Construction Noise Management Planning

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ABSTRACT

Construction works can cause significant noise and vibration impacts if not managed properly. Often a lack of project information at the environmental assessment (pre-approval) stage leads to generalised statements about noise and vibration impact and lists of standard management practices. Generalised statements can greatly hinder an understanding about expected noise impacts and lists of standard management practices can make it appear that no further consideration of noise management is needed. Many construction noise impact statements focus on quantifying the expected construction noise levels, however few follow this with a clearly documented examination of what feasible and reasonable practices will be applied to manage the identified impacts. This paper presents two case studies based on real life construction projects. The first case study illustrates what can happen on a medium-sized construction project in an urban area without a noise management plan in place, and to also outline what can be the key features of a noise management plan. The second case study outlines how a clear and concise construction noise management plan prepared during the post-approval stage can greatly assist in communicating to the project team, regulator and the community what are the identified noise impacts and how will they be managed. Also discussed is an 'impacted zone' approach for large and complex projects to precisely understand the extent and location of noise impacts.

INTRODUCTION

RailCorp undertakes a large range of construction works in and around the rail network in New South Wales. Even with an environmental assessment that meets the basic legislative framework, more careful noise management at the post-approval stage is needed on many construction projects.

This paper presents two case studies; Case Study A illustrates what can happen without a project-specific construction noise management plan in place, and Case Study B illustrates how a concise noise management plan prepared prior to commencing the works and customised to the work undertaken can greatly assist in managing construction noise impacts well. As background to the two case studies below, RailCorp is currently implementing a program of upgrading almost 100 train stations to improve commuter access (for example lifts for people with impaired mobility).

Environmental impact is assessed under the *Environmental Planning and Assessment Act* (NSW Government 1979) (herein "EP&A Act"). This typically occurs well in advance of appointment of the works contractor so limited construction methodology information is available, limiting the assessment to generalised statements about noise impact and lists of standard management practices. It follows that assessing noise impact at the pre-approval stage is alone unlikely to be sufficient to properly manage noise. Careful noise management at the post-approval stage is also needed, including collaboration with the contractor.

REGULATORY FRAMEWORK

In 2009 the Department of Environment and Climate Change NSW (now OEH) published the *Interim Construction Noise Guideline* (DECC 2009) (herein "ICNG"). The ICNG provides useful guidance on managing construction noise, including information on recommended standard work hours and noise management levels. Most importantly, the ICNG provides extensive information on a range of work practice options for managing construction noise. The intention of the ICNG is not that the project team solely "cut and paste" these practices into noise management plans, instead work practices should be selected through collaboration between the noise specialist and the Principal Contractor.

Conditions of approval such as requiring the Principal Contractor prepare a construction noise management plan prior to commencing works are a means of effectively regulating noise once approval is granted.

CASE STUDY A: WHAT CAN HAPPEN WITHOUT A NOISE MANAGEMENT PLAN

Environmental assessment

A train station upgrade project was located in an urban area with the nearest residences around 45 metres away, as shown in Figure 1. The project involved a mix of above and below ground work to demolish existing structures and construct lifts and associated new structures, with a planned project duration of around 12 months. The daytime and evening noise environment was largely influenced by road traffic noise, with noise levels reducing around 7dB during the night as road traffic lessened. Noise sensitive locations were both external to the station (eg residences) and also internal (eg retail, commuters, station staff).

RailCorp prepared a Review of Environmental Factors for the project. Given limited construction methodology information available at the time of preparing the environmental impact assessment (EIA), the noise assessment assumed a range of construction noise levels and proposed work hours. Noise impact during out-of-hours works was underestimated in the environment assessment (although this was only later known following a night-time noise complaint). The conditions of approval included a requirement that an environmental management plan be prepared (though there was no specific reference to noise).

