precinct fall within this category. Consequently, further investigation would be undertaken in the detailed design stage at these locations to examine whether potential noise and vibration mitigation measures identified in the EIS are reasonable and feasible. Feasibility generally relates to engineering considerations and what can practically be built. While, reasonableness relates to a judgement taking into consideration factors such as noise-mitigation benefits, cost, aesthetic impacts, noise levels and community views. Absorptive trackforms are one of a number of mitigation measures to be examined in more detail for Surry Hills, with cost versus benefit being one of the factors to be considered in determining what mitigation is feasible and reasonable. An operational noise and vibration review would be prepared to confirm the noise impacts and determine the final form of mitigation to be provided. Technical Paper 11 in the EIS, Volume 6 (refer Table 21) identifies that high-resilience (vibration mitigating) trackforms are likely to be required throughout the Surry Hills Precinct to control groundborne noise and vibration impacts. Continuously welded rails are proposed to be used throughout the proposal area.	WM considers the response adequate.
233, 235, 237, 271, 312, 323, 389, 404	c) Other management/mitigation measures: • Use noise barriers to mitigate noise impacts on properties in quiet streets. • Run light rail for limited hours (not late at night or early in the morning). • Run LRVs at a frequency of every 5-10 minutes (or less frequently) to minimise noise and vibration impacts.	Noise barriers are not considered appropriate in urban, city centre environments and/or where embedded rail (flush with the road surface) is installed, in order to allow easy pedestrian and vehicular access across tracks. Barriers would prevent pedestrian and vehicular access across tracks and would also have substantial amenity impacts. The proposed noise mitigation strategy is therefore to reduce the source level as far as possible, using best practice measures such as more stringent noise specification for LRVs, higher absorption track forms, speed restrictions, and minimising track and wheel roughness to minimise noise and vibration impacts. The EIS identifies that the expected hours of service operations would be from 5.00am until 1.00am; however, the frequency of services is likely to vary with demand. For example, the service may vary from	WM considers the response adequate.

Submission No.	Specific Issues Raised in Submissions	Response to Specific Issues	WM Review Comment
	• Enforce slower light rail travel (20 kilometres per hour). • Request for compensation due to noise and vibration impacts on residents, or reimbursement for the costs of soundproofing solutions for residents and businesses in Devonshire Street. • Request for conditions of approval to include the management of motorcycle/excessive noise emissions in the noise catchment areas. • Any road surface treatment on Devonshire Street to discourage cyclists should be such that it does not increase noise from motor vehicle movements.	every three minutes during peak times (7.30am to 9.30am and 5.00pm to 7.00pm) to a service every 10 minutes between 10.00pm and 7.30am. The noise impacts in Surry Hills and elsewhere would therefore be greatest during peak times and on special event days, and less at other times. As described in section 5.4.2 of the EIS (Volume 1A), LRVs would generally operate within the existing posted road speeds (with the exception of dedicated corridor sections and the George Street pedestrian zone). However, the option of speed restrictions to 30 kilometres per hour during the night time between the Central Station and Surry Hills stops (with the exception of during special events) is also proposed to be further considered during detailed design. Any further restrictions would have an unacceptable impact on travel times along the CSELR. In the event that the proposal's operational noise goals cannot be met, property treatments for residential receivers would be considered as a last-resort mitigation measure in accordance with the EPA's *RING*. Considerations of property treatments are only applicable in the event that the noise goals cannot be met through other means. Also, as identified in the EIS, it is proposed that minor (1 dB to 2 dB) residual exceedances of the noise goals after application of reasonable and feasible source mitigation measures would be accepted without treatment, as these levels are barely audible. Financial compensation for noise and vibration impacts would not be provided; however all feasible and reasonable measures to mitigate noise and vibration impacts in accordance with the relevant EPA guidelines would be implemented. Retail premises are not considered to be 'sensitive receivers' under the RING and would not be eligible for compensation or soundproofing treatments. Noise from motorcycles on Elizabeth Street and Devonshire Street is outside the control of the proposal. Excessively noisy vehicles can be reported to the EPA via its website, http://www.epa.nsw.gov.au/noise/noisyexhaust.htm. Any changes to road pavement surfaces would need to consider and minimise the potential for a resultant increase in noise from road traffic.	

