
APPENDIX A

Post-Operational Noise Monitoring Plan

OCTOBER 2014

SAPPHIRE TO WOOLGOOLGA PACIFIC HIGHWAY UPGRADE

Post-Opening Noise Monitoring Plan

28 October 2014

Roads and Maritime Services

TG908-01F03 (rev 2) Post-Opening Noise Monitoring Plan

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1 Introduction

The primary purpose of carrying out post-opening operational noise monitoring is to assess the adequacy of the implemented traffic noise mitigation measures and to identify areas of non-conformance where additional feasible and reasonable noise mitigation measures may be warranted, in accordance with the Minister's Conditions of Approval 3.2 and 3.3.

In general, Condition 3.2 requires that post-opening operational noise monitoring be undertaken within one year of the commencement of operation of the project to compare the actual noise performance of the project against the noise performance predicted in the Operational Noise Management Report (ONMR) which was prepared and submitted in December 2013 as part of the Project's design.

Furthermore, in accordance with Condition 3.3, an Operational Noise Report presenting the findings of the post-opening operational noise monitoring, shall be provided to the Director-General and the EPA (ex DECC) within 60 days of completing the operational noise monitoring work referred to under Condition 3.2, or as otherwise agreed.

The purpose of preparing this Operational Noise Monitoring Plan (the Plan) is to:

- outline the objectives of the proposed post-opening operational noise monitoring,
- identify proposed noise monitoring sites,
- describe the methodology of the proposed post-opening operational noise monitoring work, and
- describe the proposed engine brake testing.

2 Conditions of Approval

The Minister's Condition of Approval 3.2 (Condition 3.2) states:

"No later than one year after commencement of operation of the project, or as otherwise agreed by the Director-General, the Proponent shall undertake operational noise monitoring to compare actual noise performance of the project against noise performance predicted in the review of noise mitigation measures required by Condition 2.24 and prepare an Operational Noise Report. The Report shall include, but not necessarily be limited to:

- a) noise monitoring to assess compliance with the operational noise levels predicted in the review of operational noise mitigation measures required under Condition 2.24 and documents specified under Condition 1.1 of this approval;*
- b) a review of the operational noise levels in terms of criteria and noise goals established in the Environmental Criteria for Road Traffic Noise (EPA 1999);*
- c) methodology, location and frequency of noise monitoring undertaken, including monitoring sites at which project noise levels are ascertained, with specific reference to locations indicative of impacts on sensitive receivers;*
- d) details of any complaints and enquiries received in relation to operational noise generated by the project between the date of commencement of operation and the date the report was prepared;*
- e) any required recalibrations of the noise model taking into consideration factors such as noise monitoring undertaken and actual traffic numbers and proportions;*
- f) an assessment of the performance and effectiveness of applied noise mitigation measures together with a review and if necessary, reassessment of all reasonable and feasible mitigation measures; and*
- g) any additional feasible and reasonable measures, as identified in the review of noise mitigation measures required by Condition 2.24, that would be implemented to comply with the criteria outlined in the Environmental Criteria for Road Traffic Noise (NSW EPA, 1999), when these measures would be implemented and how their effectiveness would be measured and reported to the Director-General and the DECC."*

The Minister's Condition of Approval 3.3 (Condition 3.3) states:

"The Proponent shall provide the Director-General and the DECC with a copy of the Operational Noise Report within 60 days of completing the operational noise monitoring referred to under condition 3.2 of this approval, or as otherwise agreed by the Director-General."

3 Monitoring Methodology

3.1 General Description

Monitoring of operational noise shall be undertaken in accordance with Practice Note viii of the NSW Roads and Maritime Services (formerly Roads and Traffic Authority's) 'Environmental Noise Management Manual' (ENMM) to meet Condition 3.2.