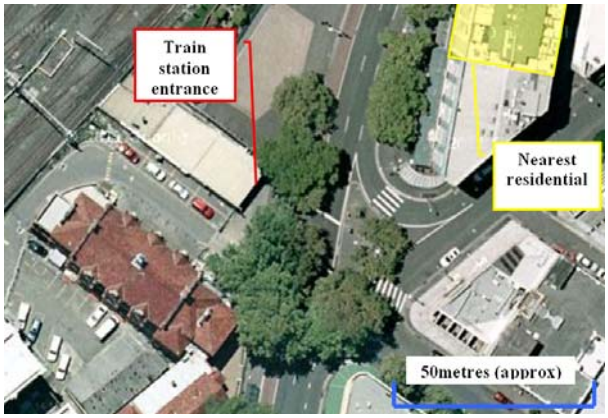

Figure 1. Case Study A: project site and nearby residential buildings (image courtesy of Google Maps)

Subsequently a Principal Contractor ("PC" herein) was awarded the contract. The principal contractor included in their environmental management plan generalised wording on how construction noise will be managed, for example "noise is to be kept to a minimum so as to not cause environmental nuisance" and "noise and vibration output in response to bona fide complaints will be monitored".

Noise complaints

Soon after the PC commencing work, RailCorp station staff made a complaint about noise from the works within the underground ticketing area. In response to the noise complaint, and contrary to the preferred daytime construction hours stated in the PC's environmental management plan, the PC decided to undertake work at night to avoid noise impacts within the station. Shortly after, RailCorp and the regulator (OEH) received a complaint from a nearby resident about drilling and jackhammering over several consecutive nights near the station entrance.

Understanding noise impact

The noise complaint for night-time works highlighted the need to avoid night works wherever possible, however increased works during the day would have greater impact on commuters, retail and staff within the underground train station if not managed properly.

After receiving the noise complaint from a nearby resident, the PC engaged an noise specialist to advise on managing noise from the works. The noise specialist undertook short-term (approximate duration 15 minutes) attended noise measurements of background noise as well as short-term attended measurements of noise from specific equipment.

The measurements overestimated the daytime background noise levels by around 10 dB (only known much later with long-term noise monitoring). In addition noise levels presented in the noise specialist's report were for specific plant items (for example as shown in Table 1) instead of calculating the total noise from each work stage. This meant the PC had inadequate information on noise impact.

Table 1 shows that noise from all works would be above the management levels during evening and night (therefore indicating noise impacts likely).

Table 1. Measured $L_{Aeq,15minute}$ noise from specific plant

Work stage	*Predicted level with mitigation (dBA)*	*Noise Management Level (dBA)*		
		Day	*Evening*	*Night*
Jackhamner + Compressor	69	75	62	54
Rock/Concrete Saw	71			
Excavator with hammer attachment	71			

The PC installed some temporary hoarding within and around the station as shown in Figures 2, 3 and 4, however as the estimated noise level reduction was not quantified the PC was not able to determine if other controls were also required.

Figure 2. Temporary hoarding at station entrance

Figure 3. Commuters and retail within station

Consequently, the PC limited work hours to 9:30am to 2:30pm Monday to Friday and 9:30am to 1pm Saturday to address the night-time noise complaint, while attempting to manage noise impact on commuters, retail and ticketing staff at peak times within the train station.

The PC delivered notification letters to residences around the train station, an extract is below:

> There will be some noisy work from construction and the removal of materials however, to ensure noise is kept to a minimum no heavy machinery will be used and only hand tools will be used.

Residents who received the notification may have found it difficult to understand how loud the work will be or how long the noisy work will last.

Figure 4. Temporary hoarding within underground station

The PC's noise report assessed impacts at external sensitive locations, however lacked an assessment of speech intelligibility at internal locations (the assessment failed to adequately address noise impact on station staff and commuters as it included only a comparison with occupational health and safety noise limits).

Comprehensive noise impact assessment

Limiting work hours caused substantial project delays. To avoid further project delays, RailCorp requested the PC engage another noise specialist to firstly prepare a comprehensive noise impact assessment report and secondly a noise management plan tailored to the works. The noise assessment report was to assess impact at both external and internal locations, aimed at informing the noise management plan.