Table 5.10.10 Management and Mitigation of Operational Noise and/or Vibration – Other

Submission No.	Specific Issues Raised in Submissions	Response to Specific Issues	WM Review Comment
88	a) Hotel in City Centre Precinct requests ongoing consultation regarding hours of noisy works, to ensure guest satisfaction.	The community (including affected hotels and other businesses) would be informed about upcoming works throughout the construction period using a combination of means described in the EIS (refer Chapter 2 in Volume 1A). This includes regular mailed out notifications, the proposal website, an email distribution list, the proposal Info-line and the Construction Response Line. Specific notifications, phone calls and individual briefings would also be available if requested.	WM considers the response adequate.
90	b) The impact on the Moore and Centennial Parks Precinct is unacceptable without a clear plan to replace any sound abatement mounds in the Robertson Road area.	The operational noise levels at residential receivers in the Robertson Road and wider area are predicted to comply with the noise goals as defined in the EPA's *RING*.	WM considers the response adequate.
182	c) Property treatments should be used as an absolute last resort in noise mitigation strategies. Reduce the noise impact in the design and planning phases using some of the other options proposed in the EIS. Expresses support for vegetated trackforms, which has been successfully implemented in Europe.	It is agreed that property treatments are a last-resort mitigation measure, and are only applicable in the event that the noise goals cannot be met through other means. However, the other mitigation measures described in the EIS require further investigation to determine if they are feasible, reasonable and effective. Even with a combination of mitigation measures, the EIS identifies that residual exceedances of the noise goals are likely to remain at some locations. For this reason, property treatments are included in the list of potential mitigation measures. An operational noise and vibration review would be prepared in the next stage of the proposal to determine the final design of mitigation measures, and to identify any residual exceedances of the operational goals. This review would include investigation of absorptive trackforms and other noise and vibration reducing trackform designs.	WM considers the response adequate.
271, 312, 323, 331, 389, 413, 428, 447, 449	d) Provide double glazing for windows and insulation of residences and businesses in close proximity to proposed stops to mitigate against noise impacts. e) Assess the need for, and provide, solid wood front doors, screening and sound walls for affected residents.	As noted in row c) above, and in the EIS, property treatments are considered a last-resort mitigation measure under the EPA's *RING*, and are only applicable in the event that the noise goals cannot be met through other means. As identified in the EIS, the operational noise levels are predicted to comply with the *RING* at all locations with the exception of parts of Surry Hills (residential receivers). Noise barriers are not considered appropriate in urban, city centre environments in order to allow easy pedestrian and vehicular access across tracks. Barriers would prevent pedestrian and vehicular access across tracks and would also have substantial amenity impacts.	WM considers the response adequate.

Submission No.	Specific Issues Raised in Submissions	Response to Specific Issues	WM Review Comment
403	f) Use subsurface technology and construction methods to isolate vibration caused by light rail operation.	The EIS (refer Table 21 in Technical Paper 11, Volume 6) identifies that high-resilience (vibration-mitigating) trackforms are likely to be required at various locations along the CSELR alignment to control ground-borne noise and vibration impacts (including through parts of the City Centre, Surry Hills, Randwick and Kensington/Kingsford precincts where sensitive receivers line the route). This is subject to further investigation during detailed design.	WM considers the response adequate.
447	g) Ensure light rail rolling stock has quiet operation.	The noise emissions of rolling stock would be controlled by specification of best practice noise emissions in the acquisition of rolling stock, as well as requirements for the future Operator to maintain track and rolling stock to minimise noise emissions.	WM considers the response adequate.
299	h) Use absorptive paving materials to mitigate operational noise impacts for residents of Wansey Road.	The operational noise levels at residential receivers on Wansey Road are predicted to comply with the noise goals as defined in the EPA's *RING*. An operational noise and vibration review would be prepared in the next stage of the proposal to confirm the EIS predictions, and to identify any residual exceedances of the operational noise levels (refer to mitigation measures B.1 to B.4 in the revised list of mitigation measures in Chapter 8 of this Submissions Report). This review would include investigation of absorptive trackforms and other noise and vibration reducing trackform designs at locations where the RING noise trigger levels are exceeded.	WM considers the response adequate.
347	i) Given the sensitive nature of tenant businesses within the Dymocks Building, utilise high resilience rail bedding adjacent to the building to reduce vibrations of the LRVs.	Technical Paper 11 of the EIS (refer Table 21 in Volume 6) notes that standard trackform is likely to be employed between Bathurst Street and the Wynyard stop because of the low LRVs speeds proposed in this zone. Notwithstanding this, there are a number of different trackform designs available for light rail systems. The final design would be confirmed in the detailed design stage, with consideration of the requirements for vibration mitigation at all sensitive receivers along the alignment in accordance with the relevant guideline (*Assessing Vibration: A Technical Guideline*, DEC 2006).	WM considers the response adequate.