In accordance with Condition 3.2, no later than one year after commencement of operation of the Project, or as otherwise agreed by the Director-General, operational noise monitoring shall be conducted to compare actual noise performance of the Project against noise performance predicted in the review of noise mitigation measures required by Condition 2.24. That is, operational noise monitoring shall compare actual traffic noise levels with the predicted mitigated noise levels and determine whether the intended acoustical outcomes, as presented in the Operational Noise Management Report (ONMR), in accordance with CoA 2.24 and other relevant environmental documents, are achieved.

In accordance with Condition 3.3, results of the operational noise monitoring shall be reported to the Director-General and the EPA within 60 days of completing the entire operational monitoring work as outlined in Condition 3.2.

As part of the operational noise monitoring program, a combination of long term (unattended) and short term (attended) noise monitoring will be undertaken at selected residential locations. The results from the long term (unattended) noise monitoring and concurrent traffic classification counts will be used to calibrate and validate the updated noise model. The results from the short term (attended) noise monitoring will be used for information purposes only, to provide an understanding of the traffic noise environment at the monitoring location.

In addition to the long term and short term traffic noise monitoring, engine brake noise monitoring is also to be undertaken at strategic locations where there are high incidents of engine braking from heavy vehicles. The engine brake testing is to be undertaken in accordance with the National Transport Commission (NTC) Australia's 'National In-Service Test Procedures for Engine Brake Noise from Heavy Vehicles' (August 2007).

Given the length of the Project and the number of affected receivers, the monitoring will be divided into two stages, as follows:

- **Stage 1** – Northern section of the Project, between the Graham Drive South overpass and the northern end of the Project at the Arrawarra Interchange
- **Stage 2** – Southern section of the Project, between the southern end of the Project at Korora and the Graham Drive South overpass

3.2 Monitoring Locations

3.2.1 Long Term (Unattended) Noise Monitoring

Long term (unattended) noise monitoring locations are selected to represent the potentially most affected noise-sensitive receptor in each noise catchment area (NCA). Where possible, the noise monitoring sites have been selected to be the same as those monitored earlier for this Project as part of the design work and as presented in the ONMR so to allow correlation with noise monitoring locations selected prior to the Project's construction.

Furthermore, additional long term (unattended) noise monitoring locations have been included to monitor noise levels at residences where comments or complaints have been received to date from the community with regard to traffic noise. This provides an opportunity for Roads and Maritime to address specific areas of concern raised by the community.

It is important to note that where noise monitoring is conducted at large distances from the Project (i.e. more than approx. 100m), the influence of non-traffic or ambient type noise tends to become more significant and extra caution needs to be taken. Therefore, to avoid the influence of noise unrelated to the Project from contaminating the noise monitoring results, noise monitoring is proposed to be conducted at sites that are within close proximity to the Project and are representative of the typical and/or worst-affected receiver locations. However, where noise monitoring is required to be undertaken at distances far enough removed from the road or well shielded from the road, then a closer analysis and review of the monitored noise levels combined with additional short-term attended noise measurements can be used where possible to identify possible extraneous noise events and remove these events from the datasets.

Table 1 lists the proposed post-opening operational long term (unattended) noise monitoring locations and the corresponding stages that monitoring will be undertaken. The positioning of noise monitors at each site will be subject to on-site inspections during set up.

Table 1 – Proposed Long Term (unattended) Noise Monitoring Locations

Location No.	Monitoring Address
Stage 2 – Southern Section	
M1	11 Coachmans Close, Sapphire Beach
M2	280 Old Coast Road, Korora
M3	28 Warrawee Street, Sapphire Beach
M4	33 Old Coast Road, Korora
M5	7 Reicks Close, Sapphire Beach
M6	7 Wakelands Road, Sapphire Beach
M7	40C Sullivans Road, Moonee Beach
M8	545 Solitary Islands Way, Moonee Beach
M9	1579 Pacific Highway, Moonee Beach
M10	3 Fiddaman Road, Emerald Beach