Key features of the noise impact assessment report were:

- Project description including typical equipment for each main stage of work.
- Results from long term background noise monitoring.
- Noise management levels for external (residential) sensitive locations consistent with the ICNG
- Noise management levels for internal (commercial) sensitive locations, based on managing speech intelligibility and protecting against hearing loss.
- Predicted noise levels for each of the main stages of work (see Table 2), validated by measurements.
- Recommended feasible and reasonable work practices to be implemented for each main stage of work
- Estimated noise level (dB) reduction from each work practice.

Table 2. Predicted $L_{Aeq,15minute}$ noise levels at residences

Main work stage	*Predicted level with mitigation (dBA)*	*Noise Management Level (dBA)*		
		Day	*Evening*	*Night*
Delivery of plant/equipment	58	65	62	53
Demolish old structures	72			
Install gantries	59			
Install new structures	67			

Key features of the noise management plan were:

- Identified sensitive locations, external and internal.
- Summary of expected noise impacts.
- Clear description of work hours to balance external and internal noise impacts
- Commitment to work practices that will be implemented to manage noise
- How complaints will be handled
- Monitoring and reporting processes
- How often the plan will be reviewed and updated to continuously apply best practice noise management.

Noise management plan

As a result of the noise management plan the PC was able to identify where work hours could be extended without risk of further noise complaints (for example, deliveries and installing gantries) and identify a process to follow should additional out of hours work be required for safety reasons. An extract of typical notification the PC regularly provides the community is given below.

> The removal of the hoarding at station entrance will take place on Tuesday 22nd March between 11pm and 5am. For the safety of pedestrians the entrance will be closed during this work. The removal of the hoarding requires the use of hand tools, forklifts and a semi trailer and may be noisy.

The information is clear, concise and explains what work is being done, when and for how long. This greatly helps the community manage expectations about noise from the works. This project is now progressing well, with minimal noise complaints.

One less positive point to note; the PC's construction noise impact statement was 79 pages in length. As a result the PC had difficulty understanding what work could be done outside standard daytime hours without increasing the risk of noise complaints. The noise management plan was 47 pages in length; the reality of construction management is that such a lengthy plan is unlikely to be implemented effectively.

CASE STUDY B: HOW A PLAN HELPS TO PROACTIVELY MANAGE NOISE

Another train station upgrade project was located in an inner-city urban area, between 15 and 60 metres from the nearest residential building as shown in Figure 5.

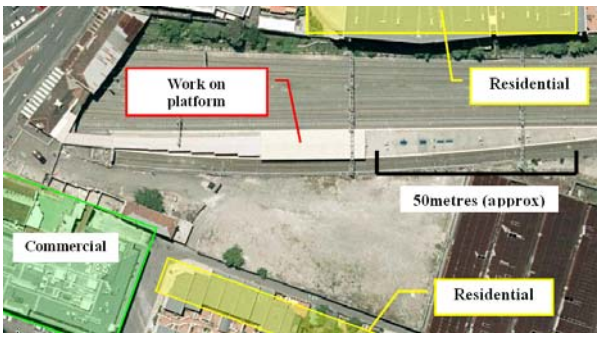

Figure 5. Case Study B: project site and nearby residential buildings (image courtesy Google Maps)

Environmental assessment

The environmental assessment included a brief assessment of construction noise but was mainly focused on operational

noise. Due to the nature of works at the station, works were separated into two main contracts. The Stage 1 contract did not specifically require a construction noise management plan to be prepared though RailCorp did work closely with the contractor in an attempt to have some noise management and monitoring documented and applied. However at the end of Stage 1 there was a complaint about noise from concrete trucks arriving site at 6:00am (an hour before the approved start time).

Noise impact statement

In response to the noise complaint occurring during Stage 1, the contract for Stage 2 included a requirement for the PC to prepare a construction noise management plan prior to commencing the works. The planned duration for Stage 2 was approximately 18 months. The PC for Stage 2 engaged an noise specialist to prepare a construction noise impact statement and construction noise management plan for works during standard construction hours.