Table 5.10.11 Noise and Vibration Impact Assessment/Approach and/or Scope

Submission No.	Specific Issues Raised in Submissions	Response to Specific Issues	WM Review Comment
299, 312, 323, 354, 407, 433	a) Noise monitoring/measurement issues: • Data collected during noise monitoring at 3 Wansey Road will be significantly influenced by road traffic noise on Alison Road. Existing noise levels should be measured at the midpoint of Wansey Road which correlates with the location that light rail would be operating at its highest speed. • Further noise monitoring is required to establish accurate existing levels and evaluate operational noise impacts during special events. • Concerned that noise levels recorded for the EIS (Surry Hills) were taken from outside a noisy local pub; not representative of neighbourhood noise levels. • Concern that noise recordings were taken in an environment that cannot be compared to Surry Hills. • There must be clear rules on noise measurement to determine EPA guidelines are being met at all points along the route at all times during operation. • Concern that noise monitoring results are described in terms of noise sources but do not distinguish between types of motor vehicle noise.	The noise logger placement at number 3 Wansey Road was chosen for its proximity to the light rail stop location proposed in the EIS. The existing noise environment at the logger locations is used to determine appropriate construction noise management levels, and operational noise goals for fixed facilities such as light rail stops (e.g. public address system noise). As described in section 6.11 of this Submissions Report, the location of the Wansey Road stop is now proposed on Alison Road near the corner with Wansey Road. The noise monitoring location is also considered appropriate for this relocated stop. The operational noise goals and assessment of impacts for LRVs are defined in the EPA's *RING*, and are independent of the existing noise environment. This comment also applies to special events – the operational rail noise goals are independent of existing noise from road traffic or other sources. Placing noise loggers is subject to receipt of permission from the landowner/occupier, and the security of the equipment. The position at 158 Devonshire Street was selected after failure to gain permission at nearby suitable residential properties. The results reported remain representative of the ambient noise environment at that location. It is noted that there are several licensed venues distributed along Devonshire Street and that all these venues contribute to the ambient noise environment. Notwithstanding this, the logger at 158 Devonshire Street was not used in the assessment of noise impacts – operational rail noise goals are independent of the existing noise environment, and construction noise management levels for the Surry Hills Precinct were based on the noise logger results from 44 Parkham Street, which is expected to be conservative for other locations along Devonshire Street. The specific proposal requirements for post-operational noise compliance measurements would be defined by the Conditions of Approval for the proposal (if approved). Rail noise measurements would need to be undertaken in accordance with the relevant Australian Standards, including AS 2377-2002 *Acoustics – Methods for the measurement of rail bound vehicle noise* and AS 1055-1997 *Acoustics – Description and measurement of environmental noise.* The attended measurements as reported in Technical Paper 11 in the EIS (Volume 6) are intended to provide indicative information on the maximum noise emissions from different sources at each location.	WM considers the response adequate.