Location No.	Monitoring Address
Stage 1 – Northern Section	
M11	1 Emerald Heights Drive, Emerald Beach
M12	9 Casuarina Court, Sandy Beach
M13	8 Oak Close, Sandy Beach
M14	7 Pines Crescent, Sandy Beach
M15	8 Hearnese Lake Road, Woolgoolga (The Pines Estate)
M16	1719B Solitary Islands Way, Woolgoolga
M17	25 Greys Road, Woolgoolga
M18	17 Park Avenue, Woolgoolga
M19	187 Newmans Road, Woolgoolga
M20	66A Palmer Road, Woolgoolga
M21	226 Bark Hut Road, Woolgoolga
M22	2324 Solitary Islands Way, Arrawarra

3.2.2 Short Term (Attended) Noise Measurements

In addition to the long term (unattended) noise monitoring, short term (attended) noise monitoring is to be undertaken at residences where comments or complaints have been received to date from the community with regard to traffic noise. These locations have been reviewed and were determined to potentially be influenced by contributions from noise sources other than traffic from the Project. With this in mind, long term (unattended) noise monitoring would not be ideal at these locations as the noise environment would be significantly influenced by non-traffic noise (eg. birds, insects, frogs, etc), and the resulting noise levels would not be conducive of traffic noise impacts from the Project.

Therefore, short term (attended) noise measurements would be undertaken at these locations, which would allow the engineer to distinguish and note down extraneous noise and traffic noise from the Project. The resulting noise levels would provide an understanding of the traffic noise contribution from the Project.

It is noted that the results of the short term measurements will be used for comparison and information purposes only and will not be used directly to determine the adequacy of noise mitigation measures implemented as part of the Project.

Table 2 lists the proposed short term (attended) noise measurement locations and the corresponding stages that monitoring will be undertaken.

Table 2 – Proposed Short Term (attended) Noise Measurement Locations

Location No.	Monitoring Address
Stage 2 – Southern Section	
S1	219 Old Coast Road, Korora
S2	387D Old Coast Road, Korora

Location No.	Monitoring Address
S3	6 Alpini Place, Sapphire Beach
S4	26 Gaudrons Road, Sapphire Beach
S5	20 Woodhouse Road, Moonee Beach
S6	1 Tidal Crescent, Moonee Beach
S7	40 Heritage Drive, Moonee Beach
S8	36 Pinehyrst Drive, Moonee Beach
S9	8 Bream Close, Emerald Beach
S10	29 Fishermans Drive, Emerald Beach
S11	63 Dammerel Crescent, Emerald Beach
Stage 1 – Northern Section	
S12	2 Anselmo Close, Emerald Beach
S13	20 Redbox Crescent, Sandy Beach
S14	14 Mahogany Avenue, Sandy Beach
S15	15 Ryan Crescent, Woolgoolga
S16	21 Gresham Drive, Woolgoolga
S17	44 Whitton Place, Mullaway

3.2.3 Engine Brake Noise Monitoring

Concerns regarding engine braking noise from heavy vehicles have been raised by the communities surrounding the Project. The causes for engine braking are typically due to changes in road grade and/or changes in posted speed limits.

As a result of complaints received by Roads and Maritime, engine brake noise monitoring in accordance with relevant procedures is to be undertaken at strategic locations along the upgrade.

It is noted that the results of the engine brake noise monitoring are to provide Roads and Maritime with an understanding of engine brake events along the Project and are not required to be used to determine the adequacy or the design of noise mitigation measures for the Project.

Table 3 lists the proposed engine brake noise monitoring locations and the corresponding stages that monitoring will be undertaken.

Table 3 – Proposed Engine Brake Noise Monitoring Locations

Location No.	Monitoring Location Details
Stage 1 – Northern Section	
EB1	South of Bark Hut Road overpass
EB2	Approach to Woolgoolga Creek
EB3	Adjacent to southbound carriageway north of South Woolgoolga Interchange

Location No.	Monitoring Location Details
Stage 2 – Southern Section	
EB4	Southern end of Project, adjacent to southbound carriageway where change in speed zone from 110km/h to 80km/h

3.3 Noise Monitoring Procedures

3.3.1 L_{eq} Noise Monitoring

Noise monitoring shall be conducted in accordance with Australian Standard 2702-1984 "Acoustic Methods of Measurement of Road Traffic Noise", Appendix C4 'Noise monitoring procedures' in the ECRTN and Appendix E 'Model consultant brief for post-construction road traffic noise monitoring' in the ENMM.

