Noise Management in Urban Environments

# Decision-support Software Tool Handbook

# Decision-support Software Tool Handbook



Office: Cooperative Research Centre for *Construction Innovation*
9th Floor, Level 9, QUT Gardens Point
2 George Street, Brisbane, Qld, 4000 Australia
Telephone: +61 7 3864 1393
Email: enquiries@construction-innovation.info
Web: www.construction-innovation.info



First published 2005 by Cooperative Research Centre for *Construction Innovation*, for Icon.Net Pty Ltd.

For further information on our publications, please visit our website:
www.construction-innovation.info

ISBN

# Foreword

The Cooperative Research Centre (CRC) for *Construction Innovation* is committed to leading the Australian property, design, construction and facility management industry in collaboration and innovation. We are dedicated to disseminating the practical research outcomes to our industry – to improve business practice and enhance the competitiveness of your firm. Developing applied technology and management solutions, and delivering education and relevant industry information is what our CRC is all about.

This publication "Decision Support Software Tool Handbook" results from one of our leading projects headed by Dr. Saman de Silva with a project team comprising Dr. Li Chen and Mr. Philip Douglas (*RMIT University*) and Mrs. Julie Peters, (*Queensland Department of Main Roads*).

This publication has examined … and provides clear guidelines to industry in the areas of … to improve the business.

We look forward to your converting the results of this CRC research project into tangible outcomes and working together in leading the transformation of our industry to a new era of enhanced business practices, safety and innovation within the sector.

Mr John McCarthy
Chair

Dr Keith Hampson
Chief Executive Officer

Contents

# Preface

The Decision Support Handbook is a product of the research project Noise Management in Urban Environments, funded by CRC for Construction Innovation Australia. The research work has been conducted jointly by the RMIT University and the Queensland Department of Main Roads in collaboration with the Queensland Department of Public Works, Arup Pty Ltd, and the Queensland University of Technology.

This handbook is a noise amelioration procedural guide outlining the system framework developed for the decision support tool and incorporates the DST software user guide.

It is not intended for this document to cover policy issues. In this regard, please refer to the current policy and/or guidelines established by the managing authority.

# 1. Introduction

The road and transport industry in Australia and overseas has come a long way to understanding the impact of road traffic noise on the urban environment. Most road authorities now have guidelines to help assess and manage the impact of road traffic noise on noise-sensitive areas and development.

While several economic studies across Australia and overseas have tried to value the impact of noise on property prices, decision-makers investing in road traffic noise management strategies have relatively limited historic data and case studies to go on.

The perceived success of a noise management strategy currently relies largely on community expectations at a given time, and is not necessarily based on the analysis of the costs and benefits, or the long-term viability and value to the community of the proposed treatment options.

With changing trends in urban design, it is essential that the 'whole-of-life' costs and benefits of noise ameliorative treatment options and strategies be identified and made available for decision-makers in future investment considerations.

For this reason, CRC for Construction Innovation Australia funded a research project, Noise Management in Urban Environments to help decision-makers with future road traffic noise management investment decisions. RMIT University and the Queensland Department of Main Roads (QDMR) have conducted the research work, in collaboration with the Queensland Department of Public Works, ARUP Pty Ltd, and the Queensland University of Technology.

The research has formed the basis for the development of a decision-support software tool, and helped collate technical and costing data for known noise amelioration treatment options.

We intend that the decision support software tool (DST) should help an investment decision-maker to be better informed of suitable noise ameliorative treatment options on a project-by-project basis and identify likely costs and benefits associated with each of those options.

This handbook has been prepared as a procedural guide for conducting a comparative assessment of noise ameliorative options. The handbook outlines the methodology and assumptions adopted in the decision-support framework for the investment decision-maker and user of the DST.

The DST has been developed to provide an integrated user-friendly interface between road traffic noise modelling software, the relevant assessment criteria and the options analysis process. A user guide for the DST is incorporated in this handbook.

# 2. Overview of the decision-support framework

A decision-support framework has been established to reflect the decision-making process involved in conducting a comparative analysis of noise amelioration treatment options for any given project. The decision-support framework is presented in the form of a flowchart as illustrated in Figure 1.

The decision-support framework has seven key processes, labelled as “zones”. The seven zones are:

Zone 1: Noise impact and code assessment

Zone 2: Option identification

Zone 3: Amelioration analyses

Zone 4: Feasibility of options

Zone 5: Concept costing

Zone 6: Benefit analyses

Zone 7: Report generation

A number of the processes outlined in the framework have already been adopted and streamlined by industry and road authorities, but these processes have not been fully integrated and supported to incorporate the feasibility and cost–benefit evaluation as part of the decision-support environment.

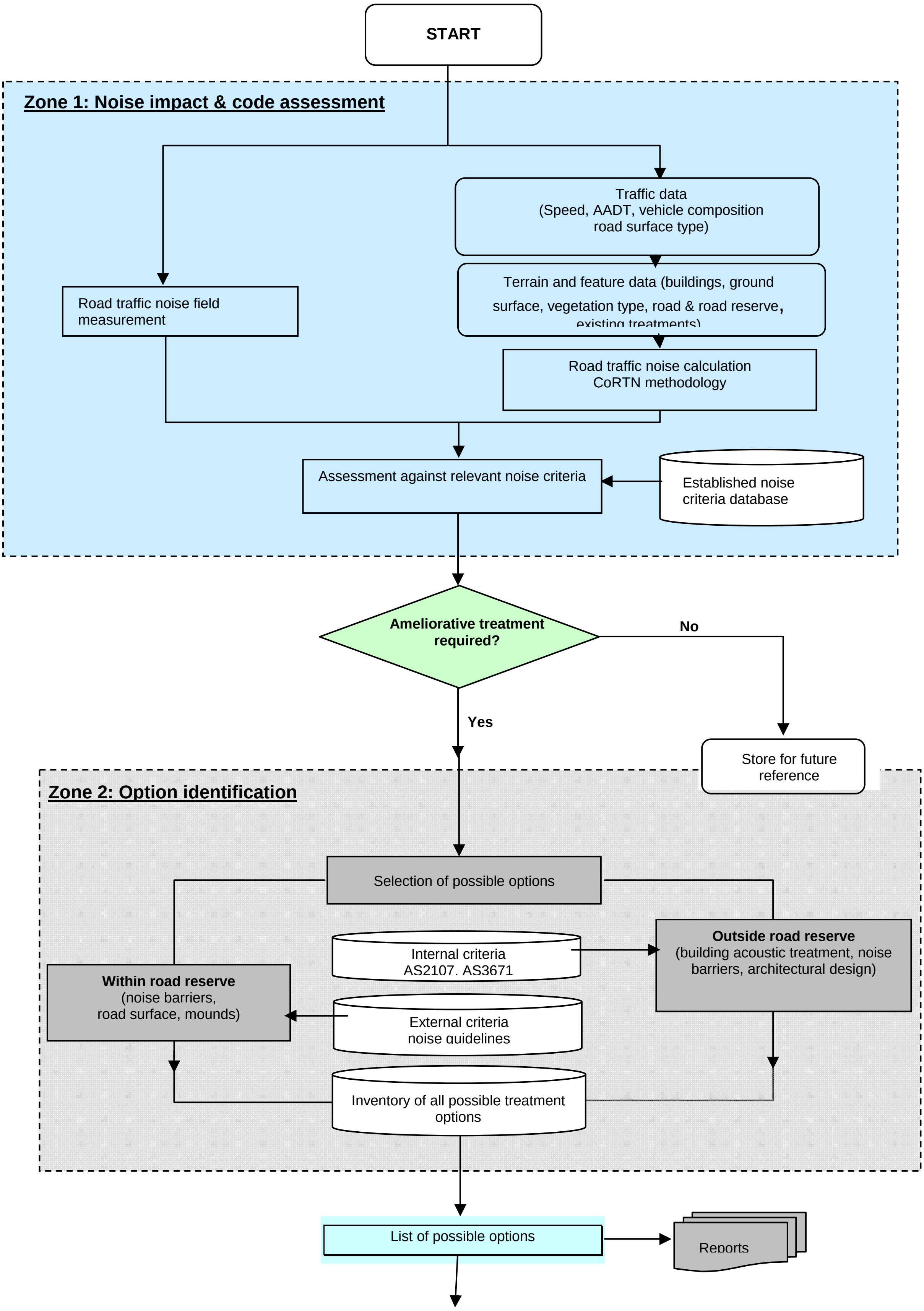
Throughout the framework, there are data inputs, assessment stages and decisions points necessary to ultimately identify the likely costs and benefits of suitable noise ameliorative treatment options.

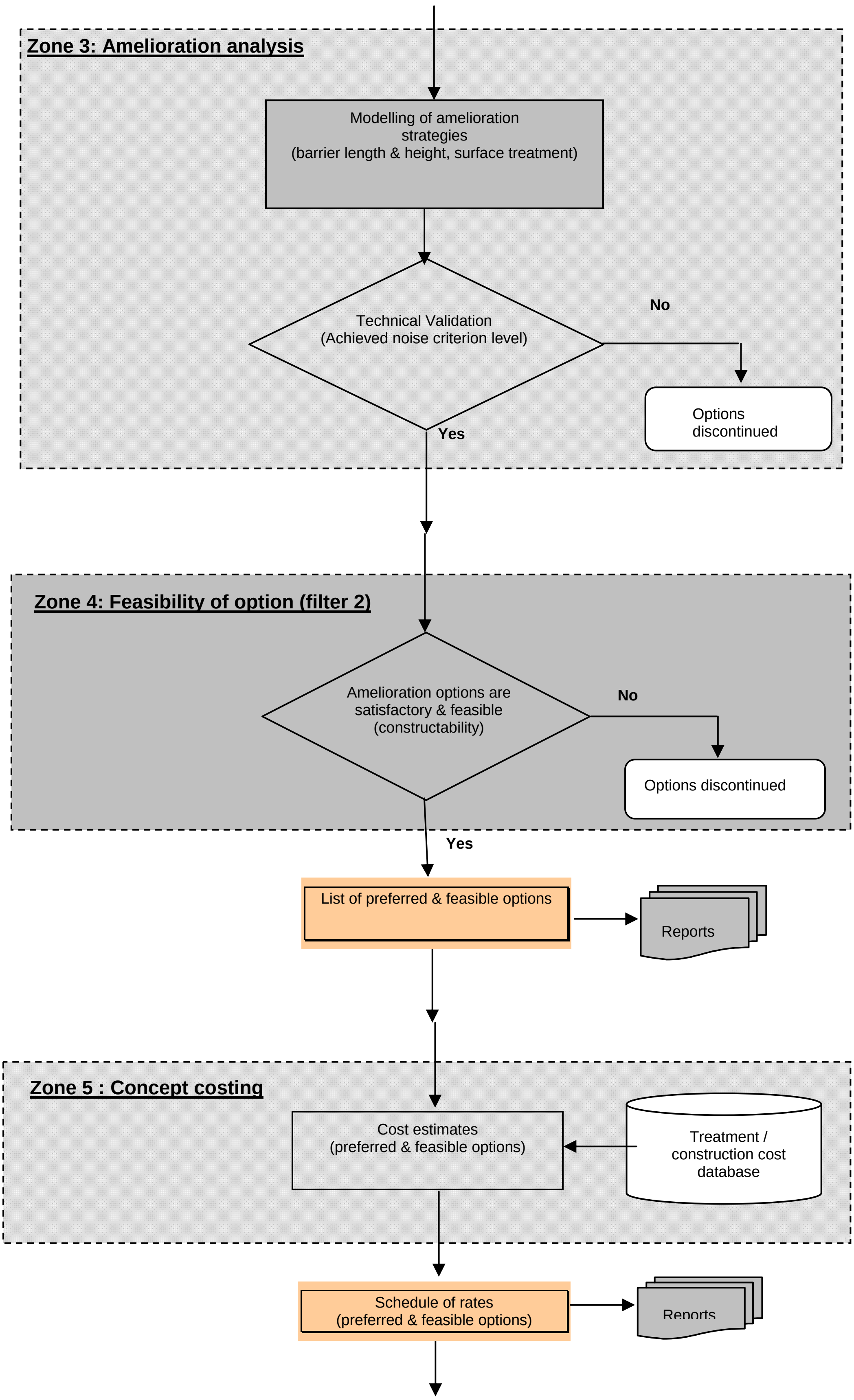
The decision-support framework adopts a filtering approach to all possible treatment options by assessing their technical viability and feasibility, and assessing the costs and benefits of those suitable treatment options on a given road segment. The decision-maker is still responsible for the accuracy of the data inputs required and the final judgment of the most preferred option, based on the information at hand.

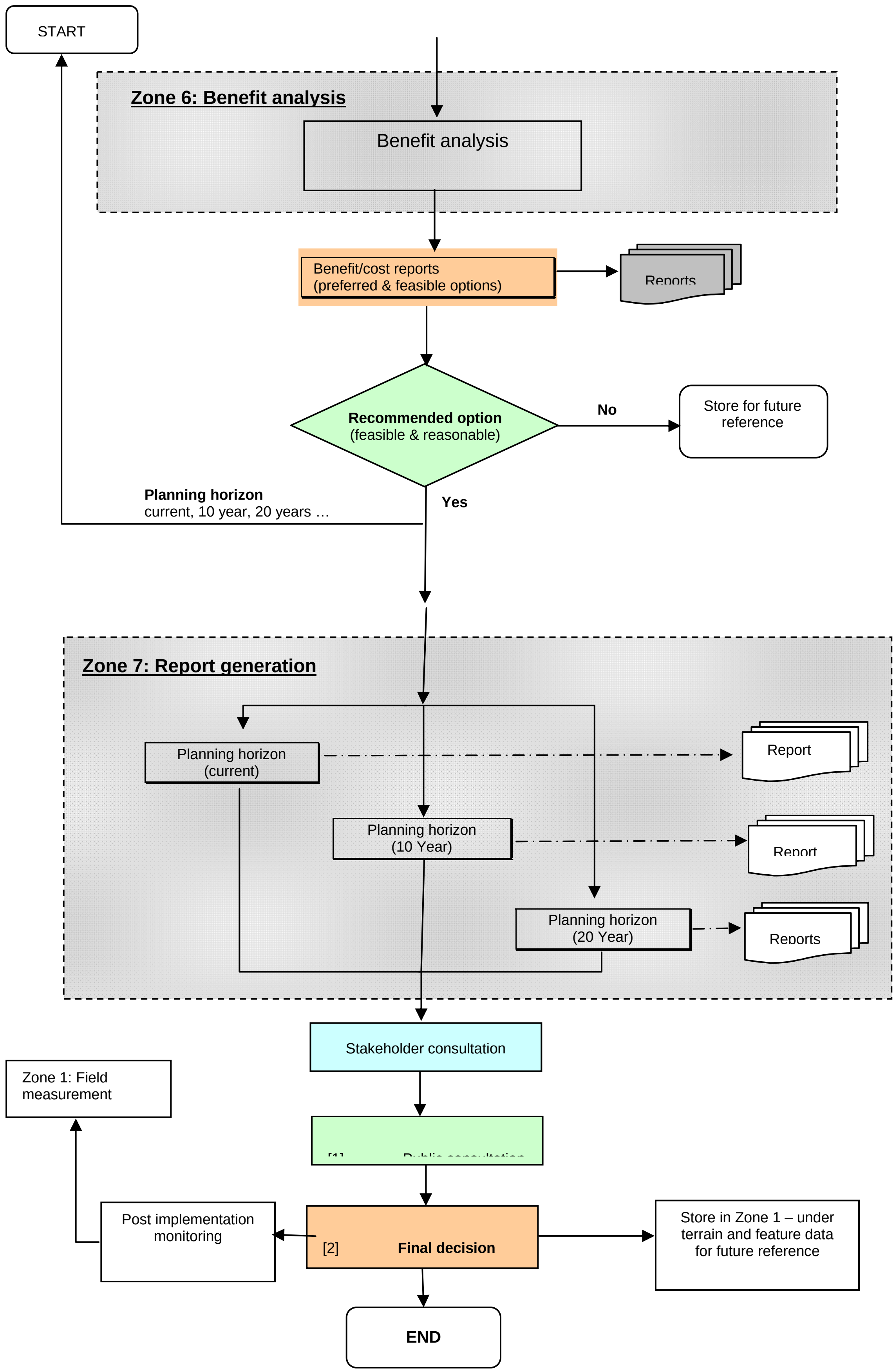
In Section 3 of this handbook, the decision-support procedural guide outlines the inputs required and the assessment methodology adopted in each zone of the decision-support framework.

The DST has been developed using the framework described above and illustrated in Figure 1. The DST facilitates the integration of traffic noise modelling software packages, provides the cost database for alternative ameliorative treatments within and outside the road reserve, references relevant noise assessment criteria and generates reports. The software has an interactive user interface that enables the user to conduct cost–benefit analyses of suitable alternative amelioration treatment options. The user guide for the DST is provided in Section 4 of this handbook.

FIGURE 1: DECISION-SUPPORT FRAMEWORK




Zone 3: Amelioration analysis
Modelling of amelioration strategies (barrier length & height, surface treatment)
Technical Validation (Achieved noise criterion level)
No
Options discontinued
Yes
Zone 4: Feasibility of option (filter 2)
Amelioration options are satisfactory & feasible (constructability)
No
Options discontinued
Yes
List of preferred & feasible options
Reports
Zone 5 : Concept costing
Cost estimates (preferred & feasible options)
Treatment / construction cost database
Schedule of rates (preferred & feasible options)
Reports



START
Zone 6: Benefit analysis
Benefit analysis
Benefit/cost reports
(preferred & feasible options)
Reports
Recommended option
(feasible & reasonable)
No
Store for future reference
Planning horizon
current, 10 year, 20 years …
Yes
Zone 7: Report generation
Planning horizon
(current)
Report
Planning horizon
(10 Year)
Report
Planning horizon
(20 Year)
Reports
Stakeholder consultation
Zone 1: Field measurement
Post implementation monitoring
[2]
Final decision
Store in Zone 1 – under terrain and feature data for future reference
END

# 3. Decision-support procedural guide

## 3.1 Zone 1: Noise impact and code assessment

*Noise impact*
A road traffic noise assessment must first be undertaken for a given road segment to determine the impact of road traffic noise on adjacent noise-sensitive land uses.

In the noise impact and code assessment zone, the road segment under investigation is identified and described in terms of both the traffic noise source details and the surrounding terrain and feature data. The parameters that define the traffic noise source are the speed, average annual daily traffic (AADT), vehicle composition, and road surface type.

Three-dimensional models, in a form typical of an AutoCAD file, that contain spatial information for the road and the environment surrounding the road segment represent the terrain and feature data. The terrain and feature data includes topography, vegetation type, building property, and road and road reserve boundaries.

The noise impact and code assessment zone is also designed to provide a user interface to call or launch the commercially available road traffic noise modelling software. The road traffic modelling software can access the terrain, feature and traffic data of the road segment and surrounding environment in DXF format. When executed, the modelling software calculates predicted noise levels at selected nearby noise-sensitive receivers (residences, schools, hospitals). These prediction noise levels must be verified against noise measurement data at representative locations.

A number of traffic noise prediction models and commercially available noise modelling software packages are available. The decision-support framework cites the UK's Department of Transport (1988) procedure, Calculation of Road Traffic Noise (Corn 88), as an example of a traffic noise prediction model.

*Code assessment*
It should be noted that in version (V 1.0a) of the DST, the noise assessment criteria adopted in the code assessment is based on the QDMR's Road Traffic Noise Management: Code of Practice, January 2000.