The construction noise impact statetment focussed on:

- A brief description of the project and typical equipment for each main stage
- Measured background noise levels (obtained during Stage 1) and identified noise management levels consistent with the ICNG
- Predicted noise levels for each main stage of work and comparison with the daytime noise management level (see Table 3).

Noise management plan

The plan was concise (approximately 20 pages in length) yet included:

- A summary of the project, work hours and expected noise impacts
- An examination of what feasible and reasonable work practices will be applied to manage noise (this list was developed in collaboration with the PC to check all recommendations were realistic).

Table 3. Predicted $L_{Aeq,15minute}$ noise levels for main work stages – at nearby residences

Work stage	*Predicted range of noise levels (dBA)*	*Daytime Noise Management Level*
New station concourse	53-75	Noise Affected 57 dBA Highly Noise Affected 75 dBA
Refurbish buildings B and C	62-78	
Refurbish Booking House	50-66	
Refurbish Bridge House	50-54	
Various external work	73-78	

As shown in Table 3, the plan identified that the various external work may result in noise levels exceeding the Highly Noise Affected management level of 75 dBA. The plan recommended work practices that will be implemented to manage construction noise and indicated that the practices (such as temporary hoarding shown in Figure 6) would reduce the predicted noise levels by around 5 to 10 dB.

Figure 6. Temporary hoarding used on station concourse

The PC also prepared additional noise management plans which were used in seeking RailCorp approval for work outside standard hours (such as during weekend rail shutdowns to minimise impacts on train services). These noise management plans have detailed specific control measures for the activities occurring and have enabled high noise activities to be successfully carried out round the clock over a weekend period with limited noise complaints.

Again the success of these noise management plans primarily results from the noise specialist working closely with the PC when developing recommended work practices to manage noise. In most cases it is only possible to do this during the post-approval stage; the key lesson is that contruction noise assessment at the EIA stage can not be relied upon as an adequate means of managing noise during the actual works.

LARGER PROJECTS

Noise catchment zones

Noise catchment zones have typically been used when assessing noise from large and complex construction projects. The zones are normally defined geographically and are based on a single type of land use (eg. residential, commercial or industrial). A noise catchment zone can include a large number of noise sensitive locations. In order to determine a noise management level (NML) for each catchment zone, a representative background noise environment needs to be identified. Typically background noise monitoring is conducted at the expected most noise-affected location (often referred to as a "representative receiver"). Construction noise levels from the works are normally also predicted at this same location.

The distance between receivers in each catchment zone and the works can vary greatly, from several metres to several hundreds of metres. Moreover, the sound propagation path to receivers located on the outer boundary of a catchment zone is typically affected by multiple factors, the most predominant two being shielding from solid objects (such as buildings) and refraction.

The left-hand map of Figure 7 illustrates noise catchment zones used in an actual noise impact assessment study for the construction of a rail yard facility in a densely populated area.

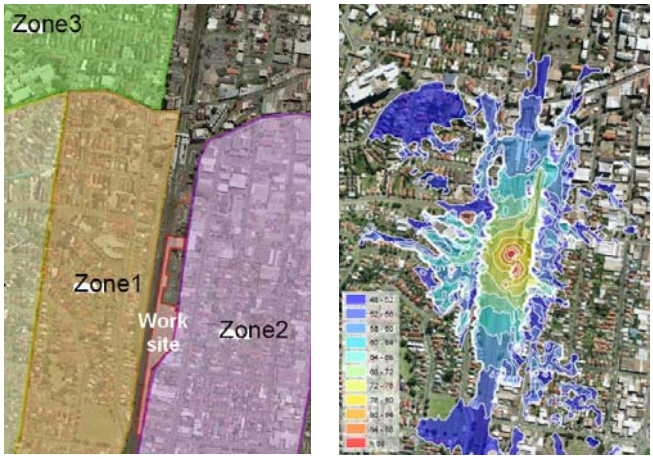

Figure 7. Noise catchment zones (left) and predicted noise contours (right) during the construction of a rail yard facility in a densely populated area. (Courtesy of Novo Rail)

Table 4 presents the results given in the abovementioned study for three of the catchment zones defined on the left-hand map of Figure 7.