A minimum of seven (7) days of noise monitoring is to be conducted, excluding all adverse weather [e.g. rain, wind, temperature inversions etc.] and excluding all non-traffic noise influences [e.g. noise from fauna (insects, frogs etc.), rail activity, industrial activity, local traffic noise unrelated to the Project, foliage noise etc.].

Of less importance to this Project, due to its coastal location, is to avoid any potential temperature inversions impacting on the noise monitoring, it is advisable that noise monitoring be conducted only during the warmer summer and/or spring months of the year, as the cooler winter and autumn months can increase the likelihood of temperature inversion occurrences.

Where practicable, long term and short term noise monitoring shall be conducted at 1m from the building facade most exposed to traffic noise, at a height of 1.5m above the floor level. Where physical constraints on site prevent noise monitoring to be undertaken at such a location, monitoring shall be conducted in the free-field, and a +2.5dB(A) facade correction shall be applied to the measured L_{Aeq} noise levels to convert the free-field measurements to equivalent measurements at 1m from the relevant building facade.

In the case of multi-level residential buildings, where practicable, long term (unattended) noise monitoring shall be undertaken at the two floors of the building most exposed to traffic noise (generally the ground and first floors). Where this is not practicable, then long term (unattended) noise monitoring shall be conducted at the most accessible floor of the building backed up by supporting short term (attended) noise measurements conducted on the other floor concurrently with the long term noise monitor, to establish a relationship of traffic noise levels between the two floors.

All short term (unattended) noise measurements shall be conducted during the day period (between 7am and 10pm) and night time period (between 10pm and 7am).

Classified traffic monitoring is to be conducted simultaneously with the noise monitoring to identify:

- traffic volumes,

- vehicle classifications – as a minimum the total vehicles and % heavy vehicles, and
- mean and 85-percentile vehicle speeds.

The above data shall be provided daily for each day period (15 hours; 7am to 10pm) and night period (9 hours; 10pm to 7am) over the entire noise monitoring period covering all noise monitoring sites. The above information shall be provided as spreadsheets and reports for each traffic monitoring site.

To avoid the noise of vehicle tyres passing over the traffic counter tubes and affecting the monitored noise levels, the position of traffic counter tubes shall be placed at locations well removed from the noise monitors. The exact locations shall be discussed and agreed to prior to the deployment of traffic monitors on site. However, as a guide the maps in Appendix A provide approximate locations of the traffic monitors.

3.3.2 Engine Brake Noise Monitoring

In addition to the above, noise monitoring engine braking from heavy vehicles will be conducted at four strategic locations, as detailed in Table 3 above. The engine brake noise monitors will be located adjacent to the road at the nominated monitoring locations, with the microphone positioned as close to the ground as possible (approximately 1m or less above the ground). The engine brake noise monitoring will be undertaken over a minimum of seven (7) days and concurrent with the long term (unattended) noise monitoring and traffic monitoring.

The results of the engine brake noise monitoring will provide an understanding of the distribution of engine brake noise events which have modulated root mean squared (RMS) levels of greater than 2.5RMS.

It is noted that the results of the engine brake noise monitoring will not be used to determine compliance of the operational noise levels or the adequacy of mitigation measures presented in the ONMR, but instead the monitored results can provide an understanding of engine brake events occurring along the Project.

3.3.3 Noise Monitoring Outputs

The long term (unattended) noise monitoring shall store $L_{Aeq,15hr}$ and $L_{Aeq,9hr}$ noise levels as a minimum, while the short term (attended) noise measurements will store the L_{Aeq} noise levels. The study primarily focuses on the L_{Aeq} results, which is the noise assessment index embodied in the NSW ECRTN.