Having established the noise impact on the surrounding environment, the decision-support framework leads to the code assessment. This is to determine whether the receivers are predicted to be exposed to noise that exceeds the criteria in the guidelines. The noise criteria are a set of limiting noise levels that private residences, schools, and so on can be exposed to without the need for ameliorative treatment. The established noise criteria database in the DST provides a way for the decision-maker to import the receiver details and predicted noise levels for a given assessment year and also select the relevant authority's assessment criteria. If the predicted noise level exceeds the external noise criteria, ameliorative treatment is required.

If ameliorative treatment is not required for the assessment year, then there is no need to progress to Zone 2, Option identification.

## 3.2 Zone 2: Option identification

The purpose of this zone is to identify all the amelioration options that could be used to reduce the noise level that exceeds the noise criteria.

The proposed decision-support framework facilitates the identification of possible treatments not only within and outside the road reserve, but also a combination of both. The decision-maker needs to identify a list of possible treatment options available. A user of the DST is presented with the 'inventory of all possible treatment options'. This inventory of possible treatment options includes:

*Ameliorative treatment options within the road reserve*

- pavement resurfacing
- noise barrier — wall
- noise barrier — earthmound
- reduction of signposted speed.

*Amelioration treatment options outside the road reserve*

- acoustic treatment of buildings
- courtyard screen/fence.

*Combination of ameliorative treatment options within and outside the road reserve*

- pavement resurfacing and noise barrier — wall or earthmound
- pavement resurfacing and reduction of signposted speed
- pavement resurfacing and acoustic treatment of buildings
- pavement resurfacing and courtyard screen/fence
- noise barrier (wall or earthmound) and reduction of signposted speed
- noise barrier (wall or earthmound) and acoustic treatment of buildings
- noise barrier (wall or earthmound) and courtyard screen/fence
- acoustic treatment of buildings and courtyard screen/fence.

The purpose of treating the building envelope is to reduce the internal noise only, when the external noise criteria cannot be achieved. The Australian standard (AS3671, 1989) provides a procedure for determining appropriate treatments that correspond to the noise reduction required for internal noise levels.

In the DST, the user can display a list of the possible treatment options and discard any. A record of options discarded and the reasons why can be reported.

## 3.3 Zone 3: Amelioration analysis

The purpose of the amelioration analysis zone is to determine whether the preferred treatment options identified in Zone 2 are technically viable to achieve the noise criteria. The DST provides for technical validation of preferred amelioration options within the road reserve, outside the road reserve, and in a combination of both.

The commercially available traffic noise modelling software packages are to be used to model and analyse preferred treatment options including noise barriers, road surface treatments, and a courtyard screen/fence.

The prediction noise model can be run for a number of designs for each treatment option or a combination of options. The predicted noise levels at the sensitive receivers are then compared to the relevant criterion level. Interactively, by a process of iteration, the amelioration treatment option design can be varied and the models re-run to achieve the relevant criterion level.

The expected maximum reduction in noise level that can be achieved by pavement resurfacing and reduction of signposted speed is conveyed to the user of the DST. This is used as the technical validation of these specific treatment options, and it is based on research conducted by the QDMR.

*Acoustic treatment of buildings*
The DST makes reference to sections of the Australian Standard (AS2107, 2000), which are stored in the internal criteria database. Provisions are made to determine the necessary construction category of the building envelope to achieve the desired reduction of noise through transmission losses at the building facade. The type of construction used in the noise-sensitive building could then be assessed to determine whether it was equivalent to or could be realistically upgraded to be equivalent to the construction category required. If the construction category of the building envelope was found to be unsuitable for treatment, this option would have to be discarded.

Commercially available software based on the Australian Standards (AS3671, 1989; AS2107, 2000) is also available to assess the architectural requirements for acoustic treatment at the building envelope and so on. This software for outside road reserve treatments can evaluate composite noise transmission losses through the building envelope. The user can select the target values based on the internal noise criteria established in the Australian Standards (AS2107, 2000).

Having selected the appropriate internal noise criteria, and knowing the external noise levels, the target reduction is established. The user then tries out different acoustic treatments to building facade elements until either the internal noise level is equal to, or lower than, the target value, or it is found that it is not possible to sufficiently reduce the noise level. The user can also select the number of buildings of this type that would require similar treatment. This process can be repeated for each different building type that is exposed to a noise level that exceeds the external noise criteria.

The decision-support framework offers a combination of external and internal criteria to achieve the desired outcome. This approach is good when all amelioration options within the road reserve have been fully or partially exhausted.

## 3.4 Zone 4: Feasibility of options

This is an interactive process in which the experience and knowledge of the decision-maker plays a major role in identifying options that are not practicable, already in place, or fully exhausted.

Many road authorities' current guidelines recommend or only support amelioration strategies within the road reserve. Options such as acoustic treatment of the building envelope may be considered only if all other treatment options have been exhausted.

At this stage, and after considering their practical viability and constructability, the decision-maker can narrow-down the technically viable ameliorative options. In judging whether an option is practical or can be constructed, several integrated design and social factors specific to the road segment and road authorities may get in the way of the chosen treatment option. Examples are:

- where there is insufficient corridor width within the existing road reserve for an earthmound
- when the road segment is non-access controlled; noise barriers cannot be continuous because of access to the road segment from adjoining noise-sensitive properties
- if a reduction of signposted speed may not be acceptable to the road user
- where the required height of the noise barrier exceeds the barrier height restriction of the road authority.

## 3.5 Zone 5: Concept costing

In this zone, we look at the cost of carrying out the preferred option. It is a good idea to establish a cost database for standard noise ameliorative treatment options both within and outside the road reserve. A cost database has been incorporated into the DST, based on historic and estimated cost data provided by the QDMR, and current when this document was prepared (February 2005), but such a database needs to be updated to reflect the latest industry costs and practices.

At this stage each selected treatment option is conceptually developed and the technical details are available for estimating costs. The concept design of the treatment option has been developed to the extent that parameters such as the length, height and material type can be determined. Reasonable cost estimates and a concept cost can be established for each option based on the cost database.

The concept costing module of the DST allows the user  to select relevant items through a pull-down form, and the user enters the quantity. A concept cost estimate is produced by the software giving the total concept cost of the treatment option. The cost estimate can include project management, survey/design and service relocation estimated costs.

An evaluation of the costs in terms of present value or discounted future values should also be undertaken when assessing future assessment years to work towards an optimum solution. This enables the possibility of comparing a number of treatment strategies developed over several planning horizons.

## 3.6 Zone 6: Benefit analysis

The benefits of a treatment option depend on the perspective of who is to receive the benefit as well as on how it is measured. Accordingly there are many different ways to measure benefit. For this reason, the decision-support framework does not attempt to quantify the benefits. Figure 2 illustrates a cost–benefit matrix approach. Ameliorative treatment options are identified in the matrix and the advantages and disadvantages of each are represented against each cost–benefit factor.

The decision-maker needs to be able to conduct an analysis using a range of measures, including social and environmental factors, to identify the preferred treatment option for a given road segment.

In addition the cost–benefit matrix can be used for reference and reporting when conducting a comparative analysis of the cost and the selected measures of benefit for each of the suitable treatment options.

At this stage it is also possible to assess the feasible and reasonable treatment options at planning dates 10 or 20 years into the future. The process is the same as for assessing treatment options in the current planning where the decision-maker again follows the procedures from Zone 1 to Zone 6 as discussed previously.

## 3.7 Zone 7: Report generation

In this zone a final report should be compiled, listing all the ameliorative treatment options investigated and identifying the options discarded and why. The report should include cost estimates and benefit analyses for the options analysed, and also assess the ameliorative treatment options required now and in the future.

The report can then be made available for stakeholder and public consultation before the final judgment is made. Once the treatment option has been implemented, post-implementation monitoring should be carried out for audit purposes and future reference.

FIGURE 2: COST–BENEFIT MATRIX
+ Represents potential advantages or nil impact
– Represents potential disadvantages

| Cost–benefit factors | | Ameliorative treatment options | | | | |
|---|---|---|---|---|---|---|
| | | Within the road reserve | | | | Outside the road reserve |
| ***Category*** | ***Factors*** | ***Pavement resurfacing*** | ***Noise barrier (wall)*** | ***Noise barrier (earthmound)*** | ***Signposted speed reduction*** | ***Acoustic treatment of buildings*** |
| **Economic** | **Initial project costs** | + Moderate | – High | – High | + Low | + Low to moderate |
| | **Maintenance/operational costs** | – Moderate | – Moderate | – Low | + Low | – Moderate (responsibility of property owner) |
| | | | | | | |
| **Environ-mental** | **Air circulation** | + Nil impact | – Potential impact | – Potential impact | + NIL impact | – May require mechanical ventilation/air exchange |
| | **Shade effects** | + Nil impact | – Potential impact | + Minimal impact | + Nil impact | + Nil impact |
| | **Fauna movements** | + Nil impact | – Potential impact | ± Site-specifics to be considered in design | + Nil impact | + Nil impact |
| | **Adverse operational impacts** | + Nil impact | + Minimal impact | + Minimal impact | + Nil impact | – Need to solve problems with ventilation & air-conditioning noise |
| | **Visual aesthetics** | + Nil impact | – Potential impact | – Minimal impact if suitable design incl. landscaping | + Nil impact | + Minimal impact |
| | | | | | | |
| **Social** | **Safety requirements** | + Surface drainage to be considered | – Site-specifics to be considered in design | – Site-specifics to be considered in design | ± Road safety audit should be undertaken | + Nil impact |
| | **Maintenance/access requirements** | + Nil impact | – Site-specifics to be considered in design | – Site-specifics to be considered in design | + Nil impact | + Nil impact |
| | **Preserving views** | + Nil impact | – Potential impact | – Potential impact | + Nil impact | + Nil impact |
| | **Public amenity** | + Nil impact | – Restricts access in area | – Restricts access in area | + Potential to improve local area amenity | – May restrict options to open and close windows & doors |
| | **Visual considerations** | + Nil impact | – Site-specifics to be considered in design (incl. community art) | – Site-specifics to be considered in design | + Nil impact | + Nil impact |
| | **Community benefit** | + Provides benefit to local community and road user | + Provides benefit to local community | + Provides benefit to local community | + Provides benefit to local community | – Restricts benefit to individual dwellings |
| | **Privacy and security** | + Nil impact | – Site-specifics to be considered in design | – Site-specifics to be considered in design | + Nil impact | + No direct impact |

# References

Australian Standard 2107 (2000), *Acoustics: Recommended design sound levels and reverberation times for building interiors*

Australian Standard 3671 (1989), *Acoustics: Road traffic noise intrusion — Building siting and construction*

CRC-CI, *Cooperative Research Centre for Construction Innovation*, Australia, December 2004 *Noise Management in Urban Environments, Project 2002-004B, Research Report*

CRC-CI, *Cooperative Research Centre for Construction Innovation*, Australia, www.construction-innovation.info.

Great Britain Department of Transport, Welsh Office, (1988), *Calculation of Road Traffic Noise*, Her Majesty's Stationery Office, London

Queensland Department of Main Roads, January 2000, *Road Traffic Noise Management: Code of Practice*

# Decision-support Software Tool User Guide

**February 2005**


Research team

Dr. Saman de Silva

Dr. Li Chen, RMIT University

Mr. Philip Douglas, RMIT University

Mrs. Julie Peters, Queensland Department of Main Roads

# Section 1

## Hardware and software requirements

The hardware and software requirements of the Road Traffic Noise Management Decision-support Software Tool (DST) are:

- Pentium 90 MHz or higher microprocessor
- VGA 640X480 or higher resolution screen supported by Microsoft Windows
- Microsoft Windows 97 or later
- 24 MB RAM for Windows 97
- CD Drive (for installation from CD)
- Microsoft Excel 2000 or later.

For further details regarding the hardware requirements:
http://msdn.microsoft.com/library/default.asp?url=/library/en-us/vbcon98/html/vbconsystemrequirementsforvisualbasicapplications.asp

## Set-up

Set-up from CD

- Insert CD into CD drive
- Execute Setup.exe from CD drive
- Follow the prompts until the program has been successfully installed.

Updating the DST.exe from an email attachment

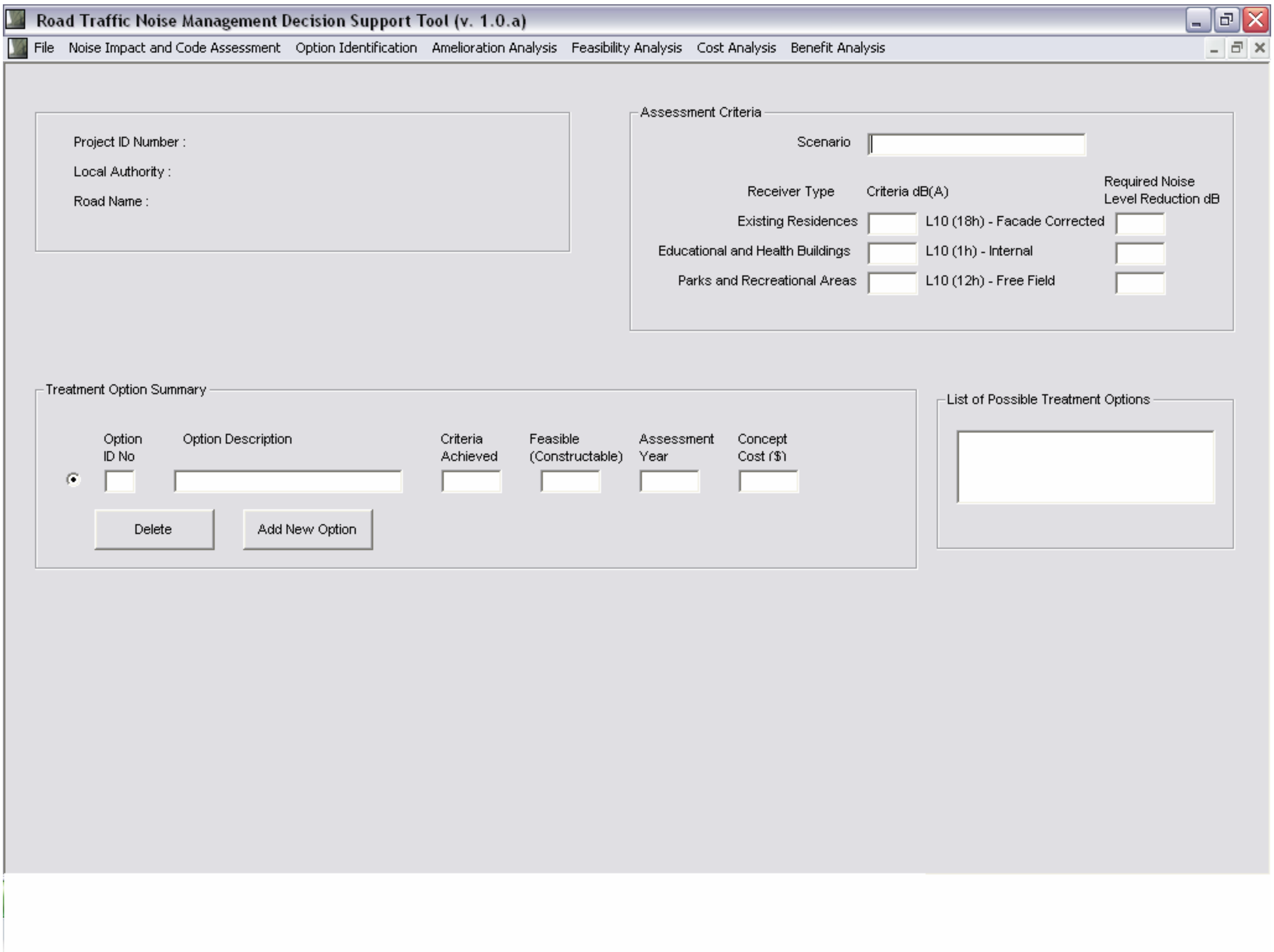
- Copy the DST.exe file that has been attached to the email, to the folder in which the existing DST.exe has been set up
- Replace the existing DST.exe with the new DST.exe.

# Section 2

## Start-up screen

“DST- v.1.0.a” is what we call a properly set up DST, and it will give you an icon called DST1 on the desktop.

Double click on the DST1 icon to start the program. When you open the program the Main Window will be displayed as shown below. This works as a back-drop through the entire process, so we call it the Back-drop screen. All critical decision-support information will be written on to this screen. The drop-down menu bar at the top shows the six pull-down platforms required to complete the noise management decision-support process.




The process is sequential. This means the user has to complete each stage in this order:

1. Impact and Code Assessment
2. Options Identification
3. Amelioration Analysis
4. Feasibility Analysis
5. Cost Analysis
6. Benefit Analysis.

Work your way from left to right. As you complete each stage, the resulting critical information is displayed in the Back-drop screen.

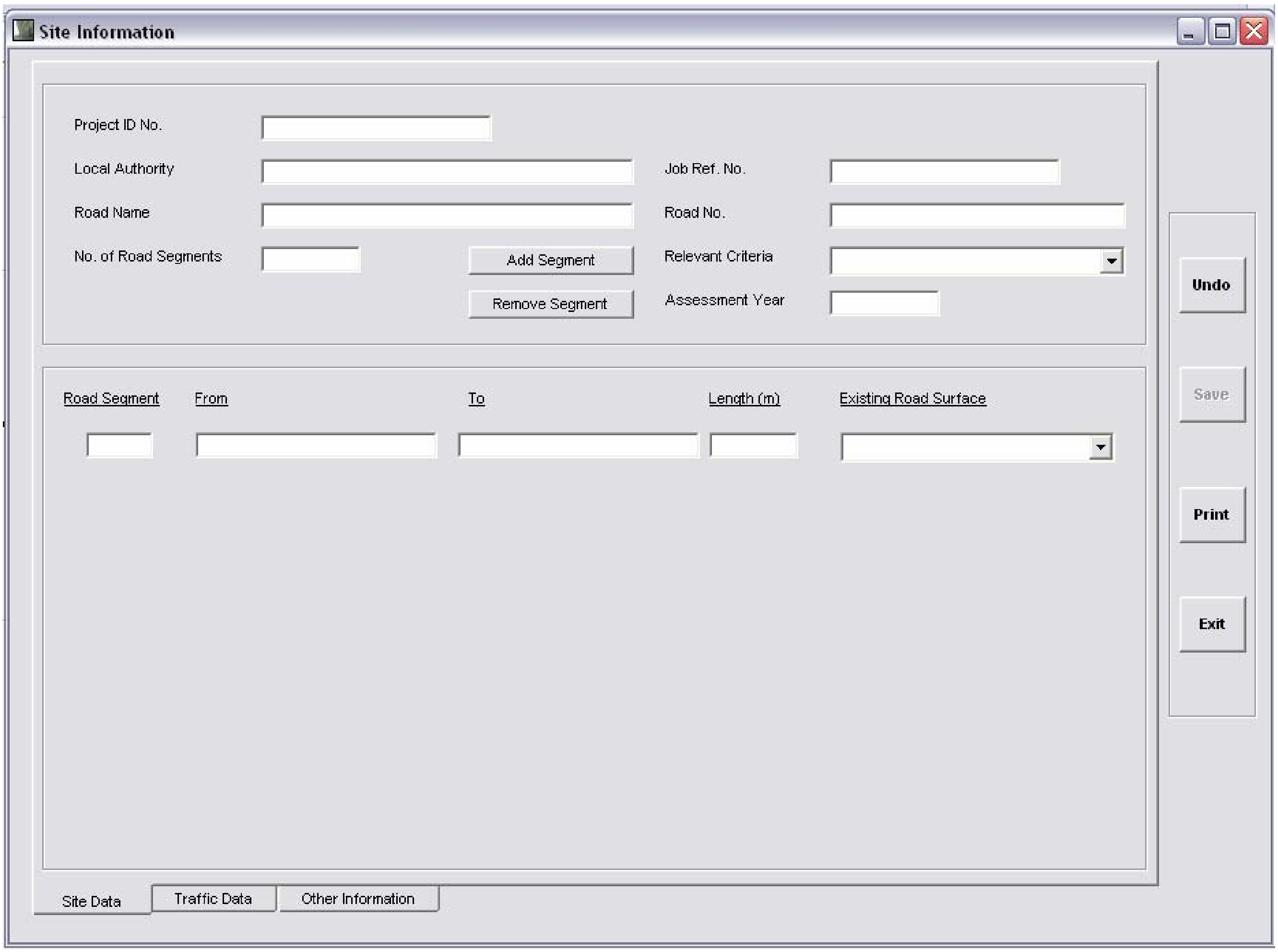

## Starting a project and entering Site Information

The first stage of the process is to register the project, by giving the project an identification number called a Project ID Number. All projects are identified by this number for future use.