Submission No.	Specific Issues Raised in Submissions	Response to Specific Issues	WM Review Comment
347, 354	b) Appropriate noise goal/classification as sensitive receiver: • Concern that external noise trigger levels have been adopted in the EIS on the assumption that a 25 dB attenuation outside-to-inside is applicable to the sensitive receptors without confirmation that the assumption is valid. • The Dymocks Building should be classified as an educational facility and be included in Table 12.32 of the EIS and as a sensitive receiver in Table 14.3.1 of Technical Paper 11. • The Quaker Meeting House is a sensitive receiver. Its form of worship is characterised by people gathering together in a meditative kind of worship. Therefore, the internal noise goals would be more appropriate at a lower level, for instance at a drama theatre level.	The assumption of a 25 dB outside-to-inside attenuation has been applied to recording studios, theatres and auditoria, and cinemas. This assumption would be confirmed during the detailed design stage; however, it is noted that these receiver types are typically well insulated from external noise break in. In most cases, a greater attenuation to noise-sensitive spaces within these buildings would be expected than was assumed in the EIS. The 'educational' uses in the Dymocks Building are businesses providing vocational adult training, with an expected similar sensitivity to construction noise as general office spaces. These businesses are also in the upper levels of the building (levels 7-10), so are not the most affected occupants of the building. The most affected levels of the Dymocks Building are considered to be commercial receivers as defined by the relevant guidelines. The sensitivity of the Quaker Meeting House as a Place of Worship is noted. The EIS identifies that the operational noise impacts at this location have the potential to exceed the noise goals, triggering consideration of noise mitigation measures. The operational noise and vibration review to be prepared during the detailed design phase of the proposal would include investigation of source noise control, and any requirements for treatment of individual sensitive receivers. Inspection of the Quaker Meeting House to determine the existing internal noise environment and the attenuation across the facade would form part of the review of reasonable and feasible mitigation measures.	WM considers the response adequate.
299, 327, 354, 433	c) Additional assessment required: • The EIS does not include an assessment of vibration and ground-borne noise impacts from the stabling facility on residents of Doncaster Avenue. Transport for NSW should demonstrate impacts on adjoining residential properties are acceptable. • Concern that noise assessment is incomplete. Approval should only be granted with conditions for proper assessment, verification, options and budget for noise mitigation for consultation	It is anticipated that the design of the stabling facility would incorporate measures to mitigate ground-borne noise and vibration in accordance with the relevant guidelines. These impacts would be assessed during preparation of the operational noise and vibration review in the detailed design stage. The concern that approval should only be granted with conditions is noted. The noise impact assessment has been undertaken in accordance with the Director General's Requirements for the EIS. The predicted impacts would be refined, reviewed and verified going forward, both during the detailed design stage and during post-operational compliance measurements. There would be ongoing consultation and engagement with affected premises throughout this process. The EIS identifies that there is potential for a reduction in existing road traffic noise impacts along Devonshire Street, due to the closure of the street to westbound traffic. The impacts of road traffic changes would be refined, reviewed and verified going forward to the detailed design stage.	WM considers the response adequate.

	with affected premises ('sensitive receivers'). • Concern that noise impacts of proposed traffic changes to Devonshire Street have not been assessed. Requests that operational road and traffic noise impacts be assessed based on actual changes later in proposal to inform mitigation strategy for operational noise. • P&I should undertake independent noise and vibration studies.	The NSW EPA has had involvement in the planning approval process for the CSELR proposal and has reviewed the noise and vibration impact assessment.	
433	d) Clarification needed: • Notes that the EIS is unclear about how the noise footprints were derived. • Notes the noise and vibration assessment for Devonshire Street uses unclear LRV speeds.	The inputs to the noise contours in the EIS have been derived from operational noise modelling as described in section 5.4 of Technical Paper 11 (Volume 6 of the EIS). The speeds used in the noise and vibration assessment are shown in Figure 5 in Technical Paper 11. Along Devonshire Street, the maximum modelled speed is 40 kilometres per hour when travelling away from the city, and 45 kilometres per hour when travelling towards Central Station. Speeds would be less near stops, and intersections with roads.	WM considers the response adequate.