Upon processing the noise monitoring data, any 'suspect' data influenced by factors other than road traffic noise such as adverse weather conditions, industrial, commercial, domestic, insects, fauna or other extraneous noise sources unrelated to the project shall be excluded. The operational noise report prepared will clearly identify instances where data has been excluded and where possible, shall provide reasons for exclusion.

3.4 Noise Monitoring Instrumentation

Long term (unattended) noise monitoring shall be conducted using noise monitors which comply with Australian Standard AS IEC 61672.1 2004 "Electroacoustics - Sound Level Meters" and are designated as Type 1 instruments suitable for field and laboratory use. A long-term noise monitor consists of a sound level meter and a computer housed in a weather resistant enclosure. Noise levels are monitored continuously with statistical data stored in memory for every 15-minute period.

Short term (attended) noise monitoring shall be conducted using sound level meters which comply with Australian Standard AS IEC 61672.1 2004 "Electroacoustics - Sound Level Meters" and are designated as Type 1 instruments suitable for field and laboratory use.

Engine brake noise monitoring shall be conducted using noise monitors which comply with Australian Standard AS IEC 61672.1 2004 "Electroacoustics - Sound Level Meters" and are designated as Type 1 instruments suitable for field and laboratory use. The engine brake noise monitors are capable of recording continuous audio data, which is stored in memory for post-processing.

The equipment shall be calibrated prior and subsequent to each measurement period using appropriate precision sound level calibrators. Any significant drift in calibration in any noise monitor shall be observed and noted.

3.5 Meteorological Conditions During Monitoring

Measurements affected by extraneous noise, wind (greater than 5m/s at the microphone) or rain will be excluded from the recorded data. Meteorological data will be monitored on site using temporary weather stations positioned at the northern and southern ends of each monitoring stage. The monitoring of meteorological conditions will be undertaken concurrently with the noise, traffic and engine brake monitoring for the corresponding monitoring stage.

Noise enhancing or noise diminishing meteorological conditions from winds and temperature inversions do not form part of the requirements of the ECRTN. Furthermore, the ENMM states the following:

'...in most cases the distances involved in traffic noise impact assessments are less than 300 metres from the road, and meteorological conditions have little impact on traffic noise problems over these short distances.'

Given that long term (unattended) noise monitoring will be undertaken at distances less than 300m from the Project, noise enhancing or noise diminishing meteorological conditions should have little impact on the assessable traffic noise level outcomes.

4 Assessment methodology

4.1 General Discussion

Practice Note viii of the ENMM gives guidance for post-construction (or post-opening) noise monitoring and states:

“Post-construction monitoring is undertaken to determine whether the mitigation measures have been adequate for the predicted design noise levels to be met.

The “Design Noise Level for Year 1” is the noise level for the road development at project opening, after all feasible and reasonable mitigation strategies have been applied.

Provided traffic flows and mixes following the road’s opening are in line with those used for the predictions, it can be expected that if the predicted noise levels for Year 1 are achieved the predicted Year 10 noise levels will also be achieved.

It should be recognised that noise prediction modelling has some accuracy limitations and will commonly produce acceptable errors of around 2 dB(A). In addition, when noise levels for a new road are being monitored short-term and uncharacteristic variations in traffic flow need to be taken into account when comparing the measured and predicted noise levels.”

Also according to Practice Note viii of the ENMM, if the monitoring indicates operational noise levels exceed the design noise levels then the following action shall be taken:

- If the measured noise levels exceed the design noise levels by 2 dB(A) or less, the noise data should be examined, the prediction methodology and suitability of mitigation measures should be reassessed and the reasons for the marginal exceedance(s) be identified and reported.
- If measured noise levels exceed the design noise level by more than 2 dB(A), the adequacy of the noise mitigation needs to be reviewed, and if problems are identified steps need to be taken to rectify the situation. Additional noise treatments may be required to achieve the design noise level, where this is feasible and reasonable.