To start:

1. Pull down the ***Noise Impact and Code Assessment*** menu.

2. Click ***Site Data*** to open the ***Site Information*** window.

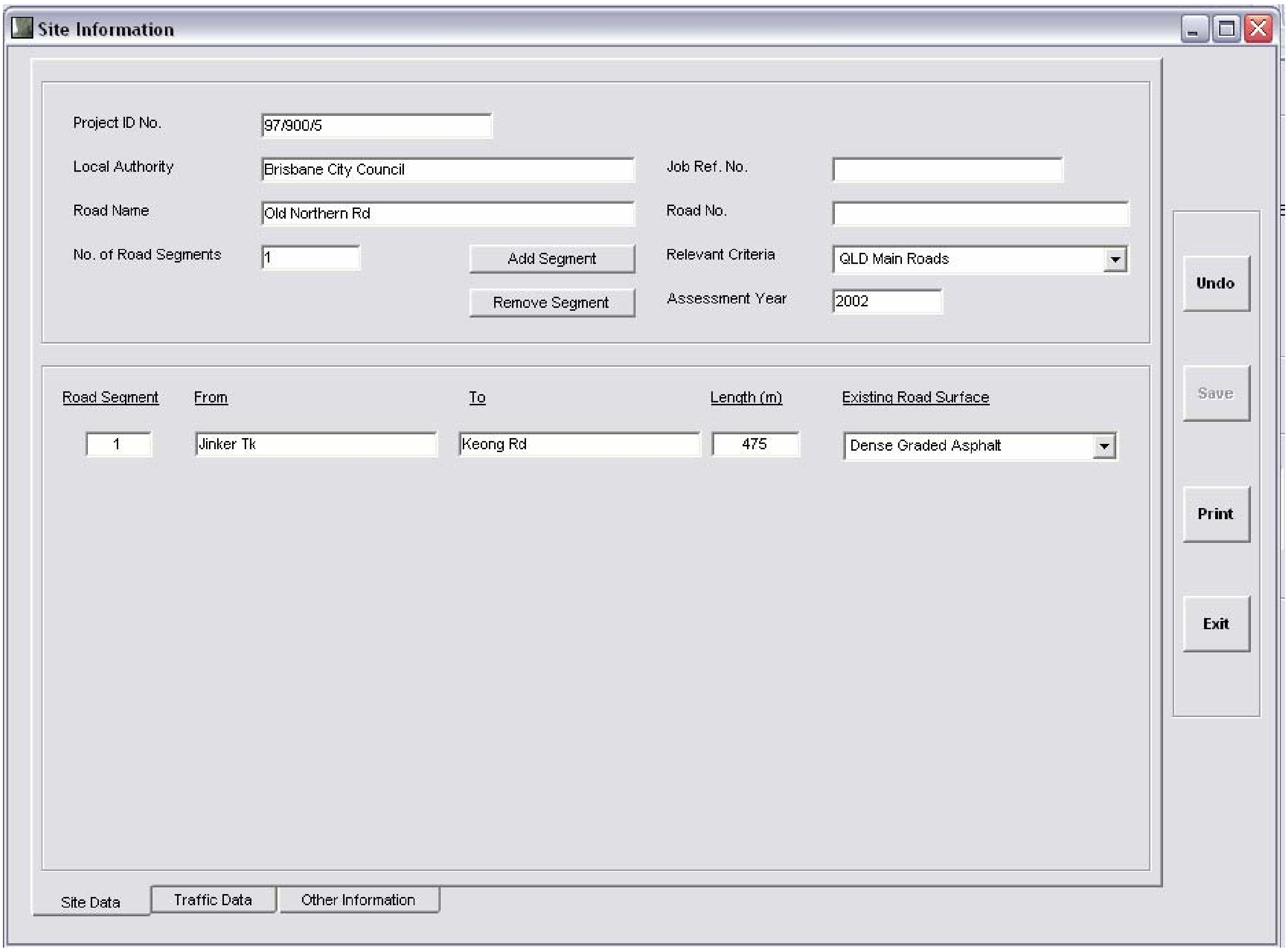



*Enter site information, starting with the Project ID Number. If the Project ID Number entered already exists, you will be prompted with the message "Project ID is already there".*

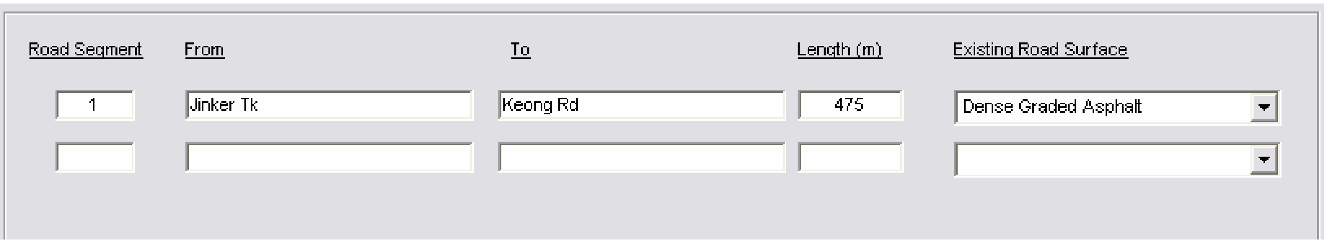
3. Click ***OK*** to acknowledge the prompt.

4. Enter all project identification details into the upper frame on the Site Information window.

*The project identification details (shown on upper panel) apply to the whole project. Data entered within **Site Data** and **Traffic Data** apply only to each road segment (you can subdivide the noise corridor into segments).*



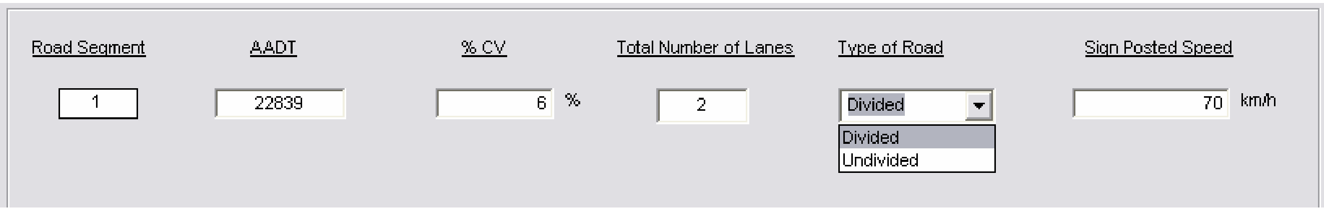

5. Click ***Add Segment*** to add a set of textboxes to both the Site Data and Traffic Data frames.




6. Enter ***Site Data*** and ***Traffic Data*** for all road segments.

7. Click on the ***Existing Road Surface*** pull-down menu and select the pavement surface type for each road segment.


8. Click on the ***Type of Road*** pull-down menu and select the road type for each road segment.




9. Click ***Save*** to save data to the database after carefully checking data has been accurately entered.

10. Click ***Exit*** to close the Site Information window.

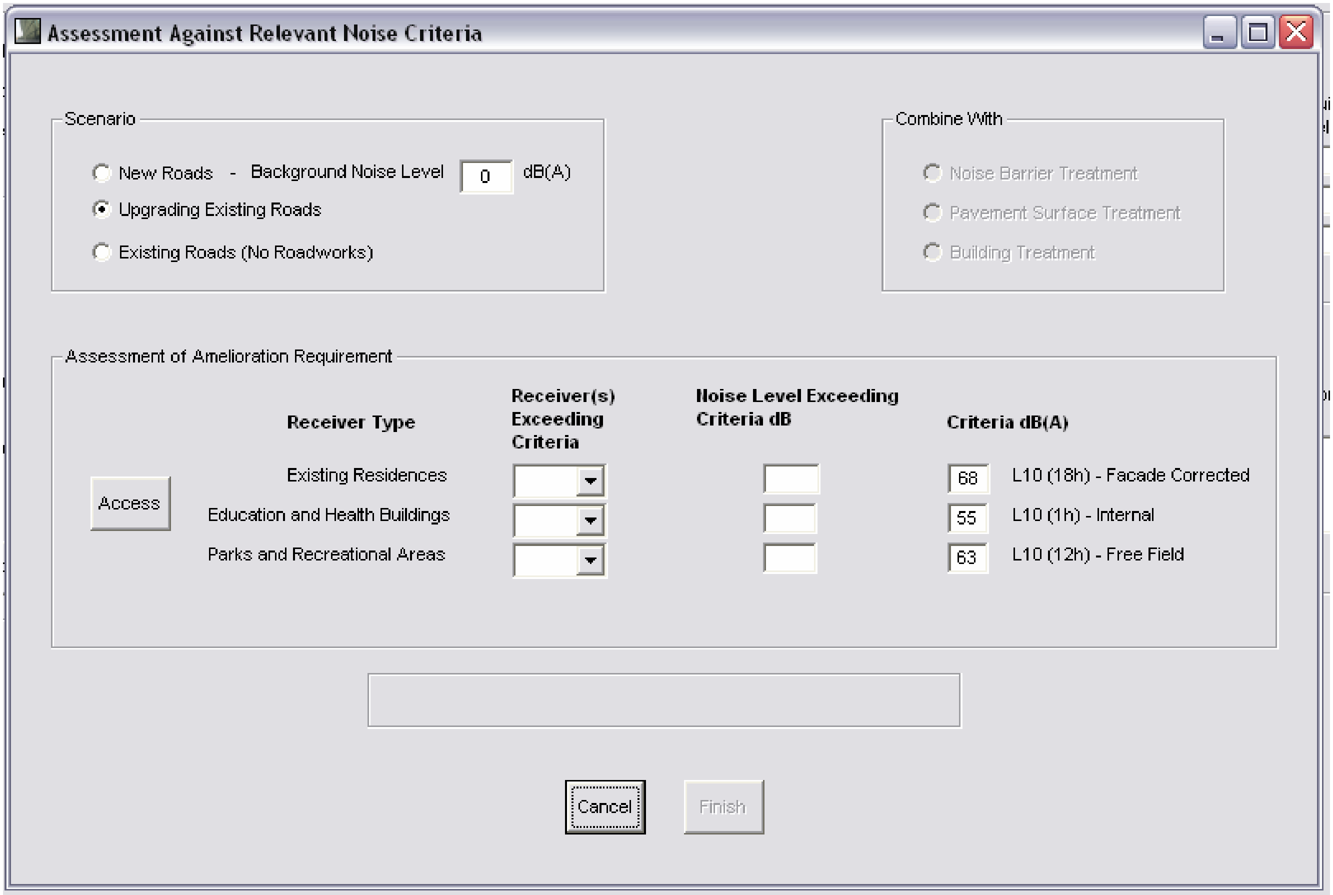
## To compare assessment noise levels against the relevant criteria

You can determine the relevant criteria for a given scenario, compare assessment noise levels with the criteria, determine the amount by which a noise level exceeds the criteria, and determine the requirement for noise amelioration.

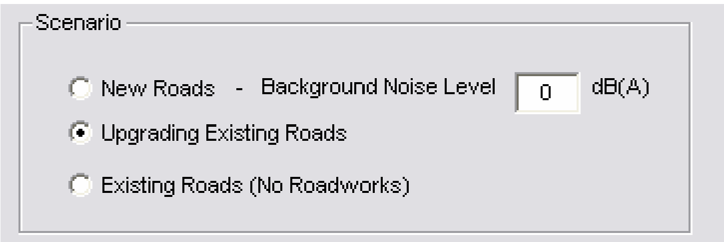
To start:

1. Pull down the ***Noise Impact and Code Assessment*** menu.


2. Click ***Assessment Against Relevant Noise Criteria*** to open the window.




3. In the Road Development Type frame select the relevant road development type for the project.



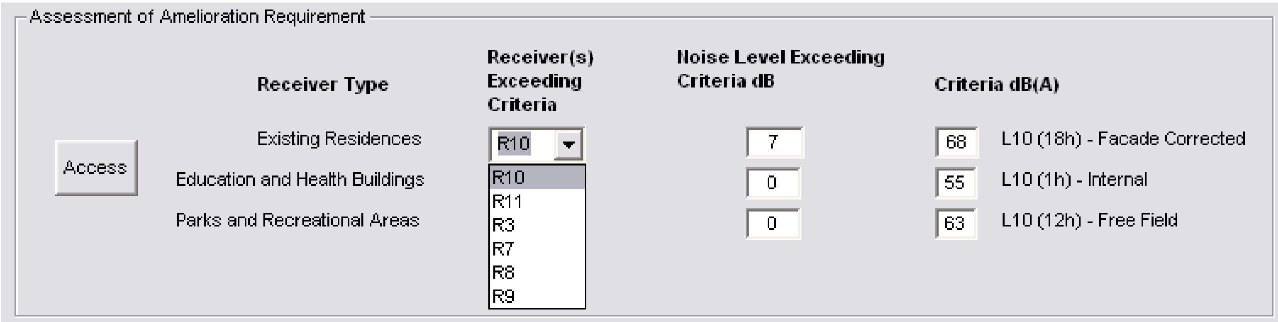

*The relevant criteria for a given scenario depend on the scenario or road development type. In the Road Development Type frame you can select the button corresponding to the scenario being assessed. The criteria values used are from the QDMR code of practice (2000). The criteria will change in accordance with the scenario selected and, in the case of a new road, also according to the background noise level measured before the new road development.*

4. If the road development type is a New Road, input the ***Background Noise Level*** into the textbox.

5. Click ***Import/Edit*** in the Assessment of Amelioration Requirement frame to open the Import/Edit window.

*Before the Import/Edit window opens, the **Open** window appears enabling you to locate and select the file from which single-point receiver assessment noise levels will be imported. This information is coming from analyses already completed using noise modelling software (SoundPLAN, TNM,* *etc.). Once the noise levels have been imported and the Import/Edit window has been closed, the noise levels are compared to the criteria. The receivers with noise levels exceeding the criteria are listed in the Receivers Exceeding Criteria pull-down menu corresponding to the assigned land-use type of each receiver.*

6. Select any receiver from the ***Receiver(s) Exceeding Criteria*** pull-down menu to view the amount by which the receiver noise level exceeds the relevant criteria. This appears in the ***Noise Level Exceeding Criteria*** textbox when you select the receiver.




7. View the notice, which provides a final statement telling you whether amelioration is required.


8. Click ***Finish*** to return to the Back-drop screen.

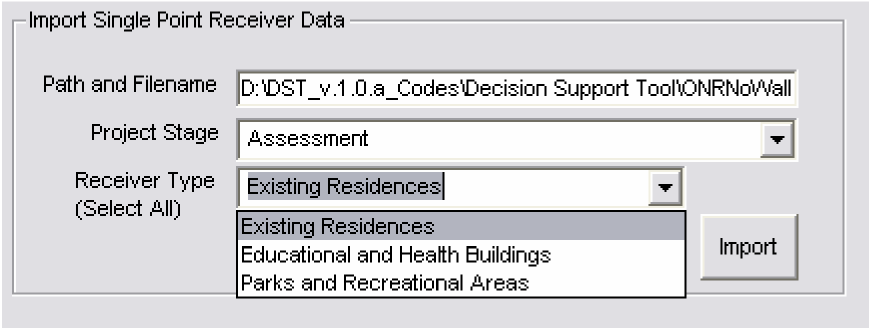
## To import and edit single-point receiver noise data

You can select a file of single-point receiver noise levels, import them into the DST, assign a land-use type and read the noise levels at each receiver. The DST assigns the project stage depending on the stage of the project being assessed. The project stage can be either Assessment or Amelioration.

The file types that can be imported are output files from traffic noise modelling software such as SoundPlan or TNM. The output files contain single-point receiver noise levels and are imported as Excel files.

To start:

1. In the Import Single-Point Receiver Data frame select the desired ***Path and Filename*** if it is not already presented.

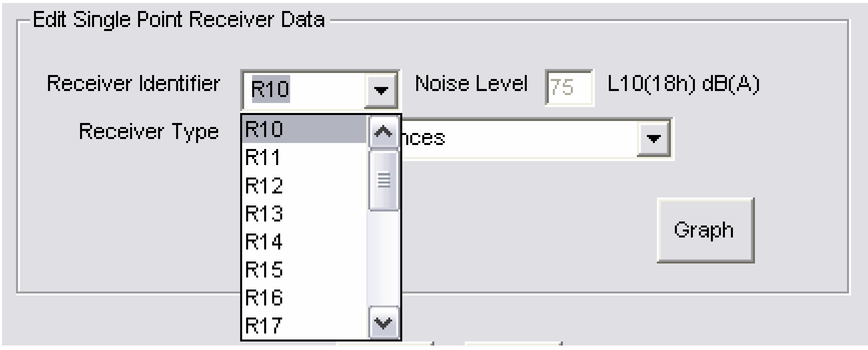



2. Ensure that the project stage (Assessment or Amelioration) displayed in the Import Single-Point Receiver Data frame corresponds to the type of noise level data being imported.

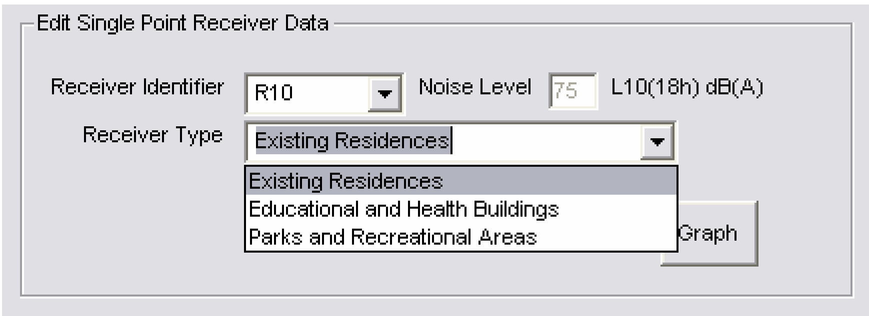
3. In the Import Single-Point Receiver Data frame click on the ***Receiver Type*** pull-down menu and select the receiver type that applies to most receiver identifiers. The receiver type selected here will be applied to all single-point receiver identifiers.

4. Click the ***Import*** button to import the Single-Point Receiver Data.

5. In the Edit Single-Point Receiver Data frame select the receiver identifier to be edited from the ***Receiver Identifier*** pull-down menu.