Table 4. Results from a construction noise assessment using catchment zones (all results in $L_{Aeq,15minute}$)

Construction ScenarioA				
Zone ID	*Address of "representative receiver"*	*Daytime Noise Management Level (dBA)*	*Predicted noise levels (dBA)*	*Extent above NML (dB)*
1	xxxxxx	52	75	23
2	xxxxxx	49	61	12
3	xxxxxx	48	48	0

Large catchment zones, such shown in Figure 7, can lead to misleading information by potentially overestimating (or underestimating) noise impact at receivers where construction noise level have not been predicted. From Table 4, it is difficult to accept that construction noise will be significantly (for example 20dB or more) above the identified noise management levels for all receivers within one catchment zone. Also, the results in Table 4 do not indicate how far from the works the reported impact actually applies, nor the number of affected receivers. Information about the extent and magnitude of expected noise impact is essential to inform an effective noise management plan for a large or complex construction project.

Impacted zones

An approach that would provide more useful input to a noise management plan would be to establish impacted zones where construction noise levels are predicted to be above the identified noise management levels. Computer noise models and noise contour maps can assist in determining expected construction noise levels in a given area. The complexity of large-scale works and numerous buildings surrounding the project area usually warrants the use of a three-dimensional computer noise model to calculate expected construction noise levels.

The right-hand map of Figure 7 showns the predicted noise contours for the construction scenario of Table 4. The noise contours range from the minimum daytime noise management level (dark blue) to the maximum predicted construction noise levels (red). Comparing the two maps of Figure 7, it is possible to see that overall a fewer number of receivers are expected to be impacted by the works than the total area of catchment zones, and some impacted receivers were not identified by the catchment zone approach.

Some benefits of the 'impacted zone' approach over the 'noise catchment zone' approach for noise management planning purpose are:

- The overall zone predicted to be impacted by the works is clearly identified. This enables the noise management plan to focus on likely to be impacted by the works, rather than all receivers in an arbitrarally large noise catchment zone.
- Noise contours allow impact zones to be categorised based on the level (dB) above noise management levels.
- The number and exact location of receivers in each impact zone can be easily established. This information will greatly assist preparing an effective noise management plan that includes community consultation, monitoring and reviewing relevant to the expected noise impact.

OTHER BENEFITS OF A PLAN

Another good reason for preparing a construction noise management plan is it can also be used to manage workplace noise levels. Many of the at-source engineering practices implemented to reduce environmental noise impacts can also reduce worker exposure to construction noise. Some examples of at-source noise control (WorkSafe 2006) are:

- Using bore piling instead of impact sheet piling
- Lower-noise portable generators
- Ventilation fans (eg for tunnelling) with intake and exhaust silencers, ducts lined and wrapped outside.

CONCLUSION

RailCorp has a strong focus on managing environmental impact from construction and renewal works.

The first key message from the two case studies presented above is that assessing noise impact at the pre-approval stage is alone unlikely to be sufficient to properly manage noise. RailCorp recommends a project's approval conditions require the Principal Contractor prepare prior to commencing works a construction noise management plan that focusses on:

- Understanding where are nearby noise sensitive locations
- Understanding what stages of work will likely generate noise impact
- Planning what times of day noisy works should be undertaken
- Preparing suitably clear and concise notification for the nearby community prior to works
- Applying all feasible and reasonable noise management.

For complex projects, preparing a construction noise impact statement that identifies impacted zones prior to developing a noise management plan helps precisely understand the expected noise impacts, including estimating how many people are likely to be impacted.

The second key message is that collaboration between the noise specialist and the Principal Contractor is essential when selecting what noise management practices will be implemented. This should also be required in the conditions of approval. RailCorp recommends that all construction noise management plans should be prepared with a case-by-case consideration of what noise management practices are rele-

vant to the works. Alone referring to standard lists of practices not specifically developed for the works - such as in the ICNG or the *Construction Noise Strategy (Rail Projects)* (TCA 2010) – is not sufficient.

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