4.2 Proposed Compliance Assessment

An assessment of compliance with the operational noise levels predicted in the review of operational noise mitigation measures presented in the ONMR shall be undertaken, as required by Condition 3.2. The methodology to be used for the assessment shall be as follows:

1. Monitor operational traffic noise levels of the Project at the monitoring locations nominated in Table 1.
2. Compare monitored operational traffic noise levels to those predicted in the review of operational noise mitigation measures presented in the ONMR for the nominated monitoring locations.

3. Where the monitored operational traffic noise levels are found to be greater than but within 2dB(A) of the predicted noise levels presented in the ONMR, then the noise data shall be examined, the prediction methodology and mitigation measures shall be checked giving reasons for the marginal exceedance(s) and noting that the Project's operational noise levels are deemed as complying with the Project's noise design objectives.
4. Where the monitored operational traffic noise levels are found to be greater than 2dB(A) in comparison to the predicted noise levels presented in the ONMR, then a more detailed analysis shall be carried out including:
 - a. a comparison of the measured traffic volumes, classifications and vehicle speed data to those used in the prediction modelling
 - b. a close inspection of the installed in-corridor noise mitigation measures in case of defects which can be rectified
 - c. a close inspection of the as-built road corridor survey and comparison to the Project's design drawings and files.
5. Following from Step 4 above and where required, monitoring locations found to not comply with the prediction modelling shall have the noise model for their relevant NCA recalibrated taking into consideration factors such as noise monitoring undertaken and actual traffic numbers and proportions [in accordance with Condition 3.2 e)], and the noise prediction model shall be re-run to establish revised design year (ie. 2024 - 10 years after opening) traffic noise levels.
6. Following from Step 5, design year traffic noise levels predicted with the recalibrated noise model, shall be compared against the Project's noise goals as set out in the ONMR to determine the adequacy of the noise mitigation measures implemented for the relevant NCA. Should it be found that the noise mitigation measures are inadequate for that NCA, additional feasible and reasonable noise mitigation measures shall be investigated with the objective of meeting the Project noise goals.

4.3 Additional Mitigation Measures

Additional mitigation measures shall only be provided where operational traffic noise levels are found to be greater than 2dB(A) in comparison to the predicted noise levels presented in the ONMR and following the completion of Steps 4, 5 and 6 of the above process, where the noise criteria for the Project are determined to be exceeded. Any necessary additional mitigation measures shall be determined and provided where feasible and reasonable in accordance with the ECRTN and the ENMM.

'Feasibility' relates to engineering considerations and what can practically be built. 'Reasonableness' is judged in terms of noise mitigation benefits and costs, and many other aspects such as community views, aesthetic impacts, existing and future noise levels at the affected sites and the benefits arising from the development.

Given that there may be physical limitations associated with applying any necessary additional noise mitigation measures to within the road corridor once the Project has been constructed and is operational, where found necessary and practical, consideration shall also be given to the provision of at-property treatment to additional properties, subject to the consent of affected property owners. That is, any additional at-property mitigation measures shall be determined in consultation with affected property owners.

5 Reporting

In accordance with Conditions 3.2 and 3.3, operational noise monitoring shall be undertaken within 1 year of the Project opening with an operational noise report submitted to the Director-General and EPA within 60 days upon completion of the entire noise monitoring work, which does not just comprise noise monitoring, but also includes data analysis, assessment, any necessary modelling reviews and where required the consideration of additional feasible and reasonable noise mitigation measures.

The operational noise report shall be prepared, in accordance with Condition 3.2, and shall include the following information:

- methodology, location and frequency of noise monitoring undertaken,
- summary of measured traffic noise levels,
- assessment of the performance and effectiveness of applied noise mitigation measures, as determined in the ONMR,
- where required, reassessment of additional feasible and reasonable noise mitigation measures, and
- in accordance with Condition 3.2 (d), detail any complaints and enquiries received in relation to operational noise generated by the Project.

APPENDIX A Operational Noise Monitoring Location Maps