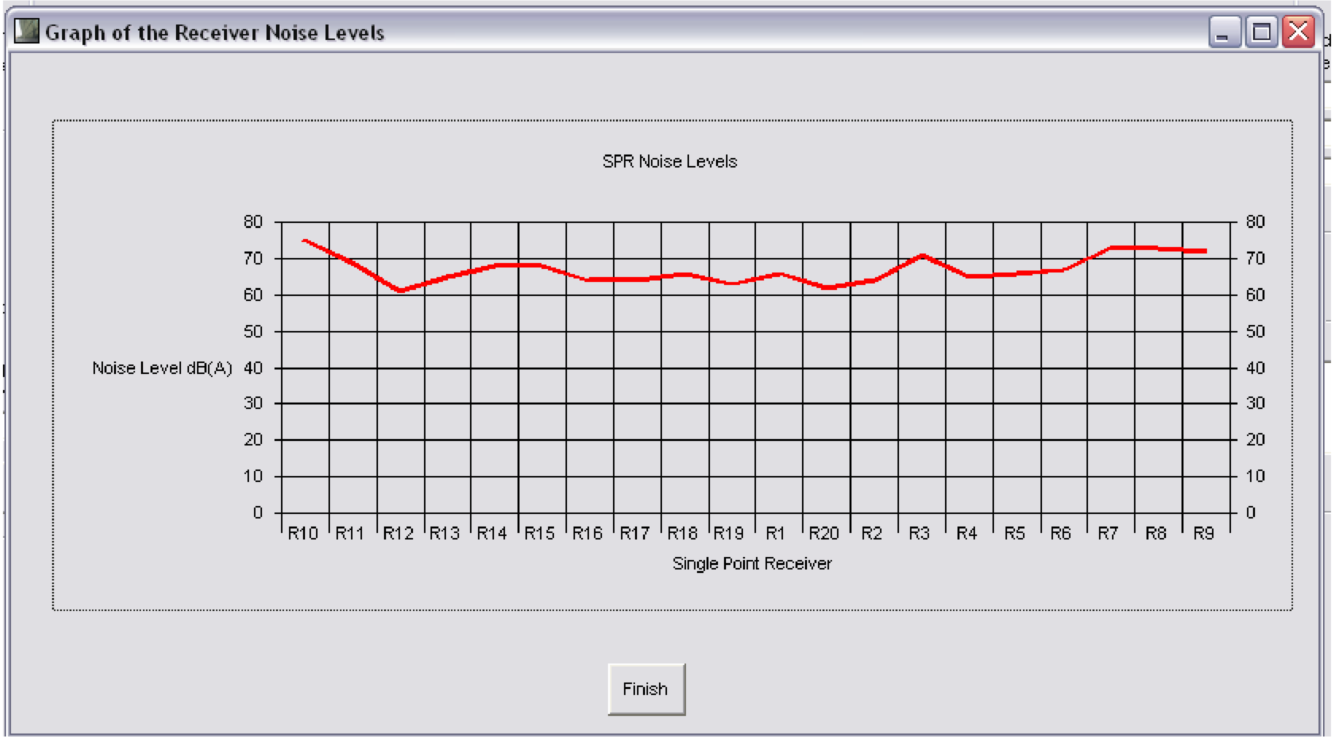



6. Select the desired Receiver Type for the selected receiver identifier from the ***Receiver Type*** pull-down menu.




7. View the noise level corresponding to the selected receiver identifier in the ***Noise Level*** textbox.

8. Click ***Graph*** to view a graph of all the receiver identifier noise levels.




9. Click ***Finish*** to return to the Import/Edit window.

10. Click ***Finish*** to return to the Assessment Against the Relevant Criteria window.

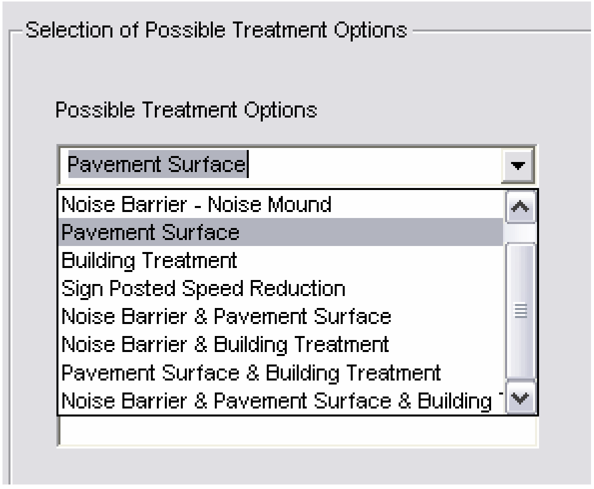
## To identify and select a range of possible treatment options

You can identify possible treatment options for the noise project. You can determine the possible noise reduction values and read qualifying comments for each treatment option. *These are envelope values only* and are to be verified before making a decision. The selected options will be registered in the Selected Treatment Options textbox.

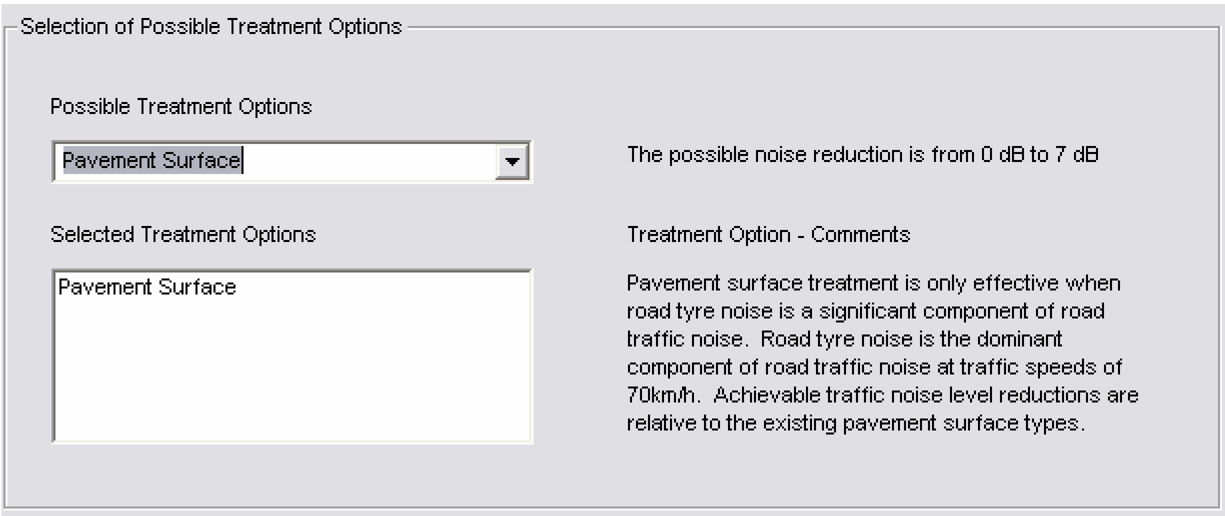
To start:

1. Click ***Option Identification*** on the menu bar to open the Option Identification window.


2. Select a Treatment Option from the ***Possible Treatment Options*** pull-down list.




3. Compare the possible noise reductions with the maximum noise reduction required (displayed in the Traffic Noise Criteria and Amelioration Requirement section of the Back-drop screen) and read qualifying comments about the option.




4. Click the ***Possible Treatment Options*** pull-down list and select a noise amelioration option. You can select as many different treatment options as you like.

5. Click on the selected treatment option in the ***Selected Treatment Option*** pull-down list to remove it from the selected list.

6. Click ***Finish*** to return to the Back-drop screen.

## To conduct an amelioration analysis

You can see whether a selected treatment option is technically valid. The treatment options that can be assessed include noise barriers, pavement resurfacing and building treatment. It is also possible to combine the noise reductions resulting from different treatments. Building treatment, if included in a combination of treatments, must be the last treatment combined. This is because building treatment is assessed against an internal standard which cannot be converted back to, or compared with, external criteria.

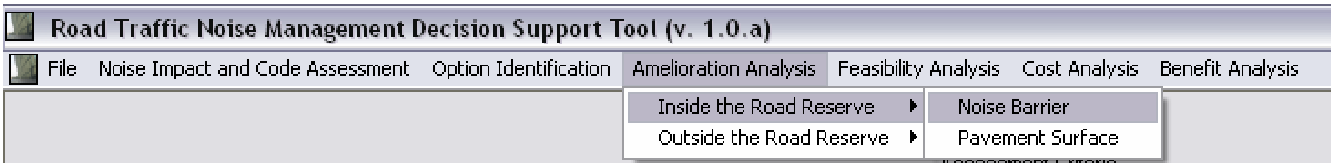
## To conduct an amelioration analysis of a non-combined treatment

To start:

1. Pull down the ***Amelioration Analysis*** menu bar.

2. Click on ***Inside the Road Reserve.***

3. Click on ***Noise Barrier*** to open the Amelioration Analysis Window > Noise Barrier.




or

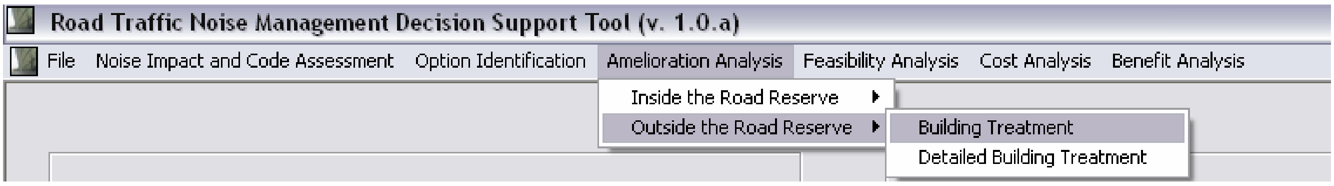
2. Click on ***Inside the Road Reserve.***

3. Click on ***Pavement Surface*** to open the Amelioration Analysis Window > Pavement Surface.

or

2. Click on ***Outside the Road Reserve.***

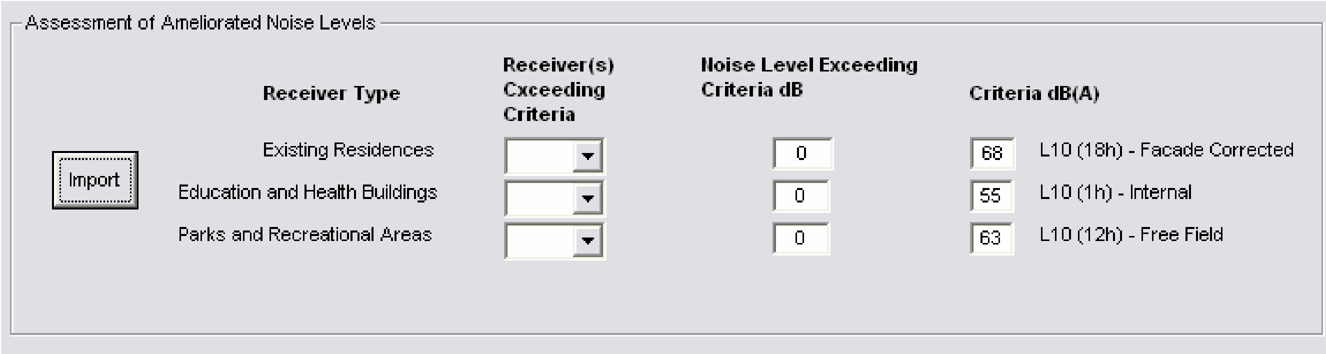
3. Click on ***Building Treatment*** to open the Amelioration Analysis Window > Building Treatment.




4. Click ***Import, Select*** or ***Assess*** in the Assessment of Ameliorated Noise Levels frame depending on whether the treatment option is a noise barrier, pavement surface or building treatment.

*Clicking **Import, Select** or **Assess** opens the window corresponding to the selected treatment. Once the selected treatment has been processed and the treatment window closed, the ameliorated noise levels are compared to the relevant criteria. The single-point receiver identifiers with noise levels still exceeding the criteria are listed in the pull-down list corresponding to the assigned land-use type of each single-point receiver identifier.*

5. Select a receiver in the ***Receiver(s) Exceeding Criteria*** pull-down list to view the amount by which the receiver noise level exceeds the criteria in the Noise Level Exceeding Criteria textbox.




6. View the notice below the Assessment of Amelioration Noise Levels frame. This provides a final statement telling you whether the noise amelioration was satisfactory or whether further amelioration is required.

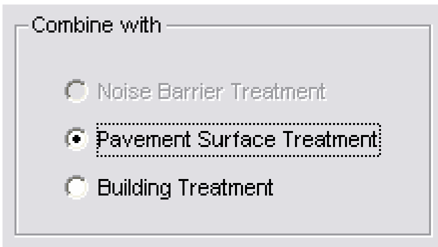
7. Click ***Finish*** to return to the Back-drop screen.

## To conduct amelioration analysis of combined treatments

If you have conducted an amelioration analysis and there remains at least one receiver exceeding the criteria, you can combine the treatment option with another. Building treatment, if included in a combination of treatments, must be the last treatment combined. This is because building treatment is assessed against an internal standard which cannot be converted back to, or compared with, external criteria.

To start:

1. With the Amelioration Analysis window open, click the radio button of the desired treatment option to be combined with the previous treatment option in the ***Combine With*** frame. You cannot combine two treatment options that are of the same type.




2. Click ***Import, Select*** or ***Assess*** in the Assessment of Ameliorated Noise Levels frame depending on whether the treatment option is a noise barrier, pavement surface or building treatment.

*Clicking **Import, Select** or **Assess** opens the window corresponding to the selected treatment. Once the selected treatment has been processed and the treatment window closed the ameliorated noise levels are compared to the relevant criteria. The single-point receiver identifiers with noise levels still exceeding the criteria are listed in the pull-down list corresponding to the assigned land-use type of each single-point receiver Identifier.*

3. Select a receiver in the ***Receiver(s) Exceeding Criteria*** pull-down list to view the amount by which the receiver noise level exceeds the criteria in the Noise Level Exceeding Criteria textbox.

4. View the notice below the Assessment of Amelioration Noise Levels frame which provides a final statement telling you whether the noise amelioration was satisfactory or whether further amelioration is required.

5. If after you have conducted the second amelioration analysis there still remains at least one receiver exceeding the criteria, you can repeat this process and further combine the treatment options with another.

6. Click ***Finish*** to return to the Back-drop screen.

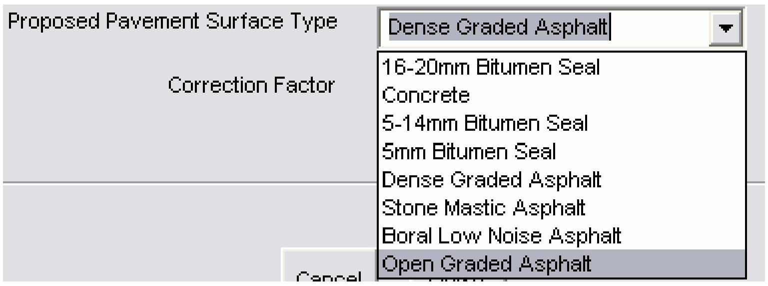
*To select a proposed pavement surface type*

To start:

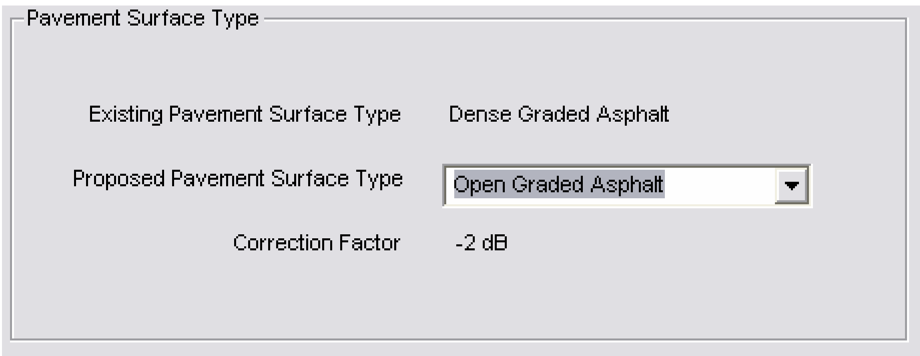
1. From the Amelioration Analysis window, click ***Select*** in the Assessment of Ameliorated Noise Levels frame to open the Pavement Surface window.

2. View the existing pavement surface type in the Pavement Surface Type frame.

3. Click the Proposed Pavement Surface Type pull-down list and select a pavement surface type.




4. View the correction factor in the Pavement Surface Type frame.




5. Click ***Finish*** to return to the Amelioration Analysis window.

## To apply building treatment to all receivers exceeding criteria

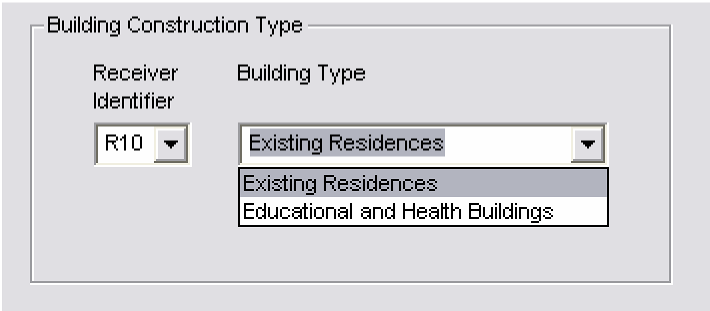
To start:

1. From the Amelioration Analysis window click ***Assess*** in the Assessment of Ameliorated Noise Levels frame to open the Building Treatment window

To change the building type corresponding to a receiver identifier:

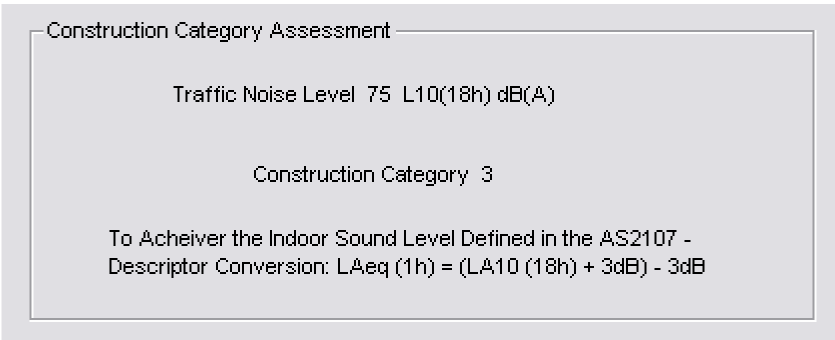
2. Click on the ***Receiver Identifier*** pull-down list to select a receiver identifier.

3. Click on the ***Building Type*** pull-down list to define a building type for the selected receiver identifier.




4. View the traffic noise level corresponding to the selected receiver identifier.

5. View the construction category required in order that the selected receiver identifier achieves the Indoor sound level recommended in the Australian Standards, AS/NZS 2107–2000.




6. Click ***Finish*** to return to the Amelioration Analysis window.

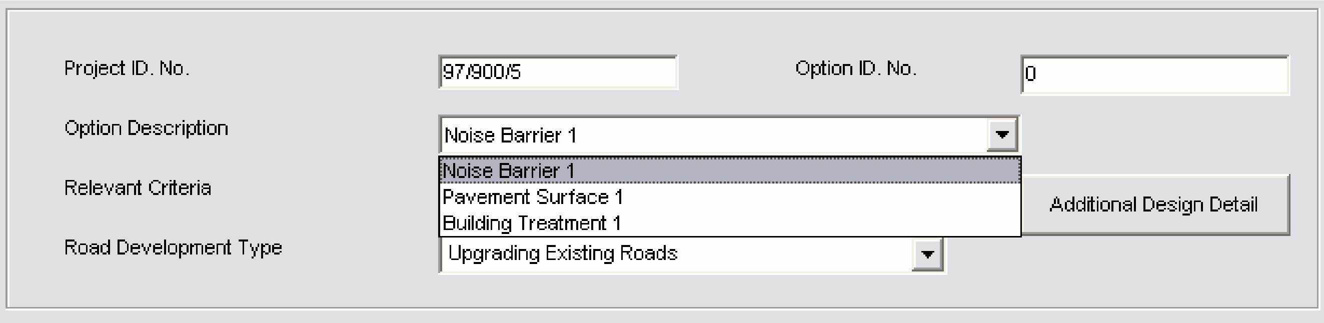
## To compare treatment options with the preferred ameliorative strategies

You can compare treatment options with the preferred ameliorative strategies defined in the Road Traffic Noise Management: Code of Practice. The criteria used to define the preferred ameliorative strategies are listed in the treatment option frame. It is up to you to decide whether a treatment option design sufficiently satisfies the preferred ameliorative strategy criteria.

To start:

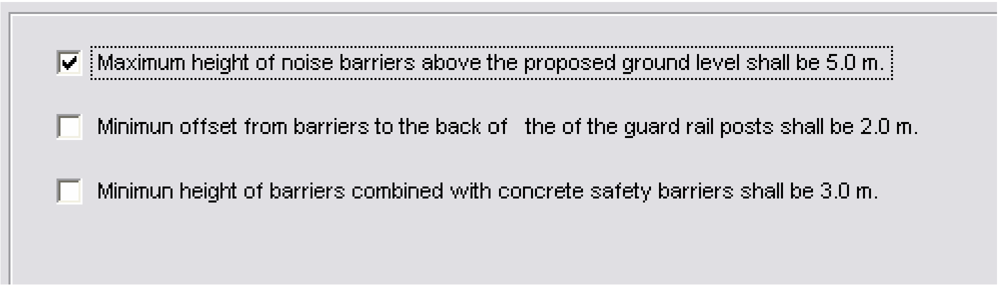
1. Click on the ***Feasibility Analysis*** menu bar to open the Feasibility of Options window.

2. Click on the ***Option Description*** pull-down list and select the treatment option to be assessed.

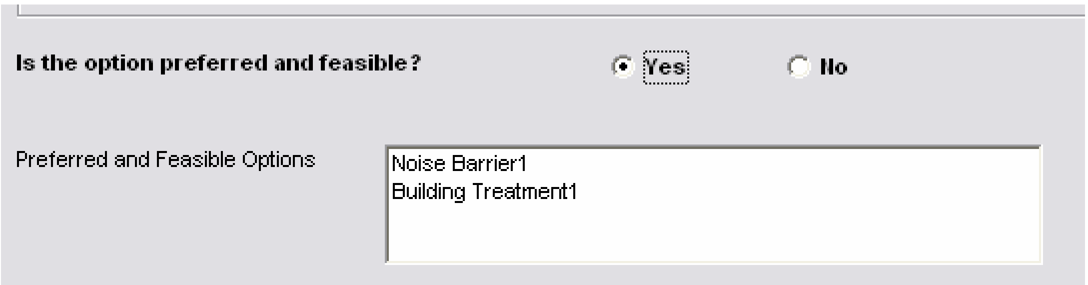



3. If the treatment option is a noise barrier, then click on the ***Additional Design Detail*** button and view the design parameters.

4. Check the criteria listed in the treatment option frame to determine whether the selected treatment option design parameters sufficiently satisfy the preferred ameliorative strategy criteria.




5. If you consider that the selected treatment option design sufficiently satisfies the preferred ameliorative strategy criteria, click the ***Yes*** radio button corresponding to the statement, ***Is the option preferred and feasible?***




6. To remove a treatment option from the preferred and feasible list, click on the option in the list to highlight it and then click the ***No*** radio button corresponding to the statement, ***Is the option preferred and feasible?***

7. Repeat the process for all treatment options listed in the Option Description pull-down list.

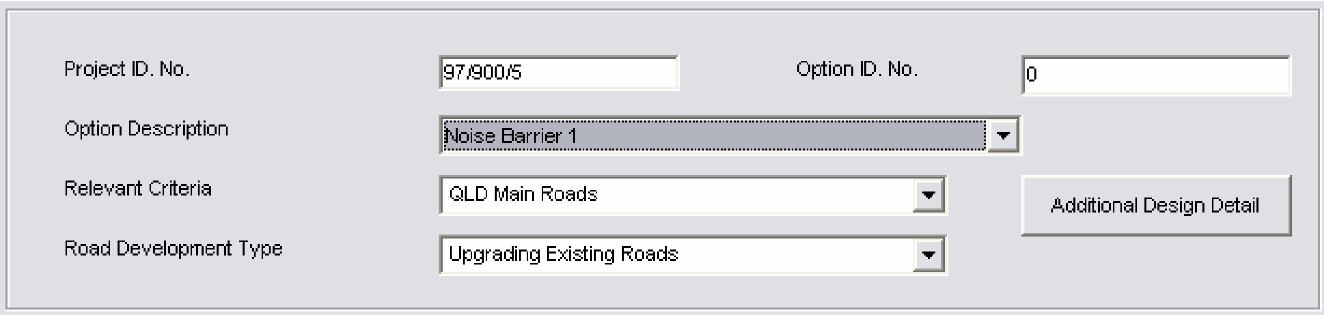
8. Click ***Exit*** to return to the Back-drop screen.

## To import noise barrier design details

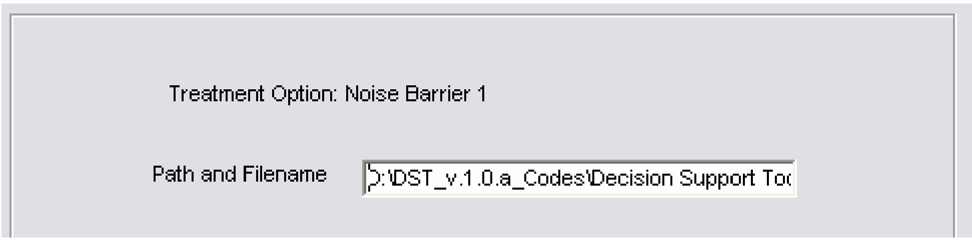
You can select a file of noise barrier design details and import them into the DST. The file types that can be imported are output files from traffic noise modelling software such as SoundPlan or TNM. The output files contain noise barrier coordinates and are imported as Excel files.

To start

1. Click on the ***Additional Design Detail*** button from the Feasibility of Options window.




2. Before the Noise Barrier Design Details window opens, the **Open** window appears enabling you to locate and select the file from which the noise barrier design details will be imported. In the Noise Barrier Design Details window the desired Path and Filename are displayed.




3. Click the ***Import*** button to import, calculate and display noise barrier design details such as number of barrier segments, barrier segments lengths and heights.

4. View the segment lengths and heights by clicking on the up and down buttons in the Barrier Segment frame.


5. Click ***Finish*** to return to the Feasibility of Options window.

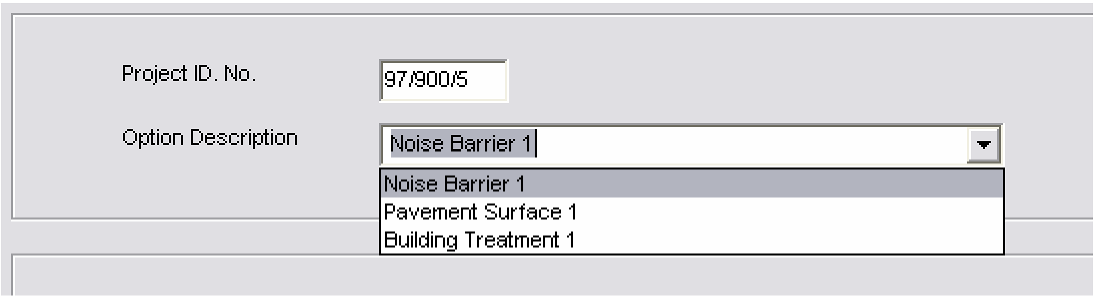
## To develop a concept costing for a treatment option

You can develop a concept costing for each selected treatment option based on design parameters such as overall dimensions and material types. Other items also included in the costing are project management, survey and design, land acquisition, service relocation, and site-specific works. You can set a contingency value as a percentage of the total cost to allow for unexpected costs. You can also enter the cost of items not listed in the Cost frame in the Miscellaneous Items textbox.

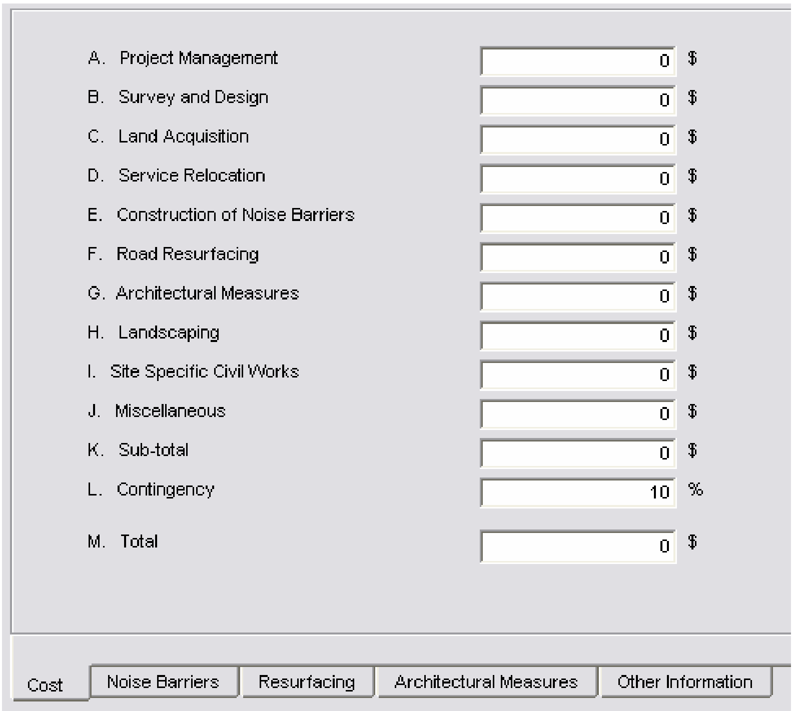
To start:

1. Click on the ***Cost Analysis*** menu bar to open the Concept Costing window.


2. Click on the ***Option Description*** pull-down list and select the treatment option to be evaluated.




3. Click on the tab corresponding to the selected treatment option and select the appropriate item(s) from the pull-down menu to evaluate the treatment construction cost.




4. Click on the ***Cost Tab*** to return to the Cost Frame.

5. Enter costs for Project Management, Survey and Design, Land Acquisition, Landscaping, Site-specific Works, and Miscellaneous items.

6. Enter a percentage value for the Contingency value to change it from the default value of 10%.

*The Subtotal and Total values are automatically calculated.*

7. Click ***Exit*** to return to the Back-drop screen.

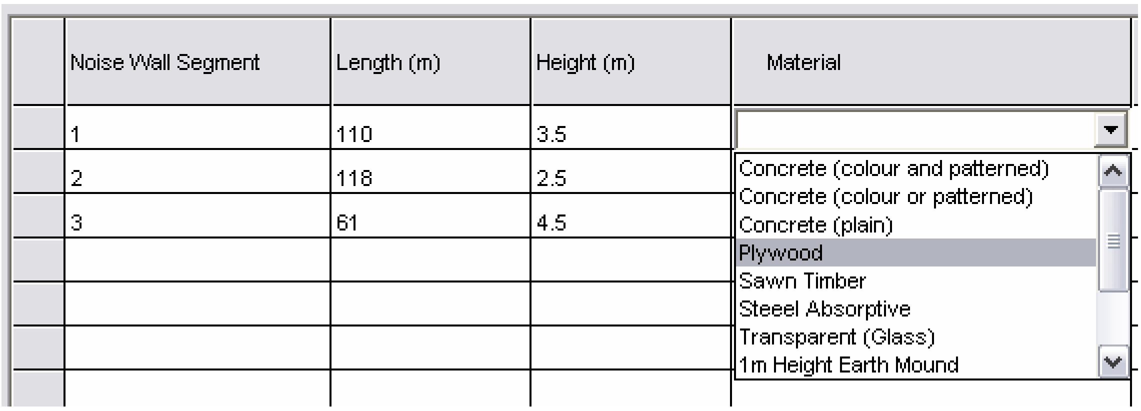
## To cost the construction of noise barriers

You can estimate the construction cost of a noise barrier based on the length, height and material used. You need to either import the noise barrier design details from the Feasibility of Options section which will automatically be displayed in the Noise Barriers frame, or manually input the length and heights of each noise barrier segment.

To start:

1. Click the ***Noise Barriers*** Tab, from the Concept Costing window.


2. Click on the ***Material*** pull-down list and select a material type for each noise wall segment listed.




3. The price per square metre and the segment cost are evaluated and displayed automatically.

| | Noise Wall Segment | Length (m) | Height (m) | Material | Price ($/m2) | Cost ($) |
|---|---|---|---|---|---|---|
| | 1 | 110 | 3.5 | Plywood | 195 | 75075 |
| | 2 | 118 | 2.5 | Plywood | 195 | 57525 |
| | 3 | 61 | 4.5 | Plywood | 195 | 53527 |

4. The sum of the cost of all barrier segments will be passed to Item E, ***Construction of Noise Barriers***, on the Cost frame.

5. Click the ***Cost Tab*** to return to the Cost Frame.

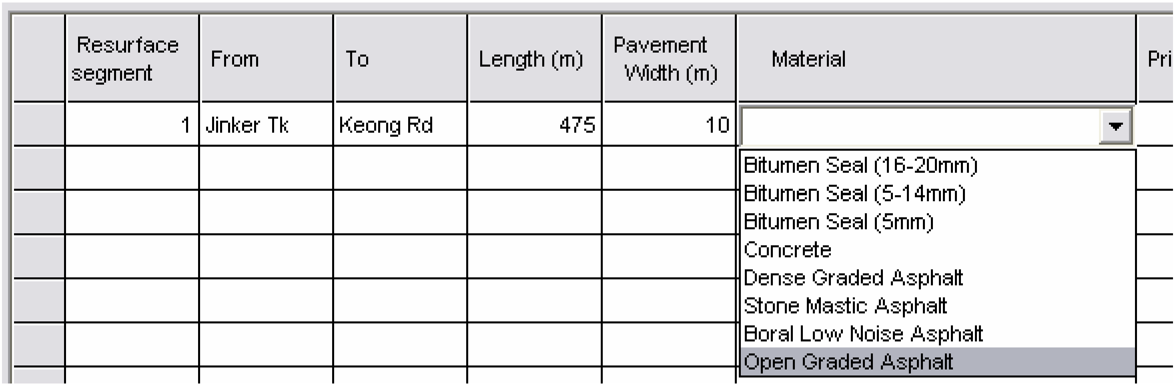
## To cost the resurfacing of a road

You can estimate the cost of resurfacing a road based on the road length, number of lanes and pavement surface type. You can enter the length of the road at the Site Information project stage and you can determine the required pavement surface type at the Amelioration Stage of the process. You can change the default lane width which has been set at 5 m by editing the Pavement Width Column of the Resurfacing frame.

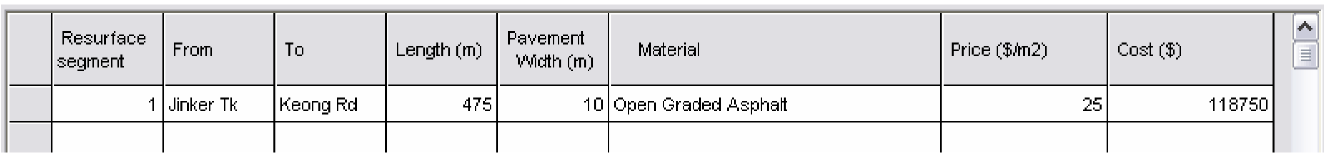
To start:

1. Click the ***Resurfacing*** Tab from the Concept Costing window.


2. Click on the ***Material*** pull-down list and select a pavement surface type.




3. The price per square metre and the cost are calculated and displayed automatically.




4. The sum of the cost of resurfacing will be passed to Item F, ***Road Resurfacing***, on the Cost frame.

5. Click the ***Cost Tab*** to return to the Cost Frame.

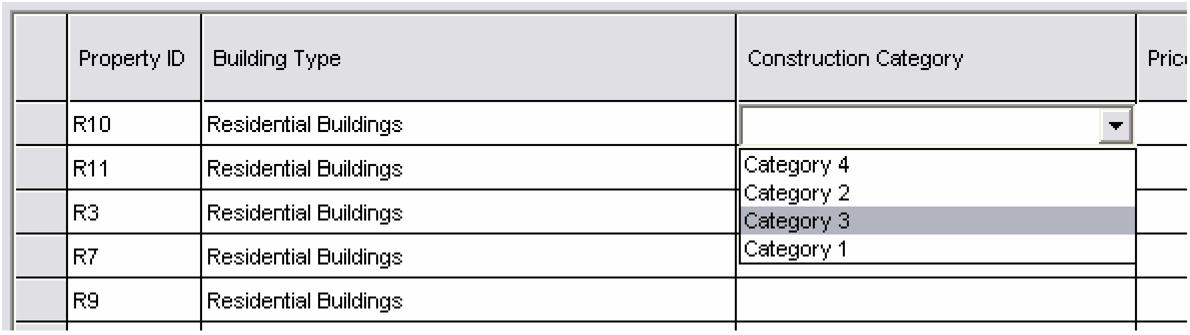
## To cost the treatment of buildings

You can estimate the cost of building treatment based on the building type and construction category required to ensure satisfactory indoor sound levels. You can define the building type at the Assessment against Relevant Noise Criteria stage of the process. You can determine the required construction category at the Amelioration Stage of the process.

To start:

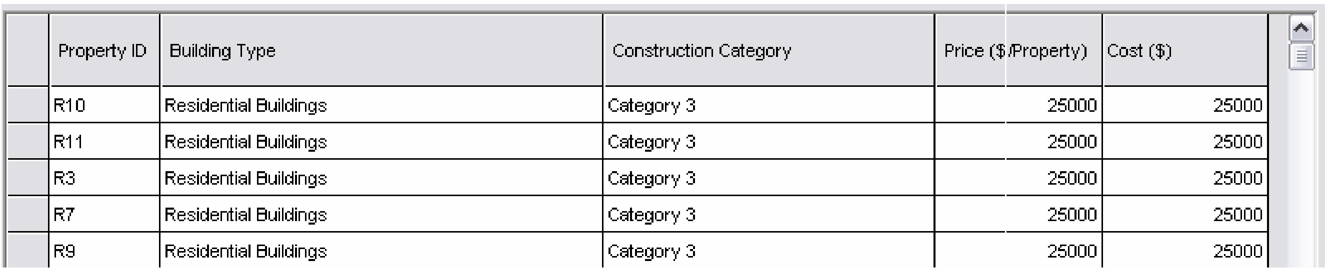
1. Click the ***Architectural Measures*** Tab from the Concept Costing window.


2. Click on the ***Construction Category*** pull-down list and select a construction category for each property listed. The construction category has been determined at the Amelioration Stage of the process.



| | Property ID | Building Type | Construction Category | Pric |
|---|---|---|---|---|
| | R10 | Residential Buildings | | |
| | R11 | Residential Buildings | Category 4 | |
| | R3 | Residential Buildings | Category 2<br>Category 3 | |
| | R7 | Residential Buildings | Category 1 | |
| | R9 | Residential Buildings | | |

3. The price per property as a lump sum, based on the construction category and building type, are displayed automatically.



| | Property ID | Building Type | Construction Category | Price ($/Property) | Cost ($) |
|---|---|---|---|---|---|
| | R10 | Residential Buildings | Category 3 | 25000 | 25000 |
| | R11 | Residential Buildings | Category 3 | 25000 | 25000 |
| | R3 | Residential Buildings | Category 3 | 25000 | 25000 |
| | R7 | Residential Buildings | Category 3 | 25000 | 25000 |
| | R9 | Residential Buildings | Category 3 | 25000 | 25000 |

4. The sum of the building treatment costs will be passed to Item G, ***Architectural Measures***, on the Cost frame.

5. Click the ***Cost Tab*** to return to the Cost frame

## To analyse the benefit of a treatment option

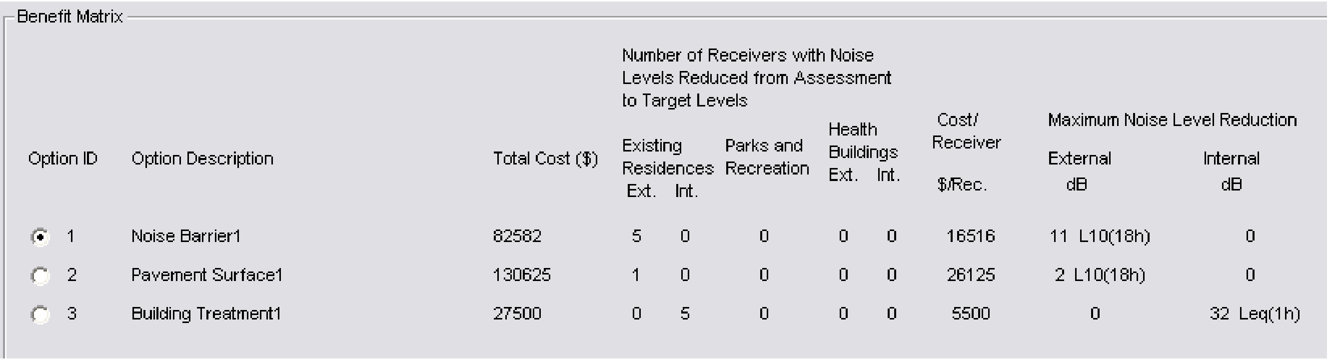
Many of the parameters used to measure benefits have already been evaluated and so when you open the Benefit Analysis window they are displayed in the Benefit Matrix. You can view a table in which the cost and benefit factors are listed for a range of ameliorative treatment options. You can also assign a number of positive environmental and positive social factors to a treatment option.

To start:

1. Click on the ***Benefit Analysis*** menu bar to open the Benefit Analysis window.


2. View the Benefit Matrix to assess the benefit of alternative treatment options. The parameters presented in the Benefit Matrix include Cost, Number of Receivers with Noise

Levels Reduced from Assessment to Target Levels, Cost/Receiver (cost per receiver) and the Maximum Noise Level Reduction.


Benefit Matrix

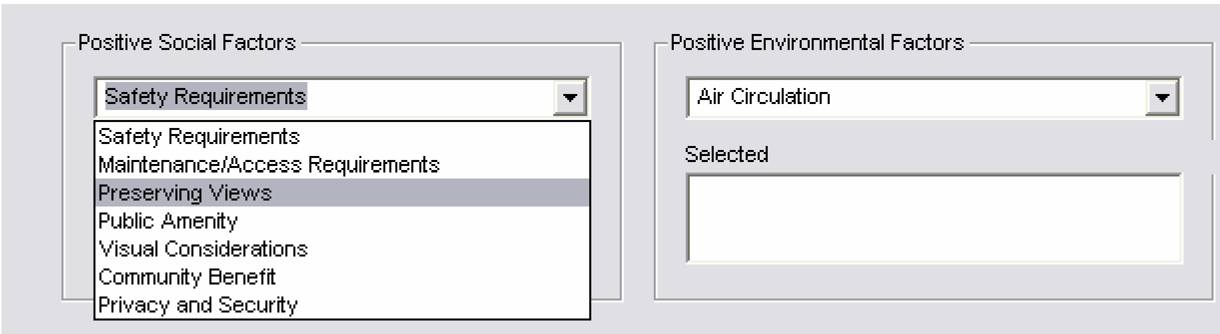
| Option ID | Option Description | Total Cost ($) | Number of Receivers with Noise Levels Reduced from Assessment to Target Levels: Existing Residences Ext. | Int. | Parks and Recreation | Health Buildings Ext. | Int. | Cost/ Receiver $/Rec. | Maximum Noise Level Reduction: External dB | Internal dB |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Noise Barrier1 | 82582 | 5 | 0 | 0 | 0 | 0 | 16516 | 11 L10(18h) | 0 |
| 2 | Pavement Surface1 | 130625 | 1 | 0 | 0 | 0 | 0 | 26125 | 2 L10(18h) | 0 |
| 3 | Building Treatment1 | 27500 | 0 | 5 | 0 | 0 | 0 | 5500 | 0 | 32 Leq(1h) |

3. Click on the ***Economic, Environmental and Social Benefit Factors*** tab to view the table of cost and benefit factors.

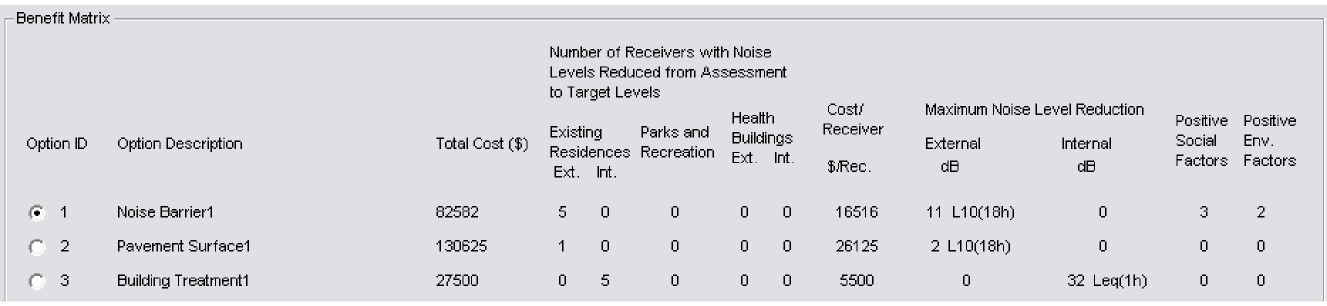

4. Click on the ***Benefit Matrix*** tab to return to the Benefit Matrix frame.

5. Click the radio button to select a treatment option.

6. Click on the ***Positive Social Factors*** pull-down menu and select a positive factor. Select as many factors as apply to the treatment option.




7. Click on the ***Positive Environmental Factors*** pull-down menu and select a positive factor. Select as many factors as apply to the treatment option.


Benefit Matrix

| Option ID | Option Description | Total Cost ($) | Number of Receivers with Noise Levels Reduced from Assessment to Target Levels: Existing Residences Ext. | Int. | Parks and Recreation | Health Buildings Ext. | Int. | Cost/ Receiver $/Rec. | Maximum Noise Level Reduction: External dB | Internal dB | Positive Social Factors | Positive Env. Factors |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Noise Barrier1 | 82582 | 5 | 0 | 0 | 0 | 0 | 16516 | 11 L10(18h) | 0 | 3 | 2 |
| 2 | Pavement Surface1 | 130625 | 1 | 0 | 0 | 0 | 0 | 26125 | 2 L10(18h) | 0 | 0 | 0 |
| 3 | Building Treatment1 | 27500 | 0 | 5 | 0 | 0 | 0 | 5500 | 0 | 32 Leq(1h) | 0 | 0 |

*The number of positive factors selected will be displayed in the Positive Social and Environmental*

*Factors columns of the Benefit Matrix respectively.*

8. Click ***Finish*** to return to the Back-drop screen.

# Section 3

## Troubleshooting

| Project stage | Trouble | Possible causes | Solution |
|---|---|---|---|
| Assessment Against Relevant Noise Criteria | The new road criterion is 60 but should be 63. | 1. Background noise level not input.<br>2. Background noise level incorrectly input as a value less than 55. | Input correct noise level which is greater than 55. |
| Assessment Against Relevant Noise Criteria | All receiver noise levels are higher/lower than expected. | Receiver identifiers may have had their land-use type incorrectly assigned. | Check that the land-use type has been correctly assigned to all receiver Identifiers. |
| Amelioration Analysis | The Amelioration Analysis window does not open when a treatment has been selected. | An existing treatment option has been selected and the amelioration method that has been selected is of a different type to that of the existing treatment. | 1. Select a new treatment option and select the desired amelioration method.<br>2. Select an existing treatment option and select the amelioration method that is the same as has been applied to the selected existing treatment. |
| Amelioration Analysis | Noise barrier receiver noise levels don’t satisfy criteria. | 1. The wrong file could have been imported.<br>2. The road development type may have changed from that assigned during the assessment. | 1. Check that the correct file has been imported.<br>2. Check that the road development type has not changed from that assigned during the assessment. |
| Feasibility of Options | Clicking Feasibility Analysis from the Back-drop screen does not open the Feasibility of Options window. | The Feasibility of Options window will not open until at least one amelioration analysis has been completed. | Conduct at least one amelioration analysis before opening the Feasibility of Options window. |
| Feasibility of Options | Clicking Noise Barrier Design Details button does not open Noise Barrier Design Details window. | Treatment option selected does not include a noise barrier. | Select a treatment option that includes a noise barrier. |
| Concept Costing Details — Noise Barrier tab selected | Noise wall segments, lengths and heights not displayed. | 1. Treatment option selected does not include a noise barrier.<br>2. Noise barrier design | 1. Select a treatment option that includes a noise barrier.<br>2. Import noise barrier |

| | | | |
|---|---|---|---|
| | | details have not been imported. | design details from the feasibility analysis stage.<br>3. Enter noise barrier design details manually. |
| Concept Costing Details — Architectural Measures tab selected | Property ID and Building Type not displayed. | 1. Treatment option selected does not include a building treatment. | 1. Select a treatment option that includes a building treatment. |
| Concept Costing Details — Resurfacing tab selected | Resurface segment, From, To, Length and Pavement Width not displayed | 1. Treatment option selected does not include resurfacing. | 1. Select a treatment option that includes resurfacing. |
| Concept Costing details — Cost tab selected | Data entered into textboxes is not automatically added to subtotal and total. | Data updates when another textbox is clicked. | Click another textbox in the list to update subtotal and totals. |
| Benefit Analysis | When adding social and environmental factors they are added to the wrong treatment option. | The treatment option to which the benefit factors are to be added has not been selected. | Select the treatment option to which the benefit factors are to be added. |

# Noise Management in Urban Environments

**2002-004-B**

# DST Verification

# Case Studies

**February 2005**

Research team

Dr. Saman de Silva, RMIT University

Dr. Li Chen, RMIT University

Mr. Philip Douglas, RMIT University

Mrs. Julie Peters, Queensland Department of Main Roads

## Introduction

The results of three case studies that have been assessed using the Decision-support Software Tool (DST) are presented in this report. Each of the three case studies was also assessed manually by the Queensland Department of Main Roads (QDMR). The reasons for conducting the case studies were to:

- demonstrate the capability of the DST
- demonstrate that the DST can be used to efficiently conduct cost–benefit analyses of noise amelioration strategies, and that it is robust in terms of alternative treatment options and their respective costs
- calibrate the DST by comparing cost profiles generated using the DST with those produced by the QDMR.

The road traffic noise management projects representing the case studies are:

- Case Study 1: Old Northern Road between Jinker Track and Keong Road, Brisbane
- Case Study 2: Mt Lindesay Highway between Kantenna Street and Talinga Drive, Brisbane
- Case Study 3: Pacific Motorway between Peachey Road Street and Pimpama River, Ormeau

The Old Northern Road case study involves an existing four-lane road (no road works), and all the noise-sensitive receivers were existing residences. The Pacific Motorway involves noise-sensitive receivers with both existing residences, and parks and recreational area land-use types. The Mt Lindesay Highway case study is particularly interesting because it involves noise-sensitive receivers of all three land-use types: existing residences, educational and health buildings, and parks and recreational areas.

## Case study 1: Old Northern Road between the Jinker Track to Keong Road, Albany Creek, Queensland

### Noise study area

The noise study area to be investigated in this case study runs along the Old Northern Road between the Jinker Track and Keong Road, Albany Creek, Queensland. The road consists two double lanes with residential land uses on both sides of the road, and educational land use, Albany Hills Primary School, on the west side of the road. The traffic flow and road surface data are:

Old Northern Road:

| | |
|---|---|
| AADT | 22,893 |
| % commercial vehicles | 6.0% |
| Growth rate (cumulative) | 4.27% p.a. |
| Posted traffic speed | 70 km/h |
| Existing road surface type | dense-grade asphalt (DGA) |

Noise barriers have been constructed for the residences to the west side of Old Northern Road within the noise study area. The existing noise barriers are typically around 1 m in height.

The road authority, QDMR, has conducted a site visit to determine the existing noise levels at Meyumi Ct, Albany Creek, for both the main residence and the ‘granny flat’. The QDMR’s noise monitoring recorded a noise level of 72.5 dB(A) $L_{A10\ (18\ hours)}$ at the main residence and 70.6 dB(A) $L_{A10\ (18\ hours)}$ at the granny flat.

## Noise impact and code assessment

According to the relevant noise criteria, the study area is defined as an existing road (no road work). The noise receivers in the study area are defined as existing residences. An external level, 68 dB(A) $L_{A10(18\ hours)}$, is recommended as the noise criterion for adjacent residential properties of the study area.

Table 1-1 lists existing noise levels predicted by SoundPlan, a software package based on the CoRTN method.

**Table 1-1: Predicted external levels of the noise receivers, Old Northern Road**

| Receiver no: | Land-use type | Predicted noise level dB(A) | Descriptor |
|---|---|---|---|
| R1 | Existing residences | 66 | $L_{A10(18\ hours)}$ |
| R2 | Existing residences | 63 | $L_{A10(18\ hours)}$ |
| R3 | Existing residences | **71** | $L_{A10(18\ hours)}$ |
| R4 | Existing residences | 65 | $L_{A10(18\ hours)}$ |
| R5 | Existing residences | 66 | $L_{A10(18\ hours)}$ |
| R6 | Existing residences | 67 | $L_{A10(18\ hours)}$ |
| R7 | Existing residences | **73** | $L_{A10(18\ hours)}$ |
| R8 | Existing residences | **73** | $L_{A10(18\ hours)}$ |
| R9 | Existing residences | **72** | $L_{A10(18\ hours)}$ |
| R10 | Existing residences | **74** | $L_{A10(18\ hours)}$ |
| R10 Granny | Existing residences | **75** | $L_{A10(18\ hours)}$ |
| R11 | Existing residences | **69** | $L_{A10(18\ hours)}$ |
| R12 | Existing residences | 59 | $L_{A10(18\ hours)}$ |
| R13 | Existing residences | 65 | $L_{A10(18\ hours)}$ |
| R14 | Existing residences | 68 | $L_{A10(18\ hours)}$ |
| R15 | Existing residences | 68 | $L_{A10(18\ hours)}$ |
| R16 | Existing residences | 64 | $L_{A10(18\ hours)}$ |
| R17 | Existing residences | 64 | $L_{A10(18\ hours)}$ |
| R18 | Existing residences | 65 | $L_{A10(18\ hours)}$ |
| R19 | Existing residences | 61 | $L_{A10(18\ hours)}$ |
| R20 | Existing residences | 62 | $L_{A10(18\ hours)}$ |

Note: * Road surface type is dense-grade asphalt (DGA)
** Receivers exceeding their relevant criterion have been highlighted in bold type.

Out of 12 receivers on the east side of Old Northern Road, from R1 to R11, five receivers were predicted to exceed the noise criterion, 68 dB(A) $L_{A10\ (18\ hours)}$. The highest $L_{A10\ (18\ hours)}$ exceeded the criterion by 7 dB(A). So, the "Noise Ameliorative is Required" result was concluded by using the DST for the noise study area of Old Northern Road.

## Option identification

For reductions of 7 dB(A) in external noise level and 17 dB(A) in internal noise level, four potential ameliorative options for the study area were selected for further study and are shown in Table 1-2.

**Table 1-2: Selected potential ameliorative options, east side of Old Northern Road**

| Option ID no: | Within/Outside road reserve option | Individual/Combined option | Option description |
|---|---|---|---|
| 1 | Within | Individual | Noise barrier — noise wall/noise mound |
| 2 | Within | Combined | Noise barrier — noise wall/noise mound & Pavement surface |
| 3 | Outside | Individual | Building treatment |
| 4 | Within & outside | Combined | Noise barrier — noise wall/noise mound & Building treatment |

## Amelioration analysis

For the potential ameliorative option, Noise barrier — noise wall/noise mound, the modelling results processed by SoundPlan indicated four possible options listed in Table I-3.

For the potential ameliorative options related to building treatment, the built-in evaluation process is based on the Australian Standard 3671 and the results are listed in Table 1-3 as well.

**Table 1-3: Possible ameliorative options, east side of Old Northern Road**

**Within-road reserve**

Option 1: Noise barrier — noise wall

Surface type: Dense-grade asphalt (DGA)

| Barrier no. | Height (m) | Length (m) | Area ($m^2$) |
|---|---|---|---|
| Barrier 1 | 4.5 | 61 | 275 |
| Barrier 2 | 3.5 | 111 | 387 |
| Barrier 3 | 2.5 | 118 | 296 |
| | | Total barrier length | Total barrier area |
| | | 290 m | 959 $m^2$ |

Option 2. Noise barrier — noise wall & Pavement surface

Surface type: Open-grade asphalt (OGA)

| Barrier no: | Height (m) | Length (m) | Area ($m^2$) |
|---|---|---|---|

| | | | |
|---|---|---|---|
| Barrier 1 | 4 | 61 | 245 |
| Barrier 2 | 2 | 117 | 234 |
| | | Total barrier length | Total barrier area |
| | | 178 | 479 |

Option 3. Noise barrier — noise wall & Pavement surface
Surface type: Stone mastic asphalt (SMA)

| Barrier no: | Height (m) | Length (m) | Area ($m^2$) |
|---|---|---|---|
| Barrier 1 | 4 | 61 | 245 |
| Barrier 2 | 3 | 98 | 294 |
| Barrier 2 | 2 | 131 | 262 |
| | | Total barrier length | Total barrier area |
| | | 290 | 801 |

Option 4. Noise barrier — noise mounds
Surface type: Dense-grade asphalt (DGA)

| Mound no: | Height (m) | Length (m) |
|---|---|---|
| Mound 1 | 4.5 | 61 |
| Mound 2 | 3.5 | 111 |
| Mound 3 | 2.5 | 118 |
| | | Total mound length |
| | | 290 |

**Outside-road reserve**

Option 5: Building treatment 1
Surface type: Dense-grade asphalt (DGA)

| Receiver no: | Building type | Construction category |
|---|---|---|
| R3 | Residential | 3 |
| R7 | Residential | 3 |
| R8 | Residential | 3 |
| R9 | Residential | 3 |
| R10 | Residential | 3 |
| R11 | Residential | 3 |

**Combination of treatment of within- and outside-road reserve**

Option 6: Pavement surface & building treatment
Surface type: Open-grade asphalt (OGA)

| Receiver no: | Building type | Construction category |
|---|---|---|
| R3 | Residential | 3 |

| | | |
|---|---|---|
| R7 | Residential | 3 |
| R8 | Residential | 3 |
| R9 | Residential | 3 |
| R10 | Residential | 3 |

## Feasibility of options

The on-site investigation showed that mounding is not feasible for the study area due to actual terrain features. Hence, the feasibility of possible ameliorative options is shown in Table 1-4.

**Table 1-4: Feasible ameliorative options, east side of Old Northern Road**

| **Within-road reserve** | Feasible/Constructable |
|---|---|
| Option 1: Noise barrier — noise wall<br>Surface type: Dense-grade asphalt (DGA) | Yes |
| Option 2. Noise barrier — noise wall & Pavement surface<br>Surface type: Open-grade asphalt (OGA) | Yes |
| Option 3. Noise barrier — noise wall & Pavement surface<br>Surface type: Stone mastic asphalt (SMA) | Yes |
| Option 4. Noise barrier — noise mound<br>Surface type: Dense-grade asphalt (DGA) | No |
| **Outside-road reserve** | |
| Option 5: Building treatment<br>Surface type: Dense-grade asphalt (DGA) | Yes |
| **Combination of treatments of within- and outside-road reserve** | |
| Option 6: Building treatment & Pavement surface<br>Surface type: Open-grade asphalt (OGA) | Yes |

## Concept costing

The five feasible ameliorative options developed in the previous sections have been evaluated in terms of concept costs. A cost comparison study of the five options has been carried out and is presented in Table 1-5.

**Table 1-5: Concept costing of the five feasible ameliorative options, east side of Old Northern Road**

| Option ID no: | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Option description | Noise barrier (plywood) | Pavement surface (OGA) & Noise barrier (plywood) | Pavement surface (SMA) & Noise barrier (plywood) | Building treatment | Pavement surface (OGA) & Building treatment |
| A. Project Management ($) | 9,753 | 9,753 | 9,753 | 9,753 | 9,753 |
| B. Survey and Design ($) | 56,056 | 56,056 | 56,056 | 56,056 | 56,056 |
| C. Land Acquisition ($) | 0 | 0 | 0 | 0 | 0 |
| D. Service Relocation ($) | 0 | 0 | 0 | 0 | 0 |
| E. Construction of Noise | 186,128 | 93,210 | 156,000 | 0 | 0 |

| | | | | | |
|---|---|---|---|---|---|
| Barriers ($) | | | | | |
| F. Road Resurfacing ($) | 0 | 118,750 | 118,750 | 0 | 118,750 |
| G. Architectural Measure ($) | 0 | 0 | 0 | 150,000 | 125,000 |
| H. Landscaping ($) | 12,500 | 12,500 | 12,500 | 0 | 12,500 |
| I. Site-specific Civil Works ($) | 55,535 | 55,535 | 55,535 | 0 | 55,535 |
| J. Miscellaneous ($) | 0 | 0 | 0 | 0 | 0 |
| **K. Subtotal ($)** | 319,972 | 345,804 | 408,594 | 215,809 | 377,594 |
| L. Contingency (%) | 10 | 10 | 10 | 10 | 10 |
| **M. Total ($)** | 351,969 | 380,384 | 449,453 | 237,390 | 415,353 |

It is assumed that for all five options, the costs of the items, Project Management, and Survey and Design, are the same. The costs of items, Landscaping, and Site-specific Civil Works, are the same for the amelioration options with noise barrier or/and road resurfacing.

## Benefit analysis

A range of criteria are used to evaluate and compare noise ameliorative options in terms of benefits. Some, such as costs, are readily expressed in dollar terms, and used in economic benefit evaluation. Some, such as environmental and social benefits, are not readily expressed in dollar terms and can only be presented in relative terms for comparisons between treatment options.

Table 1-6 shows the dollar benefits arising from implementing the feasible ameliorative options for the noise study area.

**Table 1-6: Benefit analysis of viable amelioration options, Old Northern Road**

| Option ID no: | Option description | Number of receivers with noise levels reduced from assessment to target levels, dB | | | | | Cost/receiver ($/rec.) | Maximum noise level reduction (dB) | |
|---|---|---|---|---|---|---|---|---|---|
| | | Existing residences | | Parks and recreation | Education and health buildings | | | | |
| | | Ext. | Int. | | Ext. | Int. | | Ext. | Int. |
| 1 | Noise barrier (plywood) | 6 | 0 | 0 | 0 | 0 | 58,662 | 13.2 dB $L_{A10(18 \text{ hours})}$ | 0 |
| 2 | Pavement surface (OGA) & Noise barrier (plywood) | 6 | 0 | 0 | 0 | 0 | 63,397 | 15.4 dB $L_{A10(18 \text{ hours})}$ | 0 |
| 3 | Pavement surface (SMA) & Noise barrier (plywood) | 6 | 0 | 0 | 0 | 0 | 74,909 | 15.7 dB $L_{A10(18 \text{ hours})}$ | 0 |
| 4 | Building treatment | 0 | 6 | 0 | 0 | 0 | 39,565 | 0 | 22 dB $L_{eq(1 \text{ hour})}$ |
| 5 | Pavement surface (OGA) & Building treatment | 1 | 5 | 0 | 0 | 0 | 69,226 | 2 dB $L_{A10(18 \text{ hours})}$ | 20 dB $L_{eq(1 \text{ hour})}$ |

Table 1-7 shows the non-dollar benefits arising from implementing the relevant ameliorative options to the noise study.

**Table 1-7: Non-dollar benefits from noise reduction arising from implementing ameliorative options at Old Northern Road**

| **Cost–benefit Factors** | | **Ameliorative treatment options** | | |
|---|---|---|---|---|
| | | **Within the road reserve** | | **Outside the road reserve** |
| ***Category*** | ***Factors*** | ***Pavement resurfacing*** | ***Noise barrier wall*** | ***Acoustic treatment of buildings*** |
| **Economic** | **Initial project costs** | + Moderate | – High | + Low to moderate |
| | **Maintenance / operational costs** | – Moderate | – Moderate | – Moderate (responsibility of property owner) |
| **Environmental** | **Air Circulation** | + Nil impact | – Potential impact | – May require mechanical ventilation /air exchange |
| | **Shade effects** | + Nil impact | – Potential impact | + Nil impact |
| | **Fauna movements** | + Nil impact | – Potential impact | + Nil impact |

| | | | | |
|---|---|---|---|---|
| | **Adverse operational impacts** | + Nil impact | + Minimal impact | – Need to solve problems with ventilation & air-conditioning unit noise |
| | **Visual aesthetics** | + Nil impact | – Potential impact | + Minimal impact |
| **Social** | **Safety requirements** | + Surface drainage to be considered | – Site-specifics to be considered in design | + Nil impact |
| | **Maintenance / access requirements** | + Nil impact | – Site-specifics to be considered in design | + Nil impact |
| | **Preserving views** | + Nil impact | – Potential impact | + Nil impact |
| | **Public amenities** | + Nil impact | – Restricts access in area | – May restrict options to open and close windows & doors |
| | **Visual considerations** | + Nil impact | – Site-specifics to be considered in design (incl. community art) | + Nil impact |
| | **Community benefit** | + Provides benefit to local community and road users | + Provides benefit to local community | – Restricts benefit to individual dwellings |
| | **Privacy and security** | + Nil impact | – Site-specifics to be considered in design | + No direct impact |

Note: + Represents potential advantages or nil impact
– Represents potential disadvantages

# Case study 2: Mt Lindesay Highway

## Noise study area

The noise study area was located along the Mount Lindesay Highway between Kantenna Street and Talinga Drive in the Brisbane suburb of Park Ridge, Queensland. The two lane highway was proposed to be upgraded to a two lane divided road. Within the study area there are existing residences, commercial buildings, educational buildings and outdoor recreational areas. Noise ameliorative measures were not considered for those noise-sensitive receivers located on Main Roads owned land or commercial premises located within the study area. The traffic flow and road surface data were:

Mt Lindesay Highway:

| | |
|---|---|
| AADT | 35816 (North of Park Ridge Rd) & 24,972 (South of Park Ridge Rd) |
| % commercial vehicles | 6.0% |
| Based on growth rate | 2.5% p.a. |
| Assessment year | 2012 |

Posted traffic speed 80 km/h

Existing road surface type dense-grade asphalt (DGA)

The road authority was the Brisbane City Council and the road development type was defined as upgrading an existing road.

## Noise impact and code assessment

The relevant criterion for each property is determined based on the land use and the road development type. The noise level criteria were 68 dB(A) $L_{A10(18\ hours)}$, 55 dB(A) $L_{A10(1\ hour)}$ internal and 63 dB(A) $L_{A10(12\ hours}$ for existing residences, educational and health buildings, and parks and recreational areas respectively. The predicted noise levels after the road upgrade and land-use types for the receivers in the study area are presented in Table 2-1 (receivers exceeding their relevant criterion have been highlighted in bold type).

**Table 2-1: Predicted external levels of noise receivers, Mt Lindesay Highway for the assessment year 2012**

| Receiver no: | Land-use type | Predicted noise level dB(A) | Descriptor |
|---|---|---|---|
| R2 | Existing residences | 61 | $L_{A10(18\ hours)}$ |
| R3 | Existing residences | 60 | $L_{A10(18\ hours)}$ |
| R4 | Existing residences | 59 | $L_{A10(18\ hours)}$ |
| R9 | Existing residences | 62 | $L_{A10(18\ hours)}$ |
| R10 | Existing residences | 63 | $L_{A10(18\ hours)}$ |
| R11 | Existing residences | 64 | $L_{A10(18\ hours)}$ |
| R12 | Existing residences | 65 | $L_{A10(18\ hours)}$ |
| R13 | Existing residences | 64 | $L_{A10(18\ hours)}$ |
| R14 | Existing residences | 63 | $L_{A10(18\ hours)}$ |
| R15 | Existing residences | **69** | $L_{A10(18\ hours)}$ |
| R16 | Existing residences | 68 | $L_{A10(18\ hours)}$ |
| R17 | Existing residences | 67 | $L_{A10(18\ hours)}$ |
| R18 | Existing residences | 61 | $L_{A10(18\ hours)}$ |
| R19 | Existing residences | 67 | $L_{A10(18\ hours)}$ |
| R20 | Existing residences | 66 | $L_{A10(18\ hours)}$ |
| R21 | Existing residences | 61 | $L_{A10(18\ hours)}$ |
| R22 | Existing residences | 67 | $L_{A10(18\ hours)}$ |
| R26 | Existing residences | 59 | $L_{A10(18\ hours)}$ |
| R27 | Existing residences | 48 | $L_{A10(18\ hours)}$ |

| | | | |
|---|---|---|---|
| R38 | Educational and health buildings | **59** | $L_{A10(1\ hour)}$ - internal |
| R39 | Educational and health buildings | 54 | $L_{A10(1\ hour)}$ - internal |
| R40 | Educational and health buildings | 52 | $L_{A10(1\ hour)}$ - internal |
| R41 | Educational and health buildings | 54 | $L_{A10(1\ hour)}$ - internal |
| R42 | Educational and health buildings | 54 | $L_{A10(1\ hour)}$ - internal |
| R43 | Educational and health buildings | 49 | $L_{A10(1\ hour)}$ - internal |
| R44 | Educational and health buildings | 54 | $L_{A10(1\ hour)}$ - internal |
| R45 | Educational and health buildings | 50 | $L_{A10(1\ hour)}$ - internal |
| R46 | Educational and health buildings | **57** | $L_{A10(1\ hour)}$ - internal |
| R47 | Educational and health buildings | 55 | $L_{A10(1\ hour)}$ - internal |
| R48 | Educational and health buildings | **56** | $L_{A10(1\ hour)}$ - internal |
| R49 | Parks and recreational areas | **65** | $L_{A10(12\ hours)}$ |
| R50 | Parks and recreational areas | 59 | $L_{A10(12\ hours)}$ |
| R51 | Parks and recreational areas | 52 | $L_{A10(12\ hours)}$ |
| R56 | Existing residences | 67 | $L_{A10(18\ hours)}$ |
| R58 | Educational and health buildings | 53 | $L_{A10(1\ hour)}$ - internal |
| R59 | Educational and health buildings | 55 | $L_{A10(1\ hour)}$ - internal |
| R60 | Educational and health buildings | 56 | $L_{A10(1\ hour)}$ - internal |
| R61 | Parks and recreational areas | 62 | $L_{A10(18\ hours)}$ |
| R62 | Existing residences | 65 | $L_{A10(18\ hours)}$ |

Note: *Road surface type is dense-grade asphalt (DGA).
**Receivers exceeding their relevant criterion have been highlighted in bold type.

The noise modelling revealed that with the upgraded road, six receivers would exceed their relevant criterion in the year 2012. One existing residence and one outdoor recreational area were found to exceed the criteria by 1dB and 2 dB respectively. Four educational buildings were found to exceed the criterion by 4, 2, 1 and 1 dB respectively. Accordingly it was found that noise amelioration was required.

## Option identification

Seven options considered potentially capable of being used to ameliorate the noise levels within the study area were identified. The options are presented in the Table 2-2.

**Table 2-2: Selected potential options, Mt Lindesay Highway**

| Option ID no: | Within/Outside road reserve option | Individual/Combined option | Option description |
|---|---|---|---|
| 1 | Within | Individual | Noise barrier — noise wall |
| 2 | Within | Individual | Noise barrier — noise mound |
| 3 | Within | Individual | Pavement surface |
| 4 | Within | Combined | Noise barrier — noise wall & Pavement surface |
| 5 | Within | Combined | Noise barrier — noise mound & Pavement surface |
| 6 | Within & outside | Combined | Noise barrier — noise wall & Building treatment |
| 7 | Within & outside | Combined | Noise barrier — noise mound & Building treatment |

The non-combined option of building treatment was not considered viable because one of the receivers represented an outdoor recreational area in which there was no building present and which could not be treated with the building treatment options available.

### Amelioration analysis

The options considered to have the potential to satisfactorily ameliorate the noise levels in the study area were evaluated. Options 1 and 2 were evaluated using traffic noise modelling software, SoundPlan to determine the ameliorated noise levels and the barrier design details. There is no difference between the models for noise walls and mounds when using noise modelling software. The differences are assessed in terms of feasibility and constructability.

The ameliorated noise levels were imported into the DST and compared with the relevant criteria. Options 1 and 2 were found to be usable to reduce the noise levels to below the criteria. Three noise barriers were required to ameliorate the noise levels in the study area. The dimensions of the noise barriers are presented in Table 3. Noise barrier 1 is required to ameliorate the noise level at the existing residence R15. Noise barrier 2 is required to ameliorate the noise levels at the Park Ridge State Primary School buildings R38, R46, R48, and at the outdoor recreation area R49. Noise barrier 3 is required to ameliorate the noise level at the Park Ridge State High School building R60.
Option 3 was evaluated using the DST. Option 3 involved resurfacing the road pavement from dense-grade asphalt to stone mastic asphalt. When resurfacing involves these two pavement surface types the largest possible correction factor of -2dB is achieved. In this case it was found that the noise levels at all but one of the receivers exceeding the criteria (R38) could be reduced to that of their respective criterion. Accordingly Option 3, which involved only pavement resurfacing, was found to be not a technically viable option.

Options 4 & 5 involved a combination of a noise barrier and pavement resurfacing. By resurfacing the road pavement with stone mastic asphalt it was found that the receiver noise levels at the existing residence (R15) and at the Park Ridge State High School (R60) could be reduced to that of their relevant criteria. However it was found that by combining this treatment with a noise barrier to reduce the noise level at the Park Ridge State Primary School, all receiver noise levels could be reduced to that of their relevant criterion. The dimensions of the noise barrier segments in Options 4 & 5 are presented in Table 2-3.

Options 6 & 7 involved a combination of a noise barrier and building treatments. Building treatments were applied to the existing residence R15, the Park Ridge State Primary School buildings R38, R46, R48 and the Park Ridge State High School building R60. The internal noise levels of all buildings treated were reduced to the relevant criterion. A noise barrier was constructed to reduce the noise level of the outdoor recreational area at the primary school. The dimensions of the noise barrier segments in Options 6 & 7 are presented in Table 2-3.

**Table 2-3: Possible ameliorative option design parameters, Mt Lindesay Highway**

**Within-road reserve**

Option 1 & 2: Noise barrier — noise wall or noise mound

Surface type: Dense-grade asphalt (DGA)

| Barrier no. | Height (m) | Length (m) | Area ($m^2$) |
|---|---|---|---|
| 1 | 1.8 | 57 | 102.6 |
| 2a | 4.5 | 59 | 265.5 |
| 2b | 5 | 215 | 1075 |
| 2c | 5 - 2 | 35 | 140 |
| 2d | 2 | 69 | 138 |
| 3 | 3.0 | 210 | 630 |
| | | Total barrier length | Total barrier area |
| | | 645 m | 2351.1 $m^2$ |

Options 4 & 5. Noise barrier — noise wall or noise mound & Pavement surface

Surface type: Stone mastic asphalt (SMA)

| Barrier no. | Height (m) | Length (m) | Area ($m^2$) |
|---|---|---|---|
| 1 | 2.5 | 42 | 105 |
| 2 | 3.5 | 173 | 605.5 |
| 3 | 2.5 | 35 | 87.5 |
| | | Total barrier length | Total barrier area |
| | | 250 m | 798 $m^2$ |

**Combination of treatment of within- and outside-road reserve**

Options 6 & 7: Noise barrier — noise wall or noise mound and Building treatment

Surface type: Dense-grade asphalt (DGA)

| Property ID | Building type | Construction category |
|---|---|---|
| R15 | Residential | 3 |
| R38 | Educational | 2 |
| R46 | Educational | 2 |
| R48 | Educational | 2 |
| R60 | Educational | 2 |

| Barrier no. | Height (m) | Length (m) | Area ($m^2$) |
|---|---|---|---|
| 1 | 2.5 | 42 | 105 |

| | | | |
|---|---|---|---|
| 2 | 3.5 | 173 | 605.5 |
| 3 | 2.5 | 35 | 87.5 |
| | | Total barrier length | Total barrier area |
| | | 250 m | 798 $m^2$ |

## Feasibility of options

The Noise barrier — noise wall design parameters associated with Options 1, 2, 4, 5, 6 and 7 were within the allowable limits set out in the Road Traffic Noise Management Code of Practice. As no other restrictions were found through site investigations the Noise barrier — noise wall options were all considered feasible and constructible. It was also found that there was sufficient width within the road corridor for the Noise barrier — noise mound options to be considered feasible and constructible.

The construction types and the condition of the Park Ridge State Primary and High Schools and the existing residence were found to be sufficient to ensure that building treatments would be effective in reducing the noise levels to their relevant criterion. Accordingly the building treatment components in Options 6 and 7 were considered feasible and constructible. The viable pavement resurfacing options (4 and 5) were found to be feasible and constructible. The feasibility/constructability statuses of all viable options are presented in Table 2-4.

**Table 2-4: Amelioration option feasibility/constructability status, Mt Lindesay Highway**

| | Feasible/Constructable |
|---|---|
| **Within-road reserve** | |
| Option 1: Noise barrier — noise wall<br>Surface type: Dense-grade asphalt (DGA) | Yes |
| Option 2. Noise barrier — noise mound<br>Surface type: Open-grade asphalt (DGA) | Yes |
| **Combination of treatments of within- and outside-road reserve** | |
| Option 4. Noise barrier — noise wall & Pavement surface<br>Surface type: Stone mastic asphalt (SMA) | Yes |
| Option 5. Noise barrier — noise mound & Pavement surface<br>Surface type: Stone mastic asphalt (SMA) | Yes |
| Option 6. Noise barrier — noise wall & Building treatment<br>Surface type: Dense-grade asphalt (DGA) | Yes |
| Option 7. Noise barrier — noise mound & Treatment<br>Surface type: Dense-grade asphalt (DGA) | Yes |

## Concept costing

The Mt Lindesay Highway project has not yet been completed and so not all concept costing details were available for use in this report. The DST was used to generate construction, resurfacing and building treatment costs for the viable amelioration options and are presented in Table 2-5.

**Table 2-5: Concept costing of viable amelioration options, Mt Lindesay Highway**

| **Option ID no:** | 1 | 2 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| **Option description** | Noise barrier — noise wall (plywood) | Noise barrier — noise mound | Noise barrier — noise wall (plywood) & Pavement surface (SMA) | Noise barrier — noise mound & Pavement surface (SMA) | Noise barrier — noise wall (plywood) & Building treatment | Noise barrier — noise mound & Building treatment |
| A. Project Management ($) | | | | | | |
| B. Survey and Design ($) | | | | | | |
| C. Land Acquisition ($) | | | | | | |
| D. Service Relocation ($) | | | | | | |
| E. Construction of Noise Barriers ($) | | | | | | |
| F. Road Resurfacing ($) | | | | | | |
| G. Architectural Measures ($) | $437,697 | - | $146,250 | - | $46,800 | - |
| H. Landscaping ($) | - | $852,045 | - | $253,750 | - | $81,200 |
| I. Site-specific Civil Works ($) | - | - | $1,150,000 | $1,150,000 | - | - |
| J. Miscellaneous ($) | - | - | - | - | $85,000 | $85,000 |
| **K. Subtotal ($)** | | | | | | |
| L. Contingency (%) | | | | | | |
| **M. Total ($)** | | | | | | |

## Benefit analysis

The results of the benefit analysis for each viable option, and obtained using the DST, are presented in Table 2-7.

An analysis of the environmental and social benefit factors has been undertaken using the benefit matrix included as a part of the benefit analysis section of the DST. Deciding on whether the factors will have a positive or negative effect is, however, dependant on the experience and site knowledge of the decision-maker. The effect of noise barriers/mounds and building treatment on the environmental and social factors are presented in Table 2-8.

**Table 2-7: Benefit analysis of viable amelioration options, Mt Lindesay Highway**

| Option ID no: | Option description | Number of receivers with noise levels reduced from assessment to target levels | | | | | Cost/receiver ($/rec.) | Maximum noise level reduction (dB) | |
|---|---|---|---|---|---|---|---|---|---|
| | | Existing residences | | Parks and recreation | Education and health buildings | | | | |
| | | Ext. | Int. | | Ext. | Int. | | Ext. | Int. |
| 1 | Noise barrier — noise wall | 1 | 0 | 1 | 4 | 0 | 80,244 | 4 dB $L_{A10(1 hour)}$ | 0 |
| 2 | Noise barrier — noise mound | 1 | 0 | 1 | 4 | 0 | 142,008 | 4 dB $L_{A10(1 hour)}$ | 0 |
| 4 | Noise barrier — noise wall & Pavement surface | 1 | 0 | 1 | 4 | 0 | 216,041 | 6 dB $L_{A10(1 hour)}$ | 0 |
| 5 | Noise barrier — noise mound & Pavement surface | 1 | 0 | 1 | 4 | 0 | 233,959 | 6 dB $L_{A10(1 hour)}$ | 0 |
| 6 | Noise barrier — noise wall & Building treatment | 0 | 1 | 1 | 0 | 4 | 21,967 | 2 dB $L_{A10(12 hours)}$ | 16 dB $L_{A10(1 hour)}$ |
| 7 | Noise barrier — noise mound & Building treatment | 0 | 1 | 1 | 0 | 4 | 27,700 | 2 dB $L_{A10(12 hours)}$ | 16 dB $L_{A10(1 hour)}$ |

**Table 2-8: Benefit analysis of environmental and social factors, Mt Lindesay Highway**

| Cost–benefit factors | | Ameliorative treatment options | | |
|---|---|---|---|---|
| | | Within the road reserve | | Outside the road reserve |
| ***Category*** | ***Factors*** | ***Pavement resurfacing*** | ***Noise barrier wall*** | ***Acoustic treatment of buildings*** |
| **Economic** | **Initial project costs** | + Moderate | – High | + Low to moderate |
| | **Maintenance/operational costs** | – Moderate | – Moderate | – Moderate (responsibility of property owner) |
| **Environmental** | **Air circulation** | + Nil impact | – Potential impact | – May require mechanical ventilation, or air exchange |
| | **Shade effects** | + Nil impact | – Potential impact | + Nil impact |
| | **Fauna movements** | + Nil impact | – Potential impact | + Nil impact |

| | | | | |
|---|---|---|---|---|
| | **Adverse operational impacts** | + Nil impact | + Minimal impact | – Need to solve problems with ventilation & air-conditioning unit noise |
| | **Visual aesthetics** | + Nil impact | – Potential impact | + Minimal impact |
| **Social** | **Safety requirements** | + Surface drainage to be considered | – Site-specifics to be considered in design | + Nil impact |
| | **Maintenance/access requirements** | + Nil impact | – Site-specifics to be considered in design | + Nil impact |
| | **Preserving views** | + Nil impact | – Potential impact | + Nil impact |
| | **Public amenities** | + Nil impact | – Restricts access in area | – May restrict options to open and close windows & doors |
| | **Visual considerations** | + Nil impact | – Site-specifics to be considered in design (incl. community art) | + Nil impact |
| | **Community benefit** | + Provides benefit to local community and road users | + Provides benefit to local community | – Restricts benefit to individual dwellings |
| | **Privacy and security** | + Nil impact | – Site-specifics to be considered in design | + No direct impact |

Note: + Represents potential advantages or nil impact
– Represents potential disadvantages

# Case study 3: Pacific Motorway between Peachey Road and Pimpama River, Ormeau, Queensland

## Noise study area

The noise study area is located along the Pacific Motorway between Peachey Road and Pimpama River, Ormeau, Queensland. The road consists four double lanes with residential land uses on the both sides of the road. The road authority, QDMR, has conducted a road project to upgrade the existing road in the study area. The traffic flow and road surface data at the assessment year 2011 are:

| | |
|---|---|
| Pacific Motorway: | |
| AADT | 51,633 |
| % commercial vehicles | 9.0% |
| Posted traffic speed | 110 km/h |
| Existing road surface type | Concrete |

## Noise impact and code assessment

According to the relevant noise criteria, the study area is defined as upgrading existing road. The noise receivers in the study area are defined as existing residences and an outdoor recreational area for a tennis court . An external level, 68 dB(A) $L_{A10(18\ hours)}$, is recommended as the noise criterion for adjacent residential properties of the study area, and an external level, 63 dB(A) $L_{A10(12\ hours)}$ for the recreational areas.

Table 3-1 lists the predicted noise levels calculated by SoundPlan.

**Table 3-1: Predicted external levels of noise receivers, Pacific Motorway**

| Receiver no: | Land-use type | Predicted noise level dB(A) | Descriptor |
|---|---|---|---|
| R1523 | Existing residences | 67 | $L_{A10(18\ hours)}$ |
| R1524 | Existing residences | 63 | $L_{A10(18\ hours)}$ |
| R1525 | Existing residences | 62 | $L_{A10(18\ hours)}$ |
| R1526 | Existing residences | 63 | $L_{A10(18\ hours)}$ |
| R1527 | Existing residences | 62 | $L_{A10(18\ hours)}$ |
| R1528 | Existing residences | 68 | $L_{A10(18\ hours)}$ |
| R1529 | Existing residences | 67 | $L_{A10(18\ hours)}$ |
| R1530 | Existing residences | 67 | $L_{A10(18\ hours)}$ |
| R1531 | Existing residences | 66 | $L_{A10(18\ hours)}$ |

| | | | |
|---|---|---|---|
| R1532 | Existing residences | 67 | $L_{A10(18\ hours)}$ |
| R1533 | Existing residences | **69** | $L_{A10(18\ hours)}$ |
| R1534 | Existing residences | 68 | $L_{A10(18\ hours)}$ |
| Tennis Court | Parks and recreational areas | **67** | $L_{A10(12\ hours)}$ |
| R1535 | Existing residences | **70** | $L_{A10(18\ hours)}$ |
| R1536 | Existing residences | **69** | $L_{A10(18\ hours)}$ |
| R1537 | Existing residences | **69** | $L_{A10(18\ hours)}$ |
| R1538 | Existing residences | 67 | $L_{A10(18\ hours)}$ |
| R1539 | Existing residences | 67 | $L_{A10(18\ hours)}$ |
| R1540 | Existing residences | 66 | $L_{A10(18\ hours)}$ |
| R1541 | Existing residences | 68 | $L_{A10(18\ hours)}$ |
| R1542 | Existing residences | 68 | $L_{A10(18\ hours)}$ |
| R1543 | Existing residences | **69** | $L_{A10(18\ hours)}$ |
| R1544 | Existing residences | 68 | $L_{A10(18\ hours)}$ |

Note: *Road surface type is concrete.
**Receivers exceeding their relevant criterion have been highlighted in bold type.

Table 1 shows that five out of 22 residential noise receivers are predicted to exceed the noise criteria, 68 dB(A) $L_{A10(18\ hours)}$, and the tennis court is predicted to exceed the noise criteria, 63 dB(A) $L_{A10(12\ hours)}$. The highest noise level $L_{A10(18\ hours)}$, 70 dB(A), exceeds the criteria by 2 dB, and the noise level of the tennis court, 67 dB(A) $L_{A10(18\ hours)}$, exceeds the noise criteria by 4 dB. All the six receivers that exceed the criteria are sited on the west side of the Pacific Motorway. The result obtained using the DST was that “Noise Ameliorative is Required” for the noise study area.

## Option identification

For reductions of the residential receivers, 2 dB(A) in external noise level and 12 dB(A) in internal noise level, three potential ameliorative options for the study area were selected for further study and are shown in Table 3-2.

**Table 3-2: Selected potential ameliorative options for the residential noise receivers, west side of Pacific Motorway**

| Option ID no: | Within/Outside road reserve option | Individual/Combined option | Option description |
|---|---|---|---|
| 1 | Within | Individual | Noise barrier — noise wall/noise mound |
| 2 | Within | Individual | Pavement surface |
| 3 | Outside | Individual | Building treatment |

The noise amelioration options relating to building treatment are not applicable for the outdoor recreational area (the tennis court). In order to achieve a reduction in the noise level for the outdoor recreational area (tennis court) of 4 dB(A), the first two options in Table 3-2 are viable ameliorative options, but the building treatment is kept for the comparison with the options Within-road reserve.

### Amelioration analysis

For the potential ameliorative option, Noise barrier — noise wall/noise mound, the modelling results carried out using SoundPlan are listed in Table 3-3.

For the potential ameliorative options, Pavement surface and Building treatment, the built-in evaluation process produced the amelioration results listed in Table 3-3.

**Table 3-3: Possible ameliorative options, west side of Pacific Motorway**

**Within-road reserve**

Option 1: Noise barrier — noise wall/noise mound

Surface type: Concrete

| Barrier no. | Height (m) | Length (m) | Area ($m^2$) |
|---|---|---|---|
| Barrier 1 | 3 | 150 | 450 |
| Barrier 2 | 5 | 44 | 220 |
| | 6 | 49 | 294 |
| | 7 | 27 | 189 |
| | 6 | 82 | 492 |
| | 5.5 | 395 | 2172.5 |
| | 5 | 55 | 275 |
| | | Total barrier length | Total barrier area |
| | | 802 m | 4092.5 $m^2$ |

Option 2. Pavement surface

Surface type: Open-grade asphalt (OGA)

**Outside-road reserve**

Option 3: Building treatment 1

Surface type: Concrete

| Property ID | Building type | Construction category |
|---|---|---|
| R1533 | Residential | 3 |
| R1534 | Residential | 3 |
| R1535 | Residential | 3 |
| R1536 | Residential | 3 |
| R1537 | Residential | 3 |
| R1543 | Residential | 3 |

## Feasibility of options

According to the relevant noise criteria, noise barriers over 5 m high are defined as not feasible. Hence, the feasibility status of possible ameliorative options is shown in Table 3-4.

**table 3-4: feasibility status of the possible ameliorative options, west side of Pacific Motorway**

| Within-road reserve | Feasible/Constructable |
|---|---|
| Option 1: Noise barrier — noise wall/noise mound<br>Surface type: Concrete | No |
| Option 2. Pavement surface<br>Surface type: Open-grade asphalt (OGA) | Yes |
| **Outside-road reserve** | |
| Option 3: Building treatment<br>Surface type: Concrete | Yes |

## Concept costing

The three possible ameliorative options developed in the previous sections have been evaluated in terms of concept costs in this section. A cost comparison study of the five options has been carried out and presented in Table 3-5.

**Table 3-5: Concept costing of the five feasible ameliorative options, west side of Pacific Motorway**

| Option ID no:<br>Option description | 1<br>Noise barrier (plywood) | 2<br>Pavement surface (OGA) | 3<br>Building treatment |
|---|---|---|---|
| A. Project Management ($) | 79,200 | 79,200 | 79,200 |
| B. Survey and Design ($) | 48,000 | 48,000 | 48,000 |
| C. Land Acquisition ($) | 0 | 0 | 0 |
| D. Service Relocation ($) | 10000 | 0 | 0 |
| E. Construction of Noise Barriers ($) | 798,038 | 0 | 0 |
| F. Road Resurfacing ($) | 0 | 1,400,000 | 0 |
| G. Architectural Measure ($) | 0 | 0 | 125,000 |
| H. Landscaping ($) | 1,590 | 1,590 | 1,590 |
| I. Site-specific Civil Works ($) | 216,310 | 0 | 0 |
| J. Miscellaneous ($) | 0 | 0 | 0 |
| **K. Subtotal ($)** | 1,153,138 | 1,528,790 | 253,790 |
| L. Contingency (%) | 10 | 10 | 10 |
| **M. Total ($)** | 1,268,452 | 1,681,669 | 279,169 |

It is assumed that for all three options, the costs of the items, Project Management, and Survey and Design, are the same. The costs of items, Landscaping, and Site-specific Civil Works, are the same for the amelioration options with Noise barrier and/or Road resurfacing.

### Benefit analysis

Table 3-6 shows the dollar benefits arising from implementing the possible ameliorative options for the noise study area.

**Table 3-6: Benefit analysis of viable amelioration options, Mt Lindesay Highway**

| Option ID no: | Option description | Number of receivers with noise levels reduced from assessment to target levels | | | | | Cost/receiver ($/rec.) | Maximum noise level reduction (dB) | |
|---|---|---|---|---|---|---|---|---|---|
| | | Existing residences | | Parks and recreation | Education and health buildings | | | Ext. | Int. |
| | | Ext. | Int. | | Ext. | Int. | | | |
| 1 | Noise barrier (plywood) | 5 | 0 | 1 | 0 | 0 | 211,409 | 7 dB $L_{A10(18\ hours)}$ | 0 |
| 2 | Pavement surface (OGA) | 5 | 0 | 1 | 0 | 0 | 280,278 | 6 dB $L_{A10(18\ hours)}$ | 0 |
| 3 | Building treatment | 0 | 5 | 0 | 0 | 0 | 46,273 | 0 | 17 dB $L_{eq(1\ hour)}$ |

Table 3-7 shows the non-dollar benefits arising from implementing the relevant ameliorative options within the study area.

**Table 3-7: Non-dollar benefits arising from noise reduction resulting from implementing ameliorative options within the study area on the Pacific Motorway**

| Cost–benefit factors | | Ameliorative treatment options | | |
|---|---|---|---|---|
| | | Within the road reserve | | Outside the road reserve |
| *Category* | *Factors* | *Pavement resurfacing* | *Noise barrier wall* | *Acoustic treatment of buildings* |
| **Economic** | **Initial project costs** | + Moderate | – High | + Low to moderate |
| | **Maintenance/operational costs** | – Moderate | – Moderate | – Moderate (responsibility of property owner) |
| **Environmental** | **Air circulation** | + Nil impact | – Potential impact | – May require mechanical ventilation /air exchange |
| | **Shade effects** | + Nil impact | – Potential impact | + Nil impact |
| | **Fauna movements** | + Nil impact | – Potential impact | + Nil impact |
| | **Adverse operational impacts** | + Nil impact | + Minimal impact | – Need to solve problems with ventilation & air-conditioning unit noise |
| | **Visual aesthetics** | + Nil impact | – Potential impact | + Minimal impact |

| | | | | |
|---|---|---|---|---|
| **Social** | **Safety requirements** | + Surface drainage to be considered | – Site-specifics to be considered in design | + Nil impact |
| | **Maintenance/access requirements** | + Nil impact | – Site-specifics to be considered in design | + Nil impact |
| | **Preserving views** | + Nil impact | – Potential impact | + Nil impact |
| | **Public amenities** | + Nil impact | – Restricts access in area | – May restrict options to open and close windows & doors |
| | **Visual considerations** | + Nil impact | – Site-specifics to be considered in design (incl. community art) | + Nil impact |
| | **Community benefit** | + Provides benefit to local community and road users | + Provides benefit to local community | – Restricts benefit to individual dwellings |
| | **Privacy and security** | + Nil impact | – Site-specifics to be considered in design | + No direct impact |

+ Represents potential advantages or nil impact
– Represents potential disadvantages

# Conclusion

Three case studies have been conducted using the DST, and the findings for each have been presented in this report. Using the DST it was possible to compare assessment noise levels against relevant criteria and determine whether noise amelioration would be required; evaluate the capability and feasibility (constructability) of alternative noise amelioration strategies; and analyse the respective costs and benefits.

The findings presented in the report are used to demonstrate that the DST can be used to analyse not only traditional noise amelioration strategies such as noise barriers and resurfacing, but also strategies outside of the road reserve such as architectural treatments. In addition, the findings were used to demonstrate that combinations of treatments could also be analysed.

By combining all these features into a single tool we have been able to unite all aspects of the road traffic noise amelioration process. With such a tool the decision-maker can quickly and efficiently compare alternative strategies and identify the most promising ones, worthy of being reviewed by other stakeholders and the wider community.

| **Further information** | **Partners in progress** |
| --- | --- |
| **Dr Saman de Silva**<br>School of Civil and Chemical Engineering<br>RMIT University<br>GPO Box 2476V<br>Melbourne VIC 3001<br>Australia<br>**Phone:** +61 3 9925 3235<br>**Email:** s.desilva@construction-innovation.info<br><br>**CRC for *Construction Innovation***<br>9th Floor, L Block, QUT Gardens Point,<br>2 George Street, Brisbane, Qld, 4000<br>**Phone:** +61 7 3864 1393<br>**Fax:** +61 7 3864 9151<br>**Email:** enquiries@construction-innovation.info<br>**Web:** www.construction-innovation.info | Decision Support Tools Handbook is a collaborative product developed by the CRC for *Construction Innovation* with project input from the following partners: RMIT University and Queensland Department of Main Roads |